# SUSQUEHANNA STEAM ELECTRIC STATION

# ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

## REPORT PERIOD: 12/30/98 – 1/13/00


Prepared by:

W. A. Hill
Health Physicist

Reviewed by:

B. H. Carson
Health Physicist

Approved by:

R. L. Doty
Supervisor – Operations Technology

PP&L, Inc.
Two North Ninth Street
Allentown, Pennsylvania 18101

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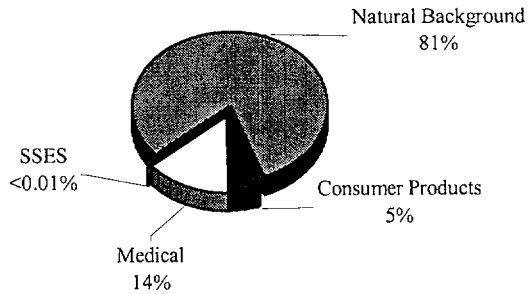
# SUMMARY AND CONCLUSIONS

## Radiological Dose Impact

The extent of the 1999 Radiological Environmental Monitoring Program (REMP) sampling met or exceeded the requirements of the Susquehanna Steam Electric Station (SSES) Technical Requirements. The types of analyses that were performed on these samples for the identification and quantification of radioactivity also met or exceeded the SSES Technical Requirements during the 1999 REMP. The result of this effort was the verification of the SSES Effluent Monitoring Program data that indicate that the SSES operation has no deleterious effect on the health and safety of the public or the environment.

The amounts of the radionuclides detected in environmental samples during 1999 were very small, as in past years. Based on the radionuclide levels measured by the REMP, the maximum whole body dose or maximum organ dose to a member of the public from SSES operation is estimated to be less than one-tenth of one percent of the per unit dose limits established by the Nuclear Regulatory Commission (NRC) as stated in 10 CFR 50, Appendix I. The maximum hypothetical off-site whole body and organ doses from radionuclides detected by the REMP and attributable to the SSES operations were calculated to be approximately 0.0022 mrem/year and 0.0025 mrem/year, respectively.

***COMPARISON OF PERCENT OF AVERAGE ANNUAL PUBLIC EFFECTIVE DOSE-EQUIVALENT FROM OTHER SOURCES WITH THAT FROM THE SSES***




Sources for the values provided, with the exception of Susquehanna, are the following from NCRP Report #93 (1987): Tables 2.4 (Natural Background), 5.1 (Consumer Products), and 7.4 (Medical).

By contrast, potassium-40, a very long-lived, naturally occurring radionuclide found in the human body, is estimated to deliver an average annual dose to the blood forming organs of individuals in the United States of about 27 millirem. While a small portion of the background dose from natural radiation sources, the potassium-40 dose is still more than 11,000 times the estimated maximum whole body and organ doses to a hypothetical member of the public from ingestion of radionuclides attributable to the SSES.

The maximum direct radiation dose from SSES operation to a member of the public was determined to be 0.012 millirem/year. The total whole body dose from both ingested radionuclides and direct radiation is negligible compared to the public's exposure from natural background radiation, medical irradiation, and radiation from consumer products of more than 300 millirem/year effective dose-equivalent.

## Identified Radionuclides and Their Dose Contributions

### *Naturally Occurring Radionuclides*

In 1999, the SSES REMP reported the naturally occurring radionuclides beryllium-7, potassium-40, radium-226, and thorium-228 in the environment at levels exceeding the minimum detectable concentrations (MDCs) for their respective gamma spectroscopic analyses. Beryllium-7 was identified in air. Potassium-40 was observed in fish, sediment, air, milk, soil, and fruit and vegetables. Thorium-228 was found in sediment and soil. Radium-226 also was seen in sediment and soil. None of these results were unexpected, and they are not related to the operation of the SSES. Doses from the presence of these radionuclides were not included in the estimate of the dose from SSES attributable radionuclides.

### *Man-made Radionuclides*

Although not all due to SSES operation, the following man-made radionuclides were reported at levels in the environment in excess of the MDCs for their respective analyses: tritium, manganese-54, iodine-131, and cesium-137. These radionuclides, with the exception of cesium-137, were identified in surface water. Tritium was measured above minimum detectable concentrations in some surface water and drinking water analyzed. Manganese-54 was reported in sediment. Iodine-131 was identified in surface water and drinking water. Cesium-137 was observed in sediment and soil.

Tritium and manganese-54 were the only man-made radionuclides attributed to the SSES operation. Tritium in media other than Susquehanna River water downstream of the SSES was attributed to both natural production by the interaction of cosmic radiation with the upper atmosphere and previous atmospheric testing of nuclear weapons. The manganese-54 found in sediment was the result of liquid discharges to the river from the SSES. The presence of cesium-137 was attributed to non-SSES sources. Cesium-137 was considered to be present only as residual fallout from

atmospheric weapons testing. Iodine-131 was believed to be found in the aquatic pathway only as the result of the discharge of medical waste to the Susquehanna or Lackawanna Rivers through sewage treatment plants upstream of the SSES.

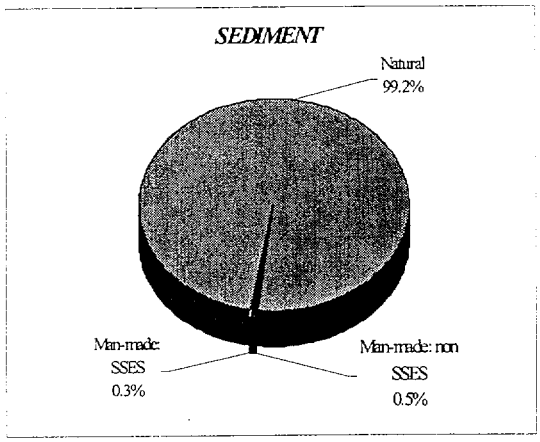
All of the man-made radionuclides mentioned above were not analyzed for in all media. For example, no analyses were performed in an effort to determine iodine-131 levels in ground water. When selecting the types of analyses that would be performed, consideration was given to the potential importance of different radionuclides in the pathways to man and the regulatory analysis requirements for various environmental media.

## *Relative Radionuclide Activity Levels in Selected Media*

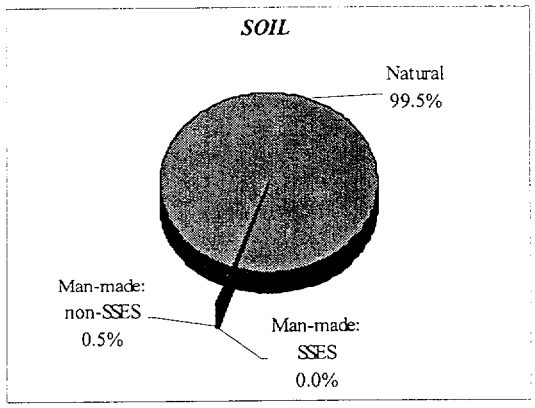
Some media monitored in the environment are significant for the numbers of gamma-emitting radionuclides routinely measured at levels exceeding analysis MDCs. Sediment in the aquatic pathway and soil in the terrestrial pathway are two such media.

The following pie graphs show the relative activity contributions for the types of gamma-emitting radionuclides reported at levels above the analysis MDCs in sediment and soil at indicator locations during 1999.

**AQUATIC PATHWAY PERCENT TOTAL GAMMA ACTIVITY**




**TERRESTRIAL PATHWAY PERCENT TOTAL GAMMA ACTIVITY**




Naturally occurring radionuclides account for 99.2% and 99.5 % of the gamma-emitting activity in sediment and in soil, respectively, in 1999. Man-made radionuclides of non-SSES origin account for most of the rest of the gamma-emitting activity in sediment and all of the rest in soil during 1999. Generally, the activity for naturally occurring radionuclides reported in

sediment and soil dwarfs the activity of the man-made radionuclides also reported, especially those originating from the SSES.

## *Radionuclides Contributing to Dose from SSES Operation*

Of the four man-made radionuclides reported in the environment by the SSES REMP, tritium and manganese-54 are the only radionuclides attributable to the SSES operation.

Because tritium and manganese-54 were the only radionuclides attributable to the SSES operation, the dose to members of the public from REMP-identified radionuclides was based on the amount of tritium estimated to have been released from the SSES and the manganese-54 measured in sediment. Tritium was included in the dose calculation because it was identified in the REMP samples of water being discharged to the river. The concentration of tritium in the water and the volume of water discharged were used to determine the amount of tritium released. The presumed exposure pathways to the public from this radionuclide were drinking water taken from the Susquehanna River at Danville, PA, and eating fish caught near the SSES discharge to the river. Exposure from tritium was only assumed to occur through the eating of fish and the consumption of drinking water. This assumption is based on the fact that tritium does not emit gamma radiation and the beta radiation emitted by tritium is not sufficiently penetrating to reach an individual on the shore.

Exposure of the public from manganese-54 in sediment was presumed to be by way of shoreline exposure due to gamma radiation.

# INTRODUCTION

## Radioactive Materials Releases

### *Radioactive Materials Generation*

The SSES produces the thermal power to generate electricity using two boiling water reactors (BWRs). Radioactive materials are produced at the SSES by the fissioning of uranium and the activation of materials inside the cores of these nuclear reactors. When very small quantities of fission products escape through the cladding of the core's fuel rods, they enter the water with the activation products circulating through the reactor.

Since the mid-1980s, improvements in the following have all contributed to minimization of the escape of radioactive materials from the fuel to the reactor core's circulating water: the manufacture of nuclear fuel, PP&L Inc.'s fuel conditioning (to minimize heat stresses on the fuel), reductions in the numbers of reactor scrams (rapid control rod insertions) that put stresses on the fuel, and maintenance of good water chemistry in the reactors. This has been responsible for significant reductions in the already relatively small amounts of some radioactive materials released in both gaseous and liquid effluents from the SSES.

### *Gaseous Effluents*

In boiling water reactors (BWRs), such as the SSES Units 1 and 2, some fraction of the radioactive materials that enter the circulating water are vaporized and others are entrained in the steam, carrying over to the turbines and eventually the condensers. In turn, some fraction of the radioactive materials in the condensers are removed from them with the offgas. Offgas is eventually released to the atmosphere through turbine building vents. Other pathways also exist for the release of gases through each of five continuously monitored rooftop vents at the SSES.

The radioactive material released as gaseous effluent from the SSES may be divided into the following three categories: noble gases (xenons and kryptons), iodines and particulates, and tritium (a radioactive isotope of hydrogen). These categories are used for the purposes of tracking the amounts of radioactive material being released from the SSES and monitoring the SSES release performance. Reduction of the amounts of radioactivity otherwise destined to be released with the gaseous effluent depends on the category into which the radioactive material fits.

Short-lived noble gas activity is reduced by radioactive waste processing systems which delay the release of gases to the environment to permit them to decay prior to release. Iodine and particulate radioactivity in the gaseous effluent are reduced by adsorption in charcoal beds and capture in particulate filters, respectively. There is a total of 74 tons of charcoal distributed in five beds that the gaseous effluent must pass through

prior to release. A delay time of over 30 days for some of the gases is expected as a result of the charcoal beds, providing a significant amount of decay time prior to release. This provides for a significant reduction in the radioactivity levels of the gases before release. The charcoal is typically very efficient at capturing the iodine. Similarly, the particulate filters are expected to have capture efficiencies of more than 99.7% for particles 0.3 microns or larger in size.

Unfortunately, no practical means yet exists to eliminate tritium from the gaseous effluent. Some elimination of tritium in the form of tritiated water vapor by chilling of the offgas and subsequent collection of the condensate prior to passage through the charcoal adsorbers does occur. But, the primary purpose of this chilling is to reduce the moisture entering the charcoal beds so that they will maintain their efficiency for the removal of iodine.

## *Liquid Effluents*

Maintaining the quality of water circulating through the reactor core at acceptable levels and capturing water that leaks from reactor systems, results in the generation of waste water at the SSES. This waste water also contains radioactivity that has escaped from fuel rod cladding. In order to minimize the release of this water to the environment, as much of it as is practical is cleaned up and recycled. Because this water sometimes contains chemicals that may be harmful to the reactor if recycled, some water must be released in batches to the Susquehanna River.

For the purpose of tracking radioactive releases and monitoring SSES release performance, liquid effluent radioactive materials are divided into two groups, tritium being one group, and all other radioactive materials constituting the other. Prior to releasing water to the river, a significant effort is made to reduce the level of radioactivity in waste water to levels which are as low as practicable by filtering the water through media, such as diatomaceous earth, and passing it through ion exchange material, similar in function to household water softeners. These methods are effective to varying degrees with all of the radioactive materials except tritium, which can't be removed from water by either method. For most radionuclides, the ion exchange media may be expected to have a removal efficiency of roughly 99%.

## *Controlling Radioactive Releases*

NRC regulations (10 CFR 50.34 and 10 CFR 20.1101b) require that nuclear power plants be designed, constructed, and operated to keep levels of radioactive materials in effluents to areas unrestricted to the public as low as reasonably achievable (ALARA). To ensure that these criteria are met, each license authorizing reactor operation includes technical specifications (10 CFR 50.36a) that contain requirements governing radioactive effluents. Instantaneous, as well as quarterly and annual limits, have been set based on the dose that the maximally exposed individual in the public could be expected to receive. During routine operation of the SSES, doses are kept as much below these actual limits as possible.

The NRC release limits are far below the approximately 300 millirem dose received on average each year by residents of the United States from all natural background sources. On the other hand, the allowable limits are far above the doses estimated for the levels of radioactivity actually being released from the SSES. The actual doses are typically small fractions of one millirem or less per year of SSES operation. Such doses are far below the levels at which any health effects would be expected to be observed in the exposed population.

### *Monitoring Releases*

Roof top vents from which gaseous releases take place are continuously monitored to detect any excessive rates of radioactivity release that might occur well before any release limits are reached. Also, discharge rates of radioactively contaminated water to the Susquehanna River are carefully controlled to remain as far below the discharge limits as possible. Discharges are monitored by radiation detectors so that if levels of radioactivity in the water would inadvertently approach the limits of permissible levels, the discharges could be stopped quickly.

## Radiological Environmental Monitoring

In addition to the steps taken to control and to monitor radioactive effluents from the SSES, the SSES Technical Specifications also require a program for the radiological monitoring of the environment in the vicinity of the SSES. The objectives of the SSES REMP are as follows:

- Fulfillment of SSES Technical Requirements' radiological environmental surveillance obligations,
- Verification of no detrimental effects on public health and safety and the environment from SSES operations,
- Assessment of dose impacts to the public, if any,
- Verification of adequate SSES radiological effluent controls, and
- Identification, measurement, trending, and evaluation of radionuclides and their concentrations in critical environmental pathways near the SSES.

PP&L has maintained a Radiological Environmental Monitoring Program (REMP) in the vicinity of the existing Susquehanna Steam Electric Station Units 1 and 2 since April, 1972, prior to construction of both units and ten years prior to the initial operation of Unit 1 in September, 1982. The SSES is located on an approximately 1500 acre tract along the Susquehanna River, five miles northeast of Berwick in Salem Township, Luzerne County, Pennsylvania. The area around the site is primarily rural, consisting predominately of forest and agricultural lands. (More specific information on the demography, hydrology, meteorology, and land use characteristics of the area in the vicinity

of the SSES can be found in the Environmental Report (14), the Final Safety Analysis Report (15), and the Final Environmental Statement (16) for the SSES.) The purpose of the preoperational REMP (April, 1972 to September, 1982) was to establish a baseline for radioactivity in the local environment that could be compared with the radioactivity levels observed in various environmental media throughout the operational lifetime of the SSES. This comparison facilitates assessments to be made of the radiological impact of the SSES operation.

The SSES REMP was designed on the basis of the NRC's Radiological Assessment Branch Technical Position on radiological environmental monitoring, as described in Revision 1, November 1979.(17) However, the REMP conducted by PP&L for the SSES exceeds the monitoring suggested by the NRC's branch technical position, as well as the SSES Technical Requirements in terms of the number of monitoring locations, the frequency of certain monitoring, the types of analyses required for the samples, and the achievable analysis sensitivities.

## *Potential Exposure Pathways*

The three pathways through which radioactive material may reach the public from nuclear power plants are the atmospheric, terrestrial, and aquatic pathways. (Figure 1 depicts these pathways for the intake of radioactive materials.) Comprehensive radiological environmental monitoring must sample media from all of these pathways.

Mechanisms by which people may be exposed to radioactivity and radiation in the environment vary with the pathway. Three mechanisms by which a member of the public has the potential to be exposed to radioactivity or radiation from nuclear power plants such as the SSES are as follows:

- inhalation (breathing)
- ingestion (eating and drinking), and
- whole body irradiation directly from a plant or from immersion in the radioactive effluents.

## *REMP Scope*

During the operational period of the SSES, it has been important to establish two different categories of monitoring locations, called control and indicator locations, to further assist in assessing the impact of the station operation. So-called control monitoring locations have been situated at sites where it is considered unlikely that radiation or radioactive material from normal station operation would be detected. Indicator monitoring locations are sited where it is expected that radiation and radioactive material that might originate from the station would be most readily detectable.

Control locations for the atmospheric and terrestrial pathways are more than 10 miles from the station. Preferably, the controls also are in directions from the station less likely to be exposed to wind blowing from the station than are the indicator locations. Control monitoring locations for the aquatic pathway, the Susquehanna River, are

upstream of the station's discharge to the river.

Indicator monitoring locations are selected primarily on the basis of proximity to the station, although factors such as meteorology, topography, and sampling practicality also are considered. Indicator locations for the atmospheric and terrestrial pathways are typically less than 10 miles from the station. Most often, they are within 5 miles of the station.

monitors ambient radiation levels using thermoluminescent dosimeters (TLDs) at 86 indicator and control locations, making as many as 344 radiation level measurements each year. The media monitored and analyses performed are summarized in the table above. Figures 2 through 7 display the REMP TLDs and sampling locations in the vicinity of the SSES. Appendix C provides directions, distances, and a brief description of each of the locations in Figures 2 through 7.

| SSES REMP | |
|---|---|
| **Type of Monitoring** | **Media Monitored** |
| Gross Alpha Activity | Drinking Water |
| Gross Beta Activity | All Waters, except Ground Water, and Air Particulates |
| Gamma-Emitting Radionuclide Activities | All Media |
| Tritium Activity | All Waters |
| Iodine-131 Activity | Surface Water, Drinking Water, Air & Milk |
| Exposure Rates (by TLD) | Ambient Radiation Levels |

Indicator locations in the Susquehanna River are downstream of the station's discharge. Monitoring results from indicator locations are compared with results from control locations. These comparisons are made to discern any differences in the levels and/or types of radioactive material and/or radiation that might exist between indicators and controls and that could be attributable to the station.

In 1999, the SSES REMP collected almost 900 samples at more than 40 locations and performed more than 1,600 analyses. In addition, the REMP

Regulatory agencies also participate in monitoring the SSES environment and also oversee PP&L Inc.'s monitoring efforts. The State of Pennsylvania's Department of Environmental Protection (PADEP) monitors air for radioactive particulates and radioactive iodine, milk, fruits and vegetables, surface and drinking water, fish, river sediments, and ambient radiation levels. PADEP makes this data available to the NRC. Inspectors from the NRC regularly visit both PP&L Inc.'s Corporate Office and the SSES to review procedures and records, conduct personnel interviews, observe activities

first-hand, and generally examine the programs supporting the effluent and environmental monitoring for the SSES.

## *REMP Monitoring Sensitivity*

The sensitivity of the SSES REMP was demonstrated in 1986, following the problem with the Chernobyl reactor in the former Soviet Union. When the Chernobyl incident occurred, the SSES REMP was able to detect a relatively small increase in the level of gross beta activity in air samples at both control and indicator locations, as well as the presence of some specific radioactive materials that are not normally observed.

Detection of radiation and radioactive material from the SSES in the environment is complicated by the presence of naturally occurring radiation and radioactive materials from both terrestrial and cosmic sources. Man-made radiation and radioactive material from non-SSES sources, such as nuclear fallout from previous nuclear weapons tests and medical wastes, also can make identification of SSES radiation and radioactive material difficult. Together, this radiation and radioactive material present background levels from which an attempt is made to distinguish relatively small contributions from the SSES. This effort is further complicated by the natural variations that typically occur from both monitoring location to location and with time at the same locations.

The naturally occurring radionuclides potassium-40, beryllium-7, radium-226, and thorium-228 are routinely observed in certain environmental media. Potassium-40 has been observed in all monitored media and is routinely seen at readily detectable levels in such media as milk, meat, fish, and fruits and vegetables. Seasonal variations in beryllium-7 in air samples are regularly observed. Man-made radionuclides, such as cesium-137 and strontium-90 left over from nuclear weapons testing are often observed as well. In addition, the radionuclide tritium, produced by both cosmic radiation interactions in the upper atmosphere as well as man-made (nuclear weapons), is another radionuclide typically observed.

Radioactivity levels in environmental media are usually so low that their measurements, even with state-of-the-art measurement methods, typically have significant degrees of uncertainty associated with them.(18) As a result, expressions are often used when referring to these measurements that convey information about the levels being measured relative to the measurement sensitivities. Terms such as "minimum detectable concentration" (MDC) are used for this purpose. When the value of the MDC for a specific measurement is compared to the value of the actual measurement, the comparison provides information about the difficulty in differentiating the activity being measured from background activity. The formulas used to calculate MDCs may be found in Appendix E.

The methods of measurement for sample radioactivity levels used by PP&L Inc.'s contracted REMP radioanalytical laboratory are capable of meeting the analysis sensitivity requirements found in the SSES

Technical Requirements. Summary descriptions of the analytical procedures and the accompanying calculational methods used by the laboratory can be found in Appendix E.

# Exposure Pathways to Humans

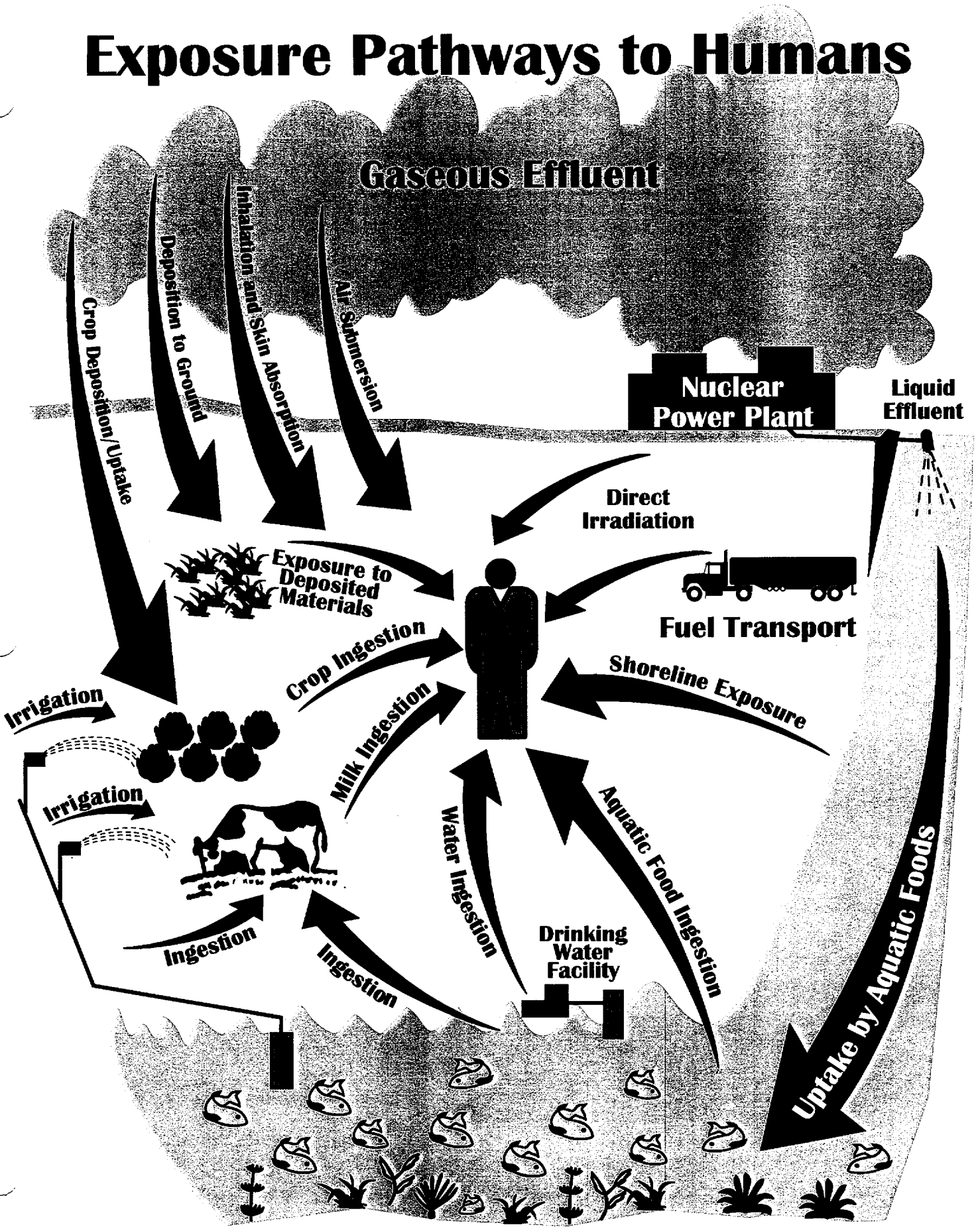



Figure 1

**FIGURE 2**
**1999 TLD MONITORING LOCATIONS**
**WITHIN ONE MILE OF THE SSES**

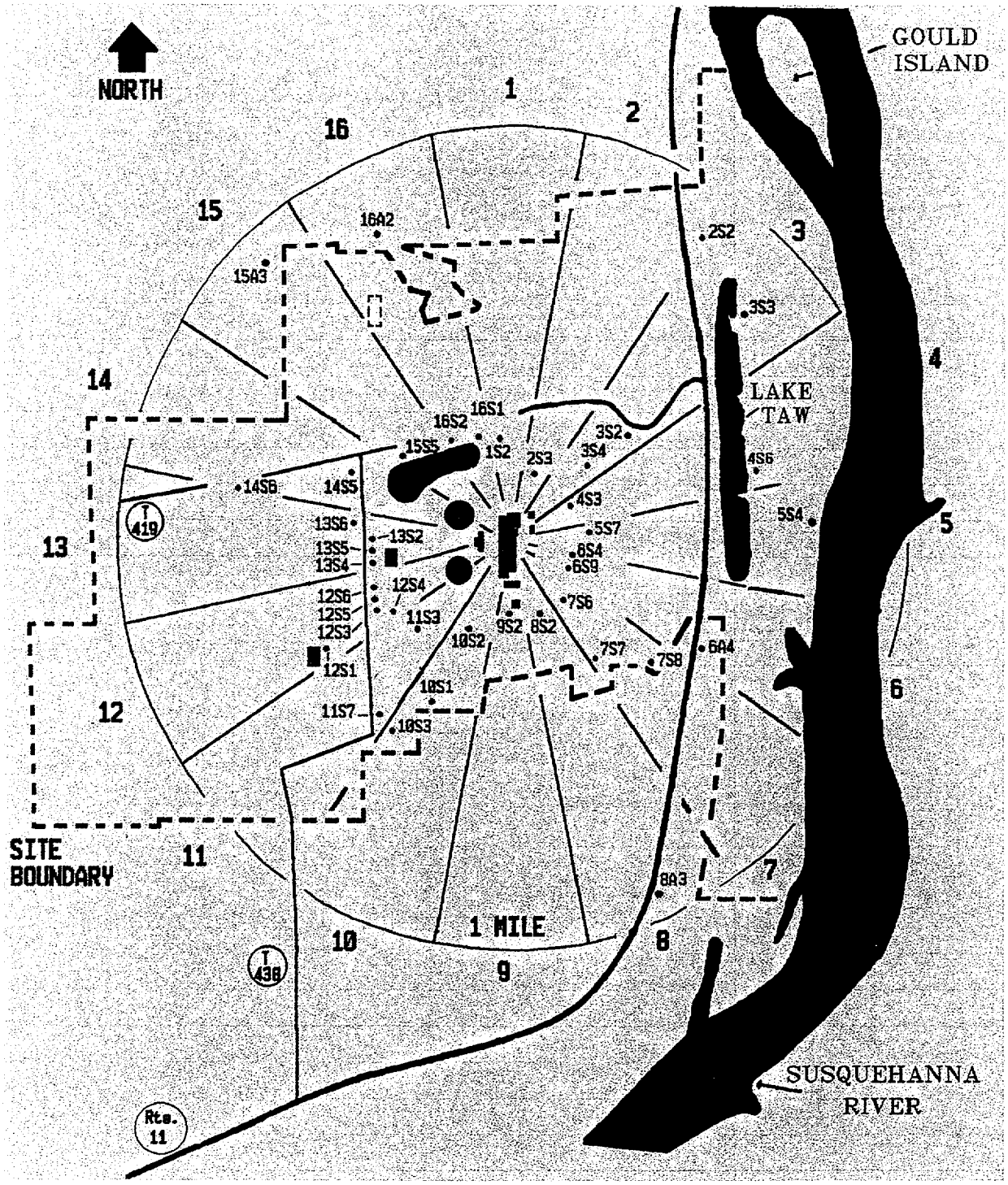


**FIGURE 3**
**1999 TLD MONITORING LOCATIONS**
**FROM ONE TO FIVE MILES FROM THE SSES**

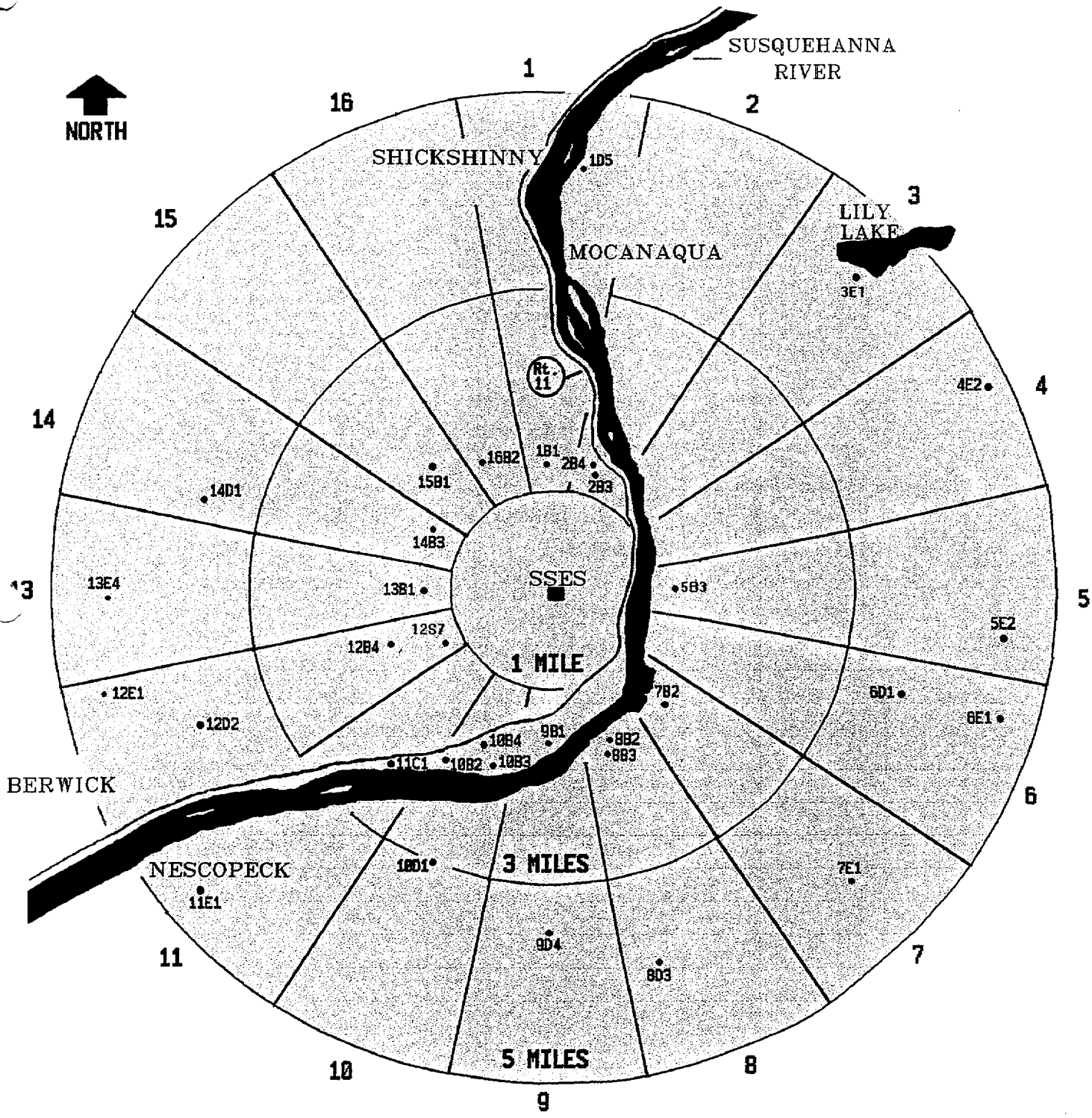
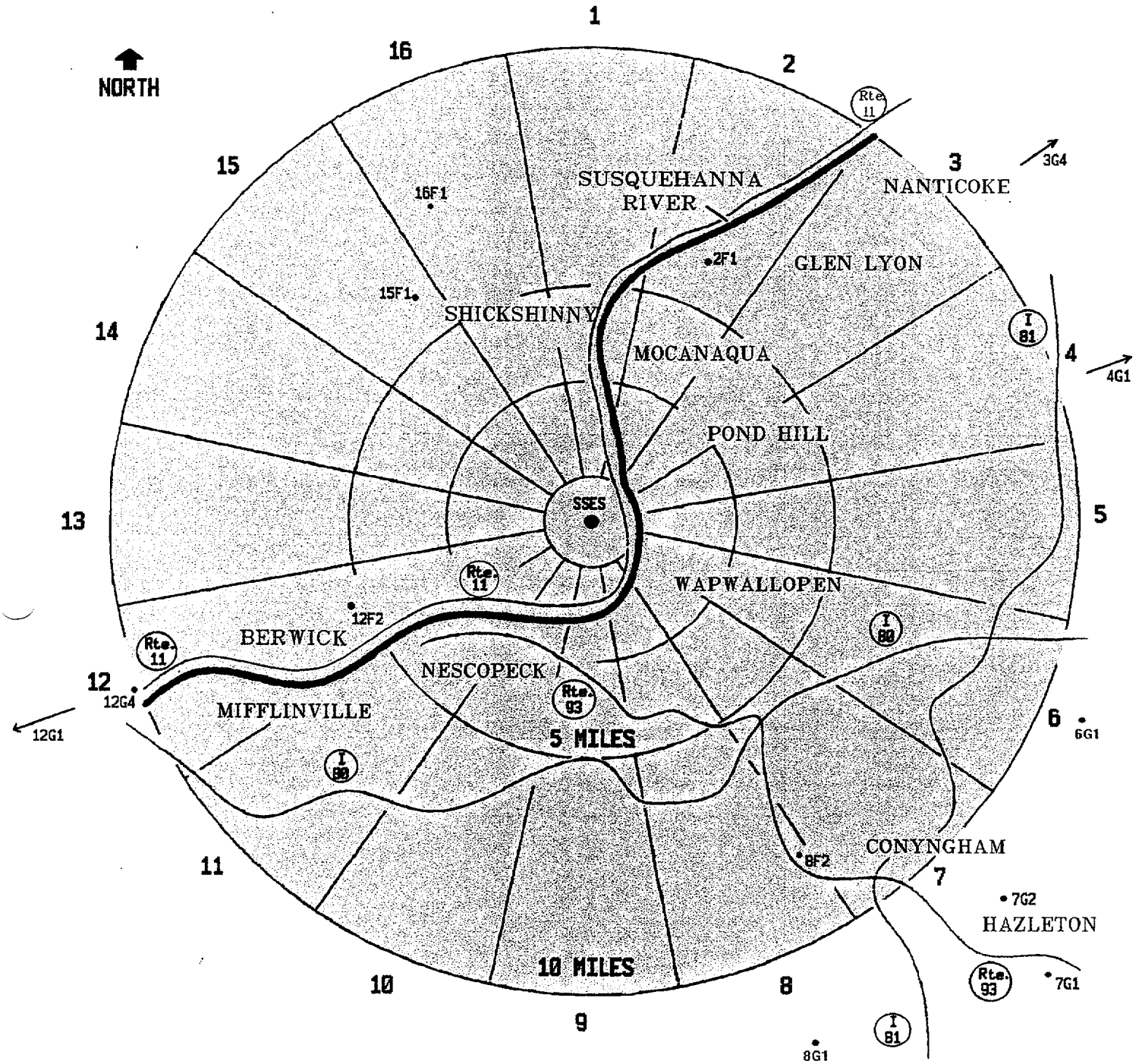
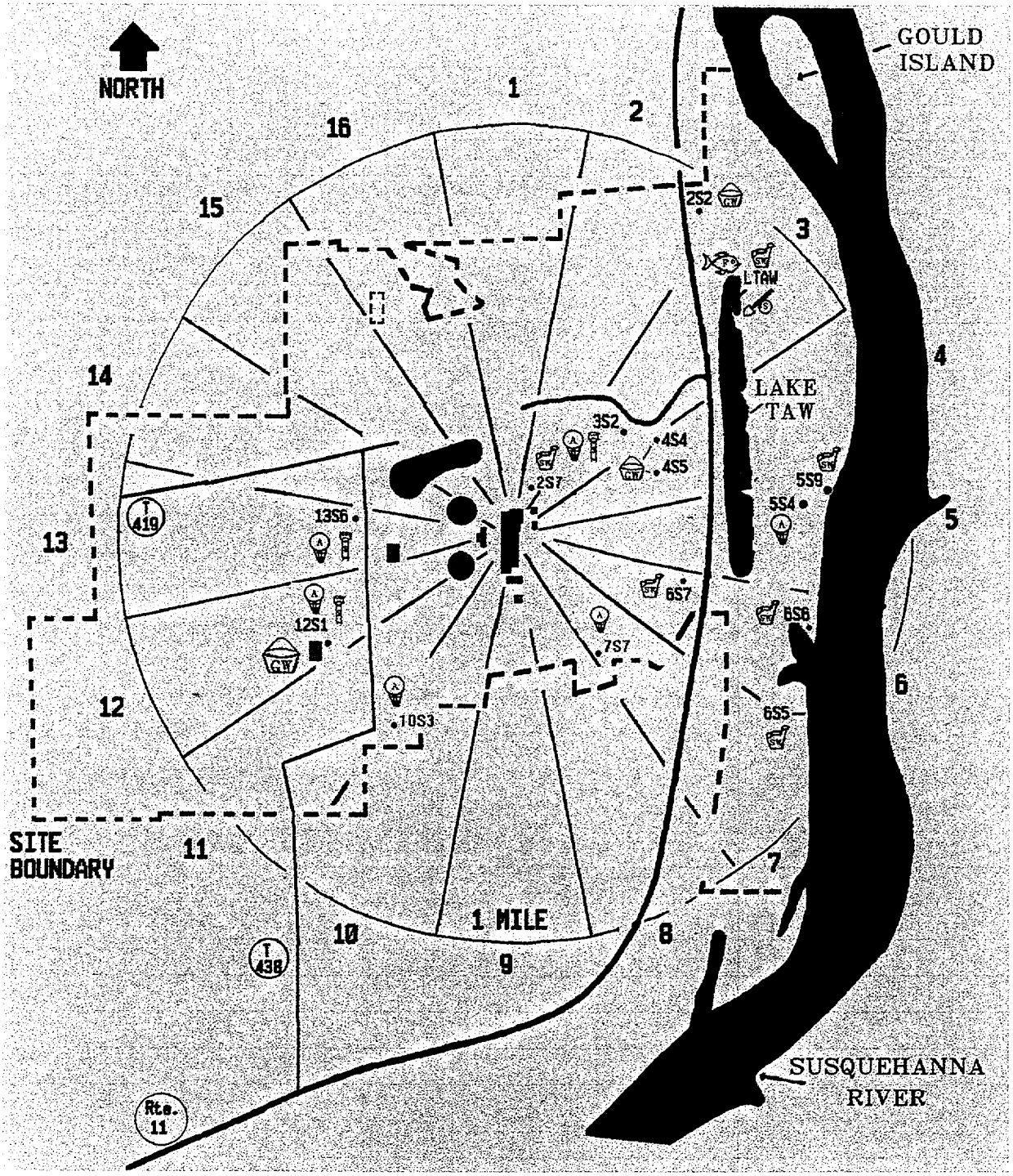


**FIGURE 4**
**1999 TLD MONITORING LOCATIONS**
**GREATER THAN FIVE MILES FROM THE SSES**



# FIGURE 5
# 1999 ENVIRONMENTAL SAMPLING LOCATIONS
# WITHIN ONE MILE OF THE SSES




SURFACE WATER
SEDIMENT
FISH
GROUND WATER
AIR
MILK
FRUITS/VEGETABLES
SOIL

**FIGURE 6**
**1999 ENVIRONMENTAL SAMPLING LOCATIONS**
**FROM ONE TO FIVE MILES FROM THE SSES**

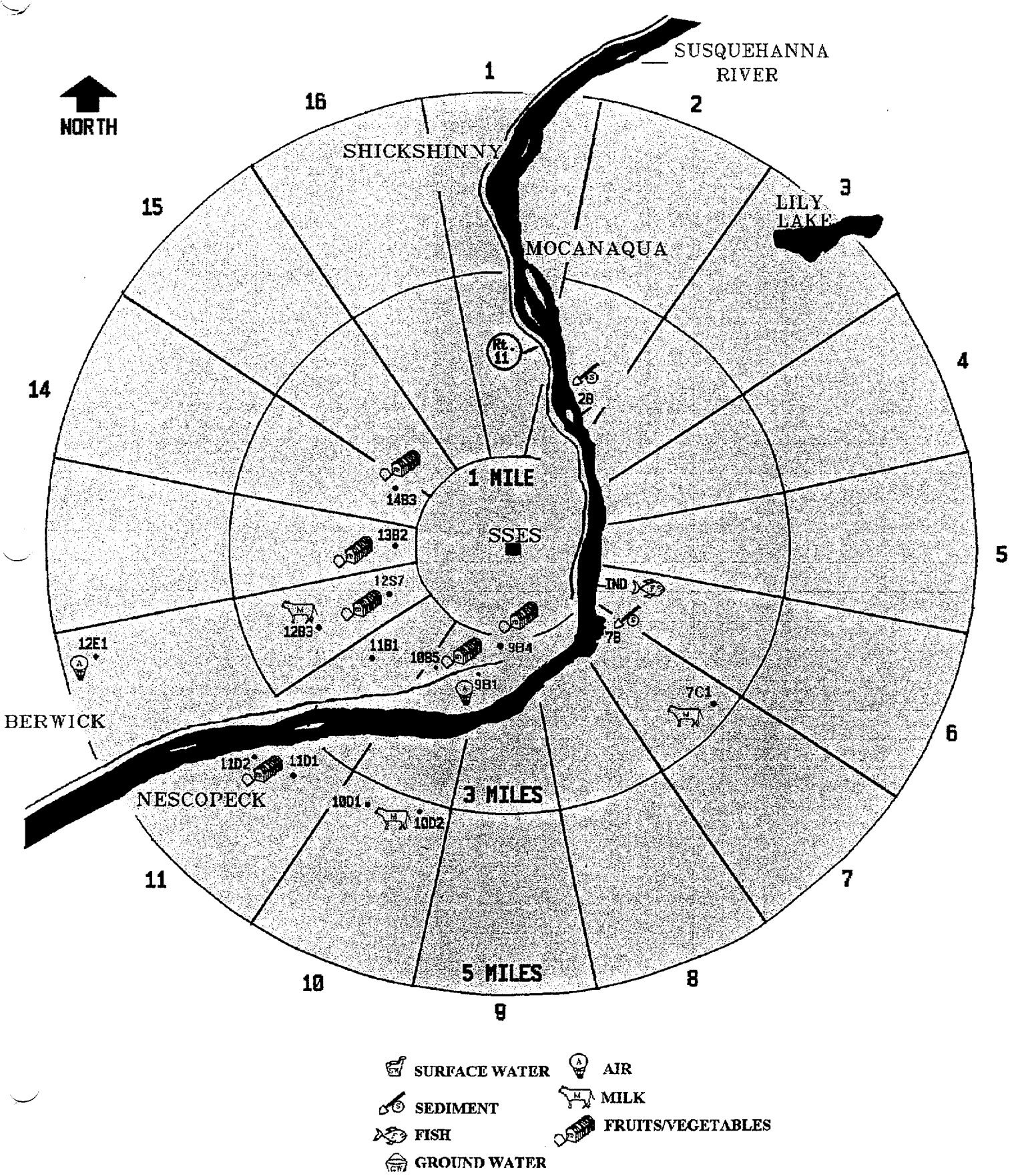
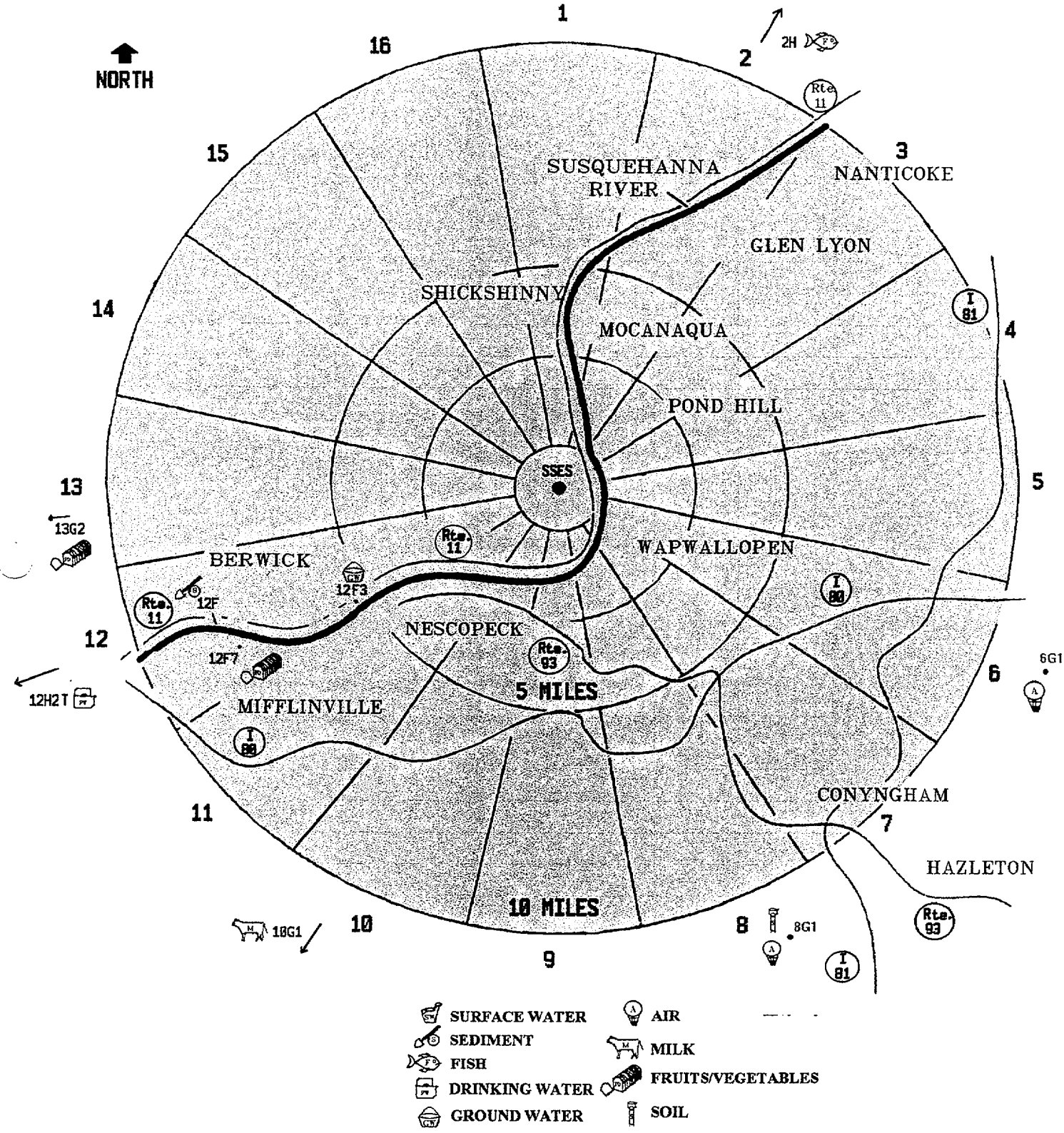


**FIGURE 7**
**1999 ENVIRONMENTAL SAMPLING LOCATIONS**
**GREATER THAN FIVE MILES FROM THE SSES**



# AMBIENT RADIATION MONITORING

## INTRODUCTION

The principal or primary method for the SSES REMP's measurement of ambient radiation levels is the use of thermoluminescent dosimeters (TLDs). The TLDs are crystals (calcium sulfate) capable of detecting and measuring low levels of radiation by absorbing a portion of the radiation's energy that is incident upon them and storing the captured energy until the TLDs are processed (read). Processing involves heating the TLDs to release their stored energy in the form of light and measuring the intensity of the light that they emit. The intensity of the emitted light is proportional to the amount of radiation to which they were exposed. Calibration of the TLD processors permits a reliable relationship to be established between the light emitted and the amount of radiation dose received by the TLDs; the result permits accurate measurements of the ambient radiation in the environment.

Environmental TLDs are continually exposed to natural radiation from the ground (terrestrial radiation) and from the sky (cosmic) radiation. In addition, they also may be exposed to man-made radiation. Most of the environmental TLD's natural radiation exposure comes from sources in the ground. These terrestrial sources vary naturally with time due to changes in soil moisture, snow cover, etc. The natural-radiation picture is complicated because these factors affecting radiation reaching the TLDs from the ground vary differently with time from one location to another due to locational differences in such factors as soil characteristics (amounts of organic matter, particle size, etc.), drainage opportunities, and exposure to sunlight. Environmental TLDs can also be affected by direct radiation (shine) from the SSES turbine buildings during operation, radwaste transfer and storage, and radioactive gaseous effluents from the SSES.

Unfortunately, TLDs do not have any inherent ability to indicate the source of the radiation to which they are exposed. The placement of numerous TLDs in the environment can facilitate decision-making about the possible radiation sources to which TLDs are exposed. However, a method for evaluating TLD data is still required. The SSES REMP relies on a statistically based approach to simultaneously compare indicator TLD data with control TLD data and operational TLD data with preoperational TLD data. This approach permits the flagging of environmental TLD doses that might have been produced by both man-made sources of radiation, as well as natural radiation sources. It also provides a means for attributing a portion of the total TLD dose to SSES operation if appropriate. Appendix E, pages E-6 through E-10, provides a description of the process for evaluating the results of TLD measurements.

## Scope

### *TLDs*

The area around the SSES was divided for monitoring purposes into sixteen sectors radiating outwards from the plant site, each encompassing an area described by an arc of 22.5 degrees. TLDs were placed in all 16 sectors at varying distances from the plant. Monitoring locations were chosen according to the criteria presented in the NRC Branch Technical Position on Radiological Monitoring (Revision 1, November, 1979).(17) The locations for the TLDs were selected by considering factors such as local meteorological, topographical, and population distribution characteristics.

At the end of 1999, the SSES REMP had 78 indicator TLD locations and eight control TLD locations. This level of monitoring exceeds that which is required by the Nuclear Regulatory Commission. The indicator TLDs nearest the SSES are positioned at the security or perimeter fences surrounding the site. This is the closest that a member of the public would be able to approach the station. The control TLDs are the most distant from the SSES, ranging from 10 to 20 miles from the site.

## Monitoring Results

### *TLDs*

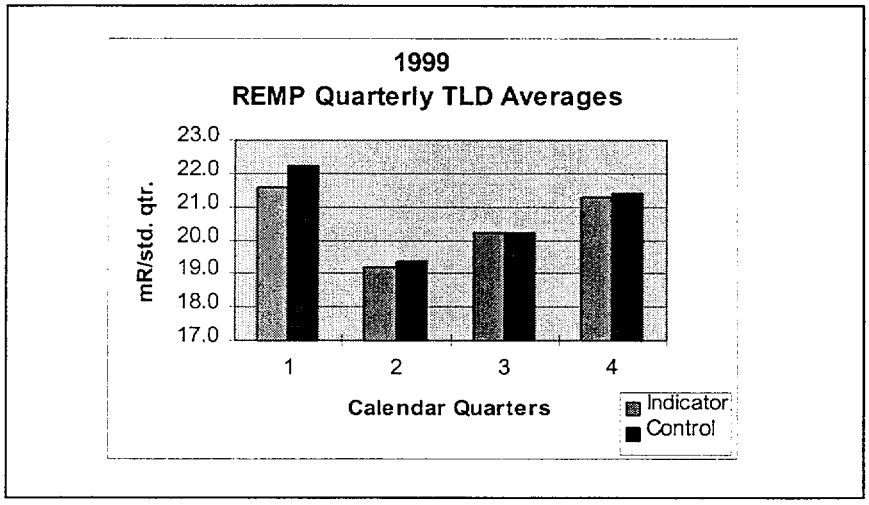
TLDs were retrieved and processed quarterly in 1999. Average ambient radiation levels measured by environmental TLDs were lower in the second and third quarters of 1999, as shown in the bar graph on the following page than in the first and fourth quarters. This pattern is similar to that observed in 1998. Refer to Figure 8 which trends both indicator and control data quarterly from 1973 through 1999.

The 1999 annual average exposures for indicator and control locations were the same at 20.8 mR/std. qtr. The 1999 annual average exposures for both indicator and control locations are 2.2 mR/std. qtr. greater than the 1998 annual averages. The 1999 annual average exposures at both indicator and control locations are higher than the ranges of annual averages for both the pre-operational and prior operational periods at each type of monitoring location. Refer to Figure 8 at the end of this section which trends quarterly TLD results for both preoperational and operational periods at the SSES. Refer to Appendix H, Table H 1, page H 3 for a comparison of the 1999 mean indicator and control TLD results with the means for the preoperational and prior operational periods at the SSES.

Indicator environmental TLD results for 1999 were examined quarterly on an individual location basis and compared with both current control location results and preoperational data. Very small SSES exposure contributions were suggested during 1999 at the following **onsite** locations: 9S2 and 11S3 in all four quarters, 6S4 and 10S2 in the third and fourth quarters, and 6S9 and 12S4 in the fourth quarter only. Thus, there were six monitored locations in 1999 where a SSES dose contribution is considered to have been discernible. It should be noted that the

fourth quarter excess ratios and the exposures for the locations in the table above, expecially at location 9S2, suggest an increase in the very small station-related exposures when compared to those from the first two quarters of 1999. It is possible that these SSES attributable exposures were actually not the result of SSES operations, but, in fact, resulted from fluctuations in background radiation levels. Refer to Appendix E, page E-6, for a discussion of "TLD Data Interpretation." TLD results for all locations for each quarter of 1999 may be found in Appendix I, Table I-1, beginning at page I-2.

This dose amounts to only 0.048% of the 25 mrem whole-body dose limit of SSES Technical Requirement 3.11.3.




The estimated quarterly exposure contributions were summed by location for the entire year. The largest dose suggested was approximately 1.2E-2 millirem at an onsite monitoring location, 9S2, 0.2 mile south of the SSES. This dose was used for determining compliance with SSES Technical Requirement Limit 3.11.3 for annual effluent reporting purposes.

# AMBIENT RADIATION LEVELS
# BASED ON TLD DATA

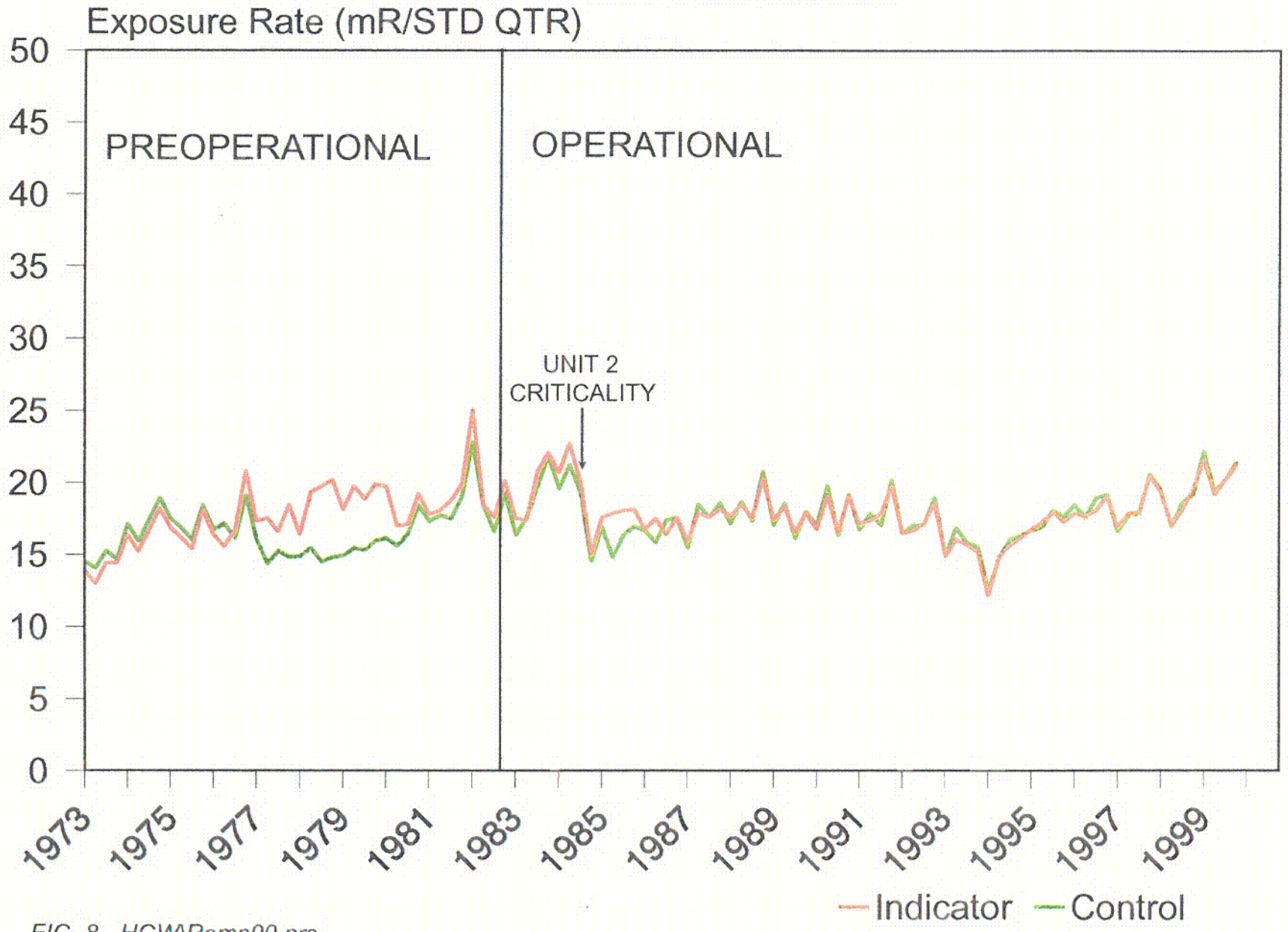



*FIG. 8 - HGW\Remp99.prs*

# AQUATIC PATHWAY MONITORING

## INTRODUCTION

The following media were monitored in 1999 by the SSES REMP in the aquatic pathway: surface water, drinking water, fish, and sediment. Some of the media (e.g., drinking water and fish) provide information that can be especially useful to the estimation of possible dose to the public from potentially ingested radioactivity, if detected. Other media, such as sediment, can be useful for trending radioactivity levels in the aquatic pathway, primarily because of their tendency to assimilate certain materials that might enter the surface water to which they are exposed. The results from monitoring all of these media provide a picture of the aquatic pathway that is more clear than that which could be obtained if one or more were not included in the REMP.

Fruits or vegetables that are grown in fields irrigated with surface water would also be in the aquatic pathway. The land use census (Reference 61) conducted in 1999 looked at farms within 10 miles downstream of the SSES. Three farms were found to have irrigated during the 1999 growing season.

The aquatic pathway in the vicinity of the SSES is the Susquehanna River. Monitoring of all of the aquatic media, except drinking water, is conducted both downstream and upstream of the location from which occasional SSES low-level radioactive discharges enter the river. The upstream monitoring locations serve as controls to provide data for comparison with downstream monitoring results. The potential exists for radioactive material that might be present in SSES airborne releases to enter the Susquehanna River upstream of the plant through either direct deposition (e.g., settling or washout) or by way of runoff from deposition on land adjacent to the river. However, direct deposition and runoff are considered to be potentially insignificant as means of entry for SSES radioactivity into the Susquehanna River when compared to liquid discharges under normal conditions.

Lake Took-a-While (LTAW), which is located in PP&L Inc.'s Riverlands Recreation Area adjacent to the Susquehanna River, is also considered to be part of the aquatic pathway for monitoring purposes. Although it is not in a position to receive water discharged to the river from the SSES, it can receive storm runoff from the SSES. Storm runoff from the SSES site should not normally contain any measurable radioactivity from the plant. However, the SSES REMP, consistent with other aspects of aquatic monitoring and the REMP, in general, goes beyond its requirements by monitoring LTAW.

## Scope

### *Surface Water*

Surface water was routinely sampled from the Susquehanna River at one indicator location (6S5) and one control location (6S6) at the SSES River Water Intake during 1999. Sampling also took place at the following additional indicator locations: the SSES discharge line to the river (2S7/6S7) and Lake Took-A-While (LTAW).

### *Drinking Water*

Drinking water samples were collected at location 12H2, the Danville Municipal Water Authority's treatment facility on the Susquehanna River, in 1999. Treated water is collected from the end of the processing flowpath, representing finished water that is suitable for drinking. This is the nearest point downstream of the SSES discharge to the River at which drinking water is obtained. No drinking water control location is sampled. For all intents and purposes, control surface water sampling locations would be suitable for comparison.

### *Fish*

Fish were sampled from the Susquehanna River in the spring and fall of 1999 at one indicator location, IND, downstream of the SSES liquid discharge to the River and one control location, 2H, sufficiently upstream to essentially preclude the likelihood that the fish caught there would spend any time below the SSES discharge. In addition, fish were also sampled from PP&L Inc.'s Lake Took-a-While, location LTAW. This location is not downstream of the SSES discharge. It is sampled because of its potential for receiving runoff from the SSES. LTAW is considered an indicator location.

### *Sediment*

Sediment sampling was performed in the spring and fall at indicator locations 7B and 12F and control location 2B on the Susquehanna River. In addition, sediment was also obtained from location LTAW.

## Sampling

### *Surface Water*

Weekly grab sampling was performed at the indicator location 6S5. Weekly grab samples were composited both monthly and biweekly at this location. Location 6S5 was considered a backup for locations 2S7 and 6S7 in the event that water could not be obtained from the automatic samplers at these locations. Nevertheless, 6S5 was sampled routinely throughout 1999, since it is the closest downstream sampling point to the SSES discharge.

Indicator locations 2S7 and 6S7, the SSES Cooling Tower Blowdown Discharge (CTBD) line, and control location 6S6, the SSES River Water Intake structure, were sampled time proportionally using automatic continuous samplers. The samplers were typically set to obtain 30-60 ml aliquots every 20-25 minutes. Weekly, the water obtained by these samplers was retrieved for either biweekly or monthly compositing.

The other surface water monitoring location, LTAW, was grab sampled once each month.

### *Drinking Water*

Treated water was sampled time proportionally by an automatic sampler. The sampler was typically set to obtain 30-60 ml aliquots every twenty minutes. Weekly, the water obtained by this sampler was retrieved for either biweekly or monthly compositing.

### *Fish*

Fish were obtained by electrofishing. Electrofishing stuns the fish and allows them to float to the surface so that those of the desired species and sufficient size can be sampled. Sampled fish include recreationally important species, such as smallmouth bass, and also channel catfish and white suckers. The fish are filleted and the edible portions are kept for analysis.

### *Sediment*

Shoreline sediment was collected to depths of four feet of water.

## Sample Preservation and Analysis

### *Surface and Drinking Water*

Surface and drinking water samples were analyzed monthly for beta activities, the activities of gamma-emitting radionuclides, and tritium activities. Iodine-131 was analyzed biweekly for composite samples and monthly for the grab samples. In addition, drinking water samples were analyzed for gross alpha activity.

To optimize the accuracy of these sample analyses, preservatives were added to the samples as soon after collection as practical. Nitric acid was added to sample aliquots destined for gross alpha and beta activity analysis and the analysis of gamma-emitting radionuclide activity analysis. Sufficient acid was added to reduce the pH of these sample aliquots to nearly two in order to reduce the potential for radionuclides leaving the water and depositing on the sides of the sample containers.

Sodium bisulfite was added to sample aliquots destined for iodine-131 analysis in amounts equivalent to one gram per each gallon of water. This amount was recommended by the radioanalytical laboratory (Teledyne Brown Engineering) analyzing the samples. The purpose for sodium bisulfite addition is to reduce the potential for volatilization and loss of iodine from samples by maintaining it in a chemically reduced form.

### *Sediment and Fish*

Fish are frozen until shipment. All samples are analyzed by gamma spectroscopy for the activities of any gamma emitting radionuclides that may be present.

## Monitoring Results

### *Surface Water*

Results from specific sample analyses of surface water may be found in Tables I-2 and I-3 of Appendix I. A summary of the 1999 surface water data may be located in Table G of Appendix G. Comparisons of 1999 monitoring

results with those of past years may be found in Tables H 2 through H 4 of Appendix H.

The Nuclear Regulatory Commission (NRC) requires that averages of the activity levels for indicator environmental monitoring locations and for control environmental monitoring locations of surface water, as well as other monitored media, be reported to the NRC annually. Data from the following three surface water monitoring locations were averaged together as indicators for reporting purposes: one location (6S5) on the Susquehanna River downstream of the SSES, Lake-Took-a While (LTAW) adjacent to the river, and the SSES cooling tower blowdown discharge (CTBD) line to the river (2S7).

Technically, the CTBD line is not part of the environment. The CTBD line is a below ground pipe to which the public has no access, contrary to the other environmental monitoring locations on the Susquehanna River to which the public does have access. However, it currently is required that the water that is discharged to the Susquehanna River through the CTBD line from the SSES be included as an indicator monitoring location in the radiological environmental monitoring program.

Most of the water entering the Susquehanna River through the SSES CTBD line is simply water that was taken from the river upstream of the SSES, used for cooling purposes without being radioactively contaminated by SSES operation, and returned to the river. Nevertheless, batch discharges of relatively small volumes of slightly radioactively contaminated water are made to the river through the SSES CTBD at times throughout each year. The water is released from tanks of radioactively contaminated water on site to the CTBD and mixes with the noncontaminated water already present in the CTBD. Flow rates from the tanks containing radioactively contaminated water being discharged to the CTBD are limited to a maximum of 200 gpm. In addition, the minimum flow rate for the returning water in the CTBD is maintained at a flow rate of 5,000 gpm or higher. These requirements are in place to ensure adequate dilution of radioactively contaminated water by the returning noncontaminated water in the CTBD prior to entering the river.

At the point that CTBD water enters the river, additional, rapid dilution of the discharged water by the river is promoted by releasing it through a diffuser. The diffuser is a large pipe with numerous holes in it that is positioned near the bottom of the river. CTBD discharges exit the diffuser through the many holes, enhancing the mixing of the discharge and river waters. The concentrations of contaminants are reduced significantly as the discharged water mixes with the much larger flow of river water. The mean flow rate of the Susquehanna River in 1999 was approximately 4,690,000 gpm. This is more than 600 times the required minimum flow rate through the CTBD for discharges to be permitted.

The amounts of radioactively contaminated water being discharged are small. Nevertheless, sensitive

analyses of the water samples can often detect the low levels of certain types of radioactivity in the CTBD water following dilution. Though the levels of radioactivity measured in the CTBD water are generally quite low, they tend to be higher than those in the river downstream of the SSES. Most radionuclides discharged from the SSES CTBD are at such low levels in the downstream river water that, even with the sensitive analyses performed, they cannot be detected.

When the radioactivity levels from the CTBD samples throughout the year are averaged with those obtained from actual downstream monitoring locations, the result is an overall indicator location average that is too high to be representative of the actual average radioactivity levels of the downstream river water. As the following discussions are reviewed, consideration should be given to this inflation of average radioactivity levels from the inclusion of CTBD (location 2S7/6S7) results in the indicator data that is averaged.

The 1999 data for **gross beta activity** analyses of surface water are higher than those of 1998. The 1999 mean gross beta activity of 6.6 pCi/liter for indicator locations is greater than the 1998 indicator mean gross beta activity of 6.1 pCi/liter. The 1999 indicator activity is above the average of the annual means for the previous operational period of the SSES. The 1999 mean gross beta activity of 4.7 pCi/liter for control locations is lower than the 6.7 pCi/liter for the 1998 control mean gross beta activity. It is within the range of the annual means for the previous operational and preoperational periods. Refer to Figure 9 which trends gross beta activities separately for surface water indicator and control locations quarterly from 1975 through 1999.

Comparison of the 1999 indicator mean (6.6 pCi/l) to the 1999 control mean (4.7 pCi/l) suggests a contribution of beta activity from the SSES. The 1999 data is similar in this regard to the averages of annual means for indicator and control locations for the prior operational period. During the prior operational period, the average of annual indicator means exceeds the average of annual control means for gross beta activity.

The 1999 means for **iodine-131 activity** at indicator and control surface water monitoring locations were 0.38 pCi/liter and 0.37 pCi/liter, respectively. Both the 1999 indicator and control means for iodine-131 activity are slightly greater than 1998's corresponding activity means. Both 1999's indicator and control mean activities are also greater than the averages of the annual means for both indicator and control locations for the prior operational period of the SSES.

Throughout the course of a year, iodine-131 is typically measured at levels in excess of analysis MDCs in some samples obtained from control surface water monitoring locations on the Susquehanna River upstream of the SSES as well as indicator locations downstream of the SSES. As determined by measurements of samples obtained by the SSES REMP, the mean iodine-131 activity level from

the CTBD for all of 1999 was approximately 0.71 pCi/liter. This may be compared to the activity level of 0.37 pCi/liter for control surface water monitoring locations in 1999.

Iodine-131 from the discharge of medical wastes into the Susquehanna River upstream of the SSES is drawn into the SSES cooling tower basins through the SSES River Water Intake Structure. It is not unreasonable to assume that concentration of the already existing iodine-131 in the cooling tower basins occurs as it does for other substances found in the river. For example, the SSES routinely assumes concentration factors in the basin for calcium of four to five times the concentrations in the river water entering the basins, based on past measurements. This concentrating effect occurs because of the evaporation of the water in the basins, leaving behind most dissolved and suspended materials in the unevaporated water remaining in the basins. If a concentration factor of four for iodine-131 were to be applied to the 1999 mean iodine-131 activity level for the control samples from the Susquehanna River, a mean concentration of 1.48 pCi/liter for iodine-131 in the basin water and the water being discharged from the basins would be expected. The actual 1999 mean for the CTBD iodine-131 activity level was less than this.

Because iodine-131 is radioactive, unlike the calcium that has been measured, iodine-131 is removed from the water while it is in the basins through the radioactive decay process. Thus, it might be expected that the net concentration factor for iodine-131 would be somewhat less than that for calcium, considering this additional removal process. The extent to which the iodine-131 concentration factor is less than that for calcium would depend on the mean residence time for the water in the basins compared to iodine-131's radioactive half-life - the greater the ratio of the mean residence time to the half-life, the smaller the concentration factor. A mean residence time for water in the basins is expected to be about two days. This is only about one-fourth of the approximately eight-day half-life of iodine-131. Thus, radioactive decay would not be expected to reduce the concentration factor for iodine-131 by a large amount. Therefore, the difference between the 1999 mean iodine-131 activity of about 0.71 pCi/liter in the CTBD and the 1999 mean iodine-131 activity for the control location of 0.37 pCi/liter should be the result of concentration in the basins. Iodine-131 was not reported to have been discharged with water released from the SSES to the Susquehanna River during 1999.

The 1999 mean **tritium activity** for indicator locations was significantly less than the corresponding 1998 mean. The 1999 and 1998 mean tritium activities for control locations were both negative values (less than background). The 1999 means for tritium activity at indicator and control locations were 754 pCi/liter and -14 pCi/liter, respectively. The 1999 indicator mean is within the range of the annual means reported for the prior operational period of the SSES. The 1999 control mean is lower than the average of the annual means reported for both prior operational and preoperational

monitoring periods. Refer to Figure 10 which trends tritium activity levels separately for surface water indicator and control locations from 1972 through 1999.

The 1999 indicator mean tritium level for all surface water locations can be misleading for those interested in the mean tritium level in the Susquehanna River downstream of the SSES for 1999. The much higher levels of tritium observed in the CTBD (location 2S7/6S7), when averaged with the low levels from the downstream location 6S5 sample analysis results distort the real environmental picture. The mean tritium activity from indicator location 6S5 for 1998 was –5.5 pCi/liter, which is essentially indistinguishable from the mean tritium activity, -14 pCi/liter, for the control location, both of which represent actual river water levels.

In spite of the fact that the tritium activity levels reported for 2S7/6S7 are from the discharge line prior to dilution in the river, the highest quarterly average tritium activity reported at 2S7/6S7 during 1999 was 4,468 pCi/liter for the third quarter, well below the NRC non-routine reporting levels for quarterly average activity levels of 20,000 pCi/liter when a drinking pathway exists or 30,000 pCi/liter when no drinking water pathway exists.

The tritium activity reported in the CTBD line from location 2S7/6S7 is attributable to the SSES. Refer to the "Dose from the Aquatic Pathway" discussion at the end of this section for additional information on the projected dose to the population from tritium and other radionuclides in the aquatic pathway attributable to the SSES.

With the exception of iodine-131, no **gamma-emitting radionuclides** were measured in surface water primary samples at an activity level exceeding an analysis MDC in 1999.

## *Drinking Water*

Drinking water was monitored during 1999 at the Danville Water Company's facility 26 miles WSW of the SSES on the Susquehanna River. From 1977 (when drinking water samples were first collected) through 1984, drinking water samples were also obtained from the Berwick Water Company at location 12F3, 5.2 miles WSW of the SSES. The drinking water supply for the Berwick Water Company is not, however, water from the Susquehanna River; it is actually well water.

There are no known drinking water supplies in Pennsylvania on the Susquehanna River upstream of the SSES and therefore no drinking water control monitoring locations. Danville drinking water analysis results may be compared to the results for surface water control monitoring locations.

Results from specific sample analyses of drinking water may be found in Table I-4 of Appendix I. A summary of the 1999 drinking water data may be located in Table G of Appendix G. Comparisons of 1999 monitoring results with those of past years may be found in Tables H 5 through H 7 of Appendix H.

Gross alpha activity has been monitored in drinking water since 1980. Gross

alpha activity has been observed at levels above the analysis MDCs in a small minority of the samples during most years since 1980. In 1999, one sample was reported with a gross alpha activity level above the analysis MDC. The 1999 mean gross alpha activity level for drinking water was 0.26 pCi/liter. The 1999 mean alpha activity is significantly below the average of the corresponding annual means for both the prior operational years as well as the preoperational period. The mean gross alpha activity is lower than the means of many of the previous years. This is primarily because of the averaging method used since 1991. But, it may also be the result of discontinuing the sampling of untreated drinking water in July, 1995. Generally the untreated water may have contributed more naturally occurring alpha activity due to higher levels of sediment than the treated water. No gross alpha activity in drinking water during 1999 is attributed to liquid discharges from the SSES to the Susquehanna River.

Gross beta activity has been monitored in drinking water since 1977. Gross beta activity is typically measured at levels exceeding the MDCs in drinking water samples. The 1999 mean gross beta activity level for drinking water was 2.8 pCi/liter. The 1999 mean is below the 1998 mean gross beta activity level for drinking water but within the range of the corresponding annual means for the prior operational period of the SSES. Refer to Figure 11 which trends gross beta activity levels separately for drinking water indicator and control locations from 1977 through 1999.

The 1999 mean gross beta activity for drinking water is less than the 1999 gross beta activity level for surface water control locations. Drinking water samples were analyzed for gross beta activity by a different laboratory than surface water samples in 1999. This may have contributed somewhat to differences in gross beta activity between the two media. However, treated drinking water may be expected to have less naturally occurring beta activity due to lower levels of sediment than the surface water. No gross beta activity in drinking water during 1999 is attributed to liquid discharges from the SSES to the Susquehanna River.

Iodine-131 was measured in excess of analysis MDCs in 12 out of 27 drinking water samples in 1999. This compares with results from five samples for which analysis MDCs were exceeded in 1998. The 1999 mean iodine-131 activity level in drinking water samples was 0.21 pCi/liter. This is more than the 1998 mean drinking water activity level of 0.13 pCi/liter and less than the 1999 mean of 0.37 pCi/liter for surface water control locations. No iodine-131 activity in drinking water during 1999 is attributed to liquid discharges from the SSES to the Susquehanna River.

Tritium was measured in excess of analysis MDCs once in 1999 in drinking water. The 1999 mean tritium activity level for drinking water was 37 pCi/liter. The 1999 mean is below the averages of the corresponding annual means for both the prior operational and preoperational periods of the SSES. The low 1999 mean tritium activity level for drinking water

is higher than the 1999 mean tritium activity level for surface water control locations. Tritium activity in drinking water can be attributed to liquid discharges from the SSES to the Susquehanna River.

No gamma-emitting radionuclides were measured above the analysis MDCs for gamma spectroscopic analyses of drinking water samples during 1999.

## *Fish*

Results from specific sample analyses of fish may be found in Table I 5 of Appendix I. A summary of the 1999 fish data may be located in Table G of Appendix G. A comparison of 1999 monitoring results with those of past years may be found in Table H 8 of Appendix H.

Four species of fish were sampled at each of one indicator location and one control location on the Susquehanna River in April and May, 1999 and again in October, 1999. The species included the following: white sucker, smallmouth bass, channel catfish, and shorthead redhorse. In addition, one largemouth bass was sampled from PP&L Inc.'s LTAW in October, 1999. A total of 14 fish were collected and analyzed.

The only gamma-emitting radionuclide reported in excess of analysis MDCs in fish during 1999 was naturally occurring potassium-40. The 1999 indicator and control means for the activity levels of potassium-40 in fish were both 3.2 pCi/gram. The 1999 indicator and control means are less than the 1998 indicator and control means. Both the 1999 indicator and control means are within the ranges of their corresponding annual means for prior operational and preoperational years. Naturally occurring potassium-40 in fish is not attributable to the liquid discharges from the SSES to the Susquehanna River.

## *Sediment*

Shoreline sediment was sampled in April, 1999 and again in October, 1999. Results from specific sample analyses of sediment may be found in Table I-6 of Appendix I. A summary of the 1999 sediment data may be located in Table G of Appendix G. Comparisons of 1999 monitoring results with those of past years may be found in Tables H 9 through H 12 of Appendix H.

Naturally occurring potassium-40, radium-226, and thorium-228 were measured at activity levels above analysis MDCs in all shoreline sediment samples in 1999.

The 1999 indicator and control means for potassium-40 activity levels in shoreline sediment were 12.7 pCi/gram and 13.0 pCi/gram, respectively. The 1999 indicator and control means for potassium-40 activity are greater than their corresponding 1998 means. These 1999 means were within the ranges of the corresponding annual means for all prior operational years.

The 1999 indicator and control means for radium-226 activity levels in shoreline sediment were both 1.7 pCi/gram. The 1999 indicator and control mean radium-226 activities are higher than the corresponding 1998

means. These 1999 radium-226 means were within the ranges of the corresponding annual means for all prior operational years.

The 1999 indicator and control means for thorium-228 activity levels in shoreline sediment were 1.1 pCi/gram and 1.0 pCi/gram, respectively. These means are the same as the averages of the corresponding means for 1998 and for prior operational years. The naturally occurring radionuclides in sediment discussed above are not attributable to the liquid discharges from the SSES to the Susquehanna River.

Cesium-137 was measured at activity levels in shoreline sediment exceeding analysis MDCs during 1999. The 1999 indicator and control means for cesium-137 activity levels in sediment were 0.077 pCi/gram and 0.082 pCi/gram, respectively. The 1999 indicator mean is slightly greater than the 1998 indicator mean. However, the 1999 control mean is slightly below the 1998 control mean. The 1999 indicator and control means are less than the averages of corresponding annual means for both prior operational as well as preoperational years. This cesium-137 in the sediment is attributed to residual fallout from past atmospheric nuclear weapons tests.

Manganese-54 was reported at a level in excess of the analysis MDC for one of eight sediment samples collected during 1999. It was reported at an activity concentration of 0.24 pCi/gram in a sediment sample from indicator location 12F (the old Berwick Test Track, 6.9 miles from the SSES) in the Susquehanna River below the discharge from the SSES. Manganese-54 has been reported previously in indicator samples during the following operational years: 1985, 1988, 1990, and 1995. It also has been reported before in control samples during the following operational years: 1987, 1989, and 1990. With the results of this sample analysis, manganese-54 has been identified in sediment from the river a total of seven years since the beginning of SSES operation. It has been reported in samples from monitoring location 12F in five of these seven years. The level reported this year was higher than those reported since 1985 but less than the activity concentration for one sample reported during 1985.

## Dose from the Aquatic Pathway

Tritium and manganese-54 were the only radionuclides identified in 1999 by the SSES REMP in the aquatic pathway that was attributable to SSES operation and also included in the pathway to man.

The maximum whole-body and organ doses to hypothetical maximally exposed individuals in four age groups (adult, teenager, child, and infant) were determined according to the methodology of the Offsite Dose Calculation manual using the LADTAP II code. This is in accordance with SSES Technical Requirement 3.11.4.1.3.

For the purpose of performing the dose calculation, tritium was assumed to be present continuously in the CTBD line

throughout 1999 at a level equivalent to the annual mean activity level of 2,142 pCi/liter for the CTBD line. The annual mean flow rate for the CTBD line during releases of about 7,400 gpm was multiplied times this mean activity level to obtain an equivalent annual discharge of about 32 curies of tritium in 1999. (This is more than 12 curies less than the total amount of tritium reported to have been released in 1999 from SSES effluent monitoring.) Because no positive annual mean activity level for tritium was obtained for the control in 1999, no subtraction of control annual mean activity was performed prior to multiplying by the annual CTBD mean flow rate.

Doses from tritium were estimated at the nearest downriver municipal water supplier via the drinking water pathway and near the outfall of the SSES discharge to the Susquehanna River via the fish pathway. The maximum whole body and organ doses were each estimated to be less than 0.0008 mrem.

The maximum annual total body and skin doses, based on the presence of the manganese-54 at the level detected for an entire year, would each be expected to be less than 0.002 mrem. This would be the result of exposure from gamma radiation emitted by the manganese-54 to the maximally exposed individual spending time on the shoreline. Thus, the impact of the presence of Mn-54 in this sediment sample is also negligible.

# GROSS BETA ACTIVITY IN SURFACE WATER

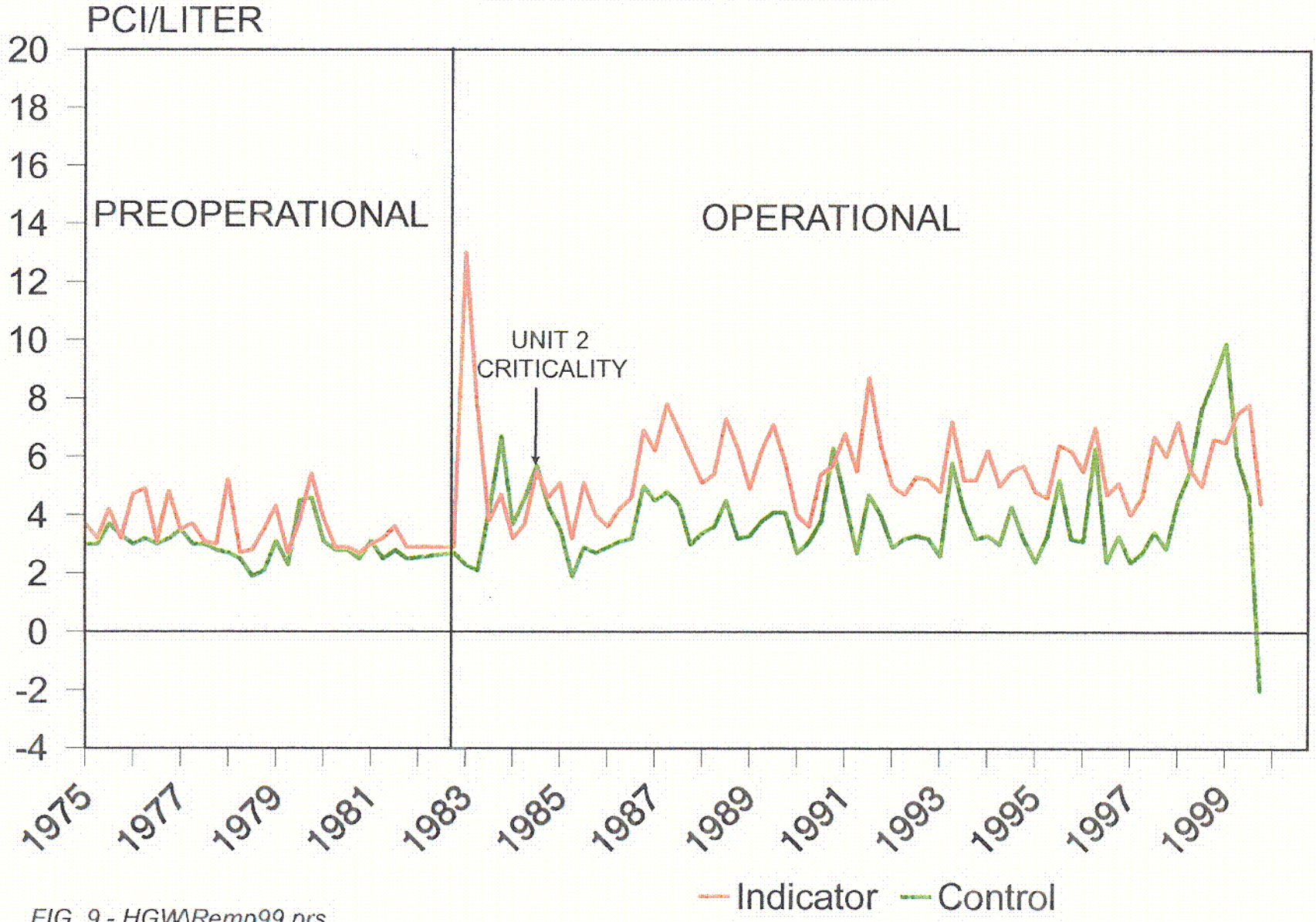
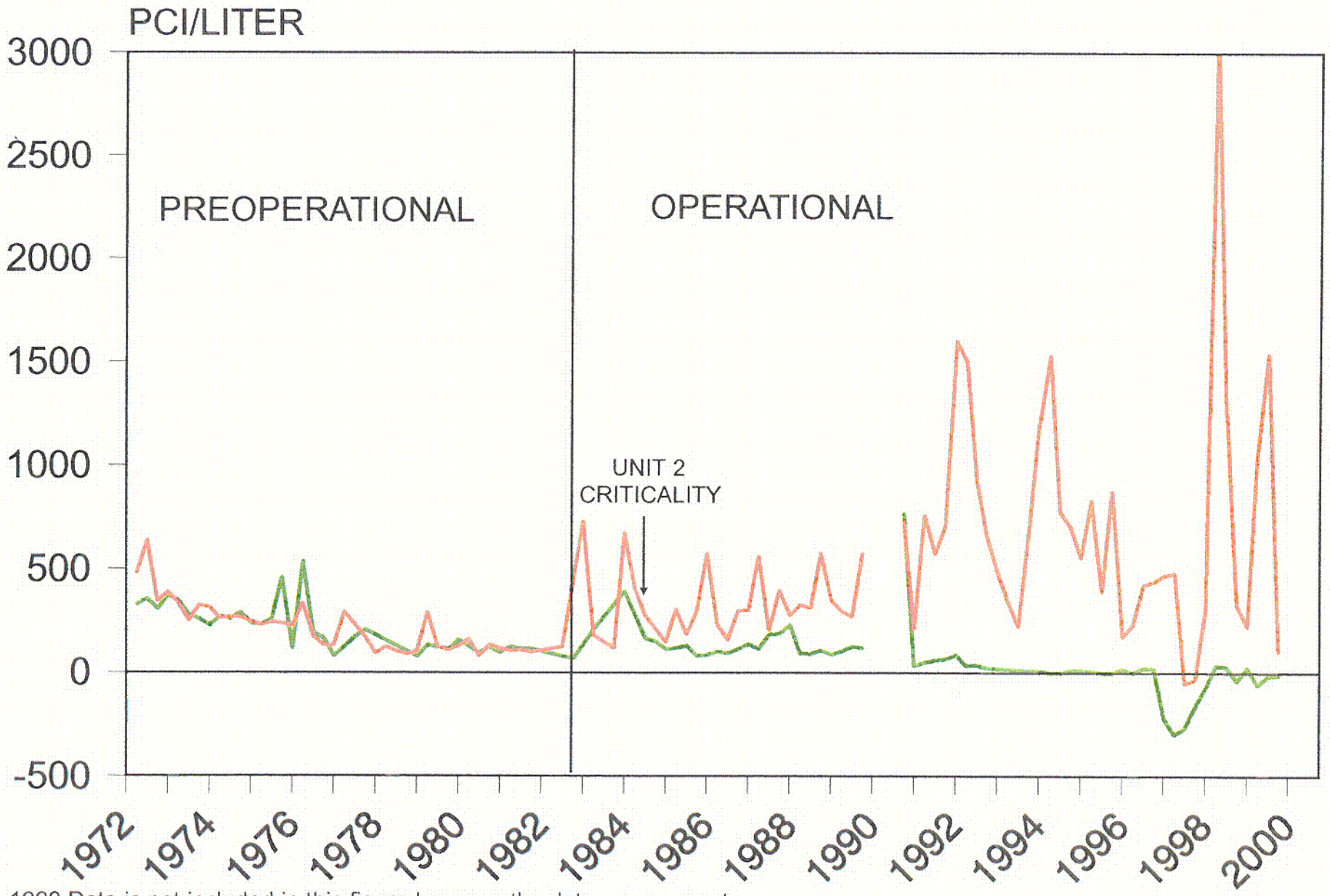



*FIG. 9 - HGW\Remp99.prs*

C2

# TRITIUM ACTIVITY IN SURFACE WATER




1990 Data is not included in this figure because the data was suspect.

*FIG. 10 - HGW\Remp99.prs*

C3

# GROSS BETA ACTIVITY IN DRINKING WATER

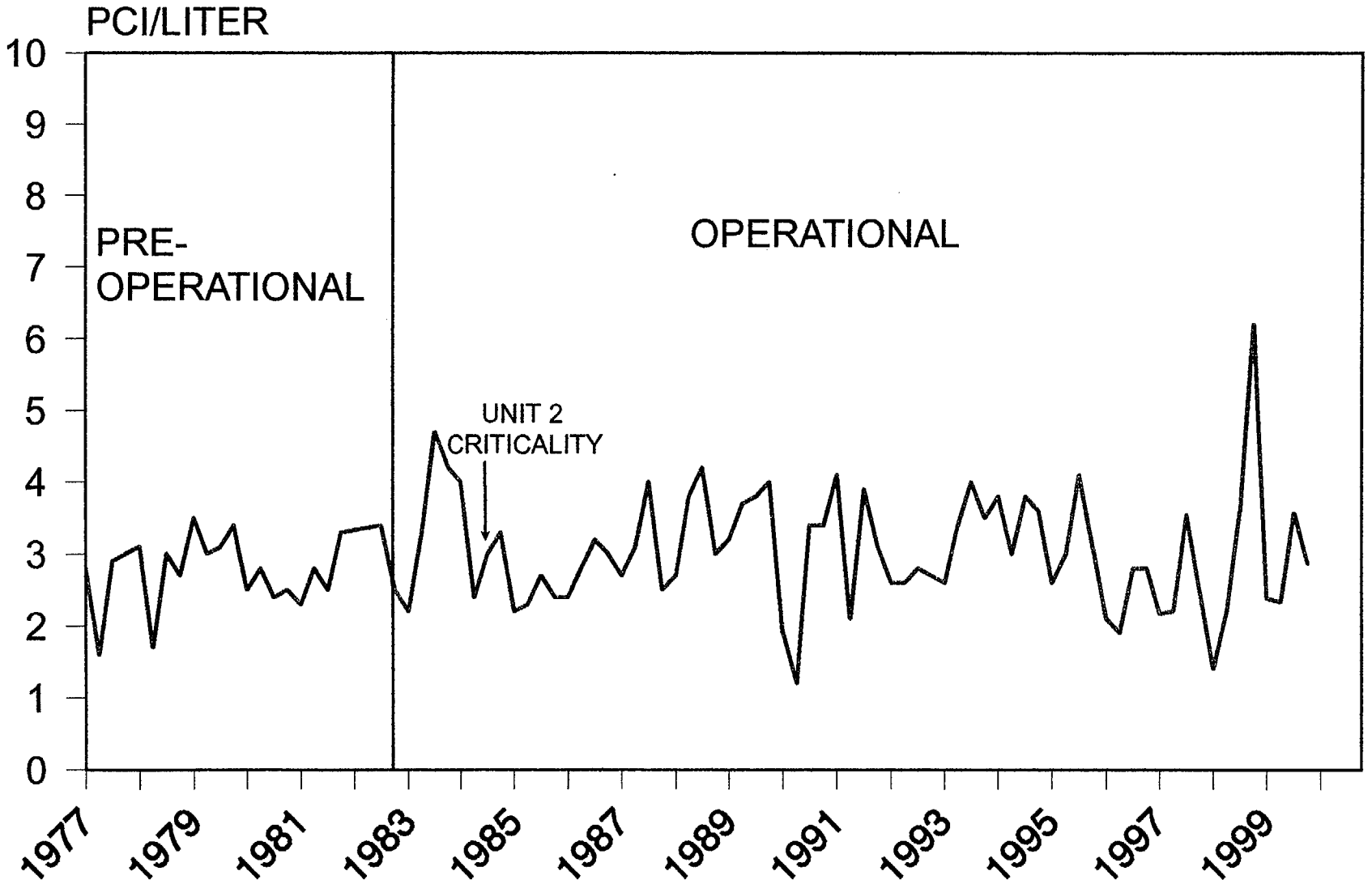



*FIG. 11 - HGW\Remp99.prs*

# ATMOSPHERIC PATHWAY MONITORING

## INTRODUCTION

Atmospheric monitoring by the SSES REMP involves the sampling and analysis of air. Because the air is the first medium that SSES vent releases enter in the pathway to man, it is fundamental that it be monitored. Mechanisms do exist for the transport of airborne contaminants to other media and their concentration in them. For example, airborne contaminants may move to the terrestrial environment and concentrate in milk. Concentrations of radionuclides can make the sampling and analysis of media like milk more sensitive approaches for the detection of radionuclides, such as iodine-131, in the pathway to man than the monitoring of air directly. (PP&L also samples milk; refer to the Terrestrial Pathway Monitoring section of this report.) Nevertheless, the sensitivity of air monitoring can be optimized by the proper selection of sampling techniques and the choice of the proper types of analyses for the collected samples.

## Scope

Air samples were collected on particulate filters and charcoal cartridges at indicator locations 3S2, 5S4, 7S7, 10S3, 12S1, 13S6, 9B1, and 12E1 and control locations 6G1 and 8G1.

## Sampling and Analysis

### *Air*

Throughout the year, the SSES REMP was monitoring the air at eight indicator locations and two control locations. The SSES Technical Requirements require monitoring at only a total of five sites. Monitoring is required at three locations at the SSES site boundary in different sectors with the greatest predicted sensitivities for the detection of SSES releases. Also, monitoring must be performed at the community in the vicinity of the SSES with the greatest predicted sensitivity and a control monitoring location that is expected to be unaffected by any routine SSES releases.

Airborne particulates were collected on glass fiber filters using low volume (typically 2.0 to 2.5 cfm sampling rates) air samplers that run continuously. Air iodine samples were collected on charcoal cartridges, placed downstream of the particulate filters.

Particulate filters and charcoal cartridges were exchanged weekly at the air monitoring sites. Sampling times were recorded on elapsed-time meters. Air sample volumes for particulate filters and charcoal cartridges were measured with dry-gas meters.

Air filters were analyzed weekly for gross beta activity, then composited quarterly and analyzed for the activities of gamma-emitting radionuclides. The

charcoal cartridges were analyzed weekly for iodine-131.

## Monitoring Results

### *Air Particulates*

Gross beta activity is always measured at levels in excess of the analysis MDCs on the fiber filters. The highest gross beta activity levels that have been measured during the operational period of the SSES were obtained in 1986 following the Chernobyl accident in the former Soviet Union. Figure 12 trends the quarterly mean indicator and control location gross beta activities separately from 1974 through 1999. Note that prior to SSES operation, before 1982, the unusually high gross beta activities were generally attributable to fallout from atmospheric nuclear weapons tests. Typical gross beta activities measured on air particulate filters are the result of naturally occurring radionuclides associated with dust particles suspended in the sampled air. They are thus terrestrial in origin.

Particulate gross beta activity levels for each monitoring location and monitoring period in 1999 are presented in Table I-8 of Appendix I. Comparisons of 1999 gross beta analysis results with those of previous years may be found in Table H 13 of Appendix H. Annual means for the beta activities of the indicator and control locations in 1999 of 14.8E-3 pCi/m$^3$ and 13.7E-3 pCi/m$^3$, respectively, are near the low end of the corresponding ranges of previous operational yearly averages. 1999 annual means are significantly below the corresponding lower ends of their preoperational yearly averages. No contribution of radioactivity from the SSES is discernible from 1999 airborne gross beta data.

Quarterly gamma spectroscopic measurements of composited filters often show the naturally occurring radionuclide beryllium-7. Occasionally, other naturally occurring radionuclides, potassium-40 and radium-226 are also observed. Beryllium-7 is cosmogenic in origin, being produced by the interaction of cosmic radiation with the earth's atmosphere. The other two gamma-emitting radionuclides originate from soil and rock.

Beryllium-7 was measured above analysis MDCs for all quarterly composite samples in 1999. The 1999 indicator and control means for beryllium-7 activity were 126 E-3 pCi/m$^3$, and 116E-3 pCi/m$^3$, respectively. The 1999 indicator and control means were higher than the averages of the corresponding annual means for both prior operational and preoperational periods. The 1999 means are similar to the corresponding 1998 means. Beryllium-7 activity levels for each 1999 calendar quarter at each monitoring location are presented in Table I-9 of Appendix I. Comparisons of 1999 beryllium-7 analysis results with previous years may be found in Table H 14 of Appendix H.

Potassium-40 was seen in excess of analysis MDCs in some quarterly composites during 1999. The 1999 indicator and control means for potassium-40 activity were 4.7E-4 and 2.1E-3 pCi/m$^3$, respectively. No other

gamma-emitting radionuclides were reported for air in 1999. Beryllium-7 and potassium-40 are not attributable to SSES operation.

## *Air Iodine*

Iodine-131 has been detected infrequently from 1976, when it was first monitored, through 1999. Since operation of the SSES began in 1982, iodine-131 has only been positively detected in air samples in 1986 due to the Chernobyl accident. No iodine-131 was reported for the 1999 air monitoring results.

# GROSS BETA ACTIVITY IN AIR PARTICULATES

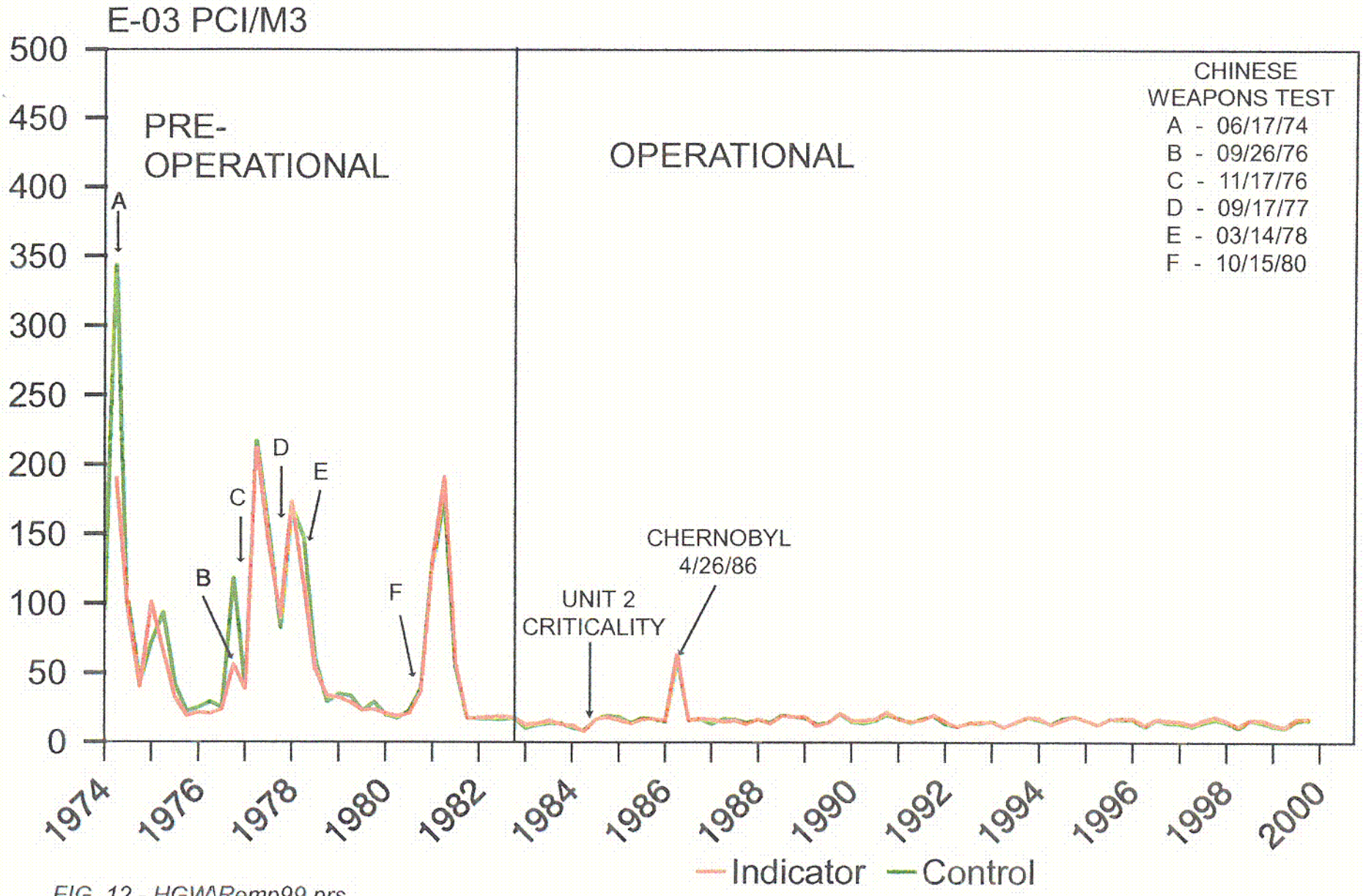



*FIG. 12 - HGW\Remp99.prs*

C4

# TERRESTRIAL PATHWAY MONITORING

## INTRODUCTION

The following media were monitored in the Terrestrial Pathway in 1999: soil, milk, fruits and vegetables.

Soil can be a great accumulator of man-made radionuclides that enter it. The extent of the accumulation in the soil depends of course on the amount of the radionuclides reaching it, but it also depends on the chemical nature of those radionuclides and the particular characteristics of the soil. For example, the element cesium, and, therefore, cesium-137 can be bound very tightly to clay in soils. The amount of clay in soil can vary greatly from one location to another. In highly clay soils, cesium-137 may move very slowly and also may be taken up very slowly in plants as they absorb soil moisture.

Any medium, such as soil, that tends to accumulate radioactive materials can also provide more sensitivity for radionuclide detection in the environment than those media that don't. Such a medium facilitates the early identification of radionuclides in the environment, as well as awareness of changes that subsequently may occur in the environmental levels of the identified radionuclides.

The SSES REMP samples soil near four of the ten REMP air sampling stations. The purpose for soil sampling near the air sampling sites is to make it easier to correlate air sampling results with soil sampling results if any SSES related radioactive material were found in either medium. Sampling is performed at different depths near the surface to help provide information on how recently certain radioactive materials may have entered the soil. Sampling at more than one depth also may help ensure the detection of materials that move relatively quickly through the soil. Such quick-moving materials may have already passed through the topmost layer of soil at the time of sampling.

Milk was sampled at four locations and fruit and vegetable samples were obtained at seven more locations than required in 1999. SSES Technical Requirements require that the SSES REMP sample milk at the three most sensitive monitoring locations near the SSES and one control location distant from the SSES. SSES Technical Requirements only require that fruit and vegetables be sampled at locations irrigated by Susquehanna River from points downstream of the SSES discharge to the River. There are only three locations within ten miles downstream of the SSES that have been known to irrigate with water from the Susquehanna River during unusually dry periods. These locations do not irrigate every year. Irrigation was performed at both the Zehner Brothers Farm (11D1) and the Lupini Farm (11D2 and 12F7) during 1999 which were surveyed in the 1999 Land Use Census (Reference 64).

No requirement exists for the SSES REMP to monitor soil. All monitoring of the terrestrial pathway that is conducted by the SSES REMP in addition to milk and certain fruit and vegetables is voluntary and reflects PPL Corporation's willingness to exceed regulatory requirements, if necessary, to ensure that the public and the environment are protected.

## Scope

### *Soil*

Soil was sampled once, in accordance with its scheduled annual sampling frequency, at each of the four REMP air sampling locations, 3S2, 12S1, 13S6, and 8G1 in September 1999. Location 8G1 was a control sampling location; the remaining sampling sites were indicator locations.

Top and bottom soil plugs were taken, representing soil to a depth of two inches in the first case and soil from a depth of two inches to six inches in the second case, at a total of four monitoring locations in 1999. Twelve plugs from each layer were composited for analysis at each location, as is routine. A total of eight soil samples were analyzed in 1999.

### *Milk*

Milk was sampled at least monthly at the following four locations in 1999: 10D1, 10D2, 10G1, and 7C1.

Milk was sampled semi-monthly from April through October when cows were more likely to be in the pastures. Locations 7C1, 10D1, and 10D2 are believed to be the most sensitive monitoring sites available for the detection of any radionuclides that might be released from the SSES and find their way into milk from local dairy farms. Location 10G1 is the one control location that is sampled by the SSES REMP. A total of 76 milk samples from both indicator and control locations were analyzed in 1999.

### *Fruits and Vegetables*

Fruits and vegetables were sampled at 10 locations in six different sectors surrounding the SSES during the harvest season. Fifteen different kinds of fruits and vegetables were obtained for a total of 41 samples. Samples were obtained from the following locations: 9B4, 10B5, 11B1, 11D1, 11D2, 12S7, 12F7, 13B2, 13G2, and 14B3. Location 13G2 was the control location.

The availability of fruits and vegetables from growers typically varies from one year to the next. For example, gardeners may grow different plants or choose not to plant gardens. An attempt is made each year to obtain samples from the most sensitive locations. This leads to the intentional substitution of some gardens for others based on consideration of annual meteorological data and available gardens as indicated in the Land Use Census from the previous year.

Two locations 11D1 and 12F7 are required to be monitored every year. Three locations, 11D1, 11D2, and 12F7 were identified as having irrigated with Susquehanna River water from downstream of the SSES during 1999. These locations will be sampled each year even though there are often years

with adequate rainfall when no irrigation is performed.

## Sample Preservation and Analysis

The only sample medium monitored in the terrestrial pathway in which preservatives are used is milk. Sodium bisulfite is added to milk samples at the rate of 40 grams per gallon. This both helps maintain iodine in a reduced form and reduces the spoilage rate.

All media in the terrestrial pathway are analyzed for the activities of gamma-emitting radionuclides using gamma spectroscopy. The other analysis that is routinely performed is the radiochemical analysis for iodine-131 in milk.

## Monitoring Results

The only man-made radionuclides normally measured at levels in excess of analysis MDCs in the terrestrial pathway are strontium-90 and cesium-137. Strontium-90 analyses are not now routinely performed for any media samples in the terrestrial pathway. Strontium-90 activity would be expected to be found routinely in milk as the result of fallout from previous nuclear weapons tests if analyses were being performed for it. SSES Technical Requirements do not require that milk be analyzed for strontium-90. Strontium-90 analyses may be performed at any time if the results of other milk analyses would show detectable levels of fission product activity which might suggest the SSES as the source. Cesium-137 normally has been measured in excess of analysis MDCs in most soil samples. Although game is not currently being monitored, cesium-137 has also been seen often at levels above the MDCs in game in the past. This radionuclide also is present in the environment as a residual from previous atmospheric nuclear weapons testing.

Certain naturally occurring radionuclides are also routinely found above analysis MDCs in terrestrial pathway media. Potassium-40, a primordial and very long-lived radionuclide, which is terrestrial in origin, is observed in all terrestrial pathway media exceeding analysis MDCs. Other naturally-occurring radionuclides often observed above MDCs are thorium-228 and radium-226 in soil, and beryllium-7 in fruits and vegetables.

The results of the 1999 terrestrial pathway monitoring resemble those of the past. Results for specific sample analyses of terrestrial pathway media may be found in Tables I-10 through I-12 of Appendix I. A summary of the 1999 terrestrial monitoring data may be located in Appendix G. Comparisons of 1999 monitoring results with those of past years may be found in Tables H 15 through H 20 of Appendix H.

### *Soil*

The 1999 analysis results for all gamma-emitting radionuclides, naturally occurring potassium-40, radium-226, and thorium-228 and man-made cesium-137, that are routinely measured in soil at levels exceeding analysis MDCs were similar to those for

previous years. No other gamma-emitting radionuclides were reported at levels above analysis MDCs in soil in 1999.

The 1999 means for indicator and control location sample potassium-40 activity were 12.7 pCi/gram and 9.1 pCi/gram, respectively. Both means were within the ranges of corresponding means for prior operational years. The indicator mean was higher than the corresponding range of preoperational means. This is not the result of SSES operation because the potassium-40 is naturally occurring. The 1999 indicator and control means for potassium-40 were slightly above their corresponding 1998 means.

The 1999 means for indicator and control location sample radium-226 activity were 1.4 pCi/gram and 1.7 pCi/gram, respectively. These means are within the ranges of the annual means for the previous operational period of the SSES, but they are above the corresponding range of annual means obtained during the preoperational period. This is not the result of SSES operation because the radium-226 is naturally occurring.

The 1999 means for indicator and control location sample thorium-228 activity were 0.8 pCi/gram and 0.7 pCi/gram, respectively. The 1999 indicator mean for thorium-228 is slightly less than the corresponding 1998 mean. The 1999 indicator mean is within the range of corresponding means for the previous operational period of the SSES but below the range of corresponding means for the preoperational period. The 1999 control mean is within the range of its corresponding means for the previous operational period. Thorium-228 in soil is not the result of SSES operation because it is naturally occurring.

The 1999 means for indicator and control location sample cesium-137 activity were 0.08 pCi/g and 0.12 pCi/g, respectively. The 1999 indicator mean is within the range of the corresponding annual mean for prior operational years, but below the range of such means for preoperational years. The 1999 control mean is below both the ranges of the corresponding annual means for both prior operational and preoperational years. Cesium-137 levels in soil samples typically vary widely from sample to sample. Levels of cesium-137 activity in 1999 samples varied by nearly a factor of ten over the entire range. Cesium-137 in soil, although man-made, is not from the operation of the SSES. It is residual fallout from previous atmospheric nuclear weapons testing.

### *Milk*

Iodine-131 has been chemically separated in milk samples and counted routinely since 1977. Refer to Figure 13 which trends iodine-131 activity in milk separately for indicator and control locations from 1977 through 1999. Typically, iodine-131 is not reported at levels exceeding the MDCs for the analyses in any milk samples during a monitored year. The 1999 monitoring year was no exception; no iodine-131 above the analysis MDCs was observed in either indicator or control samples.

The preoperational years 1976, 1978, and 1980 were exceptional years in the sense that iodine-131 activity was observed in excess of MDCs due to fallout from atmospheric nuclear weapons testing. Iodine-131 activity was also measured at levels exceeding MDCs in milk samples in 1986 in the vicinity of the SSES as a result of the Chernobyl incident. Subsequent levels observed near the baseline of Figure 13 in 1991 and 1992 represent background fluctuations in data that appear as a result of averaging methods. No iodine-131 levels exceeding analysis MDCs were observed in milk during these years.

With the exception of the naturally occurring potassium-40, no gamma-emitting radionuclides were measured in excess of analysis MDCs in 1999. The 1999 means for indicator and control location sample potassium-40 activity were 1360 pCi/liter and 1339 pCi/liter, respectively. The 1999 indicator mean is slightly greater than the 1998 mean. However, the 1999 control mean is slightly less than the corresponding 1998 mean. The 1999 indicator mean for potassium-40 activity is slightly above the range of annual means for previous operational years, but within the range of such means for preoperational years. The 1999 control mean is within the ranges of such means for both prior operational and preoperational years. The potassium-40 activity in milk is not attributable to the SSES operation because it is naturally occurring.

## *Fruits and Vegetables*

Naturally occurring potassium-40 was the only gamma-emitting radionuclide reported in fruits and vegetables at activity levels in excess of analysis MDCs during 1999. The 1999 means for indicator and control location sample potassium-40 activity were 2.5 pCi/gram and 2.8 pCi/gram, respectively. The 1999 indicator and control means are slightly above their corresponding 1998 means. The 1999 means are within the ranges of the corresponding annual means for prior operational years. But, the 1999 control mean is below the range of corresponding annual means for preoperational years. Potassium-40 in fruits and vegetables is not attributable to SSES operation because it is a naturally occurring radionuclide.

# IODINE-131 ACTIVITY IN MILK

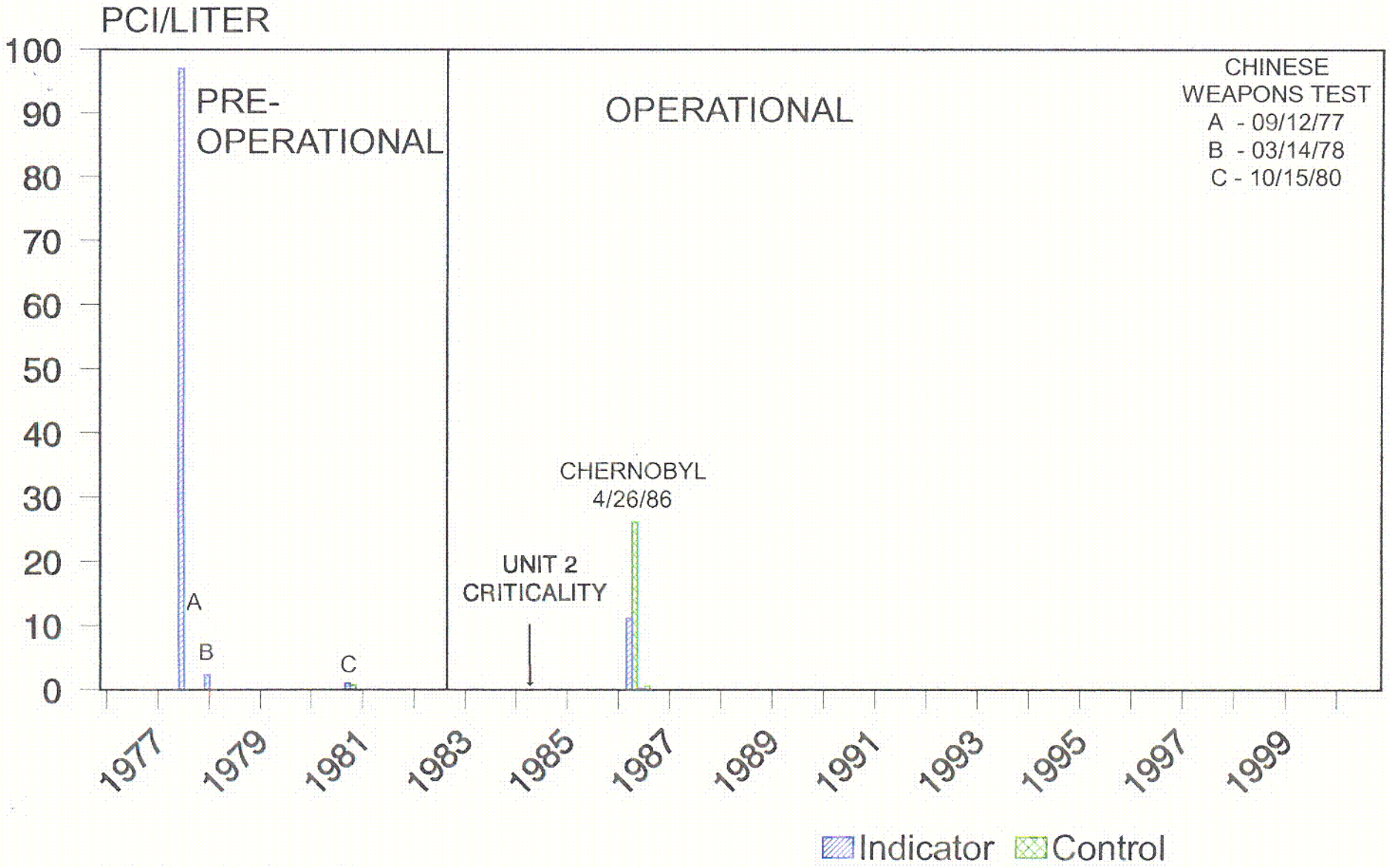



*FIG. 13 - HGW\Remp99.prs*

C-5

# GROUND WATER MONITORING

## INTRODUCTION

Normal operation of the SSES does not involve the release of radioactive material to ground water directly or indirectly through the ground. As a result, there are no effluent monitoring data to verify or to compare with REMP ground water monitoring results. Ground water could conceivably become contaminated by the washout or deposition of radioactive material that might be airborne. If deposited on the ground, precipitation/soil moisture could aid in the movement of radioactive materials through the ground to water that could conceivably be pumped for drinking purposes. (No use of ground water for irrigation near the SSES has been identified.)

Because routine SSES operation releases primarily tritium and, to a lesser extent, isotopes of xenon and krypton to the air, no radionuclides attributable to SSES operation are expected to be observed in ground water. Iodine and particulate releases to the air are negligible. Gaseous xenon and krypton tend to remain airborne; deposition or washout of these would be expected to be very minimal. Tritium would be the most likely radionuclide to reach the ground with precipitation and, if not lost to streams (surface water) by runoff, move readily through the soil to the ground water.

## Scope

In spite of the improbability of measuring any radioactivity attributable to SSES operation in the ground water in the SSES vicinity, it was sampled monthly at four indicator locations (2S2, 4S4, 4S5, and 12S1) and one control location (12F3) during 1999.

With the exception of location 4S4, untreated ground water was sampled. (Untreated means that the water has not undergone any processing such as filtration, chlorination, or softening.) At location 4S4, the SSES Training Center, well water actually is obtained from on-site and piped to the Training Center after treatment. This sampling is performed as a check to ensure that this water has not been radioactively contaminated. Sampling is performed at the Training Center to facilitate the sample collection process.

## Sample Preservation & Analysis

All samples (except the aliquots assigned for tritium analyses) were preserved with nitric acid, the same as described in the section of this report on Aquatic Pathway Monitoring.

Ground water samples were analyzed for the activities of gamma-emitting radionuclides and tritium activity. Gamma spectrometric analyses of ground water were begun in 1979 and tritium analyses in 1972, both prior to SSES operation.

## Monitoring Results

Tritium activity levels in ground water have typically been observed to be lower than surface water tritium levels. A noticeable decline occurred between 1992 and 1993 in the ground water tritium levels. Fewer measurements of tritium resulted in levels above the analysis sensitivities in 1993 than in 1992.

Gamma spectrometric analyses have identified and measured gamma-emitting radionuclides in excess of MDCs in only a few samples in all the years that these analyses have been being performed. The naturally occurring radionuclides potassium-40 and thorium-228 have been measured above their MDCs occasionally in ground water. Potassium-40 has been measured above MDCs in 1979, 1981, 1985, 1991, 1992, 1993, and 1997. Thorium-228 has been observed above MDCs in 1985 and 1986. The man-made radionuclide cesium-137 has been measured above MDCs only occasionally since 1979. Its presence has always been attributed to residual fallout from previous atmospheric nuclear weapons tests.

The results of the 1999 REMP ground water surveillance resemble those of the past. Results for specific ground water sample analyses may be found in Table I-7 of Appendix I. A summary of the 1999 ground water monitoring data may be located in Appendix G. Comparisons of 1999 monitoring results for tritium with those of past years may be found in Table H 21 of Appendix H.

During 1999, tritium was measured in excess of an analysis MDC in a ground water sample on only one occasion. The 1999 mean tritium activity levels for indicator and control ground water monitoring locations were 25 pCi/liter and 21 pCi/liter, respectively. Similar to those for 1998, the indicator and control ground water monitoring location means are less than the MDCs that are typically achieved. Both the 1999 indicator and control mean tritium activity levels are significantly below the corresponding averages of annual means for prior operational and preoperational years. A decline in tritium averages for various waters, including ground water, first occurred in 1991 when data averaging methods changed. Another decline in tritium averages was noted in 1993 for waters generally. In 1997, another significant decline in tritium levels from the previous years was observed.

Naturally occurring potassium-40 was not measured in excess of an analysis MDC for any ground water samples during 1999. No man-made gamma-emitting radionuclides were measured at levels in excess of analysis MDCs in 1999 in ground water samples. The results from gamma spectroscopic analyses indicated that no radioactivity contributions to ground water from the SSES were identifiable in 1999.

# REFERENCES


1. Radiation Management Corporation, "Susquehanna Steam Electric Station, Radiological Environmental Monitoring Program, Report #1 (April - December 1972)" RMC-TR-73-14, July 1973.

2. Radiation Management Corporation, "Susquehanna Steam Electric Station, Pre-operational Radiological Environmental Monitoring Program 1973," RMC-TR-74-07, May 1974.

3. Radiation Management Corporation, "Susquehanna Steam Electric Station, Preoperational Radiological Environmental Monitoring Program, 1974 Annual Report," RMC-TR-75-07, April 1975.

4. Radiation Management Corporation, "Susquehanna Steam Electric Station, Radiological Environmental Monitoring Program, 1975 Annual Report," RMC-TR-76-05, May 1976.

5. Radiation Management Corporation, "Susquehanna Steam Electric Station, Radiological Environmental Monitoring Program, 1976 Annual Report," RMC-TR-77-04, March 1977.

6. Radiation Management Corporation, "Susquehanna Steam Electric Station, Radiological Environmental Monitoring Program, 1977 Annual Report," RMC-TR-78-01, May 1978.

7. Radiation Management Corporation, "Susquehanna Steam Electric Station, Radiological Environmental Monitoring Program, 1978 Annual Report," RMC-TR-79-01, April 1979.

8. Radiation Management Corporation, "Susquehanna Steam Electric Station, Radiological Environmental Monitoring Program, 1979 Annual Report," RMC-TR-80-01, March 1980.

9. Radiation Management Corporation, "Susquehanna Steam Electric Station, Radiological Environmental Monitoring Program, 1980 Annual Report," RMC-TR-81-02, July 1981.

10. Radiation Management Corporation, "Susquehanna Steam Electric Station, Radiological Environmental Monitoring Program, 1981 Annual Report," RMC-TR-82-03, July 1982.

11. Radiation Management Corporation, "Susquehanna Steam Electric Station, Radiological Environmental Monitoring Program, 1982 Preoperational Report," RMC-TR-83-01, April 1983.

12. Radiation Management Corporation, "Susquehanna Steam Electric Station, Radiological Environmental Monitoring Program, 1982 Operational Report." RMC-TR-83-02, April 1983.

13. NUS Corporation, "Susquehanna Steam Electric Station, Radiological Environmental Monitoring Program, 1983 Annual Report," NUS-4516 March 1984.

14. Pennsylvania Power and Light Company, "Susquehanna Steam Electric Station, Environmental Report, Operating License Stage," May 1978.

15. Pennsylvania Power and Light Company, "Susquehanna Steam Electric Station, Final Safety Analysis Report".

16. United States Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, "Final Environmental Statement Related to the Operation of Susquehanna Steam Electric Station, Units 1 and 2," Docket Nos. 50-387 and 50-388, June 1981.

17. United States Nuclear Regulatory Commission, "An Acceptable Radiological Environmental Monitoring Program," Radiological Assessment Branch Technical Position, November 1979, Revision 1.

18. National Council on Radiation Protection and Measurements, "Environmental Radiation Measurement," NCRP Report No. 50, Washington, D.C., December 27, 1976.

19. Oakley, D.C., "Natural Radiation Exposure in the United States," ORP/SID 72-1 Office of Radiation Programs, U.S. Environmental Protection Agency, Washington, D.C., June 1972.

20. Denham, D.H., Roberts, M.C., Novitsky, W.M., Testa, E.D., "Investigation of Elevated Cesium-137 Concentrations in Small Game in Luzerne County, Pennsylvania." Proceedings of Papers presented at Health Physics Society Tenth Midyear Topical Symposium, October 11-13, 1976, pgs 271-279.

21. Teledyne Isotopes, "Susquehanna Steam Electric Station, Radiological Environmental Monitoring Program, 1984 Annual Report," April 1985.

22. Currie L.A., "Lower Limit of Detection: Definition and Elaboration of a Proposed Position for Radiological Effluent and Environmental Measurements," NUREG/CR-4007, September 1984.

23. Pennsylvania Power and Light Company, "Susquehanna Steam Electric Station, Semi-annual Effluent Waste Disposal Report, Data Period: January - June 1986", August 1986.

24. Pennsylvania Power and Light Company, "Susquehanna Steam Electric Station, Semi-annual Effluent Waste Disposal Report, Data Period: July - December 1986," February 1987.

25. Pennsylvania Power and Light Company Technical Specifications Susquehanna Steam Electric Station, Units no. 1 and 2; Docket no. 50-387 and 50-388 Appendix A to License no. NPF-14 and NPF-22.

26. Teledyne Isotopes, "Susquehanna Steam Electric Station, Radiological Environmental Monitoring Program, 1985 Annual Report", April 1986.

27. Teledyne Isotopes, "Susquehanna Steam Electric Station, Radiological Environmental Monitoring Program, 1986 Annual Report," April 1987.

28. Pennsylvania Power and Light Company, "Susquehanna Steam Electric Station, Semi-annual Effluent Waste Disposal Report, Data Period: January - June 1987, August 1987.

29. Pennsylvania Power and Light Company, "Susquehanna Steam Electric Station, Semi-annual Effluent Waste Disposal Report, Data Period: July - December 1987, February 1988.

30. Pennsylvania Power & Light Company, "Susquehanna Steam Electric Station, Radiological Environmental Monitoring Program, 1987 Annual Report," April 1988.

31. Pennsylvania Power & Light Company, "Susquehanna Steam Electric Station, Semi-annual Effluent Waste Disposal Report, Data Period: January-June 1988," August 1988.

32. Pennsylvania Power & Light Company, "Susquehanna Steam Electric Station, Semi-annual Effluent Waste Disposal Report, Data Period: July-December 1988," February 1989.

33. Pennsylvania Power & Light Company, "Susquehanna Steam Electric Station, Radiological Environmental Monitoring Program, 1988 Annual Report," April 1989.

34. Pennsylvania Power & Light Company, "Susquehanna Steam Electric Station, Semi-annual Effluent Waste Disposal Report, Data Period: January-June 1989," August 1989.

35. Pennsylvania Power & Light Company, "Susquehanna Steam Electric Station, Semi-annual Effluent Waste Disposal Report, Data Period: July-December 1989," February 1990.

36. Pennsylvania Power & Light Company, "Susquehanna Steam Electric Station, Radiological Environmental Monitoring Program, 1989 Annual Report," April 1990.

37. Pennsylvania Power & Light Company, "Susquehanna Steam Electric Station, Semi-annual Effluent Waste Disposal Report, Data Period: January-June 1990," August 1990.

38. Pennsylvania Power & Light Company, "Susquehanna Steam Electric Station, Semi-annual Effluent Waste Disposal Report, Data Period: July-December, 1990," February 1991.

39. Pennsylvania Power & Light Company, "Susquehanna Steam Electric Station, Radiological Environmental Monitoring Program, 1990 Annual Report," April 1991.

40. Pennsylvania Power & Light Company, "Susquehanna Steam Electric Station, Semi-Annual Effluent Waste Disposal Report, Data Period: January - June 1991," August 1991.

41. Pennsylvania Power & Light Company, "Susquehanna Steam Electric Station, Semi-Annual Effluent Waste Disposal Report, Data Period: July 1 - December, 1991," February 1992.

42. Pennsylvania Power & Light Company, "Susquehanna Steam Electric Station, Radiological Environmental Monitoring Program, 1991 Annual Report," April 1992.

43. Pennsylvania Power & Light Company, "Susquehanna Steam Electric Station, Semi-Annual Effluent Waste Disposal Report, Data Period: January - June 1992," August 1992.

44. Pennsylvania Power & Light Company, "Susquehanna Steam Electric Station, Semi-Annual Effluent Waste Disposal Report, Data Period: July 1 - December 1992," February 1993.

45. Pennsylvania Power & Light Company, "Susquehanna Steam Electric Station, Radiological Environmental Monitoring Program, 1992 Annual Report," April 1993.

46. Pennsylvania Power & Light Company, "Susquehanna Steam Electric Station, Annual Effluent & Waste Disposal Report, Data Period: January - December 1993, March 1994.

47. Pennsylvania Power & Light Company, "Susquehanna Steam Electric Station, Radiological Environmental Monitoring Program, 1993 Annual Report," April, 1994.

48. Pennsylvania Power & Light Company, "Susquehanna Steam Electric Station, Annual Effluent & Waste Disposal Report," Data Period: January-December 1994, March, 1995.

49. Ecology III, Inc., "Susquehanna Steam Electric Station, 1994 Land Use Census," November, 1994.

50. Pennsylvania Power & Light Company, "Susquehanna Steam Electric Station, Radiological Environmental Monitoring Program, 1994 Annual Report," April, 1995.

51. Pennsylvania Power & Light Company, "Susquehanna Steam Electric Station, Annual Effluent & Waste Disposal Report," Data Period: January - December 1995, March, 1996.

52. Ecology III, Inc., "Susquehanna Steam Electric Station, 1995 Land Use Census," October, 1995.

53. Pennsylvania Power & Light Company, "Susquehanna Steam Electric Station, Radiological Environmental Monitoring Program, 1995 Annual Report," April, 1996.

54. Pennsylvania Power & Light Company, "Susquehanna Steam Electric Station, Annual Effluents & Waste Disposal Report," Data Period: January - December 1996, March 1997.

55. Ecology III, Inc., "Susquehanna Steam Electric Station, 1996 Land Use Census," November, 1996.

56. Pennsylvania Power & Light Company, "Susquehanna Steam Electric Station, Radiological Environmental Monitoring Program 1996 Annual Report," April 1997.

57. Pennsylvania Power & Light Company, "Susquehanna Steam Electric Station, Annual Effluents & Waste Disposal Report," Data Period: January - December 1997, March 1998.

58. Ecology III, Inc., "Susquehanna Steam Electric Station, 1997 Land Use Census," November 1997.

59. Pennsylvania Power & Light Company, "Susquehanna Steam Electric Station, 1997 Annual Radiological Environmental Operating Report," April 1998.

60. Pennsylvania Power & Light Company, "Susquehanna Steam Electric Station, Annual Effluents & Waste Disposal Report," Data Period: January – December 1998, April 1999.

61. Ecology III, Inc., "Susquehanna Steam Electric Station, 1998 Land Use Census," October 1998.

62. Pennsylvania Power & Light Company, "Susquehanna Steam Electric Station, 1998 Annual Radiological Environmental Operating Report," May 1999.

63. Pennsylvania Power & Light Company, "Susquehanna Steam Electric Station, Annual Effluents & Waste Disposal Report," Data Period: January – December 1999, April 2000.

64. Ecology III, Inc., "Susquehanna Steam Electric Station, 1999 Land Use Census," October 1999.

# APPENDIX A

## 1999 REMP CHANGES

## Aquatic Pathway Monitoring

Beginning on February 11, 1999, PP&L's Corporate Environmental Radioactivity Measurements Laboratory (CERML) resumed the primary analyses, which are normally those of record, for all water samples for tritium activity. Also effective on that date, Teledyne Brown Engineering's laboratory in Westwood, NJ resumed the tritium analyses of quality control samples for the surface water monitoring locations 6S6 and 2S7, the drinking water monitoring location 12H2T, and the ground water monitoring location, 4S5. This change returned the responsibilities for tritium analyses of water samples to the laboratories to which they had been assigned prior to June 1998.

The reason for the return to the original assignment of tritium analysis responsibilities was that CERML had replenished its supply of tritium standard for the determination of counting efficiencies. Also, CERML demonstrated its ability to obtain accurate analysis results for tritium using the newly acquired tritium standard by achieving excellent agreement with the calculated tritium level of a spiked water.

## Terrestrial Pathway Monitoring

On January 5, 1999, the SSES REMP began sampling at a new milk monitoring location, 7C1. This location is the Zajac farm, 2.5 miles southeast of the SSES. This replaced a milk sampling location, 12B3 that had previously been monitored. This old location was the Young farm. Milk was no longer obtainable from this location because the farm had sold all its dairy cows.

The replacement location 7C1 was selected because meteorological data indicated that it was the most sensitive milk producing location for the detection of airborne radioactivity that might be released from the SSES that was not already being sampled and from which samples could be obtained. Meteorological data indicated that another milk producing location, 15B2, should be a more sensitive location for monitoring, however, permission to sample the milk there could not be obtained because of the small amount of milk produced by the two cows at that location.

# APPENDIX B

## 1999 REMP MONITORING SCHEDULE (SAMPLING AND ANALYSIS)

**TABLE 1**
**(Page 1 of 2)**

**Annual Analytical Schedule for the**
**PP&L Susquehanna Steam Electric Station**
**Radiological Environmental Monitoring Program - 1999**

| Media & Code | No. of Locations | Sample Freq.(a) | Analyses Required | Analysis Freq. (b) |
|---|---|---|---|---|
| Airborne Particulates | 10 | W | Gross Beta (c)<br>Gamma Spectrometry | W<br>QC |
| Airborne Iodine | 10 | W | I-131 | W |
| Sediment | 4 | SA | Gamma Spectrometry | SA |
| Fish | 2<br>1 | SA<br>A | Gamma Spectrometry<br>(on edible portion) | SA |
| Surface Water (d) | 4 | MC, M, or BWC | Gross Beta<br>I-131<br>Gamma Spectroscopy<br>Tritium | M<br>BW<br>M<br>M |
| Well (ground) Water | 5 | M | Gamma Spectroscopy<br>Tritium | M<br>M |
| Drinking Water (e) | 1 | MC, BWC | Gross Alpha<br>Gross Beta<br>I-131<br>Gamma Spectrometry<br>Tritium | M<br>M<br>BW<br>M<br>M |
| Cow Milk | 4 | M, SM(f) | I-131<br>Gamma Spectrometry | SM, M<br>SM, M |
| Food Products (Various Fruits and Vegetables) | 10 | A | Gamma Spectrometry | A |
| Soil | 4 | A | Gamma Spectrometry | A |
| Direct Radiation | 86 | Q | TLD | Q |

Note: See footnotes at end of table.

(a) W = weekly, BW = bi-weekly, BWC = bi-weekly composite, M = monthly, SM = semi-monthly, Q = quarterly, QC = quarterly composite, SA = semi-annually, A = annually, MC = monthly composite.

(b) Codes are the same as for sample frequency.

(c) If the gross beta activity were greater than 10 times the yearly mean of the control sample, gamma analysis would be performed on the individual filter. Gross beta analysis was performed 24 hours or more following filter change to allow for radon and thoron daughter decay.

(d) Stations 6S6, 6S7, and 2S7 were checked at least weekly to ensure that the automatic composite samplers were operational. Time proportional sampling was performed at locations 6S6, 6S7 and 2S7 the entire year. Station 6S5 was grab sampled weekly. Individual composites of the weekly samples were made both monthly (MC) and biweekly for analysis.

(e) Water from station 12H2 TREATED was retrieved weekly. Composite samples of the weekly collections at this location were made both monthly (MC) and biweekly (BWC) for analysis. Sampling at 12H2 TREATED was performed using an automatic continuous sampler (ACS) that was operated in the time proportional mode.

(f) Stations 7C1, 10D1, 10D2, and 10G1 were sampled semi-monthly from April through October.

# APPENDIX C

# 1999
# REMP MONITORING LOCATION DESCRIPTIONS

# TABLE C 1
(Page 1 of 5)

## TLD Locations for the SSES
## Radiological Environmental Monitoring Program – 1999

**Less Than One Mile from the SSES[a] - See Figure 2**

| Location Code(b) | Distance (miles) | Direction | Description |
|---|---|---|---|
| 1S2 | 0.2 | N | Perimeter Fence |
| 2S2 | 0.9 | NNE | Energy Information Center |
| 2S3 | 0.2 | NNE | Perimeter Fence |
| 3S2 | 0.5 | NE | SSES Backup Met Tower |
| 3S3 | 0.9 | NE | ANSP Riverlands Garden |
| 3S4 | 0.3 | NE | Perimeter Fence |
| 4S3 | 0.2 | ENE | Post, West of SSES APF |
| 4S6 | 0.7 | ENE | Riverlands |
| 5S4 | 0.8 | E | West of Environmental Laboratory |
| 5S7 | 0.3 | E | Perimeter Fence |
| 6S4 | 0.2 | ESE | Perimeter Fence (north) |
| 6S9 | 0.2 | ESE | Perimeter Fence (south) |
| 7S6 | 0.2 | SE | Perimeter Fence |
| 7S7 | 0.4 | SE | End of Kline's Road |
| 7S8 | 0.4 | SE | Kline Residence |
| 8S2 | 0.2 | SSE | Perimeter Fence |
| 9S2 | 0.2 | S | Security Fence |
| 10S1 | 0.4 | SSW | Post - south of switching station |
| 10S2 | 0.2 | SSW | Security Fence |
| 10S3 | 0.6 | SSW | Confer's Lane – south of Towers Club |
| 11S3 | 0.3 | SW | Security Fence |
| 11S7 | 0.4 | SW | SSES Access Road Gate #50 |
| 12S1 | 0.4 | WSW | SSES West Building |

# TABLE C 1
(Page 2 of 5)

## TLD Locations for the SSES
## Radiological Environmental Monitoring Program – 1999

**Less Than One Mile from the SSES[a] - See Figure 2**

| Location Code (b) | Distance (miles) | Direction | Description |
|---|---|---|---|
| 12S3 | 0.4 | WSW | Perimeter Fence |
| 12S4 | 0.4 | WSW | Perimeter Fence |
| 12S5 | 0.4 | WSW | Perimeter Fence |
| 12S6 | 0.4 | WSW | Perimeter Fence |
| 13S2 | 0.4 | W | Perimeter Fence |
| 13S4 | 0.4 | W | Perimeter Fence |
| 13S5 | 0.4 | W | Perimeter Fence |
| 13S6 | 0.4 | W | Former Laydown Area - west of Confer's Lane |
| 14S5 | 0.5 | WNW | Beach Grove Road/Confer's Lane |
| 14S6 | 0.7 | WNW | Beach Grove Road (pole) |
| 15S5 | 0.4 | NW | Perimeter Fence |
| 16S1 | 0.3 | NNW | Perimeter Fence (east) |
| 16S2 | 0.3 | NNW | Perimeter Fence (west) |
| 6A4 | 0.6 | ESE | Restaurant (U.S. Route 11) |
| 8A3 | 0.9 | SSE | PP&L Wetlands Sign (U. S. Route 11) |
| 15A3 | 0.9 | NW | Fritz & Boom Residence |
| 16A2 | 0.8 | NNW | Benkinney Residence |
| **From One to Five Miles from the SSES[a] - See Figure 3** | | | |
| 12S7 | 1.1 | WSW | Kisner Residence |
| 1B1 | 1.4 | N | Mingle Inn Road |
| 2B3 | 1.3 | NNE | Durabond Corporation |
| 2B4 | 1.4 | NNE | U.S. Route 11/Mingle Inn Road Intersection |
| 5B3 | 1.6 | E | PP&L Switchyard |
| 7B2 | 1.5 | SE | Heller's Orchard Store |
| 8B2 | 1.4 | SSE | Lawall Residence |
| 8B3 | 1.5 | SSE | Wapwallopen Post Office |

# TABLE C 1
**(Page 3 of 5)**

## TLD Locations for the SSES
## Radiological Environmental Monitoring Program – 1999

**From One to Five Miles from the SSES[a] - See Figure 3**

| Location Code (b) | Distance (miles) | Direction | Description |
|---|---|---|---|
| 9B1 | 1.3 | S | Transmission Line - east of Route 11 |
| 10B2 | 2.0 | SSW | Algatt Residence |
| 10B3 | 1.7 | SSW | Castek Inc. |
| 10B4 | 1.4 | SSW | U. S. Route 11/River Road Intersection |
| 12B4 | 1.7 | WSW | Shultz Farm |
| 13B1 | 1.3 | W | Walker Run Creek (Tele. Pole #36) |
| 14B3 | 1.3 | WNW | Moskaluk Residence |
| 15B1 | 1.7 | NW | Country Estates Trailer Park |
| 16B2 | 1.7 | NNW | Walton Power Line |
| 11C1 | 2.0 | SW | Salem Township Fire Company |
| 1D5 | 4.0 | N | Shickshinny/Mocanaqua Sewage Treatment Plt. |
| 6D1 | 3.5 | ESE | St. Peters Church – Hobbie |
| 8D3 | 4.0 | SSE | Mowry Residence |
| 9D4 | 3.6 | S | Country Folk Store |
| 10D1 | 3.0 | SSW | R. & C. Ryman Farm |
| 12D2 | 3.7 | WSW | Dagostin Residence |
| 14D1 | 3.6 | WNW | Moore's Hill/Mingle Inn Roads Intersection |
| 3E1 | 4.7 | NE | Webb Residence - Lilly Lake |
| 4E2 | 4.7 | ENE | Ruckles Hill/Pond Hill Roads Intersection |
| 5E2 | 4.5 | E | Bloss Farm |
| 6E1 | 4.7 | ESE | St. James Church |

# TABLE C1
**(Page 4 of 5)**

## TLD Locations for the SSES
## Radiological Environmental Monitoring Program – 1999

**From One to Five Miles from the SSES[a] - See Figure 3**

| Location Code (b) | Distance (miles) | Direction | Description |
|---|---|---|---|
| 7E1 | 4.2 | SE | Harwood Transmission Line Pole #2 |
| 11E1 | 4.7 | SW | Thomas Residence |
| 12E1 | 4.7 | WSW | Berwick Hospital |
| 13E4 | 4.1 | W | Kessler Farm |

**Greater than Five Miles from the SSES[a] - See Figure 4**

| | | | |
|---|---|---|---|
| 2F1 | 5.9 | NNE | St. Adalberts Cemetery |
| 8F2 | 8.5 | SSE | Huff Residence |
| 12F2 | 5.2 | WSW | Berwick Substation |
| 15F1 | 5.4 | NW | Zatwatski Farm |
| 16F1 | 7.8 | NNW | Hidlay Residence |
| 3G4 | 17 | NE | Wilkes Barre Service Center |
| 4G1 | 14 | ENE | Mountaintop - Crestwood Industrial Park |
| 6G1 | 13.5 | ESE | Freeland Substation |
| 7G1 | 14 | SE | Hazleton PP&L Complex |
| 7G2 | 12 | SE | Hazleton Cemetery - 14th Street |
| 8G1 | 12 | SSE | PP&L SFC - Humbolt Industrial Park |
| 12G1 | 15 | WSW | PP&L Service Center, Bloomsburg |
| 12G4 | 10 | WSW | Naus Residence |

# TABLE C 1
## (Page 5 of 5)

## TLD Locations for the SSES
## Radiological Environmental Monitoring Program – 1999

a) All distances from the SSES to monitoring locations are measured from the standby gas treatment vent at 44200/N34117 (Pa. Grid System). The location codes are based on both distance and direction from the SSES. The letters in the location codes indicate if the monitoring locations are on site (within the site boundary) or, if they are not on site, the approximate distances of the locations from the SSES as described below:

| | |
|---|---|
| S - on site | E - 4-5 miles |
| A - <1 mile | F - 5-10 miles |
| B - 1-2 miles | G - 10-20 miles |
| C - 2-3 miles | H - >20 miles |
| D - 3-4 miles | |

The numbers preceding the letters in the location codes provide the directions of the monitoring locations from the SSES by indicating the sectors in which they are located. A total of 16 sectors (numbered 1 through 16) equally divide an imaginary circle on a map of the SSES and its vicinity, with the SSES at the center of the circle. The middle of sector 1 is directed due north (N). Moving clockwise from sector 1, the sector immediately adjacent to sector 1 is sector 2, the middle of which is directed due north, northeast (NNE). Continuing to move clockwise, the sector numbers increase to 16, which is the north, northwest sector.

The numbers following the letters in the location codes are used to differentiate sampling locations found in the same sectors at approximately the same distances from the SSES.

# TABLE C 2
(Page 1 of 4)

## Sampling Locations for the SSES
## Radiological Environmental Monitoring Program – 1999

**Less Than One Mile from the SSES[a] - See Figure 5**

| Location Code | Distance (miles) | Direction | Description |
|---|---|---|---|
| **SURFACE WATER** | | | |
| 2S7 | 0.1 | NNE | Cooling Tower Blowdown Line |
| 5S9 | 0.8 | E | Environmental Lab Boat Ramp (Alternate for 6S6) |
| 6S5 | 0.9 | ESE | Outfall Area |
| 6S6 | 0.8 | ESE | River Water Intake Line |
| 6S7 | 0.4 | ESE | Cooling Tower Blowdown Line |
| LTAW | | NE - ESE | Lake Took-A-While (on site) |
| **FISH** | | | |
| LTAW | | NE - ESE | Lake Took-A-While (on site) |
| **SEDIMENT[c]** | | | |
| LTAW | | NE - ESE | Lake Took-A-While (on site) |
| **AIR** | | | |
| 3S2 | 0.5 | NE | SSES Backup Meteorological Tower |
| 5S4 | 0.8 | E | West of SSES Environmental Laboratory |
| 7S7 | 0.4 | SE | End of Kline's Road |
| 10S3 | 0.6 | SSW | East of Confer's Lane, South of Towers Club |
| 12S1 | 0.4 | WSW | West Building |
| 13S6 | 0.4 | W | Former Laydown Area, West of Confers Lane |
| **SOIL** | | | |
| 3S2 | 0.5 | NE | SSES Backup Meteorological Tower |
| 12S1 | 0.4 | WSW | West Building |
| 13S6 | 0.4 | W | Former Laydown Area, West of Confers Lane |

# TABLE C2
## (Page 2 of 4)

## Sampling Locations for the SSES
## Radiological Environmental Monitoring Program – 1999

**Less Than One Mile from the SSES[a] - See Figure 5**

| Location Code | Distance (miles) | Direction | Description |
|---|---|---|---|
| | | | **GROUND WATER** |
| 2S2 | 0.9 | NNE | Energy Information Center |
| 4S4 | 0.5 | ENE | Training Center |
| 4S5 | 0.5 | ENE | White House |
| 12S1 | 0.5 | SW | West Building |
| **From One to Five Miles From the SSES - See Figure 6** | | | |
| | | | **FISH[b]** |
| IND | 0.9 - 1.4 | ESE | At or Below the SSES Discharge Diffuser |
| | | | **SEDIMENT[c]** |
| 2B | 1.6 | NNE | Gould Island |
| 7B | 1.2 | SE | Bell Bend |
| | | | **AIR** |
| 9B1 | 1.3 | S | Transmission Line - East of Route 11 |
| 12E1 | 4.7 | WSW | Berwick Hospital |
| | | | **MILK** |
| 10D1 | 3.0 | SSW | R. & C. Ryman Farm |
| 10D2 | 3.1 | SSW | Raymond Ryman Farm |
| 7C1 | 2.6 | SE | Zajac Farm |
| | | | **FRUITS/VEGETABLES** |
| 12S7 | 1.1 | WSW | Kisner Residence |
| 9B4 | 1.1 | S | Cope Residence |
| 10B5 | 1.2 | SSW | Bodnar Residence |
| 13B2 | 1.2 | W | Seely/Hummel Residence |
| 14B3 | 1.3 | WNW | Moskaluk Residence |
| 11B1 | 1.9 | SW | H. Shultz Residence |
| 11D1 | 3.3 | SW | Zehner Farm |
| 11D2 | 3.5 | SW | Lupini Farm (Route 93) |

# TABLE C 2
## (Page 3 of 4)

## Sampling Locations for the SSES
## Radiological Environmental Monitoring Program – 1999

**Greater than Five Miles from the SSES[a] - See Figure 7**

| Location Code | Distance (miles) | Direction | Description |
|---|---|---|---|
| **DRINKING WATER** | | | |
| 12H2T | 26 | WSW | Danville Water Co. (treated) |
| **FISH[b]** | | | |
| 2H | 30 | 30 | Near Falls, Pa. |
| **SEDIMENT[c]** | | | |
| 12F | 6.9 | WSW | Old Berwick Test Track |
| **AIR** | | | |
| 6G1 | 13.5 | ESE | Freeland Substation |
| 8G1 | 12 | SSE | PP&L SFC - Humbolt Industrial Park |
| **SOIL** | | | |
| 8G1 | 12 | SSE | PP&L SFC - Humbolt Industrial Park |
| **MILK** | | | |
| 10G1 | 14 | SSW | Davis Farm |
| **FRUITS/VEGETABLES** | | | |
| 12F7 | 8.3 | WSW | Lupini Farm |
| 13G2 | 16 | W | Kile Farm |
| **GROUND WATER** | | | |
| 12F3 | 5.2 | WSW | Berwick Water Company |

# TABLE C 2
**(Page 4 of 4)**

## Sampling Locations for the SSES
## Radiological Environmental Monitoring Program – 1999

a) All distances from the SSES to monitoring locations are measured from the standby gas treatment vent at 44200/N34117 (Pa. Grid System. The location codes are based on both distance and direction from the SSES. The letters in the location codes indicate if the monitoring locations are on site (within the site boundary) or, if they are not on site, the approximate distances of the locations from the SSES as described below:

| | |
|---|---|
| S - on site | E - 4-5 miles |
| A - <1 mile | F - 5-10 miles |
| B - 1-2 miles | G - 10-20 miles |
| C - 2-3 miles | H - >20 miles |
| D - 3-4 miles | |

The numbers preceding the letters in the location codes provide the directions of the monitoring locations from the SSES by indicating the sectors in which they are located. A total of 16 sectors (numbered 1 through 16) equally divide an imaginary circle on a map of the SSES and its vicinity, with the SSES at the center of the circle. The middle of sector 1 is directed due north (N). Moving clockwise from sector 1, the sector immediately adjacent to sector 1 is sector 2, the middle of which is directed due north, northeast (NNE). Continuing to move clockwise, the sector numbers increase to 16, which is the north, northwest sector.

The numbers following the letters in the location codes are used to differentiate sampling locations found in the same sectors at approximately the same distances from the SSES.

b) No actual location is indicated since fish are sampled over an area which extends through 3 sectors (5, 6, 7) near the outfall area.

c) No permanent locations exist; samples are taken based on availability. Consequently, it is not necessary to assign a number following the letter in the location code.

# APPENDIX D

## 1999 LAND USE CENSUS RESULTS

# 1999 LAND USE CENSUS RESULTS

The SSES Technical Requirements require that a census be conducted annually during the growing season to determine the location of the nearest milk animal, residence, and garden greater than 50 $m^2$ (≈500 $ft^2$) producing broad leaf vegetation in each of the 16 meteorological sectors within a distance of 8 km (≈5 miles) in each of the 16 meteorological sectors surrounding the SSES. To comply with this requirement, a land-use survey was conducted for the SSES during 1999. The closest qualified gardens and residences and all dairy animals within five miles of SSES in each of the 16 sectors were identified.

Table 5 lists the results of the census. The results are used in conjunction with the most recent year's meteorological data to determine if any changes in required REMP sampling locations for milk must be made. These results are also used to determine the optimum sampling locations for fruits and vegetables and to make changes in such sampling locations if warranted and practical. Such changes ensure that the most sensitive monitoring locations are included in the REMP. Land use census results are also used in the assessment of potential radiological doses to individuals and populations living in the vicinity of the SSES.

A comparison of the 1998 and 1999 Land Use Census results for the Susquehanna SES indicates that changes occurred in two of the nearest residences and one of the nearest dairy animal locations from 1998 to 1999. No changes occurred with any of the nearest gardens. Refer to the summary of these changes in the table below.

**CHANGES FROM 1998 TO 1999 IN NEAREST RESIDENCES AND DAIRY ANIMALS AS DETERMINED BY THE 1999 LAND USE CENSUS**

| Exposure Pathway | Sector/ Direction | 1998 | | 1999 | |
|---|---|---|---|---|---|
| | | Name | Distance (mi.) | Name | Distance (mi.) |
| Residence | 3/NE | Danko | 2.3 | Tuggle | 0.9 |
| | 5/E | Faux | 1.7 | Kozlowski | 1.4 |
| Dairy Animal | 12/WSW | Young | 2.0 | none | none |

The 1999 Land Use Census also identified changes in meat and produce usage from 1998 to 1999. Refer to the summary of these changes in the table below.

**CHANGES FROM 1998 TO 1999 IN MEAT AND PRODUCE USAGE AT THE NEAREST GARDEN & DAIRY ANIMAL LOCATIONS**

| Exposure Pathway | Sector/ Direction | Name | Distance (mi.) | Meat/Produce Usage | |
|---|---|---|---|---|---|
| | | | | 1998 | 1999 |
| Garden | 2/NNE | Chapin | 2.3 | None | Ducks & Beef Cattle |
| | 4/ENE | Dennis | 2.4 | Chickens, Eggs, Goats, & Pheasants | None |
| Dairy Animal | 6/ESE | Moyer | 2.7 | Garden | No Garden |

In April 1999, the annual evaluation of current REMP milk sampling locations and available locations from which milk might be sampled, as identified by the previous (1998) Land Use Census, was performed. Considering available meteorological data from 1998, this evaluation determined that the location, the Dennis residence, of goats 2.4 miles ENE of the SSES had better meteorological characteristics for monitoring milk than those of existing REMP milk sampling locations. However, the 1998 Land Use Census determined that these goats were not "fresh" or, in other words, not capable of supplying milk at the time of the Census. The status of the goats as not "fresh" was confirmed again in April 1999 by direct observation of an environmental sampling person. Therefore, replacement of any of the existing milk sampling locations with sampling from the Dennis residence was not possible.

# TABLE 5

Nearest residence, garden, and dairy animal in each of the 16 meteorological sectors within a 5-mile radius of the Susquehanna Steam Electric Station, 1999.

| SECTOR | DIRECTION | NEAREST RESIDENCE | NEAREST GARDEN | NEAREST DAIRY ANIMAL |
|---|---|---|---|---|
| 1 | N | 1.3 mi | 3.2 mi | >5.0 mi |
| 2 | NNE | 1.0 mi | 2.3 mi[b,i] | >5.0 mi |
| 3 | NE | 0.9 mi | 2.3 mi | >5.0 mi |
| 4 | ENE | 2.1 mi | 2.4 mi | >5.0 mi |
| 5 | E | 1.4 mi | 1.8 mi | 4.5 mi[g,i] |
| 6 | ESE | 0.5 mi | 2.5 mi | 2.7 mi |
| 7 | SE | 0.5 mi | 0.6 mi | 2.6 mi[g] |
| 8 | SSE | 0.6 mi | 1.5 mi | >5.0 mi |
| 9 | S | 1.0 mi | 1.1 mi | >5.0 mi |
| 10 | SSW | 0.9 mi | 1.2 mi | 3.0 mi[a,b,c,d,e,g] |
| 11 | SW | 1.5 mi | 1.9 mi | >5.0 mi |
| 12 | WSW | 1.1 mi | 1.1 mi | >5.0 mi |
| 13 | W | 1.2 mi | 1.2 mi | 5.0 mi[g] |
| 14 | WNW | 0.8 mi | 1.3 mi | >5.0 mi |
| 15 | NW | 0.8 mi | 1.8 mi | 1.8 mi[a,i] |
| 16 | NNW | 0.6 mi | 4.0 mi | 4.2 mi |

[a]Chickens raised for consumption at this location.
[b]Ducks raised for consumption at this location.
[c]Eggs consumed from chickens raised at this location.
[d]Geese raised for consumption at this location.
[e]Pigs raised for consumption at this location.
[f]Turkeys raised for consumption at this location.*
[g]Fruits/vegetables grown for consumption at this location.
[h]Rabbits raised for consumption at this location*
[i]Beef cattle raised for consumption at this location.
[j]Goats raised for consumption at this location.
[k]Pheasants raised for consumption at this location.

*No locations were identified as raising turkeys, rabbits, and pheasants during 1999.

# APPENDIX E

## SUMMARY DESCRIPTION OF SSES REMP ANALYTICAL METHODS

# TLD MEASUREMENTS

The PP&L Inc. dosimetry system used for monitoring ambient radiation levels in the environment consists of Panasonic 710A readers and Panasonic UD-814 TLDs. The UD-814 TLD badges each contain four elements. Elements 2, 3, and 4 in each badge are made of calcium sulfate with 800 mg/cm$^2$ of filtering and element 1 is composed of lithium tetraborate with filtering of 25 mg/cm$^2$. Only the calcium sulfate elements are normally used for environmental measurements because of their higher light output per unit of radiation exposure relative to the lithium tetraborate and, consequently, greater sensitivity for the detection and measurement of radiation.

Note: Element 1 would be of value in the event of an unusually large release of noble gases, especially xenon, that would produce relatively low-energy X-ray or gamma emissions. This is because the lithium tetraborate does not over-respond to such low-energy emissions as does the calcium sulfate.

The TLD element manufacturers' attempt to make each element as similar as possible to each of the other elements in each batch that is produced. Nevertheless, each element ends up somewhat different in its response to radiation. In order to minimize the effect of these inherent differences when comparing actual monitoring results for different elements, Element Correction Factors (ECFs) are determined for each element. The ECFs are used to effectively normalize the readings of the field elements placed at particular monitoring locations for given monitoring periods to the average of the readings that would be expected if so-called reference elements were to be placed simultaneously at those individual locations. Reference elements are elements that have been demonstrated to display superior measurement performance.

The selection process for reference elements involves repeatedly irradiating a large set of elements, processing them, calculating the mean response for each set of elements, and evaluating the deviation of each individual element response from the mean response. After this process has been repeated at least several times, the elements with the least variability in their responses and with mean responses nearest to the mean response of the entire population of elements are chosen as reference elements.

To determine ECFs for individual field elements, the elements are first exposed to known amounts of radiation (100 mR) and processed, a minimum of three times each. Each element reading is then divided by the mean of the readings obtained from reference elements (typically 30 to 35) that were exposed to the same amounts of radiation as the elements for which the ECFs are being determined and that were processed at the same time as these elements. The mean quotient (ratio) is then calculated for each element by summing the quotients obtained for each processing and then dividing by the total number of the processings performed.

The following equation shows how ECFs are calculated:

$$ECF = \left[ \frac{\sum_{i=1}^{n} \frac{E_i}{\overline{E}_{ref}}}{n} \right]$$

where

$E_i$ an uncorrected exposure reading for the element.

$n =$ the total number of individual element exposures averaged.

$\overline{E}_{ref} =$ the mean of the ECF-corrected exposure readings of the reference elements.

Irradiated control TLDs are processed (read) with the batches of TLDs from the field to provide both processing calibration information and quality control. Field control TLDs, which accompany the field TLDs when they are being taken to their monitoring locations and subsequently retrieved from these locations, and cave control TLDs, which are stored with the field TLDs for the periods between annealing and field distribution and between retrieval from the field and processing, are also read with the field TLDs to provide checks on the exposures that the field TLDs might receive on their way to and from their monitoring locations and while in storage, respectively.

The raw data from the field TLD processings is Run Calibration Factor (RCF) corrected using the irradiated control TLD data. The irradiated control TLDs are exposed to 100 mR from a cesium-137 source at the University of Michigan. The irradiated TLDs are accompanied enroute to and from the University of Michigan by transit control TLDs. An estimate of the exposures received by the irradiated TLDs in-transit is obtained by processing the transit controls and determining the transit control mean by the following equation:

$$\overline{E}_{tc} = \frac{\sum_{i=1}^{n} \left[ \frac{E_i}{ECF_i} \right]_{tc}}{n}$$

where

$\overline{E}_{tc} =$ the mean of the elementally corrected exposure readings of all the transit control elements.

$E_i =$ the uncorrected exposure reading of each individual transit control element.

$ECF_i$ = the elemental correction factor of each individual transit control element.

$n$ = the total number of individual element exposures averaged.

The mean of the transit control exposures is then subtracted from each of the elementally corrected exposures of the irradiated elements to obtain the net exposures for each element resulting from the irradiation. The mean of these net exposures is then divided by the known exposure (100 mR) from the irradiation to determine the RCF. The following equation describes the calculations performed:

$$RCF = \frac{\left[\dfrac{\sum_{i=1}^{n}\left(\dfrac{E_i}{ECF_i} - \overline{E}_{tc}\right)_{ic}}{n}\right]}{KE_{ic}}$$

where

$RCF$ = the run correction factor for an individual field monitoring element.

$E_i$ = the exposure reading of each individual irradiated control element.

$ECF_i$ = the elemental correction factor of each individual irradiated control element.

$n$ = the total number of individual element exposures averaged.

$KE_{ic}$ = the known exposure for each of the irradiated control elements.

Exposure readings for individual field monitoring elements are corrected using the appropriate mean transit exposure and the elemental and run correction factors as follows:

$$CE_x = \frac{UE_x - \overline{E}_{TC}}{ECF_x \times RCF_x}$$

where

$CE_x$ = the corrected exposure reading for field monitoring element x.

$UE_x$ = the uncorrected exposure reading for field monitoring element x.

$ECF_x$ = the elemental correction factor for field monitoring element x.

$\overline{E}_{TC}$ = mean transit exposure

$RCF_x$ = the run correction factor for field monitoring element x.

NOTE: The mean transit exposure is determined from the elements of the TLDs that accompany the field TLDs during transportation to and from the field locations.

The exposure representing each environmental monitoring location and monitoring period is normally the mean of the corrected exposure readings for a total of six calcium sulfate elements, three from each of two different TLDs at each location. The following equation shows the calculation of this exposure:

$$\overline{E}_c = \frac{\sum_{i=1}^{n} CE_i}{n}$$

where

$\overline{E}_c$ = the mean of the corrected exposure readings for a given monitoring location and period.

$CE_i$ = the corrected exposure reading of an individual element for a given monitoring location and period.

$n$ = the total number of individual element exposures averaged.

The mean of the corrected exposure readings for a given location and period may be calculated using less than the six calcium sulfate elements if the reading from one of the elements is more than two standard deviations from the mean. In this situation, the mean would be recalculated with only five element readings, excluding the element reading that was more than two standard deviations from the originally calculated mean. The mean may be automatically calculated by the dosimetry software with as few as four element readings before the data is flagged. The following calculation is used to determine the standard deviation of the corrected elemental exposure readings:

$$S_{ce} = \sqrt{\frac{\sum_{i=1}^{n} \left(CE_i - \overline{E}_c\right)^2}{n-1}}$$

where

$S_{ce}$ = the standard deviation of the corrected exposure readings from a given monitoring location and period for (n-1) degrees of freedom.

$\overline{E}_c$ = the mean of the corrected exposure readings for a given monitoring location and period.

$CE_i$ = the corrected exposure reading of an individual element for a given monitoring location and period.

$n$ = the total number of individual element exposures averaged.

The standard monitoring period for the reporting of TLD exposures is the calendar quarter. The calendar quarter is defined as a period of 91.25 days. The actual monitoring periods for TLDs in the field are often for times other than 91.25 days. The means of the corrected exposures for these nonstandard periods must be normalized to the standard calendar quarter. The following equation shows how the normalization is performed:

$$NE = \frac{\overline{E}_c \times 91.25}{MP}$$

where

$NE$ = mean corrected exposure normalized to a standard calendar quarter of 91.25 days.

$\overline{E}_c$ = the mean of the corrected exposure readings for a given monitoring location and period.

$MP$ = the actual TLD monitoring period (time in the field) in days.

## TLD DATA INTERPRETATION

Pre-operational and operational data are compared for the purpose of determining whether or not TLD data may indicate a dose contribution from SSES operation. Between 1979 and 1994, both TLD types and TLD processing systems changed more than once. In order to avoid possible confusion in data interpretation as a result of these changes, ratios of TLD doses for specific indicator locations to the average of the TLD doses for control locations from operational periods compared to their counterparts from the preoperational period. Comparison of these ratios is performed in lieu of comparing the actual operational and preoperational doses. The following equation shows how these ratios are calculated:

$$r_i = d_i \div \bar{d}_c$$

where

$r_i$ - is the indicator-to-control-average dose ratio for a particular location and calendar quarter,

$d_i$ - is the quarterly dose for a particular indicator location, and

$\bar{d}_c$ - is the average quarterly dose for certain control locations.

**Note:**

The $r_i$ are the quotients of the indicator doses to the average doses of the following control locations: 3G4, 4G1, 7G1, 12G1, and 12G4. Only these control locations are used because they were the only ones existing during the preoperational period.

Operational $r_i$ for indicator locations that do not have preoperational histories are compared with the range of preoperational control-to-control-average dose ratios ($r_c$) experienced at control locations. It can be safely assumed that the preoperational range of these $r_c$ at control locations are the result of variations in the levels of background radiation at those locations. Any operational indicator $r_i$ for an indicator location without a preoperational history that is above the uppermost range expected at control locations based on preoperational data is assumed to suggest a possible contribution from the SSES operation. The following equation shows how $r_c$ is calculated:

$$r_c = d_c \div \bar{d}_c$$

where

$r_c$ - is the control-to-control-average dose ratio for a particular location and calendar quarter,

$d_c$ - is the quarterly dose for a particular control location, and

$\bar{d}_c$ - is the average quarterly dose for certain control locations.

## Flagging Environmental TLD Measurements for Possible Non-Natural Dose Contributions

Confidence ranges, within which 95% of environmental TLD doses resulting from natural, background radiation are expected to be, have been derived for each location

with a preoperational history by multiplying the standard deviation (S) of the $r_i$ for the location by the appropriate t score (t) based on the applicable degrees of freedom for each location. (Degrees of freedom (df) are equal to the number of ratios that were averaged less one.) The product of the t score and the standard deviation (tS) was then subtracted from the mean ($\bar{x}$) to determine the lower end of the 95% confidence range (R) and added to the mean to obtain the upper end of the range (R) as indicated by the following equation:

$$R = \left(\bar{x} - t*S\right) to \left(\bar{x} + t*S\right)$$

The following t scores were used in the range calculations:

| t SCORES | |
|---|---|
| **df** | **$t_{0.05}$** |
| 1 | 12.706 |
| 2 | 4.303 |
| 3 | 3.182 |
| 4 | 2.776 |
| 5 | 2.571 |
| 6 | 2.447 |
| 7 | 2.365 |

For indicator locations with no preoperational history, TLD results are flagged for potential non-natural dose contributions to TLD measurements based on comparisons to the maximum expected variation in control-to-control-average dose ratios ($r_c$) for control locations. The expected ranges of $r_c$ for each control location for each calendar quarter during the 1980-81 preoperational period have been calculated. The highest expected $r_c$ for all the preoperational control locations is 1.22.
Ratios for indicator locations greater than 1.22 are flagged for possible SSES direct radiation dose contributions.

**Calculation of SSES Attributable Direct Radiation Dose based on Onsite Indicator TLD Measurements**

For TLD locations where direct radiation dose contributions from the SSES are indicated, these calendar quarter doses are estimated based on the amounts referred to as the excess ratios. Excess ratio for each location's $r_i$ for a particular calendar quarter is the amount by which that $r_i$ exceeds the high end of its range of preoperational $r_i$. The excess ratio at a specific location is multiplied times both the average dose for control locations measured during that calendar quarter and an occupancy factor based on a

reasonable estimate of the portion of the calendar quarter that a MEMBER OF THE PUBLIC might spend near an onsite TLD location. The following is a table of occupancy factors that are used:

| Environmental TLD Monitoring Locations | Occupancy Factors |
|---|---|
| Onsite | 4.56E-4 |
| Offsite (other than Private Residences) | 3.65E-3 |
| Private Residences | 1 |

The following equation is used for obtaining direct radiation doses attributable to the SSES at indicator TLD locations when preoperational data exists for those locations:

$$D_{SSES}=(r_i-r_u)\times D_{CA}\times OF$$

where

$D_{SSES}$ - is the dose attributable to SSES fuel cycle operations,

$r_i$ - is the indicator-to-control average ratio for a particular location and calendar quarter,

$r_u$ - is the indicator-to-control average ratio corresponding to the upper end of the 95% confidence range for a particular location for the preoperational period, and

$D_{CA}$ - is the average quarterly dose for control locations.

OF - is the occupancy factor.

The equation below is used for obtaining direct radiation doses attributable to the SSES at indicator locations when preoperational data
**does not** exist for those locations:

$$D_{SSES}=(r_i-1.22)\times D_{CA}\times OF$$

where

$D_{SSES}$ - is the dose attributable to SSES fuel cycle operations,

$r_i$ - is the indicator-to-control average ratio for a particular location and calendar quarter,

1.22 - is the highest expected $r_c$ for control locations due to variations in natural radiation levels based on preoperational data. Refer to location 12G4 in Attachment 1.

$D_{CA}$ - is the average quarterly dose for control locations.

OF - is the occupancy factor.

Each year, the SSES attributable doses calculated for each calendar quarter are summed for all calendar quarters at each location to obtain annual doses by location.

# DETERMINATION OF GROSS ALPHA AND/OR GROSS BETA ACTIVITY

## TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES & PP&L INC.'S CORPORATE ENVIRONMENTAL RADIOACTIVITY MEASUREMENTS LABORATORY

Aliquots of water samples are evaporated to near dryness in beakers. The remaining volumes (approximately five milliliters or less) are transferred to stainless steel planchets and evaporated to dryness.

All planchets are counted in low background gas-flow proportional counters. Calculations of both gross alpha and beta activities include the use of empirical self-absorption correction curves to account for changes in effective counting efficiency occurring as a result of changes in the masses of residue being counted.

Weekly air particulate filters are placed into planchets as received and counted in low background gas-flow proportional counters. No corrections are made for beta self-absorption when calculating the gross beta activities of the air particulate filters because of the impracticality of weighing the deposit and because the penetration depth of the deposit into the filter is unknown.

### CALCULATION OF THE SAMPLE ACTIVITY

$$\frac{pCi}{unit\ volume\ or\ mass} = \underbrace{\frac{\left[\frac{C}{t} - R_b\right]}{2.22\,(V)(E)}}_{\textbf{net activity}} \pm \underbrace{\frac{2\sqrt{\frac{\frac{C}{t} + R_b}{t}}}{2.22\,(V)\,(E)}}_{\textbf{random uncertainty}}$$

where: C = total counts for sample

t = count time for sample/background (minutes)

$R_b$ = background count rate of counter (cpm)

2.22 = $\frac{\text{dpm}}{\text{pCi}}$

V(M) = volume or mass of sample analyzed

E = efficiency of the counter (cpm/dpm)

**Calculation of the Minimum Detectable Concentration (MDC) Value**

$$MDC = \frac{4.66\sqrt{\frac{R_b}{t}}}{2.22\,(V)\,(E)}$$

# RADIOCHEMICAL DETERMINATION OF I-131 IN MILK AND WATER SAMPLES

## TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES

A four-liter aliquot of sample is first equilibrated with stable iodide carrier. Following a period of time sufficient for equilibration, anion exchange resin is added to the aliquot to capture the iodide ions present. The iodide ion is subsequently removed from the resin using sodium hypochlorite. Hydroylamine hydrochloride is then used to produce free iodine. The resulting free iodine is then extracted from the aqueous phase by dissolution in toluene. This is followed by a reduction back to the iodide form using sodium bisulfite and back-extraction to the aqueous phase. Once in the aqueous phase again, the iodide is precipitated as palladium iodide following the addition of palladium chloride.

Another aliquot of the sample is used to determine the stable iodide content of the milk by the use of a specific-ion electrode. This information is then used to correct the chemical yield determined from the mass of the dried precipitate obtained.

The dried precipitate is beta counted on a low-level counter.

### CALCULATION OF THE SAMPLE ACTIVITY

$$\frac{pCi}{\ell} = \frac{\left[\frac{C}{t} - R_b\right]}{2.22(v)(y)(DF)(E)} \pm \frac{2\sqrt{\frac{C}{t} + R_b}}{2.22(V)(y)(DF)(E)}$$

net activity | random uncertainty

where:
- C = total counts from sample
- t = counting time for sample (min)
- $R_b$ = background count rate of counter (cpm)
- 2.22 = $\frac{dpm}{pCi}$
- V = volume of sample analyzed (liters)
- y = chemical yield of the mount or sample counted
- DF = decay factor from the collection to the mid-count time

E = efficiency of the counter for the I-131 betas.

Note: Efficiency is determined by counting an I-131 standard.

**Calculation of the MDC**

$$MDC = \frac{4.66\sqrt{\frac{R_b}{t}}}{2.22(V)(y)(DF)(E)}$$

# DETERMINATION OF TRITIUM IN WATER BY LIQUID SCINTILLATION COUNTING

## TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES & PP&L INC.'S CORPORATE ENVIRONMENTAL RADIOACTIVITY MEASUREMENTS LABORATORY

Ten milliliters of water is mixed with liquid scintillation material and counted for typically 200 minutes to determine its activity.

### CALCULATION OF THE SAMPLE ACTIVITY FOR TRITIUM

$$\frac{pCi}{\ell} = \frac{\left[\frac{C}{t} - R_b\right]}{2.22(V)(E)^*} \pm \frac{2\sqrt{\frac{\frac{C}{t} + R_b}{t}}}{2.22(V)(E)^*}$$

net activity random uncertainty

where:
- C = total counts from sample
- t = count time for sample (minutes)
- $R_b$ = background count rate of counter (cpm)
- 2.22 = $\frac{\text{dpm}}{\text{pCi}}$
- V = initial volume before enrichment (liters)
- E = efficiency of the counter for tritium (cpm/dpm)

**Calculation of the MDC**

$$MDC = \frac{4.66\sqrt{\frac{R_b}{t}}}{(2.22)(V)(E)^*}$$

*Note that PP&L Inc.'s Corporate Environmental Radioactivity Measurements Laboratory incorporates a decay factor (D) in the denominators of these expressions to account for the small amount of radioactive decay between sample collection and sample counting.

# DETERMINATION OF GAMMA EMITTING RADIOISOTOPES

## TELEDYNE BROWN ENGINEERING
## ENVIRONMENTAL SERVICES

Gamma emitting radionuclides are determined with the use of a lithium-drifted germanium (Ge(Li)) and high purity germanium detectors with high resolution spectrometry in specific media, such as, air particulate filters, charcoal filters, milk, water, vegetation, soil/sediments, biological media, etc. Each sample is prepared and counted in standard geometries such as one liter or four liter wrap-around Marinelli containers, 300 ml or 150 ml bottles, two-inch filter paper source geometries, etc.

Samples are counted on large ( 55 cc volume) germanium detectors connected to Nuclear Data 6620 data acquisition and computation systems. All resultant spectra are stored on magnetic tape.

The analysis of each sample consists of calculating the specific activities of all detected* radionuclides as well as the minimum detectable concentration for a standard list of nuclides. The germanium detection systems are calibrated for each standard geometry using certified radionuclide standards traceable to the National Institute of Standards and Technology.

### CALCULATION OF THE SAMPLE ACTIVITY

$$Net\ pCi/vol\ or\ mass = \frac{[C-B]}{2.22(V)(E)(GA)DF)(t)} \pm \frac{2\sqrt{C+B}}{2.22(V)(E)(GA)(DF)(t)}$$

net activity random uncertainty

where: C = area, in counts, of a spectral region containing a gamma emission of the nuclide of interest

Note (1): If the detector exhibits a peak in this region when counting a blank , the counts from that peak are subtracted from C before using the above equation.

Note (2): If no peaks are exhibited, the counts in the channels where the predominant peaks for gammas from selected radionuclides would be expected are summed for C and used in the calculation of "net" activity.

B = background counts in the region of interest, calculated by fitting a straight line across the region connecting the two adjacent regions.

Note: If no peak exists in a region from which a "net" activity is being calculated, background is represented by the average of the counts in one channel from each side of that region.

t = counting interval of sample (minutes)

2.22 = dpm/pCi

V = volume or mass of sample analyzed

E = efficiency of counter at the energy region of interest

GA = gamma abundance of the nuclide at the gamma emission energy under consideration

DF = decay factor from sample collection time to midpoint of the counting interval

**Calculation of the MDC**

$$MDC\ (pCi\ /\ vol\ or\ mass) = \frac{4.66\sqrt{C}}{2.22(V)(E)(GA)(DF)(t)}$$

The width of the region around the energy where an emission is expected is calculated differently for MDCs than it is for the width of a peak that is actually identified. Consequently, the value of C used in the two equations may differ.

*The analyst's judgment is exercised in the decision to report an activity. The agreement between various spectral lines of the same nuclide, and possible interference from other nuclides, are considered in this decision.

# DETERMINATION OF RADIOSTRONTIUM IN MILK* AND WATER

## TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES

Strontium-89/90 analyses may be performed on water samples for PP&L. The first step in the preparation of milk and water for analysis is the addition of strontium carrier. The addition of stable strontium facilitates the precipitation of any radioactive strontium that may be present and provides sufficient quantities of strontium to be able to reliably determine the amount of radioactive strontium recovered from the samples for counting.

Subsequent steps in the preparation of both the water and the milk samples for counting involves a number of physical and chemical separations to isolate any radioactive strontium that might be in the samples originally, as well as the stable strontium that is added to the sample aliquots to be analyzed. The isolation removes other metallic elements that may be present in both the water and the milk and organic materials that are present in the milk in significant quantities.

Strontium is precipitated twice, first as strontium nitrate and second as strontium sulfate, in the preparation of the water samples. This permits the removal of radium and other naturally occurring radioactive materials as the result of the first precipitation and iron by way of the second precipitation.

Milk is first evaporated and ashed to remove organic materials. The residue is then redissolved with an aqueous solution of hydrochloric acid and filtered to remove insoluble materials, after which strontium is precipitated as a phosphate to remove other unwanted materials. The phosphate precipitate then is redissolved with an aqueous solution of nitric acid and the resulting solution is passed through a chromatographic column. The strontium is retained on the column, allowing other unwanted material to pass through. The strontium is later removed from the column by passing deionized water through it.

Following all of the purification steps for both water and milk, stable yttrium carrier is added to the purified portions remaining to facilitate the precipitation of any radioactive yttrium-90 that appears in the processed sample from the radioactive decay of strontium-90. The yttrium carrier also aids in the yield determination for yttrium-90. These portions are then allowed to stand for at least five days to permit yttrium-90 ingrowth. After the yttrium-90 ingrowth period, yttrium is precipitated as an oxalate and strontium is precipitated as a carbonate. Each is then collected on separate filter discs for gravimetric yielding and beta counting.

*No milk was analyzed for strontiums 89 and 90 in 1998.

The filter discs are mounted on planchets prior to counting. Strontium-89 activity is determined by counting the strontium planchets while they are covered with 80 mg/cm$^2$ aluminum absorbers to eliminate interference from the strontium-90 betas. Strontium-90 activity is inferred by counting the yttrium planchets.

## CALCULATION OF THE SAMPLE ACTIVITY

$$\frac{pCi}{unit\ volume\ mass} = \frac{\left[\frac{C}{t} - R_b\right] f}{2.22(V)(y_1)(y_2)(DF)(IF)(E)} \pm \frac{2\sqrt{\frac{C}{t} + \frac{R_b}{t}}}{2.22(V)(y_1)(y_2)(DF)(IF)(E)}$$

C = total counts from sample

t = counting time for sample (background)

$R_b$ = background count rate

f = ash fraction (gm ash/gm milk)

V = volume of sample analyzed

$y_1$ = chemical yield of yttrium

$y_2$ = chemical yield of strontium

DF = decay factor of yttrium from the milking time to the mid-count time

IF = Ingrowth factor for Y-90 from scavenge time to milking time

E = efficiency of the counter for Y-90

**Calculation of the Minimum Detectable Concentration Value**

$$MDC = \frac{4.66 f \sqrt{\frac{R_b}{t}}}{2.22(V)(y_1)(y_2)(DF)(IF)(E)}$$

## CALCULATION OF THE SAMPLE SR-89 ACTIVITY

$$\frac{pCi}{unit\ volume\ (mass)} = \frac{\left[\frac{C}{t} - B_C - B_A\right] f}{2.22(V)(Y_s)(DF_{Sr-89})(E_{Sr-89})} \pm \frac{2f\sqrt{\left[\frac{C}{t} + B_C + B_A\right]/t}}{2.22(V)(Y_s)(DF_{Sr-89})(E_{Sr-89})}$$

where

| | | |
|---|---|---|
| C | = | total counts from sample |
| t | = | counting time for sample |
| $B_C$ | = | background rate of counter using absorber configuration |
| $B_A$ | = | background addition from Sr-90 and Y-90 ingrowth (cpm)* |
| f | = | ash fraction (gm ash/gm milk) |
| V | = | volume of sample analyzed |
| $Y_S$ | = | 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$^2$ aluminum absorber |

*Note that $B_A$ is a calculated value.

**Calculation of the Minimum Detectable Concentration Value**

$$MDC = \frac{4.66f\sqrt{\frac{[B_C + B_A]}{t}}}{2.22(V)(Y_s)(DF_{Sr-89})}$$

# APPENDIX F

## 1999 EXCEPTIONS TO THE SSES TECHNICAL REQUIREMENTS SAMPLE SCHEDULE, METHODS AND ANALYSIS SENSITIVITIES

Exceptions to the SSES Technical Specifications occurred in the monitoring of the following media: surface water, drinking water, air, milk, and ambient radiation levels. These exceptions involved sample collections that did not take place for the required periods, sampling that was performed in a manner not stated in the Technical Requirements, and, in one instance, sample analysis sensitivities that did not meet the Technical Requirements. Generally, they were caused by equipment malfunctions and events taking place in the vicinity of monitoring stations that interfered in some way with the normal course of sampling. These exceptions are discussed in this appendix and specifically documented in the tables of Appendix I.

## Surface Water

Monitoring at control location 6S6, the SSES River Water Intake Structure, and indicator location 2S7 or its alternate location 6S7, the SSES Cooling Tower Blowdown Discharge (CTBD) to the Susquehanna River, are the only environmental surveillances of surface water required by SSES Technical Specifications. The other SSES REMP routine indicator surface water monitoring location on the Susquehanna River, which is downstream from the SSES discharge to the river, and the monitoring location at LTAW are not required. They have been monitored to provide added assurance that the environment is not being compromised by radiological releases resulting from the SSES operation.

Sampling at locations 6S6 and 2S7 or 6S7 is required to be performed by the collection of aliquots at time intervals that are small compared to the compositing period. Composite samples from these locations are required to be analyzed monthly and are expected to be representative of the streams from which they are collected.

The only problem in 1999 with the automatic composite sampler (ACS) at sampling location 6S6 was during the weekly collection period ending on 6/7/99 when the collection container was found overflowing; this resulted in a sample that was not as representative of the water flowing in the sampled stream as desired. During the subsequent performance of preventative maintenance for the ACS, it was determined that partial clogging of the ACS's drain line may have restricted flow, leading to the overflowing container. Monthly, the ACS at location 6S6 was deliberately removed from service for brief periods to permit performing preventative maintenance on the sampler. The ACS at monitoring location 6S6 operated routinely (as expected) for approximately 98% of 1999.

Monitoring at location 2S7 in 1999 was considered to be very good. One grab sample was collected at this location during the entire year. This sample was collected on 9/7/99. Sampling by the ACS was interrupted on 9/5/99 for an unknown reason. The ACS was initially not operating when visited on 9/7/99. The keypad to controlling the ACS was unresponsive until the ACS was disconnected from and reconnected to its power supply. The ACS at this location was checked on each of the following three days (9/8/99 – 9/10/99) for proper operation, but no further problems with ACS were observed. The only other instances of non-routine operation by the ACS at location 2S7 during 1999 were during the monthly compositing periods from 2/1/99 through 3/1/99 and 10/4/99 through 11/1/99. Sample aliquots were missed during these periods as

follows: one on 2/15/99, five on 10/22/99, one on 10/23/99, and one on 10/29/99. The ACS at monitoring location 2S7 operated routinely (as expected) for more than 99% of 1999.

The intervals between gamma analyses for the samples collected from locations 6S6 and 2S7 for the following monitoring periods and the gamma analyses for samples collected from these locations for the previous monitoring periods exceeded 36 days: 6S6 & 2S7 (3/1/99 – 4/5/99), 6S6 & 2S7 (6/28/99 – 8/2/99), 6S6 (8/2/99 – 9/7/99), and 2S7 (8/2/99 – 9/5/99). These are being presented as exceptions to Technical Requirements because of the need during 1999 for clarification of the significance of frequency requirements for REMP sample analyses. REMP sample analyses are considered surveillances in accordance with the SSES Technical Requirements. Unless otherwise stated in these Technical Requirements, surveillances must be performed within 1.25 times the required intervals, such as monthly. A month is approximately 30 days and 36 days is a slightly conservative application of the factor of 1.25 to that period. Because an exception for sample analyses had not been noted in the Technical Requirements, an unnecessarily conservative interpretation of the stated frequency was applied during 1999. It has subsequently been established that analysis frequencies are an exception to the frequency requirements for intervals between surveillances. Thus, the times between successive analyses are no longer conservatively being used as a criterion for determining if analysis requirements are being met.

All required analyses were performed on surface water samples composited at the required frequencies from locations 6S6 and 2S7. These analyses met or surpassed the required analysis sensitivities.

**Drinking Water**

The collection container at the automatic composite sampler (ACS) at monitoring location 12H2T, the Danville Municipal Drinking Water Facility, was observed to be overflowing on 1/11/99; however, the ACS was observed to be sampling properly at that time. No reason for the overflowing condition could be determined and no action was taken. Only one grab sample was collected at location 12H2T in 1999. This grab sample was obtained on May 24 because the ACS at this location was found to be inoperable at that time. Repairs were made and the ACS was returned to service the same day. These are the only two instances in 1999 when the ACS at location 12H2T was not operating as expected. The ACS at monitoring location 12H2T operated routinely (as expected) for approximately 98% of 1999.

The intervals between the beta analyses for the samples collected from location 12H2T for the following monitoring periods and the beta analyses for the samples collected from this location for the previous monitoring periods exceeded 36 days: 3/1/99 - 4/5/99 and 8/2/99 – 9/7/99. Also, the intervals between the gamma analyses for the samples collected from this location for the following monitoring periods and the gamma analyses for the samples collected from this location for the previous monitoring periods exceeded 36 days: 3/1/99 – 4/5/99, 6/28/99 – 8/2/99, and 8/2/99 – 9/7/99. These are being presented as exceptions to Technical Requirements because of the need during 1999 for clarification of the significance of frequency requirements for REMP sample analyses. REMP sample analyses are considered surveillances in accordance with the

SSES Technical Requirements. Unless otherwise stated in these Technical Requirements, surveillances must be performed within 1.25 times the required intervals, such as monthly. A month is approximately 30 days and 36 days is a slightly conservative application of the factor of 1.25 to that period. Because an exception for sample analyses had not been noted in the Technical Requirements, an unnecessarily conservative interpretation of the stated frequency was applied during 1999. It has subsequently been established that analysis frequencies are an exception to the frequency requirements for intervals between surveillances. Thus, the times between successive analyses are no longer conservatively being used as a criterion for determining if analysis requirements are being met.

All required analyses were performed on drinking water samples composited at the required frequencies from location 12H2T. These analyses met or surpassed the required analysis sensitivities.

## Air

Electrical power supplying the air sampling stations was interrupted a total of 12 times in 1999 for reasons other than the retrieval of filters and charcoal cartridges or the normal, planned maintenance and upkeep of the sampling equipment at the beginnings and ends of sampling periods. The table below summarizes the monitoring locations and sampling periods affected by the electrical power interruptions, the reasons for the unplanned interruptions in electrical power, and the total number of sampling hours lost at each station as a result.

**Occurrences of Electrical Power Interruptions to REMP Air Sampling Stations During 1999**

| Monitoring Location | Scheduled Monitoring Period Affected | Reason for Interruption | Total Number of Lost Sampling Hours Per Station |
|---|---|---|---|
| 3S2 | 4/6/99 – 4/14/99 | Unknown – Possibly a Storm | 28.9 |
| | 9/1/99 – 9/8/99 | Intentional – for PADEP Work | |
| 5S4 | 3/24/99 – 3/31/99 | Intentional – Maintenance | 3.7 |
| | 8/4/99 – 8/11/99 | Intentional – for PADEP Work | |
| | 11/17/99 – 11/23/99 | Intentional - Maintenance | |
| 8G1 | 1/20/99 – 1/27/99 | Ground Fault Interrupter Trip | 381.0 |
| | 3/3/99 – 3/10/99 | Ground Fault Interrupter Trip | |
| | 7/14/99 – 7/21/99 | Ground Fault Interrupter Trip | |
| | 9/15/99 – 9/22/99 | Ground Fault Interrupter Trip | |
| | 12/8/99 – 12/15/99 | Intentional - Facility Maintenance | |
| 12S1 | 11/3/99 – 11/10/99 | Intentional – for PADEP Work | 1.0 |
| 13S6 | 4/28/99 – 5/5/99 | Unknown | 133.4 |
| | 5/19/99 – 5/26/99 | Repair of Electrical Line | |
| | 5/26/99 – 6/2/99 | Repair of Electrical Line | |

Five out of the twelve electrical power interruptions listed in the table above were intentional, although not scheduled, interruptions in sampling. Three were to allow replacement of air sampling enclosures by the Pennsylvania Department of Environmental Protection (PADEP) at locations that it co-monitors with PP&L and the other two were to perform electrical maintenance external to the air sampling stations. The majority of the lost sampling time occurred at monitoring locations 8G1 and 13S6 and was not the result of intentional interruptions of the electricity being supplied to the air sampling equipment at these locations.

The ground fault interrupter at monitoring location 8G1 was determined to be too sensitive and was replaced by a less sensitive circuit breaker on October 8. Since the replacement of the ground fault interrupter, no more interruptions in sampling at location 8G1 have been experienced as the result of circuit breaker trips. The air sampling station at location 8G1 is one of two monitoring locations located more than 10 miles from the SSES that serve as control locations for air monitoring. Because of the distance and direction of 8G1 and the other control location from the SSES, they are considered very unlikely to be affected by any airborne releases from the SSES. Therefore, the results of monitoring at these locations provides data indicative of natural fluctuations in airborne radioactivity levels on a global scale to compare with monitoring results from the indicator locations that would reasonably be expected to see radioactivity that might be release from the SSES. Because there is redundancy in the control locations, the ability to compare results would only be lost entirely if sampling at both of the control locations were interrupted simultaneously.

Prompt notification of an electrical problem by sampling personnel to the appropriate PP&L work group was made following the detection of a loss of electrical power to monitoring location 13S6. The extent of the interruption to sampling at this location was the result of the time needed to determine the nature of the problem and to make repairs to an electrical line external to the sampling station.

Air sampling was interrupted only once in 1999 due to a problem with an air sampling pump. This occurred at air sampling location 5S4 during the monitoring period from 10/20/99 through 10/29/99. Because sampling personnel heard the pump operating in a louder than normal manner, the pump was replaced. The brief interruption of sampling lasted only seven minutes while the change in sampling pumps took place.

Collectively, the air sampling equipment at the ten monitoring locations operated routinely (as expected) for more than 99% of 1999.

The following table lists the sampling periods for all ten monitoring locations when the intervals between the gross beta analyses of particulate filters and/or the intervals between the iodine-131 analyses of charcoal cartridges and the same analyses performed for samples from the previous monitoring periods exceeded 8.5 days.

| Air Monitoring Periods for which the Intervals between the Listed Sample Analyses and Those for the Previous Monitoring Periods Exceeded 8.5 Days | |
|---|---|
| **Gross Beta Analyses of Particulate Filters** | **Iodine-131 Analyses of Charcoal Cartridges** |
| 12/30/98 – 1/6/99 | 2/17/99 – 2/24/99 |
| 1/6/99 – 1/13/99 | 4/21/99 – 4/28/99 |
| 1/20/99 – 1/27/99 | 6/16/99 – 6/23/99 |
| 1/27/99 – 2/3/99 | 10/6/99 – 10/13/99 |
| 2/10/99 – 2/17/99 | 11/3/99 – 11/10/99 |
| 3/3/99 – 3/10/99 | 11/23/99 – 12/1/99 |
| 3/31/99 – 4/6/99 | 12/21/99 – 12/28/99 |
| 5/19/99 – 5/26/99 | |
| 6/16/99 – 6/23/99 | |
| 6/23/99 – 6/30/99 | |
| 7/21/99 – 7/28/99 | |
| 8/18/99 – 8/25/99 | |
| 8/25/99 – 9/1/99 | |
| 9/22/99 – 9/29/99 | |
| 9/29/99 – 10/6/99 | |
| 10/27/99 – 11/3/99 | |
| 11/3/99 – 11/10/99 | |
| 12/8/99 – 12/15/99 | |

The exceptions to Technical Requirements in the table above were presented because of the need during 1999 for clarification of the significance of frequency requirements for REMP sample analyses. REMP sample analyses are considered surveillances in accordance with the SSES Technical Requirements. Unless otherwise stated in these Technical Requirements, surveillances must be performed within 1.25 times the required intervals, such as weekly. A week is seven days and 8.5 days is a slightly conservative application of the factor of 1.25 to that period. Because an exception for sample analyses had not been noted in the Technical Requirements, an unnecessarily conservative interpretation of the stated frequency was applied during 1999. It has subsequently been established that analysis frequencies are an exception to the frequency requirements for intervals between surveillances. Thus, the times between successive analyses are no longer conservatively being used as a criterion for determining if analysis requirements are being met. It should be noted that no required analysis sensitivities were exceeded for the samples represented above because of the times when the analyses were performed.

Required analysis sensitivities for gross beta and iodine-131 analyses were met in all but one instance where electrical power was lost to an air sampling station. Because of the unusually small volume sampled during the 11.5 hours that the air sampling equipment was operating at monitoring location 8G1 on March 3, the required analysis sensitivities for both gross beta analyses of particulate filters and iodine-131 analyses of charcoal cartridges could not be met.

## Milk

All required milk samples were collected during 1999, all required analyses were performed, and all required analysis sensitivities for these milk samples were met. The required intervals between milk sample collections were exceeded for milk sampling at monitoring locations 10D1 and 10D2 between May and June. The intervals between samples collected on June 7 and those collected on May 19 exceeded 18 days. Milk samples are required to be collected semi-monthly while animals are on pasture. This has been conservatively interpreted as requiring semi-monthly collections from April through October. Semi-monthly has been defined as 15 days, with a grace period of 3 days.

The following table lists the applicable milk monitoring locations and sampling dates for those samples when the intervals between the gamma analyses and/or the iodine-131 analyses of semi-monthly samples collected on one date and those collected on the previous date exceeded 18 days.

**Semi-Monthly Milk Sampling Dates for which the Intervals between the Listed Sample Analyses and Those for the Previous Sampling Dates Exceeded 18 Days**

| Monitoring Location | Applicable Intervals Between Sampling Dates | | | |
|---|---|---|---|---|
| | Gamma Analysis | | Iodine-131 Analysis | |
| | Previous | Next | Previous | Next |
| 10G1 | 5/6/99 | 5/25/99 | | |
| 10D1 | 5/6/99 | 5/25/99 | 5/8/99 | 5/27/99 |
| 10D2 | 5/6/99 | 5/25/99 | 5/7/99 | 5/27/99 |
| 7C1 | 5/6/99 | 5/25/99 | | |
| 10D1 | | | 5/27/99 | 6/15/99 |

These exceptions to Technical Requirements in the table above were presented because of the need during 1999 for clarification of the significance of frequency requirements for REMP sample analyses. REMP sample analyses are considered surveillances in accordance with the SSES Technical Requirements. Unless otherwise stated in these Technical Requirements, surveillances must be performed within 1.25 times the required intervals, such as weekly. Multiplying 1.25 times 15 days produces 18.75 days. Because whole days are evaluated, an interval ≥19 days exceeds the required interval between semi-monthly samples/analyses. Because an exception for sample analyses had not been noted in the Technical Requirements, an unnecessarily conservative interpretation of the stated frequency was applied during 1999. It has subsequently been established that analysis frequencies are an exception to the frequency requirements for intervals between surveillances. Thus, the times between successive analyses are no longer conservatively being used as a criterion for determining if analysis requirements are being met. It should be noted that no required analysis sensitivities were exceeded for the samples represented above because of the times when the analyses were performed.

## Ambient Radiation Levels

One instance occurred in 1999 in which the ambient radiation level for a required monitoring location, 7G1, could not be measured because the TLDs were not retrieved at the end of the first quarterly monitoring period, 1/19/99 through 4/14/99. The TLDs and the box in which the TLDs were placed were found missing. Construction activity near the location of this TLD was the apparent cause for the loss of these TLDs and their box. When the box was replaced at the beginning of the second quarterly monitoring period, a tag was attached to the box with the intention of reducing the likelihood that TLDs will be lost from this location in the future. The tag identifies the box and TLDs as an environmental sampler that should not be disturbed. In addition, the tag provides a phone number to contact, with the hope that the TLDs would not be removed and discarded and any information on ambient radiation levels that they have stored would not be lost.

Missing environmental TLDs resulting from vandalism are a very infrequent observance. Nevertheless, the standards for positioning environmental TLDs in the field require that they be relatively close to the ground, making them relatively accessible to passersby at remote monitoring locations. Enclosing many of the TLDs in locked boxes or within fenced areas with locked gates reduces the possibility that someone may tamper with them, but does not prevent vandalism entirely. Identifying a contact by attaching tags with information to TLD containers may increase the likelihood of notification prior to any actions to remove the TLDs by those who are not intent on vandalism.

# APPENDIX G

## 1999 SSES REMP SUMMARY OF DATA

The averages for indicator and control locations reported in the Summary of Data Table, which summarizes the entire year's results for the SSES REMP, were calculated using all measured values, whether or not they were reported in Appendix I tables. Values below the MPCs, even zeroes and negatives, were part of the averaging process for these analysis results.

Preferably, the averages reported in the Summary of Data table for analysis results of sample media that are normally collected continuously are determined using only those results from continuously collected samples. Occasionally, grab samples are taken for these media when equipment malfunctions or some other anomaly precludes or otherwise perturbs routine continuous sampling. These grab samples are taken to minimize the time periods when no sampling is being performed, or, in some instances, when continuous sampling is considered to be nonrepresentative.

Because grab samples best represent snapshots of the sampled media for the relatively brief periods during which they are typically collected, it is normally preferable not to average the analysis results of these samples with those for continuously collected composite samples. However, when equipment malfunctions are protracted, relatively large periods of time could be entirely unrepresented by averages if the results from grab sample analyses are not considered together with those representing continuously sampled periods.

Allowing analysis results for grab samples to be weighted equally with those representing relatively large periods of time would tend to bias the resulting averages unjustifiably towards the conditions at the times that the grabs are obtained. Averages obtained in this way might less accurately reflect the conditions for the combined period of continuous sampling and grab sampling than if only the results from continuous sampling were used. On the other hand, using weighting factors for the analysis results of grab samples derived from the actual time it takes to collect those samples would lead to the grab sample analysis results having a negligible effect on the overall average and not justifying the effort involved.

Grab samples collected in lieu of normal continuous sampling are typically obtained at regular intervals corresponding to the intervals at which the continuously collected samples would usually be retrieved for eventual compositing. For example, grab samples are collected once a week and composited monthly in place of continuously collected samples that would normally be retrieved weekly and composited monthly. Since each grab sample is used to represent an entire week, albeit imperfect, it is reasonable to weight the analysis results the same. Thus, the results of one weekly grab are given approximately one-fourth the weight of the results for a monthly composite sample collected continuously for each of the four weeks in a month. Similarly, the analysis results of a composite of four weekly grab samples would carry the same weight as the analysis results for a composite of four weeks of continuously collected sample.

**TABLE G**
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**NAME OF FACILITY: SUSQUEHANNA STEAM ELECTRIC STATION**
**LOCATION OF FACILITY: LUZERNE COUNTY, PENNSYLVANIA**
REPORTING PERIOD: DECEMBER 30, 1998 TO JANUARY 13, 2000



| MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT) | ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED(1) | | LOWER LIMIT OF DETECTION (LLD) (2) | ALL INDICATOR LOCATIONS MEAN(3) RANGE | LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION | MEAN(3) RANGE | CONTROL LOCATION MEAN(3) RANGE | NUMBER OF NONROUTINE REPORTED MEASUREMENTS(4) |
|---|---|---|---|---|---|---|---|---|
| **Ambient Radiation** (mR/std. qtr.) | TLD | 343 | | 20.8(312) (13.9 - 40.7) | 9S2 On site | 32.0(4) (25.1- 40.7) | 20.8(31) (16.5 - 25.1) | 0 |
| **Surface Water** (pCi/l) | Gross Beta | 49 | 4 | 6.6(37) (-1.4 - 19.2) | 2S7 Discharge | 11.1(13) (-1.4 - 19.2) | 4.7(12) (-4.0 - 14.1) | 0 |
| | Tritium | 49 | 2000 | 754(37) (-170 - 7332) | 2S7 Discharge | 2142(13) (-102 - 7332) | -14.1(12) (-136 - 68) | 0 |
| | Iodine-131 | 92 | 1 | 0.4 (66) (-0.01 - 2.0) | 2S7 Discharge | 0.7(28) (0.05 - 2.0) | 0.4(26) (0.0 - 1.1) | 0 |
| | Gamma Spec K-40 | 49 | | -44(37) (-170 - 23) | LTAW NE - ESE | -31(12) (-110 - 23) | -35(12) (-110 - 3.7) | 0 |
| | Mn-54 | 49 | 15 | 0.3(37) (-3.3 - 2.1) | 2S7 Discharge | 0.6(13) (-0.6 - 2.1) | -0.2(12) (-2.0 - 1.8) | 0 |
| | Co-58 | 49 | 15 | -0.2(37) (-2.6 - 2.2) | 6S6 0.8 mi ESE | -0.1(12) (-2.0 - 1.3) | -0.1(12) (-2.0 - 1.3) | 0 |
| | Fe-59 | 49 | 30 | 0.9(37) (-3.4 - 4.4) | LTAW NE - ESE | 1.7(12) (0.0 - 4.4) | 0.4(12) (-2.7 - 5.1) | 0 |
| | Co-60 | 49 | 15 | 0.3(37) (-1.7 - 2.1) | 6S5 0.9 mi ESE | 0.5(12) (-1.7 - 2.1) | 0.3(12) (-0.8 - 2.1) | 0 |
| | Zn-65 | 49 | 30 | 0.7(37) (-8.8 - 6.1) | 6S5 0.9 mi ESE | 1.4(12) (-2.8 - 6.1) | -1.0(12) (-6.5 - 1.6) | 0 |

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**LOCATION OF FACILITY: LUZERNE COUNTY, PENNSYLVANIA**
REPORTING PERIOD: DECEMBER 30, 1998 TO JANUARY 13, 2000



| MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT) | ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED(1) | | LOWER LIMIT OF DETECTION (LLD) (2) | ALL INDICATOR LOCATIONS MEAN(3) RANGE | LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION | MEAN(3) RANGE | CONTROL LOCATION MEAN(3) RANGE | NUMBER OF NONROUTINE REPORTED MEASUREMENTS(4) |
|---|---|---|---|---|---|---|---|---|
| **Surface Water** Cont. | Zr-95 | 49 | 30 | 1.3(37)<br>(-12 - 10) | 6S5<br>0.9 mi ESE | 3.0(12)<br>(-1.4 - 10) | 2.2(12)<br>(-4.4 - 8.2) | 0 |
| | Nb-95 | 49 | 15 | 1.3(37)<br>(-1.2 - 4.2) | 6S6<br>0.8 mi ESE | 1.8(12)<br>(0.0 - 2.9) | 1.8(12)<br>(0.0 - 2.9) | 0 |
| | Cs-134 | 49 | 15 | -0.2(37)<br>(-4.5 - 2.1) | 2S7<br>Discharge | 0.2(13)<br>(-1.4 - 1.9) | 0.1(12)<br>(-1.6 -4.4) | 0 |
| | Cs-137 | 49 | 18 | 1.3(37)<br>(-1.3 - 3.9) | LTAW<br>NE-ESE | 1.9(12)<br>(0.4 - 3.9) | 1.5(12)<br>(0.0 - 3.6) | 0 |
| | Ba-140 | 49 | 60 | 0.4(37)<br>(-5.9 - 7.6) | 6S6<br>0.8 mi ESE | 1.3(12)<br>(-5.4 - 10) | 1.3(12)<br>(-5.4 -10) | 0 |
| | La-140 | 49 | 15 | 0.02(37)<br>(-2.8 - 4.5) | 6S5<br>0.9 mi ESE | 0.6(12)<br>(-2.8 - 3.3) | 0.08(12)<br>(-1.5 - 2.2) | 0 |
| **Potable Water** (pCi/l) | Gross Alpha | 14 | | 0.3(14)<br>(-0.3 - 1.5) | 12H2T<br>26 mi WSW | 0.3(14)<br>(-0.3 - 1.5) | Only indicator stations sampled for this medium. | 0 |
| | Gross Beta | 14 | 4 | 2.8(14)<br>(1.4 - 4.1) | 12H2T<br>26 mi WSW | 2.8(14)<br>(1.4 - 4.1) | | 0 |
| | Iodine-131 | 27 | 1 | 0.2(27)<br>(0.0 - 0.6) | 12H2T<br>26 mi WSW | 0.2(27)<br>(0.0 - 0.6) | | 0 |
| | Tritium | 14 | 2000 | 37(14)<br>(-237 - 125) | 12H2T<br>26 mi WSW | 37(14)<br>(-237 - 125) | | 0 |
| | Gamma Spec<br>K-40 | 14 | | -14(14)<br>(-85 - 47) | 12H2T<br>26 mi WSW | -14(14)<br>(-85 - 47) | | 0 |
| | Mn-54 | 14 | 15 | 0.6(14)<br>(-1.0 - 2.3) | 12H2T<br>26 mi WSW | 0.6(14)<br>(-1.0 - 2.3) | | 0 |

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REPORTING PERIOD: DECEMBER 30, 1998 TO JANUARY 13, 2000



| MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT) | ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED(1) | | LOWER LIMIT OF DETECTION (LLD) (2) | ALL INDICATOR LOCATIONS MEAN(3) RANGE | LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION | MEAN(3) RANGE | CONTROL LOCATION MEAN(3) RANGE | NUMBER OF NONROUTINE REPORTED MEASUREMENTS(4) |
|---|---|---|---|---|---|---|---|---|
| **Potable Water** Cont. (pCi/l) | Co-58 | 14 | 15 | 0.07(14) (-1.3 - 1.1) | 12H2T 26 mi WSW | 0.07(14) (-1.3 - 1.1) | | 0 |
| | Fe-59 | 14 | 30 | 0.5(14) (-4.6 - 4.4) | 12H2T 26 mi WSW | 0.5(14) (-4.6 - 4.4) | | 0 |
| | Co-60 | 14 | 15 | 0.005(14) (-0.8 - 0.8) | 12H2T 26 mi WSW | 0.005(14) (-0.8 - 0.8) | | 0 |
| | Zn-65 | 14 | 30 | 0.4(14) (-6.8 - 6.9) | 12H2T 26 mi WSW | 0.4(14) (-6.8 - 6.9) | | 0 |
| | Zr-95 | 14 | 30 | 0.7(14) (-2.0 - 6.2) | 12H2T 26 mi WSW | 0.7(14) (-2.0 - 6.2) | | 0 |
| | Nb-95 | 14 | 15 | 0.8(14) (-1.4 - 2.4) | 12H2T 26 mi WSW | 0.8(14) (-1.4 - 2.4) | | 0 |
| | Cs-134 | 14 | 15 | 0.4(14) (-1.3 - 1.8) | 12H2T 26 mi WSW | 0.4(14) (-1.3 - 1.8) | | 0 |
| | Cs-137 | 14 | 18 | 0.4(14) (-5.5 - 2.8) | 12H2T 26 mi WSW | 0.4(14) (-5.5 - 2.8) | | 0 |
| | Ba-140 | 14 | 60 | -1.0(14) (-7.6 - 4.5) | 12H2T 26 mi WSW | -1.0(14) (-7.6 - 4.5) | | 0 |
| | La-140 | 14 | 15 | -0.5(14) (-4.2 - 1.0) | 12H2T 26 mi WSW | -0.5(14) (-4.2 - 1.0) | | 0 |

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| MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT) | ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED(1) | LOWER LIMIT OF DETECTION (LLD) (2) | ALL INDICATOR LOCATIONS MEAN(3) RANGE | LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION | MEAN(3) RANGE | CONTROL LOCATION MEAN(3) RANGE | NUMBER OF NONROUTINE REPORTED MEASUREMENTS(4) |
|---|---|---|---|---|---|---|---|
| **Fish** (pCi/g wet) | Gamma Spec | | | | | | |
| | K-40 13 | | 3.2(7) (2.6 - 3.6) | LTAW On site NE-ESE | 3.2(1) (3.2 - 3.2) | 3.2(6) (2.6 - 4.0) | 0 |
| | Mn-54 13 | 0.13 | 0.002(7) (-0.004 - 0.006) | LTAW On site NE-ESE | 0.006(1) (0.006 - 0.006) | 0.002(6) (-0.007 - 0.008) | 0 |
| | Co-58 13 | 0.13 | -0.005(7) (-0.01 - 0.004) | 2H 30 mi NNE | -0.0002(6) (-0.003 - 0.002) | -0.0002(6) (-0.003 - 0.002) | 0 |
| | Fe-59 13 | 0.26 | 0.0005(7) (-0.01- 0.01) | IND 0.9-1.4 mi ESE | 0.003(6) (-0.005 - 0.01) | 0.001(6) (-0.01 - 0.01) | 0 |
| | Co-60 13 | 0.13 | 0.002(7) (-0.001 - 0.006) | IND 0.9-1.4 mi ESE | 0.003(6) (-0.001 - 0.006) | -0.0005(6) (-0.01 - 0.007) | 0 |
| | Zn-65 13 | 0.26 | 0.003(7) (-0.02 - 0.04) | LTAW On site NE-ESE | 0.006(1) (0.006 - 0.006) | 0.003(6) (-0.006 - 0.01) | 0 |
| | Zr-95 13 | | 0.007(7) (-0.005 - 0.02) | IND 0.9-1.4 mi ESE | 0.008(6) (-0.005 - 0.02) | -0.003(6) (-0.02 - 0.01) | 0 |
| | Nb-95 13 | | 0.006(7) (-0.01 - 0.02) | IND 0.9-1.4 mi ESE | 0.006(6) (-0.01 - 0.02) | 0.003(6) (0.0 - 0.005) | 0 |
| | Cs-134 13 | 0.13 | -0.001(7) (-0.008 - 0.004) | LTAW On site NE-ESE | 0.004(1) (0.004 - 0.004) | -0.002(6) (-0.007 - 0.003) | 0 |
| | Cs-137 13 | 0.15 | 0.002(7) (-0.007 - 0.007) | 2H 30 mi NNE | 0.005(6) (-0.004 - 0.009) | 0.005(6) (-0.004- 0.009) | 0 |
| | Ba-140 13 | | 0.008(7) (-0.02 - 0.03) | IND 0.9-1.4 mi ESE | 0.01(6) (-0.009 - 0.03) | -0.004(6) (-0.03 - 0.03) | 0 |
| | La-140 13 | | -0.005(7) (-0.02 - 0.004) | 2H 30 mi NNE | 0.002(6) (-0.005 - 0.01) | 0.002(6) (-0.005 - 0.01) | 0 |

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| MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT) | ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED(1) | LOWER LIMIT OF DETECTION (LLD) (2) | ALL INDICATOR LOCATIONS MEAN(3) RANGE | LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION MEAN(3) RANGE | CONTROL LOCATION MEAN(3) RANGE | NUMBER OF NONROUTINE REPORTED MEASUREMENTS(4) |
|---|---|---|---|---|---|---|
| **Sediment** (pCi/g dry) | Gamma Spec | | | | | |
| | Be-7 8 | | 1.2(6) (0.1 - 7.4) | 12F 6.9 mi WSW 4.2(2) (1.0 - 7.4) | 0.3(2) (0.2 - 0.3) | 0 |
| | K-40 8 | | 13(6) (9.3 - 18) | 12F 6.9 mi WSW 14(2) (9.3 - 18) | 13(2) (12 - 14) | 0 |
| | Mn-54 8 | | 0.05(6) (0.004 - 0.2) | 12F 6.9 mi WSW 0.1(2) (0.007 - 0.2) | 0.01(2) (0.004 - 0.02) | 0 |
| | Co-58 8 | | -0.009(6) (-0.02 - -0.002) | 7B 1.2 mi SE -0.007(2) (-0.01 - -0.004) | -0.01(2) (-0.03 - -0.005) | 0 |
| | Fe-59 8 | | -0.02(6) (-0.06 - -0.003) | LTAW On site NE-ESE -0.005(2) (-0.007 - -0.003) | -0.03(2) (-0.03 - -0.025) | 0 |
| | Co-60 8 | | 0.02(6) (-0.008 - 0.1) | 12F 6.9 mi WSW 0.05(2) (0.0 - 0.1) | 0.003(2) (0.002 - 0.003) | 0 |
| | Zn-65 8 | | 0.008(6) (-0.007 - 0.05) | LTAW On site NE-ESE 0.02(2) (-0.006 - 0.05) | 0.004(2) (-0.008 - 0.02) | 0 |
| | Zr-95 8 | | 0.07(6) (0.01 - 0.2) | 7B 1.2 mi SE 0.08(2) (0.01 - 0.2) | 0.06(2) (0.003 - 0.1) | 0 |
| | Nb-95 8 | | 0.04(6) (0.02 - 0.05) | 2B 1.6 mi NNE 0.05(2) (0.04 - 0.05) | 0.05(2) (0.04 - 0.05) | 0 |
| | Cs-134 8 | 0.15 | 0.05(6) (0.03 - 0.06) | 12F 6.9 mi WSW 0.06(2) (0.05 - 0.06) | 0.05(2) (0.04 - 0.06) | 0 |
| | Cs-137 8 | 0.18 | 0.08(6) (0.008 - 0.2) | 12F 6.9 mi WSW 0.1(2) (0.08 - 0.2) | 0.08 (2) (0.07 - 0.1) | 0 |
| | Ba-140 8 | | 0.04(6) (-0.03 - 0.2) | 12F 6.9 mi WSW 0.1(2) (0.02 - 0.2) | 0.03(2) (0.01 - 0.04) | 0 |
| | La-140 8 | | -0.01(6) (-0.04 - 0.02) | 12F 6.9 mi WSW -0.01(2) (-0.04 - -0.02) | -0.01(2) (-0.04 - 0.02) | 0 |

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**LOCATION OF FACILITY: LUZERNE COUNTY, PENNSYLVANIA**
REPORTING PERIOD: DECEMBER 30, 1998 TO JANUARY 13, 2000



| MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT) | ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED(1) | LOWER LIMIT OF DETECTION (LLD) (2) | ALL INDICATOR LOCATIONS MEAN(3) RANGE | LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION | MEAN(3) RANGE | CONTROL LOCATION MEAN(3) RANGE | NUMBER OF NONROUTINE REPORTED MEASUREMENTS(4) |
|---|---|---|---|---|---|---|---|
| **Sediment** Cont. (pCi/g dry) | Ra-226 8 | | 1.7(6) (1.2 - 2.2) | LTAW On site NE-ESE | 1.8(2) (1.6 - 2.0) | 1.7(2) (1.6 - 1.7) | 0 |
| | Th-228 8 | | 1.1(6) (0.8 - 1.7) | 12F 6.9 mi WSW | 1.2(2) (0.8 - 1.7) | 1.0(2) (0.9 - 1.1) | 0 |
| **Ground Water** (pCi/l) | Gamma Spec K-40 60 | | -23(48) (-150 - 1000) | 12S1 0.4 mi WSW | 53(12) (-150 - 1000) | -58(12) (-130 - -16) | 0 |
| | Mn-54 60 | 15 | 0.4(48) (-2.9 - 2.1) | 2S2 0.9 mi NNE | 0.6(12) (-0.8 - 2.1) | -0.2(12) (-3.0 - 1.5) | 0 |
| | Co-58 60 | 15 | -0.5(48) (-4.1 - 1.1) | 12S1 0.4 mi WSW | -0.2(12) (-1.8 - 0.9) | -0.8(12) (-2.7 - 0.1) | 0 |
| | Fe-59 60 | 30 | 0.9(48) (-3.7 - 5.9) | 4S5 0.5 mi ENE | 1.9(12) (-1.2 - 5.1) | 0.1(12) (-3.9 - 4.1) | 0 |
| | Co-60 60 | 15 | 0.4(48) (-4.9 - 2.3) | 12S1 0.5 mi SW | 0.6(12) (-0.8 - 2.3) | 0.6(12) (-1.6 - 2.4) | 0 |
| | Zn-65 60 | 30 | 1.4(48) (-7.7 - 14) | 12F3 5.2 mi WSW | 3.5(12) (-2.9 - 12) | 3.5(12) (-2.9 - 12) | 0 |
| | Zr-95 60 | 30 | 0.2(48) (-9.8 - 13) | 2S2 0.9 mi NNE | 0.4(12) (-5.2 - 4.1) | 0.05(12) (-5.5 - 4.7) | 0 |
| | Nb-95 60 | 15 | 1.8(48) (-3.2 - 5.4) | 12F3 5.2 mi WSW | 3.7(12) (0.7 - 7.9) | 3.7(12) (0.7 - 7.9) | 0 |
| | Cs-134 60 | 15 | 0.1(48) (-2.8 - 1.9) | 2S2 0.9 mi NNE | 0.3(12) (-0.8 - 1.3) | 0.2(12) (-1.1 - 1.3) | 0 |
| | Cs-137 60 | 18 | 1.5(48) (-0.7 - 4.3) | 4S4 0.5 mi ENE | 1.9(12) (-0.7 - 3.8) | 1.4(12) (-1.2 - 3.7) | 0 |

**TABLE G**
**SUMMARY OF DATA FOR THE SSES**
**OPERATIONAL RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM - 1999**
**NAME OF FACILITY: SUSQUEHANNA STEAM ELECTRIC STATION**
**LOCATION OF FACILITY: LUZERNE COUNTY, PENNSYLVANIA**
REPORTING PERIOD: DECEMBER 30, 1998 TO JANUARY 13, 2000



| MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT) | ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED(1) | | LOWER LIMIT OF DETECTION (LLD) (2) | ALL INDICATOR LOCATIONS MEAN(3) RANGE | LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION | MEAN(3) RANGE | CONTROL LOCATION MEAN(3) RANGE | NUMBER OF NONROUTINE REPORTED MEASUREMENTS(4) |
|---|---|---|---|---|---|---|---|---|
| **Ground Water** Cont. | Ba-140 | 60 | 60 | 0.07(48)<br>(-12 - 8.1) | 4S4<br>0.5 mi ENE | 0.7(12)<br>(-3.8 - 6.3) | 0.2(12)<br>(-5.6 - 5.2) | 0 |
| | La-140 | 60 | 15 | -0.7(48)<br>(-12 - 4.3) | 12F3<br>5.2 mi WSW | 0.8(12)<br>(-1.3 - 4.4) | 0.8(12)<br>(-1.3 - 4.4) | 0 |
| | H-3 | 60 | 2000 | 25(48)<br>(-73 - 102) | 4S4<br>0.5 mi ENE | 44(12)<br>(-32 - 102) | 21(12)<br>(-45 - 170) | 0 |
| **Air Particulates**<br>(E-03 pCi/$m^3$) | Gross Beta | 519 | 10 | 15(416)<br>(5.0 - 35) | 9B1<br>1.3 mi S | 15(52)<br>(5.3 - 28) | 14(103)<br>(5.0 - 25) | 0 |
| **Air Iodine**<br>(E-03 pCi/$m^3$) | I-131 | 519 | 70 | -0.08(416)<br>(-3.0 - 5.9) | 8G1<br>12 mi SSE | 0.2(51)<br>(-8.5 - 8.1) | 0.03(103)<br>(-12.0 - 8.1) | 0 |
| **Air Particulates**<br>Quarterly Composite<br>(E-03 pCi/$m^3$) | Gamma Spec | | | | | | | |
| | Be-7 | 40 | | 126 (32)<br>(84 - 181) | 9B1<br>1.3 mi S | 139(4)<br>(92 - 163) | 116(8)<br>(90 - 148) | 0 |
| | K-40 | 40 | | 0.5(32)<br>(-4.2 - 8.0) | 6G1<br>13.5 mi ESE | 2.5(4)<br>(-2.0 - 8.0) | 2.1(8)<br>(-2.0 - 8.0) | 0 |
| | Mn-54 | 40 | | 0.04(32)<br>(-0.2 - 0.2) | 3S2<br>0.5 mi NE | 0.08(4)<br>(-0.03 - 0.2) | -0.01(8)<br>(-0.1 - 0.05) | 0 |
| | Co-58 | 40 | | 0.02(32)<br>(-0.3 - 0.4) | 13S6<br>0.4 mi W | 0.1(4)<br>(-0.01 - 0.4) | 0.02(8)<br>(-0.09 - 0.1) | 0 |
| | Fe-59 | 40 | | 0.01(32)<br>(-0.7 - 1.9) | 5S4<br>0.8 mi E | 0.3(4)<br>(-0.3 - 1.9) | -0.3(8)<br>(-0.9 - 0.2) | 0 |
| | Co-60 | 40 | | 0.02(32)<br>(-0.1 - 0.1) | 13S6<br>0.4 mi W | 0.06(4)<br>(-0.04 - 0.1) | 0.01(8)<br>(-0.06 - 0.08) | 0 |
| | Zn-65 | 40 | | 0.1(32)<br>(-0.3 - 0.4) | 5S4<br>0.8 mi E | 0.2(4)<br>(0.1 - 0.4) | -0.01(8)<br>(-0.2 - 0.3) | 0 |

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| MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT) | ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED(1) | LOWER LIMIT OF DETECTION (LLD) (2) | ALL INDICATOR LOCATIONS MEAN(3) RANGE | LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION | MEAN(3) RANGE | CONTROL LOCATION MEAN(3) RANGE | NUMBER OF NONROUTINE REPORTED MEASUREMENTS(4) |
|---|---|---|---|---|---|---|---|
| **Air Particulates** Cont. Quarterly Composite (E-03 pCi/$m^3$) | Zr-95 40 | | 0.08(32) (-0.3 - 0.6) | 10S3 0.6 mi SSW | 0.4(4) (0.2- 0.6) | 0.2(8) (-0.4 - 0.4) | 0 |
| | Nb-95 40 | | 0.1(32) (-0.1 - 0.6) | 3S2 0.5 mi NE | 0.3(4) (0.1 - 0.6) | 0.02(8) (-0.1 - 0.3) | 0 |
| | Cs-134 40 | 50 | 0.004(32) (-0.2 - 0.2) | 6G1 13.5 mi ESE | 0.08(4) (-0.02 - 0.2) | 0.01(8) (-0.02 - 0.02) | 0 |
| | Cs-137 40 | 60 | -0.02(32) (-1.3 - 0.1) | 7S7 0.4 mi SE | 0.07(4) (-0.06 - 0.1) | 0.04(8) (-0.05 - 0.1) | 0 |
| | Ba-140 40 | | -3.6(32) (-43 - 19) | 13S6 0.4 mi W | 1.5(4) (-4.3 - 6.6) | -3.1(8) (-31 - 10) | 0 |
| | La-140 40 | | -0.3(32) (-15 - 14) | 12S1 0.4 mi WSW | 2.4(4) (-8.9 - 14) | -2.5(8) (-25 - 8.4) | 0 |
| **Milk** (pCi/l) | I-131 76 | 1 | 0.02(57) (-0.4 - 0.2) | 10G1 14 mi SSW | 0.04(19) (-0.1 - 0.1) | 0.04(19) (-0.1 - 0.1) | 0 |
| | Gamma Spec K-40 76 | | 1360(57) (1230 - 1640) | 10D2 2.0 mi WSW | 1369(19) (1260 - 1640) | 1339(19) (1210 - 1450) | 0 |
| | Mn-54 76 | | 0.2(57) (-1.5 - 2.3) | 7C1 2.0 mi SE | 0.4(19) (-0.6 - 1.7) | 0.4(19) (-1.3 - 1.9) | 0 |
| | Co-58 76 | | -0.1(57) (-2.3 - 2.3) | 10D1 3.0 mi SSW | 0.03(19) (-1.0 - 1.1) | -0.3(19) (-2.8 - 1.1) | 0 |
| | Fe-59 76 | | 0.8(57) (-6.0 - 6.5) | 10G1 14 mi SSW | 1.5(19) (-2.2 - 6.8) | 1.5(19) (-2.2 - 6.8) | 0 |
| | Co-60 76 | | 0.1(57) (-1.7 - 2.6) | 10D1 3.0 mi SSW | 0.2(19) (-1.7 - 2.2) | 0.2(19) (-2.4 - 2.2) | 0 |

**TABLE G**
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**LOCATION OF FACILITY: LUZERNE COUNTY, PENNSYLVANIA**
REPORTING PERIOD: DECEMBER 30, 1998 TO JANUARY 13, 2000



| MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT) | ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED(1) | | LOWER LIMIT OF DETECTION (LLD) (2) | ALL INDICATOR LOCATIONS MEAN(3) RANGE | LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION | MEAN(3) RANGE | CONTROL LOCATION MEAN(3) RANGE | NUMBER OF NONROUTINE REPORTED MEASUREMENTS(4) |
|---|---|---|---|---|---|---|---|---|
| **Milk** Cont. (pCi/l) | Zn-65 | 76 | | 0.3(57) (-4.9 - 6.8) | 10D1 3.0 mi SSW | 1.5(19) (-4.9 - 6.8) | -0.6(19) (-8.3 - 7.0) | 0 |
| | Zr-95 | 76 | | 1.1(57) (-11 - 12) | 10D2 3.1 mi SSW | 2.2(19) (-1.4 - 12) | -0.1(19) (-8.3 - 7.0) | 0 |
| | Nb-95 | 76 | | 1.0(57) (-2.1 - 3.0) | 10D2 3.1 mi SSW | 1.3(19) (-0.3 - 2.7) | 1.2(19) (-0.5 - 3.6) | 0 |
| | Cs-134 | 76 | 15 | -0.3(57) (-6.1 - 2.1) | 10D1 3.0 mi SSW | 0.002(19) (-3.6 - 2.1) | -0.2(19) (-2.0 - 1.7) | 0 |
| | Cs-137 | 76 | 18 | 1.6(57) (-2.6 - 4.6) | 10D2 3.1 mi SSW | 1.7(19) (-2.6 - 4.6) | 0.8(19) (-1.3 - 3.3) | 0 |
| | Ba-140 | 76 | 60 | -0.01(57) (-5.6 - 8.3) | 10D1 3.0 mi SSW | 0.6(19) (-5.6 - 7.1) | -0.09(19) (-9.3 - 5.3) | 0 |
| | La-140 | 76 | 15 | -0.4(57) (-8.2 - 3.2) | 7C1 2.0 mi SE | -0.4(19) (-8.2 - 2.8) | -0.5(19) (-3.0 - 5.0) | 0 |
| **Soil** (pCi/g dry) | Gamma Spec K-40 | 8 | | 13(6) (11 - 16) | 3S2 0.5 mi NE | 14(2) (13- 16) | 9.1(2) (8.9 - 9.3) | 0 |
| | Mn-54 | 8 | | 0.002(6) (-0.02 - 0.01) | 8G1 12 mi SSE | 0.01(2) (-0.002 - 0.02) | 0.01(2) (-0.002 - 0.02) | 0 |
| | Co-58 | 8 | | -0.009(6) (-0.02 - -0.005) | 13S6 0.4 mi W | -0.006(2) (-0.008 - -0.005) | -0.009(2) (-0.01 - -0.005) | 0 |
| | Fe-59 | 8 | | -0.006(6) (-0.03 - 0.02) | 12S1 0.4 mi WSW | 0.006(2) (0.001 - 0.01) | -0.02(2) (-0.03 - -0.01) | 0 |
| | Co-60 | 8 | | 0.005(6) (-0.009 - 0.02) | 3S2 0.5 mi NE | 0.01(2) (0.009 - 0.02) | -0.004(2) (-0.005 - -0.002) | 0 |

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|---|---|---|---|---|---|---|---|
| **Soil** Cont. (pCi/g dry) | Zn-65 | 8 | 0.002(6) (-0.04- 0.03) | 13S6 0.4 mi W | 0.03(2) (0.03 - 0.03) | 0.02(2) (0.002 - 0.04) | 0 |
| | Zr-95 | 8 | 0.02(6) (-0.02 - 0.05) | 13S6 0.4 mi W | 0.04(2) (0.03 - 0.05) | 0.03(2) (-0.004 - 0.06) | 0 |
| | Nb-95 | 8 | 0.02(6) (0.004 - 0.03) | 13S6 0.4 mi W | 0.03(2) (0.03 - 0.03) | 0.03(2) (0.02 - 0.03) | 0 |
| | Cs-134 | 8 | 0.04(6) (0.03 - 0.05) | 12S1 0.4 mi WSW | 0.04(2) (0.03 - 0.05) | 0.02(2) (0.02 - 0.03) | 0 |
| | Cs-137 | 8 | 0.08(6) (0.02 - 0.2) | 12S1 0.4 mi WSW | 0.2(2) (0.1 - 0.2) | 0.1(2) (0.1 - 0.1) | 0 |
| | Ba-140 | 8 | -0.008(6) (-0.03 - 0.02) | 3S2 0.5 mi NE | 0.008(2) (0.002 - 0.02) | -0.01 (2) (-0.04 - 0.02) | 0 |
| | La-140 | 8 | -0.01(6) (-0.04 - 0.03) | 3S2 0.5 mi NE | 0.009(2) (-0.02 - 0.03) | -0.01(2) (-0.03 - -0.002) | 0 |
| | Ra-226 | 8 | 1.4(6) (1.1 - 2.0) | 3S2 0.5 mi NE | 1.9(2) (1.8 - 2.0) | 1.7(2) (1.5 - 2.0) | 0 |
| | Th-228 | 8 | 0.8(6) (0.6 - 1.0) | 3S2 0.5 mi NE | 0.9(2) (0.8 - 1.0) | 0.7(2) (0.7 - 0.8) | 0 |
| **Food/Garden Crops** (pCi/g wet) | Gamma Spec Be-7 | 41 | 0.006(35) (-0.03 - 0.04) | 11D2 3.3 mi SW | 0.02(1) (0.02 - 0.02) | 0.01(6) (-0.005 - 0.03) | 0 |
| | K-40 | 41 | 2.5(35) (0.7 - 4.9) | 11D2 3.3 mi SW | 4.9(1) (4.9 - 4.9) | 2.8(6) (1.9 - 3.9) | 0 |
| | Mn-54 | 41 | 0.0004(35) (-0.005 - 0.004) | 10B5 2.0 mi SSW | 0.002(8) (-0.001 - 0.004) | 0.001(6) (-0.0003 - 0.004) | 0 |

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| MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT) | ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED(1) | LOWER LIMIT OF DETECTION (LLD) (2) | ALL INDICATOR LOCATIONS MEAN(3) RANGE | LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION | MEAN(3) RANGE | CONTROL LOCATION MEAN(3) RANGE | NUMBER OF NONROUTINE REPORTED MEASUREMENTS(4) |
|---|---|---|---|---|---|---|---|
| **Food/Garden** Cont. **Crops** (pCi/g wet) | Co-58 41 | | -0.0006(35) (-0.005 - 0.004) | 11D2 3.3 mi SW | 0.001(1) (0.001 - 0.001) | 0.0002(6) (-0.001 - 0.002) | 0 |
| | Fe-59 41 | | 0.003(35) (-0.004 - 0.01) | 12F7 8.3 mi WSW | 0.01(1) (0.01 - 0.01) | 0.001(6) (-0.003 - 0.005) | 0 |
| | Co-60 41 | | 0.0005(35) (-0.003 - 0.005) | 11D2 3.3 mi SW | 0.003(1) (0.003 - 0.003) | 0.001(6) (-0.001 - 0.004) | 0 |
| | Zn-65 41 | | 0.0005(35) (-0.01 - 0.01) | 12S7 0.4 mi WSW | 0.005(3) (0.004 - 0.008) | 0.003(6) (-0.003 - 0.01) | 0 |
| | Zr-95 41 | | 0.003(35) (-0.006 - 0.01) | 12S7 0.4 mi WSW | 0.01(3) (0.004 - 0.01) | 0.002(6) (-0.0006 - 0.004) | 0 |
| | Nb-95 41 | | 0.002(35) (-0.003 - 0.007) | 9B4 1.1 mi S | 0.004(2) (0.001 - 0.007) | 0.0009(6) (-0.002 - 0.004) | 0 |
| | I-131 41 | 0.06 | -0.0006(35) (-0.005 - 0.004) | 12F7 8.3 mi WSW | 0.001(1) (0.001 - 0.001) | 0.00008(6) (-0.002 - 0.003) | 0 |
| | Cs-134 41 | 0.06 | -0.00004(35) (-0.008 - 0.006) | 10B5 2.0 mi SSW | 0.001(8) (-0.005 - 0.006) | -0.0004(6) (-0.004 - 0.002) | 0 |
| | Cs-137 41 | 0.08 | 0.003(35) (-0.002 - 0.01) | 9B4 1.1 mi S | 0.007(2) (0.004 - 0.01) | 0.003(6) (0.0007 - 0.006) | 0 |
| | Ba-140 41 | | -0.0008(35) (-0.02 - 0.01) | 9B4 1.1 mi S | 0.008(2) (0.004 - 0.001) | -0.0007(6) (-0.006 - 0.005) | 0 |
| | La-140 41 | | -0.0003(35) (-0.02- 0.01) | 9B4 1.1 mi S | 0.004(2) (0.002 - 0.006) | 0.0005(6) (-0.003 - 0.003) | 0 |

1. The total number of analyses does not include duplicates, splits or repeated analyses.
2. The Technical Specification LLD's are shown when applicable.
3. The means are based on all analysis results.
4. USNRC reporting levels are specified in the Technical Specifications.

# APPENDIX H

# COMPARISON OF INDICATOR AND CONTROL 1999 REMP ANNUAL MEANS FOR SELECTED MEDIA ANALYSIS RESULTS WITH MEANS FROM PREOPERATIONAL AND PRIOR OPERATIONAL PERIODS

The data presented in the following tables were included if specific analysis results routinely exceeded the applicable MDCs in 1999 and/or routinely may have done so in previous years. While the comparisons may be useful for observing any step changes that may occur in the environment over a wide area, the importance attached to these comparisons should be tempered by the understanding that changes in methods of analysis, typical MDCs achieved by the analyses, and averaging methods over the years may tend to blur the picture in some cases.

Note that medians are presented in these tables in addition to means only when there appears to be a significant difference between them.

## AMBIENT RADIATION MONITORING

*TABLE H 1*

| AMBIENT RADIATION LEVELS AS MEASURED BY TLDS (mR/STD QTR) | | | | | | |
|---|---|---|---|---|---|---|
| **Location** | **Indicator** | | | **Control** | | |
| **Period** | **Pre-Op** | **Operational** | | **Pre-Op** | **Operational** | |
| | **1978-81** | **1982-98** | **1999** | **1978-81** | **1982-98** | **1999** |
| **Range** | 18.5-19.2 | 14.7-19.2 | -- | 15.0-17.9 | 14.8-19.2 | -- |
| **Mean** | 18.9 | 17.8 | 20.8 | 16.3 | 17.6 | 20.8 |

## AQUATIC PATHWAY MONITORING

*TABLE H 2*

| SURFACE WATER GROSS BETA ACTIVITIES (pCi/l) | | | | | | |
|---|---|---|---|---|---|---|
| **Location** | **Indicator** | | | **Control** | | |
| **Period** | **Pre-Op** | **Operational** | | **Pre-Op** | **Operational** | |
| | **1978-81** | **1982-98** | **1999** | **1978-81** | **1982-98** | **1999** |
| **Range** | 3.2-4.9 | 3.0-7.7 | -- | 2.9-5.2 | 2.8-6.7 | -- |
| **Mean** | 3.8 | 5.5 | 6.6 | 4.0 | 3.8 | 4.7 |

*TABLE H 3*

| SURFACE WATER IODINE-131 ACTIVITIES (pCi/l) | | | | | | |
|---|---|---|---|---|---|---|
| **Location** | **Indicator** | | | **Control** | | |
| **Period** | **Pre-Op** | **Operational** | | **Pre-Op** | **Operational** | |
| | **1979-81** | **1982-98** | **1999** | **1979-81** | **1982-98** | **1999** |
| **Range** | 0.24-0.37 | 0.06-0.60 | -- | 0.29-0.43 | 0.03-1.0 | -- |
| **Mean** | 0.29 | 0.28 | 0.38 | 0.36 | 0.27 | 0.37 |

*TABLE H 4*

| SURFACE WATER TRITIUM ACTIVITIES (pCi/l) | | | | | | |
|---|---|---|---|---|---|---|
| **Location** | **Indicator** | | | **Control** | | |
| **Period** | **Pre-Op** | **Operational** | | **Pre-Op** | **Operational** | |
| | **1978-81** | **1982-98** | **1999** | **1978-81** | **1982-98** | **1999** |
| **Range** | 101-122 | 126-1217 | -- | 119-319 | -239-212 | -- |
| **Mean** | 109 | 502 | 754 | 171 | 59 | -14 |

*1990 results were not averaged with 1982-98 data because the validity of the 1990 values is questionable in some instances. Laboratory analysis error is suspected. See the 1990 Annual Report.

*TABLE H 5*

| DRINKING WATER GROSS ALPHA ACTIVITIES (pCi/l) | | | |
|---|---|---|---|
| **Period** | **Preoperational** | **Operational** | |
| | **1980 - 81** | **1982 - 98** | **1999** |
| **Range** | -- | 0.1 – 10.0 | -- |
| **Mean (median)**** | 1.3 | 1.7 | 0.3 |

*TABLE H 6*

| DRINKING WATER GROSS BETA ACTIVITIES (pCi/l) | | | |
|---|---|---|---|
| **Period** | **Preoperational** | **Operational** | |
| | **1977 - 81** | **1982 - 98** | **1999** |
| **Range** | 2.2 - 3.2 | 2.4 - 5.4 | -- |
| **Mean** | 2.7 | 3.2 | 2.8 |

*TABLE H 7*

| DRINKING WATER TRITIUM ACTIVITIES (pCi/l) | | | |
|---|---|---|---|
| **Period** | **Preoperational** | **Operational** | |
| | **1977 - 81** | **1982 - 98** | **1999** |
| **Range** | 101 - 194 | -247 - 220 | -- |
| **Mean** | 132 | 68 | 37 |

*TABLE H 8*

| FISH POTASSIUM-40 ACTIVITIES (pCi/g wet) | | | | | | |
|---|---|---|---|---|---|---|
| **Location** | **Indicator** | | | **Control** | | |
| **Period** | **Pre-Op** | **Operational** | | **Pre-Op** | **Operational** | |
| | **1977-81** | **1982-98** | **1999** | **1977-81** | **1982-98** | **1999** |
| **Range** | 2.7 - 3.5 | 3.1 - 5.3 | -- | 2.8 - 3.6 | 3.1 - 4.2 | -- |
| **Mean** | 3.2 | 3.8 | 3.2 | 3.2 | 3.6 | 3.2 |

*TABLE H 9*

| SEDIMENT POTASSIUM-40 ACTIVITIES (pCi/g dry) | | | | | | |
|---|---|---|---|---|---|---|
| **Location** | **Indicator** | | | **Control** | | |
| **Period** | **Pre-Op** | **Operational** | | **Pre-Op** | **Operational** | |
| | **1978-81** | **1982-98** | **1999** | **1978-81** | **1982-98** | **1999** |
| **Range** | 8.6-10.4 | 7.4-13.2 | -- | 7.5-11.0 | 6.2-13.0 | -- |
| **Mean** | 9.3 | 10.5 | 12.7 | 9.4 | 10.6 | 13.0 |

*TABLE H 10*

| SEDIMENT RADIUM-226 ACTIVITIES (pCi/g dry) | | | | | | |
|---|---|---|---|---|---|---|
| **Location** | **Indicator** | | | **Control** | | |
| **Period** | **Pre-Op** | **Operational** | | **Pre-Op** | **Operational** | |
| | **1978-81** | **1982-98** | **1999** | **1978-81** | **1982-98** | **1999** |
| **Range** | 0.5-0.7 | 0.5-1.9 | -- | 0.6-1.9 | 0.4-2.1 | -- |
| **Mean** | 0.6 | 1.4 | 1.7 | 0.7 | 1.5 | 1.7 |

*TABLE H 11*

| SEDIMENT THORIUM-228 ACTIVITIES (pCi/g dry) | | | | |
|---|---|---|---|---|
| **Location** | **Indicator** | | **Control** | |
| **Period** | **1984 - 98*** | **1999** | **1984 - 98*** | **1999** |
| **Range** | 1.0 - 1.3 | -- | 1.0 - 1.4 | -- |
| **Mean** | 1.1 | 1.1 | 1.1 | 1.0 |

*Th-232 was reported instead of Th-228 in 1990.

*TABLE H 12*

| SEDIMENT CESIUM-137 ACTIVITIES (pCi/g dry) | | | | | | |
|---|---|---|---|---|---|---|
| **Location** | **Indicator** | | | **Control** | | |
| **Period** | **Pre-Op** | **Operational** | | **Pre-Op** | **Operational** | |
| | **1978-81** | **1982-98** | **1999** | **1978-81** | **1982-98** | **1999** |
| **Range** | 0.08-0.15 | 0.04-0.17 | -- | 0.08-0.21 | 0.06-0.21 | -- |
| **Mean** | 0.10 | 0.09 | 0.08 | 0.11 | 0.11 | 0.08 |

## ATMOSPHERIC PATHWAY MONITORING

*TABLE H 13*

| AIR PARTICULATE GROSS BETA ACTIVITIES (E-3 pCi/m$^3$) | | | | | | |
|---|---|---|---|---|---|---|
| **Location** | **Indicator** | | | **Control** | | |
| **Period** | **Pre-Op** | **Operational** | | **Pre-Op** | **Operational** | |
| | **1978-81** | **1982-98** | **1999** | **1978-81** | **1982-98** | **1999** |
| **Range** | 24 - 97 | 13 - 29 | -- | 24 - 102 | 12 - 28 | -- |
| **Mean** | 61 | 17 | 15 | 62 | 16 | 14 |

*TABLE H 14*

| AIR PARTICULATE BERYLLIUM-7 ACTIVITIES (E-3 pCi/m$^3$) | | | | | | |
|---|---|---|---|---|---|---|
| **Location** | **Indicator** | | | **Control** | | |
| **Period** | **Pre-Op** | **Operational** | | **Pre-Op** | **Operational** | |
| | **1978-81** | **1982-98** | **1999** | **1978-81** | **1982-98** | **1999** |
| **Range** | 69 - 81 | 62 - 132 | -- | 59 - 85 | 53 - 126 | -- |
| **Mean** | 76 | 91 | 126 | 72 | 86 | 116 |

*1990 results were not averaged with 1982-98 data because the validity of the 1990 values is questionable in some instances. Laboratory analysis error is suspected. See the 1990 Annual Report.

## TERRESTRIAL PATHWAY MONITORING

*TABLE H 15*

| SOIL POTASSIUM-40 ACTIVITIES (pCi/g dry) | | | | | | |
|---|---|---|---|---|---|---|
| **Location** | **Indicator** | | | **Control** | | |
| **Period** | **Pre-Op** | **Operational** | | **Pre-Op** | **Operational** | |
| | **1979&81** | **1984-98** | **1999** | **1979&81** | **1984-98** | **1999** |
| **Range** | 9.2 - 9.7 | 9.4-14.3 | -- | 9.1-11.0 | 7.4-14.1 | -- |
| **Mean** | 9.5 | 11.4 | 12.7 | 10.1 | 10.6 | 9.1 |

*TABLE H 16*

| SOIL RADIUM-226 ACTIVITIES (pCi/g dry) | | | | | | |
|---|---|---|---|---|---|---|
| **Location** | **Indicator** | | | **Control** | | |
| **Period** | **Pre-Op** | **Operational** | | **Pre-Op** | **Operational** | |
| | **1979&81** | **1984-98** | **1999** | **1979&81** | **1984-98** | **1999** |
| **Range** | 0.8 - 1.3 | 0.8 - 2.5 | -- | 0.8 - 1.2 | 1.0 - 2.1 | -- |
| **Mean** | 1.1 | 1.6 | 1.4 | 1.0 | 1.8 | 1.7 |

*TABLE H 17*

| SOIL THORIUM-228 ACTIVITIES (pCi/g dry) | | | | | | |
|---|---|---|---|---|---|---|
| **Location** | **Indicator** | | | **Control** | | |
| **Period** | **Pre-Op** | **Operational** | | **Pre-Op** | **Operational** | |
| | **1979&81** | **1984-98** | **1999** | **1979&81** | **1984-98** | **1999** |
| **Range** | 0.9 - 1.3 | 0.8 - 1.3 | -- | -- | 0.7 - 1.2 | -- |
| **Mean** | 1.1 | 1.0 | 0.8 | 1.0 | 1.0 | 0.7 |

*TABLE H 18*

| SOIL CESIUM-137 ACTIVITIES (pCi/g dry) | | | | | | |
|---|---|---|---|---|---|---|
| **Location** | **Indicator** | | | **Control** | | |
| **Period** | **Pre-Op** | **Operational** | | **Pre-Op** | **Operational** | |
| | **1979&81** | **1982-98** | **1999** | **1979&81** | **1982-98** | **1999** |
| **Range** | 0.5 - 0.7 | 0.05 - 0.5 | -- | 0.2 - 1.2 | 0.2 - 1.2 | -- |
| **Mean** | 0.6 | 0.3 | 0.08 | 0.7 | 0.5 | 0.12 |

*TABLE H 19*

| MILK POTASSIUM-40 ACTIVITIES (pCi/l) | | | | | | |
|---|---|---|---|---|---|---|
| **Location** | **Indicator** | | | **Control** | | |
| **Period** | **Pre-Op** | **Operational** | | **Pre-Op** | **Operational** | |
| | **1978-81** | **1985-98** | **1999** | **1978-81** | **1985-98** | **1999** |
| **Range** | 1222-1500 | 1241-1357 | -- | 1273-1500 | 1247-1363 | -- |
| **Mean** | 1325 | 1322 | 1360 | 1390 | 1332 | 1339 |

*TABLE H 20*

| FRUITS/VEGETABLES POTASSIUM-40 ACTIVITIES (pCi/g wet) | | | | | | |
|---|---|---|---|---|---|---|
| **Location** | **Indicator** | | | **Control** | | |
| **Period** | **Pre-Op** | **Operational** | | **Pre-Op** | **Operational** | |
| | **1980-81** | **1982-98** | **1999** | **1980-81** | **1982-98** | **1999** |
| **Range** | 2.5 - 3.0 | 2.0-4.2 | -- | 3.0 - 3.1 | 2.2 - 2.8 | -- |
| **Mean** | 2.8 | 2.7 | 2.5 | 3.1 | 2.4 | 2.8 |

*1990 results were not average with 1982-98 data because the validity of the 1990 values is questionable in some instances. Laboratory analysis error is suspected. See the 1990 Annual Report.

*TABLE H 21*

| GROUND WATER TRITIUM ACTIVITIES (pCi/l) | | | | | | |
|---|---|---|---|---|---|---|
| **Location** | **Indicator** | | | **Control** | | |
| **Period** | **Pre-Op** | **Operational** | | **Pre-Op** | **Operational** | |
| | **1980-81** | **1982-98** | **1999** | **1980-81** | **1982-98** | **1999** |
| **Range** | 94-109 | -206 - 180 | -- | 117 - 119 | -206 - 260 | -- |
| **Mean** | 101 | 62 | 25 | 118 | 76 | 21 |

# APPENDIX I

## SPECIFIC ANALYSIS RESULTS TABULATED BY MEDIA AND SAMPLING PERIOD

Results of analyses are generally reported in the following tables to two significant figures. Random uncertainties of counting are reported to the same decimal place as the result.

Calculated values for analysis results in the tables that follow are reported with the random uncertainty of counting at two standard deviations (2S), determined by considering both the sample and background count rates. The uncertainty of an activity is influenced by the volume or mass of the sample, the background count rate, the count times, the method used to round off the value obtained to reflect its degree of significance, and other factors. The uncertainties of activities determined by gamma spectrometric analyses are also influenced by the relative concentrations of the radionuclides in the sample, the energies and intensities of the gammas emitted by those radionuclides, and the assumptions used in selecting the radionuclides to be quantitatively determined.

Results reported as less than (<) in these tables are below the minimum detectable concentrations (MDCs). The MDC is an estimate of the detection capabilities of the overall measurement method, taking into account not only the counting system, but also the characteristics of the sample being counted. When the MDC is used as the level to decide whether or not to enter a measured value into a table, there is a 50% chance that the value will be entered when the actual sample activity is equivalent to the MDC. There is only a five percent chance that a value representing a fluctuation in background activity will be entered as sample activity in such an instance.

Measured values for the activities of specific radionuclides, such as the man-made gamma-emitting radionuclides beryllium-7 and cesium-137, only appear in the following tables for each specific medium when the levels that are measured exceed the MDC values for those measurements and those radionuclides are actually identified as present in the samples. Measured values for the analyses that are not radionuclide specific, such as gross alpha and beta analyses, also are presented in the tables for specific media only when the levels that are measured actually exceed the MDCs.

TABLE I-1

ENVIRONMENTAL THERMOLUMINESCENT DOSIMETRY RESULTS

SUSQUEHANNA STEAM ELECTRIC STATION - 1999

Results (1) are in mR/std. qtr. (2) ± 2S (3)

| Location | First Quarter 01/12/99 to 04/14/99 | Second Quarter 04/12/99 to 07/15/99 | Third Quarter 07/13/99 to 10/14/99 | Fourth Quarter 10/12/99 to 01/13/00 |
|---|---|---|---|---|
| **ONSITE** | | | | |
| 1S2 + | 23.0 ± 1.6 | 20.3 ± 1.2 | 21.3 ± 1.2 | 25.4 ± 1.8 |
| 2S2 | 20.9 ± 1.4 | 19.0 ± 1.0 | 19.7 ± 1.0 | 19.7 ± 1.0 |
| 2S3 + | 20.8 ± 1.6 | 19.6 ± 1.2 | 22.3 ± 1.0 | 23.1 ± 2.1 |
| 3S2 | 19.5 ± 1.2 | 17.5 ± 1.6 | 17.7 ± 0.4 | 19.4 ± 1.0 |
| 3S3 | 19.7 ± 0.6 | 17.0 ± 0.8 | 18.4 ± 1.2 | 18.9 ± 2.0 |
| 3S4 + | 18.9 ± 0.6 | 17.3 ± 0.8 | 17.6 ± 0.6 | 19.3 ± 1.0 |
| 4S3 + | 23.8 ± 1.0 | 21.8 ± 1.2 | 23.3 ± 1.2 | 25.0 ± 1.8 |
| 4S6 | 20.4 ± 0.6 | 18.1 ± 0.8 | 19.6 ± 0.6 | 19.2 ± 1.4 |
| 5S4 | 18.4 ± 1.2 | 16.3 ± 0.8 | 16.7 ± 0.4 | 17.9 ± 0.8 |
| 5S7 + | 19.2 ± 1.0 | 17.0 ± 0.8 | 17.8 ± 1.0 | 20.0 ± 1.4 |
| 6S4 + | 24.7 ± 1.6 | 23.5 ± 2.0 | 25.4 ± 0.8 | 27.9 ± 2.3 |
| 6S9 + | 22.8 ± 1.6 | 21.6 ± 1.2 | 23.4 ± 0.8 | 26.6 ± 1.8 |
| 7S6 + | 23.6 ± 0.4 | 20.4 ± 2.2 | 23.6 ± 1.0 | 25.6 ± 1.8 |
| 7S7 | 19.6 ± 0.6 | 16.8 ± 1.2 | 18.7 ± 0.6 | 18.7 ± 1.2 |
| 7S8 | 19.5 ± 1.2 | 17.5 ± 1.2 | 18.6 ± 1.2 | 18.9 ± 1.6 |
| 8S2 + | 23.1 ± 1.0 | 20.2 ± 0.8 | 23.2 ± 0.8 | 25.5 ± 2.5 |
| 9S2 + | 27.9 ± 1.6 | 25.1 ± 2.7 | 34.4 ± 1.4 | 40.7 ± 2.9 |

See the comments at the end of the table.

TABLE I-1

ENVIRONMENTAL THERMOLUMINESCENT DOSIMETRY RESULTS

SUSQUEHANNA STEAM ELECTRIC STATION - 1999

Results (1) are in mR/std. qtr. (2) ± 2S (3)

| Location | First Quarter 01/12/99 to 04/14/99 | Second Quarter 04/12/99 to 07/15/99 | Third Quarter 07/13/99 to 10/14/99 | Fourth Quarter 10/12/99 to 01/13/00 |
|---|---|---|---|---|
| 10S1 + | 18.1 ± 0.4 | 16.0 ± 1.2 | 16.5 ± 0.8 | 18.3 ± 1.0 |
| 10S2 | 25.7 ± 2.2 | 23.7 ± 1.0 | 26.7 ± 1.2 | 31.0 ± 2.5 |
| 10S3 | 18.0 ± 1.0 | 16.4 ± 0.6 | 17.8 ± 0.6 | 18.3 ± 0.8 |
| 11S3 + | 27.2 ± 1.2 | 24.1 ± 1.2 | 24.9 ± 1.4 | 28.5 ± 0.8 |
| 11S7 | 21.0 ± 0.2 | 18.7 ± 0.8 | 20.2 ± 0.8 | 20.9 ± 1.4 |
| 12S1 | 21.7 ± 0.8 | 19.0 ± 1.2 | 20.3 ± 1.0 | 21.5 ± 0.8 |
| 12S3 + | 25.5 ± 1.6 | 23.0 ± 1.6 | 24.9 ± 0.8 | 26.2 ± 1.0 |
| 12S4 | 25.7 ± 1.2 | 23.1 ± 0.8 | 24.5 ± 1.2 | 26.5 ± 1.6 |
| 12S5 | 22.7 ± 0.6 | 20.6 ± 1.2 | 21.5 ± 1.0 | 23.0 ± 1.2 |
| 12S6 | 22.1 ± 1.0 | 19.9 ± 0.8 | 21.7 ± 0.8 | 22.6 ± 0.8 |
| 12S7 | 19.3 ± 1.2 | 16.6 ± 1.2 | 17.4 ± 1.2 | 17.9 ± 1.0 |
| 13S2 + | 23.4 ± 1.6 | 20.5 ± 1.0 | 22.5 ± 1.0 | 23.6 ± 1.6 |
| 13S4 | 25.2 ± 1.0 | 22.0 ± 0.8 | 23.5 ± 0.8 | 24.8 ± 1.4 |
| 13S5 | 26.0 ± 1.8 | 22.9 ± 1.0 | 24.5 ± 1.0 | 25.9 ± 1.8 |
| 13S6 | 24.1 ± 1.0 | 21.3 ± 1.2 | 22.3 ± 1.2 | 24.4 ± 1.4 |
| 14S5 + | 23.4 ± 1.8 | 22.0 ± 1.0 | 21.9 ± 0.8 | 23.8 ± 1.4 |
| 14S6 | 22.4 ± 1.0 | 20.5 ± 1.0 | 20.4 ± 1.2 | 22.7 ± 1.4 |
| 15S5 + | 20.7 ± 1.0 | 19.7 ± 0.6 | 20.3 ± 1.2 | 21.2 ± 2.5 |
| 16S1 + | 22.4 ± 1.2 | 20.0 ± 1.0 | 23.0 ± 1.2 | 24.7 ± 1.6 |
| 16S2 + | 23.9 ± 0.6 | 21.9 ± 0.8 | 23.2 ± 1.2 | 26.0 ± 1.2 |

See the comments at the end of this table.

**TABLE I-1**

**ENVIRONMENTAL THERMOLUMINESCENT DOSIMETRY RESULTS**

SUSQUEHANNA STEAM ELECTRIC STATION - 1999

Results (1) are in mR/std. qtr. (2) ± 2S (3)

| Location | First Quarter 01/12/99 to 04/14/99 | Second Quarter 04/12/99 to 07/15/99 | Third Quarter 07/13/99 to 10/14/99 | Fourth Quarter 10/12/99 to 01/13/00 |
|---|---|---|---|---|
| **0-1 MILE OFFSITE** | | | | |
| 6A4 + | 22.1 ± 0.8 | 18.7 ± 1.7 | 21.0 ± 0.6 | 21.9 ± 1.4 |
| 8A3 | 19.9 ± 1.0 | 16.7 ± 1.3 | 17.7 ± 1.0 | 18.7 ± 1.0 |
| 15A3 | 20.5 ± 0.6 | 19.0 ± 0.8 | 19.7 ± 0.6 | 20.7 ± 1.4 |
| 16A2 | 17.5 ± 1.2 | 16.6 ± 1.2 | 18.1 ± 2.6 | 18.3 ± 1.2 |
| **1-2 MILES OFFSITE** | | | | |
| 1B1 | 21.4 ± 0.8 | 19.1 ± 0.8 | 19.5 ± 0.6 | 20.5 ± 1.0 |
| 2B3 + | 20.6 ± 1.0 | 17.5 ± 1.2 | 19.2 ± 0.4 | 19.3 ± 1.0 |
| 2B4 | 20.5 ± 0.8 | 18.5 ± 1.3 | 19.5 ± 0.4 | 19.8 ± 1.2 |
| 5B3 | 19.4 ± 0.9 | 16.1 ± 1.0 | 17.2 ± 1.6 | 17.7 ± 1.4 |
| 7B2 | 21.1 ± 0.9 | 18.4 ± 1.2 | 19.4 ± 0.4 | 20.3 ± 1.4 |

See the comments at the end of this table.

## TABLE I-1

## ENVIRONMENTAL THERMOLUMINESCENT DOSIMETRY RESULTS

SUSQUEHANNA STEAM ELECTRIC STATION - 1999

Results (1) are in mR/std. qtr. (2) ± 2S (3)

| Location | First Quarter 01/12/99 to 04/14/99 | Second Quarter 04/12/99 to 07/15/99 | Third Quarter 07/13/99 to 10/14/99 | Fourth Quarter 10/12/99 to 01/13/00 |
|---|---|---|---|---|
| 8B2 + | 20.5 ± 0.9 | 17.6 ± 0.8 | 18.9 ± 1.4 | 19.8 ± 1.6 |
| 8B3 | 22.3 ± 0.6 | 18.9 ± 0.8 | 19.3 ± 0.6 | 20.8 ± 1.4 |
| 9B1 | 19.4 ± 1.2 | 16.8 ± 1.2 | 17.9 ± 1.2 | 17.9 ± 0.6 |
| 10B2 | 16.6 ± 1.0 | 13.9 ± 0.6 | 15.5 ± 0.4 | 15.4 ± 1.0 |
| 10B3 | 18.4 ± 1.6 | 15.8 ± 1.2 | 16.6 ± 0.2 | 17.4 ± 1.2 |
| 10B4 | 22.7 ± 0.8 | 18.9 ± 0.6 | 19.7 ± 0.8 | 20.4 ± 1.4 |
| 12B4 | 20.6 ± 1.0 | 17.8 ± 0.8 | 18.9 ± 0.8 | 19.3 ± 0.8 |
| 13B1 | 20.4 ± 0.8 | 17.8 ± 0.6 | 19.0 ± 0.4 | 19.5 ± 0.8 |
| 14B3 + | 20.2 ± 1.4 | 17.8 ± 1.3 | 18.6 ± 0.8 | 19.3 ± 1.0 |
| 15B1 | 20.1 ± 1.2 | 18.3 ± 1.3 | 18.4 ± 1.0 | 19.0 ± 1.4 |
| 16B2 | 18.7 ± 0.8 | 16.7 ± 0.8 | 17.8 ± 0.4 | 18.0 ± 1.2 |
| **2-3 MILES OFFSITE** | | | | |
| 11C1 | 23.6 ± 1.6 | 21.4 ± 1.5 | 21.6 ± 0.8 | 22.6 ± 0.6 |

See the comments at the end of this table.

## TABLE I-1

## ENVIRONMENTAL THERMOLUMINESCENT DOSIMETRY RESULTS

SUSQUEHANNA STEAM ELECTRIC STATION - 1999

Results (1) are in mR/std. qtr. (2) ± 2S (3)

| Location | First Quarter 01/12/99 to 04/14/99 | Second Quarter 04/12/99 to 07/15/99 | Third Quarter 07/13/99 to 10/14/99 | Fourth Quarter 10/12/99 to 01/13/00 |
|---|---|---|---|---|
| **3-4 MILES OFFSITE** | | | | |
| 1D5 + | 23.5 ± 1.1 | 21.3 ± 1.2 | 22.1 ± 0.8 | 23.4 ± 1.8 |
| 6D1 | 23.3 ± 1.1 | 21.2 ± 1.2 | 21.3 ± 1.2 | 22.9 ± 1.4 |
| 8D3 + | 21.4 ± 0.9 | 19.2 ± 0.8 | 19.5 ± 1.0 | 20.8 ± 1.4 |
| 9D4 + | 22.2 ± 1.1 | 20.2 ± 1.0 | 20.1 ± 0.2 | 21.7 ± 1.0 |
| 10D1 + | 20.6 ± 1.1 | 18.9 ± 0.8 | 19.5 ± 1.0 | 20.3 ± 1.6 |
| 12D2 | 23.5 ± 1.0 | 20.7 ± 1.5 | 21.8 ± 0.8 | 22.5 ± 1.6 |
| 14D1 | 22.5 ± 0.6 | 20.0 ± 0.8 | 20.5 ± 0.6 | 21.3 ± 1.2 |
| **4-5 MILES OFFSITE** | | | | |
| 3E1 | 18.8 ± 1.1 | 16.4 ± 0.0 | 18.2 ± 0.6 | 18.4 ± 1.6 |
| 4E2 | 23.1 ± 1.1 | 20.1 ± 0.8 | 20.8 ± 0.6 | 22.2 ± 1.2 |
| 5E2 + | 21.7 ± 0.6 | 18.9 ± 0.2 | 19.6 ± 0.8 | 21.1 ± 1.2 |
| 6E1 + | 24.3 ± 0.9 | 21.7 ± 1.2 | 22.4 ± 1.2 | 23.3 ± 1.0 |
| 7E1 + | 22.8 ± 0.2 | 19.5 ± 1.0 | 20.3 ± 1.4 | 21.8 ± 1.2 |
| 11E1 + | 18.7 ± 1.1 | 16.5 ± 0.6 | 17.2 ± 1.0 | 17.8 ± 1.0 |
| 12E1 + | 19.8 ± 1.0 | 16.5 ± 0.2 | 18.1 ± 1.0 | 18.3 ± 0.6 |
| 13E4 + | 20.7 ± 0.8 | 18.6 ± 1.2 | 19.1 ± 1.0 | 19.5 ± 1.8 |

See the comments at the end of this table.

TABLE I-1

ENVIRONMENTAL THERMOLUMINESCENT DOSIMETRY RESULTS

SUSQUEHANNA STEAM ELECTRIC STATION - 1999

Results (1) are in mR/std. qtr. (2) ± 2S (3)

| Location | First Quarter 01/12/99 to 04/14/99 | Second Quarter 04/12/99 to 07/15/99 | Third Quarter 07/13/99 to 10/14/99 | Fourth Quarter 10/12/99 to 01/13/00 |
|---|---|---|---|---|
| **5-10 MILES OFFSITE** | | | | |
| 2F1 + | 21.5 ± 0.9 | 19.1 ± 1.2 | 19.8 ± 1.0 | 20.6 ± 1.0 |
| 8F2 | 20.4 ± 1.3 | 18.1 ± 0.8 | 19.0 ± 1.2 | 19.5 ± 1.4 |
| 12F2 | 22.2 ± 1.6 | 18.8 ± 0.6 | 19.7 ± 0.6 | 20.8 ± 1.4 |
| 15F1 + | 22.7 ± 0.8 | 20.4 ± 1.5 | 21.1 ± 1.0 | 22.1 ± 1.0 |
| 16F1 + | 23.5 ± 0.8 | 21.3 ± 1.3 | 21.7 ± 0.6 | 22.6 ± 1.2 |
| **10-20 MILES** | | | | |
| 3G4 | 23.7 ± 1.5 | 20.4 ± 1.0 | 20.7 ± 1.2 | 22.6 ± 1.8 |
| 4G1 + | 24.8 ± 0.6 | 20.9 ± 1.4 | 21.7 ± 0.8 | 24.0 ± 1.4 |
| 6G1 | 24.6 ± 0.4 | 22.4 ± 1.2 | 23.7 ± 0.6 | 25.1 ± 1.4 |
| 7G1 + | (5) | 19.3 ± 0.8 | 19.4 ± 1.0 | 20.5 ± 2.6 |
| 7G2 | 21.3 ± 1.5 | 19.1 ± 1.4 | 20.1 ± 0.8 | 21.3 ± 1.4 |
| 8G1 | 19.2 ± 0.6 | 16.5 ± 1.0 | 17.3 ± 0.8 | 18.2 ± 1.2 |
| 12G1 + | 19.5 ± 0.6 | 16.6 ± 1.5 | 17.5 ± 1.2 | 18.1 ± 0.8 |
| 12G4 | 22.5 ± 1.0 | 20.1 ± 1.3 | 21.3 ± 1.2 | 21.4 ± 2.0 |

See the comments at the end of this table.

TABLE I-1

ENVIRONMENTAL THERMOLUMINESCENT DOSIMETRY RESULTS

SUSQUEHANNA STEAM ELECTRIC STATION - 1999

Results (1) are in mR/std. qtr. (2) ± 2S (3)

| Location | First Quarter 01/12/99 to 04/14/99 | Second Quarter 04/12/99 to 07/15/99 | Third Quarter 07/13/99 to 10/14/99 | Fourth Quarter 10/12/99 to 01/13/00 |
|---|---|---|---|---|
| **Indicator** | | | | |
| **Average (6)** | 21.6 ± 9.8 | 19.2 ± 9.8 | 20.2 ± 8.5 | 21.3 ± 12.5 |
| **Control** | | | | |
| **Average (6)** | 22.2 ± 2.6 | 19.4 ± 3.5 | 20.2 ± 2.8 | 21.4 ± 4.7 |

COMMENTS

(1) Individual monitor location results are normally the average of the elemental doses of six calcium elements from the two TLDs assigned to each monitoring location.

(2) A standard (std.) quarter (qtr.) is considered to be 91.25 days. Results obtained for monitoring periods of other durations are normalized by multiplying them by 91.25/x, where x is the actual duration in days of the period.

(3) Uncertainties for individual monitoring location results are two standard deviations of the elemental doses of six calcium elements from the two TLDs assigned to each monitoring location, representing the variability between the elemental doses of each of the six TLD elements.

(4) TLDs were not in the field at this monitoring location during this quarter. Refer to Appendix A of this report for an explanation of program changes to the REMP.

(5) No measurement could be made because the TLDs were lost, stolen, or damaged.

(6) Uncertainties associated with quarterly indicator and control averages are two standard deviations, representing the variability between the results of the individual monitoring locations.

(7) Data were invalidated for this period because of an unacceptably high coefficient of variation among element readings.

\+ ODCM -listed locations.

**TABLE I-2**

**GROSS BETA, TRITIUM, AND GAMMA* SPECTROSCOPIC ANALYSES OF SURFACE WATER**

SUSQUEHANNA STEAM ELECTRIC STATION - 1999

Results in pCi/liter ± 2S

| LOCATION | COLLECTION DATE | GR-BETA | TRITIUM | OTHER ACTIVITY | COMMENTS |
|---|---|---|---|---|---|
| 6S6 | 01/04/99-02/01/99 | 8.9 ± 0.8 | < 109 | | |
| 2S7 | 01/04/99-02/01/99 | 12.6 ± 1.5 | 660 ± 75 | | |
| 6S5 | 01/11/99-02/01/99 | 3.9 ± 0.6 | < 90 | | (1) |
| LTAW | 01/11/99 | 3.3 ± 0.6 | < 90 | | |
| 6S6 | 02/01/99-03/01/99 | 10.7 ± 0.8 | < 111 | | (2) |
| 2S7 | 02/01/99-03/01/99 | 12.6 ± 0.9 | 327 ± 72 | | |
| 6S5 | 02/08/99-03/01/99 | 4.1 ± 0.6 | < 111 | | (3) |
| LTAW | 02/08/99 | 2.3 ± 0.6 | 120 ± 60 | | |
| 6S6 | 03/01/99-04/05/99 | 10.1 ± 0.8 | < 109 | | (4) |
| 2S7 | 03/01/99-04/05/99 | 11.5 ± 0.8 | 711 ± 75 | | (4) |
| 6S5 | 03/08/99-04/05/99 | 5.2 ± 0.6 | < 109 | | |
| LTAW | 03/15/99 | 3.2 ± 0.6 | < 110 | | |
| 6S6 | 04/05/99-05/03/99 | 14.1 ± 0.9 | < 112 | | |
| 2S7 | 04/05/99-05/03/99 | 9.4 ± 0.8 | 4375 ± 112 | | |
| 6S5 | 04/12/99-05/03/99 | 2.1 ± 0.6 | < 112 | | |
| LTAW | 04/12/99 | 14.9 ± 0.9 | 231 ± 69 | | |
| 6S6 | 05/03/99-06/01/99 | 2.0 ± 0.6 | < 124 | | |
| 2S7 | 05/03/99-06/01/99 | 12.4 ± 0.9 | < 124 | | |
| 6S5 | 05/10/99-06/01/99 | 1.6 ± 0.6 | < 124 | | |
| LTAW | 05/10/99 | 6.8 ± 0.7 | 132 ± 70 | | |
| 6S6 | 06/01/99-06/28/99 | 2.0 ± 0.8 | < 110 | | |
| 2S7 | 06/01/99-06/28/99 | 9.4 ± 0.8 | 5324 ± 119 | | |
| 6S5 | 06/07/99-06/28/99 | 6.4 ± 0.8 | < 110 | | |
| LTAW | 06/14/99 | 4.4 ± 0.7 | < 109 | | |

* Gamma-emitters are only reported when activities exceed the MDC's: typical MDC values found in Table I-13.

**TABLE I-2**

**GROSS BETA, TRITIUM, AND GAMMA* SPECTROSCOPIC ANALYSES OF SURFACE WATER**

SUSQUEHANNA STEAM ELECTRIC STATION - 1999

Results in pCi/liter ± 2S

| LOCATION | COLLECTION DATE | GR-BETA | TRITIUM | OTHER ACTIVITY | COMMENTS |
|---|---|---|---|---|---|
| 6S6 | 06/28/99-08/02/99 | 5.9 ± 0.8 | < 107 | | (4) |
| 2S7 | 06/28/99-08/02/99 | 19.2 ± 1.1 | 7332 ± 129 | | (4) |
| 6S5 | 07/06/99-08/02/99 | 5.1 ± 0.7 | < 107 | | |
| LTAW | 07/12/99 | 4.9 ± 0.7 | < 111 | | |
| 6S6 | 08/02/99-09/07/99 | 5.4 ± 0.7 | < 108 | | (4) |
| 2S7 | 08/02/99-09/05/99 | 14.8 ± 1.0 | 3714 ± 104 | | (4, 6) |
| 2S7 | 09/07/99 | 10.0 ± 0.8 | 124 ± 67 | | |
| 6S5 | 08/09/99-09/07/99 | 2.5 ± 1.5 | < 180 | | |
| LTAW | 08/09/99 | 4.6 ± 0.7 | 163 ± 70 | | |
| 6S6 | 09/07/99-10/04/99 | < 1.4 | < 100 | | |
| 2S7 | 09/07/99-10/04/99 | 11.0 ± 0.9 | 2025 ± 85 | | |
| 6S5 | 09/13/99-10/04/99 | 2.1 ± 0.7 | < 100 | | |
| LTAW | 09/13/99 | 5.7 ± 0.8 | < 105 | | |
| 6S6 | 10/04/99-11/01/99 | < 1.4 | < 111 | | |
| 2S7 | 10/04/99-11/01/99 | 8.8 ± 0.8 | < 111 | | (7) |
| 6S5 | 10/11/99-11/01/99 | 2.9 ± 0.7 | < 111 | | |
| LTAW | 10/12/99 | 11.8 ± 0.8 | 136 ± 69 | | |
| 6S6 | 11/01/99-11/29/99 | < 1.0 | < 112 | | |
| 2S7 | 11/01/99-11/29/99 | < 1.6 | 238 ± 71 | | |
| 6S5 | 11/08/99-11/29/99 | 2.3 ± 0.6 | < 112 | | |
| LTAW | 11/15/99 | 3.1 ± 0.6 | 132 ± 67 | | |
| 6S6 | 11/29/99-12/28/99 | < 1.4 | < 107 | | |
| 2S7 | 11/29/99-12/28/99 | 9.7 ± 0.8 | 160 ± 67 | | |
| 6S5 | 12/06/99-12/28/99 | < 1.0 | < 107 | | (8) |
| LTAW | 12/13/99 | 3.0 ± 0.6 | 198 ± 67 | | |

* Gamma emitters are only reported when activities exceed the MDC's: typical MDC values are found in Table I-13.

**GROSS BETA, TRITIUM, AND GAMMA* SPECTROSCOPIC ANALYSES OF SURFACE WATER**

SUSQUEHANNA STEAM ELECTRIC STATION - 1999

Comments

1. During the monitoring period 1/11/99 through 2/1/99, all samples were collected from the shore for monitoring location 6S5 due to hazardous river conditions. These samples are normally taken from a boat further from shore. All samples are composited at the end of the monitoring period.

2. During the monitoring period 2/1/99 through 3/1/99, one aliquot of sample was missed on 2/15/99 as indicated by the LCD display on the ACS at monitoring location 2S7. The ACS was operating properly at the time of sample collection.

3. During the monitoring period 2/8/99 through 3/1/99, the sample for 2/8/99 was collected from the shore for monitoring location 6S5 due to hazardous river conditions. This sample is normally collected from a boat further from shore. This sample was composited with others at the end of the monitoring period.

4. The intervals between the gamma analyses for the surface water samples from monitoring locations 6S6 and 2S7 for the monitoring period and those for the previous monitoring period exceeded 36 days.

5. The collection container for the automatic composite sampler (ACS) at monitoring location 6S6 was found to be overflowing on 6/7/99. The problem may have been due to a partially clogged drain line that could have restricted flow. This condition was found and corrected during preventative maintenance performed on the ACS on 6/28/99.

6. During the monitoring period 8/2/99 through 9/5/99, sampling by the automatic composite sampler (ACS) was interrupted at 1417 on 9/5/99 at monitoring location 2S7. A grab sample was collected. The ACS was reset and checked for proper operation periodically following the occurrence.

7. During the monitoring period 10/4/99 through 11/1/99, the following sample aliquots were missed as indicated by the LCD display on the ACS at monitoring location 2S7: five on 10/22/99, one on 10/23/99, and one on 10/29/99. No sample could be collected from 10:45 through 13:09 on 10/22/99 because there was no flow through the CTBD line to permit maintenance to be performed. (It should be noted that 396 aliquots were collected during the week of 10/23/99 and 406 aliquots were collected during the week of 10/29/99.) The ACS was operating properly at the time of sample collection.

8. During the monitoring period 12/6/99 through 12/28/99, the sample for 12/28/99 was collected from the shore for monitoring location 6S5 due to hazardous river conditions. This sample is normally collected from a boat further from shore. This sample was composited with others at the end of the monitoring period.

**TABLE I-3**

**IODINE-131 ANALYSES OF SURFACE WATER**

SUSQUEHANNA STEAM ELECTRIC STATION - 1999

Results in pCi/liter ± 2S

| LOCATION | COLLECTION DATE | I-131 | COMMENTS |
|---|---|---|---|
| 6S6 | 01/04/99-01/18/99 | 0.58 ± 0.09 | |
| 6S6 | 01/18/99-02/01/99 | < 0.2 | |
| 2S7 | 01/04/99-01/18/99 | 1.0 ± 0.1 | |
| 2S7 | 01/18/99-02/01/99 | 0.59 ± 0.11 | |
| 6S5 | 01/11/99-01/18/99 | 0.20 ± 0.06 | (1) |
| 6S5 | 01/25/99-02/01/99 | < 0.1 | (1) |
| LTAW | 01/11/99 | < 0.06 | |
| 6S6 | 02/01/99-02/16/99 | < 0.2 | |
| 6S6 | 02/16/99-03/01/99 | 0.22 ± 0.09 | |
| 2S7 | 02/01/99-02/16/99 | 0.34 ± 0.12 | (2) |
| 2S7 | 02/16/99-03/01/99 | 0.48 ± 0.11 | |
| 6S5 | 02/08/99-02/16/99 | < 0.1 | (3) |
| 6S5 | 02/22/99-03/01/99 | 0.18 ± 0.09 | |
| LTAW | 02/08/99 | < 0.1 | |
| 6S6 | 03/01/99-03/15/99 | < 0.2 | |
| 6S6 | 03/15/99-03/29/99 | 0.53 ± 0.15 | |
| 2S7 | 03/01/99-03/15/99 | 0.35 ± 0.11 | |
| 2S7 | 03/15/99-03/29/99 | 0.73 ± 0.18 | |
| 6S5 | 03/08/99-03/15/99 | 0.65 ± 0.10 | |
| 6S5 | 03/22/99-03/29/99 | 0.47 ± 0.10 | |
| LTAW | 03/15/99 | < 0.08 | |
| 6S6 | 03/29/99-04/12/99 | 0.18 ± 0.07 | |
| 6S6 | 04/12/99-04/26/99 | < 0.1 | |
| 2S7 | 03/29/99-04/12/99 | 0.21 ± 0.12 | |
| 2S7 | 04/12/99-04/26/99 | < 0.1 | |
| 6S5 | 04/05/99-04/12/99 | 0.16 ± 0.06 | |
| 6S5 | 04/19/99-04/26/99 | < 0.09 | |
| LTAW | 04/12/99 | < 0.06 | |

**TABLE I-3**

**IODINE-131 ANALYSES OF SURFACE WATER**

SUSQUEHANNA STEAM ELECTRIC STATION - 1999

Results in pCi/liter ± 2S

| LOCATION | COLLECTION DATE | I-131 | COMMENTS |
|---|---|---|---|
| 6S6 | 04/26/99-05/10/99 | < 0.2 | |
| 6S6 | 05/10/99-05/24/99 | 0.51 ± 0.13 | |
| 2S7 | 04/26/97-05/10/99 | < 0.3 | |
| 2S7 | 05/10/99-05/24/99 | 0.28 ± 0.10 | |
| 6S5 | 05/03/99-05/10/99 | < 0.2 | |
| 6S5 | 05/17/99-05/24/99 | 0.16 ± 0.07 | |
| LTAW | 05/10/99 | < 0.2 | |
| 6S6 | 05/24/99-06/07/99 | 0.71 ± 0.17 | (4) |
| 6S6 | 06/07/99-06/21/99 | 0.64 ± 0.12 | |
| 2S7 | 05/24/99-06/07/99 | 1.3 ± 0.2 | |
| 2S7 | 06/07/99-06/21/99 | 1.6 ± 0.2 | |
| 6S5 | 06/01/99-06/07/99 | 0.50 ± 0.10 | |
| 6S5 | 06/14/99-06/21/99 | 0.48 ± 0.09 | |
| LTAW | 06/14/99 | < 0.09 | |
| 6S6 | 06/21/99-07/06/99 | 0.45 ± 0.12 | |
| 6S6 | 07/06/99-07/19/99 | 0.18 ± 0.09 | |
| 6S6 | 07/19/99-08/02/99 | 0.30 ± 0.12 | |
| 2S7 | 06/21/99-07/06/99 | 1.0 ± 0.20 | |
| 2S7 | 07/06/99-07/19/99 | 0.30 ± 0.11 | |
| 2S7 | 07/19/99-08/02/99 | 0.47 ± 0.10 | |
| 6S5 | 06/28/99-07/06/99 | 0.16 ± 0.10 | |
| 6S5 | 07/12/99-07/19/99 | 0.18 ± 0.10 | |
| 6S5 | 07/26/99-08/02/99 | 0.90 ± 0.09 | |
| LTAW | 07/12/99 | < 0.1 | |
| 6S6 | 08/02/99-08/16/99 | 0.83 ± 0.12 | |
| 6S6 | 08/16/99-08/30/99 | 1.1 ± 0.1 | |
| 2S7 | 08/02/99-08/16/99 | 1.6 ± 0.1 | |
| 2S7 | 08/16/99-08/30/99 | 2.0 ± 0.2 | |
| 6S5 | 08/09/99-08/16/99 | 1.1 ± 0.1 | |
| 6S5 | 08/23/99-08/30/99 | 1.6 ± 0.2 | |
| LTAW | 08/09/99 | < 0.08 | |

**TABLE I-3**

**IODINE-131 ANALYSES OF SURFACE WATER**

SUSQUEHANNA STEAM ELECTRIC STATION - 1999

Results in pCi/liter ± 2S

| LOCATION | COLLECTION DATE | I-131 | COMMENTS |
|---|---|---|---|
| 6S6 | 09/07/99 | 0.72 ± 0.12 | |
| 6S6 | 08/30/99-09/13/99 | 0.63 ± 0.11 | |
| 2S7 | 08/30/99-09/05/99 | 0.94 ± 0.15 | (5) |
| 2S7 | 09/07/99 | 1.4 ± 0.2 | |
| 2S7 | 09/07/99-09/13/99 | 1.4 ± 0.1 | |
| 6S5 | 09/07/99-09/13/99 | 0.54 ± 0.10 | |
| LTAW | 09/13/99 | < 0.01 | |
| 6S6 | 09/13/99-09/27/99 | 0.16 ± 0.09 | |
| 6S6 | 09/27/99-10/11/99 | < 0.2 | |
| 2S7 | 09/13/99-09/27/99 | 0.44 ± 0.1 | |
| 2S7 | 09/27/99-10/11/99 | 0.62 ± 0.13 | |
| 6S5 | 09/20/99-09/27/99 | 0.25 ± 0.07 | |
| 6S5 | 10/04/99-10/11/99 | 0.29 ± 0.10 | |
| LTAW | 10/12/99 | < 0.2 | |
| 6S6 | 10/11/99-10/25/99 | 0.48 ± 0.12 | |
| 6S6 | 10/25/99-11/08/99 | 0.60 ± 0.14 | |
| 2S7 | 10/11/99-10/25/99 | 1.2 ± 0.1 | (6) |
| 2S7 | 10/25/99-11/08/99 | 1.4 ± 0.1 | (6) |
| 6S5 | 10/18/99-10/25/99 | 0.44 ± 0.09 | |
| 6S5 | 11/01/99-11/08/99 | 0.50 ± 0.12 | |
| 6S6 | 11/08/99-11/21/99 | 0.33 ± 0.16 | |
| 6S6 | 11/21/99-12/06/99 | < 0.2 | |
| 2S7 | 11/08/99-11/21/99 | 0.52 ± 0.17 | |
| 2S7 | 11/21/99-12/06/99 | < 0.3 | |
| 6S5 | 11/15/99-11/21/99 | 0.37 ± 0.14 | |
| 6S5 | 11/29/99-12/06/99 | < 0.2 | |
| LTAW | 11/15/99 | < 0.2 | |
| 6S6 | 12/06/99-12/20/99 | < 0.2 | |
| 6S6 | 12/20/99-01/03/00 | < 0.2 | |
| 2S7 | 12/06/99-12/20/99 | < 0.3 | |
| 2S7 | 12/20/99-01/03/00 | < 0.2 | |
| 6S5 | 12/13/99-12/20/99 | [illegible] | |
| 6S5 | 12/28/99-01/03/00 | 0.21 ± 0.08 | (7) |
| LTAW | 12/13/99 | < 0.1 | |

**TABLE I-3**

**IODINE-131 ANALYSES OF SURFACE WATER**

SUSQUEHANNA STEAM ELECTRIC STATION - 1999

Comments

1. During the monitoring periods 1/11/99 through 1/18/99 and 1/25/99 through 2/1/99, all samples were collected from the shore for monitoring location 6S5 due to hazardous river conditions. These samples are normally taken from a boat further from shore. All samples are composited at the end of the monitoring period.

2. During the monitoring period 2/1/99 through 2/16/99, one aliquot of sample was missed on 2/15/99 as indicated by the LCD display on the ACS at monitoring location 2S7. The ACS was operating properly at the time of sample collection.

3. During the monitoring period 2/8/99 through 3/1/99, the sample for 2/8/99 was collected from the shore for monitoring location 6S5 due to hazardous river conditions. This sample is normally collected from a boat further from shore. This sample was composited with others at the end of the monitoring period.

4. The collection container for the automatic composite sampler (ACS) at monitoring location 6S6 was found to be overflowing on 6/7/99. The problem may have been due to a partially clogged drain line that could have restricted flow. This condition was found and corrected during preventative maintenance performed on the ACS on 6/28/99.

5. During the monitoring period 8/30/99 through 9/5/99, sampling by the automatic composite sampler (ACS) was interrupted at 14:17 on 9/5/99 at monitoring location 2S7. A grab sample was collected. The ACS was reset and checked for proper operation periodically following the occurrence.

6. During the monitoring periods 10/11/99 through 10/25/99 and 10/25/99 through 11/8/99, the following sample aliquots were missed as indicated by the LCD display on the ACS at monitoring location 2S7: five on 10/22/99, one on 10/23/99, and one on 10/29/99. No sample could be collected from 10:45 through 13:09 on 10/22/99 because there was no flow through the CTBD line to permit maintenance to be performed. (It should be noted that 396 aliquots were collected during the week of 10/23/99 and 406 aliquots were collected during the week of 10/29/99.) The ACS was operating properly at the time of sample collection.

7. During the monitoring period 12/28/99 through 1/3/00, the sample for 12/28/99 was collected from the shore for monitoring location 6S5 due to hazardous river conditions. This sample is normally collected from a boat further from shore. This sample was composited with others at the end of the monitoring period.

**TABLE I-4**

**GROSS ALPHA, GROSS BETA, TRITIUM, IODINE-131 AND GAMMA* SPECTROSCOPIC ANALYSES OF DRINKING WATER**

SUSQUEHANNA STEAM ELECTRIC STATION - 1999

Results in pCi/liter ± 2S

| LOCATION | COLLECTION DATE | GR-ALPHA | GR-BETA | TRITIUM | OTHER ACTIVITY | |
|---|---|---|---|---|---|---|
| | COMMENTS | | | | | |
| 12H2 T | 01/04/99-01/18/99 | | | | I-131 0.22 ± 0.08 | (1) |
| 12H2 T | 01/04/99-02/01/99 | < 2.0 | 2.6 ± 0.9 | < 109 | | |
| 12H2 T | 02/01/99-03/01/99 | < 0.4 | 1.4 ± 0.7 | < 111 | | |
| 12H2 T | 03/01/99-04/05/99 | < 0.8 | 3.0 ± 0.8 | < 109 | | (2) |
| 12H2 T | 03/15/99-03/29/99 | | | | I-131 0.31 ± 0.12 | |
| 12H2 T | 03/29/99-04/12/99 | | | | I-131 0.17 ± 0.08 | |
| 12H2 T | 04/05/99-05/03/99 | < 1.0 | 1.6 ± 0.8 | < 112 | | |
| 12H2 T | 05/03/99-05/17/99 | < 2.0 | 1.8 ± 0.8 | < 124 | | (3) |
| 12H2 T | 05/24/99 | 1.5 ± 1.2 | 2.7 ± 0.9 | < 123 | | (3) |
| 12H2 T | 05/24/99-06/01/99 | < 0.9 | 1.9 ± 0.8 | < 123 | | (3) |
| 12H2 T | 05/24/99-06/07/99 | | | | I-131 0.60 ± 0.15 | (3) |
| 12H2 T | 06/01/99-06/28/99 | < 2.0 | 3.5 ± 1.0 | < 110 | | |
| 12H2 T | 06/07/99-06/21/99 | | | | I-131 0.63 ± 0.11 | |
| 12H2 T | 06/21/99-07/06/99 | | | | I-131 0.23 ± 0.11 | |

* Gamma emitters are only reported when activities exceed the MDC's: typical MDC values are found in Table I-13.

**TABLE I-4**

**GROSS ALPHA, GROSS BETA, TRITIUM, IODINE-131 AND GAMMA* SPECTROSCOPIC ANALYSES OF DRINKING WATER**

SUSQUEHANNA STEAM ELECTRIC STATION - 1999

Results in pCi/liter ± 2S

| LOCATION | COLLECTION DATE | GR-ALPHA | GR-BETA | TRITIUM | OTHER ACTIVITY | COMMENTS |
|---|---|---|---|---|---|---|
| 12H2 T | 06/28/99-08/02/99 | < 2.0 | 4.1 ± 1.1 | < 107 | | (4) |
| 12H2 T | 07/06/99-07/19/99 | | | | I-131 0.21 ± 0.1 | |
| 12H2 T | 08/02/99-09/07/99 | < 2.0 | 3.4 ± 1.0 | 125 ± 67 | | (2) |
| 12H2 T | 08/02/99-08/16/99 | | | | I-131 0.22 ± 0.10 | |
| 12H2 T | 08/16/99-08/30/99 | | | | I-131 0.35 ± 0.13 | |
| 12H2 T | 08/30/99-09/13/99 | | | | I-131 0.20 ± 0.12 | |
| 12H2 T | 09/07/99-10/04/99 | < 1.0 | 3.1 ± 1.0 | < 100 | | |
| 12H2 T | 10/11/99-10/25/99 | | | | I-131 0.27 ± 0.14 | |
| 12H2 T | 10/04/99-11/01/99 | < 2.0 | 2.2 ± 0.9 | < 111 | | |
| 12H2 T | 10/25/99-11/08/99 | | | | I-131 0.32 ± 0.12 | |
| 12H2 T | 11/01/99-11/29/99 | < 1.0 | 3.5 ± 0.9 | < 112 | | |
| 12H2 T | 11/29/99-12/28/99 | < 0.8 | 2.9 ± 0.8 | < 107 | | |

* Gamma emitters are only reported when activities exceed the MDC's: typical MDC values are found in Table I-13.

**GROSS ALPHA, GROSS BETA, TRITIUM, IODINE-131 AND GAMMA* SPECTROSCOPIC ANALYSES OF DRINKING WATER**

SUSQUEHANNA STEAM ELECTRIC STATION - 1999

Comments

1. During the monitoring period from 1/4/99 through 2/1/99, the collection container at the automatic composite sampler (ACS) at monitoring location 12H2T, the Danville Municipal Drinking Water Facility, was found overflowing on 1/11/99. Therefore, the first week of the monthly compositing period was not represented as intended. The ACS was observed to be operating properly by sample collection personnel and no non-routine actions were taken.

2. The intervals between the gamma and gross beta analyses for the drinking water sample from monitoring location 12H2T for the monitoring period and those for the previous monitoring period exceeded 36 days.

3. During the monitoring period from 5/3/99 through 6/1/99, the ACS at monitoring location 12H2T was found to be inoperable on 5/24/99. The solenoid used to initiate the collection of individual sample aliquots was observed to have fallen off the wall of the ACS cabinet. The solenoid was reattached to the wall of the ACS cabinet and the ACS was returned to service on 5/24/99. A grab sample was collected on 5/24/99 to represent the
third week of the monthly compositing period.

4. The interval between the gamma analyses for the drinking water sample from monitoring location 12H2T for the monitoring period and those for the previous monitoring period exceeded 36 days.

**TABLE I-5**

**GROSS BETA AND GAMMA* SPECTROSCOPIC ANALYSES OF FISH**

SUSQUEHANNA STEAM ELECTRIC STATION - 1999

Results in pCi/gm (wet) ± 2S

| LOCATION | SAMPLE TYPE | COLLECTION DATE | K-40 |
|---|---|---|---|
| IND | Smallmouth Bass | 04/28/99-04/28/99 | 3.60 ± 0.36 |
| IND | White Sucker | 04/28/99-04/28/99 | 3.27 ± 0.33 |
| IND | Channel Catfish | 04/28/99-04/28/99 | 3.08 ± 0.31 |
| 2H | White Sucker | 05/20/99-05/20/99 | 3.32 ± 0.33 |
| 2H | Smallmouth Bass | 05/20/99-05/20/99 | 4.00 ± 0.40 |
| 2H | Channel Catfish | 05/20/99-05/20/99 | 2.56 ± 0.26 |
| IND | Smallmouth Bass | 10/21/99-10/21/99 | 3.41 ± 0.34 |
| IND | Shorthead Redhorse | 10/21/99-10/22/99 | 2.96 ± 0.30 |
| IND | Channel Catfish | 10/25/99-10/26/99 | 2.63 ± 0.26 |
| 2H | Smallmouth Bass | 10/26/99-10/26/99 | 3.25 ± 0.33 |
| 2H | Shorthead Redhorse | 10/27/99-10/27/99 | 3.36 ± 0.34 |
| 2H | Channel Catfish | 10/26/99-10/27/99 | 2.61 ± 0.26 |
| LTAW | Largemouth Bass | 10/22/99-10/22/99 | 3.21 ± 0.32 |

* Gamma emitters are only reported when activities exceed the MDC's: typical MDC values are found in Table I-13.

**TABLE I-6**

**GAMMA* SPECTROSCOPIC ANALYSES OF SHORELINE SEDIMENT**

SUSQUEHANNA STEAM ELECTRIC STATION - 1999

Results in pCi/gm (dry) ± 2S

| LOCATION | COLLECTION DATE | K-40 | Cs-137 | Ra-226 | Th-228 | Other Activity |
|---|---|---|---|---|---|---|
| 2B | 04/28/99 | 13.7 ± 1.4 | 0.068 ± 0.029 | 1.63 ± 0.47 | 1.11 ± 0.11 | |
| 7B | 04/28/99 | 12.3 ± 1.2 | 0.096 ± 0.029 | 1.75 ± 0.47 | 0.97 ± 0.10 | |
| 12F | 04/28/99 | 9.3 ± 0.9 | 0.075 ± 0.030 | 1.16 ± 0.48 | 0.79 ± 0.08 | |
| LTAW | 04/28/99 | 13.3 ± 1.3 | < 0.03 | 1.57 ± 0.50 | 1.03 ± 0.10 | |
| 2B | 10/19/99 | 12.2 ± 1.2 | 0.096 ± 0.023 | 1.72 ± 0.53 | 0.90 ± 0.09 | |
| 7B | 10/19/99 | 11.1 ± 1.1 | 0.096 ± 0.027 | 1.50 ± 0.40 | 1.00 ± 0.10 | |
| 12F | 10/19/99 | 18.3 ± 1.8 | 0.169 ± 0.053 | 2.22 ± 0.92 | 1.65 ± 0.16 | Mn-54 0.24 +/- 0.07 |
| LTAW | 10/19/99 | 11.9 ± 1.2 | < 0.03 | 1.99 ± 0.56 | 0.94 ± 0.09 | |

* Gamma emitters are only reported when activities exceed the MDC's: typical MDC values are found in Table I-13.

**TABLE I-7**

**TRITIUM, AND GAMMA* SPECTROSCOPIC ANALYSES OF GROUND WATER**

SUSQUEHANNA STEAM ELECTRIC STATION - 1999

Results in pCi/liter ± 2S

| LOCATION | COLLECTION DATE | TRITIUM | OTHER ACTIVITY |
|---|---|---|---|
| 12F3 | 01/11/99 | < 90 | |
| 2S2 | 01/11/99 | < 90 | |
| 4S4 Treated | 01/11/99 | < 90 | |
| 4S5 | 01/11/99 | < 116 | |
| 12S1 | 01/11/99 | < 90 | |
| 12F3 | 02/08/99 | < 90 | |
| 2S2 | 02/08/99 | < 90 | |
| 4S4 Treated | 02/08/99 | < 90 | |
| 4S5 | 02/08/99 | < 108 | |
| 12S1 | 02/08/99 | < 90 | |
| 12F3 | 03/15/99 | < 110 | |
| 2S2 | 03/15/99 | < 110 | |
| 4S4 Treated | 03/15/99 | < 110 | |
| 4S5 | 03/15/99 | < 110 | |
| 12S1 | 03/15/99 | < 110 | |
| 12F3 | 04/12/99 | < 109 | |
| 2S2 | 04/12/99 | < 109 | |
| 4S4 Treated | 04/12/99 | < 109 | |
| 4S5 | 04/12/99 | < 109 | |
| 12S1 | 04/12/99 | < 109 | |
| 12F3 | 05/10/99 | < 113 | |
| 2S2 | 05/10/99 | < 113 | |
| 4S4 Treated | 05/10/99 | < 113 | |
| 4S5 | 05/10/99 | < 113 | |
| 12S1 | 05/10/99 | < 113 | |
| 12F3 | 06/14/99 | < 109 | |
| 2S2 | 06/14/99 | < 109 | |
| 4S4 Treated | 06/14/99 | < 109 | |
| 4S5 | 06/14/99 | < 109 | |
| 12S1 | 06/14/99 | < 109 | |

* Gamma emitters are only reported when activities exceed the MDC's: typical MDC values are found in Table I-13.

**TABLE I-7**

**TRITIUM, AND GAMMA* SPECTROSCOPIC ANALYSES OF GROUND WATER**

SUSQUEHANNA STEAM ELECTRIC STATION - 1999

Results in pCi/liter ± 2S

| LOCATION | COLLECTION DATE | TRITIUM | OTHER ACTIVITY |
|---|---|---|---|
| 12F3 | 07/12/99 | < 111 | |
| 2S2 | 07/12/99 | < 111 | |
| 4S4 Treated | 07/12/99 | < 111 | |
| 4S5 | 07/12/99 | < 111 | |
| 12S1 | 07/12/99 | < 111 | |
| 12F3 | 08/09/99 | < 112 | |
| 2S2 | 08/09/99 | < 112 | |
| 4S4 Treated | 08/09/99 | < 112 | |
| 4S5 | 08/09/99 | < 112 | |
| 12S1 | 08/09/99 | < 112 | |
| 12F3 | 09/13/99 | < 104 | |
| 2S2 | 09/13/99 | < 104 | |
| 4S4 Treated | 09/13/99 | < 104 | |
| 4S5 | 09/13/99 | < 104 | |
| 12S1 | 09/13/99 | < 104 | |
| 12F3 | 10/12/99 | 170 ± 69 | |
| 2S2 | 10/12/99 | < 110 | |
| 4S4 Treated | 10/12/99 | < 110 | |
| 4S5 | 10/13/99 | < 110 | |
| 12S1 | 10/12/99 | < 110 | |
| 12F3 | 11/15/99 | < 107 | |
| 2S2 | 11/15/99 | < 107 | |
| 4S4 Treated | 11/15/99 | < 107 | |
| 4S5 | 11/15/99 | < 107 | |
| 12S1 | 11/15/99 | < 107 | |
| 12F3 | 12/13/99 | < 106 | |
| 2S2 | 12/13/99 | < 106 | |
| 4S4 Treated | 12/13/99 | < 106 | |
| 4S5 | 12/13/99 | < 106 | |
| 12S1 | 12/13/99 | < 106 | |

* Gamma emitters are only reported when activities exceed the MDC's: typical MDC values are found in Table I-13.

**TABLE I-8**

**GROSS BETA ANALYSES OF AIR PARTICULATE FILTERS**

SUSQUEHANNA STEAM ELECTRIC STATION - 1999

Results in E-03 pCi/Cu.M. ± 2S

| MONTH | COLLECTION DATE (1) | 8G1 | 6G1 | 3S2 | 5S4 | 12S1 | 13S6 | 9B1 | 7S7 | 10S3 | 12E1 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| JAN | 12/30-01/06 (2) | 12 ± 1 | 13 ± 1 | 12 ± 1 | 16 ± 2 | 12 ± 2 | 14 ± 2 | 12 ± 2 | 12 ± 1 | 12 ± 2 | 13 ± 2 |
| | 01/06-01/13 | 17 ± 2 | 18 ± 2 | 20 ± 2 | 22 ± 2 | 19 ± 2 | 22 ± 2 | 18 ± 2 | 21 ± 2 | 23 ± 2 | 19 ± 2 |
| | 01/13-01/20 | 11 ± 1 | 9.2 ± 1.4 | 11 ± 1 | 10 ± 2 | 11 ± 2 | 12 ± 2 | 13 ± 2 | 11 ± 1 | 12 ± 2 | 13 ± 2 |
| | 01/20-01/27 (4) | 5.0 ± 2.5 (3) | 7.0 ± 1.4 | 8.6 ± 1.4 | 10 ± 2 | 7.7 ± 1.4 | 9.4 ± 1.5 | 10 ± 2 | 7.8 ± 1.3 | 8.6 ± 1.5 | 8.2 ± 1.4 |
| | 01/27-02/03 (5) | 12 ± 1 | 13 ± 2 | 15 ± 2 | 15 ± 2 | 15 ± 2 | 14 ± 2 | 15 ± 2 | 14 ± 1 | 15 ± 2 | 13 ± 1 |
| FEB | 02/03-02/10 | 14 ± 2 | 15 ± 2 | 15 ± 2 | 14 ± 2 | 16 ± 2 | 15 ± 2 | 16 ± 2 | 15 ± 1 | 14 ± 2 | 15 ± 2 |
| | 02/10-02/17 (6) | 14 ± 2 | 13 ± 2 | 16 ± 2 | 14 ± 2 | 13 ± 2 | 16 ± 2 | 15 ± 2 | 15 ± 2 | 12 ± 2 | 13 ± 2 |
| | 02/17-02/24 | 12 ± 2 | 12 ± 2 | 13 ± 2 | 13 ± 2 | 12 ± 2 | 12 ± 2 | 15 ± 2 | 13 ± 2 | 13 ± 2 | 13 ± 2 |
| | 02/24-03/03 | 13 ± 1 | 12 ± 2 | 13 ± 1 | 12 ± 1 | 12 ± 2 | 13 ± 2 | 14 ± 2 | 13 ± 2 | 12 ± 1 | 12 ± 1 |
| MAR | 03/03-03/10 (6) | < 30 (7) | 11 ± 2 | 16 ± 2 | 13 ± 2 | 14 ± 2 | 16 ± 2 | 13 ± 2 | 13 ± 2 | 13 ± 2 | 14 ± 2 |
| | 03/10-03/17 | 9.8 ± 1.3 | 11 ± 1 | 10 ± 1 | 9.4 ± 1.3 | 9.7 ± 1.4 | 11 ± 1 | 9.4 ± 1.3 | 10 ± 1 | 9.9 ± 1.4 | 11 ± 1 |
| | 03/17-03/24 | 8.8 ± 1.4 | 9.0 ± 1.4 | 10 ± 1 | 9.8 ± 1.4 | 11 ± 2 | 10 ± 2 | 11 ± 1 | 9.8 ± 1.4 | 10 ± 1 | 9.5 ± 1.4 |
| | 03/24-03/31 | 11 ± 1 | 11 ± 1 | 12 ± 1 | 11 ± 1 (8) | 12 ± 1 | 12 ± 2 | 13 ± 1 | 12 ± 1 | 13 ± 2 | 12 ± 1 |
| APR | 03/31-04/06 (6) | 12 ± 2 | 13 ± 2 | 14 ± 2 | 13 ± 2 | 13 ± 2 | 13 ± 2 | 15 ± 2 | 15 ± 2 | 13 ± 2 | 14 ± 2 |
| | 04/06-04/14 | 10 ± 1 | 12 ± 1 | 10 ± 1 (9) | 12 ± 1 | 13 ± 1 | 12 ± 1 | 13 ± 1 | 12 ± 1 | 12 ± 1 | 12 ± 1 |
| | 04/14-04/21 | 6.5 ± 1.5 | 7.9 ± 1.7 | 8.4 ± 1.6 | 7.1 ± 1.6 | 6.6 ± 1.6 | 7.9 ± 1.8 | 10 ± 2 | 8.3 ± 1.6 | 8.1 ± 1.7 | 6.3 ± 1.5 |
| | 04/21-04/28 | 9.9 ± 1.3 | 11 ± 1 | 12 ± 1 | 11 ± 1 | 11 ± 2 | 9.7 ± 1.5 | 12 ± 2 | 11 ± 1 | 11 ± 2 | 10 ± 1 |
| MAY | 04/28-05/05 | 8.2 ± 1.4 | 9.0 ± 1.5 | 8.5 ± 1.4 | 9.9 ± 1.5 | 8.9 ± 1.5 | 10 ± 2 (10) | 11 ± 2 | 9.1 ± 1.5 | 8.1 ± 1.5 | 10 ± 2 |
| | 05/05-05/12 | 5.6 ± 1.2 | 5.4 ± 1.3 | 5.1 ± 1.2 | 5.9 ± 1.2 | 5.0 ± 1.3 | 5.9 ± 1.4 | 5.3 ± 1.3 | 5.1 ± 1.2 | 5.4 ± 1.3 | 5.0 ± 1.2 |
| | 05/12-05/19 | 8.3 ± 1.3 | 8.8 ± 1.4 | 10 ± 1 | 10 ± 1 | 10 ± 2 | 9.4 ± 1.5 | 10 ± 2 | 11 ± 2 | 10 ± 2 | 9.4 ± 1.5 |
| | 05/19-05/26 (6) | 9.3 ± 1.4 | 8.9 ± 1.5 | 9.4 ± 1.5 | 11 ± 2 | 10 ± 2 | 8.3 ± 1.6 (11) | 11 ± 2 | 10 ± 2 | 9.8 ± 1.6 | 9.6 ± 1.5 |
| | 05/26-06/02 | 15 ± 2 | 18 ± 2 | 16 ± 2 | 15 ± 2 | 17 ± 2 | 18 ± 2 | 21 ± 2 | 16 ± 2 | 15 ± 2 | 18 ± 2 |
| JUN | 06/02-06/08 | 13 ± 2 | 15 ± 2 | 13 ± 2 | 15 ± 2 | 13 ± 2 | 14 ± 2 | 16 ± 2 | 15 ± 2 | 14 ± 2 | 14 ± 2 |
| | 06/08-06/16 | 9.7 ± 1.3 | 11 ± 1 | 11 ± 1 | 11 ± 1 | 10 ± 1 | 9.3 ± 1.3 | 12 ± 1 | 11 ± 1 | 11 ± 1 | 9.4 ± 1.4 |
| | 06/16-06/23 | 14 ± 2 | 10 ± 2 | 12 ± 2 | 9.8 ± 1.7 | 11 ± 2 | 11 ± 2 | 13 ± 2 | 12 ± 2 | 11 ± 2 | 11 ± 2 |
| | 06/23-06/30 (6) | 11 ± 2 | 13 ± 2 | 14 ± 2 | 14 ± 2 | 13 ± 2 | 13 ± 2 | 16 ± 2 | 14 ± 2 | 14 ± 2 | 13 ± 2 |

**TABLE I-8**

**GROSS BETA ANALYSES OF AIR PARTICULATE FILTERS**

SUSQUEHANNA STEAM ELECTRIC STATION - 1999

Results in E-03 pCi/Cu.M. ± 2S

| MONTH | COLLECTION DATE (1) | 8G1 | 6G1 | 3S2 | 5S4 | 12S1 | 13S6 | 9B1 | 7S7 | 10S3 | 12E1 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| JUL | 06/30-07/07 | 16 ± 2 | 18 ± 2 | 17 ± 2 | 16 ± 2 | 18 ± 2 | 18 ± 2 | 18 ± 2 | 18 ± 2 | 17 ± 2 | 19 ± 2 |
| | 07/07-07/14 | 15 ± 2 | 11 ± 2 | 13 ± 2 | 11 ± 2 | 13 ± 2 | 14 ± 2 | 11 ± 2 | 13 ± 2 | 13 ± 2 | 11 ± 2 |
| | 07/14-07/21 | 19 ± 3 (12) | 23 ± 2 | 21 ± 2 | 26 ± 2 | 22 ± 2 | 23 ± 2 | 25 ± 2 | 22 ± 2 | 21 ± 2 | 24 ± 2 |
| | 07/21-07/28 (6) | 20 ± 2 | 19 ± 2 | 20 ± 2 | 22 ± 2 | 22 ± 2 | 19 ± 2 | 24 ± 2 | 20 ± 2 | 20 ± 2 | 21 ± 2 |
| | 07/28-08/04 | 15 ± 2 | 14 ± 2 | 14 ± 2 | 15 ± 2 | 15 ± 2 | 14 ± 2 | 16 ± 2 | 15 ± 2 | 16 ± 2 | 15 ± 2 |
| AUG | 08/04-08/11 | 13 ± 2 | 13 ± 1 | 13 ± 2 | 16 ± 2 (13) | 14 ± 2 | 14 ± 2 | 15 ± 2 | 15 ± 2 | 13 ± 2 | 14 ± 2 |
| | 08/11-08/18 | 18 ± 2 | 19 ± 2 | 18 ± 2 | 20 ± 2 | 20 ± 2 | 19 ± 2 | 19 ± 2 | 18 ± 2 | 18 ± 2 | 19 ± 2 |
| | 08/18-08/25 (6) | 12 ± 2 | 12 ± 2 | 12 ± 2 | 15 ± 2 | 14 ± 2 | 12 ± 2 | 14 ± 2 | 12 ± 2 | 13 ± 2 | 13 ± 2 |
| | 08/25-09/01 (6) | 13 ± 2 | 13 ± 2 | 14 ± 2 | 13 ± 2 | 13 ± 2 | 14 ± 2 | 14 ± 2 | 14 ± 2 | 13 ± 2 | 14 ± 2 |
| SEP | 09/01-09/08 | 12 ± 2 | 13 ± 2 | 14 ± 2 (14) | 17 ± 2 | 17 ± 2 | 15 ± 2 | 16 ± 2 | 16 ± 2 | 16 ± 2 | 17 ± 2 |
| | 09/08-09/15 | 24 ± 2 | 24 ± 2 | 26 ± 2 | 26 ± 2 | 24 ± 2 | 24 ± 2 | 25 ± 2 | 25 ± 2 | 24 ± 2 | 26 ± 2 |
| | 09/15-09/22 | 13 ± 2 (15) | 9.1 ± 1.6 | 12 ± 2 | 14 ± 2 | 11 ± 2 | 13 ± 2 | 13 ± 2 | 12 ± 2 | 12 ± 2 | 12 ± 2 |
| | 09/22-09/29 (6) | 20 ± 2 | 18 ± 2 | 22 ± 2 | 23 ± 2 | 21 ± 2 | 23 ± 2 | 22 ± 2 | 25 ± 2 | 23 ± 2 | 23 ± 2 |
| OCT | 09/29-10/06 (6) | 17 ± 2 | 16 ± 2 | 18 ± 2 | 16 ± 2 | 18 ± 2 | 17 ± 2 | 17 ± 2 | 16 ± 2 | 16 ± 2 | 16 ± 2 |
| | 10/06-10/13 | 15 ± 2 | 15 ± 2 | 15 ± 2 | 17 ± 2 | 16 ± 2 | 15 ± 2 | 16 ± 2 | 17 ± 2 | 16 ± 2 | 15 ± 2 |
| | 10/13-10/20 | 11 ± 3 | 11 ± 1 | 12 ± 2 | 11 ± 2 | 11 ± 1 | 10 ± 2 | 10 ± 2 | 13 ± 2 | 11 ± 1 | 11 ± 2 |
| | 10/20-10/27 | 14 ± 2 | 15 ± 2 | 16 ± 2 | 18 ± 2 (16) | 14 ± 2 | 14 ± 2 | 13 ± 2 | 15 ± 2 | 14 ± 2 | 16 ± 2 |
| | 10/27-11/03 (6) | 25 ± 2 | 25 ± 2 | 32 ± 2 | 35 ± 2 | 29 ± 2 | 30 ± 2 | 28 ± 2 | 31 ± 2 | 29 ± 2 | 28 ± 2 |
| NOV | 11/03-11/10 (6) | 22 ± 2 | 23 ± 2 | 22 ± 2 | 22 ± 2 | 22 ± 2 (17) | 21 ± 2 | 22 ± 2 | 23 ± 2 | 23 ± 2 | 23 ± 2 |
| | 11/10-11/17 | 17 ± 2 | 18 ± 2 | 18 ± 2 | 17 ± 2 | 17 ± 2 | 19 ± 2 | 17 ± 2 | 17 ± 2 | 18 ± 2 | 17 ± 2 |
| | 11/17-11/23 | 12 ± 2 | 14 ± 2 | 15 ± 2 | 16 ± 2 (18) | 13 ± 2 | 13 ± 2 | 13 ± 2 | 14 ± 2 | 14 ± 2 | 16 ± 2 |
| | 11/23-12/01 | 12 ± 1 | 12 ± 1 | 13 ± 2 | 13 ± 2 | 14 ± 2 | 12 ± 1 | 13 ± 1 | 12 ± 1 | 13 ± 2 | 12 ± 2 |
| DEC | 12/01-12/08 | 16 ± 2 | 20 ± 2 | 20 ± 2 | 20 ± 2 | 19 ± 2 | 18 ± 2 | 21 ± 2 | 20 ± 2 | 19 ± 2 | 18 ± 2 |
| | 12/08-12/15 (6) | 17 ± 2 (19) | 17 ± 2 | 20 ± 2 | 23 ± 2 | 21 ± 2 | 24 ± 2 | 21 ± 2 | 23 ± 2 | 20 ± 2 | 22 ± 2 |
| | 12/15-12/21 | 14 ± 2 | 14 ± 2 | 14 ± 2 | 14 ± 2 | 14 ± 2 | 12 ± 2 | 13 ± 2 | 15 ± 2 | 14 ± 2 | 13 ± 2 |
| | 12/21-12/28 | 17 ± 2 | 17 ± 2 | 17 ± 2 | 18 ± 2 | 16 ± 2 | 16 ± 2 | 17 ± 2 | 19 ± 2 | 19 ± 2 | 17 ± 2 |

**GROSS BETA ANALYSES OF AIR PARTICULATE FILTERS**

SUSQUEHANNA STEAM ELECTRIC STATION - 1999

Comments

1. Sampling periods for some sampling locations may vary by a day or two at both the beginnings and ends of the periods from those dates presented in this table. The dates presented in this table were selected because they represented the sampling periods for most of the sampling locations.

2. The interval between the gross beta analyses for the air sample from all monitoring locations for the monitoring period 12/30/98 through 1/6/99 and those for the previous monitoring period 12/22/98 through 12/30/98 exceeded 8.5 days. The radioanalytical laboratory and sample collection personnel were apprised by letter on 2/5/99 of the need for adhering to a strict interpretation of Technical Requirement REMP sample analysis surveillance frequencies as the result of surveillance procedure changes until clarification of the application of frequency requirements can be obtained.

3. During the monitoring period 1/20/99 through 1/27/99, a loss of electricity occurred as the result of a breaker trip at monitoring location 8G1. Based on the electrical timer reading sampling was calculated to have stopped on 1/23/99 at 1512. A lower than normal volume (10,400 $ft^3$) of air was sampled. Personnel responsible for the electrical supply to the air sampling equipment at location 8G1 were contacted on 1/29/99. These personnel indicated on 2/1/99 that they would replace the ground fault interrupter with a different circuit breaker when weather conditions became more favorable for such work

4. The interval between the gross beta analyses for the air sample from all monitoring locations for the monitoring period 1/20/99 through 1/27/99 and those for the previous monitoring period 1/13/99 through 1/20/99 exceeded 8.5 days.

5. The interval between the gross beta analyses for the air sample from all monitoring locations for the monitoring period 1/27/99 through 2/3/99 and those for the previous monitoring period 1/20/99 through 1/27/99 exceeded 8.5 days.

6. The interval between the gross beta analyses for the air sample from all monitoring locations for the monitoring period and those for the previous monitoring period exceeded 8.5 days.

7. During the scheduled monitoring period from 3/3/99 through 3/10/99, a loss of electricity occurred as the result of a breaker trip at monitoring location 8G1. Based on the reading of the electrical timer box, the sampling at location 8G1 occurred for only about 11.5 hours on 3/3/99. The required analysis sensitivity of 1E-2 $pCi/m^3$ was not met for the analysis of this sample.

8. During the monitoring period 3/24/99 through 3/31/99, electricity was unavailable to the air sampling equipment at monitoring location 5S4 because of transformer maintenance. Electricity was restored to the sampling equipment following completion of the maintenance.

9. During the monitoring period 4/6/99 through 4/14/99, there was an apparent loss of electricity to the air sampling equipment at monitoring location 3S2 based on the electrical timer reading and the volume of air sampled. The station was sampling appropriately at the time of sample collection.

10. During the monitoring period 4/28/99 through 5/5/99, there was an apparent loss of electricity to the air sampling equipment at monitoring location 13S6 based on the electrical timer reading and low sample volume. The equipment was functioning properly at the time of sample collection.

11. During the scheduled monitoring period 5/19/99 through 5/26/99, there was a loss of electrical power to the air sampling equipment at monitoring location 13S6. Sampling personnel found the sampling equipment not operating at the time of sample collection.The stop date and time for sampling, 5/25/99 at 2022, were calculated based on the electrical timer reading. The problem was reported to PP&L's Customer Service on 5/26/99. Repairs were made on 5/28/99 and the air sampling equipment was returned to operation.

**GROSS BETA ANALYSES OF AIR PARTICULATE FILTERS**

SUSQUEHANNA STEAM ELECTRIC STATION - 1999

12. During the scheduled monitoring period 7/14/99 through 7/21/99, there was a loss of electricity to the air sampling equipment at monitoring location 8G1. Sampling personnel found the sampling equipment not operating at the time of sample collection. The stop date and time for sampling, 7/17/99 at 16:01, were calculated based on the electrical timer reading. A lower than normal volume (9.900 $ft^3$) of air was sampled. Personnel responsible for the electrical supply to the air sampling equipment at location 8G1 were contacted on 7/22/99.

13. During the scheduled monitoring period 8/4/99 through 8/11/99, electricity was interrupted to the air sampling equipment at monitoring location 5S4 from 10:07 to 11:37 on 8/4/99 to permit the PADEP to replace the housing on their air monitor at this location. The equipment was returned to operation following this work.

14. During the scheduled monitoring period 9/1/99 through 9/8/99, electricity was interrupted to the air sampling equipment at monitoring location 3S2 from 10:35 to 11:40 on 9/1/99 to permit the PADEP to perform maintenance on their air sampling equipment at this location. The equipment was returned to operation following this work.

15. During the monitoring period 9/15/99 through 9/22/99, sampling at monitoring location 8G1 was apparently interrupted due to a loss of electricity as indicated by the electrical timer reading. Between 30 and 40 hours of sampling time were lost as a result of this interruption. Personnel responsible for the electrical supply to the air sampling equipment at this location were notified of the problem. The ground fault interrupter for this air sampling equipment was replaced with another circuit breaker on 10/8/99.

16. During the monitoring period 10/20/99 through 10/27/99, sampling was interrupted from 12:17 through 12:24 on 10/26/99 to replace the air sampling pump at monitoring location 5S4. The pump was replaced because the previously installed pump was making more noise than usual, indicating a possible problem.

17. During the scheduled monitoring period 11/3/99 through 11/10/99, electricity was interrupted to the air sampling equipment at monitoring location 12S1 from 10:30 to 11:30 on 11/10/99 to permit the PADEP to replace the housing on their air monitor at this location. The equipment was returned to operation following this work.

18. During the monitoring period 11/17/99 through 11/23/99, electricity was interrupted from 10:35 to 11:44 on 11/20/99 to the air sampling equipment at monitoring location 5S4 for electrical maintenance.

19. During the monitoring period 12/8/99 through 12/15/99, the electricity was interrupted from 06:30 to 09:00 on 12/12/99 to the air sampling equipment at monitoring location 8G1. This was an intentional interruption to permit work to be performed at the PP&L facility where the air sampling equipment is located.

**TABLE I-9**

**GAMMA* SPECTROSCOPIC ANALYSES OF COMPOSITED AIR PARTICULATE FILTERS**

SUSQUEHANNA STEAM ELECTRIC STATION - 1999

Results in E-03 pCi/Cu. M. ± 2S

| LOCATION | COLLECTION DATE | Be-7 | K-40 | OTHER ACTIVITY |
|---|---|---|---|---|
| 6G1 | 12/30/98-03/31/99 | 108 ± 11 | | |
| 8G1 | 12/30/98-03/31/99 | 99.7 ± 10 | | |
| 7S7 | 12/30/98-03/31/99 | 110 ± 11 | | |
| 10S3 | 12/30/98-03/31/99 | 124 ± 12 | | |
| 3S2 | 12/30/98-03/31/99 | 114 ± 11 | | |
| 5S4 | 12/30/98-03/31/99 | 108 ± 11 | | |
| 9B1 | 12/30/98-03/31/99 | 157 ± 16 | 4.39 ± 1.74 | |
| 12E1 | 12/30/98-03/31/99 | 124 ± 12 | | |
| 12S1 | 12/30/98-03/31/99 | 101 ± 10 | | |
| 13S6 | 12/30/98-03/31/99 | 117 ± 12 | | |
| 6G1 | 03/31/99-06/30/99 | 137 ± 14 | 7.96 ± 2.39 | |
| 8G1 | 03/31/99-06/60/99 | 131 ± 13 | | |
| 7S7 | 03/31/99-06/30/99 | 144 ± 14 | | |
| 10S3 | 03/31/99-06/30/99 | 171 ± 17 | 3.75 ± 1.58 | |
| 3S2 | 03/31/99-06/30/99 | 181 ± 18 | | |
| 5S4 | 03/31/99-06/30/99 | 144 ± 14 | | |
| 9B1 | 03/31/99-06/30/99 | 163 ± 16 | | |
| 12E1 | 03/31/99-06/30/99 | 133 ± 13 | | |
| 12S1 | 03/31/99-06/30/99 | 144 ± 14 | | |
| 13S6 | 03/31/99-06/30/99 | 160 ± 16 | | |

**TABLE I-9**

**GAMMA* SPECTROSCOPIC ANALYSES OF COMPOSITED AIR PARTICULATE FILTERS**

SUSQUEHANNA STEAM ELECTRIC STATION - 1999

Results in E-03 pCi/Cu. M. ± 2S

| LOCATION | COLLECTION DATE | Be-7 | K-40 | OTHER ACTIVITY |
|---|---|---|---|---|
| 6G1 | 06/30/99-09/29/99 | 126 ± 13 | 4.22 ± 1.92 | |
| 8G1 | 06/30/99-09/29/99 | 148 ± 15 | 3.93 ± 1.75 | |
| 7S7 | 06/30/99-09/29/99 | 139 ± 14 | | |
| 10S3 | 06/30/99-09/29/99 | 136 ± 14 | | |
| 3S2 | 06/30/99-09/29/99 | 138 ± 14 | | |
| 5S4 | 06/30/99-09/29/99 | 141 ± 14 | | |
| 9B1 | 06/30/99-09/29/99 | 146 ± 15 | | |
| 12E1 | 06/30/99-09/29/99 | 131 ± 13 | 8.03 ± 2.24 | |
| 12S1 | 06/30/99-09/29/99 | 129 ± 13 | | |
| 13S6 | 06/30/99-09/29/99 | 122 ± 12 | | |
| 6G1 | 09/29/99-12/28/99 | 90.2 ± 9.0 | | |
| 8G1 | 09/29/99-12/28/99 | 91.5 ± 9.1 | | |
| 7S7 | 09/29/99-12/28/99 | 103 ± 10 | | |
| 10S3 | 09/29/99-12/28/99 | 92.6 ± 9.3 | | |
| 3S2 | 09/29/99-12/28/99 | 94.1 ± 9.4 | | |
| 5S4 | 09/29/99-12/28/99 | 92.0 ± 9.2 | | |
| 9B1 | 09/29/99-12/28/99 | 91.7 ± 9.2 | | |
| 12E1 | 09/29/99-12/28/99 | 96.1 ± 9.6 | | |
| 12S1 | 09/29/99-12/28/99 | 96.7 ± 9.7 | | |
| 13S6 | 09/29/99-12/28/99 | 83.9 ± 8.4 | 4.99 ± 1.94 | |

**TABLE I-10**

**IODINE-131, AND GAMMA* SPECTROSCOPIC ANALYSES OF MILK**

SUSQUEHANNA STEAM ELECTRIC STATION - 1999

Results in pCi/liter ± 2S

| LOCATION | COLLECTION DATE | K-40 | COMMENTS |
|---|---|---|---|
| 10G1 | 01/05/99 | 1410 ± 140 | |
| 10D1 | 01/05/99 | 1390 ± 140 | |
| 10D2 | 01/05/99 | 1390 ± 140 | |
| 7C1 | 01/05/99 | 1360 ± 140 | |
| 10G1 | 02/02/99 | 1240 ± 120 | |
| 10D1 | 02/02/99 | 1450 ± 140 | |
| 10D2 | 02/02/99 | 1390 ± 140 | |
| 7C1 | 02/02/99 | 1290 ± 130 | |
| 10G1 | 03/08/99 | 1400 ± 140 | |
| 10D1 | 03/08/99 | 1300 ± 130 | |
| 10D2 | 03/08/99 | 1280 ± 130 | |
| 7C1 | 03/08/99 | 1340 ± 130 | |
| 10G1 | 04/05/99 | 1380 ± 140 | |
| 10D1 | 04/05/99 | 1400 ± 140 | |
| 10D2 | 04/05/99 | 1360 ± 140 | |
| 7C1 | 04/05/99 | 1290 ± 130 | |
| 10G1 | 04/19/99 | 1290 ± 130 | |
| 10D1 | 04/19/99 | 1330 ± 130 | |
| 10D2 | 04/19/99 | 1340 ± 130 | |
| 7C1 | 04/19/99 | 1260 ± 130 | |
| 10G1 | 05/03/99 | 1380 ± 140 | |
| 10D1 | 05/03/99 | 1360 ± 140 | |
| 10D2 | 05/03/99 | 1350 ± 130 | |
| 7C1 | 05/03/99 | 1300 ± 130 | |
| 10G1 | 05/20/99 | 1360 ± 130 | (2) |
| 10D1 | 05/19/99 | 1300 ± 130 | (1, 2) |
| 10D2 | 05/19/99 | 1340 ± 130 | (1, 2) |
| 7C1 | 05/20/99 | 1430 ± 140 | (2) |

* Gamma emitters are only reported when activities exceed the MDC's: typical MDC values found in Table I-15.

**TABLE I-10**

**IODINE-131, AND GAMMA* SPECTROSCOPIC ANALYSES OF MILK**

SUSQUEHANNA STEAM ELECTRIC STATION - 1999

Results in pCi/liter ± 2S

| LOCATION | COLLECTION DATE | K-40 | COMMENTS |
|---|---|---|---|
| 10G1 | 06/07/99 | 1340 ± 130 | |
| 10D1 | 06/07/99 | 1420 ± 140 | (3, 4) |
| 10D2 | 06/07/99 | 1310 ± 130 | (3) |
| 7C1 | 06/07/99 | 1340 ± 130 | |
| 10G1 | 06/22/99 | 1210 ± 120 | |
| 10D1 | 06/22/99 | 1230 ± 120 | |
| 10D2 | 06/22/99 | 1390 ± 140 | |
| 7C1 | 06/22/99 | 1350 ± 130 | |
| 10G1 | 07/06/99 | 1290 ± 130 | |
| 10D1 | 07/06/99 | 1390 ± 140 | |
| 10D2 | 07/06/99 | 1480 ± 150 | |
| 7C1 | 07/06/99 | 1240 ± 120 | |
| 10G1 | 07/20/99 | 1260 ± 130 | |
| 10D1 | 07/20/99 | 1260 ± 130 | |
| 10D2 | 07/20/99 | 1340 ± 130 | |
| 7C1 | 07/20/99 | 1370 ± 140 | |
| 10G1 | 08/03/99 | 1300 ± 130 | |
| 10D1 | 08/03/99 | 1420 ± 140 | |
| 10D2 | 08/03/99 | 1420 ± 140 | |
| 7C1 | 08/03/99 | 1320 ± 130 | |
| 10G1 | 08/19/99 | 1360 ± 140 | |
| 10D1 | 08/19/99 | 1340 ± 130 | |
| 10D2 | 08/19/99 | 1280 ± 130 | |
| 7C1 | 08/19/99 | 1340 ± 130 | |
| 10G1 | 09/02/99 | 1320 ± 130 | |
| 10D1 | 09/02/99 | 1250 ± 130 | |
| 10D2 | 09/02/99 | 1310 ± 130 | |
| 7C1 | 09/02/99 | 1400 ± 140 | |



* Gamma emitters are only reported when activities exceed the MDC's: typical MDC values are found in Table I-15.

**TABLE I-10**

**IODINE-131, AND GAMMA* SPECTROSCOPIC ANALYSES OF MILK**

SUSQUEHANNA STEAM ELECTRIC STATION - 1999

Results in pCi/liter ± 2S

| LOCATION | COLLECTION DATE | K-40 | COMMENTS |
|---|---|---|---|
| 10G1 | 09/20/99 | 1300 ± 130 | |
| 10D1 | 09/20/99 | 1300 ± 130 | |
| 10D2 | 09/20/99 | 1290 ± 130 | |
| 7C1 | 09/20/99 | 1380 ± 140 | |
| 10G1 | 10/04/99 | 1430 ± 140 | |
| 10D1 | 10/04/99 | 1260 ± 130 | |
| 10D2 | 10/04/99 | 1640 ± 160 | |
| 7C1 | 10/04/99 | 1450 ± 150 | |
| 10G1 | 10/18/99 | 1350 ± 130 | |
| 10D1 | 10/18/99 | 1630 ± 160 | |
| 10D2 | 10/18/99 | 1430 ± 140 | |
| 7C1 | 10/18/99 | 1460 ± 150 | |
| 10G1 | 11/08/99 | 1450 ± 140 | |
| 10D1 | 11/08/99 | 1230 ± 120 | |
| 10D2 | 11/08/99 | 1260 ± 130 | |
| 7C1 | 11/08/99 | 1400 ± 140 | |
| 10G1 | 12/06/99 | 1380 ± 140 | |
| 10D1 | 12/06/99 | 1470 ± 150 | |
| 10D2 | 12/06/99 | 1420 ± 140 | |
| 7C1 | 12/06/99 | 1460 ± 150 | |



* Gamm[illegible]ters are only reported when activities exceed the MDC's: typical MDC value[illegible]ound in Table I-15.

**IODINE-131, AND GAMMA* SPECTROSCOPIC ANALYSES OF MILK**

SUSQUEHANNA STEAM ELECTRIC STATION - 1999

Comments

1. The intervals between the iodine-131 analyses for the milk samples from monitoring locations 10D1 and 10D2 collected on 5/19/99 and those for the previously collected samples from these locations on 5/3/99 exceeded 18 days.

2. The intervals between the gamma analyses for the milk samples from all monitoring locations collected on 5/19/99 and 5/20/99 and those for the previously collected samples on 5/3/99 exceeded 18 days.

3. The intervals from 5/19/99 to 6/7/99 between milk sample collections from monitoring locations 10D1 and 10D2 exceeded 18 days.

4. The interval between iodine-131 analyses for the milk sample from monitoring location 10D1 collected on 6/7/99 and the milk sample previously collected from this location on 5/19/99 exceeded 18 days.

**TABLE I-11**

**GAMMA* SPECTROSCOPIC ANALYSES OF SOIL**

SUSQUEHANNA STEAM ELECTRIC STATION - 1999

Results in pCi/gm (dry) ± 2S

| LOCATION | COLLECTION DATE | K-40 | Cs-137 | Ra-226 | Th-228 |
|---|---|---|---|---|---|
| 8G1 TOP | 09/22/99 | 9.26 ± 0.93 | 0.12 ± 0.03 | 2.02 ± 0.51 | 0.76 ± 0.08 |
| 8G1 BOT | 09/22/99 | 8.89 ± 0.89 | 0.12 ± 0.02 | 1.45 ± 0.04 | 0.73 ± 0.07 |
| 3S2 TOP | 09/22/99 | 12.6 ± 1.3 | 0.05 ± 0.03 | 1.95 ± 0.50 | 1.0 ± 0.1 |
| 3S2 BOT | 09/22/99 | 15.6 ± 1.6 | 0.07 ± 0.02 | 1.75 ± 0.46 | 0.82 ± 0.08 |
| 12S1 TOP | 09/22/99 | 11.2 ± 1.1 | 0.17 ± 0.02 | 1.30 ± 0.32 | 0.82 ± 0.08 |
| 12S1 BOT | 09/22/99 | 10.7 ± 1.1 | 0.14 ± 0.03 | 1.09 ± 0.40 | 0.63 ± 0.06 |
| 13S6 TOP | 09/22/99 | 12.9 ± 1.3 | | 1.06 ± 0.38 | 0.78 ± 0.08 |
| 13S6 BOT | 09/22/99 | 13.2 ± 1.3 | | 1.16 ± 0.41 | 0.79 ± 0.08 |

* Gamma emitters are only reported when activities exceed the MDC's: typical MDC values are found in Table I-13.

**TABLE I-12**

**GAMMA* SPECTROSCOPIC ANALYSES OF FOOD PRODUCTS (FRUITS AND VEGETABLES)**

SUSQUEHANNA STEAM ELECTRIC STATION - 1999

Results in pCi/gm (wet) ± 2S

| LOCATION | SAMPLE TYPE | COLLECTION DATE | K-40 | OTHER ACTIVITY |
|---|---|---|---|---|
| 9B4 | Apples | 09/20/99 | 0.918 ± 0.092 | |
| 10B5 | Apples | 09/20/99 | 0.914 ± 0.091 | |
| 12S7 | Apples | 09/20/99 | 0.697 ± 0.070 | |
| 13G2 | Beans | 07/12/99 | 2.39 ± 0.24 | |
| 11B1 | Beans | 07/26/99 | 3.05 ± 0.31 | |
| 14B3 | Beets | 07/26/99 | 3.94 + 0.39 | |
| 11B1 | Beets | 07/07/99 | 4.27 ± 0.43 | |
| 13B2 | Cabbage | 07/26/99 | 1.24 ± 0.12 | |
| 10B5 | Cabbage | 07/07/99 | 2.02 ± 0.20 | |
| 14B3 | Cabbage | 07/07/99 | 2.51 ± 0.25 | |
| 11D1 | Cantaloupe | 08/17/99 | 3.81 ± 0.38 | |
| 11B1 | Cantaloupe | 08/17/99 | 4.45 ± 0.45 | |
| 13G2 | Corn | 08/04/99 | 2.79 ± 0.28 | |
| 11D1 | Corn | 07/20/99 | 2.90 ± 0.29 | |
| 12S7 | Corn | 08/09/99 | 3.16 ± 0.32 | |
| 14B3 | Corn | 07/26/99 | 3.31 ± 0.33 | |
| 10B5 | Corn | 07/26/99 | 3.30 ± 0.33 | |
| 11B1 | Corn | 07/26/99 | 3.38 ± 0.34 | |
| 13G2 | Cucumber | 07/12/99 | 1.88 ± 0.19 | |
| 10B5 | Cucumber | 07/26/99 | 2.29 ± 0.23 | |
| 13B2 | Cucumber | 07/26/99 | 1.40 ± 0.14 | |
| 11B1 | Onion | 07/26/99 | 1.50 ± 0.15 | |
| 14B3 | Peppers | 08/16/99 | 2.09 ± 0.21 | |
| 10B5 | Peppers | 08/16/99 | 1.58 ± 0.16 | |
| 11B1 | Peppers | 08/17/99 | 1.78 ± 0.18 | |
| 13G2 | Potatoes | 08/04/99 | 3.94 ± 0.39 | |
| 10B5 | Potatoes | 07/26/99 | 4.01 ± 0.40 | |

* Gamma emitters are only reported when activities exceed the MDC's: typical MDC values are found in Table I-13.

**TABLE I-12**

**GAMMA* SPECTROSCOPIC ANALYSES OF FOOD PRODUCTS (FRUITS AND VEGETABLES)**

SUSQUEHANNA STEAM ELECTRIC STATION - 1999

Results in pCi/gm (wet) ± 2S

| LOCATION | SAMPLE TYPE | COLLECTION DATE | K-40 | OTHER ACTIVITY |
|---|---|---|---|---|
| 13G2 | Pumpkin | 10/05/99 | 2.82 ± 0.28 | |
| 11D1 | Pumpkin | 09/13/99 | 3.17 ± 0.32 | |
| 12S7 | Squash | 09/20/99 | 1.95 ± 0.19 | |
| 13G2 | Tomatoes | 08/04/99 | 2.68 ± 0.27 | |
| 9B4 | Tomatoes | 08/09/99 | 1.47 ± 0.16 | |
| 14B3 | Tomatoes | 08/16/99 | 1.86 ± 0.19 | |
| 10B5 | Tomatoes | 08/16/99 | 2.18 ± 0.22 | |
| 11D1 | Tomatoes | 08/17/99 | 2.02 ± 0.20 | |
| 11D2 | Tomatoes | 08/17/99 | 4.86 ± 0.49 | |
| 11B1 | Tomatoes | 08/17/99 | 3.12 ± 0.31 | |
| 13B2 | Tomatoes | 08/17/99 | 2.19 ± 0.22 | |
| 10B5 | Tomatoes | 09/20/99 | 2.30 ± 0.23 | |
| 12F7 | Wax Beans | 07/15/99 | 1.93 ± 0.19 | |
| 11B1 | Zucchini | 07/07/99 | 1.69 ± 0.17 | |

* Gamma emitters are only reported when activities exceed the MDC's: typical MDC values are found in Table I-13.

## TABLE I-13

### TYPICAL * MINIMUM DETECTABLE CONCENTRATIONS OF NUCLIDES SEARCHED FOR BUT NOT FOUND BY GAMMA SPECTROMETRY IN THE VICINITY OF SUSQUEHANNA STEAM ELECTRIC STATION, 1999

| Nuclide | Fish (pCi/g wet) | Sediment (pCi/g dry) | Surface Water (pCi/l) | Ground Water (pCi/l) | Potable Water (pCi/l) |
|---|---|---|---|---|---|
| Mn-54 | 0.019 | 0.088 | 3.8 | 4.3 | 3.0 |
| Co-58 | 0.023 | 0.072 | 4.1 | 4.3 | 3.6 |
| Fe-59 | 0.043 | 0.180 | 9.1 | 9.5 | 8.6 |
| Co-60 | 0.019 | 0.088 | 4.2 | 4.6 | 3.0 |
| Zn-65 | 0.046 | 0.180 | 9.0 | 10 | 7.7 |
| Zr-95 | 0.039 | 0.181 | 8.7 | 9.5 | 8.2 |
| Nb-95 | 0.023 | 0.091 | 4.5 | 4.8 | 4.1 |
| Ru-103 | 0.026 | 0.091 | 4.9 | 5.1 | 4.9 |
| I-131** | 0.075 | 0.562 | 0.3 | 10 | 0.3 |
| Cs-134 | 0.021 | 0.074 | 4.5 | 4.7 | 3.6 |
| Cs-137 | 0.024 | 0.093 | 4.6 | 5.1 | 4.4 |
| Ba-140 | 0.100 | 0.637 | 39 | 20 | 21 |
| La-140 | 0.040 | 0.292 | 9.2 | 8.1 | 9.2 |
| Ce-141 | 0.036 | 0.106 | 7.9 | 7.8 | 8.7 |

| Nuclide | Air Particulate (10-3 pCi/m3) | Milk (pCi/l) | Fruit/Veg. (pCi/g wet) | Soil (pCi/g dry) |
|---|---|---|---|---|
| Mn-54 | 0.32 | 4.7 | 0.009 | 0.037 |
| Co-58 | 0.61 | 4.7 | 0.009 | 0.034 |
| Fe-59 | 2.43 | 10 | 0.025 | 0.071 |
| Co-60 | 0.34 | 4.8 | 0.010 | 0.037 |
| Zn-65 | 0.78 | 10 | 0.026 | 0.079 |
| Zr-95 | 1.10 | 9.5 | 0.022 | 0.072 |
| Nb-95 | 0.68 | 4.9 | 0.009 | 0.041 |
| Ru-103 | 1.10 | 5.1 | 0.010 | 0.037 |
| I-131** | 0.02 | 0.2 | 0.014 | 0.061 |
| Cs-134 | 0.32 | 5.1 | 0.012 | 0.030 |
| Cs-137 | 0.31 | 5.1 | 0.013 | 0.055 |
| Ba-140 | 108 | 16 | 0.031 | 0.111 |
| La-140 | 57 | 6.3 | 0.013 | 0.052 |
| Ce-141 | 2.3 | 8.2 | 0.014 | 0.062 |

* Typical refers to mean plus two standard deviations.

** Iodine-131 in surface water, potable water and milk is determined by radiochemical methods. Iodine-131 in air is collected on charcoal and measured by gamma spectrometry. See appendix E-13.

# APPENDIX J

## PERFORMANCE SUMMARY FOR THE RADIOANALYSES OF SPIKED ENVIRONMENTAL SAMPLE MEDIA - 1999

## TELEDYNE BROWN ENGINEERING
## &
## PPL CORPORATION
## CORPORATE ENVIRONMENTAL RADIOACTIVITY MEASUREMENTS LABORATORY RESULTS

The data in the tables that follow show how well Teledyne and PPL's Corporate Environmental Radioactivity Measurements Laboratory (CERML) performed in the analysis of radioactively spiked environmental sample media. Table J-1 shows the agreement of Teledyne's analysis results with the levels of radioactivity reported by Analytics, Inc., for spiked samples procured by Teledyne as part of its QC Spike Program. Table J-2 presents the analysis results of Teledyne and the levels of radioactivity reported by Analytics for spiked environmental sample media procured from Analytics by PPL as part of its quality control for the PPL Radiological Environmental Monitoring Program (REMP). The spiked samples represented in both Tables J-1 and J-2 are prepared by Analytics as part of its Environmental Radioactivity Cross-Check Program. The spiked sample analysis results in Table J-3 are for tritium analyses performed by CERML, which performs the primary analyses for tritium in surface water, drinking water and ground water samples collected for the REMP.

**TABLE J-1**

ENVIRONMENTAL RESOURCE ASSOCIATES (ERA)

PROFICIENCY TESTING (PT) PROGRAM - 1999

TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES



| Collection Date | Media | Nuclide | ERA Known Results(a) | Teledyne Brown Eng. Results(b) | Ratio | Mean Recovery (c) | Control Limits |
|---|---|---|---|---|---|---|---|
| 07/30/99 Rad - 08 | Water | Sr-89 | 26.6 ± 5.0 | 25.0 ± 1.0 | 0.94 | 26.8 | 17.9 - 35.3 |
| | | Sr-90 | 40.2 ± 5.0 | 39.7 ± 2.3 | 0.99 | 37.1 | 31.5 - 48.9 |
| 08/02/99 Rad - 09 | Water | Gr-Alpha | 48.6 ± 12.2 | 30.3 ± 6.5 | 0.62 (c) | 43.5 | 27.7 - 69.5 (d) |
| | | Gr-Beta | 20.0 ± 5.0 | 22.0 ± 2.7 | 1.10 | 20.3 | 11.3 - 28.7 |
| 08/23/99 Rad - 10 | Water | H-3 | 6130 ± 613 | 5530 ± 153 | 0.90 | 5860 | 5090 - 7170 |
| 11/10/99 Rad - 12 | Water | I-131 | 23.3 ± 3.0 | 26.0 ± 0.0 | 1.11 | 23.6 | 18.1 - 28.5 |
| 11/15/99 Rad - 13 | Water | Gr-Alpha | 71.8 ± 18.0 | 14.0 ± 2.7 | 0.20 | 66.2 | 40.9 - 103 (e) |
| | | Gr- Beta | 194 ± 29.1 | 34.0 ± 4.0 | 0.18 | 184 | 144 - 244 (e) |
| | | Sr-89 | 16.4 ± 5.0 | 15.7 ± 2.3 | 0.96 | 16.4 | 20.2 - 37.6 |
| | | Sr-90 | 28.9 ± 5.0 | 29.0 ± 2.0 | 1.00 | 26.5 | 20.2 - 37.6 |
| | | Co-60 | 64.4 ± 5.0 | 68.3 ± 0.6 | 1.06 | 69.1 | 55.7 - 73.1 |
| | | Cs-134 | 12.3 ± 5.0 | 12.0 ± 0.0 | 0.98 | 11.5 | 3.6 - 21.0 |
| | | Cs-137 | 72.2 ± 5.0 | 76.3 ± 0.6 | 1.06 | 75.2 | 63.5 - 80.9 |
| 12/15/99 Rad - 14 | Water | Gr-Alpha | 25.4 ± 6.4 | 14.0 ± 2.7 | 0.55 | 21.9 | 14.5 - 36.3 (f) |
| | | Gr-Beta | 42.1 ± 5.0 | 34.0 ± 4.0 | 0.81 | 21.9 | 33.4 - 50.8 (f) |
| 12/20/99 Rad - 15 | Water | Co-60 | 99.6 ± 5.0 | 101 ± 1.0 | 1.01 | 102 | 90.9 - 108 |
| | | Zn-65 | 313 ± 31.3 | <1.0 | 0.00 | 327 | 260 - 367 (g) |
| | | Ba-133 | 98.2 ± 9.8 | 91.7 ± 1.2 | 0.93 | 98.9 | 81.5 - 115 |
| | | Cs-134 | 49.2 ± 5.0 | 48.0 ± 0.0 | 0.97 | 46.2 | 40.5 - 57.9 |
| | | Cs-137 | 209 ± 10.4 | 76.3 ± 0.6 | 0.37 | 212 | 191 - 227 (h) |

**TABLE J-1**

ENVIRONMENTAL RESOURCE ASSOCIATES (ERA)

PROFICIENCY TESTING (PT) PROGRAM - 1999

TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES



**Footnotes:**

(a) ERA Know Value is equal to 100 % of the parameter present as determined by gravimetric and/or volumetric measurements made during preparation. Units are pCi/liter for water.

(b) Teledyne Results - Average of three measurements ± 1 sigma. Units are pCi/liter for water.

(c) The low value is attributed to greater self-adsorption characteristics of the sample matrix compared to those of the calibration matrix. This source of bias is often observed in gross alpha measurements, nevertheless, the average is within the control region (but also in the warning region).

(d) The mean recovery has been determined from the data reported to ERA for the parameter during the study

(e) The incorrect results were reported for Rad-13. Information on the paperwork and on the sample bottles were confusing and caused the Rad-14 results to be reported for Rad-13.

(f) Results under investigation.

(g) The incorrect results were submitted for this analysis. Actual results reported on L9307, TI #'s 23920 - 23922, provides an averaged result of 341 ± 1 pCi/l, which is in agreement with ERA value of 313 ± 31.3 pCi/l.

(h) The incorrect results were submitted for this analysis. Actual results reported on L9307, TI #'s 23920 - 23922, provides an averaged result of 222 ± 2 pCi/l, which is in agreement with ERA value of 209 ± 10.4 pCi/l.

**TABLE J-2**

ANALYTICS ENVIRONMENTAL RADIOACTIVITY CROSS CHECK PROGRAM - 1999

TELEDYNE QUALITY CONTROL SPIKE PROGRAM

TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES

(Page 1 of 2)

| Collection Date | Identification No. | Media | Nuclide | Analytics Results (b) | Teledyne Brown Eng. Results(a) | Ratio (c) |
|---|---|---|---|---|---|---|
| 06/24/99 | E1823-396 | Water | Sr-89 | 69 ± 9 | 60 ± 5 | 0.87 |
| | TI # 09576 | | Sr-90 | 46 ± 6 | 35 ± 2 | 0.76 (d) |
| 06/24/99 | E1824-396 | Water | Gr-A | 98 ± 15 | 160 ± 10 | 1.63 (e) |
| | TI # 09577 | | Gr-B | 290 ± 45 | 300 ± 10 | 1.03 |
| 06/24/99 | E1825-396 | Water | I-131 | 68 ± 9 | 77 ± 13 | 1.13 |
| | TI # 09578 | | Ce-141 | 134 ± 21 | 139 ± 14 | 1.04 |
| | | | Cr-51 | 172 ± 27 | 162 ± 42 | 0.94 |
| | | | Cs-134 | 92 ± 15 | 86 ± 9 | 0.93 |
| | | | Cs-137 | 151 ± 24 | 167 ± 17 | 1.11 |
| | | | Mn-54 | 68 ± 9 | 77 ± 8 | 1.13 |
| | | | Fe-59 | 38 ± 6 | 40 ± 9 | 1.05 |
| | | | Zn-65 | 98 ± 15 | 113 ± 12 | 1.15 |
| | | | Co-60 | 171 ± 27 | 179 ± 18 | 1.05 |
| 06/24/99 | E1826-396 | Filter | Ce-141 | 162 ± 24 | 169 ± 17 | 1.04 |
| | TI # 09579 | | Cr-51 | 208 ± 30 | 241 ± 24 | 1.16 |
| | | | Cs-134 | 111 ± 18 | 105 ± 10 | 0.95 |
| | | | Cs-137 | 182 ± 27 | 211 ± 21 | 1.16 |
| | | | Mn-54 | 82 ± 12 | 96 ± 10 | 1.17 |
| | | | Fe-59 | 46 ± 6 | 55 ± 8 | 1.20 |
| | | | Zn-65 | 118 ± 18 | 144 ± 14 | 1.22 |
| | | | Co-60 | 206 ± 30 | 214 ± 21 | 1.04 |
| 06/24/99 | E1827-396 | Soil | Ce-141 | 0.269 ± 0.39 | 0.274 ± 0.027 | 1.02 |
| | TI # 09580 | | Cr-51 | 0.345 ± 0.51 | 0.374 ± 0.103 | 1.08 |
| | | | Cs-134 | 0.184 ± 0.27 | 0.200 ± 0.020 | 1.09 |
| | | | Cs-137 | 0.429 ± 0.63 | 0.450 ± 0.045 | 1.05 |
| | | | Mn-54 | 0.136 ± 0.21 | 0.153 ± 0.015 | 1.13 |
| | | | Fe-59 | 0.077 ± 0.12 | 0.118 ± 0.022 | 1.53 (f) |
| | | | Zn-65 | 0.196 ± 0.30 | 0.206 ± 0.021 | 1.05 |
| | | | Co-60 | 0.343 ± 0.51 | 0.315 ± 0.035 | 1.02 |

**TABLE J-2**

ANALYTICS ENVIRONMENTAL RADIOACTIVITY CROSS CHECK PROGRAM - 1999

TELEDYNE QUALITY CONTROL SPIKE PROGRAM

TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES



**Footnotes:**

(a) Teledyne Results - counting error is two standard deviations. Units are pCi/liter for water. For gamma results, if two standard deviations are less than 10%, then a 10% error is reported. Units are total pCi for air particulate filters. Units are pCi/gram dry for soil.

(b) Analytics Results - counting error is three standard deviations. Units are pCi/liter for water. Units are total pCi for air particulate filters. Units are pCi/gram dry for soil.

(c) Ratio of Teledyne Brown Engineering to Analytics results.

(d) Results under investigation.

(e) A high gross alpha result was obtained because the calculation was mistakenly performed using Th-230 counting efficiency. If the normal Am-241 efficiencies were used, the reported result would have been 110 ± 10 pCi/l, which is an acceptable value.

(f) Random or coincidental summing caused the Fe-59 outlier. Two different energy lines can sum a peak on the same energy band causing more counts to be added. The key line was changed and the resulting value was 0.079 pCi/g, which is in agreement with Analytics.

**TABLE J-3**

ANALYTICS ENVIRONMENTAL RADIOACTIVITY CROSS CHECK PROGRAM - 1999

PP&L QC SPIKE PROGRAM

TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES



| Collection Date | Identification No. | Media | Nuclide | Analytics Calculated Results (b) | Teledyne Brown Eng. Results(a) | Ratio (c) |
|---|---|---|---|---|---|---|
| Mar/1999 | E1694-186 | Milk | I-131 | 96 ± 3 | 97 ± 10 | 1.01 |
| Sep/1999 | E1919-186 | Milk | I-131 | 91 ± 3 | 90 ± 20 | 0.99 |
| Dec/1999 | E2037-186 | Milk | I-131 | 77 ± 3 | 78 ± 10 | 1.01 |
| Mar/1999 | E1694-186 | Milk | Ce-141 | 136 ± 9 | 131 ± 13 | 0.96 |
| | | | Cr-51 | 306 ± 19 | 319 ± 44 | 1.04 |
| | | | Cs-134 | 88 ± 5 | 87 ± 9 | 0.99 |
| | | | Cs-137 | 185 ± 12 | 188 ± 19 | 1.02 |
| | | | Mn-54 | 117 ± 7 | 121 ± 12 | 1.03 |
| | | | Fe-59 | 61 ± 4 | 68 ± 11 | 1.11 |
| | | | Zn-65 | 150 ± 9 | 164 ± 16 | 1.09 |
| | | | Co-60 | 139 ± 9 | 148 ± 15 | 1.06 |
| Sept/1999 | E1919-186 | Milk | Ce-141 | 197 ± 7 | 198 ± 20 | 1.01 |
| | | | Cr-51 | 149 ± 5 | 170 ± 32 | 1.14 |
| | | | Cs-134 | 96 ± 3 | 97 ± 97 | 1.01 |
| | | | Cs-137 | 217 ± 7 | 234 ± 23 | 1.08 |
| | | | Mn-54 | 170 ± 5 | 193 ± 19 | 1.14 |
| | | | Fe-59 | 76 ± 3 | 90 ± 9 | 1.19 |
| | | | Zn-65 | 164 ± 5 | 169 ± 17 | 1.03 |
| | | | Co-60 | 129 ± 4 | 134 ± 13 | 1.04 |
| Dec/1999 | E2037-186 | Milk | Ce-141 | 117 ± 4 | 116 ± 12 | 0.99 |
| | | | Cr-51 | 322 ± 11 | 358 ± 44 | 1.11 |
| | | | Cs-134 | 138 ± 5 | 136 ± 14 | 0.99 |
| | | | Cs-137 | 104 ± 3 | 109 ± 11 | 1.05 |
| | | | Co-58 | 114 ± 4 | 119 ± 12 | 1.04 |
| | | | Mn-54 | 111 ± 4 | 110 ± 11 | 0.99 |
| | | | Fe-59 | 104 ± 3 | 110 ± 12 | 1.06 |
| | | | Zn-65 | 206 ± 7 | 203 ± 20 | 0.99 |
| | | | Co-60 | 146 ± 5 | 139 ± 14 | 0.95 |

**TABLE J-3**

ANALYTICS ENVIRONMENTAL RADIOACTIVITY CROSS CHECK PROGRAM - 1999

PP&L QC SPIKE PROGRAM

TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES



| Collection Date | Identification No. | Media | Nuclide | Analytics Calculated Results (b) | Teledyne Brown Eng. Results(a) | Ratio (c) | |
|---|---|---|---|---|---|---|---|
| Mar/1999 | E1695-186 | AP Filter | Ce-141 | 117 ± 4 | 145 ± 14 | 1.24 | |
| | | | Cr-51 | 262 ± 9 | 292 ± 30 | 1.11 | |
| | | | Cs-134 | 75 ± 3 | 73 ± 7 | 0.97 | |
| | | | Cs-137 | 158 ± 5 | 187 ± 19 | 1.18 | |
| | | | Mn-54 | 100 ± 3 | 126 ± 13 | 1.26 | (d) |
| | | | Fe-59 | 52 ± 2 | 70 ± 10 | 1.35 | (d) |
| | | | Zn-65 | 129 ± 4 | 156 ± 16 | 1.21 | |
| | | | Co-60 | 119 ± 4 | 138 ± 14 | 1.16 | |
| Mar/1999 | E1696-186 | AP Filter | Ce-141 | 75 ± 3 | 78 ± 8 | 1.04 | |
| | | | Cr-51 | 168 ± 6 | 183 ± 22 | 1.09 | |
| | | | Cs-134 | 48 ± 2 | 40 ± 4 | 0.83 | |
| | | | Cs-137 | 101 ± 3 | 107 ± 11 | 1.06 | |
| | | | Mn-54 | 64 ± 2 | 73 ± 7 | 1.14 | |
| | | | Fe-59 | 33 ± 1 | 40 ± 6 | 1.21 | |
| | | | Zn-65 | 82 ± 3 | 95 ± 10 | 1.16 | |
| | | | Co-60 | 76 ± 3 | 78 ± 8 | 1.03 | |
| Mar/1999 | E1697-186 | AP Filter | Ce-141 | 101 ± 3 | 105 ± 11 | 1.04 | |
| | | | Cr-51 | 225 ± 8 | 245 ± 25 | 1.09 | |
| | | | Cs-134 | 65 ± 2 | 59 ± 6 | 0.91 | |
| | | | Cs-137 | 136 ± 5 | 165 ± 16 | 1.21 | |
| | | | Mn-54 | 86 ± 3 | 106 ± 11 | 1.23 | |
| | | | Fe-59 | 45 ± 2 | 57 ± 7 | 1.27 | (d) |
| | | | Zn-65 | 111 ± 4 | 146 ± 15 | 1.32 | (d) |
| | | | Co-60 | 103 ± 3 | 105 ± 11 | 1.02 | |

**TABLE J-3**

ANALYTICS ENVIRONMENTAL RADIOACTIVITY CROSS CHECK PROGRAM - 1999

PP&L QC SPIKE PROGRAM

TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES

(Page 3 of 5)

| Collection Date | Identification No. | Media | Nuclide | Analytics Calculated Results (b) | Teledyne Brown Eng. Results(a) | Ratio (c) | |
|---|---|---|---|---|---|---|---|
| Dec/1999 | E2038-186 | AP Filter | Ce-141 | 100 ± 3 | 126 ± 13 | 1.26 | (e) |
| | | | Cr-51 | 276 ± 9 | 321 ± 32 | 1.16 | |
| | | | Cs-134 | 118 ± 4 | 116 ± 12 | 0.98 | |
| | | | Cs-137 | 91 ± 3 | 103 ± 10 | 1.13 | |
| | | | Co-58 | 104 ± 3 | 125 ± 12 | 1.20 | |
| | | | Mn-54 | 95 ± 3 | 114 ± 11 | 1.20 | |
| | | | Fe-59 | 89 ± 3 | 114 ± 11 | 1.28 | (d) |
| | | | Zn-65 | 176 ± 6 | 225 ± 23 | 1.28 | (d) |
| | | | Co-60 | 125 ± 4 | 143 ± 14 | 1.14 | |
| Dec/1999 | E2039-186 | AP Filter | Ce-141 | 86 ± 3 | 93 ± 9 | 1.08 | |
| | | | Cr-51 | 238 ± 8 | 270 ± 28 | 1.13 | |
| | | | Cs-134 | 102 ± 3 | 97 ± 10 | 0.95 | |
| | | | Cs-137 | 79 ± 3 | 88 ± 9 | 1.11 | |
| | | | Co-58 | 90 ± 3 | 98 ± 10 | 1.09 | |
| | | | Mn-54 | 82 ± 3 | 93 ± 9 | 1.13 | |
| | | | Fe-59 | 77 ± 3 | 86 ± 10 | 1.12 | |
| | | | Zn-65 | 152 ± 5 | 175 ± 17 | 1.15 | |
| | | | Co-60 | 108 ± 4 | 116 ± 12 | 1.07 | |
| Dec/1999 | E2040-186 | AP Filter | Ce-141 | 89 ± 3 | 88 ± 3 | 0.99 | |
| | | | Cr-51 | 245 ± 8 | 243 ± 24 | 0.99 | |
| | | | Cs-134 | 105 ± 4 | 92 ± 9 | 0.88 | |
| | | | Cs-137 | 81 ± 3 | 86 ± 9 | 1.06 | |
| | | | Co-58 | 93 ± 3 | 98 ± 10 | 1.19 | |
| | | | Mn-54 | 85 ± 3 | 93 ± 9 | 1.09 | |
| | | | Fe-59 | 79 ± 3 | 95 ± 10 | 1.21 | |
| | | | Zn-65 | 157 ± 5 | 178 ± 18 | 1.13 | |
| | | | Co-60 | 111 ± 4 | 111 ± 11 | 1.00 | |

**TABLE J-3**

ANALYTICS ENVIRONMENTAL RADIOACTIVITY CROSS CHECK PROGRAM - 1999

PP&L QC SPIKE PROGRAM

TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES



| Collection Date | Identification No. | Media | Nuclide | Analytics Calculated Results (b) | Teledyne Brown Eng. Results(a) | Ratio (c) | |
|---|---|---|---|---|---|---|---|
| Jun/1999 | E1794-186 | Charcoal Filter | I-131 | 82 ± 3 | 72 ± 7 | 0.88 | |
| | E1795-186 | Charcoal Filter | I-131 | 76 ± 3 | 67 ± 7 | 0.88 | |
| | E1796-186 | Charcoal Filter | I-131 | 70 ± 3 | 63 ± 6 | 0.89 | |
| Sep/1999 | E1920-186 | Charcoal Filter | I-131 | 55 ± 2 | 45 ± 5 | 0.82 | |
| | E1921-186 | Charcoal Filter | I-131 | 64 ± 2 | 54 ± 5 | 0.85 | |
| | E1922-186 | Charcoal Filter | I-131 | 74 ± 3 | 67 ± 7 | 0.90 | |
| Mar/1999 | E1698-186 | Sediment | Ce-141 | 152 ± 5 | 149 ± 38 | 0.98 | |
| | | | Cr-51 | 341 ± 11 | 147 ± 20 | 0.43 | (f) |
| | | | Cs-134 | 98 ± 3 | 113 ± 26 | 1.15 | |
| | | | Cs-137 | 333 ± 11 | 323 ± 32 | 0.97 | |
| | | | Mn-54 | 131 ± 5 | 147 ± 20 | 1.12 | |
| | | | Fe-59 | 68 ± 2 | 65 ± 34 | 0.96 | |
| | | | Zn-65 | 167 ± 5 | 179 ± 33 | 1.07 | |
| | | | Co-60 | 155 ± 5 | 159 ± 25 | 1.03 | |

**TABLE J-3**

ANALYTICS ENVIRONMENTAL RADIOACTIVITY CROSS CHECK PROGRAM - 1999

PP&L QC SPIKE PROGRAM

TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES



**Footnotes:**

(a) Teledyne Results - counting error is two standard deviations. Units are pCi/liter for water and milk. For gamma results, if two standard deviations are less than 10%, then a 10% error is reported. Units are total pCi for air particulate filters.

(b) Analytics Results - counting error is two standard deviations. Units are pCi/liter for water and milk. Units are total pCi for air particulate filters.

(c) Ratio of Teledyne Brown Engineering to Analytics results.

(d) Results under investigation.

(e) Results under investigation.

(f) Results under investigation.

**TABLE J-4**

ANALYTICS ENVIRONMENTAL RADIOACTIVITY CROSS CHECK PROGRAM - 1999

PP&L QC SPIKE PROGRAM

PP&L CORPORATE ENVIRONMENTAL RADIOACTIVITY MEASUREMENTS LABORATORY (CERML)



| Collection Date | Identification No. | Media | Nuclide | Analytics Results (b) | CERML Results(a) | Ratio (c) |
|---|---|---|---|---|---|---|
| Mar/1999 | E1693-186 | Water | H-3 | 2670 ± 87 | 2720 ± 95 | 1.01 |
| Sep/1999 | E1918-186 | Water | H-3 | 4750 ± 160 | 4875 ± 121 | 1.08 |

**Footnotes:**

(a) CERML Results - counting error is two standard deviations. Units are pCi/liter for water.

(b) Analytics Results - counting error is two standard deviations. Units are pCi/liter for water.

(c) Ratio of CERML to Analytics results.