PSE&G-ENV-87-A01

ARTIFICIAL ISLAND RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

For

Salem Generating Station Unit 1: Docket No. 50-272
Salem Generating Station Unit 2: Docket No. 50-311
Hope Creek Generating Station: Docket No. 50-354

1986 ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT JANUARY 1 TO DECEMBER 31, 1986

Prepared For

PUBLIC SERVICE ELECTRIC AND GAS CO.

RESEARCH AND TESTING LABORATORY

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SUMMARY

During the period from January 1 through December 31, 1986, the Research and Testing Laboratory (RTL), PSE&G Research Corporation, has been responsible for the collection and analysis of all samples and the maintenance of sampling equipment connected with the Radiological Environmental Monitoring Program (REMP) at Artificial Island, Salem County, New Jersey.

This program was designed to identify and quantify concentrations of radioactivity in various environmental media and to quantify ambient radiation levels in the environs of Artificial Island. Due to the proximity of the Salem and Hope Creek Generating Stations a common REMP is being conducted. Salem Generating Station (SGS) Unit One became critical on December 11, 1976, thereby initiating the operational phase of the REMP. Data collected during the operational phase served as a source of preoperational data for Salem Unit two and the Hope Creek Generating Station. Salem Unit Two achieved initial criticality on August 2, 1980 and the Hope Creek Generating Station achieved initial criticality on June 28, 1986. This report presents the results of thermoluminescent dosimetry and radiological analyses of environmental samples collected during 1986.

A total of 4091 analyses were performed on 1615 environmental samples during the period covered by this report. Samples of air particulates, air iodine, surface, ground and drinking water, benthic organisms, sediment, milk, fish, crabs, vegetables, game, fodder crops, meat, soil, and precipitation were collected. Thermoluminescent dosimeters were used to measure ambient radiation levels.

Ambient radiation levels remained at normal levels observed in previous years until May 9, 1986 when radioactivity from the Chernobyl-4 reactor accident was detected. According to reports provided to Western scientists at the International Atomic Energy Agency conference on Chernobyl held in Vienna, Austria, it is now known that the accident occurred as a result of a poorly planned reactor experiment. Soviet plant personnel deliberately took actions which blocked the plant's safeguard systems that would have automatically prevented the accident. This action resulted in a reactivity excursion accident in which the reactor became prompt critical [24]. The excursion resulted in a power escalation which resulted in fuel melting and finally a steam explosion which propelled fuel fragments, activation products and burning graphite into the environment. The intense heat of the graphite fire provided a mechanism for the radioactive fission products and activation products to become sufficiently buoyant to enter the upper atmosphere [25]. Actions taken to fight the fire resulted in additional destruction of the core which caused airborne releases into the environment to fluctuated by several orders of magnitude for several days after the accident.

Estimates of projected I-131 concentrations in milk in the town of Pripyat, USSR were reported as high as 103,700,000 pCi/L [25]. The Soviets and the Scandanavian countries also reported measuring excessive concentrations of radioactivity in soils, reindeer flesh, fish, wells, rainwater and goat milk. Since all releases from our nuclear stations were within our technical specifications, the increases in radioactivity as measured in various environmental media in the vicinity of the Artificial Island were due to the accident at Chernobyl-4 and not to the operation of the Salem or Hope Creek Generating Stations.

INTRODUCTION

Artificial Island is the site of Salem and Hope Creek Generating Stations. The Salem Generating Station (SGS) consists of two operating pressurized water nuclear power reactors. Salem Unit One has a net rating of 1090 MWe (3338 MWt), and Salem Unit Two is rated at 1115 MWe (3411 MWt). The Hope Creek Generating Station (HCGS) is a boiling water nuclear power reactor which achieved initial criticality on June 28, 1986. The Hope Creek Unit has a net rating of 1067 MWe (3293 MWt).

Artificial Island is a man-made peninsula on the east bank of the Delaware River and was created by the deposition of hydraulic fill from dredging operations. It is located in Lower Alloways Creek Township, Salem County, New Jersey. The environment surrounding Artificial Island is characterized mainly by the Delaware River and Bay, extensive tidal marshlands, and low-lying meadowlands. These land types make up approximately 85% of the land area within five miles of the site. Most of the remaining land is used for agriculture [7,8]. More specific information on the demography, hydrology, meteorology, and land use of the area may be found in the Environmental Reports [7,8], Environmental Statements [9,10], and the Updated Final Safety Analysis Report for SGS [11] and the Final Safety Analysis Report for HCGS [12].

Since 1968 an off-site Radiological Environmental Monitoring Program (REMP) has been conducted at the Artificial Island Site. Starting in December 1972, more extensive radiological monitoring programs were initiated. The operational REMP was initiated in December 1976 when Salem Unit 1 achieved criticality. The Research and Testing Laboratory (RTL), PSE&G Research Corporation, a wholly-owned subsidiary of Public Service Electric and Gas Company, has been involved in the REMP since its inception. The RTL is responsible for the collection of all radiological environmental samples, and, from 1973, through June, 1983, conducted a quality assurance program in which duplicates of a portion of those samples analyzed by the primary laboratory were also analyzed by the RTL.

From January, 1973, through June, 1983, Radiation Management Corporation (RMC) had primary responsibility for the analysis of all samples under the Artificial Island REMP and the annual reporting of results. RMC reports for the the preoperational phase from 1973 to 1976 and for the operational phase from 1976 through 1982 are referenced in this report [1-3]. On July 1, 1983, the RTL assumed primary responsibility for the analysis of all samples (except TLD's) and the reporting of results. Teledyne Isotopes (TI), Westwood, NJ, at that time was made responsible for third-party QA analyses and TLD's. RTL reports for the operational phase from 1983 to 1985 are referenced in this report [4-6].

This report summarizes the results from January 1 through December 31, 1986, for the Artificial Island Radiological Environmental Monitoring Program.

THE PROGRAM

The operational phase of the REMP was conducted in accordance with Section Sections 3/4.12 and 6.9.1.10 of Appendix A to SGS Operating Licenses DPR-70 and DPR-75 [14,15] and Sections 3/4.12 and 6.9.1.6 of Appendix A to HCGS Operating License NPF-57 [15].

An overview of the program is provided in Table 1 (page 21). Radioanalytical data from samples collected under this program were compared with results from the preoperational phase. Differences between these periods were examined statistically, where applicable, to determine the effects, if any, of station operations.

The REMP for the Artificial Island Site includes additional samples and analyses not specifically required by the Salem and Hope Creek Generating Stations Technical Specifications. The summary tables in this report include these additional samples and analyses.

Objectives

The objectives of the Operational Radiological Environmental Monitoring Program are:

1. To fulfill the obligations of the Radiological Surveillance sections of the Technical Specifications for the Salem Generating Station (SGS) and the Hope Creek Generating Station (HCGS).

2. To determine whether any significant increase occurs in the concentration of radionuclides in critical pathways.

3. To determine if SGS or HCGS has caused an increase in the radioactive inventory of long-lived radionuclides.

4. To detect any change in ambient gamma radiation levels.

5. To verify that SGS and HCGS operations have no detrimental effects on the health and safety of the public or on the environment.

This report, as required by Section 6.9.1.10 of the Salem Technical Specifications, and Section 6.9.1.6 of the Hope Creek Technical Specifications summarizes the findings of the 1986 REMP. Results of the four-year preoperational program which was conducted prior to the operation of any reactors on the Artificial Island have been summarized for purposes of comparison with subsequent operational reports [2].

Sample Collection

In order to meet the stated objectives, an appropriate operational REMP was developed. Samples of various media were selected to obtain data for the evaluation of the radiation dose to man and other organisms. The selection of sample types was based on: (1) established critical pathways for the transfer of radionuclides through the environment to man, and (2) experience gained during the preoperational phase. Sampling locations were determined from site meteorology, Delaware estuarine hydrology, local demography, and land uses.

Sampling locations were divided into two classes - indicator and control. Indicator stations are those which are expected to manifest station effects, if any exist; control samples are collected at locations which are believed to be unaffected by station operations. Fluctuations in the levels of radionuclides and direct radiation at indicator stations are evaluated with respect to analogous fluctuations at control stations. Indicator and control station data are also evaluated relative to preoperational data.

Air particulates were collected on Schleicher-Schuell No. 25 glass fiber filters with low-volume air samplers. Iodine was collected from air by adsorption on TEDA-impregnated charcoal cartridges connected in series after the air particulate filters. Air sample volumes were measured with calibrated dry-gas meters and were corrected to standard temperature and pressure.

Precipitation was collected in a Wong Laboratory Automatic Precipitation Collector having a 95 square inch collection area. The collector is automatically covered during periods of no precipitation to exclude fallout resulting from dry deposition. Samples were collected monthly and transferred to new polyethyle

bottles. The collector was rinsed with distilled water to include residual particulates in the precipitation samples. Tritium results were corrected for the tritium content of the distilled water.

Ambient radiation levels in the environs were measured with energy-compensated $CaSO_4$ (Dy) thermoluminescent dosimeters (TLD's) supplied and read by Teledyne Isotopes. Packets for monthly and quarterly exposure were placed on and around the Artificial Island Site at various distances.

Well water samples were collected monthly by PSE&G personnel and separate raw and treated potable water samples were composited daily by personnel of the City of Salem water treatment plant. New two-gallon polyethylene containers were used for all water samples.

All estuarine samples were collected by V. J. Schuler Associates, Inc. and delivered by PSE&G personnel. Surface water samples were collected in new containers which were rinsed twice with the sample medium prior to collection. Edible fish and crabs were taken by net, and frozen in sealed polyethylene containers. Benthos and sediment samples were taken with a bottom grab sampler.

Milk samples were taken semi-monthly when cows were on pasture and monthly when cows were not grazing on open pasture. Samples were collected in new polyethylene containers. Food products, fodder crops, game, and beef were sealed in new plastic bags or jars. All perishable samples were transported in ice chests, and no preservatives were added.

Soil samples which are collected once every three years were collected at several locations in New Jersey and Delaware.

Appendix A describes and summarizes, in accordance with Section 6.9.1.10 of the Salem TS and Section 6.9.1.6 of the Hope Creek TS, the entire operational program as performed in 1986. Appendix B describes the coding system which identifies sample type and location. Table B-1 lists the sampling stations and the types of samples collected at each station. These sampling stations are indicated on maps B-1 and B-2.

Data Interpretation

Results of all analyses were grouped according to the analysis performed for each type of sample and are presented in the data tables in Appendix C. All results above the lower limit of detection (LLD) are at a confidence level of ± 2 sigma. This represents the range of values into which 95% of repeated analyses of the same sample should fall. As defined in Regulatory Guide 4.8, LLD is the smallest concentration of radioactive

material in a sample that will yield a net count (above system background) that will be detected with 95% probability with only 5% probability of falsely concluding that a blank observation represents a "real signal". LLD is normally calculated as 4.66 times one standard deviation of the background count or of the blank sample count as appropriate.

The grouped data were averaged and standard deviations calculated in accordance with Appendix B of Reference 18. Thus, the 2 sigma deviations of the averaged data represent sample and not analytical variability. When a group of data was composed of 50% or more LLD values, averages were not calculated.

Grab sampling is a useful and acceptable procedure for taking environmental samples of a medium in which the concentration of radionuclides is expected to vary slowly with time or where intermittent sampling is deemed sufficient to establish the radiological characteristics of the medium. This method, however, is only representative of the sampled medium for that specific location and instant of time. As a result, variation in the radionuclide concentrations of the samples will normally occur. Since these variations will tend to counterbalance one another, the extraction of averages based upon repetitive grab samples is considered valid.

Quality Assurance Program

PSE&G Research Corporation, Research and Testing Laboratory (RTL), has a quality assurance program designed to maximize confidence in the analytical procedures used. Approximately 20% of the total analytical effort is spent on quality control, including process quality control, instrument quality control, interlaboratory cross-check analyses, and data review. The analytical methods utilized in this program are summarized in Appendix D.

The quality of the results obtained by the RTL is insured by the implementation of the Quality Assurance Program as described in the Environmental Division Quality Assurance Plan [19,20] and the Environmental Division Procedures Manual [21]. The internal quality control activity of the Laboratory includes the quality control of instrumentation, equipment and reagents; the use of reference standards in calibration, documentation of established procedures and computer programs, and analysis of duplicate and spiked samples. The external quality control activity is implemented through participation in the USEPA Laboratory Intercomparison Studies Program. These results are listed in Tables E-1 through E-5 in Appendix E.

Program Changes

Location 2F4 from which milk, fodder crops and soil were collected, terminated milk production in September and was replaced by location 2F7. No samples were missed due to this change.

RESULTS AND DISCUSSION

The analytical results of the 1986 REMP samples are divided into categories based on exposure pathways: atmospheric, direct, terrestrial, and aquatic. The analytical results for the 1986 REMP are summarized in Appendix A. The data for individual samples are presented in Appendix C.

This section discusses the data for samples collected under the REMP. It does not include the data from the quality assurance program discussed previously.

Atmospheric

Air Particulates (Tables C-1, C-2, C-3)

The weekly air particulate samples were analyzed for gross alpha and gross beta. Quarterly composites of the weekly samples from each station were analyzed for specific gamma emitters and a single quarterly composite sample was analyzed for Sr-89 and Sr-90. Total data recovery for the eight sampling stations during 1986 was 98.4 percent.

Concentrations were detected in 359 of the 416 weekly samples analyzed for gross alpha emitters (Table C-1). Alpha concentrations ranged from 0.8×10^{-3} to 22×10^{-3} pCi/m^3 with the grand average for all stations being 2.6×10^{-3} pCi/m^3.

Analysis of weekly air particulate samples for gross beta (Table C-2) indicated concentrations were detected in 410 of the 416 samples ranging from 6.7×10^{-3} to 370×10^{-3} pCi/m^3, with the grand average for all stations being 41×10^{-3} pCi/m^3.

Figure 1 indicates the relation between gross beta activity in air particulates and precipitation for the preoperational and operational periods, including the effects of atmospheric weapons testing and the accident at the Chernobyl-4 nuclear power reactor.

Strontium-89 and Sr-90 analyses are no longer required by the Technical Specifications for the Salem or Hope Creek Generating Stations. In order to maintain documentation of the ambient

levels of Sr-89 and Sr-90 in the air surrounding the stations, strontium analyses are performed on the 1st quarterly sample from each location as a management audit sample. Strontium-89 and Sr-90 was not detected in any of the eight monthly composited samples analyzed; LLD sensitivities ranged from $<0.3 \times 10^{-3}$ to $<2.0 \times 10^{-3}$ pCi/m^3 and from $<0.2 \times 10^{-3}$ to $<0.3 \times 10^{-3}$ pCi/m^3 for Sr-89 and Sr-90 respectively.

Results of gamma spectrometry indicated detectable levels of Be-7 in all of the 32 monthly composites, with a maximum of 110×10^{-3} pCi/m^3. Berylium-7 is a naturally-occurring radionuclide attributed to cosmic ray activity in the atmosphere. During this reporting period detectable levels of Ru-103, Ru-106, Cs-134, Cs-137, Ra-226, and Th-232 were noted in many of the locations sampled. Ruthenium-103 levels ranged from 7.5×10^{-3} to 9.2×10^{-3} pCi/m^3. Ruthenium-106 levels ranged from 4.0×10^{-3} to 8.3×10^{-3} pCi/m^3. Cesium-134 levels ranged from 8.4×10^{-3} to 10×10^{-3} pCi/m^3. Cesium-137 levels ranged from 16×10^{-3} to 18×10^{-3} pCi/m^3.

In reviewing the data it is noted that Ru-103, Cs-134 and Cs-137 levels increased significantly during the second quarter of 1986. The Ru-103, Cs-134 and Cs-137 increased levels are not attributable to the operation of the Salem or Hope Creek Generating Stations. Based on their respective effluent release reports, there were no releases of Ru-103, Cs-134 or Cs-137 during the second quarter [22,23]. The increased levels are attributable to the Chernobyl-4 reactor accident since similar concentrations existed at indicator and control station locations.

Radium-226 was also detected in one of the samples at a concentration of 1.2×10^{-3} pCi/m^3, which is within the variations of the LLD sensitivities for the other samples which ranged from $<0.3 \times 10^{-3}$ to $<10 \times 10^{-3}$ pCi/m^3. Thorium-232 was detected in one of the samples at a concentration of 1.7×10^{-3} pCi/m^3. This value is within the variations of the LLD sensitivities for the other samples which ranged from $<1.1 \times 10^{-3}$ to $<2.7 \times 10^{-3}$ pCi/m^3.

Air Iodine (Table C-4)

Cartridges for the adsorption of air iodine were connected in series after each of the air particulate filters. The adsorption media in these cartridges is triethylenediamine (TEDA) impregnated charcoal.

Iodine-131 was below detectable levels for the first four months of the year until the week of May 5 when radioactive iodine originating from the Chernobyl-4 reactor accident was detected.

Iodine-131 was detected at all locations during the three weekly sampling periods starting on May 5, 1986 and ending on May 27, 1986. Elevated levels persisted at several locations during the last week in May and the first week in June. Levels as high as 320 x 10^{-3} pCi/m^3 were detected at two locations. A value of 610 x 10^{-3} pCi/m^3 was measured in one of our management audit samples but was not used in calculating any of our averages because of the short sampling period. During the remainder of the year I-131 levels remained at levels below our LLD. The LLD sensitivities ranged from <7.7 x 10^{-3} to <40 x 10^{-3} pCi/m^3.

The increased I-131 levels are not attributable to the operation of the Salem or Hope Creek Generating Stations. Based on their respective effluent release reports, there was no significant release of I-131 during the second quarter [22,23]. All of the elevated I-131 results are attributable to the Chernobyl-4 reactor accident.

Precipitation (Tables C-6, C-7)

Although not required by the technical specifications, precipitation samples were collected at location 2F2 in the town of Salem. Monthly samples were analyzed for gross alpha, gross beta, tritium, and gamma emitters. Gross alpha concentrations were detected in four of the twelve samples analyzed. The results detected were 0.6, 0.9, 1.2 and 1.3 pCi/L. These results were within the variation of the LLD sensitivities for the remaining samples which ranged from <0.3 to <1.7 pCi/L. Beta activity was detected in all twelve monthly samples and ranged from 1.9 to 15 pCi/L, with an average of 5.5 pCi/L. Tritium was not detected in any of the twelve samples analyzed; LLD sensitivities ranged from <130 to <140 pCi/L.

Gamma analysis was performed on each of the monthly samples except for January, 1986 when there was insufficient precipitation. Detectable levels of I-131 and Cs-137 were found in one sample during May 1986 at a concentration of 7.4 and 4.8 pCi/L respectively. The increase in I-131 and Cs-137 levels was attributed to the Chernobyl-4 reactor accident since similar levels of iodine and cesium were measured in precipitation collected at the Research and Testing Laboratory location 3H3, located 110 miles away from the Salem and Hope Creek Stations. Otherwise levels of I-131 and Cs-137 were below detectable levels.

Levels of other gamma emitters were comparable to levels observed in previous years. The presence of Be-7 was detected in each sample at concentrations ranging from 35 to 71 pCi/L. Radium-226 was detected in three samples at a concentration of 7.0, 5.1 and 4.8 pCi/L. These values are within the variations of the LLD sensitivities for the other samples which ranged from <4.2 to

<13 pCi/L. A slightly detectable level of naturally-occurring K-40 was detected in one sample at a level of 59 pCi/L during the September sampling period. However, this value was within the variations of the LLD sensitivities measured throughout the year. Thorium-232 was detected in one sample during the August sampling period at a concentration of 7.5 pCi/L. This value is within the variations of the LLD sensitivities for the other samples which ranged from <7.2 to <21 pCi/L. All other gamma emitters searched for were below the LLD.

Direct Radiation (Tables C-8, C-9)

A total of 41 locations were monitored for direct radiation during 1986, including 6 on-site locations, 29 off-site locations within the 10 mile zone, and 6 control locations beyond 10 miles. Monthly and quarterly measurements were made at the 6 on-site stations and at 15 off-site indicator stations, and 3 control stations. An additional 14 quarterly measurements were taken at schools and population centers with 3 additional controls beyond the 10 mile zone in Delaware.

Four readings for each TLD at each location were taken in order to obtain a more statistically valid result. The average dose rate for the 15 monthly off-site indicator TLD's was 5.8 millirads per standard month, and the corresponding averaged control dose rate was 6.4 millirads per standard month. The average dose rate for the 29 quarterly off-site indicator TLD's was 5.1 millirads per standard month, and the averaged control rate was 5.6. For these measurements, the rad is considered equivalent to the rem, in accordance with 10CFR20.4.

In Figure 2, the average radiation levels are plotted for the 13 year period through 1986. Figure 2A shows the monthly averages of the off-site indicator stations and the control stations for 1982 through 1986. Ambient radiation levels during 1986 were comparable to those obtained during 1985.

Terrestrial

Milk (Tables C-10, C-11, C-12)

Milk samples were collected in accordance with the Salem and Hope Creek Technical Specifications at six local dairy farms. During this reporting period, one dairy operator terminated operations (location 2F4) and, as required by the SGS and HCGS Technical Specification, a replacement location (location 2F7) was found and added to the surveillance program. Samples were collected semi-monthly when cows were on pasture and monthly when cows were not on pasture.

Each sample was analyzed for I-131 and gamma emitters. In addition, although not specifically required by the SGS and ECGS Technical Specifications, one sample from each location was analyzed for Sr-89 and Sr-90 in order to maintain the data base developed in prior years. All Sr-89 results were below detectable levels. Strontium-90 results were comparable at indicator and control locations and averaged 2.1 pCi/L.

Following the nuclear accident at the Chernobyl-4 reactor in the Soviet Union, iodine-131 levels increased significantly. Estimates of the quantity of I-131 released from the Chernobyl-4 reactor indicate that as much as 20% of the core inventory of I-131 could have been discharged [25]. Samples collected during the third week in May and analyzed for I-131 using an ion exchange resin method, ranged between 11 and 53 pCi/L with the highest result obtained at the control station location. The elevated levels persisted during June and the first week of July. The mean of the indicator locations which had detectable levels of I-131 was 10 pCi/L while the mean at the control locations which had detectable concentrations of I-131 was 19 pCi/L. Levels of I-131 in milk did not return to normal levels until the third week of July. All other samples collected during the year indicated no discernible I-131 activity. Figure 3 and 3A shows the average I-131 activity measured during this year compared to results obtained in previous years. Table C-10 lists the results and shows that sensitivities ranged from <0.1 to <0.8 pCi/L.

Gamma spectrometry showed detectable concentrations of naturally-occurring K-40 in all samples. The annual mean concentration measured at indicator locations averaged 1400 pCi/L, and the annual mean concentration measured at control locations averaged 1400 pCi/L. Sodium-22 was detected in one sample in May at a concentration of 4.6 pCi/L. The Na-22 LLDs for all stations ranged from <1.0 to <6.4 pCi/L. Manganese-54 was detected in only one sample at a level of 2.9 pCi/L. The Mn-54 LLDs for all stations ranged from <0.7 to <4.9 pCi/L. Zinc-65 was detected in only one sample at a concentration of 11 pCi/L. Cesium-137 was detected in six samples at levels which ranged from 3.3 to 5.1 pCi/L. Since the Cs-137 LLDs for all stations ranged from <2.3 to <5.1 pCi/L the positive results are not considered as being significant. Levels as high as 14 pCi/L were detected during the preoperational program [2]. Radium-226 was detected in four samples at concentrations comparable to levels observed during the preoperational program [2].

Although not as sensitive as the ion exchange method, I-131 results were also obtained in the gamma scan and the values were comparable to the results obtained using the anion exchange resin method. Iodine-131 levels obtained from the gamma scan averaged 20 pCi/L at the indicator locations which had detectable levels and 36 pCi/L at the control locations. All other results searched for were below LLD.

Concentrations of I-131 in milk in the 2nd quarter exceeded the values in Table 3.12-2 of the SGS and HCGS Technical Specifications. These concentrations are not attributed to the operation of the Salem and Hope Creek Generating Stations. Based upon their respective effluent release reports, there was no significant release of I-131 during the 2nd quarter [22, 23].

Well Water (Tables C-14, C-15, C-16)

Although wells in the vicinity of the Salem and Hope Creek Generating Station are not anticipated to be affected by plant operations, water samples were collected monthly from two indicator wells and one control well. Each sample was analyzed for gross alpha, gross beta, tritium, potassium-40 and gamma emitters. Quarterly composites were analyzed for radiostrontium.

Gross alpha concentrations from 0.6 to 2.0 pCi/L were detected in seven of the indicator locations, with LLD sensitivities for the other analyses ranging from <0.5 to <3.7 pCi/L. Gross beta activity was detected in all of the samples. The mean activity for the indicator locations was 7.6 pCi/L with a range of 2.0 to 15 pCi/L; mean activity for the control location was 7.4 pCi/L with a range of 2.5 to 9.5 pCi/L. Potassium-40 in each monthly sample was determined by atomic absorption spectroscopy. Mean activity for the indicator locations was 8.7 pCi/L with a range of 2.7 to 16 pCi/L, and mean activity for the control location was 9.4 pCi/L with a range of 7.4 to 17 pCi/L. All tritium results were at LLD levels of <130 to <140 pCi/L. Neither Sr-89 nor Sr-90 was detected in any of the samples. The LLD sensitivities for Sr-89 ranged from <0.4 to <11 pCi/L, and from <0.3 to <0.6 pCi/L for Sr-90.

Gamma spectrometry was performed on each sample. Potassium-40, Ra-226 and Th-232 were the only gamma emitters detected. Although not as sensitive as atomic absorption, K-40 was detected by gamma scan in eight samples at levels ranging from 35 to 47 pCi/L. Radium-226 was detected in seventeen of the twenty four indicator locations and eleven of the twelve control station locations at values which ranged from a low 2.9 pCi/L to a high of 170 pCi/L. The range of the Ra-226 values were higher than values observed in previous years. We believe that results are higher due to a procedural change in which the samples are no longer boiled down to a 100 ml standard geometry. This change results in less radon daughters being removed from the sample. Since Ra-226 is an alpha emitter, its identification by gamma isotopic analysis is obtained by counting the Pb-214 gamma rays from the daughter products. We believe that values currently being observed are indicative of the concentrations which have always existed. Concentrations of Th-232 were detected in two indicator station samples at 8.4 and 10 pCi/L; LLD values for the other thirty four samples ranged from <4.6 to <10 pCi/L.

Potable Water (Tables C-17, C-18, C-19)

Both raw and treated water samples were collected from the Salem water treatment plant. Each consisted of daily aliquots composited into a monthly sample. The raw water source for this plant is Laurel Lake and adjacent wells. Each sample was analyzed for gross alpha, gross beta, K-40, tritium, and gamma emitters. Quarterly composites of raw and treated water were analyzed for Sr-89, Sr-90.

Detectable alpha activity was noted in eleven water samples at concentrations ranging from 0.5 to 1.5 pCi/L; LLD sensitivities ranged from <0.5 to <2.4 pCi/L (raw), and from <0.5 to <1.9 pCi/L (treated). Beta activity was observed in all of the 24 monthly samples with ranges of 2.0 to 13 pCi/L (raw), and 1.7 to 8.2 (treated), and averages of 3.6 pCi/L (raw) and 3.6 pCi/L (treated). Potassium-40 concentrations for raw and treated samples were similar but lower than the gross beta activity in all cases. The K-40 average for the raw and treated samples was 1.6 and 2.0 pCi/L respectively. Tritium activity was observed in one of the twenty-four samples at a concentration of 150 pCi/L.

Strontium-89 was detected in one of the eight quarterly composite water samples at a concentration of 0.8 pCi/L; LLD sensitivities ranged from <0.5 to <1.6 pCi/L for Sr-89. Strontium-90 was not detected in any of the water samples and the LLDs ranged from <0.4 to <1.0 pCi/L for Sr-90. Gamma spectrometry detected Ru-103 in one sample at 2.6 pCi/L; Ra-226 in three samples at concentrations ranging from 2.6 to 8.4 pCi/L; and Th-232 in three samples at concentrations ranging from 5.7 to 6.8 pCi/L. The LLDs ranged from <0.5 to <5.6 pCi/L for Ru-103; from <3.7 to <5.8 pCi/L for Ra-226 and from <4.9 to <9.6 for Th-232.

Food Products (Table C-20)

Although vegetables in the region are not irrigated with water in which liquid plant effluents have been discharged, a variety of food products grown in the area for human consumption were sampled. These included sweet corn, peppers, asparagus, cabbage, and tomatoes.

All samples contained naturally occurring K-40 at concentrations from 910 to 3400 pCi/kg-wet, with an average for all samples of 2100 pCi/kg-wet. Berylium-7 was detected in one sample at a concentration of 24 pCi/kg-wet. Iodine-131 was detected in one indicator location and one control location at levels of 33 and 62 pCi/kg-wet for samples collected during May. The increased I-131 levels are not attributable to the operation of the Salem or Hope Creek Generating Stations. Based on their respective

effluent release reports, there were no significant release of I-131 during the second quarter [22,23]. All of the elevated I-131 results are attributable to the Chernobyl-4 reactor accident.

A trace of Cs-137 was detected in tomatoes from two control stations at 1.5 and 2.1 pCi/kg-wet. Since the LLD sensitivities ranged from <1.6 to <24 pCi/kg-wet, the detectable levels of Cs-137 are not considered as being significant. Concentrations of Ra-226 were detected in three samples ranging from 8.3 to 68 pCi/kg-wet. The two highest concentrations measured occurred at two different control locations at concentrations which were comparable to the LLD values. The LLD values ranged from <1.8 to <51 pCi/kg-wet. Thorium-232 was detected in one tomato sample at a concentration of 8.8 pCi/kg-wet. The LLDs ranged from <5.5 to <110 pCi/kg-wet for a variety of food products collected during the reporting period.

Game (Table C-21)

Since muskrats inhabit the marsh lands surrounding the site, and since muskrats are consumed by local inhabitants, two muskrat samples were collected and analyzed for gamma emitters. Gamma scans of the flesh indicated the presence of naturally-occurring K-40 in both samples at concentrations of 2200 and 2400 pCi/kg-wet.

Beef (Table C-21)

Although not required by the SGS or HCGS Technical Specifications, beef samples are collected, when available, twice a year. The second semi-annual beef sample was not obtained. Farmers from whose animals the samples are normally obtained did not slaughter from July through December 1986.

Analysis of the flesh for gamma emitters indicated the presence of naturally-occurring K-40 at concentrations of 2500 pCi/kg-wet, and Cs-137 at 7.3 pCi/kg-wet.

Fodder Crops (Table C-22)

Samples of crops normally used as cattle feed were collected at nine locations where these products may be a significant element in the food-chain pathway. Six of the locations are or were milk sampling stations. Samples collected for wet gamma analysis included barley, feed corn, corn silage and soybeans.

Potassium-40 was detected in all of the nine samples at concentrations ranging from 2300 to 15000 pCi/kg-wet, with an average of 7000 pCi/kg-wet. Berylium-7, from the atmosphere, was found in five of the samples at concentrations ranging from 370 to 1400 pCi/kg-wet. Cesium-137 was detected in one of our control locations at a concentration of 13 pCi/kg-wet. The LLDs for Cs-137 ranged from <17 to <54 pCi/kg-wet. Radium-226 and Th-232 were detected in two different samples at a concentrations of 35 and 170 pCi/kg-wet. The LLDs for the Ra-226 ranged from <36 to <100 pCi/kg-wet while the LLDs for Th-232 ranged from <59 to <130 pCi/kg-wet.

Soil (Table C-23)

Soil is sampled every three years at 16 locations, including two controls, and analyzed for Sr-90 and gamma emitters. Samples are collected at each station in areas that have been relatively undisturbed since the last collection in order to determine any change in the radionuclide inventory of the area.

The concentrations of Sr-90 for the indicator stations ranged from 27 to 140 pCi/kg-dry with an average of 91 pCi/kg-dry. The two control stations yielded results of 56 and 130 pCi/kg-dry with an average of 93 pCi/kg. Since the purpose of these samples is to determine if the operation of the nuclear stations is resulting in an increase in the inventory of long lived reactor produced radionuclides in the environment, the values obtained were compared to data reported in previous years. Averages for the indicator stations were 220 pCi/kg in 1977, 149 pCi/kg in 1980, and 125 pCi/kg in 1983. Averages for the control stations were 430 pCi/kg in 1977, 195 pCi/kg, and 93 pCi/kg in 1983. The gradual decrease is perhaps attributable to the wash-out and decay of weapons testing fall-out from the 1950's to the 1960's.

Gamma spectrometry of these samples showed detectable concentrations of the naturally occurring radionuclides (K-40, Ra-226, and Th-232) and the fission product Nb-95 and Cs-137. The Nb-95 concentrations found ranged from 34 to 63 pCi/kg with an average of 48 pCi/kg. These results are comparable to measurements obtained during the preoperational studies in which levels of Nb-95 of 90 pCi/kg were observed [2]. The Cs-137 at the indicator stations ranged from 78 to 1500 pCi/kg with an average of 393 pCi/kg. The two control stations were 210 and 690 pCi/kg with an average of 450 pCi/kg. Averages for the indicator stations were 710 pCi/kg in 1977, 445 pCi/kg in 1980 and 440 pCi/kg in 1983. Averages for the control stations were 620 pCi/kg in 1977, 650 pCi/kg in 1980 and 615 pCi/kg in 1983.

Aquatic

Surface Water (Tables C-24, C-25, C-26, C-27)

Surface water samples were collected monthly at five locations in the Delaware estuary. One location is at the outfall area, another is downstream from the outfall area, and another is directly west of the outfall area at the mouth of the Appoquinimink River. Two upstream locations are in the Delaware River and at the mouth of the Chesapeake and Delaware Canal, the latter being sampled when the flow is from the Canal into the river. Station 12C1, at the mouth of the Appoquinimink River, serves as the operational control. All surface water samples were analyzed monthly for gross alpha and gross beta emitters, and gamma emitters. Quarterly composites were analyzed for tritium.

Alpha concentrations were detected in 19 of the 48 indicator samples and in four of the twelve control samples, with concentrations for all samples ranging from 0.7 to 12 pCi/L; LLD sensitivities which ranged from <0.6 to <4.7 pCi/L. Beta concentrations for the indicator stations ranged from 2.4 to 130 pCi/L with an average of 51 pCi/L, and for the control station, from 7.5 to 81 pCi/L with an average of 45 pCi/L. Nearly all of the beta activity was contributed by K-40, a natural component of salt and brackish waters, as illustrated in Figure 4, which compares averaged gross beta and K-40 concentrations.

Tritium concentrations for the indicator stations ranged from 130 to 270 pCi/L. The average of the eight indicator samples with detectable levels of tritium was 160 pCi/L. Tritium was detected in one of the four control samples at 150 pCi/L. Levels for the years 1973 through 1986 are plotted in Figure 5.

Gamma spectrometric analysis of surface water samples showed detectable concentrations of K-40 in 34 of the 48 samples. The average K-40 concentration at the indicator stations was 88 pCi/L, with a range of 33 to 160 pCi/L. Average K-40 concentration at the control station, where detectable concentrations were found in nine of the twelve samples, was 70 pCi/L with a range of 29 to 95 pCi/L. Radium-226 was detected in seven indicator station samples, with the values ranging from 2.6 to 11 pCi/L, and one control station sample at 25 pCi/L. Radium-226 concentrations in this year's samples were higher than in previous years due to procedural change in which water samples are no longer boiled down to a 100 ml standard geometry. This change results in less radon daughters being removed from the sample. Since Ra-226 is an alpha emitter, its identification by gamma isotopic analysis is obtained by counting the Pb-214 daughter product. Concentrations of Th-232 in five indicator station samples were detected ranging from 5.3 to 9.3 pCi/L and one control sample at 9.2 pCi/L. LLD sensitivities for Th-232 ranged from <5.3 to <9.3 pCi/L.

Fish (Tables C-28, C-29)

Edible species of fish were collected semi-annually at three locations and analyzed for tritium and gamma emitters (flesh) and for Sr-89 and Sr-90 (bones). Samples included channel catfish, summer flounder, weakfish and bluefish.

Gamma spectrometry of these samples indicated K-40 in all six samples at an average concentration of 3000 pCi/kg-wet with a range of 2700 to 3300 pCi/kg-wet. One of the six samples had detectable concentrations of Cs-137 with a value of 8.3 pCi/kg-wet. The LLD sensitivity for the other five samples ranged from <12 to <19 pCi/kg-wet. Radium-226 was detected in the second semi-annual sample at two locations, at concentrations of 33 and 41 pCi/kg-wet. Levels as high as 130 pCi/kg-wet were observed during the preoperational period [2]. Thorium-232 was detected in the first semi-annual sample from the control station at a concentration of 29 pCi/kg-wet. LLD sensitivities for Th-232 ranged from <31 to <61 pCi/kg-wet.

Strontium-89 was detected in one of the six bone samples, with a concentration of 330 pCi/kg-dry. The LLD sensitivities for the other six samples ranged from <40 to <75 pCi/kg-dry. Two of the four semi-annual indicator samples analyzed for Sr-90 had detectable concentrations of 34 and 240 pCi/kg-dry, with an average of 137 pCi/kg-dry. The level seen at the control location for the sample collected during the period from May 12 to May 19, 1986 was 1500 pCi/kg-dry. A review of station effluent release records does not indicate any significant quantity of Sr-89 or Sr-90 being discharged during the first half of the year [23].

Tritium analyses were performed on the aqueous fraction of the flesh portions of these samples. None of the samples analyzed indicated any detectable concentrations of tritium.

Blue Crab (Table C-30)

Blue crab samples were collected semi-annually at two locations, and the edible portions were analyzed for gamma emitters, Sr-89 and Sr-90, and tritium in the aqueous fraction. The shells were also analyzed for Sr-89 and Sr-90.

Potassium-40 was detected in the flesh portion of all four samples. Potassium-40 levels ranged from 1700 to 2000 pCi/kg-wet with an average of 1800 pCi/kg-wet. Radium-226 was detected in two samples from the control location at concentrations of 19 and 20 pCi/kg-wet.

Strontium-89 was not detected in any of the four flesh samples; LLD sensitivities ranged from <28 to <46 pCi/kg-wet. One shell sample from the first semi-annual set had detectable levels of Sr-89 at 300 pCi/kg-dry; and LLD sensitivities ranging from <67 to <89 pCi/kg-dry. Similiar concentrations were observed during the preoperational program [2].

Strontium-90 was not detected in any of the edible flesh portions of the blue crab samples. The LLD sensitivities for these samples ranged from <18 to <24 pCi/kg-wet for Sr-90. All four shell samples had detectable concentrations of Sr-90 ranging from 150 to 490 pCi/kg-dry with an average of 340 pCi/kg-dry.

Tritium activity was not detected in the aqueous fraction of any of the edible flesh portion of the four blue crab samples collected. The LLD sensitivity achieved, in all cases was <50 pCi/kg-wet.

Benthic Organisms and Sediment (Tables C-31, C-32)

Benthic organisms were separated from the bottom sediment and analyzed for gamma emitters. All gamma emitters searched for were <LLD sensitivities. It should be noted that, due to the very small sample sizes for all samples, satisfactory gamma sensitivities could not be achieved.

Sediment samples of sufficient size were available to enable sensitivity requirements for both Sr-90 and gamma emitters to be met. Levels of Sr-90 were below LLD (<19 to <38 pCi/kg-dry) in all twelve samples analyzed. Results of gamma spectrometry indicated the presence of naturally-occurring K-40, Ra-226, and Th-232 in all twelve samples with averages of 10000, 620, and 740 pCi/kg-dry respectively. Concentrations of the gamma emitters, Mn-54, Co-58, Co-60, Cs-134 and Cs-137 were also detected. Manganese-54 was detected in three samples at an average concentration of 26 pCi/kg-dry with LLDs ranging from <18 to <38 pCi/kg-dry. Concentrations of Co-58 were detected in four samples ranging from 31 to 80 pCi/kg-dry, with the average being 57 pCi/kg-dry. Cobalt-58 LLD sensitivities for the remaining four samples ranged from <23 to <38 pCi/kg-dry. Concentrations of Co-60 were detected in eight samples ranging from 37 to 110 pCi/kg-dry, with the average being 72 pCi/kg-dry. Cobalt-60 LLD sensitivities for the remaining four samples ranged from <36 to <48 pCi/kg-dry. Cesium-134 concentrations were detected in four samples at levels ranging from 46 to 82 pCi/kg-dry, with LLDs ranging from <16 to <34 pCi/kg-dry. Cesium-137 concentrations in four samples ranged from 49 to 82 pCi/kg-dry; LLD sensitivities ranged from <16 to <39 pCi/kg-dry.

PROGRAM DEVIATIONS

Air particulate/iodine sampler location 2S2 for the week beginning January 13, was operational for only 1.2 days out of a 7 day sampling week due to an instrument malfunction.

Direct radiation measurement results from location 6F1 for March are unavailable; TLDs were missing from the field location.

Air particulate/iodine sampler location 5D1 for the week beginning May 12, was operational for only 2.1 days out of a 7 day sampling week due to an instrument malfunction.

Air particulate/iodine sampler location 16E1 for the week beginning May 27, was operational for only 0.6 days out of a 7 day sampling week due to an instrument malfunction.

Iodine-131 results from location 3H3 for the week beginning June 2, are unavailable due to a faulty sampling assembly.

Milk gamma results from location 3G1 for the September 22-23, sample are unavailable due to loss of sample during preparation.

Air particulate/iodine sampler location 2S2 for the week beginning November 24, was operational for only 0.2 days out of a 7 day sampling week due to an instrument malfunction.

Air particulate/iodine sampler location 3H3 for the week beginning December 1, was operational for only 2.0 days out of a 7 day sampling week due to an instrument malfunction.

Air particulate/iodine sampler location 5D1 for the week beginning December 15, was operational for only 0.3 days out of a 7 day sampling week due to an instrument malfunction.

CONCLUSIONS

The Radiological Environmental Monitoring Program for Artificial Island was conducted during 1986 in accordance with the SGS and HCGS Technical Specifications. The objectives of the program were met during this period. The data collected assists in demonstrating that SGS Units One and Two and HCGS were operated in compliance with Technical Specifications.

The ability of the program to detect radionuclides released from the accident at the Chernobyl-4 reactor, has demonstrated that the program being conducted is effective in sensing small increases in radiation levels. It is evident that air, milk, water, food products and soil surrounding the Chernobyl power reactor complex were seriously contaminated as a result of the

accident. However, radiation levels measured in the United States due to the accident were not affected in terms of public health and safety. Ambient radiation levels as measured in our program were relatively low, averaging 5.1 mrad/std. month. Although ambient radiation levels remained normal, our surveillance programs were sufficiently sensitive to detect radionuclides in the environment which were discharged from the damaged Chernobyl-4 reactor. The concentrations measured and provided in this report although higher than normal were not excessive. In fact, with the exception of I-131 in milk, none of the concentration found exceeded the reporting levels established by the USNRC. The reporting levels established in the Technical Specifications applies only to abnormal environmental measurements caused by the licensed power reactor. None of the I-131 detected in milk was due to the operation of the Salem or Hope Creek reactors. The operation of SGS Units One and Two and HCGS had no significant effect on the radiological characteristics of the environs of Artificial Island.

TABLE 1

1986 ARTIFICIAL ISLAND RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

MEDIUM	STATION CODE INDICATOR				CONTROL	COLLECTION FREQUENCY	TYPE/FREQUENCY* OF ANALYSIS
I. ATMOSPHERIC ENVIRONMENT							
a. Air Particulate	2S2 5S1	5D1 10D1	16E1	1F1 2F2	3H3	Weekly	Gross alpha/weekly Gross beta/weekly Sr-89 & Sr-90/first quarterly** Gamma scan/quarterly
b. Air Iodine	2S2 5S1	5D1 10D1	16E1	1F1 2F2	3H3	Weekly	Iodine-131/weekly
c. Precipitation		2F2				Monthly	Gross alpha/monthly Gross beta/monthly Tritium/monthly Gamma scan/monthly
II. DIRECT RADIATION							
a. Thermoluminescent Dosimeters	2S2 5S1 6S2 7S1 10S1 11S1	5D1 10D1 14D1	2E1 3E1 13E1 16E1	1F1 2F2 2F6 5F1 6F1 7F2 11F1 13F4	3G1	3H1 3H3	Monthly & Quarterly	Gamma dose/monthly Gamma dose/quarterly

TABLE 1 (cont'd)

1986 ARTIFICIAL ISLAND RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

MEDIUM	STATION CODE INDICATOR	STATION CODE CONTROL	COLLECTION FREQUENCY	TYPE/FREQUENCY* OF ANALYSIS
a. Thermoluminescent Dosimeters (cont'd)	4D2 9E1 2F5 11E2 12E1 3F3 10F2 12F1 13F2 13F3 14F2 15F3 16F2	3F2 1G3 10G1 16G1	Quarterly	Gamma dose/quarterly
III. TERRESTRIAL ENVIRONMENT				
a. Milk	13E3 2F4 2F7*** 5F2 11F3 14F1	3G1	Monthly (animals not on pasture)	Iodine-131/monthly Gamma scan/monthly
			Semi-monthly (animals on on pasture)	Iodine-131/semi-monthly Gamma scan/semi-monthly Sr-89 & Sr-90/July, first collection**
b. Well Water	2S3 5D1	3E1	Monthly	Gross alpha/monthly Gross beta/monthly Potassium-40/monthly Tritium/monthly Gamma scan/monthly Sr-89 & Sr-90/quarterly

TABLE 1 (cont'd)

1986 ARTIFICIAL ISLAND RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

MEDIUM	STATION CODE		COLLECTION FREQUENCY	TYPE/FREQUENCY* OF ANALYSIS
	INDICATOR	CONTROL		
c. Potable Water (Raw & Treated)	2F3		Monthly (composited daily)	Gross alpha/monthly Gross beta/monthly Potassium-40/monthly Tritium/monthly Gamma scan/monthly Sr-89 & Sr-90/quarterly
d. Vegetables	2E1 1F3 3E1 4F1 5F1 14F3	1G1 3H5 2G1	Annually (at harvest)	Gamma scan/on collection
e. Game (Muskrat)	4C1	11D1	Semi-annually	Gamma scan/on collection
f. Beef	3E1		Semi-annually	Gamma scan/on collection
g. Fodder Crops	3E1 2F7 13E3 5F2 11F3 14F1	3G1	Annually	Gamma scan/on collection

TABLE 1 (cont'd)

1986 ARTIFICIAL ISLAND RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

MEDIUM	STATION CODE INDICATOR	STATION CODE CONTROL	COLLECTION FREQUENCY	TYPE/FREQUENCY* OF ANALYSIS
h. Soil	6S1 5D1 2E1 1F1 10D1 16E1 2F1 2F2 2F4 2F7 5F1 5F2 11F3 14F1	3G1 3H3	Collected from each location once every three years.	Sr-90/on collection Gamma scan/on collection
IV. AQUATIC ENVIRONMENT				
a. Surface Water	11A1 7E1 1F2 16F1	12C1	Monthly	Gross alpha/monthly Gross beta/monthly Gamma scan/monthly Tritium/quarterly
b. Edible Fish	11A1 7E1	12C1	Semi-annually	Tritium (flesh) Aqueous fraction/on collection Sr-89 & Sr-90 (bones)/on collection Gamma scan (flesh)/on collection
c. Blue Crabs	11A1	12C1	Semi-annually	Tritium (flesh)/on collection Sr-89 & Sr-90 (shell)/on collection Sr-89 & Sr-90 (flesh)/on collection Gamma scan (flesh)/on collection

TABLE 1 (cont'd)

1986 ARTIFICIAL ISLAND RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

MEDIUM	STATION CODE		COLLECTION FREQUENCY	TYPE/FREQUENCY* OF ANALYSIS
	INDICATOR	CONTROL		
d. Benthic Organisms	11A1 7E1 16F1	12C1	Semi-annually	Gamma scan/on collection
e. Sediment	11A1 7E1 16F1 15A1 16A1	12C1	Semi-annually	Sr-90/on collection Gamma scan/on collection

* Except for TLDs, the quarterly analysis is performed on a composite of individual samples collected during the quarter.

** Management audit analyses, not required by Technical Specifications or by specific commitments to local officials.

*** Station 2F7 replaced station 2F4 (terminated milk production) on September 1, 1986.

FIGURE 1
COMPARISON OF AVERAGE CONCENTRATIONS OF BETA EMITTERS IN PRECIPITATION AND AIR PARTICULATES 1973 THROUGH 1986

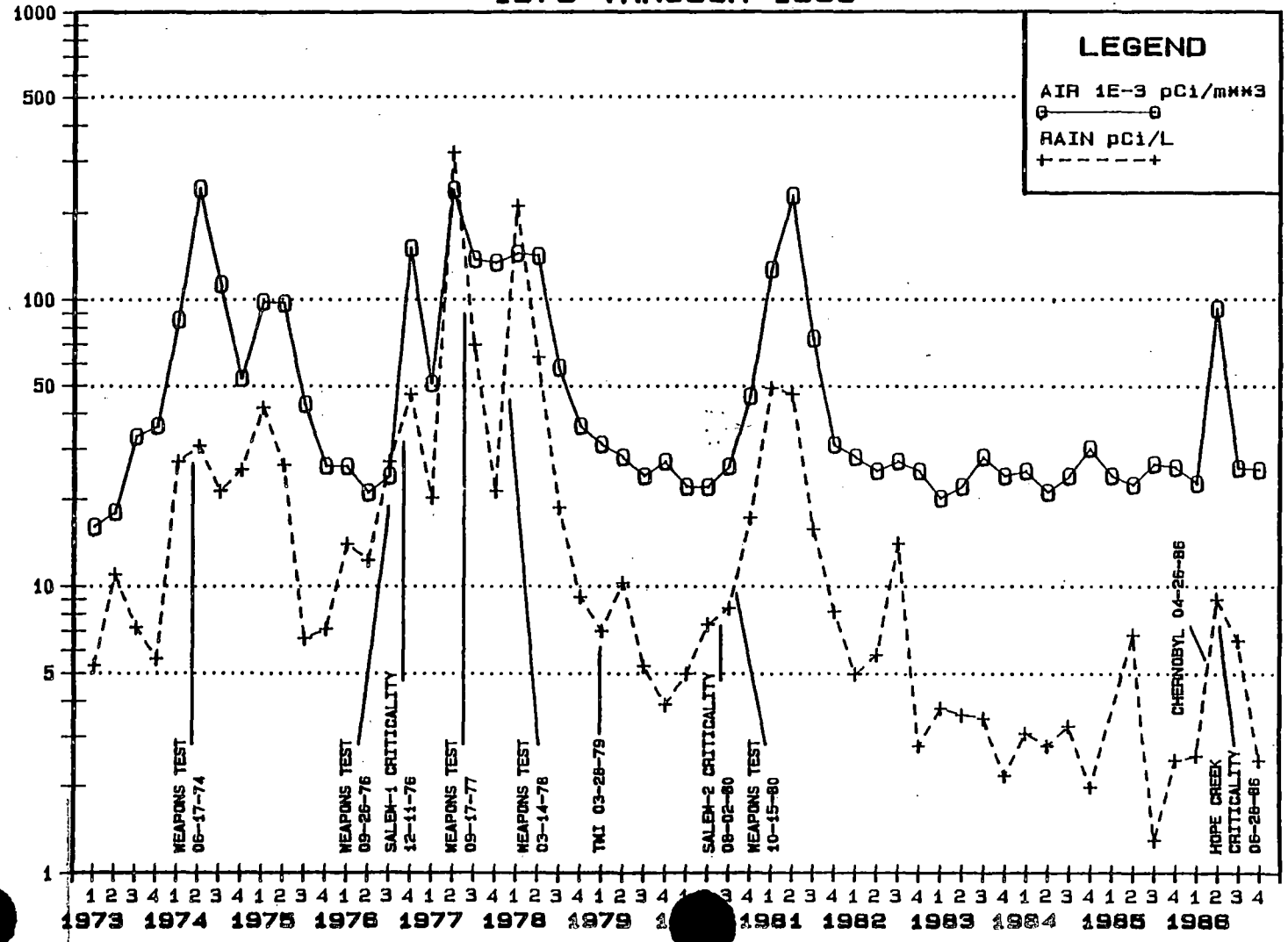


FIGURE 1A
COMPARISION OF AVERAGE CONCENTRATIONS OF BETA EMITTERS IN PRECIPITATION AND IN AIR PARTICULATES 1983 THROUGH 1986

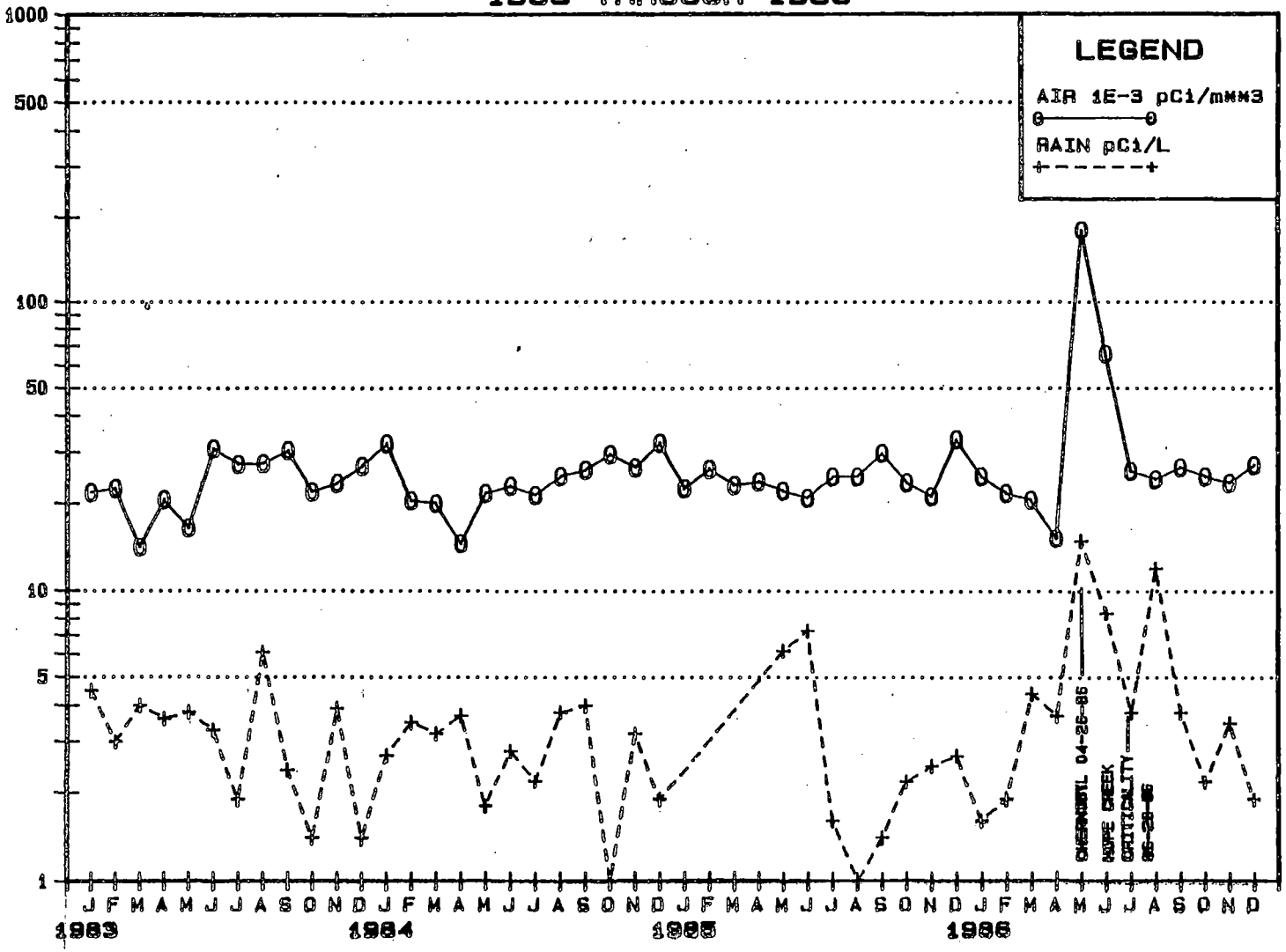


FIGURE 2
AVERAGE AMBIENT RADIATION LEVELS FROM QUARTERLY TLDS IN THE VICINITY OF ARTIFICIAL ISLAND 1973 THROUGH 1986

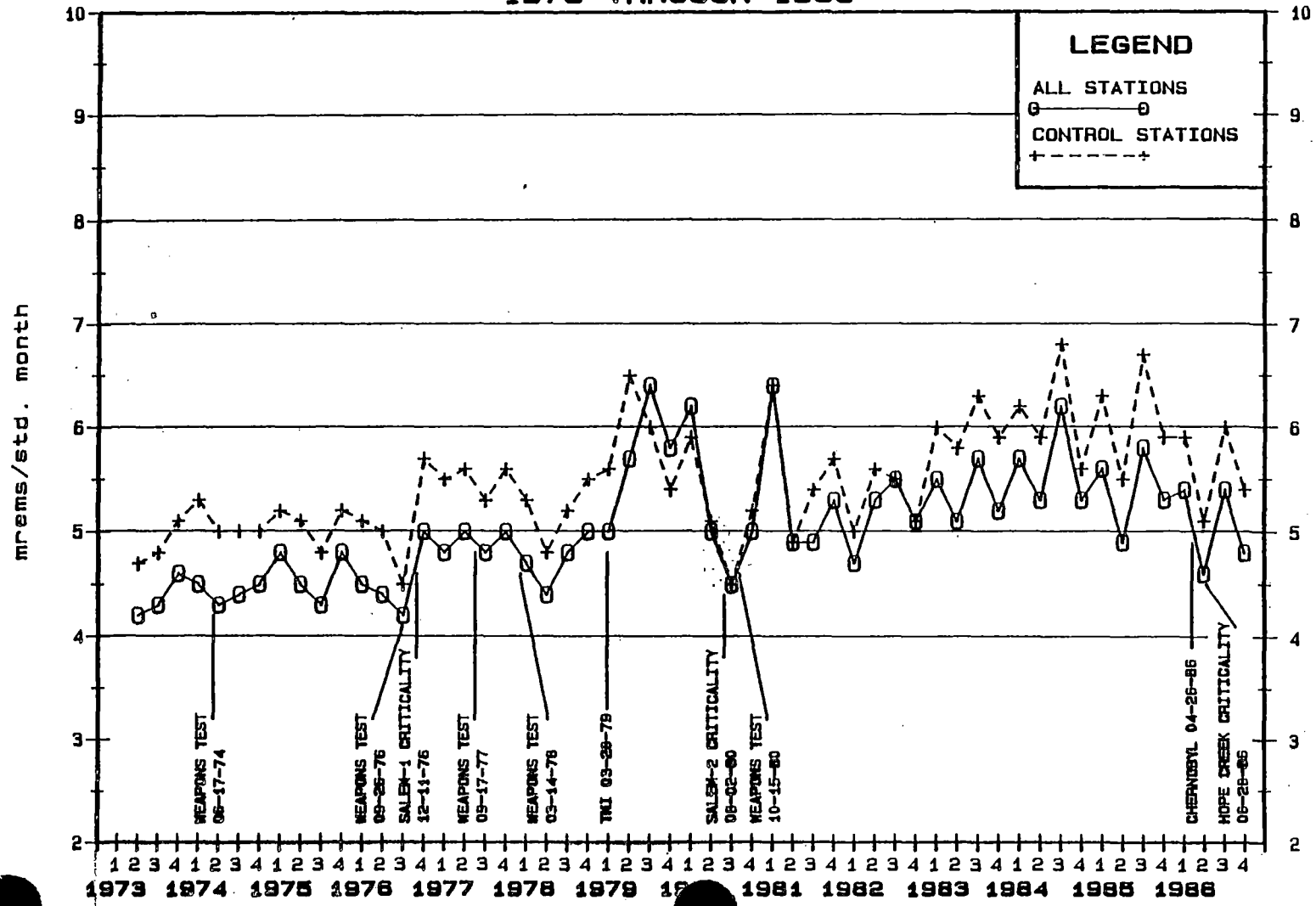


FIGURE 2A
COMPARISON OF AMBIENT RADIATION LEVELS OF OFF-SITE INDICATOR STATIONS VS. CONTROL STATIONS 1982 THROUGH 1986

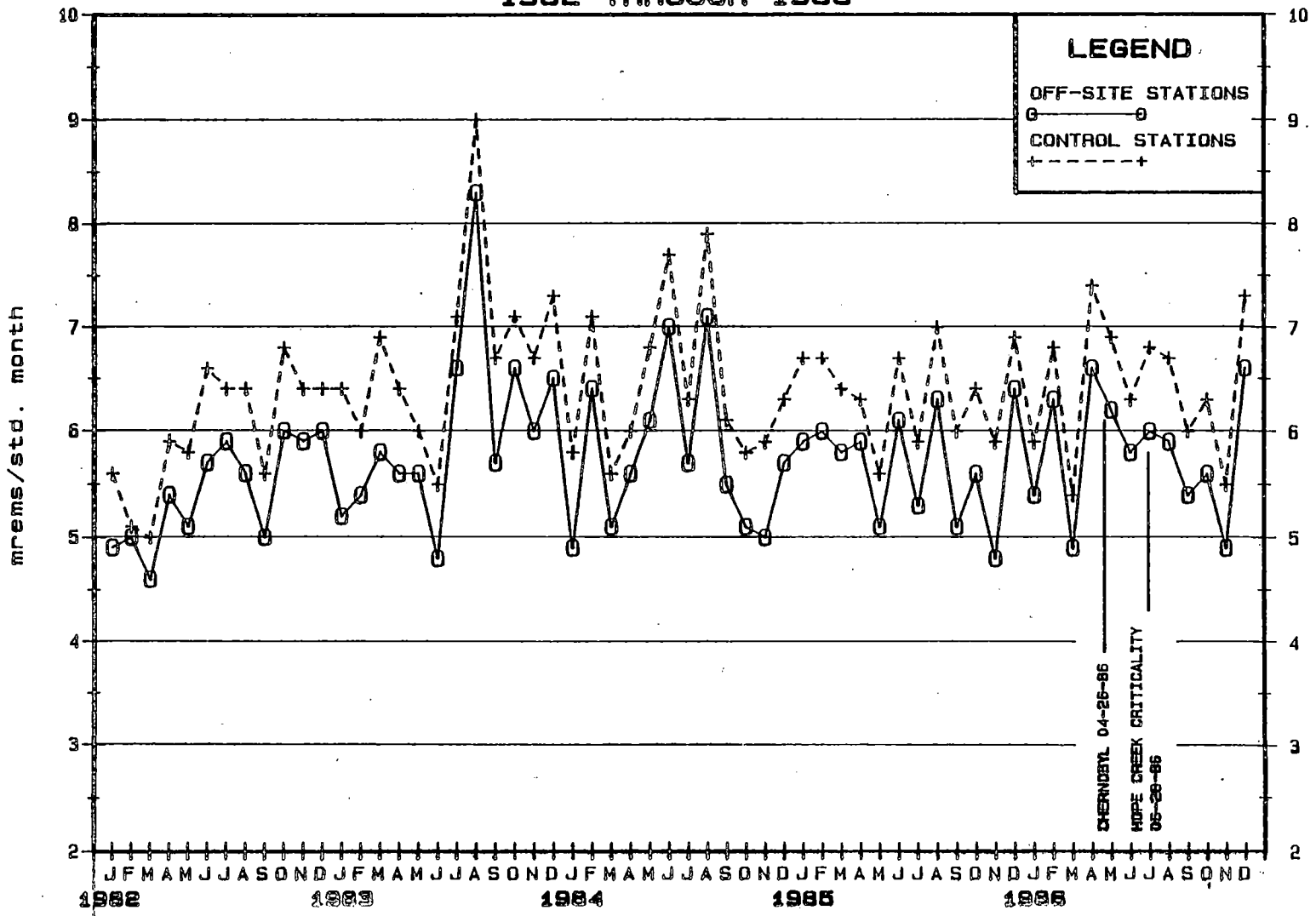


FIGURE 3
AVERAGE CONCENTRATIONS OF IODINE-131 IN MILK IN THE VICINITY OF ARTIFICIAL ISLAND 1974 THROUGH 1986

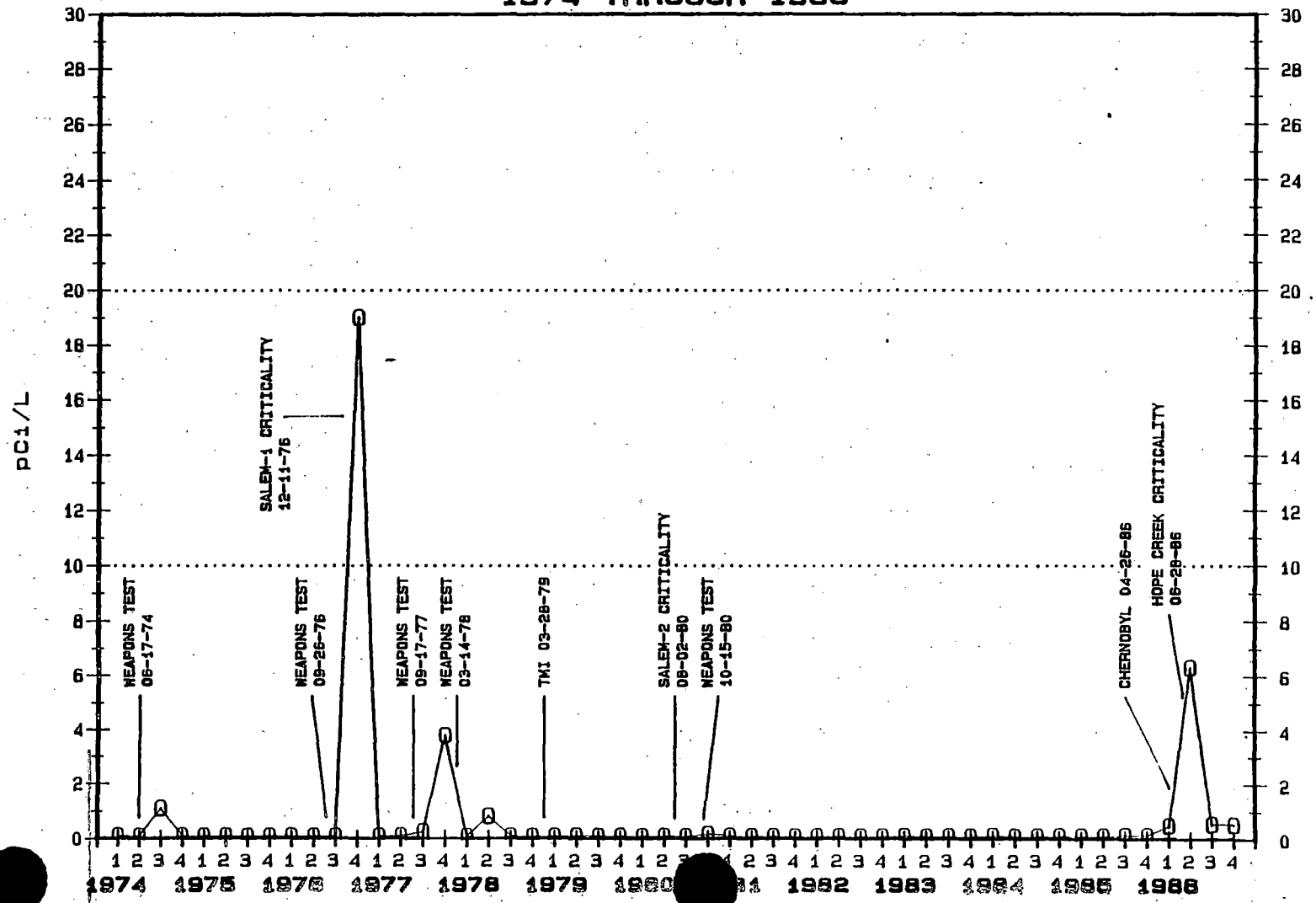


FIGURE 3A
AVERAGE CONCENTRATIONS OF IODINE-131 IN MILK IN THE VICINITY OF ARTIFICIAL ISLAND 1983 THROUGH 1986

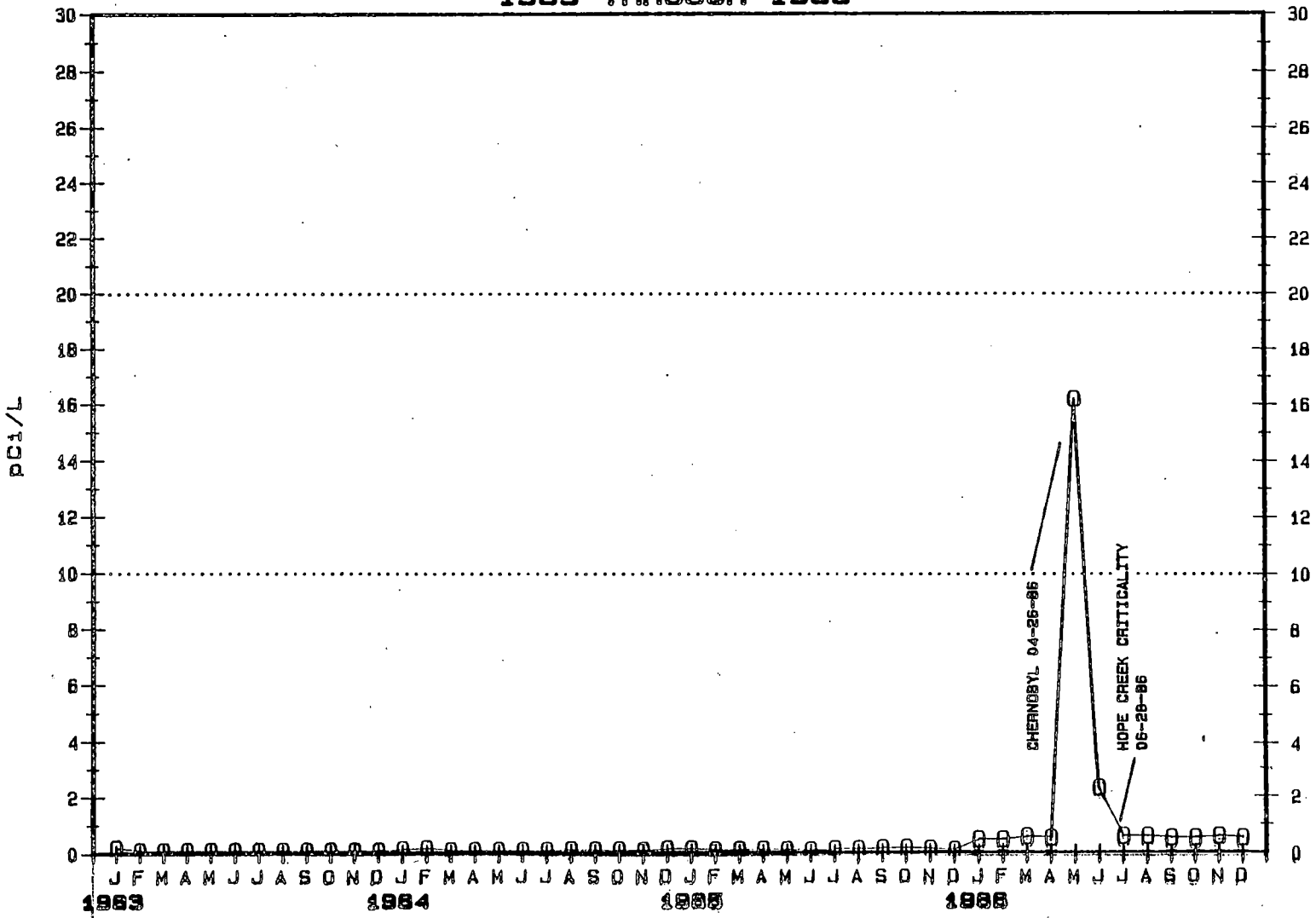


FIGURE 4
AVERAGE CONCENTRATIONS OF BETA EMITTERS & K-40 IN THE DEL. RIVER IN THE VICINITY OF ARTIFICIAL ISL.
1973 THROUGH 1986

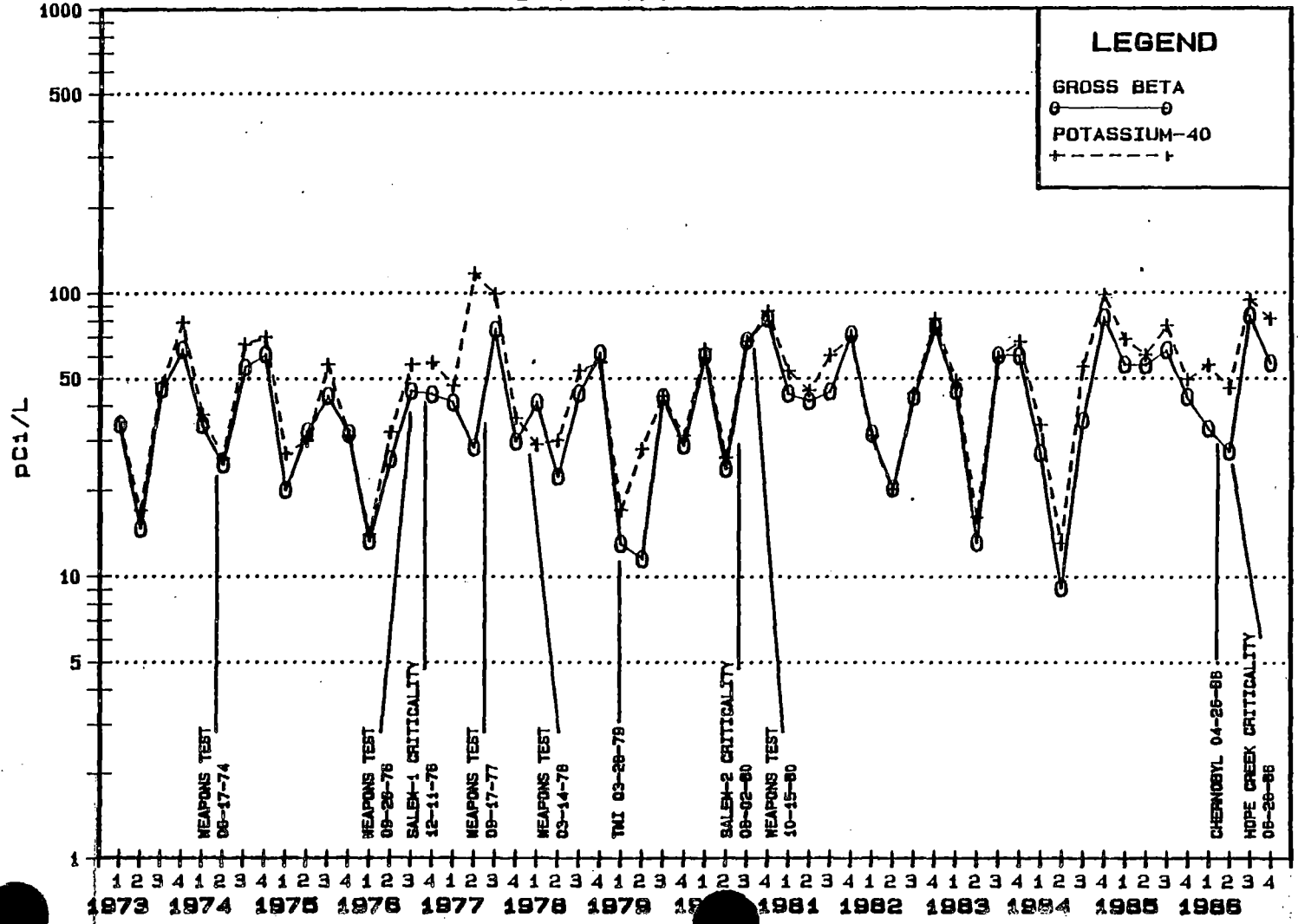


FIGURE 4A
AVERAGE CONCENTRATIONS OF BETA EMITTERS & K-40 IN THE DEL. RIVER IN THE VICINITY OF ARTIFICIAL ISL.
1983 THROUGH 1986

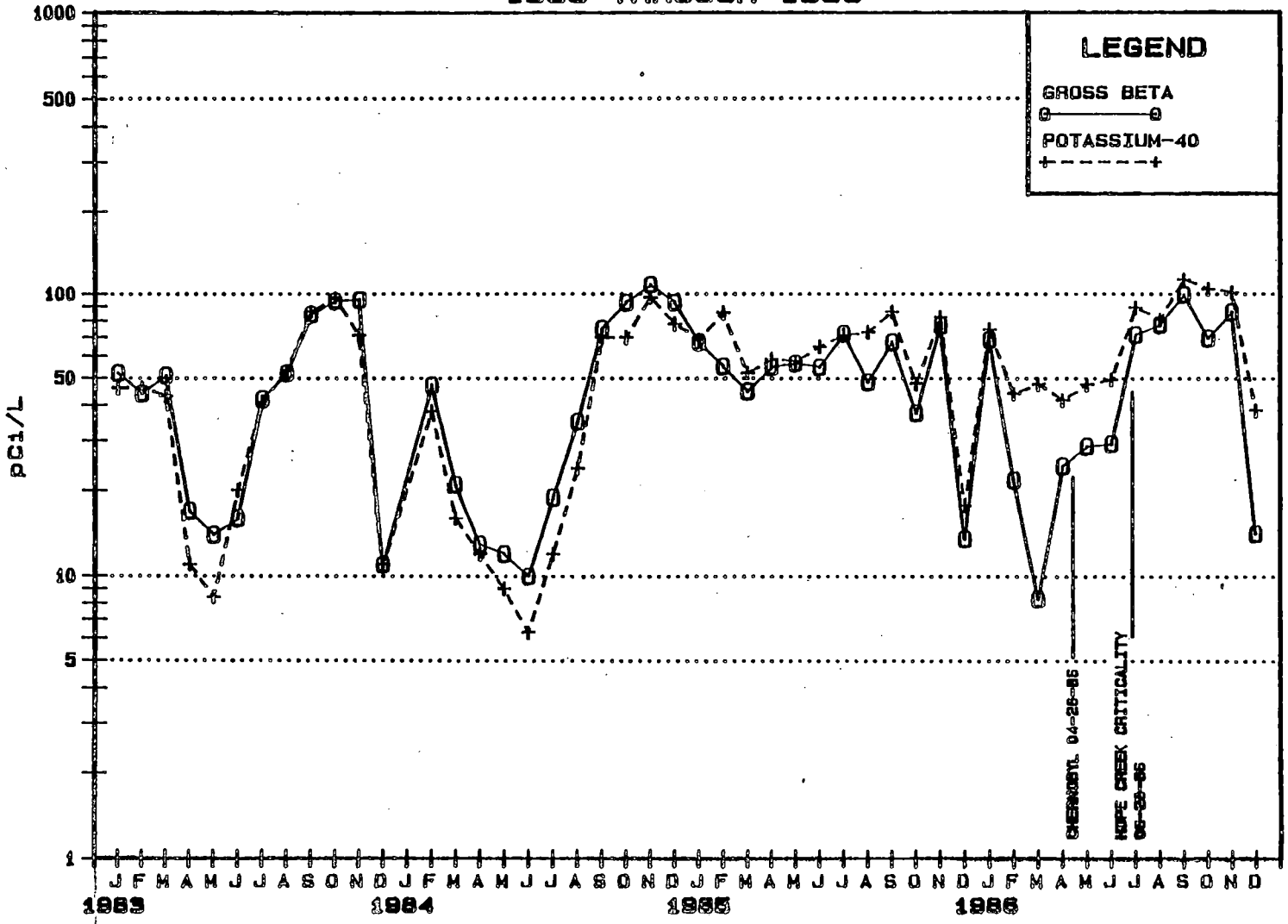


FIGURE 5
AVERAGE CONCENTRATIONS OF TRITIUM IN THE DELAWARE RIVER IN THE VICINITY OF ARTIFICIAL ISL. 1973 THROUGH 1986

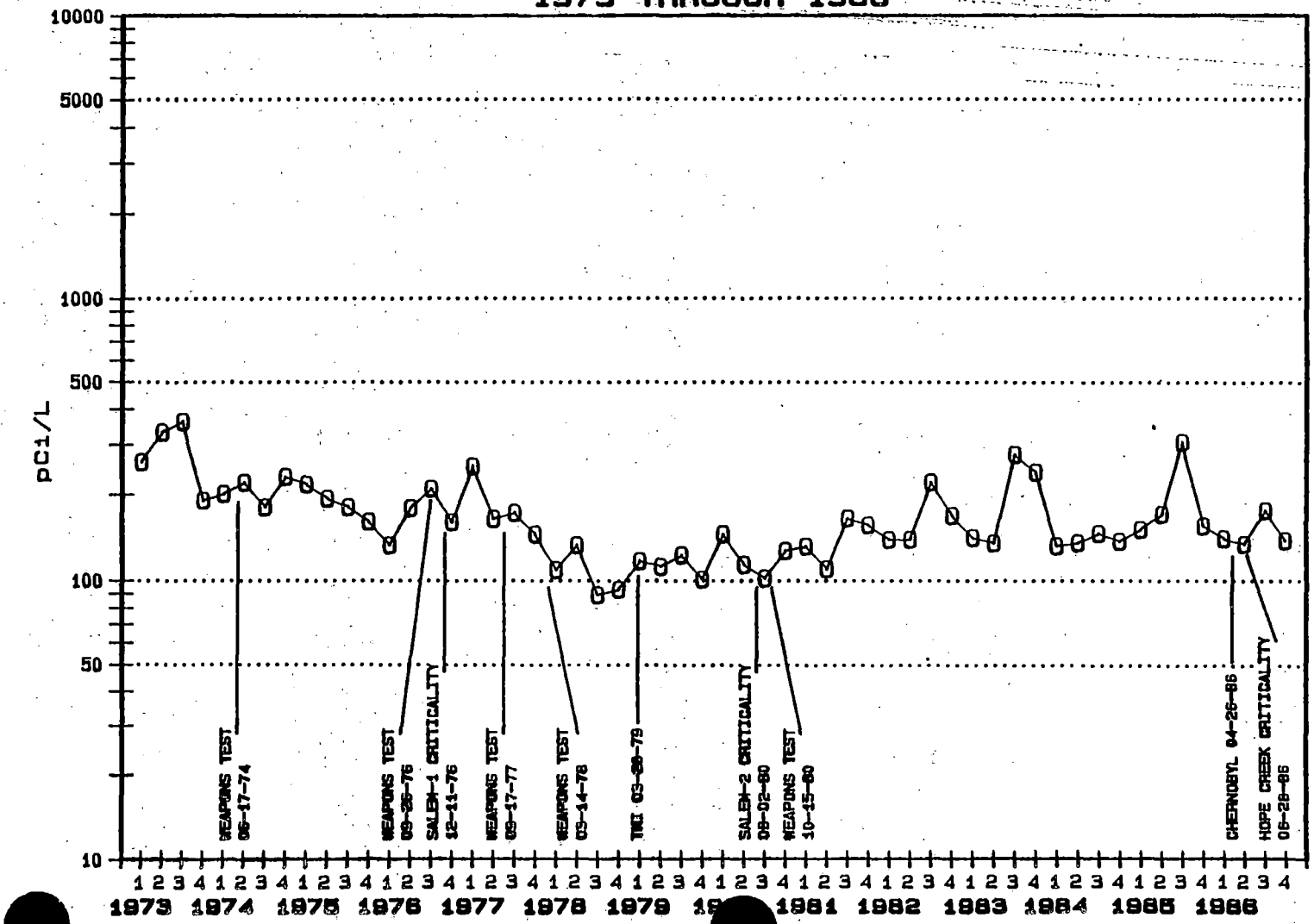
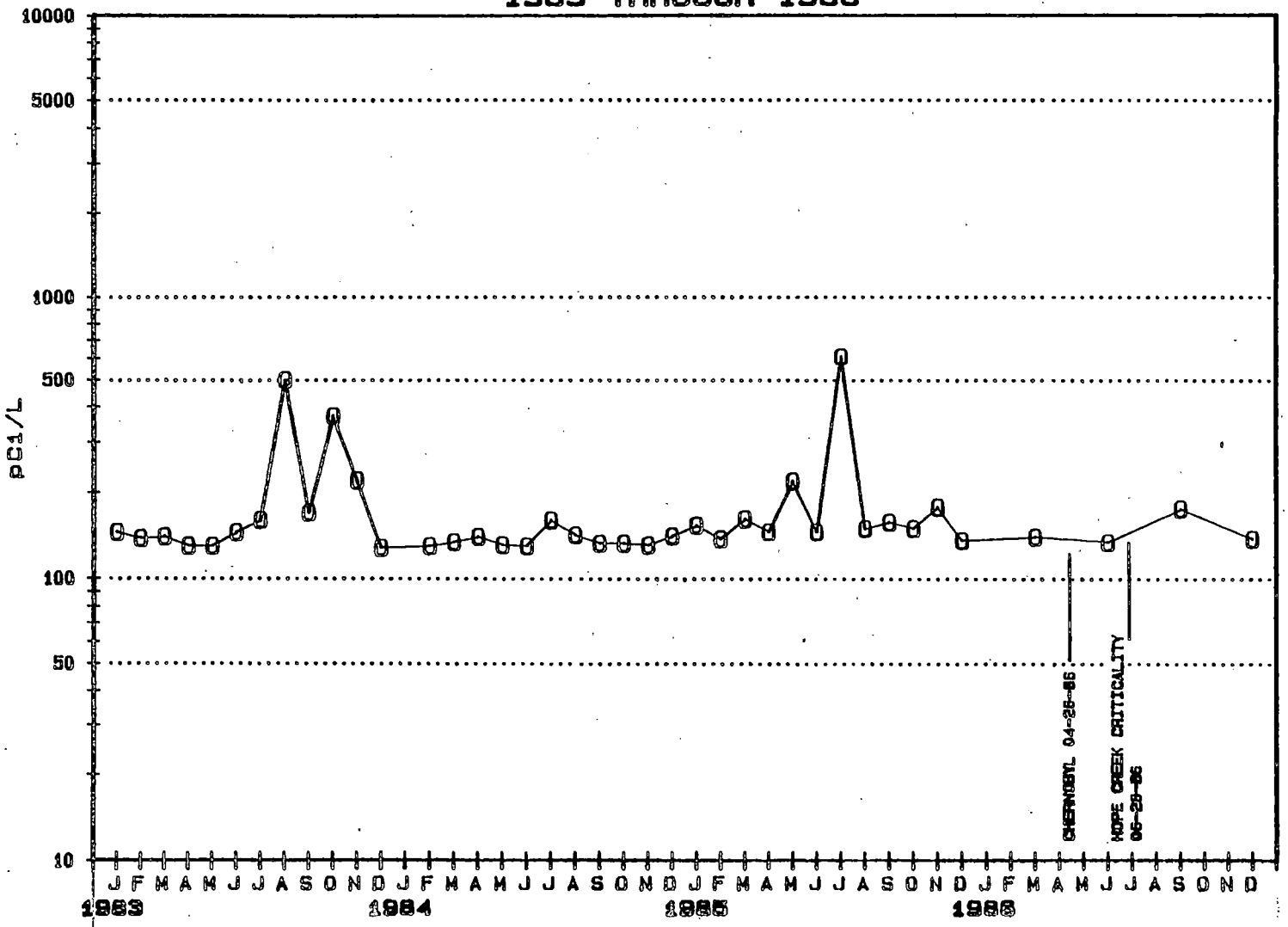


FIGURE 5A
AVERAGE CONCENTRATIONS OF TRITIUM IN THE
DELAWARE RIVER IN THE VICINITY OF ARTIFICIAL ISL.
1983 THROUGH 1986



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APPENDIX A

PROGRAM SUMMARY

ARTIFICIAL ISLAND RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

SALEM GENERATING STATION — DOCKET NOS. 50-272/-311
HOPE CREEK GENERATING STATION — DOCKET NO. 50-354

SALEM COUNTY, NEW JERSEY — JANUARY 1, 1986 to DECEMBER 31, 1986

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED		LOWER LIMIT OF DETECTION (LLD)*	ALL INDICATOR LOCATIONS MEAN** (RANGE)	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION		MEAN (RANGE)	CONTROL LOCATION MEAN (RANGE)	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Air Particulates (10^{-3} pCi/m^3)	Alpha	416	0.8	2.8 (311/364) (0.8-22)	2S2	0.4 mi NNE	3.1 (46/62) (0.9-22)	2.8 (48/62) (1.0-20)	0
	Beta	416	-	41 (359/364) (6.7-370)	2S2	0.4 mi NNE	45 (60/62) (9.4-350)	42 (51/62) (11-330)	0
	Sr-89	8	0.3	<LLD		-	<LLD	<LLD	0
	Sr-90	8	0.2	<LLD		-	<LLD	<LLD	0
	Gamma								
	Be-7	32	-	77 (28/28) (60-110)	5D1	3.5 mi E	91 (4/4) (80-110)	75 (4/4) (64-90)	0
	Ru-103	32	0.1	8.5 (7/28) (7.5-9.2)	5D1	3.5 mi E	9.2 (1/4) (9.2)	7.6 (1/4) (7.6)	0
	Ru-106	32	1.5	5.5 (3/28) (4.0-8.3)	1F1	5.8 mi N	8.3 (1/4) (8.3)	4.0 (1/4) (4.0)	0
	Cs-134	32	0.3	9.3 (7/28) (8.4-10)	1F1	5.8 mi N	10 (1/4) (10)	9.2 (1/4) (9.2)	0
					2F2	8.7 mi NNE	10 (1/4) (10)		
	Cs-137	32	0.3	17 (7/28) (16-18)	2S2	0.4 mi NNE	18 (1/4) (18)	17 (1/4) (17)	0
					5D1	3.5 mi E	18 (1/4) (18)		
	Ra-226	32	0.3	1.2 (1/28) (1.2)	1F1	5.8 mi N	1.2 (1/4) (1.2)	<LLD	0
	Th-232	28	1.1	1.7 (1/24) (1.7)	1F1	5.8 mi N	1.7 (1/4) (1.7)	<LLD	0

ARTIFICIAL ISLAND RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

SALEM GENERATING STATION — DOCKET NOS. 50-272/-311
HOPE CREEK GENERATING STATION — DOCKET NO. 50-354

SALEM COUNTY, NEW JERSEY — JANUARY 1, 1986 to DECEMBER 31, 1986

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED		LOWER LIMIT OF DETECTION (LLD)*	ALL INDICATOR LOCATIONS MEAN** (RANGE)	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION		MEAN (RANGE)	CONTROL LOCATION MEAN (RANGE)	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Air Iodine (10^{-3} pCi/m^3)	I-131	416	7.7	150 (27/364) (25-320)	16E1	4.1 mi NNW	190 (3/52) (70-300)	170 (4/61) (64-320)	0
Precipitation (pCi/L)	Alpha	12	0.3	1.0 (4/12) (0.6-1.3)	2F2	8.7 mi NNE	1.0 (4/12) (0.6-1.3)	No Control Location	0
	Beta	12	1.6	5.5 (11/12) (1.9-15)	2F2	8.7 mi NNE	5.5 (11/12) (1.9-15)	No Control Location	0
	H-3	12	130	<LLD	-		<LLD	No Control Location	0
	Gamma								
	Be-7	11	-	47 (11/11) (35-71)	2F2	8.7 mi NNE	47 (11/11) (35-71)	No Control Location	0
	K-40	11	25	69 (1/11) (69)	2F2	8.7 mi NNE	69 (1/11) (69)	No Control Location	0
	I-131	11	1.5	7.4 (1/11) (7.4)	2F2	8.7 mi NNE	7.4 (1/11) (7.4)	No Control Location	0
	Cs-137	11	0.8	4.8 (1/11) (4.8)	2F2	8.7 mi NNE	4.8 (1/11) (4.8)	No Control Location	0
	Ra-226	11	4.2	5.6 (3/11) (4.8-7.0)	2F2	8.7 mi NNE	5.6 (3/11) (4.8-7.0)	No Control Location	0
	Th-232	11	7.2	7.5 (1/11) (7.5)	2F2	8.7 mi NNE	7.5 (1/11) (7.5)	No Control Location	0

ARTIFICIAL ISLAND RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

SALEM GENERATING STATION — DOCKET NOS. 50-272/-311
HOPE CREEK GENERATING STATION — DOCKET NO. 50-354

SALEM COUNTY, NEW JERSEY — JANUARY 1, 1986 to DECEMBER 31, 1986

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED	LOWER LIMIT OF DETECTION (LLD)*	ALL INDICATOR LOCATIONS MEAN** (RANGE)	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	MEAN (RANGE)	CONTROL LOCATION MEAN (RANGE)	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Direct Radiation (mrad/std. month)	Gamma Dose (monthly) 287	-	6.9 (251/251) (3.8 - 7.7)	7S1 0.1 mi SE	6.9 (12/12) (5.9-7.7)	6.4 (36/36) (5.1-7.6)	0
	Gamma Dose (qtrly.) 164		6.0 (140/140) (3.4-6.7)	7S1 0.1 mi SE	6.0 (4/4) (5.6-6.6)	5.6 (24/24) (4.9-6.4)	0
Milk (pCi/L)	I-131 122	0.1	10 (16/103) (0.2-47)	3G1 17 mi NE	19 (3/19) (0.3-63)	19 (3/19) (0.3-63)	0
	Sr-89 7	0.8	<LLD	-	<LLD	<LLD	0
	Sr-90 7	-	2.0 (6/6) (1.2-3.0)	6F2 7.0 mi E	3.0 (1/1) (3.0)	2.7 (1/1) (2.7)	0
	Gamma						
	Na-22 121	1.0	4.6 (1/102) (4.6)	6F2 7.0 mi E	4.6 (1/20) (4.6)	<LLD	0
	K-40 121	-	1400 (102/102) (1200-1500)	2F4 6.3 mi NNE	1400(13/13) (1300-1500)	1300 (19/19) (1100-1400)	0
	Mn-54 121	0.7	2.9 (1/102) (2.9)	13E3 4.9 mi W	2.9 (1/20) (2.9)	<LLD	0
	Zn-65 121	1.8	11 (1/102) (11)	11F3 5.3 mi SW	11 (1/20) (11)	<LLD	0
	I-131 121	0.6	20 (8/102) (3.8-49)	3G1 17 mi NE	36 (2/19) (7.4-65)	36 (2/19) (7.4-65)	0
	Cs-137 121	2.3	4.1 (5/102) (3.3-5.1)	6F2 7.0 mi E	4.6 (2/20) (3.9-5.1)	<LLD	0
	Ra-226 121	5.1	5.6 (3/102) (4.4-7.3)	14F1 5.5 mi WNW	5.8 (2/20) (4.4-7.3)	5.5 (1/19) (5.5)	0

ARTIFICIAL ISLAND RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

SALEM GENERATING STATION — DOCKET NOS. 50-272/-311
HOPE CREEK GENERATING STATION — DOCKET NO. 50-354

SALEM COUNTY, NEW JERSEY — JANUARY 1, 1986 to DECEMBER 31, 1986

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED		LOWER LIMIT OF DETECTION (LLD)*	ALL INDICATOR LOCATIONS MEAN** (RANGE)	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	MEAN (RANGE)	CONTROL LOCATION MEAN (RANGE)	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Well Water (pCi/L)	Alpha	36	0.6	1.2 (7/24) (0.6-2.0)	2S3 700 ft NNE	1.2 (4/12) (0.7-1.7)	<LLD	0
	Beta	36	1.0***	7.6 (24/24) (2.0-16)	6D1 3.6 mi E	10 (12/12) (2.0-16)	7.4 (12/12) (2.6-9.6)	0
	K-40	36	-	8.7 (24/24) (2.7-16)	6D1 3.6 mi E	13 (12/12) (8.8-16)	9.4 (12/12) (7.4-17)	0
	H-3	36	130	<LLD	-	<LLD	<LLD	0
	Sr-89	12	0.4	<LLD	-	<LLD	<LLD	0
	Sr-90	12	0.3	<LLD	-	<LLD	<LLD	0
	Gamma							
	K-40	36	21	42 (4/24) (36-47)	6D1 3.6 mi E	42 (4/12) (36-47)	<LLD	0
	Ra-226	36	3.3	29 (17/24) (3.3-96)	3E1 4.1 mi NE	69 (11/12) (2.9-170)	69 (11/12) (2.9-170)	0
	Th-232	36	4.6	9.2 (2/24) (8.4-10)	6D1 3.6 mi E	9.2 (2/12) (8.4-10)	<LLD	0
Potable Water Raw-Treated (pCi/L)	Alpha	24	0.6	0.8 (11/24) (0.6-1.6)	2F3 8.0 mi NNE	0.8 (11/24) (0.6-1.6)	No Control Location	0
	Beta	24	1.0***	3.6 (24/24) (1.7-13)	2F3 8.0 mi NNE	3.6 (24/24) (1.7-13)	No Control Location	0
	K-40	24	-	1.8 (24/24) (1.3-4.9)	2F3 8.0 mi NNE	1.8 (24/24) (1.3-4.9)	No Control Location	0
	H-3	24	130	150 (1/24) (150)	2F3 8.0 mi NNE	150 (1/24) (150)	No Control Location	0

ARTIFICIAL ISLAND RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

SALEM GENERATING STATION — DOCKET NOS. 50-272/-311
HOPE CREEK GENERATING STATION — DOCKET NO. 50-354

SALEM COUNTY, NEW JERSEY — JANUARY 1, 1986 to DECEMBER 31, 1986

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED		LOWER LIMIT OF DETECTION (LLD)*	ALL INDICATOR LOCATIONS MEAN** (RANGE)	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	MEAN (RANGE)	CONTROL LOCATION MEAN (RANGE)	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Potable Water cont'd Raw-Treated (pCi/L)	Sr-89	8	0.5	0.8 (1/8) (0.8)	2F3 8.0 mi NNE	0.8 (1/8) (0.8)	No Control Location	0
	Sr-90	8	0.4	<LLD	-	<LLD	No Control Location	0
	Gamma							
	K-40	24	22	25 (2/24) (25-25)	2F3 8.0 mi NNE	25 (2/24) (25-25)	No Control Location	0
	Ru-103	24	0.5	2.6 (1/24) (2.6)	2F3 8.0 mi NNE	2.6 (1/24) (2.6)	No Control Location	0
	Ra-226	24	3.7	5.9 (3/24) (2.6-8.4)	2F3 8.0 mi NNE	5.9 (3/24) (2.6-8.4)	No Control Location	0
	Th-232	24	4.9	6.1 (3/24) (5.7-6.8)	2F3 8.0 mi NNE	6.1 (3/24) (5.7-6.8)	No Control Location	0
Fruit & Vegetables (pCi/kg-wet)	Gamma							
	Be-7	20	11	24 (1/12) (24)	4F1 5.1 mi ENE	24 (1/2) (24)	<LLD	0
	K-40	20	-	2100 (12/12) (910-2600)	2G1 12 mi NNE	3400 (1/1) (3400)	2100 (8/8) (1500-3400)	0
	I-131	20	2.3	33 (1/12) (33)	2G1 12 mi NNE	62 (1/1) (62)	62 (1/8) (62)	0
	Cs-137	20	1.6	<LLD	3H5 25 mi NE	2.1 (1/4) (2.1)	1.8 (2/8) (1.5-2.1)	0
	Ra-226	20	1.8	8.3 (1/12) (8.3)	1G1 10.3 mi N	68 (1/3) (68)	63 (2/8) (58-68)	0
	Th-232	20	5.5	8.8 (1/12) (8.8)	14F3 5.4 mi WNW	8.8 (1/3) (8.8)	<LLD	0

ARTIFICIAL ISLAND RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

SALEM GENERATING STATION — DOCKET NOS. 50-272/-311
HOPE CREEK GENERATING STATION — DOCKET NO. 50-364

SALEM COUNTY, NEW JERSEY — JANUARY 1, 1986 to DECEMBER 31, 1986

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED		LOWER LIMIT OF DETECTION (LLD)*	ALL INDICATOR LOCATIONS MEAN** (RANGE)	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION		MEAN (RANGE)	CONTROL LOCATION MEAN (RANGE)	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Game (pCi/kg-wet)	Gamma K-40	2	-	2400 (1/1) (2400)	4C1	2.8 mi ENE	2400 (1/1) (2400)	2200 (1/1) (2200)	0
Beef (pCi/kg-wet)	Gamma K-40	1	-	2600 (1/1) (2600)	3E1	4.1 mi NE	2600 (1/1) (2600)	No Control Location	0
	Cs-137	1	-	7.3 (1/1) (7.3)	3E1	4.1 mi NE	7.3 (1/1) (7.3)	No Control Location	0
Fodder Crops (pCi/kg-wet)	Gamma Be-7	9	140	880 (4/7) (370-1400)	14F1	5.6 mi WNW	1400 (1/1) (1400)	1100 (1/2) (1100)	0
	K-40	9	-	6600 (7/7) (2300-15000)	3E1	4.1 mi NE	15000 (1/1) (15000)	8600 (2/2) (3000-14000)	0
	Cs-137	9	17	<LLD	3G1	17 mi NE	13 (1/2) (13)	13 (1/2) (13)	0
	Ra-226	9	36	36 (1/7) (36)	2F7	5.7 mi NNE	36 (1/1) (36)	<LLD	0
	Th-232	9	59	170 (1/7) (170)	14F1	5.6 mi WNW	170 (1/1) (170)	<LLD	0

ARTIFICIAL ISLAND RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

SALEM GENERATING STATION — DOCKET NOS. 50-272/-311
HOPE CREEK GENERATING STATION — DOCKET NO. 50-354

SALEM COUNTY, NEW JERSEY — JANUARY 1, 1986 to DECEMBER 31, 1986

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED		LOWER LIMIT OF DETECTION (LLD)*	ALL INDICATOR LOCATIONS MEAN** (RANGE)	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION		MEAN (RANGE)	CONTROL LOCATION MEAN (RANGE)	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Soil (pCi/kg-dry)	Sr-90	16	22	91 (13/14) (27-140)	2F1	6.0 mi NNE	140 (1/1) (140)	93 (2/2) (56-130)	0
	Gamma								
	K-40	16	-	7800 (14/14) (3200-13000)	11F3	6.3 mi SW	13000 (1/1) (13000)	8600 (2/2) (7900-9200)	0
	Nb-95	16	4.6	48 (2/14) (34-63)	2F7	6.7 mi NNE	63 (1/1) (63)	<LLD	0
	Cs-137	16	-	390 (14/14) (78-1600)	1F1	6.8 mi N	1600 (1/1) (1600)	460 (2/2) (210-690)	0
	Ra-226	16	-	680 (14/14) (260-1000)	16E1	4.1 mi NNW	1000 (1/1) (1000)	810 (2/2) (770-850)	0
					11F3	5.3 mi SW	1000 (1/1) (1000)		
	Th-232	16	-	710 (14/14) (270-1200)	16E1	4.1 mi NNW	1200 (1/1) (1200)	800 (2/2) (780-810)	0
Surface Water (pCi/L)	Alpha	60	0.6	3.1 (19/48) (0.7-12)	1F2	7.1 mi N	6.6 (3/12) (2.6-12)	3.6 (4/12) (1.8-8.3)	0
	Beta	60	3.8***	61 (48/48) (2.4-130)	7E1	4.6 mi SE	76 (12/12) (16-130)	46 (12/12) (7.6-81)	0
	H-3	20	130	160 (8/16) (130-270)	11A1	0.2 mi SW	210 (2/4) (150-270)	150 (1/4) (150)	0

ARTIFICIAL ISLAND RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

SALEM GENERATING STATION — DOCKET NOS. 50-272/-311
HOPE CREEK GENERATING STATION — DOCKET NO. 50-354

SALEM COUNTY, NEW JERSEY — JANUARY 1, 1986 to DECEMBER 31, 1986

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED		LOWER LIMIT OF DETECTION (LLD)*	ALL INDICATOR LOCATIONS MEAN** (RANGE)	LOCATION WITH HIGHEST MEAN DISTANCE	NAME AND DIRECTION	MEAN (RANGE)	CONTROL LOCATION MEAN (RANGE)	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Surface Water cont'd.	Gamma								
	K-40	60	24	88 (34/48) (33-160)	7E1	4.6 mi SE	100 (12/12) (66-160)	70 (9/12) (29-96)	0
	Ra-226	60	3.3	6.6 (7/48) (2.6-11)	12C1	2.6mi WSW	26 (1/12) (26)	26 (1/12) (26)	0
	Th-232	60	4.9	7.4 (6/48) (6.3-9.3)	12C1	2.6 mi WSW	9.2 (1/12) (9.2)	9.2 (1/12) (9.2)	0
Edible Fish (pCi/kg-dry)	Sr-89 (bones)	6	40	<LLD	12C1	2.6 mi WSW	330 (1/2) (330)	330 (1/2) (330)	0
	Sr-90 (bones)	6	24	140 (2/4) (34-240)	12C1	2.6 mi WSW	1600 (1/2) (1600)	1600 (1/2) (1600)	0
(pCi/kg-wet)	H-3 (aqueous)	6	60	<LLD	-		<LLD	<LLD	0
	Gamma								
	K-40	6	-	3000 (4/4) (2700-3300)	11A1	0.2 mi SW	3000 (2/2) (2700-3300)	3000 (2/2) (2700-3300)	0
					12C1	2.6 mi WSW	3000 (2/2) (2700-3300)		
	Cs-137	6	12	8.3 (1/4) (8.3)	11A1	0.2 mi SW	8.3 (1/2) (8.3)	<LLD	0
	Ra-226	6	20	37 (2/4) (33-41)	11A1	0.2 mi SW	41 (1/2) (41)	<LLD	0
	Th-232	6	31	<LLD	12C1	2.6 mi WSW	29 (1/2) (29)	29 (1/2) (29)	0

ARTIFICIAL ISLAND RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

SALEM GENERATING STATION — DOCKET NOS. 50-272/-311
HOPE CREEK GENERATING STATION — DOCKET NO. 50-354

SALEM COUNTY, NEW JERSEY — JANUARY 1, 1986 to DECEMBER 31, 1986

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED		LOWER LIMIT OF DETECTION (LLD)*	ALL INDICATOR LOCATIONS MEAN** (RANGE)	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION		MEAN (RANGE)	CONTROL LOCATION MEAN (RANGE)	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Blue Crabs (pCi/kg-dry)	Sr-89 (shells)	4	67	300 (1/2) (300)	11A1	0.2 mi SW	300 (1/2) (300)	<LLD	0
	Sr-90 (shells)	4	-	260 (2/2) (150-380)	12C1	2.5 mi WSW	400 (2/2) (320-490)	400 (2/2) (320-490)	0
(pCi/kg-wet)	H-3 (aqueous)	4	50	<LLD		-	<LLD	<LLD	0
	Sr-89 (flesh)	4	28	<LLD		-	<LLD	<LLD	0
	Sr-90 (flesh)	4	18	<LLD		-	<LLD	<LLD	0
	Gamma								
	K-40	4	-	1800 (2/2) (1700-2000)	11A1	0.2 mi SW	1800 (2/2) (1700-2000)	1800 (2/2) (1700-2000)	0
					12C1	2.5 mi WSW	1800 (2/2) (1700-2000)		
	Ra-226	4	28	<LLD	12C1	2.5 mi WSW	20 (2/2) (19-20)	20 (2/2) (19-20)	0
Benthic Organisms (pCi/kg-dry)	Gamma	8	-	<LLD		-	<LLD	<LLD	0

ARTIFICIAL ISLAND RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

SALEM GENERATING STATION — DOCKET NOS. 50-272/-311
HOPE CREEK GENERATING STATION — DOCKET NO. 50-354

SALEM COUNTY, NEW JERSEY — JANUARY 1, 1986 to DECEMBER 31, 1986

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED		LOWER LIMIT OF DETECTION (LLD)*	ALL INDICATOR LOCATIONS MEAN** (RANGE)	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	MEAN (RANGE)	CONTROL LOCATION MEAN (RANGE)	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Sediment (pCi/kg-dry)	Sr-90	12	19	<LLD	-	<LLD	<LLD	0
	Gamma							
	K-40	12	-	9600 (10/10) (3500-16000)	16F1 6.9 mi NNW	16000 (2/2) (15000-16000)	15000 (2/2) (14000-16000)	0
	Mn-54	12	18	26 (3/10) (24-29)	11A1 0.2 mi SW	27 (2/2) (25-29)	<LLD	0
	Co-58	12	23	57 (4/10) (31-80)	16A1 0.3 mi NW	80 (1/2) (80)	<LLD	0
	Co-60	12	36	72 (8/10) (37-110)	11A1 0.2 mi SW	100 (2/2) (92-110)	<LLD	0
	Cs-134	12	16	61 (3/10) (46-82)	16A1 0.7 mi NNW	82 (1/2) (82)	60 (1/2) (60)	0
	Cs-137	12	16	61 (3/10) (49-82)	11A1 0.2 mi SW	82 (1/2) (82)	20 (1/2) (20)	0
	Ra-226	12	-	610 (10/10) (330-810)	16A1 0.7 mi NNW	780 (2/2) (750-810)	700 (2/2) (570-840)	0
	Th-232	12	-	720 (10/10) (300-1000)	16F1 6.9 mi NNW	970 (2/2) (940-1000)	880 (2/2) (870-880)	0

* LLD listed is the lowest calculated LLD during the reporting period.
** Mean calculated using values above LLD only. Fraction of measurements above LLD are in parentheses.
*** Typical LLD value.

APPENDIX B

SAMPLE DESIGNATION AND LOCATIONS

APPENDIX B

SAMPLE DESIGNATION

The PSE&G Research Corporation identifies samples by a three part code. The first two letters are the power station identification code, in this case "SA". The next three letters are for the media sampled.

AIO	=	Air Iodine	IDM	=	Immersion Dose (TLD)
APT	=	Air Particulates	MLK	=	Milk
ECH	=	Hard Shell Blue Crab	PWR	=	Potable Water (Raw)
ESB	=	Benthic Organisms	PWT	=	Potable Water (Treated)
ESF	=	Edible Fish	RWA	=	Rain Water
ESS	=	Sediment	SOL	=	Soil
FPB	=	Beef	SWA	=	Surface Water
FPL	=	Green Leafy Vegetables	VGT	=	Fodder Crops (Various)
FPV	=	Vegetables (Various)	WWA	=	Well Water
GAM	=	Game			

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 sixteen angular sectors of 22.5 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 plant:

S	=	On-site 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,... For example, the designation SA-WWA-5D1 would indicate a sample in the SGS program (SA), consisting of well water (WWA), which had been collected in sector number 5, centered at 90° (due east) with respect to the reactor site at a radial distance of 3 to 4 miles off-site, (therefore, radial distance D). The number 1 indicates that this is sampling station #1 in that particular sector.

SAMPLING LOCATIONS

All 1986 sampling locations and specific information about the individual locations are given in Table B-1. Maps B-1 and B-2 show the locations of sampling stations with respect to the site.

TABLE B-1

STATION CODE	STATION LOCATION	SAMPLE TYPES
2S2	0.4 mi. NNE of vent	AIO,APT,IDM
2S3	700 ft. NNE of vent; fresh water holding tank	WWA
5S1	1.0 mi. E of vent; site access road	AIO,APT,IDM
6S1	0.2 mi. ESE of vent; observation building area	SOL
6S2	0.2 mi. ESE of vent; observation building	IDM
7S1	0.12 mi. SE of vent; station personnel gate	IDM
10S1	0.14 mi. SSW of vent; site shoreline	IDM
11S1	0.09 mi. SW of vent; site shoreline	IDM
11A1	0.2 mi. SW of vent; outfall area	ECH,ESB,ESF, ESS,SWA
15A1	0.3 mi. NW of vent; cooling tower blowdown discharge line outfall	ESS
16A1	0.7 mi. NNW of vent; south storm drain discharge line	ESS
4C1	2.8 mi. ENE of vent	GAM
12C1	2.5 mi. WSW of vent; west bank of Delaware River	ECH,ESB,ESF, ESS,SWA
4D2	3.7 mi. ENE of vent; Alloway Creek Neck Road	IDM
5D1	3.5 mi. E of vent; local farm	AIO,APT,IDM, SOL,WWA
10D1	3.9 mi. SSW of vent; Taylor's Bridge Spur	AIO,APT,IDM,SOL
11D1	3.5 mi. SW of vent	GAM
14D1	3.4 mi. WNW of vent; Bay View, Delaware	IDM

TABLE B-1 (cont'd)

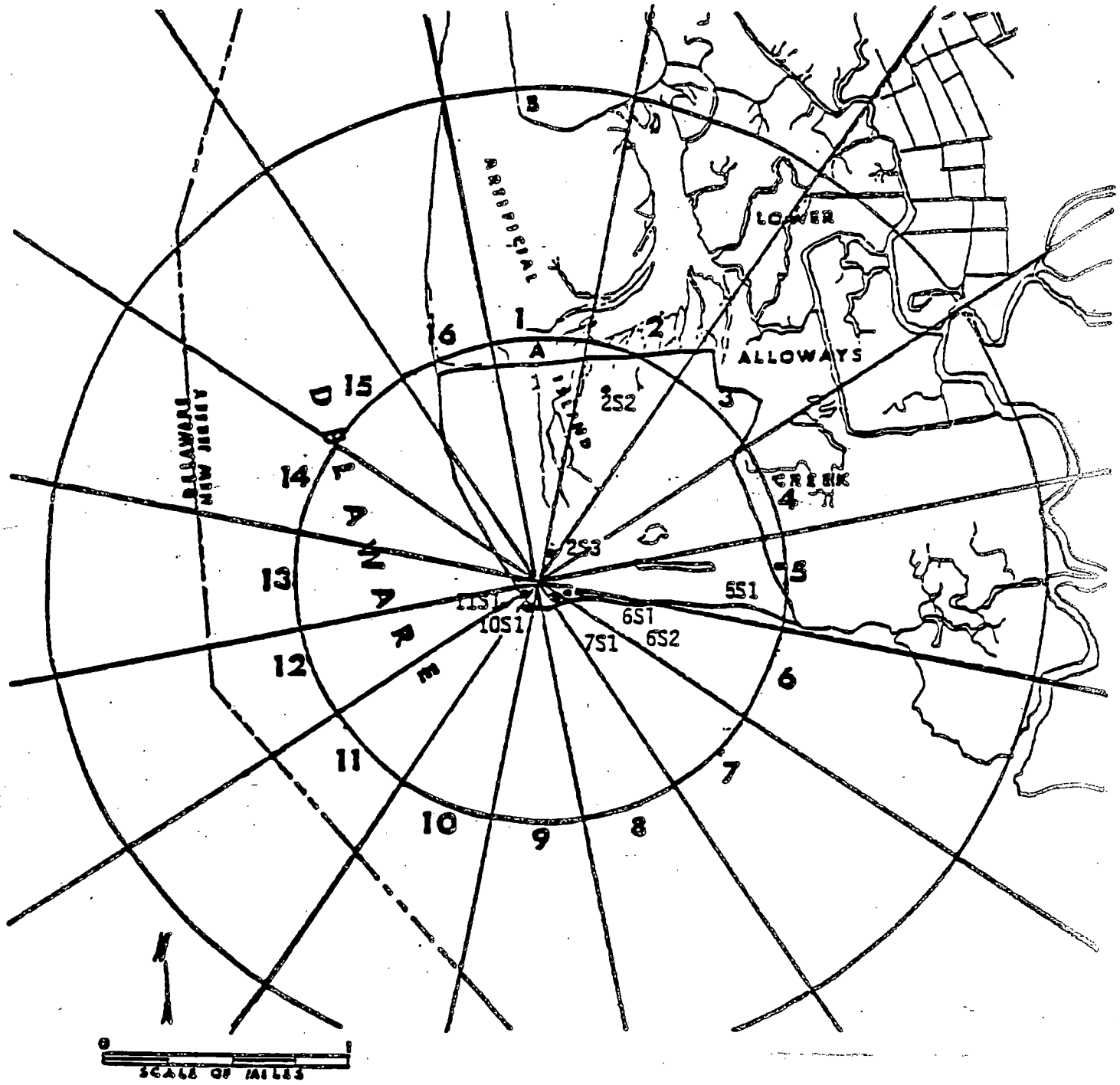
STATION CODE	STATION LOCATION	SAMPLE TYPES
2E1	4.4 mi. NNE of vent; local farm	FPV,IDM,SOL
3E1	4.1 mi. NE of vent; local farm	FPB,FPV,IDM, VGT,WWA
7E1	4.5 mi. SE of vent; 1 mi. W of Mad Horse Creek	ESB,ESF,ESS,SWA
9E1	4.2 mi. S of vent	IDM
11E2	5.0 mi. SW of vent	IDM
12E1	4.4 mi. WSW of vent; Thomas Landing	IDM
13E1	4.2 mi. W of vent; Diehl House Lab	IDM
13E3	4.9 mi. W of vent; local farm	MLK,VGT
16E1	4.1 mi. NNW of vent; Port Penn	AIO,APT,IDM,SOL
1F1	5.8 mi. N of vent; Fort Elfsborg	AIO,APT,IDM,SOL
1F2	7.1 mi. N of vent; midpoint of Delaware River	SWA
1F3	5.9 mi. N of vent; local farm	FPL,FPV
2F1	5.0 mi. NNE of vent; local farm	SOL
2F2	8.7 mi. NNE of vent; Salem Substation	AIO,APT,IDM, RWA,SOL
2F3	8.0 mi. NNE of vent; Salem Water Company	PWR,PWT
2F4	6.3 mi. NNE of vent; local farm	MLK,SOL
2F5	7.4 mi. NNE of vent; Salem High School	IDM
2F6	7.3 mi. NNE of vent; Southern Training Center	IDM
2F7	5.7 mi. NNE of vent; local farm	MLK,SOL,VGT
3F2	5.1 mi. NE of vent; Hancocks Bridge Municipal Building	IDM
3F3	8.6 mi. NE of vent; Quinton Township School	IDM
4F1	5.1 mi. ENE of vent; local farm	FPL,FPV
5F1	6.5 mi. E of vent	FPV,IDM,SOL
5F2	7.0 mi. E of vent; local farm	MLK,VGT,SOL

TABLE B-1 (cont'd)

STATION CODE	STATION LOCATION	SAMPLE TYPES
6F1	6.4 mi. ESE of vent; Stow Neck Road	IDM
7F2	9.1 mi. SE of vent; Bayside, New Jersey	IDM
10F2	5.8 mi. SSW of vent	IDM
11F1	6.2 mi. SW of vent; Taylor's Bridge Delaware	IDM
11F3	5.3 mi. SW of vent; Townsend, Delaware	MLK,SOL,VGT
12F1	9.4 mi. WSW of vent; Townsend Elementary School	IDM
13F2	6.5 mi. W of vent; Odessa, Delaware	IDM
13F3	9.3 mi. W of vent; Redding Middle School, Middletown, Delaware	IDM
13F4	9.8 mi. W of vent; Middletown, Delaware	IDM
14F1	5.5 mi. WNW of vent; local farm	MLK,SOL,VGT
14F2	6.6 mi. WNW of vent; Boyds Corner	IDM
14F3	5.4 mi. WNW of vent; local farm	FPV
15F3	5.4 mi. NW of vent	IDM
16F1	6.9 mi. NNW of vent; C&D Canal	ESB,ESS,SWA
16F2	8.1 mi. NNW of vent; Delaware City Public School	IDM
1G1	10.3 mi. N of vent; local farm	FPV
1G3	19 mi. N of vent; Wilmington, Delaware	IDM
2G1	12 mi. NNE of vent; Mannington Township, NJ	FPV
3G1	17 mi. NE of vent; local farm	IDM,MLK,SOL,VGT
10G1	12 mi. SSW of vent; Smyrna, Delaware	IDM
16G1	15 mi. NNW of vent; Greater Wilmington Airport	IDM
3H1	32 mi. NE of vent; National Park, New Jersey	IDM
3H3	110 mi. NE of vent; Research and Testing Laboratory	AIO,APT,IDM,SOL
3H5	25 mi. NE of vent; local farm	FPL,FPV

MAP 8-1

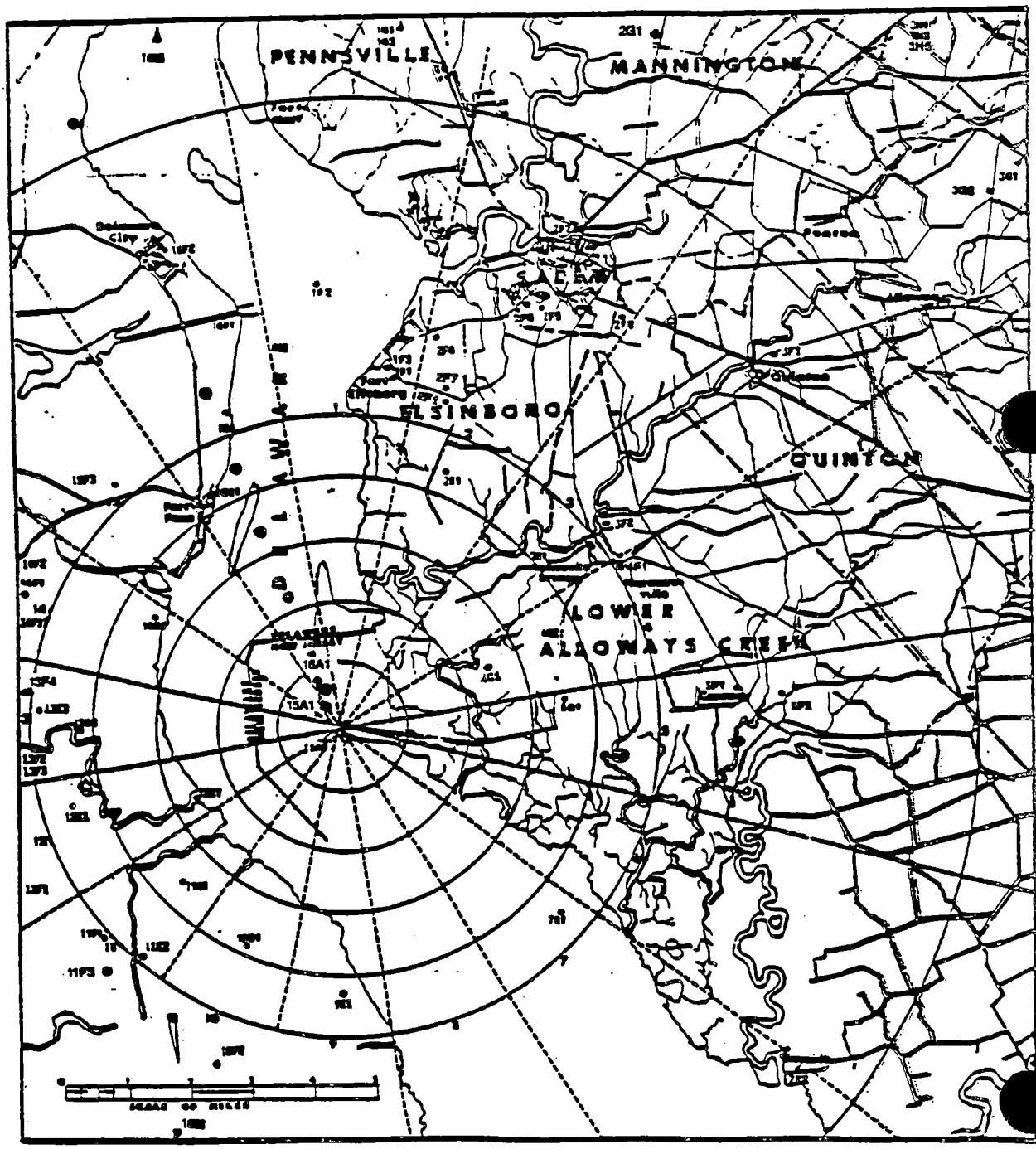
ON SITE SAMPLING LOCATIONS
ARTIFICIAL ISLAND



MAP B-2

OFF-SITE SAMPLING LOCATIONS

ARTIFICIAL ISLAND



APPENDIX C

DATA TABLES

DATA TABLES

Appendix C presents the analytical results of the 1986 Artificial Island Radiological Environmental Monitoring Program for the period of January 1 to December 31, 1986.

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DATA TABLES (cont'd.)

DATA TABLES (cont'd.)

TABLE C-1

1986 CONCENTRATIONS OF GROSS ALPHA EMITTERS IN AIR PARTICULATES

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

	STATION ID								
MONTH*	SA-APT-2S2	SA-APT-6S1	SA-APT-6D1**	SA-APT-10D1	SA-APT-16E1	SA-APT-1F1	SA-APT-2F2	SA-APT-3H3 (Control)	AVERAGE
JANUARY	1.7±0.9	2.2±0.8	1.7±1.1	2.6±1.1	1.8±0.8	1.8±0.8	2.1±0.9	3.1±1.1	2.1±1.0
	1.8±1.0	1.8±0.9	2.1±1.1	1.9±0.9	2.0±0.8	<1.0	2.4±1.0	1.7±0.8	1.8±0.8
	<4.0 (1)	1.4±0.6	2.0±1.0	1.3±0.8	1.7±0.7	1.7±0.8	1.8±0.7	3.2±1.0	1.9±1.3
	1.4±0.7	1.9±0.8	<0.9	1.6±0.9	1.6±0.8	1.6±0.8	1.3±0.7	1.4±0.7	1.5±0.6
	2.8±1.0	2.4±0.8	<0.9	1.9±0.9	1.7±0.9	2.0±0.9	2.0±0.8	1.8±1.0	1.9±1.1
FEBRUARY	<1.0	1.3±0.9	3.3±1.6	1.3±0.8	2.0±0.9	1.7±0.8	1.9±0.9	<0.9	1.7±1.5
	2.0±0.8	2.9±0.8	1.1±0.8	2.6±0.9	2.6±0.8	2.2±0.9	2.0±0.7	2.1±0.7	2.2±1.1
	1.3±0.8	1.6±0.9	<1.0	1.6±0.9	2.6±0.9	1.5±0.8	1.7±0.8	1.0±0.6	1.5±1.0
	2.4±0.9	1.9±0.8	1.6±1.0	1.5±0.8	2.3±0.9	1.9±0.9	1.9±0.8	2.4±0.8	2.0±0.7
MARCH	2.7±1.0	2.3±0.8	2.6±1.3	2.6±0.8	3.0±0.9	2.4±0.8	2.5±0.8	2.4±0.8	2.6±0.4
	1.2±0.8	<0.9	<1.0	<1.1	<0.8	<0.9	<0.9	1.1±0.7	1.0±0.3
	2.4±0.8	2.2±0.9	<1.0	2.8±1.0	3.0±1.0	2.0±0.8	2.2±0.8	2.1±0.8	2.2±1.2
	1.8±0.8	0.8±0.6	1.3±1.0	2.4±0.9	2.3±0.8	2.5±0.9	1.6±0.8	2.3±0.8	1.9±1.2
APRIL	2.2±0.8	2.1±0.8	<1.0	1.3±0.8	1.2±0.8	1.1±0.7	1.5±0.7	1.3±0.7	1.5±0.9
	0.9±0.7	1.1±0.7	<1.0	<0.8	1.1±0.6	1.4±0.7	1.5±0.7	1.0±0.6	1.1±0.5
	1.8±0.8	1.3±0.7	1.8±1.3	1.5±0.9	1.7±0.8	2.0±0.8	<1.3	2.1±0.8	1.7±0.6
	2.0±0.8	1.3±0.7	1.7±1.1	1.0±0.7	2.0±0.8	1.5±0.8	2.2±0.8	1.1±0.7	1.6±0.9
MAY	2.2±0.8	3.3±1.0	1.8±1.3	3.0±1.0	3.2±1.0	2.3±0.8	2.8±0.9	1.9±0.7	2.6±1.2
	22±2	21±2	<0.8	19±2	21±2	19±2	20±2	20±2	18±14
	11±2	10±2	<3.0 (1)	9.9±1.6	8.9±1.5	12±2	10±2	9.8±1.6	10±2
	7.4±1.3	5.8±1.2	3.0±1.4	6.6±1.3	5.6±1.1	5.3±1.1	7.1±1.3	4.7±1.0	5.7±2.8
	7.2±1.5	6.2±1.5	2.6±1.8	6.2±1.5	<9.2 (1)	5.8±1.4	7.4±1.5	7.4±1.5	6.1±3.4
JUNE	12±2	9.3±1.6	<2.0	10±2	8.2±1.4	9.2±1.6	9.5±1.6	8.7±1.4	8.6±5.8
	2.0±0.8	1.3±0.7	<1.0	0.9±0.7	1.7±0.8	1.6±0.8	1.9±0.8	1.5±0.7	1.5±0.8
	2.8±1.0	3.0±1.0	2.1±1.2	2.0±1.0	2.2±0.8	2.3±1.0	2.4±0.9	2.4±0.9	2.4±0.7
	2.5±0.9	<0.8	1.4±1.1	1.9±0.8	1.2±0.7	1.8±0.8	1.5±0.8	2.2±0.8	1.7±1.1

TABLE C-1 (cont'd)

1986 CONCENTRATIONS OF GROSS ALPHA EMITTERS IN AIR PARTICULATES

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

	STATION ID								
MONTH*	SA-APT-2S2	SA-APT-6S1	SA-APT-5D1**	SA-APT-10D1	SA-APT-16E1	SA-APT-1F1	SA-APT-2F2	SA-APT-3H3 (Control)	AVERAGE
JULY	1.2±0.7	1.1±0.6	<2.0	2.2±0.9	2.4±0.8	2.4±0.9	2.1±0.8	1.3±0.7	1.8±1.1
	1.8±0.9	2.0±0.8	<2.0	2.2±0.9	1.8±0.8	2.2±0.9	2.8±0.9	2.6±0.9	2.2±0.7
	<1.2	<1.2	2.3±1.4	1.6±0.9	1.7±0.9	1.1±0.8	1.8±1.0	1.6±0.9	1.6±0.8
	<1.1	1.4±0.8	<1.0	2.7±0.9	2.8±1.0	<1.1	1.3±0.9	<1.1	1.6±1.6
AUGUST	1.6±0.9	1.2±0.8	<1.0	1.0±0.8	1.0±0.8	1.8±0.8	1.9±1.0	1.7±0.8	1.4±0.8
	2.6±1.0	1.9±0.9	<2.0	1.8±0.9	2.6±0.9	<1.1	1.8±0.9	2.0±0.9	2.0±0.9
	3.8±1.0	3.8±0.9	<1.0	4.0±1.0	4.6±1.0	4.4±1.0	2.6±0.8	1.6±0.8	3.2±2.6
	2.6±1.1	1.2±0.8	<2.0	2.6±0.9	2.2±0.9	1.8±0.9	1.7±0.9	3.0±1.0	2.1±1.1
	1.0±0.7	<0.9	1.9±1.1	2.0±0.8	3.6±0.9	1.4±0.7	1.6±0.8	1.2±0.8	1.7±1.7
SEPTEMBER	1.4±0.9	1.2±0.8	<2.0	1.4±0.9	1.9±1.0	1.2±0.8	1.7±0.9	1.6±0.9	1.6±0.6
	2.4±0.8	3.0±0.8	1.9±1.2	3.1±0.9	2.9±0.8	2.7±0.8	3.2±0.8	2.4±0.8	2.7±0.9
	2.0±0.8	1.6±0.8	1.9±1.6	1.6±0.8	1.6±0.8	1.7±0.9	1.7±0.8	1.6±0.8	1.7±0.3
	1.7±0.8	1.9±0.8	2.2±1.3	2.0±0.8	1.2±0.6	2.0±0.8	1.2±0.7	2.0±0.8	1.8±0.8
OCTOBER	<1.2	<1.1	<1.0	<1.3	<1.2	<1.1	<1.2	<1.2	-
	1.1±0.7	0.8±0.6	<1.0	1.7±0.7	1.6±0.6	1.6±0.7	1.6±0.7	1.8±0.8	1.4±0.7
	2.0±0.9	2.0±0.8	<1.0	1.7±0.8	2.0±0.9	1.4±0.8	1.2±0.7	1.6±0.8	1.6±0.8
	2.3±1.0	2.4±0.9	3.3±1.6	1.8±0.8	1.9±0.8	1.7±0.8	1.9±1.0	1.9±0.9	2.2±1.0
	1.2±0.7	1.4±0.8	2.8±1.6	1.2±0.8	2.1±0.9	1.6±0.8	<0.8	2.1±0.8	1.6±1.3
NOVEMBER	3.7±1.1	3.1±0.9	1.8±1.2	3.1±0.9	4.0±1.0	4.1±1.1	3.6±1.1	3.2±1.0	3.3±1.4
	1.7±0.9	1.2±0.8	2.2±1.3	1.1±0.8	1.4±0.8	1.6±0.8	1.6±0.8	1.6±0.8	1.5±0.7
	1.9±0.9	2.6±0.9	<1.0	1.8±0.9	1.8±0.8	2.7±1.0	1.2±0.8	2.4±1.0	1.9±1.2
	<29 (1)	1.8±0.9	3.7±1.7	2.1±0.8	2.2±0.8	1.8±0.9	2.0±0.9	2.6±0.9	2.3±1.3
DECEMBER	1.2±0.9	1.4±0.8	2.0±1.2	<1.0	1.6±0.8	<1.0	<1.0	<3.6 (1)	1.3±0.7
	2.9±1.0	2.7±1.0	2.0±1.3	2.2±0.9	2.4±0.9	2.0±0.9	2.1±0.8	2.6±0.9	2.4±0.7
	2.1±1.0	2.1±0.9	<20 (1)	2.6±1.0	1.9±0.8	1.9±0.8	1.8±0.9	2.6±0.9	2.1±0.7
	2.0±0.8	2.2±0.9	2.1±1.3	2.4±0.9	2.6±0.8	1.2±0.7	1.4±0.8	1.0±0.7	1.8±1.1
AVERAGE	2.9±7.1	2.6±6.4	1.8±1.4	2.7±5.9	2.8±6.0	2.6±6.1	2.7±6.2	2.7±6.1	
								Grand Average	2.6±5.9

* Sampling dates can be found in Table C-5.
** Results by Teledyne Isotopes.
(1) High LLD due to low sample volume. Result not included in any averages.

TABLE C-2

1986 CONCENTRATIONS OF GROSS BETA EMITTERS IN AIR PARTICULATES

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

	STATION ID								
MONTH*	SA-APT-2S2	SA-APT-6S1	SA-APT-5D1**	SA-APT-10D1	SA-APT-16E1	SA-APT-1F1	SA-APT-2F2	SA-APT-3H3 (Control)	AVERAGE
JANUARY	26±3	27±3	25±3	32±3	28±3	26±3	28±3	32±3	28±6
	29±3	27±3	26±3	28±3	27±2	14±2	27±3	25±3	25±9
	32±12 (1)	19±2	20±3	22±3	20±2	20±3	22±2	28±3	22±6
	21±3	20±2	22±3	24±3	22±3	17±2	19±2	18±2	20±6
	29±3	28±3	29±3	29±3	30±3	32±3	29±3	24±3	29±4
FEBRUARY	17±2	16±3	19±3	19±3	18±2	16±2	14±2	13±2	16±4
	30±3	32±3	29±3	36±3	30±2	33±3	32±2	27±2	31±6
	16±3	14±3	17±3	18±3	17±3	15±3	13±2	16±2	16±3
	28±3	24±3	23±3	24±3	24±3	22±3	24±3	24±3	24±3
MARCH	25±3	22±2	24±3	26±3	22±2	25±3	26±3	20±2	24±4
	13±2	13±2	17±2	15±3	13±2	15±2	15±2	17±2	15±3
	24±2	24±3	21±3	24±3	22±3	22±2	21±2	19±2	22±4
	23±2	23±2	20±3	24±3	23±2	20±2	21±2	24±2	22±3
APRIL	15±2	13±2	17±3	10±2	12±2	16±2	13±2	12±2	14±5
	9.4±2.3	7.6±2.2	10±2	9.0±2.3	8.6±2.0	8.0±2.3	8.0±2.2	11±2	8.9±2.3
	19±2	16±2	19±3	22±3	20±3	18±2	12±3	20±2	18±6
	24±3	21±2	23±3	21±3	21±2	19±2	21±3	15±2	21±5
MAY	23±3	24±3	23±3	26±3	24±3	23±3	20±3	22±2	23±3
	350±8	340±8	20±3	330±8	370±8	350±8	340±8	330±8	300±230
	270±7	260±7	170±10 (1)	260±7	240±7	270±7	260±7	260±7	260±22
	170±6	180±6	140±10	180±6	160±5	180±6	180±6	130±5	160±40
	170±6	150±6	140±10	170±7	200±27 (1)	150±6	160±6	190±7	160±34
JUNE	200±6	180±6	160±10	190±6	160±6	190±6	180±6	170±5	180±29
	31±3	26±3	27±3	30±3	29±3	35±3	26±3	31±3	29±6
	32±3	34±3	28±3	34±3	34±3	30±3	35±3	37±3	33±6
	27±3	6.7±1.9	25±3	24±3	25±3	24±3	23±3	24±3	22±13

TABLE C-2 (cont'd)

1986 CONCENTRATIONS OF GROSS BETA EMITTERS IN AIR PARTICULATES

Results in Units of 10-3 pCi/m3 ± 2 sigma

	STATION ID								
MONTH*	SA-APT-2S2	SA-APT-6S1	SA-APT-6D1**	SA-APT-10D1	SA-APT-16E1	SA-APT-1F1	SA-APT-2F2	SA-APT-3H3 (Control)	AVERAGE
JULY	29±3	24±3	27±3	31±3	31±3	24±3	24±3	25±3	27±6
	30±3	26±3	20±3	30±3	28±3	30±3	31±3	27±3	28±7
	26±3	24±3	27±3	24±3	24±3	24±3	27±3	24±3	25±3
	27±3	24±3	25±3	26±3	26±3	22±3	22±3	24±3	24±4
AUGUST	22±3	22±3	22±3	21±3	24±3	20±2	23±3	19±3	22±3
	36±3	33±3	30±4	32±3	33±3	32±3	31±3	28±3	32±4
	28±3	26±2	21±3	24±3	25±3	28±3	27±3	22±3	25±5
	20±3	15±3	24±3	20±3	20±3	20±3	18±3	19±3	20±5
	23±2	22±2	23±3	22±2	24±2	26±2	24±3	24±3	23±2
SEPTEMBER	25±3	25±3	28±4	26±3	26±3	28±3	26±3	26±3	26±2
	30±3	32±3	30±3	30±3	32±3	29±3	25±3	28±3	30±4
	22±3	20±2	26±3	24±3	21±2	24±3	23±3	19±2	22±5
	28±3	31±3	24±3	28±3	28±3	27±3	28±3	36±3	29±7
OCTOBER	21±3	18±2	19±3	18±3	19±3	19±2	19±3	22±3	19±3
	19±2	20±2	15±2	20±2	20±2	18±2	20±2	20±2	19±4
	25±3	27±3	25±4	25±3	26±3	26±3	25±3	20±3	25±4
	39±3	40±3	38±4	35±3	34±3	38±3	38±3	38±3	38±4
	24±3	22±3	25±3	21±3	23±3	24±3	23±3	25±3	23±3
NOVEMBER	17±3	15±2	16±3	14±2	16±2	15±2	15±2	20±3	16±4
	22±3	24±3	25±3	26±3	22±2	24±3	23±3	24±3	24±3
	28±3	27±3	26±3	28±3	26±2	28±3	26±3	32±3	28±4
	<90 (2)	29±3	36±4	23±2	26±3	26±3	30±3	27±3	28±8
DECEMBER	20±3	21±2	23±3	18±2	19±2	20±2	22±3	16±7 (1)	20±3
	29±3	29±3	30±4	28±3	29±3	26±3	27±3	25±3	28±3
	35±3	36±3	99±49 (1)	36±3	32±3	33±3	33±3	29±3	33±5
	25±2	28±3	27±3	29±3	25±2	27±3	29±3	26±3	27±3
AVERAGE	45±130	42±120	31±60	44±130	40±120	43±130	43±120	42±120	
								Grand Average	41±120

* Sampling dates can be found in Table C-5.
** Results by Teledyne Isotopes.
(1) Due to low sample volume, result not included in any averages.
(2) High LLD due to low sample volume. Result not included in any averages.

TABLE C-3

1986 CONCENTRATIONS OF STRONTIUM-89* AND STRONTIUM-90 AND GAMMA EMITTERS** IN QUARTERLY COMPOSITES OF AIR PARTICULATES

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

STATION ID COLLECTION PERIOD	Sr-89***	Sr-90***	Be-7	Ru-103	Ru-106	Cs-134	Cs-137	Ra-226	Th-232
SA-APT-2S2									
12-30-85 to 03-31-86	<0.4	<0.3	64±5	<0.4	<3.1	<0.5	<0.5	<1.0	<2.2
03-31-86 to 06-30-86	-	-	95±7	8.8±0.8	<7.7	9.8±0.9	18±1	<1.8	<2.6
06-30-86 to 09-29-86	-	-	89±6	<0.5	<4.4	<0.5	<0.4	<1.0	<1.7
09-29-86 to 12-29-86	-	-	66±6	<0.6	<5.9	<0.5	<0.7	<1.2	<2.7
SA-APT-6S1									
12-30-85 to 03-31-86	<0.4	<0.2	66±5	<0.3	<4.1	<0.6	<0.4	<1.1	<1.9
03-31-86 to 06-30-86	-	-	77±5	7.8±0.6	4.0±2.1	9.3±0.8	17±1	<1.3	<1.6
06-30-86 to 09-29-86	-	-	88±5	<0.3	<4.3	<0.5	<0.4	<0.3	<1.2
09-29-86 to 12-29-86	-	-	66±5	<0.3	<5.3	<0.6	<0.5	<1.0	<2.1
SA-APT-6D1 (1)									
12-30-85 to 03-31-86	<2.0	<0.3	85±8	<0.8	<5.0	<0.6	<0.6	<9.0	(2)
03-31-86 to 06-30-86	-	-	110±12	9.2±1.3	<7.0	8.4±1.1	18±2	<10	(2)
06-30-86 to 09-29-86	-	-	89±11	<1.0	<8.0	<1.0	<1.0	<10	(2)
09-29-86 to 12-29-86	-	-	80±6	<0.6	<3.0	<0.3	<0.4	<6.0	(2)
SA-APT-10D1									
12-31-85 to 04-01-86	<0.4	<0.3	71±5	<0.4	<4.7	<0.6	<0.3	<1.0	<2.3
04-01-86 to 07-01-86	-	-	88±6	8.7±0.7	<7.0	9.0±0.9	17±1	<1.5	<2.4
07-01-86 to 09-30-86	-	-	76±5	<0.5	<4.3	<0.5	<0.4	<1.0	<1.2
09-30-86 to 12-30-86	-	-	60±4	<0.5	<2.7	<0.5	<0.4	<0.7	<1.6

TABLE C-3 (cont'd)

1986 CONCENTRATIONS OF STRONTIUM-89* AND STRONTIUM-90 AND GAMMA EMITTERS** IN QUARTERLY COMPOSITES OF AIR PARTICULATES

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

STATION ID COLLECTION PERIOD	Sr-89***	Sr-90***	Be-7	Ru-103	Ru-106	Cs-134	Cs-137	Ra-226	Th-232
SA-APT-16E1									
12-31-85 to 04-01-86	<0.4	<0.3	64±4	<0.4	<3.9	<0.4	<0.4	<1.0	<1.5
04-01-86 to 07-01-86	-	-	83±6	7.5±0.6	4.2±2.1	8.4±0.8	16±1	<1.4	<1.6
07-01-86 to 09-30-86	-	-	83±5	<0.3	<4.2	<0.5	<0.4	<0.4	<1.1
09-30-86 to 12-30-86	-	-	64±4	<0.3	<2.6	<0.4	<0.4	<0.6	<1.1
SA-APT-1F1									
12-30-85 to 03-31-86	<0.5	<0.3	66±6	<0.1	<4.5	<0.6	<0.6	1.2±0.6	<2.2
03-31-86 to 06-30-86	-	-	86±6	8.8±0.7	8.3±3.3	10±1	17±1	<1.4	<2.3
06-30-86 to 09-29-86	-	-	79±5	<0.4	<4.5	<0.6	<0.5	<0.9	1.7±1.0
09-29-86 to 12-29-86	-	-	64±5	<0.2	<3.5	<0.6	<0.4	<0.8	<1.3
SA-APT-2F2									
12-30-85 to 03-31-86	<0.3	<0.2	63±4	<0.3	<2.8	<0.5	<0.3	<0.3	<1.2
03-31-86 to 06-30-86	-	-	80±6	9.0±0.8	<7.2	10±1	17±1	<1.7	<2.3
06-30-86 to 09-29-86	-	-	78±6	<0.6	<3.0	<0.6	<0.4	<1.1	<2.2
09-29-86 to 12-29-86	-	-	67±6	<0.5	<1.5	<0.4	<0.4	<1.1	<1.8
SA-APT-3H3 (Control)									
12-30-85 to 03-31-86	<0.3	<0.2	64±4	<0.3	<3.9	<0.4	<0.4	<0.9	<1.1
03-31-86 to 06-30-86	-	-	83±5	7.6±0.5	4.0±1.9	9.2±0.7	17±1	<0.3	<1.1
06-30-86 to 09-29-86	-	-	90±7	<0.7	<7.6	<0.6	<0.5	<1.1	<2.1
09-29-86 to 12-29-86	-	-	64±6	<0.5	<5.8	<0.3	<0.6	<1.3	<1.9
AVERAGE	-	-	76±24	-	-	-	-	-	-

* Sr-89 results are corrected for decay to sample stop date.
** All other gamma emitters searched for were <LLD; typical LLDs are given in Table C-33.
*** Management audit analyses, not required by Technical specifications or by specific commitments to local officials.
(1) Results by Teledyne Isotopes.
(2) Not analyzed by Teledyne Isotopes.

TABLE C-4

1986 CONCENTRATIONS OF IODINE-131* IN FILTERED AIR

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

	STATION ID								
MONTH**	SA-AIO-2S2	SA-AIO-6S1	SA-AIO-6D1***	SA-AIO-10D1	SA-AIO-16E1	SA-AIO-1F1	SA-AIO-2F2	SA-AIO-3H3 (Control)	AVERAGE
JANUARY	<19	<16	<20	<33	<22	< 9.3	<24	<15	-
	<14	<26	<20	<14	<17	< 8.0	<14	<13	-
	<140 (1)	<13	<20	<23	<18	<22	<17	<22	-
	<17	<23	<20	<27	<18	<16	<17	<16	-
	<16	<16	<10	<11	<25	<15	<22	<29	-
FEBRUARY	<21	<24	<20	<23	<18	<21	<19	<16	-
	<19	<10	<10	<11	<14	<17	<11	<15	-
	<16	<41	<30	<13	<28	<30	<21	<13	-
	<16	<24	<10	<28	<20	<18	<14	<17	-
MARCH	<26	<21	<30	<14	<14	<19	<22	<13	-
	<15	<17	<10	<26	<20	<16	<18	<18	-
	<19	<14	<20	<17	<19	<19	<11	<18	-
	<13	<16	<10	<13	<12	<16	<20	<16	-
APRIL	<18	< 8.7	<40	<19	<22	<18	<25	<20	-
	<16	<20	<20	<21	<15	<18	<17	<14	-
	<19	<30	<30	<18	<21	<17	<39	<12	-
	<15	< 9.9	<40	<15	<13	<23	<13	<16	-
MAY	<20	<15	<40	<16	<25	<20	<26	<22	-
	310±34	310±32	280±60	310±29	300±32	320±35	270±32	320±32	300±37
	230±30	180±28	610±220 (2)	180±28	190±29	220±28	220±28	230±30	210±46
	81±14	56±16	73±15	60±17	70±18	76±16	73±18	65±15	69±17
	48±20	<32	<60	46±20	<390 (1)	42±23	62±22	64±20	48±20
JUNE	25±11	33±13	<30	<28	<28	32±15	<30	(3)	-
	<16	<22	<40	<29	<19	<18	<20	<16	-
	<17	<22	<20	<14	< 8.9	<28	<21	<19	-
	<17	<14	<30	<14	<18	<14	<22	<20	-

TABLE C-4 (cont'd)

1986 CONCENTRATIONS OF IODINE-131* IN FILTERED AIR

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

	STATION ID								
MONTH**	SA-AIO-2S2	SA-AIO-6S1	SA-AIO-6D1***	SA-AIO-10D1	SA-AIO-16E1	SA-AIO-1F1	SA-AIO-2F2	SA-AIO-3H3 (Control)	AVERAGE
JULY	<24	<14	<20	<25	<20	<19	<25	<18	-
	<22	<13	<30	<15	<21	<18	<20	<16	-
	<20	<14	<20	<22	<19	<16	<30	<17	-
	<19	<12	<20	<11	<13	<20	<15	<20	-
AUGUST	< 9.4	<17	<30	< 9.9	<28	<14	<18	<15	-
	<25	<19	<20	<22	<23	<12	<21	<15	-
	<14	<16	<20	<30	< 8.0	<21	<10	<24	-
	<19	<18	<30	<19	<13	<23	<15	<18	-
	<15	<12	<20	<14	<13	<20	<15	<16	-
SEPTEMBER	<22	<24	<30	<21	<27	<23	<17	<20	-
	< 9.7	< 7.7	<20	<26	<16	<19	<21	<22	-
	<26	<24	<20	<17	<25	<33	<17	<12	-
	<18	<32	<20	<14	<25	<13	<22	<19	-
OCTOBER	<20	<10	<20	<36	<20	<21	<11	<17	-
	<14	<11	<10	<14	< 9.0	<16	<22	<18	-
	<23	<17	<30	<22	<31	<33	<25	<19	-
	<18	<19	<20	<11	< 8.5	<20	<30	<20	-
	<16	< 9.6	<20	<26	<14	<12	< 8.5	<18	-
NOVEMBER	<20	<15	<20	<19	<15	<20	<24	<15	-
	<27	<28	<10	<27	<17	<17	<23	<26	-
	<19	<15	<30	<21	<11	<16	<14	<18	-
	<1000 (1)	<17	<10	<19	<21	<28	<25	<21	-
DECEMBER	< 9.2	<18	<20	< 8.1	<12	<13	<19	<120 (1)	-
	<22	<15	<10	<19	<16	<21	<22	<18	-
	<20	<11	<1000 (1)	<20	<13	<16	< 7.9	<17	-
	<23	<21	<10	<29	<18	<29	<35	<30	-

* I-131 results are corrected for decay to sample stop date.
** Sampling dates can be found in Table C-5.
*** Results by Teledyne Isotopes.
(1) High LLD due to low sample volume.
(2) High uncertainty due to low sample volume. Result not included in any averages.
(3) No results due to faulty sampling assembly.

TABLE C-6

1986 SAMPLING DATES FOR AIR SAMPLES

MONTH	STATION ID							
	2S2	6S1	6D1	10D1	16E1	1F1	2F2	3H3
JANUARY	12-30-85 to 01-06-86	12-30-85 to 01-06-86	12-30-85 to 01-06-86	12-31-85 to 01-06-86	12-31-85 to 01-06-86	12-30-85 to 01-06-86	12-30-85 to 01-06-86	12-30-85 to 01-06-86
	01-06-86 to 01-13-86	01-06-86 to 01-13-86	01-06-86 to 01-13-86	01-06-86 to 01-14-86	01-06-86 to 01-14-86	01-06-86 to 01-13-86	01-06-86 to 01-13-86	01-06-86 to 01-13-86
	01-13-86 to 01-14-86*	01-13-86 to 01-20-86	01-13-86 to 01-20-86	01-14-86 to 01-21-86	01-14-86 to 01-21-86	01-13-86 to 01-20-86	01-13-86 to 01-20-86	01-13-86 to 01-20-86
	01-20-86 to 01-27-86	01-20-86 to 01-27-86	01-20-86 to 01-27-86	01-21-86 to 01-28-86	01-21-86 to 01-28-86	01-20-86 to 01-27-86	01-20-86 to 01-27-86	01-20-86 to 01-27-86
	01-27-86 to 02-03-86	01-27-86 to 02-03-86	01-27-86 to 02-03-86	01-28-86 to 02-03-86	01-28-86 to 02-03-86	01-27-86 to 02-03-86	01-27-86 to 02-03-86	01-27-86 to 02-01-86*
FEBRUARY	02-03-86 to 02-10-86	02-03-86 to 02-10-86	02-03-86 to 02-10-86	02-03-86 to 02-11-86	02-03-86 to 02-11-86	02-03-86 to 02-10-86	02-03-86 to 02-10-86	02-03-86 to 02-10-86
	02-10-86 to 02-18-86	02-10-86 to 02-18-86	02-10-86 to 02-18-86	02-11-86 to 02-19-86	02-11-86 to 02-19-86	02-10-86 to 02-18-86	02-10-86 to 02-18-86	02-10-86 to 02-18-86
	02-18-86 to 02-24-86	02-18-86 to 02-24-86	02-18-86 to 02-24-86	02-19-86 to 02-25-86	02-19-86 to 02-25-86	02-18-86 to 02-24-86	02-18-86 to 02-24-86	02-18-86 to 02-24-86
	02-24-86 to 03-03-86	02-24-86 to 03-03-86	02-24-86 to 03-03-86	02-25-86 to 03-03-86	02-25-86 to 03-03-86	02-24-86 to 03-03-86	02-24-86 to 03-03-86	02-24-86 to 03-03-86
MARCH	03-03-86 to 03-10-86	03-03-86 to 03-10-86	03-03-86 to 03-10-86	03-03-86 to 03-11-86	03-03-86 to 03-11-86	03-03-86 to 03-10-86	03-03-86 to 03-10-86	03-03-86 to 03-10-86
	03-10-86 to 03-17-86	03-10-86 to 03-17-86	03-10-86 to 03-17-86	03-11-86 to 03-18-86	03-11-86 to 03-18-86	03-10-86 to 03-17-86	03-10-86 to 03-17-86	03-10-86 to 03-17-86

TABLE C-5 (cont'd)

1986 SAMPLING DATES FOR AIR SAMPLES

MONTH	STATION ID							
	2S2	5S1	6D1	10D1	16E1	1F1	2F2	3H3
MARCH	03-17-86 to 03-24-86	03-17-86 to 03-24-86	03-17-86 to 03-24-86	03-18-86 to 03-25-86	03-18-86 to 03-25-86	03-17-86 to 03-24-86	03-17-86 to 03-24-86	03-17-86 to 03-24-86
	03-24-86 to 03-31-86	03-24-86 to 03-31-86	03-24-86 to 03-31-86	03-25-86 to 04-01-86	03-25-86 to 04-01-86	03-24-86 to 03-31-86	03-24-86 to 03-31-86	03-24-86 to 03-31-86
APRIL	03-31-86 to 04-07-86	03-31-86 to 04-07-86	03-31-86 to 04-07-86	04-01-86 to 04-07-86	04-01-86 to 04-07-86	03-31-86 to 04-07-86	03-31-86 to 04-07-86	03-31-86 to 04-07-86
	04-07-86 to 04-14-86	04-07-86 to 04-14-86	04-07-86 to 04-14-86	04-07-86 to 04-15-86	04-07-86 to 04-15-86	04-07-86 to 04-14-86	04-07-86 to 04-14-86	04-07-86 to 04-14-86
	04-14-86 to 04-21-86	04-14-86 to 04-21-86	04-14-86 to 04-21-86	04-15-86 to 04-21-86	04-15-86 to 04-21-86	04-14-86 to 04-21-86	04-14-86 to 04-18-86*	04-14-86 to 04-21-86
	04-21-86 to 04-28-86	04-21-86 to 04-28-86	04-21-86 to 04-28-86	04-21-86 to 04-29-86	04-21-86 to 04-29-86	04-21-86 to 04-28-86	04-21-86 to 04-28-86	04-21-86 to 04-28-86
MAY	04-28-86 to 05-05-86	04-28-86 to 05-05-86	04-28-86 to 05-05-86	04-29-86 to 05-05-86	04-29-86 to 05-05-86	04-28-86 to 05-05-86	04-28-86 to 05-05-86	04-28-86 to 05-05-86
	05-05-86 to 05-12-86	05-05-86 to 05-12-86	05-05-86 to 05-12-86	05-05-86 to 05-12-86	05-05-86 to 05-12-86	05-05-86 to 05-12-86	05-05-86 to 05-12-86	05-05-86 to 05-12-86
	05-12-86 to 05-19-86	05-12-86 to 05-19-86	05-12-86 to 05-14-86*	05-12-86 to 05-19-86	05-12-86 to 05-19-86	05-12-86 to 05-19-86	05-12-86 to 05-19-86	05-12-86 to 05-19-86
	05-19-86 to 05-27-86	05-19-86 to 05-27-86	05-19-86 to 05-27-86	05-19-86 to 05-27-86	05-19-86 to 05-27-86	05-19-86 to 05-27-86	05-19-86 to 05-27-86	05-19-86 to 05-27-86
	05-27-86 to 06-02-86	05-27-86 to 06-02-86	05-27-86 to 06-02-86	05-27-86 to 06-02-86	05-27-86 to 05-28-86*	05-27-86 to 06-02-86	05-27-86 to 06-02-86	05-27-86 to 06-02-86

TABLE C-5 (cont'd)

1986 SAMPLING DATES FOR AIR SAMPLES

MONTH	STATION ID							
	2S2	6S1	6D1	10D1	16E1	1F1	2F2	3H3
JUNE	06-02-86 to 06-09-86	06-02-86 to 06-09-86	06-02-86 to 06-09-86	06-02-86 to 06-09-86	06-03-86 to 06-09-86	06-02-86 to 06-09-86	06-02-86 to 06-09-86	06-02-86 to 06-09-86
	06-09-86 to 06-16-86	06-09-86 to 06-16-86	06-09-86 to 06-16-86	06-09-86 to 06-16-86	06-09-86 to 06-16-86	06-09-86 to 06-16-86	06-09-86 to 06-16-86	06-09-86 to 06-16-86
	06-16-86 to 06-23-86	06-16-86 to 06-23-86	06-16-86 to 06-23-86	06-16-86 to 06-23-86	06-16-86 to 06-23-86	06-16-86 to 06-23-86	06-16-86 to 06-23-86	06-16-86 to 06-23-86
	06-23-86 to 06-30-86	06-23-86 to 06-30-86	06-23-86 to 06-30-86	06-23-86 to 07-01-86	06-23-86 to 07-01-86	06-23-86 to 06-30-86	06-23-86 to 06-30-86	06-23-86 to 06-30-86
JULY	06-30-86 to 07-07-86	06-30-86 to 07-07-86	06-30-86 to 07-07-86	07-01-86 to 07-07-86	07-01-86 to 07-07-86	06-30-86 to 07-07-86	06-30-86 to 07-07-86	06-30-86 to 07-07-86
	07-07-86 to 07-14-86	07-07-86 to 07-16-86	07-07-86 to 07-16-86	07-07-86 to 07-16-86	07-07-86 to 07-16-86	07-07-86 to 07-14-86	07-07-86 to 07-16-86	07-07-86 to 07-14-86
	07-14-86 to 07-21-86	07-16-86 to 07-21-86	07-16-86 to 07-21-86	07-16-86 to 07-21-86	07-16-86 to 07-21-86	07-14-86 to 07-21-86	07-16-86 to 07-21-86	07-14-86 to 07-21-86
	07-21-86 to 07-28-86	07-21-86 to 07-28-86	07-21-86 to 07-28-86	07-21-86 to 07-29-86	07-21-86 to 07-29-86	07-21-86 to 07-28-86	07-21-86 to 07-28-86	07-21-86 to 07-28-86
AUGUST	07-28-86 to 08-04-86	07-28-86 to 08-04-86	07-28-86 to 08-04-86	07-29-86 to 08-04-86	07-29-86 to 08-04-86	07-28-86 to 08-04-86	07-28-86 to 08-04-86	07-28-86 to 08-04-86
	08-04-86 to 08-11-86	08-04-86 to 08-11-86	08-04-86 to 08-11-86	08-04-86 to 08-12-86	08-04-86 to 08-12-86	08-04-86 to 08-11-86	08-04-86 to 08-11-86	08-04-86 to 08-11-86
	08-11-86 to 08-19-86	08-11-86 to 08-19-86	08-11-86 to 08-19-86	08-12-86 to 08-19-86	08-12-86 to 08-19-86	08-12-86** to 08-19-86	08-11-86 to 08-19-86	08-11-86 to 08-18-86

TABLE C-5 (cont'd)

1986 SAMPLING DATES FOR AIR SAMPLES

MONTH	STATION ID							
	2S2	6S1	6D1	10D1	16E1	1F1	2F2	3H3
AUGUST	08-19-86 to 08-26-86	08-19-86 to 08-26-86	08-19-86 to 08-26-86	08-19-86 to 08-26-86	08-19-86 to 08-26-86	08-19-86 to 08-26-86	08-19-86 to 08-26-86	08-18-86 to 08-26-86
	08-26-86 to 09-02-86	08-26-86 to 09-02-86	08-26-86 to 09-02-86	08-26-86 to 09-03-86	08-26-86 to 09-03-86	08-26-86 to 09-02-86	08-26-86 to 09-02-86	08-26-86 to 09-02-86
SEPTEMBER	09-02-86 to 09-08-86	09-02-86 to 09-08-86	09-02-86 to 09-08-86	09-03-86 to 09-08-86	09-03-86 to 09-08-86	09-02-86 to 09-08-86	09-02-86 to 09-08-86	09-02-86 to 09-08-86
	09-08-86 to 09-15-86	09-08-86 to 09-15-86	09-08-86 to 09-15-86	09-08-86 to 09-15-86	09-08-86 to 09-15-86	09-08-86 to 09-15-86	09-08-86 to 09-15-86	09-08-86 to 09-15-86
	09-15-86 to 09-22-86	09-15-86 to 09-22-86	09-15-86 to 09-22-86	09-15-86 to 09-22-86	09-15-86 to 09-22-86	09-15-86 to 09-22-86	09-15-86 to 09-22-86	09-15-86 to 09-22-86
	09-22-86 to 09-29-86	09-22-86 to 09-29-86	09-22-86 to 09-29-86	09-22-86 to 09-30-86	09-22-86 to 09-30-86	09-22-86 to 09-29-86	09-22-86 to 09-29-86	09-22-86 to 09-29-86
OCTOBER	09-29-86 to 10-06-86	09-29-86 to 10-06-86	09-29-86 to 10-06-86	09-30-86 to 10-06-86	09-30-86 to 10-06-86	09-29-86 to 10-06-86	09-29-86 to 10-06-86	09-29-86 to 10-06-86
	10-06-86 to 10-14-86	10-06-86 to 10-14-86	10-06-86 to 10-14-86	10-06-86 to 10-15-86	10-06-86 to 10-15-86	10-06-86 to 10-14-86	10-06-86 to 10-14-86	10-06-86 to 10-14-86
	10-14-86 to 10-20-86	10-14-86 to 10-20-86	10-14-86 to 10-20-86	10-15-86 to 10-20-86	10-15-86 to 10-20-86	10-14-86 to 10-20-86	10-14-86 to 10-20-86	10-14-86 to 10-20-86
	10-20-86 to 10-27-86	10-20-86 to 10-27-86	10-20-86 to 10-27-86	10-20-86 to 10-28-86	10-20-86 to 10-28-86	10-20-86 to 10-27-86	10-20-86 to 10-27-86	10-20-86 to 10-27-86
	10-27-86 to 11-03-86	10-27-86 to 11-03-86	10-27-86 to 11-03-86	10-28-86 to 11-03-86	10-28-86 to 11-03-86	10-27-86 to 11-03-86	10-27-86 to 11-03-86	10-27-86 to 11-03-86

TABLE C-5 (cont'd)

1986 SAMPLING DATES FOR AIR SAMPLES

MONTH	STATION ID							
	2S2	6S1	5D1	10D1	16E1	1F1	2F2	3H3
NOVEMBER	11-03-86 to 11-10-86	11-03-86 to 11-10-86	11-03-86 to 11-10-86	11-03-86 to 11-10-86	11-03-86 to 11-10-86	11-03-86 to 11-10-86	11-03-86 to 11-10-86	11-03-86 to 11-10-86
	11-10-86 to 11-17-86	11-10-86 to 11-17-86	11-10-86 to 11-17-86	11-10-86 to 11-17-86	11-10-86 to 11-17-86	11-10-86 to 11-17-86	11-10-86 to 11-17-86	11-10-86 to 11-17-86
	11-17-86 to 11-24-86	11-17-86 to 11-24-86	11-17-86 to 11-24-86	11-17-86 to 11-24-86	11-17-86 to 11-24-86	11-17-86 to 11-24-86	11-17-86 to 11-24-86	11-17-86 to 11-24-86
	11-24-86 to 11-24-86*	11-24-86 to 12-01-86	11-24-86 to 12-01-86	11-24-86 to 12-02-86	11-24-86 to 12-02-86	11-24-86 to 12-01-86	11-24-86 to 12-01-86	11-24-86 to 12-01-86
DECEMBER	12-01-86 to 12-08-86	12-01-86 to 12-08-86	12-01-86 to 12-08-86	12-02-86 to 12-09-86	12-02-86 to 12-09-86	12-01-86 to 12-08-86	12-01-86 to 12-08-86	12-01-86 to 12-03-86*
	12-08-86 to 12-15-86	12-08-86 to 12-15-86	12-08-86 to 12-15-86	12-09-86 to 12-15-86	12-09-86 to 12-15-86	12-08-86 to 12-15-86	12-08-86 to 12-15-86	12-08-86 to 12-15-86
	12-15-86 to 12-22-86	12-15-86 to 12-22-86	12-15-86 to 12-15-86*	12-15-86 to 12-22-86	12-15-86 to 12-22-86	12-15-86 to 12-22-86	12-15-86 to 12-22-86	12-15-86 to 12-22-86
	12-22-86 to 12-29-86	12-22-86 to 12-29-86	12-22-86 to 12-29-86	12-22-86 to 12-30-86	12-22-86 to 12-30-86	12-22-86 to 12-29-86	12-22-86 to 12-29-86	12-22-86 to 12-29-86

* Reduced sampling period due to instrument malfunction.
** Start date was delayed by one day due to instrument malfunction at time of startup. This required replacement of the air sampler.

TABLE C-6

1986 CONCENTRATIONS OF GROSS ALPHA AND GROSS BETA EMITTERS, AND TRITIUM IN PRECIPITATION

STATION ID: SA-RWA-2F2

Results in Units of pCi/L ± 2 sigma

COLLECTION PERIOD	ALPHA	BETA	TRITIUM
12-31-85 to 01-27-86	<1.6	<1.6	<140
01-27-86 to 02-25-86	<1.5	1.9±1.2	<130
02-25-86 to 03-31-86	<1.6	4.4±1.4	<140
03-31-86 to 04-28-86	<0.3	3.7±0.8	<140
04-28-86 to 06-03-86	<0.3	15±1	<140
06-03-86 to 07-01-86	1.3±0.7	8.4±1.0	<140
07-01-86 to 07-29-86	<1.1	3.8±0.8	<140
07-29-86 to 09-03-86	1.2±1.1	12±1	<130
09-03-86 to 09-30-86	0.9±0.5	3.8±0.8	<140
09-30-86 to 10-27-86	<1.2	2.2±0.6	<140
10-27-86 to 12-01-86	0.6±0.6	3.5±0.7	<140
12-01-86 to 12-29-86	<1.7	1.9±0.6	<130
AVERAGE	-	5.2±8.6	-

TABLE C-7

1986 CONCENTRATIONS OF GAMMA EMITTERS* IN PRECIPITATION

STATION ID: SA-RWA-2F2

Results in Units of pCi/L ± 2 sigma

COLLECTION PERIOD	Be-7	K-40	I-131	Cs-137	Ra-226	Th-232
12-31-85 to 01-27-86**	-	-	-	-	-	-
01-27-86 to 02-25-86	35±12	<39	<2.4	<2.4	7.0±3.0	<7.2
02-25-86 to 03-31-86	71±21	<57	<4.7	<2.9	<6.7	<12
03-31-86 to 04-28-86	64±15	<32	<2.6	<2.0	<4.6	<8.0
04-28-86 to 06-03-86	41±23	<81	7.4±3.5	4.8±3.0	<13	<21
06-03-86 to 07-01-86	54±13	<40	<3.4	<3.2	<6.4	<11
07-01-86 to 07-29-86	52±14	<42	<4.8	<3.2	<6.4	<11
07-29-86 to 09-03-86	42±10	<25	<1.6	<0.8	<4.2	7.5±4.1
09-03-86 to 09-30-86	35±14	59±25	<3.8	<3.7	<7.7	<14
09-30-86 to 10-27-86	36±12	<40	<3.4	<2.6	5.1±2.4	<11
10-27-86 to 12-01-86	43±12	<41	<1.5	<2.1	4.8±2.7	<7.6
12-01-86 to 12-29-86	42±13	<29	<4.8	<2.0	<4.8	<7.4
AVERAGE	47±24	-	-	-	-	-

* All other gamma emitters searched for were <LLD; typical LLDs are given in Table C-33.

** Not analyzed due to insufficient precipitation during sampling period.

TABLE C-8

1986 DIRECT RADIATION MEASUREMENTS - QUARTERLY TLD RESULTS

Results in mrad/standard month*

(Results by Teledyne Isotopes)

STATION ID	JANUARY to MARCH	APRIL to JUNE	JULY to SEPTEMBER	OCTOBER to DECEMBER	AVERAGE
SA-IDM-2S2	5.3±0.3	4.4±0.2	5.2±0.3	4.7±0.6	4.9±0.8
SA-IDM-5S1	5.1±0.2	4.0±0.3	4.9±0.3	4.2±0.3	4.6±1.1
SA-IDM-6S2	5.3±0.3	4.3±0.2	5.4±0.2	4.6±0.3	4.9±1.1
SA-IDM-7S1	6.6±0.7	5.6±0.5	6.2±0.4	5.6±0.5	6.0±1.0
SA-IDM-10S1	5.8±0.5	5.0±0.3	4.8±0.2	5.1±0.3	5.2±0.9
SA-IDM-11S1	5.0±0.2	5.2±0.3	5.2±0.3	4.7±0.3	5.0±0.5
SA-IDM-4D2	5.8±0.2	4.9±0.4	6.7±1.8	5.1±0.5	5.6±1.6
SA-IDM-5D1	5.5±0.2	4.6±0.1	5.4±0.3	4.6±0.3	5.0±1.0
SA-IDM-10D1	5.4±0.4	5.0±0.3	5.7±0.5	4.8±0.4	5.2±0.8
SA-IDM-14D1	5.4±0.6	4.5±0.2	5.5±0.3	4.9±0.7	5.1±0.9
SA-IDM-2E1	5.6±0.5	4.2±0.5	5.5±0.4	4.7±0.5	5.0±1.3
SA-IDM-3E1	5.2±0.4	4.4±0.2	5.3±0.3	4.5±0.5	4.8±0.9
SA-IDM-9E1	6.3±0.8	5.4±0.3	6.2±0.5	5.7±0.9	5.9±0.8
SA-IDM-11E2	5.9±0.6	5.2±0.7	6.3±0.5	5.5±0.7	5.7±1.0
SA-IDM-12E1	5.7±0.5	4.8±0.3	6.0±0.4	5.4±0.8	5.5±1.0
SA-IDM-13E1	4.9±0.1	4.2±0.2	5.0±0.3	4.3±0.4	4.6±0.8
SA-IDM-16E1	5.5±0.2	4.8±0.5	5.6±0.3	5.0±0.5	5.2±0.8
SA-IDM-1F1	5.4±0.5	4.3±0.4	5.5±0.4	5.0±0.5	5.0±1.1
SA-IDM-2F2	4.5±0.7	3.6±0.3	4.4±0.3	3.7±0.3	4.0±0.9
SA-IDM-2F5	5.4±0.1	4.6±0.2	5.4±0.4	4.8±0.5	5.0±0.8
SA-IDM-2F6	5.1±0.2	4.4±0.4	5.4±0.4	4.8±0.2	4.9±0.8
SA-IDM-3F2	5.5±1.2	4.2±0.3	4.9±0.2	4.1±0.3	4.7±1.2
SA-IDM-3F3	5.0±0.2	4.3±0.2	5.0±0.2	4.3±0.3	4.6±0.7
SA-IDM-5F1	5.2±0.7	4.3±0.5	5.1±0.3	4.6±0.5	4.8±0.8
SA-IDM-6F1	4.7±0.3	3.6±0.1	4.6±0.2	3.8±0.3	4.2±1.1
SA-IDM-7F2	4.6±0.2	3.4±0.2	4.3±0.2	3.5±0.1	4.0±1.2
SA-IDM-10F2	5.7±0.5	5.1±0.4	5.9±0.3	5.1±0.5	5.4±0.8
SA-IDM-11F1	5.8±0.5	5.2±0.4	5.8±0.5	5.3±0.6	5.5±0.6
SA-IDM-12F1	5.7±0.3	4.7±0.3	5.7±0.1	4.9±0.4	5.2±1.0
SA-IDM-13F2	5.3±0.4	4.6±0.4	5.4±0.3	4.8±0.4	5.0±0.8
SA-IDM-13F3	5.7±0.4	4.8±0.3	5.7±0.4	5.0±0.5	5.3±0.9
SA-IDM-13F4	5.7±0.2	4.6±0.5	5.6±0.3	4.9±0.5	5.2±1.1
SA-IDM-14F2	5.3±0.1	4.5±0.4	5.5±0.4	5.1±0.7	5.1±0.9
SA-IDM-15F3	6.0±0.5	5.2±0.2	6.3±0.4	5.4±0.4	5.7±1.0
SA-IDM-16F2	5.2±0.7	4.3±0.2	5.4±0.3	4.6±0.4	4.9±1.0
SA-IDM-1G3 (C)	5.8±0.4	5.5±0.8	6.4±0.4	5.7±0.4	5.8±0.8
SA-IDM-3G1 (C)	5.8±0.4	4.9±0.3	5.8±0.3	5.1±0.6	5.4±0.9
SA-IDM-10G1 (C)	6.1±0.6	5.1±0.6	5.9±0.5	5.3±0.5	5.6±1.0
SA-IDM-16G1 (C)	6.1±0.6	5.3±0.5	6.3±0.6	5.8±0.7	5.9±0.9
SA-IDM-3H1 (C)	6.0±0.5	5.0±0.3	5.8±0.2	5.2±0.5	5.5±1.0
SA-IDM-3H3 (C)	5.9±0.5	5.0±0.2	5.9±0.3	5.2±0.6	5.5±0.9
AVERAGE	5.5±0.9	4.6±1.0	5.5±1.1	4.9±1.1	
				Grand Average	5.1±1.3

* The standard month = 30.4 days.
(C) Control station

TABLE C-9
1986 DIRECT RADIATION MEASUREMENTS - MONTHLY TLD RESULTS
Results in mrad/standard month*
(Results by Teledyne Isotopes)

STATION ID	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE
SA-IDM-2S2	5.3±0.3	6.6±0.1	5.2±0.4	6.6±1.2	6.7±0.8	5.6±0.5
SA-IDM-5S1	5.2±0.4	5.9±0.1	4.5±0.2	6.2±0.7	5.9±0.6	5.0±1.2
SA-IDM-6S2	5.6±0.4	6.4±0.4	4.9±0.5	6.8±0.5	6.3±0.4	5.9±0.5
SA-IDM-7S1	6.5±0.6	7.5±0.7	6.0±0.7	7.7±0.6	7.3±0.6	7.0±0.9
SA-IDM-10S1	5.9±0.6	6.8±0.2	5.4±0.5	7.4±0.7	6.9±0.6	6.4±0.7
SA-IDM-11S1	5.2±0.4	6.1±0.3	4.7±0.2	6.9±0.4	7.7±1.0	6.0±0.9
SA-IDM-5D1	5.5±0.5	6.1±0.1	5.0±0.5	6.6±0.8	6.1±0.4	5.8±0.6
SA-IDM-10D1	5.7±0.5	6.6±0.3	5.3±0.4	7.2±0.6	6.9±0.6	6.7±0.7
SA-IDM-14D1	5.6±0.4	6.6±0.4	5.5±1.3	6.9±0.5	6.9±0.7	6.2±0.7
SA-IDM-2E1	5.5±0.3	6.2±0.4	4.9±0.5	6.6±0.6	6.7±1.0	5.6±0.6
SA-IDM-3E1	5.5±0.5	6.1±0.3	4.7±0.1	6.5±0.5	6.4±0.6	5.2±0.8
SA-IDM-13E1	5.3±0.8	6.2±0.2	4.7±0.3	6.5±0.4	5.8±0.7	5.9±0.7
SA-IDM-16E1	5.6±0.6	6.7±0.6	5.0±0.2	7.0±0.4	6.8±0.7	6.3±0.9
SA-IDM-1F1	5.7±0.3	6.4±0.6	5.1±0.3	6.9±0.6	6.5±0.6	6.3±0.8
SA-IDM-2F2	4.8±0.4	5.8±0.3	4.1±0.2	6.0±0.5	5.4±0.3	5.0±0.4
SA-IDM-2F6	5.9±0.6	6.6±0.5	5.0±0.6	6.8±0.6	5.9±0.5	6.0±0.9
SA-IDM-5F1	5.5±0.6	5.9±0.3	4.6±0.3	6.5±0.5	6.1±0.4	5.6±0.7
SA-IDM-6F1	5.0±0.3	5.7±0.1	(1)	5.9±0.4	5.4±0.3	5.0±0.3
SA-IDM-7F2	4.3±0.3	5.4±0.3	3.8±0.3	5.5±0.7	5.1±0.4	4.5±0.7
SA-IDM-11F1	5.8±0.4	7.0±1.0	5.5±0.5	7.4±0.6	7.1±0.9	6.5±0.6
SA-IDM-13F4	5.8±0.6	6.9±0.7	4.9±0.3	7.0±0.5	6.6±0.6	6.2±0.4
SA-IDM-3G1 (C)	5.5±0.2	6.3±1.0	5.3±0.4	7.4±1.5	6.8±0.8	6.1±0.4
SA-IDM-3H1 (C)	5.9±0.2	6.8±0.3	5.3±0.4	7.2±0.4	6.7±0.7	6.3±0.8
SA-IDM-3H3 (C)	6.3±0.6	7.4±0.4	5.6±0.3	7.6±0.6	7.3±0.6	6.6±1.0
AVERAGE	5.5±0.9	6.4±1.0	5.0±1.0	6.8±1.1	6.5±1.3	5.9±1.2

TABLE C-9 (cont'd)
1986 DIRECT RADIATION MEASUREMENTS - MONTHLY TLD RESULTS
Results in mrad/standard month*
(Results by Teledyne Isotopes)

STATION ID	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	AVERAGE
SA-IDM-2S2	5.9±0.3	5.7±0.5	5.3±0.5	5.4±0.3	4.9±0.4	7.1±0.7	5.8±1.4
SA-IDM-5S1	5.5±0.4	5.9±0.7	4.9±0.7	5.3±0.3	4.6±0.3	6.2±0.5	5.4±1.2
SA-IDM-6S2	6.1±0.5	6.1±0.4	5.5±0.4	5.7±0.4	4.9±0.5	6.6±0.6	5.9±1.2
SA-IDM-7S1	7.0±0.8	6.9±0.4	6.6±0.8	6.5±0.9	5.9±0.7	7.7±1.0	6.9±1.2
SA-IDM-10S1	6.5±0.6	6.5±0.4	5.7±0.5	6.4±0.6	5.5±0.3	7.6±0.9	6.4±1.4
SA-IDM-11S1	6.4±0.6	6.1±0.5	5.0±0.2	5.4±0.3	5.0±0.1	6.9±0.9	5.9±1.8
SA-IDM-5D1	6.2±0.5	6.0±0.7	5.5±0.5	5.5±0.5	4.8±0.4	6.5±0.6	5.8±1.1
SA-IDM-10D1	5.7±1.1	6.3±0.5	5.8±0.4	6.1±0.5	5.3±0.4	6.9±0.6	6.2±1.3
SA-IDM-14D1	6.8±0.1	6.2±0.3	5.7±0.5	6.0±0.8	5.2±0.4	6.9±0.6	6.2±1.2
SA-IDM-2E1	6.0±0.7	6.0±0.3	5.5±0.3	5.6±0.5	4.9±0.6	6.5±0.9	5.8±1.2
SA-IDM-3E1	6.0±0.4	5.9±0.5	5.1±0.3	5.5±0.3	4.8±0.4	6.3±0.5	5.7±1.2
SA-IDM-13E1	5.9±0.4	5.9±0.4	5.2±0.6	5.7±0.4	4.8±0.5	6.6±0.6	5.7±1.2
SA-IDM-16E1	6.4±0.5	6.1±0.4	5.8±0.6	5.9±0.5	5.1±0.4	7.1±0.7	6.1±1.4
SA-IDM-1F1	6.3±0.5	6.2±0.3	5.5±0.3	5.9±0.5	5.1±0.5	6.7±0.4	6.0±1.2
SA-IDM-2F2	5.4±0.4	5.3±0.2	4.7±0.2	4.8±0.2	4.2±0.2	5.9±0.3	5.1±1.2
SA-IDM-2F6	6.0±0.6	6.1±0.3	5.6±0.3	5.6±0.3	5.0±0.5	7.1±0.6	6.0±1.3
SA-IDM-5F1	6.1±0.3	5.9±0.2	5.5±0.3	5.6±0.4	5.0±0.3	6.4±0.6	5.7±1.1
SA-IDM-6F1	5.6±0.3	5.3±0.2	4.8±0.3	5.0±0.3	4.3±0.2	6.1±0.5	5.3±1.0
SA-IDM-7F2	5.0±0.3	4.9±0.1	4.2±0.2	4.6±0.3	3.8±0.2	5.5±0.6	4.7±1.2
SA-IDM-11F1	6.8±1.0	6.7±0.4	6.2±0.8	6.2±0.5	5.6±0.5	7.2±0.8	6.5±1.3
SA-IDM-13F4	6.5±0.4	6.1±0.2	5.7±0.4	6.0±0.5	5.3±0.4	6.9±0.5	6.2±1.3
SA-IDM-3G1 (C)	6.7±0.5	6.6±0.7	6.1±0.4	6.3±1.3	5.1±0.3	7.2±0.3	6.3±1.4
SA-IDM-3H1 (C)	6.7±0.9	6.7±0.4	5.6±0.6	6.0±0.5	5.4±0.2	7.2±0.5	6.3±1.3
SA-IDM-3H3 (C)	6.9±0.5	6.9±0.4	6.3±0.8	6.5±0.3	5.9±0.4	7.4±0.6	6.7±1.3
AVERAGE	6.2±1.0	6.1±1.0	5.5±1.1	5.7±1.0	5.0±1.0	6.8±1.1	
						Grand Average	6.0±1.6

* The standard month = 30.4 days.
(C) Control station
(1) TLD missing from field location.

TABLE C-10

1986 CONCENTRATIONS OF IODINE-131* IN MILK**

Results in Units of pCi/L ± 2 Sigma

STATION ID***	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE
SA-MLK-13E3	<0.4	<0.6	<0.6	<0.5	<0.6	3.3±0.8
	-	-	-	<0.6	11±1	0.7±0.4
SA-MLK-2F4	<0.4	<0.6	<0.6	<0.5	<0.3	2.2±0.4
	-	-	-	<0.6	29±1	1.3±0.4
SA-MLK-5F2	<0.6	<0.1	<0.4	<0.4	<0.5	6.2±0.9
	-	-	-	<0.6	47±2	1.2±0.4
SA-MLK-11F3	<0.4	<0.5	<0.6	<0.6	<0.3	2.5±0.6
	-	-	-	<0.4	27±2	0.6±0.2
SA-MLK-14F1	<0.6	<0.6	<0.9	<0.4	<0.1	5.0±0.8
	-	-	-	<0.6	25±2	1.0±0.4
SA-MLK-3G1	<0.6	<0.6	<0.6	<0.6	<0.6	3.3±0.6
(Control)	-	-	-	<0.6	63±2	0.3±0.2
AVERAGE	-	-	-	-	-	2.3±3.7

STATION ID***	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
SA-MLK-13E3	<0.4	<0.6	<0.4	<0.6	<0.7	<0.6
	<0.6	<0.6	<0.6	<0.6	<0.6	-
SA-MLK-2F4 (1)	0.2±0.1	<0.6	--	--	--	--
	<0.6	<0.6	--	--	--	--
SA-MLK-2F7 (2)	--	<0.6	<0.6	<0.6	<0.6	<0.6
	--	<0.6	<0.2	<0.6	<0.4	-
SA-MLK-5F2	<0.7	<0.6	<0.6	<0.4	<0.6	<0.6
	<0.6	<0.3	<0.7	<0.6	<0.7	-
SA-MLK-11F3	<0.7	<0.7	<0.3	<0.6	<0.6	<0.6
	<0.6	<0.8	<0.7	<0.6	<0.6	-
SA-MLK-14F1	<0.7	<0.8	<0.7	<0.6	<0.6	<0.1
	<0.8	<0.6	<0.6	<0.4	<0.8	-
SA-MLK-3G1	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
(Control)	<0.8	<0.4	<0.6	<0.6	<0.6	-
AVERAGE	-	-	-	-	-	-

* I-131 results are corrected for decay to midpoint of collection period.
** Monthly sample collected during Jan., Feb., March and Dec., when animals are not on pasture.
*** Sampling dates can be found in Table C-13.
(1) Station SA-MLK-2F4 terminated milk production on September 1, 19[redacted]
(2) Station SA-MLK-2F7 replaced station SA-MLK-2F4 on September 1, 1[redacted]

TABLE C-11

1986 CONCENTRATIONS OF STRONTIUM-89* AND STRONTIUM-90 IN MILK**

Results in Units of pCi/L ± 2 sigma

STATION ID	COLLECTION PERIOD	Sr-89	Sr-90
SA-MLK-13E3	07/06-07/86	<0.9	1.9±0.3
SA-MLK-2F4	07/06-07/86	<0.8	1.8±0.3
SA-MLK-2F7	08/03-04/86	<1.5	2.4±0.6
SA-MLK-5F2	07/05-07/86	<1.1	3.0±0.4
SA-MLK-11F3	07/07-08/86	<0.8	1.7±0.3
SA-MLK-14F1	07/06-07/86	<0.8	1.2±0.3
SA-MLK-3G1 (Control)	07/07-08/86	<0.9	2.7±0.3
AVERAGE		-	2.1±1.2

* Sr-89 results are corrected for decay to midpoint of collection period.

** Management audit analyses, not required by Technical Specifications or by specific commitments to local officials.

TABLE C-12

1986 CONCENTRATIONS OF GAMMA EMITTERS* IN MILK

Results in Units of pCi/L ± 2 sigma

STATION ID**	NUCLIDE	JANUARY MONTHLY	FEBRUARY MONTHLY	MARCH MONTHLY
SA-MLK-13E3	Na-22	<3.4	<3.9	<4.0
	K-40	1400±75	1400±79	1400±98
	Mn-54	<2.5	<3.4	<4.0
	Zn-65	<7.2	<7.7	<10
	I-131	<3.0	<2.5	<4.7
	Cs-137	<2.7	<2.8	<4.9
	Ra-226	<5.9	<7.2	<9.4
SA-MLK-2F4 (1)	Na-22	<3.7	<5.6	<3.4
	K-40	1400±74	1400±98	1400±76
	Mn-54	<2.5	<4.1	<2.3
	Zn-65	<5.9	<6.3	<6.9
	I-131	<3.0	<3.8	<3.0
	Cs-137	<2.9	<4.6	<2.7
	Ra-226	<5.5	<7.4	<5.9
SA-MLK-2F7 (2)	Na-22	-	-	-
	K-40	-	-	-
	Mn-54	-	-	-
	Zn-65	-	-	-
	I-131	-	-	-
	Cs-137	-	-	-
	Ra-226	-	-	-
SA-MLK-5F2	Na-22	<3.5	<2.2	<1.7
	K-40	1300±72	1300±81	1300±82
	Mn-54	<2.5	<3.3	<2.7
	Zn-65	<5.9	<9.1	<1.8
	I-131	<3.2	<3.8	<0.6
	Cs-137	<2.9	<2.9	<3.6
	Ra-226	<6.2	<7.7	<5.9
SA-MLK-11F3	Na-22	<4.6	<4.5	<3.6
	K-40	1300±90	1300±82	1300±74
	Mn-54	<3.2	<2.0	<2.3
	Zn-65	<8.7	<7.3	<5.9
	I-131	<3.3	<0.6	<3.3
	Cs-137	<3.3	<3.7	<2.9
	Ra-226	<6.6	<6.8	<6.2
SA-MLK-14F1	Na-22	<2.4	<3.6	<3.5
	K-40	1300±81	1400±77	1400±77
	Mn-54	<3.8	<2.6	<3.2
	Zn-65	<9.1	<6.9	<1.8
	I-131	<4.7	<3.1	<4.7
	Cs-137	<3.9	<2.6	<3.7
	Ra-226	<6.1	<5.5	<7.9
SA-MLK-3G1 (Control)	Na-22	<4.2	<5.2	<4.9
	K-40	1300±92	1300±92	1400±92
	Mn-54	<3.2	<3.5	<3.2
	Zn-65	<8.7	<8.7	<8.2
	I-131	<3.1	<3.4	<3.6
	Cs-137	<3.3	<3.5	<3.3
	Ra-226	<7.0	<7.0	<6.6
AVERAGE	K-40	1300±100	1400±110	1400±100

TABLE C-12 (cont'd.)

1986 CONCENTRATIONS OF GAMMA EMITTERS* IN MILK

Results in Units of pCi/L ± 2 sigma

STATION ID**	NUCLIDE	APRIL SEMI-MONTHLY		MAY SEMI-MONTHLY		JUNE SEMI-MONTHLY	
SA-MLK-13E3	Na-22	<4.9	<4.5	<4.6	<4.2	<4.9	<4.5
	K-40	1400±100	1400±83	1300±76	1300±77	1300±92	1400±79
	Mn-54	<4.9	2.9±1.7	<2.8	<1.8	<3.0	<1.4
	Zn-65	<8.6	<7.4	<9.7	<7.3	<9.5	<8.3
	I-131	<0.8	<1.9	<3.9	13±2	3.8±2.3	<4.4
	Cs-137	<4.5	<3.6	<3.6	<3.4	<3.6	<4.2
	Ra-226	<8.6	<7.0	<7.4	<8.0	<7.0	<6.2
SA-MLK-2F4	Na-22	<6.2	<4.4	<4.8	<4.6	<3.1	<4.6
	K-40	1400±99	1400±77	1400±99	1400±92	1400±77	1400±93
	Mn-54	<3.8	<1.8	<4.4	<3.5	<2.5	<3.1
	Zn-65	<11	<6.9	<8.8	<8.7	<6.6	<8.2
	I-131	<2.3	<3.4	<3.5	32±3	<3.5	<4.0
	Cs-137	<4.2	<4.2	<3.0	<3.8	<2.9	<3.6
	Ra-226	<9.2	<8.3	<7.9	<7.0	<6.9	<6.2
SA-MLK-2F7	Na-22	-	-	-	-	-	-
	K-40	-	-	-	-	-	-
	Mn-54	-	-	-	-	-	-
	Zn-65	-	-	-	-	-	-
	I-131	-	-	-	-	-	-
	Cs-137	-	-	-	-	-	-
	Ra-226	-	-	-	-	-	-
SA-MLK-5F2	Na-22	<2.8	<4.5	<4.0	4.6±2.3	<1.6	<3.6
	K-40	1200±74	1300±96	1300±74	1300±76	1200±94	1300±72
	Mn-54	<2.9	<3.8	<2.9	<3.5	<4.0	<2.3
	Zn-65	<7.0	<11	<6.4	<6.2	<7.0	<6.7
	I-131	<3.0	<3.7	<3.2	49±4	7.3±2.7	<3.4
	Cs-137	<3.0	<4.7	<3.7	<3.6	5.1±2.4	3.9±1.6
	Ra-226	<7.6	<6.6	<7.7	<7.7	<8.0	<6.2
SA-MLK-11F3	Na-22	<1.0	<4.9	<4.8	<4.1	<2.3	<3.1
	K-40	1400±77	1400±92	1400±97	1300±83	1200±75	1300±82
	Mn-54	<2.3	<3.1	<4.6	<1.9	<3.3	<3.1
	Zn-65	<9.1	<8.7	<9.2	11±6	<8.7	<8.1
	I-131	<3.9	<3.7	<3.5	24±3	<4.2	<3.0
	Cs-137	<2.3	<3.2	<4.3	<3.8	<3.8	<3.3
	Ra-226	<6.3	<7.4	<7.8	<6.7	<7.1	<7.1
SA-MLK-14F1	Na-22	<3.8	<5.1	<1.2	<1.6	<3.7	<4.9
	K-40	1300±94	1300±96	1300±83	1300±95	1400±76	1400±97
	Mn-54	<1.1	<3.6	<2.8	<3.8	<2.6	<3.9
	Zn-65	<6.7	<5.0	<4.7	<5.4	<7.2	<10
	I-131	<4.4	<3.2	<2.8	26±4	4.7±1.9	<4.9
	Cs-137	<2.6	<3.1	<3.8	<4.1	3.3±1.7	<4.2
	Ra-226	<8.1	<8.8	7.3±4.3	<7.9	4.4±2.8	<8.2
SA-MLK-3G1 (Control)	Na-22	<4.8	<3.5	<4.8	<5.5	<4.7	<4.8
	K-40	1400±93	1400±74	1400±82	1400±97	1300±81	1400±93
	Mn-54	<3.5	<2.6	<2.9	<3.2	<4.2	<3.7
	Zn-65	<8.7	<6.7	<4.8	<11	<8.6	<7.4
	I-131	<4.1	<3.4	<4.0	65±5	7.4±2.6	<3.3
	Cs-137	<3.8	<2.9	<2.7	<4.2	<4.2	<3.9
	Ra-226	<7.7	5.5±2.9	<7.0	<8.8	<6.2	<6.6
AVERAGE	K-40	1400±170	1400±100	1400±110	1300±100	1300±180	1400±100

TABLE C-12 (cont'd.)

1986 CONCENTRATIONS OF GAMMA EMITTERS* IN MILK

Results in Units of pCi/L ± 2 sigma

STATION ID**	NUCLIDE	JULY SEMI-MONTHLY		AUGUST SEMI-MONTHLY		SEPTEMBER SEMI-MONTHLY	
SA-MLK-13E3	Na-22	<3.5	<5.0	<4.9	<3.0	<2.1	<3.3
	K-40	1400±75	1500±97	1400±96	1400±85	1400±78	1400±96
	Mn-54	<2.6	<3.8	<2.8	<0.8	<0.7	<4.4
	Zn-65	<5.4	<11	<8.0	<2.1	<3.6	<9.7
	I-131	<3.6	<3.3	<4.0	<2.9	<3.1	<2.8
	Cs-137	<2.7	<4.5	<3.9	<4.0	3.7±2.0	<4.0
	Ra-226	<5.9	<8.4	<6.6	<6.0	<8.8	<8.4
SA-MLK-2F4	Na-22	<4.8	<3.7	<2.9	<5.4	-	-
	K-40	1300±92	1400±75	1400±96	1500±96	-	-
	Mn-54	<3.0	<2.5	<4.1	<3.0	-	-
	Zn-65	<9.5	<5.9	<9.0	<9.7	-	-
	I-131	<4.0	<3.4	<0.7	<3.8	-	-
	Cs-137	<3.8	<3.0	<4.5	<3.3	-	-
	Ra-226	<7.0	<5.5	<8.0	<7.0	-	-
SA-MLK-2F7	Na-22	-	-	<3.7	<3.5	<4.5	<2.6
	K-40	-	-	1400±74	1300±73	1400±78	1400±78
	Mn-54	-	-	<2.6	<2.5	<2.6	<4.3
	Zn-65	-	-	<6.7	<6.9	<8.1	<3.5
	I-131	-	-	<3.2	<3.2	<3.2	<2.3
	Cs-137	-	-	<3.2	<2.7	<3.2	<3.7
	Ra-226	-	-	5.1±2.8	<5.5	<8.1	<8.7
SA-MLK-5F2	Na-22	<3.9	<4.9	<6.4	<3.2	<1.6	<3.9
	K-40	1300±77	1300±92	1300±95	1300±72	1200±91	1200±77
	Mn-54	<0.7	<3.1	<3.9	<2.2	<2.0	<1.6
	Zn-65	<5.5	<8.2	<7.3	<6.4	<12	<2.1
	I-131	<4.1	<3.4	<4.3	<3.2	<2.3	<4.6
	Cs-137	<4.7	<3.9	<3.8	<2.9	<5.1	<3.8
	Ra-226	<7.1	<7.0	<7.2	<5.9	<7.3	<7.7
SA-MLK-11F3	Na-22	<6.3	<3.2	<6.0	<5.0	<5.9	<4.4
	K-40	1500±98	1300±78	1400±98	1500±100	1300±96	1300±93
	Mn-54	<3.6	<3.1	<2.9	<3.2	<3.3	<3.1
	Zn-65	<14	<9.5	<4.7	<9.0	<8.2	<8.5
	I-131	<4.6	<0.6	<4.5	<4.7	<0.8	<3.8
	Cs-137	<4.8	<4.0	<3.0	<3.7	<4.4	<3.6
	Ra-226	<6.8	<7.3	<8.3	<8.2	<8.2	<6.6
SA-MLK-14F1	Na-22	<5.5	<4.8	<4.1	<3.9	<3.5	<3.3
	K-40	1400±80	1400±97	1400±77	1400±78	1400±75	1300±82
	Mn-54	<3.3	<1.8	<3.1	<1.7	<2.3	<3.1
	Zn-65	<9.4	<11	<1.8	<9.3	<6.4	<8.8
	I-131	<2.1	<3.7	<3.7	<4.4	<3.2	<3.6
	Cs-137	<3.6	<4.0	<3.7	<2.9	<2.7	<3.7
	Ra-226	<8.0	<7.5	<6.3	<8.7	<6.2	<6.9
SA-MLK-3G1 (Control)	Na-22	<3.9	<2.9	<4.6	<4.5	<3.9	(3)
	K-40	1300±73	1400±84	1300±83	1100±86	1300±92	-
	Mn-54	<2.5	<2.4	<2.2	<3.2	<3.5	-
	Zn-65	<6.9	<8.6	<6.3	<7.7	<9.0	-
	I-131	<3.0	<3.7	<3.3	<3.3	<3.7	-
	Cs-137	<2.9	<3.2	<3.7	<3.8	<3.5	-
	Ra-226	<5.5	<7.5	<5.8	<6.6	<7.0	-
AVERAGE	K-40	1400±160	1400±150	1400±100	1400±280	1300±160	1300±170

TABLE C-12 (cont'd.)

1986 CONCENTRATIONS OF GAMMA EMITTERS* IN MILK

Results in Units of pCi/L ± 2 sigma

STATION ID**	NUCLIDE	OCTOBER SEMI-MONTHLY		NOVEMBER SEMI-MONTHLY		DECEMBER MONTHLY	AVERAGE
SA-MLK-13E3	Na-22	<2.6	<5.3	<3.5	<5.3	<6.4	-
	K-40	1400±79	1400±93	1400±79	1500±84	1400±98	1400±100
	Mn-54	<3.1	<3.1	<3.6	<2.0	<3.5	-
	Zn-65	<9.0	<8.7	<6.6	<10	<7.6	-
	I-131	<3.8	<3.7	<2.4	<2.8	<3.6	-
	Cs-137	<3.5	<3.6	<3.8	4.4±2.2	<3.5	-
	Ra-226	<7.1	<7.4	<6.4	<6.4	<6.7	-
SA-MLK-2F4	Na-22	-	-	-	-	-	-
	K-40	-	-	-	-	-	1400±82
	Mn-54	-	-	-	-	-	-
	Zn-65	-	-	-	-	-	-
	I-131	-	-	-	-	-	-
	Cs-137	-	-	-	-	-	-
	Ra-226	-	-	-	-	-	-
SA-MLK-2F7	Na-22	<2.9	<4.2	<4.4	<4.0	<4.2	-
	K-40	1300±81	1400±98	1300±95	1400±74	1300±81	1400±100
	Mn-54	<3.0	<3.4	<3.2	<2.6	<3.2	-
	Zn-65	<10	<5.8	<9.9	<6.9	<8.2	-
	I-131	<4.3	<4.4	<4.4	<2.9	<2.3	-
	Cs-137	<4.2	<4.9	<3.9	<3.2	<4.2	-
	Ra-226	<6.7	<7.9	<8.3	<5.9	<7.1	-
SA-MLK-5F2	Na-22	<3.9	<4.6	<3.5	<4.6	<4.1	-
	K-40	1200±71	1200±73	1200±71	1300±81	1200±88	1300±100
	Mn-54	<2.3	<2.3	<2.3	<3.3	<3.4	-
	Zn-65	<6.2	<7.6	<6.9	<6.2	<8.4	-
	I-131	<2.9	<3.3	<3.3	<2.4	<3.8	-
	Cs-137	<3.0	<3.6	<3.0	<4.3	<3.5	-
	Ra-226	<6.2	<7.4	<5.1	<7.3	<7.4	-
SA-MLK-11F3	Na-22	<3.1	<2.6	<3.9	<5.2	<4.4	-
	K-40	1400±78	1400±98	1300±83	1400±94	1300±77	1400±150
	Mn-54	<2.8	<4.9	<3.3	<3.2	<3.6	-
	Zn-65	<9.2	<13	<7.3	<8.5	<9.9	-
	I-131	<2.9	<4.9	<4.5	<3.7	<3.6	-
	Cs-137	<3.3	<3.5	<3.9	<3.6	<4.7	-
	Ra-226	<7.3	<8.8	<6.5	<7.0	<7.5	-
SA-MLK-14F1	Na-22	<3.3	<3.6	<5.3	<4.7	<3.8	-
	K-40	1300±74	1400±74	1500±100	1300±76	1300±76	1400±120
	Mn-54	<3.1	<2.6	<4.1	<3.1	<1.7	-
	Zn-65	<7.8	<6.4	<7.8	<7.0	<9.0	-
	I-131	<3.1	<3.2	<4.3	<1.9	<2.2	-
	Cs-137	<4.1	<2.7	<4.9	<2.7	<3.2	-
	Ra-226	<8.2	<5.9	<7.4	<6.6	<8.0	-
SA-MLK-3G1 (Control)	Na-22	<5.1	<4.7	<5.0	<3.9	<4.9	-
	K-40	1300±96	1400±78	1400±94	1400±98	1300±76	1300±150
	Mn-54	<4.2	<3.3	<3.6	<4.0	<2.4	-
	Zn-65	<10	<7.6	<9.0	<11	<6.0	-
	I-131	<3.8	<3.8	<3.6	<3.7	<3.8	-
	Cs-137	<4.1	<4.7	<3.8	<4.9	<3.8	-
	Ra-226	<6.7	<9.0	<6.6	<7.9	<5.4	-
AVERAGE	K-40	1300±150	1400±160	1400±210	1400±150	1300±130	1300±150

* All other gamma emitters searched for were <LLD; typical LLDs are given in Table C-33.
** Sampling dates can be found in Table C-13.
(1) Station SA-MLK-2F4 terminated milk production on September 1, 1986.
(2) Station SA-MLK-2F7 replaced station SA-MLK-2F4 on September 1, 1986.
(3) Sample lost during preparation

TABLE C-13

1986 SAMPLING DATES FOR MILK SAMPLES

MONTH	STATION ID 13E3	2F4	6F2	11F3	14F1	3G1
JANUARY	01-06-86 to 01-07-86	01-05-86 to 01-06-86	01-04-86 to 01-06-86	01-06-86 to 01-07-86	01-05-86 to 01-06-86	01-06-86 to 01-07-86
FEBRUARY	02-03-86 to 02-04-86	02-02-86 to 02-03-86	02-01-86 to 02-03-86	02-03-86 to 02-04-86	02-02-86 to 02-03-86	02-03-86 to 02-04-86
MARCH	03-03-86 to 03-04-86	03-03-86 to 03-04-86	03-01-86 to 03-03-86	03-03-86 to 03-04-86	03-02-86 to 03-03-86	03-03-86 to 03-04-86
APRIL	04-07-86 to 04-08-86	04-07-86 to 04-08-86	04-06-86 to 04-07-86	04-06-86 to 04-07-86	04-07-86 to 04-08-86	04-06-86 to 04-07-86
	04-22-86 to 04-22-86	04-21-86 to 04-22-86	04-20-86 to 04-21-86	04-20-86 to 04-21-86	04-21-86 to 04-22-86	04-20-86 to 04-21-86
MAY	05-05-86 to 05-06-86	05-05-86 to 05-06-86	05-04-86 to 05-05-86	05-04-86 to 05-05-86	05-05-86 to 05-06-86	05-04-86 to 05-05-86
	05-19-86 to 05-20-86	05-19-86 to 05-20-86	05-18-86 to 05-19-86	05-19-86 to 05-19-86	05-19-86 to 05-20-86	05-18-86 to 05-19-86
JUNE	06-08-86 to 06-09-86	06-08-86 to 06-09-86	06-07-86 to 06-09-86	06-09-86 to 06-10-86	06-08-86 to 06-09-86	06-09-86 to 06-10-86
	06-22-86 to 06-23-86	06-22-86 to 06-23-86	06-21-86 to 06-23-86	06-23-86 to 06-24-86	06-22-86 to 06-23-86	06-23-86 to 06-24-86
JULY	07-06-86 to 07-07-86	07-06-86 to 07-07-86	07-05-86 to 07-07-86	07-07-86 to 07-08-86	07-06-86 to 07-07-86	07-07-86 to 07-08-86
	07-21-86 to 07-22-86	07-20-86 to 07-21-86	07-19-86 to 07-21-86	07-21-86 to 07-22-86	07-20-86 to 07-21-86	07-21-86 to 07-22-86

TABLE C-13 (cont'd)

1986 SAMPLING DATES FOR MILK SAMPLES

MONTH	STATION ID						
	13E3	2F4*	2F7**	5F2	11F3	14F1	3G1
AUGUST	08-03-86 to 08-04-86	08-03-86 to 08-04-86	08-03-86 to 08-04-86	08-02-86 to 08-04-86	08-04-86 to 08-05-86	08-04-86 to 08-05-86	08-03-86 to 08-04-86
	08-19-86 to 08-20-86	08-19-86 to 08-20-86	08-19-86 to 08-20-86	08-18-86 to 08-19-86	08-18-86 to 08-19-86	08-18-86 to 08-19-86	08-19-86 to 08-20-86
SEPTEMBER	09-08-86 to 09-09-86		09-08-86 to 09-09-86	09-07-86 to 09-08-86	09-07-86 to 09-08-86	09-07-86 to 09-08-86	09-08-86 to 09-09-86
	09-22-86 to 09-23-86		09-22-86 to 09-23-86	09-21-86 to 09-22-86	09-21-86 to 09-22-86	09-21-86 to 09-22-86	09-22-86 to 09-23-86
OCTOBER	10-06-86 to 10-07-86		10-06-86 to 10-07-86	10-05-86 to 10-06-86	10-05-86 to 10-06-86	10-05-86 to 10-06-86	10-06-86 to 10-07-86
	10-20-86 to 10-21-86		10-20-86 to 10-21-86	10-19-86 to 10-20-86	10-19-86 to 10-20-86	10-19-86 to 10-20-86	10-20-86 to 10-21-86
NOVEMBER	11-02-86 to 11-03-86		11-09-86 to 11-10-86	11-01-86 to 11-02-86	11-02-86 to 11-03-86	11-02-86 to 11-03-86	11-01-86 to 11-03-86
	11-17-86 to 11-18-86		11-17-86 to 11-18-86	11-16-86 to 11-17-86	11-16-86 to 11-17-86	11-16-86 to 11-17-86	11-17-86 to 11-18-86
DECEMBER	12-07-86 to 12-08-86		12-07-86 to 12-08-86	12-06-86 to 12-08-86	12-08-86 to 12-09-86	12-08-86 to 12-09-86	12-07-86 to 12-08-86

* Station SA-MLK-2F4 terminated milk production on September 1, 1986.
** Station SA-MLK-2F7 replaced station SA-MLK-2F4 on September 1, 1986.

TABLE C-14

1986 CONCENTRATIONS OF GROSS ALPHA AND GROSS BETA EMITTERS, POTASSIUM-40 AND TRITIUM IN WELL WATER

Results in Units of pCi/L ± 2 sigma

STATION ID RADIOACTIVITY	01-13-86	02-10-86	03-10-86	04-14-86	05-12-86	06-16-86
SA-WWA-2S3						
Alpha	<2.2	<1.2	<1.6	<1.1	<1.0(1)	<0.5
Beta	3.3±0.8	5.8±0.9	3.6±0.8	3.2±0.7	5.4±0.9	2.5±0.7
K-40	3.0±0.3	6.9±0.7	4.2±0.4	3.6±0.4	5.9±0.6	2.9±0.3
H-3	<130	<130	<140	<140	<130	<140
SA-WWA-5D1						
Alpha	<3.7	<1.4	<1.9	<0.8	<0.7	0.9±0.5
Beta	13±1	13±1	13±1	12±1	13±1	2.0±0.6
K-40	8.8±0.9	13±1	15±2	15±2	14±1	12±1
H-3	<130	<140	<150	<140	<130	<130
SA-WWA-3E1 (Control)						
Alpha	<2.9	<1.4	<1.9	<0.9	<0.8	<0.8
Beta	8.5±1.0	9.5±1.1	8.1±1.0	8.8±1.1	8.4±1.0	2.5±0.6
K-40	17±2	9.3±0.9	9.6±1.0	9.9±1.0	9.1±0.9	7.6±0.8
H-3	<130	<140	<140	<140	<130	<140
AVERAGE						
Alpha	-	-	-	-	-	-
Beta	8.3±9.7	9.4±7.2	8.2±9.4	8.0±8.9	8.9±7.6	2.3±0.6
K-40	9.6±14	9.7±6.1	9.6±11	9.5±11	9.7±8.2	7.5±9.1
H-3	-	-	-	-	-	-

TABLE C-14 (cont'd)

1986 CONCENTRATIONS OF GROSS ALPHA AND GROSS BETA EMITTERS, POTASSIUM-40 AND TRITIUM IN WELL WATER

Results in Units of pCi/L ± 2 sigma

STATION ID RADIOACTIVITY	07-14-86	08-11-86	09-15-86	10-14-86	11-10-86	12-15-86	AVERAGE
SA-WWA-2S3							
Alpha	1.7±1.3	1.6±1.2	0.9±0.6	0.7±0.5	<1.3	<1.9	-
Beta	8.6±1.1	6.5±1.0	2.5±0.6	7.3±1.0	3.6±0.8	3.8±0.8	4.7±4.0
K-40	7.3±0.7	8.0±0.8	4.7±0.5	3.2±0.3	2.9±0.3	2.7±0.3	4.6±3.8
H-3	<130	<140	<140	<140	<140	<130	-
SA-WWA-5D1							
Alpha	<1.5	2.0±1.2	0.6±0.5	<0.5	<1.4	<1.9	-
Beta	13±1	12±1	3.8±0.7	4.9±0.8	12±1	15±1	10±9
K-40	13±1	16±2	12±1	12±1	12±1	11±1	13±4
H-3	<130	<130	<140	<140	<140	<130	-
SA-WWA-3E1 (Control)							
Alpha	<1.5	<1.2	<0.5	<0.5	<1.5	<2.0	-
Beta	8.5±1.1	8.8±1.1	5.3±0.8	3.5±0.7	8.6±1.0	8.6±1.1	7.4±4.6
K-40	8.5±0.8	11±1	8.1±0.8	8.2±0.8	7.7±0.8	7.4±0.7	9.4±5.2
H-3	<130	<130	<140	<140	<140	<130	-
AVERAGE							
Alpha	-	1.6±0.8	0.7±0.4	-	-	-	-
Beta	10±5	9.1±5.5	3.9±2.8	5.2±3.8	8.1±8.4	9.1±11	7.6±7.7
K-40	9.6±6.0	12±8	8.3±7.3	7.8±8.8	7.5±9.1	7.0±8.3	9.0±8.0
H-3	-	-	-	-	-	-	-

(1) Station SA-WWA-2S3 was collected on 05-13-86.

TABLE C-15

1986 CONCENTRATIONS OF GAMMA EMITTERS* IN WELL WATER

Results in Units of pCi/L ± 2 sigma

STATION ID NUCLIDE	01-13-86	02-10-86	03-10-86	04-14-86	05-12-86	06-16-86
SA-WWA-2S3						
K-40	<27	<28	<26	<27	<23(1)	<32
Ra-226	3.3±1.9	15±3	6.0±3.1	<5.2	<3.3	7.4±2.9
Th-232	<6.6	<7.1	<4.6	<7.1	<5.3	<6.8
SA-WWA-5D1						
K-40	<38	<34	35±15	<33	<26	<40
Ra-226	<4.0	15±3	59±5	42±4	<4.0	44±4
Th-232	<7.1	<6.1	<8.0	<7.9	<7.1	8.4±4.8
SA-WWA-3E1 (Control)						
K-40	<23	<38	<45	<42	<41	<31
Ra-226	2.9±1.5	21±3	110±7	71±5	<4.6	63±5
Th-232	<5.8	<7.1	<9.9	<10	<8.7	<8.2
AVERAGE						
K-40	-	-	-	-	-	-
Ra-226	3.4±1.1	17±7	58±100	39±66	-	38±56
Th-232	-	-	-	-	-	-

TABLE C-15 (cont'd)

1986 CONCENTRATIONS OF GAMMA EMITTERS* IN WELL WATER

Results in Units of pCi/L ± 2 sigma

STATION ID NUCLIDE	07-14-86	08-11-86	09-15-86	10-14-86	11-10-86	12-15-86	AVERAGE
SA-WWA-2S3							
K-40	<23	<27	<30	<21	<27	<30	-
Ra-226	15±2	<4.8	<4.4	<3.7	9.6±2.6	8.4±2.9	7.2±8.3
Th-232	<5.3	<7.0	<6.3	<5.3	<5.2	<6.7	-
SA-WWA-5D1							
K-40	<29	<29	<28	41±15	47±16	44±17	-
Ra-226	50±4	29±4	10±3	66±5	21±3	96±6	37±56
Th-232	<7.1	<7.1	10±4	<7.5	<7.1	<8.4	-
SA-WWA-3E1 (Control)							
K-40	<30	<39	<39	<32	<23	<33	-
Ra-226	97±6	11±3	11±4	170±7	28±3	68±5	55±100
Th-232	<8.0	<7.7	<8.8	<6.1	<5.3	<8.0	-
AVERAGE							
K-40	-	-	-	-	-	-	-
Ra-226	54±82	15±25	8.5±7.1	80±168	20±18	57±89	33±77
Th-232	-	-	-	-	-	-	-

* All other gamma emitters searched for were <LLD; typical LLDs are given in Table C-33.
(1) Station SA-WWA-2S3 was collected on 05-13-86.

TABLE C-16

1986 CONCENTRATIONS OF STRONTIUM-89* AND STRONTIUM-90
IN QUARTERLY COMPOSITES OF WELL WATER

Results in Units of pCi/L ± 2 sigma

STATION ID NUCLIDE	01-13-86 to 03-10-86	04-14-86 to 06-16-86	07-14-86 to 09-15-86	10-14-86 to 12-15-86
SA-WWA-2S3				
Sr-89	<0.4	<11(1)	<0.6	<0.9
Sr-90	<0.3	<0.5	<0.4	<0.6
SA-WWA-5D1				
Sr-89	<0.5	<8.0(1)	<0.5	<0.7
Sr-90	<0.4	<0.4	<0.4	<0.5
SA-WWA-3E1 (Control)				
Sr-89	<0.6	<9.0(1)	<0.5	<0.8
Sr-90	<0.5	<0.4	<0.4	<0.5

* Sr-89 results are corrected for decay to sample stop date.
(1) High LLD due to extended period between collection and analysis.

TABLE C-17

1986 CONCENTRATIONS OF GROSS ALPHA AND GROSS BETA EMITTERS, POTASSIUM-40 AND TRITIUM IN RAW AND TREATED POTABLE WATER

STATION ID: SA-PWR/T-2F3

Results in Units of pCi/L ± 2 sigma

RADIOACTIVITY		JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE
Alpha	(Raw)	<2.4	0.7±0.5	0.7±0.5	<0.5	0.5±0.4	<1.0
	(Treated)	<1.9	0.6±0.5	<0.6	0.8±0.5	0.6±0.5	<1.4
Beta	(Raw)	2.2±0.6	3.7±0.8	2.4±0.6	2.2±0.6	2.1±0.6	2.4±0.7
	(Treated)	2.4±0.7	2.6±0.7	2.3±0.6	3.0±0.7	2.2±0.6	2.1±0.7
K-40	(Raw)	1.4±0.1	1.7±0.2	1.4±0.1	2.0±0.2	1.3±0.1	1.4±0.1
	(Treated)	2.3±0.2	1.7±0.2	1.4±0.1	2.0±0.2	1.9±0.2	1.5±0.2
H-3	(Raw)	<140	<140	<140	<130	150±80	<140
	(Treated)	<140	<140	<140	<140	<130	<130

RADIOACTIVITY		JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	AVERAGE
Alpha	(Raw)	0.7±0.5	1.0±0.8	<0.6	<1.3	<2.0	1.5±1.0	-
	(Treated)	1.1±0.7	0.9±0.6	<0.5	<1.3	<1.7	<0.9	-
Beta	(Raw)	2.0±0.6	3.1±0.7	13±1	2.8±0.6	3.2±0.7	4.5±0.8	3.6±6.1
	(Treated)	1.7±0.6	8.2±1.0	5.1±0.8	6.5±0.9	2.8±0.7	3.8±0.7	3.6±4.0
K-40	(Raw)	1.3±0.1	1.3±0.1	1.3±0.1	1.5±0.1	1.7±0.2	2.6±0.3	1.6±0.8
	(Treated)	1.3±0.1	1.3±0.1	1.3±0.1	4.9±0.5	1.6±0.2	2.3±0.2	2.0±2.0
H-3	(Raw)	<130	<140	<140	<140	<130	<130	-
	(Treated)	<130	<140	<140	<140	<140	<130	-

TABLE 18

1986 CONCENTRATIONS OF GAMMA EMITTERS* IN RAW AND TREATED POTABLE WATER

Results in Units of pCi/L ± 2 sigma

STATION ID NUCLIDE	01-01-86 to 01-31-86	02-01-86 to 02-28-86	03-01-86 to 03-31-86	04-01-86 to 04-30-86	05-01-86 to 05-31-86	06-01-86 to 06-30-86
SA-PWR-2F3						
K-40	<22	<40	<23	<22	<27	≤44
Ru-103	<1.7	<1.5	<1.4	<4.6	<3.3	<2.1
Ra-226	2.6±1.4	<5.0	<3.7	<3.7	<4.0	<5.1
Th-232	<5.8	<8.1	<4.9	<5.8	<7.1	<9.1
SA-PWT-2F3						
K-40	<36	<29	<28	<28	<37	<28
Ru-103	<2.2	<1.9	<0.9	<5.6	<1.9	2.6±1.3
Ra-226	<4.4	<4.2	<4.0	<4.4	<5.3	<4.8
Th-232	<6.6	5.7±3.4	<7.3	<7.1	<7.2	<7.7

STATION ID NUCLIDE	07-01-86 to 07-31-86	08-01-86 to 08-31-86	09-01-86 to 09-30-86	10-01-86 to 10-31-86	11-01-86 to 11-30-86	12-01-86 to 12-31-86
SA-PWR-2F3						
K-40	<29	<23	<27	25±13	<37	25±14
Ru-103	<2.2	<1.4	<1.7	<2.1	<1.8	<1.9
Ra-226	<4.4	<3.7	<4.2	8.4±2.4	<4.3	<4.4
Th-232	<7.5	<5.8	<6.0	<7.1	<6.1	5.8±3.3
SA-PWT-2F3						
K-40	<22	<29	<41	<22	<40	<22
Ru-103	<2.0	<1.1	<1.2	<1.7	<0.5	<1.6
Ra-226	<3.7	<4.5	<4.8	6.6±1.8	<5.8	<3.7
Th-232	<4.9	6.8±3.6	<9.6	<5.3	<9.5	<5.3

* All other gamma emitters searched for were <LLD; typical LLDs are given in Table C-33.

TABLE C-19

1986 CONCENTRATIONS OF STRONTIUM-89* AND STRONTIUM-90
IN QUARTERLY COMPOSITES OF POTABLE WATER

Results in Units of pCi/L ± 2 sigma

STATION ID NUCLIDE	01-01-86 to 03-31-86	04-01-86 to 06-30-86	07-01-86 to 09-30-86	10-01-86 to 12-31-86
SA-PWR-2F3 (Raw)				
Sr-89	<1.6	<0.8	0.8±0.3	<1.0
Sr-90	<1.0	<0.5	<0.6	<0.8
SA-PWT-2F3 (Treated)				
Sr-89	<0.8	<0.7	<0.5	<0.8
Sr-90	<0.5	<0.5	<0.4	<0.6

* Sr-89 results are corrected for decay to sample stop date.

TABLE C-20

1986 CONCENTRATIONS OF GAMMA EMITTERS* IN VEGETABLES

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

STATION ID	COLLECTION DATE(S)	SAMPLE TYPE	Be-7	K-40	I-131	Cs-137	Ra-226	Th-232
SA-FPV-2E1	05/14-15/86	Asparagus	<110	2300±310	33±13	<21	<47	< 94
SA-FPV-3E1	07-30-86	Tomatoes	< 12	2300±54	< 2.3	< 1.6	< 1.8	< 5.7
SA-FPV-3E1	07-30-86	Corn	<130	2400±310	< 4.0	<12	<36	< 55
SA-FPL-1F3	07-29-86	Cabbage	< 27	2200±93	< 3.1	< 3.8	< 7.9	< 13
SA-FPV-1F3	07-29-86	Peppers	< 82	1800±300	<25	<14	<51	< 83
SA-FPV-1F3	07-29-86	Tomatoes	< 15	2200±63	< 3.3	< 2.2	< 3.5	< 7.1
SA-FPL-4F1	07-29-86	Cabbage	24±15	2300±99	< 3.9	< 3.7	8.3±3.6	< 15
SA-FPV-4F1	07-30-86	Tomatoes	< 17	2600±74	< 4.0	< 2.2	< 3.9	< 6.7
SA-FPV-5F1	07-29-86	Peppers	<130	1800±270	<24	<17	<37	< 61
SA-FPV-14F3	07-28-86	Tomatoes	< 17	1700±53	< 3.7	< 2.0	< 3.7	8.8±4.7
SA-FPV-14F3	07-28-86	Corn	<160	2300±260	< 3.8	< 3.2	<33	< 53
SA-FPV-14F3	07-30-86	Peppers	<130	910±230	<22	<18	<36	<67
SA-FPV-1G1 (C)	07-28-86	Tomatoes	< 11	1500±52	< 3.3	1.5±0.8	< 2.9	< 6.1
SA-FPV-1G1 (C)	07-28-86	Corn	<140	2200±290	<20	<18	<40	< 78
SA-FPV-1G1 (C)	07-28-86	Peppers	<190	1700±280	< 3.8	<24	68±34	<110
SA-FPV-2G1 (C)	06-13-86	Asparagus	< 28	3400±340	62±20	<23	<51	< 95
SA-FPV-3H5 (C)	07-28-86	Tomatoes	< 14	1600±52	< 3.2	2.1±0.9	< 2.9	< 5.5
SA-FPV-3H5 (C)	07-28-86	Corn	<170	2700±350	<22	<22	58±26	< 95
SA-FPL-3H5 (C)	07-28-86	Cabbage	< 40	1900±120	< 5.2	< 4.7	<10	< 21
SA-FPV-3H5 (C)	07-29-86	Peppers	<130	1500±260	<20	<21	<44	< 70
AVERAGE			-	2100±1100	-	-	-	-

* All other gamma emitters searched for were <LLD; typical LLDs are given in Table C-33.
C Control Station

TABLE C-21

1986 CONCENTRATIONS OF GAMMA EMITTERS* IN GAME AND MEAT

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

STATION ID	COLLECTION DATE(S)	SAMPLE TYPE	K-40	Cs-137
SA-GAM-11D1 (Control)	01/11-13/86	Muskrat	2200±170	<9.9
SA-GAM-4C1	01-12-86	Muskrat	2400±220	<15
SA-FPB-3E1	02-24-86	Beef	2500±180	7.3±4.6
AVERAGE		Muskrat	2300±280	-
		Beef	2500±180	7.3±4.6

* All other gamma emitters searched for were <LLD; typical LLDs are given in Table C-33.

TABLE C-22

1986 CONCENTRATIONS OF GAMMA EMITTERS* IN FODDER CROPS

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

STATION ID	COLLECTION DATE(S)	SAMPLE TYPE	Be-7	K-40	Cs-137	Ra-226	Th-232
SA-VGT-3E1	10-13-86	Soybeans	<160	15000±590	<25	<39	<88
SA-VGT-13E3	09/01-05/86	Silage	1000±190	3600±510	<28	<67	<120
SA-VGT-2F7	09/03-08/86	Silage	370±90	2600±280	<17	35±17	<63
SA-VGT-5F2	09-14-86	Silage	<250	2300±470	<28	<76	<130
SA-VGT-5F2	11-01-86	Soybeans	<150	15000±610	<21	<38	<77
SA-VGT-11F3	09-01-86	Silage	740±180	4000±430	<19	<51	<76
SA-VGT-14F1	09-15-86	Silage	1400±260	3400±520	<54	<100	170±100
SA-VGT-3G1 (C)	09-08-86	Silage	1100±240	3000±550	<41	<83	<130
SA-VGT-3G1 (C)	11-01-86	Soybeans	<140	14000±480	13±7	<36	<59
AVERAGE			590±960	7000±12000	-	-	-

* All other gamma emitters searched for were <LLD; typical LLDs are given in Table C-33.
(C) Control station

TABLE C-23

1986 CONCENTRATIONS OF STRONTIUM-90 AND GAMMA EMITTERS* IN SOIL

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

STATION ID	COLLECTION DATE	Sr-90	K-40	Nb-95	Cs-137	Ra-226	Th-232
SA-SOL-6S1	07-30-86	27±10	9200±450	34±19	100±19	490±40	620±72
SA-SOL-5D1	07-30-86	120±14	5200±340	<22	350±23	510±37	550±64
SA-SOL-10D1	07-30-86	110±14	8300±420	<29	370±24	800±41	840±70
SA-SOL-2E1	07-29-86	110±13	7300±400	<12	380±27	700±45	720±74
SA-SOL-16E1	07-30-86	110±14	12000±410	<27	260±18	1000±40	1200±68
SA-SOL-1F1	07-30-86	120±13	3600±240	<15	1500±35	260±24	270±35
SA-SOL-2F1	07-29-86	140±15	9100±430	<24	330±25	870±47	840±77
SA-SOL-2F2	07-29-86	<22	5500±380	<22	110±16	380±36	340±60
SA-SOL-2F4	07-29-86	55±10	7400±400	<28	370±24	770±40	730±67
SA-SOL-2F7	07-30-86	87±13	8300±420	63±22	330±26	890±50	890±81
SA-SOL-5F1	07-29-86	97±14	5100±270	<18	800±26	340±26	410±41
SA-SOL-5F2	07-29-86	77±12	3200±330	<22	290±24	480±38	410±59
SA-SOL-11F3	07-30-86	43±12	13000±560	< 4.5	78±19	1000±51	1100±98
SA-SOL-14F1	07-30-86	87±14	12000±500	<19	230±25	960±48	1000±82
SA-SOL-3G1 (C)	07-29-86	56±11	7900±450	<15	210±22	770±46	780±82
SA-SOL-3H3 (C)	07-28-86	130±15	9200±440	<26	690±31	850±46	810±76
AVERAGE		87±74	7900±5800	-	400±700	690±490	720±540

* All other gamma emitters searched for were <LLD; typical LLDs are given in Table C-33.
(C) Control station

TABLE C-24

1985 CONCENTRATIONS OF GROSS ALPHA EMITTERS IN SURFACE WATER

Results in Units of pCi/L ± 2 sigma

STATION ID	01-20-86	02-03-86	03-03-86	04-08-86	05-05-86	06-09-86
SA-SWA-11A1	<2.0	8.3±4.2	2.6±1.6	5.2±4.0	<4.0	2.0±1.4
SA-SWA-12C1 (Control)	<1.7	<4.7	<1.2	8.3±2.5	1.8±1.3	<1.4
SA-SWA-7E1	<2.0	3.6±2.6	1.2±0.9	<3.8	<1.4	<1.2
SA-SWA-1F2	<1.8	5.0±3.1	<1.1	12±3	<1.6	<1.3
SA-SWA-16F1	<3.7	4.4±2.9	<1.1	<4.1	<1.5	<1.2
AVERAGE	-	5.2±3.6	-	6.7±6.9	-	-

STATION ID	07-11-86	08-04-86	09-08-86	10-07-86	11-03-86	12-08-86	AVERAGE
SA-SWA-11A1	1.6±1.2	1.8±1.0	<0.8	<0.8	<1.8	1.2±0.9	2.7±4.4
SA-SWA-12C1 (Control)	2.2±1.6	1.8±1.0	<1.6	<0.6	<1.9	<1.1	-
SA-SWA-7E1	1.6±1.2	1.3±1.0	1.1±0.7	1.2±0.8	<1.7	<1.1	-
SA-SWA-1F2	<1.5	2.6±1.1	<0.8	<0.8	<1.8	<1.2	-
SA-SWA-16F1	<1.6	1.5±1.0	0.7±0.5	<0.9	<2.0	<1.1	-
AVERAGE	1.7±0.6	1.8±1.0	-	-	-	-	

TABLE C-25

1986 CONCENTRATIONS OF GROSS BETA EMITTERS IN SURFACE WATER

Results in Units of pCi/L ± 2 sigma

STATION ID	01-20-86	02-03-86	03-03-86	04-08-86	05-05-86	06-09-86
SA-SWA-11A1	81±8	27±4	12±1	32±4	24±4	24±4
SA-SWA-12C1 (Control)	81±8	17±3	7.5±1.1	17±3	36±5	33±5
SA-SWA-7E1	92±9	51±6	16±2	50±6	63±7	42±6
SA-SWA-1F2	39±5	6.0±2.4	2.4±0.7	10±2	9.2±2.7	22±4
SA-SWA-16F1	50±6	8.1±2.6	3.8±0.8	13±3	11±3	25±4
AVERAGE	69±46	22±37	8.3±11	24±33	29±44	29±16

STATION ID	07-11-86	08-04-86	09-08-86	10-07-86	11-03-86	12-08-86	AVERAGE
SA-SWA-11A1	89±9	96±9	130±12	77±8	120±11	14±3	60±86
SA-SWA-12C1 (Control)	68±8	69±7	76±8	59±7	72±8	9.8±2.7	45±56
SA-SWA-7E1	110±12	120±11	130±12	110±11	100±11	30±4	76±77
SA-SWA-1F2	42±6	38±5	85±9	45±6	51±6	6.4±2.4	30±50
SA-SWA-16F1	48±6	66±7	75±8	56±6	87±8	11±3	38±58
AVERAGE	71±57	78±62	99±57	69±51	86±53	14±18	
						Grand Average	50±73

TABLE C-26

1986 CONCENTRATIONS OF GAMMA EMITTERS* IN SURFACE WATER

Results in Units of pCi/L ± 2 sigma

STATION ID	NUCLIDE	01-20-86	02-03-86	03-03-86	04-08-86	05-05-86	06-09-86
SA-SWA-11A1	K-40	80±26	<41	80±19	33±18	43±19	64±20
	Ra-226	<4.6	<4.4	<4.4	<4.9	<4.4	<3.7
	Th-232	<7.6	<6.6	6.2±3.7	8.8±4.0	<8.4	5.3±2.8
SA-SWA-12C1 (Control)	K-40	86±20	29±17	41±18	<29	46±23	<43
	Ra-226	<5.2	<3.7	<3.7	<4.8	<4.6	<4.7
	Th-232	<5.8	<5.8	<5.3	<6.4	9.2±4.3	<7.6
SA-SWA-7E1	K-40	90±27	84±18	67±21	73±25	87±20	83±22
	Ra-226	<4.4	<6.5	<4.5	<5.0	<4.6	<4.4
	Th-232	<8.1	<8.6	<8.3	<6.5	<6.2	<7.1
SA-SWA-1F2	K-40	67±19	<39	<24	<32	<35	<27
	Ra-226	<4.4	<4.4	<3.3	<3.9	5.4±2.9	<3.3
	Th-232	<6.5	<9.0	<4.9	<7.6	<7.4	<5.3
SA-SWA-16F1	K-40	51±22	<27	<26	<41	<26	<30
	Ra-226	<4.2	<4.0	11±3	<5.1	<4.3	<4.9
	Th-232	<6.9	<7.1	<6.2	<8.2	<5.7	<7.7
AVERAGE	K-40	75±32	-	48±50	-	47±47	-

STATION ID	NUCLIDE	07-11-86	08-04-86	09-08-86	10-07-86	11-03-86	12-08-86	AVERAGE
SA-SWA-11A1	K-40	120±24	110±26	140±26	140±23	120±23	<32	84±83
	Ra-226	<4.6	<4.8	<4.1	<4.4	<4.9	<4.6	-
	Th-232	<7.8	<7.5	7.5±4.4	<8.0	<7.4	<7.5	-
SA-SWA-12C1 (Control)	K-40	73±25	92±21	79±25	95±20	91±23	<43	62±52
	Ra-226	<5.3	<4.5	<4.3	25±3	<4.5	<5.1	-
	Th-232	<8.6	<6.4	<8.9	<5.8	<5.8	<7.8	-
SA-SWA-7E1	K-40	140±21	100±26	160±24	130±27	140±31	66±17	102±64
	Ra-226	2.9±1.7	<4.4	<4.6	<5.5	<5.1	<4.4	-
	Th-232	<5.3	<6.2	<7.5	<8.5	<9.0	<7.1	-
SA-SWA-1F2	K-40	44±22	49±17	85±26	95±20	61±20	<24	-
	Ra-226	<4.0	8.4±2.0	<4.8	<5.7	<4.6	2.6±1.6	-
	Th-232	<7.5	<5.8	<7.2	<7.5	<6.9	<5.3	-
SA-SWA-16F1	K-40	68±19	53±23	100±21	60±18	94±27	<27	-
	Ra-226	<4.9	<4.0	<4.4	3.3±1.7	5.2±2.8	<4.5	-
	Th-232	<6.3	<7.5	<6.4	<5.8	9.3±4.8	<6.5	-
AVERAGE	K-40	89±79	81±56	110±71	100±64	100±60	-	
							Grand Average K-40	69±72

* other gamma emitters searched for were <LLD; typical LLDs a[illegible]n in Table C-33.

TABLE C-27

1986 CONCENTRATIONS OF TRITIUM IN QUARTERLY COMPOSITES OF SURFACE WATER

Results in Units of pCi/L ± 2 sigma

STATION ID	01-20-86 to 03-03-86	04-08-86 to 06-09-86	07-11-86 to 09-08-86	10-07-86 to 12-08-86	AVERAGE
SA-SWA-11A1	150±80	<140	270±90	<140	-
SA-SWA-12C1 (Control)	150±80	<130	<140	<130	-
SA-SWA-7E1	130±80	<140	140±90	<140	-
SA-SWA-1F2	<130	<130	170±80	<140	-
SA-SWA-16F1	140±80	<130	160±80	140±80	140±25
AVERAGE	140±20	-	180±110	-	

TABLE C-28

1986 CONCENTRATIONS OF STRONTIUM-89* AND STRONTIUM-90 AND TRITIUM IN EDIBLE FISH

STATION ID	COLLECTION PERIOD	STRONTIUM (BONES) pCi/kg (dry) ± 2 sigma Sr-89	Sr-90	TRITIUM (FLESH)** AQUEOUS FRACTION pCi/kg (wet) ± 2 sigma H-3
SA-ESF-11A1	05-05-86 to 05-13-86	<70	240±17	<50
	10-08-86 to 10-08-86	<48	<29	<50
SA-ESF-12C1 (Control)	05-12-86 to 05-19-86	330±100	1500±64	<50
	10-08-86 to 10-08-86	<75	<44	<50
SA-ESF-7E1	05-06-86 to 05-07-86	<65	34±13	<50
	10-09-86 to 10-09-86	<40	<24	<50

* Sr-89 results are corrected for decay to sample stop date.
** Tritium results by Controls for Environmental Pollution, Inc.

TABLE C-29

1986 CONCENTRATIONS OF GAMMA EMITTERS* IN EDIBLE FISH

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

STATION ID	COLLECTION PERIOD	K-40	Cs-137	Ra-226	Th-232
SA-ESF-11A1	05-05-86 to 05-13-86	2700±180	8.3±4.5	<20	<31
	10-08-86 to 10-08-86	3300±290	<19	41±19	<61
SA-ESF-12C1 (Control)	05-12-86 to 05-19-86	2700±230	<12	<24	29±18
	10-08-86 to 10-08-86	3300±240	<16	<34	<59
SA-ESF-7E1	05-06-86 to 05-07-86	2800±230	<12	<24	<47
	10-09-86 to 10-09-86	3000±240	<14	33±17	<53
AVERAGE		3000±560	-	-	-

* All other gamma emitters searched for were <LLD; typical LLDs are given in Table C-33.

TABLE C-30

1986 CONCENTRATIONS OF STRONTIUM-89* AND STRONTIUM-90, GAMMA EMITTERS**
AND TRITIUM IN BLUE CRABS

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

STATION ID	COLLECTION PERIOD	SAMPLE	Sr-89	Sr-90	K-40	Ra-226	AQUEOUS FRACTION H-3***
SA-ECH-11A1	06/05-06/86	Flesh	<28	<18	1700±210	<30	<50
		Shell (1)	300±32	150±24	(2)	(2)	(2)
	10/08-09/86	Flesh	<46	<24	2000±210	<28	<50
		Shell (1)	<67	380±19	(2)	(2)	(2)
SA-ECH-12C1 (Control)	06/05-06/86	Flesh	<29	<19	2000±160	19±9	<50
		Shell (1)	<71	490±26	(2)	(2)	(2)
	10/08-09/86	Flesh	<44	<24	1700±150	20±9	<50
		Shell (1)	<89	320±24	(2)	(2)	(2)
AVERAGE		Flesh	-	-	1800±350	-	-
		Shell	-	340±280	-	-	-

* Sr-89 results are corrected for decay to sample stop date.
** All other gamma emitters searched for were <LLD; typical LLDs are given in Table C-33.
*** Tritium results by Controls for Environmental Pollution, Inc.
(1) Strontium results in units of pCi/kg (dry).
(2) Gamma and tritium analyses not required.

TABLE C-31

1986 CONCENTRATIONS OF GAMMA EMITTERS* IN BENTHIC ORGANISMS

Results in Units of pCi/kg (dry)

STATION ID	COLLECTION DATE	GAMMA ACTIVITY
SA-ESB-11A1	06-05-86	<LLD
	10-14-86	<LLD
SA-ESB-12C1 (Control)	06-05-86	<LLD
	10-14-86	<LLD
SA-ESB-7E1	06-05-86	<LLD
	10-14-86	<LLD
SA-ESB-16F1	06-05-86	<LLD
	10-14-86	<LLD

* All gamma emitters searched for were <LLD; typical LLDs are given in Table C-33.

TABLE C-32

1986 CONCENTRATIONS OF STRONTIUM-90 AND GAMMA EMITTERS* IN SEDIMENT**

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

STATION ID DATE	Sr-90	K-40	Mn-54	Co-58	Co-60	Cs-134	Cs-137	Ra-226	Th-232
SA-ESS-11A1									
06-05-86	<19	3600±410	29±16	<32	92±17	<34	<28	330±44	360±82
10-14-86	<27	8600±430	25±14	38±17	110±23	<22	82±19	760±46	980±83
SA-ESS-15A1									
06-05-86	<20	7800±610	<34	<33	97±22	<44	<35	390±50	440±92
10-14-86	<21	6800±360	<18	80±15	37±11	<16	<22	400±33	300±57
SA-ESS-16A1									
06-05-86	<24	4300±450	<35	<38	80±26	82±27	<16	810±62	900±110
10-14-86	<38	6000±400	24±13	79±18	49±21	<21	<29	760±46	780±76
SA-ESS-12C1 (Control)									
06-05-86	<21	16000±830	<34	<37	<48	60±24	<35	570±63	880±110
10-14-86	<25	14000±640	<23	<23	<36	<20	20±12	840±42	870±74
SA-ESS-7E1									
06-05-86	<20	16000±650	<26	<27	37±19	46±18	49±15	590±44	770±80
10-14-86	<30	13000±550	<29	31±16	78±25	<21	51±15	690±42	720±78
SA-ESS-16E1									
06-05-86	<28	16000±830	<38	<37	<48	56±25	<39	680±56	940±110
10-14-86	<29	15000±670	<33	<36	<44	<24	<25	680±47	1000±91
AVERAGE	-	10000±9900	-	-	63±53	-	-	620±330	740±490

* All other gamma emitters searched for were <LLD; typical LLDs are given in Table C-33.
** Sediment samples which include benthic organisms constitute the benthos sample.

TABLE C-33

1986 PSE&G RESEARCH CORPORATION LLDs FOR GAMMA SPECTROMETRY

NUCLIDES GEOMETRY:	AIR PARTICULATES (10^{-3}pCi/m^3) 13 Filters	WATER ALL TYPES (pCi/L) 3.5 Liter	MILK (pCi/L) 3.5 Liter	FOOD PRODUCTS AND FODDER CROPS (pCi/kg-wet) 100ml	400ml	MEAT AND GAME (pCi/kg-wet) 100ml	400ml
Be-7	3.0	14	14	8.0	120	37	92
Na-22	0.54	1.8	1.8	1.2	15	5.3	11
K-40	8.0	32	*	*	*	*	*
Cr-51	2.8	12	12	9.5	140	45	107
Mn-54	0.38	1.4	1.4	1.0	14	4.4	10
Co-58	0.39	1.6	1.6	0.99	15	4.5	11
Fe-59	0.83	3.2	3.2	2.4	32	10	24
Co-60	0.46	2.0	2.0	1.1	16	5.0	11
Zn-65	0.86	3.3	3.3	2.0	31	9.0	22
Nb-95	0.43	1.7	1.7	1.1	16	5.0	12
Zr-95	0.71	3.0	3.0	2.0	28	8.8	21
ZrNb-95	0.71	3.0	3.0	2.0	28	8.8	21
Mo-99	12	20	20	51	1300	370	2400
Ru-103	0.39	1.4	1.4	1.0	16	4.9	12
Ru-106	4.0	14	14	10	130	42	98
Ag-110m	0.67	1.5	1.5	1.6	14	7.2	11
Sb-125	0.90	4.1	4.1	2.6	39	12	27
Te-129m	14	63	63	40	620	183	480
I-131	0.46	1.8	1.8	1.7	30	9.0	30
Te-132	0.89	2.1	2.1	3.9	99	26	170
Cs-134	0.51	1.7	1.7	1.3	13	5.7	9.3
Cs-136	0.49	1.9	1.9	1.3	22	6.4	20
Cs-137	0.35	1.7	1.7	1.0	17	4.4	12
Ba-140	1.6	6.2	6.2	5.0	82	25	71
La-140	0.73	2.3	2.3	2.2	32	11	28
BaLa-140	1.6	6.2	6.2	5.0	82	25	71
Ce-141	0.42	2.4	2.4	1.2	19	5.6	15
Ce-144	1.4	10	10	4.1	79	18	57
Ra-226	0.86	4.0	4.0	2.2	32	10	23
Th-232	1.7	6.8	6.8	3.8	54	17	40

TABLE C-33 (cont'd)
1986 PSE&G RESEARCH CORPORATION LLDs FOR GAMMA SPECTROMETRY

NUCLIDES	FISH (pCi/kg-wet)		SHELLFISH (pCi/kg-wet)		SEDIMENT AND SOIL (pCi/kg-dry)	NUCLIDES	AIR IODINE (10^{-3}pCi/m^3)
GEOMETRY:	100ml	400ml	100ml	400ml	100ml		100ml
Be-7	37	92	142	85	120	I-131	15
Na-22	5.3	11	21	10	14	I-132	26
K-40	*	*	*	*	*	I-133	39
Cr-51	45	107	170	91	150	I-135	1.2
Mn-54	4.4	10	17	10	13		
Co-58	4.5	11	18	10	14		
Fe-59	10	24	41	22	36		
Co-60	5.0	11	19	11	15		
Zn-65	9.0	22	35	22	25		
Nb-95	5.0	12	19	10	15		
Zr-95	8.8	21	35	20	26		
ZrNb-95	8.8	21	35	20	26		
Mo-99	370	2400	1200	530	13000		
Ru-103	4.9	12	19	11	14		
Ru-106	42	98	160	97	120		
Ag-110m	7.2	11	28	10	19		
Sb-125	12	27	46	27	28		
Te-129m	183	480	720	430	600		
I-131	9.0	30	33	18	52		
Te-132	26	170	85	49	650		
Cs-134	5.7	9.3	22	9	12		
Cs-136	6.4	20	24	14	31		
Cs-137	4.4	12	17	12	12		
Ba-140	25	71	94	51	105		
La-140	11	28	41	20	52		
BaLa-140	25	71	94	51	105		
Ce-141	5.6	15	22	13	17		
Ce-144	18	57	73	56	55		
Ra-226	10	23	40	23	230		
Th-232	17	40	69	40	48		

* Indicates a positive concentration was measured in all samples analyzed.

APPENDIX D

SYNOPSIS OF ANALYTICAL PROCEDURES

SYNOPSIS OF ANALYTICAL PROCEDURES

Appendix D presents a synopsis of the analytical procedures utilized by various laboratories for analyzing the 1986 Artificial Island Radiological Environmental Monitoring Program samples.

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SYNOPSIS OF ANALYTICAL PROCEDURES (cont'd)

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* PSE&G - PSE&G Research Corporation
  TI - Teledyne Isotopes
  CEP - Controls for Environmental Pollution, Inc.

SYNOPSIS OF PSE&G RESEARCH CORPORATION PROCEDURE

GROSS ALPHA ANALYSIS OF AIR PARTICULATE SAMPLES

After allowing at least a three-day (extending from the sample stop date to the sample count time) period for the short-lived radionuclides to decay out, air particulate samples are counted for gross alpha activity on a low background gas proportional counter. Along with a set of air particulate samples, a clean air filter is included as a blank with an Am-241 air filter geometry alpha counting standard.

The specific alpha activity is computed on the basis of total corrected air flow sampled during the collection period. This corrected air flow takes into account the air pressure correction due to the vacuum being drawn, the correction factor of the temperature-corrected gas meter as well as the gas meter efficiency itself.

Calculation of Gross Alpha Activity:

Air flow is corrected first by using the following equations:

$$P = (B-\bar{V})/29.92$$

P = Pressure correction factor
B = Time-averaged barometric pressure during sampling period, "Hg
$\bar{V}$ = Time-averaged vacuum during sampling period, "Hg
29.92 = Standard atmospheric pressure at 32°F, "Hg

$$V = \frac{F*P*0.946*0.0283}{E}$$

F = Uncorrected air flow, ft^3
0.946 = Temperature correction factor from 60°F to 32°F
0.0283 = Cubic meters per cubic foot
E = Gas meter efficiency (= % efficiency/100)
V = Corrected air flow, m^3
P = Pressure correction factor

Using these corrected air flows, the gross alpha activity is computed as follows:

$$\text{Result } (pCi/m^3) = \frac{(G-B)/T}{(2.22)*(E)*(V)}$$

G = Sample gross counts
B = Background counts (from blank filter)
T = Count time of sample and blank, mins.
E = Fractional Am-241 counting efficiency
V = Corrected air flow of sample, m^3
2.22 = No. of dpm per pCi

$$\text{2-sigma error } (pCi/m^3) = \frac{(1.96*(G+B)^{1/2})*A}{(G-B)}$$

A = Gross alpha activity, pCi/m^3
G = Sample gross counts
B = Background counts (from blank filter)

Calculation of lower limit of detection:

A sample activity is assumed to be LLD if the sample net count is less than 4.66 times the standard deviation of the count on the blank.

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

B = Background counts (from blank filter)
E = Fractional Am-241 counting efficiency
V = Corrected air flow of sample, m^3
T = Count time of blank, mins.

SYNOPSIS OF TELEDYNE ISOTOPES PROCEDURE

ANALYSIS OF AIR PARTICULATE FILTERS FOR GROSS ALPHA AND BETA

The air filter is first stored for 2 to 5 days from date of receipt to allow for decay of the radon-thoron daughters. It is then placed in a stainless steel planchet which has been coated in the center with rubber cement. The filter is then counted for beta activity and subsequently repeat counted for alpha activity (at a different voltage setting) in a Beckman-Sharp Wide Beta II automatic alpha-beta counter.

Gross alpha and beta activity (pCi/m^3) are computed as follows:

$$A = \frac{(G/T - B)}{(2.22*V*Y*D*E)} \pm \frac{\sigma_m*((G/T + B)/T)^{1/2}}{(2.22*V*Y*D*E)}$$

Where G = Total sample counts
B = Background counts per minute
T = Sample count time, mins.
2.22 = dpm/pCi
V = Sample volume, m^3
Y = Chemical yield (Y = 1 in this case)
D = Decay factor from collection to count date (D = 1 in this case)
E = Counter efficiency
σ_m = Multiples of counting error

If the net activity (G/T -B) is equal to or less than the counting error, then the activity is considered to be the minimum detectable level, or MDL.

$$\text{where MDL} = \frac{3*(2*B/T)^{1/2}}{(2.22*V*Y*D*E)}$$

Variables are as previously defined

SYNOPSIS OF PSE&G RESEARCH CORPORATION PROCEDURE

GROSS ALPHA ANALYSIS OF WATER SAMPLES

The sample is thoroughly mixed. Then, a 250ml portion of sample and an equal volume of deionized water blank are acidified with dilute sulfuric acid. Barium carrier is added and the sample heated to 50°C in order to help precipitate barium sulfate. Maintaining the same temperature for the remainder of the procedure, iron carrier is then introduced. After a 30 minute equilibration period, the sample is neutralized with dilute ammonium hydroxide to precipitate ferric hydroxide. The mixed precipitates are then filtered onto a membrane filter, dried under an infrared heat lamp, weighed and mounted on a stainless steel planchet. The sample is then alpha-counted for 100 minutes on a low background gas proportional counter, along with a U-238 source of the same geometry. The blank is treated in the same manner as the sample.

Water samples found to be excessively turbid due to the presence of suspended organic material require pretreatment of this material for the purpose of keeping the final sample thickness to a minimum. This is accomplished by filtering a measured aliquot of the sample (while the filtrate is set aside) and ashing the collected residue in a crucible. A blank of the same volume is handled in the same manner. Whatever leftover sample residue remains,after the ashing,is dissolved in concentrated nitric acid and passed through a hardened fast filter paper and combined with the sample filtrate. The combined sample is then neutralized with dilute ammonium hydroxide. From this point, both sample and blank are acidified with dilute sulfuric acid. Barium carrier is added and the sample is heated to 50°C in order to help precipitate barium sulfate. Maintaining the same temperature for the remainder of the procedure, iron carrier is then introduced. After a 30 minute equilibration period, the sample is neutralized with dilute ammonium hydroxide to precipitate ferric hydroxide. The mixed precipitates are then filtered onto a membrane filter, dried under an infrared heat lamp, weighed and mounted on a stainless steel planchet. The sample is then alpha-counted for the appropriate time on a low background gas proportional counter, along with a U-238 source of the same geometry. The blank is treated in the same manner as the sample.

Calculation of Gross Alpha Activity:

$$\text{Result (pCi/L)} = \frac{(G-B)/T}{(2.22)*(E)*(V)*(S)}$$

G = Sample gross counts
B = Background counts (from blank sample)
T = Count time of sample and blank
E = Fractional counting efficiency from U-238 source
V = Sample volume, liters
S = Normalized efficiency regression equation as a function of thickness
2.22 = No. of dpm per pCi

$$\text{2-sigma error (pCi/L)} = \frac{(1.96*(G+B)^{1/2})*A}{(G-B)}$$

A = Gross alpha activity, pCi/L
G = Sample gross counts
B = Background counts (from blank sample)

SYNOPSIS OF PSE&G RESEARCH CORPORATION PROCEDURE

GROSS BETA ANALYSIS OF AIR PARTICULATE SAMPLES

After allowing at least a three-day (extending from the sample stop date to the sample count time) period for the short-lived radionuclides to decay out, air particulate samples are counted for gross beta activity on a low background gas proportional counter. Along with a set of air particulate samples, a clean air filter is included as a blank with an Sr-90 air filter geometry beta counting standard.

The gross beta activity is computed on the basis of total corrected air flow sampled during the collection period. This corrected air flow takes into account the air pressure correction due to the vacuum being drawn, the correction factor of the temperature-corrected gas meter as well as the gas meter efficiency itself.

Calculation of Gross Beta Activity:

Air flow is corrected first by using the following equations:

$$P = (B-\bar{V})/29.92$$

P = Pressure correction factor
B = Time-averaged barometric pressure during sampling period, "Hg
$\bar{V}$ = Time-averaged vacuum during sampling period, "Hg
29.92 = Standard atmospheric pressure at 32°F, "Hg

$$V = \frac{F*P*0.946*0.0283}{E}$$

F = Uncorrected air flow, ft^3
0.946 = Temperature correction factor from 60°F to 32°F
0.0283 = Cubic meters per cubic foot
E = Gas meter efficiency (= % efficiency/100)
V = Corrected air flow, m^3
P = Pressure correction factor

Using these corrected air flows, the gross beta activity is computed as follows:

$$\text{Result } (pCi/m^3) = \frac{(G-B)/T}{(2.22)*(E)*(V)}$$

G = Sample gross counts
B = Background counts (from blank filter)
T = Count time of sample and blank, mins.
E = Fractional Sr-90 counting efficiency
V = Corrected air flow of sample, m
2.22 = No. of dpm per pCi

$$\text{2-sigma error } (pCi/m^3) = \frac{(1.96*(G+B)^{1/2})*A}{(G-B)}$$

A = Gross beta activity, pCi/m^3
G = Sample gross counts
B = Background counts (from blank filter)

Calculation of lower limit of detection:

A sample activity is assumed to be LLD if the sample net count is less than 4.66 times the standard deviation of the count on the blank.

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

B = Background counts (from blank filter)
E = Fractional Sr-90 counting efficiency
V = Corrected air flow of sample, m^3
T = Count time of blank, mins.

SYNOPSIS OF TELEDYNE ISOTOPES PROCEDURE

ANALYSIS OF AIR PARTICULATE FILTERS FOR GROSS ALPHA AND BETA

The air filter is first stored for 2 to 5 days from date of receipt to allow for decay of the radon-thoron daughters. It is then placed in a stainless steel planchet which has been coated in the center with rubber cement. The filter is then counted for beta activity and subsequently repeat counted for alpha activity (at a different voltage setting) in a Beckman-Sharp Wide Beta II automatic alpha-beta counter.

Gross alpha and beta activity (pCi/m^3) are computed as follows:

$$A = \frac{(G/T - B)}{(2.22*V*Y*D*E)} \pm \frac{\sigma_m*((G/T + B)/T)^{1/2}}{(2.22*V*Y*D*E)}$$

Where G = Total sample counts
B = Background counts per minute
T = Sample count time, mins.
2.22 = dpm/pCi
V = Sample volume, m^3
Y = Chemical yield (Y = 1 in this case)
D = Decay factor from collection to count date (D = 1 in this case)
E = Counter efficiency
σ_m = Multiples of counting error

If the net activity (G/T -B) is equal to or less than the counting error, then the activity is considered to be the minimum detectable level, or MDL.

$$\text{where MDL} = \frac{3*(2*B/T)^{1/2}}{(2.22*V*Y*D*E)}$$

Variables are as previously defined

SYNOPSIS OF PSE&G RESEARCH CORPORATION PROCEDURE

GROSS BETA ANALYSIS OF WATER SAMPLES

The sample is mixed thoroughly. Then, a 1.0 liter portion is removed from the potable, rain or well water container and 250ml taken from each surface water. A deionized water blank is prepared for each different volume of sample (e.g. 1.0 liter blank for 1.0 liter samples and 250ml for 250ml samples). All samples and blanks are then evaporated on a hotplate until the volume approaches 20 to 25ml. At that point, the samples and blanks are transferred to tared stainless steel ribbed planchets and evaporated to dryness under an infrared heat lamp. They are subsequently cooled in a desiccator, weighed and counted on a low background gas proportional counter along with an Sr-90 source of the same geometry.

Calculation of Gross Beta Activity:

$$\text{Result (pCi/L)} = \frac{(G-B)/T}{(2.22)*(E)*V)*(S)}$$

G = Sample gross counts
B = Background counts (from blank sample)
T = Count time of sample and blank
E = Fractional counting efficiency from Sr-90 source
V = Sample volume, liters
S = Normalized efficiency regression equation as a function of thickness
2.22 = No. of dpm per pCi

$$\text{2-sigma error (pCi/L)} = \frac{(1.96*(G+B)^{1/2})*A}{(G-B)}$$

A = Gross beta activity, pCi/L
G = Sample gross counts
B = Background counts (from blank sample)

SYNOPSIS OF PSE&G RESEARCH CORPORATION PROCEDURE

ANALYSIS OF WATER FOR POTASSIUM 40

A 60 ml aliquot of water sample (with the exception of rain water) received by the Research and Testing Laboratory is first acidified to pH <2 with concentrated nitric acid and then analyzed for potassium by the following Atomic Absorption Spectrophotometry method: potassium standards of known concentration (similar to that of the unknowns) are first prepared. An aliquot of each sample and standard is pipetted into stoppered flasks. In addition, a duplicate sample, ERA standard and blank water sample are likewise pipetted into their respective flasks. A solution consisting of 4% sodium is diluted 1:1 with water and then added to all the flasks. Depending on the AA instrument used, a calibration curve is prepared from the standards after which the samples are then run. If the absorbance of any sample is higher than the upper standard used, the sample is then either diluted and re-run, the burner head turned 90°, a more concentrated standard added to the calibration curve or a less sensitive wavelength used.

The results, reported in parts per million (ppm), are converted to pCi/L by means of a computer program.

Calculation of K-40 Activity:

K-40 Activity (pCi/L) = 0.85*C

0.85 = Proportionality constant for converting ppm to pCi/L
C = Potassium concentration, ppm

SYNOPSIS OF PSE&G RESEARCH CORPORATION PROCEDURE

ANALYSIS OF WATER FOR TRITIUM

Approximately 50ml of raw sample is mixed with sodium hydroxide and potassium permanganate and is distilled under vacuum. Eight ml of distilled sample is mixed with 10ml of Instagel® liquid scintillation solution, and placed in the liquid scintillation spectrometer for counting. An internal standard is prepared by mixing 8ml of sample, 10ml of Instagel, and 0.1ml of a standard with known activity. The efficiency is determined from this. Also prepared is a blank consisting of 8ml of distilled low-tritiated water and 10ml of Instagel, to be used for a background determination. This is done for each pair of samples to be counted.

Activity is computed as follows:

$$A\ (pCi/L) = \frac{(G-B)*(1000)}{2.22*(E)*(V)*(T)}$$

A = Activity
B = Background count of sample
G = Gross count of sample
E = Counting Efficiency
V = Aliquot volume (ml)
T = Count time (min)
2.22 = DPM/pCi
1000 = Number of ml per L

Efficiency (E) is computed as follows:

$$E = \frac{(N)*(D)}{A'}$$

N = Net CPM of spiked sample
D = Decay factor of spike
A' = DPM of spike

N is determined as follows:

$$N = C-(G/T)$$

C = CPM of spiked sample
G = Gross counts of sample
T = Count time (min)

The associated error is expressed at 95% confidence limit, as follows:

$$\frac{1.96*(G/T^2+B/T^2)^{1/2}*(1000)}{2.22*(V)*(E)}$$

Samples are designated LLD if the activity is less than the following value:

$$LLD\ (pCi/L) = \frac{(4.66)*(B)^{1/2}*(1000)}{2.22*(V)*(E)*(T)}$$

SYNOPSIS OF CONTROLS FOR ENVIRONMENTAL POLLUTION, INC., PROCEDURE

TRITIUM ANALYSIS OF AQUEOUS FRACTION OF BIOLOGICAL MATERIALS

An aliquot of fish or crab flesh is placed in a round bottom flask, along with 200ml of benzene, and the water removed via azeotropic distillation. Three milliliters of the extracted water is then mixed with aquasol cocktail (NEF-934 Aquasol® cocktail, manufactured by New England Nuclear Corporation).

The resultant mixture is comprised of 19 percent sample in a clear gel-type aquasol and provides a tritium counting efficiency of approximately 30 percent, when counted on a Beckman LS-100 Liquid Scintillation Spectrometer. The efficiency of the counting system is determined by placing 6 tritium standards (certified by NBS) before each set of water samples to be counted. The counting efficiency is determined from these standards which are equal in activity but vary in the amount of quenching. All samples are counted for 500 minutes each.

SYNOPSIS OF PSE&G RESEARCH CORPORATION PROCEDURE

GAMMA ANALYSIS OF AIR IODINE

Approximately 300m^3 of air is drawn through a 50ml bed of triethylenediamine (TEDA)-impregnated charcoal granules at a rate which closely corresponds to the breathing rate of an adult male. The contents of the exposed air iodine cartridge are emptied into an aluminum sample can containing 50ml of fresh TEDA-impregnated charcoal. The can is hermetically sealed and then counted on a gamma detector.

Calculation of Gamma Activity:

The following are the calculations performed for the gamma activity, 2-sigma error and LLD:

$$\text{Result } (pCi/m^3) = \frac{N*D}{(2.22)*(E)*(A)*(T)*(V)} = R$$

N = Net counts under photopeak
D = Decay correction factor

$$\frac{\lambda t1*EXP(\lambda t2)}{1-EXP(-\lambda t1)}$$

t1 = Acquisition live time
t2 = Elapsed time from sample collection to start of acquisition
λ = 0.693/nuclide half life
E = Detector efficiency
A = Gamma abundance factor (no. of photons per disintegration)
T = Acquisition live time, mins.
V = Sample volume, m^3
2.22 = No. of dpm per pCi

$$\text{2-sigma error } (pCi/m^3) = \frac{1.96*(GC+BC)^{1/2}*R}{N}$$

GC = Gross counts
BC = Background counts

All other variables are as defined earlier.

$$\text{The LLD } (pCi/m^3) = \frac{4.66*(BC)^{1/2}*D}{(2.22)*(E)*(A)*(T)*(V)}$$

SYNOPSIS OF TELEDYNE ISOTOPES PROCEDURE

ANALYSIS OF CHARCOAL FILTERS FOR IODINE-131

Charcoal cartridges are analyzed for I-131 using a lithium-drifted germanium detector interfaced with a 2048 channel pulse height analyzer calibrated at 1.0 Kev per channel. Teledyne Isotopes employs one of three possible data acquisition and computation systems. The first, a Data General NOVA mini-computer, in series with the pulse height analyzer, calculates the number of counts (and the standard deviation) in the peak region by performing a linearly-interpolated background subtraction. If no peak is observed, then only the background is used (along with sample volume, collection date and length of count) to determine the detection limit. The activity or MDL of each nuclide is computed on an IBM 360. This semi-automatic system is in contrast with the other two data acquisition and computation systems, namely, a Tracor Northern TN-11 and a Nuclear Data 6620, which perform all the above computations automatically. All resultant spectra are stored on magnetic tape.

SYNOPSIS OF PSE&G RESEARCH CORPORATION PROCEDURE

ANALYSIS OF RAW MILK FOR IODINE-131

Stable iodine carrier is equilibrated in a 4-liter volume of raw milk before two separate 50ml batches of anion exchange resin are introduced to extract iodine. After each batch has been stirred in the milk for an appropriate time, both are then transferred to an aluminum sample can where the resins are rinsed with demineralized water several times and any leftover rinsewater removed with an aspirator stick. The can is hermetically sealed and then counted on a gamma detector.

Calculation of I-131 Activity:

$$\text{I-131 Results (pCi/L)} = \frac{(G-B)/T*(1.05)*(H)}{(2.22)*(E)*(V)*(Y)}$$

G = Sample gross counts
B = Background counts (from blank sample)
T = Count time of sample and blank
E = E_0*EXP(-λ*M) = efficiency equation where E_0 = counting efficiency at zero sample thickness
λ = Self-absorption coefficient
M = Sample thickness, mg/cm^2
V = Sample volume, liters
Y = Chemical recovery = $\frac{R}{R1+R2}$
where R = mg of I^- recovered
R1 = mg of I^- carrier added
R2 = mg of intrinsic stable I^- measured in sample
1.05 = Correction factor for protein-bound iodine
H = J/(1-K)*EXP(L) = correction factor for I-131 decay during counting period
J = (0.693/8.05)*(R/1440)
R = Count time, minutes
1440 = No. of minutes per day
8.05 = Half-life of I-131, days
K = EXP(-J)
L = (0.693/8.05)*N
N = Elapsed time (days) from mid-point of collection period to beginning of count time.

SYNOPSIS OF PSE&G RESEARCH CORPORATION PROCEDURE

RADIOSTRONTIUM ANALYSIS OF AIR FILTERS

The air filters are placed in a small beaker and just enough fuming nitric acid is added to cover the filters. A blank, composed of the same number of clean air filters, is prepared in the same way. Stable strontium carrier is then introduced into each sample and several fuming nitric acid leachings are carried out to remove the radiostrontium from the filter media. Once this is done, the resultant nitrates are dissolved in distilled water and the filter residue is filtered out. Radioactive interferences are stripped out by coprecipitation on ferric hydroxide (yttrium strip) followed by a barium chromate strip. The strontium is precipitated as a carbonate, which is dried and weighed. The samples and blank are then counted on a low background gas proportional counter and, again, at least 14 days later. The basis for this two count method is that Sr-90 and Sr-89 are both unknown quantities requiring two simultaneous equations to solve for them.

Calculation of Sr-90 Activity:

$$\text{Sr-90 Results } (pCi/m^3) = \frac{N4/R}{(2.22)*(E)*(E(15)/E')*(S6)*(V)*(U)}$$

$$= W2$$

where $S6 = A + B*M + C*M^2$ (This is the general form of the normalized Sr-90 efficiency regression equation for one particular gas proportional counter, where A, B and C are regression coefficients.)

M = Thickness density of strontium carbonate precipitate, mg/cm^2

E(15)/E' = Ratio of Sr-90 efficiency at thickness value of $15mg/cm^2$ to Sr-90 counting standard efficiency run at the time of instrument calibration (This standard is run with each group of environmental strontium samples)

E = Sr-90 counting standard efficiency

V = Sample quantity (m^3)

U = Chemical yield

N4 = (N2 - F1*N1)/W1 = net counts due to Sr-90 only

W1 = ((1 + R1*I2) - (1 + R1*I1)*F1)

I1 = 1 - EXP ((-0.693/2.667)*t1)

I2 = 1 - EXP ((-0.693/2.667)*t2)

t1 = Elapsed time from Y-90 strip to first count

t2 = Elapsed time from Y-90 strip to second count

2.667 = Half-life of Y-90, days

R1 = D + E*M + F*M^2 (This is the general form of the regression equation for Y-90 eff'y/Sr-90 eff'y ratio for one particular gas proportional counter, where D, E and F are regression coefficients.)

N2 = X - Y, where X and Y are recount gross counts and background counts, respectively

N1 = X1 - Y1, where X1 and Y1 are initial gross counts and background counts, respectively

2.22 = No. of dpm per pCi

F1 = EXP ((-0.693/2.667)*t2)

R = Count time of sample and blank

Using the same variable definitions as above, the 2-sigma error for Sr-90 (pCi/m^3) =

$$2*\left[\frac{(X+Y)}{W1^2} + \frac{(X1+Y1)*F1^2}{W1^2}\right]^{1/2}*\frac{(W1*W2)}{(N2-F1*N1)}$$

Again, keeping the same variable definitions, the LLD for Sr-90 (pCi/m^3) =

$$4.66*\left[\frac{(X+Y)}{W1^2} + \frac{(X1+Y1)*F1^2}{W1^2}\right]^{1/2}$$

Calculation of Sr-89 Activity:

$$\text{Sr-89 Results (pCi/m}^3) = \frac{N6/R}{(2.22)*(E)*(E(15)/E')*(S7)*(V)*(U)*(F9)}$$

$$= W3$$

S7 = G + H*M + I*M^2 (This is the general form of the normalized Sr-89 efficiency regression equation for one particular gas proportional counter where G, H and I are regression coefficients.)

N6 = N1 - N7*(1 + R1*I1)

N7 = (N2 - F1*N1)/W1 (This represents counts due to Sr-90)

E(15)/E' = Ratio of Sr-89 efficiency at thickness value of 15mg/cm^2 to Sr-90 counting standard efficiency run at the time of instrument calibration (This standard is run with each group of environmental strontium samples)

F9 = EXP ((-0.693/50.5)*t)

t = Elapsed time from midpoint of collection period to time of recount for milk samples only. For all other samples, this represents the elapsed time from sample stop date to time of recount.

50.5 = Half-life of Sr-89, days

All other quantities are as previously defined.

The 2-sigma error for Sr-89 (pCi/m^3) = $\frac{2*\ (S8^2+S9^2)^2\ *W3}{(N1\ -\ N7*(1+R1*I1))}$

$$S8 = \left[\frac{(X+Y)}{W1^2} + \frac{(X1+Y1)*F1^2}{W1^2}\right]^{1/2}$$

$$S9 = (X1+Y1)^{1/2}$$

All other variables are as previously defined.

Keeping the same variable definitions, the LLD for Sr-89 (pCi/m^3) = $4.66*(S8^2+S9^2)^{1/2}$

SYNOPSIS OF TELEDYNE ISOTOPES PROCEDURE

ANALYSIS OF COMPOSITED AIR PARTICULATE FILTERS FOR RADIOSTRONTIUM

The composited air filters are leached with concentrated nitric acid, with heating, in the presence of strontium carrier. After adding deionized water, the sample is gravity filtered through a paper filter and the filtrate diluted further with additional deionized water, before being split into two equal parts. One part is put aside for gross alpha analysis and the other part evaporated on a hotplate to a small volume. The sample is transferred to a centrifuge tube and fuming nitric acid added to form the strontium nitrate precipitate. After centrifuging and pouring off the supernate, the precipitate is dissolved in deionized water and an iron scavenge performed. This marks the beginning of the Y-90 ingrowth period. Centrifuging and discarding the precipitate, standardized yttrium carrier is added to the supernate and the sample is set aside for 5 to 7 days. After this period, the sample is alkalinized with ammonium hydroxide and heated in a hot water bath to form yttrium hydroxide. After cooling, the sample is centrifuged and the supernate saved for Sr-89 determination. The precipitate is dissolved with dilute nitric and hydrochloric acids, and the yttrium precipitated as oxalate using saturated ammonium oxalate solution. The yttrium oxalate is mounted on a tared paper filter, oven dried, weighed and counted on a gas proportional counter. The sample is then recounted the following day to confirm the decay of Y-90.

The supernate, saved for Sr-89 determination, is treated with saturated sodium carbonate solution to precipitate strontium carbonate which is filtered on a tared glass fiber filter, oven-dried and likewise counted 200 minutes on a gas proportional counter. These samples, however, are covered with an 80mg/cm^2 aluminum absorber to stop the Sr-90 beta emissions, thus allowing the Sr-89 betas to be counted alone.

The Sr-89 activity (pCi/m^3) is computed as follows:

$$A = \frac{(G/T - B_c - B_a)}{(2.22*V*Y*D*E)} \pm \frac{\sigma_m*((G/T + B_c + B_a)/T)^{1/2}}{(2.22*V*Y*D*E)}$$

If the net activity (G/T -B) is less than or equal to the 2σ counting error, the activity is considered MDL

$$\text{where MDL} = \frac{2*(2*B/T)^{1/2}}{(2.22*V*Y*D*E)}$$

where G = Total sample counts
T = Sample count time, mins.
B_c = Background rate of counter, cpm
B_a = Background addition from Sr-90 and ingrowth of Y-90
2.22 = dpm/pCi
V = Sample volume, m^3
Y = Chemical yield of strontium
D = Sr-89 decay factor from midpoint of collection period to counting date.
E = Sr-89 counting efficiency with 80 mg/cm^2 aluminum absorber
σ_m = Multiples of counting error

The Sr-90 activity (pCi/m^3) is computed as follows:

$$A = \frac{(G/T-B)}{(2.22*V*Y*D*E)} \pm \frac{\sigma_m*((G/T+B)/T)^{1/2}}{(2.22*V*Y*D*E)}$$

Y = Chemical yield of the mount or sample counted
D = Decay factor from the collection to the counting date
E = Counter efficiency

All other variables are as previously defined.

If the net activity (G/T-B) is less than or equal to the 2σ counting error, the activity is considered MDL

$$\text{where MDL} = \frac{2*(2*B/T)^{1/2}}{(2.22*V*Y_1*Y_2*I*D*E)}$$

SYNOPSIS OF PSE&G RESEARCH CORPORATION PROCEDURE

RADIOSTRONTIUM ANALYSIS OF RAW MILK

Stable strontium carrier is first introduced into a milk sample and into a distilled water sample of equal volume to be used as a blank. The sample(s) and blank are passed through cation resin columns which adsorb strontium, calcium, magnesium and other cations. These cations are then eluted off with a TRIS-buffered 4N sodium chloride solution into a beaker and precipitated as carbonates. The carbonates are converted to nitrates with 6N nitric acid and, by acidifying further to an overall concentration of 70% nitric acid, strontium is forced out of solution somewhat ahead of calcium. Barium chromate precipitation is then performed to remove any traces of radium and radiobarium. Strontium recrystallization is carried out to remove residual calcium which may have been coprecipitated with the initial strontium precipitation. Another recrystallization removes ingrown Y-90, marking the time of the yttrium strip. The strontium is precipitated as its carbonate, filtered, dried and weighed to determine strontium recovery. The samples and blank are then counted on a low background gas proportional counter and, again, at least 14 days later. The basis for this two-count method is that Sr-90 and Sr-89 are both unknown quantities requiring two simultaneous equations to solve for them.

Calculation of Sr-90 Activity:

$$\text{Sr-90 Results (pCi/L)} = \frac{N4/R}{(2.22)*(E)*(E(15)/E')*(S6)*(V)*(U)}$$

$$= W2$$

where $S6 = A + B*M + C*M^2$ (This is the general form of the normalized Sr-90 efficiency regression equation for one particular gas proportional counter, where A, B and C are regression coefficients.)

M = Thickness density of strontium carbonate precipitate, mg/cm^2

$E(15)/E'$ = Ratio of Sr-90 efficiency at thickness value of $15 mg/cm^2$ to Sr-90 counting standard efficiency run at the time of instrument calibration (This standard is run with each group of environmental strontium samples)

E = Sr-90 counting standard efficiency

V = Sample quantity (liters)

U = Chemical yield

$N4 = (N2 - F1*N1)/W1$ = net counts due to Sr-90 only

$W1 = ((1 + R1*I2) - (1 + R1*I1)*F1)$

$I1 = 1 - EXP((-0.693/2.667)*t1)$

I2 = 1 - EXP ((-0.693/2.667)*t2)

t1 = Elapsed time from Y-90 strip to first count

t2 = Elapsed time from Y-90 strip to second count

2.667 = Half-life of Y-90, days

R1 = D + E*M + F*M^2 (This is the general form of the regression equation for Y-90 eff'y/Sr-90 eff'y ratio for one particular gas proportional counter, where D, E and F are regression coefficients.)

N2 = X - Y, where X and Y are recount gross counts and background counts, respectively

N1 = X1 - Y1, where X1 and Y1 are initial gross counts and background counts, respectively

2.22 = No. of dpm per pCi

F1 = EXP ((-0.693/2.667)*t2)

R = Count time of sample and blank

Using the same variable definitions as above, the 2-sigma error for Sr-90 (pCi/L) =

$$2*\left[\frac{(X+Y)}{W1^2} + \frac{(X1+Y1)*F1^2}{W1^2}\right]^{1/2} * \frac{(W1*W2)}{(N2-F1*N1)}$$

Again, keeping the same variable definitions, the LLD for Sr-90 (pCi/L) =

$$4.66*\left[\frac{(X+Y)}{W1^2} + \frac{(X1+Y1)*F1^2}{W1^2}\right]^{1/2}$$

Calculation of Sr-89 Activity:

$$\text{Sr-89 Results (pCi/L)} = \frac{N6/R}{(2.22)*(E)*(E(15)/E')*(S7)*(V)*(U)*(F9)}$$

$$= W3$$

S7 = G + H*M + I*M^2 (This is the general form of the normalized Sr-89 efficiency regression equation for one particular gas proportional counter where G, H and I are regression coefficients.)

N6 = N1 - N7*(1 + R1*I1)

N7 = (N2 - F1*N1)/W1 (This represents counts due to Sr-90)

E(15)/E' = Ratio of Sr-89 efficiency at thickness value of 15mg/cm^2 to Sr-90 counting standard efficiency run at the time of instrument calibration (This standard is run with each group of environmental strontium samples)

F9 = EXP ((-0.693/50.5)*t)

t = Elapsed time from midpoint of collection period to time of recount for milk samples only. For all other samples, this represents the elapsed time from sample stop date to time of recount.

50.5 = Half-life of Sr-89, days

All other quantities are as previously defined.

The 2-sigma error for Sr-89 (pCi/L) = $\frac{2*(S8^2+S9^2)^{1/2}*W3}{(N1 - N7*(1+R1*I1))}$

$$S8 = \left[\frac{(X+Y)}{W1^2} + \frac{(X1+Y1)*F1^2}{W1^2}\right]^{1/2}$$

$$S9 = (X1+Y1)^{1/2}$$

All other variables are as previously defined.

Keeping the same variable definitions, the LLD for Sr-89 (pCi/L) = $4.66*(S8^2+S9^2)^{1/2}$

SYNOPSIS OF PSE&G RESEARCH CORPORATION PROCEDURE

RADIOSTRONTIUM ANALYSIS OF WATER

Stable strontium carrier is introduced into a water sample and into a distilled water sample of the same volume which is used as a blank. The sample(s) and blank are then made alkaline and heated to near boiling before precipitating the carbonates. The carbonates are converted to nitrates by fuming nitric acid recrystallization which acts to purify the sample of most of the calcium. Radioactive interferences are stripped out by coprecipitation on ferric hydroxide (yttrium strip) followed by a barium chromate strip. The strontium is precipitated as a carbonate before being dried and weighed. The samples and blank are then counted on a low background gas proportional counter and, again, at least 14 days later. The basis for this two count method is that Sr-90 and Sr-89 are both unknown quantities requiring two simultaneous equations to solve for them.

Since surface waters, as well as some drinking water samples, have been found to contain significant amounts of stable strontium, a separate aliquot from each sample is analyzed for stable strontium. These results are used in correcting the chemical recovery of strontium to its true value.

Calculation of Sr-90 Activity:

$$\text{Sr-90 Results (pCi/L)} = \frac{N4/R}{(2.22)*(E)*(E(15)/E')*(S6)*(V)*(U)}$$

$$= W2$$

where $S6 = A + B*M + C*M^2$ (This is the general form of the normalized Sr-90 efficiency regression equation for one particular gas proportional counter, where A, B and C are regression coefficients.)

M = Thickness density of strontium carbonate precipitate, mg/cm^2

$E(15)/E'$ = Ratio of Sr-90 efficiency at thickness value of $15 mg/cm^2$ to Sr-90 counting standard efficiency run at the time of instrument calibration (This standard is run with each group of environmental strontium samples)

E = Sr-90 counting standard efficiency

V = Sample quantity (liters)

U = Chemical yield

$N4 = (N2 - F1*N1)/W1$ = net counts due to Sr-90 only

$W1 = ((1 + R1*I2) - (1 + R1*I1)*F1)$

$I1 = 1 - EXP((-0.693/2.667)*t1)$

I2 = 1 - EXP ((-0.693/2.667)*t2)

t1 = Elapsed time from Y-90 strip to first count

t2 = Elapsed time from Y-90 strip to second count

2.667 = Half-life of Y-90, days

R1 = D + E*M + F*M^2 (This is the general form of the regression equation for Y-90 eff'y/Sr-90 eff'y ratio for one particular gas proportional counter, where D, E and F are regression coefficients.)

N2 = X - Y, where X and Y are recount gross counts and background counts, respectively

N1 = X1 - Y1, where X1 and Y1 are initial gross counts and background counts, respectively

2.22 = No. of dpm per pCi

F1 = EXP ((-0.693/2.667)*t2)

R = Count time of sample and blank

Using the same variable definitions as above, the 2-sigma error for Sr-90 (pCi/L) =

$$2*\left[\frac{(X+Y)}{W1^2} + \frac{(X1+Y1)*F1^2}{W1^2}\right]^{1/2} * \frac{(W1*W2)}{(N2-F1*N1)}$$

Again, keeping the same variable definitions, the LLD for Sr-90 (pCi/L) =

$$4.66*\left[\frac{(X+Y)}{W1^2} + \frac{(X1+Y1)*F1^2}{W1^2}\right]^{1/2}$$

Calculation of Sr-89 Activity:

$$\text{Sr-89 Results (pCi/L)} = \frac{N6/R}{(2.22)*(E)*(E(15)/E')*(S7)*(V)*(U)*(F9)}$$

$$= W3$$

S7 = G + H*M + I*M^2 (This is the general form of the normalized Sr-89 efficiency regression equation for one particular gas proportional counter where G, H and I are regression coefficients.)

N6 = N1 - N7*(1 + R1*I1)

N7 = (N2 - F1*N1)/W1 (This represents counts due to Sr-90)

E(15)/E' = Ratio of Sr-89 efficiency at thickness value of 15mg/cm^2 to Sr-90 counting standard efficiency run at the time of instrument calibration (This standard is run with each group of environmental strontium samples)

F9 = EXP ((-0.693/50.5)*t)

t = Elapsed time from midpoint of collection period to time of recount for milk samples only. For all other samples, this represents the elapsed time from sample stop date to time of recount.

50.5 = Half-life of Sr-89, days

All other quantities are as previously defined.

The 2-sigma error for Sr-89 (pCi/L) = $\frac{2*(S8^2+S9^2)^{1/2}*W3}{(N1 - N7*(1+R1*I1))}$

$$S8 = \left[\frac{(X+Y)}{W1^2} + \frac{(X1+Y1)*F1^2}{W1^2}\right]^{1/2}$$

$$S9 = (X1+Y1)^{1/2}$$

All other variables are as previously defined.

Keeping the same variable definitions, the LLD for Sr-89 (pCi/L) = $4.66*(S8^2+S9^2)^{1/2}$

SYNOPSIS OF PSE&G RESEARCH CORPORATION PROCEDURE

RADIOSTRONTIUM ANALYSIS OF VEGETATION, MEAT AND AQUATIC SAMPLES

The samples are weighed (recorded as "wet" weight) as received, before being placed in an oven to dry at 100°C. At the completion of the drying period, samples are again weighed (recorded as "dry" weight) and then pulverized. A measured amount (quantity dependent on desired sensitivity) of the pulverized sample is first charred over a Bunsen burner and then ashed in a muffle furnace. The ash is fused with 40g sodium carbonate, along with 20mg strontium carrier, at 900°C for 1/2 hour. After removal from the furnace, the melt is cooled, pulverized and added to 500ml distilled water and heated to near boiling for 30 minutes, with stirring. The sample is filtered (filtrate discarded) and the carbonates on the filter dissolved with 1:1 nitric acid (HNO_3). The resultant nitrates are heated to dryness and are dissolved in 20ml distilled water before adding 60ml fuming HNO_3. After calcium removal with anhydrous acetone, radioactive interferences are stripped out by coprecipitation on ferric hydroxide followed by coprecipitation on barium chromate. The strontium is precipitated as its carbonate, which is dried and weighed. The samples are then counted on a low background gas proportional counter and, again, at least 14 days later. The basis for this two-count method is that Sr-90 and Sr-89 are both unknown quantities requiring two simultaneous equations to solve for them.

Calculation of Sr-90 Activity:

$$\text{Sr-90 Results (pCi/kg wet)} = \frac{N4/R}{(2.22)*(E)*(E(15)/E')*(S6)*(V)*(U)}$$

$$= W2$$

where $S6 = A + B*M + C*M^2$ (This is the general form of the normalized Sr-90 efficiency regression equation for one particular gas proportional counter, where A, B and C are regression coefficients.)

M = Thickness density of strontium carbonate precipitate, mg/cm^2

E(15)/E' = Ratio of Sr-90 efficiency at thickness value of $15mg/cm^2$ to Sr-90 counting standard efficiency run at the time of instrument calibration (This standard is run with each group of environmental strontium samples)

E = Sr-90 counting standard efficiency

V = Sample quantity (kg wet)

U = Chemical yield

N4 = (N2 - F1*N1)/W1 = net counts due to Sr-90 only

W1 = ((1 + R1*I2) - (1 + R1*I1)*F1)

I1 = 1 - EXP ((-0.693/2.667)*t1)

I2 = 1 - EXP ((-0.693/2.667)*t2)

t1 = Elapsed time from Y-90 strip to first count

t2 = Elapsed time from Y-90 strip to second count

2.667 = Half-life of Y-90, days

R1 = $D + E*M + F*M^2$ (This is the general form of the regression equation for Y-90 eff'y/Sr-90 eff'y ratio for one particular gas proportional counter, where D, E and F are regression coefficients.)

N2 = X - Y, where X and Y are recount gross counts and background counts, respectively

N1 = X1 - Y1, where X1 and Y1 are initial gross counts and background counts, respectively

2.22 = No. of dpm per pCi

F1 = EXP ((-0.693/2.667)*t2)

R = Count time of sample and blank

Using the same variable definitions as above, the 2-sigma error for Sr-90 (pCi/kg wet) =

$$2*\left[\frac{(X+Y)}{W1^2} + \frac{(X1+Y1)*F1^2}{W1^2}\right]^{1/2} * \frac{(W1*W2)}{(N2-F1*N1)}$$

Again, keeping the same variable definitions, the LLD for Sr-90 (pCi/kg wet) =

$$4.66*\left[\frac{(X+Y)}{W1^2} + \frac{(X1+Y1)*F1^2}{W1^2}\right]^{1/2}$$

Calculation of Sr-89 Activity:

$$\text{Sr-89 Results (pCi/kg wet)} = \frac{N6/R}{(2.22)*(E)*(E(15)/E')*(S7)*(V)*(U)*(F9)}$$

$$= W3$$

S7 = $G + H*M + I*M^2$ (This is the general form of the normalized Sr-89 efficiency regression equation for one particular gas proportional counter where G, H and I are regression coefficients.)

N6 = N1 - N7*(1 + R1*I1)

N7 = (N2 - F1*N1)/W1 (This represents counts due to Sr-90)

E(15)/E' = Ratio of Sr-89 efficiency at thickness value of 15mg/cm^2 to Sr-90 counting standard efficiency run at the time of instrument calibration (This standard is run with each group of environmental strontium samples)

F9 = EXP ((-0.693/50.5)*t)

t = Elapsed time from midpoint of collection period to time of recount for milk samples only. For all other samples, this represents the elapsed time from sample stop date to time of recount.

50.5 = Half-life of Sr-89, days

All other quantities are as previously defined.

The 2-sigma error for Sr-89 (pCi/kg wet) = $\frac{2*(S8^2+S9^2)^{1/2}*W3}{(N1 - N7*(1+R1*I1))}$

$$S8 = \left[\frac{(X+Y)}{W1^2} + \frac{(X1+Y1)*F1^2}{W1^2}\right]^{1/2}$$

$$S9 = (X1+Y1)^{1/2}$$

All other variables are as previously defined.

Keeping the same variable definitions, the LLD for Sr-89 (pCi/kg wet) = $4.66*(S8^2+S9^2)^{1/2}$

SYNOPSIS OF PSE&G RESEARCH CORPORATION PROCEDURE

RADIOSTRONTIUM ANALYSIS OF BONE AND SHELL

The bone or shell is first physically separated from the rest of the sample before being broken up and boiled in 6N sodium hydroxide (NaOH) solution for a brief time to digest remaining flesh/collagen material adhering to the sample. After multiple rinses with distilled water, the bone/shell is then oven dried and pulverized. An aliquot of the sample is removed, weighed and ashed in a muffle furnace. Then, in the presence of strontium carrier and cesium holdback carrier, the radiostrontium is leached out of the ash by boiling in diluted nitric acid, after which the sample is filtered.

The sample is then treated with concentrated (70%) nitric acid and boiled until strontium nitrate crystallizes out. The strontium nitrate is freed of calcium by repeated fuming nitric acid recrystallizations. From this point on, any radiological impurities are removed by coprecipitation with ferric hydroxide followed by coprecipitation with barium chromate. The strontium is precipitated as strontium carbonate, which is dried, weighed, then beta-counted on a low background gas proportional counter. A second count is performed at least 14 days later. The basis for this two-count method is that Sr-90 and Sr-89 are both unknown quantities requiring two simultaneous equations to solve for them.

Calculation of Sr-90 Activity:

$$\text{Sr-90 Results (pCi/kg dry)} = \frac{N4/R}{(2.22)*(E)*(E(15)/E')*(S6)*(V)*(U)}$$

$$= W2$$

where $S6 = A + B*M + C*M^2$ (This is the general form of the normalized Sr-90 efficiency regression equation for one particular gas proportional counter, where A, B and C are regression coefficients.)

M = Thickness density of strontium carbonate precipitate, mg/cm^2

E(15)/E' = Ratio of Sr-90 efficiency at thickness value of $15mg/cm^2$ to Sr-90 counting standard efficiency run at the time of instrument calibration (This standard is run with each group of environmental strontium samples)

E = Sr-90 counting standard efficiency

V = Sample quantity (kg dry)

U = Chemical yield

N4 = (N2 - F1*N1)/W1 = net counts due to Sr-90 only

W1 = ((1 + R1*I2) - (1 + R1*I1)*F1)

I1 = 1 - EXP ((-0.693/2.667)*t1)

I2 = 1 - EXP ((-0.693/2.667)*t2)

t1 = Elapsed time from Y-90 strip to first count

t2 = Elapsed time from Y-90 strip to second count

2.667 = Half-life of Y-90, days

R1 = D + E*M + F*M^2 (This is the general form of the regression equation for Y-90 eff'y/Sr-90 eff'y ratio for one particular gas proportional counter, where D, E and F are regression coefficients.)

N2 = X - Y, where X and Y are recount gross counts and background counts, respectively

N1 = X1 - Y1, where X1 and Y1 are initial gross counts and background counts, respectively

2.22 = No. of dpm per pCi

F1 = EXP ((-0.693/2.667)*t2)

R = Count time of sample and blank

Using the same variable definitions as above, the 2-sigma error for Sr-90 (pCi/kg dry) =

$$2*\left[\frac{(X+Y)}{W1^2} + \frac{(X1+Y1)*F1^2}{W1^2}\right]^{1/2} * \frac{(W1*W2)}{(N2-F1*N1)}$$

Again, keeping the same variable definitions, the LLD for Sr-90 (pCi/kg dry) =

$$4.66*\left[\frac{(X+Y)}{W1^2} + \frac{(X1+Y1)*F1^2}{W1^2}\right]^{1/2}$$

Calculation of Sr-89 Activity:

$$\text{Sr-89 Results (pCi/kg dry)} = \frac{N6/R}{(2.22)*(E)*(E(15)/E')*(S7)*(V)*(U)*(F9)}$$

$$= W3$$

S7 = G + H*M + I*M^2 (This is the general form of the normalized Sr-89 efficiency regression equation for one particular gas proportional counter where G, H and I are regression coefficients.)

N6 = N1 - N7*(1 + R1*I1)

N7 = (N2 - F1*N1)/W1 (This represents counts due to Sr-90)

E(15)/E' = Ratio of Sr-89 efficiency at thickness value of 15mg/cm^2 to Sr-90 counting standard efficiency run at the time of instrument calibration (This standard is run with each group of environmental strontium samples)

F9 = EXP ((-0.693/50.5)*t)

t = Elapsed time from midpoint of collection period to time of recount for milk samples only. For all other samples, this represents the elapsed time from sample stop date to time of recount.

50.5 = Half-life of Sr-89, days

All other quantities are as previously defined.

The 2-sigma error for Sr-89 (pCi/kg dry) = $\frac{2*(S8^2+S9^2)^{1/2}*W3}{(N1 - N7*(1+R1*I1))}$

$$S8 = \left[\frac{(X+Y)}{W1^2} + \frac{(X1+Y1)*F1^2}{W1^2}\right]^{1/2}$$

$$S9 = (X1+Y1)^{1/2}$$

All other variables are as previously defined.

Keeping the same variable definitions, the LLD for Sr-89 (pCi/kg dry) = $4.66*(S8^2+S9^2)^{1/2}$

SYNOPSIS OF PSE&G RESEARCH CORPORATION PROCEDURE

RADIOSTRONTIUM ANALYSIS OF SOIL AND SEDIMENT

After the soil or sediment sample has been dried and pulverized, a 50gm aliquot is added to approximately 1/3 - liter concentrated hydrochloric acid (HCl), containing 5ml of strontium carrier (10mg Sr^{++}/ml). A blank containing only 1/3 - liter concentrated HCl and 5ml strontium carrier is run in parallel with the sample. The samples are stirred vigorously for at least 30 minutes and then filtered. The filtrate is then diluted to a known volume and aliquots removed for stable strontium. The remaining sample is alkalinized with ammonium hydroxide to precipitate all the transitional elements. After filtering out these interferences, the filtrate is heated and sodium carbonate added to precipitate strontium and calcium carbonate. These carbonates are first filtered and then digested with 6N HNO_3. Two fuming (90%) HNO_3 recrystallizations are then performed to remove calcium. Subsequently, radioactive impurities are removed by two precipitation steps, using ferric hydroxide and barium chromate as carriers. The strontium is precipitated as strontium carbonate before being dried and weighed. The samples are counted for beta activity in a low background gas proportional counter (Count time will vary, depending on the desired sensitivity.). There is a second count at least 14 days later. The basis for this two-count method is that Sr-90 and Sr-89 are both unknown quantities requiring two simultaneous equations to solve for them.

Calculation of Sr-90 Activity:

$$\text{Sr-90 Results (pCi/kg dry)} = \frac{N4/R}{(2.22)*(E)*(E(15)/E')*(S6)*(V)*(U)}$$

$$= W2$$

where $S6 = A + B*M + C*M^2$ (This is the general form of the normalized Sr-90 efficiency regression equation for one particular gas proportional counter, where A, B and C are regression coefficients.)

M = Thickness density of strontium carbonate precipitate, mg/cm^2

E(15)/E' = Ratio of Sr-90 efficiency at thickness value of $15mg/cm^2$ to Sr-90 counting standard efficiency run at the time of instrument calibration (This standard is run with each group of environmental strontium samples)

E = Sr-90 counting standard efficiency

V = Sample quantity (kg dry)

U = Chemical yield

N4 = (N2 - F1*N1)/W1 = net counts due to Sr-90 only

W1 = ((1 + R1*I2) - (1 + R1*I1)*F1)

I1 = 1 - EXP ((-0.693/2.667)*t1)

I2 = 1 - EXP ((-0.693/2.667)*t2)

t1 = Elapsed time from Y-90 strip to first count

t2 = Elapsed time from Y-90 strip to second count

2.667 = Half-life of Y-90, days

R1 = $D + E*M + F*M^2$ (This is the general form of the regression equation for Y-90 eff'y/Sr-90 eff'y ratio for one particular gas proportional counter, where D, E and F are regression coefficients.)

N2 = X - Y, where X and Y are recount gross counts and background counts, respectively

N1 = X1 - Y1, where X1 and Y1 are initial gross counts and background counts, respectively

2.22 = No. of dpm per pCi

F1 = EXP ((-0.693/2.667)*t2)

R = Count time of sample and blank

Using the same variable definitions as above, the 2-sigma error for Sr-90 (pCi/kg dry) =

$$2*\left[\frac{(X+Y)}{W1^2} + \frac{(X1+Y1)*F1^2}{W1^2}\right]^{1/2} * \frac{(W1*W2)}{(N2-F1*N1)}$$

Again, keeping the same variable definitions, the LLD for Sr-90 (pCi/kg dry) =

$$4.66*\left[\frac{(X+Y)}{W1^2} + \frac{(X1+Y1)*F1^2}{W1^2}\right]^{1/2}$$

Calculation of Sr-89 Activity:

$$\text{Sr-89 Results (pCi/kg dry)} = \frac{N6/R}{(2.22)*(E)*(E(15)/E')*(S7)*(V)*(U)*(F9)}$$

$$= W3$$

S7 = $G + H*M + I*M^2$ (This is the general form of the normalized Sr-89 efficiency regression equation for one particular gas proportional counter where G, H and I are regression coefficients.)

N6 = N1 - N7*(1 + R1*I1)

N7 = (N2 - F1*N1)/W1 (This represents counts due to Sr-90)

E(15)/E' = Ratio of Sr-89 efficiency at thickness value of 15mg/cm^2 to Sr-90 counting standard efficiency run at the time of instrument calibration (This standard is run with each group of environmental strontium samples)

F9 = EXP ((-0.693/50.5)*t)

t = Elapsed time from midpoint of collection period to time of recount for milk samples only. For all other samples, this represents the elapsed time from sample stop date to time of recount.

50.5 = Half-life of Sr-89, days

All other quantities are as previously defined.

The 2-sigma error for Sr-89 (pCi/kg dry) = $\frac{2*(S8^2+S9^2)^{1/2}*W3}{(N1 - N7*(1+R1*I1))}$

$$S8 = \left[\frac{(X+Y)}{W1^2} + \frac{(X1+Y1)*F1^2}{W1^2}\right]^{1/2}$$

$$S9 = (X1+Y1)^{1/2}$$

All other variables are as previously defined.

Keeping the same variable definitions, the LLD for Sr-89 (pCi/kg dry) = $4.66*(S8^2+S9^2)^{1/2}$

SYNOPSIS OF PSE&G RESEARCH CORPORATION PROCEDURE

ANALYSIS OF ENVIRONMENTAL SAMPLES FOR STABLE STRONTIUM

It has been the practice of the Environmental Division to perform a stable strontium determination on any samples to be analyzed for strontium 90 and 89, if they are likely to contain significant amounts of the stable isotopes. In the case of mineral (soil or sediment) or biological (bone and shell) media, an ashing and/or acid leaching is performed to extract the element(s) of interest. The removal of the aliquot is done early in the course of the radiostrontium analysis and involves the withdrawl of 25 ml of diluted leachate (soil and sediment only) from the regular sample, transferring it to a flask. Bone and shell are prepared by ashing 2 g of sample, digesting in 6N HCl, filtering out insoluble residues and then transferring to a flask. All the above samples are analyzed by the method of Standard Additions, whereby each sample leachate is spiked with known concentrations of stable strontium. Absorbances for sample, spiked samples and blank are determined by Atomic Absorption Spectroscopy (AAS) and are then plotted graphically and the true concentration is then extrapolated. Chemical and ionization interferences are controlled by adding 1% or more of lanthanum as chloride to all samples to be analyzed. Stable strontium is then determined by AAS in the air-acetylene flame at the 460.7 nm line.

For analysis of water, a 60-ml aliquot of sample is removed, acidified to pH<2 with hydrochloric acid and analyzed by AAS as follows: A group of strontium standards (of similar concentration to the unknowns) is prepared. Then, to 9 ml of each prepared sample, blank and standard, is added 1 ml of lanthanum oxide solution. These are analyzed at 460.7 nm by air-acetylene AAS, following the manufacturer's recommended instrument parameters.

All results (calculated as milligrams of strontium per liter) are then used to find the true chemical recovery of strontium based on both the amount of carrier added (only in the case of soil and sediment) and the quantity of strontium intrinsic to the sample.

Sample Calculation of Corrected Chemical Recovery of Strontium in Soil and Sediment:

Reported concentration of stable strontium (mg/L):119
Volume of specimen (ml):25 (removed from 1000ml of diluted leachate)
Proportion of sample used for aliquot: 0.025

Milligrams strontium in 25ml flask = (119mg/L) x (.025L/25ml) x (25ml)
= 2.98mg Sr

Since 2.98mg Sr represents the quantity of stable strontium in 2 1/2 percent of the sample, total strontium (stable + carrier) in the full sample =

$$\frac{2.98\text{mg Sr}}{0.025} = 119 \text{ mg}$$

Net weight of $SrCO_3$ precipitate (mg): 125
Percent of Sr in precipitate: 59.35
Quantity of strontium recovered = (125mg) x (.5935) = 74.2

Corrected chemical recovery of strontium = $\frac{74.2}{119.0}$ = 0.623

The calculations follow the same sequence for bone and shell samples.

Sample Calculation of Corrected Chemical Recovery of Strontium in Water:

Reported concentrations of stable strontium (mg/L): 1.65
Volume of radiochemical water sample (liters): 2.0

Stable strontium in 2 liter sample = (1.65mg/L) x (2.0L)
= 3.30mg

Quantity of strontium carrier added to sample (mg): 20.0
Total amount of strontium in sample (mg): 20.0 + 3.30 = 23.3mg

Net weight of $SrCO_3$ precipitate (mg): 28.9
Percent of Sr in precipitate: 59.35
Quantity of strontium recovered = (28.9mg) x (.5935) = 17.2mg

Corrected chemical recovery of strontium = $\frac{17.2mg}{23.3mg}$ = .738

SYNOPSIS OF PSE&G RESEARCH CORPORATION PROCEDURE

GAMMA ANALYSIS OF AIR PARTICULATE COMPOSITES

At the end of each calendar quarter, 13 weekly air filters from a given location are stacked in a two inch diameter Petri dish in chronological order, with the oldest filter at the bottom, nearest the detector, and the newest one on top. The Petri dish is closed and the sample counted on a gamma detector.

The following are the calculations performed for the gamma activity, 2-sigma error and LLD:

$$\text{Result } (pCi/m^3) = \frac{N*D}{(2.22)*(E)*(A)*(T)*(V)} = R$$

N = Net counts under photopeak
D = Decay correction factor

$$\frac{\lambda t1*EXP(\lambda t2)}{1-EXP(-\lambda t1)}$$

t1 = Acquisition live time
t2 = Elapsed time from sample collection to start of acquisition
λ = 0.693/nuclide half life
E = Detector efficiency
A = Gamma abundance factor (no. of photons per disintegration)
T = Acquisition live time, mins.
V = Sample volume, m^3
2.22 = No. of dpm per pCi

$$\text{2-sigma error } (pCi/m^3) = \frac{1.96*(GC+BC)^{1/2}*R}{N}$$

GC = Gross counts
BC = Background counts

All other variables are as defined earlier.

$$\text{The LLD } (pCi/m^3) = \frac{4.66*(BC)^{1/2}*D}{(2.22)*(E)*(A)*(T)*(V)}$$

SYNOPSIS OF TELEDYNE ISOTOPES PROCEDURE

ANALYSIS OF AIR PARTICULATE FILTERS FOR GAMMA

Air particulate filters are analyzed for gamma using a lithium-drifted germanium detector interfaced with a 2048 channel pulse height analyzer calibrated at 1.0 Kev per channel. Teledyne Isotopes employs one of three possible data acquisition and computation systems. The first, a Data General NOVA minicomputer, in series with the pulse height analyzer, calculates the number of counts (and a one standard deviation) in the peak region by performing a linearly-interpolated background subtraction. If no peak is observed, then only the background is used (along with sample volume, collection date and length of count) to determine the detection limit. The activity or MDL of each nuclide is computed on an IBM 360. This semi-automatic system is in contrast with the other two data acquisition and computation systems, namely, a Tracor Northern TN-11 and Nuclear Data 6620 which perform all the above computations automatically. All resultant spectra are stored on magnetic tape.

SYNOPSIS OF PSE&G RESEARCH CORPORATION PROCEDURE

GAMMA ANALYSIS OF RAW MILK

A well mixed 3.5-liter sample of raw milk is poured into a calibrated Marinelli beaker along with 20ml of 37% formaldehyde solution (used as a preservative). After stirring, the sample is allowed to reach ambient temperature and then counted on a gamma detector.

Calculation of Gamma Activity:

The following are the calculations performed for the gamma activity, 2-sigma error and LLD:

$$\text{Result (pCi/L)} = \frac{N*D}{(2.22)*(E)*(A)*(T)*(V)} = R$$

N = Net counts under photopeak
D = Decay correction factor

$$\frac{\lambda\, t1*EXP(\lambda t2)}{1-EXP(-\lambda t1)}$$

t1 = Acquisition live time
t2 = Elapsed time from sample collection to start of acquisition
λ = 0.693/nuclide half life
E = Detector efficiency
A = Gamma abundance factor (no. of photons per disintegration)
T = Acquisition live time, mins.
V = Sample volume, liters
2.22 = No. of dpm per pCi

$$\text{2-sigma error (pCi/L)} = \frac{1.96*(GC+BC)^{1/2}*R}{N}$$

GC = Gross counts
BC = Background counts

All other variables are as defined earlier.

$$\text{The LLD (pCi/L)} = \frac{4.66*(BC)^{1/2}*D}{(2.22)*(E)*(A)*(T)*(V)}$$

SYNOPSIS OF PSE&G RESEARCH CORPORATION PROCEDURE

GAMMA ANALYSIS OF WATER

After thoroughly agitating the sample container, 3.5 liters of water sample is poured into a calibrated Marinelli beaker and then counted on a gamma detector.

Calculation of Gamma Activity:

The following are the calculations performed for the gamma activity, 2-sigma error and LLD:

$$\text{Result (pCi/L)} = \frac{N*D}{(2.22)*(E)*(A)*(T)*(V)} = R$$

N = Net counts under photopeak
D = Decay correction factor

$$\frac{\lambda t1*EXP(\lambda t2)}{1-EXP(-\lambda t1)}$$

t1 = Acquisition live time
t2 = Elapsed time from sample collection to start of acquisition
λ = 0.693/nuclide half life
E = Detector efficiency
A = Gamma abundance factor (no. of photons per disintegration)
T = Acquisition live time, mins.
V = Sample volume, liters
2.22 = No. of dpm per pCi

$$\text{2-sigma error (pCi/L)} = \frac{1.96*(GC+BC)^{1/2}*R}{N}$$

GC = Gross counts
BC = Background counts

All other variables are as defined earlier.

$$\text{The LLD (pCi/L)} = \frac{4.66*(BC)^{1/2}*D}{(2.22)*(E)*(A)*(T)*(V)}$$

SYNOPSIS OF PSE&G RESEARCH CORPORATION PROCEDURE

GAMMA ANALYSIS OF SOLIDS

Several methods are employed in preparing solids for gamma analysis, depending on the type of sample or sensitivity required. For high sensitivity analysis of vegetation, meat and seafood, the sample is first weighed, then oven-dried to a constant weight. A ratio of wet-to-dry weight is computed before the sample is ground and compressed to unit density ($1g/cm^3$), whenever possible, in a tared aluminum can. The can is weighed and then hermetically sealed and counted on a gamma detector.

In most cases, a wet sample is prepared (assuming sensitivity can be met) by using a food processor to puree it. The sample is then poured into a calibrated and tared clear plastic container until a standard volume is reached. The sample is weighed and then sealed with a screw cap before gamma counting.

Soil and sediment samples are first oven dried until a constant weight is achieved and then pulverized. The sample is added to a tared aluminum can, compacted to a standard volume and weighed. It is hermetically sealed and gamma counted.

Benthic organisms are oven dried, followed by the physical removal of any obvious impurities (such as shells or twigs). The dried organisms are weighed and then wet-ashed with concentrated nitric acid. After all solids have been digested, the sample is evaporated to near dryness and the residual salts taken up with distilled water. The sample is filtered and the filtrate added to an aluminum can. The sample volume is brought up to the standard geometry with distilled water and the can hermetically sealed before gamma counting.

Calculation of Gamma Activity:

The following are the calculations performed for the gamma activity, 2-sigma error and LLD:

$$\text{Result (pCi/kg)} = \frac{N*D}{(2.22)*(E)*(A)*(T)*(V)} = R$$

N = Net counts under photopeak
D = Decay correction factor

$$\frac{\lambda t1*EXP(\lambda t2)}{1-EXP(-\lambda t1)}$$

t1 = Acquisition live time
t2 = Elapsed time from sample collection to start of acquisition
λ = 0.693/nuclide half life
E = Detector efficiency
A = Gamma abundance factor (no. of photons per disintegration)
T = Acquisition live time, mins.
V = Sample volume, kilograms
2.22 = No. of dpm per pCi

$$\text{2-sigma error (pCi/kg)} = \frac{1.96*(GC+BC)^{1/2}*R}{N}$$

GC = Gross counts
BC = Background counts

All other variables are as defined earlier.

$$\text{The LLD (pCi/kg)} = \frac{4.66*(BC)^{1/2}*D}{(2.22)*(E)*(A)*(T)*(V)}$$

SYNOPSIS OF TELEDYNE ISOTOPES PROCEDURE

ANALYSIS OF TELEDYNE ISOTOPES THERMOLUMINESCENT DOSIMETERS

These devices are rectangular Teflon wafers impregnated with 25% $CaSO_4$:Dy phosphor. They are first annealed in a 250°C oven prior to exposure in the field. Following field exposure (for a 1-month or 3-month period) four separate areas of the dosimeter are read in a Teledyne Isotopes model 8300 TLD reader. The dosimeter is then re-irradiated by a standardized Cs-137 source and the four areas are read again. Calculation of the environmental exposure is performed by computer, using the re-irradiation readings to determine the sensitivity of each area of the dosimeter. The readings of control dosimeters are subtracted to allow for transit dose and system background.

The results are computed as follows:

For any given area of the dosimeter, the dose in mR is calculated by the following formula:

$$DOSE = R * (REDOSE/RR) - AVC$$

R = Initial reading of the area
RR = Second reading of the area (after re-irradiation)
REDOSE = Re-irradiation dose, mR
AVC = Average of control values, mR

$$\text{where } AVC = \sum_{i=1}^{4N} CDOSE/4N$$

N = Total number of control dosimeters

$$CDOSE = CR*(CREDOSE/CRR)$$

CDOSE = Control area dose, mR
CR = Initial reading of control area
CRR = Second reading of the control area (after re-irradiation)
CREDOSE = Re-irradiation dose of the control dosimeter, mR

APPENDIX E

SUMMARY OF USEPA ENVIRONMENTAL RADIOACTIVITY LABORATORY INTERCOMPARISON STUDIES PROGRAM RESULTS

SUMMARY OF USEPA INTERCOMPARISON STUDIES PROGRAM

Appendix E presents a summary of the analytical results for the 1986 USEPA Environmental Radioactivity Laboratory Intercomparison Studies Program.

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TABLE E-1

USEPA ENVIRONMENTAL RADIOACTIVITY LABORATORY INTERCOMPARSION STUDY PROGRAM

Gross Alpha and Gross Beta Analysis of Water (pCi/L)
and Air Particulate (pCi/filter)

DATE MM-YY	ENV SAMPLE CODE ENV ID	MEDIUM	ANALYSIS	* PSE&G Mean ± s.d.	** EPA Known	*** GRAND AVG Mean ± s.d.
01-86	EPA-WAT-AB169	Water	Alpha	3.6±0.3	3.0±8.7	3.6±1.4
	86-90		Beta	6.7±0.5	7.0±8.7	7.2±1.8
03-86	EPA-WAT-AB175	Water	Alpha	18±3	15±8.7	13±3
	86-374		Beta	8±1	8±8.7	10±3
03-86	EPA-APT-GABS176	APT	Alpha	17±1	15±8.7	16±3
	86-660		Beta	50±1	47±8.7	51±6
04-86	EPA-WAT-P178	Water	Alpha	18±1	17±8.7	15±4
	86-512		Beta	29±1	35±8.7	32±5
05-86	EPA-WAT-AB180	Water	Alpha	8±1	8±8.7	7±2
	86-871		Beta	14±1	15±8.7	15±3
07-86	EPA-WAT-AB189	Water	Alpha	6±1	6±8.7	6±2
	86-1204		Beta	15±1	18±8.7	18±3
08-86	EPA-APT-GABS192	APT	Alpha	24±1	22±8.7	22±4
	86-1567		Beta	90±2	66±8.7	71±8
09-86	EPA-WAT-AB194	Water	Alpha	15±1	15±8.7	15±4
	86-1766		Beta	8±2	8±8.7	10±3
10-86	EPA-WAT-P197	Water	Alpha	44±1	40±8.7	36±10
	86-2079		Beta	19±1	51±8.7	47±6
11-86	EPA-WAT-AB199	Water	Alpha	19±2	20±8.7	17±5
	86-2666		Beta	16±1	20±8.7	21±3

* s.d. - one standard deviation of three individual analytical results
** known value with control limits, indicating whether results are in agreement or disagreement
*** s.d. - one standard deviation of acceptable results of all participating laboratories

TABLE E-2

USEPA ENVIRONMENTAL RADIOACTIVITY LABORATORY INTERCOMPARSION STUDY PROGRAM

Gamma Analysis of Milk, Water (pCi/L), Air Particulate (pCi/filter) and Food Products (pCi/kg)

DATE MM-YY	ENV SAMPLE CODE ENV ID	MEDIUM	ANALYSIS	* PSE&G Mean ± s.d.	** EPA Known	*** GRAND AVG Mean ± s.d.
01-86	EPA-ORG-GS170 86-108	Food	I-131	<30	20±10.4	21±2
			Cs-137	14±1	15±8.7	17±2
			K(1)	922±11	950±248	957±90
02-86	EPA-WAT-G171 86-173	Water	Cr-51	42±4	38±8.7	39±6
			Co-60	18±1	18±8.7	18±3
			Zn-65	41±2	40±8.7	41±4
			Ru-106	<11	0	
			Cs-134	28±1	30±8.7	28±4
			Cs-137	22±1	22±8.7	22±3
04-86	EPA-APT-GABS176 86-660	APT	Cs-137	10±1	10±8.7	11±2
04-86	EPA-WAT-P178 86-512	Water	Co-60	9±1	10±8.7	10±2
			Cs-134	5±1	5±8.7	5±1
			Cs-137	6±1	5±8.7	6±1
06-86	EPA-MLK-GS184 86-1071	Milk	I-131	43±1	41±10.6	44±4
			Cs-137	37±1	31±8.7	37±3
			K(1)	1660±10	1600±140	1600±110
06-86	EPA-WAT-G181 86-921	Water	Cr-51	<18	0	0
			Co-60	66±1	66±8.7	64±4
			Zn-65	87±3	86±8.7	86±6
			Ru-106	43±5	50±8.7	50±11
			Cs-134	46±1	49±8.7	46±4
			Cs-137	10±1	10±8.7	11±2
07-86	EPA-ORG-GS190 86-1205	Food	I-131	26±1	30±10.4	28±3
			Cs-137	21±1	20±8.7	21±3
			K(1)	1150±30	1150±100	1150±104
08-86	EPA-APT-GABS192 86-1567	APT	CS-137	21±1	22±8.7	24±4

TABLE E-2 (cont'd)

USEPA ENVIRONMENTAL RADIOACTIVITY LABORATORY INTERCOMPARSION STUDY PROGRAM

Gamma Analysis of Milk, Water (pCi/L), Air Particulate (pCi/filter) and Food Products (pCi/kg)

DATE MM-YY	ENV SAMPLE CODE ENV ID	MEDIUM	ANALYSIS	* PSE&G Mean ± s.d.	** EPA Known	*** GRAND AVG Mean ± s.d.
10-86	EPA-WAT-G195 86-1964	Water	Cr-51	57±8	57±8.7	56±17
			Co-60	28±2	31±8.7	31±3
			Zn-65	79±6	85±8.7	85±7
			Ru-106	69±9	74±8.7	68±8
			Cs-134	26±2	28±8.7	26±3
			Cs-137	42±2	44±8.7	45±4
10-86	EPA-MLK-GS198 86-2147	Milk	I-131	48±1	49±10.4	49±5
			Cs-137	44±1	39±8.7	44±3
			K(1)	1540±20	1565±135	1565±106
11-86	EPA-WAT-P197 86-2079	Water	Co-60	23±1	24±8.7	24±2
			Cs-134	11±1	12±8.7	11±2
			Cs-137	8±1	8±8.7	9±2

* s.d. - one standard deviation of three individual analytical results
** known value with control limits, indicating whether results are in agreement or disagreement
*** s.d. - one standard deviation of acceptable results of all participating laboratories
(1) Reported as mg/L of Potassium.

TABLE E-3

USEPA ENVIRONMENTAL RADIOACTIVITY LABORATORY INTERCOMPARSION STUDY PROGRAM

Tritium Analysis of Water (pCi/L)

DATE MM-YY	ENV SAMPLE CODE ENV ID	MEDIUM	ANALYSIS	* PSE&G Mean ± s.d.	** EPA Known	*** GRAND AVG Mean ± s.d.
02-86	EPA-WAT-H172 86-244	Water	H-3	5170±70	5227±906	5105±340
06-86	EPA-WAT-H182 86-981	Water	H-3	3000±80	3125±624	3052±347
10-86	EPA-WAT-H196 86-1965	Water	H-3	5890±100	5973±1034	5694±406

* s.d. - one standard deviation of three individual analytical results
** known value with control limits, indicating whether results are in agreement or disagreement
*** s.d. - one standard deviation of acceptable results of all participating laboratories

TABLE E-4

USEPA ENVIRONMENTAL RADIOACTIVITY LABORATORY INTERCOMPARSION STUDY PROGRAM

Iodine Analysis of Water and Milk (pCi/L)

DATE MM-YY	ENV SAMPLE CODE ENV ID	MEDIUM	ANALYSIS	* PSE&G Mean ± s.d.	** EPA Known	*** GRAND AVG Mean ± s.d.
03-86	EPA-MLK-I172 86-245	Milk(1)	I-131	2.4±1	9±10.4	9±2
04-86	EPA-WAT-I177 86-424	Water	I-131	8±1	9±10.4	9±2
08-86	EPA-WAT-I191 86-1305	Water	I-131	39±1	45±10.4	42±6

* s.d. - one standard deviation of three individual analytical results
** known value with control limits, indicating whether results are in agreement or disagreement
*** s.d. - one standard deviation of acceptable results of all participating laboratories
(1) Special EPA/NRC low level study.

TABLE E-5

USEPA ENVIRONMENTAL RADIOACTIVITY LABORATORY INTERCOMPARSION STUDY PROGRAM

Strontium-89 and Strontium-90 Analysis of Air Particulates (pCi/filter), Milk, Water (pCi/L) and Food Products (pCi/kg)

DATE MM-YY	ENV SAMPLE CODE ENV ID	MEDIUM	ANALYSIS	* PSE&G Mean ± s.d.	** EPA Known	*** GRAND AVG Mean ± s.d.
01-86	EPA-WAT-S168	Water	Sr-89	24±2	31±10.4	31±5
	86-26		Sr-90	12±1	15±2.6	14±2.2
01-86	EPA-ORG-GS170	Food	Sr-89	(1)		
	86-108		Sr-90	(1)		
03-86	EPA-APT-GABS176	APT	Sr-90	16±1	18±2.6	17±2
	86-660					
04-86	EPA-WAT-P178	Water	Sr-89	6±1	7±8.7	6±2
	86-512		Sr-90	6±1	7±2.6	7±1
05-86	EPA-WAT-S179	Water	Sr-89	4±1	5±8.7	5±2
	86-675		Sr-90	4±1	5±2.6	5±1
06-86	EPA-MLK-GS184	Milk	Sr-89	<4	0	0
	86-1071		Sr-90	12±1	16±2.6	15±3
07-86	EPA-ORG-GS190	Food	Sr-89	24±2	30±8.7	25±3
	86-1205		Sr-90	16±2	19±2.6	19±7
08-86	EPA-WAT-GABS192	APT	Sr-90	22±1	22±2.6	22±3
	86-1567					
10-86	EPA-MLK-GS198	Milk	Sr-89	8±1	9±8.7	9±3
	86-2147		Sr-90	<1.6	0	1±0.5
11-86	EPA-WAT-P197	Water	Sr-89	10±1	10±8.7	9±3
	86-2079		Sr-90	3±1	4±2.6	4±1

* s.d. - one standard deviation of three individual analytical results.
** known value with control limits, indicating whether results are in agreement or disagreement
*** s.d. - one standard deviation of acceptable results of all participating laboratories
(1) Not analyzed by PSE&G.

APPENDIX F

SYNOPSIS OF LAND USE CENSUS

APPENDIX F

SYNOPSIS OF 1986 LAND USE CENSUS

A land use census was conducted to identify, within a distance of 8 km (5 miles), the location of the nearest milk animal, the nearest residence and the nearest garden of greater than $50m^2$ ($500ft^2$) producing broad leaf vegetation in each of the 16 meteorological sectors.

Tabulated below are the results of these surveys:

Meteorological Sector	Milk Animal Aug., 1986 km (miles)	Nearest Residence Aug., 1986 km (miles)	Vegetable Garden Aug., 1986 km (miles)
N	None	None	None
NNE	None	6.9 (4.3)	None
NE	None	6.4 (4.0)	None
ENE	None	6.1 (3.8)	None
E	None	5.4 (3.4)	None
ESE	None	None	None
SE	None	None	None
SSE	None	None	None
S	None	6.1 (4.1)	None
SSW	None	5.5 (3.4)	None
SW	None	6.9 (4.3)	None
WSW	None	7.1 (4.4)	None
W	7.8 (4.9)	6.5 (4.0)	None
WNW	None	5.5 (3.4)	None
NW	None	5.9 (3.7)	None
NNW	None	6.8 (4.2)	None