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SUSQUEHANNA STEAM ELECTRIC STATION

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

1979 ANNUAL REPORT

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by

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

SUMMARY

During 1979 Radiation Management Corporation (RMC) conducted the radiological environmental monitoring program (REMP) for Pennsylvania Power and Light Company (PP&L) in the vicinity of the Susquehanna Steam Electric Station (SES). This report presents the analytical results for samples taken during 1979. A total of 878 thermoluminescent dosimeter measurements and samples including surface water, fish, sediment, air particulates, air iodine, well water, potable water, milk, food products, game, soil and fodder crops were collected in 1979.

A variety of radionuclides, both naturally occurring and man-made, were detected in the environs of the Susquehanna SES. Annual seasonal variations resulting from the spring atmospheric inversion are also observed in the air particulate samples. The detection of this event shows that the Susquehanna SES REMP is sensitive to fluctuations in the radiological characteristics of the environment around Susquehanna SES. No other unusual radionuclide concentrations or ambient radiation levels were observed as part of the routine environmental surveillance program.

INTRODUCTION

The Susquehanna SES will contain 2 BWR generating units, each with a capacity of about 1050 MWe. Units #1 and #2 are scheduled for commercial operation in 1982 and 1983, respectively. This site is located on a 1075 acre tract along the Susquehanna River, five miles northeast of Berwick in Salem Township, Luzerne County, Pennsylvania.

The area surrounding the site can generally be characterized as rural, with forest and agricultural lands predominating. More specific information on the demography, hydrology, meteorology and land use characteristics of the local area may be found in the Environmental Report(1), the Safety Analysis Report(2) and the Draft Environmental Statement - O.L. (3) for Susquehanna SES.

RMC has previously reported results for the radiological environmental monitoring program (REMP) from 1972-1978 (4-10); the present document continues the series with coverage for 1979. It presents in detail the type and number of samples analyzed, the analyses performed and the data generated. Data are discussed and compared with those from previous years. This report provides information to Pennsylvania Power and Light Company, regulatory agencies and the general public.

PROGRAM

The REMP continued in 1979 and will continue until initial criticality of Unit #1. At that time the operational phase of the program will be instituted and continue thereafter. The REMPs are and will be designed utilizing the guidance in NUREG-0473, Draft Radiological Effluent Technical Specifications for BWR's (11) and ORP/SID 72-2, Environmental Radioactivity Surveillance Guide (12). The REMPs were designed:

1. To establish baseline radiological characteristics of the environs of Susquehanna SES for comparison with future data;

2. To assure that media sampled and analyzed are sensitive to fluctuations in the radiological characteristics of the Susquehanna SES environs; and assure that the program will be responsive to station radioeffluent discharge;

3. To establish potential critical pathways of station radioeffluent to man.

Samples for the 1979 REMP were taken from direct, waterborne, airborne and ingestion pathways with emphasis on those media which would yield data for the evaluation of radiation dose to man. Specific sampling locations were chosen on the basis of potential water use, site meteorology, local demography and land uses.

Environmental sampling locations were divided into two classes, indicator and control. Indicator samples are those collected at locations which are expected to manifest future station effects, if any exist, and were selected on the basis of distance from the site, topography, hydrology, meteorology, demography, and drainage

characteristics. Control samples are collected at locations which it is believed will be unaffected by station operation. These provide a basis by which to evaluate fluctuations in radioactivity at indicator locations in relation to natural phenomena and fallout after the station is operational.

Table 1 summarizes the Susquehanna REMP for 1979. Appendix A describes and summarizes the entire program as performed in 1979. Appendix B describes the RMC coding system, which specifies sample type and locations. Included in Appendix B, Table B-1 gives the pertinent information on individual sampling locations, while maps B-1 and B-2 show the sampling locations.

Sample Collection

Waterborne pathways around Susquehanna SES were examined by analyzing samples of surface water, ground water, drinking water and sediment. Surface, ground and drinking water samples were collected in new, unused two gallon containers monthly. Sample containers were rinsed three times with the sample medium prior to collection. Susquehanna River sediment was also sampled. The biological consultants to PP&L collected the samples.

Airborne pathways were examined by analyzing air particulates, and air iodine. Air particulates were collected weekly at five locations on Gelman type-A/E, glass fiber filters with low-volume air samplers. Air sample volumes were measured with temperature-compensated dry-gas meters. Air iodine was collected on a one inch deep Mine Safety Appliance charcoal cartridges connected in series behind the particulate filter.

Ingestion pathways were examined by analyzing samples of fish, soil, milk, fodder crops, game and locally grown food products. Fish samples were collected in spring and late summer at both the control and indicator locations. The samples were prepared by fillet, and frozen for shipment to RMC. Milk and food products were purchased directly from local farmers. The soil samples were taken in the immediate vicinity of the air monitors. Game samples were obtained by hunting or from road killed animals.

Direct radiation (immersion dose) measurements were made using thermoluminescent dosimeters (TLDs). The TLDs were placed at locations designed to take advantage of local meteorologic, topographic characteristics and population distribution characteristics.

Data Interpretation

The radioanalytical and ambient radiation data collected during 1979, together with that collected previously, will be used as a baseline with which operational data may be compared. Several factors are important in the interpretation of the data. These factors are discussed here to avoid repetition in sections that follow.

Within the data tables (Appendix C) a 95% (+2 sigma) confidence interval is supplied for each result above the lower limit of detection (LLD) with the exception of strontium-89, -90 analyses, which are reported as minimum detectable level (MDL). Numerically, the LLD is equal to 4.66 times the square root of the quotient resulting from the background counts divided by the background counting time. The result is then divided by a dpm/picocurie conversion factor, the counting efficiency and the sample volume. Whereas the MDL is equal to 3 times the square root of the quotient resulting from the background counts divided by the background counting time. This result is then divided by the dpm/picocurie conversion factor, the counter efficiency and the sample volume (the exact specifications of the calculations are noted in Appendix D). The MDL or LLD is reported when

the 2 sigma error exceeds 100% of the calculated activity. The 2 sigma intervals represent the range of values into which 95% of repeated analyses of the same sample would fall. The LLD or MDL quoted for particular sample types (Table C-21) are nominal values. The actual LLD or MDLs are calculated for each sample analyzed and will show variability due to the amount of sample analyzed, the length of time between sample collection and counting, the length of time a particular sample was counted and fluctuations in counting background.

It is characteristic of environmental monitoring data that many results occur at or below the LLD or MDL. In this report, all results occurring at or below the relevant LLD or MDL were reported as being "less than" the LLD or MDL value.

Results for each type of sample were grouped according to the analysis performed. Means and standard deviations of these results were calculated when applicable. The calculated standard deviations of grouped data (by location or over time) represent sample rather than analytical variability. For these calculations any values below LLD or MDL were considered to be at the LLD or MDL. Thus, these averages were biased high and the corresponding standard deviations were biased low. Averages were not calculated when a group of data was composed of many (>50%) LLD or MDL values.

Program Exceptions

As the REMP for Susquehanna SES progressed, in 1979, certain samples and analyses were omitted from the schedule. These exceptions are delineated, and reasons for the omission stated. However, taking into account all program exceptions, it should be noted that the 1979 Susquehanna SES REMP had a 98.8% success rate.

Surface Water

A monthly analysis for I-131 was omitted in September and December due to an error in scheduling.

Air Particulates

1. The gross beta results of samples taken at station 1D2 between January 26 and February 9 were reported as pCi/filter because the recorded sample volumes were suspect.
2. No sample was received from station 3D1 between December 10 and December 17 because the filter paper was lost during removal.
3. No sample was received from station 12E1 between February 16 and February 23 due to a blown fuse, or between July 22 and August 13 due to a pump malfunction.

Air Iodine

1. No sample was received from station 12E1 between February 16 and February 23 due to a blown fuse, or between July 22 and August 13 due to a pump malfunction.
2. The sample received from station 12E1 for the period May 12-19 was not counted due to a delay in shipment of 18 days.
3. No sample was received from station 7H1 for the period March 7-21 due to loss during shipment.
4. Sensitivity was not reached on the analysis of a sample from station 7H1 taken between March 26 and March 29 due to insufficient volume from the short sampling period.

Program Changes

In order to provide consistency and clarification of the current status for the environmental monitoring stations, in the vicinity of the Susquehanna Steam Electric Station, an extensive historical investigation was made into each station's nomenclature, in 1979. Specifically, the ring/sector designations and the station numerical designations were studied and updated.

The deletion of the station number for sampling locations 3S (GAS), 1GA(GAD), 2B(AQS), 7B(AQS), 11C(AQS) and 2G(AQF) was made because no permanent sampling station exists in these sectors for the environmental media and sample collectors are unable to take subsequent samples at the exact locations where the samples were taken previously. Also, sample type availability may vary from sampling period to sampling period. As a result, during certain sampling periods certain sample types may not be found in a predesignated ring/sector location, if this occurs, the sample may be deleted or taken from another ring/sector location. As an example, a comparison was made between the sampling locations noted in the 1976, 1977 and 1978 annual reports. In 1976, a pheasant was taken in 2S and in 1977 and 1978 no phesants were taken at all, also in 1976 a deer was taken in 5S and in 1977 no deer were taken, but in 1978 a deer was taken in 3S.

Other changes in nomenclature also include changes in the station number. These changes were made as to chronological priority when the station began operation, the first station in a ring/sector location receives a 1, the second receives a 2 and so on. Specific station code changes are listed below:

1. The air particulate, air iodine and TLD station located 0.7 miles E at the biological consultants was changed from 5S3 to 5S4.

2. The surface water location, 0.9 miles ESE in the outfall area was changed from 6S1 to 6S2.

3. The pasture grass location, 0.8 miles NNW on the Serafin Farm, was changed from 15A2 to 15A1.

4. The food product fruit location, 1.5 miles SE at Heller's Orchard, was changed from 7B1 to 7B2.

5. The food product station, 1.4 miles WSW at the Kisner Farm, was changed from 12B3 to 12B1.

6. The milk station, 1.7 miles WSW at the Schultz Farm, was changed from 12B1 to 12B2.

7. The milk and food product station, 1.2 miles WSW at the Young Farm, was changed from 12B2 to 12B3.

8. The air particulate and TLD station, 3.7 miles N near the Nocanagua Substation was changed from 1D1 to 1D2.

9. The TLD station, 5.2 miles WSW at the Berwick Substation, was changed from 12F1 to 12F2.

10. The well water and potable water station, 5.2 miles WSW at the Berwick Water Co., was changed from 12F2 to 12F3.

RESULTS AND DISCUSSION

All environmental samples and TLDs were analyzed by standard RMC procedures(12). A synopsis of the analytical procedures used appears in Appendix D. Since the precision and accuracy of the analytical results is of paramount importance, RMC devotes a fraction (usually 15-20%) of all analyses to quality control (QC). The results of RMC's QC program for 1979 are included in a separate RMC report (14). One important aspect in maintaining laboratory quality control is RMC's participation in the United States Environmental Protection Agency (USEPA) inter-laboratory comparison program. This data appears in RMC's annual QC report and is also presented as Appendix E to this report.

The analytical results of the 1979 REMP have been divided into four categories: waterborne, airborne, ingestion and direct radiation. The individual samples and analyses within each category provide an adequate means of estimating radiation doses to individuals from the principal pathways. The analytical results for the 1979 program are summarized in Appendix A. The data for individual samples are presented in tabular form in Appendix C. Also, included in this section are the instances in which the analytical sensitivities stated in the Susquehanna REMP, were not met. However, the sensitivities stated in Regulatory Guide 4.8, Environmental Technical Specifications for Nuclear Power Plants were met for all samples (11).

Waterborne Pathway

The waterborne pathways of exposure from Susquehanna SES were evaluated by analyzing samples of surface water, well water, drinking water and sediment.

Surface Water

Susquehanna River was sampled at six locations. Daily grab samples were collected at 12H1 (Merck Company) then composited into a monthly sample. A monthly sample was also composited from weekly grabs at station 6S2 (near planned outfall area). A monthly grab sample was collected at location 12F1 (Berwick Bridge). Monthly grab samples were collected at location 1D3 (Mocanagua Substation) beginning on 5-31-79. Also, monthly grab samples were collected at location 12G2 (downstream from U.S. Radium Plant) beginning on 6-25-79. One additional monthly grab surface water sample was collected at the Glen Brook Reservoir (13E1). Each surface water was analyzed monthly for gross beta, gamma emitters (quarterly composite changed to monthly in May 1979) and iodine-131. Iodine analyses were started in May 1979 with the exception of station 12G2, which began in June. Quarterly composites for each location were analyzed for tritium.

Analysis for beta emitters in samples of surface water showed detectable activity in 34 of 63 samples, with results ranging from 2.3 to 14 pCi/l. The gross beta results were consistent with the data previously obtained from 1972-1978 (4-10). Gamma analysis of the surface water samples showed positive K-40 results in four of the fifty-one samples ranging from 8.3 to 16 pCi/l. All other gamma emitters were below LLD.

The analysis of tritium in surface water showed detectable activity in 14 of 22 samples with results ranging from 79 to 695 pCi/l, with a yearly average of 135 pCi/l. The average tritium concentrations in surface water samples shows a gradual decline for the period 1973 to 1979. This is likely the result of a reduction in atmospheric tritium from nuclear detonations. Average tritium concentrations for all locations since 1973 were graphed in Figure 1. Positive tritium results are reported when the 2 sigma counting error is less than the result. In some cases, this may cause positive results to be reported, which are lower than the calculated LLDs. For clarification of the method of calculation check Appendix D, Analysis of Samples for Tritium.

The analysis of surface water for iodine-131 began in May 1979, on a monthly basis. Iodine analyses were not performed during September and December, due to an analytical scheduling error. Positive iodine results, in surface water, were reported in three of thirty-five samples. Positive values were reported in samples from station 6S2 of 0.11 and 0.5 pCi/l during June and November, respectively, and station 12F1 of 0.15 pCi/l in June.

Some results of I-131 analysis failed to meet the analytical sensitivity as stated in the REMP of 0.1 pCi/l. However, the sensitivity, as quoted in USNRC Regulatory Guide 4.8 (11), of 1.0 pCi/l was met for all samples. The samples involved are as follows.

All samples collected in May were analyzed with one-half the required volume and not counted within 8 days due to transit time. LLD values ranged from <.2 to <.5 pCi/l.

A sample from station 12F1 collected in August had a low chemical yield resulting in an LLD of <.2 pCi/l. A sample from station 12G2, also collected in August was analyzed using a reduced volume resulting in an LLD of <.6 pCi/l.

Samples collected in October from locations 1D3, 13E1 & 12G2 had a low chemical yield resulting in LLDs of <.2 pCi/l. The October sample from location 6S2 was not counted within 8 days resulting in an LLD of <.2 pCi/l.

Well Water

Two wells, the peach stand on-site (5S2) and the Berwick Water Co. (12F3), were sampled quarterly until May, 1979, when the sampling frequency was changed to monthly. Well water was analyzed for tritium quarterly until May, when the sampling frequency changed to monthly. The tritium analysis was changed to a quarterly composite of monthly grab samples. Gross beta and gamma analyses were performed on the monthly samples. Three of eight samples showed positive tritium results, ranging from 81 to 92 pCi/l with an LLD of 120 pCi/l. Gamma analyses were all below LLD, with exception of the November sample taken at 5S2. A small concentration of naturally-occurring K-40 (12 pCi/l) was detected. Gross beta results were generally at or below the LLD of 3.0 pCi/l.

Drinking (Potable) Water

Potable water was sampled on a quarterly basis until May 1979, when monthly sampling was initiated. Gross beta and gamma emitters were analyzed monthly beginning in May. Tritium and strontium-89 and -90 were analyzed as quarterly composites. Three of eight samples showed positive tritium results ranging from 99 to 138 pCi/l, with other results below the LLD (120 pCi/l). The tritium results, for potable water, were consistent with results for tritium observed in surface water of the Susquehanna River. Strontium-90 analyses of eight quarterly composites showed strontium-90 results in three samples ranging from 0.4 to 0.7 pCi/l. The MDLs of the other samples were between <0.5 and <1.1 pCi/l. All Sr-89 results were below the MDL (<0.7-<2.0 pCi/l). Gross beta analyses were performed quarterly until May, when monthly analyses were initiated. Of the eighteen samples analyzed for gross beta, eight were positive ranging from 2.0 to 4.8 pCi/l. Gamma analysis of potable water was initiated in May 1979. All results for all gamma emitting nuclides were less than LLD.

Sediment

Sediment samples were taken from three locations in the Susquehanna River. Samples were taken at Bell Bend (7B), downstream near Hess Island (11C) and upstream near Gould Island (2B). All samples were analyzed by Ge(Li) gamma spectrometry. Naturally-occurring

K-40, Ra-226, and Th-232 were detected in all samples. Be-7, from cosmic ray activity, was also observed in four of the six samples analyzed. Cs-137 was detected in all samples, with levels ranging from 0.05 to 0.13 pCi/g(dry). These nuclides have been observed periodically throughout the program. Since the station is not in operation, and there are no other major nuclear power installations in the area, the man-made nuclides observed were attributed to nuclear weapons testing fallout.

Airborne Pathway

The airborne pathways of exposure from Susquehanna SES were evaluated by analyzing samples of air particulates for beta and gamma emitters and filtered air, passed through a charcoal cartridge, for I-131. Samples of air particulates were collected on filter paper and exchanged weekly at eight stations; the biological laboratory (5S4), Berwick Hospital (12E1), the Nocanagua Substation (1D2), near Pond Hill NE of the site (3D1), the PP&L roof in Allentown (7H1), Golomb House (11A1), Transmission line east of route 11 (9B1) and at Bloomsburg (12G1). Stations 11A1 and 9B1 began operations in September. Air iodine was collected on Mine Safety Appliance charcoal cartridges in series with the air particulate filter at stations 12E1, 7H1, 11A1, 5S4 and 9B1. The charcoal cartridges have an efficiency of removal for elemental iodine of 98% (18). Sampling for air iodine began at station 5S4 in May; and at stations 11A1 and 9B1 in September.

The gross beta concentration of each sample was determined weekly. These concentrations ranged from .008-.071 pCi/cubic meter in all samples and an annual average of .027 pCi/m^3. The gross beta results for the Susquehanna SES site vicinity (plotted in Figure 2) show a gradual increasing trend with the approach of spring. This trend is typical of the spring maximum concentration of fallout in the troposphere due to the winter maximum exchange of fallout between lower stratosphere and the troposphere at temperate and high latitudes (15), with high latitudes being defined as those latitudes between 50° and 90°.

Quarterly composites of air particulate filters from each location were analyzed by gamma spectrometry. Be-7, from cosmic radiation, was detected in all 28 samples. Cs-137 was observed in eight of 28 samples at concentrations of .001 to .002 pCi/m^3. Ce-144 was observed in seven samples, ranging from .002 to .009 pCi/m^3. These may be attributed to the atmospheric mixing of nuclear weapons fallout. Of the 160 air iodine samples analyzed, none showed detectable levels of I-131. The detection limit ranged from 0.004 - 0.02 pCi/cubic meters.

In general, all 1979 air analyses (gross beta, gamma (excluding Be-7) and I-131) showed results lower than those found in 1978. The higher 1978 results were attributed to the Chinese atmospheric nuclear test of March 14, 1978 (10).

Ingestion Pathway

Ingestion pathways of exposure from Susquehanna SES were evaluated analyzing samples of milk, fish, food products, game, pasture grass (fodder crops) and soil.

Milk

Milk samples were collected at six (five cow and one goat) locations. Initially, milk was sampled on a quarterly basis. However, beginning in June, samples were collected monthly. The goat milk is sampled on a quarterly basis, because an insufficient volume of milk is produced to sample more frequently. Each sample collected was analyzed for I-131, Sr-89 & -90 and gamma emitters. Of the thirty-five samples analyzed for I-131, all were less than LLD (0.1-0.4 pCi/l). Samples which did not meet the REMP sensitivity of a 0.1 pCi/l are listed below. However, the sensitivity for I-131 in milk as quoted in USNRC

Regulatory Guide 4.8 (11) of 1.0 pCi/l was met by all analyses.

Samples collected in April from locations 12B2 and 12B3 were not counted within 8 days resulting in an LLD of .2 pCi/l. Samples from all locations collected in June were inadvertently counted for the lower sensitivity. LLDs for these samples ranged from 0.3-0.4 pCi/l. Samples collected in November from locations 10C1 and 9G1 had low chemical yields resulting in an LLD of 0.2 pCi/l. Since insufficient volume is always used in analyzing goat's milk, the best achievable LLD was 0.4 pCi/l.

Strontium-89 analyses showed eight of thirty-six samples with positive results ranging from 1.1 to 33 pCi/l, with MDL values ranging from 1.9 to 27 pCi/l for strontium-89. Thirty-two of thirty-six samples had positive results for strontium-90, ranging from 0.9 to 11 pCi/l. High results have large counting errors associated with them and are generally the result of low yields. The strontium procedure is currently under review to eliminate this source of error. Specific samples where the MDL or result were high (for Sr-89, <6.5-33 pCi/l and for Sr-90, <2.7 to <12 pCi/l) because of low chemical yields were as follows: July samples from locations 12B2 and 9G1; and December samples from locations 12B2, 10C1 and 9G1. High MDLs for Sr-89 (<13 pCi/l) in goat's milk (8D1) sampled in September was due to insufficient volume.

K-40 was found in all milk samples, in levels ranging from 630 to 1800 pCi/l. Cs-137 was found in twenty of thirty-six samples, in levels ranging from 1.6 to 5.7 pCi/l.

Fish

Analysis of the flesh for strontium-89, -90 and gamma emitters was performed on each species sampled. The species included were: walleye, white sucker and channel catfish.

Strontium-89 and -90 analyses were generally less than MDL, ranging from .007-01 pCi/g(wet) for Sr-89 and .003-.007 pCi/g(wet) for Sr-90. A positive Sr-89 result of .005 pCi/g(wet) in the channel catfish sample taken at the control location can be attributed to statistical fluctuations.

Gamma spectrometry of the flesh portions of all fish samples detected concentrations of two nuclides above the LLD; K-40 and Cs-137. Naturally-occurring K-40 was detected in eleven of twelve samples with results ranging from 1.7 to 4.0 pCi/g(wet). Cesium-137 was detected in one walleye, at a level of .016 pCi/g(wet). All results were consistent with those previously found. Since the station is not in operation, and there are no other major nuclear power installations in the area, the man-made nuclide observed can be attributed to nuclear weapons testing fallout.

Food Products

Gamma spectrometry was used to analyze various types of food products, including lettuce, corn, cabbage, apples, eggs, chicken (flesh & bones) and beef (flesh & bones). Naturally-occurring K-40 at levels of 0.8 to 7.2 pCi/g(wet) was found in all samples, except beef bones. Cs-137 at a concentration of .20 pCi/g(wet) was found in one sample of beef bones. All other gamma emitting nuclides were below the respective LLDs. Strontium-89 and -90 analyses were performed on chicken and beef bones. Strontium-89 was found in one sample of beef bones at the detection level (0.9 pCi/g-dry). Strontium-90 was found in both chicken bones (0.38 pCi/g-dry) and beef bones (4.1 pCi/g-dry).

Game

Three game samples (two squirrel and one deer) were taken in the fall of 1979. The flesh was analyzed for gamma emitters and the bones were analyzed for strontium-89 and -90, as well as gamma emitters. Naturally-occurring K-40 was detected in all samples (flesh and bones), 2.9 to 3.0 pCi/gram(wet) in squirrel flesh, and 3.5 pCi/gram(wet) in deer flesh. Squirrel bones showed levels of 2.9 and 4.1 pCi/gram(dry). Cs-137 was also found in all samples. Squirrel flesh contained 1.7 and 3.6 pCi/gram(wet) and deer flesh contained 0.55 pCi/gram(wet). Bones showed values of 0.7 and 1.9 pCi/gram (wet) for Cs-137. Strontium-89 and -90 analyses were performed on squirrel bones with concentrations of 0.6 and 0.7 pCi/gram(dry) and 2.4 and 3.1 pCi/gram(dry) of strontium-89 and -90, respectively.

Fodder Crops (pasture grass)

Pasture grass was sampled on a quarterly basis until June 1979, when the sampling frequency was changed to monthly. Samples were collected at the closest farm (15A1). Each sample is analyzed by gamma spectrometry. Be-7 and K-40 were found in 5 of 9 samples and 7 of 9 samples, respectively. Be-7 concentrations ranged from 2.7 to 13 pCi/g(dry), and K-40 concentrations ranged from 3.4 to 18 pCi/g(dry). Also, Cs-137 and Ce-144 were found in one sample taken on April 1, 1979 at concentrations of 0.25 pCi/g(dry) and 1.1 pCi/g(dry), respectively, and were in the LLD range of other samples. All other gamma emitters were less than LLD.

Soil

Five soil samples were taken in December 1979, at the following stations: 5S5 (west of Biological Consultants to PP&L), 1D4 (Nocanagua Substation), 3D2 (Pond Hill), 12E2 (Berwick Hospital) and 12G3 (Bloomsburg). Gamma analysis was performed on the samples and five gamma emitters (Be-7, K-40, Cs-137, Ra-226 and Th-232) were detected. Be-7 was found at 12G3 only, at a concentration of 0.3 pCi/gram(dry). K-40 was observed in all samples, ranging from 8.8 to 12 pCi/gram(dry). Cs-137 was observed in all samples, ranging in concentration from 0.2 to 1.3 pCi/gram(dry). Ra-226 was observed in all samples, ranging in concentration from 0.75 to 2.5 pCi/gram(dry). Th-232 was observed in all samples, ranging in concentration from 0.73 to 2.6 pCi/gram(dry). All other gamma emitters were found to be less than LLD. These initial data will serve as a baseline for comparison to subsequent soil samples.

Direct Radiation

Direct radiation measurements were made on a quarterly basis at 16 locations using thermoluminescent dosimeters consisting of calcium sulfate doped with thulium ($CaSO_4(Tm)$). A total of 51 quarterly TLD packets were exposed and analyzed. All TLD results presented in this report have been normalized to a standard month (30.4 days) to eliminate the apparent differences in data caused by the variations in exposure periods. These analyses yielded an average dose rate of 6.40 mrem/standard month at all indicator locations, and an average dose rate of 5.17 mrem/standard month at all control locations.

The projected annual dose from direct radiation computed from these results is about 77 mrads, or 77 mrems assuming a quality factor of 1, at indicator locations, and 62 mrad or 62 mrem at the control locations. The EPA terrestrial and cosmic radiation dose rate calculated for the Wilkes-Barre area is 82 mrem/year, neglecting any neutron contribution (17). This compares with the average TLD measured dose rate of 74 mrem/year. This difference is not unexpected since the EPA values are gross general averages for an area and do not take into consideration specific terrestrial variations. The monthly average dose rates for all monitoring locations since 1973 are plotted in Figure 3. The differences observed between locations or between sampling periods were similar to those found previously (4-10).

CONCLUSIONS

The Radiological Environmental Monitoring Program for Susquehanna SES was conducted during 1979 as a continuation of the program initiated in 1972. The data collected during 1979 further develops a baseline for comparison with future operational data.

The purposes of the design and development of the Susquehanna SES REMP were:

1. To establish baseline radiological characteristics of the environs of Susquehanna SES for comparison with future data;

2. To assure that the media sampled and analyzed are sensitive to fluctuations in the radiological characteristics of the Susquehanna SES environs; and assure that the program will be responsive to station radioeffluent discharge;

3. To establish potential critical pathways of station radioeffluent to man.

The 1979 REMP further establishes the baseline radiological characteristics for the vicinity of the Susquehanna SES. This is evident by the continuation of sampling and analysis for the aquatic, atmospheric and terrestrial environments, as well as monitoring of ambient radiation. The sampling and analysis of these media reflect the normal background radiation found in this environment.

The media sampled by the Susquehanna REMP are sensitive to radiological fluctuations of the environment monitored. This is evident by the measured gradual decline in the surface water concentration of tritium, primarily due to the decrease in atmospheric nuclear detonations. Gross beta analyses of air particulates are sensitive to seasonal variations, as well as the atmospheric testing of nuclear weapons (10).

The media sampled by the Susquehanna REMP also monitors potential critical pathways of station radioeffluent to man.

Monitoring of the waterborne pathway consisted of sampling surface water, well water, drinking water and sediment and were chosen to reflect the characteristics of normal background radiation for this medium. The airborne pathway was monitored by filtering and analyzing the particulate matter, and by passing filtered air through a charcoal filter which was analyzed for the presence of iodine-131. The ingestion pathway was monitored by the sampling and analysis of milk, fish, game, various food products and soil. The results obtained by analysis of these samples were consistent with previously measured levels of radioactivity, in their respective media. Direct radiation levels, in the vicinity of Susquehanna SES, were approximately the same at all locations.

From the results obtained and the analyses performed on the samples, it can be concluded that the levels and fluctuations of radioactivity detected in the vicinity of the Susquehanna SES were expected for this environment.

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(12) United States Environmental Protection Agency, ORP/SID 72-2, "Environmental Radioactivity Surveillance Guide," June 1972.

(13) Radiation Management Corporation, "T-1, Specifications for Analytical Instructions", August, 1978.

(14) Radiation Management Corporation, "Quality Control Data - 1979 Annual Report", February 1980.

(15) United Nations Scientific Committee on the Effects of Atomic Radiation, Ionizing Radiation: Levels and Effects, Volume 1: Levels, United Nations Publication, New York, 1972.

(16) Conover, W. J., Practical Nonparametic Statistics, John Wiley & Sons Inc., New York, 1971.

(17) Oakley, Donald T., Natural Radiation Exposure in the United States, ORP/SID 72-1, United States Environmental Protection Agency, June 1972.

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TABLE 1

SYNOPSIS OF THE SUSQUEHANNA SES RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

1979

SAMPLE TYPE	SAMPLING FREQUENCY	NUMBER OF SAMPLING LOCATIONS	NUMBER COLLECTED	ANALYSIS TYPE	ANALYSIS FREQUENCY	NUMBER PERFORMED
WATERBORNE PATHWAY						
Surface Water	M	6	63	Gross Beta	M	63
				H-3	QC	22
				Gamma	M(1)	51
				I-131	M	35
Well Water (2)	M	2	18	Gross Beta	M	16
				H-3	QC	8
				Gamma	M	16
Drinking Water (3)	M	2	18	H-3	QC	8
				Gross Beta	M	18
				Sr-89	QC	8
				Sr-90	QC	8
				Gamma	M	18
Sediment	SA	3	6	Gamma	SA	6
AIRBORNE PATHWAY						
Air Particulate	W	8	336	Gross Beta	W	336
				Gamma	QC	28
Air Iodine	W	5	160	I-131	W	160
INGESTION PATHWAY						
Fish (Flesh)	SA	2	12	Gamma	SA	12
				Sr-89	SA	12
				Sr-90	SA	12
Milk (4)	M	6	37	I-131	M	37
				Sr-89	M	32
				Sr-90	M	32
				Gamma	M	36
Fodder Crops (5)	M	1	9	Gamma	M	9
Food Products	A	6	5	Gamma	M	5
Game (flesh)	A	2	3	Gamma	A	3
Game (bones)	A	1	2	Gamma	A	2
Beef and Poultry (flesh)	SA	2	2	Gamma	SA	2
Beef and Poultry (bones)	SA	2	2	Gamma	SA	2
Soil	-	5	5	Gamma	-	5
DIRECT RADIATION						
Dosimeters (TLDs)	Q	16	204	Gamma Dose rate	Q	204

(1) Surface water quarterly composite gamma analyses were changed to monthly in May 1979.
(2) Quarterly well water samples were changed to monthly, gross beta and gamma analyses were added monthly, and tritium analyses were changed to quarterly composite in May 1979.
(3) Quarterly drinking water samples were changed to monthly, gross beta analyses were changed to monthly, and gamma analyses were added monthly in May 1979.
(4) Quarterly milk samples were changed to monthly and iodine-131, strontium-89, -90 and gamma analyses were changed to monthly in June 1979. Goat milk was sampled and analyzed for iodine-131 on a quarterly basis, beginning in September 1979 and analyzed for gamma and strontium-89 and -90 during September 1979.
(5) Quarterly fodder crop samples and gamma analyses were changed to monthly in June, 1979.

FIG. 1 AVERAGE CONCENTRATIONS OF TRITIUM IN SURFACE WATER IN THE VICINITY OF THE SUSQUEHANNA SES 1973 THROUGH 1979

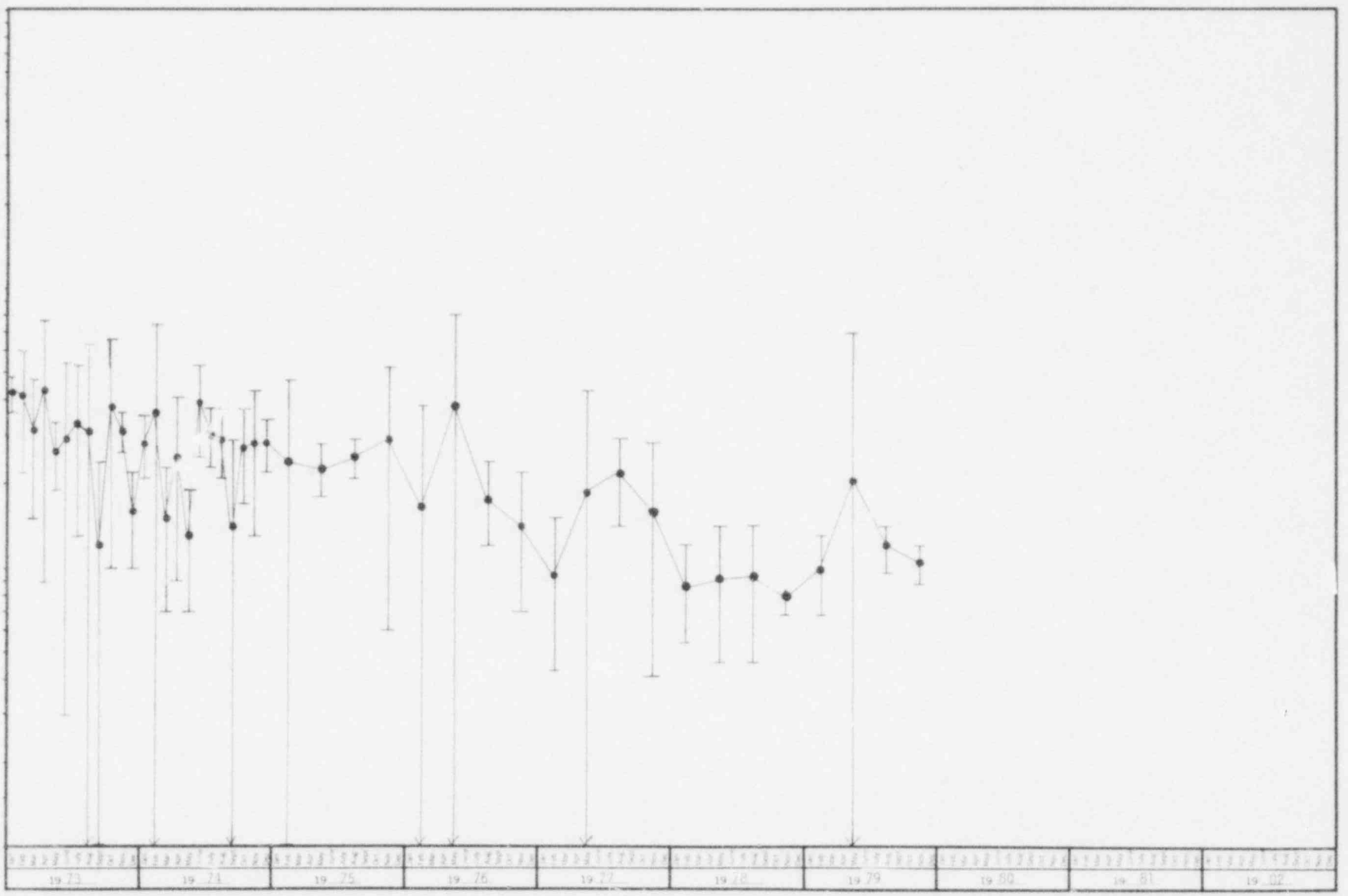


FIG. 2 GROSS BETA ACTIVITY IN AIR PARTICULATES
IN THE VICINITY OF THE SUSQUEHANNA SES SITE 1979

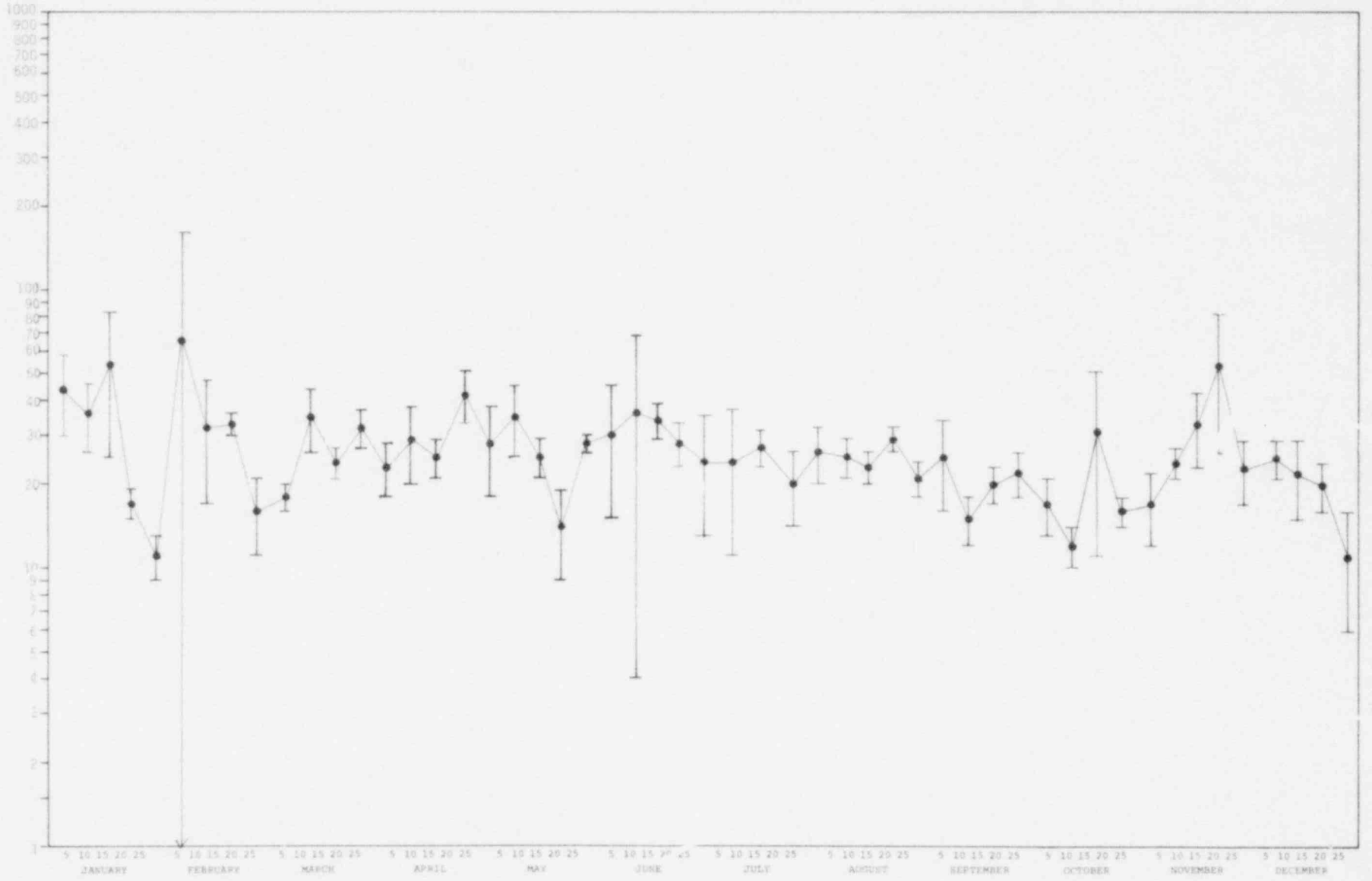
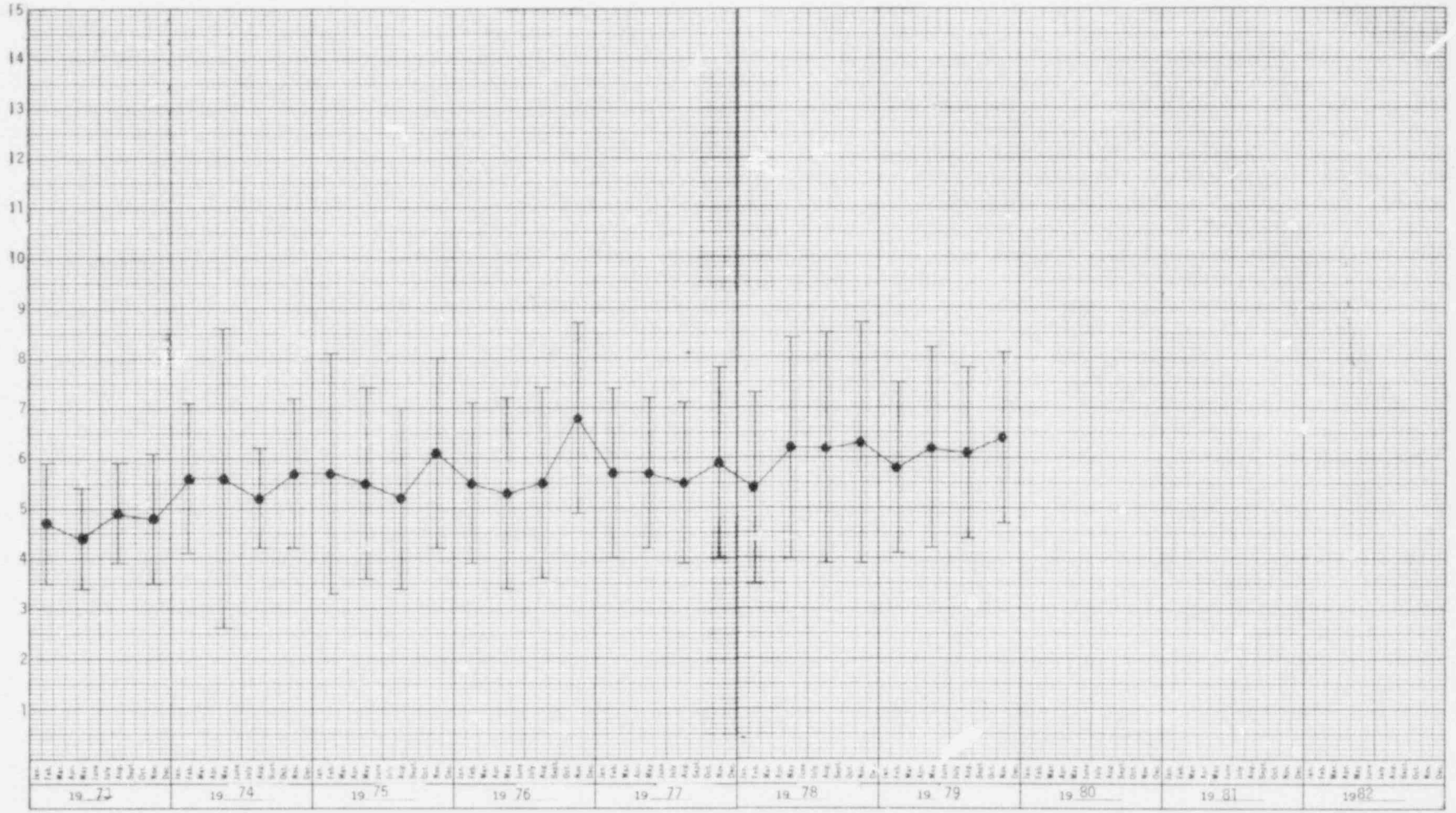


FIG. 3 AVERAGE AMBIENT RADIATION LEVELS IN THE VICINITY OF THE SUSQUEHANNA SES
1973 THROUGH 1979



APPENDIX A

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM ANNUAL SUMMARY

Susquehanna SES Docket No.: 50-387 & 50-388

Luzerne, Pa. January 1 to December 31, 1979

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	TYPE AND TOTAL NUMBER OF ANALYSES PERFORMED	LOWER LIMIT OF DETECTION (LLD) (1)	ALL INDICATOR LOCATIONS MEAN (2) RANGE	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE & DIRECTION	MEAN (2) RANGE	CONTROL LOCATION MEAN (2) RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Surface Water (pCi/l)	Gross Beta 63	2.5	4.9 (17/36) (2.3-14)	12F1 5.2 mi WSW	5.2 (7/12) (3.2-14)	5.2 (17/27) (2.8-13)	0
	H-3 22	100	104 (7/12) (79-118)	12G2 17 mi WSW	319 (3/3) (118-695)	197 (7/10) (94-695)	0
	I-131 35	0.08	.25 (3/18) (.11-.5)	6S2 0.9 mi ESE	.31 (2/6) (.11-.5)	- (0/17) -	0
	Gamma K-40 51	7.8	12.4 (3/27) (8.3-16)	6S2 0.9 mi ESE	12.2 (2/9) (8.3-16)	16 (1/24) (16)	0
Well Water (pCi/l)	H-3 8	100	85 (3/8) (81-92)	12F2 5.2 mi WSW	92 (1/4) (92)	N/A	0
	Gross Beta 16	2.7	2.3 (3/16) (2.1-2.4)	5S2 0.4 mi E	2.4 (1/8) (2.4)	N/A	0
	Gamma K-40 16	7.8	12 (1/16) (12)	5S2 0.4 mi E	12 (1/8) (12)	N/A	0
Drinking Water (pCi/l)	H-3 8	115	120 (3/4) (99-138)	12F2 5.2 mi WSW	120 (3/4) (99-138)	- (0/4) -	0
	Gross Beta 18	3.0	3.2 (5/9) (2.0-4.3)	12F2 5.2 mi WSW	3.2 (5/8) (2.0-4.8)	3.1 (3/9) (2.3-4.2)	0
	Sr-89 8	0.7	- (0/4) -	N/A	N/A	- (0/4) -	0
	Sr-90 8	0.5	0.5 (2/4) (0.4-0.6)	12H2 26 mi WSW	0.7 (1/4) (0.7)	0.7 (1/4) (0.7)	0
	Gamma 16	-	- (0/8) -	N/A	N/A	N/A	0
Sediment (pCi/g(dry)	Gamma Be-7 6	0.2	0.5 (2/4) (0.5)	7B 1.4 mi SE	0.5 (1/2) (0.5)	0.4 (2/2) (0.3-0.4)	0

APPENDIX A (cont.)

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM ANNUAL SUMMARY

Susquehanna SES Docket No.: 50-387 & 50-388

Luzerne, Pa. January 1 to December 31, 1979

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	TYPE AND TOTAL NUMBER OF ANALYSES PERFORMED		LOWER LIMIT OF DETECTION (LLD) (1)	ALL INDICATOR LOCATIONS MEAN (2) RANGE	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE & DIRECTION		MEAN (2) RANGE	CONTROL LOCATION MEAN (2) RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Sediment (cont.) (pCi/g(dry)	K-40		-	9.2 (4/4) (7.4-11)	7B	1.4 mi SE	10.3 (2/2) (9.7-11)	9.3 (2/2) (8.9-9.6)	0
	Cs-137		-	0.08 (4/4) (0.05-0.11)	2B	1.6 mi NNE	0.12 (2/2) (0.10-0.13)	0.12 (2/2) (0.10-0.13)	0
	Ra-226		-	0.58 (4/4) (0.46-0.66)	2B	1.6 mi NNE	0.75 (2/2) (0.71-0.78)	0.75 (2/2) (0.71-0.78)	0
	Th-232		-	0.68 (4/4) (0.5-0.93)	7B	1.4 mi SE	0.84 (2/2) (0.74-0.93)	.87 (2/2) (.87)	0
Air Particulates (10^{-3} pCi/m^3)	Gross Beta	336	-	26.6 (234/234) (7.7-71)	1D2	3.7 mi N	29.9 (52/52) (11-71)	28.2 (102/102) (9.8-64)	0
	Gamma	28							
	Be-7		-	81 (20/20) (37-130)	3D1	3.2 mi NE	82 (4/4) (54-130)	85 (8/8) (51-140)	0
	Cs-137		0.6	1.6 (4/20) (1.1-1.8)	1D2	3.7 mi N	1.5 (2/4) (1.1-1.8)	1.7 (4/8) (0.6-3.2)	0
	Ce-144		3.2	5.1 (6/20) (2.1-9.0)	3D1	3.2 mi NE	5.7 (2/4) (2.3-9.0)	2.7 (1/8) (2.7)	0
Air Iodine (10^{-3} pCi/m^3)	I-131	160	1.5	- (0/109) -		N/A	N/A	- (0/51) -	0
Milk (pCi/l	Sr-89	36	1.7	6.3 (7/27) (1.1-33)	12B2	1.7 mi WSW	12 (3/9) (1.1-33)	7.5 (1/9) (7.5)	0
	Sr-90		2.7	4.7 (24/27) (0.9-11)	8D1	3.3 mi SSE	11 (1/1) (11)	7.5 (3/9) (5.3-10)	0
	I-131		0.09	- (0/28) -		N/A	N/A	- (0/9) -	0
	Gamma	36							
	K-40		-	1222 (27/27) (630-1600)	10C1	2.9 mi SSW	1386 (7/7) (1100-1500)	1273 (9/9) (970-1800)	0
	Cs-137		1.1	3.0 (14/27) (1.6-4.5)	9G1	19.0 mi S	3.7 (6/9) (2.4-5.7)	3.7 (6/9) (24-5.7)	0
Fish (pCi/g-wet)	Sr-89	12	0.007	- (0/6) -	2G	30 mi NNE	0.005 (1/6) (0.005)	- (0/6) -	0
	Sr-90	12	0.003	- (0/6) -		N/A	N/A	- (0/6) -	0

APPENDIX A (cont.)

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM ANNUAL SUMMARY

Susquehanna SES Docket No.: 50-387 & 50-388

Luzerne, Pa. January 1 to December 31, 1979

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	TYPE AND TOTAL NUMBER OF ANALYSES PERFORMED	LOWER LIMIT OF DETECTION (LLD) (1)	ALL INDICATOR LOCATIONS MEAN (2) RANGE	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (2) RANGE	CONTROL LOCATION MEAN (2) RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Fodder Crops (pCi/g-dry)	Gamma 9						
	Be-7	3.0	7.2 (5/9) (2.7-13)	15A1 0.8 mi NNW	7.2 (5/9) (2.7-13)	No Control Location	0
	K-40	1.6	9.9 (7/9) (3.4-18)	15A1 0.8 mi NNW	9.9 (7/9) (3.4-18)		0
	Cs-137	0.1	.25 (1/9) (.25)	15A1 0.8 mi NNW	.25 (1/9) (.25)		0
	Ce-144	0.3	1.1 (1/9) (1.1)	15A1 0.8 mi NNW	1.1 (1/9) (1.1)		0
Fruits & Vegetables (pCi/g-dry)	Gamma 6						
	K-40	-	3.4 (6/6) (0.8-7.2)	15A1 0.8 mi NW	7.2 (1/1) (7.2)	3.1 (1/1) (3.1)	0
	Cs-137	0.008	- (0/5) -	N/A	N/A	- (0/1) -	0
Meat & Poultry (Flesh) (pCi/g-wet)	Gamma 4						
	K-40	-	1.7 (3/3) (1.0-2.5)	12B2 1.7 mi WSW	2.5 (1/1) (2.5)	No Control Location	0
	Cs-137	-	- (0/3) -	N/A	N/A		0
Meat & Poultry (Bones) (pCi/g-dry)	Gamma 2						
	K-40	-	2.8 (1/2) (2.8)	12B3 1.2 mi WSW	2.8 (1/1) (2.8)	No Control Location	0
	Cs-137	-	0.2 (1/2) (0.2)	12B2 1.7 mi WSW	0.2 (1/1) (0.2)		0
	Sr-89 2	-	0.9 (1/2) (0.9)	12B2 1.7 mi WSW	0.9 (1/1) (0.9)		0
	Sr-90 2	-	2.2 (1/2) (.38-4.1)	12B2 1.7 mi WSW	4.1 (1/1) (4.1)		0
Game (Flesh) (pCi/g-wet)	Gamma 3						
	K-40	-	3.1 (3/3) (2.9-3.5)	3S (Site Vicinity)	3.0 (2/2) (2.9-3.0)	No Control Location	0
	Cs-137	-	2.0 (3/3) (0.55-3.6)	3S (Site Vicinity)	2.7 (2/2) (1.7-3.6)		0

APPENDIX A (cont.)

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM ANNUAL SUMMARY

Susquehanna SES Docket No.: 50-387 & 50-388

Luzerne, Pa. January 1 to December 31, 1979

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	TYPE AND TOTAL NUMBER OF ANALYSES PERFORMED		LOWER LIMIT OF DETECTION (LLD) (1)	ALL INDICATOR LOCATIONS MEAN (2) RANGE	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE & DIRECTION	MEAN (2) RANGE	CONTROL LOCATIONS MEAN (2) RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Game (Bones) (pCi/g-dry)	Gamma	2						
	K-40		-	3.5 (2/2) (2.9-4.1)	3S (Site Vicinity)	3.5 (2/2) (2.9-4.1)		0
	Cs-137		-	1.3 (2/2) (0.7-1.9)	3S (Site Vicinity)	1.3 (2/2) (0.7-1.9)	No Control Location	0
	Sr-89	2	-	0.7 (2/2) (0.6-0.7)	3S (Site Vicinity)	0.7 (2/2) (0.6-0.7)		0
	Sr-90	2	-	2.8 (2/2) (2.4-3.1)	3S (Site Vicinity)	2.8 (2/2) (2.4-3.1)		0
Soil (pCi/g-dry)	Gamma	5						
	Be-7		0.3	- (0/4) -	12G3 17 mi WSW	0.3 (1/1) (0.3)	0.3 (1/1) (0.3)	0
	K-40		-	9.7 (4/4) (8.8-12)	3D2 3.2 mi NE	12 (1/1) (12)	11 (1/1) (11)	0
	Cs-137		-	.68 (4/4) (.21-1.3)	3D2 3.2 mi NE	1.3 (1/1) (1.3)	0.2 (1/1) (0.2)	0
	Ra-226		-	1.3 (4/4) (.75-2.5)	3D2 3.2 mi NE	2.5 (1/1) (2.5)	1.2 (1/1) (1.2)	0
	Th-232		-	1.3 (4/4) (.73-2.6)	3D2 3.2 mi NE	2.6 (1/1) (2.6)	1.0 (1/1) (1.0)	0
Direct Radiation (mrem)	TLD	51	-	6.40 (40/40, (4.38-7.84)	3D1 3.2 mi NE	7.71 (2/2) (7.69-7.73)	5.17 (11/11) (4.38-6.03)	0

(1) The LLDs quoted are the lowest actual LLD obtained in the various media during the reporting period. A typical gamma LLD was determined for each searched for nuclide as found in Table C-21. Where all nuclides were >LLD for a specific media no LLD was listed. Strontium-89 and -90 are reported as minimum detectable levels (MDLs) rather than LLDs.

(2) Mean and range based upon detectable measurements only. Fraction of detectable measurements is indicated in parentheses.

The mean ($\overline{X}$) is defined as follows: $\overline{X} = \frac{\sum_{i=1}^{n} X_i}{n}$

Where: X_i = the activity of an individual measurement (i)

n = number of total measurements

APPENDIX B

Table B-1 lists the sampling locations and includes both the distance and direction from the Susquehanna SES and the media sampled at each location. Maps B-1 and B-2 show the sampling locations with respect to the Susquehanna SES.

Sample Designation

Samples are identified by a three part code. The first two letters are the power station identification code, in this case "SS" for Susquehanna Steam Electric Station. The next three letters are for the media sampled.

AIO	= Air Iodine	FPP	= Food Products, Poultry
AQF	= Fish	GAD	= Game, Deer
AQS	= Sediment	GAS	= Game, Squirrel
APT	= Air Particulates	GMK	= Goat Milk
FPB	= Food Products, Beef	IDM	= Immersion Dose (TLD)
FPE	= Food Products, Eggs	MLK	= Milk
FPF	= Food Products, Fruit	PAS	= Pasture Grass
FPG	= Food Products, Grain	PWT	= Potable Water, Treated
FPL	= Food Products, Leafy Vegetables	SOL	= Soil
FPV	= Food Products, Vegetables	SWA	= Surface Water
		WWA	= Well Water

The last four symbols are a location code based on direction and distance from the site. Of these, the first two represent each of the 16 angular sectors of 22-1/2 degrees centered about the reactor site. Sector one is divided evenly by the north axis and other sectors are numbered in a clockwise direction; i.e., 2=NNE, 3=NE, 4=ENE, etc. The next digit is a letter which represents the radial distance from the station:

S	= Site[1] location	E	= 4-5 miles off-site
A	= 0-1 miles off-site	F	= 5-10 miles off-site
B	= 1-2 miles off-site	G	= 10-20 miles off-site
C	= 2-3 miles off-site	H	= >20 miles off-site
D	= 3-4 miles off-site		

The last number is the station numerical designation within each sector and zone; e.g. 1, 2, 3, ...

Specific information about the individual sampling locations is given in table B-1. Maps B-1 and B-2 show the locations of sampling stations with respect to the site.

---

1. Site is defined as that area within PP&L's property boundary.

TABLE B-1

SUSQUEHANNA SES RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SAMPLING LOCATIONS

1979

LOCATION CODE	DESCRIPTION*	SAMPLE TYPES
IND**	0.8 mile , Outfall Area	AQF
3S***	0.1 mile NE, Near Site Boundary	GAS
3S1	0.8 mile NE, Off Route 11	IDM
4S1	0.8 mile ENE, Off Route 11	IDM
5S1	0.7 mile E, North of Biological Consultants	IDM
5S2	0.4 mile E Site - Peach Stand	WWA
5S4	0.7 mile E, West of Biological Consultants	APT,AIO,IDM
5S5	0.7 mile E, West of Biological Consultants	SOL
6S2	0.9 mile ESE, Outfall Area	SWA
7S1	0.3 mile SE, On 230 KV tower	IDM
11S1	0.3 mile SW, On 230 KV tower	IDM
2A1	0.9 mile NE, Energy Information Center	IDM
11A1	0.5 mile SW, Goloumb House	APT,AIO,IDM
15A1	0.8 mile NNW, Serafin Farm	PAS,FPL
16A***	0.8 mile NNW, Near Site Boundary	GAD
2B***	1.6 mile NNE, Gould Island	AQS
7B***	1.4 mile SE, Bell Bend	AQS
7B2	1.5 mile SE, Heller Orchard	FPF
9B1	1.3 mile S, Transmission Line East of Route 11	APT,AIO,IDM
12B1	1.4 mile WSW, Kisner Farm	FPB,FPE,FPP,FPV
12B2	1.7 mile WSW, Shultz Farm	MLK

TABLE B-1 (cont.)

SUSQUEHANNA SES RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SAMPLING LOCATIONS

1979

LOCATION CODE	DESCRIPTION*	SAMPLE TYPES
12B3	1.9 mile WSW, Young Farm	MLK,FPB
11C***	2.0 mile SW, Hess Island	AQS
1D2	3.7 mile N, Near Mocanagua Substation	APT,IDM
1D3	3.7 mile N, Near Mocanagua Substation	SWA
1D4	3.7 mile N, Near Mocanagua Substation	SOL
3D1	3.2 mile NE, Pond Hill	APT,IDM
3D2	3.2 mile NE, Pond Hill	SOL
8D1	3.3 mile SSE, Poltrock Farm	GMK
10D1	3.1 mile SSW, Ross Ryman Farm	MLK,FPL
12D1	3.2 mile WSW, N. Shultz	MLK
12E1	4.7 mile WSW, Berwick Hospital	APT,AIO,IDM
12E2	4.7 mile WSW, Berwick Hospital	SOL
13E1	4.5 mile W, Glen Brook Reservoir	SWA
12F1	5.2 mile WSW, Berwick Bridge	SWA
12F2	5.2 mile WSW, Berwick Substation	IDM
12F3	5.2 mile WSW, Berwick Water Co.	WWA,PWT
2G***	30 mile NNE, Near Falls, PA	AQF
9G1	14 mile S, Davis Farm	MLK
12G1	17 mile WSW, Bloomsburg, PA	APT,IDM
12G2	17 mile WSW, between Bloomsburg and Berwick, PA	SWA
12G3	17 mile WSW, Bloomsburg, PA	SOL
2H1	21 mile NNE, Vegetable Stand	FPL
7H1	47 mile SE, PP&L roof, Allentown	APT,AIO,IDM

TABLE B-1 (cont.)

SUSQUEHANNA SES RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SAMPLING LOCATIONS

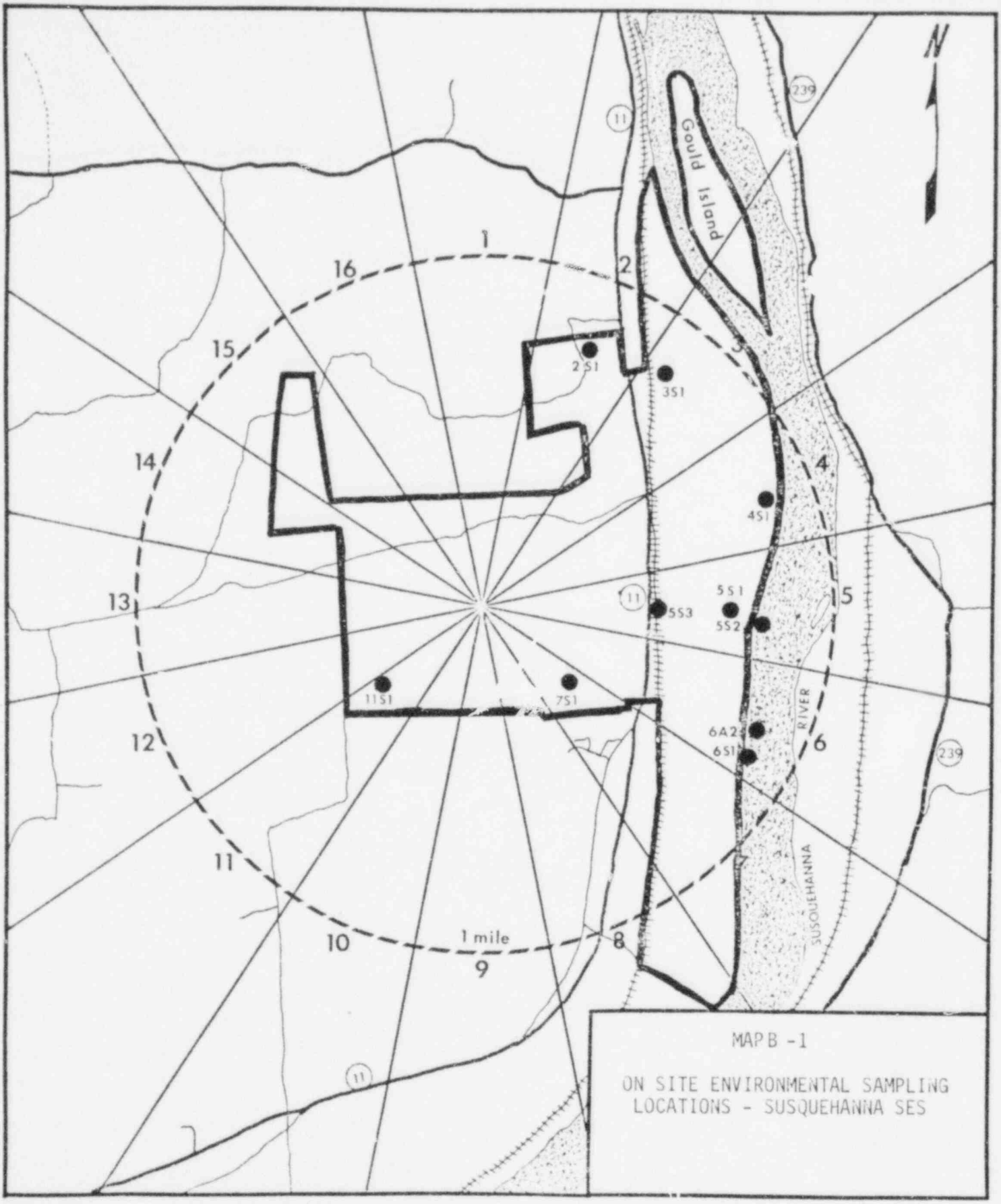
1979

LOCATION CODE	DESCRIPTION*	SAMPLE TYPES
8H1	92 mile SSE, RMC roof, Philadelphia	IDM
12H1	26 mile WSW, Merck Co.	SWA
12H2	26 mile WSW, Danville Water Company	PWT

* All distances measured from vent.

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

*** Station code is omitted, because no permanent locations exist and are based on availability.

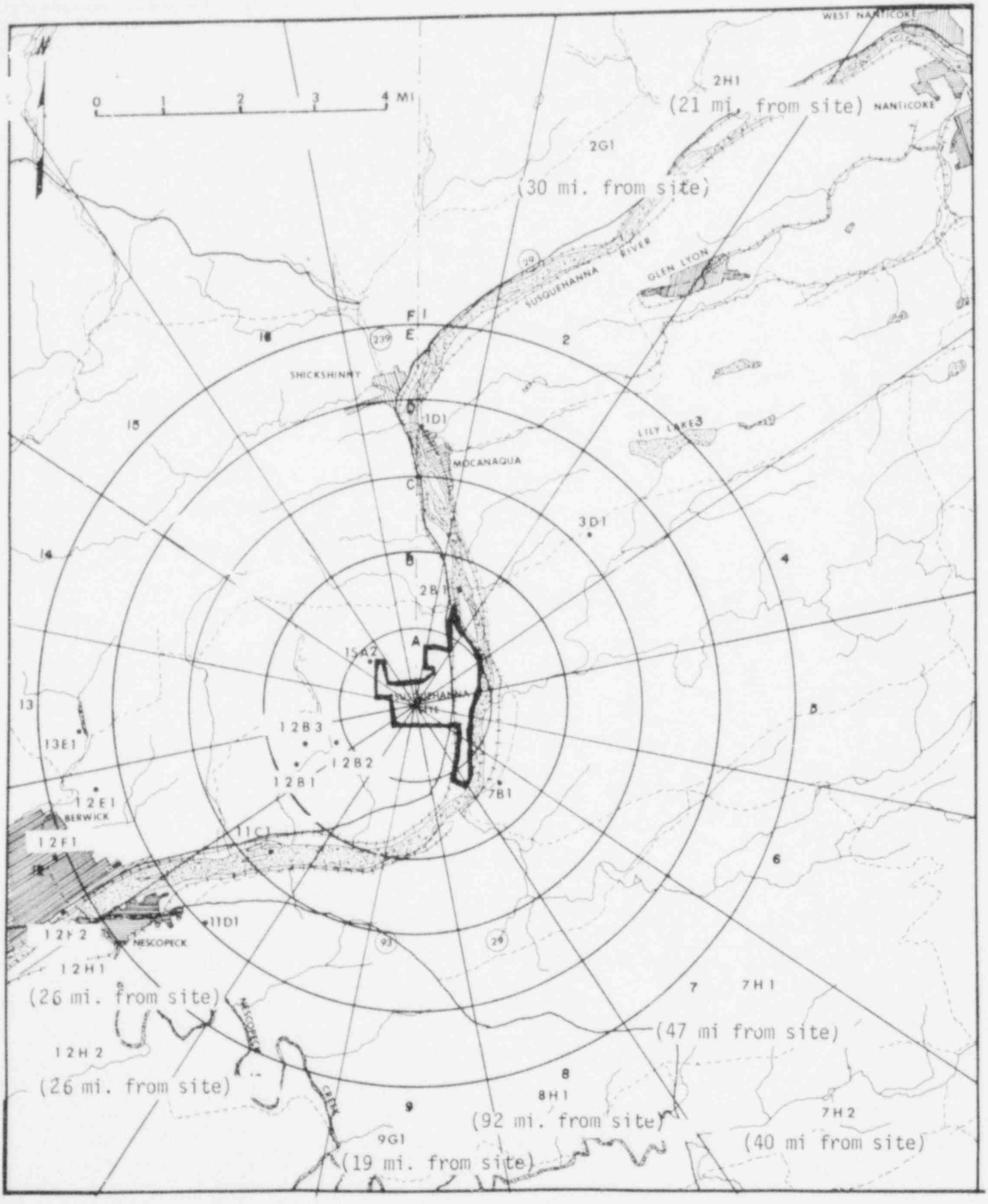


MAP B -1

ON SITE ENVIRONMENTAL SAMPLING LOCATIONS - SUSQUEHANNA SES

MAP B-2

OFF SITE ENVIRONMENTAL SAMPLING LOCATIONS - SUSQUEHANNA SES



APPENDIX C

DATA TABLES

APPENDIX C (cont.)

DATA TABLES

TABLE C-1

CONCENTRATIONS OF BETA EMITTERS IN SURFACE WATER SAMPLES
IN THE VICINITY OF SUSQUEHANNA SES

Results in Units of pCi/l ± 2 sigma

STATION NO.	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE
SS-SWA-6S2	<3.4	3.5±1.9	9.0±2.7	<3.3	4.5±2.2	2.3±2.2
SS-SWA-1D3	-	-	-	-	<3.0(1)	<3.4
SS-SWA-13E1	<3.4	<2.5	<3.5	<3.3	4.6±2.2	<3.4
SS-SWA-12F1	<3.4	5.9±2.1	<3.5	<3.3	4.0±2.2	<3.4
SS-SWA-12G2	-	-	-	-	-	2.9±2.3(2)
SS-SWA-12H1	<3.4	3.3±1.9	<3.5	<3.3	4.3±2.3	<3.4
Average	<3.4	3.8±2.9	4.9±5.5	<3.3	4.1±1.3	3.1±0.9

STATION NO.	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
SS-SWA-6S2	5.4±2.2	3.7±2.2	2.3±2.2	<3.2	<3.2(3)	3.6±1.9
SS-SWA-1D3	11±3	3.2±2.2	<3.3	<3.2	11±3	4.3±2.0
SS-SWA-13E1	<2.8	<3.1	<3.3	<3.2	<3.2	2.8±1.9
SS-SWA-12F1	3.2±2.0	3.3±2.2	3.4±2.3	<3.2	14±3	7.5±2.3
SS-SWA-12G2	5.8±2.2	3.7±2.2	3.5±2.3	2.8±2.2	13±3	4.6±2.0
SS-SWA-12H1	4.3±2.1	3.3±2.2	4.0±2.3	<3.2	<3.2	3.2±1.9
Average	5.4±6.0	3.4±0.5	3.3±1.1	3.1±0.3	7.9±10.6	4.3±3.4

(1) Surface water station SS-SWA-1D3 was initiated on 5-31-79.
(2) Surface water station SS-SWA-12G2 was initiated on 6-25-79.
(3) Insufficient sample for confirmation by reanalysis.

TABLE C-2

CONCENTRATIONS OF GAMMA EMITTERS* IN QUARTERLY COMPOSITE SAMPLES OF SURFACE WATER IN THE VICINITY OF SUSQUEHANNA SES

Results in Units of pCi/l ± 2 sigma

STATION NO.	NUCLIDES	JAN to MARCH	MAY(1)	JUNE	JULY	AUGUST
SS-SWA-6S2	K-40	8.3±7.6	<7.8	<9.3	<9.3	<9.3
	Others	<LLD	<LLD	<LLD	<LLD	<LLD
SS-SWA-1D3		-	All<LLD(2)	All<LLD	All<LLD	All<LLD
SS-SWA-13E1		All<LLD	All<LLD	All<LLD	All<LLD	All<LLD
SS-SWA-12F1	K-40	<7.0	<7.8	<14	<9.3	<7.8
	Others	<LLD	<LLD	<LLD	<LLD	<LLD
SS-SWA-12G2	K-40	-	-	<12(3)	<7.8	<7.8
	Others			<LLD	<LLD	<LLD
SS-SWA-12H1		All<LLD	All<LLD	All<LLD	All<LLD	All<LLD

STATION NO.	NUCLIDES	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
SS-SWA-6S2	K-40	<7.8	<9.3	16±8(4)	<9.3
	Others	<LLD	<LLD	<LLD	<LLD
SS-SWA-1D3		All<LLD	All<LLD	All<LLD	All<LLD
SS-SWA-13E1		All<LLD	All<LLD	All<LLD	All<LLD
SS-SWA-12F1	K-40	<7.8	<9.3	13±8	<9.3
	Others	<LLD	<LLD	<LLD	<LLD
SS-SWA-12G2	K-40	<9.3	<16	[illegible]	<9.3
	Others	<LLD	<LLD	<LLD	<LLD
SS-SWA-12H1		All<LLD	All<LLD	All<LLD	All<LLD

* Typical LLDs are found on Table C-21.

(1) Beginning in May 1979, gamma analyses were performed on monthly surface water samples.
(2) Surface water station SS-SWA-1D3 was initiated on 5-31-79.
(3) Surface water station SS-SWA-12G2 was initiated on 6-25-79.
(4) Insufficient sample for confirmation by reanalysis.

TABLE C-3

CONCENTRATIONS OF TRITIUM* IN QUARTERLY COMPOSITE SAMPLES OF SURFACE WATER IN THE VICINITY OF SUSQUEHANNA SES

Results in Units of pCi/l ± 2 sigma

STATION NO.	JAN to MARCH	APRIL to JUNE	JULY to SEPT	OCT to DEC	ANNUAL AVERAGE
SS-SWA-6S2	107±70	<103	118±77	<100	107±16
SS-SWA-1D3	-	134±65(1)	<115	<100	116±34
SS-SWA-13E1	79±69	<103	<115	113±62	103±33
SS-SWA-12F1	114±70	85±64	114±77	<100	103±28
SS-SWA-12G2	-	695±82(2)	145±71	118±62	319±651
SS-SWA-12H1	96±69	94±64	<115	97±62	101±19
Quarterly Average	99±31	202±484	120±24	105±17	135±252

(1) Surface water station SS-SWA-1D3 was initiated on 5-31-79; therefore, the composite period is for May and June samples.

(2) Surface water station SS-SWA-12G2 was initiated on 6-25-79. This sample was a grab sample.

* Positive tritium results are reported when the 2 sigma counting error is less than the result. In some cases, positive results to be reported are lower than the calculated LLDs. For classification, check the method of calculation found in Appendix D, Analysis of Samples for Tritium.

TABLE C-4

CONCENTRATIONS OF IODINE* IN SURFACE WATER SAMPLES
IN THE VICINITY OF SUSQUEHANNA SES

Results in Units of pCi/l ± 2 sigma

STATION NUMBER	MAY	JUNE	JULY	AUGUST	SEPTEMBER(1)	OCTOBER	NOVEMBER	DECEMBER(1)
SS-SWA-6S2	<0.5(4)	0.11±0.05	<0.09	<0.1		<0.2(4)	0.5±0.2	
SS-SWA-1D3	<0.3(2,4)	<0.1	<0.09	<0.1		<0.2(6)	<0.1	
SS-SWA-13E1	<0.4(4)	<0.08	<0.09	<0.1		<0.2(6)	<0.1	
SS-SWA-12F1	<0.3(4)	0.15±0.05	<0.1	<0.2(6)		<0.1	<0.1	
SS-SWA-12G2	-	<0.1(3)	<0.1	<0.6(5)		<0.2(6)	<0.1	
SS-SWA-12H1	<0.2(4)	<0.08	<0.09	<0.1		<0.1	<0.1	

* Beginning in May 1979, Iodine analyses were performed on monthly surface water samples.
(1) Samples collected in September and December were inadvertently omitted from the analysis schedule.
(2) Surface water station SS-SWA-1D3 was initiated on 5-31-79.
(3) Surface water station SS-SWA-12G2 was initiated on 6-25-79.
(4) High LLD due to an insufficient sample volume and a delay in analysis.
(5) High LLD due to an insufficient sample volume.
(6) High LLD due to low yield.

TABLE C-5

CONCENTRATIONS OF BETA EMITTERS* IN WELL WATER SAMPLES
IN THE VICINITY OF SUSQUEHANNA SES

Results - Units of pCi/l ± 2 sigma

STATION NO.	5-29-79	6-27-79	7-24-79	8-29-79	9-27-79	10-29-79	11-28-79	12-26-79
SS-WWA-5S2	2.4±2.0	<3.4	<2.8	<3.1	<3.3	<3.2	<3.2	<2.7
SS-WWA-12F3	<3.0	<3.4	<2.8	2.4±2.1	<3.3	<3.2	<3.2	2.1±1.8

* Beginning in May 1979, gross beta analyses were performed on monthly samples of well water.

TABLE C-6

CONCENTRATIONS OF GAMMA EMITTERS* IN WELL WATER SAMPLES
IN THE VICINITY OF SUSQUEHANNA SES

Results in Units of pCi/l ± 2 sigma

STATION NO.	5-29-79(1)	6-27-79	7-24-79	8-29-79	9-27-79	10-29-79	11-28-79	12-26-79
SS-WWA-5S2	All<LLD	All<LLD	All<LLD	All<LLD	All<LLD	All<LLD	K-40 (12±7) Others <LLD	All<LLD
SS-WWA-12F3	All<LLD	All<LLD	All<LLD	All<LLD	All<LLD	All<LLD	All<LLD	All<LLD

* All other gamma emitters searched for were <LLD; typical LLDs are found on Table C-21.
(1) Beginning in May 1979, gamma analyses were performed on monthly samples of well water.

TABLE C-7

CONCENTRATIONS OF TRITIUM IN QUARTERLY COMPOSITE SAMPLES*
OF WELL WATER IN THE VICINITY OF SUSQUEHANNA SES

Results in Units of pCi/l ± 2 sigma

STATION NUMBER	3-31-79	5-29-79 to 6-27-79	7-24-79 to 9-27-79	10-29-79 to 12-26-79
SS-WWA-5S2	81±76	<121	<115	83±62
SS-WWA-12F3	92±76	<121	<115	<100

* Beginning in May 1979, tritium analyses were performed on quarterly composite samples of well water.

TABLE C-8

CONCENTRATIONS OF BETA EMITTERS AND GAMMA* EMITTERS IN
DRINKING (POTABLE) WATER SAMPLES IN THE VICINITY OF SUSQUEHANNA SES

Results in Units of pCi/l ± 2 sigma

STATION NO. RADIOACTIVITY	JANUARY TO MARCH	MAY(1)	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
SS-PWT-12F3									
Beta	<3.5	2.6±2.0	3.0±2.3	3.6±2.0	<3.1	<3.6	4.8±2.2	<3.2	2.0±1.8
Gamma Emitters	-	All<LLD(2)	All<LLD	All<LLD	All<LLD	All<LLD	All<LLD	All<LLD	All<LLD
SS-PWT-12H2									
Beta	<3.5	<3.0	<3.4	2.3±1.9	2.7±2.1	<3.3	<3.2	<3.2	4.2±2.0
Gamma Emitters	-	All<LLD(2)	All<LLD	All<LLD	All<LLD	All<LLD	All<LLD	All<LLD	All<LLD

* Typical LLDs are found on Table C-21.
(1) Beginning in May 1979, gross beta and gamma analyses were performed on monthly potable water samples.
(2) Gamma analysis of potable water samples was begun in May 1979.

TABLE C-9

CONCENTRATIONS OF TRITIUM AND STRONTIUM-89* AND -90 IN DRINKING (POTABLE) WATER SAMPLES
IN THE VICINITY OF SUSQUEHANNA SES

Results in Units of pCi/l ± 2 sigma

STATION NO. RADIOACTIVITY	JAN TO MAR	APRIL(1) TO JUNE	JULY TO SEPT	OCT TO DEC
SS-PWT-12F3				
H-3	124±76	<121	99±70	138±62
Sr-89	<0.7	<2.0	<1.0	<1.4
Sr-90	0.4±0.3	<1.1	<0.5	0.6±0.5
SS-PWT-12H2				
H-3	<124	<121	<115	<100
Sr-89	<0.8	<0.9	<1.3	<1.3
Sr-90	0.7±0.3	<0.5	<0.6	<0.7

* Sr-89 results are corrected for decay to sample stop date.
(1) No sample was received in April; therefore, the second quarterly composite contained only May and June samples.

TABLE C-10

CONCENTRATIONS OF GAMMA EMITTERS* IN SEDIMENT SAMPLES
FROM THE SUSQUEHANNA RIVER IN THE VICINITY OF SUSQUEHANNA SES

Results in Units of pCi/g(dry) ± 2 sigma

STATION NO.	SS-AQS-2B**		SS-AQS-7B**		SS-AQS-11C**	
DATE	5-23-79	9-27-79	5-23-79	9-27-79	5-23-79	9-27-79
Be-7	0.3±0.1	0.4±0.2	0.5±0.2	<0.2	<0.2	0.5±0.2
K-40	9.6±1.0	8.9±0.9	11±1	9.7±1.0	8.3±0.9	7.4±0.7
Cs-137	0.10±0.02	0.13±0.02	0.06±0.02	0.05±0.02	0.05±0.02	0.11±0.02
Ra-226	0.71±0.07	0.78±0.08	0.58±0.06	0.61±0.06	0.46±0.05	0.66±0.07
Th-232	0.87±0.09	0.87±0.09	0.93±0.09	0.74±0.07	0.55±0.09	0.5±0.2

* All other gamma emitters searched for were <LLD; typical LLDs are found on Table C-21.
** Station code is omitted because no permanent sampling locations exist; samples are taken based on availability. Exact locations are noted in Table B-1.

TABLE C-11

CONCENTRATIONS OF BETA EMITTERS IN AIR PARTICULATE SAMPLES IN THE VICINITY OF SUSQUEHANNA SES

Results in Units of 10^{-3} pCi/m^3 ± 2 sigma

SAMPLE START DATE	SAMPLE STOP DATE	STATION SS-APT-5S4	SS-APT-11A1	SS-APT-9B1	SS-APT-1D2	SS-APT-3D1	SS-APT-12E1	SS-APT-12G1	AVERAGE**	SAMPLE START DATE	SAMPLE STOP DATE	STATION SS-APT-7H1
12-31-78	1-07-79	39±4	-	-	54±5	39±4	43±4	-	44±14	1-03-79	1-08-79	58±7
1-07-79	1-14-79	33±4	-	-	43±4	34±4	33±4	-	36±10	1-08-79	1-15-79	39±6
1-14-79	1-20-79	48±5	-	-	76±8	45±5	47±5	-	54±29	1-15-79	1-23-79	34±4
1-20-79	1-26-79	16±3	-	-	18±3	18±3	16±3	16±2(3)	17±2	1-23-79	1-31-79	12±3
1-26-79	2-02-79	10±2	-	-	8±1(1)	11±2	12±3	12±2	11±2	1-31-79	2-05-79	33±5
2-02-79	2-09-79	46±5	-	-	30±3(1)	42±4	47±5	43±4	66±94	2-05-79	2-12-79	41±5
2-09-79	2-16-79	35±4	-	-	42±4	32±3	23±3	26±3	32±15	2-12-79	2-20-79	25±3
2-16-79	2-23-79	35±4	-	-	34±4	32±4	*	32±3	33±3	2-20-79	2-27-79	23±4
2-23-79	3-02-79	18±3	-	-	17±3	16±2	12±3(2)	18±2	16±5	2-27-79	3-07-79	23±4
3-02-79	3-10-79	17±3	-	-	18±3	18±3	20±3	19±2	18±2	3-07-79	3-12-79	35±5
3-10-79	3-16-79	33±4	-	-	43±5	33±4	32±4	33±4	35±9	3-12-79	3-19-79	71±7
3-16-79	3-23-79	25±4	-	-	25±3	23±3	22±3	25±3	24±3	3-19-79	3-26-79	24±4
3-23-79	3-30-79	34±3	-	-	32±3	33±4	*	28±3	32±5	3-26-79	3-29-79	34±7
3-30-79	4-06-79	22±3	-	-	27±3	24±3	22±3	21±3	23±5	3-29-79	4-02-79	41±7
4-06-79	4-13-79	29±3	-	-	29±3	34±4	21±3	30±3(4)	29±9	4-02-79	4-10-79	28±4
4-13-79	4-21-79	28±3	-	-	22±3	25±3	24±3	26±3	25±4	4-10-79	4-16-79	21±4
4-21-79	4-28-79	38±4	-	-	48±5	36±4	41±4	43±4	42±9	4-16-79	4-23-79	35±5
										4-23-79	4-30-79	24±4
4-28-79	5-05-79	30±3	-	-	26±3	29±3	20±3	33±4	28±10	4-30-79	5-07-79	40±5
5-05-79	5-12-79	31±4	-	-	33±4	43±5	35±4	32±3	35±10	5-07-79	5-15-79	27±4
5-12-79	5-19-79	28±3	-	-	22±3	24±3	24±3	25±3	25±4	5-15-79	5-21-79	21±4
5-19-79	5-25-79	16±3	-	-	13±2	15±3	10±2	15±2	14±5	5-21-79	5-29-79	21±3
5-25-79	6-01-79	29±4	-	-	27±3	30±3	28±3	28±3	28±2			
6-01-79	6-08-79	36±4	-	-	31±4	30±4	35±4	17±3	30±15	5-29-79	6-05-79	25±4
6-08-79	6-15-79	44±5	-	-	23±3	61±6	25±3	29±3	36±32	6-05-79	6-12-79	35±4
6-15-79	6-21-79	32±4	-	-	34±4	33±4	34±4	38±4	34±5	6-12-79	6-18-79	53±6
6-21-79	6-27-79	31±4	-	-	28±4	25±4	25±3	29±3	28±5	6-18-79	6-25-79	64±6
6-27-79	7-05-79	29±4	-	-	17±3	23±3	31±4	22±3	24±11	6-25-79	7-03-79	37±5
7-05-79	7-13-79	28±3	-	-	33±4	24±3	18±3	18±3	24±13	7-03-79	7-10-79	30±4
7-13-79	7-22-79	28±3	-	-	25±3	28±3	29±3	25±3	27±4	7-10-79	7-16-79	19±4
7-22-79	7-29-79	20±3	-	-	18±3	18±3	*	24±3	20±6	7-16-79	7-24-79	28±4
										7-24-79	7-30-79	21±4

TABLE C-11 (CONT.)

CONCENTRATIONS OF BETA EMITTERS IN AIR PARTICULATE SAMPLES IN THE VICINITY OF SUSQUEHANNA SES

Results in Units of 10^{-3} pCi/m^3 ± 2 sigma

SAMPLE START DATE	SAMPLE STOP DATE	STATION SS-APT-6S4	SS-APT-11A1	SS-APT-9B1	SS-APT-1D2	SS-APT-3D1	SS-APT-12E1	SS-APT-12G1	AVERAGE**	SAMPLE START DATE	SAMPLE STOP DATE	STATION SS-APT-7H1
7-29-79	8-06-79	29±4	-	-	23±3	24±3	*	28±3	26±6	7-30-79	8-07-79	29±4
8-06-79	8-13-79	26±3	-	-	24±3	23±3	*	28±4	25±4	8-07-79	8-13-79	31±7
8-13-79	8-19-79	22±4	-	-	22±3	25±4	23±3	21±3	23±3	8-13-79	8-20-79	34±9
8-19-79	8-26-79	31±4	-	-	28±3	27±4	30±3	28±3	29±3	8-20-79	8-27-79	29±8
8-26-79	9-03-79	24±2	-	-	21±2	21±2	21±2	20±2	21±3	8-27-79	9-04-79	31±8
9-03-79	9-09-79	25±4	-	-	25±3	25±4	25±3	24±3	25±9	9-04-79	9-10-79	25±8
9-09-79	9-16-79	16±3	15±4(5)	12±3(6)	15±2	13±3	16±2	16±2	15±3	9-10-79	9-17-79	30±8
9-16-79	9-24-79	19±3	18±2	19±2	21±3	18±3	20±2	22±3	20±3	9-18-79	9-24-79	24±4
9-24-79	10-01-79	26±4	21±3	22±3	22±3	21±3	20±3	25±3	22±4	9-24-79	10-02-79	21±3
10-01-79	10-08-79	20±3	14±2	17±2	19±3	16±3	17±3	15±2	17±4	10-01-79	10-08-79	19±4
10-08-79	10-15-79	13±3	13±2	12±2	13±2	14±2	11±2	11±2	12±2	10-08-79	10-15-79	9.8±2.2
10-15-79	10-22-79	27±4	19±3	24±3	43±5	46±5	32±4	26±3	31±20	10-15-79	10-22-79	66±7
10-22-79	10-30-79	16±2	16±2	15±2	18±2	17±3	16±2	17±2	16±2	10-22-79	10-29-79	22±3
10-30-79	11-06-79	17±3	13±2	19±3	20±3	16±3	19±3	17±2	17±5	10-29-79	11-05-79	23±4
11-06-79	11-13-79	25±3	23±3	23±3	23±3	27±3	24±3	23±3	24±3	11-05-79	11-12-79	25±5
11-13-79	11-19-79	36±4	32±4	23±3	32±4	36±4	39±4	31±3	33±10	11-12-79	11-19-79	35±4
11-19-79	11-25-79	30±4	56±6	39±4	63±6	63±6	67±7	62±7	54±28	11-19-79	11-27-79	58±6
11-25-79	12-03-79	25±3	22±3	23±3	23±3	27±3	24±2	18±3	23±6	11-27-79	12-03-79	25±4
12-03-79	12-10-79	28±4	22±3	27±3	24±3	25±4	23±3	26±4	25±4	12-03-79	12-10-79	25±5
12-10-79	12-17-79	17±3	20±3	21±3	25±3	*	26±4	25±3	22±7	12-10-79	12-17-79	35±6
12-17-79	12-24-79	22±4	18±3	21±3	19±3	19±3	23±1	17±3	20±4	12-17-79	12-26-79	23±4
12-24-79	1-01-80	13±3	7.9±1.6	12±2	12±2	14±3	7.7±1.8	13±2	11±5	12-26-79	12-31-79	13±3
AVERAGE		27±17	21±21	21±13	30±42	27±22	26±22	25±18	26±26			31±26

\- No sample was received because the sampling station had not initiated operation.
* No sample was received.
** Average of indicator stations.
(1) Results are reported as pCi/sample because of questionable sample volume, and not included in the calculation of averages.
(2) Sampling period was 2-25-79 to 3-02-79.
(3) SS-APT-12G1 began operation on 1-19-79; therefore, the first sampling period was 1-19-79 to 1-26-79.
(4) Sampling period was 4-07-79 to 4-13-79.
(5) SS-APT-11A1 began operation on 9-13-79; therefore, the first sampling period was 9-13-79 to 9-16-79.
(6) SS-APT-9B1 began operation on 9-11-79; therefore, the first sampling period was 9-11-79 to 9-16-79.

TABLE C-1:

CONCENTRATIONS OF GAMMA EMITTERS* IN QUARTERLY COMPOSITE OF AIR PARTICULATE SAMPLES IN THE VICINITY OF SUSQUEHANNA ES

Results in Units of 10^{-3} pCi/m^3 ± 2 sigma

STATION NO. AND DATE	Be-7	Cs-137	Ce-144
SS-APT-5S4			
12-31-78 to 3-30-79	37±7	<0.6	<3.2
3-30-79 to 6-27-79	100±15	1.7±1.1	<6.6
6-27-79 to 10-01-79	80±15	1.6±0.8	<5.0
10-01-79 to 1-01-80	71±11	<1.2	<3.2
SS-APT-1D2			
12-31-78 to 3-30-79	62±9	1.1±0.6	2.1±1.6
3-30-79 to 6-27-79	130±15	.8±0.8	7.0±3.0
6-27-79 to 10-01-79	72±12	<0.9	<5.3
10-01-79 to 1-01-80	79±11	<1.1	<3.2
SS-APT-3D1			
12-31-78 to 3-30-79	54±8	<0.9	2.3±1.6
3-30-79 to 6-27-79	130±16	<1.6	9.0±3.2
6-27-79 to 10-01-79	93±16	<1.1	<5.0
10-01-79 to 1-01-80	72±11	<1.1	<6.4

TABLE C-12 (CONT.)

CONCENTRATIONS OF GAMMA EMITTERS* IN QUARTERLY COMPOSITES OF AIR PARTICULATE SAMPLES IN THE VICINITY OF SUSQUEHANNA SES

Results in Units of 10^{-3} pCi/m^3 ± 2 sigma

STATION NO. AND DATE	Be-7	Cs-137	Ce-144
SS-APT-12E1			
12-31-78 to 3-23-79	49±	<0.9	2.7±2.0
3-30-79 to 6-27-79	110±15	<1.4	7.2±4.2
6-27-79 to 10-01-79	93±18	<1.6	<5.3
10-01-79 to 1-01-80	63±8	<0.9	<3.2
SS-APT-12G1			
1-19-79 to 3-30-79	76±9	0.6±0.5	2.7±1.7
3-30-79 to 6-27-79	65±11	<1.1	<4.9
6-27-79 to 10-01-79	81±12	1.1±0.6	<5.1
10-01-79 to 1-01-80	58±9	<0.9	<3.2
SS-APT-7H1			
1-03-79 to 3-29-79	51±10	<1.1	<3.2
3-29-79 to 6-25-79	140±22	3.2±1.2	<8.2
6-25-79 to 10-02-79	130±21	1.7±1.2	<6.7
10-01-79 to 12-31-79	79±13	<1.1	<6.4

TABLE C-12 (CONT.)

CONCENTRATIONS OF GAMMA EMITTERS* IN QUARTERLY COMPOSITES OF AIR PARTICULATE SAMPLES IN THE VICINITY OF SUSQUEHANNA SES

Results in Units of 10^{-3} pCi/m^3 ± 2 sigma

STATION NO. AND DATE	Be-7	Cs-137	Ce-144
SS-APT-9B1			
9-11-79 to 10-01-79	110±31	<1.6	<8.5
10-01-79 to 1-01-80	63±8	<0.9	<3.2
SS-APT-11A1			
9-13-79 to 10-01-79	87±36	<3.1	<12
10-01-79 to 1-01-80	65±8	<0.9	<3.2

* All other gamma emitters searched for were <LLD; typical LLDs are found on Table C-21.

TABLE C-13

CONCENTRATIONS OF I-131* IN FILTERED AIR IN THE VICINITY OF SUSQUEHANNA SES

Results in Units of 10^{-2} pCi/m^3 ± 2 sigma

START DATE	STOP DATE	STATION SS-AIO-11A1	STATION SS-AIO-12E1	STATION SS-AIO-5S4	STATION SS-AIO-9B1	START DATE	STOP DATE	STATION SS-AIO-7H1
12-31-79	1-07-79	-	<4.0(1)	-	-	1-03-79	1-08-79	<6.4(1)
1-07-79	1-14-79	-	<4.2(1)	-	-	1-08-79	1-15-79	<4.9(1)
1-14-79	1-20-79	-	<6.0	-	-	1-15-79	1-23-79	<7.4
1-20-79	1-26-79	-	<8.6	-	-	1-23-79	1-31-79	<6.2
1-26-79	2-02-79	-	<8.7	-	-	1-31-79	2-05-79	<11
2-02-79	2-09-79	-	<7.8	-	-	2-05-79	2-12-79	<10
2-09-79	2-16-79	-	<7.3	-	-	2-12-79	2-20-79	<5.4
2-16-79	2-25-79	-	(2)	-	-	2-20-79	2-27-79	<2.6
2-25-79	3-02-79	-	<8.1	-	-	2-27-79	3-07-79	<11
3-02-79	3-10-79	-	<5.9	-	-	3-07-79	3-12-79	(3)
3-10-79	3-16-79	-	<7.9	-	-	3-12-79	3-19-79	<6.7
3-16-79	3-23-79	-	<10	-	-	3-19-79	3-26-79	<7.2
3-23-79	3-30-79	-	(2)	-	-	3-26-79	3-29-79	<67(4)
3-30-79	4-06-79	-	<7.8	-	-	3-29-79	4-10-79	<8.5
4-06-79	4-13-79	-	<7.9	-	-	4-10-79	4-16-79	<11
4-13-79	4-21-79	-	<6.8	-	-	4-16-79	4-23-79	<8.3
4-21-79	4-28-79	-	<8.1	-	-	4-23-79	4-30-79	<7.7
4-28-79	5-05-79	-	<6.9	-	-	4-30-79	5-07-79	<7.8
5-05-79	5-12-79	-	<6.3	-	-	5-07-79	5-15-79	<6.1
5-12-79	5-19-79	-	(3)	-	-	5-15-79	5-21-79	<8.0
5-19-79	5-25-79	-	<7.6	<10(5)	-	5-21-79	5-29-79	<5.9
5-25-79	6-01-79	-	<1.5	<1.9	-			
6-01-79	6-08-79	-	<6.6	<7.5	-	5-29-79	6-05-79	<6.9
6-08-79	6-15-79	-	<4.3	<8.0	-	6-05-79	6-12-79	<7.4
6-15-79	6-21-79	-	<8.3	<9.1	-	6-12-79	6-18-79	<7.3
6-20-79	6-27-79	-	<5.9	<6.6	-	6-18-79	6-25-79	<6.4
6-27-79	7-05-79	-	<7.2	<6.8	-	6-25-79	7-03-79	<9.6
7-05-79	7-13-79	-	<4.5	<5.4	-	7-03-79	7-10-79	<8.9
7-13-79	7-22-79	-	<5.6	<5.8	-	7-10-79	7-16-79	<7.5
7-22-79	7-29-79	-	(2)	<7.3	-	7-16-79	7-24-79	<7.7
						7-24-79	7-30-79	<8.8

TABLE C-13 (CONT.)

CONCENTRATIONS OF I-131* IN FILTERED AIR IN THE VICINITY OF SUSQUEHANNA SES

Results in Units of 10^{-3} pCi/m^3 ± 2 sigma

START DATE	STOP DATE	STATION SS-AIO-11A1	STATION SS-AIO-12E1	STATION SS-AIO-5S4	STATION SS-AIO-9B1	START DATE	STOP DATE	STATION SS-AIO-7H1
7-29-79	8-06-79	-	(2)	<5.6	-	7-30-79	8-07-79	<6.1
8-06-79	8-13-79	-	(2)	<9.7	-	8-07-79	8-13-79	<15
8-13-79	8-19-79	-	<7.5	<9.1	-	8-13-79	8-20-79	<23
8-19-79	8-26-79	-	<5.3	<7.2	-	8-20-79	8-27-79	<17
8-26-79	9-03-79	-	<4.5	<6.9	-	8-27-79	9-04-79	<19
9-03-79	9-09-79	-	<8.4	<10	-	9-04-79	9-10-79	<22
9-09-79	9-16-79	<14(6)	<5.3	<7.4	-	9-10-79	9-17-79	<25
9-16-79	9-24-79	<7.2	<6.0	<7.9	<7.3(7)	9-18-79	9-24-79	<7.9
9-24-79	10-01-79	<5.9	<5.0	<7.2	<6.0	9-24-79	10-02-79	<5.6
10-01-79	10-08-79	<6.8	<5.6	<7.0	<5.7	10-01-79	10-08-79	<8.0
10-08-79	10-15-79	<5.3	<5.5	<6.5	<5.5	10-08-79	10-15-79	<5.7
10-15-79	10-22-79	<7.9	<8.9	<8.5	<7.0	10-15-79	10-22-79	<15
10-22-79	10-30-79	<4.5	<5.5	<6.7	<4.2	10-22-79	10-29-79	<7.0
10-30-79	11-06-79	<4.9	<5.0	<7.5	<4.6	10-29-79	11-05-79	<8.9
11-06-79	11-13-79	<8.4	<9.2	<8.9	<7.6	11-05-79	11-12-79	<18
11-13-79	11-19-79	<9.3	<10	<10	<9.5	11-12-79	11-19-79	<6.5
11-19-79	11-25-79	<15	<19	<12	<14	11-19-79	11-27-79	<10
11-25-79	12-03-79	<4.5	<4.0	<6.0	<4.7	11-27-79	12-03-79	<8.3
12-03-79	12-10-79	<5.3	<6.3	<6.2	<6.3	12-03-79	12-10-79	<11
12-10-79	12-17-79	<4.8	<7.6	<6.1	<6.0	12-10-79	12-17-79	<13
12-17-79	12-24-79	<5.8	<7.6	<8.4	<5.2	12-17-79	12-26-79	<11
12-24-79	1-01-80	<4.1	<4.3	<6.4	<4.4	12-25-79	12-31-79	<6.7

- No sample because the sampling station had not initiated operation.
* Iodine-131 results are corrected for decay to sample stop date.
(1) Sensitivities were reported as MDLs instead of LLDs prior to January 23, 1979.
(2) No sample was received.
(3) Cartridge was not counted because it was delayed in shipment.
(4) High LLD due to low sample volume.
(5) SS-AIO-5S4 began operation on 5-19-79.
(6) SS-AIO-11A1 began operation on 9-13-79; therefore, the first sampling period was 9-13-79 to 9-16-79.
(7) SS-AIO-9B1 began operation on 9-16-79.

TABLE C-14

CONCENTRATIONS OF GAMMA EMITTERS* AND STRONTIUM-89** AND -90 IN MILK IN THE VICINITY OF SUSQUEHANNA SES

Results in Units of pCi/l ± 2 sigma

STATION NO. AND DATE	K-40	Sr-89	Sr-90	Cs-137
SS-MLK-12B2				
4-01-79	1000±100	1.2±1.0	1.9±0.6	<1.1
6-01-79	1600±160	<2.5	1.9±0.8	2.3±0.7
6-26-79	1300±130	<1.9	1.3±0.5	<1.2
7-25-79	630±63	<6.5(2)	<2.7(2)	<1.1
8-30-79	1300±130	<3.0	2.5±1.0	<1.2
9-28-79	1400±140	<3.6	3.1±0.8	<1.4
10-30-79	1500±150	<1.7	2.2±0.6	<1.4
11-29-79	1500±150	1.1±1.0	0.9±0.6	3.5±1.2
12-27-79	1300±130	33±24(1)	<17(2)	<1.4
SS-MLK-12B3				
4-01-79	760±76	<3.0	6.8±1.3	4.0±0.9
6-01-79	990±99	<9.5(6)	2.4±1.4	4.5±0.9
6-27-79	970±97	<3.0	3.9±1.2	4.2±0.8
7-25-79	1300±130	<4.8	8.0±1.4	3.7±1.0
8-30-79	1200±120	<2.5	6.6±0.9	3.3±1.1
9-28-79	1100±110	<4.1	9.4±1.4	2.5±1.0
10-30-79	1000±100	2.5±1.8	4.3±1.2	2.5±1.1
11-29-79	1200±120	2.3±2.3	7.5±1.3	4.1±1.2
12-27-79	1300±130	1.9±1.3	1.5±0.8	1.6±1.0
SS-MLK-12D1(3)				
6-01-79	950±95	<4.2	3.2±1.7	1.8±0.7
SS-MLK-10C1(4)				
6-26-79	1300±130	<3.3	3.0±0.9	2.4±1.3
7-25-79	1500±150	1.8±1.7	5.3±1.2	<1.2
8-30-79	1100±110	<5.0	8.7±1.6	<1.4
9-28-79	1400±140	<2.9	6.3±1.0	<1.2
10-30-79	1500±150	<2.4	4.5±1.0	<1.2
11-29-79	1500±150	<3.6	5.1±1.2	1.7±1.0
12-27-79	1400±140	<27(2)	<12(2)	<1.2
SS-MLK-9G1				
4-01-79	990±99	<2.7	8.2±1.0	5.7±0.6
5-01-79	970±97	<2.7	7.8±1.0	4.6±0.8
6-26-79	1500±150	7.5±5.7	8.2±3.4	3.9±0.7
7-25-79	1800±180	<5.5(2)	10±2	3.1±1.1
8-30-79	1200±120	<2.8	6.2±1.0	2.4±1.3
9-28-79	1300±130	<3.9	8.3±1.0	<1.4
10-30-79	1200±120	<2.8	6.4±1.3	<1.2
11-29-79	1400±140	<4.2	5.3±1.5	2.6±1.2
12-27-79	1100±110	<27(2)	<12(2)	<1.6
SS-GMK-8D1(5)				
9-28-79	1000±100	<13(6)	11±3	<3.1

* All other gamma emitters searched for were <LLD; typical LLDs are found on Table C-21.
** Sr-89 results are corrected for decay to the sample stop date.
(1) High result due to low chemical yield.
(2) High MDL due to low chemical yield.
(3) Station SS-MLK-12D1 was initiated on 6-01-79. It was found to be an unsatisfactory station and was discontinued after the first sampling.
(4) Station SS-MLK-10C1 was initiated on 6-26-79.
(5) Station SS-GMK-8D1 is a quarterly sample that was initiated on 9-28-79. The goat milk was sampled on a quarterly basis, because an insufficient quantity of milk is produced for more frequent sampling.
(6) High MDL due to insufficient sample volume.

TABLE C-15

CONCENTRATIONS OF I-131* IN MILK IN THE VICINITY OF SUSQUEHANNA SES

Results in Units of pCi/l ± 2 sigma

STATION NO.	4-01-79	6-01-79	6-26-79	7-25-79	8-30-79	9-28-79	10-30-79	11-29-79	12-27-79
SS-MLK-12B2	<0.2(4)	<0.3(5)	<0.09	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
SS-MLK-12B3	<0.2(4)	<0.4(5)	<0.09	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
SS-MLK-12D1	-	<0.3(1,5)	-	-	-	-	-	-	-
SS-MLK-10C1	-	-	<0.1(2)	<0.1	<0.1	<0.1	<0.1	<0.2(7)	<0.1
SS-MLK-9G1	<0.1	<0.3(5)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2(7)	<0.1
SS-GMK-8D1(3)	-	-	-	-	-	<0.4(6)	-	-	<0.4(6)

* Iodine-131 results are corrected for decay to the sample stop date.

(1) Station SS-MLK-12D1 was initiated on 6-01-79. It was found to be an unsatisfactory sampling station, and was discontinued after the first sampling.
(2) Station SS-MLK-10C1 was initiated on 6-26-79.
(3) Station SS-GMK-8D1 is a quarterly sample that was initiated on 9-28-79.
(4) High LLD due to delay in transit.
(5) High LLD due to short analytical counting time.
(6) High LLD due to insufficient sample volume.
(7) High LLD due to low chemical yield.

TABLE C-16

CONCENTRATIONS OF GAMMA EMITTERS* AND STRONTIUM-89** AND -90 IN FISH FLESH
IN THE VICINITY OF SUSQUEHANNA SES

Results in Units of pCi/g(wet) ± 2 sigma

STATION NUMBER	SAMPLE TYPE	SAMPLE DATE	Sr-89	Sr-90	K-40	Cs-137
SS-AQF-IND	Channel Catfish	4-19-79 to 5-04-79	<0.007	<0.003	3.0±0.3	<0.01
	White Sucker	4-19-79	<0.008	<0.003	3.7±0.4	<0.01
	Walleye	4-19-79 to 5-03-79	<0.01	<0.005	3.5±0.4	<0.01
	Channel Catfish	9-11-79	<0.01	<0.004	2.6±0.3	<0.01
	White Sucker	9-11-79	<0.02	<0.007	2.7±0.3	<0.01
	Walleye	9-11-79	<0.01	<0.005	<0.3	<0.01
SS-AQF-2G***	Channel Catfish	4-25-79 to 4-26-79	0.005±0.005	<0.003	2.2±0.2	<0.009
	White Sucker	4-25-79	<0.009	<0.003	1.7±0.2	<0.008
	Walleye	4-25-79	<0.008	<0.003	4.0±0.4	0.016±0.007
	Channel Catfish	9-13-79 to 9-14-79	<0.01	<0.004	2.9±0.3	<0.009
	White Sucker	9-13-79	<0.01	<0.004	3.0±0.3	<0.009
	Walleye	9-13-79	<0.009	<0.004	3.4±0.3	<0.008

* All other gamma emitters searched for were <LLD; typical LLDs are found on Table C-21.
** Sr-89 results are corrected for decay to the sample stop date.
*** Station code is omitted because no permanent sampling locations exist; samples are taken based on availability. Exact locations are noted in Table B-1.

TABLE C-17

CONCENTRATIONS OF STRONTIUM-89 AND -90* AND GAMMA EMITTERS** IN VARIOUS FOOD AND GAME SAMPLES IN THE VICINITY OF SUSQUEHANNA SES

Results in Units of pCi/g(wet)*** ± 2 sigma

STATION NO.	SAMPLE DATE	DESCRIPTION	K-40	Cs-137	Sr-89	Sr-90
SS-FPP-15A1	6-01-79	Lettuce	7.2±0.9	<0.08	-	-
SS-FPE-12B1	-25-79	Eggs	1.0±0.1	<0.01	-	-
SS-FPP-12B1	6-25-79	Chicken	1.7±0.2	<0.006	-	-
SS-FPP-12B1	6-25-79	Chicken Bones	2.8±0.4	<0.03	<0.1	0.38±0.36
SS-FPG-12B1	7-24-79	Corn	2.2±0.2	<0.009	-	-
SS-FPL-10C1	8-29-79	Cabbage	5.4±0.5	<0.03	-	-
SS-FPL-2H1	8-29-79	Cabbage	3.1±0.4	<0.03	-	-
SS-FPF-7B2	9-28-79	Apples	1.5±0.2	<0.009	-	-
SS-FPF-12B1	9-28-79	Apples	0.8±0.1	<0.008	-	-
SS-FPB-12B3	10-29-79	Beef	2.5±0.3	<0.01	-	-
SS-FPB-12B3	10-29-79	Beef Bones	<0.3	0.20±0.04	0.9±0.7	4.1±0.4
SS-GAS-3S****	11-15-79	Squirrel Flesh	3.0±0.3	3.6±0.4	-	-
SS-GAS-3S****	11-15-79	Squirrel Bones	4.1±1.3	1.9±0.2	0.6±0.3	3.1±0.3
SS-GAS-3S****	11-16-79	Squirrel Flesh	2.9±0.3	1.7±0.2	-	-
SS-GAS-3S****	11-16-79	Squirrel Bones	2.9±1.2	0.7±0.1	0.7±0.3	2.4±0.2
SS-GAD-16A****	12-05-79	Deer	3.5±0.4	0.55±0.06	-	-

* Radiostrontium performed on bones only. Sr-89 results are decay corrected to sample stop date.
** All other gamma emitters searched for were <LLD; typical LLDs are found on Table C-21.
*** Bones are reported in pCi/g(dry).
**** Station code is omitted because no permanent sampling locations exist; samples are taken based on availability. Exact locations are noted in Table B-1.

TABLE C-18

CONCENTRATIONS OF GAMMA EMITTERS* IN FODDER CROPS IN THE VICINITY OF SUSQUEHANNA SES

Results in Units of pCi/g(wet) ± 2 sigma

STATION NO.	SAMPLE DATE	DESCRIPTION	Be-7	K-40	Cs-137	Ce-144
SS-PAS-15A1	4-01-79	Grass	13±1	6.5±2.5	0.25±0.09	1.1±0.4
SS-PAS-15A1	6-01-79	Grass	<3.0	15±4	<0.3	<1.1
SS-PAS-15A1	6-26-79	Grass	<3.0	14±3	<0.2	<0.8
SS-PAS-15A1	7-25-79	Grass	2.7±1.1	7.9±1.3	<0.1	<0.5
SS-PAS-15A1	8-30-79	Grass	3.6±1.8	18±3	<0.2	<0.6
SS-PAS-15A1	9-28-79	Grass	<3.0	3.4±0.8	<0.08	<0.3
SS-PAS-15A1	10-30-79	Grass	<3.0	<4.7	<0.3	<1.4
SS-PAS-15A1	11-29-79	Grass	7.2±1.4	4.8±1.7	<0.2	<0.5
SS-PAS-15A1	12-27-79	Grass	9.6±1.3	<1.6	<0.1	<0.5

* All other gamma emitters searched for were <LLD; typical LLDs are found on Table C-21.

TABLE C-19

CONCENTRATIONS OF GAMMA EMITTERS* IN SOIL IN THE VICINITY OF SUSQUEHANNA SES

Results in Units of pCi/g(dry)

STATION NO.	SAMPLE DATE	Be-7	K-40	Cs-137	Ra-226	Th-232
SS-SOL-5S5	12-12-79	<0.3	9.0±0.9	0.21±0.03	1.0±0.1	0.90±0.09
SS-SOL-1D4	12-14-79	<0.3	8.9±0.9	0.77±0.08	1.1±0.1	1.0±0.1
SS-SOL-3D2	12-14-79	<0.6	12±1	1.3±0.1	2.5±0.3	2.6±0.3
SS-SOL-12E2	12-11-79	<0.3	8.8±0.9	0.42±0.04	0.75±0.08	0.73±0.08
SS-SOL-12G3	12-12-79	0.3±0.3	11±1	0.20±0.03	1.2±0.1	1.0±0.1

* All other gamma emitters searched for were <LLD; typical LLDs are found on Table C-21.

TABLE C-20

RESULTS OF QUARTERLY TLD MEASUREMENTS IN THE VICINITY OF SUSQUEHANNA SES

Results in Units of mrem/standard month

STATION NO.	12-30-78 to 4-04-79	4-04-79 to 6-27-79	6-27-79 to 10-06-79	10-06-79 to 12-29-79	ANNUAL AVERAGE
SS-IDM-3S1	5.92±0.61	6.34±0.55	6.15±0.30	6.42±0.32	6.21±0.45
SS-IDM-4S1	5.40±0.88	5.81±0.22	5.72±0.20	6.08±0.46	5.75±0.56
SS-IDM-5S1	5.07±0.31	5.71±0.52	5.56±0.48	5.91±0.63	5.56±0.72
SS-IDM-7S1	5.83±0.30	6.08±0.69	5.55±0.84	6.26±1.22	5.93±0.62
SS-IDM-11S1	7.17±0.62	7.90±0.43	7.40±0.62	7.84±0.53	7.58±0.70
SS-IDM-1D2	5.89±0.62	7.13±0.44	6.74±0.30	7.06±0.95	6.71±1.14
SS-IDM-12F2	7.08±0.75	7.14±0.54	6.45±0.31	7.05±0.59	6.93±0.64
SS-IDM-12G1	-	5.28±0.33(1)	5.34±0.72	5.42±0.95	5.35±0.14
SS-IDM-7H1(2)	4.64±0.23	4.65±0.19	4.38±0.21	4.55±0.38	4.56±0.25
SS-IDM-8H1(3)	5.33±0.82	5.56±0.23	5.64±0.50	6.03±0.65	5.64±0.58
SS-IDM-5S4	-	-	6.25±1.33(4)	6.39±0.70	6.32±0.20
SS-IDM-11A1	-	-	5.43±0.33(4)	5.42±0.35	5.43±0.01
SS-IDM-2A1	-		5.75±0.61(4)	6.16±0.53	5.96±0.58
SS-IDM-9B1	-	-	6.49±0.29(5)	6.68±1.08	6.59±0.27
SS-IDM-3D1	-	-	7.73±0.74(4)	7.69±0.36	7.71±0.06
SS-IDM-12E1	-	-	6.37±0.66(5)	7.27±0.89	6.82±1.27
AVERAGE	5.81±1.70	6.16±1.97	6.06±1.65	6.39±1.74	6.14±1.74

(1) Station 12G2 began operation on 5-04-79.
(2) Sampling dates for station 7H1: 1-03-79 to 4-06-79; 4-06-79 to 7-02-79; 7-02-79 to 10-08-79; 10-08-79 to 1-03-80.
(3) Sampling dates for station 8H1 were: 12-28-79 to 4-09-79; 3-30-79 to 7-02-79; 6-26-79 to 10-06-79; 10-06-79 to 12-29-79.
(4) Station began operation on 8-26-79; therefore, the first sampling period was 8-26-79 to 10-06-79.
(5) Station began operation on 8-13-79; therefore, the first sampling period was 8-13-79 to 10-06-79.

TABLE C-21

TYPICAL LLDs* FOR GAMMA SPECTROMETRY

NUCLIDE	POTABLE WATER (pCi/l)	SURFACE WATER (pCi/l)	WELL WATER (pCi/l)	AIR PARTICULATES (10^{-3} pCi/m^3)	FISH (pCi/g-wet)	MILK (pCi/l)
Be-7	-	-	-	**	-	3.9
Na-22	0.8	0.8	0.8	1.0	0.01	1.4
K-40	9.3	9.3	7.8	1.6	0.3	**
Cr-51	7.6	7.1	7.1	5.9	0.1	12
Mn-54	0.6	0.6	0.6	1.1	0.01	1.3
Co-58	0.7	1.1	0.7	1.0	0.01	1.4
Fe-59	2.0	1.8	1.7	1.8	0.03	4.9
Co-60	0.8	0.8	0.8	1.4	0.009	1.1
Zn-65	1.6	1.6	1.5	1.6	0.02	3.3
Zr-95	-	-	-	1.0	-	1.3
Nb-95	-	-	-	0.6	-	0.6
ZrNb-95	0.6	0.6	0.6	1.0	0.008	1.1
Mo-99	640	180	640	63	41	1200
Ru-103	-	-	-	1.1	-	0.6
Ru-106	6.4	6.4	6.4	6.3	0.01	11
Ag-110m	0.7	0.7	0.7	3.2	0.008	1.2
Sb-125	-	-	-	1.6	-	1.4
Te-129m	15	15	13	11	0.2	26
I-131	3.4	2.2	3.7	4.3	0.1	12
Te-132	31	11	38	4.7	0.4	440
I-133	-	-	-	170	-	1400
Cs-134	0.6	0.6	0.6	0.8	0.01	1.3
Cs-136	2.2	2.7	1.9	1.8	0.06	7.6
Cs-137	0.8	0.8	0.6	0.9	0.009	1.2
BaLa-140	2.3	1.9	1.5	3.2	0.04	4.7
Ce-141	-	-	-	1.0	-	0.7
Ce-144	3.3	3.2	3.2	3.2	0.03	3.3
Ra-226	1.2	1.2	1.1	1.6	0.02	1.6
Th-232	3.1	3.1	3.1	3.1	0.03	4.7

TABLE C-21 (cont.)

TYPICAL LLDs* FOR GAMMA SPECTROMETRY

NUCLIDE	SOIL (pCi/g-dry)	VARIOUS FOOD PRODUCTS (pCi/g-wet)	MEAT AND GAME(Flesh) (pCi/g-wet)	MEAT AND GAME(Bones) (pCi/g-dry)	SEDIMENT (pCi/g-dry)	FODDER CROPS (pCi/g-wet)
Be-7	0.3	-	-	-	0.2	**
Na-22	0.03	0.01	0.03	0.1	0.02	0.3
K-40	**	**	-	0.3	**	4.7
Cr-51	0.5	0.2	0.3	1.5	0.2	1.1
Mn-54	0.04	0.008	0.01	0.1	0.02	0.3
Co-58	0.02	0.03	0.02	0.2	0.02	0.2
Fe-59	0.1	0.02	0.07	0.3	0.06	0.2
Co-60	0.03	0.03	0.03	0.03	0.03	0.3
Zn-65	0.07	0.02	0.05	0.07	0.05	0.3
Zr-95	0.08	-	-	-	0.04	0.2
Nb-95	0.03	-	-	-	0.02	0.08
ZrNb-95(1)	-	0.008	0.02	0.1	-	0.1
Mo-99	-	1.8	0.2	-	8.0	11
Ru-103	0.07	-	-	-	0.02	0.09
Ru-106	0.2	0.08	0.1	1.0	0.2	1.6
Ag-110m	0.09	0.008	0.08	0.1	0.07	0.3
Sb-125	0.08	-	-	-	0.06	0.2
Te-129m	0.8	0.6	1.7	3.3	0.4	1.8
I-131	1.9	0.07	0.2	6.8	0.06	0.2
Te-132	-	0.3	8.8	13	0.3	0.7
I-133	-	1.6		-	-	32
Cs-134	0.03	0.03	0.01	0.03	0.03	0.1
Cs-136	0.4	0.03	0.2	1.3	0.07	0.2
Cs-137	**	0.03	0.01	0.03	**	0.2
BaLa-140	0.6	0.03	0.02	0.9	0.08	0.5
Ce-141	0.1	-	-	-	0.04	0.1
Ce-144	0.2	0.03	0.1	0.2	0.1	0.5
Ra-226	**	0.02	0.02	0.2	**	0.3
Th-232	**	0.1	0.05	0.3	**	0.5

* Decay corrected to sample stop date. The large LLDs are due to short half-life.
** Indicates a positive concentration was measured in all samples analyzed.
- Indicates that no LLD was calculated for that nuclide in that media.
(1) Not decay corrected.

GROSS BETA ANALYSIS OF SAMPLES

Total Water (BØ)

A 250 ml aliquot is evaporated to dryness and transferred to a preweighed, 2" x 1/4", ringed planchet and reweighed. The planchet is then counted in a low background gas-flow proportional counter. Self-absorption corrections are made based on the measured residue weight and calculated thickness. The calibration standard used is Sr-90 - Y-90. A 250 ml sample of distilled water is evaporated in the same manner and used as a blank.

Air Particulates (BD)

After a delay of two to five days, allowing for the radon-222 and radon-220 (thoron) daughter products to decay, the filters are counted in a gas-flow proportional counter. Unused filter paper is counted as the blank.

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

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

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

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

where:

S = Gross counts of sample including blank
B = Counts of blank
E = Fractional Sr-90-Y-90 counting efficiency
T = Number of minutes sample was counted
t = Number of minutes blank was counted
V = Volume of sample (cubic meters or liters)

ANALYSIS OF SAMPLES FOR TRITIUM

Water (H2)

A 15 ml aliquot of the sample is vacuum distilled to eliminate dissolved gasses and non-volatile matter. The distillate is frozen in a trap cooled with a dry ice-isopropanol mixture. Eight (8) ml of the distillate are mixed with ten (10) ml of Insta-Gel liquid scintillation solution. The sample is then counted for tritium in a liquid scintillation counter. A sample of low tritium (< 50 pCi/l) water is vacuum distilled as a blank and is counted with each batch of samples. In the calculation of the result it is assumed that the condensated and original sample are of equivalent volumes. The volume change associated with the removal of dissolved gases and non-volatile matter is not significant compared to the other errors in the analysis.

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

$$\text{RESULT (pCi/l)} = ((S/T) - (B/t)) / (2.22\ V\ E)$$

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

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

where:

S = Gross counts of sample including blank
B = Counts of blank
E = Fractional H-3 counting efficiency
T = Number of minutes sample was counted
t = Number of minutes blank was counted
V = Volume of aliquot (liters)

ANALYSIS OF SAMPLES FOR STRONTIUM-89 AND -90

Total Water (TØ, SØ)

A two liter aliquot of sample is used. Stable strontium carrier is added to the liquid to facilitate chemical separation of Sr-89 and -90, and to determine the strontium recovery. Strontium concentration and purification is ultimately realized by at least two precipitations of strontium nitrate in concentrated nitric acid. Additional iron/rare earth hydroxide precipitations and barium chromate separations are performed to remove suspected interferring nuclides. The purified strontium is converted to a carbonate for weighing and counting. Soon after the separation, the sample is counted in a low-background gas-flow proportional counter. After about 14 days, the sample is recounted, then Sr-89 and -90 activities are calculated on the basis of Y-90 ingrowth and Sr-89 decay. A sample of distilled water is used as a blank.

Milk (S4, T4)

A one and half liter aliquot of milk is ashed to destroy organic material and then dissolved in concentrated mineral acid. Stable strontium is added to the eluted liquid or dissolved ash to facilitate chemical separation of Sr-89 and -90, and to determine the strontium recovery. Strontium concentration and purification is ultimately realized by at least two precipitations of strontium nitrate in concentrated nitric acid. Additional iron/rare earth hydroxide precipitations and barium chromate separations are performed to remove suspected interferring nuclides. The purified strontium is converted to a carbonate for weighing and counting. Soon after the separation, the sample is counted in a low-background gas-flow proportional counter. After about 14 days, the sample is recounted, then Sr-89 and -90 activities are calculated on the basis of Y-90 ingrowth and Sr-89 decay. A sample of distilled water is used as a blank.

Organic Solids (S8, T8)

A 250 g wet portion of the sample is ashed, then dissolved in concentrated nitric or mineral acid. Stable strontium carrier is added to the dissolved sample to facilitate chemical separation of Sr-89 and -90, and to determine the strontium recovery. Strontium concentration and purification is ultimately realized by at least two precipitations of strontium nitrate in concentrated nitric acid. Additional iron/rare earth hydroxide precipitations and barium chromate separations were performed. The purified strontium is converted to a carbonate for weighing and counting. Soon after the separation, the sample is counted in a low-background gas-flow proportional counter. After about 14 days, the sample is recounted, then Sr-89 and -90 activities are calculated on the basis of Y-90 ingrowth and Sr-89 decay. A sample of distilled water is used as a blank.

Calculations of the results, the two sigma errors and minimum detectable levels (MDL) for Sr-89, -90 are expressed in activity (pCi) per unit volume (liter) or mass (gram).

RESULT Sr-90 = $((Z(S1-B1) - (S2-B2)) / (2.22\ K\ V\ E9\ Y\ T)$
(pCi/vol. or mass)

2 SIGMA ERROR Sr-90 = $2\ (Z^2(S1+B1) + S2+B2)^{1/2} / (2.22\ (K^2)^{1/2}\ V\ E9\ Y\ T)$
(pCi/vol. or mass)

MDL Sr-90 = $(-9 - 6(2BZ+2(S1-B1) + 2.25 + Z^2 (S1+B1))^{1/2} / 2K) / (2.22 V E9 Y T)$
(pCi/vol. or mass)

RESULT Sr-89 = $(F(S1-B1) + H(S2-B2)) / (2.22 V E8 Y T \exp. (-.693t4/52.7))$
(pCi/vol. or mass)

2 SIGMA ERROR Sr-89 = $2 (F^2(S1+B1) + H^2(S2+B2))^{1/2} / (2.22 V E8 Y T \exp. (-.693t4/52.7)$
(pCi/vol. or mass)

MDL Sr-89 = $(F(X-B1) + H(S2-B2)) / (2.22 V E8 Y T \exp. (-.693t4/52.7))$
(pCi/vol. or mass)

where:

Sr-89(1)	=	Sr-89 counts on first count
Sr-89(2)	=	Sr-89 counts on second count
Sr-90	=	Counts of Sr-90
Y-90(1)	=	Counts of Y-90 on first count
Y-90(2)	=	Counts of Y-90 on second (after equil.)
S1	=	Sr-89(1) + Sr-90 + Y-90(1) + B(1)
S2	=	Sr-89(2) + Sr-90 + Y-90(2) + B(2)
B1	=	Background counts in first count
B2	=	Background counts in second count
t1	=	Time in hours from separation time to S1
t2	=	Time in days from separation time to S2
t3	=	Time in days from S1 to S2
t4	=	Time in days from sampling date to separation date
E1	=	1 - exp (-.693t3/64 hours
E2	=	1 - exp (-.693t2/2.667 days)
Z	=	exp (-.693t3/5[illegible].7 days)
R	=	E9/EY
H	=	(1 + E1/R) /K
K	=	Z (E1/R + 1) - 1 - (E2/R)
F	=	1 - (Z/K) - Z (E1/KR)
C	=	$(-9 F^2 B1) - 9 H^2 (S2+B2) + (F B1)^2 - 2 F H B1 S2 + 2 F H B1 B2 + (H(S2-B2))^2$
B	=	$2 F H (S2-B2) - 2 F^2 B1 - 9 F^2$
X	=	$((B^2 - 4 F^2 C)^{1/2} - B) / (2 F^2)$
E9	=	Counting eff. of Sr-90 = .3590 - .7082 X (Wt. in g of strontium carbonate)
EY	=	Counting eff. of Y-90 = .4380 - .1337 X (Wt. in g of strontium carbonate)
E8	=	Counting eff. of Sr-89 = .4568 - .2060 X (Wt. in g of strontium carbonate)
T	=	Number of minutes sample and background were counted
Y	=	Yield (determined by atomic absorption spectrophotometry)
V	=	Aliquot size (liters or grams)

ANALYSIS OF SAMPLES FOR IODINE-131

Milk or Water (IØ)

The initial stable iodide concentration in milk is determined with an iodide ion specific electrode. Thirty milligrams of stable iodide carrier is then added to four (4) liters of milk. The iodide is removed from the milk by passage through ion-exchange resin. The iodide is eluted from the resin with sodium hypochlorite, and purified by a series of solvent extractions with the final extraction into a toluene phase. The toluene phase is mixed with a toluene-based liquid scintillation solution. The sample is then counted in a beta-gated gamma coincidence detector, shielded by six inches of steel. Distilled water is used as a blank. The yield is calculated from stable iodide recovery based on the recovered volume. Results are corrected for decay from the sampling time to the middle of the counting period, using a half-life value for I-131 of 8.06 days.

Air Cartridges (I1)

An iodine absorber composed of charcoal is emptied into an aluminum can (6 cms high by 8 cms in diameter) and counted with a NaI (Tl) detector, coupled to a multi-channel pulse height analyzer.

Calculation of results, two sigma error and the lower limit of detection (LLD).

The data are obtained by smoothing the spectrum to eliminate spurious statistical noise. Iodine-131 is identified by fitting the spectrum to a Gaussian curve, and noting the net area, in counts, above the baseline projection. The calculations of the results, the two sigma error and the lower limit of detection (LLD) for Iodine-131 are then expressed in activity (pCi) per unit volume (liter or cubic meter, depending whether the sample is either milk and water or air).

$$\text{RESULT (pCi/vol)} = ((S/T) - (B/t)) / (2.22\ E\ V\ Y\ F)$$

$$\text{2 SIGMA ERROR (pCi/vol)} = 2\ ((S/T^2) + (B/t^2))^{1/2} / (2.22\ E\ V\ Y\ F)$$

$$\text{LLD (pCi/vol)} = 4.66\ (B^{1/2}) / (2.22\ E\ V\ Y\ F\ t)$$

where:

- S = Net area, in counts, of sample (I-131 peak)
- B = Net area, in counts, of background (I-131 peak)
- T = Number of minutes sample was counted
- t = Number of minutes background was counted
- E = I-131 counting efficiency
- V = Volume of sample (aliquot) utilized
- F = Fractional gamma abundance (specific for each emitted gamma)
- Y = Chemical yield of Iodine (milk and water only)

GAMMA SPECTROMETRY OF SAMPLES

Water (N1)

Four liters of sample is reduced to 100 ml and sealed in a standard container and counted with a NaI(Tl) detector coupled to a multi-channel pulse-height analyzer. The counting time is 50,000 seconds.

Milk (N7)

A three liter aliquot is dried at 175°C, ashed at 500°C until no carbon residue is present, compressed and sealed in a standard container, and then counted with a NaI(Tl) detector, coupled to a multi-channel pulse-height analyzer. The counting time is 50,000 seconds.

Dried Solids (N8, G8)

A large quantity of the sample is dried at a low temperature, less than 100°C. A 100 gram aliquot (or the total sample if less than 100 grams) is taken, compressed to unit density, sealed in a standard container, and counted with a NaI(Tl) or Ge(Li) detector, coupled to a multi-channel pulse-height analyzer. The counting time is 50,000 seconds.

Air Dried Solids (NA)

A large quantity of sample is air dried, compressed to a known geometry and sealed in a standard container and counted with a NaI(Tl) detector, coupled to a multi-channel pulse-height analyzer. The counting time is 50,000 seconds.

Air Particulate (GB)

All samples received for the month are mixed and sealed in the standard container, and counted with the high resolution Ge(Li) detector, coupled to a multi-channel pulse-height analyzer.

Calculation of results, two sigma error and the lower limit of detection (LLD).

The data are obtained [illegible]oothing the spectrum to eliminate spurious statistical noise. Peaks are identified by changes in the slope of the gross spectrum. The spectrum is fitted to a Gaussian curve and the net area, in counts, above the baseline projection is determined. The calculations of the results, two sigma error and the lower limit of detection (LLD) for Iodine-131 are then expressed in activity (pCi) per unit volume or mass (liters or grams).

$$\text{RESULT (pCi/vol. or mass)} = ((S/T) - (B/t)) / (2.22\ E\ V\ F)$$

$$\text{2 SIGMA ERROR (pCi/vol. or mass)} = 2\ ((S/T^2) + (B/t^2))^{1/2} / (2.22\ E\ V\ F)$$

$$LLD \text{ (pCi/vol. or mass)} = 4.66\ (.63\ (Q^{1/2})\ S)^{1/2} / (2.22\ E\ V\ F\ t)$$

where:

S = Net area, in counts, of sample (Region of spectrum of interest)
B = Net area, in counts, of background (Region of spectrum of interest)
T = Number of minutes sample was counted
t = Number of minutes background was counted
E = Detector efficiency for energy of interest
V = Volume of sample (aliquot)
F = Fractional gamma abundance (specific for each emitted gamma)
Q = Channel number

ENVIRONMENTAL DOSIMETRY (DØ)

By RMC definition, a thermoluminescent dosimeter (TLD) is considered one end of a capillary tube containing calcium sulfate (Tm) powder as the thermoluminescent material. This material was chosen for its characteristic high light output, minimal thermally induced signal loss (fading), and negligible self-dosing. The energy response curve has been flattened by a complex multiple element energy compensator shield supplied by Panasonic Corporation, manufacturer of the TLD reader. There exists four dosimeters per station sealed in a polyethylene bag to demonstrate integrity at the time of measurement, and for visualization of the sample placement instructions. The zero dose is determined from TLDs located in the lead shield found at RMC, Philadelphia.

Following the predesignated exposure period the TLDs are placed in the TLD reader. The reader heats the calcium sulfate (Tm) and the measured light emission (luminescence) is used to calculate the environmental radiation exposure.

Data are normalized to standard machine conditions by correcting machine settings to designated values before readout. Data are also corrected for in-transit dose using a set of TLDs kept in a lead shield in the field, exposed only during transit. The average dose per exposure period, and its associated error is then calculated.

The Cs-137 source is used to expose TLDs as a reference sample. An absorbed dose in tissue is determined using the 0.955 rad/Roentgen conversion factor and dose equivalent (mrem) by using a quality factor of 1.

Calculation of results and two sigma error:

$$\text{Gross TLD (i)} = (\text{TLD(i)} - \text{D}\emptyset\text{(i)}) \times \text{CF (i)} \times \text{CF (ins)} \times 0.955 \text{ mrad/mRoentgen}$$

$$\text{ITD} = \text{NET (site } \emptyset\text{)} - (\text{NET(RMC } \emptyset\text{) (D(sta) / D (RMC } \emptyset\text{)))}$$

$$\text{NET TLD(i)} = \text{gross TLD(i)} - \text{ITD}$$

$$\text{AVG} = \left(\left(\sum_{i=1}^{n} \text{NET TLD}\right) / n\right) (\text{D(STD)} / \text{D (EX)})$$

$$\text{ERROR (95\% CL)} = t(n-1) (\text{sigma NET TLD (i)} / n) (\text{D(STD)} / \text{D (EX)})$$

where:

Gross TLD(i)	=	Individual TLD reading corrected to standard instrument conditions
TLD(i)	=	Gross reading of dosimeter i
NET TLD (i)	=	Net dose obtained during exposure period in the field
CF(ins)	=	Correction factor of reader = (6.21) (ELS-0.95)
ELS	=	External light source
DØ(i)	=	Zero for dosimeter, i
CF(i)	=	Calibration factor for dosimeter i
ITD	=	In-Transit dose
NET(site)Ø	=	Mean of n dosimeters in site lead shield
NET(RMC)Ø	=	Mean of n dosimeters in RMC lead shield

D(sta)	=	Exposure period of station
D(RMCØ)	=	Exposure period of RMCØ
AVG	=	Mean exposure per standard exposure period at a given station
n	=	Number of readings
D(EX)	=	Days exposed
D(STD)	=	Days in standard exposure period
t(n-1)	=	T-distribution (student) factor for 95% CL
sigma NET TLD(i)	=	Standard deviation of n readings of NET TLD(i)
ERROR	=	The 95% confidence limit error of AVG

APPENDIX E

RESULTS OF INTER-LABORATORY COMPARISON PROGRAM

RMC participates in the EPA radiological interlaboratory comparison (cross check) program. This participation includes a number of analyses on various sample media as found in the Susquehanna SES REMP. As a result of participation in the program an objective measure of analytical precision and accuracy as well as a bias estimation in RMC results is obtained. Reference 13 discusses discrepancies between the data when they occurred. RMC's EPA code is AC.

TABLE E-1

INTER-LABORATORY COMPARISONS
GROSS ALPHA AND BETA IN WATER
(pCi/liter and AIR PARTICULATES (pCi/filter)

DATE	RMC #	SAMPLE AND TYPE OF RADIATION		RMC MEAN±S.D.	EPA MEAN±S.D.	All Participants MEAN±S.D.
Jan. 1979	99915	APT	α	4±1	5±5	5±2
			β	21±1	18±5	20±3
Jan. 1979	100511	Water	α	7±1	6±5	7±2
			β	13±2	16±5	16±3
Apr. 1979	2323	Water	α	8±1	10±5	10±4
			β	17±1	16±5	16±3
Apr. 1979	2546	APT	α	13±1	14±5	14±3
			β	61±3	63±5	65±6
May 1979	4650	Water	α	22±1	22±6	25±8
			β	36±3	44±5	43±6
June 1979	6446	Water	α	19±2	18±5	16±6
			β	25±3	22±5	23±5
July 1979	8393	APT	α	9±1	9±5	10±2
			β	39±2	30±5	33±4
July 1979	8672	Water	α	8±2	9±5	*
			β	15±1	12±5	*
Oct. 1979	19885	Water	α	5±1	5±5	8±2
			β	43±2	40±5	41±6
Oct. 1979	20468	APT	α	10±1	*	*
			β	33±2	*	*

TABLE E-1 (cont.)

INTER-LABORATORY COMPARISONS
GROSS ALPHA AND BETA IN WATER
(pCi/liter and AIR PARTICULATES (pCi/filter)

DATE	RMC #	SAMPLE AND TYPE OF RADIATION		RMC MEAN±S.D.	EPA MEAN±S.D.	All Participants MEAN±S.D.
Nov. 1979	21865	Water	α	8±1	*	*
			β	35±3	*	*
Dec. 1979	23054	Water	α	10±3	*	*
			β	23±4	*	*

* Results are not available at this time.

TABLE E-2

INTER-LABORATORY COMPARISONS
TRITIUM IN WATER
All results in pCi/liter

DATE	RMC #	SAMPLE TYPE	RMC MEAN±S.D.	EPA MEAN±S.D.	All Participants MEAN±S.D.
Feb. 1979	100914	Water	1158±30	1280±331	1293±224
Apr. 1979	3729	Water	2057±232	2270±349	2292±257
June 1979	7054	Water	1367±140	1540±337	1573±231
Aug. 1979	9937	Water	1054±140	1480±335	1508±214
Oct. 1979	20368	Water	1498±63	1560±370	*
Dec. 1979	23541	Water	2068±49	*	*

* Results are not available at this time.

TABLE E-3

INTER-LABORATORY COMPARISON
STRONTIUM-89 AND STRONTIUM-90(1)

DATE	RMC #	SAMPLE TYPE	ANALYSIS	RMC MEAN±S.D.	EPA MEAN±S.D.	All Participants MEAN±S.D.
Jan. 1979	99915	APT	Sr-90	5±0	6±1.5	6±1
Jan. 1979	00557	Milk	Sr-89	23±1	33±5	29±4
			Sr-90	24±1	19±1.5	17±3
Mar. 1979	1604	Food	Sr-89	36±4	48±5	43±8
			Sr-90	15±2	22±1.5	22±4
Apr. 1979	2546	APT	Sr-90	20±1	21±1.5	19±3
Apr. 1979	4606	Milk	Sr-89	29±6	42±5	34±12
			Sr-90	41±2	54±3	48±7
May 1979	4650	Water	Sr-89	9±3	9±5	10±4
			Sr-90	8±2.3	8±1.5	8±1
July 1979	8393	APT	Sr-90	7±1.2	10±1.7	10±2
July 1979	8394	Food	Sr-89	<32	*	*
			Sr-90	<24	*	*
July 1979	8837	Milk	Sr 89	<3	5±5	6±3
			Sr 90	7±1.5	11±2	12±2
Oct. 1979	20468	APT	Sr-90	6±1	*	*
Nov. 1979	21865	Water	Sr-89	16±4	*	*
			Sr-90	6±3	*	*
Nov. 1979	22473	Food	Sr-89	57±8	*	*
			Sr-90	24±4	*	*
Nov. 1979	22079	Milk	Sr-89	23±1	25±5	*
			Sr-90	14±1	17±2	*

* Results not available at this time.

(1) Data are reported in: pCi/l for milk and water
pCi/filter for air particulate
pCi/kg for food

TABLE E-4

INTER-LABORATORY COMPARISONS: GAMMA
Results reported in pCi/liter for milk and water, pCi/sample for air particulates, and pCi/kilograms for food products except K which is reported in mg/kilogram

DATE	RMC #	SAMPLE TYPE	ISOTOPE	RMC MEAN±S.D.	EPA MEAN±S.D.	All Participants MEAN±S.D.
Jan. 1979	99915	APT	Cs-137	7±1	6±5	8±2
Jan. 1979	10057	Milk	I-131	102±3	105±5	106±8
			Cs-137	51±1	49±5	51±4
			Ba-140	<6	0	0
			K	1516±44	1560±78	1499±113
Mar. 1979	101060	Water	Cr-51	<14	0	0
			Co-60	12±1	9±5	10±3
			Zn-65	25±3	21±5	22±5
			Ru-106	<9	0	0
			Cs-134	6±1	6±5	7±2
			Cs-137	13±1	12±5	13±3
Mar. 1979	1604	Food[1]	I-131	140±17	90±5	90±6
			Cs-137	92±3	74±5	75±6
			Ba-140	<70	0	0
			K	3189±71	2700±135	2798±236
Apr. 1979	2546	APT	Cs-137	24±2	21±5	23±5
Apr. 1979	3577	Water	I-131	43±4	40±4	41±7
Apr. 1979	4606	Milk	I-131	73±11	96±5	100±10
			Cs-137	182±10	154±8	156±13
			Ba-140	<22	0	0
			K	1702±31	1560±78	1504±110
May 1979	4650	Water	Co-60	13±1	15±5	16±4
			Cs-134	10±1	19±5	20±5
			Cs-137	<2	0	0
Jun 1979	7025	Water	Cr-51	<35	0	0
			Co-60	44±6	47±5	47±6
			Zn-65	<3	0	0
			Ru-106	<12	0	0
			Cs-134	62±5	71±5	68±7
			Cs-137	<2	0	0
July 1979	8393	APT	Cs-137	13±1	10±5	12±4

TABLE E-4 (cont.)

INTER-LABORATORY COMPARISON: GAMMA
Results reported in pCi/liter for milk and water, pCi/sample for air particulates, and pCi/kilogram for food products except K which is reported in mg/kilogram

DATE	RMC #	SAMPLE TYPE	ISOTOPE	RMC MEAN±S.D.	EPA MEAN±S.D.	All Participants MEAN±S.D.
July 1979	8394	Food	I-131	<3	*	*
			Cs-137	30±3	*	*
			Ba-140	<1	*	*
			K	2812±377	*	*
July 1979	8837	Milk	I-131	17±3	17±5	*
			Cs-137	15±3	12±5	*
			Ba-140	<6	0	*
			K	1629±77	1629±83	*
Aug. 1979	9208	Water	I-131	21±1	26±5	25±4
Oct. 1979	20446	Water	Cr-51	116±5	*	*
			Co-60	9±2	*	*
			Zn-65	<3	*	*
			Ru-106	<11	*	*
			Cs-134	7±1	*	*
			Cs-137	12±2	*	*
Oct. 1979	20468	APT	Cs-137	18±0	*	*
Nov. 1979	21865	Water	Co-60	38±2	*	*
			Cs-134	53±7	*	*
			Cs-137	<2	*	*
Nov. 1979	22079	Milk	I-131	632±12	637±32	*
			Cs-137	52±2	49±5	*
			K	1509±67	1470±73	*
Nov. 1979	22473	Food	I-131	13±3	*	*
			Cs-137	21±3	*	*
			Ba-140	<1	*	*
			K	1440±59	*	*

* Results are not available at this time.

(1) RMC gamma analysis, for March 1979, was not acceptable. Check reference (13) for explanation.

INTERLABORATORY ANOMALIES

The interlaboratory results for gross alpha and beta, tritium in water and urine and Ra-226 were very good and no anomalies were noted. Interlaboratory anomalies were noted in the gamma analysis of food and milk for March 1979 and April 1979. Also, anomalies were noted for strontium-89 and -90 analyses; milk (January 1979), food (March 1979), milk (April 1979) and milk (July 1979).

The results of I-131, Cs-137 and K were not acceptable for the March 1979 food sample. An investigation was conducted, resulting in no finding for the anomalous results. The results of I-131 and Cs-137 were not acceptable for the April 1979 milk sample. An investigation was conducted, resulting in no findings for these anomalous results. A thorough examination of the data for the above anomalies did not reveal any errors in calculations, efficiency calibration, geometry and/or sample preparation. All of these samples were counted in Marinelli beakers.

The results of strontium-89 and -90 for the January 1979 milk sample were 23±1 pCi/l and 24±1 pCi/l, respectively. The strontium-89 result was not decay corrected. The decay corrected result is 28±7 pCi/l and is acceptable. The strontium-90 result was based on only two analyses. The corrected result for strontium-90 (based on three analyses) is 21±5 pCi/l and is acceptable. The average chemical yield (based on three analyses) for the March 1979 food sample was 11% which is not acceptable. For the April 1979 milk sample, the ingrowth period was 6 days instead of 14 days. The results of strontium-89 was 29±6 pCi/l without decay correction, with decay correction the result was 51±9 pCi/l and is acceptable. The results of strontium-89 and -90 for July 1979 milk samples were <3 pCi/l and 7±1.5, respectively. Due to other analyses, 0.5 liters of milk samples were used for strontium analyses. Insufficient sample size resulted in poor agreement.

GAMMA ANOMALIES (INTER-LABORATORY)

DATE	RMC #	SAMPLE TYPE	NUCLIDE	RMC MEAN±s.d.	EPA MEAN±s.d.	All Participants MEAN±s.d.	UNIT
Mar 1979	1604	Food	I-131	140±17	90±5	90±6	pCi/kg
			Cs-137	92±3	74±5	75±6	pCi/kg
			K	3189±71	2700±135	2798±236	mg/kg
Apr 1979	4606	Milk	I-131	73±11	96±5	100±10	pCi/l
			Cs-137	182±10	154±8	156±13	pCi/l

STRONTIUM ANOMALIES (INTER-LABORATORY)

DATE	RMC #	SAMPLE TYPE	ISOTOPE	RMC MEAN±s.d.	EPA MEAN±s.d.	All Participants MEAN±s.d.	UNIT
Jan 1979	100557	Milk	Sr-89	23±1(28±7)	33±5	29±4	pCi/l
			Sr-90	24±1(21±5)	19±1.5	17±3	pCi/l
Mar 1979	1604	Food	Sr-89	36±4	48±5	43±8	pCi/kg

STRONTIUM ANOMALIES (INTER-LABORATORY) (CONT)

DATE	RMC #	SAMPLE TYPE	ISOTOPE	RMC MEAN±s.d.	EPA MEAN±s.d.	All Participants MEAN±s.d.	UNIT
Mar 1979	1604	Food	Sr-90	15±2	11±1.5	22±4	pCi/kg
Apr 1979	4606	Milk	Sr-89	29±6(51±9)	42±5	34±12	pCi/l
			Sr-90	41±2	54±3	48±7	pCi/l
Jul 1979	8837	Milk	Sr-89	<3	5±5	*	pCi/l
			Sr-90	7±1.5	11±1.7	*	pCi/l

( ) indicates corrected result.
* Results are not available at this time.

APPENDIX F

COW AND GARDEN SURVEY

During 1979, a farm survey was performed, in the vicinity of the Susquehanna Steam Electric Station. The information, pertaining to the location of the nearest milk producer (within five miles) is listed on Table F-1.

TABLE F-1

NEAREST MILK

Sector		Distance (Miles)
1	N	>5
2	NNE	>5
3	NE	>5
4	ENE	3.5
5	E	2.7
6	ESE	2.4
7	SE	2.5
8	SSE	3.3
9	S	2.4
10	SSW	3.05
11	SW	3.5
12	WSW	1.6
13	W	4.9
14	WNW	>5
15	NW	0.7
16	NNW	4.1