RTL-ENV-85-01

ARTIFICIAL ISLAND RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

1984 RADIOLOGICAL REPORT
JANUARY 1 TO DECEMBER 31, 1984

Prepared for

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

By

PSE&G RESEARCH CORPORATION
RESEARCH AND TESTING LABORATORY

MARCH 1985

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SUMMARY

During the period from January 1 through December 31, 1984, the Research and Testing Laboratory (RTL), PSE&G Research Corporation, has been responsible for the collection and analysis of all samples and the maintenance of sampling equipment for SGS connected with the Operating Radiological Environmental Monitoring Program at Artificial Island, Salem County, New Jersey.

Salem Generating Station (SGS) Unit One 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 Two achieved initial criticality on August 2, 1980. During the operational phase, the program will monitor the operations of SGS Units One and Two, will fulfill the requirements of the SGS 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 1984.

A total of 4305 analyses were performed on 1626 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 manmade, were found in the above samples. An elevated level of two radionuclides was found in one sediment/benthic organism sample. Subsequent sampling of the indicators in the estuarine food-chain were at levels similar to those found during the peroperational phase of this program. It can be concluded that the radiological characteristics of the environment around Artificial Island during 1984 were not adversely affected by the operation of SGS Units One and Two.

INTRODUCTION

Artificial Island is the site of Salem Generating Station (SGS) which consists of two operating pressurized water nuclear power reactors. Unit One has a net rating of 1090 MWe (3338 MWt), and Unit Two is rated at 1115 MWe (3411 MWt).

Artificial Island is a man-made peninsula on the east bank of the Delaware River and was created by the deposition of hydraulic fill from dredging operations. It is located in Lower Alloways Creek Township, Salem County, New Jersey. The environment surrounding Artificial Island is characterized mainly by the Delaware River and Bay, extensive tidal marshlands, and low-lying meadowlands. These land types make up approximately 85% of the land area within five miles of the site. Most of the remaining land is used for agriculture [13]. More specific information on the demography, hydrology, meteorology, and land use of the area may be found in the Environmental Report [13], Environmental Statement [14], and the Final Safety Analysis Report for SGS [15].

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

From January 1973, through June 1983, Radiation Management Corporation (RMC) had primary responsibility for the analysis of all samples under the Artificial Island REMP and the annual reporting of results. RMC reports for the the preoperational phase from 1973 to 1976 and for the operational phase from 1976 through 1982 are referenced in this report [1-11]. On July 1, 1983, the RTL assumed primary responsibility for the analysis of all samples (except TLD's) and the reporting of results. Teledyne Isotopes (TI), Westwood, NJ, at that time was made responsible for third-party QA analyses and TLD's.

This report summarizes the results from January 1 through December 31, 1984 for the Artificial Island Radiological Environmental Monitoring Program.

THE PROGRAM

The operational phase of the REMP is conducted in accordance with Section 3.2 of the Environmental Technical Specifications for SGS Units 1 and 2 [16,17]. An overview of this program is provided in Table 1. Radioanalytical data from samples collected under this program were compared with results from the preoperational phase. Differences between these periods were examined statistically, where applicable, to determine the effects, if any, of station operations.

Objectives

The objectives of the operational radiological environmental program are:

1. To fulfill the obligations of the Radiological Surveillance sections of the Environmental Technical Specifications for Salem Generating Station (SGS).

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

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

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

5. To verify that SGS 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 1984 REMP. Results of the four-year preoperational program have been summarized for purposes of comparison with subsequent operational reports [4].

TABLE -1

1984 ARTIFICIAL ISLAND RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

MEDIUM	STATION CODE INDICATOR	STATION CODE CONTROL	COLLECTION FREQUENCY	TYPE/FREQUENCY* OF ANALYSIS
I. ATMOSPHERIC ENVIRONMENT				
a. Air Particulate	2S2 5D1 16E1 1F1 5S1 10D1 2F2	3H3	Weekly	Gross alpha/weekly Gross beta/weekly Sr-89 & -90/quarterly Gamma scan/quarterly
b. Air Iodine	2S2 5D1 16E1 1F1 5S1 10D1 2F2	3H3	Weekly	Iodine-131/weekly
c. Precipitation	2F2		Monthly	Gross alpha/monthly Gross beta/monthly Tritium/monthly Sr-89 & -90/quarterly Gamma scan/quarterly
II. DIRECT RADIATION				
a. Thermoluminescent Dosimeters	2S2 5D1 2E1 1F1 5S1 10D1 3E1 2F2 6S2 14D1 13E1 2F6 7S1 16E1 5F1 10S1 6F1 11S1 7F2 11F1 13F1/4	3G1 3H1 3H3	Monthly & Quarterly	Gamma dose/monthly Gamma dose/quarterly

TABLE -1 (cont'd)

1984 ARTIFICIAL ISLAND RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

MEDIUM	STATION CODE INDICATOR	STATION CODE CONTROL	COLLECTION FREQUENCY	TYPE/FREQUENCY* OF ANALYSIS
a. Thermoluminescent Dosimeters (cont'd)	4D2 9E1 2F5 11E2 3F2 12E1 3F3 10F2 12F1 13F2 13F3 14F2 15F3 16F2	1G3 10G1 16G1	Quarterly	Gamma dose/quarterly
III. TERRESTRIAL ENVIRONMENT				
a. Milk	13E3 2F4 5F2 14F1 15F1	3G1	Semi-monthly	Iodine-131/semi-monthly Sr-89 & -90/monthly Gamma scan/monthly
b. Well Water	2S3 5D1	3E1	Monthly	Gross alpha/monthly Gross beta/monthly Potassium-40/monthly Tritium/monthly Sr-89 & -90/quarterly Gamma scan/quarterly

TABLE -1 (cont'd)

1984 ARTIFICIAL ISLAND RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

MEDIUM	STATION CODE INDICATOR	STATION CODE CONTROL	COLLECTION FREQUENCY	TYPE/FREQUENCY* OF ANALYSIS
c. Potable Water (Raw & Treated)	2F3		Monthly (Composited daily)	Gross alpha/monthly Gross beta/monthly Potassium-40/monthly Tritium/monthly Sr-89 & -90/quarterly Gamma Scan/quarterly
d. Vegetables	5D1 2E1 1F3 4F1 5F1 14F3	1G1 3H5	Annually (At Harvest)	Sr-89 & -90/on collection Gamma scan/on collection
e. Game (Muskrat)	3E1	11D1	Semi-annually	Sr-89 & -90 (bones)/on collection Gamma scan (flesh)/on collection
f. Beef	3E1		Semi-annually	Gamma scan/on collection
g. Bovine Thyroid	3E1		Semi-annually	Gamma scan/on collection
h. Fodder Crops	3E1 2F4 5F2 14F1 15F1	3G1	Annually	Gamma scan/on collection

TABLE -1 (cont'd)

1984 ARTIFICIAL ISLAND RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

MEDIUM	STATION CODE INDICATOR	STATION CODE CONTROL	COLLECTION FREQUENCY	TYPE/FREQUENCY* OF ANALYSIS
IV. AQUATIC ENVIRONMENT				
a. Surface Water	11A1 7E1 1F2 16F1	12C1	Monthly	Gross alpha/monthly Gross beta/monthly Tritium/monthly Sr-89 & -90/quarterly Gamma scan/monthly
b. Edible Fish	11A1 7E1	12C1	Semi-annually	Tritium in Aqueous fraction/on collection Organic fraction/on collection Sr-89 & -90 (bones)/on collection Gamma scan (flesh)/on collection
c. Blue Crabs	11A1	12C1	Semi-annually	Tritium (flesh)/on collection Sr-89 & -90 (shell)/on collection Sr-89 & -90 (flesh)/on collection Gamma scan (flesh)/on collection
d. Benthic Organisms	11A1 7E1 16F1	12C1	Semi-annually	Sr-89 & -90/on collection Gamma scan/on collection
e. Sediment	11A1 7E1 16F1	12C1	Semi-annually	Sr-90/on collection Gamma scan/on collection

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

Sample Collection

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

Sampling locations were divided into two classes - indicator and control. Indicator stations are those which are expected to manifest station effects, if any exist; control samples are collected at locations which are believed to be unaffected by station operations. Fluctuations in the levels of radionuclides and direct radiation at indicator stations are evaluated with respect to analogous fluctuations at control stations. Indicator and control station data are also evaluated relative to preoperational data. 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-impregnated charcoal cartridges connected in series after the air particulate filters. Air sample volumes were measured with calibrated dry-gas meters and were corrected to standard temperature and pressure.

Precipitation was collected in a Wong Laboratory Automatic Precipitation Collector having a 95 square inch collection area. The collector is automatically covered during periods of no precipitation to exclude fallout resulting from dry deposition. Samples were collected monthly and transferred to new polyethylene bottles. The collector was rinsed with distilled water to include residual particulates in the precipitation samples. Tritium results were corrected for the tritium content of the distilled water.

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

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

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

Milk samples were taken semi-monthly in new polyethylene containers. Food products, fodder crops, game, beef, and bovine thyroid were sealed in new plastic bags or jars. All perishable samples were transported in ice chests, and no preservatives were added.

Appendix A describes and summarizes, in the format of Table 5.6-1 of the Salem ETS, the entire operational program as performed in 1984. Appendix B describes the coding system which identifies sample type and location. Table B-1 lists the sampling stations and the types of samples collected at each station. These sampling stations are indicated on maps B-1 and B-2.

Data Interpretation

Results of all analyses were grouped according to the analysis performed for each type of sample and are presented in the data tables in Appendix C. All results above the lower limit of detection (LLD) are at a confidence level of ± 2 sigma. This represents the range of values into which 95% of repeated analyses of the same sample should fall. As defined in Regulatory Guide 4.8, LLD is the smallest concentration of radioactive material in a sample that will yield a net count (above system background) that will be detected with 95% probability with only 5% probability of falsely concluding that a blank observation represents a "real signal". LLD is normally calculated as 4.66 times one standard deviation of the background count or of the blank sample count as appropriate.

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

Grab sampling is a useful and acceptable procedure for taking environmental samples of a medium in which the concentration of radionuclides is expected to vary slowly with time or where intermittent sampling is deemed sufficient to establish the radiological characteristics of the medium. This method, however, is only representative of the sampled medium for that specific location and instant of time. As a result, variation

in the radionuclide concentrations of the samples will normally occur. Since these variations will tend to counterbalance one another, the extraction of averages based upon repetitive grab samples is considered valid.

Quality Assurance Program

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

The quality of the results obtained by the RTL is insured by the implementation of the Quality Assurance Program as described in the Environmental Division Quality Assurance Manual [19] and the Environmental Division Procedures Manual [20]. The internal quality control activity of the Laboratory includes the quality control of instrumentation, equipment, and reagents, the use of reference standards in calibration, documentation of established procedures and computer programs, and analysis of duplicate and spiked samples. The external quality control activity is implemented through participation in the USEPA Laboratory Intercomparison Studies Program. These results are listed in Tables E-1 through E-6 in Appendix E.

Program Changes

TLD location 13F1 was relocated to an adjacent site and designated 13F4 on March 27, 1984. This move became necessary when the new owners of the building upon which the TLD was mounted began renovation work.

An additional leafy vegetable location (14F1) became available in 1984 and was added to the program.

Vegetable control location 3H4 which is no longer growing crops was replaced by location 3H5.

RESULTS AND DISCUSSION

The analytical results of the 1984 REMP samples are divided into categories based on exposure pathways: atmospheric, direct, terrestrial, and aquatic. The analytical results for the 1984 REMP are summarized in Appendix A. The data for individual samples are presented in Appendix C.

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

Atmospheric

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

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 and gross beta. Quarterly composites of the weekly samples from each station were analyzed for Sr-89, Sr-90 and specific gamma emitters.

Concentrations were detected in 366 of the 424 weekly samples analyzed for gross alpha emitters (Table C-1). Alpha concentrations ranged from 0.7 to 4.7 x 10^{-3} pCi/m^3 with the grand average for all stations being 1.9 x 10^{-3} pCi/m^3. Three analyses exhibited high uncertainties due to low sample volumes.

Analysis of weekly air particulate samples for gross beta (Table C-2) indicated concentrations ranging from 6.0 x 10^{-3} to 44 x 10^{-3} pCi/m^3 with the grand average for all stations being 24 x 10^{-3} pCi/m^3. Figure 1 indicates the relation between gross beta activity in air particulates and precipitation for the preoperational and operational periods, including the effects of atmospheric weapons testing.

Of the 32 monthly-composited samples analyzed for strontium-89, only one (control station) had a detectable level of 1.1 x 10^{-3} pCi/m^3. There was no Sr-90 detectable activity. LLD's for Sr-89 ranged from 0.2 x 10^{-3} to 2.0 x 10^{-3} pCi/m^3 and, for Sr-90, from 0.1 x 10^{-3} to 0.6 x 10^{-3} pCi/m^3.

Results of gamma spectrometry indicated detectable levels of Be-7 in all of the 32 monthly composites with a maximum of 79 x 10^{-3} pCi/m^3. Be-7 is a naturally occurring radionuclide attributed to cosmic ray activity in the atmosphere. Traces of Cr-51, Mn-54, Co-58, Fe-59, Te-129m, Ra-226 and Th-232 were detected in 5 samples; all of these activities were below the maximum LLD's for these radionuclides.

Air Iodine (Table C-4)

Cartridges for the adsorption of air iodine were connected in series after each of the air particulate filters. The adsorption media in these cartridges is triethylenediamine (TEDA) impregnated charcoal. All results for I-131 ranged from <4.1 x 10^{-3} to <56 x 10^{-3} pCi/m^3. In addition, one did not meet minimum sensitivity of 60 x 10^{-3} pCi/m^3.

FIGURE 1

COMPARISON OF AVERAGE CONCENTRATIONS OF BETA EMITTERS IN PRECIPITATION AND IN AIR PARTICULATES, 1973 THROUGH 1984

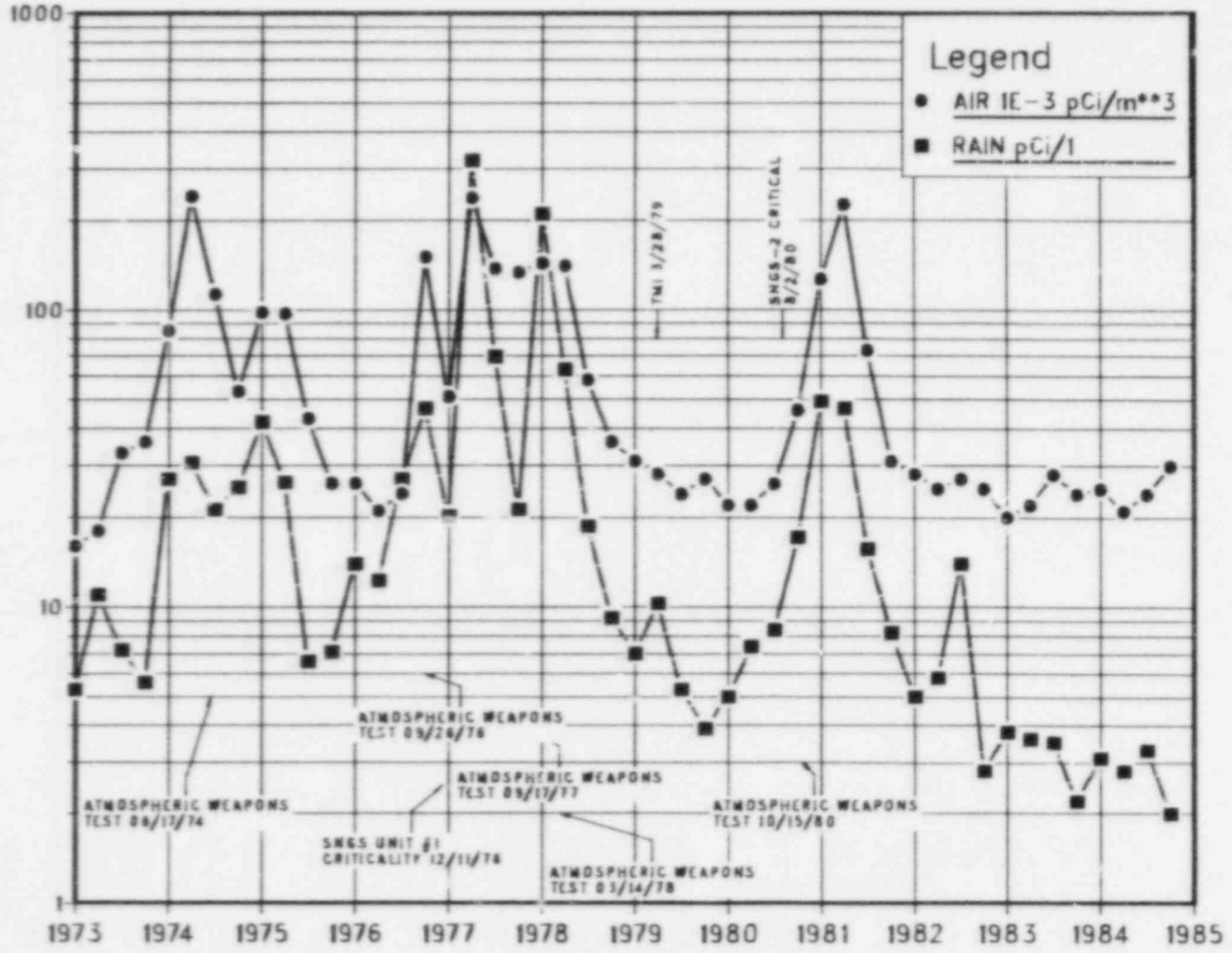
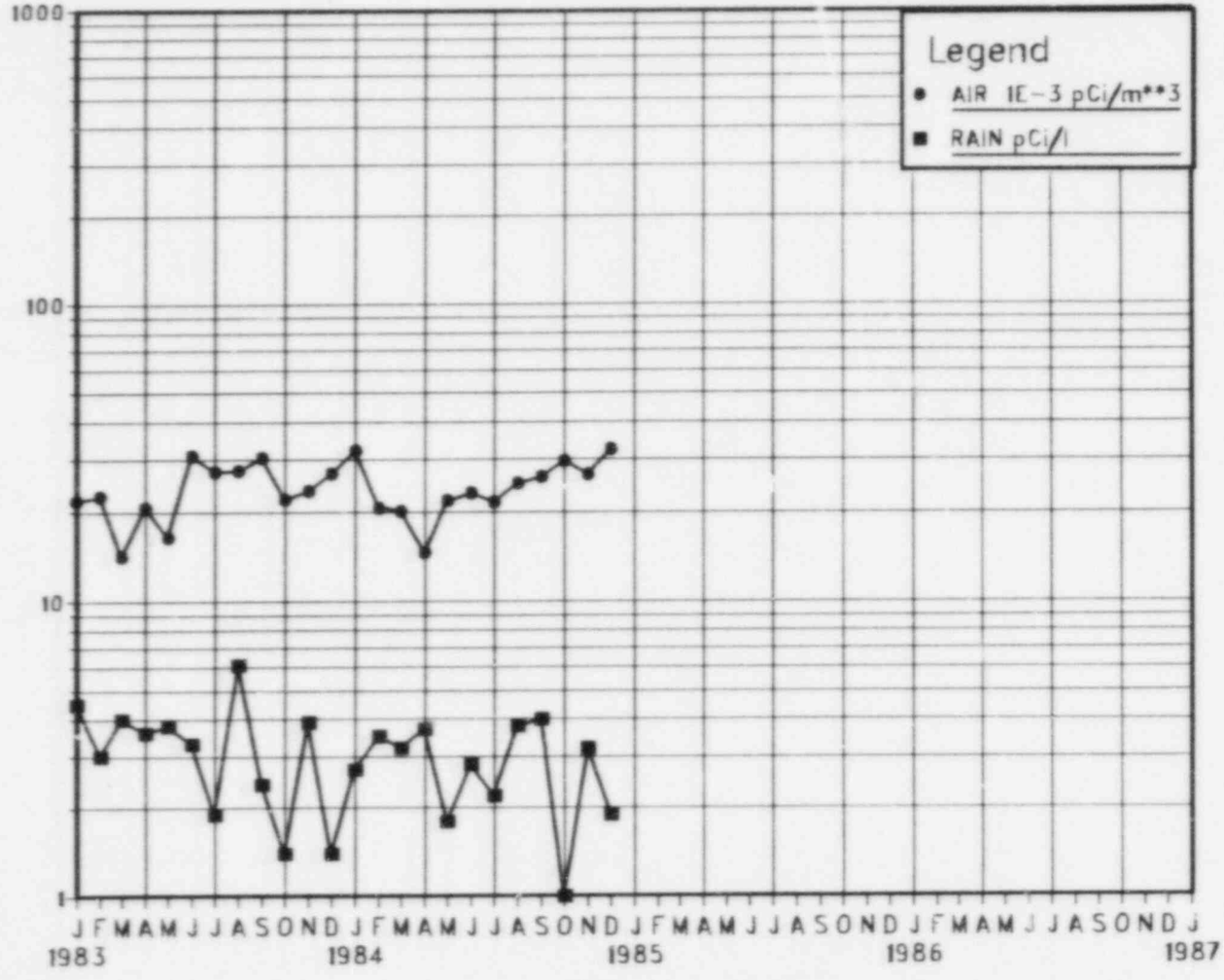


FIGURE 1A

COMPARISON OF AVERAGE CONCENTRATIONS OF BETA EMITTERS IN PRECIPITATION AND IN AIR PARTICULATES 1983 THROUGH 1984



Precipitation (Tables C-6, C-7)

Although not required by the Salem ETS, precipitation samples were collected at 2F2 in the town of Salem. Monthly samples were analyzed for gross alpha, gross beta, and tritium. Alpha activities in 4 samples ranged from 0.8 to 2.4 pCi/L, with LLD's in 8 samples from 0.8 to 1.9 pCi/L. Beta activity in eleven of the monthly samples ranged from 1.0 to 4.0 pCi/L, with an LLD in one sample of <2.7 pCi/L. Tritium was detected in three samples at levels ranging from 140 to 150 pCi/L; this is below the required sensitivity of 200 pCi/L.

Quarterly composites were analyzed for radiostrontium and gamma emitters. Neither Sr-89 nor Sr-90 was detected. Be-7 at concentrations of 25 to 39 pCi/L was found in the quarterly samples. In addition, Ra-226 at 5.6 pCi/L and Th-232 at 7.8 pCi/L was seen in the fourth quarterly sample.

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

A total of 41 locations were monitored for direct radiation during 1984, including 6 on-site locations, 29 off-site locations within the 10 mile zone, and 6 control locations beyond 10 miles. Monthly and quarterly measurements were made at the 6 on-site stations and at 15 off-site indicator stations, and 3 control stations. An additional 14 quarterly measurements were taken at schools and population centers with 3 additional controls beyond the 10 mile zone in Delaware.

Four readings for each TLD at each location were taken in order to obtain a more statistically valid result. The average dose rate for the 15 monthly off-site indicator TLD's was 5.8 millirads per standard month, and the corresponding averaged control dose rate was 6.4 millirads per standard month. The average dose rate for the 29 quarterly off-site indicator TLD's was 5.5 millirads per standard month, and the averaged control rate was 6.1. For these measurements, the rad is considered equivalent to the rem, in accordance with 10CFR20.4.

In Figure 2, the average radiation levels are plotted for the 12 year period through 1984. Figure 2A shows the monthly averages of the off-site indicator stations and the control stations for 1982 through 1984. An increase in ambient radiation levels over those of 1983 for both indicator and control locations was noted for the months of February, May and June while the other months indicated a decrease. The annual averages for both off-site indicators and controls were slightly lower than those in 1983.

FIGURE 2

AVERAGE AMBIENT RADIATION LEVELS FROM QUARTERLY TLDS IN THE VICINITY OF ARTIFICIAL ISLAND, 1973 THROUGH 1984

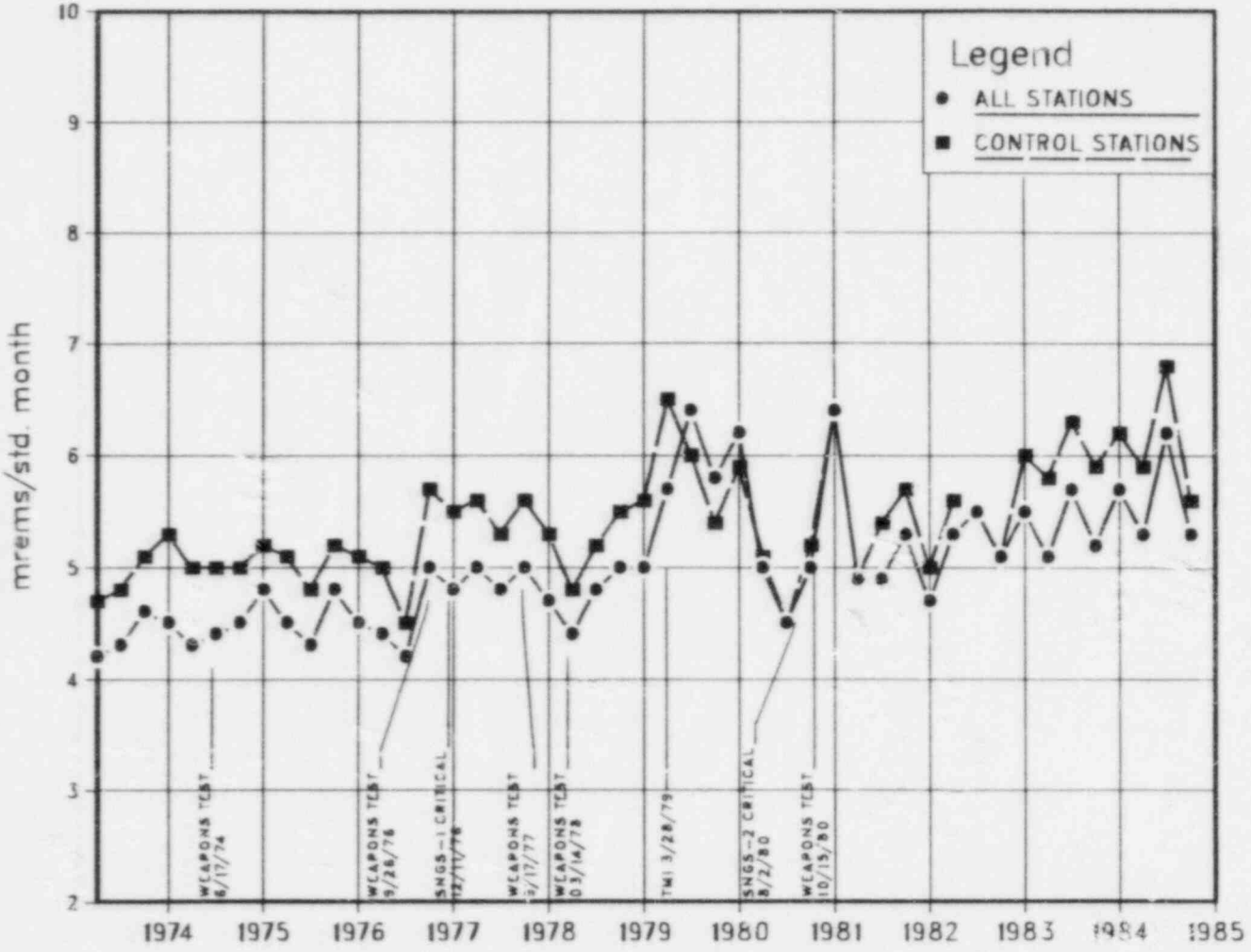
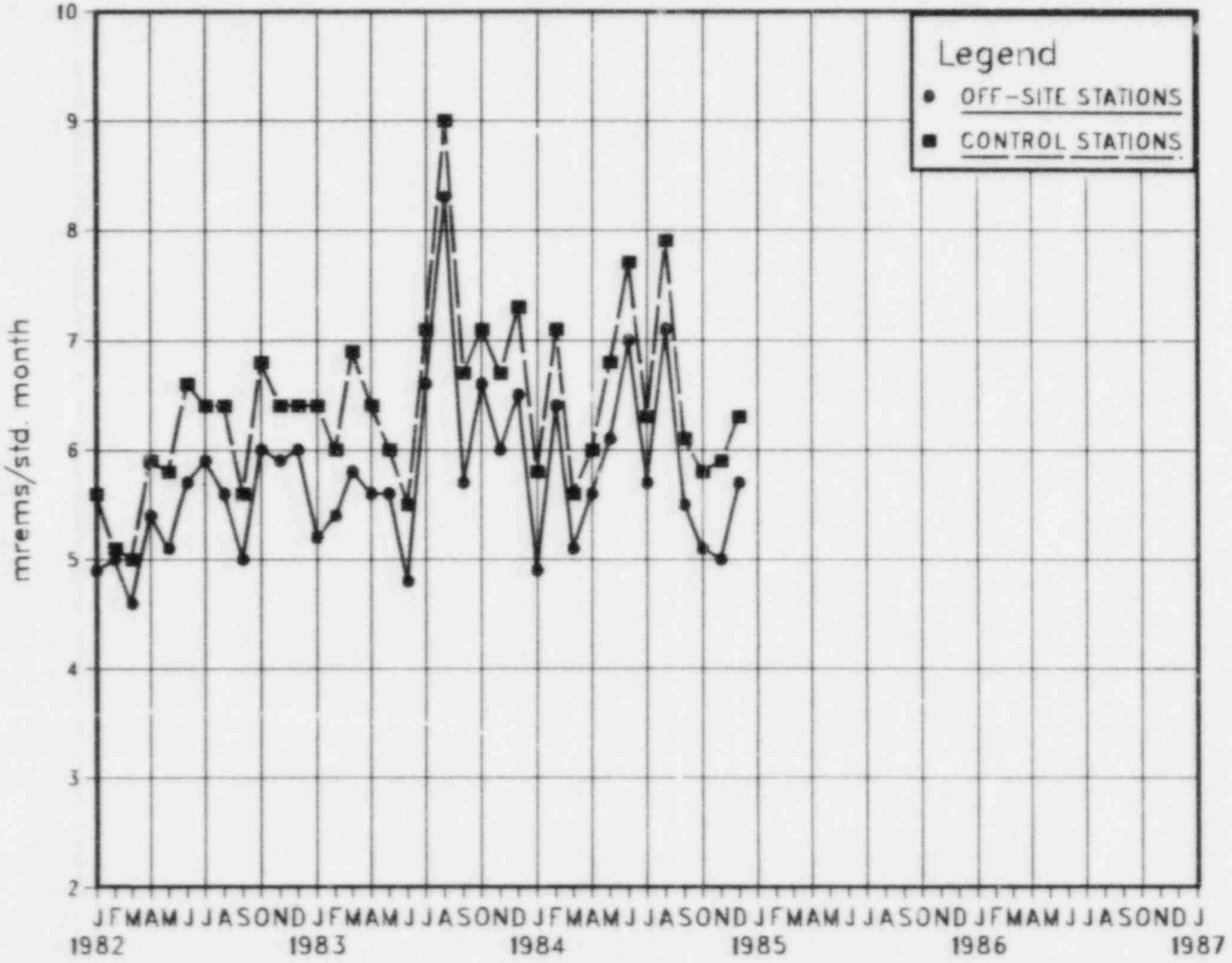


FIGURE 2A

COMPARISON OF AMBIENT RADIATION LEVELS OF OFF-SITE INDICATOR STATIONS VS. CONTROL STATIONS 1982 THROUGH 1984



Terrestrial

Milk (Tables C-10, C-11, C-12, C-13)

Milk samples were collected twice each month at six local dairy farms. Each sample was analyzed for I-131 and the first collection each month was also analyzed for Sr-89 and -90 and gamma emitters. Figure 3A indicates that I-131 was not detected in any sample during 1984. Table C-10 lists the results and shows that sensitivities ranged from <0.1 to <0.2 pCi/L.

Strontium-89 was not detected in any of the samples; LLD values ranged from <0.8 to <2.0 pCi/L. Strontium-90 was found in all of the samples analyzed. The Sr-90 annual mean for the indicator locations was 2.4 pCi/L with a range of 1.2 to 5.3 pCi/L; annual mean for the control location was 3.2 pCi/L with a range of 2.2 to 4.9 pCi/L.

Gamma spectrometry showed detectable concentrations of K-40 in all samples and Cs-137 in eleven of the sixty indicator locations and none was detected in the twelve samples from the control location. The annual mean concentration of K-40 for the indicator locations was 1347 pCi/L with a range of 1200 to 1500 pCi/L; K-40 mean for the control location was 1380 pCi/L with a range of 1300 to 1500 pCi/L. The annual mean of Cs-137 for the indicator locations was 3.1 pCi/L with a range of 1.8 to 6.2 pCi/L; preoperational levels ranged from <0.4 to 14 pCi/L with an average of 3.0 pCi/L. Traces of Na-22, Mn-54, La-140, Ra-226 and Th-232 was detected at levels near or below the LLD values in seven of the 72 samples analyzed.

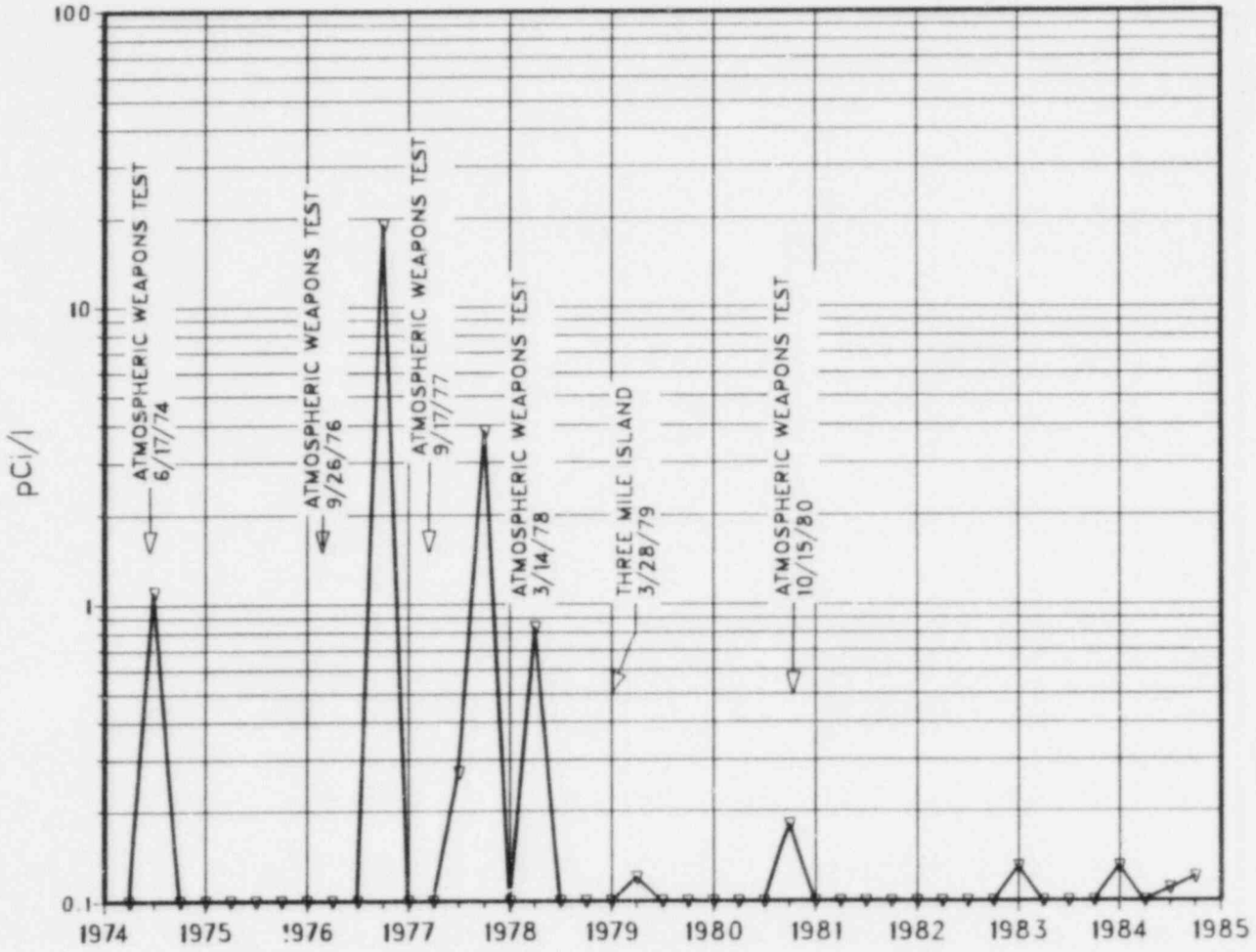
Well Water (Tables C-14, C-15)

Well water samples were collected monthly from two indicator wells and one control well. Each sample was analyzed for gross alpha, gross beta, tritium and potassium-40. Quarterly composites were analyzed for radiostrontium and gamma emitters.

Gross alpha concentrations from 0.9 to 2.0 pCi/L were detected in six of the indicator samples, with LLD sensitivities for the other analyses ranging from <0.6 to <1.9 pCi/L. Gross beta activity was detected in all of the samples. The mean activity for the indicator locations was 10 pCi/L with a range of 2.9 to 17 pCi/L; mean activity for the control location was 8.4 pCi/L with a range of 6.0 to 10 pCi/L. K-40 in each monthly sample was determined by atomic absorption spectroscopy. Mean activity for the indicator locations was 11 pCi/L with a range of 2.8 to 28 pCi/L, and mean activity for the control location was 8.4 pCi/L with a range of 5.5 to 9.3 pCi/L. All tritium results were at LLD levels of <130 to <140 pCi/L. Strontium-89 was detected in one indicator location sample at 0.9 pCi/L; LLD values ranged from <0.4 to <0.6 pCi/L. Sr-90 was not detected in any of the samples; LLD values ranged from <0.4 to <0.5 pCi/L.

FIGURE 3

AVERAGE CONCENTRATIONS OF IODINE–131 IN MILK IN THE VICINITY OF ARTIFICIAL ISLAND, MAY 1974 THROUGH 1984



[14] United States Atomic Energy Commission. "Final Environmental Statement - Salem Nuclear Generating Station, Units 1 and 2". Docket No. 50-272 and 50-311, 1973.

[15] Public Service Electric and Gas Company. "Updated Final Safety Analysis Report - Salem Nuclear Generating Station, Units 1 and 2". 1982.

[16] Public Service Electric and Gas Company. "Environmental Technical Specifications - Salem Nuclear Generating Station Units 1 and 2", Appendix B to Operating License DPR-70, 1976 (through Amendment 58).

[17] Public Service Electric and Gas Company. "Environmental Technical Specifications - Salem Nuclear Generating Station Unit 2", Appendix B to Facility Operating License No. DPR-75, 1981 (through Amendment 27).

[18] U. S. Environmental Protection Agency. "Prescribed Procedures for Measurement of Radioactivity in Drinking Water." EPA-600/4-80-032, August, 1980.

[19] PSE&G Research Corporation, Research and Testing Laboratory. "Environmental Division Quality Assurance Manual." September, 1980.

[20] PSE&G Research Corporation, Research and Testing Laboratory. "Environmental Division Procedures Manual." February, 1981.

[21] Public Service Electric and Gas Company. "Radioactive Effluent Release Report, RERR-16 - Salem Generating Station, Units 1 and 2". 1984.

APPENDIX A

PROGRAM SUMMARY

ARTIFICIAL ISLAND RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

SALEM NUCLEAR GENERATING STATION DOCKET NO. 50-272/-311

SALEM COUNTY, NEW JERSEY JANUARY 1, 1984 to DECEMBER 31, 1984

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	LOCATION WITH HIGHEST MEAN MEAN (RANGE)	CONTROL LOCATION(S) MEAN (RANGE)	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Precipitation (pCi/L)	Alpha 12	0.8	1.5 (4/12) (0.8-2.4)	2F2 8.7 mi NNE	1.5 (4/12) (0.8-2.4)	No Control Location	0
	Beta 12	2.7	2.8 (11/12) (1.0-4.0)	2F2 8.7 mi NNE	2.8 (11/12) (1.0-4.0)	No Control Location	0
	H-3 12	130	143 (3/12) (140-150)	2F2 8.7 mi NNE	143 (3/12) (140-150)	No Control Location	0
	Sr-89 4	0.5	<LLD	-	<LLD	No Control Location	0
	Sr-90 4	0.4	<LLD	-	<LLD	No Control Location	0
	Gamma						
	Be-7 4	-	34 (4/4) (25-39)	2F2 8.7 mi NNE	34 (4/4) (25-39)	No Control Location	0
	Ra-226 4	1.3	5.6 (1/4) (5.6)	2F2 8.7 mi NNE	5.6 (1/4) (5.6)	No Control Location	0
	Th-232 4	2.2	7.8 (1/4) (7.8)	2F2 8.7 mi NNE	7.8 (1/4) (7.8)	No Control Location	0
Direct Radiation (mrad/std. month)	Gamma 287 Dose (monthly)	-	5.9 (251/251) (3.5-11.3)	1IS1 0.09 mi SW	6.8 (12/12) (4.7-11.3)	6.4 (36/36) (5.2-8.5)	0
	Gamma 163 Dose (qtrly.)	-	5.5 (139/139) (3.5-8.7)	1G3 19 mi N	6.7 (4/4) (6.0-7.2)	6.1 (24/24) (5.0-7.2)	0

ARTIFICIAL ISLAND RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

SALEM NUCLEAR GENERATING STATION DOCKET NO. 50-272/-311

SALEM COUNTY, NEW JERSEY JANUARY 1, 1984 to DECEMBER 31, 1984

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(S) MEAN (RANGE)	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Air Particulates (10^{-3} pCi/m^3)	Alpha	424	0.6	2.0 (315/371) (0.7-4.7)	16E1 4.1 mi NNW	2.2 (50/53) (0.8-4.7)	2.0 (51/53) (0.8-3.7)	0
	Beta	424	3.0***	24 (371/371) (10-44)	16E1 4.1 mi NNW	26 (53/53) (12-43)	24 (53/53) (6.0-41)	0
	Sr-89	32	0.2	<LLD	3H3 110 mi NE	1.1 (1/4) (1.1)	1.1 (1/4) (1.1)	0
	Sr-90	32	0.1	<LLD	-	<LLD	<LLD	0
	Gamma							
	Be-7	32	-	64 (28/28) (52-79)	5D1 3.5 mi E	73 (4/4) (63-79)	60 (4/4) (52-69)	0
	Cr-51	28	1.9	2.0 (1/24) (2.0)	2S2 0.4 mi NNE	2.0 (1/4) (2.0)	<LLD	0
	Mn-54	32	0.1	0.7 (1/28) (0.7)	16E1 4.1 mi NNW	0.7 (1/4) (0.7)	<LLD	0
	Co-58	32	0.2	0.3 (1/28) (0.3)	2S2 0.4 mi NNE	0.3 (1/4) (0.3)	<LLD	0
	Fe-59	32	0.3	1.0 (1/28) (1.0)	5S1 1.0 mi E	1.0 (1/4) (1.0)	<LLD	0
	Te-129m	28	2.5	15 (1/24) (15)	5S1 1.0 mi E	15 (1/4) (15)	<LLD	0
	Ra-226	32	0.4	0.9 (1/28) (0.9)	16E1 4.1 mi NNW	0.9 (1/4) (0.9)	<LLD	0
	Th-232	28	1.0	1.4 (2/24) (1.3-1.6)	16E1 4.1 mi NNW	1.6 (1/4) (1.6)	<LLD	0
Air Iodine (10^{-3} pCi/m^3)	I-131	424	4.1	<LLD	-	<LLD	<LLD	0

REFERENCES

[1] Radiation Management Corporation. "Salem Nuclear Generating Station - Radiological Environmental Monitoring Program - 1973". RMC-TR-74-09, 1974.

[2] Radiation Management Corporation. "Artificial Island Radiological Environmental Monitoring Program - 1974 Annual Report". RMC-TR-75-04, 1975.

[3] Radiation Management Corporation. "Artificial Island Radiological Environmental Monitoring Program - 1975 Annual Report". RMC-TR-76-04, 1976.

[4] Radiation Management Corporation. "Artificial Island Radiological Environmental Monitoring Program - Preoperation Summary - 1973 through 1976". RMC-TR-77-03, 1978.

[5] Radiation Management Corporation. "Artificial Island Radiological Environmental Monitoring Program - December 11 to December 31, 1976". RMC-TR-77-02, 1977.

[6] Radiation Management Corporation. "Artificial Island Radiological Environmental Monitoring Program - 1977 Annual Report". RMC-TR-78-04A, 1978.

[7] Radiation Management Corporation. "Artificial Island Radiological Environmental Monitoring Program - 1978 Annual Report". RMC-TR-79-03, 1979.

[8] Radiation Management Corporation. "Artificial Island Radiological Environmental Monitoring Program - 1979 Annual Report". RMC-TR-80-03, 1980.

[9] Radiation Management Corporation. "Artificial Island Radiological Environmental Monitoring Program - 1980 Annual Report". RMC-TR-81-03, 1981.

[10] Radiation Management Corporation. "Artificial Island Radiological Environmental Monitoring Program - 1981 Annual Report". RMC-TR-82-01, 1982.

[11] Radiation Management Corporation. "Artificial Island Radiological Environmental Monitoring Program - 1982 Annual Report". RMC-TR-83-03, 1983.

[12] PSE&G Research Corporation, Research and Testing Laboratory. "Artificial Island Radiological Environmental Monitoring Program - 1983 Annual Report". RTL-ENV-84-01, 1984.

[13] Public Service Electric and Gas Company. "Environmental Report, Operating License Stage - Salem Nuclear Generating Station Units 1 and 2". 1971.

PROGRAM DEVIATIONS

The January surface water sample from all five locations was unavailable due to icing conditions on the river.

The second semi-annual collection of muskrat samples was not obtained. Muskrats are normally trapped during November and December each year. However, in 1984, because of weather conditions and the poor quality of the pelts, muskrats were not available from the trappers.

The second semi-annual collection of beef and bovine thyroid samples was not obtained. Farmers from whose animals the samples are normally obtained did not slaughter from July through December 1984.

Direct radiation measurement results from location 6S2 for September and the third quarter are unavailable; TLDs were missing from the field location.

CONCLUSIONS

The Radiological Environmental Monitoring Program for Salem Generating Station was conducted during 1984 in accordance with the SGS Environmental Technical Specifications. The objectives of the program were met during this period. The data collected assists in demonstrating that SGS Units One and Two 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. Ambient radiation levels were relatively low, averaging about 6.0 mrad/std. month. Except for the Co-58 and Co-60 seen in one sediment/benthic organism sample which did not appear in subsequent analyses of any of the estuarine samples, no unusual radiological characteristics were observed in the environs of Artifical Island. The operation of SGS Units #1 and #2 had no significant effect on the radiological characteristics of the environs of Artifical Island.

Tritium activity in the aqueous fraction of the flesh was detected only in the second semi-annual samples at levels of 300 and 600 pCi/kg-wet with an average of 450 pCi/kg-dry.

Benthic Organisms and Sediment (Tables C-29, C-30)

As required by the Technical Specifications, benthic organisms were separated from the bottom sediment and analyzed for Sr-89 and -90, and gamma emitters. Sr-89 and -90 were not detected in any of the samples. The gamma emitter Ra-226 was found in one sample. It should be noted that, due to the very small sample sizes for all samples (0.1 gram to 0.25 gram dry), satisfactory strontium and gamma sensitivities could not be achieved. The small sample size was also responsible for the extremely high 2-sigma uncertainty for the gamma emitter found.

The benthos samples, which consist of sediment and associated benthic organisms, were collected at the same locations as the benthic organisms, and sample sizes are large enough to obtain more reliable results. Sediment was analyzed for Sr-90 and gamma emitters. The sensitivity requirements of the Salem Environmental Technical Specifications were met.

Levels of Sr-90 were below LLD (<19 to <39 pCi/kg-dry) in all eight samples analyzed. Results of gamma spectrometry indicated the presence of naturally-occurring K-40, Ra-226, and Th-232 in all eight samples with averages of 12000, 910, and 770 pCi/kg-dry respectively. Concentrations of the gamma emitters Mn-54, Co-58, Co-60 and Cs-137 were also detected. Trace quantities of these isotopes were found in releases from the Salem station during 1984 and reported in the semiannual Radioactive Effluent Release Report [21]. The concentrations of Co-58 and Co-60 at location 11A1 for the sample collected May 21, 1984 were 300 pCi/kg-dry and 520 pCi/kg-dry, respectively. These levels were ten times higher than levels measured at control location 12C1, which were <29 pCi/kg-dry for Co-58 and 40 pCi/kg-dry for Co-60. In accordance with our Technical Specifications these results were reported to the USNRC after the results were confirmed by reanalysis. There was no indication of unusual levels of these radionuclides in any of the other estuarine samples for either semiannual period.

Fish (Tables C-26, C-27)

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

Gamma spectrometry of these samples indicated K-40 in all six samples at an average concentration of 2400 pCi/kg-wet with a range of 1200 to 3300 pCi/kg-wet. Cs-137 was noted in one sample at 16 pCi/kg-wet, with LLD sensitivities for the other five samples from <6.2 to <14 pCi/kg-wet.

All six bone samples analyzed for Sr-89 were below LLD of <41 to <190 pCi/kg-dry. Five of the six semi-annual samples analyzed for Sr-90 had detectable concentrations ranging from 62 to 1000 pCi/kg-dry with an average of 380 pCi/kg-dry, the sixth sample was <38 pCi/kg-dry. In 1983 the Sr-90 concentration for three of six samples ranged from 110 to 600 pCi/kg-dry with an average of 347 pCi/kg-dry. The maximum level detected during the preoperational period was 940 pCi/kg-dry with an average of 335 pCi/kg-dry.

Tritium analyses were performed on both aqueous and organic fractions of the flesh portions of these samples. Three of the six samples analyzed for the aqueous fraction of tritium showed detectable activity of 400 pCi/L at the outfall station: 11A1, 400 pCi/L at the downstream station: 7E1, and 300 pCi/L at the control station: 12C1. Only one sample, the control location, had a detectable concentration of tritium for the organic fraction with a result of 120 pCi/L. These results probably cannot be attributed to plant operation since the closest indicator station had a level of tritium in the aqueous fraction comparable to the other two stations and no detectable tritium in the organic fraction.

Blue Crab (Table C-28)

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

A trace of Co-60 in one sample and K-40 in all four samples were the only gamma emitters detected. K-40 levels ranged from 1900 to 2300 pCi/kg-wet with an average of 2100 pCi/kg-wet.

Sr-89 was not detected in either the flesh or the shell. Sr-90 was detected in all four of the shell samples at concentrations of 390 to 860 pCi/kg-dry with an average of 610 pCi/kg-dry. Preoperational average for the shell was 614 pCi/kg-dry.

FIGURE 5A

AVERAGE CONCENTRATIONS OF TRITIUM IN THE DELAWARE RIVER IN THE VICINITY OF ARTIFICIAL ISLAND, 1983 THROUGH 1984

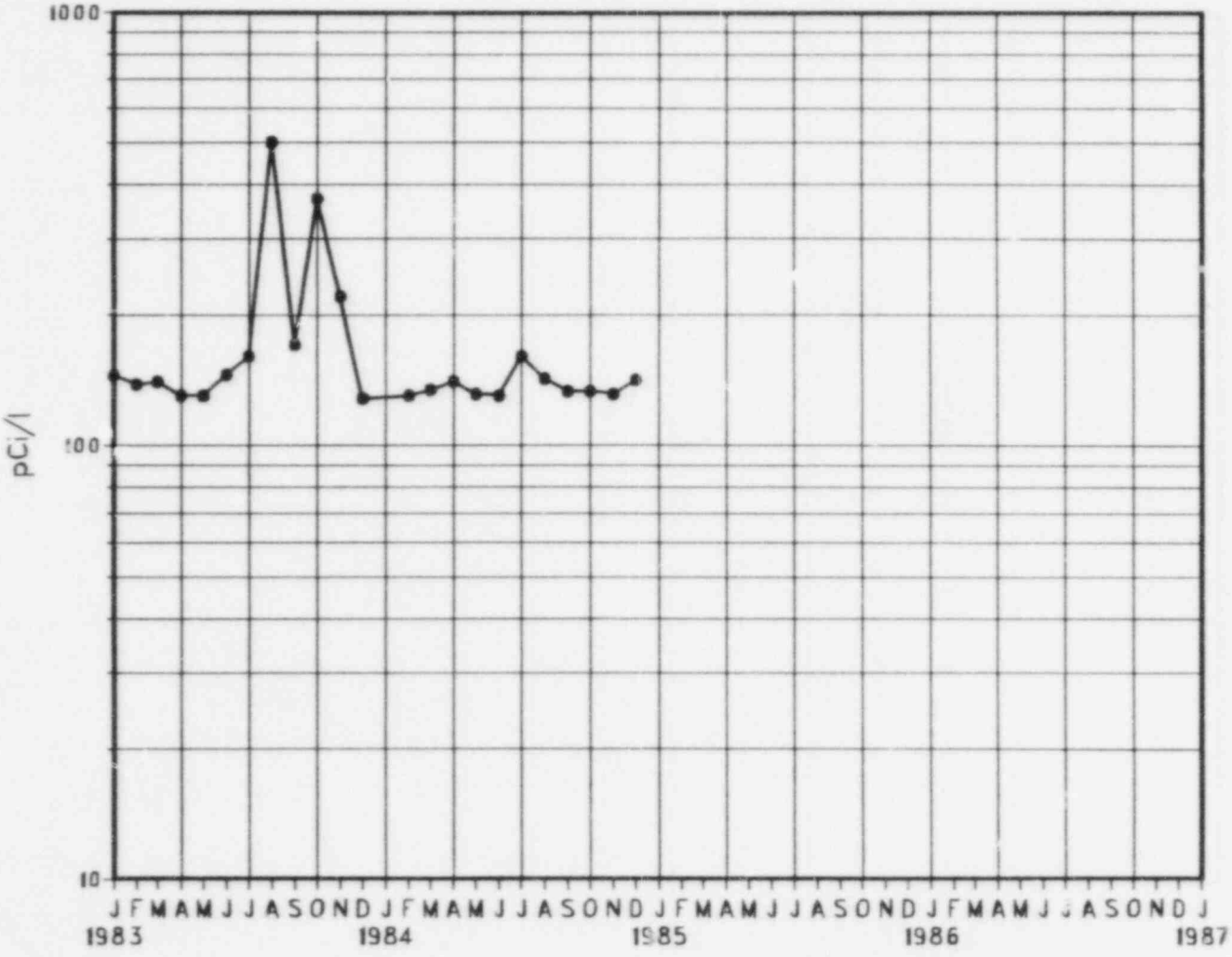


FIGURE 5

AVERAGE CONCENTRATIONS OF TRITIUM IN THE DELAWARE RIVER IN THE VICINITY OF ARTIFICIAL ISLAND, 1973 THROUGH 1984

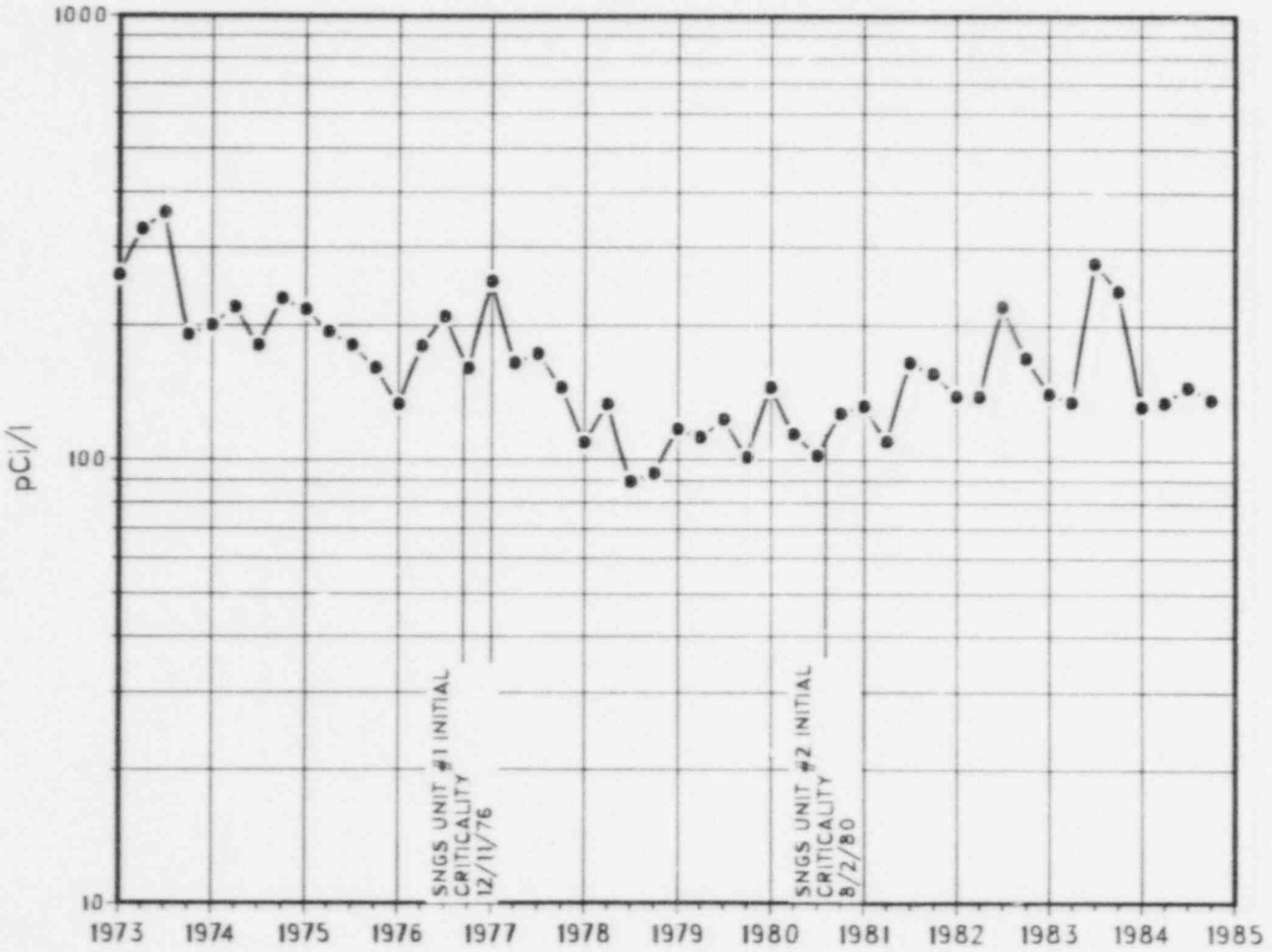


FIGURE 4A

AVERAGE CONCENTRATIONS OF BETA EMITTERS AND POTASSIUM–40 IN THE DELAWARE RIVER IN THE VICINITY OF ARTIFICIAL ISLAND, 1983 THROUGH 1984

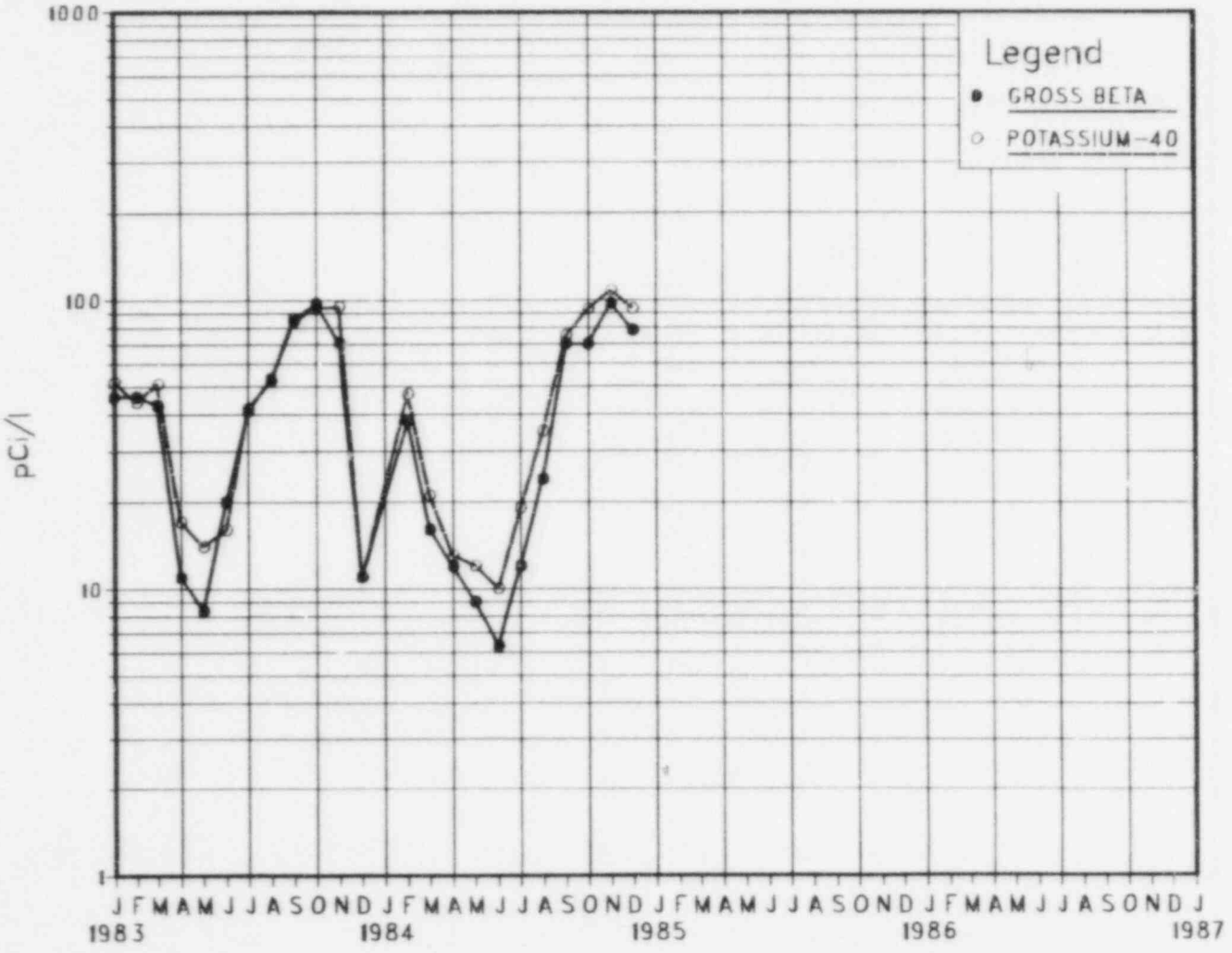
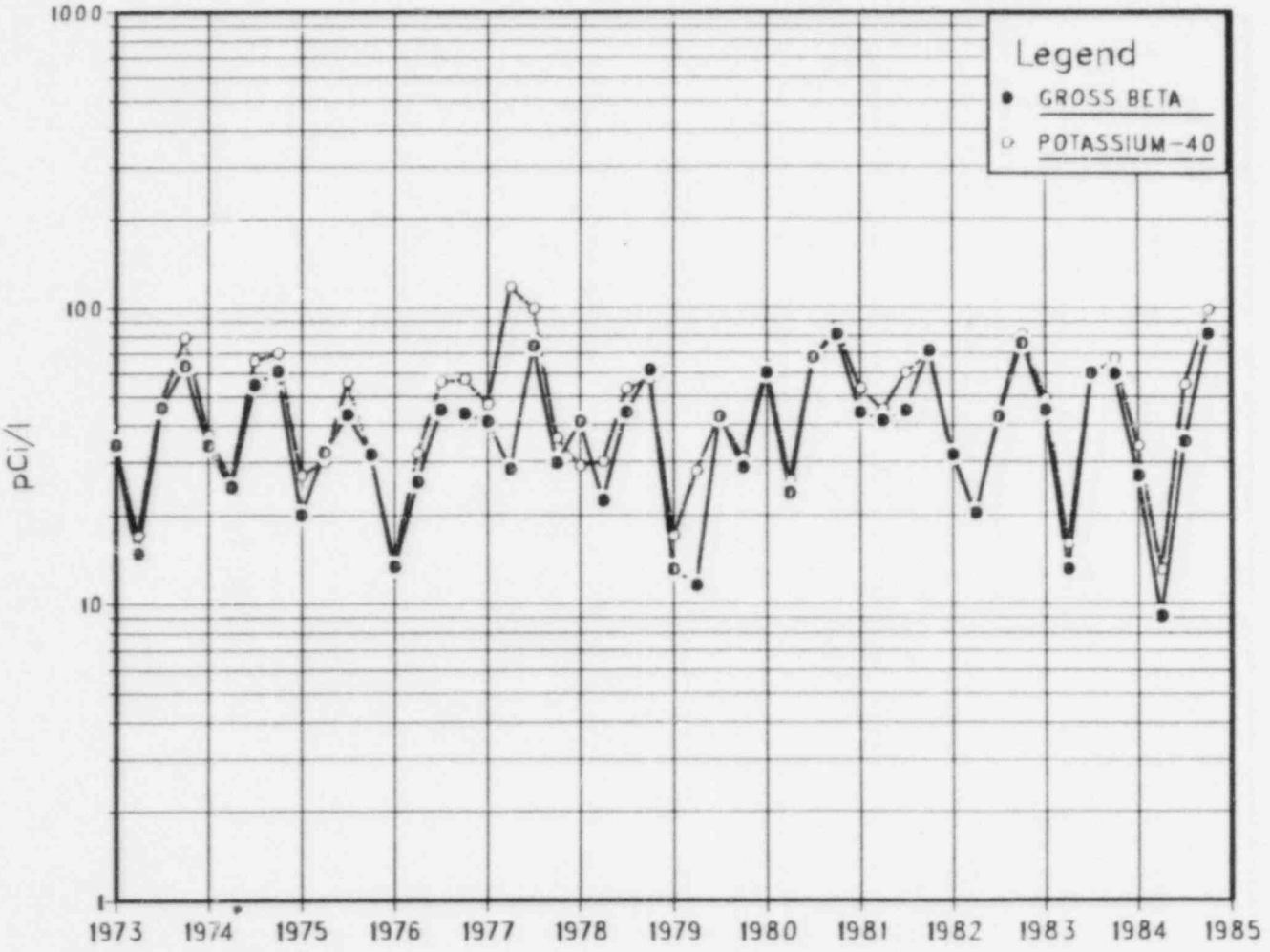


FIGURE 4

AVERAGE CONCENTRATIONS OF BETA EMITTERS AND POTASSIUM-40 IN THE DELAWARE RIVER IN THE VICINITY OF ARTIFICIAL ISLAND, 1973 THROUGH 1984



Aquatic

Surface Water (Tables C-21, C-22, C-23, C-24, C-25)

Surface water samples were collected monthly at five locations in the Delaware estuary, except for the January samples which were unavailable due to icing conditions on the river. One location is at the outfall area, another is downstream from the outfall area, and another is directly west of the outfall area at the mouth of the Appoquinimink River. Two upstream locations are in the Delaware River and at the mouth of the Chesapeake and Delaware Canal, the latter being sampled when the flow is from the Canal into the river. Station 12C1, at the mouth of the Appoquinimink River, serves as the operational control. All surface water samples were analyzed monthly for gross alpha and gross beta emitters, tritium, and gamma emitters. Quarterly composites were analyzed for Sr-89 and Sr-90.

Alpha concentrations were detected in eleven of the 44 indicator samples and in five of the eleven control samples. Levels ranged from 1.6 to 7.0 pCi/L. All the other samples were at or below the LLD, which ranged from <1.3 to <3.9. Beta concentrations for the indicator stations ranged from 3.2 pCi/L to 140 pCi/L with an average of 41 pCi/L, and, for the control station, from 4.3 pCi/L to 88 pCi/L with an average of 37 pCi/L. Nearly all of the beta activity was contributed by K-40, a natural component of salt and brackish waters, as illustrated in Figure 4, which compares averaged gross beta and K-40 concentrations.

Tritium analysis for the indicator stations ranged from 130 to 250 pCi/L. The average of the nine indicator samples with detectable levels of tritium was 164 pCi/L. Tritium was detected in two of the eleven control samples and ranged from 130 to 140 pCi/L with an average of 135 pCi/L. Levels for the years 1973 through 1984 are plotted in Figure 5.

Gamma spectrometric analysis of surface water samples showed detectable concentrations in 44 of the 55 samples. The average K-40 concentration at the indicator stations was 61 pCi/L with a range of 9.7 to 140 pCi/L. Average K-40 concentration at the control station was 60 pCi/L with a range of 16 to 110 pCi/L. Traces of Mn-54, Co-60, Cs-137, La-140, Ra-226 and Th-232 were detected at levels near or below the LLD in 15 of the 55 samples analyzed.

Strontium-89 was detected in one of sixteen indicator station samples at 1.3 pCi/L, none was detected in the four control station samples. The LLD sensitivities ranged from <0.5 to <1.4 pCi/L. Sr-90 was not detected in any of the twenty samples; LLD sensitivities ranged from <0.4 to <0.7 pCi/L.

All samples contained K-40 at concentrations from 1700 to 3000 pCi/kg-wet, with an average for all samples of 2100 pCi/kg-wet. A trace of Ra-226 was seen in one control station pepper sample and a trace of Th-232 was detected in an indicator station cabbage sample. No other gamma emitters were detected in these food products.

Game (Table C-19)

Two muskrat samples were collected in January. Bones from both samples were analyzed for Sr-89 and -90 while the flesh was analyzed for gamma emitters. Sr-89 was not found in either of the samples; Sr-89 LLD's were <100 and <160 pCi/kg-dry. Sr-90 was found in both samples at levels of 290 and 810 pCi/kg-dry. These levels, while higher than in 1983, were significantly below those seen in the preoperational program. Gamma scans of the flesh indicated the presence of naturally-occurring K-40, in both samples at levels of 2400 and 3000 pCi/kg-wet; and Cs-137 in one sample at 5.6 pCi/kg-wet.

Beef and Bovine Thyroid (Table C-19)

One beef sample and the thyroid glands were collected in February. Analysis of the flesh for gamma emitters indicated only the presence of naturally-occurring K-40 at a concentration of 2500 pCi/kg-wet, and Ra-226 at a level of 9.3 pCi/kg-wet.

Analysis of the thyroid glands for gamma emitters indicated only K-40 at a concentration of 1200 pCi/kg-wet. No detectable concentrations of I-131 were found.

Fodder Crops (Table C-20)

Samples of crops normally used as cattle feed were collected at six locations where these products may be a significant element in the food-chain pathway. Five of the locations are milk sampling stations, and the sixth supplied a beef/thyroid sample. Samples collected for wet gamma analysis included hay, corn silage, green chop, and soybeans.

K-40 was detected in all of the ten samples at concentrations from 2000 to 14000 pCi/kg-wet, with an average of 6700 pCi/kg-wet. Be-7, from the atmosphere, was found in seven of the samples at concentrations from 260 to 1400 pCi/kg-wet, with an average of 390 pCi/kg-wet. Traces of Ra-226 or Th-232 were detected in hay, and soybeans at one indicator station. Nothing is known of the composition of fertilizers which may have been applied to the soil in which these crops were grown.

Gamma spectrometry showed detectable levels of K-40 in six of the eight indicator samples at an average concentration of 12 pCi/L with a range of 11 to 14 pCi/L. One control station sample had detectable K-40 at 6.3 pCi/L which was below the LLD values of <8.6 to <9.9 pCi/L. Traces of Ra-226 were detected in three samples at levels near or below the LLD values of the other nine samples.

Potable Water (Tables C-16, C-17)

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

Detectable alpha activity was noted in six raw and four treated water samples with ranges of 1.2 to 4.5 pCi/L (raw), and 1.0 to 1.6 pCi/L (treated). This resulted in an average activity of 2.4 pCi/L for the raw and 1.3 pCi/L for the treated potable waters. Beta activity was observed in all 24 of the monthly samples with ranges of 1.5 to 3.8 pCi/L (raw), and 1.7 to 3.4 (treated), and averages of 2.6 pCi/L (raw) and 2.4 pCi/L (treated). K-40 concentrations for raw and treated samples were practically identical and were lower than the beta activity in all cases. The K-40 average for both the raw and treated samples was 1.5 pCi/L. Tritium activity was observed in four of the twenty-four ranging from 140 to 250 pCi/L.

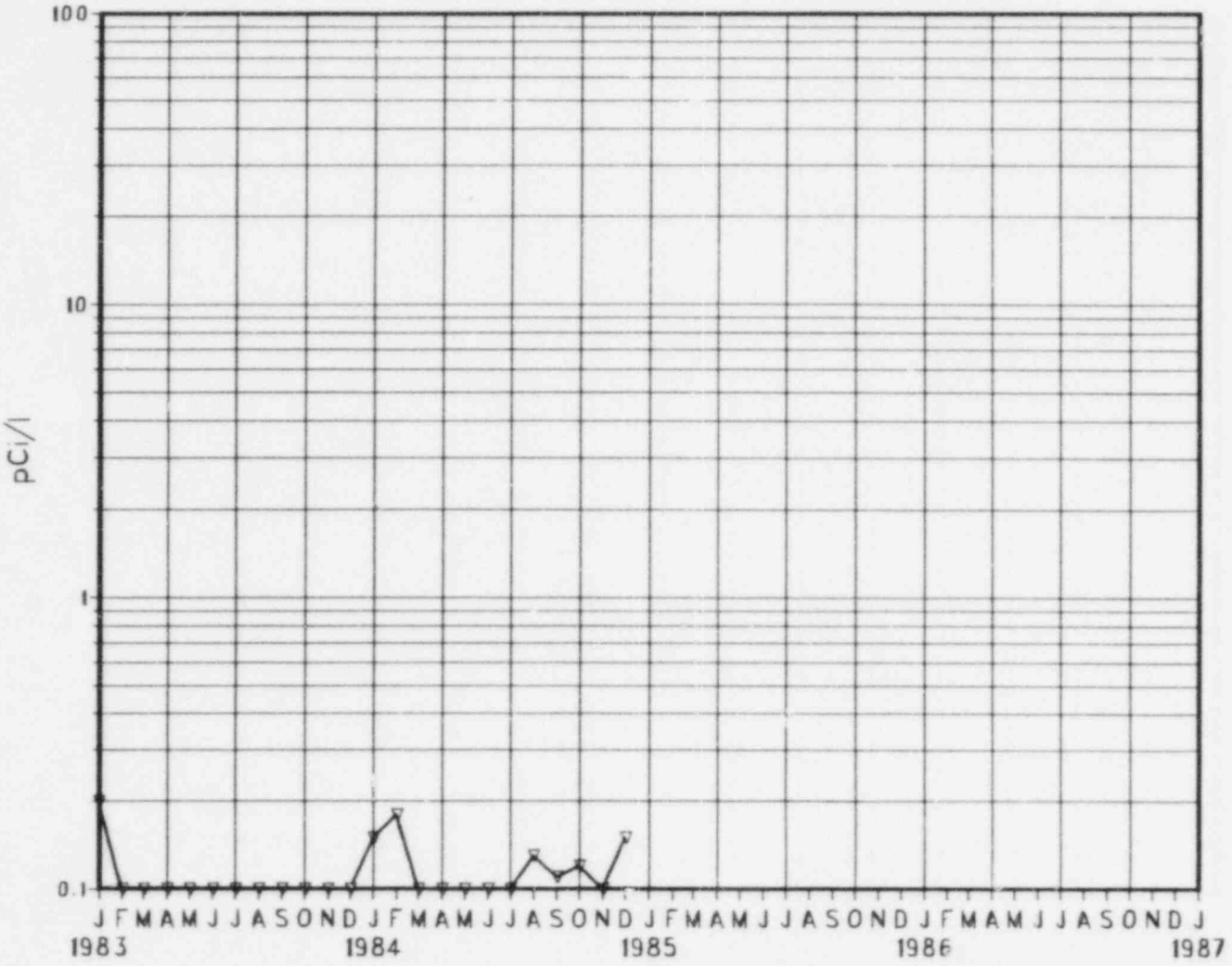
Sr-90 was observed in one of the quarterly raw water composites at 0.3 pCi/L; no Sr-89 was found. LLD's ranged from 0.4 to 0.9 pCi/L for Sr-89, and from 0.3 to 0.8 pCi/L for Sr-90. K-40 (via gamma spectrometry) was detected in the second quarter treated water composite at 7.4 pCi/L.

Food Products (Table C-18)

A variety of food products grown in the area for human consumption were sampled. These included sweet corn, peppers, asparagus, cabbage, and tomatoes. Each sample was analyzed for Sr-89, Sr-90, and gamma emitters. Sr-89 was not found in any of the seventeen samples; Sr-89 LLD's ranged from <2.8 to <20 pCi/kg-wet. Sr-90 was detected in eight of the seventeen samples with activities ranging from 1.8 to 32 pCi/kg-wet. These activities were detected in one sweet corn (control location), one pepper (control location), three cabbage (two indicator, one control location), and three tomatoe (two indicator, one control location) samples. Sr-90 LLD's ranged from <1.8 to <6.1 pCi/kg-wet.

FIGURE 3A

AVERAGE CONCENTRATIONS OF IODINE-131 IN MILK IN THE VICINITY OF ARTIFICIAL ISLAND, 1983 THROUGH 1984



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Milk (pCi/L)	I-131	144	0.1	<LLD	-	<LLD	<LLD	0
	Sr-89	72	0.8	<LLD	-	<LLD	<LLD	0
	Sr-90	72	-	2.4 (60/60) (1.2-5.3)	5F2 7.0 mi E	3.8 (12/12) (1.8-5.3)	3.2 (12/12) (2.2-4.9)	0
	Gamma							
	Na-22	72	0.5	<LLD	3G1 17 mi NE	2.1 (1/12) (2.1)	2.1 (1/12) (2.1)	0
	K-40	72	-	1347 (60/60) (1200-1500)	2F4 6.3 mi NNE	1383 (12/12) (1300-1400)	1350 (12/12) (1300-1500)	0
	Mn-54	72	0.8	2.4 (1/60) (2.4)	14F1 5.5 mi WNW	2.4 (1/12) (2.4)	<LLD	0
	Cs-137	72	1.3	3.1 (11/60) (1.8-6.2)	5F2 7.0 mi E	3.4 (8/12) (1.8-6.2)	<LLD	0
	La-140	72	0.6	2.4 (1/60) (2.4)	5F2 7.0 mi E	2.4 (1/12) (2.4)	<LLD	0
	Ra-226	72	2.5	5.8 (3/60) (5.1-6.5)	15F1 5.4 mi NW	6.5 (1/12) (6.5)	<LLD	0
	Th-232	72	3.6	13 (1/60) (13)	5F2 7.0 mi E	13 (1/12) (13)	<LLD	0
Well Water (pCi/L)	Alpha	36	0.6	1.4 (6/24) (0.9-2.0)	2S3 700 ft NNE	1.5 (4/12) (1.1-2.0)	<LLD	0
	Beta	36	1.0***	10 (24/24) (2.9-17)	5D1 3.5 mi E	13 (12/12) (12-15)	8.4 (12/12) (6.0-10)	0
	K-40	36	-	11 (24/24) (2.8-28)	5D1 3.5 mi E	14 (12/12) (6.4-28)	8.4 (12/12) (5.5-9.3)	0
	H-3	36	130	<LLD	-	<LLD	<LLD	0
	Sr-89	12	0.4	0.9 (1/8) (0.9)	2S3 700 ft NNE	0.9 (1/8) (0.9)	<LLD	0
	Sr-90	12	0.4	<LLD	-	<LLD	<LLD	0
	Gamma							
	K-40	12	8.4	12 (6/8) (11-14)	5D1 3.5 mi E	13 (3/4) (12-14)	6.3 (1/4) (6.3)	0
	Ra-226	12	0.7	1.3 (3/8) (0.6-2.1)	2S3 700 ft NNE	2.1 (1/4) (2.1)	1.3 (1/4) (1.3)	0

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Potable Water Raw-Treated (pCi/L)	Alpha	24	0.9	2.0 (10/24) (1.0-4.5)	2F3 8.0 mi NNE	2.0 (10/24) (1.0-4.5)	No Control Location	0
	Beta	24	1.0***	2.5 (24/24) (1.5-3.8)	2F3 8.0 mi NNE	2.5 (24/24) (1.5-3.8)	No Control Location	0
	K-40	24	-	1.5 (24/24) (1.1-2.0)	2F3 8.0 mi NNE	1.5 (24/24) (1.1-2.0)	No Control Location	0
	H-3	24	120	172 (4/24) (140-250)	2F3 8.0 mi NNE	172 (4/24) (140-250)	No Control Location	0
	Sr-89	8	0.4	<LLD	-	<LLD	No Control Location	0
	Sr-90	8	0.3	0.3 (1/8) (0.3)	2F3 8.0 mi NNE	0.3 (1/8) (0.3)	No Control Location	0
	Gamma							
	K-40	8	5.9	7.4 (1/8) (7.4)	2F3 8.0 mi NNE	7.4 (1/8) (7.4)	No Control Location	0
Fruit & Vegetables (pCi/kg-wet)	Sr-89	17	2.8	<LLD	-	<LLD	<LLD	0
	Sr-90	17	1.8	15 (4/10) (2.7-32)	4F1 5.1 mi ENE	32 (1/2) (32)	6.9 (4/7) (1.8-12)	0
	Gamma							
	K-40	17	-	2140 (10/10) (1700-2700)	4F1 5.1 mi ENE	2300 (2/2) (1900-2700)	2114 (7/7) (1700-3000)	0
					14F3 5.4 mi WNW	2300 (2/2) (2000-2600)		
	Ra-226	17	1.0	<LLD	3H5 25 mi NE	49 (1/4) (49)	49 (1/7) (49)	0
	Th-232	17	4.8	16 (1/10) (16)	4F1 5.1 mi ENE	16 (1/2) (16)	<LLD	0

ARTIFICIAL ISLAND RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

SALEM NUCLEAR GENERATING STATION DOCKET NO. 50-272/-311

SALEM COUNTY, NEW JERSEY JANUARY 1, 1984 to DECEMBER 31, 1984

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	LOCATION WITH HIGHEST MEAN MEAN (RANGE)	CONTROL LOCATION(S) MEAN (RANGE)	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Game	Sr-89 (bones)	2	100	<LLD	-	<LLD	<LLD	0
(pCi/kg-dry)	Sr-90 (bones)	2	-	810 (1/1) (810)	3E1 4.1 mi NE	810 (1/1) (810)	290 (1/1) (290)	0
(pCi/kg-wet)	Gamma (flesh)							
	K-40	2	-	3000 (1/1) (3000)	3E1 4.1 mi NE	3000 (1/1) (3000)	2400 (1/1) (2400)	0
	Cs-137	2	7.7	<LLD	11D1 3.5 mi SW	5.6 (1/1) (5.6)	5.6 (1/1) (5.6)	0
Beef	Gamma							
(pCi/kg-wet)	K-40	1	-	2500 (1/1) (2500)	3E1 4.1 mi NE	2500 (1/1) (2500)	No Control Location	0
	Ra-226	1	-	9.3 (1/1) (9.3)	3E1 4.1 mi NE	9.3 (1/1) (9.3)	No Control Location	0
Bovine Thyroid	Gamma							
(pCi/kg-wet)	K-40	1	-	1200 (1/1) (1200)	3E1 4.1 mi NE	1200 (1/1) (1200)	No Control Location	0
Fodder Crops	Gamma							
(pCi/kg-wet)	Be-7	10	130	527 (6/8) (260-1400)	15F1 5.4 mi NW	830 (2/3) (260-1400)	260 (1/2) (260)	0
	K-40	10	-	6287 (8/8) (2000-13000)	3E1 4.1 mi NE	13000 (1/1) (13000)	8350 (2/2) (2700-14000)	0
	Ra-226	10	14	41 (1/8) (41)	15F1 5.4 mi NW	41 (1/3) (41)	<LLD	0
	Th-232	10	27	95 (1/8) (95)	15F1 5.4 mi NW	95 (1/3) (95)	<LLD	0

ARTIFICIAL ISLAND RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

SALEM NUCLEAR GENERATING STATION — DOCKET NO. 50-272/-311

SALEM COUNTY, NEW JERSEY — JANUARY 1, 1984 to DECEMBER 31, 1984

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(S) MEAN (RANGE)	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Surface Water (pCi/L)	Alpha	55	1.3	3.1 (11/44) (1.6-5.2)	12C1 2.5 mi WSW	5.2 (5/11) (3.4-7.0)	5.2 (5/11) (3.4-7.0)	0
	Beta	55	3.0	41 (43/44) (3.2-140)	7E1 4.5 mi SE	57 (11/11) (8.3-140)	37 (11/11) (4.3-88)	0
	H-3	55	120	164 (9/44) (130-250)	1F2 7.1 mi N	197 (3/11) (150-250)	135 (2/11) (130-140)	0
	Sr-89	20	0.5	1.3 (1/16) (1.3)	16F1 6.9 mi NNW	1.3 (1/4) (1.3)	<LLD	0
	Sr-90	20	0.4	<LLD	-	<LLD	<LLD	0
	Gamma							
	K-40	55	6.7	61 (34/44) (9.7-140)	7E1 4.5 mi SE	74 (10/11) (20-140)	60 (7/11) (16-110)	0
	Mn-54	55	0.3	0.7 (1/44) (0.7)	11A1 0.2 mi SW	0.7 (1/11) (0.7)	<LLD	0
	Co-60	55	0.2	0.6 (1/44) (0.6)	7E1 4.5 mi SE	0.6 (1/11) (0.6)	<LLD	0
	Cs-137	55	0.3	<LLD	12C1 2.5 mi WSW	0.5 (1/11) (0.5)	0.5 (1/11) (0.5)	0
	La-140	55	0.3	1.2 (1/44) (1.2)	11A1 0.2 mi SW	1.2 (1/11) (1.2)	<LLD	0
	Ra-226	55	0.5	1.0 (6/44) (0.6-1.5)	7E1 4.5 mi SE	1.2 (2/11) (0.9-1.5)	1.2 (2/11) (1.0-1.3)	0
					11A1 0.2 mi SW	1.2 (1/11) (1.2)		
	Th-232	55	1.3	1.7 (5/44) (0.9-2.1)	1F2 7.1 mi N	2.0 (2/11) (2.0-2.1)	1.6 (2/11) (1.2-1.9)	0

ARTIFICIAL ISLAND RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

SALEM NUCLEAR GENERATING STATION DOCKET NO. 50-272/-311

SALEM COUNTY, NEW JERSEY JANUARY 1, 1984 to DECEMBER 31, 1984

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(S) MEAN (RANGE)	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Edible Fish (pCi/kg-dry)	Sr-89 (bones)	6	41	<LLD	-	<LLD	<LLD	0
	Sr-90 (bones)	6	38	334 (3/4) (62-730)	12C1 2.5 mi WSW	615 (1/2) (230-1000)	615 (1/2) (230-1000)	0
(pCi/kg-wet)	H-3 (aqueous)	6	50	400 (2/4) (400-400)	7E1 4.5 mi SE	400 (1/2) (400)	300 (1/2) (300)	0
					11A1 0.2 mi SW	400 (1/2) (400)		
	H-3 (organic)	6	50	<LLD	12C1 2.5 mi WSW	120 (1/2) (120)	120 (1/2) (120)	0
	Gamma							
	K-40	6	-	2600 (4/4) (1200-3300)	7E1 4.5 mi SE	3300 (2/2) (3300-3300)	1900 (2/2) (1400-2400)	0
	Cs-137	6	6.2	16 (1/4) (16)	11A1 0.2 mi SW	16 (1/2) (16)	<LLD	0
Blue Crabs (pCi/kg-dry)	Sr-89 (shells)	4	88	<LLD	-	<LLD	<LLD	0
	Sr-90 (shells)	4	-	600 (2/2) (580-620)	12C1 2.5 mi WSW	625 (2/2) (390-860)	625 (2/2) (390-860)	0
(pCi/kg-wet)	H-3 (flesh)	4	50	600 (1/2) (600)	11A1 0.2 mi SW	600 (1/2) (600)	300 (1/2) (300)	0
	Sr-89 (flesh)	4	46	<LLD	-	<LLD	<LLD	0
	Sr-90 (flesh)	4	26	<LLD	-	<LLD	<LLD	0
	Gamma							
	K-40	4	-	2200 (2/2) (2100-2300)	11A1 0.2 mi SW	2200 (2/2) (2100-2300)	1950 (2/2) (1900-2000)	0
	Co-60	4	16	24 (1/2) (24)	11A1 0.2 mi SW	24 (1/2) (24)	<LLD	0

ARTIFICIAL ISLAND RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

SALEM NUCLEAR GENERATING STATION DOCKET NO. 50-272/-311

SALEM COUNTY, NEW JERSEY JANUARY 1, 1984 to DECEMBER 31, 1984

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(S) MEAN (RANGE)	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Benthic Organisms (pCi/kg-dry)	Sr-89	8	2600	<LLD	-	<LLD	<LLD	0
	Sr-90	8	1800	<LLD	-	<LLD	<LLD	0
	Gamma							
	Ra-226	8	24000	23000 (1/6) (23000)	11A1 0.2 mi SW	23000 (1/2) (23000)	<LLD	0
Sediment (pCi/kg-dry)	Sr-90	8	19	<LLD	-	<LLD	<LLD	0
	Gamma							
	Be-7	8	140	877 (3/6) (330-1300)	11A1 0.2 mi SW	1300 (1/2) (1300)	<LLD	0
	K-40	8	-	11783 (6/6) (4700-15000)	16F1 6.9 mi NNW	15000 (2/2) (15000-15000)	13000 (2/2) (12000-14000)	0
	Mn-54	8	17	47 (3/6) (22-87)	11A1 0.2 mi SW	87 (1/2) (87)	25 (1/2) (25)	0
	Co-58	8	22	158 (3/6) (73-300)	11A1 0.2 mi SW	186 (2/2) (73-300)	<LLD	1
	Co-60	8	32	184 (6/6) (22-520)	11A1 0.2 mi SW	350 (2/2) (180-520)	40 (1/2) (40)	1
	Cs-137	8	20	108 (5/6) (26-180)	11A1 0.2 mi SW	180 (1/2) (180)	26 (2/2) (19-32)	0
	Ra-226	8	-	883 (6/6) (430-1300)	7E1 4.5 mi SE	1140 (2/2) (980-1300)	995 (2/2) (790-1200)	0
	Th-232	8	-	742 (6/6) (340-980)	16F1 6.9 mi NNW	930 (2/2) (900-960)	845 (2/2) (770-920)	0

* LLD listed is the lowest calculated LLD during the reporting period.

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

*** Typical LLD value.

APPENDIX B

SAMPLE DESIGNATION

AND

LOCATIONS

APPENDIX B

Sample Designation

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

AIO	=	Air Iodine	GAM	=	Game
APT	=	Air Particulates	IDM	=	Immersion Dose (TLD)
ECH	=	Hard Shell Blue Crab	MLK	=	Milk
ESB	=	Benthic Organisms	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 SGS program (SA), consisting of well water (WWA), which had been collected in sector number 5, centered at 90° (due east) with respect to the reactor site at a radial distance of 3 to 4 miles off-site, (therefore, radial distance D). The number 1 indicates that this is sampling station #1 in that particular sector.

Sampling Locations

All 1984 sampling locations and specific information about the individual locations are given in Table B-1. Maps B-1 and B-2 show the locations of sampling stations with respect to the site.

TABLE B-1

STATION CODE	STATION LOCATION	SAMPLE TYPES
2S2	0.4 mi. NNE of vent	AIO,APT,IDM
2S3	700 ft. NNE of vent; fresh water holding tank	WWA
5S1	1.0 mi. E of vent; site access road	AIO,APT,IDM
6S2	0.2 mi. ESE of vent; observation bldg.	IDM
7S1	0.12 mi. SE of vent; station personnel gate	IDM
10S1	0.14 mi. SSW of vent; site shoreline	IDM
11S1	0.09 mi. SW of vent; site shoreline	IDM
11A1	0.2 mi. SW of vent; outfall area	ECH,ESB,ESF, ESS,SWA
12C1	2.5 mi. WSW of vent; west bank of Delaware River	ECH,ESB,ESF, ESS,SWA
4D2	3.7 mi. ENE of vent; Alloway Creek Neck Road	IDM
5D1	3.5 mi. E of vent; local farm	AIO,APT,FPV, IDM,WWA
10D1	3.9 mi. SSW of vent; Taylor's Bridge Spur	AIO,APT,IDM
11D1	3.5 mi. SW of vent	GAM
14D1	3.4 mi. WNW of vent; Bay View, Delaware	IDM
2E1	4.4 mi. NNE of vent; local farm	FPV,IDM
3E1	4.1 mi. NE of vent; local farm	FPB,FPG,GAM,IDM, THB,WWA
7E1	4.5 mi. SE of vent; 1 mi. W of Mad Horse Creek	ESB,ESF,ESS,SWA
9E1	4.2 mi. S of vent	IDM
11E2	5.0 mi. SW of vent	IDM

TABLE B-1 (cont'd)

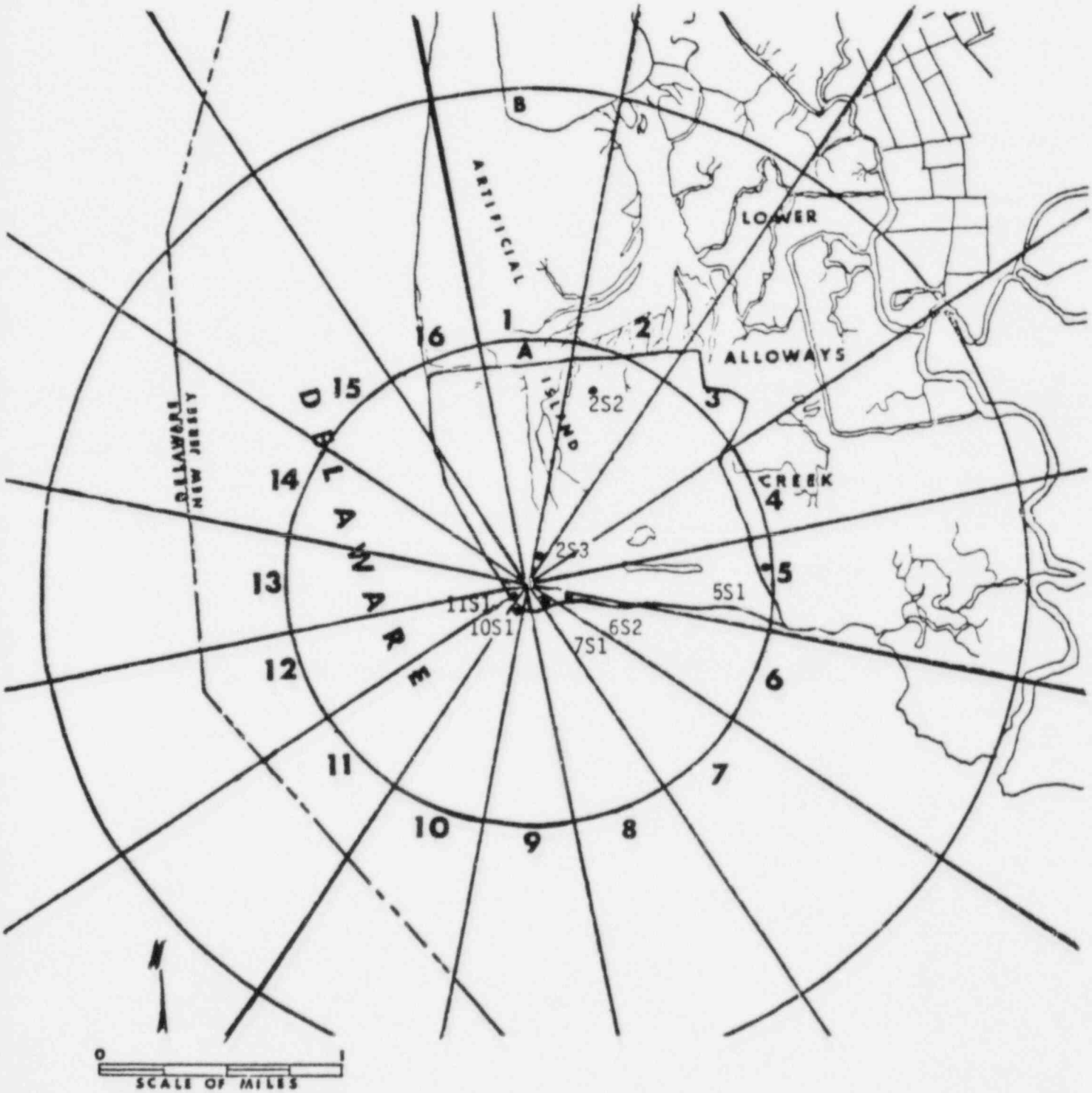
STATION CODE	STATION LOCATION	SAMPLE TYPES
12E1	4.4 mi. WSW of vent; Thomas Landing	IDM
13E1	4.2 mi. W of vent; Diehl House Lab	IDM
13E3	4.9 mi. W of vent; local farm	MLK
16E1	4.1 mi. NNW of vent; Port Penn	AIO,APT,IDM
1F1	5.8 mi. N of vent; Fort Elfsborg	AIO,APT,IDM
1F2	7.1 mi. N of vent; midpoint of Delaware River	SWA
1F3	5.9 mi. N of vent; local farm	FPL,FPV
2F2	8.7 mi. NNE of vent; Salem Substation	AIO,APT,IDM,RWA
2F3	8.0 mi. NNE of vent; Salem Water Company	PWR,PWT
2F4	6.3 mi. NNE of vent; local farm	MLK,VGT
2F5	7.4 mi. NNE of vent; Salem High School	IDM
2F6	7.3 mi. NNE of vent; Southern Training Center	IDM
3F2	5.1 mi. NE of vent; Hancocks Bridge Municipal Building	IDM
3F3	8.6 mi. NE of vent; Quinton Township School	IDM
4F1	5.1 mi. ENE of vent; local farm	FPL,FPV
5F1	6.5 mi. E of vent	FPV,IDM
5F2	7.0 mi. E of vent; local farm	MLK,VGT
6F1	6.4 mi. ESE of vent; Stow Neck Road	IDM
7F2	9.1 mi. SE of vent; Bayside, New Jersey	IDM
10F2	5.8 mi. SSW of vent	IDM
11F1	6.2 mi. SW of vent; Taylor's Bridge Delaware	IDM
12F1	9.4 mi. WSW of vent; Townsend Elementary School	IDM
13F1	9.8 mi. W of vent; Middletown, Delaware	IDM
13F2	6.5 mi. W of vent; Odessa, Delaware	IDM

TABLE B-1 (cont'd)

STATION CODE	STATION LOCATION	SAMPLE TYPES
13F3	9.3 mi. W of vent; Redding Middle School, Middletown, DE	IDM
13F4	9.8 mi. W of vent; Middletown, Delaware	IDM
14F1	5.5 mi. WNW of vent; local farm	MLK,VGT
14F2	6.6 mi. WNW of vent; Boyds Corner	IDM
14F3	5.4 mi. WNW of vent; local farm	FPV
15F1	5.4 mi. NW of vent; local farm	FPG,MLK,VGT
15F3	5.4 mi. NW of vent	IDM
16F1	6.9 mi. NNW of vent; C&D Canal	ESB,ESS,SWA
16F2	8.1 mi. NNW of vent; Delaware City Public School	IDM
1G1	10.3 mi. N of vent; local farm	FPV
1G3	19 mi. N of vent; Wilmington, Delaware	IDM
3G1	17 mi. NE of vent; local farm	FPG,IDM,MLK,VGT
10G1	12 mi. SSW of vent; Smyrna, Delaware	IDM
16G1	15 mi. NNW of vent; Greater Wilmington Airport	IDM
3H1	32 mi. NE of vent; National Park, N.J.	IDM
3H3	110 mi. NE of vent; Research and Testing Laboratory	AIO,APT,IDM
3H5	25 mi. NE of vent; local farm	FPL,FPV

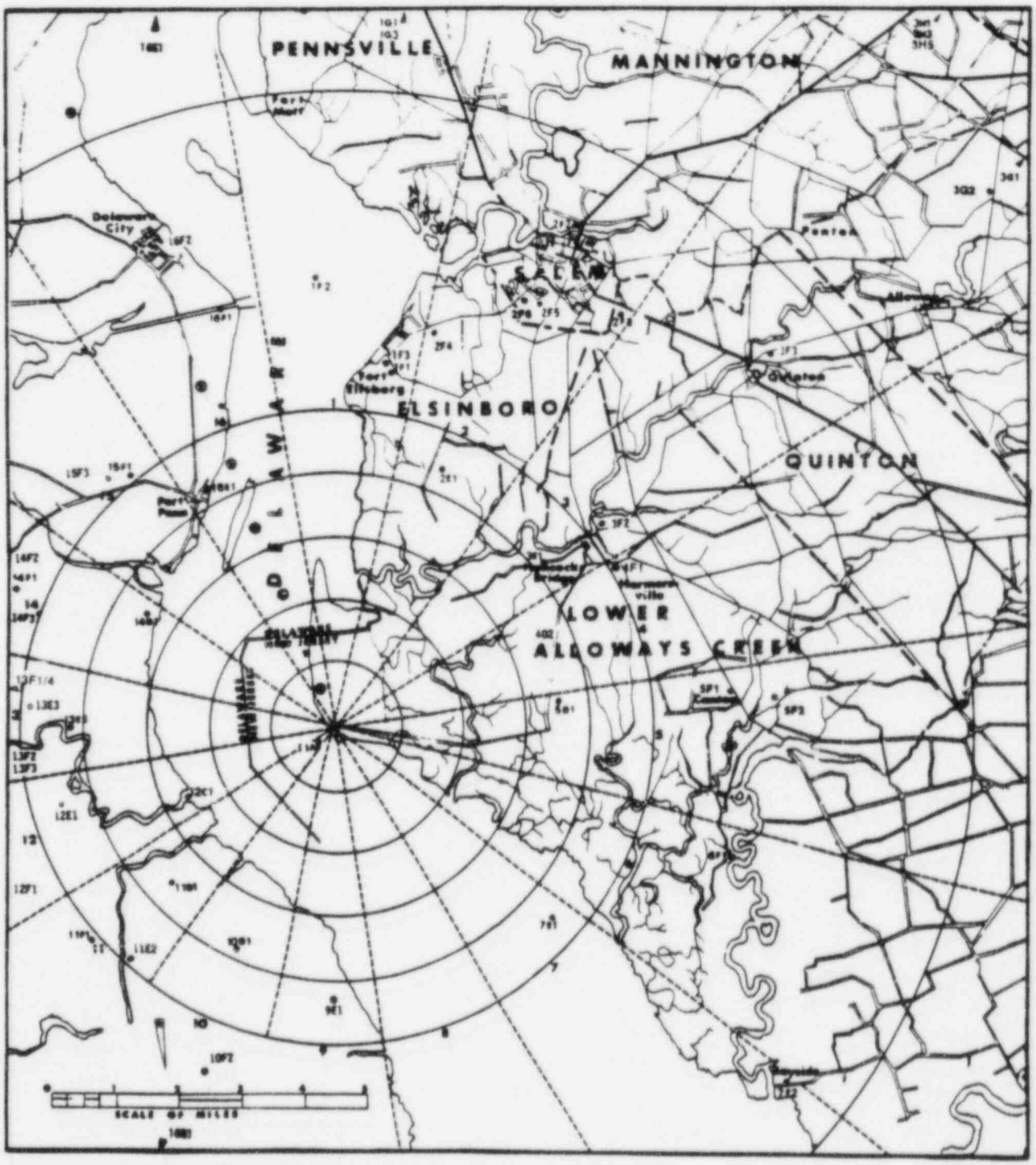
MAP B-1

ON SITE SAMPLING LOCATIONS
ARTIFICIAL ISLAND



MAP B-2

OFF-SITE SAMPLING LOCATIONS
ARTIFICIAL ISLAND



APPENDIX C

1984 DATA TABLES

DATA TABLES

Appendix C presents the analytical results of the 1984 Artificial Island Radiological Environmental Monitoring Program for the period of January 1 to December 31, 1984.

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TABLE C-1

1984 CONCENTRATIONS OF GROSS ALPHA EMITTERS IN AIR PARTICULATES

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

	STATION NO.								
MONTH*	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	2.6±0.8	1.6±0.6	1.2±1.0	1.4±0.6	1.5±0.6	2.0±0.7	2.2±0.8	1.9±0.7	1.8±0.9
	2.8±1.0	1.9±0.8	<1.0	2.7±0.9	2.9±0.9	1.5±0.9	1.7±1.1	2.6±0.9	2.1±1.4
	2.5±0.9	2.1±0.8	<2.0	2.4±1.0	2.7±1.0	<1.1	<1.4	1.6±0.7	2.0±1.1
	4.0±1.0	3.7±0.9	2.4±1.2	3.4±1.0	4.7±1.0	3.6±1.0	4.3±1.0	2.7±0.9	3.6±1.5
	1.6±0.7	1.4±0.6	<2.0	1.0±0.6	1.6±0.7	1.3±0.7	0.9±0.7	1.8±0.8	1.4±0.8
FEBRUARY	2.1±0.8	1.8±0.7	<0.8	1.0±0.8	<0.8	1.3±0.7	1.4±1.1(1)	1.2±0.6	1.3±0.9
	2.0±0.7	2.1±0.6	1.9±1.0	1.5±0.6	2.7±0.9	2.2±0.7	2.3±0.8	3.1±0.8	2.2±1.0
	1.1±0.6	0.8±0.6	1.7±1.0	1.0±0.7	0.9±0.6	<1.0	<1.0	<0.8	1.0±0.6
	1.7±0.8	1.3±0.7	1.0±0.9	<0.6	1.3±0.7	1.3±0.7	1.1±0.7	1.8±0.7	1.3±0.8
MARCH	1.2±0.6	1.3±0.6	<1.0	<0.8	1.6±0.8	1.1±0.6	1.4±0.7	2.5±1.0	1.4±1.0
	2.3±0.8	2.8±0.8	1.6±1.2	3.6±1.0	3.8±1.0	2.3±0.9	4.4±1.1	3.1±0.9	3.0±1.8
	1.2±0.7	0.9±0.6	1.3±1.0	<1.0	1.6±0.8	1.6±0.8	1.1±0.8	1.4±0.7	1.3±0.5
	1.5±0.8	1.1±0.7	2.1±1.1	1.2±0.7	1.6±0.8	1.0±0.7	1.7±0.8	1.4±0.8	1.4±0.7
APRIL	1.4±0.7	1.2±0.6	<2.0	<0.7	1.7±0.7	1.5±0.8	2.7±1.0	0.9±0.6	1.5±1.3
	1.1±0.8	1.2±0.7	<1.0	<0.9	1.0±0.8	1.0±0.8	1.5±0.9	1.2±0.8	1.1±0.4
	1.4±0.8	1.2±0.7	<1.0	1.5±0.9	<1.2	<1.0	1.4±0.8	1.7±0.8	1.3±0.5
	1.0±0.6	1.3±0.6	<1.0	0.7±0.5	0.8±0.6	1.6±0.7	<0.7	1.0±0.6	1.0±0.6
	1.6±0.9	1.7±0.7	<1.0	1.8±0.9	2.3±0.9	1.6±0.8	2.0±0.9	1.4±0.8	1.7±0.8
MAY	2.9±1.3	2.6±0.9	<1.0	2.4±0.9	2.8±0.9	2.8±1.0	2.1±0.9	1.4±0.7	2.2±1.4
	2.6±1.0	1.6±0.7	<0.9	2.4±0.8	2.3±0.8	1.3±0.7	4.0±2.5(1)	2.0±0.7	2.1±1.9
	2.4±0.8	2.9±0.8	<1.0	2.5±0.9	2.1±0.9	2.0±0.8	2.0±0.8	1.6±0.6	2.1±1.2
	1.9±0.7	1.9±0.7	0.9±0.8	2.5±0.8	1.9±0.7	1.5±0.8	1.5±0.8	2.2±0.8	1.8±1.0
JUNE	1.5±0.8	2.1±0.9	<1.6	1.7±0.9	1.2±0.9	1.4±0.8	1.8±0.9	1.5±0.8	1.5±0.7
	3.6±0.9	2.4±0.8	2.1±1.1	3.5±0.9	3.2±0.8	3.5±1.0	4.2±1.1	3.3±0.9	3.2±1.4
	1.3±0.8	1.8±0.9	1.3±1.0	<1.2	2.3±1.1	1.4±0.9	1.4±0.9	1.4±0.8	1.5±0.7
	2.0±0.8	1.8±0.7	1.4±1.0	1.6±0.8	2.3±0.8	1.0±0.7	<1.0	1.7±0.7	1.6±0.9
	1.7±0.8	1.9±0.8	<1.0	1.2±0.8	2.5±1.0	1.7±0.9	1.9±0.9	2.0±1.0	1.7±0.9

TABLE C-1 (cont'd)

1984 CONCENTRATIONS OF GROSS ALPHA EMITTERS IN AIR PARTICULATES

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

	STATION NO.								
MONTH*	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	2.6±0.8	1.8±0.7	<2.0	2.0±0.8	1.9±0.8	2.4±0.9	2.6±0.9	2.6±0.8	2.2±0.7
	3.1±0.9	4.1±1.0	1.6±1.1	3.4±0.9	3.0±0.8	2.7±0.8	2.4±0.8	2.4±0.7	2.8±1.5
	2.3±0.9	1.6±0.7	<1.0	<1.0	1.3±0.8	1.2±0.9	1.7±0.9	2.0±0.8	1.5±0.9
	<1.1	<1.1	<1.0	<1.2	1.6±1.0	<1.3	1.6±1.0	1.0±0.7	-
AUGUST	2.5±0.9	1.4±0.7	1.3±1.1	1.3±0.9	2.0±0.9	2.2±1.0	1.5±0.8	2.8±0.9	1.9±1.2
	3.2±1.0	2.6±0.9	2.1±1.2	2.1±0.8	2.9±1.0	2.5±1.0	2.6±1.0	2.7±0.9	2.6±0.7
	1.9±0.7	3.3±0.9	<0.8	1.9±0.9	3.0±1.0	2.7±1.0	2.6±1.0	2.2±0.7	2.3±1.6
	1.5±0.6	1.9±0.7	<1.0	2.0±0.8	2.0±0.7	1.5±0.7	1.6±0.7	2.1±0.8	1.7±0.7
SEPTEMBER	3.3±0.9	2.3±0.7	2.0±1.3	2.8±0.9	3.1±0.9	2.5±0.8	2.0±0.8	2.9±0.8	2.6±1.0
	1.5±0.8	<0.6	<2.0	0.9±0.6	1.3±0.7	0.9±0.6	1.4±0.8	0.8±0.6	1.2±0.9
	1.6±0.6	1.2±0.6	<2.0	1.8±0.8	1.3±0.6	1.7±0.7	1.8±0.8	1.3±0.6	1.6±0.6
	1.4±0.6	1.7±0.7	<1.0	2.2±0.8	1.8±0.7	1.2±0.6	1.4±0.6	1.9±0.8	1.6±0.8
	1.0±0.8	<0.9	1.6±1.1	<1.0	<1.0	1.2±0.8	1.2±0.9	2.0±0.8	1.2±0.8
OCTOBER	2.4±0.8	2.5±0.8	<1.0	3.2±1.0	1.5±0.8	2.2±0.8	2.5±0.8	3.4±0.9	2.3±1.6
	3.0±1.0	2.6±1.0	1.2±0.9	3.6±1.1	4.2±1.3	2.8±1.1	2.9±1.1	3.1±1.0	2.9±1.7
	2.9±1.0	2.9±1.0	<1.0	2.5±1.0	2.8±1.1	2.9±1.0	2.5±1.0	3.7±1.9(1)	2.6±1.5
	1.4±0.6	1.7±0.7	2.7±1.2	1.2±0.6	1.6±0.7	1.0±0.6	1.4±0.8	1.6±0.7	1.6±1.0
NOVEMBER	1.9±0.8	1.7±0.8	1.1±0.5	0.9±0.7	1.7±0.9	1.8±0.8	2.2±0.9	1.7±0.7	1.6±0.8
	2.2±0.7	2.0±0.7	1.8±1.0	1.9±0.7	2.4±0.7	2.3±0.8	2.4±0.8	1.7±0.6	2.1±0.5
	3.1±1.1	3.4±1.2	1.8±1.1	2.3±0.9	3.0±1.0	1.6±0.9	3.6±1.2	2.6±0.9	2.7±1.5
	2.4±0.9	3.0±1.1	3.0±1.3	3.2±1.0	4.3±1.1	2.8±1.0	2.4±1.0	2.2±0.8	2.9±1.3
DECEMBER	2.4±0.9	2.0±0.9	<1.0	1.5±0.8	2.0±1.0	2.1±0.9	2.0±0.9	2.8±0.9	2.0±1.1
	1.6±0.7	2.4±0.8	2.0±1.1	2.3±0.8	3.0±0.8	2.1±0.9	2.0±0.9	2.7±0.8	2.3±0.9
	2.2±0.8	2.4±0.8	<1.0	2.0±0.8	2.5±0.9	2.6±0.9	2.7±0.9	1.8±0.7	2.2±1.1
	1.8±0.7	1.3±0.6	2.5±1.2	1.0±0.7	1.7±0.7	1.5±0.7	1.4±0.7	1.3±0.6	1.6±0.9
	<1.1	1.2±0.8	<1.0	<1.0	1.6±0.8	<1.1	<1.0	<1.2	-
AVERAGE	2.0±1.5	1.9±1.5	-	1.8±1.7	2.1±1.8	1.8±1.4	2.0±1.7	2.0±1.4	
								Grand Average	1.9±1.6

* Sampling dates can be found in Table C-5.
** Results by Teledyne Isotopes.
(1) High uncertainty due to low sample volume.

TABLE C-2

1984 CONCENTRATIONS OF GROSS BETA EMITTERS IN AIR PARTICULATES

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

	STATION NO.								
MONTH*	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	36±3	37±3	34±4	36±3	39±3	36±3	40±4	36±3	37±4
	35±3	35±3	30±3	30±3	31±3	32±3	35±4	32±3	32±4
	26±3	26±3	21±3	29±3	30±3	26±3	27±4	26±2	26±5
	38±3	42±3	39±4	39±3	42±3	40±3	41±3	38±3	40±3
	25±3	24±2	21±3	23±3	23±3	27±3	24±3	29±3	24±5
FEBRUARY	23±2	23±2	16±3	22±3	23±3	23±3	27±4	24±2	23±6
	24±3	22±2	21±3	22±2	26±3	24±2	24±3	28±2	24±5
	15±2	14±2	17±3	16±2	16±2	14±2	17±3	16±2	16±2
	19±3	19±3	21±3	20±3	19±3	19±3	20±3	21±3	20±2
MARCH	18±2	15±2	15±3	17±3	14±3	13±2	15±3	11±3	15±4
	26±3	28±3	30±3	29±3	30±3	29±3	29±3	29±3	29±2
	21±2	19±2	18±3	16±2	20±2	21±2	21±3	18±2	19±4
	17±2	17±2	18±3	18±2	19±2	16±2	20±2	14±2	17±4
APRIL	13±2	10±2	13±3	11±2	13±2	12±2	14±3	6±2	12±5
	15±2	15±2	13±3	15±2	16±2	14±2	14±2	14±2	14±2
	14±2	12±2	13±3	12±2	12±2	13±2	15±2	13±2	13±2
	13±2	13±2	14±2	13±2	13±2	43±3	12±2	14±2	17±21
	16±3	16±2	16±3	19±3	20±3	16±3	18±3	15±2	17±4
MAY	24±4	23±3	20±3	22±3	24±3	31±3	24±3	22±2	24±6
	24±3	19±2	21±3	19±2	21±2	17±2	16±7(1)	18±2	19±5
	23±3	22±2	24±3	24±3	24±3	23±3	23±3	19±2	23±3
	22±2	22±2	19±2	19±2	23±2	21±2	21±2	20±2	21±3
JUNE	15±3	17±3	12±3	15±3	14±3	17±3	16±3	11±2	15±4
	41±3	41±3	35±3	38±3	43±3	42±3	43±3	41±3	40±5
	21±3	21±2	23±3	17±3	18±3	19±3	20±3	21±2	20±4
	22±2	21±2	17±3	21±2	24±2	21±3	23±3	19±2	21±4
	20±3	19±2	19±3	18±3	17±3	17±3	21±3	20±3	19±3

TABLE C-2 (cont'd)

1984 CONCENTRATIONS OF GROSS BETA EMITTERS IN AIR PARTICULATES

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

	STATION NO.								
MONTH*	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	23±3	24±2	17±3	22±3	24±3	23±3	22±3	21±3	22±4
	32±3	30±3	24±3	29±3	30±3	25±3	32±3	28±3	29±6
	23±3	20±2	21±3	17±3	17±2	20±3	20±3	22±2	20±4
	15±2	13±2	17±3	14±2	18±3	14±3	14±3	15±2	15±3
AUGUST	21±2	20±2	21±3	21±3	24±3	21±3	23±3	31±3	23±7
	34±3	32±3	30±4	31±3	31±3	35±3	34±3	31±3	32±4
	24±3	25±2	25±3	24±3	25±3	21±3	27±3	24±2	24±3
	20±2	21±2	19±3	19±3	23±2	18±2	23±3	17±2	20±4
SEPTEMBER	36±3	33±3	32±3	34±3	40±3	34±3	40±4	30±2	35±7
	20±3	19±3	21±3	19±3	22±3	17±3	22±3	17±2	20±4
	20±2	20±2	18±3	18±3	21±3	20±3	24±3	23±2	20±4
	30±3	33±3	24±3	34±3	37±3	29±3	34±3	29±3	31±8
	25±3	23±3	26±3	20±3	23±3	18±3	27±3	32±3	24±9
OCTOBER	27±3	27±3	23±3	26±3	30±3	28±3	23±2	24±2	26±5
	31±3	34±3	33±3	34±3	37±4	34±4	37±4	34±3	34±4
	33±3	29±3	31±4	33±3	35±4	31±3	35±3	32±6(1)	32±4
	22±2	24±3	26±3	24±2	25±2	25±3	27±3	31±3	26±5
NOVEMBER	27±3	28±3	26±2	25±3	33±4	25±3	28±3	23±2	27±6
	21±2	26±2	25±3	21±2	23±2	23±2	27±3	23±2	24±4
	32±3	31±4	28±4	26±3	32±3	32±3	30±4	30±3	30±4
	25±3	33±4	27±3	25±3	29±3	23±3	24±3	21±3	26±8
DECEMBER	32±3	31±3	33±4	29±3	31±3	31±3	35±3	39±3	33±6
	26±2	30±3	31±3	32±3	35±3	29±3	29±3	30±3	30±5
	41±3	40±3	38±4	38±3	41±3	36±3	37±3	34±3	38±5
	42±3	44±3	37±4	38±3	39±3	40±3	39±3	37±3	40±5
	21±3	18±2	23±3	20±2	21±2	22±3	22±3	22±3	21±3
AVERAGE	25±15	24±16	23±14	24±15	26±17	24±16	26±16	24±16	
								Grand Average	24±16

* Sampling dates can be found in Table C-5.
** Results by Teledyne Isotopes.
(1) High uncertainty due to low sample volume.

TABLE C-3

1984 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

STATION NO. AND DATES	Sr-89	Sr-90	Be-7	Cr-51	Mn-54	Co-58	Fe-59	Te-129m	Ra-226	Th-232
SA-APT-2S2										
12-27-83 to 3-26-84	<0.3	<0.2	57±4	<2.8	<0.3	<0.4	<0.9	< 4.4	<0.7	<1.2
3-26-84 to 7-02-84	<0.6	<0.4	73±5	2.0±1.3	<0.4	0.3±0.2	<0.7	< 4.3	<0.9	<1.1
7-02-84 to 10-01-84	<0.3	<0.2	71±5	<2.8	<0.3	<0.4	<0.9	<14	<1.0	<1.6
10-01-84 to 1-02-85	<0.2	<0.2	62±4	<2.5	<0.3	<0.3	<0.8	<12	<0.9	<1.5
SA-APT-5S1										
12-27-83 to 3-26-84	<0.3	<0.2	52±4	<2.5	<0.4	<0.4	<0.6	15±10	<1.0	<1.6
3-26-84 to 7-02-84	<0.4	<0.3	69±5	<3.9	<0.3	<0.5	<0.9	<15	<1.1	<2.5
7-02-84 to 10-01-84	<0.3	<0.2	64±5	<3.7	<0.3	<0.5	1.0±0.6	< 3.7	<1.1	1.3±0.8
10-01-84 to 1-02-85	<0.2	<0.2	65±5	<3.9	<0.4	<0.5	<0.9	<17	<1.0	<1.5
SA-APT-5D1***										
12-27-83 to 3-26-84	<1.0	<0.2	73±9	(1)	<0.4	<0.6	<2.0	(1)	<9.0	(1)
3-26-84 to 7-02-84	<2.0	<0.2	78±5	(1)	<0.3	<0.3	<0.8	(1)	<5.0	(1)
7-02-84 to 10-01-84	<2.0	<0.4	79±8	(1)	<0.4	<0.4	<1.0	(1)	<7.0	(1)
10-01-84 to 1-02-85	<0.7	<0.1	63±11	(1)	<0.8	<1.0	<2.0	(1)	<10	(1)
SA-APT-10D1										
12-27-83 to 3-27-84	<0.4	<0.3	55±5	<3.2	<0.3	<0.2	<0.9	<17	<1.1	<1.9
3-27-84 to 7-03-84	<0.8	<0.6	64±5	<2.2	<0.5	<0.4	<1.0	<11	<0.9	<2.0
7-03-84 to 10-02-84	<0.3	<0.2	63±5	<2.8	<0.3	<0.4	<0.3	<11	<1.0	<1.4
10-02-84 to 1-03-85	<0.2	<0.2	54±5	<2.8	<0.4	<0.4	<0.9	<16	<1.1	<1.9

TABLE C-3 (cont'd)

1984 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

STATION NO. AND DATES	Sr-89	Sr-90	Be-7	Cr-51	Mn-54	Co-58	Fe-59	Te-129m	Ra-226	Th-232
SA-APT-16E1										
12-27-83 to 3-27-84	<0.4	<0.3	5e±5	<3.7	0.7±0.3	<0.5	<1.0	<16	<1.0	<1.5
3-27-84 to 7-03-84	<0.4	<0.3	66±5	<1.9	<0.3	<0.4	<1.1	< 6.3	<1.0	<1.6
7-03-84 to 10-02-84	<0.3	<0.2	63±5	<2.5	<0.5	<0.2	<1.0	< 4.8	<1.2	<1.8
10-02-84 to 1-03-85	<0.2	<0.2	65±5	<2.9	<0.4	<0.6	<0.6	<15	0.9±0.5	1.6±1.0
SA-APT-1F1										
12-27-83 to 3-26-84	<0.3	<0.2	55±4	<3.0	<0.4	<0.4	<0.7	< 3.2	<1.0	<1.3
3-26-84 to 7-02-84	<0.3	<0.2	60±5	<4.6	<0.1	<0.4	<1.0	< 6.9	<1.0	<1.9
7-02-84 to 10-01-84	<0.3	<0.2	65±6	<3.7	<0.3	<0.6	<0.8	<11	<1.0	<1.9
10-01-84 to 1-02-85	<0.2	<0.2	58±4	<2.6	<0.3	<0.4	<0.7	<13	<1.0	<1.2
SA-APT-2F2										
12-27-83 to 3-26-84	<0.4	<0.3	56±5	<2.7	<0.5	<0.3	<1.0	<17	<1.0	<1.8
3-26-84 to 7-02-84	<0.4	<0.3	73±5	<4.5	<0.5	<0.4	<1.0	< 4.8	<0.4	<1.7
7-02-84 to 10-01-84	<0.3	<0.3	72±5	<4.7	<0.4	<0.4	<0.8	<15	<1.1	<1.7
10-01-84 to 1-02-85	<0.3	<0.2	60±5	<2.8	<0.4	<0.4	<0.7	<18	<1.0	<1.6
SA-APT-3H3 (Control)										
12-27-83 to 3-26-84	<0.3	<0.2	57±5	<2.1	<0.4	<0.4	<0.8	<15	<0.9	<1.8
3-26-84 to 7-02-84	1.1±0.2	<0.3	62±4	<2.4	<0.3	<0.3	<0.8	< 2.5	<0.8	<1.4
7-02-84 to 10-01-84	<0.3	<0.2	69±5	<2.8	<0.3	<0.2	<0.5	<15	<0.8	<1.4
10-01-84 to 1-02-85	<0.2	<0.2	52±3	<2.3	<0.3	<0.3	<0.6	<11	<0.6	<1.0
AVERAGE	-	-	63±15	-	-	-	-	-	-	-

* 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-31.
*** Results by Teledyne Isotopes.
(1) Not analyzed by Teledyne Isotopes.

TABLE C-4

1984 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-1F1	SA-AIO-2F2	SA-AIO-3H3 (Control)
JANUARY	< 9.1	< 6.7	<40	< 6.2	< 7.7	< 6.4	<19	< 6.4
	< 9.0	< 5.4	<20	< 7.4	< 7.6	< 9.6	<12	< 5.6
	< 8.3	< 7.6	<20	< 9.9	< 8.4	< 9.8	<12	< 4.1
	<13	<15	<20	<13	<16	<28	<17	< 7.6
	<16	<21	<20	<19	<33	<23	<26	<21
FEBRUARY	<17	<13	<10	<22	<17	<15	<38(1)	<17
	<17	<17	<30	<12	<23	<17	<21	<15
	<17	<19	<20	<23	<18	<17	<25	<16
	<21	<17	<10	<18	<26	<24	<26	<19
MARCH	<15	<14	<10	<23	<25	<25	<18	<22
	<14	<16	<20	<15	<20	<18	<17	<12
	<16	<16	<30	<24	<17	<19	<21	<13
	<14	< 8.9	<20	<18	<13	<13	<14	<18
APRIL	<17	<16	<50	<27	<24	<25	<21	< 7.1
	<16	<20	<30	<18	<21	<26	<19	<12
	<14	< 5.0	<20	<19	<21	<16	<20	<13
	<22	<16	<10	<15	< 6.7	<17	<15	< 5.7
	<20	<17	<10	< 7.9	<17	<15	<25	<14
MAY	<20	<10	<20	< 7.8	<19	<20	<18	<14
	<21	< 6.1	<20	<14	<17	<20	<110(1)	<13
	<17	<13	<30	<20	<25	<13	<20	<19
	<11	< 8.2	<10	<13	< 9.3	<18	<16	< 5.4
JUNE	<19	<21	<20	<23	<32	<19	<24	<16
	<15	<12	<20	<16	<18	<27	<15	<13
	<18	<12	<20	<17	<21	<19	<14	<10
	< 6.5	<13	<20	< 7.5	<14	<11	<24	<16
	<15	<11	<40	< 8.7	<20	<19	<15	<15

TABLE C-4 (cont'd)

1984 CONCENTRATIONS OF IODINE-131* IN FILTERED AIR

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

	STATION NO.							
MONTH**	SA-AIO-2S2	SA-AIO-5S1	SA-AIO-5D1***	SA-AIO-10D1	SA-AIO-16E1	SA-AIO-1F1	SA-AIO-2P2	SA-AIO-3H3 (Control)
JULY	<17	<18	<40	<24	<16	<26	<26	<20
	<19	<23	<20	<23	<18	<13	< 8.2	<15
	<20	<19	<10	<14	<16	< 9.1	<15	<15
	<11	<15	<50	< 8.0	<31	<27	<17	<21
AUGUST	<12	<16	<30	<18	<20	<19	<23	<16
	<16	< 6.7	<20	<17	<14	<12	<15	<17
	<17	<12	<10	<20	<21	<20	<19	< 6.1
	<12	<16	<20	<14	<18	<15	<13	<16
SEPTEMBER	<17	<18	< 8.0	<20	<17	<12	<13	<15
	<18	<20	<10	<15	<12	< 9.3	<28	<18
	<15	<18	<10	<24	<21	<19	<20	<13
	<15	< 8.5	<20	<13	<14	< 5.7	<15	<16
	<16	< 9.6	<20	<21	<23	<20	<25	<13
OCTOBER	<11	<12	<20	<20	<14	< 5.9	< 5.9	<14
	<21	<21	<20	< 7.0	<21	<18	<22	< 6.7
	<10	<18	<40	<23	<22	<17	<15	<56(1)
	<15	<17	<20	<13	<13	<21	<19	<15
NOVEMBER	<17	<15	<20	<21	<19	<14	< 7.4	<14
	<17	<17	<20	< 6.2	<15	< 6.6	<17	<14
	<22	<24	<40	<20	<19	<18	<24	< 5.7
	<15	<16	< 9.0	< 6.7	<14	<17	<10	<18
DECEMBER	<19	<26	<10	<19	<20	<18	<16	<14
	<14	<21	<20	<20	< 5.3	<23	<13	<12
	<16	<15	< 9.0	<14	<16	<26	<21	<12
	<11	< 6.3	<30	<16	<15	<21	<12	<14
	<22	<19	<30	<10	<14	<14	<13	<15

* I-131 results are corrected for decay to sample stop date.
** Sampling dates can be found in Table C-5.
*** Results by Teledyne Isotopes.
(1) High LLD due to low sample volume.

TABLE C-5

1984 SAMPLING DATES FOR AIR SAMPLES

MONTH	STATION NO. 2S2	5S1	5D1	10D1	16E1	1F1	2F2	3H3
JANUARY	12-27-83 to 1-03-84	12-27-83 to 1-03-84	12-27-83 to 1-03-84	12-27-83 to 1-03-84	12-27-83 to 1-03-84	12-27-83 to 1-03-84	12-27-83 to 1-03-84	12-27-83 to 1-03-84
	1-03-84 to 1-09-84	1-03-84 to 1-09-84	1-03-84 to 1-09-84	1-03-84 to 1-10-84	1-03-84 to 1-10-84	1-03-84 to 1-09-84	1-03-84 to 1-09-84	1-03-84 to 1-09-84
	1-09-84 to 1-16-84	1-09-84 to 1-16-84	1-09-84 to 1-16-84	1-10-84 to 1-16-84	1-10-84 to 1-16-84	1-09-84 to 1-16-84	1-09-84 to 1-16-84	1-09-84 to 1-16-84
	1-16-84 to 1-23-84	1-16-84 to 1-23-84	1-16-84 to 1-23-84	1-16-84 to 1-24-84	1-16-84 to 1-24-84	1-16-84 to 1-23-84	1-16-84 to 1-23-84	1-16-84 to 1-23-84
	1-23-84 to 1-30-84	1-23-84 to 1-30-84	1-23-84 to 1-30-84	1-24-84 to 1-31-84	1-24-84 to 1-31-84	1-23-84 to 1-30-84	1-23-84 to 1-30-84	1-23-84 to 1-30-84
FEBRUARY	1-30-84 to 2-06-84	1-30-84 to 2-06-84	1-30-84 to 2-06-84	1-31-84 to 2-06-84	1-31-84 to 2-06-84	1-30-84 to 2-06-84	1-30-84 to 2-03-84*	1-30-84 to 2-06-84
	2-06-84 to 2-14-84	2-06-84 to 2-14-84	2-06-84 to 2-14-84	2-06-84 to 2-14-84	2-06-84 to 2-14-84	2-06-84 to 2-14-84	2-07-84 to 2-14-84	2-06-84 to 2-14-84
	2-14-84 to 2-21-84	2-14-84 to 2-21-84	2-14-84 to 2-21-84	2-14-84 to 2-21-84	2-14-84 to 2-21-84	2-14-84 to 2-21-84	2-14-84 to 2-21-84	2-14-84 to 2-21-84
	2-21-84 to 2-27-84	2-21-84 to 2-27-84	2-21-84 to 2-27-84	2-21-84 to 2-28-84	2-21-84 to 2-28-84	2-21-84 to 2-27-84	2-21-84 to 2-27-84	2-21-84 to 2-27-84
MARCH	2-27-84 to 3-05-84	2-27-84 to 3-05-84	2-27-84 to 3-05-84	2-28-84 to 3-05-84	2-28-84 to 3-05-84	2-27-84 to 3-05-84	2-27-84 to 3-05-84	2-27-84 to 3-05-84
	3-05-84 to 3-12-84	3-05-84 to 3-12-84	3-05-84 to 3-12-84	3-05-84 to 3-13-84	3-05-84 to 3-13-84	3-05-84 to 3-12-84	3-05-84 to 3-12-84	3-05-84 to 3-12-84

TABLE C-5 (cont'd)

1984 SAMPLING DATES FOR AIR SAMPLES

MONTH	STATION NO. 2S2	5S1	5D1	10D1	16E1	1F1	2F2	3H3
MARCH	3-12-84 to 3-19-84	3-12-84 to 3-19-84	3-12-84 to 3-19-84	3-13-84 to 3-19-84	3-13-84 to 3-19-84	3-12-84 to 3-19-84	3-12-84 to 3-19-84	3-12-84 to 3-19-84
	3-19-84 to 3-26-84	3-19-84 to 3-26-84	3-19-84 to 3-26-84	3-19-84 to 3-27-84	3-19-84 to 3-27-84	3-19-84 to 3-26-84	3-19-84 to 3-26-84	3-19-84 to 3-26-84
APRIL	3-26-84 to 4-02-84	3-26-84 to 4-02-84	3-26-84 to 4-02-84	3-27-84 to 4-02-84	3-27-84 to 4-02-84	3-26-84 to 4-02-84	3-26-84 to 4-02-84	3-26-84 to 4-02-84
	4-02-84 to 4-09-84	4-02-84 to 4-09-84	4-02-84 to 4-09-84	4-02-84 to 4-10-84	4-02-84 to 4-10-84	4-02-84 to 4-09-84	4-02-84 to 4-09-84	4-02-84 to 4-09-84
	4-09-84 to 4-16-84	4-09-84 to 4-16-84	4-09-84 to 4-16-84	4-10-84 to 4-16-84	4-10-84 to 4-16-84	4-09-84 to 4-16-84	4-09-84 to 4-16-84	4-09-84 to 4-16-84
	4-16-84 to 4-23-84	4-16-84 to 4-23-84	4-16-84 to 4-23-84	4-16-84 to 4-24-84	4-16-84 to 4-24-84	4-16-84 to 4-23-84	4-16-84 to 4-23-84	4-16-84 to 4-23-84
	4-23-84 to 4-30-84	4-23-84 to 4-30-84	4-23-84 to 4-30-84	4-24-84 to 4-30-84	4-24-84 to 4-30-84	4-23-84 to 4-30-84	4-23-84 to 4-30-84	4-23-84 to 4-30-84
MAY	4-30-84 to 5-07-84	4-30-84 to 5-07-84	4-30-84 to 5-07-84	4-30-84 to 5-07-84	4-30-84 to 5-07-84	4-30-84 to 5-07-84	4-30-84 to 5-07-84	4-30-84 to 5-07-84
	5-07-84 to 5-14-84	5-07-84 to 5-14-84	5-07-84 to 5-14-84	5-07-84 to 5-15-84	5-07-84 to 5-15-84	5-07-84 to 5-14-84	5-07-84 to 5-10-84*	5-07-84 to 5-14-84
	5-14-84 to 5-21-84	5-14-84 to 5-21-84	5-14-84 to 5-21-84	5-15-84 to 5-21-84	5-15-84 to 5-21-84	5-14-84 to 5-21-84	5-14-84 to 5-21-84	5-14-84 to 5-21-84
	5-21-84 to 5-29-84	5-21-84 to 5-29-84	5-21-84 to 5-29-84	5-21-84 to 5-30-84	5-21-84 to 5-30-84	5-21-84 to 5-29-84	5-21-84 to 5-29-84	5-21-84 to 5-29-84

TABLE C-5 (cont'd)

1984 SAMPLING DATES FOR AIR SAMPLES

MONTH	STATION NO. 2S2	5S1	5D1	10D1	16E1	1F1	2F4	3H3
JUNE	5-29-84 to 6-04-84	5-29-84 to 6-04-84	5-29-84 to 6-04-84	5-30-84 to 6-04-84	5-30-84 to 6-04-84	5-29-84 to 6-04-84	5-29-84 to 6-04-84	5-29-84 to 6-04-84
	6-04-84 to 6-11-84	6-04-84 to 6-11-84	6-04-84 to 6-11-84	6-04-84 to 6-12-84	6-04-84 to 6-12-84	6-04-84 to 6-11-84	6-04-84 to 6-11-84	6-04-84 to 6-11-84
	6-11-84 to 6-18-84	6-11-84 to 6-18-84	6-11-84 to 6-18-84	6-12-84 to 6-18-84	6-12-84 to 6-18-84	6-11-84 to 6-18-84	6-11-84 to 6-18-84	6-11-84 to 6-18-84
	6-18-84 to 6-25-84	6-18-84 to 6-25-84	6-18-84 to 6-25-84	6-18-84 to 6-26-84	6-18-84 to 6-26-84	6-13-84 to 6-25-84	6-18-84 to 6-25-84	6-18-84 to 6-25-84
	6-25-84 to 7-02-84	6-25-84 to 7-02-84	6-25-84 to 7-02-84	6-26-84 to 7-03-84	6-26-84 to 7-03-84	6-25-84 to 7-02-84	6-25-84 to 7-02-84	6-25-84 to 7-02-84
JULY	7-02-84 to 7-09-84	7-02-84 to 7-09-84	7-02-84 to 7-09-84	7-03-84 to 7-09-84	7-03-84 to 7-09-84	7-02-84 to 7-09-84	7-02-84 to 7-09-84	7-02-84 to 7-09-84
	7-09-84 to 7-16-84	7-09-84 to 7-16-84	7-09-84 to 7-16-84	7-09-84 to 7-17-84	7-09-84 to 7-17-84	7-09-84 to 7-16-84	7-09-84 to 7-16-84	7-09-84 to 7-16-84
	7-16-84 to 7-23-84	7-16-84 to 7-23-84	7-16-84 to 7-23-84	7-17-84 to 7-24-84	7-17-84 to 7-24-84	7-16-84 to 7-23-84	7-16-84 to 7-23-84	7-16-84 to 7-23-84
	7-23-84 to 7-30-84	7-23-84 to 7-30-84	7-23-84 to 7-30-84	7-24-84 to 7-31-84	7-24-84 to 7-31-84	7-23-84 to 7-30-84	7-23-84 to 7-30-84	7-23-84 to 7-30-84
AUGUST	7-30-84 to 8-06-84	7-30-84 to 8-06-84	7-30-84 to 8-06-84	7-31-84 to 8-06-84	7-31-84 to 8-06-84	7-30-84 to 8-06-84	7-30-84 to 8-06-84	7-30-84 to 8-06-84
	8-06-84 to 8-13-84	8-06-84 to 8-13-84	8-06-84 to 8-13-84	8-06-84 to 8-14-84	8-06-84 to 8-14-84	8-06-84 to 8-13-84	8-06-84 to 8-13-84	8-06-84 to 8-13-84

TABLE C-5 (cont'd)

1984 SAMPLING DATES FOR AIR SAMPLES

MONTH	STATION NO. 2S2	5S1	5D1	10D1	16E1	1F1	2F2	3H3
AUGUST	8-13-84 to 8-20-84	8-13-84 to 8-20-84	8-13-84 to 8-20-84	8-14-84 to 8-20-84	8-14-84 to 8-20-84	8-13-84 to 8-20-84	8-13-84 to 8-20-84	8-13-84 to 8-20-84
	8-20-84 to 8-28-84	8-20-84 to 8-28-84	8-20-84 to 8-28-84	8-20-84 to 8-29-84	8-20-84 to 8-29-84	8-20-84 to 8-28-84	8-20-84 to 8-28-84	8-20-84 to 8-27-84
SEPTEMBER	8-28-84 to 9-04-84	8-28-84 to 9-04-84	8-28-84 to 9-04-84	8-29-84 to 9-04-84	8-29-84 to 9-04-84	8-28-84 to 9-04-84	8-28-84 to 9-04-84	8-27-84 to 9-04-84
	9-04-84 to 9-10-84	9-04-84 to 9-10-84	9-04-84 to 9-10-84	9-04-84 to 9-11-84	9-04-84 to 9-11-84	9-04-84 to 9-10-84	9-04-84 to 9-10-84	9-04-84 to 9-10-84
	9-10-84 to 9-17-84	9-10-84 to 9-17-84	9-10-84 to 9-17-84	9-11-84 to 9-17-84	9-11-84 to 9-17-84	9-10-84 to 9-17-84	9-10-84 to 9-17-84	9-10-84 to 9-17-84
	9-17-84 to 9-25-84	9-17-84 to 9-25-84	9-17-84 to 9-25-84	9-17-84 to 9-26-84	9-17-84 to 9-26-84	9-17-84 to 9-25-84	9-17-84 to 9-25-84	9-17-84 to 9-24-84
	9-25-84 to 10-01-84	9-25-84 to 10-01-84	9-25-84 to 10-01-84	9-26-84 to 10-02-84	9-26-84 to 10-02-84	9-25-84 to 10-01-84	9-25-84 to 10-01-84	9-24-84 to 10-01-84
OCTOBER	10-01-84 to 10-09-84	10-01-84 to 10-09-84	10-01-84 to 10-09-84	10-02-84 to 10-09-84	10-02-84 to 10-10-84	10-01-84 to 10-09-84	10-01-84 to 10-09-84	10-01-84 to 10-09-84
	10-09-84 to 10-15-84	10-09-84 to 10-15-84	10-09-84 to 10-15-84	10-09-84 to 10-16-84	10-10-84 to 10-16-84	10-09-84 to 10-15-84	10-09-84 to 10-15-84	10-09-84 to 10-15-84
	10-15-84 to 10-22-84	10-15-84 to 10-22-84	10-15-84 to 10-22-84	10-16-84 to 10-22-84	10-16-84 to 10-22-84	10-15-84 to 10-22-84	10-15-84 to 10-22-84	10-15-84 to 10-17-84*
	10-22-84 to 10-29-84	10-22-84 to 10-29-84	10-22-84 to 10-29-84	10-22-84 to 10-30-84	10-22-84 to 10-30-84	10-22-84 to 10-29-84	10-22-84 to 10-29-84	10-22-84 to 10-29-84

TABLE C-5 (cont'd)

1984 SAMPLING DATES FOR AIR SAMPLES

MONTH	STATION NO. 2S2	5S1	5D1	10D1	16E1	1F1	2F2	3H3
NOVEMBER	10-29-84 to 11-05-84	10-29-84 to 11-05-84	10-29-84 to 11-05-84	10-30-84 to 11-05-84	10-30-84 to 11-05-84	10-29-84 to 11-05-84	10-29-84 to 11-05-84	10-29-84 to 11-05-84
	11-05-84 to 11-13-84	11-05-84 to 11-13-84	11-05-84 to 11-13-84	11-05-84 to 11-13-84	11-05-84 to 11-13-84	11-05-84 to 11-13-84	11-05-84 to 11-13-84	11-05-84 to 11-13-84
	11-13-84 to 11-19-84	11-13-84 to 11-19-84	11-13-84 to 11-19-84	11-13-84 to 11-20-84	11-13-84 to 11-20-84	11-13-84 to 11-19-84	11-13-84 to 11-19-84	11-13-84 to 11-19-84
	11-19-84 to 11-26-84	11-19-84 to 11-26-84	11-19-84 to 11-26-84	11-20-84 to 11-27-84	11-20-84 to 11-27-84	11-19-84 to 11-26-84	11-19-84 to 11-26-84	11-19-84 to 11-26-84
DECEMBER	11-26-84 to 12-03-84	11-26-84 to 12-03-84	11-26-84 to 12-03-84	11-27-84 to 12-03-84	11-27-84 to 12-03-84	11-26-84 to 12-03-84	11-26-84 to 12-03-84	11-26-84 to 12-03-84
	12-03-84 to 12-10-84	12-03-84 to 12-10-84	12-03-84 to 12-10-84	12-03-84 to 12-11-84	12-03-84 to 12-11-84	12-03-84 to 12-10-84	12-03-84 to 12-08-84*	12-03-84 to 12-10-84
	12-10-84 to 12-18-84	12-10-84 to 12-18-84	12-10-84 to 12-18-84	12-11-84 to 12-18-84	12-11-84 to 12-18-84	12-10-84 to 12-18-84	12-11-84 to 12-18-84	12-10-84 to 12-18-84
	12-18-84 to 12-26-84	12-18-84 to 12-26-84	12-18-84 to 12-26-84	12-18-84 to 12-26-84	12-18-84 to 12-26-84	12-18-84 to 12-26-84	12-18-84 to 12-26-84	12-18-84 to 12-26-84
	12-26-84 to 1-02-85	12-26-84 to 1-02-85	12-26-84 to 1-02-85	12-26-84 to 1-03-85	12-26-84 to 1-03-85	12-26-84 to 1-02-85	12-26-84 to 1-02-85	12-26-84 to 1-02-85

* Reduced sampling period due to instrument malfunction.

TABLE C-6

1984 CONCENTRATIONS OF GROSS ALPHA AND GROSS BETA EMITTERS, AND TRITIUM IN PRECIPITATION

STATION NO. SA-RWA-2F2

Results in Units of pCi/L ± 2 sigma

COLLECTION PERIOD	ALPHA	BETA	TRITIUM
12-27-83 to 1-30-84	<0.8	<2.7	<130
1-30-84 to 2-27-84	1.1±0.8	3.5±0.7	<130
2-27-84 to 3-26-84	<1.4	3.2±0.7	140±80
3-26-84 to 4-30-84	<0.9	3.7±0.7	<130
4-30-84 to 5-30-84	<1.5	1.8±0.6	<130
5-30-84 to 7-02-84	<1.0	2.8±0.7	140±80
7-02-84 to 7-31-84	1.7±1.1	2.2±0.6	<130
7-31-84 to 8-28-84	<1.9	3.8±0.8	<140
8-28-84 to 10-02-84	2.4±1.2	4.0±0.8	150±80
10-02-84 to 10-29-84	<1.0	1.0±0.5	<130
10-29-84 to 11-27-84	<1.0	3.2±1.2	<130
11-27-84 to 1-02-85	0.8±0.7	1.9±0.7	<140
AVERAGE	-	2.8±1.8	-

TABLE C-7

1984 CONCENTRATIONS OF STRONTIUM-89* AND -90 AND GAMMA EMITTERS**
IN QUARTERLY COMPOSITES OF PRECIPITATION

STATION NO. SA-RWA-2F2

Results in Units of pCi/L ± 2 sigma

NUCLIDE	12-27-83 to 3-26-84	3-26-84 to 7-02-84	7-02-84 to 10-02-84	10-02-84 to 10-29-84(1)	AVERAGE
Sr-89	<0.5	<0.5	<0.5	<1.0	-
Sr-90	<0.4	<0.4	<0.4	<0.4	-
Be-7	36±6	35±4	25±4	39±21	34±12
Ra-226	<1.5	<8.4	<1.3	5.6±2.4	-
Th-232	<2.4	<2.2	<2.5	7.8±4.5	-

* 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-31.
(1) Results are only taken from the October sample due to insufficient rainfall in the remaining two months of the fourth quarter.

TABLE C-8

1984 DIRECT RADIATION MEASUREMENTS - QUARTERLY TLD RESULTS

Results in mrad/standard month*

(Results by Teledyne Isotopes)

STATION NO.	JANUARY to MARCH	APRIL to JUNE	JULY to SEPTEMBER	OCTOBER to DECEMBER	AVERAGE
SA-IDM-2S2	5.9±0.1	5.3±0.3	5.6±0.2	4.8±0.3	5.4±0.9
SA-IDM-5S1	4.9±0.2	4.4±0.3	5.0±0.4	4.5±0.2	4.7±0.6
SA-IDM-6S2	5.1±0.1	5.1±0.2	(1)	5.1±0.2	5.1±0.0
SA-IDM-7S1	6.2±0.2	5.9±0.2	6.6±0.2	6.2±0.2	6.2±0.6
SA-IDM-10S1	5.8±0.1	5.4±0.1	6.8±0.7	6.3±0.3	6.1±1.2
SA-IDM-11S1	4.9±0.1	4.7±0.1	6.7±0.2	8.7±0.3	6.2±3.7
SA-IDM-4D2	6.1±0.5	5.7±0.4	6.1±0.4	5.4±0.3	5.8±0.7
SA-IDM-5D1	5.3±0.2	5.1±0.1	5.8±0.2	5.1±0.1	5.3±0.7
SA-IDM-10D1	6.0±0.5	5.4±0.3	6.1±0.1	5.3±0.2	5.7±0.8
SA-IDM-14D1	5.3±0.3	5.4±0.3	6.1±0.2	5.1±0.2	5.5±0.9
SA-IDM-2E1	5.5±0.1	5.1±0.5	6.0±0.6	5.2±0.6	5.4±0.8
SA-IDM-3E1	5.2±0.2	5.0±0.3	5.6±0.4	4.9±0.3	5.2±0.6
SA-IDM-9E1	6.6±0.2	6.2±0.8	6.8±0.5	6.1±0.1	6.4±0.7
SA-IDM-11E2	6.5±0.4	6.1±0.3	7.1±0.6	5.9±0.3	6.4±1.0
SA-IDM-12E1	6.4±0.1	5.7±0.1	6.6±0.1	5.6±0.2	6.1±1.0
SA-IDM-13E1	5.2±0.2	5.0±0.5	5.7±0.2	4.8±0.3	5.2±0.8
SA-IDM-16E1	5.6±0.1	5.6±0.8	6.4±0.3	5.3±0.1	5.7±0.9
SA-IDM-1F1	5.0±0.5	5.1±0.6	6.0±0.3	5.2±0.1	5.3±0.9
SA-IDM-2F2	4.2±0.1	4.8±0.5	4.8±0.2	3.8±0.1	4.4±1.0
SA-IDM-2F5	6.1±0.1	5.4±0.1	6.3±0.1	5.3±0.1	5.8±1.0
SA-IDM-2F6	5.5±0.3	5.1±0.2	6.0±0.3	5.0±0.1	5.4±0.9
SA-IDM-3F2	5.7±1.1	4.6±0.2	5.4±0.3	4.8±0.0	5.1±0.3
SA-IDM-3F3	5.3±0.2	4.4±0.2	5.5±0.1	4.5±0.1	4.9±0.9
SA-IDM-5F1	5.0±0.1	4.7±0.1	5.7±0.3	4.9±0.2	5.1±0.8
SA-IDM-6F1	4.5±0.2	4.2±0.0	5.1±0.3	4.0±0.2	4.4±1.0
SA-IDM-7F2	4.0±0.1	3.5±0.1	4.3±0.2	3.8±0.2	3.9±0.7
SA-IDM-10F2	6.3±0.1	5.5±0.5	6.7±0.1	5.8±0.2	6.1±1.1
SA-IDM-11F1	5.9±0.1	5.7±0.2	6.6±0.1	5.2±0.4	5.8±1.2
SA-IDM-12F1	6.2±0.1	5.2±0.3	6.2±0.1	4.9±0.3	5.6±1.4
SA-IDM-13F2	5.8±0.1	5.2±0.4	6.1±0.3	5.0±0.4	5.5±1.0
SA-IDM-13F3	6.2±0.2	5.5±0.2	6.4±0.2	5.2±0.2	5.8±1.1
SA-IDM-13F1/4**	5.6±0.1	5.4±0.4	6.1±0.1	5.3±0.2	5.6±0.7
SA-IDM-14F2	5.9±0.1	5.1±0.4	6.1±0.4	5.2±0.2	5.6±1.0
SA-IDM-15F3	6.6±0.2	6.1±0.5	7.1±0.5	5.6±0.3	6.3±1.3
SA-IDM-16F2	5.7±0.1	4.8±0.5	5.7±0.3	4.7±0.0	5.2±1.1
SA-IDM-1G3 (C)	6.8±0.2	6.7±0.2	7.2±0.3	6.0±0.3	6.7±1.0
SA-IDM-3G1 (C)	5.6±0.1	5.8±0.3	6.7±0.3	5.3±0.2	5.8±1.2
SA-IDM-10G1 (C)	6.6±0.2	6.0±0.3	6.8±0.5	5.5±0.3	6.2±1.2
SA-IDM-16G1 (C)	6.9±0.2	6.1±0.3	7.2±0.3	5.9±0.2	6.5±1.2
SA-IDM-3H1 (C)	5.5±0.2	5.0±0.6	6.6±0.2	5.4±0.2	5.6±1.4
SA-IDM-3H3 (C)	5.7±0.2	5.7±0.2	6.5±0.3	5.4±0.2	5.8±0.9
AVERAGE	5.7±1.3	5.3±1.2	6.2±1.3	5.3±1.6	
				Grand Average	5.6±1.5

* The standard month = 30.4 days.
** Effective 3-27-84, Loc. 13F1 has been moved to a new location (13F4).
(1) TLD missing from field location.
(C) Control station

TABLE C-9

1984 DIRECT RADIATION MEASUREMENTS - MONTHLY TLD RESULTS

Results in mrad/standard month*

(Results by Teledyne Isotopes)

STATION NO.	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE
SA-IDM-2S2	6.1±0.6	6.7±0.3	5.4±0.3	6.1±0.2	6.5±0.6	7.5±1.0
SA-IDM-5S1	4.3±0.2	6.1±0.1	4.6±0.1	4.9±0.1	5.8±0.2	6.3±0.3
SA-IDM-6S2	4.4±0.1	6.5±0.3	5.2±0.1	5.5±0.1	6.4±1.2	6.9±0.6
SA-IDM-7S1	5.3±0.2	7.7±0.1	5.9±0.4	6.6±0.5	7.0±0.2	7.8±0.2
SA-IDM-10S1	5.4±0.1	6.8±0.2	5.8±0.3	5.9±0.1	6.6±0.2	7.7±0.4
SA-IDM-11S1	4.8±0.8	5.7±0.1	4.7±0.1	5.4±0.6	5.8±0.4	6.8±0.9
SA-IDM-5D1	4.4±0.3	6.6±0.2	5.1±0.2	5.4±0.2	6.2±0.2	7.0±0.2
SA-IDM-10D1	5.0±0.4	6.9±0.3	6.0±0.4	6.4±0.1	6.5±0.3	7.4±0.2
SA-IDM-14D1	5.4±0.1	6.8±0.5	5.4±0.2	6.2±0.3	6.5±0.3	7.6±0.2
SA-IDM-2E1	5.4±0.4	6.7±0.2	5.1±0.3	5.5±0.1	6.3±0.4	7.4±1.5
SA-IDM-3E1	5.3±0.3	6.4±0.1	4.9±0.2	5.6±0.7	6.0±0.1	6.8±0.3
SA-IDM-13E1	4.9±0.6	6.4±0.2	5.1±0.4	5.7±0.2	5.9±0.4	6.9±0.2
SA-IDM-16E1	5.2±0.8	7.2±0.3	5.7±0.3	6.0±0.2	6.3±0.5	7.5±0.1
SA-IDM-1F1	5.5±0.1	6.5±0.2	5.8±0.5	6.1±0.2	6.8±0.7	7.3±1.1
SA-IDM-2F2	4.6±0.1	5.6±0.2	4.5±0.9	4.4±0.1	5.2±1.0	6.0±0.2
SA-IDM-2F6	6.0±0.1	6.6±0.2	5.2±0.3	5.7±0.2	6.8±0.5	7.1±0.4
SA-IDM-5F1	4.3±0.3	6.2±0.1	4.8±0.2	5.2±0.2	5.9±0.2	6.6±0.3
SA-IDM-6F1	3.6±0.4	5.5±0.2	4.4±0.2	4.5±0.1	5.6±0.2	6.0±0.3
SA-IDM-7F2	3.5±0.2	5.6±0.5	3.8±0.2	4.3±0.3	4.9±0.3	5.5±0.4
SA-IDM-11F1	5.6±0.2	7.1±0.5	5.9±0.1	6.5±0.2	6.7±0.2	7.8±0.0
SA-IDM-13F1/4**	5.3±0.4	6.5±0.2	5.4±0.2	6.2±0.3	6.6±0.2	7.6±0.9
SA-IDM-3G1 (C)	6.1±0.1	7.2±0.2	5.7±0.3	5.8±0.2	6.2±0.2	7.7±0.4
SA-IDM-3H1 (C)	6.0±0.3	6.9±0.2	5.3±0.2	5.8±0.1	7.0±0.2	7.3±0.2
SA-IDM-3H3 (C)	5.2±0.4	7.3±0.2	5.9±0.2	6.3±0.3	7.1±0.2	8.0±1.0
AVERAGE	5.1±1.4	6.6±1.1	5.2±1.1	5.7±1.3	6.3±1.1	7.1±1.3

TABLE C-9 (cont'd)
1984 DIRECT RADIATION MEASUREMENTS - MONTHLY TLD RESULTS
Results in mrad/standard month*
(Results by Teledyne Isotopes)

STATION NO.	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	AVERAGE
SA-IDM-2S2	5.6±0.3	7.1±0.3	5.5±0.5	5.0±0.1	4.6±0.4	5.9±0.3	6.0±1.7
SA-IDM-5S1	5.3±0.3	6.6±0.7	5.1±0.2	4.8±0.2	4.8±0.8	5.5±0.2	5.3±1.4
SA-IDM-6S2	5.9±0.4	6.9±0.4	(1)	5.4±0.2	5.2±0.5	5.8±0.3	5.8±1.6
SA-IDM-7S1	6.5±0.4	8.1±0.4	6.7±0.2	6.4±0.2	6.3±0.6	6.9±0.5	6.8±1.6
SA-IDM-10S1	6.0±0.5	8.0±0.1	6.5±0.1	6.8±0.2	6.3±0.9	6.1±0.4	6.5±1.5
SA-IDM-11S1	5.4±0.6	8.5±0.4	8.3±0.5	11.3±0.6	9.3±2.4	5.7±0.5	6.8±4.2
SA-IDM-5D1	5.7±0.5	7.0±0.5	5.6±0.2	5.0±0.3	4.8±0.4	5.8±0.3	5.7±1.7
SA-IDM-10D1	6.4±0.3	8.1±0.4	6.3±0.1	5.7±0.2	5.5±0.5	6.1±0.6	6.4±1.7
SA-IDM-14D1	6.0±0.3	7.4±0.4	6.0±0.2	5.5±0.6	5.5±0.5	6.0±0.1	6.2±1.5
SA-IDM-2E1	5.8±0.2	7.1±0.3	5.8±0.3	5.5±0.2	5.0±0.2	6.0±0.4	6.0±1.5
SA-IDM-3E1	5.6±0.3	7.0±0.2	5.4±0.4	4.9±0.2	4.9±1.0	5.5±0.3	5.7±1.4
SA-IDM-13E1	5.9±0.2	7.1±0.1	5.9±1.2	5.1±0.4	4.9±0.4	5.7±0.4	5.8±1.5
SA-IDM-16E1	6.3±0.4	7.6±0.2	5.9±0.1	5.3±0.3	5.2±0.3	6.1±0.3	6.2±1.7
SA-IDM-1F1	5.8±0.3	7.6±0.2	6.0±1.0	5.4±0.3	5.0±0.3	5.7±0.4	6.1±1.6
SA-IDM-2F2	4.7±0.2	5.9±0.1	4.4±0.2	4.3±0.2	4.2±0.3	4.8±0.1	4.9±1.3
SA-IDM-2F6	6.2±0.5	7.1±0.4	5.5±0.3	5.4±0.2	5.1±0.2	6.1±0.3	6.1±1.4
SA-IDM-5F1	5.6±0.4	6.8±0.4	5.4±0.2	5.1±0.1	4.9±0.6	5.7±0.3	5.5±1.5
SA-IDM-6F1	5.0±0.2	6.1±0.2	4.7±0.4	4.6±0.1	4.8±0.3	5.0±0.1	5.0±1.4
SA-IDM-7F2	4.6±0.2	5.8±0.6	4.1±0.2	4.1±0.2	4.3±0.6	4.8±0.2	4.6±1.5
SA-IDM-11F1	6.3±0.2	8.2±0.6	6.1±0.4	6.0±0.3	5.8±0.3	6.1±0.4	6.5±1.6
SA-IDM-13F4	6.4±0.6	7.5±0.2	5.8±0.2	5.3±0.4	5.4±0.4	6.0±0.3	6.2±1.5
SA-IDM-3G1 (C)	6.3±0.8	7.7±0.3	6.4±1.3	5.7±0.1	5.5±0.4	6.1±0.3	6.4±1.5
SA-IDM-3H1 (C)	5.9±0.7	7.6±0.4	5.9±0.2	5.9±0.3	5.9±0.2	6.2±0.3	6.3±1.4
SA-IDM-3H3 (C)	6.6±0.9	8.5±0.2	6.1±0.3	5.8±0.3	6.3±0.3	6.5±0.3	6.6±1.9
AVERAGE	5.8±1.1	7.3±1.5	5.8±1.7	5.6±2.7	5.4±2.0	5.8±1.0	
						Grand Average	6.0±2.0

* The standard month = 30.4 days.
** Effective 3-27-84, Loc. 13F1 has been moved to a new location (13F4).
(1) TLD missing from field location.
(C) Control station

TABLE C-10

1984 CONCENTRATIONS OF IODINE-131* IN MILK

Results in Units of pCi/L

STATION NO.**	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE
SA-MLK-13E3	<0.1 <0.2	<0.1 <0.2	<0.1 <0.1	<0.1 <0.1	<0.1 <0.1	<0.1 <0.1
SA-MLK-2F4	<0.1 <0.2	<0.2 <0.2	<0.1 <0.1	<0.1 <0.1	<0.1 <0.1	<0.1 <0.1
SA-MLK-5F2	<0.1 <0.2	<0.2 <0.2	<0.1 <0.1	<0.1 <0.1	<0.1 <0.1	<0.1 <0.1
SA-MLK-14F1	<0.1 <0.2	<0.2 <0.2	<0.1 <0.1	<0.1 <0.1	<0.1 <0.1	<0.1 <0.1
SA-MLK-15F1	<0.1 <0.2	<0.2 <0.2	<0.1 <0.1	<0.1 <0.1	<0.1 <0.1	<0.1 <0.1
SA-MLK-3G1 (Control)	<0.1 <0.2	<0.1 <0.2	<0.1 <0.1	<0.1 <0.1	<0.1 <0.1	<0.1 <0.1

STATION NO.**	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
SA-MLK-13E3	<0.1 <0.1	<0.1 <0.1	<0.1 <0.2	<0.1 <0.1	<0.1 <0.1	<0.2 <0.1
SA-MLK-2F4	<0.1 <0.1	<0.2 <0.1	<0.1 <0.1	<0.1 <0.1	<0.1 <0.1	<0.2 <0.1
SA-MLK-5F2	<0.1 <0.1	<0.2 <0.1	<0.1 <0.1	<0.1 <0.1	<0.1 <0.1	<0.2 <0.1
SA-MLK-14F1	<0.1 <0.1	<0.2 <0.1	<0.1 <0.1	<0.1 <0.1	<0.1 <0.1	<0.2 <0.1
SA-MLK-15F1	<0.1 <0.1	<0.2 <0.1	<0.1 <0.1	<0.2 <0.1	<0.1 <0.1	<0.2 <0.1
SA-MLK-3G1 (Control)	<0.1 <0.1	<0.1 <0.1	<0.1 <0.1	<0.1 <0.1	<0.1 <0.1	<0.2 <0.1

* I-131 results are corrected for decay to midpoint of collection period.
** Sampling dates can be found in Table C-13.

TABLE C-11

1984 CONCENTRATIONS OF 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	Sr-89	<1.0	<1.2	<1.2	<1.3	<1.1	<1.4
	Sr-90	2.5±0.4	2.9±0.5	2.6±0.5	3.2±0.6	2.4±0.4	2.7±0.6
SA-MLK-2F4	Sr-89	<1.0	<1.0	<1.1	<1.3	<1.1	<1.6
	Sr-90	1.6±0.4	1.9±0.4	1.2±0.4	3.4±0.6	2.1±0.4	1.6±0.6
SA-MLK-5F2	Sr-89	<1.1	<1.2	<1.2	<1.2	<1.2	<1.7
	Sr-90	2.7±0.4	3.8±0.5	3.2±0.4	4.8±0.5	4.1±0.5	5.3±0.7
SA-MLK-14F1	Sr-89	<1.2	<1.4	<1.2	<1.3	<1.1	<1.4
	Sr-90	2.0±0.4	2.5±0.5	2.2±0.5	2.7±0.6	2.5±0.4	2.3±0.6
SA-MLK-15F1	Sr-89	<1.0	<1.4	<1.1	<1.2	<1.1	<1.3
	Sr-90	1.4±0.4	2.6±0.6	1.8±0.4	2.3±0.5	1.4±0.4	2.0±0.5
SA-MLK-3G1 (Control)	Sr-89	<1.2	<1.2	<1.3	<1.3	<1.2	<1.8
	Sr-90	2.9±0.4	3.5±0.5	3.7±0.5	3.1±0.6	3.1±0.5	3.3±0.7

STATION NO.**	NUCLIDE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	AVERAGE
SA-MLK-13E3	Sr-89	<1.1	<1.0	<1.5	<1.1	<1.0	<0.8	-
	Sr-90	2.1±0.5	2.1±0.4	2.2±0.6	2.2±0.4	2.0±0.4	1.9±0.4	2.4±0.8
SA-MLK-2F4	Sr-89	<1.0	<1.0	<1.5	<1.0	<1.0	<0.8	-
	Sr-90	1.3±0.4	1.3±0.4	1.2±0.4	1.5±0.4	1.8±0.4	1.5±0.3	1.7±1.2
SA-MLK-5F2	Sr-89	<1.4	<1.3	<1.7	<1.3	<1.4	<1.0	-
	Sr-90	4.9±0.6	4.2±0.6	4.3±0.7	4.5±0.6	4.4±0.6	2.5±0.4	3.8±2.1
SA-MLK-14F1	Sr-89	<1.1	<1.1	<1.4	<1.1	<1.1	<0.9	-
	Sr-90	1.9±0.5	2.1±0.4	1.9±0.4	2.4±0.5	2.1±0.4	1.7±0.4	2.2±0.6
SA-MLK-15F1	Sr-89	<1.3	<1.0	<2.0	<1.1	<1.1	<1.2	-
	Sr-90	2.1±0.6	1.8±0.4	2.0±0.8	1.9±0.4	1.6±0.5	2.3±0.4	1.9±0.7
SA-MLK-3G1 (Control)	Sr-89	<1.3	<1.2	<1.6	<1.2	<1.2	<0.9	-
	Sr-90	4.9±0.6	3.8±0.5	3.3±0.6	3.0±0.5	2.3±0.5	2.2±0.4	3.3±1.4
						Grand Average	Sr-89	-
							Sr-90	2.5±1.9

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

** Sampling dates can be found in Table C-13.
Strontium analysis performed only on first milk collection of each month.

TABLE C-12

1984 CONCENTRATIONS OF GAMMA EMITTERS* IN MILK

Results in Units of pCi/L ± 2 sigma

STATION NO.**	NUCLIDE	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE
SA-MLK-13E3	Na-22	<2.1	<3.2	<2.9	<2.9	<3.5	<0.5
	K-40	1400±55	1400±68	1300±67	1200±57	1300±65	1300±58
	Mn-54	<1.5	<2.1	<2.8	<1.9	<2.1	<2.1
	Cs-137	2.3±1.5	<2.6	<2.4	<2.3	<2.3	<1.4
	La-140	<2.0	<2.6	<2.8	<1.3	<2.3	<2.6
	Ra-226	<6.0	5.1±2.2	<9.8	<9.2	<4.8	<4.8
	Th-232	<7.3	<9.3	<9.7	<7.6	<10	<8.0
SA-MLK-2F4	Na-22	<3.1	<2.6	<2.2	<3.7	<3.6	<3.5
	K-40	1400±61	1400±59	1400±55	1400±67	1400±70	1400±69
	Mn-54	<2.3	<2.5	<2.1	<2.3	<2.3	<2.3
	Cs-137	<2.3	<2.5	<1.8	<2.6	<2.4	2.3±1.3
	La-140	<2.4	<1.9	<2.0	<2.8	<2.6	<2.9
	Ra-226	<5.9	<9.4	<6.9	5.8±2.4	<4.8	<5.1
	Th-232	<8.0	<7.4	<9.1	<9.3	<9.3	<9.3
SA-MLK-5F2	Na-22	<3.0	<4.7	<2.7	<2.3	<3.5	<2.9
	K-40	1200±65	1200±53	1300±57	1400±59	1400±59	1400±53
	Mn-54	<2.6	<2.2	<1.8	<0.9	<2.1	<2.7
	Cs-137	<2.3	<3.7	<2.3	2.3±1.4	<2.1	4.3±1.7
	La-140	<2.3	<2.3	<1.8	<2.1	<2.2	<1.5
	Ra-226	<9.3	<9.0	<9.9	<9.0	<4.6	<5.8
	Th-232	13±6	<11	<8.8	<8.2	<8.7	<9.0
SA-MLK-14F1	Na-22	<2.8	<2.9	<2.5	<3.1	<1.6	<1.3
	K-40	1400±56	1400±55	1400±55	1300±54	1300±58	1400±54
	Mn-54	<2.6	<2.3	<2.1	<2.1	<1.0	<1.8
	Cs-137	<2.8	<2.8	<2.7	<2.4	<2.2	<2.1
	La-140	<2.6	<2.5	<2.0	<1.9	<1.2	<1.8
	Ra-226	<7.2	<7.5	<7.9	<6.8	<4.2	<4.6
	Th-232	<11	<8.6	<10	<8.3	<10	<8.2
SA-MLK-15F1	Na-22	<3.1	<3.5	<3.4	<2.9	<1.7	<4.1
	K-40	1300±58	1300±67	1300±67	1200±66	1300±66	1300±68
	Mn-54	<2.2	<2.4	<2.1	<1.1	<2.4	<1.9
	Cs-137	2.7±1.4	<2.0	<2.4	<2.5	<2.6	<3.3
	La-140	<2.2	<3.0	<2.6	<3.3	<2.8	<1.7
	Ra-226	<9.8	<9.6	<9.0	<9.7	<9.4	6.5±3.4
	Th-232	<7.1	<8.6	<9.1	<8.2	<8.3	<8.3
SA-MLK-3G1 (Control)	Na-22	<3.5	<2.8	<3.0	2.1±1.2	<2.6	<1.5
	K-40	1500±69	1300±68	1400±59	1400±68	1300±54	1300±57
	Mn-54	<2.3	<2.2	<1.7	<2.2	<2.4	<1.0
	Cs-137	<2.6	<2.2	<1.9	<2.7	<2.2	<1.8
	La-140	<2.2	<2.6	<1.7	<2.8	<2.4	<1.9
	Ra-226	<6.1	<9.2	<9.7	<5.1	<5.9	<5.0
	Th-232	<9.3	<10	<9.2	<9.3	<8.8	<6.7
AVERAGE	K-40	1400±210	1300±160	1400±110	1300±200	1300±100	1400±110

TABLE C-12 (cont'd)

1984 CONCENTRATIONS OF GAMMA EMITTERS* IN MILK

Results in Units of pCi/L ± 2 sigma

STATION NO.**	NUCLIDE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	AVERAGE
SA-MLK-13E3	Na-22	<3.0	<3.5	<1.6	<2.0	<2.7	<2.7	-
	K-40	1300±58	1500±68	1400±54	1400±60	1400±59	1400±59	1400±160
	Mn-54	<1.1	<2.3	<1.8	<1.7	<2.1	<0.9	-
	Cs-137	<2.4	<2.6	<2.6	<2.4	<2.2	<2.5	-
	La-140	<1.2	<2.4	<0.6	<1.3	<1.1	<2.1	-
	Ra-226	<4.7	<4.8	<4.4	<3.9	<3.8	<4.6	-
	Th-232	<8.2	<9.8	<3.6	<6.8	<9.6	<7.8	-
SA-MLK-2F4	Na-22	<3.2	<3.1	<3.3	<2.9	<2.8	<3.3	-
	K-40	1400±69	1400±69	1300±64	1400±59	1300±61	1400±68	1400±78
	Mn-54	<1.2	<2.1	<2.3	<1.0	<2.3	<2.3	-
	Cs-137	<2.5	<2.8	<2.4	<2.0	<2.6	<2.4	-
	La-140	<2.1	<3.8	<2.3	<3.0	<2.9	<2.3	-
	Ra-226	<5.5	<5.1	<4.8	<4.4	<4.8	<4.8	-
	Th-232	<8.2	<9.2	<8.9	<8.3	<8.9	<9.3	-
SA-MLK-5F2	Na-22	<2.7	<2.4	<2.6	<3.5	<3.2	<2.3	-
	K-40	1300±55	1400±58	1200±56	1300±66	1300±64	1300±52	1300±160
	Mn-54	<0.8	<2.4	<2.3	<2.5	<2.5	<1.8	-
	Cs-137	4.2±1.7	3.1±1.9	6.2±1.9	3.0±1.7	2.1±1.3	1.8±1.0	3.1±2.6
	La-140	<1.8	2.4±1.4	<2.1	<3.1	<3.0	<1.6	-
	Ra-226	<5.7	<4.3	<3.9	<5.3	<4.4	<2.5	-
	Th-232	<7.8	<8.8	<6.8	<10	<8.9	<8.0	-
SA-MLK-14F1	Na-22	<3.0	<3.0	<3.4	<2.7	<2.8	<2.8	-
	K-40	1400±59	1300±54	1400±66	1400±54	1300±54	1500±60	1400±120
	Mn-54	2.4±1.4	<1.1	<2.3	<1.9	<1.8	<1.6	-
	Cs-137	<2.4	<2.0	<2.6	<2.2	<2.0	<1.3	-
	La-140	<3.3	<1.5	<2.6	<2.7	<1.1	<1.5	-
	Ra-226	<4.8	<4.7	<4.8	<5.2	<5.0	<5.2	-
	Th-232	<7.4	<7.9	<9.3	<8.6	<5.3	<8.2	-
SA-MLK-15F1	Na-22	<3.3	<2.5	<2.9	<1.4	<3.2	<3.6	-
	K-40	1300±53	1400±68	1300±58	1400±55	1400±66	1200±53	1300±130
	Mn-54	<1.8	<2.4	<1.1	<1.2	<2.3	<1.9	-
	Cs-137	<1.9	<2.2	<2.0	<1.9	<2.6	<2.7	-
	La-140	<2.6	<2.9	<2.0	<2.4	<2.7	<2.6	-
	Ra-226	<5.5	<5.4	<4.9	<4.1	<4.8	<5.6	-
	Th-232	<9.0	<8.6	<8.0	<8.5	<9.3	<8.7	-
SA-MLK-3G1 (Control)	Na-22	<3.3	<2.3	<3.3	<3.7		<2.6	-
	K-40	1300±67	1400±59	1300±67	1300±66		1400±69	1400±130
	Mn-54	<2.2	<0.9	<2.3	<1.6		<2.5	-
	Cs-137	<2.6	<2.3	<2.6	<2.1		<2.2	-
	La-140	<2.6	<1.7	<2.9	<2.4		<3.1	-
	Ra-226	<5.1	<4.9	<5.1	<5.0		<5.5	-
	Th-232	<8.9	<7.6	<12	<9.5		<9.4	-
AVERAGE	K-40	1300±100	1400±130	1300±150	1400±100			1300±140

* All other gamma emitters searched for were <LLD; typical LLDs are given in Table C-31.

** Sampling dates can be found in Table C-13.
Gamma analysis performed only on first milk collection of each month.

TABLE C-13

1984 SAMPLING DATES FOR MILK SAMPLES

MONTH	STATION NO. 13E3	2F4	5F2	14F1	15F1	3G1
JANUARY	1-03-84 to 1-04-84	1-01-84 to 1-03-84	1-02-84 to 1-03-84	1-02-84 to 1-03-84	1-02-84 to 1-03-84	1-03-84 to 1-04-84
	1-15-84 to 1-16-84	1-16-84 to 1-17-84	1-16-84 to 1-16-84	1-15-84 to 1-16-84	1-16-84 to 1-16-84	1-15-84 to 1-16-84
FEBRUARY	2-06-84 to 2-07-84	2-05-84 to 2-06-84	2-06-84 to 2-07-84	2-05-84 to 2-06-84	2-05-84 to 2-06-84	2-06-84 to 2-07-84
	2-20-84 to 2-21-84	2-21-84 to 2-22-84	2-21-84 to 2-22-84	2-21-84 to 2-22-84	2-21-84 to 2-22-84	2-20-84 to 2-21-84
MARCH	3-05-84 to 3-06-84	3-04-84 to 3-05-84	3-03-84 to 3-05-84	3-04-84 to 3-05-84	3-04-84 to 3-05-84	3-05-84 to 3-06-84
	3-19-84 to 3-20-84	3-18-84 to 3-19-84	3-18-84 to 3-19-84	3-18-84 to 3-19-84	3-18-84 to 3-19-84	3-19-84 to 3-20-84
APRIL	4-02-84 to 4-03-84	4-01-84 to 4-02-84	4-01-84 to 4-02-84	4-01-84 to 4-02-84	4-01-84 to 4-02-84	4-02-84 to 4-03-84
	4-16-84 to 4-17-84	4-15-84 to 4-16-84	4-15-84 to 4-16-84	4-15-84 to 4-16-84	4-15-84 to 4-16-84	4-16-84 to 4-17-84
MAY	5-06-84 to 5-08-84	5-07-84 to 5-08-84	5-07-84 to 5-08-84	5-07-84 to 5-08-84	5-07-84 to 5-08-84	5-06-84 to 5-07-84
	5-20-84 to 5-21-84	5-21-84 to 5-22-84	5-21-84 to 5-22-84	5-21-84 to 5-22-84	5-21-84 to 5-22-84	5-20-84 to 5-21-84
JUNE	6-03-84 to 6-04-84	6-04-84 to 6-05-84	6-04-84 to 6-05-84	6-04-84 to 6-05-84	6-04-84 to 6-05-84	6-03-84 to 6-04-84
	6-17-84 to 6-18-84	6-18-84 to 6-19-84	6-18-84 to 6-19-84	6-18-84 to 6-19-84	6-18-84 to 6-19-84	6-17-84 to 6-18-84

TABLE C-13 (cont'd)

1984 SAMPLING DATES FOR MILK SAMPLES

MONTH	STATION NO. 13E3	2F4	5F2	14F1	15F1	3G1
JULY	7-09-84 to 7-10-84	7-08-84 to 7-09-84	7-08-84 to 7-09-84	7-08-84 to 7-09-84	7-08-84 to 7-09-84	7-09-84 to 7-10-84
	7-23-84 to 7-24-84	7-22-84 to 7-23-84	7-22-84 to 7-23-84	7-22-84 to 7-23-84	7-22-84 to 7-23-84	7-23-84 to 7-24-84
AUGUST	8-06-84 to 8-07-84	8-05-84 to 8-06-84	8-05-84 to 8-06-84	8-05-84 to 8-06-84	8-05-84 to 8-06-84	8-06-84 to 8-07-84
	8-20-84 to 8-21-84	8-19-84 to 8-20-84	8-19-84 to 8-20-84	8-19-84 to 8-20-84	8-19-84 to 8-20-84	8-20-84 to 8-21-84
SEPTEMBER	9-03-84 to 9-04-84	9-04-84 to 9-05-84	9-04-84 to 9-05-84	9-04-84 to 9-05-84	9-04-84 to 9-05-84	9-03-84 to 9-04-84
	9-17-84 to 9-18-84	9-16-84 to 9-17-84	9-16-84 to 9-17-84	9-16-84 to 9-17-84	9-16-84 to 9-17-84	9-17-84 to 9-18-84
OCTOBER	10-09-84 to 10-10-84	10-08-84 to 10-09-84	10-08-84 to 10-09-84	10-08-84 to 10-09-84	10-08-84 to 10-09-84	10-09-84 to 10-10-84
	10-21-84 to 10-22-84	10-22-84 to 10-23-84	10-22-84 to 10-23-84	10-22-84 to 10-23-84	10-22-84 to 10-23-84	10-21-84 to 10-22-84
NOVEMBER	11-04-84 to 11-05-84	11-03-84 to 11-05-84	11-03-84 to 11-04-84	11-03-84 to 11-04-84	11-03-84 to 11-04-84	11-04-84 to 11-05-84
	11-18-84 to 11-19-84	11-19-84 to 11-20-84	11-19-84 to 11-20-84	11-19-84 to 11-20-84	11-19-84 to 11-20-84	11-18-84 to 11-19-84
DECEMBER	12-02-84 to 12-03-84	12-03-84 to 12-04-84	12-03-84 to 12-04-84	12-03-84 to 12-04-84	12-03-84 to 12-04-84	12-02-84 to 12-03-84
	12-18-84 to 12-19-84	12-17-84 to 12-18-84	12-17-84 to 12-18-84	12-17-84 to 12-18-84	12-17-84 to 12-18-84	12-16-84 to 12-18-84

TABLE C-14

1984 CONCENTRATIONS OF GROSS ALPHA AND GROSS BETA EMITTERS, POTASSIUM-40 AND TRITIUM IN WELL WATER

Results in Units of pCi/L ± 2 sigma

STATION NO. RADIOACTIVITY	1-09-84	2-06-84	3-12-84	4-09-84	5-14-84	6-11-84
SA-WWA-2S3						
Alpha	<1.1	<0.8	<1.1	<1.6	<1.4	<1.2
Beta	6.3±0.9	6.2±0.9	6.4±1.0	8.8±1.0	8.3±1.2	7.3±1.0
K-40	7.5±0.8	6.1±0.6	7.0±0.7	8.5±0.8	12±1	7.3±0.7
H-3	<130	<130	<130	<130	<130	<130
SA-WWA-5D1						
Alpha	<1.1	<0.9(1)	<1.1	<1.7	<1.2	<1.2
Beta	14±1	14±1	12±1	12±1	12±1	14±1
K-40	13±1	14±1	13±1	13±1	13±1	13±1
H-3	<130	<130	<130	<130	<130	<130
SA-WWA-3E1 (Control)						
Alpha	<1.0	<1.0	<1.1	<1.7	<1.3	<1.3
Beta	8.6±1.0	8.3±1.0	8.8±1.1	8.7±1.0	6.0±1.1	10±1
K-40	9.3±0.9	9.3±0.9	8.8±0.9	8.7±0.9	8.9±0.9	8.8±0.9
H-3	<130	<130	<130	<130	<130	<130

TABLE C-14 (cont'd)

1984 CONCENTRATIONS OF GROSS ALPHA AND GROSS BETA EMITTERS,
POTASSIUM-40 AND TRITIUM IN WELL WATER

Results in Units of pCi/L ± 2 sigma

STATION NO. RADIOACTIVITY	7-16-84	8-13-84	9-10-84	10-15-84	11-13-84	12-10-84	AVERAGE
SA-WWA-2S3							
Alpha	<1.4	1.4±1.2	2.0±1.5	1.6±1.0(2)	<1.2	1.1±0.9	-
Beta	4.7±0.8	2.9±0.7	7.7±1.0	17±2	13±1	5.3±0.9	7.8±7.6
K-40	3.7±0.4	2.8±0.3	7.4±0.7	19±2	12±1	5.3±0.5	8.2±8.8
H-3	<130	<130	<140	<130	<140	<130	-
SA-WWA-5D1							
Alpha	<1.5	<1.5	<1.7	0.9±0.8	<1.1	1.4±1.0	-
Beta	13±1	14±1	12±1	12±1	14±1	13±1	13±2
K-40	6.4±0.6	28±3	14±1	14±1	13±1	13±1	14±10
H-3	<140	<140	<130	<140	<130	<140	-
SA-WWA-3E1 (Control)							
Alpha	<1.4	<1.5	<1.9	<0.6	<1.4	<1.1	-
Beta	9.6±1.1	8.2±1.0	8.3±1.1	8.1±1.0	8.3±1.0	8.5±1.0	8.4±1.9
K-40	5.5±0.6	7.8±0.8	7.6±0.8	9.1±0.9	8.5±0.8	8.3±0.8	8.4±2.1
H-3	<130	<140	<140	<130	<130	<140	-

(1) Station SA-WWA-5D1 was collected on 2-07-84.
(2) Station SA-WWA-2S3 was collected on 10-16-84.

TABLE C-15

1984 CONCENTRATIONS OF STRONTIUM-89* AND -90 AND GAMMA EMITTERS**
IN QUARTERLY COMPOSITES OF WELL WATER

Results in Units of pCi/L ± 2 sigma

STATION NUMBER RADIOACTIVITY	1-09-84 to 3-12-84	4-09-84 to 6-11-84	7-16-84 to 9-10-84	10-15-84 to 12-10-84
SA-WWA-2S3				
Sr-89	<0.5	<0.5	0.9±0.4	<0.4(1)
Sr-90	<0.5	<0.4	<0.5	<0.4
K-40	11±6	12±5	<9.4	14±6
Ra-226	<1.0	2.1±0.5	<6.8	<1.2
SA-WWA-5D1				
Sr-89	<0.5	<0.5	<0.6	<0.5
Sr-90	<0.4	<0.4	<0.4	<0.4
K-40	<8.4	12±6	14±6	12±6
Ra-226	1.2±0.6	<1.4	<1.4	0.6±0.4
SA-WWA-3E1 (Control)				
Sr-89	<0.5	<0.5	<0.6	<0.4
Sr-90	<0.4	<0.4	<0.4	<0.4
K-40	<8.6	<9.9	<9.0	6.3±4.1
Ra-226	<0.8	<1.3	1.3±0.7	<0.7

* 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-31.
(1) Collection period for station SA-WWA-2S3 was 10-16-84 to 12-10-84.

TABLE C-16

1984 CONCENTRATIONS OF GROSS ALPHA AND GROSS BETA EMITTERS, POTASSIUM-40 AND TRITIUM IN RAW AND TREATED POTABLE WATER

STATION NO. SA-PWR/T-2F3

Results in Units of pCi/L ± 2 sigma

RADIOACTIVITY		JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE
Alpha	(Raw)	<1.2	3.3±1.6	<2.0	<1.4	<1.7	1.9±1.6
	(Treated)	<1.2	<1.1	<1.6	1.3±1.0	1.6±1.2	<1.5
Beta	(Raw)	3.8±0.7	2.3±0.7	3.0±0.6	3.5±0.7	3.1±0.7	3.0±0.7
	(Treated)	3.4±0.7	2.4±0.7	2.5±0.6	2.1±0.6	2.5±0.6	2.6±0.7
K-40	(Raw)	2.0±0.2	1.5±0.2	1.4±0.1	1.5±0.2	1.7±0.2	1.9±0.2
	(Treated)	2.0±0.2	1.5±0.2	1.4±0.1	1.4±0.1	1.4±0.1	1.8±0.2
H-3	(Raw)	<130	<130	<130	<130	<130	<130
	(Treated)	<140	<130	<130	250±80	<120	140±80

RADIOACTIVITY		JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	AVERAGE
Alpha	(Raw)	4.5±2.5	<2.6	2.2±1.6	<1.4	1.5±1.2	1.2±0.8	-
	(Treated)	1.4±1.2	<1.9	1.0±0.7	<1.2	<1.0	<0.9	-
Beta	(Raw)	2.9±0.7	2.2±0.7	1.9±0.6	2.4±0.6	2.1±0.6	1.5±0.7	2.6±1.4
	(Treated)	2.5±0.7	1.7±0.6	1.8±0.6	2.6±0.6	2.1±0.6	2.7±0.8	2.4±0.9
K-40	(Raw)	1.6±0.2	1.1±0.1	1.4±0.1	1.2±0.1	1.4±0.1	1.4±0.1	1.5±0.5
	(Treated)	1.6±0.2	1.3±0.1	1.5±0.2	1.4±0.1	1.5±0.1	1.6±0.2	1.5±0.4
H-3	(Raw)	<130	<130	<140	140±80	<140	<140	-
	(Treated)	<140	<130	<140	160±80	<140	<140	-

TABLE C-17

1984 CONCENTRATIONS OF STRONTIUM-89* AND -90 AND GAMMA EMITTERS**
IN QUARTERLY COMPOSITES OF POTABLE WATER

Results in Units of pCi/L ± 2 sigma

STATION NUMBER RADIOACTIVITY	1-01-84 to 3-31-84	4-01-84 to 6-30-84	7-01-84 to 9-30-84	10-01-84 to 12-31-84
SA-PWR-2F3 (Raw)				
Sr-89	<0.7	<0.7	<0.9	<0.4
Sr-90	<0.6	<0.6	<0.8	0.3±0.1
K-40	<9.8	<9.1	<7.7	<5.9
SA-PWT-2F3 (Treated)				
Sr-89	<0.8	<0.7	<0.6	<0.4
Sr-90	<0.7	<0.6	<0.5	<0.3
K-40	<8.9	7.4±3.0	<8.5	<7.0

* 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-31.

TABLE C-18

1984 CONCENTRATIONS OF STRONTIUM-89* AND -90 AND GAMMA EMITTERS** IN VEGETABLES

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

STATION NO.	COLLECTION DATE(S)	SAMPLE TYPE	Sr-89	Sr-90	K-40	Ra-226	Th-232
SA-FPV-5D1	8-01-84	Corn	< 6.2	< 3.7	2400±290	<28	<81
SA-FPV-5D1	8-01-84	Tomatoes	< 3.5	3.3±0.9	1800±55	< 2.9	< 6.6
SA-FPV-2E1	5-13-84	Asparagus	< 4.1	< 3.0	2200±77	< 4.0	<11
SA-FPL-1F3	8-01-84	Cabbage	< 8.3	21±2	2200±120	<11	<20
SA-FPV-1F3	8-01-84	Peppers	< 3.2	< 1.8	1700±190	<25	<42
SA-FPV-4F1	8-01-84	Peppers	< 3.4	< 1.8	1900±250	<30	<51
SA-FPL-4F1	8-01-84	Cabbage	< 9.9	32±3	2700±130	< 9.1	16±9
SA-FPV-5F1	8-13-84	Tomatoes	< 2.8	< 1.9	1900±56	< 1.0	< 6.5
SA-FPV-14F3	8-01-84	Corn	< 8.3	< 5.0	2600±280	<36	<60
SA-FPV-14F3	7-31 & 8-1-84	Tomatoes	< 2.8	2.7±0.7	2000±61	< 1.1	< 6.4
SA-FPV-1G1 (C)	8-01-84	Corn	<20	12±5	3000±340	<44	<64
SA-FPV-1G1 (C)	7-31 & 8-1-84	Peppers	< 3.8	2.7±1.0	1800±210	<17	<47
SA-FPV-1G1 (C)	7-31-84	Tomatoes	< 2.9	1.8±0.7	1700±43	<13	< 4.8
SA-FPV-3H5 (C)	8-01-84	Tomatoes	< 4.1	< 2.4	2000±54	< 3.0	< 5.2
SA-FPV-3H5 (C)	8-02-84	Corn	<10	< 6.1	2700±290	<41	<73
SA-FPV-3H5 (C)	8-01-84	Peppers	< 3.9	< 2.2	1700±210	49±22	<55
SA-FPL-3H5 (C)	8-01-84	Cabbage	< 7.0	11±2	1900±97	<11	<17
AVERAGE			-	-	2100±800	-	-

* 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-31.
(C) Control station

TABLE C-19

1984 CONCENTRATIONS OF STRONTIUM-89* AND -90 AND GAMMA EMITTERS**
IN GAME, MEAT AND BOVINE THYROID

STATION NO.	COLLECTION DATE(S)	SAMPLE TYPE	Results in Units of pCi/kg (dry) ± 2 sigma		Results in Units of pCi/kg (wet) ± 2 sigma		
			Sr-89	Sr-90	K-40	Cs-137	Ra-226
SA-GAM-11D1 (Control)	1-27-84	Muskrat	<100	290±33	2400±140	5.6±2.8	<9.6
SA-GAM-3E1	1/12-16/84	Muskrat	<160	810±46	3000±180	<7.7	<14
SA-FPB-3E1	2-13-84	Beef	(1)	(1)	2500±150	<6.7	9.3±5.7
SA-THB-3E1	2-13-84	Bovine Thyroid	(1)	(1)	1200±480	<39	<96
AVERAGE		Muskrat	-	550±740	2700±850	-	-
		Beef	-	-	2500±150	-	-
		Bovine Thyroid	-	-	1200±480	-	-

* 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-31.
(1) Strontium-89 and -90 analysis not required.

TABLE C-20

1984 CONCENTRATIONS OF GAMMA EMITTERS* IN FODDER CROPS

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

STATION NO.	COLLECTION DATE(S)	SAMPLE TYPE	Be-7	K-40	Ra-226	Th-232
SA-FPG-3E1	10-15-84	Soybean	<130	13000±530	<280	<69
SA-VGT-2F4	9-04-84	Corn Silage	380±79	2300±200	<180	<37
SA-VGT-2F4	9-17-84	Sudex Hay	400±60	3900±210	<14	<35
SA-VGT-5F2	10/06-07/84	Corn Silage	410±92	2900±200	<15	<38
SA-VGT-14F1	9-05-84	Green Chop	310±79	2000±170	<140	<35
SA-VGT-15F1	9-04-84	Green Chop	260±67	4200±240	<18	<38
SA-VGT-15F1	9-08-84	Hay	1400±190	9000±480	41±24	<88
SA-FPG-15F1	10-22-84	Soybean	<180	13000±580	<46	95±56
SA-VGT-3G1(C)	9-04-84	Green Chop	260±59	2700±170	<97	<27
SA-FPG-3G1(C)	10-21-84	Soybean	<160	14000±640	<44	<92
AVERAGE			390±740	6700±10000	-	-

* All other gamma emitters searched for were <LLD; typical LLDs are given in Table C-31.
(C) Control station

TABLE C-21

1984 CONCENTRATIONS OF GROSS ALPHA EMITTERS IN SURFACE WATER

Results in Units of pCi/L ± 2 sigma

STATION NO.	1----84[1]	2-16-84	3-06-84	4-10-84	5-11-84	6-05-84
SA-SWA-11A1	-	<2.3	<1.7	<1.7	4.8±2.7	<3.1
SA-SWA-12C1 (Control)	-	6.6±3.8	4.4±2.8	<1.6	<2.1	<3.6
SA-SWA-7E1	-	<3.1	1.6±1.3	<1.4	<1.8	<2.9
SA-SWA-1F2	-	<2.3	2.8±1.6	<1.7	<1.5	<2.5
SA-SWA-16F1	-	<3.9	3.6±2.3	5.2±2.7	<1.9	<2.0
AVERAGE	-	-	2.8±2.4	-	-	-

STATION NO.	7-12-84	8-06-84	9-07-84	10-10-84	11-06-84	12-03-84
SA-SWA-11A1	<3.0	1.7±1.3	4.2±2.1	<1.6	<2.1	<3.5
SA-SWA-12C1 (Control)	<2.6	3.4±2.4	7.0±3.6	<1.3	<2.9	4.9±2.6
SA-SWA-7E1	<2.2	2.1±1.3	<2.1	<1.8	<1.8	<3.4
SA-SWA-1F2	<2.6	<1.6	<2.1	<1.4	<2.1	2.2±1.6
SA-SWA-16F1	<2.8	<1.7	<3.6	2.1±1.5	<2.3	4.0±3.0
AVERAGE	-	2.1±1.3	-	-	-	
					Grand Average	3.6±2.0

(1) Unable to collect January sample due to icing conditions on the river.

TABLE C-22

1984 CONCENTRATIONS OF GROSS BETA EMITTERS IN SURFACE WATER

Results in Units of pCi/L ± 2 sigma

STATION NO.	1----84[1]	2-16-84	3-06-84	4-10-84	5-11-84	6-05-84
SA-SWA-11A1	-	50±6	14±3	11±2	14±3	12±3
SA-SWA-12C1 (Control)	-	49±5	18±3	9.2±2.3	6.3±2.4	4.3±2.0
SA-SWA-7E1	-	46±6	35±5	25±4	18±4	8.3±2.4
SA-SWA-1F2	-	22±4	6.2±2.4	5.3±1.9	3.6±2.2	3.2±1.9
SA-SWA-16F1	-	24±4	6.6±2.4	8.8±2.3	<3.0	3.7±1.9
AVERAGE	-	38±28	16±24	12±15	9.0±13	6.3±7.5

STATION NO.	7-12-84	8-06-84	9-07-84	10-10-84	11-06-84	12-03-84	AVERAGE
SA-SWA-11A1	12±3	22±4	98±9	74±10	110±10	110±10	48±84
SA-SWA-12C1 (Control)	7.0±2.2	30±5	64±7	58±8	88±9	73±8	37±61
SA-SWA-7E1	32±4	38±5	98±10	104±12	140±12	84±10	57±85
SA-SWA-1F2	3.8±1.9	9.9±2.9	43±6	58±8	66±7	52±6	25±50
SA-SWA-16F1	4.4±1.9	19±4	48±6	54±8	81±8	72±8	29±58
AVERAGE	12±23	24±21	70±53	70±41	97±58	78±42	
						Grand Average	39±71

(1) Unable to collect January sample due to icing conditions on the river.

TABLE C-23

1984 CONCENTRATIONS OF TRITIUM IN SURFACE WATER

Results in Units of pCi/L ± 2 sigma

STATION NO.	1----84[1]	2-16-84	3-06-84	4-10-84	5-11-84	6-05-84
SA-SWA-11A1	-	130±80	150±80	<130	<130	<120
SA-SWA-12C1 (Control)	-	<130	<130	<130	<130	<140
SA-SWA-7E1	-	<130	<130	<130	<130	<130
SA-SWA-1F2	-	<130	<130	<130	190±80	<130
SA-SWA-16F1	-	<130	<130	<130	<120	<140

STATION NO.	7-12-84	8-06-84	9-07-84	10-10-84	11-06-84	12-03-84
SA-SWA-11A1	<140	160±80	<130	140±80	<130	180±80
SA-SWA-12C1 (Control)	140±80	<140	130±80	<130	<140	<140
SA-SWA-7E1	<130	130±80	<130	<140	<130	<130
SA-SWA-1F2	250±80	<140	150±80	<140	<130	<130
SA-SWA-16F1	<140	<140	<140	<130	<130	<140

(1) Unable to collect January sample due to icing conditions on the river.

TABLE C-24

1984 CONCENTRATIONS OF STRONTIUM-89* AND -90 IN SURFACE WATER

Results in Units of pCi/L ± 2 sigma

STATION NO.	2-16-84** to 3-06-84		4-10-84 to 6-05-84		7-12-84 to 9-07-84		10-10-84 to 12-03-84	
	Sr-89	Sr-90	Sr-89	Sr-90	Sr-89	Sr-90	Sr-89	Sr-90
SA-SWA-11A1	<0.9	<0.6	<0.6	<0.5	<1.2	<0.5	<0.5	<0.4
SA-SWA-12C1 (Control)	<1.0	<0.7	<0.6	<0.5	<1.4	<0.6	<0.6	<0.5
SA-SWA-7E1	<0.8	<0.6	<0.6	<0.4	<0.8	<0.4	<0.5	<0.4
SA-SWA-1F2	<0.6	<0.5	<0.6	<0.5	<0.8	<0.5	<0.5	<0.4
SA-SWA-16F1	<0.6	<0.5	<0.6	<0.5	1.3±0.4	<0.5	<0.6	<0.5

* Sr-89 results are corrected for decay to sample stop date.
** Unable to collect January sample due to icing conditions on the river.

TABLE C-25

1984 CONCENTRATIONS OF GAMMA EMITTERS* IN SURFACE WATER

Results in Units of pCi/L ± 2 sigma

STATION NO.	NUCLIDE	1----84(1)	2-16-84	3-06-84	4-10-84	5-11-84	6-05-84
SA-SWA-11A1	K-40	-	53±8	21±6	11±5	14±6	14±5
	Mn-54	-	<0.6	<0.5	0.7±0.3	<0.5	<0.5
	Co-60	-	<0.6	<0.6	<0.6	<0.8	<0.7
	Cs-137	-	<0.6	<0.5	<0.6	<0.5	<0.5
	La-140	-	<2.9	<1.4	<0.9	<0.9	<1.3
	Ra-226	-	<11	<1.0	<1.0	<1.0	<1.0
	Th-232	-	<1.8	<1.9	2.1±1.1	<2.4	1.4±0.8
SA-SWA-12C1 (Control)	K-40	-	39±8	16±7	<8.1	<7.1	<8.8
	Mn-54	-	<0.5	<0.6	<0.5	<0.5	<0.4
	Co-60	-	<0.6	<0.6	<0.6	<0.5	<0.7
	Cs-137	-	<0.6	<0.3	<0.4	<0.5	<0.4
	La-140	-	<1.2	<0.8	<1.4	<0.6	<1.1
	Ra-226	-	<1.2	1.3±0.6	<1.2	<0.8	<8.2
	Th-232	-	<1.9	<1.9	1.9±1.0	<1.7	<2.3
SA-SWA-7E1	K-40	-	88±9	47±9	28±7	20±6	<9.3
	Mn-54	-	<0.6	<0.5	<0.6	<0.3	<0.5
	Co-60	-	<0.7	0.6±0.4	<0.7	<0.5	<0.6
	Cs-137	-	<0.6	<0.6	<0.4	<0.5	<0.3
	La-140	-	<2.1	<2.3	<1.3	<0.5	<1.7
	Ra-226	-	<13	0.9±0.6	<1.0	<1.1	<1.2
	Th-232	-	<3.1	<1.6	<2.4	<1.7	<1.7
SA-SWA-1F2	K-40	-	31±7	<8.3	<6.7	<10	<9.6
	Mn-54	-	<0.4	<0.4	<0.4	<0.6	<0.4
	Co-60	-	<0.7	<0.2	<0.5	<0.8	<0.5
	Cs-137	-	<0.4	<0.5	<0.5	<0.6	<0.4
	La-140	-	<1.1	<2.1	<1.6	<1.0	<0.6
	Ra-226	-	<9.1	<0.9	1.1±0.6	<1.2	<8.2
	Th-232	-	<2.3	<1.3	<1.6	<2.3	<2.2
SA-SWA-16F1	K-40	-	23±7	<11	9.7±5.4	<8.7	<10
	Mn-54	-	<0.7	<0.5	<0.5	<0.4	<0.6
	Co-60	-	<0.7	<0.5	<0.6	<0.7	<0.4
	Cs-137	-	<0.9	<0.6	<0.5	<0.4	<0.6
	La-140	-	<3.2	<1.0	<1.2	<0.3	<1.7
	Ra-226	-	<1.2	<1.1	0.8±0.4	<1.0	<1.1
	Th-232	-	<2.4	<2.2	0.9±0.6	<2.0	<2.0
AVERAGE	K-40	-	47±51	21±31	13±17	-	-

TABLE C-25 (cont'd)

1984 CONCENTRATIONS OF GAMMA EMITTERS* IN SURFACE WATER

Results in Units of pCi/L ± 2 sigma

STATION NO.	NUCLIDE	7-12-84	8-06-84	9-07-84	10-10-84	11-06-84	12-03-84	AVERAGE
SA-SWA-11A1	K-40	19±4	47±6	87±9	130±10	120±11	120±12	58±96
	Mn-54	<0.5	<0.5	<0.3	<0.4	<0.5	<0.6	-
	Co-60	<0.6	<0.6	<0.3	<0.7	<0.8	<0.4	-
	Cs-137	<0.5	<0.5	<0.6	<0.6	<0.7	<0.5	-
	La-140	<0.7	<1.3	1.2±0.6	<0.4	<1.0	<1.4	-
	Ra-226	<0.5	<0.5	<8.6	<9.0	1.2±0.7	<1.3	-
	Th-232	<1.9	<1.9	<2.3	<1.9	<2.8	<2.2	-
SA-SWA-12C1 (Control)	K-40	<10	29±7	65±9	82±9	110±10	76±9	41±73
	Mn-54	<0.4	<0.6	<0.6	<0.6	<0.5	<0.5	-
	Co-60	<0.4	<0.9	<0.5	<0.9	<0.7	<0.7	-
	Cs-137	<0.5	<0.6	0.5±0.3	<0.6	<0.5	<0.5	-
	La-140	<1.2	<1.0	<1.1	<1.2	<1.3	<0.8	-
	Ra-226	<1.3	<12	<9.8	<1.3	1.0±0.4	<1.3	-
	Th-232	<1.5	<3.0	<2.0	<2.0	1.2±0.7	<1.9	-
SA-SWA-7E1	K-40	42±6	56±9	110±10	81±10	140±12	130±9	68±89
	Mn-54	<0.5	<0.6	<0.6	<0.6	<0.4	<0.5	-
	Co-60	<0.7	<0.6	<0.7	<0.5	<0.7	<0.6	-
	Cs-137	<0.5	<0.5	<0.6	<0.5	<0.3	<0.4	-
	La-140	<1.3	<1.1	<0.4	<1.1	<0.9	<0.7	-
	Ra-226	<0.5	<1.2	<1.2	<1.1	1.5±0.7	<0.5	-
	Th-232	<1.9	<2.0	<2.0	<2.3	<2.0	<1.6	-
SA-SWA-1F2	K-40	<9.5	21±5	58±9	86±10	86±9	59±8	35±63
	Mn-54	<0.4	<0.6	<0.3	<0.5	<0.3	<0.5	-
	Co-60	<0.6	<0.6	<0.6	<0.7	<0.2	<0.7	-
	Cs-137	<0.5	<0.5	<0.4	<0.5	<0.6	<0.5	-
	La-140	<0.8	<1.1	<0.9	<1.3	<1.2	<0.7	-
	Ra-226	<1.2	<0.5	<1.2	<1.0	<1.1	<1.0	-
	Th-232	2.1±1.3	<1.9	<1.9	<1.9	2.0±1.2	<1.9	-
SA-SWA-16F1	K-40	<12	24±7	55±8	84±10	84±10	79±7	30±65
	Mn-54	<0.5	<0.5	<0.5	<0.6	<0.4	<0.5	-
	Co-60	<0.5	<0.6	<0.7	<0.7	<0.6	<0.6	-
	Cs-137	<0.8	<0.5	<0.5	<0.5	<0.6	<0.4	-
	La-140	<1.0	<0.9	<1.1	<1.0	<1.0	<0.6	-
	Ra-226	<1.4	<1.1	<1.0	0.6±0.3	<1.0	<0.5	-
	Th-232	<2.2	<2.2	<1.9	<1.9	<1.8	<1.6	-
AVERAGE	K-40	-	35±31	75±46	93±42	108±47	93±61	
							Grand Average K-40	48±80

* All other gamma emitters searched for were <LLD; typical LLDs are given in Table C-31.
(1) Unable to collect January sample due to icing conditions on the river.

TABLE C-26

1984 CONCENTRATIONS OF STRONTIUM-89* AND -90 AND TRITIUM IN EDIBLE FISH

STATION NO.	COLLECTION PERIOD	STRONTIUM (BONES) pCi/kg (dry) ± 2 sigma Sr-89	Sr-90	TRITIUM (FLESH)** AQUEOUS FRACTION pCi/kg (wet) ± 2 sigma H-3	ORGANIC FRACTION H-3
SA-ESF-11A1	6-04-84 to 6-11-84	<190	730±57	<50	<100
	9-04-84 to 10-29-84	<67	210±20	400±100	<50
SA-ESF-12C1 (Control)	6-08-84 to 6-25-84	<140	1000±50	<50	<100
	9-09-84 to 10-18-84	<120	230±31	300±100	120±50
SA-ESF-7E1	6-21-84 to 6-22-84	<54	<38	<50	<100
	9-09-84 to 10-18-84	<41	62±10	400±100	<50
AVERAGE		-	380±790	-	-

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

TABLE C-27

1984 CONCENTRATIONS OF GAMMA EMITTERS* IN EDIBLE FISH

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

STATION NO.	COLLECTION PERIOD	K-40	Cs-137
SA-ESF-11A1	06-04-84 to 06-11-84	2600±220	16±8
	09-04-84 to 10-29-84	1200±110	< 6.2
SA-ESF-12C1 (Control)	06-08-84 to 06-25-84	2400±240	<13
	09-09-84 to 10-18-84	1400±110	< 6.6
SA-ESF-7E1	06-21-84 to 06-22-84	3300±230	<14
	09-09-84 to 10-18-84	3300±230	<13
AVERAGE		2400±1800	-

* All other gamma emitters searched for were <LLD; typical LLDs are given in Table C-31.

TABLE C-28

1984 CONCENTRATIONS OF STRONTIUM-89* AND -90, GAMMA EMITTERS** AND TRITIUM IN BLUE CRABS

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

STATION NO.	COLLECTION PERIOD	SAMPLE	Sr-89	Sr-90	K-40	Co-60	AQUEOUS FRACTION H-3***
SA-ECH-11A1	6/18-19/84	Flesh	<57	<26	2100±340	<28	<50
		Shell(1)	<110	620±40	(2)	(2)	(2)
	10/25-26/84	Flesh	<46	<28	2300±230	24±12	600±300
		Shell(1)	<89	580±29	(2)	(2)	(2)
SA-ECH-12C1 (Control)	6/18-19/84	Flesh	<59	<28	1900±300	<27	<50
		Shell(1)	<120	860±46	(2)	(2)	(2)
	10/22-23/84	Flesh	<49	<28	2000±200	<16	300±100
		Shell(1)	<88	390±27	(2)	(2)	(2)
AVERAGE		Flesh	-	-	2100±340	-	-
		Shell	-	610±390	-	-	-

* 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-31.

*** Tritium results by Controls for Environmental Pollution, Inc.

(1) Strontium results in units of pCi/kg (dry).

(2) Gamma and tritium analysis not required.

TABLE C-29

1984 CONCENTRATIONS OF SR-89* AND -90 AND GAMMA EMITTERS** IN BENTHIC ORGANISMS

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

STATION NO.	COLLECTION DATE	Sr-89	Sr-90	Ra-226
SA-ESB-11A1	5-21-84	<7900	<5100	<43000
	10-17-84	<9400	<5600	23000±14000
SA-ESB-12C1 (Control)	5-21-84	<2600	<1800	<24000
	10-17-84	<13000	<8000	<42000
SA-ESB-7E1	5-21-84	<3400	<2100	<51000
	10-17-84	<7800	<4600	<40000
SA-ESB-16F1	5-21-84	<8800	<6000	<66000
	10-17-84	<14000	<8700	<47000

NOTE: Analyses performed on benthic organisms have extremely high uncertainties and sensitivities due to the unavailability of an adequate sample. Sample sizes ranged from approximately 0.1 grams to 0.25 grams dry.

* 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-31.

TABLE C-30

1984 CONCENTRATIONS OF STRONTIUM-90 AND GAMMA EMITTERS* IN SEDIMENT**

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

STATION NO. DATE	Sr-90	Be-7	K-40	Mn-54	Co-58	Co-60	Cs-137	Ra-226	Th-232
SA-ESS-11A1									
5-21-84	<32	1300±220	15000±600	87±22	300±30	520±29	180±30	890±370	750±100
10-17-84	<22	<160	4700±300	<17	73±15	180±16	<20	430±210	340±53
SA-ESS-12C1 (Control)									
5-21-84	<30	<230	12000±490	25±15	<29	40±14	32±17	1200±320	770±82
10-17-84	<21	<160	14000±530	<22	<22	<32	19±11	790±240	920±72
SA-ESS-7E1									
5-21-84	<39	<180	10000±450	22±13	<26	53±20	35±19	1300±300	980±81
10-17-84	<19	<160	11000±470	<20	<22	22±13	26±10	980±210	520±59
SA-ESS-16F1									
5-21-84	<35	330±200	15000±590	<31	<30	69±18	150±24	910±360	960±92
10-17-84	<25	1000±140	15000±520	32±18	100±20	260±21	150±23	790±310	900±82
AVERAGE	-	-	12000±7100	-	-	150±340	76±140	910±530	770±460

* All other gamma emitters searched for were <LLD; typical LLDs are given in Table C-31.
** Sediment samples which include benthic organisms constitute the benthos sample.

TABLE C-31

1984 PSE&G RESEARCH CORPORATION LLDs FOR GAMMA SPECTROMETRY

NUCLIDES	AIR PARTICULATES (10^{-3}pCi/m^3)	PRECIPITATION (pCi/L)	MILK (pCi/L)	WELL/POTABLE WATER (pCi/L)	FOOD PRODUCTS (pCi/kg-wet)		MEAT AND GAME (pCi/kg-wet)	FODDER CROPS (pCi/kg-wet)
GEOMETRY:	13 Filters	100ml	3.5 Liter	100ml	100ml	400ml	100ml	100ml
Be-7	3.0	4.3	14	4.0	8.0	120	43	78
Na-22	0.54	0.62	1.8	0.50	1.2	15	6.0	10
K-40	-	-	-	-	-	-	-	-
Cr-51	2.8	5.2	12	4.6	9.5	140	54	100
Mn-54	0.38	0.51	1.4	0.41	1.0	14	5.0	8.5
Co-58	0.39	0.52	1.6	0.43	0.99	15	5.0	9.3
Fe-59	0.83	1.2	3.2	1.1	2.4	32	12	23
Co-60	0.46	0.57	2.0	0.52	1.1	16	5.5	9.4
Zn-65	0.86	1.0	3.3	0.93	2.0	31	10	17
Nb-95	0.43	0.59	1.7	0.53	1.1	16	6.0	11
Zr-95	0.71	1.0	3.0	0.93	2.0	28	10	19
Mo-99	12	55	20	48	51	1300	990	6800
Ru-103	0.39	0.57	1.4	0.50	1.0	16	5.7	11
Ru-106	4.0	4.9	14	4.4	10	130	47	81
Ag-110m	0.67	0.82	1.5	0.72	1.6	14	8.0	14
Sb-125	0.90	1.4	4.1	1.2	2.6	39	13	22
Te-129m	14	22	63	19	40	620	220	410
I-131	0.46	1.1	1.8	1.0	1.7	30	13	37
Te-132	0.89	3.8	2.1	3.4	3.9	99	62	340
Cs-134	0.51	0.65	1.7	0.56	1.3	13	6.3	11
Cs-136	0.49	0.78	1.9	0.70	1.3	22	8.5	20
Cs-137	0.35	0.50	1.7	0.43	1.0	17	4.8	8.0
Ba-140	1.6	3.0	6.2	2.7	5.0	82	33	76
La-140	0.73	1.3	2.3	1.1	2.2	32	14	83
Ce-141	0.42	0.65	2.4	0.59	1.2	19	6.7	13
Ce-144	1.4	2.1	10	1.7	4.1	79	20	35
Ra-226	0.86	1.2	4.0	1.0	2.2	32	11	19
Th-232	1.7	2.0	6.8	1.8	3.8	54	19	33

TABLE C-31 (cont'd)

1984 PSE&G RESEARCH CORPORATION LLDs FOR GAMMA SPECTROMETRY

NUCLIDES	SURFACE WATER (pCi/L)	FISH (pCi/kg-wet)		SHELLFISH (pCi/kg-wet)		SEDIMENT (pCi/kg-dry)	NUCLIDES	AIR IODINE (10^{-3}pCi/m^3)
GEOMETRY:	100ml	100ml	400ml	100ml	400ml	100ml		100ml
Be-7	4.1	37	92	142	85	120	I-131	15
Na-22	0.59	5.3	11	21	10	14	I-132	26
K-40	-	-	-	-	-	-	I-133	39
Cr-51	5.1	45	107	170	91	150	I-135	1.2
Mn-54	0.48	4.4	10	17	10	13		
Co-58	0.50	4.5	11	18	10	14		
Fe-59	1.2	10	24	41	22	36		
Co-60	0.54	5.0	11	19	11	15		
Zn-65	0.99	9.0	22	35	22	25		
Nb-95	0.58	5.0	12	19	10	15		
Zr-95	1.0	8.8	21	35	20	26		
Mo-99	68	370	2400	1200	530	13000		
Ru-103	0.55	4.9	12	19	11	14		
Ru-106	4.6	42	98	160	97	120		
Ag-110m	0.79	7.2	11	28	10	19		
Sb-125	1.3	12	27	46	27	28		
Te-129m	21	183	480	720	430	600		
I-131	1.2	9.0	30	33	18	52		
Te-132	18	26	170	85	49	650		
Cs-134	0.62	5.7	9.3	22	9	12		
Cs-136	0.78	6.4	20	24	14	31		
Cs-137	0.47	4.4	12	17	12	12		
Ba-140	3.0	25	71	94	51	105		
La-140	1.3	11	28	41	20	52		
Ce-141	0.64	5.6	15	22	13	17		
Ce-144	2.0	18	57	73	56	55		
Ra-226	1.1	10	23	40	23	230		
Th-232	1.8	17	40	69	40	48		

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

APPENDIX D

SYNOPSIS OF ANALYTICAL PROCEDURES

SYNOPSIS OF ANALYTICAL PROCEDURES

Appendix D presents a synopsis of the analytical procedures utilized by various laboratories for analyzing the 1984 Artificial Island Radiological Environmental Monitoring Program samples.

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

SYNOPSIS OF PSE&G RESEARCH CORPORATION PROCEDURE

GROSS ALPHA ANALYSIS OF AIR PARTICULATE SAMPLES

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

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

Calculation of Gross Alpha Activity:

Air flow is corrected first by using the following equations:

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

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

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

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

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

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

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

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

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

Calculation of lower limit of detection:

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

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

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

SYNOPSIS OF TELEDYNE ISOTOPES PROCEDURE

ANALYSIS OF AIR PARTICULATE FILTERS FOR GROSS ALPHA AND BETA

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

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

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

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

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

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

Variables are as previously defined

SYNOPSIS OF PSE&G RESEARCH CORPORATION PROCEDURE

GROSS ALPHA ANALYSIS OF WATER SAMPLES

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

Calculation of Gross Alpha Activity:

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

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

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

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

SYNOPSIS OF PSE&G RESEARCH CORPORATION PROCEDURE

GROSS BETA ANALYSIS OF AIR PARTICULATE SAMPLES

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

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

Calculation of Gross Beta Activity:

Air flow is corrected first by using the following equations:

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

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

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

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

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

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

G = Sample gross counts
B = Background counts (from blank filter)
T = Count time of sample and blank, mins.
E = Fractional ^{90}Sr counting efficiency
V = Corrected air flow of sample, m^3
2.22 = No. of dpm per pCi

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

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

Calculation of lower limit of detection:

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

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

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

SYNOPSIS OF TELEDYNE ISOTOPES PROCEDURE

ANALYSIS OF AIR PARTICULATE FILTERS FOR GROSS ALPHA AND BETA

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

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

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

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

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

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

Variables are as previously defined

SYNOPSIS OF PSE&G RESEARCH CORPORATION PROCEDURE

GROSS BETA ANALYSIS OF WATER SAMPLES

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

Calculation of Gross Beta Activity:

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

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

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

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

SYNOPSIS OF PSE&G RESEARCH CORPORATION PROCEDURE

ANALYSIS OF WATER FOR POTASSIUM 40

Water samples (with the exception of rain water) received by the Research and Testing Laboratory are routinely analyzed for potassium by the Chemical Division. The results, reported in parts per million (ppm), are converted to pCi/L by means of a computer program.

Calculation of ^{40}K Activity:

^{40}K Activity (pCi/L) = 0.85*C

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

SYNOPSIS OF PSE&G RESEARCH CORPORATION PROCEDURE

ANALYSIS OF WATER FOR TRITIUM

Approximately 50ml of raw sample is mixed with sodium hydroxide and potassium permanganate and is distilled under vacuum. Eight ml of distilled sample is mixed with 10ml of Instagel® liquid scintillation solution, and placed in the liquid scintillation spectrometer for counting. An internal standard is prepared by mixing eight ml of sample, 10 ml of Instagel, and 0.1ml 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 10ml of Instagel, to be used for a background determination. This is done for each pair of samples to be counted.

Activity is computed as follows:

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

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

Efficiency (E) is computed as follows:

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

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

N is determined as follows:

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

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

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

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

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

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

SYNOPSIS OF CONTROLS FOR ENVIRONMENTAL POLLUTION, INC., PROCEDURE

TRITIUM ANALYSIS OF AQUEOUS FRACTION OF BIOLOGICAL MATERIALS

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

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

SYNOPSIS OF CONTROLS FOR ENVIRONMENTAL POLLUTION, INC., PROCEDURE

TRITIUM ANALYSIS OF ORGANIC FRACTION OF BIOLOGICAL MATERIALS

An aliquot of fish or crab is first oxidized by heating in the presence of oxygen, with the off-gas passing over heated copper oxide. The resulting converted water is then mixed with aquasol cocktail (NEF-934 Aquasol® cocktail, manufactured by New England Nuclear Corporation).

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

A second method, used to verify results, is the wet oxidation method using hydrogen peroxide and the same counting method as described above.

SYNOPSIS OF PSE&G RESEARCH CORPORATION PROCEDURE

GAMMA ANALYSIS OF AIR IODINE

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

Calculation of Gamma Activity:

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

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

N = Net counts under photopeak
D = Decay correction factor $\frac{\lambda t1*EXP(\lambda t2)}{1-EXP(-\lambda t1)}$
t1 = Acquisition live time
t2 = Elapsed time from sample collection to start of acquisition
λ = 0.693/nuclide half life
E = Detector efficiency
A = Gamma abundance factor (no. of photons per disintegration)
T = Acquisition live time, mins.
V = Sample volume, m^3
2.22 = No. of dpm per pCi

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

GC = Gross counts
BC = Background counts

All other variables are as defined earlier.

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

SYNOPSIS OF TELEDYNE ISOTOPES PROCEDURE

ANALYSIS OF CHARCOAL FILTERS FOR IODINE-131

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

SYNOPSIS OF PSE&G RESEARCH CORPORATION PROCEDURE

ANALYSIS OF RAW MILK FOR IODINE-131

Stable iodine carrier is equilibrated in a 4-liter volume of raw milk before two separate batches of anion exchange resin are introduced to extract iodine. The iodine is removed from the resin and converted to free iodine. The free iodine is then extracted into carbon tetrachloride and reduced to iodide with sodium bisulfite when back-extracted into water. Then cuprous chloride is added to precipitate cuprous iodide, which is mounted on a membrane filter, sealed in a cut-down x-ray cell, vacuum dried and counted for 120 minutes on a beta-gamma coincidence system.

On the same day the above analysis is performed, a stable iodide analysis is also run, using a digital voltmeter, iodide specific ion electrode and double junction reference electrode. Using the known addition technique, fixed quantities of a dilute sodium iodide standard solution are added to 100ml of raw milk. For each addition, the millivolt reading from the meter is plotted vs. amount of stable iodine added, using Gran's plot paper. The concentration of stable iodide in the sample can be found by plotting a line through the points and extending it to the concentration axis. The chemical recovery of iodide for the radiochemical analysis is then computed on the basis of both carrier iodide and intrinsic stable iodide measured in the sample.

Calculation of ^{131}I Activity:

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

G = Sample gross counts
B = Background counts (from blank sample)
T = Count time of sample and blank
E = $E_0*EXP(-\lambda*M)$ = efficiency equation where E_0 = counting efficiency at zero sample thickness
λ = Self-absorption coefficient
M = sample thickness, mg/cm^2
V = Sample volume, liters
Y = Chemical recovery = $\frac{R}{R1+R2}$
where R = mg of I^- recovered
R1 = mg of I^- carrier added
R2 = mg of intrinsic stable I^- measured in sample
1.05 = Correction factor for protein-bound iodine

H = J/(1-K)*EXP(L) = correction factor for ^{131}I decay during counting period

J = (0.693/8.05)*(R/1440)

R = Count time, minutes

1440 = No. of minutes per day

8.05 = Half-life of ^{131}I, days

K = EXP(-J)

L = (0.693/8.05)*N

N = Elapsed time (days) from mid-point of collection period to beginning of count time.

SYNOPSIS OF PSE&G RESEARCH CORPORATION PROCEDURE

ANALYSIS OF BOVINE THYROID FOR IODINE-131

The thyroid sample is first weighed and then, in combination with ethyl alcohol and 3.0ml iodine carrier, pureed in a blender in order to achieve a reasonably homogeneous sample. The contents are transferred to a sample can and additional alcohol added until the total sample volume reaches 100ml. The can is then hermetically sealed and counted on a gamma detector.

Calculation of ^{131}I Activity:

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

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

N = Net counts under photopeak
D = Decay correction factor $\frac{\lambda t1*EXP(\lambda t2)}{1-EXP(-\lambda t1)}$
t1 = Acquisition live time
t2 = Elapsed time from sample collection to start of acquisition
λ = 0.693/nuclide half life
E = Detector efficiency
A = Gamma abundance factor (no. of photons per disintegration)
T = Acquisition live time, mins.
V = Sample quantity, kg wet
2.22 = No. of dpm per pCi

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

GC = Gross counts
BC = Background counts

All other variables are as defined earlier.

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

SYNOPSIS OF PSE&G RESEARCH CORPORATION PROCEDURE

RADIOSTRONTIUM ANALYSIS OF AIR FILTERS

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

Calculation of ^{90}Sr Activity:

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

$$= W2$$

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

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

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

E = ^{90}Sr counting standard efficiency

V = Sample quantity (m^3)

U = Chemical yield

N4 = (N2 - F1*N1)/W1 = net counts due to ^{90}Sr 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 ^{90}Y strip to first count

t2 = Elapsed time from ^{90}Y strip to second count

2.667 = Half-life of ^{90}Y, days

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

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

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

2.22 = No. of dpm per pCi

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

R = Count time of sample and blank

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

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

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

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

Calculation of ^{89}Sr Activity:

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

= W3

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

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

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

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

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

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

50.5 = Half-life of ^{89}Sr, days

All other quantities are as previously defined.

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

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

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

All other variables are as previously defined.

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

SYNOPSIS OF TELEDYNE ISOTOPES PROCEDURE

ANALYSIS OF COMPOSITED AIR PARTICULATE FILTERS FOR RADIOSTRONTIUM

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

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

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

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

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

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

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

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

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

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

All other variables are as previously defined.

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

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

SYNOPSIS OF PSE&G RESEARCH CORPORATION PROCEDURE

RADIOSTRONTIUM ANALYSIS OF RAW MILK

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

Calculation of ^{90}Sr Activity:

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

$$= W2$$

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

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

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

R = ^{90}Sr counting standard efficiency

V = Sample quantity (liters)

U = Chemical yield

N4 = (N2 - F1*N1)/W1 = net counts due to ^{90}Sr 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 ^{90}Y strip to first count

t2 = Elapsed time from ^{90}Y strip to second count

2.667 = Half-life of ^{90}Y, days

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

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

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

2.22 = No. of dpm per pCi

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

R = Count time of sample and blank

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

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

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

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

Calculation of ^{89}Sr Activity:

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

= W3

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

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

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

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

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

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

50.5 = Half-life of ^{89}Sr, days

All other quantities are as previously defined.

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

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

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

All other variables are as previously defined.

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

SYNOPSIS OF PSE&G RESEARCH CORPORATION PROCEDURE

RADIOSTRONTIUM ANALYSIS OF WATER

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

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

Calculation of ^{90}Sr Activity:

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

$$= W2$$

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

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

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

E = ^{90}Sr counting standard efficiency

V = Sample quantity (liters)

U = Chemical yield

N4 = (N2 - F1*N1)/W1 = net counts due to ^{90}Sr 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 ^{90}Y strip to first count

t2 = Elapsed time from ^{90}Y strip to second count

2.667 = Half-life of ^{90}Y, days

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

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

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

2.22 = No. of dpm per pCi

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

R = Count time of sample and blank

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

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

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

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

Calculation of ^{89}Sr Activity:

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

= W3

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

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

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

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

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

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

50.5 = Half-life of ^{89}Sr, days

All other quantities are as previously defined.

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

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

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

All other variables are as previously defined.

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

SYNOPSIS OF PSE&G RESEARCH CORPORATION PROCEDURE

RADIOSTRONTIUM ANALYSIS OF VEGETATION, MEAT AND AQUATIC SAMPLES

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

Calculation of ^{90}Sr Activity:

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

$$= W2$$

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

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

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

E = ^{90}Sr counting standard efficiency

V = Sample quantity (kg wet)

U = Chemical yield

N4 = (N2 - F1*N1)/W1 = net counts due to ^{90}Sr 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 ^{90}Y strip to first count

t2 = Elapsed time from ^{90}Y strip to second count

2.667 = Half-life of ^{90}Y, days

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

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

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

2.22 = No. of dpm per pCi

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

R = Count time of sample and blank

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

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

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

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

Calculation of ^{89}Sr Activity:

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

= W3

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

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

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

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

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

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

50.5 = Half-life of ^{89}Sr, days

All other quantities are as previously defined.

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

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

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

All other variables are as previously defined.

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

SYNOPSIS OF PSE&G RESEARCH CORPORATION PROCEDURE

RADIOSTRONTIUM ANALYSIS OF BONE AND SHELL

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

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

Calculation of ^{90}Sr Activity:

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

$$= W2$$

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

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

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

E = ^{90}Sr counting standard efficiency

V = Sample quantity (kg dry)

U = Chemical yield

N4 = (N2 - F1*N1)/W1 = net counts due to ^{90}Sr 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 ^{90}Y strip to first count

t2 = Elapsed time from ^{90}Y strip to second count

2.667 = Half-life of ^{90}Y, days

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

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

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

2.22 = No. of dpm per pCi

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

R = Count time of sample and blank

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

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

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

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

Calculation of ^{89}Sr Activity:

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

= W3

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

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

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

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

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

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

50.5 = Half-life of ^{89}Sr, days

All other quantities are as previously defined.

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

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

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

All other variables are as previously defined.

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

SYNOPSIS OF PSE&G RESEARCH CORPORATION PROCEDURE

RADIOSTRONTIUM ANALYSIS OF SOIL AND SEDIMENT

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

Calculation of ^{90}Sr Activity:

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

$$= W2$$

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

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

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

E = ^{90}Sr counting standard efficiency

V = Sample quantity (kg dry)

U = Chemical yield

N4 = (N2 - F1*N1)/W1 = net counts due to ^{90}Sr 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 ^{90}Y strip to first count

t2 = Elapsed time from ^{90}Y strip to second count

2.667 = Half-life of ^{90}Y, days

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

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

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

2.22 = No. of dpm per pCi

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

R = Count time of sample and blank

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

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

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

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

Calculation of ^{89}Sr Activity:

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

= W3

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

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

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

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

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

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

50.5 = Half-life of ^{89}Sr, days

All other quantities are as previously defined.

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

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

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

All other variables are as previously defined.

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

SYNOPSIS OF PSE&G RESEARCH CORPORATION PROCEDURE

ANALYSIS OF ENVIRONMENTAL SAMPLES FOR STABLE STRONTIUM

It has been the practice of the Environmental Division to perform a stable strontium determination on any samples to be analyzed for strontium 90 and 89, if they are likely to contain significant amounts of the stable isotopes. For water samples, this involves removal of a 60-ml aliquot of sample. However, mineral and biological media require acid leaching and/or ashing steps to extract the element(s) of interest. The removal of the aliquot is done early in the course of the radiostrontium analysis and involves the withdrawl of 25ml of diluted leachate (in the case of soil or sediment) which is then transferred to a flask. Bone and shell are prepared by ashing 2g of sample, digesting in 20ml 6N HCl, filtering out insoluble residues and then transferring to a flask. All samples are sent to Chemical Division for analysis. The results (reported as milligrams strontium per liter) are then used to find the true chemical recovery of strontium based on both the amount of carrier added (only in the case of soil and sediment) and the quantity of strontium intrinsic to the sample.

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

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

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

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

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

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

Corrected Chemical Recovery of strontium = $\frac{74.2}{119} = 0.623$

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

Sample Calculation of Corrected Chemical Recovery of Strontium in Water:

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

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

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

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

Corrected Chemical Recovery of Strontium = $\frac{17.2mg}{23.3mg}$ = .738

SYNOPSIS OF PSE&G RESEARCH CORPORATION PROCEDURE

GAMMA ANALYSIS OF AIR PARTICULATE COMPOSITES

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

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

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

N = Net counts under photopeak
D = Decay correction factor $\frac{\lambda t1*EXP(\lambda t2)}{1-EXP(-\lambda t1)}$
t1 = Acquisition live time
t2 = Elapsed time from sample collection to start of acquisition
λ = 0.693/nuclide half life
E = Detector efficiency
A = Gamma abundance factor (no. of photons per disintegration)
T = Acquisition live time, mins.
V = Sample volume, m^3
2.22 = No. of dpm per pCi

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

GC = Gross counts
BC = Background counts

All other variables are as defined earlier.

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

SYNOPSIS OF TELEDYNE ISOTOPES PROCEDURE

ANALYSIS OF AIR PARTICULATE FILTERS FOR GAMMA

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

SYNOPSIS OF PSE&G RESEARCH CORPORATION PROCEDURE

GAMMA ANALYSIS OF RAW MILK

A well mixed 3.5-liter sample of raw milk is poured into a calibrated Marinelli beaker along with 20ml of 37% formaldehyde solution (used as a preservative). After stirring, the sample is allowed to reach ambient temperature and then counted on a gamma detector for 1000 minutes.

Calculation of Gamma Activity:

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

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

N = Net counts under photopeak
D = Decay correction factor $\frac{\lambda t1 * EXP(\lambda t2)}{1-EXP(-\lambda t1)}$
t1 = Acquisition live time
t2 = Elapsed time from sample collection to start of acquisition
λ = 0.693/nuclide half life
E = Detector efficiency
A = Gamma abundance factor (no. of photons per disintegration)
T = Acquisition live time, mins.
V = Sample volume, liters
2.22 = No. of dpm per pCi

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

GC = Gross counts
BC = Background counts

All other variables are as defined earlier.

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

SYNOPSIS OF PSE&G RESEARCH CORPORATION PROCEDURE

GAMMA ANALYSIS OF WATER

A 4-liter sample of water is added to a brown glass jug. Then, a bent glass tube is connected to the open end of the jug by means of a rubber stopper inserted into it. The other end of the glass tube (which is flared) is closed with a small cork. This assembly is inverted and mounted in a ring stand. An aluminum can is positioned on a hotplate underneath the end of the glass tube. The cork is removed with the aid of a forceps and the water flows into the can until the water level meets the tip of the glass tube. The height of the glass tube is critical and is adjusted up or down until the water level automatically reaches the 100ml mark scribed on the inside of the can. After all the sample has left the jug, any salts which have crept up the inside of the can, are pushed back into the sample by means of a rubber policeman. Also, the jug and glass tube are rinsed with distilled water and the rinsing added to the can. The water level is then adjusted back to the 100ml level by additional evaporation. The sample is finally left to cool to room temperature before sealing the can and then counting on a gamma detector for 1000 minutes.

Calculation of Gamma Activity:

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

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

N = Net counts under photopeak
D = Decay correction factor $\frac{\lambda t1*EXP(\lambda t2)}{1-EXP(-\lambda t1)}$
t1 = Acquisition live time
t2 = Elapsed time from sample collection to start of acquisition
λ = 0.693/nuclide half life
E = Detector efficiency
A = Gamma abundance factor (no. of photons per disintegration)
T = Acquisition live time, mins.
V = Sample volume, liters
2.22 = No. of dpm per pCi

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

GC = Gross counts
BC = Background counts

All other variables are as defined earlier.

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

SYNOPSIS OF PSE&G RESEARCH CORPORATION PROCEDURE

GAMMA ANALYSIS OF SOLIDS

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

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

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

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

Calculation of Gamma Activity:

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

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

N = Net counts under photopeak

D = Decay correction factor $\frac{\lambda t1*EXP(\lambda t2)}{1-EXP(-\lambda t1)}$

t1 = Acquisition live time

t2 = Elapsed time from sample collection to start of acquisition

λ = 0.693/nuclide half life

E = Detector efficiency

A = Gamma abundance factor (no. of photons per disintegration)

T = Acquisition live time, mins.

V = Sample volume, liters

2.22 = No. of dpm per pCi

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

GC = Gross counts
BC = Background counts

All other variables are as defined earlier.

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

SYNOPSIS OF TELEDYNE ISOTOPES PROCEDURE

ANALYSIS OF TELEDYNE ISOTOPES THERMOLUMINESCENT DOSIMETERS

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

The results are computed as follows:

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

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

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

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

N = Total number of control dosimeters

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

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

APPENDIX E

SUMMARY OF USEPA ENVIRONMENTAL RADIOACTIVITY LABORATORY INTERCOMPARISON STUDIES PROGRAM RESULTS

SUMMARY OF USEPA INTERCOMPARISON STUDIES PROGRAM

Appendix E presents a summary of the analytical results for the 1984 USEPA Environmental Radioactivity Laboratory Intercomparison Studies Program.

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TABLE E-1

USEPA ENVIRONMENTAL RADIOACTIVITY LABORATORY INTERCOMPARSION STUDY PROGRAM

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

DATE	PSE&G ENV ID NUMBER	MEDIUM	ANALYSIS	PSE&G Mean ± s.d.	EPA Mean ± s.d.	GRAND AVG Mean ± s.d.
1/84	EPA-WAT-AB85	Water	Alpha	33±3	10±5	10±3
	84-116		Beta	11±1	12±5	13±3
3/84	EPA-WAT-AB91	Water	Alpha	5±1	5±5	6±2
	84-363		Beta	18±1	20±5	20±3
3/84	EPA-APT-GABS92	APT	Alpha	18±1	15±5	16±3
	84-364		Beta	69±2	51±5	56±6
5/84	EPA-BLD-P95	Water	Alpha	35±4	(1)	(1)
	84-612		Beta	119±2	(1)	(1)
5/84	EPA-WAT-AB97	Water	Alpha	3±1	3±5	3±1
	84-740		Beta	5±1	6±5	7±2
7/84	EPA-WAT-AB102	Water	Alpha	7±1	6±5	5±2
	84-1007		Beta	12±1	13±5	13±3
8/84	EPA-APT-GABS106	APT	Alpha	19±1	17±5	17±3
	84-1144		Beta	58±2	51±5	52±6
9/84	EPA-WAT-AB113	Water	Alpha	6±1	5±5	5±2
	84-1368		Beta	13±1	16±6	15±3
11/84	EPA-WAT-AB122	Water	Alpha	7±1	7±5	7±2
	84-1680		Beta	18±1	20±5	21±3
11/84	EPA-WAT-P116	Water	Alpha	11±1	14±5	13±4
	84-1542		Beta	22±1	64±5	60±7
11/84	EPA-APT-GABS123	APT	Alpha	17±1	(1)	(1)
	84-1681		Beta	63±1	(1)	(1)

(1) Results not received from EPA.

TABLE E-2

USEPA ENVIRONMENTAL RADIOACTIVITY LABORATORY INTERCOMPARSION STUDY PROGRAM

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

DATE	PSE&G ENV ID NUMBER	MEDIUM	NUCLIDE	PSE&G Mean ± s.d.	EPA Mean ± s.d.	GRAND AVG Mean ± s.d.
2/84	EPA-WAT-G87	Water	Cr-51	46±4	40±5	40±8
	84-177		Co-60	11±1	10±5	11±2
			Zn-65	53±3	50±5	50±8
			Ru-106	65±10	61±5	55±9
			Cs-134	30±3	31±5	29±3
			Cs-137	16±2	16±5	16±3
3/84	EPA-ORG-GS86	Food	I-131	19±2	20±6	20±4
	84-117		Cs-137	21±2	20±5	21±3
			K(*)	2510±80	2720±140	2665±250
3/84	EPA-APT-GABS92	APT	Cs-137	10±1	10±5	12±3
	84-364					
5/84	EPA-WAT-P95	Water	Co-60	29±2	(1)	(1)
	84-612		Cs-134	30±2	(1)	(1)
			Cs-137	26±1	(1)	(1)
6/84	EPA-MLK-GS101	Milk	I-131	43±1	43±6	43±4
	84-819		Cs-137	36±1	35±5	36±3
			K(*)	1530±20	1496±75	1560±97
6/84	EPA-WAT-G98	Water	Cr-51	73±12	66±5	64±13
	84-741		Co-60	32±3	31±5	31±4
			Zn-65	66±5	63±5	63±9
			Ru-106	34±7	29±5	30±11
			Cs-134	44±2	47±5	44±6
			Cs-137	37±1	37±5	37±4
7/84	EPA-ORG-GS103	Food	I-131	39±2	39±6	39±5
	84-985		Cs-137	25±2	25±5	27±3
			K(*)	2590±90	2605±130	2571±229
8/84	EPA-APT-GABS106	APT	CS-137	14±1	15±5	17±4
	84-1144					

TABLE E-2 (cont'd)

USEPA ENVIRONMENTAL RADIOACTIVITY LABORATORY INTERCOMPARSION STUDY PROGRAM

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

DATE	PSE&G ENV ID NUMBER	MEDIUM	NUCLIDE	PSE&G Mean ± s.d.	EPA Mean ± s.d.	GRAND AVG Mean ± s.d.
10/84	EPA-WAT-G114	Water	Cr-51	50±9	40±5	38±8
	84-1479		Co-60	20±1	20±5	20±3
			Zn-65	14±1	147±7	149±12
			Ru-106	40±1	47±5	45±9
			Cs-134	30±1	31±5	29±3
			Cs-137	25±1	24±5	25±3
10/84	EPA-MLK-GS117	Milk	I-131	62±22	42±6	40±5
	84-1579		Cs-137	31±2	32±5	32±3
			K(*)	1265±16	1517±76	1498±143
11/84	EPA-WAT-P116	Water	Co-60	16±1	14±5	16±2
	84-1542		Cs-134	2±1	2±5	3±2
			Cs-137	15±2	14±5	16±2
11/84	EPA-APT-GABS123	APT	Cs-137	10±1	(1)	(1)
	84-1681					

(*) Reported as mg/L of Potassium
(1) Results not received from EPA.

TABLE E-3

USEPA ENVIRONMENTAL RADIOACTIVITY LABORATORY INTERCOMPARSION STUDY PROGRAM

Tritium Analysis of Water (pCi/L)

DATE	PSE&G ENV ID NUMBER	MEDIUM	NUCLIDE	PSE&G Mean ± s.d.	EPA Mean ± s.d.	GRAND AVG Mean ± s.d.
2/84	EPA-WAT-H88 84-178	Water	H-3	2370±80	2383±351	2366±247
4/84	EPA-WAT-H94 84-472	Water	H-3	3360±100	3508±364	3461±288
6/84	EPA-WAT-H99 84-785	Water	H-3	2920±40	3051±359	3039±235
8/84	EPA-WAT-H105 84-1029	Water	H-3	2780±20	2817±356	2842±251
10/84	EPA-WAT-H115 84-1480	Water	H-3	2760±20	2810±356	2814±213
12/84	EPA-WAT-H125 84-1783	Water	H-3	3280±70	3182±360	3206±236

TABLE E-4

USEPA ENVIRONMENTAL RADIOACTIVITY LABORATORY INTERCOMPARSION STUDY PROGRAM

Iodine Analysis of Water and Milk (pCi/L)

DATE	PSE&G ENV ID NUMBER	MEDIUM	NUCLIDE	PSE&G Mean ± s.d.	EPA Mean ± s.d.	GRAND AVG Mean ± s.d.
3/84	EPA-MLK-I89(**) 84-265	Milk	I-131	6±1	6±1	6±1
4/84	EPA-WAT-I93 84-426	Water	I-131	6±1	6±1	6±2
8/84	EPA-WAT-I104 84-1028	Water	I-131	36±1	34±6	36±5
12/84	EPA-WAT-I124 84-1688	Water	I-131	32±1	36±6	36±5

(**) Special EPA/NRC low level study

TABLE E-5

USEPA ENVIRONMENTAL RADIOACTIVITY LABORATORY INTERCOMPARSION STUDY PROGRAM

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

DATE	PSE&G ENV ID NUMBER	MEDIUM	NUCLIDE	PSE&G Mean ± s.d.	EPA Mean ± s.d.	GRAND AVG Mean ± s.d.
1/84	EPA-WAT-S84	Water	Sr-89	41±1	36±5	36±9
	84-94		Sr-90	24±1	24±2	23±3
3/84	EPA-ORG-GS86	Food	Sr-89	27±1	34±5	31±5
	84-117		Sr-90	21±2	20±5	20±4
3/84	EPA-APT-GABS92	APT	Sr-90	18±1	21±2	19±2
	84-364					
5/84	EPA-BLD-P95	Water	Sr-89	22±1	(1)	(1)
	84-612		Sr-90	26±1	(1)	(1)
5/84	EPA-WAT-S96	Water	Sr-89	24±2	25±5	24±4
	84-683		Sr-90	4±1	5±2	5±1
6/84	EPA-MLK-GS101	Milk	Sr-89	LT4	25±5	21±5
	84-819		Sr-90	LT2	17±1.5	15±2
7/84	EPA-ORG-GS103	Food	Sr-89	(2)	-	-
	84-985		Sr-90	(2)	-	-
8/84	EPA-WAT-GABS106	APT	Sr-90	16±1	18±1.5	17±2
	84-1144					
9/84	EPA-WAT-S107	Water	Sr-89	32±2	34±5	30±8
	84-1174		Sr-90	17±1	19±1.5	18±3
10/84	EPA-MLK-GS117	Milk	Sr-89	18±3	22±5	19±4
	84-1579		Sr-90	12±1	16±1.5	15±2
11/84	EPA-WAT-P116	Water	Sr-89	10±2	11±5	11±4
	84-1542		Sr-90	11±1	12±1.5	13±3
11/84	EPA-APT-GABS123	APT	Sr-90	17±1	(1)	(1)
	84-1681					

(1) Results not received from EPA.
(2) No analysis results due to equipment failure.

TABLE E-6

USEPA ENVIRONMENTAL RADIOACTIVITY LABORATORY INTERCOMPARSION STUDY PROGRAM

Radium-226 and -228 Analysis of Water (pCi/L)

DATE	PSE&G ENV ID NUMBER	MEDIUM	NUCLIDE	PSE&G Mean ± s.d.	EPA Mean ± s.d.	GRAND AVG Mean ± s.d.
3/84	EPA-WAT-R90	Water	Ra-226	5.4±1	4.1±1	3.8±1
	84-331		Ra-228	1.7±1	2.0±1	2.4±1
5/84	EPA-BLD-P95	Water	Ra-226	15±1	(1)	(1)
	84-612		Ra-228	9.8±0.6	(1)	(1)
6/84	EPA-WAT-R100	Water	Ra-226	5.5±0.1	3.5±0.5	3.5±0.5
	84-785		Ra-228	1.8±0.4	2.0±0.3	2.2±0.9
9/84	EPA-WAT-R112	Water	Ra-226	(2)	-	-
	84-1367		Ra-228	(2)	-	-
12/84	EPA-WAT-R126	Water	Ra-226	(2)	-	-
	84-1784		Ra-228	(2)	-	-

(1) Results not received from EPA.
(2) Analysis cancelled by PSE&G.

APPENDIX F

SYNOPSIS OF DAIRY AND VEGETABLE GARDEN SURVEY

APPENDIX F

SYNOPSIS OF 1984 MILK ANIMAL AND VEGETABLE GARDEN SURVEYS

MILK ANIMAL SURVEY

A survey of dairy farms conducted out to a distance of five miles from the Salem Generating Station (SGS) was performed in May and September, 1984.

The results of the May survey were as follows:

One dairy farm, situated 4.9 miles West of SGS was located.

The results of the September survey were as follows:

No change from the May survey.

VEGETABLE GARDEN SURVEY

A survey of vegetable gardens conducted out to a distance of one mile of the SGS was performed in September 1984.

No vegetable gardens were found within this area.

RTL-ENV-85-01

ARTIFICIAL ISLAND RADIOLOGICAL

ENVIRONMENTAL MONITORING PROGRAM

1984 RADIOLOGICAL REPORT
JANUARY 1 TO DECEMBER 31, 1984

Prepared for

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

By

PSE&G RESEARCH CORPORATION
RESEARCH AND TESTING LABORATORY

MARCH 1985