RMC-TR-83-03

ARTIFICIAL ISLAND RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

1982 RADIOLOGICAL REPORT
JANUARY 1 TO DECEMBER 31, 1982

Prepared For

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

By

RADIATION MANAGEMENT CORPORATION

APRIL 1983

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SUMMARY

During the period January 1 to December 31, 1982, Radiation Management Corporation (RMC) participated in the Operational Radiological Environmental Monitoring Program conducted by Public Service Electric and Gas Company (PSE&G) at Artificial Island, New Jersey. Salem Nuclear Generating Station (SNGS) Unit #1 became critical on December 11, 1976, thereby initiating the operational phase of the Radiological Environmental Monitoring Program (REMP). 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. Unit #2 achieved initial criticality on August 2, 1980. During the operational phase, the program will monitor the operations of SNGS Units #1 and #2, will fulfill the requirements of the SNGS Environmental Technical Specifications, and will provide background data for the Hope Creek Generating Station. This report presents the results of thermoluminescent dosimetry and radiochemical analyses of environmental samples collected during 1982.

A total of 2571 analyses were performed on 1551 environmental samples during the period covered by this report. Samples of air particulates, air iodine, surface, ground and drinking water, benthos, sediment, milk, fish, crabs, vegetables, game, fodder crops, meat and precipitation were collected. Thermoluminescent dosimeters were used to measure ambient radiation levels.

A variety of radionuclides, both naturally occurring and man-made, were found in the above samples. These nuclides were detected at levels similar to those found during the preoperational phase of this program. In general, results at indicator stations compared favorably to control stations. It is concluded that the radiological characteristics of the environment around Artificial Island during 1982 were not affected by the operation of SNGS Units #1 and #2.

INTRODUCTION

Radiation Management Corporation has participated in the Artificial Island Radiological Environmental Monitoring Program since January 1973. RMC has previously reported results for the preoperational phase of the REMP from 1973 to 1976 (1-4). On December 11, 1976, SNGS Unit #1 first achieved criticality thereby initiating the operational phase of the REMP. Continuing since then, RMC has reported results for the operational phase of the REMP from 1976 to 1981 (5-10). This report summarizes the operational period between January 1 and December 31, 1982.

Artificial Island is the site of two nuclear power reactors which are part of the Salem Nuclear Generating Station. Units #1 and #2 are pressurized water reactors (PWR), with a capacity of 1090 MWe and 1115 MWE respectively. Both are presently operational.

Artificial Island is actually a man-made peninsula in the Delaware River, created by the deposition of dredging spoils. It is located in Lower Alloways Township, Salem County, New Jersey. The environment around Artificial Island is characterized mainly by the Delaware River and Bay, extensive tidal marshes, and grass lands. 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 agricultural production (11).

More specific information on the demography, hydrology, meteorology, and land use characteristics of the local area may be found in the Environmental Report (11), Environmental Statement (12), and the Final Safety Analyses Report (Units 1 and 2 for SNGS (13).

THE PROGRAM

In the operational phase of the REMP, the program was conducted in accordance with Section 3.2 of the SNGS Environmental Technical Specifications (14). Radioanalytical data were collected and compared with results from the preoperational phase. Differences between these periods were examined statistically, where applicable, to determine whether any station operational effects existed.

Objectives

The objectives of the operational radiological environmental program are:

1. To fulfill the obligations of the Radiological Surveillance-Environmental sections of the Environmental Technical Specifications for SNGS.

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

3. To determine if SNGS 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 SNGS operations have no detrimental effects on the health and safety of the public or on the environment.

This report, as required by Section 5.6 of the Salem Environmental Technical Specifications (ETS), summarizes the findings of the 1982 REMP. Results of the four year preoperational program have been summarized for purposes of comparison with subsequent operational reports (4).

Sample Collection

In order to meet the stated objectives, an appropriate operational REMP was developed by RMC in cooperation with Public Service Electric and Gas Company. 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, which are unaffected by station operation. Indicator and control station data are also evaluated relative to preoperational data. The REMP for the Artificial Island Site includes additional samples and analyses not specifically required by the Salem ETS. The summary tables in this report include these additional samples and analyses.

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 charcoal cartridges connected in series behind the air particulate filters. Air sample volumes were measured with calibrated dry-gas meters corrected to standard temperature and pressure.

Precipitation was collected on a 95-square-inch rain gauge. Samples were collected monthly and transferred to new polyethylene bottles. The rain gauge was rinsed at collection 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 $CaSO_4$ (Tm) thermoluminescent dosimeters (TLDs). Packets containing four TLDs each were placed on and around the Artificial Island Site at various distances and were exposed on a monthly, quarterly and semi-annual basis.

Monthly well and potable water samples were taken in new two-gallon polyethylene bottles. Separate raw and treated potable water samples were composited daily by personnel of the Salem Water Company.

Surface water samples were collected by Icthyological Associates and shipped to RMC for analysis in new polyethylene bottles. Sample containers were rinsed twice with the sample medium prior to collection. Edible fish and crabs were taken by net, sealed in a bag or jar and shipped frozen. Benthos and sediment were taken with a bottom grab sampler.

Milk samples were taken in new polyethylene bottles and shipped fresh. Food products, fodder crops, game and bovine thyroid samples were taken and sealed in plastic bags or jars. Perishable samples were frozen at the time of sampling without any preservatives.

Appendix A describes and summarizes, in the format of Table 5.6-1 of the Salem ETS, the entire operational program as performed in 1982. Appendix B describes the RMC coding system, which specifies sample type and relative locations at a glance. Also in Appendix B, Table B-1 gives the pertinent information on individual sampling locations, while maps B-1 and B-2 show the sampling locations.

Data Interpretation

Radiation Management Corporation has an extensive 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, inter-laboratory cross-check analyses, and comprehensive data review. The analytical methods utilized in this program are summarized in Appendix D-1. The methods utilized by the PSE&G Research and Testing Lab are summarized in Appendix D-2. Results of the EPA inter-laboratory comparison program appear in Appendix E. A full discussion of these results can be found in the "Quality Control Data 1982 - Annual Report" (15). Several factors are important in the interpretation of the data. These factors are discussed here to avoid repetition in sections that follow.

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 valid.

Within the data tables (Appendix C) an approximate 95% (±2 sigma) confidence interval is supplied for those data points above the lower limit of detection (LLD). An exception to this is Sr-89 and -90 detection capabilities which are based on the minimum detectable limit (MDL). These intervals represent the range of values into which 95% of repeated analyses of the same sample should fall.

Results for each type of sample were grouped according to the analysis performed. Means and standard deviations of these results were calculated when applicable. The calculated standard deviations of grouped data found in Appendix C represent sample and not analytical variability. When a group of data was composed of mainly (>50%) LLD values, averages were not calculated.

It is characteristic of environmental monitoring data that many results occur at or below the lower limit of detection. For reporting and calculation of averages, any result occurring at or below the lower limit of detection is considered to be at that limit. As a result, averages obtained using this method are biased high.

Quality Assurance Program (RMC)

Beginning on October 1, 1981, modifications were made to the portion of the Radiological Environmental Monitoring Program for the Salem Nuclear Generating Station performed by RMC. It should be noted that all analyses not performed by RMC are being analyzed by the PSE&G Research and Testing Laboratory, a wholly owned subsidiary of PSE&G.

In order to insure quality of the results obtained by their laboratory, PSE&G has instituted a quality assurance program in which a portion of those samples analyzed by PSE&G will also be analyzed by RMC. This program is discussed below.

1. Milk - Station MLK-3G1 will be analyzed for Sr-89 and -90 on a monthly basis by RMC. Each month one additional station will be chosen by Public Service Electric & Gas Company to receive Sr-89 and -90 analyses.

2. Surface Water - Station SWA-12C1 will be analyzed for tritium on a monthly basis, and for Sr-89 and -90 on a quarterly composite basis by RMC. In addition, one other station will be chosen by PSE&G to receive monthly tritium analyses and quarterly composite Sr-89 and -90 analyses.

3. Potable Water - Monthly tritium analyses and quarterly composite analyses for Sr-89 and -90 will be performed for station PWT-2F3 by RMC.

All results for the samples included in the quality assurance program appear on the data tables in Appendix C. This data is not included in the Results and Discussion portion of the text or in Appendix A.

Program Changes

The sampling frequency for the semi-annual TLDs was changed to quarterly collections.

RESULTS AND DISCUSSION

The analytical results of the 1982 REMP samples are divided into categories based on exposure pathways: airborne, direct, water, aquatic and ingestion. The analytical results for the 1982 REMP samples are summarized in Appendix A. The data for individual samples are presented in Appendix C.

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

Airborne

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

Air particulate samples were analyzed for alpha and beta emitters, Sr-89 and -90, and gamma emitters. The weekly air particulate samples were analyzed for gross alpha activity at two stations and for gross beta activity at eight stations. Quarterly composites were prepared using the weekly samples from each station and analyzed for Sr-89, Sr-90 and specific gamma emitters.

Of the 104 weekly air particulate samples (two stations) analyzed for gross alpha emitters, 96 were above detectable concentrations. The range of gross alpha activity was from 0.0007 to 0.0048 pCi/m^3 and averaged 0.0016 pCi/m^3.

Weekly gross beta analyses showed concentrations ranging from 0.008 to 0.060 pCi/m^3 with the average for the eight sampling stations being 0.027 pCi/m^3. Figure 1 shows the relation between gross beta activity in air and precipitation for the preoperational and the operational periods, showing the weapons-testing fluctuations.

The Sr-89 analyses performed on the 32 quarterly composites indicated no detectable activity. The MDLs ranged between <0.0003 and <0.0013 pCi/m^3. Sr-90 concentrations in 4 of the 32 samples ranged between 0.0003 and 0.0010 pCi/m^3. The MDLs for Sr-90 ranged between 0.0002 and 0.0009 pCi/m^3.

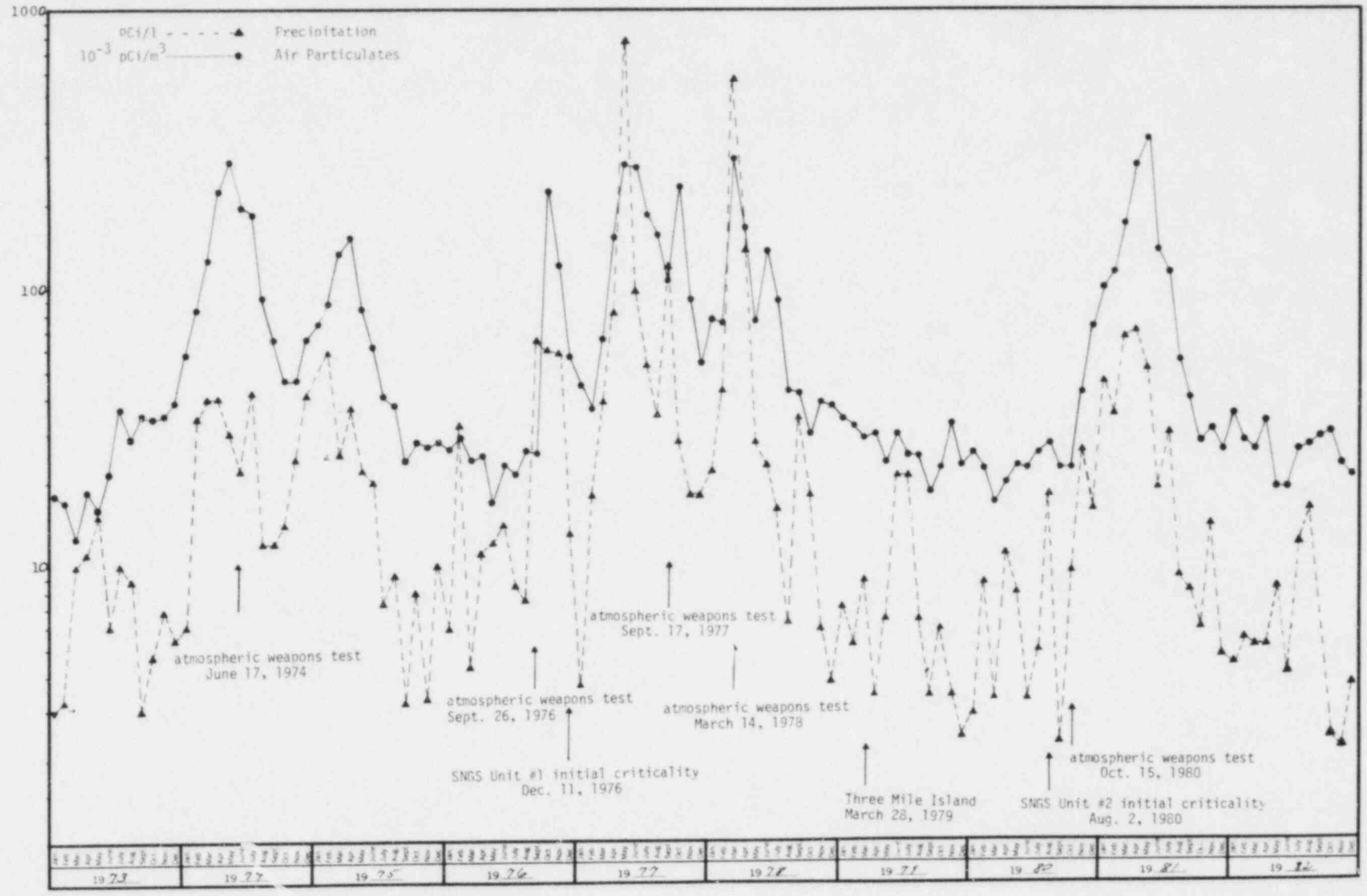
Results of gamma spectrometry showed detectable levels of several radionuclides, both naturally occurring and man-made (Be-7, Cs-137 and Ce-144). The presence of Be-7 throughout the year can be attributed to cosmic ray activity. Cs-137 and Ce-144 activities are due to fallout from previous atmospheric testing. The highest activity detected was 0.067 pCi/m^3 of Be-7 in the second quarter composite for station APT-2S2.

Air Iodine (Table C-4)

Iodine cartridges were connected in series behind each of the air particulate filters for adsorption of air iodine. The adsorption media used in these cartridges was "TEDA" impregnated charcoal. All results for I-131 were below the LLD and ranged from <0.0064 to <0.060 pCi/m^3.

FIGURE 1

COMPARISON OF AVERAGE CONCENTRATIONS OF βETA EMITTERS IN PRECIPITATION AND IN AIR PARTICULATES, 1973 THROUGH 1982



Precipitation (Tables C-6, C-7, C-8)

Although not specifically required by the Salem ETS, precipitation was sampled continuously and collected monthly at the Salem substation sampling location. The precipitation was analyzed for tritium, gross alpha and gross beta emitters on a monthly basis. Tritium activity was detected in three samples and ranged from 140 to 160 pCi/l. The LLDs ranged from <120 to <140 pCi/l. Of the eleven monthly rain water samples analyzed for gross alpha emitters, five showed detectable concentrations. The range of gross alpha activity was from 0.5 to 2.0 pCi/l. The LLDs ranged from <0.6 to <1.1 pCi/l. Gross beta emitter concentrations were detected in nine samples and ranged from 2.4 to 16 pCi/l with an average of 6.3 pCi/l.

Quarterly composites of precipitation were analyzed for radiostrontium and gamma emitters. The Sr-89 levels were below the MDL which ranged from <0.2 to <2.7 pCi/l. All results for Sr-90 were also below the MDL which ranged between <0.2 and <1.1 pCi/l. Results of gamma spectrometry showed two samples with detectable levels of K-40 (14 and 26 pCi/l.)

Direct (Tables C-9, C-10, C-11)

Direct radiation measurements were made at forty-one different locations, using $CaSO_4$ (Tm) thermoluminescent dosimeters. During 1982, 288 monthly, 113 quarterly and 34 semi-annual TLD packets were collected. Each packet included four dosimeters for a total of 1740 analyses. These analyses resulted in an average dose rate of 5.76 mrads/standard month for monthly TLDs, 5.14 mrads/standard month for quarterly TLDs and 4.93 mrads/standard month for semi-annual TLDs. All TLD results presented in this report have been normalized to a standard month (30.4 days) to eliminate the apparent differences caused by variations in exposure periods. When the monthly data is plotted as in Figure 2, a slight peak is observed after June 1979, while from March 1981 to May 1981 a sharp reduction in the average is noted. This peak is attributed to the elevated readings from two on-site TLD stations. Since the two stations, 10S1 and 11S1, are on-site, they do not represent any environmental dose to the public.

During the year a general increase in the ambient radiation levels were noted at all locations. The monthly TLD results (Table C-9) in the last quarter of 1982 were above the levels obtained earlier in the year.

Ambient radiation levels tend to fluctuate during the year due to natural variations in terrestrial and airborne radiation components, due primarily to the evolution of naturally radioactive radon daughter products from the soil and the shielding affects from the moisture content of the soil (NCRP-45). The quarterly TLD measurements (Table C-10) tend to fluctuate less than the monthly TLD measurements due to the fact that the variation in the natural radiation components mentioned above are less pronounced when averaged over a calendar quarter.

The quarterly TLD results (Table C-10) were slightly lower than some of the levels obtained earlier in the year, nevertheless, the average of the monthly and quarterly results fall within each others error bands and are consistent.

The average of all monthly TLD results and the average of only the control stations are plotted in Figure 2, to indicate that the general increase in ambient radiation levels noted occurred concurrently at indicator and control stations. A comparison of the direct radiation data for 1982 shows a similarity between the average monthly dose for both indicator stations (5.70 mrads/std. month) and control stations (6.01 mrads/std. month).

FIGURE 2

AVERAGE AMBIENT RADIATION LEVELS FROM MONTHLY TLDs IN
THE VICINITY OF ARTIFICIAL ISLAND, 1973 THROUGH 1982

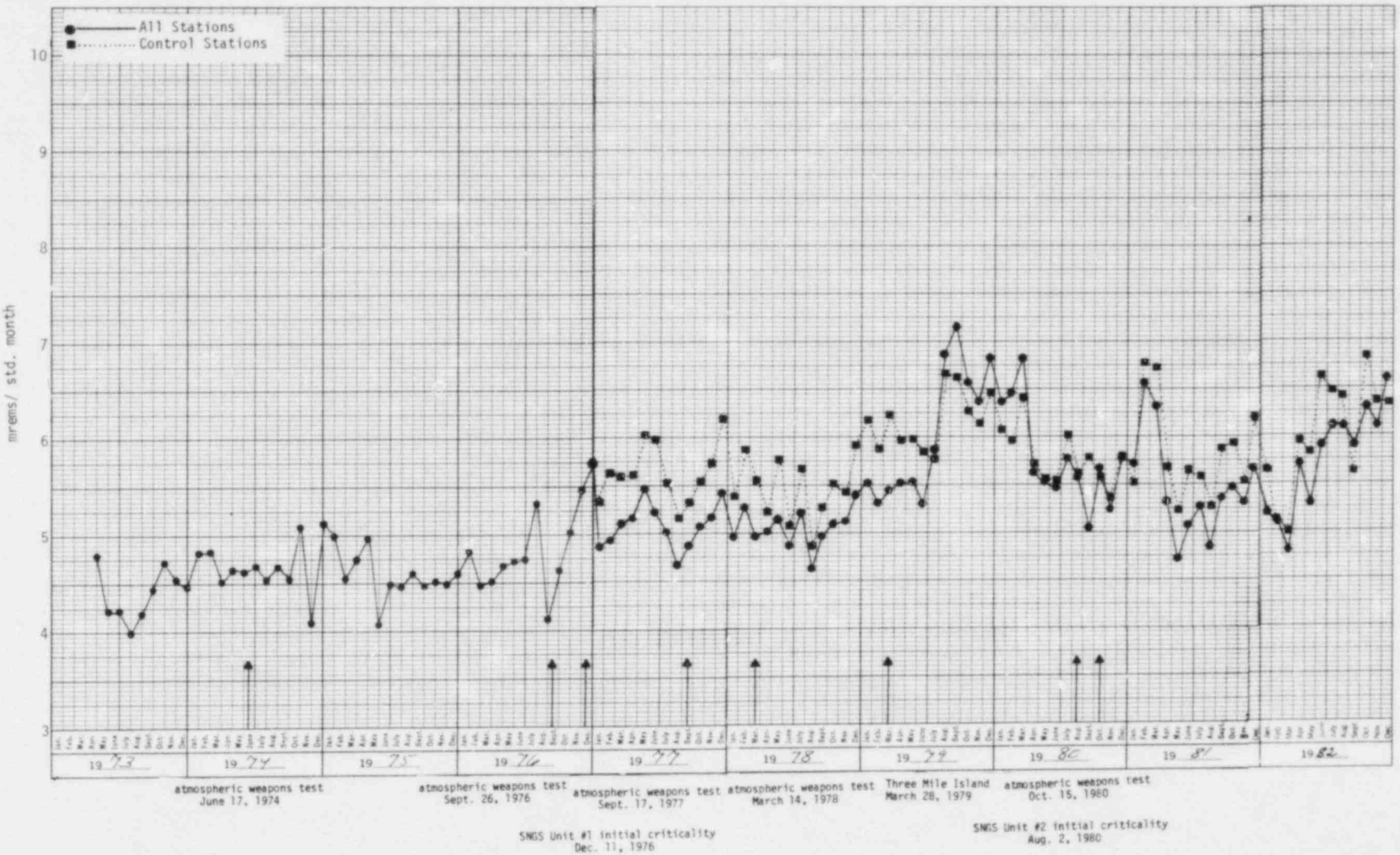
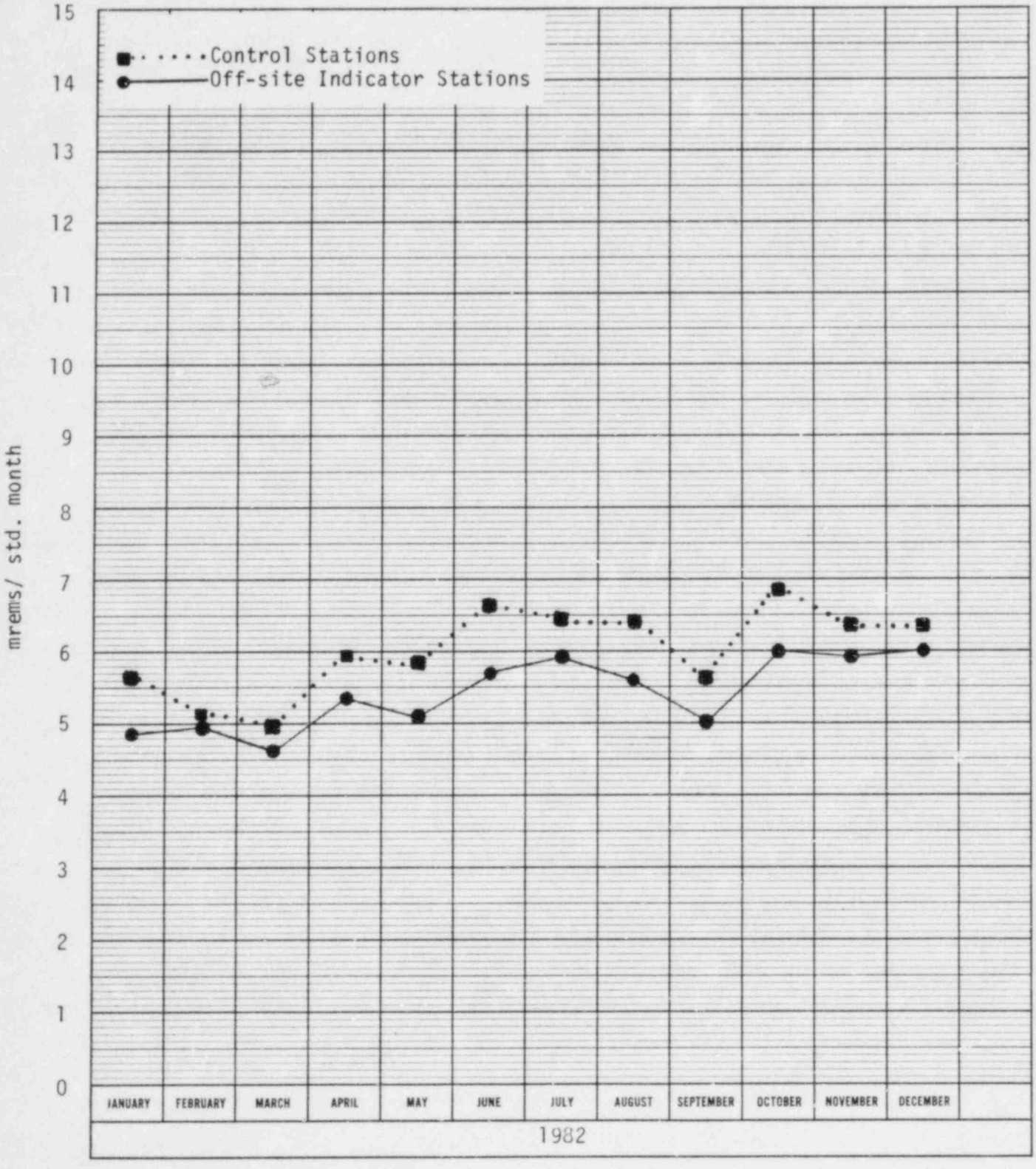


FIGURE 2A

COMPARISON OF AMBIENT RADIATIONS LEVELS OF
OFF-SITE INDICATOR STATIONS VS. CONTROL STATIONS



In order to better evaluate the variation between TLD results, a statistical model which is capable of separating a contribution by SNGS from the background component has been developed. The statistical method utilized is a linear regression analysis which involves determining the functions which best describe the background component by the least squares method. Six models were originally tested and are described in a separate publication (16). The equation which describes the model selected is:

$$Y_{jmi} = F\left(\overline{X}_j \left(CON_{im} / COT_i\right) \left(COT_i / COT_p\right)\right)$$

where:

f = denotes a function of

Y_{jmi} = predicted value for station j, month m, and year i

$\overline{X}_j$ = preoperational mean for station j

CON_{im} = average of the control stations for month m and year i

COT_i = average of the control station for year i (a "p" in place of "i" represents the preoperational period)

A computer program was developed for multiple regression analysis. The least squares fit (LSF) line based on all 1982 data was determined along with the statistics for this line. The data for 1982 was tested against predicted values and prediction limits determined from the model period line. Differences between predicted and observed values are termed residuals. Residuals outside the prediction limits of the predicted value are identified as outliers. For 1982, thirty-five outliers were predicted from a possible 288.

Eleven outliers at station 10S1 and twelve outliers at station 11S1 can be attributed to the refueling of Unit #1. These stations are located in the vicinity of the Refueling Water Storage Tank. Since these locations are on-site they do not represent a dose to the public.

Water

Surface Water (Tables C-12, C-13, C-14, C-15, C-16)

Monthly surface water samples were taken at five locations in the Delaware estuary. One is downstream from the outfall area, one is in the outfall area, and another is directly west of the outfall area at the mouth of the Appoquinimink River. Two other stations are located upstream--one station is in the river and the other is in the Chesapeake and Delaware Canal. The station (12C1) located at the mouth of the Appoquinimink River serves as the operational control. Surface water samples were analyzed for tritium, gross alpha, gross beta and gamma emitters, and strontium-89 and -90.

FIGURE 3

AVERAGE CONCENTRATIONS OF TRITIUM IN THE DELAWARE RIVER IN THE VICINITY OF ARTIFICIAL ISLAND, 1973 THROUGH 1982

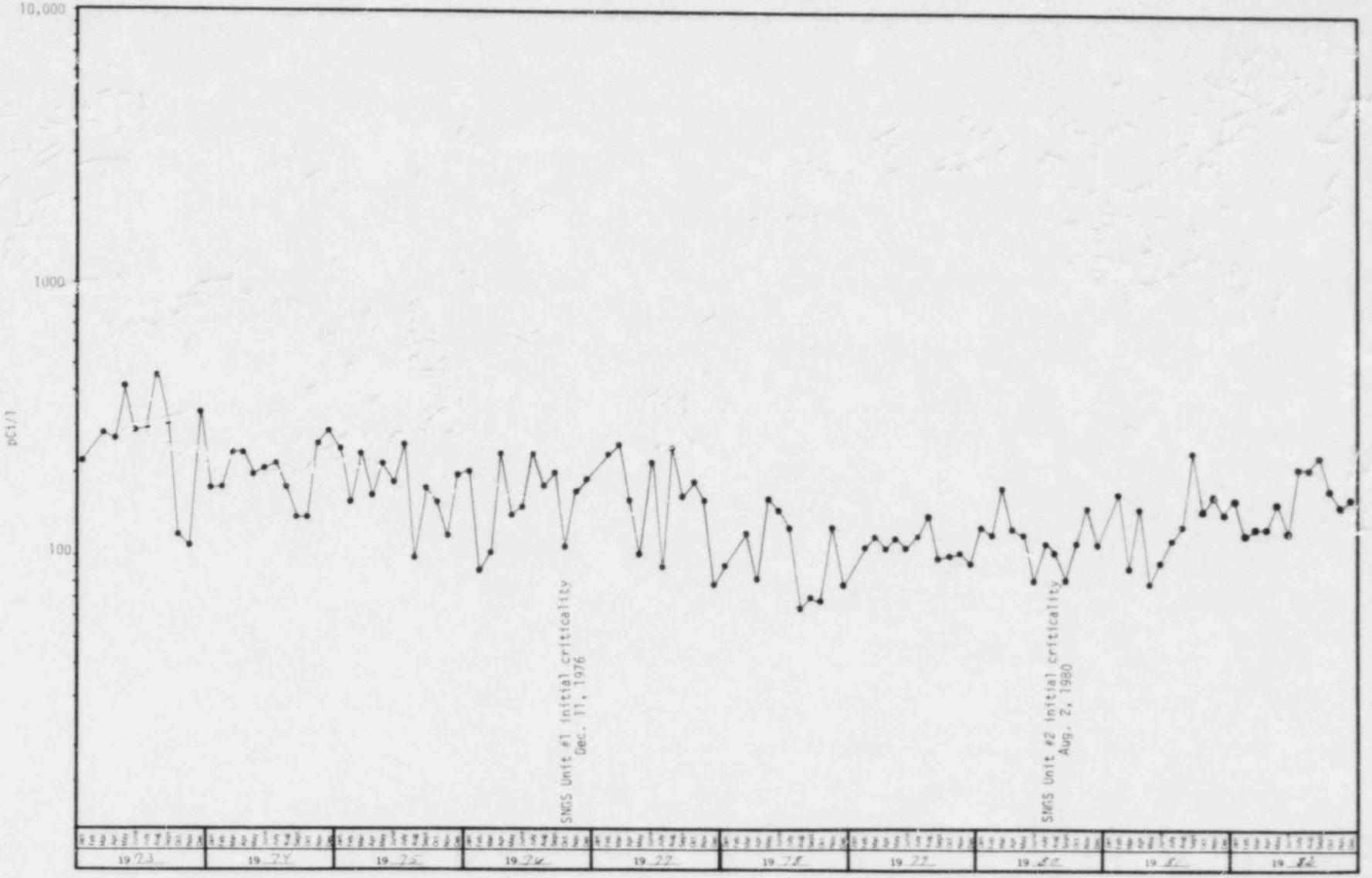
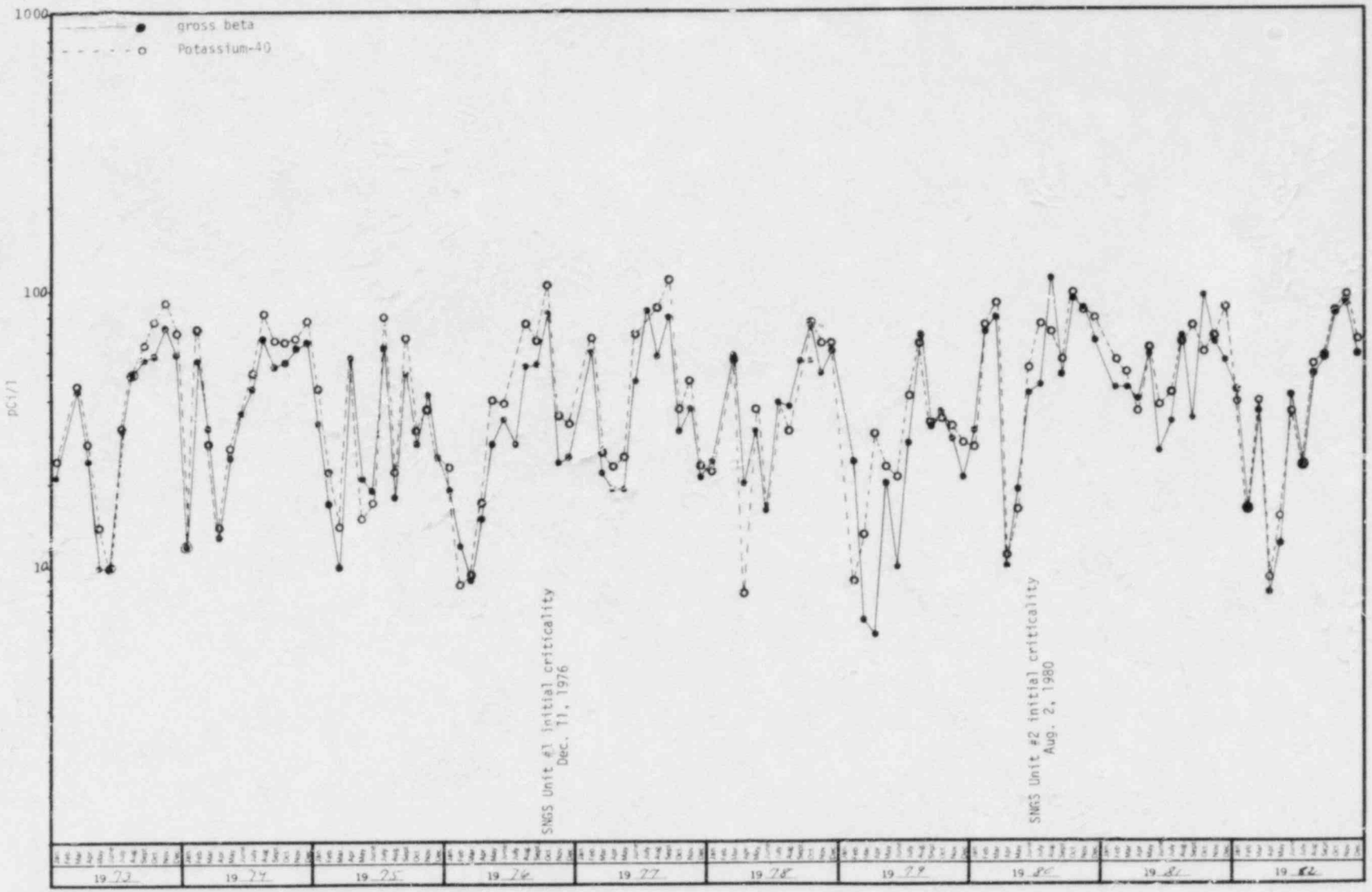


FIGURE 4

AVERAGE CONCENTRATIONS OF BETA EMITTERS AND POTASSIUM-40 IN THE DELAWARE RIVER IN THE VICINITY OF ARTIFICIAL ISLAND, 1973 THROUGH 1982



Analysis of surface water for tritium yielded an average concentration of 167 pCi/l and ranged from 120 to 470 pCi/l. These levels are similar to those measured in the preoperational program as shown in Figure 3. A gradual decrease in tritium activity from 1973 to 1982 can be attributed to general reduction in the world-wide tritium inventory with the cessation of routine atmospheric testing.

Gross alpha concentrations were generally below LLD, which ranged from <0.2 to <1.0 pCi/l. Four of the sixty samples analyzed showed detectable gross alpha activity ranging from 0.3 to 0.8 pCi/l. Gross alpha activity may be expected in suspended solids from naturally occurring radionuclides especially during periods of high surface runoff.

Gross beta concentrations found in fifty-nine of the sixty samples ranged from 2.6 to 117 pCi/l and averaged 43 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 gross beta and K-40 concentrations in the Delaware River. Due to the flow rate variations and the tidal nature of the estuarine environment, large variations in the gross beta concentrations were observed throughout the year. Much of this variation can be attributed to the tidal stage at the time of sampling.

Gamma spectrometric analysis of surface water samples showed detectable concentrations of K-40 in forty-five of sixty samples. The average K-40 concentration was 44 pCi/l and ranged from 9.7 to 150 pCi/l. K-40 is a naturally occurring radionuclide which is expected to be found in salt and brackish waters.

Levels of Sr-89 were below MDL (<0.5 to <1.2 pCi/l) in all twenty quarterly composite samples. A detectable concentration of Sr-90 was found in one sample with a result of 0.5 pCi/l. The MDL values for the remaining samples ranged from <0.4 to <0.9 pCi/l. The maximum level of Sr-90 detected in the preoperational program was 1.6 pCi/l (4).

Well Water (Tables C-17, C-18, C-19, C-20)

Monthly well water samples were taken from two indicator wells and one control well. All well water samples were analyzed for tritium, gross alpha and gross beta activity, and K-40 (by atomic absorption). Quarterly composites were analyzed for gamma emitters, and Sr-89 and Sr-90.

No detectable concentrations of tritium were observed in any of the thirty-six well water samples analyzed. The LLDs ranged from <120 pCi/l to <140 pCi/l. Gross alpha concentrations were generally below LLD which ranged from <0.8 to <3.6 pCi/l. Four of the samples analyzed showed detectable gross alpha activity ranging between 1.3 and 1.7 pCi/l. The concentrations of gross beta emitters averaged 12 pCi/l and ranged from 6.2 to 16 pCi/l. The potassium-40 activity as determined by atomic absorption averaged 10 pCi/l and ranged between 7.1 and 14 pCi/l. This indicates that the gross beta activity observed in these samples is primarily the result of naturally occurring K-40, a beta emitter.

Quarterly composites of well water samples were analyzed for gamma emitters and Sr-89 and -90. K-40 was detected by gamma spectrometry in two of the samples with results of 11 and 17 pCi/l. All results for Sr-89 were below the MDL with a range of <0.5 to <0.8 pCi/l. All results for Sr-90 were also below the MDL with a range of <0.3 to <0.7 pCi/l.

Potable Water (Tables C-21, C-22, C-23, C-24)

Both raw and treated water samples were taken at the Salem Water Company, the only drinking water processing plant in the vicinity of Artificial Island. The raw water source for this plant is Laurel Lake (a tributary of the Delaware River) and several adjacent wells. Potable water samples were analyzed monthly for tritium, gross alpha and gross beta activity, and K-40 (by atomic absorption); Sr-89 and -90, and gamma emitters were analyzed on a quarterly basis.

Detectable concentrations of tritium were observed in five of the twenty-four samples ranging from 130 to 170 pCi/l, with no significant differences occurring between the raw and treated samples. Detectable gross alpha activity was observed in thirteen of twenty-four samples ranging between 0.6 pCi/l and 3.1 pCi/l with an average of 1.2 pCi/l. Gross beta and K-40 concentrations were lower than in the saline surface water, as expected for fresh water. The average gross beta concentrations were 3.1 pCi/l (raw) and 2.6 pCi/l (treated). The average K-40 results were 2.2 pCi/l (raw) and 2.1 pCi/l (treated).

Quarterly composites of raw and treated water samples were analyzed for Sr-89 and -90 and gamma emitters. Of the eight samples analyzed for Sr-89, three showed detectable concentrations ranging from 1.1 to 1.2 pCi/l. The MDL range for Sr-89 was <0.5 to <1.3 pCi/l. Sr-90 was observed in two of the eight samples with each having a concentration of 0.6 pCi/l. The MDL range for Sr-90 was <0.4 to <0.9 pCi/l. No nuclides were detected by gamma spectrometry in any of the samples.

Aquatic

Benthos (Table C-25)

Benthic organisms were collected at four locations and analyzed for Sr-89 and Sr-90. Levels of Sr-89 were below MDL (<0.02 to <24 pCi/g-dry) for all seven analyses. The wide fluctuations in MDL values were due to inconsistencies in sample size (0.05 to 25 grams dry). Sr-90 was found in one sample with a concentration of 0.03 pCi/g-dry. The detectable activity of this sample is within the MDL range (<0.02 to <12 pCi/g-dry) of the other analyses. The MDL for radiostrontium as required by the Environmental Technical Specifications for benthic organisms was not met in all of the samples due to the impracticality of obtaining a sufficiently large sample size of benthic organisms.

Sediment (Table C-26)

Sediment was collected semiannually at four locations and analyzed for Sr-90 and gamma emitters.

Levels of Sr-90 were below MDL (<0.02 to <0.05 pCi/g-dry) in all eight samples analyzed.

Results of gamma spectrometry showed detectable levels of a variety of naturally occurring radionuclides as well as man-made radionuclides.

Ingestion

Milk (Tables C-27, C-28, C-29)

Milk samples were taken twice a month from six local farms during 1982 and analyzed for I-131; gamma emitters, Sr-89 and Sr-90 were analyzed monthly. I-131 was not observed in any milk samples during 1982. Figure 5 shows the average I-131 concentrations in milk samples resulting from atmospheric nuclear weapons tests by the Peoples Republic of China (June 1974, March 1978, and October 1980) and the Three Mile Island incident in 1979.

Gamma spectrometry showed detectable concentrations of K-40 in all samples and Cs-137 in twenty-five of the seventy-two samples analyzed. The annual average concentrations were 1500 pCi/l for K-40 and 1.8 pCi/l for Cs-137. These levels were not significantly different between control and indicator stations.

Strontium-89 was detected in one of the seventy-two samples analyzed with a result of 6.9 pCi/l. The range of MDL values for Sr-89 was <1.3 pCi/l to <2.7 pCi/l. The concentrations of Sr-90 were positive in sixty-nine of the seventy-two samples analyzed and averaged 2.9 pCi/l. The MDL range was <1.4 pCi/l to <1.8 pCi/l. Sr-90 concentrations were similar at indicator and control stations, indicating no contribution from SNGS. Due to the twenty-eight year half-life and biological assimilation, Sr-90 can be expected to remain long after routine atmospheric testing has ceased.

Fish (Tables C-31, C-32)

Edible fish samples (American Eel, White Perch, Channel Catfish, Spot, etc.) were collected at three locations and analyzed for tritium and gamma emitters. Fish bones were collected for Sr-89 and Sr-90.

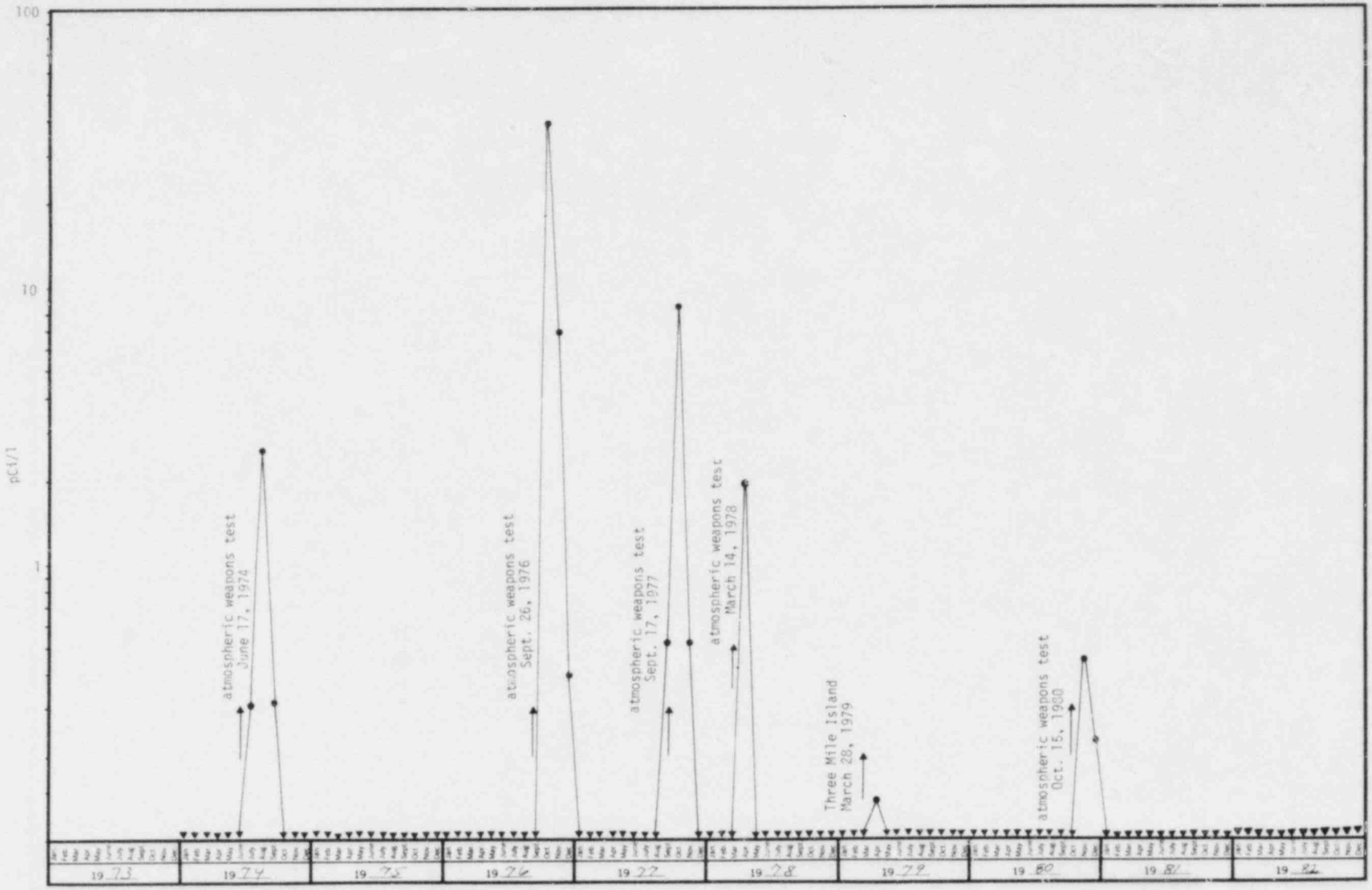
Gamma spectrometry of these samples showed K-40 in all six samples analyzed at an average concentration of 3.1 pCi/g-wet with a range of 2.9 to 3.7 pCi/g-wet.

All six bone samples analyzed for Sr-89 were below the MDL (<0.02 to <0.3 pCi/g-dry). Four of the six samples analyzed for Sr-90 had detectable concentrations ranging from 0.05 to 0.21 pCi/g-dry with an average of 0.12 pCi/g-dry. The maximum level detected during the preoperational period was 0.94 pCi/g-dry.

Tritium analyses were performed on both aqueous and organic fractions of the flesh portions of these samples. Only one sample had detectable concentrations of tritium for the aqueous fraction with a result of 81 pCi/l. Of the six samples analyzed for the aqueous fraction of tritium, all results are essentially the same as those found in surface water for the same period. Four of the six samples analyzed for the organic fraction of tritium showed detectable activity ranging between 134 and 1800 pCi/l. One sample from the control station (12C1) and one sample from the indicator station (7E1) showed results of 1740 and 1800 pCi/l, respectively. The high results could be due to chemiluminescence in the samples; however, due to the small sample sizes, the results could not be confirmed by reanalysis. These results probably cannot be attributed to plant operation since the closest indicator station (11A1) had no unusual levels of tritium in the organic fraction.

FIGURE 5

AVERAGE CONCENTRATIONS OF IODINE-131 IN MILK IN THE
VICINITY OF ARTIFICIAL ISLAND, MAY 1974 THROUGH DECEMBER 1982



Blue Crab (Tables C-33, C-34)

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

K-40 was the only gamma emitter detected with an average of 2.1 pCi/g-wet.

All results for Sr-89 in flesh were below MDL with a range of <0.006 to <0.02 pCi/g-wet. Detectable concentration of Sr-89 was found in one of the shell samples, with a result of 0.2 pCi/g-dry. The MDL range for Sr-89 in shells was <0.04 to <0.1 pCi/g-dry.

Three of four flesh samples showed detectable activity with concentrations of 0.005 to 0.014 pCi/g-wet of Sr-90. The MDL value was <0.006 pCi/g-wet. All of the shells had detectable activity of Sr-90. The range of activities was 0.09 to 0.31 pCi/g-dry.

Two samples showed detectable concentrations of tritium. The results were comparable to tritium values found in surface water for this same period.

Food Products (Table C-35)

A wide variety of other human food products was sampled and analyzed for Sr-89 and -90 and gamma emitters. These included cucumbers, asparagus, peppers, cabbage, corn, soybeans and tomatoes. Sr-89 concentrations were all below MDL, which ranged from <0.003 to <0.2 pCi/g-wet. Sixteen of the twenty-three samples analyzed showed detectable Sr-90 activity ranging from 0.002 to 0.08 pCi/g-wet. The MDLs ranged from <0.002 to <0.007 pCi/g-wet. All samples contained K-40 at concentrations of 0.9 to 12 pCi/g-wet. No other gamma emitters were detected in these food products.

Game (Table C-36)

Two samples of muskrat were taken during this period. Bones from both samples were analyzed for Sr-89 and -90 while muskrat flesh was analyzed for gamma emitters. One sample showed a detectable concentration of Sr-89 in muskrat bones with a result of 0.07 pCi/g-dry. Detectable Sr-90 concentrations averaging 0.085 pCi/g-dry were observed in both samples.

Only naturally occurring K-40 was detected in the flesh samples with results of 2.0 to 2.3 pCi/g-wet.

Beef (Table C-36)

Two beef samples were collected and analyzed for gamma emitters. Only naturally occurring K-40 was detected in these samples at concentrations of 1.1 and 2.2 pCi/g-wet.

Beef Thyroid (Table C-36)

Two beef thyroids were taken during this period and analyzed for gamma emitters. One sample showed a detectable concentration of naturally occurring K-40 at a concentration of 2.3 pCi/g-wet. The other sample had an LLD for K-40 of <0.6 pCi/g-wet. No detectable concentrations of I-131 were detected in the samples.

Fodder Crops (Table C-37)

Ten fodder crop samples were taken at six local farms and analyzed for gamma emitters. Gamma spectrometry of these samples showed K-40, a naturally occurring nuclide, in all samples ranging between 2.7 and 18 pCi/g-dry. The average for these samples was 5.9 pCi/g-dry.

CONCLUSIONS

The Radiological Environmental Monitoring Program for Salem Nuclear Generating Station at Artificial Island was conducted during 1982 in accordance with the SNGS Environmental Technical Specifications. The objectives of the program were met during this period. The data collected assists in demonstrating that SNGS Units #1 and #2 were operated in compliance with Environmental Technical Specifications.

From the results obtained, it can be concluded that the levels and fluctuations of radioactivity in environmental samples were as expected for an estuarine environment. With the possible exception of the organic fraction of tritium in fish flesh, no increases were observed in either radionuclide concentrations in critical pathways or with respect to radionuclide build up. The elevated levels of tritium in the organic fraction of fish flesh can probably be attributed to chemiluminescence rather than plant operation. Ambient radiation levels were relatively low, averaging about 5.76 mrad/std. month. No other unusual radiological characteristics were observed in the environs of Artificial Island. The operation of SNGS Units #1 and #2 had no discernable effect on the radiological characteristics of the environs of Artificial Island.

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APPENDIX A

PROGRAM SUMMARY

ARTIFICIAL ISLAND RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

SALEM NUCLEAR GENERATING STATION — DOCKET NO. 50-272

SALEM COUNTY, NEW JERSEY — JANUARY 1, 1982 TO DECEMBER 31, 1982

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	104	0.6	1.7 (45/52) (0.7-4.8)	16E1 4.1 mi NNW	1.7 (45/52) (0.7-4.8)	1.5 (51/52) (0.7-3.9)	0
	Beta	416	-	27 (364/364) (8.4-53)	2S2 0.4 mi NNE	28 (52/52) (13-53)	28 (52/52) (11-60)	0
	Sr-89	32	0.3	- (0/28) -	None Detected	-	- (0/4) -	0
	Sr-90	32	0.2	0.3 (3/28) (0.28-0.4)	3H3 110 mi NE	1.0 (1/4) (1.0)	1.0 (1/4) (1.0)	0
	Gamma	32						
	Be-7		-	44 (28/28) (29-67)	2S2 0.4 mi NNE	55 (4/4) (44-67)	49 (4/4) (40-60)	0
	Cs-137		0.4	0.6 (2/28) (0.5-0.7)	16E1 4.1 mi NNW	0.7 (1/4) (0.7)	- (0/4) -	0
	Ce-144		1.6	1.7 (5/28) (1.4-2.2)	2F2 8.7 mi NNE	2.0 (2/4) (1.8-2.2)	1.5 (1/4) (1.5)	0
Air Iodine (10^{-3} pCi/m^3)	I-131	364	6.4	- (0/312) -	None Detected	-	- (0/52) -	0
Precipitation (pCi/l)	H-3	12	120	147 (3/12) (140-160)	2F2 8.7 mi NNE	147 (3/12) (140-160)	No Control Location	0
	Alpha	11	0.6	1.1 (5/11) (0.5-2.0)	2F2 8.7 mi NNE	1.1 (5/11) (0.5-2.0)	No Control Location	0
	Beta	11	2.2	7.0 (9/11) (2.4-16)	2F2 8.7 mi NNE	7.0 (9/11) (2.4-16)	No Control Location	0
	Sr-89	4	0.2	- (0/4) -	None Detected	-	No Control Location	0
	Sr-90	4	0.2	- (0/4) -	None Detected	-	No Control Location	0
	Gamma	4						
	K-40		7.8	20 (2/4) (14-26)	2F2 8.7 mi NNE	20 (2/4) (14-26)	No Control Location	0

ARTIFICIAL ISLAND RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

SALEM NUCLEAR GENERATING STATION DOCKET NO. 50-272

SALEM COUNTY, NEW JERSEY JANUARY 1, 1982 TO DECEMBER 31, 1982

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) 288	-	5.70 (240/240) (3.65-19.63)	11S1 0.09 mi SW	8.48 (12/12) (5.41-19.63)	6.01 (48/48) (4.05-7.51)	0
	Gamma Dose (quarterly) 113	-	5.11 (94/94) (3.51-11.60)	11S1 0.09 mi SW	7.49 (4/4) (5.72-11.60)	5.30 (19/19) (4.66-5.88)	0
	Gamma Dose (semi-annual) 34	-	4.83 (28/28) (4.08-5.75)	16G1 15 mi NNW	5.63 (2/2) (5.60-5.65)	5.38 (6/6) (5.04-5.65)	0
Surface Water (pCi/l)	H-3 60	120	208 (27/48) (120-470)	11A1 0.2 mi SW	291 (7/12) (190-470)	178 (5/12) (160-200)	0
	Alpha 60	0.2	0.5 (3/48) (0.3-0.8)	7E1 4.5 mi SE	0.8 (1/12) (0.8)	0.4 (1/12) (0.4)	0
	Beta 60	3.4	45 (47/48) (2.6-117)	7E1 4.5 mi SE	65 (12/12) (18-117)	36 (12/12) (5.1-87)	0
	Gamma 60 K-40	7.8	58 (35/48) (12-150)	7E1 4.5 mi SE	73 (11/12) (29-150)	48 (10/12) (9.7-83)	0
	Sr-89 20	0.5	- (0/16) -	None Detected	-	- (0/4) -	0
	Sr-90 20	0.4	0.5 (1/16) (0.5)	1F2 7.1 mi N	0.5 (1/4) (0.5)	- (0/4) -	0
Well Water (pCi/l)	H-3 36	120	- (0/24) -	None Detected	-	- (0/12) -	0
	Alpha 36	0.8	1.5 (4/24) (1.3-1.7)	4S1 Site Well #5 ENE	1.6 (2/12) (1.4-1.7)	- (0/12) -	0
	Beta 36	-	13 (24/24) (9.3-16)	5D1 3.5 mi E	13 (12/12) (10-16)	9.0 (12/12) (6.2-11)	0
	K-40 36	-	11 (24/24) (9.2-14)	5D1 3.5 mi E	11 (12/12) (9.7-14)	8.4 (12/12) (7.1-9.3)	0
	Gamma K-40 12	7.0	14 (2/8) (11-17)	5D1 3.5 mi E	17 (1/4) (17)	- (0/4) -	0
	Sr-89 12	0.5	- (0/8) -	None Detected	-	- (0/4) -	0
	Sr-90 12	0.3	- (0/8) -	None Detected	-	- (0/4) -	0

ARTIFICIAL ISLAND RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

SALEM NUCLEAR GENERATING STATION DOCKET NO. 50-272

SALEM COUNTY, NEW JERSEY JANUARY 1, 1982 TO DECEMBER 31, 1982

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 Raw-Treated	H-3	24	120	144 (5/24) (130-170)	2F3 8.0 mi NNE	144 (5/24) (130-170)	No Control Location	0
	Alpha	24	0.5	1.2 (13/24) (0.6-3.1)	2F3 8.0 mi NNE	1.2 (13/24) (0.6-3.1)	No Control Location	0
	Beta	24	-	2.9 (24/24) (1.7-4.4)	2F3 8.0 mi NNE	2.9 (24/24) (1.7-4.4)	No Control Location	0
	K-40	24	-	2.2 (24/24) (1.1-3.2)	2F3 8.0 mi NNE	2.2 (24/24) (1.1-3.2)	No Control Location	0
	Sr-89	8	0.5	1.17 (3/8) (1.1-1.2)	2F3 8.0 mi NNE	1.17 (3/8) (1.1-1.2)	No Control Location	0
	Sr-90	8	0.4	0.6 (2/8) (0.6)	2F3 8.0 mi NNE	0.6 (2/8) (0.6)	No Control Location	0
	Gamma	8		- (0/8) -	None Detected	- (0/8) -	No Control Location	0
Benthos (pCi/g-dry)	Sr-89	7	0.02	- (0/5) -	None Detected	-	- (0/2) -	0
	Sr-90	7	0.02	0.03 (1/5) (0.03)	7E1 4.5 mi SE	0.03 (1/2) (0.03)	- (0/2) -	0
Sediment (pCi/g-dry)	Sr-90	8	0.02	- (0/6) -	None Detected	-	- (0/2) -	0
	Gamma K-40	8	-	12 (6/6) (9.1-14)	12C1 2.5 mi WSW	13 (2/2) (12-14)	13 (2/2) (12-14)	0
					16F1 6.9 mi NNW	13 (2/2) (12-14)		
	Co-60		0.03	0.07 (1/6) (0.07)	11A1 0.2 mi SW	0.07 (1/2) (0.07)	- (0/2) -	0
	Cs-137		0.03	0.11 (5/6) (0.05-0.17)	11A1 0.2 mi SW	0.14 (2/2) (0.11-0.17)	- (0/2) -	0
					16F1 6.9 mi NNW	0.14 (1/2) (0.14)		
	Ra-226		-	0.53 (6/6) (0.45-0.72)	12C1 2.5 mi WSW	0.79 (2/2) (0.73-0.84)	0.79 (2/2) (0.73-0.84)	0
	Th-232		-	0.75 (6/6) (0.54-1.3)	16F1 6.9 mi NNW	0.98 (2/2) (0.65-1.3)	0.87 (2/2) (0.80-0.94)	0

ARTIFICIAL ISLAND RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

SALEM NUCLEAR GENERATING STATION DOCKET NO. 50-272

SALEM COUNTY, NEW JERSEY JANUARY 1, 1982 TO DECEMBER 31, 1982

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
Milk (pCi/l)	I-131	139	0.03	- (0/116)	None Detected	-	- (0/23)	0
	Sr-89	72	1.3	6.9 (1/60) (6.9)	13E3 4.9 mi W	6.9 (1/12) (6.9)	- (0/12) -	0
	Sr-90	72	1.4	2.7 (57/60) (1.1-5.4)	5F2 7.0 mi E	4.2 (12/12) (3.4-5.4)	3.8 (12/12) (2.7-4.6)	0
	Gamma K-40	72	-	1479 (60/60) (900-2700)	2F4 6.3 mi NNE	1583 (12/12) (1100-2700)	1381 (12/12) (770-1800)	0
	Cs-137		1.1	2.9 (21/60) (1.4-8.7)	2F4 6.3 mi NNE	3.4 (4/12) (1.5-8.7)	1.6 (4/12) (1.4-1.9)	0
Edible Fish (pCi/l)	H-3 (aqueous)	6	112	81 (1/4) (81)	11A1 0.2 mi SW	81 (1/2) (81)	- (0/2) -	0
	H-3 (organic)	6	214	701 (3/4) (134-1800)	12C1 2.5 mi WSW	1740 (1/2) (1740)	1740 (1/2) (1740)	0
(pCi/g-dry)	Sr-89 (bones)	6	0.02	- (0/4) -	None Detected	-	- (0/2) -	0
	Sr-90 (bones)	6	0.03	0.09 (2/4) (0.05-0.13)	12C1 2.5 mi WSW	0.16 (2/2) (0.10-0.21)	0.16 (2/2) (0.10-0.21)	0
(pCi/g-wet)	Gamma K-40	6	-	3.0 (4/4) (2.9-3.1)	12C1 2.5 mi WSW	3.4 (2/2) (3.1-3.7)	3.4 (2/2) (3.1-3.7)	0
Blue Crab (pCi/g-dry)	Sr-89 (shells)	5	0.04	- (0/3) -	12C1 2.5 mi WSW	0.2 (1/2) (0.2)	0.2 (1/2) (0.2)	0
	Sr-90 (shells)	5	-	0.25 (3/3) (0.14-0.31)	11A1 0.2 mi SW	0.25 (3/3) (0.14-0.31)	0.14 (2/2) (0.09-0.19)	0
(pCi/l)	H-3 (flesh)	4	112	230 (1/2) (230)	11A1 0.2 mi SW	230 (1/2) (230)	157 (1/2) (157)	0
(pCi/g-wet)	Sr-89 (flesh)	4	0.006	- (0/2) -	None Detected	-	- (0/2) -	0
	Sr-90 (flesh)	4	0.006	0.006 (1/2) (0.006)	11A1 0.2 mi SW	0.01 (2/2) (0.005-0.014)	0.01 (2/2) (0.005-0.014)	0
	Gamma K-40	4	-	2.05 (2/2) (2.0-2.1)	11A1 0.2 mi SW 12C1 2.5 mi WSW	2.05 (2/2) (2.0-2.1) 2.05 (2/2) (2.0-2.1)	2.05 (2/2) (2.0-2.1)	0

ARTIFICIAL ISLAND RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

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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
Fruits & Vegetables (pCi/g-wet)	Sr-89	23	0.003	- (0/14)	None Detected	-	- (0/9)	0
	Sr-90	23	0.002	0.02 (9/14) (0.002-0.08)	5D1 3.5 mi E	0.03 (3/4) (0.006-0.08)	0.01 (7/9) (0.003-0.02)	0
	Gamma K-40	23	-	2.8 (14/14) (1.2-12)	5D1 3.5 mi E	4.5 (4/4) (1.8-12)	2.1 (9/9) (0.94-3.4)	0
Game (pCi/g-dry)	Sr-89 (bones)	2	0.03	0.07 (1/1) (0.07)	3E1 4.1 mi NE	0.07 (1/1) (0.07)	- (0/1)	0
	Sr-90 (bones)	2	-	0.09 (1/1) (0.09)	3E1 4.1 mi NE	0.09 (1/1) (0.09)	0.08 (1/1) (0.08)	0
(pCi/g-wet)	Gamma (flesh) K-40	2	-	2.3 (1/1) (2.3)	3E1 4.1 mi NE	2.3 (1/1) (2.3)	2.0 (1/1) (2.0)	0
Beef (pCi/g-wet)	Gamma K-40	2	-	1.1 (1/1) (1.1)	14F1 5.5 mi WNW	2.2 (1/1) (2.2)	2.2 (1/1) (2.2)	0
Bovine Thyroid (pCi/g-wet)	Gamma K-40	2	0.6	- (0/1)	14F1 5.5 mi WNW	2.3 (1/1) (2.3)	2.3 (1/1) (2.3)	0
Fodder Crops (pCi/g-wet)	Gamma K-40	10	-	5.0 (7/7) (2.9-14)	3G1 17 mi NE	8.1 (3/3) (2.7-18)	8.1 (3/3) (2.7-18)	0

* LLD listed is the lowest calculated LLD during reporting period. Strontium-89 and -90 detection levels are Minimum Detectable Levels (MDLs).

** Mean calculated using values above LLD or MDL only. Fraction of measurements above LLD or MDL are in parentheses.

APPENDIX B

SAMPLE DESIGNATION

AND

LOCATIONS

APPENDIX B

Sample Designation

RMC 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	GAM	=	Game
APT	=	Air Particulates	IDM	=	Immersion Dose (TLD)
ECH	=	Hard Shell Blue Crab	MLK	=	Milk
ESB	=	Benthos	PWR	=	Potable Water (Raw)
ESF	=	Edible Fish	PWT	=	Potable Water (Treated)
ESS	=	Sediment	RWA	=	Rain Water
FPB	=	Beef	SWA	=	Surface Water
FPV	=	Food Products, Various	THB	=	Bovine Thyroid
FPG	=	Grains	VGT	=	Fodder Crops; Vegetation
FPL	=	Green Leafy Vegetables	WWA	=	Well Water

The last four symbols are a location code based on direction and distance from the site. Of these, the first two represent each of the 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 SNGS program SA, consisting of well water (WWA), which had been collected in the 22.5 degree sector centered on each axis (5), at a distance of 3 to 4 miles off-site (D). The number 1 indicates that this is sampling station #1 in the designated area.

Sampling Locations

All 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	SAMPLE TYPES
1F1	5.8 mi. N of vent; Fort Elfsborg	APT,IDM
1F2	7.1 mi. N of vent; midpoint of Delaware River	SWA
1F3	5.9 mi. N of vent; local farm	FPL,FPV
1G1	13 mi. N of vent; local farm	FPB,FPV
1G3	19 mi. N of vent; Wilmington, Delaware	IDM
2S2	0.4 mi. NNE of vent	APT,AIO,IDM
2E1	4.4 mi. NNE of vent; local farm	IDM,FPV
2F2	8.7 mi. NNE of vent; Salem Substation	APT,AIO,RWA,IDM
2F3	8.0 mi. NNE of vent; Salem Water Company	PWR,PWT
2F4	6.3 mi. NNE of vent; local farm	MLK,VGT,FPG,FPL
2F5	7.4 mi. NNE of vent; Salem High School	IDM
2H1	34 mi. NNE of vent; RMC, Phila.	IDM
3E1	4.1 mi. NE of vent; local farm	IDM,WWA,THB,GAM,FPB
3F2	5.1 mi. NE of vent; Hancocks Bridge Municipal Bldg.	IDM
3F3	8.6 mi. NE of vent; Quinton Township School	IDM
3G1	17 mi. NE of vent; local farm	IDM,MLK,FPG,VGT
3H1	32 mi. NE of vent; National Park, N.J.	IDM
3H3	110 mi. NE of vent; Maplewood Laboratories	APT,AIO,IDM
3H4	88 mi. NE of vent; local farm	FPV,FPG,FPL
4S1	1400 ft. ENE of vent; site well #5	WWA
4D2	3.7 mi. ENE of vent; Alloway Creek Neck Road	IDM

TABLE B-1 (CONT.)

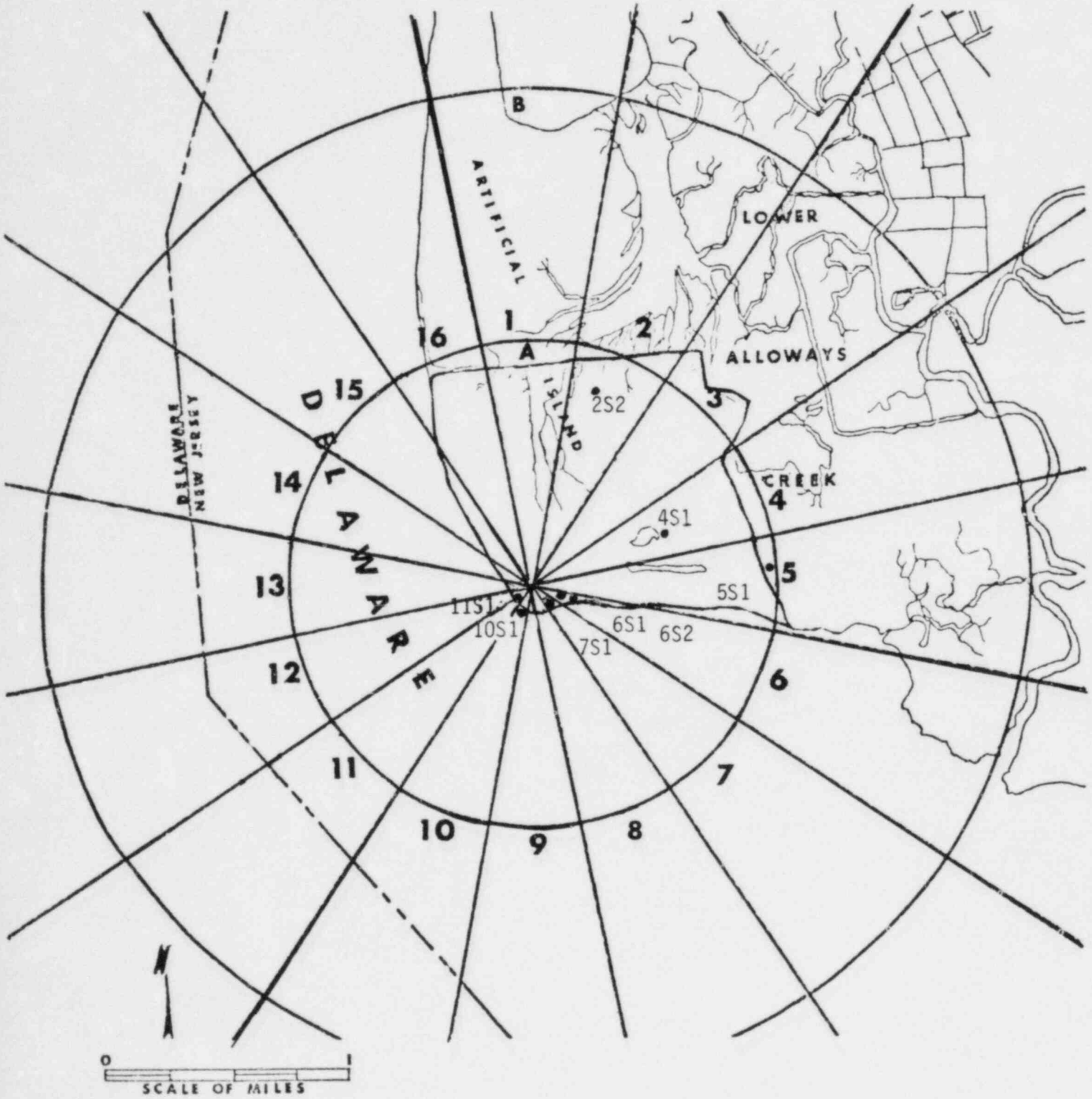
STATION CODE	STATION LOCATION	SAMPLE TYPES
5S1	1.0 mi. E of vent; site access road	APT,AIO,IDM
5D1	3.5 mi. E of vent; local farm	APT,AIO,IDM,WWA, FPV,FPG,VGT
5F1	8.0 mi. E of vent	IDM,FPV
5F2	7.0 mi. E of vent; local farm	MLK,VGT
6S2	0.2 mi. ESE of vent; observation bldg.	IDM
6F1	6.4 mi. ESE of vent; Stow Neck Road	IDM
7S1	0.12 mi. SE of vent; station personnel gate	IDM
7E1	4.5 mi. SE of vent; 1 mi. W of Mad Horse Creek	SWA,ESB,ESS,ESF
7F2	9.1 mi. SE of vent; Bayside, New Jersey	IDM
9E1	4.2 mi. S of vent	IDM
10S1	0.14 mi. SSW of vent; site shoreline	IDM
10D1	3.9 mi. SSW of vent; Taylor's Bridge Spur	APT,AIO,IDM
10F2	5.8 mi. SSW of vent	IDM
10G1	12 mi. SSW of vent; Smyrna, Delaware	IDM
11S1	0.09 mi. SW of vent; site shoreline	IDM
11A1	0.2 mi. SW of vent; outfall area	SWA,ESB,ESS,ESF, ECH
11D1	3.5 mi. SW of vent	GAM
11E2	5.0 mi. SW of vent	IDM
11F1	5.2 mi. SW of vent; Taylor's Bridge, Delaware	IDM
12C1	2.5 mi. WSW of vent; west bank of Delaware River	SWA,ESF,ECH,ESB, ESS
12E1	4.4 mi. WSW of vent; Thomas Landing	IDM
12F1	9.4 mi. WSW of vent; Townsend Elementary School	IDM
13E1	4.2 mi. W of vent; Diehl House Lab	IDM

TABLE B-1 (CONT.)

STATION CODE	STATION LOCATION	SAMPLE TYPES
13E3	4.9 mi. W of vent; local farm	MLK
13F1	9.8 mi. W of vent; Middletown, Delaware	IDM
13F2	6.5 mi. W of vent; Odessa, Delaware	IDM
13F3	9.3 mi. W of vent; Redding Middle School, Middletown, DE	IDM
14D1	3.4 mi. WNW of vent; Bay View, Delaware	IDM
14F1	5.5 mi. WNW of vent; local farm	MLK,FPB,THB,VGT
14F2	6.6 mi. WNW of vent; Boyds Corner	IDM
14F3	5.0 mi. WNW of vent; local farm	FPV,FPG,FPL
15F1	5.2 mi. NW of vent; local farm	MLK,FPG,VGT
15F3	5.4 mi. NW of vent	IDM
16E1	4.1 mi. NNW of vent; Port Penn	APT,AIO,IDM
16F1	6.9 mi. NNW of vent; C & D Canal	SWA,ESB,ESS
16F2	8.1 mi. NNW of vent; Delaware City Public School	IDM
16G1	15 mi. NNW of vent; Greater Wilmington Airport	IDM

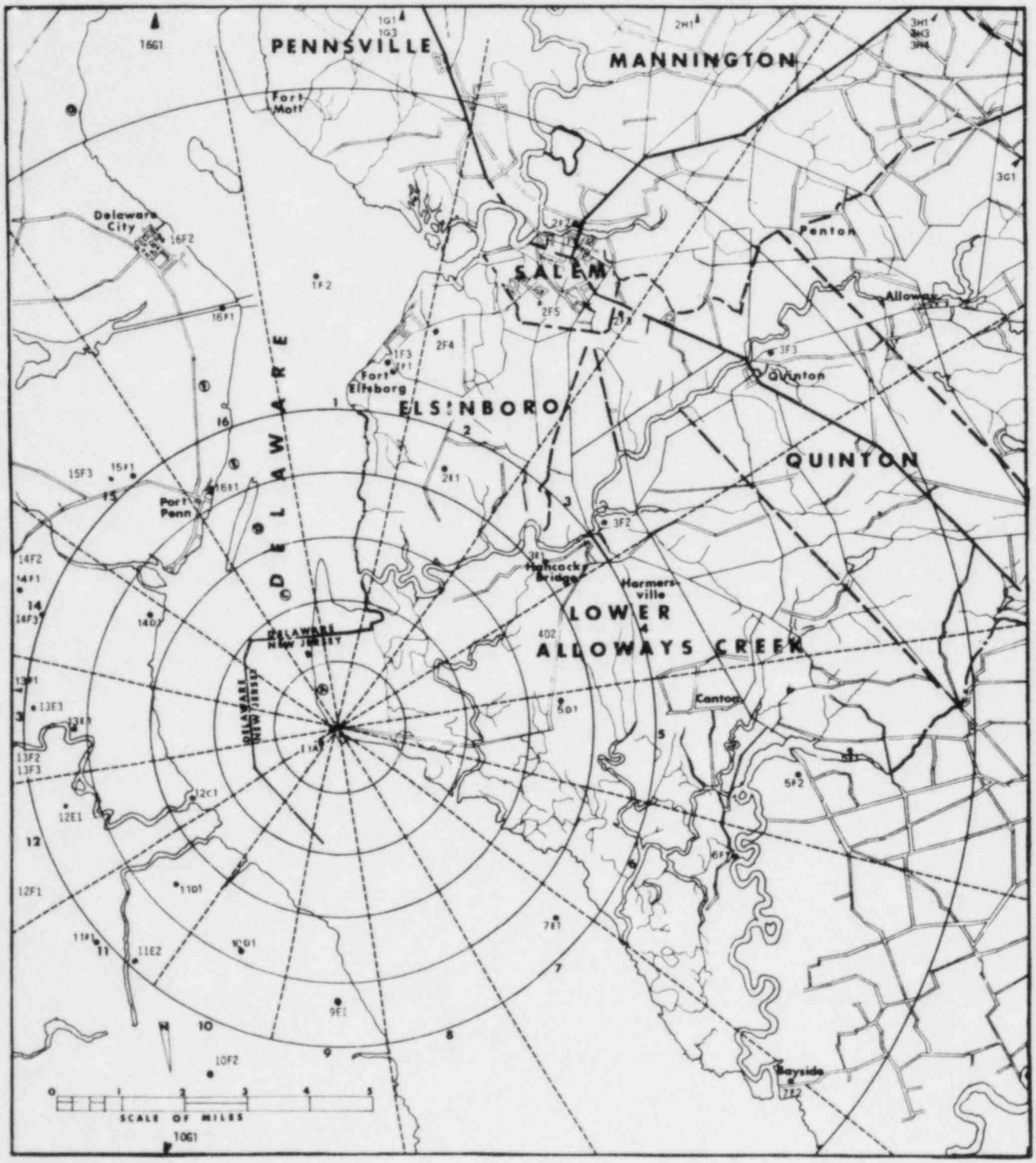
MAP B-1

ON SITE SAMPLING LOCATIONS
ARTIFICIAL ISLAND



MAP B-2

OFF SITE SAMPLING LOCATIONS
ARTIFICIAL ISLAND



APPENDIX C

1982 DATA TABLES

DATA TABLES

Appendix C presents the analytical results of the 1982 Artificial Island Radiological Environmental Monitoring Program for the period of January 1 to December 31.

DATA TABLES (cont.)

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TABLE C-1

CONCENTRATIONS OF GROSS ALPHA EMITTERS IN AIR PARTICULATES

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

(All Results by PSE&G Research Corporation)

STATION NO.	JANUARY*	FEBRUARY	MARCH	APRIL	MAY	JUNE
SA-APT-16E1	0.5±0.5 1.4±0.6 2.0±0.8 1.6±0.7 1.2±0.6	1.5±0.7 1.7±0.6 <1.1 2.1±0.7	1.0±0.6 1.4±0.7 0.7±0.4 2.3±0.7	0.9±0.5 2.0±0.7 4.4±1.1 2.1±0.7 1.4±0.7	<0.8 <0.9 <0.9 0.8±0.5	1.4±0.7 1.7±0.7 1.9±1.0 2.0±0.7
SA-APT-3H3 (Control)	1.6±0.6 1.2±0.6 1.7±0.6 2.2±0.8 0.7±0.4	1.3±0.6 2.2±0.7 2.2±1.0 1.9±0.7	1.1±0.6 1.5±0.7 0.7±0.4 1.9±0.7	2.0±0.7 2.4±0.7 3.7±0.9 1.4±0.6 2.0±0.8	0.9±0.6 <0.9 1.2±0.6 0.9±0.5	1.1±0.6 0.9±0.6 1.2±0.7 2.8±0.9

STATION NO.	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	AVERAGE
SA-APT-16E1	2.0±0.7 4.5±1.1 2.9±1.0 1.6±0.7 2.3±0.8	1.3±0.8 1.0±0.7 2.5±0.8 1.8±0.7	4.8±1.1 <2.3 2.0±0.7 1.4±0.6	1.0±0.6 2.5±0.8 1.0±0.6 <0.6 1.6±0.8	1.2±0.6 2.1±0.7 1.4±0.7 0.7±0.4	1.2±0.7 1.3±0.5 <1.1 0.9±0.5	1.7±1.8
SA-APT-3H3 (Control)	1.5±0.6 2.5±1.0 3.9±1.0 1.3±0.7 1.9±0.7	1.1±0.8 1.3±0.8 1.3±0.6 1.4±0.6	1.4±0.6 1.1±0.8 2.4±0.7 1.0±0.6	0.8±0.5 2.4±0.7 1.3±0.7 1.5±0.7 1.7±0.8	1.1±0.6 0.8±0.6 1.1±0.6 1.2±0.5	1.3±0.6 0.7±0.5 1.3±0.8 1.0±0.6	1.5±1.4

* Sampling dates can be found on Table C-5.

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TABLE C-2

CONCENTRATIONS OF GROSS BETA EMITTERS IN AIR PARTICULATES

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

(All Results by PSE&G Research Corporation)

MONTH	STATION NO. SA-APT-2S2	SA-APT-5S1	SA-APT-5D1	SA-APT-10D1	SA-APT-16E1	SA-APT-1F1	SA-APT-2F2	SA-APT-3H3 (Control)	AVERAGE
JANUARY*	20±5	27±7	27±7	20±6	20±6	25±6	23±6	23±6	23±6
	35±6	36±7	42±7	38±6	43±7	38±7	35±6	37±7	36±6
	38±6	38±7	44±7	40±7	48±8	41±7	47±7	38±6	42±8
	42±6	51±8	40±7	37±6	43±7	45±7	33±6	30±6	40±13
	29±5	30±6	33±6	31±6	31±7	30±6	32±6	35±6	31±4
FEBRUARY	24±5	27±6	30±6	26±6	30±6	30±6	27±6	28±6	28±4
	30±5	38±6	40±6	37±6	35±6	37±6	31±5	43±6	36±9
	20±6	26±7	19±6	20±6	20±6	17±6	12±5	60±9	24±30
	33±7	29±6	26±6	25±5	26±6	31±6	29±6	31±6	29±6
MARCH	25±6	26±6	28±6	29±6	20±6	26±6	27±6	27±6	26±5
	32±7	34±6	33±7	37±6	35±7	35±7	33±6	33±7	34±3
	13±6	14±6	17±6	14±6	14±6	12±5	13±5	16±5	14±3
	30±6	26±6	31±6	31±5	34±6	26±6	27±5	25±5	29±6
APRIL	33±6	30±6	31±6	29±6	31±7	28±6	30±6	30±6	30±3
	45±7	35±6	46±7	33±5	33±6	38±6	36±6	45±7	39±11
	39±7	33±6	34±6	34±6	33±6	33±6	34±6	38±6	35±5
	32±6	31±6	38±7	29±5	32±6	32±6	32±6	34±6	33±5
	31±6	27±6	32±6	35±7	32±7	29±6	29±6	31±7	31±5
MAY	30±7	25±7	27±6	26±6	27±6	29±6	26±6	30±6	28±4
	23±6	25±6	17±5	16±5	21±6	21±5	19±5	17±6	20±6
	20±6	14±5	14±5	14±5	15±5	16±5	18±5	26±5	17±8
	16±5	14±5	14±4	9.2±4.1	13±5	8.5±4.3	15±5	11±4	13±5
JUNE	20±7	10±5	11±5	8.4±5.1	8.7±5.5	9.7±5.0	11±5	12±5	11±7
	25±7	19±6	15±5	21±5	19±5	15±5	18±5	18±5	19±6
	24±6	28±6	20±6	18±6	23±6	21±5	20±5	20±5	22±6
	32±7	27±7	23±6	21±5	22±6	16±5	19±5	25±6	23±10

TABLE C-2 (cont.)

CONCENTRATIONS OF GROSS BETA EMITTERS IN AIR PARTICULATES

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

(All Results by PSE&G Research Corporation)

MONTH	STATION NO. SA-APT-2S2	SA-APT-5S1	SA-APT-5D1	SA-APT-10D1	SA-APT-16E1	SA-APT-1F1	SA-APT-2F2	SA-APT-3H3 (Control)	AVERAGE
JULY	19±6	17±6	26±6	25±6	23±7	22±6	25±6	22±6	22±6
	25±8	16±7	17±6	26±6	34±7	23±7	22±7	27±8	24±12
	26±7	22±6	20±6	22±6	25±7	23±6	25±6	26±7	24±4
	36±7	24±7	26±8	36±7	32±7	23±6	32±7	27±7	30±10
	35±7	33±7	28±7	29±6	31±7	34±7	28±7	28±7	31±6
AUGUST	30±7	25±7	29±6	29±6	30±7	28±6	25±6	27±6	28±4
	22±7	23±7	20±6	25±6	27±7	26±6	29±7	21±7	24±6
	33±7	30±7	25±6	28±6	42±8	29±6	36±7	29±6	32±11
	27±3	26±3	25±3	24±3	21±3	27±3	24±3	23±3	25±4
SEPTEMBER	28±3	21±2	24±2	24±2	27±3	27±3	25±3	19±2	24±6
	35±8	37±8	27±7	27±7	20±12	35±8	36±8	42±8	32±14
	38±7	36±7	36±6	31±6	42±7	41±7	40±7	36±7	38±7
	21±2	21±2	20±2	23±2	19±2	21±3	19±2	23±2	21±3
OCTOBER	21±6	21±6	17±5	21±6	24±6	21±6	22±6	16±5	21±7
	53±4	44±3	44±3	46±3	43±3	45±3	47±3	43±3	46±7
	26±3	20±3	23±3	21±3	23±3	21±3	25±3	27±3	23±5
	22±3	15±2	16±2	17±2	16±2	19±3	17±2	17±2	17±4
	47±4	36±3	38±3	39±3	39±3	45±3	38±3	43±3	41±8
NOVEMBER	23±3	15±3	19±2	22±3	22±3	22±3	24±3	23±3	21±6
	31±3	29±3	31±3	29±3	28±3	28±3	28±3	29±3	29±2
	21±3	23±3	20±3	19±3	19±3	21±3	22±3	25±3	21±4
	21±2	19±3	19±2	21±2	18±2	19±2	20±2	22±3	20±3
DECEMBER	18±2	14±2	13±2	20±3	14±3	14±2	14±3	18±3	16±5
	24±2	26±3	22±3	23±2	24±2	23±2	23±3	26±3	24±3
	24±3	22±3	20±3	20±3	19±3	22±3	21±3	22±3	21±3
	28±6	28±7	18±5	23±5	22±5	21±5	26±6	21±6	23±7
AVERAGE	28±16	26±17	26±18	26±16	27±18	26±18	26±16	28±19	
								Grand Average	27±17

* Sampling dates can be found on Table C-5.

TABLE C-3

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

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

(All Results by PSE&G Research Corporation)

STATION NUMBER AND DATE	Sr-89	Sr-90	Be-7	Cs-137	Ce-144
SA-APT-2S2					
12-28-81 to 3-29-82	<0.3	0.28±0.09	51±5	<0.6	<3.0
3-29-82 to 6-28-82	<0.4	<0.3	67±5	<0.6	<2.4
6-28-82 to 9-27-82	<0.3	<0.2	56±5	<0.5	<2.5
9-27-82 to 12-27-82	<0.8	<0.6	44±4	<0.4	<2.3
SA-APT-5S1					
12-28-81 to 3-29-82	<0.4	<0.3	49±4	<0.6	1.5±0.8
3-29-82 to 6-28-82	<0.5	<0.3	55±6	<0.7	<3.5
6-28-82 to 9-27-82	<0.4	<0.2	36±5	<0.6	<2.4
9-27-82 to 12-27-82	<0.9	<0.7	39±5	<0.7	<2.4

TABLE C-3 (cont.)

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

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

(All Results by PSE&G Research Corporation)

STATION NUMBER AND DATE	Sr-89	Sr-90	Be-7	Cs-137	Ce-144
SA-APT-5D1					
12-28-81 to 3-29-82	<0.5	0.4±0.1	46±4	<0.6	1.4±0.7
3-29-82 to 6-28-82	<0.6	<0.4	49±4	<0.5	1.6±0.8
6-28-82 to 9-27-82	<0.3	<0.2	33±4	<0.8	<2.8
9-27-82 to 12-27-82	<0.4	<0.3	33±4	<0.4	<1.6
SA-APT-10D1					
12-29-81 to 3-30-82	<0.4	<0.3	40±5	<0.7	<3.2
3-30-82 to 6-29-82	<0.6	<0.4	43±4	<0.4	<2.?
6-29-82 to 9-28-82	<0.3	<0.2	29±4	<0.7	<2.2
9-28-82 to 12-28-82	<0.8	<0.5	30±3	<0.5	<1.6

TABLE C-3 (cont.)

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

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

(All Results by PSE&G Research Corporation)

STATION NUMBER AND DATE	Sr-89	Sr-90	Be-7	Cs-137	Ce-144
SA-APT-16E1					
12-29-81 to 3-30-82	<0.7	<0.4	43±5	<0.7	<3.5
3-30-82 to 6-29-82	<0.4	<0.3	53±5	0.7±0.3	<3.5
6-29-82 to 9-28-82	<0.3	<0.2	33±4	<1.1	<3.5
9-28-82 to 12-28-82	<0.8	<0.6	35±4	<0.5	<2.1
SA-APT-1F1					
12-28-81 to 3-29-82	<0.4	<0.3	49±4	<0.4	<2.3
3-29-82 to 6-28-82	<0.6	<0.4	51±4	<0.5	<2.1
6-28-82 to 9-27-82	<0.3	<0.2	42±4	<0.8	<3.2
9-27-82 to 12-27-82	<0.6	<0.5	32±3	<0.4	<2.2

TABLE C-3 (cont.)

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

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

(All Results by PSE&G Research Corporation)

STATION NUMBER AND DATE	Sr-89	Sr-90	Be-7	Cs-137	Ce-144
SA-APT-2F2					
12-28-81 to 3-29-82	<0.4	0.3±0.1	44±4	<0.6	1.8±1.0
3-29-82 to 6-28-82	<0.4	<0.3	64±6	0.5±0.3	2.2±1.1
6-28-82 to 9-27-82	<0.4	<0.2	42±4	<0.4	<2.3
9-27-82 to 12-27-82	<1.3	<0.9	37±4	<0.6	<2.3
SA-APT-3H3 (Control)					
12-28-81 to 3-29-82	<1.1	1.0±0.3	48±4	<0.5	1.5±0.8
3-29-82 to 6-28-82	<0.7	<0.5	60±6	<0.8	<3.3
6-28-82 to 9-27-82	<0.3	<0.2	49±4	<1.0	<2.3
9-27-82 to 12-27-82	<0.8	<0.6	40±4	<0.4	<1.7

* Strontium-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-38.

TABLE C-4

CONCENTRATIONS OF IODINE-131* IN FILTERED AIR

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

MONTH	STATION NO. SA-AIO-2S2	SA-AIO-5S1	SA-AIO-5D1	SA-AIO-10D1	SA-AIO-16E1	SA-AIO-2F2	SA-AIO-3H3 (Control)
JANUARY**	<13	<18	<16	<16	<18	<15	<16
	<9.6	<15	<11	<9.6	<11	<11	<13
	<10	<16	<11	<13	<15	<11	<13
	<9.1	<14	<10	<9.6	<10	<9.6	<11
	<9.8	<13	<11	<11	<12	<10	<12
FEBRUARY	<11	<16	<12	<13	<14	<12	<13
	<8.6	<10	<9.0	<9.6	<10	<8.9	<9.8
	<18	<16	<16	<15	<15	<15	<16
	<13	<11	<13	<10	<10	<11	<12
MARCH	<14	<13	<13	<13	<15	<14	<13
	<13	<9.9	<13	<9.4	<10	<11	<11
	<9.7	<14	<13	<15	<14	<13	<13
	<10	<8.8	<9.7	<8.3	<8.9	<9.5	<10
APRIL	<12	<12	<12	<13	<13	<13	<13
	<11	<9.8	<10	<9.1	<10	<10	<11
	<12	<12	<11	<12	<12	<12	<13
	<10	<9.1	<10	<8.6	<9.2	<9.7	<11
	<9.0	<8.6	<9.9	<11	<12	<11	<14
MAY	<14	<12	<11	<10	<10	<11	<11
	<11	<10	<10	<13	<13	<11	<14
	<12	<8.8	<9.3	<11	<11	<8.8	<9.8
	<9.1	<8.6	<7.9	<9.1	<9.2	<10	<9.5
JUNE	<14	<13	<11	<14	<16	<13	<14
	<15	<13	<13	<11	<11	<12	<13
	<14	<12	<14	<14	<15	<13	<14
	<11	<10	<9.7	<9.4	<9.3	<10	<12

TABLE C-4 (cont.)

CONCENTRATIONS OF IODINE-131* IN FILTERED AIR

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

MONTH	STATION NO. SA-AIO-2S2	SA-AIO-5S1	SA-AIO-5D1	SA-AIO-10D1	SA-AIO-16E1	SA-AIO-2F2	SA-AIO-3H3 (Control)
JULY	<44 (1)	<32 (1)	<29 (1)	<31 (1)	<32 (1)	<30 (1)	<33 (1)
	<60 (1)	<60 (1)	<28 (1)	<44 (1)	<48 (1)	<55 (1)	<57 (1)
	<33 (1)	<45 (1)	<37 (1)	<46 (1)	<52 (1)	<42 (1)	<48 (1)
	<18	<18	<21	<16	<15	<17	<20
	<14	<17	<16	<16	<19	<19	<20
AUGUST	<18	<16	<16	<16	<16	<18	<18
	<13	<11	<11	<11	<12	<12	<14
	<17	<16	<15	<15	<17	<15	<17
	<13	<10	<12	<13	<13	<15	<13
SEPTEMBER	<10	<12	<13	<12	<17	<14	<14
	<14	<11	<11	<12	<26	<13	<13
	<9.3	<11	<11	<12	<13	<12	<12
	<16	<14	<15	<14	<14	<18	<19
OCTOBER	<12	<12	<12	<14	<13	<13	<12
	<13	<9.4	<9.2	<11	<9.8	<10	<9.8
	<14	<12	<10	<12	<12	<13	<13
	<14	<11	<9.3	<10	<10	<12	<11
	<9.8	<11	<10	<11	<12	<12	<13
NOVEMBER	<9.9	<15	<9.1	<9.8	<11	<10	<11
	<7.5	<9.8	<8.3	<7.1	<6.8	<8.6	<9.0
	<7.7	<8.0	<7.5	<8.6	<9.8	<8.3	<8.9
	<7.2	<7.9	<7.0	<6.4	<6.9	<7.5	<8.6
DECEMBER	<8.2	<8.5	<8.3	<9.8	<11	<9.6	<9.8
	<12	<13	<13	<11	<11	<14	<14
	<9.6	<10	<9.4	<12	<13	<10	<12
	<47 (1)	<53 (1)	<48 (1)	<41 (1)	<22 (1)	<26 (1)	<31 (1)

* I-131 results are corrected for decay to sample stop date.
** Actual sampling dates can be found on Table C-5.
(1) High LLD due to delay in counting resulting from equipment malfunction.

TABLE C-5

SAMPLING DATES FOR AIR SAMPLES

MONTH	STATION NO. 2S2	5S1	5D1	10D1	16E1	1F1	2F2	3H3
JANUARY	12-28-81 to 1-04-82	12-28-81 to 1-04-82	12-28-81 to 1-04-82	12-29-81 to 1-04-82	12-29-81 to 1-04-82	12-28-81 to 1-04-82	12-28-81 to 1-04-82	12-28-81 to 1-04-82
	1-04-82 to 1-11-82	1-04-82 to 1-11-82	1-04-82 to 1-11-82	1-04-82 to 1-12-82	1-04-82 to 1-12-82	1-04-82 to 1-11-82	1-04-82 to 1-11-82	1-04-82 to 1-11-82
	1-11-82 to 1-18-82	1-11-82 to 1-18-82	1-11-82 to 1-18-82	1-12-82 to 1-18-82	1-12-82 to 1-18-82	1-11-82 to 1-18-82	1-11-82 to 1-18-82	1-11-82 to 1-18-82
	1-18-82 to 1-25-82	1-18-82 to 1-25-82	1-18-82 to 1-25-82	1-18-82 to 1-26-82	1-18-82 to 1-26-82	1-18-82 to 1-25-82	1-18-82 to 1-25-82	1-18-82 to 1-25-82
	1-25-82 to 2-01-82	1-25-82 to 2-01-82	1-25-82 to 2-01-82	1-26-82 to 2-02-82	1-26-82 to 2-02-82	1-25-82 to 2-01-82	1-25-82 to 2-01-82	1-25-82 to 2-01-82
FEBRUARY	2-01-82 to 2-08-82	2-01-82 to 2-08-82	2-01-82 to 2-08-82	2-02-82 to 2-08-82	2-02-82 to 2-08-82	2-01-82 to 2-08-82	2-01-82 to 2-08-82	2-01-82 to 2-08-82
	2-08-82 to 2-16-82	2-08-82 to 2-16-82	2-08-82 to 2-16-82	2-08-82 to 2-16-82	2-08-82 to 2-16-82	2-08-82 to 2-16-82	2-08-82 to 2-16-82	2-08-82 to 2-16-82
	2-16-82 to 2-22-82	2-16-82 to 2-22-82	2-16-82 to 2-22-82	2-16-82 to 2-22-82	2-16-82 to 2-22-82	2-16-82 to 2-22-82	2-16-82 to 2-22-82	2-16-82 to 2-22-82
	2-22-82 to 3-01-82	2-22-82 to 3-01-82	2-22-82 to 3-01-82	2-22-82 to 3-02-82	2-22-82 to 3-02-82	2-22-82 to 3-01-82	2-22-82 to 3-01-82	2-22-82 to 3-01-82
MARCH	3-01-82 to 3-08-82	3-01-82 to 3-08-82	3-01-82 to 3-08-82	3-02-82 to 3-08-82	3-02-82 to 3-08-82	3-01-82 to 3-08-82	3-01-82 to 3-08-82	3-01-82 to 3-08-82
	3-08-82 to 3-15-82	3-08-82 to 3-15-82	3-08-82 to 3-15-82	3-08-82 to 3-16-82	3-08-82 to 3-16-82	3-08-82 to 3-15-82	3-08-82 to 3-15-82	3-08-82 to 3-15-82

TABLE C-5 (cont.)

SAMPLING DATES FOR AIR SAMPLES

MONTH	STATION NO. 2S2	5S1	5D1	10D1	16E1	1F1	2F2	3H3
MARCH	3-15-82 to 3-22-82	3-15-82 to 3-22-82	3-15-82 to 3-22-82	3-16-82 to 3-22-82	3-16-82 to 3-22-82	3-15-82 to 3-22-82	3-15-82 to 3-22-82	3-15-82 to 3-22-82
	3-22-82 to 3-29-82	3-22-82 to 3-29-82	3-22-82 to 3-29-82	3-22-82 to 3-30-82	3-22-82 to 3-30-82	3-22-82 to 3-29-82	3-22-82 to 3-29-82	3-22-82 to 3-29-82
APRIL	3-29-82 to 4-05-82	3-29-82 to 4-05-82	3-29-82 to 4-05-82	3-30-82 to 4-05-82	3-30-82 to 4-05-82	3-29-82 to 4-05-82	3-29-82 to 4-05-82	3-29-82 to 4-05-82
	4-05-82 to 4-12-82	4-05-82 to 4-12-82	4-05-82 to 4-12-82	4-05-82 to 4-13-82	4-05-82 to 4-13-82	4-05-82 to 4-12-82	4-05-82 to 4-12-82	4-05-82 to 4-12-82
	4-12-82 to 4-19-82	4-12-82 to 4-19-82	4-12-82 to 4-19-82	4-13-82 to 4-19-82	4-13-82 to 4-19-82	4-12-82 to 4-19-82	4-12-82 to 4-19-82	4-12-82 to 4-19-82
	4-19-82 to 4-26-82	4-19-82 to 4-26-82	4-19-82 to 4-26-82	4-19-82 to 4-27-82	4-19-82 to 4-27-82	4-19-82 to 4-26-82	4-19-82 to 4-26-82	4-19-82 to 4-26-82
	4-26-82 to 5-04-82	4-26-82 to 5-04-82	4-26-82 to 5-03-82	4-27-82 to 5-03-82	4-27-82 to 5-03-82	4-26-82 to 5-03-82	4-26-82 to 5-03-82	4-26-82 to 5-02-82
MAY	5-04-82 to 5-10-82	5-04-82 to 5-10-82	5-03-82 to 5-10-82	5-03-82 to 5-11-82	5-03-82 to 5-11-82	5-03-82 to 5-10-82	5-03-82 to 5-10-82	5-02-82 to 5-10-82
	5-10-82 to 5-17-82	5-10-82 to 5-17-72	5-10-82 to 5-17-82	5-11-82 to 5-17-82	5-11-82 to 5-17-82	5-10-82 to 5-17-82	5-10-82 to 5-17-82	5-10-82 to 5-16-82
	5-17-82 to 5-25-82	5-17-82 to 5-25-82	5-17-82 to 5-25-82	5-17-82 to 5-24-82	5-17-82 to 5-24-82	5-17-82 to 5-25-82	5-17-82 to 5-25-82	5-16-82 to 5-24-82
	5-25-82 to 6-02-82	5-25-82 to 6-02-82	5-25-82 to 6-02-82	5-24-82 to 6-01-82	5-24-82 to 6-01-82	5-25-82 to 6-01-82	5-25-82 to 6-01-82	5-24-82 to 6-01-82

TABLE C-5 (cont.)

SAMPLING DATES FOR AIR SAMPLES

MONTH	STATION NO. 2S2	5S1	5D1	10D1	16E1	1F1	2F2	3H3
JUNE	6-02-82 to 6-08-82	6-02-82 to 6-08-82	6-02-82 to 6-08-82	6-01-82 to 6-07-82	6-01-82 to 6-07-82	6-01-82 to 6-07-82	6-01-82 to 6-07-82	6-01-82 to 6-07-82
	6-08-82 to 6-14-82	6-08-82 to 6-14-82	6-08-82 to 6-14-82	6-07-82 to 6-15-82	6-07-82 to 6-15-82	6-07-82 to 6-14-82	6-07-82 to 6-14-82	6-07-82 to 6-14-82
	6-14-82 to 6-21-82	6-14-82 to 6-21-82	6-14-82 to 6-21-82	6-15-82 to 6-21-82	6-15-82 to 6-21-82	6-14-82 to 6-21-82	6-14-82 to 6-21-82	6-14-82 to 6-21-82
	6-21-82 to 6-28-82	6-21-82 to 6-28-82	6-21-82 to 6-28-82	6-21-82 to 6-29-82	6-21-82 to 6-29-82	6-21-82 to 6-28-82	6-21-82 to 6-28-82	6-21-82 to 6-28-82
JULY	6-28-82 to 7-06-82	6-28-82 to 7-06-82	6-28-82 to 7-06-82	6-29-82 to 7-06-82	6-29-82 to 7-06-82	6-28-82 to 7-06-82	6-28-82 to 7-06-82	6-28-82 to 7-06-82
	7-06-82 to 7-12-82	7-06-82 to 7-12-82	7-06-82 to 7-12-82	7-06-82 to 7-13-82	7-06-82 to 7-13-82	7-06-82 to 7-12-82	7-06-82 to 7-12-82	7-06-82 to 7-12-82
	7-12-82 to 7-19-82	7-12-82 to 7-19-82	7-12-82 to 7-19-82	7-13-82 to 7-19-82	7-13-82 to 7-19-82	7-12-82 to 7-19-82	7-12-82 to 7-19-82	7-12-82 to 7-19-82
	7-19-82 to 7-26-82	7-19-82 to 7-26-82	7-19-82 to 7-26-82	7-19-82 to 7-27-82	7-19-82 to 7-27-82	7-19-82 to 7-26-82	7-19-82 to 7-26-82	7-19-82 to 7-26-82
	7-26-82 to 8-02-82	7-26-82 to 8-02-82	7-26-82 to 8-02-82	7-27-82 to 8-03-82	7-27-82 to 8-03-82	7-26-82 to 8-02-82	7-26-82 to 8-02-82	7-26-82 to 8-02-82
AUGUST	8-02-82 to 8-09-82	8-02-82 to 8-09-82	8-02-82 to 8-09-82	8-03-82 to 8-10-82	8-03-82 to 8-10-82	8-02-82 to 8-09-82	8-02-82 to 8-09-82	8-02-82 to 8-09-82
	8-09-82 to 8-16-82	8-09-82 to 8-16-82	8-09-82 to 8-16-82	8-10-82 to 8-17-82	8-10-82 to 8-17-82	8-09-82 to 8-16-82	8-09-82 to 8-16-82	8-09-82 to 8-16-82

TABLE C-5 (cont.)

SAMPLING DATES FOR AIR SAMPLES

MONTH	STATION NO. 2S2	5S1	5D1	10D1	16E1	1F1	2F2	3H3
AUGUST	8-16-82 to 8-23-82	8-16-82 to 8-23-82	8-16-82 to 8-23-82	8-17-82 to 8-24-82	8-17-82 to 8-24-82	8-16-82 to 8-23-82	8-16-82 to 8-24-82	8-16-82 to 8-23-82
	8-23-82 to 8-30-82	8-23-82 to 8-30-82	8-23-82 to 8-30-82	8-24-82 to 8-31-82	8-24-82 to 8-31-82	8-23-82 to 8-30-82	8-24-82 to 8-30-82	8-23-82 to 8-30-82
SEPTEMBER	8-30-82 to 9-07-82	8-30-82 to 9-07-82	8-30-82 to 9-07-82	8-31-82 to 9-08-82	8-31-82 to 9-07-82	8-30-82 to 9-07-82	8-30-82 to 9-07-82	8-30-82 to 9-07-82
	9-07-82 to 9-13-82	9-07-82 to 9-13-82	9-07-82 to 9-13-82	9-08-82 to 9-14-82	9-07-82 to 9-14-82	9-07-82 to 9-13-82	9-07-82 to 9-13-82	9-07-82 to 9-13-82
	9-13-82 to 9-20-82	9-13-82 to 9-20-82	9-13-82 to 9-20-82	9-14-82 to 9-20-82	9-14-82 to 9-20-82	9-13-82 to 9-20-82	9-13-82 to 9-20-82	9-13-82 to 9-20-82
	9-20-82 to 9-27-82	9-20-82 to 9-27-82	9-20-82 to 9-27-82	9-20-82 to 9-28-82	9-20-82 to 9-28-82	9-20-82 to 9-27-82	9-20-82 to 9-27-82	9-20-82 to 9-27-82
OCTOBER	9-27-82 to 10-04-82	9-27-82 to 10-04-82	9-27-82 to 10-04-82	9-28-82 to 10-04-82	9-28-82 to 10-04-82	9-27-82 to 10-04-82	9-27-82 to 10-04-82	9-27-82 to 10-04-82
	10-04-82 to 10-12-82	10-04-82 to 10-12-82	10-04-82 to 10-12-82	10-04-82 to 10-12-82	10-04-82 to 10-12-82	10-04-82 to 10-12-82	10-04-82 to 10-12-82	10-04-82 to 10-12-82
	10-12-82 to 10-18-82	10-12-82 to 10-18-82	10-12-82 to 10-18-82	10-12-82 to 10-18-82	10-12-82 to 10-18-82	10-12-82 to 10-18-82	10-12-82 to 10-18-82	10-12-82 to 10-18-82
	10-18-82 to 10-25-82	10-18-82 to 10-25-82	10-18-82 to 10-25-82	10-18-82 to 10-26-82	10-18-82 to 10-26-82	10-18-82 to 10-25-82	10-18-82 to 10-25-82	10-18-82 to 10-25-82
	10-25-82 to 11-01-82	10-25-82 to 11-01-82	10-25-82 to 11-01-82	10-26-82 to 11-01-82	10-26-82 to 11-01-82	10-25-82 to 11-01-82	10-25-82 to 11-01-82	10-25-82 to 11-01-82

TABLE C-5 (cont.)

SAMPLING DATES FOR AIR SAMPLES

MONTH	STATION NO. 2S2	5S1	5D1	10D1	16E1	1F1	2F2	3H3
NOVEMBER	11-01-82 to 11-08-82	11-01-82 to 11-09-82	11-01-82 to 11-08-82	11-01-82 to 11-08-82	11-01-82 to 11-08-82	11-01-82 to 11-08-82	11-01-82 to 11-08-82	11-01-82 to 11-08-82
	11-08-82 to 11-15-82	11-09-82 to 11-15-82	11-08-82 to 11-15-82	11-08-82 to 11-16-82	11-08-82 to 11-16-82	11-08-82 to 11-15-82	11-08-82 to 11-15-82	11-08-82 to 11-15-82
	11-15-82 to 11-22-82	11-15-82 to 11-22-82	11-15-82 to 11-22-82	11-16-82 to 11-22-82	11-16-82 to 11-22-82	11-15-82 to 11-22-82	11-15-82 to 11-22-82	11-15-82 to 11-22-82
	11-22-82 to 11-29-82	11-22-82 to 11-29-82	11-22-82 to 11-29-82	11-22-82 to 11-30-82	11-22-82 to 11-30-82	11-22-82 to 11-29-82	11-22-82 to 11-29-82	11-22-82 to 11-29-82
DECEMBER	11-29-82 to 12-06-82	11-29-82 to 12-06-82	11-29-82 to 12-06-82	11-30-82 to 12-06-82	11-30-82 to 12-06-82	11-29-82 to 12-06-82	11-29-82 to 12-06-82	11-29-82 to 12-06-82
	12-06-82 to 12-13-82	12-06-82 to 12-13-82	12-06-82 to 12-13-82	12-06-82 to 12-14-82	12-06-82 to 12-14-82	12-06-82 to 12-13-82	12-06-82 to 12-13-82	12-06-82 to 12-13-82
	12-13-82 to 12-20-82	12-13-82 to 12-20-82	12-13-82 to 12-20-82	12-14-82 to 12-20-82	12-14-82 to 12-20-82	12-13-82 to 12-20-82	12-13-82 to 12-20-82	12-13-82 to 12-20-82
	12-20-82 to 12-27-82	12-20-82 to 12-27-82	12-20-82 to 12-27-82	12-20-82 to 12-28-82	12-20-82 to 12-28-82	12-20-82 to 12-27-82	12-20-82 to 12-27-82	12-20-82 to 12-27-82

TABLE C-6

CONCENTRATIONS OF TRITIUM IN PRECIPITATION

STATION SA-RWA-2F2

Results in Units of pCi/l ± 2 sigma

(All Results by PSE&G Research Corporation)

COLLECTION PERIOD	H-3
12-29-81 to 2-01-82	<130
2-01-82 to 3-02-82	<130
3-02-82 to 3-29-82	140±70
3-29-82 to 4-27-82	<130
4-27-82 to 6-01-82	<120
6-01-82 to 6-29-82	<120
6-29-82 to 7-26-82	160±80
7-26-82 to 8-31-82	140±80
8-31-82 to 9-27-82	<130
9-27-82 to 11-01-82	<130
11-01-82 to 11-30-82	<130
11-30-82 to 12-28-82	<140

TABLE C-7

CONCENTRATIONS OF GROSS ALPHA AND GROSS BETA EMITTERS IN PRECIPITATION

STATION SA-RWA-2F2

Results in Units of pCi/l ± 2 sigma

COLLECTION PERIOD	ALPHA	BETA
12-29-81 to 2-01-82	0.5±0.4	4.4±1.7
2-01-82 to 3-02-83	0.8±0.6	5.4±1.4
3-02-82 to 3-29-82	0.5±0.4	5.1±2.4
3-29-82 to 4-27-82	<0.7	5.1±2.2
4-27-82 to 6-01-82	<0.6	8.3±1.8
6-01-82 to 6-29-82	<1.0	4.1±2.0
6-29-82 to 7-26-82	2.0±1.0	12±3
7-26-82 to 8-31-82	1.5±0.9	16±3
8-31-82 to 9-27-82	(1)	(1)
9-27-82 to 11-01-82	<1.1	2.4±1.6
11-01-82 to 11-30-82	<1.1	<2.2
11-30-82 to 12-28-82	<1.1	<3.7
Average	-	6.3±8.5

(1) Entire sample used for strontium analyses.

TABLE C-8

CONCENTRATIONS OF STRONTIUM-89* AND -90 AND GAMMA EMITTERS** IN QUARTERLY COMPOSITES OF PRECIPITATION

STATION: SA-RWA-2F2

Results in Units of pCi/l ± 2 sigma

NUCLIDE	12-29-81 to 3-29-82	3-29-82 to 6-29-82	6-29-82 to 9-27-82	9-27-82 to 12-28-82
Sr-89	<0.2	<0.3	<2.7	<0.5
Sr-90	<0.2	<0.3	<1.1	<0.4
K-40	<16	14±7	<7.8	26±3

* 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-38.

TABLE C-9

DIRECT RADIATION MEASUREMENTS - MONTHLY TLD RESULTS

mrad/standard month*

STATION NUMBER	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE
SA-IDM-2S2	5.26±0.55	5.06±0.18	4.47±0.55	5.12±0.65	4.88±0.28	5.46±0.40
SA-IDM-5S1	4.45±0.44	4.26±0.30	4.04±0.17	4.72±0.27	4.53±0.31	4.69±0.52
SA-IDM-6S2	5.36±0.68	4.91±0.52	4.60±0.44	5.49±0.55	4.97±0.18	6.56±0.75
SA-IDM-7S1	6.68±0.72	5.89±0.44	5.55±0.46	6.10±0.76	6.05±0.38	6.18±0.52
SA-IDM-10S1	6.27±0.26	6.04±1.08	6.06±0.52	6.65±0.74	6.15±0.42	6.94±0.82
SA-IDM-11S1	5.41±0.62	6.50±0.72	6.69±0.48	8.84±0.51	6.22±0.41	5.74±0.50
SA-IDM-5D1	4.63±0.59	5.10±0.40	4.62±0.11	5.03±0.08	4.82±0.25	6.00±0.31
SA-IDM-10D1	5.03±0.57	5.47±0.21	4.85±0.43	5.72±0.73	5.47±0.70	6.10±0.32
SA-IDM-14D1	5.58±0.21	5.64±0.20	5.23±0.20	6.11±0.31	5.49±0.18	6.12±0.22
SA-IDM-2E1	4.77±0.32	4.85±0.33	4.67±0.29	5.48±0.44	5.24±0.42	5.28±0.17
SA-IDM-3E1	4.74±0.59	4.83±0.87	4.54±0.59	5.61±0.68	5.46±0.27	5.66±0.75
SA-IDM-13E1	4.89±0.25	5.04±0.93	5.56±0.73	5.49±0.25	4.87±0.74	5.71±0.50
SA-IDM-16E1	5.09±0.80	5.25±0.52	4.67±0.62	5.87±0.75	5.58±0.49	5.85±0.72
SA-IDM-1F1	5.33±0.97	5.26±0.28	4.42±0.75	5.92±0.19	5.74±0.87	5.97±0.68
SA-IDM-2F2	4.56±0.83	4.01±0.22	3.87±0.70	4.55±0.33	4.15±0.33	5.06±0.19
SA-IDM-5F1	4.83±0.53	4.87±0.74	4.60±0.34	5.53±0.51	5.01±0.39	5.76±0.50
SA-IDM-6F1	4.53±0.51	4.38±0.49	3.65±0.54	4.63±0.64	4.55±0.25	5.03±0.60
SA-IDM-7F2	4.07±0.51	3.79±0.65	3.78±0.62	3.94±0.68	4.15±0.06	4.67±0.43
SA-IDM-11F1	5.52±0.46	5.87±0.23	5.35±0.81	5.94±0.85	5.72±0.49	6.35±0.29
SA-IDM-13F1	4.91±0.27	5.32±1.20	4.63±0.44	5.37±0.38	5.29±0.06	6.27±0.46
SA-IDM-3G1	5.57±0.94	5.19±0.64	5.26±0.56	6.11±0.47	5.95±0.09	6.41±0.66
SA-IDM-2H1	6.23±0.70	4.05±0.57	4.67±0.43	5.51±0.27	5.72±0.58	7.51±0.10
SA-IDM-3H1	5.34±0.79	5.81±1.04	4.85±1.06	6.18±0.52	6.02±0.59	6.12±0.85
SA-IDM-3H3	5.37±0.56	5.43±0.12	5.16±0.71	5.96±1.01	5.56±0.87	6.41±0.58
AVERAGE	5.18±1.23	5.12±1.36	4.83±1.41	5.66±1.83	5.32±1.21	5.91±1.34

STATION NUMBER	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	AVERAGE
SA-IDM-2S2	5.49±0.55	5.49±0.51	4.44±0.44	5.81±0.69	5.49±0.37	9.26±2.02	5.52±2.50
SA-IDM-5S1	5.13±0.77	5.28±0.24	4.32±0.19	5.44±0.22	5.27±0.54	6.38±0.55	4.88±1.31
SA-IDM-6S2	6.29±0.73	5.52±0.50	5.04±0.48	6.31±0.64	6.14±0.18	7.70±1.26	5.74±1.77
SA-IDM-7S1	7.09±0.49	7.02±0.48	6.08±0.67	6.69±1.03	7.06±0.86	7.76±1.24	6.51±1.28
SA-IDM-10S1	6.72±0.24	8.09±0.61	8.31±0.63	7.41±0.73	6.86±0.62	7.72±0.76	6.94±1.58
SA-IDM-11S1	6.93±0.39	11.50±0.41	19.63±1.74	8.58±0.63	6.19±0.45	9.56±2.00	8.48±7.90
SA-IDM-5D1	5.46±0.71	5.92±0.52	4.68±0.54	5.71±0.58	5.50±0.52	8.32±0.92	5.48±2.04
SA-IDM-10D1	6.52±0.44	6.12±0.71	5.56±0.21	6.75±0.30	6.83±0.76	6.44±0.51	5.91±1.31
SA-IDM-14D1	6.75±0.41	6.82±0.20	5.67±0.69	6.63±0.54	6.37±0.83	6.29±0.65	6.06±1.06
SA-IDM-2E1	6.24±0.29	6.21±0.07	5.35±1.04	6.34±0.34	5.79±0.62	5.93±0.21	5.51±1.18
SA-IDM-3E1	5.85±0.29	5.68±0.45	5.39±0.48	5.93±0.65	6.17±0.04	8.25±0.46	5.68±1.90
SA-IDM-13E1	5.47±1.07	5.93±0.49	4.91±0.79	5.76±0.40	5.61±0.26	5.73±0.15	5.41±0.76
SA-IDM-16E1	6.42±0.66	5.56±0.69	5.43±0.74	6.31±0.88	6.64±0.53	5.93±0.89	5.72±1.15
SA-IDM-1F1	6.30±0.20	6.57±0.62	5.45±1.12	7.02±0.69	6.52±0.29	5.84±0.40	5.86±1.40
SA-IDM-2F2	5.21±0.59	4.58±0.40	4.00±0.20	5.65±0.37	5.02±0.07	4.47±0.37	4.59±1.10
SA-IDM-5F1	6.13±0.36	5.16±0.48	5.10±0.73	5.84±0.98	5.80±0.55	5.52±0.26	5.35±0.94
SA-IDM-6F1	5.23±0.26	4.52±0.51	3.93±0.64	4.88±0.23	5.26±0.50	4.79±0.29	4.62±0.96
SA-IDM-7F2	4.32±0.56	4.02±0.11	3.91±0.44	4.50±0.34	4.38±0.49	4.43±0.50	4.21±0.69
SA-IDM-11F1	6.57±0.74	5.90±0.67	5.81±0.85	6.82±0.73	6.46±0.26	6.55±0.52	6.07±0.93
SA-IDM-13F1	6.12±0.33	5.40±0.54	5.23±0.88	6.11±0.61	6.39±0.80	5.72±0.68	5.56±1.12
SA-IDM-3G1	7.15±0.33	6.17±1.09	6.10±0.31	6.85±0.83	6.52±0.38	6.36±0.68	6.14±1.18
SA-IDM-2H1	5.17±0.33	6.20±0.52	5.33±0.27	7.00±0.47	5.33±1.26	5.91±0.40	5.72±1.90
SA-IDM-3H1	6.79±0.21	6.95±0.30	5.31±0.12	6.83±0.52	6.64±0.81	6.42±0.37	6.11±1.35
SA-IDM-3H3	6.69±1.11	6.27±0.53	5.70±0.31	6.65±0.78	6.96±0.42	6.72±0.25	6.07±1.24
AVERAGE	6.11±1.40	6.12±2.89	5.66±6.14	6.33±1.70	6.05±1.40	6.58±2.73	5.78±2.62

* The standard month = 30.4 days.

TABLE C-10

DIRECT RADIATION MEASUREMENTS - QUARTERLY TLD RESULTS

mrad/standard month*

STATION NUMBER	JANUARY to MARCH	APRIL to JUNE	JULY to SEPTEMBER	OCTOBER to DECEMBER	AVERAGE
SA-IDM-2S2	4.23±0.19	5.33±0.30	3.98±0.57	4.48±0.56	4.51±1.17
SA-IDM-5S1	3.77±0.16	4.58±0.31	4.32±0.44	4.85±0.29	4.38±0.92
SA-IDM-6S2	4.61±0.89	5.32±0.29	4.69±0.26	4.64±0.39	4.82±0.68
SA-IDM-7S1	5.73±0.34	5.79±0.23	6.08±0.61	6.26±0.78	5.97±0.50
SA-IDM-10S1	5.52±0.39	6.07±0.23	6.51±0.12	6.45±0.62	6.14±0.91
SA-IDM-11S1	5.72±0.63	6.13±0.10	11.60±0.12	6.49±0.50	7.49±5.52
SA-IDM-5D1	4.26±0.44	5.13±0.24	5.87±0.09	4.66±0.90	4.98±1.38
SA-IDM-10D1	5.27±0.32	5.84±0.11	5.80±0.13	5.25±0.89	5.54±0.65
SA-IDM-14D1	5.11±0.24	5.42±0.30	5.80±0.18	5.45±1.11	5.45±0.56
SA-IDM-2E1	4.97±0.28	5.41±0.25	5.17±0.10	5.71±0.53	5.32±0.64
SA-IDM-3E1	4.65±0.45	5.01±0.14	5.63±0.14	5.52±1.11	5.20±0.91
SA-IDM-13E1	4.60±0.35	5.33±0.17	4.25±0.09	4.61±0.66	4.70±0.91
SA-IDM-16E1	4.83±0.54	5.16±0.21	5.78±0.24	5.33±0.24	5.28±0.79
SA-IDM-1F1	4.99±0.71	5.20±0.25	5.32±0.30	4.90±0.91	5.10±0.38
SA-IDM-2F2	3.75±0.29	4.72±0.17	4.03±0.34	3.61±0.24	4.03±0.99
SA-IDM-5F1	4.28±0.37	5.01±0.21	4.61±0.14	4.78±0.65	4.67±0.61
SA-IDM-6F1	3.75±0.39	4.55±0.27	4.43±0.21	3.69±0.19	4.11±0.90
SA-IDM-7F2	3.51±0.23	3.94±0.38	3.89±0.15	3.56±0.56	3.73±0.44
SA-IDM-11F1	5.30±0.37	5.82±0.21	5.80±0.20	5.09±0.16	5.50±0.73
SA-IDM-13F1	4.68±0.93	5.07±0.36	5.33±0.25	4.70±0.75	4.95±0.63
SA-IDM-3G1	5.18±0.63	5.50±0.98	5.88±0.21	4.66±0.25	5.31±1.03
SA-IDM-2H1	5.14±0.51	5.79±0.09	5.27±0.15	4.81±0.06	5.25±0.81
SA-IDM-3H1	4.77±0.36	5.56±0.36	5.49±0.25	5.41±0.95	5.31±0.73
SA-IDM-3H3	5.02±0.55	5.47±0.20	5.29±0.12	5.35±1.06	5.28±0.38
SA-IDM-4D2	(1)	(1)	(1)	5.33±0.88	5.33
SA-IDM-9E1				5.99±1.12	5.99
SA-IDM-11E2				5.89±1.16	5.89
SA-IDM-12E1				5.55±0.36	5.55
SA-IDM-2F5				4.72±0.13	4.72
SA-IDM-3F2				5.05±0.34	5.05
SA-IDM-3F3				4.64±0.88	4.64
SA-IDM-10F2				4.95±0.22	4.95
SA-IDM-12F1				5.48±0.25	5.48
SA-IDM-13F2				4.84±0.21	4.84
SA-IDM-13F3				5.20±0.80	5.20
SA-IDM-14F2				4.97±0.76	4.97
SA-IDM-15F3				5.16±0.28	5.16
SA-IDM-16F2				5.16±0.31	5.16
SA-IDM-1G3				5.70±0.98	5.70
SA-IDM-10G1				5.07±0.22	5.07
SA-IDM-16G1				5.43±0.88	5.43
AVERAGE	4.74±1.25	5.30±1.02	5.45±3.01	5.11±1.30	5.14±1.80

* -The standard month = 30.4 days.
(1) Beginning in October 1982, semi-annual collections of TLDs were changed to quarterly collections.

TABLE C-11

DIRECT RADIATION MEASUREMENTS - SEMI-ANNUAL TLD RESULTS

mrad/standard month*

STATION NO.	SEPTEMBER TO MARCH	APRIL TO SEPTEMBER	AVERAGE
SA-IDM-4D2	4.52±0.08	4.88±0.21	4.70±0.51
SA-IDM-9E1	4.87±0.61	5.37±0.36	5.12±0.71
SA-IDM-11E2	5.11±0.20	5.75±0.53	5.43±0.91
SA-IDM-12E1	5.30±0.39	5.23±0.26	5.27±0.10
SA-IDM-2F5	4.38±0.86	4.52±0.02	4.45±0.20
SA-IDM-3F2	4.08±0.38	4.15±0.06	4.12±0.10
SA-IDM-3F3	4.22±0.69	4.22±0.22	4.22
SA-IDM-10F2	5.07±0.86	5.29±0.19	5.18±0.31
SA-IDM-12F1	5.10±0.75	4.77±0.19	4.94±0.47
SA-IDM-13F2	5.10±0.49	4.56±0.48	4.83±0.76
SA-IDM-13F3	4.87±0.17	4.72±0.19	4.80±0.21
SA-IDM-14F2	4.76±0.75	4.68±0.20	4.72±0.11
SA-IDM-15F3	4.95±0.56	5.26±0.10	5.11±0.44
SA-IDM-16F2	4.54±0.20	4.94±0.56	4.74±0.57
SA-IDM-1G3	5.46±0.40	5.31±0.17	5.39±0.21
SA-IDM-10G1	5.04±0.37	5.21±0.39	5.13±0.24
SA-IDM-16G1	5.65±0.65	5.60±0.29	5.63±0.07
AVERAGE	4.88±0.85	4.97±0.92	4.93±0.88

* The standard month = 30.4 days.

TABLE C-12

CONCENTRATIONS OF TRITIUM IN SURFACE WATER

Results in Units of pCi/l ± 2 sigma

(All Results by PSE&G Research Corporation)

STATION NO.	1-07-82	2-16-82	3-11-82	4-05-82	5-03-82	6-08-82
SA-SWA-11A1	330±80	<120	<120	<120	230±80	<130
SA-SWA-12C1	<120	<120	<120	<120	<130	<120
SA-SWA-7E1	<120	<130	<130	130±70	140±70	<130
SA-SWA-1F2	120±70	<120	<120	<120	170±70	<130
SA-SWA-16F1	<130	<120	160±80	160±70	<130	<120
Average	-	-	-	-	160±85	-

STATION NO.	7-07-82	8-02-82	9-07-82	10-06-82	11-08-82	12-09-82	AVERAGE
SA-SWA-11A1	470±90	190±80	320±80	280±80	<140	220±90	223±220
SA-SWA-12C1	170±80	180±80	200±80	160±80	<140	180±80	-
SA-SWA-7E1	180±80	210±80	220±80	140±80	190±80	180±80	158±71
SA-SWA-1F2	<120	290±80	220±80	170±80	140±80	<130	154±105
SA-SWA-16F1	<130	190±80	230±80	150±80	180±90	<130	153±67
Average	214±291	212±90	238±94	180±114	158±50	168±77	167±129

TABLE C-12 (cont.)

CONCENTRATIONS OF TRITIUM IN SURFACE WATER

Results in Units of pCi/l ± 2 sigma

STATION NO.*	1-07-82	2-16-82	3-11-82	4-05-82	5-03-82	6-08-82
SA-SWA-11A1						
SA-SWA-12C1	<110	<103	<106	<104	86±73	<110
SA-SWA-7E1				<104	83±73	<110
SA-SWA-1F2	<110	<103	<106			
Average	-	-	-	-	85±4	-

STATION NO.	7-07-82	8-02-82	9-07-82	10-06-82	11-08-82	12-09-82	AVERAGE
SA-SWA-11A1	343±77	198±75	103±71	101±75	115±60	<110	162±192
SA-SWA-12C1	<120	124±74	<115	237±76	105±60	<110	-
SA-SWA-7E1							-
SA-SWA-1F2							-
Average	232±315	161±105	109±17	169±192	110±14		-

* For quality assurance purposes, station SWA-12C1 is to be analyzed for tritium on a monthly basis by RMC: in addition, one station a quarter is selected by PSE&G to receive a monthly tritium analysis.

TABLE C-13

CONCENTRATIONS OF GROSS ALPHA EMITTERS IN SURFACE WATER

Results in Units of pCi/l ± 2 sigma

STATION NO.	1-07-82	2-16-82	3-11-82	4-05-82	5-03-82	6-08-82
SA-SWA-11A1	<0.5	<0.3	<0.3	<0.5	<0.3	<0.2
SA-SWA-12C1	<0.3	<0.3	<0.3	<0.3	<0.3	<0.2
SA-SWA-7E1	<0.4	0.8±0.3	<0.3	<0.3	<0.4	<0.3
SA-SWA-1F2	<0.2	<0.3	<0.3	<0.3	<0.3	0.3±0.3
SA-SWA-16F1	<0.2	<0.3	<0.3	<0.4	<0.4	<0.4

STATION NO.	7-07-82	8-02-82	9-07-82	10-06-82	11-08-82	12-09-82
SA-SWA-11A1	<0.2	<0.4	<0.2	<0.4	<0.4	<0.3
SA-SWA-12C1	<0.2	<0.4	<0.2	<0.4	<0.5	0.4±0.2
SA-SWA-7E1	<0.3	<0.4	<0.2	<0.3	<0.5	<0.3
SA-SWA-1F2	<0.3	<0.3	<0.2	<0.3	<1.0 (1)	<0.2
SA-SWA-16F1	<0.2	<0.3	<0.3	<0.4	0.4±0.4	<0.3

(1) Elevated LLD due to small sample size.

TABLE C-14

CONCENTRATIONS OF GROSS BETA EMITTERS IN SURFACE WATER

Results in Units of pCi/l ± 2 sigma

STATION NO.	1-07-82	2-16-82	3-11-82	4-05-82	5-03-82	6-08-82
SA-SWA-11A1	56±6	24±2	45±5	6.1±2.2	14±3	67±7
SA-SWA-12C1	33±4	14±2	29±4	7.6±2.3	5.1±2.5	31±3
SA-SWA-7E1	73±7	26±3	64±6	18±3	33±5	66±7
SA-SWA-1F2	25±4	6.9±1.4	14±3	5.0±2.1	2.6±2.3	19±3
SA-SWA-16F1	26±4	11±2	30±4	4.1±2.0	<3.4	24±3
Average	43±42	16±17	36±38	8±11	12±26	41±47

STATION NO.	7-07-82	8-02-82	9-07-82	10-06-82	11-08-82	12-09-82	AVERAGE
SA-SWA-11A1	35±5	67±7	60±7	106±11	90±9	74±8	54±60
SA-SWA-12C1	21±4	46±5	53±6	65±7	87±9	45±5	36±48
SA-SWA-7E1	34±5	72±7	86±9	117±12	112±11	82±8	65±65
SA-SWA-1F2	11±3	29±4	29±5	47±6	67±7	41±5	25±39
SA-SWA-16F1	16±3	31±4	50±6	72±8	86±9	46±5	33±52
Average	23±21	49±40	56±41	81±58	88±32	58±38	43±60

TABLE C-15

CONCENTRATIONS OF GAMMA EMITTERS* IN SURFACE WATER

Results in Units of pCi/l ± 2 sigma

STATION NO.	NUCLIDE	1-07-82	2-16-82	3-11-82	4-05-82	5-03-82	6-08-82
SA-SWA-11A1	K-40	54±9	15±8	46±12	<7.8	<11	53±8
SA-SWA-12C1	K-40	54±32	9.7±6.9	38±8	<11	<9.3	29±8
SA-SWA-7E1	K-40	64±15	35±8	68±10	<9.3	37±8	73±10
SA-SWA-1F2	K-40	14±8	<9.3	12±9	<9.3	<7.8	<11
SA-SWA-16F1	K-40	<9.3	<9.3	29±8	<7.8	<9.3	16±7
Average		39±51	16±22	39±41	-	-	36±52

STATION NO.	NUCLIDE	7-07-82	8-02-82	9-07-82	10-06-82	11-08-82	12-09-82	Average
SA-SWA-11A1	K-40	43±10	76±8	70±11	120±12	70±9	76±8	53±65
SA-SWA-12C1	K-40	22±8	50±9	62±9	74±9	83±9	59±7	42±51
SA-SWA-7E1	K-40	29±8	80±10	65±9	120±12	150±15	83±8	68±78
SA-SWA-1F2	K-40	<11	30±9	32±8	27±9	92±12	58±6	26±51
SA-SWA-16F1	K-40	<9.3	28±8	55±9	73±10	81±9	50±5	31±53
Average		23±28	53±49	57±30	83±78	95±63	65±27	44±66

* By gamma spectrometry, all other gamma emitters searched for were <LLD; typical LLDs are given in Table C-38.

TABLE C-16

CONCENTRA IONS OF STRONTIUM-89* AND -90 IN SURFACE WATER

Results in Units of pCi/l ± 2 sigma

(All Results by PSE&G Research Corporation)

STATION NUMBER	1-07-82 to 3-11-82		4-05-82 to 6-08-82		7-07-82 to 9-07-82		10-06-82 to 12-09-82	
	Sr-89	Sr-90	Sr-89	Sr-90	Sr-89	Sr-90	Sr-89	Sr-90
SA-SWA-11A1	<1.1	<0.9	<0.8	<0.6	<0.9	<0.7	<0.7	<0.5
SA-SWA-12C1	<0.8	<0.6	<1.0	<0.7	<0.6	<0.5	<0.6	<0.5
SA-SWA-7E1	<1.2	<0.9	<1.0	<0.7	<0.9	<0.6	<0.6	<0.5
SA-SWA-1F2	<1.0	<0.8	<0.6	<0.4	<0.6	0.5±0.2	<0.8	<0.6
SA-SWA-16F1	<0.7	<0.6	<0.8	<0.6	<0.8	<0.6	<0.5	<0.5

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

TABLE C-16 (cont.)

CONCENTRATIONS OF STRONTIUM-89* AND -90 IN SURFACE WATER

Results in Units of pCi/l ± 2 sigma

STATION** NUMBER	1-07-82 to 3-11-82		4-05-82 to 6-08-82		7-07-82 to 9-07-82		10-06-82 to 12-09-82	
	Sr-89	Sr-90	Sr-89	Sr-90	Sr-89	Sr-90	Sr-89	Sr-90
SA-SWA-11A1					<1.6	<0.3	<0.4	<0.3
SA-SWA-12C1	<0.4	0.4±0.2	<0.3	<0.3	<1.1	<0.2	<0.4	0.3±0.2
SA-SWA-7E1			<0.6	0.5±0.4				
SA-SWA-1F2	<0.4	0.5±0.3						

* Sr-89 results are corrected for decay to sample stop date.
** For quality assurance purposes, station 12C1 is analyzed for Sr-89 and -90 on a quarterly basis by RMC; in addition, one station a quarter is selected by PSE&G to receive a quarterly composite Sr-89 and -90 analysis.

TABLE C-17

CONCENTRATIONS OF TRITIUM IN WELL WATER

Results in Units of pCi/l ± 2 sigma

(All Results by PSE&G Research Corporation)

STATION NO. RADIOACTIVITY	1-11-82	2-16-82	3-15-82	4-12-82	5-10-82	6-14-82
SA-WWA-4S1	<120	<120	<120	<120 (1)	<120	<120
SA-WWA-5D1	<120	<120	<120	<120	<120	<120
SA-WWA-3E1	<120	<120	<120	<120	<120	<120

STATION NO. RADIOACTIVITY	7-12-82	8-09-82	9-13-82	10-12-82	11-15-82	12-13-82
SA-WWA-4S1	<140	<120	<130 (2)	<130	<130	<140
SA-WWA-5D1	<130	<120	<120	<130	<130	<140
SA-WWA-3E1	<130	<120	<120	<130	<130	<140

(1) Station WWA-4S1 was collected on 4-19-82.
(2) Station WWA-4S1 was collected on 9-14-82

TABLE C-18

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

Results in Units of pCi/l ± 2 sigma

STATION NO. RADIOACTIVITY	1-11-82	2-16-82	3-15-82	4-12-82	5-10-82	6-14-82
SA-WWA-4S1						
Alpha	<2.4	1.7±1.5	1.4±1.3	<0.9 (1)	<2.5	<3.6
Beta	14±3	12±2	13±2	13±3	12±3	14±2
K-40	13±1	13±1	12±1	13±1	11±1	11±1
SA-WWA-5D1						
Alpha	<2.0	1.5±1.2	<1.1	<2.0	<1.7	<2.7
Beta	13±3	13±2	14±2	15±3	12±3	12±2
K-40	12±1	14±1	13±1	13±1	9.9±1.0	11±1
SA-WWA-3E1						
Alpha	<2.1	<1.2	<1.2	<2.1	<1.9	<3.0
Beta	10±2	9.0±1.5	9.3±1.5	8.3±2.3	8.0±2.5	9.3±2.1
K-40	8.5±0.9	8.5±0.9	9.3±0.9	7.5±0.8	8.7±0.9	9.0±0.9

STATION NO. RADIOACTIVITY	7-12-82	8-09-82	9-13-82	10-12-82	11-15-82	12-13-82
SA-WWA-4S1						
Alpha	<2.2	<1.4	<2.3 (2)	<2.7	<2.6	<1.1
Beta	14±3	9.3±3.2	13±3	11±3	15±3	12±3
K-40	10±1	9.5±1.0	9.5±1.0	9.2±0.9	9.7±1.0	12±1
SA-WWA-5D1						
Alpha	<1.5	1.3±1.1	<1.7	<2.2	<1.9	<0.8
Beta	12±3	10±3	12±3	16±3	15±3	14±3
K-40	11±1	9.7±1.0	11±1	11±1	10±1	12±1
SA-WWA-3E1						
Alpha	<1.8	<0.9	<1.8	<2.3	<2.0	<0.9
Beta	9.5±2.8	6.2±3.0	8.6±3.0	8.6±2.8	10±3	11±3
K-40	8.1±0.8	7.8±0.8	8.4±0.8	9.2±0.9	7.1±0.7	8.2±0.8

(1) Station WWA-4S1 was collected on 4-19-82.
(2) Station WWA-4S1 was collected on 9-14-82.

TABLE C

CONCENTRATIONS OF GAMMA EMITTERS* IN QUARTERLY COMPOSITES OF WELL WATER

Results in Units of pCi/l ± 2 sigma

STATION NUMBER RADIOACTIVITY	1-22-82 to 3-15-82	4-12-82 to 6-14-82	7-12-82 to 9-13-82	10-12-82 to 12-13-82
SA-WWA-4S1				
K-40	<7.8	<9.3 (1)	<7.8 (2)	11±3
Others	<LLD	<LLD	<LLD	<LLD
SA-WWA-5D1				
K-40	<9.3	<9.3	<9.3	17±4
Others	<LLD	<LLD	<LLD	<LLD
SA-WWA-3E1				
K-40	<11	<11	<9.3	<7.0
Others	<LLD	<LLD	<LLD	<LLD

* All gamma emitters searched for were <LLD; typical LLDs are given in Table C-38.
(1) Start date for station WWA-4S1 was 4-19-82.
(2) Stop date for station WWA-4S1 was 9-14-82.

TABLE C-20

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

Results in Units of pCi/l ± 2 sigma

(All Results by PSE&G Research Corporation)

STATION NUMBER RADIOACTIVITY	1-11-82 to 3-15-82	4-12-82 to 6-14-82	7-12-82 to 9-13-82	10-12-82 to 12-13-82
SA-WWA-4S1				
Sr-89	<0.6	<0.5 (1)	<0.5 (2)	<0.5
Sr-90	<0.5	<0.4	<0.4	<0.4
SA-WWA-5D1				
Sr-89	<0.8	<0.5	<0.5	<0.5
Sr-90	<0.7	<0.4	<0.4	<0.4
SA-WWA-3E1				
Sr-89	<0.7	<0.5	<0.5	<0.5
Sr-90	<0.6	<0.3	<0.4	<0.4

* Sr-89 results are corrected for decay to sample stop date.
(1) Start date for station WWA-4S1 was 4-19-82.
(2) Stop date for station WWA-4S1 was 9-14-82.

TABLE C-21

CONCENTRATIONS OF TRITIUM IN RAW AND TREATED POTABLE WATER

Results in Units of pCi/l ± 2 sigma

(All Results by PSE&G Research Corporation)

STATION RADIOACTIVITY	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE
SA-PWR-2F3 (Raw)	<140	<120	<130	130±80	<120	<130
SA-PWT-2F3 (Treated)	170±90	<120	<130	<120	<120	<130

STATION RADIOACTIVITY	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
SA-PWR-2F3 (Raw)	150±80	<130	140±80	<130	<140	<140
SA-PWT-2F3 (Treated)	<130	<130	130±80	<130	<130	<140

TABLE C-22

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

STATION SA-PWA-2F3

Results in Units of pCi/l ± 2 sigma

RADIOACTIVITY		JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE
H-3*	(Treated)	<118	<101	<104	93±74	<112	<122
Alpha	(Raw)	1.1±0.6	0.8±0.5	0.7±0.5	1.1±0.6	1.3±0.7	2.9±1.0
	(Treated)	0.7±0.6	0.6±0.5	0.6±0.5	0.9±0.7	<1.0	3.1±1.3
Beta	(Raw)	4.4±0.6	3.9±0.5	2.9±0.4	3.9±0.5	4.2±0.6	2.7±0.4
	(Treated)	3.8±0.5	2.6±0.5	2.7±0.4	3.0±0.5	3.9±0.5	2.5±0.4
K-40	(Raw)	2.2±0.3	2.4±0.2	1.9±0.2	2.0±0.2	1.5±0.2	2.3±0.2
	(Treated)	1.9±0.3	2.7±0.3	2.4±0.2	1.6±0.2	2.5±0.3	2.5±0.3

RADIOACTIVITY		JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	AVERAGE
H-3*	(Treated)	<119	<121	<121	<108	<109	<110	-
Alpha	(Raw)	<1.0	<0.8	1.0±0.5	<0.6	<0.7	0.8±0.5	1.1±1.2
	(Treated)	<1.3	<0.9	<0.5	<0.8	<0.8	<0.9	-
Beta	(Raw)	2.6±0.5	2.7±0.6	2.7±0.4	2.0±0.4	3.3±0.5	2.6±0.4	3.1±1.5
	(Treated)	2.4±0.5	1.7±0.4	2.0±0.4	2.0±0.4	2.4±0.5	2.4±0.4	2.6±1.3
K-40	(Raw)	2.2±0.2	2.0±0.2	2.1±0.2	2.1±0.2	2.3±0.2	2.3±0.2	2.2±0.8
	(Treated)	2.3±0.2	1.1±0.1	1.3±0.1	2.1±0.2	1.8±0.2	2.4±0.2	2.1±1.1

* For quality assurance purposes, treated potable water samples are analyzed for tritium on a monthly basis.

TABLE C-23

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

Results in Units of pCi/l ± 2 sigma

(All Results by PSE&G Research Corporation)

STATION RADIOACTIVITY	1-01-82 to 3-31-82	4-01-82 to 6-30-82	7-01-82 to 9-30-82	10-01-82 to 12-31-82
SA-PWR-2F3 (Raw)				
Sr-89	<1.3	1.2±0.4	1.2±0.5	<0.5
Sr-90	<0.9	<0.7	<0.7	<0.4
SA-PWT-2F3 (Treated)				
Sr-89	<0.9	<0.8	1.1±0.3	<0.7
Sr-90	0.6±0.3	0.6±0.2	<0.5	<0.5

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

TABLE C-24

CONCENTRATIONS OF STRONTIUM-89* AND -90, AND GAMMA EMITTERS** IN QUARTERLY COMPOSITES OF POTABLE WATER

STATION SA-PWA-2F3

Results in Units of pCi/l ± 2 sigma

SAMPLE	1-01-82 to 3-31-82	4-01-82 to 6-30-82	7-01-82 to 9-30-82	10-01-82 to 12-31-82
Raw				
Gamma Emitters	<LLD	<LLD	<LLD	<LLD
Treated***				
Sr-89	<0.3	<0.3	<0.4	<0.4
Sr-90	0.6±0.3	<0.3	<0.3	<0.3
Gamma Emitters	<LLD	<LLD	<LLD	<LLD

* Sr-89 results are corrected for decay to sample stop date.
** All gamma emitters searched for were <LLD; typical LLDs are given in Table C-38.
*** For quality assurance purposes, treated potable water samples are analyzed for Sr-89 and Sr-90 on a quarterly basis.

TABLE C-25

CONCENTRATIONS OF Sr-89* AND -90 IN BENTHOS

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

STATION NUMBER	DATE	Sr-89	Sr-90
SA-ESB-11A1	6-08-82	<0.02	<0.02
	10-05-82	<3.4	<1.6
SA-ESB-12C1	6-08-82	<0.03	<0.03
	10-05-82	<5.6	<2.8
SA-ESB-7E1	6-08-82	<0.03	0.03±0.02
	10-05-82	<1.5	<0.8
SA-ESB-16F1	6-08-82	(1)	(1)
	10-05-82	<24 (2)	<12 (2)

* Sr-89 results are decay corrected to sample stop date.
(1) Insufficient sample for analysis.
(2) High MDL due to small sample size.

TABLE C-26

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

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

STATION NO.	SA-ESS-11A1		SA-ESS-12C1		SA-ESS-7E1		SA-ESS-16F1	
DATE	6-08-82	10-05-82	6-08-82	10-05-82	6-08-82	10-05-82	6-08-82	10-05-82
Sr-90	<0.03	<0.04	<0.02	<0.05	<0.03	<0.04	<0.05	<0.05
K-40	13±1	11±1	14±1	12±1	12±1	9.1±0.9	14±1	12±1
Co-60	0.07±0.03	<0.04	<0.03	<0.03	<0.04	<0.03	<0.03	<0.03
Cs-137	0.11±0.02	0.17±0.02	<0.03	<0.03	0.07±0.02	0.05±0.02	<0.03	0.14±0.02
Ra-226	0.52±0.05	0.56±0.06	0.84±0.08	0.73±0.07	0.47±0.05	0.45±0.05	0.72±0.07	0.48±0.05
Th-232	0.74±0.07	0.72±0.07	0.94±0.09	0.80±0.08	0.54±0.07	0.54±0.06	1.3±0.1	0.65±0.07

* All other gamma emitters <LLD; typical LLDs are given in Table C-38.
** Sediment samples included associated benthic organisms.

TABLE C-27

CONCENTRATIONS OF IODINE-131 IN MILK

Results* in Units of pCi/l

STATION NO.	JANUARY**	FEBRUARY	MARCH	APRIL	MAY	JUNE
SA-MLK-13E3	<0.07 <0.07	<0.09 <0.07	<0.06 <0.09	<0.1 <0.08	<0.07 <0.1	<0.08 <0.08
SA-MLK-2F4	<0.06 <0.07	<0.1 <0.06	<0.08 <0.1	<0.1 <0.08	<0.09 <0.1	<0.08 <0.09
SA-MLK-5F2	<0.07 <0.07	<0.1 <0.08	<0.08 <0.1	<0.1 <0.08	<0.09 <0.1	<0.1 <0.1
SA-MLK-14F1	<0.07 <0.08	<0.1 <0.08	<0.07 <0.09	<0.1 <0.09	<0.1 <0.1	<0.1 <0.1
SA-MLK-15F1	<0.08 <0.08	<0.1 <0.08	<0.09 <0.1	<0.1 <0.09	<0.1 <0.1	<0.09 <0.1
SA-MLK-3G1	<0.1 <0.08	<0.1 <0.09	<0.07 <0.08	<0.1 <0.08	<0.03 <0.09	<0.1 <0.1

STATION NO.	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
SA-MLK-13E3	<0.3 <0.2	<0.1 <0.1	<0.2 <0.1	<0.06 <0.1	<0.09 <0.1	<0.08 <0.07
SA-MLK-2F4	<0.3 <0.2	<0.1 <0.09	<0.1 <0.1	<0.1 <0.1	<0.08 <0.1	<0.08 <0.07
SA-MLK-5F2	(1) <0.2	<0.1 <0.09	<0.2 <0.2	<0.1 <0.1	<0.1 <0.1	(1) <0.09
SA-MLK-14F1	<0.3 <0.2	<0.1 <0.1	<0.1 <0.2	<0.08 <0.1	<0.1 <0.1	<0.08 (1)
SA-MLK-15F1	<0.3 <0.2	<0.1 <0.1	<0.1 <0.2	<0.08 <0.1	<0.1 <0.1	<0.08 (1)
SA-MLK-3G1	<0.2 <0.2	<0.1 <0.1	<0.1 <0.2	<0.09 <0.1	<0.2 <0.1	<0.1 (1)

* I-131 results decay corrected to sample stop date.
** Sampling dates can be found on Table C-30.
(1) Data lost due to computer malfunction.

TABLE C-28

CONCENTRATIONS OF GAMMA EMITTERS* AND STRONTIUM-89** AND -90 IN MILK

Results in Units of pCi/l ± 2 sigma

STATION NO.***	NUCLIDE	JANUARY****	FEBRUARY	MARCH	APRIL	MAY	JUNE
SA-MLK-13E3	K-40	1400±140	1200±120	1100±110	1600±160	1500±150	1500±150
	Cs-137	<1.4	<1.4	<1.1	4.0±1.2	1.8±1.1	<1.2
	Sr-89					<2.2	
	Sr-90					4.9±1.6	
SA-MLK-2F4	K-40	1400±140	1100±110	1800±180	2700±270	1700±170	2000±200
	Cs-137	<1.4	1.6±1.1	1.5±1.0	8.7±1.4	1.9±1.2	<1.2
	Sr-89			<7.8 (1)			
	Sr-90			10±5			
SA-MLK-5F2	K-40	2000±200	1300±130	1100±110	1700±170	1300±130	1400±140
	Cs-137	1.9±1.2	<1.2	<1.2	2.2±1.1	2.0±1.1	6.9±1.2
	Sr-89	<4.7					<1.5
	Sr-90	6.7±1.1					5.5±1.1

STATION NO.	NUCLIDE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
SA-MLK-13E3	K-40	1500±150	1700±170	920±92	1300±130	1500±150	1500±150
	Cs-137	<1.4	<1.1	<1.1	<1.2	<1.4	<1.4
	Sr-89				<26 (1)		
	Sr-90				<5.0		
SA-MLK-2F4	K-40	1400±140	1500±150	1100±110	1300±130	1500±150	1500±150
	Cs-137	<1.2	<1.2	<1.2	<1.1	<1.2	<1.6
	Sr-89		<2.4				
	Sr-90		3.0±0.7				
SA-MLK-5F2	K-40	1000±100	1400±140	1100±110	1800±180	1300±130	1400±140
	Cs-137	1.9±0.8	3.6±1.3	<1.2	<1.2	<1.2	1.8±0.7
	Sr-89					<1.7	
	Sr-90					3.9±1.0	

TABLE C-28 (cont.)

CONCENTRATIONS OF GAMMA EMITTERS* AND STRONTIUM-89** AND -90 IN MILK

Results in Units of pCi/l ± 2 sigma

STATION NO.***	NUCLIDE	JANUARY****	FEBRUARY	MARCH	APRIL	MAY	JUNE
SA-MLK-14F1	K-40	1600±160	1700±170	2500±250	1600±160	1800±180	1600±160
	Cs-137	<1.2	<1.2	2.8±1.1	1.7±1.0	2.0±1.1	<1.4
	Sr-89				<1.0		
	Sr-90				2.5±0.9		
SA-MLK-15F1	K-40	1500±150	1400±140	1300±130	1500±150	1600±160	1500±150
	Cs-137	<1.4	3.1±1.1	<1.4	4.0±1.3	2.3±1.2	3.3±1.3
	Sr-89		<2.8				
	Sr-90		3.7±1.3				
SA-MLK-3G1	K-40	1400±140	1400±140	770±77	1300±130	1400±140	1400±140
	Cs-137	1.7±1.1	<1.4	1.4±1.1	<1.2	<1.2	1.9±1.1
	Sr-89	<46 (1)	<3.9	<1.1	<1.0	<1.9	<13 (1)
	Sr-90	<56 (1)	5.4±1.8	1.4±1.0	1.5±1.0	5.4±1.4	7.5±4.8

STATION NO.	NUCLIDE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
SA-MLK-14F1	K-40	1400±140	1200±120	900±90	1400±140	1400±140	1300±130
	Cs-137	<1.2	<1.2	<1.1	<1.2	<1.2	<1.4
	Sr-89			<3.3			
	Sr-90			3.6±2.4			
SA-MLK-15F1	K-40	1500±150	1500±150	1700±170	1400±140	1600±160	1300±130
	Cs-137	<1.4	<1.4	<1.2	<1.2	<1.2	1.4±0.7
	Sr-89	<1.0					3.8±2.3
	Sr-90	3.4±0.6					0.8±0.7
SA-MLK-3G1	K-40	1800±180	1600±160	1400±140	1300±130	1300±130	1500±150
	Cs-137	<1.2	<1.4	1.5±0.9	<1.2	<1.1	<1.2
	Sr-89	<1.3	<2.6	4.4±4.3	<1.2	<1.6	<1.2
	Sr-90	3.3±0.8	5.9±1.7	2.4±1.8	3.8±0.7	4.7±0.9	4.1±0.8

* All other gamma emitters searched for were <LLD; typical LLDs are given in Table C-38.
** Sr-89 results are corrected for decay to sample stop date.
*** For quality assurance purposes, station MLK-3G1 is analyzed for Sr-89 and -90 on a monthly basis by RMC; in addition, one station a month is selected by PSE&G to be analyzed for Sr-89 and -90.
**** Sampling dates can be found on Table C-30.
(1) High MDL due to low chemical yield.

TABLE C-29

CONCENTRATIONS OF STRONTIUM-89* AND -90 IN MILK

Results in Units of pCi/l ± 2 sigma

(All Results by PSE&G Research Corporation)

STATION NO.**	NUCLIDE	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE
SA-MLK-13E3	Sr-89	6.9±1.0	<1.8	<1.9	<2.1	<2.0	<1.9
	Sr-90	<1.8	2.7±0.7	2.4±0.7	2.7±0.8	2.1±0.7	2.2±0.6
SA-MLK-2F4	Sr-89	<1.9	<1.8	<1.9	<2.2	<2.0	<1.9
	Sr-90	2.0±0.6	2.4±0.6	2.4±0.7	2.6±0.8	<1.5	1.4±0.6
SA-MLK-5F2	Sr-89	<2.0	<2.4	<2.1	<2.4	<1.9	<2.2
	Sr-90	4.1±0.7	4.2±0.9	3.7±0.8	4.0±0.9	3.5±0.7	5.2±0.8
SA-MLK-14F1	Sr-89	<2.0	<1.8	<1.7	<1.7	<1.7	<2.0
	Sr-90	2.4±0.7	2.4±0.7	2.5±0.7	2.7±0.6	1.9±0.6	2.9±0.7
SA-MLK-15F1	Sr-89	<2.0	<2.1	<2.0	<2.1	<1.8	<2.7
	Sr-90	2.6±0.7	2.7±0.7	2.8±0.8	2.7±0.8	<1.4	2.6±0.9
SA-MLK-3G1	Sr-89	<2.2	<2.2	<2.2	<2.3	<1.8	<2.1
	Sr-90	4.3±0.8	3.6±0.8	3.4±0.8	3.8±0.8	2.7±0.6	4.0±0.7

STATION NO.**	NUCLIDE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
SA-MLK-13E3	Sr-89	<1.6	<1.7	<1.9	<1.7	<1.6	<1.5
	Sr-90	2.0±0.6	2.4±0.6	3.2±0.7	2.8±0.6	2.9±0.6	2.2±0.6
SA-MLK-2F4	Sr-89	<1.4	<1.3	<1.6	<1.6	<1.5	<1.5
	Sr-90	1.5±0.5	1.1±0.5	1.6±0.6	1.3±0.6	2.0±0.5	1.6±0.6
SA-MLK-5F2	Sr-89	<2.2	<1.8	<1.9	<1.9	<1.8	<1.7
	Sr-90	5.4±0.8	3.4±0.7	4.8±0.7	4.3±0.7	3.9±0.7	3.4±0.6
SA-MLK-14F1	Sr-89	<1.6	<1.7	<1.6	<1.6	<1.6	<1.5
	Sr-90	2.0±0.6	2.1±0.6	1.8±0.6	2.9±0.6	3.2±0.6	2.6±0.6
SA-MLK-15F1	Sr-89	<2.1	<1.6	<1.8	<1.6	<1.6	<1.7
	Sr-90	3.3±0.8	2.6±0.6	2.8±0.6	2.3±0.6	2.1±0.6	2.8±0.7
SA-MLK-3G1	Sr-89	<2.0	<2.0	<2.2	<1.9	<1.8	<1.8
	Sr-90	4.0±0.7	3.8±0.8	4.5±0.8	4.6±0.7	4.0±0.7	2.7±0.6

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

** Sampling dates can be found on Table C-30.

TABLE C-30

SAMPLING DATES FOR MILK SAMPLES

MONTH	13E3	2F4	5F2	14F1	15F1	3G1
JANUARY	1-04-82 to 1-05-82	1-04-82 to 1-05-82	1-04-82 to 1-05-82	1-04-82 to 1-05-82	1-04-82 to 1-05-82	1-03-82 to 1-04-82
	1-18-82 to 1-19-82	1-18-82 to 1-19-82	1-16-82 to 1-18-82	1-17-82 to 1-18-82	1-18-82 to 1-19-82	1-17-82 to 1-18-82
FEBRUARY	2-08-82 to 2-09-82	2-07-82 to 2-08-82	2-07-82 to 2-08-82	2-08-82 to 2-09-82	2-07-82 to 2-08-82	2-08-82 to 2-09-82
	2-22-82 to 2-23-82	2-21-82 to 2-22-82	2-21-82 to 2-22-82	2-22-82 to 2-23-82	2-21-82 to 2-22-82	2-22-82 to 2-23-82
MARCH	3-08-82 to 3-09-82	3-07-82 to 3-08-82	3-07-82 to 3-08-82	3-08-82 to 3-09-82	3-07-82 to 3-08-82	3-08-82 to 3-09-82
	3-22-82 to 3-23-82	3-21-82 to 3-22-82	3-21-82 to 3-22-82	3-22-82 to 3-23-82	3-21-82 to 3-22-82	3-22-82 to 3-23-82
APRIL	4-05-82 to 4-06-82	4-04-82 to 4-05-82	4-04-82 to 4-05-82	4-05-82 to 4-06-82	4-04-82 to 4-05-82	4-05-82 to 4-06-82
	4-19-82 to 4-20-82	4-18-82 to 4-19-82	4-18-82 to 4-19-82	4-19-82 to 4-20-82	4-18-82 to 4-19-82	4-19-82 to 4-20-82
MAY	5-03-82 to 5-04-82	5-02-82 to 5-03-82	5-02-82 to 5-03-82	5-03-82 to 5-04-82	5-02-82 to 5-03-82	5-03-82 to 5-04-82
	5-17-82 to 5-18-82	5-16-82 to 5-17-82	5-16-82 to 5-17-82	5-17-82 to 5-18-82	5-16-82 to 5-17-82	5-17-82 to 5-18-82
JUNE	6-06-82 to 6-07-82	6-07-82 to 6-08-82	6-06-82 to 6-07-82	6-06-82 to 6-07-82	6-07-82 to 6-08-82	6-06-82 to 6-07-82
	6-20-82 to 6-22-82	6-21-82 to 6-22-82	6-21-82 to 6-22-82	6-20-82 to 6-21-82	6-21-82 to 6-22-82	6-20-82 to 6-21-82

TABLE C-30 (cont.)

SAMPLING DATES FOR MILK SAMPLES

MONTH	13E3	2F4	5F2	14F1	15F1	3G1
JULY	7-06-82 to 7-07-82	7-05-82 to 7-06-82	7-05-82 to 7-06-82	7-06-82 to 7-07-82	7-05-82 to 7-06-82	7-06-82 to 7-07-82
	7-18-82 to 7-20-82	7-19-82 to 7-20-82	7-19-82 to 7-20-82	7-18-82 to 7-19-82	7-19-82 to 7-20-82	7-18-82 to 7-19-82
AUGUST	8-01-82 to 8-02-82	8-02-82 to 8-03-82	8-02-82 to 8-03-82	8-01-82 to 8-02-82	8-02-82 to 8-03-82	8-01-82 to 8-03-82
	8-15-82 to 8-16-82	8-16-82 to 8-17-82	8-16-82 to 8-17-82	8-15-82 to 8-16-82	8-16-82 to 8-17-82	8-15-82 to 8-16-82
SEPTEMBER	9-06-82 to 9-08-82	9-07-82 to 9-08-82	9-07-82 to 9-08-82	9-06-82 to 9-07-82	9-07-82 to 9-08-82	9-06-82 to 9-07-82
	9-20-82 to 9-21-82	9-19-82 to 9-20-82	9-19-82 to 9-20-82	9-20-82 to 9-21-82	9-19-82 to 9-20-82	9-20-82 to 9-21-82
OCTOBER	10-04-82 to 10-05-82	10-03-82 to 10-04-82	10-03-82 to 10-04-82	10-04-82 to 10-05-82	10-03-82 to 10-04-82	10-04-82 to 10-05-82
	10-18-82 to 10-19-82	10-17-82 to 10-18-82	10-17-82 to 10-18-82	10-18-82 to 10-19-82	10-17-82 to 10-18-82	10-18-82 to 10-19-82
NOVEMBER	11-07-82 to 11-09-82	11-08-82 to 11-09-82	11-08-82 to 11-08-82	11-07-82 to 11-08-82	11-08-82 to 11-09-82	11-07-82 to 11-08-82
	11-21-82 to 11-23-82	11-22-82 to 11-23-82	11-22-82 to 11-22-82	11-21-82 to 11-22-82	11-22-82 to 11-23-82	11-21-82 to 11-22-82
DECEMBER	12-05-82 to 12-06-82	12-06-82 to 12-07-82	12-06-82 to 12-07-82	12-05-82 to 12-06-82	12-06-82 to 12-07-82	12-05-82 to 12-06-82
	12-19-82 to 12-20-82	12-20-82 to 12-21-82	12-20-82 to 12-21-82	12-19-82 to 12-20-82	12-20-82 to 12-21-82	12-19-82 to 12-20-82

TABLE C-31

CONCENTRATIONS OF GAMMA EMITTERS* IN EDIBLE FISH

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

STATION NUMBER	SAMPLING DATE	K-40
SA-ESF-11A1	5-03-82 to 7-30-82	3.1±0.3
	9-16-82 to 10-08-82	2.9±0.3
SA-ESF-12C1	5-03-82 to 7-30-82	3.7±0.4
	9-16-82 to 10-08-82	3.1±0.4
SA-ESF-7E1	5-03-82 to 7-30-82	3.0±0.3
	9-16-82 to 10-08-82	2.9±0.3

* All other gamma emitters searched for were <LLD; typical LLDs are given in Table C-38.

TABLE C-32

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

STATION	DATE	Bones (pCi/g(dry) ± 2 sigma) Sr-89	Bones (pCi/g(dry) ± 2 sigma) Sr-90	Flesh Aqueous Fraction (pCi/l ± 2 sigma) H-3	Flesh Organic Fraction (pCi/l ± 2 sigma) H-3
SA-ESF-11A1	5-03-82 to 7-30-82	<0.02	0.05±0.01	<112	<214 (1)
	9-16-82 to 10-08-82	<0.06	0.13±0.03	81±72	168±73
SA-ESF-12C1	5-03-82 to 7-30-82	<0.5	0.10±0.06	<112	<641 (1)
	9-16-82 to 10-08-82	<0.1	0.21±0.05	<116	1740±170 (2)
SA-ESF-7E1	5-03-82 to 7-30-82	<0.3	<0.03	<112	134±99
	9-16-82 to 10-08-82	<0.3	<0.2	<369 (1)	1800±180 (2)

* Sr-89 results are corrected for decay to sample stop date.
(1) High LLD due to small sample size.
(2) Chemiluminescence suspected; insufficient sample for reanalysis.

TABLE C-33

CONCENTRATIONS OF GAMMA EMITTERS* IN BLUE CRAB SAMPLES

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

STATION NUMBER	DATE	SAMPLE TYPE	K-40
SA-ECH-11A1	5-03-82 to 7-30-82	Flesh	2.0±0.3
	10-26-82 to 10-26-82	Flesh	2.1±0.2
SA-ECH-12C1	5-03-82 to 7-30-82	Flesh	2.0±0.2
	9-16-82 to 10-08-82	Flesh	2.1±0.3

* All other gamma emitters <LLD; typical LLDs are given in Table C-38.

TABLE C-34

CONCENTRATIONS OF STRONTIUM-89* AND -90 AND TRITIUM IN BLUE CRAB SAMPLES

STATION NUMBER	DATE	SAMPLE	Sr-89 pCi/g ± 2 sigma	Sr-90 pCi/g ± 2 sigma	H-3 (Edible Portion) pCi/l ± 2 sigma
SA-ECH-11A1	5-03-82 to 7-30-82	Flesh	<0.01	<0.006	<112
		Shell	<0.1	0.14±0.04	-
	9-16-82 to 10-08-82	Flesh	(1)	(1)	230±74
		Shell	<0.04	0.29±0.03	-
	10-26-82	Flesh	<0.006	0.006±0.004	-
		Shell	<0.04	0.31±0.03	-
SA-ECH-12C1	5-03-82 to 7-30-82	Flesh	<0.02	0.014±0.005	<112
		Shell	0.2±0.1	0.09±0.05	-
	9-16-82 to 10-08-82	Flesh	<0.02	0.005±0.004	157±73
		Shell	<0.05	0.19±0.02	-

* Sr-89 results are corrected for decay to sample stop date.
\- Indicates tritium analysis not performed on shells.
(1) Entire amount of flesh sample used for tritium analysis. Recollected on 10-26-82.

TABLE C-35

CONCENTRATIONS OF STRONTIUM-89* AND -90 AND GAMMA EMITTERS** IN FOOD PRODUCTS

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

STATION NO.	DATE	SAMPLE TYPE	Sr-89	Sr-90	K-40
SA-FPV-2E1	5-11-82	Asparagus	<0.008	<0.007	2.1±0.2
SA-FPV-5D1	7-26-82	Corn	<0.004	<0.004	2.5±0.3
SA-FPL-1F3	7-26-82	Cabbage	<0.2	0.02±0.01	2.1±0.3
SA-FPL-2F4	7-26-82	Cabbage	<0.008	0.012±0.005	2.8±0.3
SA-FPG-2F4	7-26-82	Corn	<0.01	0.002±0.001	2.9±0.3
SA-FPV-14F3	7-26-82	Tomatoes	<0.04	<0.003	1.3±0.1
SA-FPG-1G1	7-26-82	Corn	<0.004	<0.004	2.1±0.2
SA-FPV-1G1	7-26-82	Peppers	<0.03	0.010±0.003	2.4±0.2
SA-FPV-1G1	7-26-82	Tomatoes	<0.004	0.003±0.003	0.94±0.09
SA-FPV-1G1	7-27-82	Cucumbers	<0.01	0.020±0.008	2.0±0.2
SA-FPV-1F3	8-02-82	Peppers	<0.008	<0.006	1.8±0.2
SA-FPV-1F3	8-02-82	Tomatoes	<0.006	0.008±0.003	1.4±0.1
SA-FPV-5F1	8-02-82	Tomatoes	<0.05	0.006±0.004	2.5±0.3
SA-FPL-14F3	8-02-82	Cabbage	<0.005	0.005±0.003	1.2±0.2
SA-FPG-14F3	8-02-82	Corn	<0.04	<0.005	3.1±0.3
SA-FPL-3H4	8-02-82	Cabbage	<0.01	0.009±0.007	3.4±0.3
SA-FPG-3H4	8-02-82	Corn	<0.003	<0.002	2.6±0.3
SA-FPV-3H4	8-02-82	Cucumbers	<0.02	0.003±0.002	1.4±0.1
SA-FPV-3H4	8-02-82	Peppers	<0.02	0.02±0.01	2.3±0.2
SA-FPV-3H4	8-02-82	Tomatoes	<0.004	0.004±0.004	1.4±0.1
SA-FPV-5D1	8-03-82	Peppers	<0.004	0.006±0.005	1.8±0.2
SA-FPV-5D1	8-03-82	Tomatoes	<0.03	0.006±0.002	1.8±0.2
SA-FPG-5D1	10-12-82	Soybeans	<0.03	0.08±0.01	12±1

* 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-38.

TABLE C-36

CONCENTRATIONS OF STRONTIUM-89 AND -90* AND GAMMA EMITTERS** IN GAME, MEAT AND BOVINE THYROID

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

STATION NO.	DATE	SAMPLE TYPE	Sr-89 pCi/g(dry) ± 2 sigma	Sr-90	K-40
SA-GAM-3E1	2-07-82	Muskrat	0.07±0.05	0.09±0.03	2.3±0.2
SA-GAM-11D1	2-15-82	Muskrat	<0.03	0.08±0.03	2.0±0.2
SA-FPB-3E1	2-15-82	Beef	-	-	1.1±0.1
SA-THB-3E1	2-15-82	Bovine Thyroid	-	-	<0.6
SA-FPB-14F1	11-12-82	Beef	-	-	2.2±0.2
SA-THB-14F1	11-12-82	Bovine Thyroid	-	-	2.3±0.6

* Radiostrontium performed on muskrat only. 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-38.
- Indicates strontium analyses not performed.

TABLE C-37

CONCENTRATIONS OF GAMMA EMITTERS* IN FODDER CROP SAMPLES

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

STATION NUMBER	DATE	SAMPLE TYPE	K-40
SA-VGT-3G1	8-16-82	Green Chop	3.5±0.4
SA-VGT-2F4	9-01-82 to 9-07-82	Silage	3.6±0.4
SA-VGT-3G1	9-03-82 to 9-04-82	Silage	2.7±0.5
SA-VGT-15F1	9-07-82	Alfalfa	4.8±0.5
SA-VGT-5F2	9-07-82 to 9-08-82	Silage	2.9±0.5
SA-VGT-5D1	9-13-82	Grass	3.3±0.4
SA-VGT-14F1	9-14-82	Corn Silage/Green Chop	3.6±0.6
SA-VGT-15F1	10-04-82	Silage	2.9±1.6
SA-FPG-3G1	11-21-82	Soybeans	18±2
SA-FPG-15F1	11-22-82	Soybeans	14±1

* All other gamma emitters searched for were <LLD; typical LLDs are given in Table C-38.

TABLE C-38

LLDs FOR GAMMA SPECTROMETRY

NUCLIDES	AIR PARTICULATES (10^{-3}pCi/m^3)	PRECIPITATION (pCi/l)	SURFACE WATER (pCi/l)	WELL/POTABLE WATER (pCi/l)	SEDIMENT (pCi/g-dry)	MILK (pCi/l)
Be-7	-	8.1	5.2	6.3	0.3	7.6
Na-22	0.3	0.8	0.6	0.8	*	1.0
K-40	5.5	7.8	7.8	7.0	-	-
Cr-51	3.2	7.8	5.6	5.9	0.5	7.9
Mn-54	0.3	0.7	0.6	0.6	0.02	1.0
Co-57	*	2.0	*	*	0.02	*
Co-58	0.4	0.8	0.7	0.7	0.03	1.1
Fe-59	0.7	1.7	1.4	1.4	0.08	2.0
Co-60	0.3	0.8	0.6	0.6	0.03	0.9
Zn-65	0.7	1.5	1.4	1.4	0.05	1.7
Zr-95	0.7	*	*	*	0.05	*
Nb-95	0.4	*	*	*	0.05	*
ZrNb-95	*	0.6	0.6	0.6	*	0.9
Mo-99	17	160	27	52	*	87
Ru-103	0.4	*	*	*	0.04	*
Ru-106	3.4	6.5	6.3	6.3	0.2	8.0
Ag-110m	0.3	0.7	0.6	0.6	0.02	1.0
Sb-125	0.7	*	*	*	0.06	*
Te-129m	3.4	17	11	13	1.5	19
I-131	0.6	3.5	1.1	1.4	0.6	1.9
Te-132	1.3	11	2.1	3.7	*	4.9
I-133	*	*	*	*	*	*
Cs-134	0.3	0.6	0.6	0.6	0.02	1.0
Cs-136	0.5	2.3	1.4	1.6	0.2	2.6
Cs-137	0.4	0.8	0.6	0.6	0.03	1.1
Ba-140	1.5	*	*	*	0.8	*
La-140	0.7	*	*	*	0.2	*
BaLa-140	*	2.4	1.0	1.3	*	1.7
Ce-141	0.5	*	*	*	0.05	*
Ce-144	1.6	3.3	1.6	1.6	0.1	3.2
Ra-226	1.0	1.2	1.1	1.2	-	1.6
Th-232	1.5	3.1	3.1	3.1	-	3.1

TABLE C-38 (cont.)

LLDs FOR GAMMA SPECTROMETRY

NUCLIDES	FISH (pCi/g-wet)	SHELLFISH (pCi/g-wet)	FOOD PRODUCTS (pCi/g-wet)	MEAT AND GAME (pCi/g-wet)	FODDER CROPS (pCi/g-wet)
Be-7	0.1	0.1	0.02	0.04	0.2
Na-22	0.01	0.02	0.003	0.006	0.02
K-40	-	-	-	0.6	-
Cr-51	0.1	0.1	0.02	0.06	0.2
Mn-54	0.01	0.01	0.003	0.006	0.02
Co-57	*	*	*	*	*
Co-58	0.01	0.02	0.002	0.007	0.02
Fe-59	0.02	0.04	0.007	0.008	0.07
Co-60	0.01	0.02	0.002	0.003	0.03
Zn-65	0.02	0.03	0.005	0.006	0.06
Zr-95	*	*	*	*	*
Nb-95	*	*	*	*	*
ZrNb-95	0.009	0.02	0.002	0.002	0.03
Mo-99	36	3.6	0.4	0.4	0.4
Ru-103	*	*	*	*	*
Ru-106	0.08	0.1	0.02	0.06	0.3
Ag-110m	0.01	0.02	0.002	0.006	0.03
Sb-125	*	*	*	*	*
Te-129m	0.2	0.2	0.05	0.08	0.5
I-131	0.07	0.04	0.01	0.009	0.04
Te-132	1.4	0.2	0.03	0.03	0.04
I-133	*	*	0.06	0.8	0.6
Cs-134	0.01	0.01	0.002	0.002	0.03
Cs-136	0.05	0.03	0.01	0.01	0.06
Cs-137	0.009	0.02	0.002	0.006	0.03
Ba-140	*	*	*	*	*
La-140	*	*	*	*	*
BaLa-140	0.04	0.03	0.006	0.01	0.04
Ce-141	*	*	*	*	*
Ce-144	0.03	0.05	0.007	0.02	0.09
Ra-226	0.02	0.03	0.003	0.003	0.05
Th-232	0.03	0.06	0.008	0.03	0.1

- Indicates a positive concentration was measured in all samples analyzed.
* Indicates that no LLD was calculated for that nuclide in that media.

APPENDIX D-1

SYNOPSIS OF ANALYTICAL PROCEDURES UTILIZED BY RMC

GROSS ALPHA ANALYSIS OF SAMPLES

Total Water (AØ, A1)

A 250 ml (AØ) or one l (A1) aliquot of the sample is evaporated to dryness on a hot plate in a preweighed, 2" X 1/4" ringed planchet, allowed to cool, and reweighed. The planchet is counted in a low-background, gas flow proportional counter. Self-absorption corrections are made based on the measured sample weight and calculated thickness. The calibration standard used is Pu-239. A 250 ml or one l sample of distilled water is evaporated in the same manner and used as a blank.

Total Salt Water (AA)

Alpha emitters are concentrated initially from a liter aliquot of water sample by coprecipitation with magnesium hydroxide. The precipitate is then dissolved in hydrochloric acid and titanium trichloride is added to the solution. The alpha emitters are coprecipitated by adding barium chloride and sulfuric acid to precipitate barium sulfate. The precipitate is transferred to a tared stainless steel planchet and dried. The planchet is reweighed and counted in a low background gas-flow proportional counter. Self-absorption corrections are made on the basis of the weight of the precipitate.

Calculations are made utilizing the following equations:

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

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

where:

S	=	Gross counts of sample
B	=	Counts of blank
E	=	Fractional Pu-239 counting efficiency
T	=	Number of minutes sample was counted
t	=	Number of minutes blank was counted
V	=	Sample aliquot size (liters)
TF	=	Transmission factor (based on net weight of sample in counting planchet)

Calculation of lower limit of detection (LLD)

The detection limit is assumed to be exceeded when the counting result is different from the blank reading by at least 4.66 times the standard deviation of that background.

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

where:

B	=	Counts of blank
E	=	Fractional Pu-239 counting efficiency
t	=	Number of minutes blank was counted
V	=	Sample aliquot size (liters)
TF	=	Transmission factor (based on net weight of sample in counting planchet)

GROSS BETA ANALYSIS OF SAMPLES

Total Water (BØ, B1)

A 250 ml (BØ) or one l (B1) aliquot is evaporated to dryness on a hot plate in a preweighed, 2" X 1/4", ringed planchet and reweighed. The planchet is then counted in a low background gas-flow proportional counter. Self-absorption corrections are made based on the measured residue weight and calculated thickness. The calibration standard used is Sr-90 - Y-90. A 250 ml or one l sample of distilled water is evaporated in the same manner and used as a blank.

Calculations are made utilizing the following equations:

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

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

where:

S	=	Gross counts of sample
B	=	Counts of blank
E	=	Fractional Sr-90-Y-90 counting efficiency
T	=	Number of minutes sample was counted
t	=	Number of minutes blank was counted
V	=	Volume of aliquot (liters)
TF	=	Transmission factor (based on net weight of sample in counting planchet)

Calculation of lower limit of detection (LLD)

The detection limit is assumed to be exceeded when the counting result for the sample is different from the blank reading by at least 4.66 times the standard deviation of that background.

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

where:

B	=	Counts of blank
E	=	Fractional Sr-90-Y-90 counting efficiency
t	=	Number of minutes blank was counted
V	=	Volume of aliquot (liters)
TF	=	Transmission factor (based on net weight of sample in counting planchet)

ENVIRONMENTAL DOSIMETRY (DØ, D1, D2)

Measurement Techniques

Each dosimeter utilized is a capillary tube containing calcium sulfate (Tm) powder as the thermoluminescent dosimeter (TLD) material. This was chosen primarily for its high light output, minimal thermally induced signal loss (fading), and lack of self-dosing. The energy response curve has been flattened by a complex multiple element energy compensation shield supplied by Panasonic Corporation, manufacturer of the TLD reader. The four dosimeters per station are sealed in a polyethylene bag to demonstrate integrity at time of measurement. Visible through the bag are the sample placement instructions. One set of TLDs is placed in a lead shield at RMC and represents a zero dose. The TLDs are then taken and placed in the field stations; one field TLD set is placed in a field lead shield at station 18 and is used in calculating the in-transit dose.

Following the pre-designated exposure period the TLD is heated with hot gas and the luminescence measured with a TLD reader. Data are normalized to standard machine conditions by correcting machine settings to zero before readout. Data are corrected for in-transit dose using a set of TLDs which is kept in a lead shield in the field and only exposed during transit. Average dose per exposure period, and its error, are calculated.

The basic calibration is in mR exposure to a standard Cs-137 source. This is converted to absorbed dose in tissue by the factor : 0.955 rad/Roentgen and to dose equivalent by using a quality factor of 1.

Calculations are made utilizing the following equations:

$$T = (G-Z)\ R\ C\ 0.955\ \text{mrad/ Roentgen}$$

$$I = SZ - (RZ\ DL\ /\ DR)$$

$$N = T-I$$

$$\text{Average} = \left(\left(\sum_{i=1}^{n} N\right) / n\right)(30.4 / DL)$$

$$\text{Error} = t\ (n-1)\ (SD / n^{1/2})\ (30.4 / DL)$$

where:

T	=	Individual TLD reading corrected to standard instrument conditions
G	=	Gross reading of dosimeter i
Z	=	Zero for dosimeter, i
R	=	Correction factor of reader (see Procedure T-6)
C	=	Calibration factor dosimeter i
I	=	In-transit dose
SZ	=	Mean of n dosimeters in site lead shield
RZ	=	Mean of n dosimeters in RMC lead shield
DL	=	Exposure period of location (days)
DR	=	Exposure period of RMCØ (days)

Average	=	Mean exposure per standard exposure period at a given station
N	=	Net dose obtained during exposure period in the field
n	=	Number of readings
30.4	=	Days in standard exposure period
Error	=	The 95% confidence limit error of the average
t(n-1)	=	t-distribution (student) factor for 95% CL
SD	=	Standard deviation of n readings of sum N

ANALYSIS OF WATER SAMPLES FOR POTASSIUM-40 BY AA (EØ)

Sample Preparation

An aliquot sample size of 100 ml is filtered. The concentration of potassium is determined spectrophotometrically on a Perkin Elmer Model 373 atomic absorption unit. The result obtained, in micrograms per milliliter, is multiplied by the specific activity of 0.12% for natural potassium to determine the amount of potassium-40 present in the sample. The error reported is 10% of the result. A sample of distilled water is processed as a blank.

Calculations are made using the following equations:

$$\text{K-40 (pCi/l)} = Cs\ D\ (C/S)\ K$$

$$\text{LLD (pCi/l)} = Cs\ D\ (.1/S)\ K$$

where:

Cs	=	Concentration of Standard (µg K/ml)
C	=	Sample reading
S	=	Standard reading
D	=	Dilution factor
K	=	Specific activity of K-40 per unit weight of potassium (.852 pCi/mg)

ANALYSIS OF SAMPLES FOR TRITIUM

Water (H2)

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

Calculations are made utilizing the following equations:

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

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

where:

S	=	Total gross counts of sample
B	=	Counts of blank
E	=	Fractional H-3 counting efficiency
T	=	Number of minutes sample was counted
t	=	Number of minutes blank was counted
V	=	Aliquot volume (liters)

Gross counts of sample may be corrected for the blank activity. If the collection container is rinsed with distilled water and the rinse is added to the sample, the rinse plus sample and a separate aliquot of the distilled water are counted. The corrected gross counts for the sample only are calculated using the following equations:

$$S = ((s-b)v) / G$$

$$s = (c(G+H)) / V$$

$$b = (d(H)) / V$$

$$v = G\ V/(G+H)$$

where:

S	=	Gross counts of sample
G	=	Volume of sample
H	=	Volume of rinse
s	=	Volume corrected gross counts of sample plus rinse
b	=	Volume corrected gross counts of rinse
v	=	Corrected aliquot volume
c	=	Uncorrected gross counts of sample plus rinse
d	=	Uncorrected gross counts of rinse

Calculation of lower limit of detection (LLD)

The detection limit is assumed to be exceeded when the counting result is different from the blank reading by at least 4.66 times the standard deviation of that background.

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

where:

B = Counts of blank
E = Fractional H-3 counting efficiency
t = Number of minutes blank was counted
V = Aliquot volume (liters)

Aqueous and Organic Fraction of Milk or Organic Solids (H3, H4, H9)

A carefully measured aliquot of a food product, such as milk or fish, is dried in a rotating vacuum flash evaporator. During the evaporation process, the evaporated water fraction is trapped out by a dry ice isopropanol mixture for counting as in (a) below. The dried residue is reserved for (b). The wet sample is analyzed as in (c).

a. Aqueous H-3 in Food Products

An eight (8) ml aliquot of the cold-trapped water is counted in a liquid scintillation counter in the same manner as surface water samples are counted.

b. Organic Bound H-3 in Food Products

The dried residue is combusted in an RMC designed oxidizer. The collected water - organic fraction is measured and vacuum distilled to remove any impurities. Permanganate in KOH solution is added to remove impurities which may cause quenching. An eight (8) ml aliquot is counted in a liquid scintillation counter. If less than eight (8) ml are collected, the entire portion collected is carefully measured with a 10 ml pipette and then counted. A sample of deep well water is counted as a blank.

c. Aqueous and Organic Bound H-3 in Food Products

A wet weight aliquot is combusted in an RMC designed oxidizer. The collected water fraction is measured and vacuum distilled to remove any impurities. Permanganate in KOH solution is added to remove impurities which may cause quenching. An eight (8) ml aliquot is counted in a liquid scintillation counter. If less than eight (8) ml are collected, the entire portion collected is carefully measured with a 10 ml pipette and then counted. A sample of deep well water is counted as a blank.

Calculations are made utilizing the following equations:

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

$$\text{2 sigma error (pCi/l) of distillate} = 2\ ((S/T^2) + (B/t^2))^{1/2} / (2.22\ V\ E)$$

Result (pCi/g of freeze dried sample) = A (YI)

2 sigma error (pCi/g of freeze dried sample) = C (YI)

Result (pCi/g or l of original sample) = A (YF)

2 sigma error (pCi/g or l of original sample) = C (YF)

where:

S = Gross counts of sample
B = Counts of blank
E = Fractional H-3 counting efficiency
T = Number of minutes sample was counted
t = Number of minutes blank was counted
V = Volume of distillate counted
YI = Liters of water-organic recovered/ g of freeze dried sample
YF = Liters of water recovered/ (l or g) of sample aliquot counted
A = Result in pCi/l of distillate
C = 2 sigma error in pCi/l of distillate

Calculation of lower limit of detection (LLD)

The detection limit is assumed to be exceeded when the counting result is different from the blank reading by at least 4.66 times the standard deviation of that background.

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

LLD (pCi/g of freeze dried sample) = F (YI)

LLD (pCi/l or g) of original sample = F (YF)

where:

B = Counts of blank
E = Fractional H-3 counting efficiency
t = Number of minutes blank was counted
V = Volume of distillate counted
YI = Liters of water-organic recovered/g of freeze dried sample
YF = Liters of water recovered/(l or g) of sample aliquot counted
F = LLD in pCi/l of distillate

ANALYSIS OF SAMPLES FOR IODINE-131

Milk or Water (IØ)

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

Calculations are made utilizing the following equations:

$$\text{Result (pCi/l)} = (S-B) / (2.22\ V\ E\ F\ Y\ T)$$

$$\text{2 sigma error (pCi/l)} = 2\ (S+B)^{1/2} / (2.22\ V\ E\ F\ Y)$$

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

where:

- S = Gross counts of sample in channels containing I-131 peak
- B = Background counts in channels containing I-131 peak
- T = Number of minutes sample was counted
- E = Iodine-131 counting efficiency
- V = Sample aliquot size
- F = Fractional gamma abundance
- Y = Chemical yield of iodine

Air Cartridges (I1)

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

Calculation of results and two sigma error

Peaks are identified by changes in the slope of the spectrum. If peaks are identified, the spectrum obtained is smoothed to minimize the effects of random statistical fluctuations. The presence of iodine-131 is identified by the presence of a 364 Kev peak. The net area above the baseline is calculated. This area is converted to activity in curie units, making allowance for counting efficiency and gamma ray abundance. A PDP-11 computer program is used for spectrum analysis. Results are corrected for decay from the sampling time to the middle of the counting period, using a half-life value for I-131 of 8.06 days.

Calculations are made utilizing the following equations:

$$\text{Result}_3\ (\text{pCi/m}^3) = ((S/T) - (B/t)) / (2.22\ V\ E\ F\ Y)$$

$$2 \text{ sigma error } (pCi/m^3) = 2\left((S/T^2) + (B/t^2)\right)^{1/2} / (2.22\ V\ E\ F\ Y)$$

$$LLD\ (pCi/m^3) = 4.66\ (.63(Q^{1/2})b)^{1/2} / (2.22\ V\ E\ F\ Y\ t)$$

where:

S	=	Net area, in counts, of sample in I-131 peak
B	=	Net area, in counts, of background in I-131 peak
b	=	Counts in I-131 peak channel
T	=	Number of minutes sample was counted
t	=	Number of minutes background was counted
E	=	Iodine-131 counting efficiency
V	=	Sample aliquot size
F	=	Fractional gamma abundance
Y	=	Chemical yield of iodine

GAMMA SPECTROMETRY OF SAMPLES

Water (N1)

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

Milk (N7)

A 4 liter aliquot is dried at 175°C, ashed at 500°C until no carbon residue is present, compressed and sealed in a standard container, and then counted with a NaI(Tl) detector, coupled to a multi-channel pulse-height analyzer. The counting time is 50,000 seconds.

Dried Solids (N8, G8)

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

Air Dried Solids (NA)

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

Calculation of results and two sigma error

The spectrum obtained is smoothed to minimize the effects of random statistical fluctuations. Peaks are identified by changes in the slope of the gross spectrum. The net area, in counts, above the baseline is calculated. This area is converted to activity in curie units, making allowance for counting efficiency and gamma ray abundance. A computer program is used for spectrum analysis.

Calculations are made utilizing the following equations:

$$\text{Result (pCi/l or g)} = ((S/T) - (B/t)) / (2.22\ V\ E\ F)$$

$$\text{2 sigma error (pCi/l or g)} = 2\ ((S/T^2) + (B/t^2))^{1/2} / (2.22\ V\ E\ F)$$

where:

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

Calculation of lower limit of detection (LLD) for G8

$$LLD\ (pCi/l\ or\ g) = 4.66\ (6\ S)^{1/2} / (2.22\ V\ E\ F\ T)$$

where:

S = Net area, in counts, of sample (Region of spectrum of interest)
T = Number of minutes sample was counted
E = Detector efficiency for energy of interest
V = Sample aliquot size
F = Fractional gamma abundance

Calculation of lower limit of detection (LLD) for N1, N7, N8 and NA

$$LLD\ (pCi/l\ or\ g) = 4.66\ (.63\ (Q)^{1/2}\ S)^{1/2} / (2.22\ V\ E\ F\ T)$$

where:

S = Net area, in counts, of sample (Region of spectrum of interest)
T = Number of minutes sample was counted
E = Detector efficiency for energy of interest
V = Sample aliquot size
F = Fractional gamma abundance
Q = Channel number

ANALYSIS OF SAMPLES FOR STRONTIUM-89 AND -90

Total Water (SØ, TØ)

A two liter aliquot of sample is used. Stable strontium carrier is added to the liquid to facilitate chemical separation of Sr-89 and -90, and to determine the strontium recovery. Strontium concentration and purification is ultimately realized by at least two precipitations of strontium nitrate in concentrated nitric acid. Additional iron/rare earth hydroxide precipitations and barium chromate separations are performed to remove suspected interfering nuclides. After purification, the Y-90 is allowed to ingrow for a known period of time. Sr-90 is then determined by counting yttrium oxalate after initially precipitating Y-90 as yttrium hydroxide. Sr-89 is determined by counting strontium carbonate and correcting the observed activity for the amount of Sr-90 and Y-90 on the planchet. A sample of distilled water is used as a blank.

Milk (S4, T4)

A one and half liter aliquot of milk is ashed to destroy organic material and then dissolved in concentrated mineral acid. Stable strontium is added to the eluted liquid or dissolved ash to facilitate chemical separation of Sr-89 and -90, and to determine the strontium recovery. Strontium concentrations and purification is ultimately realized by at least two precipitations of strontium nitrate in concentrated nitric acid. Additional iron/rare earth hydroxide precipitations and barium chromate separations are performed to remove suspected interfering nuclides. After purification, the Y-90 is allowed to ingrow for a known period of time. Sr-90 is then determined by counting yttrium oxalate after initially precipitating Y-90 as yttrium hydroxide. Sr-89 is determined by counting strontium carbonate and correcting the observed activity for the amount of Sr-90 and Y-90 on the planchet. A sample of distilled water is used as a blank.

Bones and Shells (S5, T5)

A large quantity of the sample is dried, ashed and a 25 g portion is then dissolved in concentrated acid. Stable strontium carrier is added to the dissolved sample to facilitate chemical separations of Sr-89 and -90, and to determine the strontium recovery. Strontium concentration and purification is ultimately realized by at least two precipitations of strontium nitrate in concentrated nitric acid. Additional iron/rare earth hydroxide precipitations and barium chromate separations are performed to remove suspected interfering nuclides. After purification, the Y-90 is allowed to ingrow for a known period of time. Sr-90 is then determined by counting yttrium oxalate after initially precipitating Y-90 as yttrium hydroxide. Sr-89 is determined by counting strontium carbonate and correcting the observed activity for the amount of Sr-90 and Y-90 on the planchet. A sample of distilled water is used as a blank.

Soil and Sediment (S6, T6)

A large quantity of sample is dried, and a 25 g portion is then leached with concentrated HCl before drying. Stable strontium carrier is added to the sample to facilitate isolation of the strontium and to determine the strontium recovery. Strontium concentration and purification is ultimately realized by at least two precipitations of strontium nitrate in concentrated nitric acid. Additional iron/rare earth hydroxide precipitations and barium chromate separations are performed to remove suspected

interfering nuclides. After purification, the Y-90 is allowed to ingrow for a known period of time. Sr-90 is then determined by counting yttrium oxalate after initially precipitating Y-90 as yttrium hydroxide. Sr-89 is determined by counting strontium carbonate and correcting the observed activity for the amount of Sr-90 and Y-90 on the planchet. A sample of distilled water is used as a blank.

Organic Solids (S8, T8)

A 250 g portion of the sample is ashed and then dissolved in concentrated acid. Stable strontium carrier is added to the dissolved sample to facilitate chemical separation of Sr-89 and -90, and to determine the strontium recovery. Strontium concentration and purification is ultimately realized by at least two precipitations of strontium nitrate in concentrated nitric acid. Additional iron/rare earth hydroxide precipitations and barium chromate separations are performed to remove suspected interfering nuclides. After purification, the Y-90 is allowed to ingrow for a known period of time. Sr-90 is then determined by counting yttrium oxalate after initially precipitating Y-90 as yttrium hydroxide. Sr-89 is determined by counting strontium carbonate and correcting the observed activity for the amount of Sr-90 and Y-90 on the planchet. A sample of distilled water is used as a blank.

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

$$\text{Result Sr-90} = (A/T1 - B/T2) \,/\, (2.22\ V\ E\ Y\ X \exp(-0.693\ t1/64.1)(1-\exp(-0.693 t2/64.1))) \quad \text{(pCi/l or g)}$$

$$\text{2 sigma error Sr-90} = 2(A/T1^2 + B/T2^2)^{1/2} \,/\, (2.22\ V\ E\ Y\ X \exp(-0.693 t1/64.1)(1-\exp(-0.693 t2/64.1))) \quad \text{(pCi/l or g)}$$

$$\text{MDL Sr-90} = 3\ B^{1/2} \,/\, (2.22\ T2\ V\ E\ Y\ X \exp(-0.693 t1/64.1)(1-\exp(-0.693 t2/64.1))) \quad \text{(pCi/l or g)}$$

where:

A	=	Gross Y-90 counts
B	=	Gross blank counts of yttrium
T1	=	Y-90 counting time
T2	=	Blank counting time
V	=	Sample aliquot size
E	=	Y-90 counting efficiency
Y	=	Yttrium chemical yield
X	=	Strontium chemical yield
t1	=	Time in hours from second separation of Y-90 until counting time of yttrium planchet plus one-half the counting time
t2	=	Time in hours between first and second separations of Y-90 (ingrowth time)

$$\text{Result Sr-89} = (C/T3 - D/T4 - G - H)/(2.22\ V\ F\ X \exp(-0.693 t4/50.5)) \quad \text{(pCi/l or g)}$$

$$\text{2 sigma error Sr-89} = 2\ (C/T3^2 + D/T4^2 + G/T3 + H/T3)^{1/2} \,/\, (2.22\ V\ F\ X \exp(-0.693 t4/50.5)) \quad \text{(pCi/l or g)}$$

$$\text{MDL Sr-89} = 3(D+GT3+HT3)^{1/2} / (2.22\ T4\ V\ F\ X \exp(-0.693t4/50.5))$$
(pCi/l or g)

where:

C	=	Gross strontium counts
D	=	Gross blank counts of strontium
G	=	Additional background from Sr-90 activity
	=	(Sr-90 activity of sample) (2.22 VXJ)
H	=	Additional background from Y-90 activity
	=	(Sr-90 activity of sample) (2.22 VXE) (1-exp(-0.693t5/64.1))
V	=	Sample aliquot size
J	=	Sr-90 counting efficiency
F	=	Sr-89 counting efficiency
X	=	Strontium chemical yield
t4	=	Time in days from sampling date to strontium count
T3	=	Strontium counting time
T4	=	Blank counting time
t5	=	Time in hours from second separation of Y-90 to counting of strontium planchet plus one-half the counting time

APPENDIX D-2

SYNOPSIS OF ANALYTICAL PROCEDURES UTILIZED BY THE RESEARCH AND TESTING LABORATORY

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 then 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:

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

P = Pressure correction factor
B = Time-averaged barometric pressure during sampling period, "Hg
$\overline{V}$ = Time-averaged vacuum during sampling period
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 count
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's 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.

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

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.

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 then 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-Y-90 air filter geometry beta counting standard.

The specific 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:

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

P = Pressure correction factor
B = Time-averaged barometric pressure during sampling period, "Hg
$\overline{V}$ = Time-averaged vacuum during sampling period
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^3
2.22 = No. of dpm's 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.

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

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.

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, active area facing down, 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 Ge(Li) detector for 500 minutes.

Calculation of Gamma Activity

A special program developed by Tracor Northern is run on a PDP-11 computer. Photopeaks are located by passing a digital filter through the spectrum, channel-by-channel, with the effect that the background portion of the spectrum is greatly reduced, leaving the peaks intact. To compute the desired net count under any one of these photopeaks, a background baseline is established extending from 1.5 times the full-width-at-half-max above, to the same distance below the centroid. The counts under this baseline are then subtracted out from the total number of counts under the photopeak.

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

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

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
= 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's per pCi

$$2 \text{ sigma error } (\text{pCi/m}^3) = 2 * (\sigma k^{2} + \sigma s^{2})^{1/2}$$

$$\sigma k = \left[\frac{1}{\sum_{i=1}^{n} \frac{1}{\sigma^2} * A (\gamma)_i^2} \right]^{1/2}$$

σk = statistical error of the activity measurement. It is determined from the accuracy of the least squares evaluation performed on the peaks of a particular nuclide.

n = number of peaks in the nuclide of question

$\sigma i = (GC+BC)^{1/2}$, where GC and BC are gross counts and background counts, respectively.

$$A(\gamma)\,i = \frac{N*D}{(E)*(R)*(2.22)*(T)*(V)}$$

= gamma abundance factor for the i^{th} peak under consideration, for a given nuclide

σs represents systematic errors (such as errors in detector efficiency) over and above the statistical error of the activity measurement. It is assigned a fixed value representing 5% of the computed activity and should be regarded as a minimum estimate of the activity error.

All other variables are as defined earlier.

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

Again, all other variables are as defined earlier.

ANALYSIS OF AIR FILTERS FOR RADIOSTRONTIUM

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 a couple of fuming 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, now largely devoid of any radiological impurities, is converted to a carbonate form 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:

$$\text{Sr-90 Results } (pCi/m^3) = \frac{N4/R}{(2.22) * (E) * (0.7621) * (S6) * (V) * (U)} = W2$$

where $S6 = 1.4115 - 0.03409*M + 0.000443*M^2$ (This is normalized Sr-90 efficiency regression equation for one particular gas proportional counter)

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

0.7621 = Ratio of Sr-90 efficiency at thickness value of 15 mg/cm^2 to Sr-90 counting standard efficiency (This standard is run with each group of environmental strontium samples)

E = Sr-90 counting standard efficiency

V = Sample quantity (liters, m^3 or kg)

U = Chemical yield

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

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

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

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

$t1$ = 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

$R1 = 1.242 + 0.0179*M + 0.000151*M^2$ (This is regression equation for Y-90 eff'y/Sr-90 eff'y ratio).

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's 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) =

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

Again, keeping the same variable definitions, the

$$\text{LLD Sr-90 } (pCi/m^3) = 4.66* \left[\frac{(X+Y)}{W1^2} + \frac{(X1+Y1)*F1^2}{W1^2}\right]^{1/2}$$

Calculation of Sr-89 Activity:

$$\text{Sr-89 Results } (pCi/m^3) = \frac{N6/R}{(2.22) * (E) * (1.0922) * (S7) * (V) * (U) * (F9)} = W3$$

$S7 = 1.052 - 0.00272*M - 0.00005*M^2$ (This is normalized Sr-89 efficiency regression equation for one particular gas proportional counter)

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

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

1.0922 = Ratio of Sr-89 efficiency at thickness value of 15 mg/cm^2 to Sr-90 counting standard efficiency (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 variables are as originally defined.

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

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

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

All other variables are as originally defined.

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

ANALYSIS OF RAW MILK FOR RADIOSTRONTIUM

A stable strontium carrier is first introduced into a one liter 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 pick up 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 upon heating. 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 reconverted to the 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:

$$\text{Sr-90 Results (pCi/l)} = \frac{N4/R}{(2.22) * (E) * (0.7621) * (S6) * (V) * (U)} = W2$$

where S6 = $1.4115 - 0.03409*M + 0.000443*M^2$ (This is normalized Sr-90 efficiency regression equation for one particular gas proportional counter)

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

0.7621 = Ratio of Sr-90 efficiency at thickness value of 15 mg/cm^2 to Sr-90 counting standard efficiency (This standard is run with each group of environmental strontium samples)

E = Sr-90 counting standard efficiency

V = Sample quantity (liters, m^3 or kg)

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 = $1.242 + 0.0179*M + 0.000151*M^2$ (This is regression equation for Y-90 eff'y/Sr-90 eff'y ratio)

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's 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 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:

$$\text{Sr-89 Results (pCi/l)} = \frac{N6/R}{(2.22) * (E) * (1.0922) * (S7) * (V) * (U) * (F9)}$$

$$= W3$$

S7 = $1.052 - 0.00272*M - 0.00005*M^2$ (This is normalized Sr-89 efficiency regression equation for one particular gas proportional counter)

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

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

1.0922 = Ratio of Sr-89 efficiency at thickness value of 15 mg/cm^2 to Sr-90 counting standard efficiency (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 variables are as originally defined

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

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

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

All other variables are as originally defined

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

ANALYSIS OF WATER SAMPLES FOR TRITIUM

Approximately 50 ml of raw sample is mixed with sodium hydroxide and potassium permanganate and is distilled under vacuum. Eight ml of distilled sample is mixed with 10 ml of Instagel® liquid scintillation solution, and placed in the liquid scintillation spectrometer for counting. Prepared simultaneously for counting is the internal standard. This is done by mixing eight ml of sample, 10 ml of Instagel, and 0.1 ml of a standard with known activity. The efficiency is determined from this. Also prepared is a blank consisting of eight ml of distilled low-tritiated water and 10 ml 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:

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

A = Activity
B = Background count of sample
G = Gross count of sample
E = Counting efficiency
V = Aliquot volume (L)
T = Count time (min)
2.22 = dpm/pCi

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:

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

If collection container is rinsed with distilled water (e.g., rainwater), the sample is corrected for the blank as follows:

$$A\ (pCi/l) = \frac{\frac{(G)\ (S1)}{V} - \frac{(R)\ (S2)}{V}}{2.22(V-S2)\ (E)\ (1000)}$$

S1 = Rainwater volume
V = Sample volume
S2 = Rinsewater volume
R = Rinse counts

Note: G and R are corrected for background counts

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

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

RADIOSTRONTIUM IN WATER

Stable strontium carrier is first introduced into a two liter 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 over 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, now largely devoid of any chemical or radiological impurities, is converted back to a carbonate form 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 via DC Argon Plasma Emission. These results are used in correcting the chemical recovery of strontium to its true value.

Calculation of Sr-90 Activity:

$$\text{Sr-90 Results (pCi/l)} = \frac{N4/R}{(2.22) * (E) * (0.7621) * (S6) * (V) * (U)} = W2$$

where S6 = $1.4115 - 0.03409*M + 0.000443*M^2$ (This is normalized Sr-90 efficiency regression equation for one particular gas proportional counter)

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

0.7621 = Ratio of Sr-90 efficiency at thickness value of 15 mg/cm^2 to Sr-90 counting standard efficiency (This standard is run with each group of environmental strontium samples)

E = Sr-90 counting standard efficiency

V = Sample quantity (liters, m^3 or kg)

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 = $1.242 + 0.0179*M + 0.000151*M^2$ (This is regression equation for Y-90 eff'y/Sr-90 eff'y ratio)

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's 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 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:

$$\text{Sr-89 Results (pCi/l)} = \frac{N6/R}{(2.22) * (E) * (1.0922) * (S7) * (V) * (U) * (F9)} = W3$$

S7 = $1.052 - 0.00272*M - 0.00005*M^2$ (This is normalized Sr-89 efficiency regression equation for one particular gas proportional counter)

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

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

1.0922 = Ratio of Sr-89 efficiency at thickness value of 15 mg/cm^2 to Sr-90 counting standard efficiency (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 variables are as originally 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 originally defined

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

APPENDIX E

SUMMARY OF INTERLABORATORY COMPARISONS

TABLE E-1

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

DATE	RMC #	SAMPLE TYPE	ANALYSIS	RMC MEAN±s.d.	EPA MEAN±s.d.	All Participants MEAN±s.d.
Jan 1982	67011	Water	α	22±2	24±6	21±6
			β	29±1	32±5	31±6
March 1982	70043	Water	α	15±1	19±5	18±4
			β	19±1	19±5	20±4
March 1982	70631	APT	α	24±3	27±7	26±4
			β	58±2	55±5	59±8
April 1982	72020	Water	α	50±3	85±21	75±16
			β	93±2 (a)	106±5	106±13
May 1982	73330	Water	α	22±1	28±7	25±7
			β	31±3	29±5	30±6
July 1982	76747	Water	α	11±2	16±5	16±5
			β	22±1	23±5	21±5
Sept 1982	81226	Water	α	20±1	29±7	26±6
			β	34±1	40±5	38±6
Sept 1982	81457	APT	α	27±3	32±8	28±6
			β	38±2 (b)	67±5	61±8
Oct 1982	83052	Water	α	48±2	55±14	47±14
			β	101±1	81±5	76±11
Nov 1982	84691	Water	α	17±2	19±5	17±4
			β	22±2	24±5	24±3
Nov 1982	91763	APT	α	28±1	27±7	29±4
			β	64±2	59±5	66±7

(a) Insufficient sample to reanalyze. Probable reasons for discrepancy are incomplete transfer of sample to planchet, incorrect pipetting of sample aliquot and nonhomogeneity of sample.

(b) Calculation was verified. Sample could not be reanalyzed because it was destroyed in the strontium analysis. Gross alpha, gamma and strontium-90 for that sample were in agreement with the EPA.

TABLE E-2

INTER-LABORATORY COMPARISONS
GAMMA(1)

DATE	RMC #	SAMPLE TYPE	ISOTOPE	RMC MEAN±s.d.	EPA MEAN±s.d.	All Participants MEAN±s.d.
Feb 1982	68029	Water	Cr-51	<56	0	5±9
			Co-60	22±4	20±5	20±5
			Zn-65	16±3	15±5	15±4
			Ru-106	<32 (a)	20±5	19±8
			Cs-134	20±1	22±5	21±3
			Cs-137	22±0	23±5	24±4
March 1982	70631	APT	Cs-137	32±1	23±5	27±6
April 1982	72020	Water	Co-60	<3	0	5±10
			Cs-134	16±1	15±5	15±4
			Cs-137	16±2	16±5	17±4
April 1982	72074	Milk	Co-60	30±2	30±5	31±4
			Cs-137	28±3	28±5	30±4
			Ba-140	<147	0	5±7
			K	1530±204	1500±75	1495±178
June 1982	74569	Water	Cr-51	<72 (b)	23±5	25±13
			Co-60	29±2	29±5	31±4
			Zn-65	26±3	26±5	27±6
			Ru-106	<30	0	10±11
			Cs-134	34±1	35±5	34±4
			Cs-137	24±2	25±5	27±4
July 1982	76127	Food	I-131	105±13	94±9	100±9
			Cs-137	27±4	20±5	26±4
			Ba-140	<19	0	0
			K	2660±244	2400±120	2645±244
Sept 1982	81457	APT	Cs-137	25±4	27±5	25±4
Oct 1982	82539	Water	Cr-51	<93 (b)	51±5	51±15
			Co-60	21±4	20±5	20±3
			Zn-65	21±6	24±5	24±4
			Ru-106	41±6	30±5	31±8
			Cs-134	16±2	19±5	18±3
			Cs-137	17±3	20±5	21±3

TABLE E-2 (cont.)

INTER-LABORATORY COMPARISONS
GAMMA(1)

DATE	RMC #	SAMPLE TYPE	ISOTOPE	RMC MEAN±s.d.	EPA MEAN±s.d.	All Participants MEAN±s.d.
Oct 1982	83052	Water	Co-60	<4	0	3±7
			Cs-134	<3	2±5	6±11
			Cs-137	21±2	20±5	20±3
Oct 1982	83535	Milk	I-131	47±5	42±6	40±7
			Cs-137	35±4	34±5	35±3
			Ba-140	<31	0	2±5
			K	1682±68	1560±78	1528±196
Nov 1982	84177	Food	I-131	30±6	25±6	25±5
			Cs-137	28±4	27±5	29±4
			Ba-140	<32	0	0
			K	2934±118	2780±140	2846±207
Nov 1982	91763	APT	Cs-137	31±2	27±5	30±5

(1) Results reported in pCi/liter for milk and water, pCi/sample for air particulates, and pCi/kilograms for food products except K which is reported in mg/liter for milk and mg/kilogram for food products.

(a) Positive activity was not detected due to the low sensitivity of the analysis for Ru-106.

(b) Positive activity was not detected due to the low sensitivity of the analysis for Cr-51.

TABLE E-3

INTER-LABORATORY COMPARISONS
TRITIUM IN WATER
pCi/liter

DATE	RMC #	SAMPLE TYPE	ANALYSIS	RMC MEAN±s.d.	EPA MEAN±s.d.	All Participants MEAN±s.d.
Feb 1982	67807	Water	H-3	1913±138	1820±342	1853±229
Apr 1982	71295	Water	H-3	2800±89	2860±360	2812±242
June 1982	74602	Water	H-3	1867±590	1830±340	1765±229
Aug 1982	77486	Water	H-3	3077±100	2890±360	2847±270
Oct 1982	82727	Water	H-3	2473±58	2560±350	2517±250
Dec 1982	90744	Water	H-3	2007±75	1990±345	2009±233

TABLE E-4

INTER-LABORATORY COMPARISONS
IODINE-131 IN WATER
pCi/liter

DATE	RMC #	SAMPLE TYPE	ANALYSIS	RMC MEAN±s.d.	EPA MEAN±s.d.	All Participants MEAN±s.d.
Jan 1982	67243	Water	I-131	7.0±0.1	8.4±1.5	8.3±1.0
Apr 1982	70963	Water	I-131	66±4	62±6	63±8
June 1982	75597	Water	I-131	3.9±0.7	4.4±0.7	4.5±1.1
July 1982	77316	Water	I-131	5.5±0.3	5.4±0.8	5.7±1.5
Aug 1982	78175	Water	I-131	88±2	87±9	86±10
Dec 1982	90378	Water	I-131	40±3	37±6	38±5

TABLE E-5

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

DATE	RMC #	SAMPLE TYPE	ANALYSIS	RMC MEAN±s.d.	EPA MEAN±s.d.	All Participants MEAN±s.d.
Jan 1982	66079	Water	Sr-89	15±1	21±5	20±4
			Sr-90	12±1	12±2	11±2
March 1982	70631	APT	Sr-90	28±6 (a)	16±1	16±2
April 1982	72020	Water	Sr-89	14±8 (a)	24±5	24±4
			Sr-90	10±1	12±2	12±2
April 1982	72074	Milk	Sr-89	<23	25±5	22±5
			Sr-90	<26	16±2	14±3
May 1982	73333	Water	Sr-89	17±2	22±5	22±5
			Sr-90	13±2	13±2	12±2
July 1982	76127	Food	Sr-89	22±11	26±5	29±7
			Sr-90	18±8	20±5	23±2
Sept 1982	80211	Water	Sr-89	19±1	25±5	24±4
			Sr-90	15±1	15±2	14±2
Sept 1982	81457	APT	Sr-90	17±1	20±2	17±2
Oct 1982	83052	Water	Sr-89	<5	0	13±20
			Sr-90	12±1	17±2	16±2
Oct 1982	83535	Milk	Sr-89	<5	0	3±3
			Sr-90	17±1	19±2	17±3
Nov 1982	84177	Food	Sr-89	16±2	0	7±13
			Sr-90	22±17	28±2	26±7
Nov 1982	91763	APT	Sr-90	16±1	16±2	16±2

(1) Results reported in pCi/l for water and milk, pCi/filter for air particulates, and pCi/kg for food.

(a) A new strontium procedure was introduced in March 1982. These intercomparison samples were analyzed in the testing stage and showed the need for retraining in separation technique.

APPENDIX F

SYNOPSIS OF DAIRY & VEGETABLE GARDEN SURVEY

APPENDIX F

SYNOPSIS OF DAIRY & VEGETABLE GARDEN SURVEY

A door-to-door survey of dairy farms within 5 miles of SNGS was performed in April and July. The results of the April survey were as follows:

One dairy farm, situated 4.4 miles from SNGS in the NNE sector was located.

One dairy farm, situated 4.9 miles from SNGS in the west sector was located.

The results of the July survey were as follows:

No change from April survey.

Since dairy farms were located within 5 miles of the site, the vegetable garden survey was performed to a distance of one mile. No vegetable gardens were found in this area.