RTL-ENV-84-01

ARTIFICIAL ISLAND RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

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1983 RADIOLOGICAL REPORT
JANUARY 1 TO DECEMBER 31, 1983

Prepared for

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

By

PSE&G RESEARCH CORPORATION
RESEARCH AND TESTING LABORATORY

MARCH 1984

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TABLE OF CONTENTS

LIST OF FIGURES

SUMMARY

During the period from January 1 through December 31, 1983, the Research and Testing Laboratory (RTL), PSE&G Research Corporation, has been responsible for the collection of all samples and maintenance of sampling equipment connected with the Operating Radiological Environmental Monitoring Program at Artificial Island, Salem County, New Jersey. Through June, sample analyses were performed by Radiation Management Corporation (RMC). Beginning July 1, the RTL assumed responsibility for the radiochemical analysis and has maintained continuity of the program.

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 1983.

A total of 4321 analyses were performed on 1640 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. These nuclides were detected at levels similar to those found during the preoperational phase of this program. It can be concluded that the radiological characteristics of the environment around Artificial Island during 1983 were not 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 [12]. More specific information on the demography, hydrology, meteorology, and land use of the area may be found in the Environmental Report [12], Environmental Statement [13], and the Final Safety Analysis Report for SNGS [14].

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, since 1973, has 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.

Since January 1973, Radiation Management Corporation (RMC) has 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 of RMC from January 1 through June 30,1983 and the results of the RTL and TI from July 1 through December 31, 1983 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 [15,16]. 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 Nuclear Generating Station (SNGS).
2. To determine whether any significant increase occurs in the concentration of radionuclides in critical pathways.
3. To determine if SNGS has caused an increase in the radioactive inventory of long lived radionuclides.
4. To detect any change in ambient gamma radiation levels.
5. To verify that SNGS operations have no detrimental effects on the health and safety of the public or on the environment.

This report, as required by Section 5.6 of the Salem Environmental Technical Specifications (ETS), summarizes the findings of the 1983 REMP. Results of the four-year preoperational program have been summarized for purposes of com- parison with subsequent operational reports [4].

TABLE -1

1983 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
d. Direct Radiation	2S2 5D1 2E1 1F1 5S1 10D1 3E1 2F2 6S2 14D1 13E1 2F6 7S1 16E1 5F1 10S1 6F1 11S1 7F2 11F1 13F1	3G1 2H1 3H1 3H3	Monthly & Quarterly	Gamma dose/monthly Gamma dose/quarterly

TABLE -1 (cont'd)

1983 ARTIFICIAL ISLAND RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

MEDIUM	STATION CODE		COLLECTION FREQUENCY	TYPE/FREQUENCY* OF ANALYSIS
	INDICATOR	CONTROL		
d. Direct Radiation	4D2 9E1 2F5	1G3	Quarterly	Gamma dose/quarterly
(cont'd)	11E2 3F2	10G1		
	12E1 3F3	16G1		
	10F2			
	12F1			
	13F2			
	13F3			
	14F2			
	15F3			
	16F2			
II. TERRESTRIAL ENVIRONMENT				
a. Milk	13E3 2F4	3G1	Semi-monthly	Iodine-131/semi-monthly
	5F2			Sr-89 & -90/monthly
	14F1			Gamma scan/monthly
	15F1			
b. Well Water	4S1/2S3 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)

1983 ARTIFICIAL ISLAND RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

MEDIUM	STATION CODE INDICATOR	 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 5F1 14F3	1G1 3H4	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	14F1	Semi-annually	Gamma scan/on collection
g. Bovine Thyroid	3E1	14F1	Semi-annually	Gamma scan/on collection

TABLE -1 (cont'd)

1983 ARTIFICIAL ISLAND RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

MEDIUM	STATION CODE INDICATOR	STATION CODE CONTROL	COLLECTION FREQUENCY	TYPE/FREQUENCY* OF ANALYSIS
h. Fodder Crops	3E1 2F4 5F2 14F1 15F1	3G1	Annually	Gamma scan/on collection
i. Soil	6S1 5D1 2E1 1F1 10D1 16E1 2F1 2F2 2F4 5F1 5F2 14F1 15F1	3G1 3H3	Collected from each location once every three years.	Sr-90/on collection Gamma scan/on collection
<u>III. AQUATIC ENVIRONMENT</u>				
a. Surface Water	11A1 7E1 1F2 16F1	12C1	Monthly	Gross alpha/monthly Gross beta/monthly Tritium/monthly Sr-89 & -90/quarterly Gamma scan/monthly

TABLE -1 (cont'd)

1983 ARTIFICIAL ISLAND RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

MEDIUM	STATION CODE		COLLECTION FREQUENCY	TYPE/FREQUENCY* OF ANALYSIS
	INDICATOR	CONTROL		
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

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* 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 thermoluminescent dosimeters (TLD's). Packets for monthly and quarterly exposure were placed on and around the Artificial Island Site at various distances. TLD's for the months of January through June and for the first and second quarters were $CaSO_4$ (Tm) supplied and read by Radiation Management Corporation. TLD's for the months of July through December and for the third and fourth quarters were $CaSO_4$ (Dy) supplied and read by Teledyne Isotopes.

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 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 a sealed polyethylene container. 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 1983. 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 17. 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

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 [18] and the Environmental Division Procedures Manual [19]. 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

As discussed in the Introduction, beginning July 1, 1983, PSE&G Research Corporation, Research and Testing Laboratory assumed responsibility for analysis of all samples under the REMP except TLD's. The TLD's since July have been supplied and analyzed by Teledyne Isotopes.

An additional location for monthly and quarterly TLD's was added at 2F6.

With the discontinuance of RMC's services, TLD control station SA-IDM-2H1 at its laboratory in Philadelphia, was terminated on June 28, 1983.

Well water sampling location 4S1 was replaced by location 2S3 beginning in October, due to the difficulty in obtaining samples at 4S1.

RESULTS AND DISCUSSION

The analytical results of the 1983 REMP samples are divided into categories based on exposure pathways: atmospheric, direct, terrestrial, and aquatic. The analytical results for the 1983 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 at eight stations, except for six weeks in June and July when samples at only two stations were analyzed. The weekly samples were analyzed for gross beta at eight stations for the entire year. Quarterly composites of the weekly samples from each station were analyzed for Sr-89, Sr-90 and specific gamma emitters.

Concentrations were detected in 320 of the 382 weekly samples analyzed for gross alpha emitters (Table C-1). Alpha concentrations ranged from 0.5 to 14 x 10^{-3} pCi/m^3 with the grand average for all stations being 1.6 x 10^{-3} pCi/m^3. Two analyses exhibited high uncertainties due to low sample volumes: the fourth sample in May at location 2S2 (<4% of normal volume) and the first week in October at location 1F1 (11% of normal volume).

Analysis of weekly air particulate samples for gross beta (Table C-2) indicated concentrations ranging from 5.9 x 10^{-3} to 70 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 and -90, there was no detectable activity. LLD's for Sr-89 ranged from 0.2 x 10^{-3} to 0.6 x 10^{-3} pCi/m^3 and, for Sr-90, from 0.1 x 10^{-3} to 0.4 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 69 x 10^{-3} pCi/m^3 in 3 samples. Be-7 is a naturally occurring radionuclide attributed to cosmic ray activity in the atmosphere. Traces of Co-60, Ra-226, and Th-232 were detected in 5 samples;

FIGURE 1

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

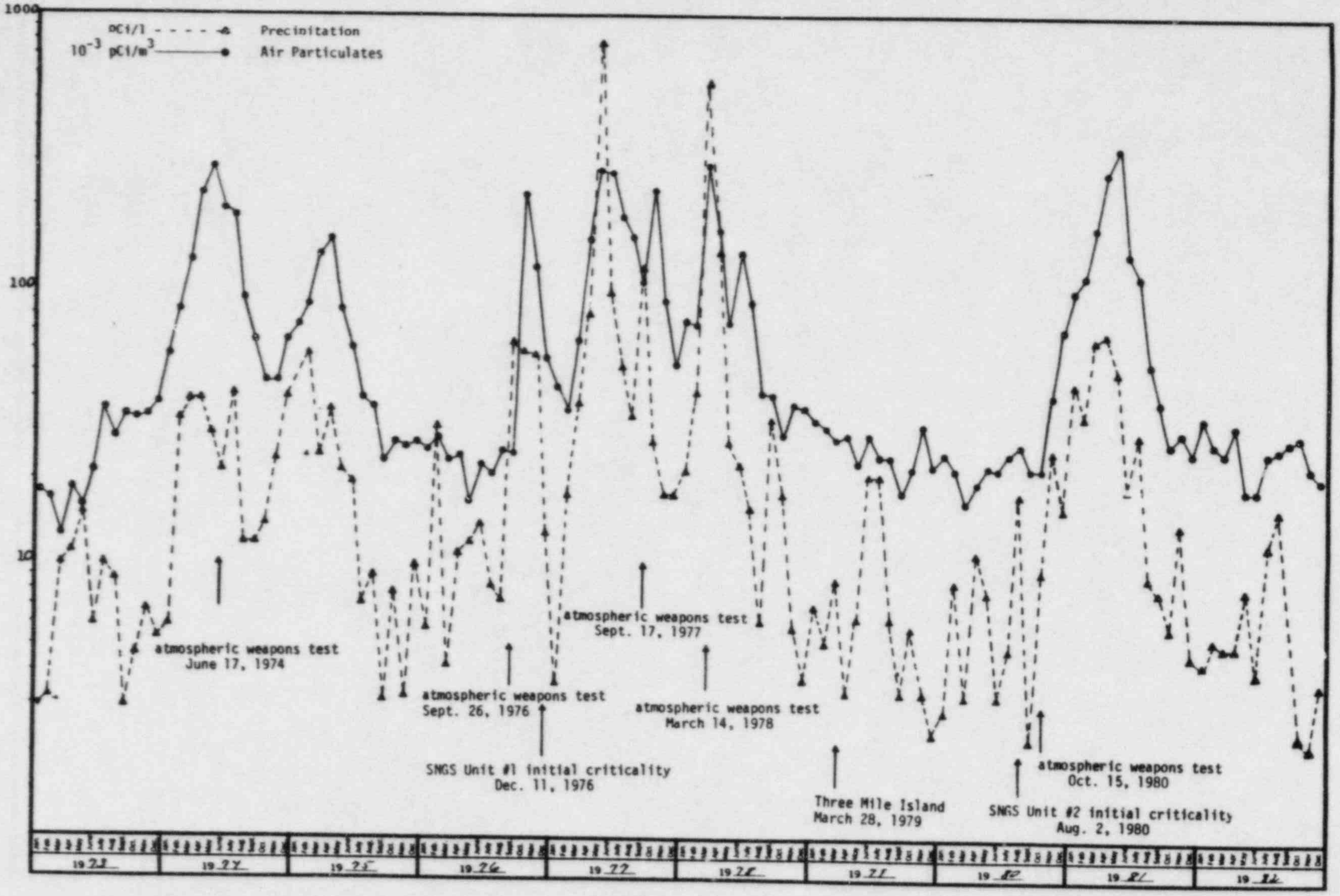
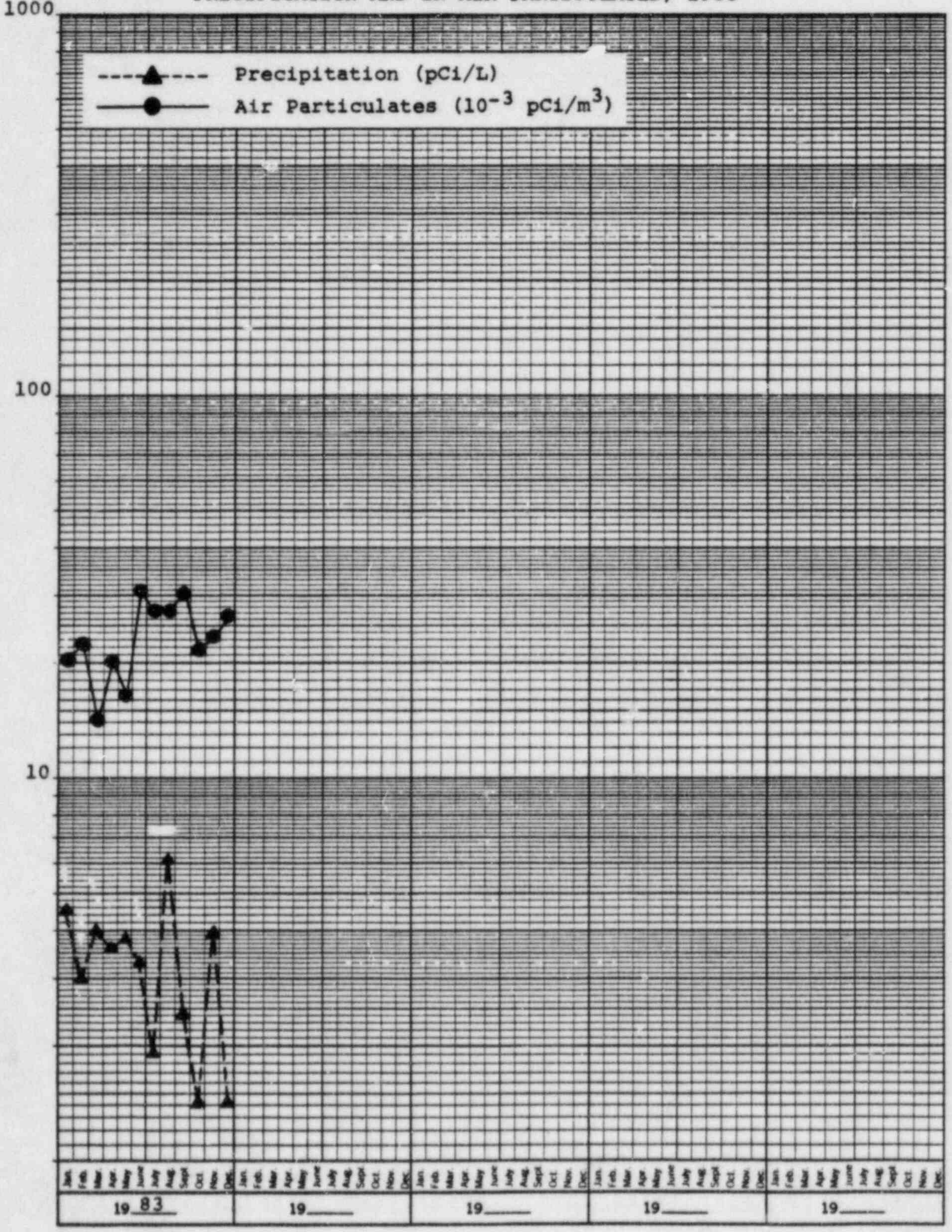


FIGURE 1 (cont'd)

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



all of these activities were at or below the maximum LLD's for these radionuclides which were 0.7, 1.6, and 2.1 x 10^{-3} pCi/m^3 respectively.

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 were below the LLD and ranged from <3.2 x 10^{-3} to 60 x 10^{-3} pCi/m^3. In addition, nine did not meet minimum sensitivity of 60 x 10^{-3} pCi/m^3.

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 0.5 to 4.6 pCi/L, with LLD's in 8 samples from 0.4 to 1.9 pCi/L. Beta activity in 10 of the monthly samples ranged from 1.4 to 19 pCi/L. Tritium was detected in the January sample at a level of 190 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 were detected in the samples for the first two quarters. There was insufficient rainfall during the third quarter for radiostrontium analysis and the fourth quarter sample was lost during analysis. The only gamma emitter detected was Be-7, with activities ranging from 15 to 63 pCi/L in the four samples.

The relatively high levels of alpha and beta activity detected in the July sample (4.6 and 19 pCi/L respectively) was possibly due to the scarcity of rain during this month. Washout of particles from the atmosphere occurs during the initial period of rainfall, with dilution of particle concentration as the rain continues. The total rainfall at this location for the July sampling period was 0.36 inches. It is probable that this small amount of precipitation contained a higher concentration of alpha and beta activity than would have been detected had there been more rain during July.

Perhaps a more meaningful assessment of the impact of rainfall on the environment would be obtained if if the activity deposited per unit area were reported. This can be determined by dividing the total activity of the collected sample by the collector area. Thus, for July with a total rainfall of 0.36 inches and alpha and beta activity of 4.6 and 19 pCi/L respectively, the surface deposition was 41 pCi/m^2 for alpha and 176 pCi/m^2 for beta. For November with a rainfall of 2.80 inches and alpha and beta activity of 0.6 and 3.9 pCi/L, the surface deposition was 46 pCi/m^2 alpha and 280 pCi/m^2 beta.

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

A total of 42 locations were monitored for direct radiation during 1983, including 6 on-site locations, 29 off-site locations within the 10 mile zone, and 7 control locations beyond 10 miles. Monthly and quarterly measurements were made at the 6 on-site stations and at 15 off-site indicator stations, with 4 controls through June and 3 for the remainder of the year, as discussed previously. 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 6.0 millirads per standard month, and the corresponding averaged control dose rate was 6.7 millirads per standard month. The average dose rate for the 29 quarterly off-site indicator TLD's was 5.2 millirads per standard month, and the averaged control rate was 6.0. 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 10 year period through 1982. Figure 2A shows the monthly averages of the off-site indicator stations and the control stations for 1982 and 1983. All of the readings, including controls, increased significantly in August. However, the magnitude of this increase was not confirmed by the quarterly data for these same locations (Table C-8). These results are still being investigated. As was noted in 1982, a general increase in ambient radiation levels was observed at all locations, including control stations, indicating that the increased levels were not due to the operation of SGS. The average of each monthly off-site and control TLD for 1983 was higher than its corresponding average in 1982. For the quarterly TLD's, this increase was noted at twenty of twenty-eight indicator stations and at all of the control stations.

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 3 indicates that I-131 was not detected in any sample during 1983. Table C-10 lists the results and shows that sensitivities ranged from <0.06 to <0.5 pCi/L.

Strontium-89 was not detected in any of the samples; LLD values ranged from <1.0 to <3.1 pCi/L. Strontium-90 was found in all of the samples analyzed. The Sr-90 annual mean for the indicator locations was 2.7 pCi/L with a range of 0.8 to 5.9 pCi/L; annual mean for the control location was 3.3 pCi/L with a range of 2.2 to 4.2 pCi/L.

FIGURE 2

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

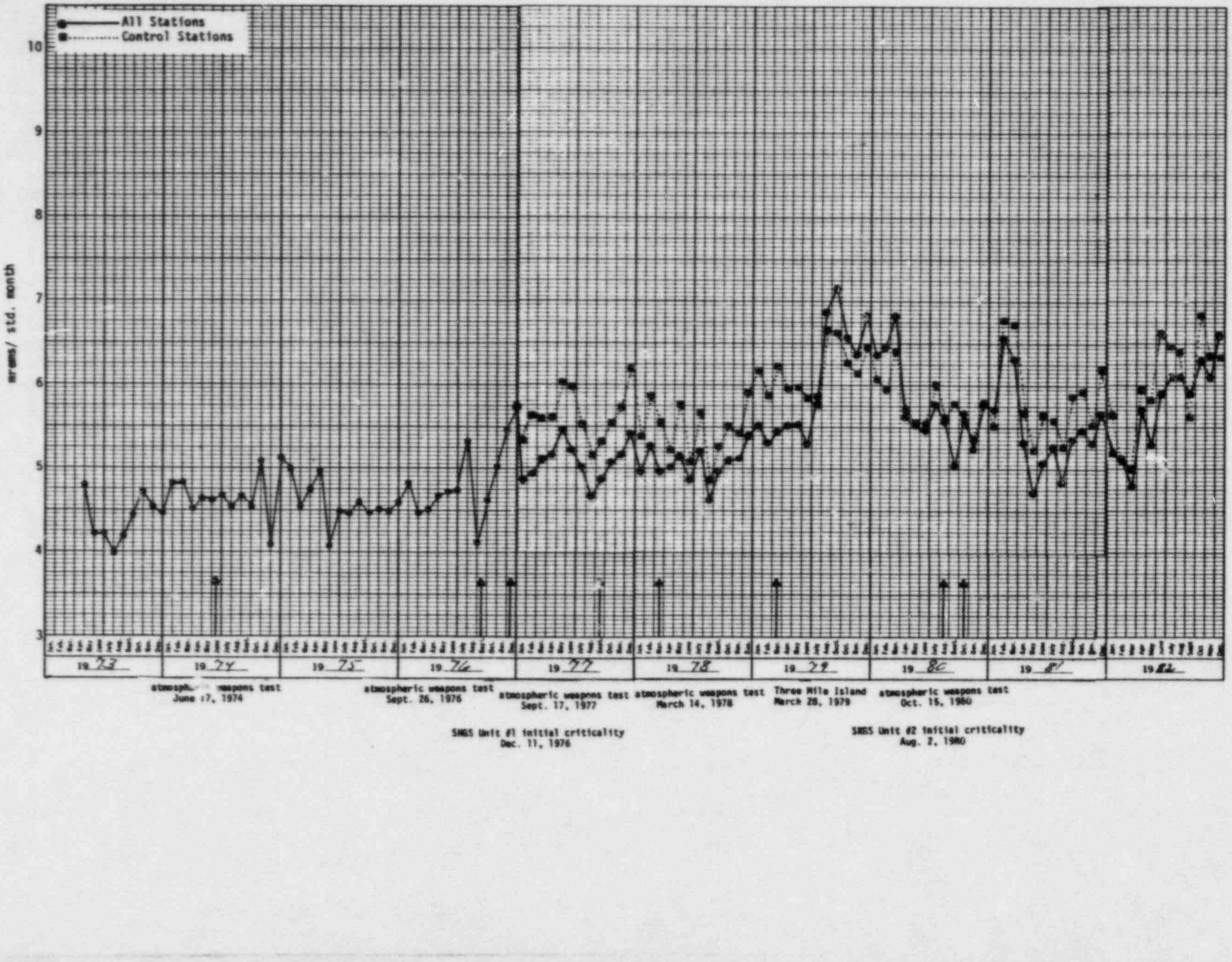
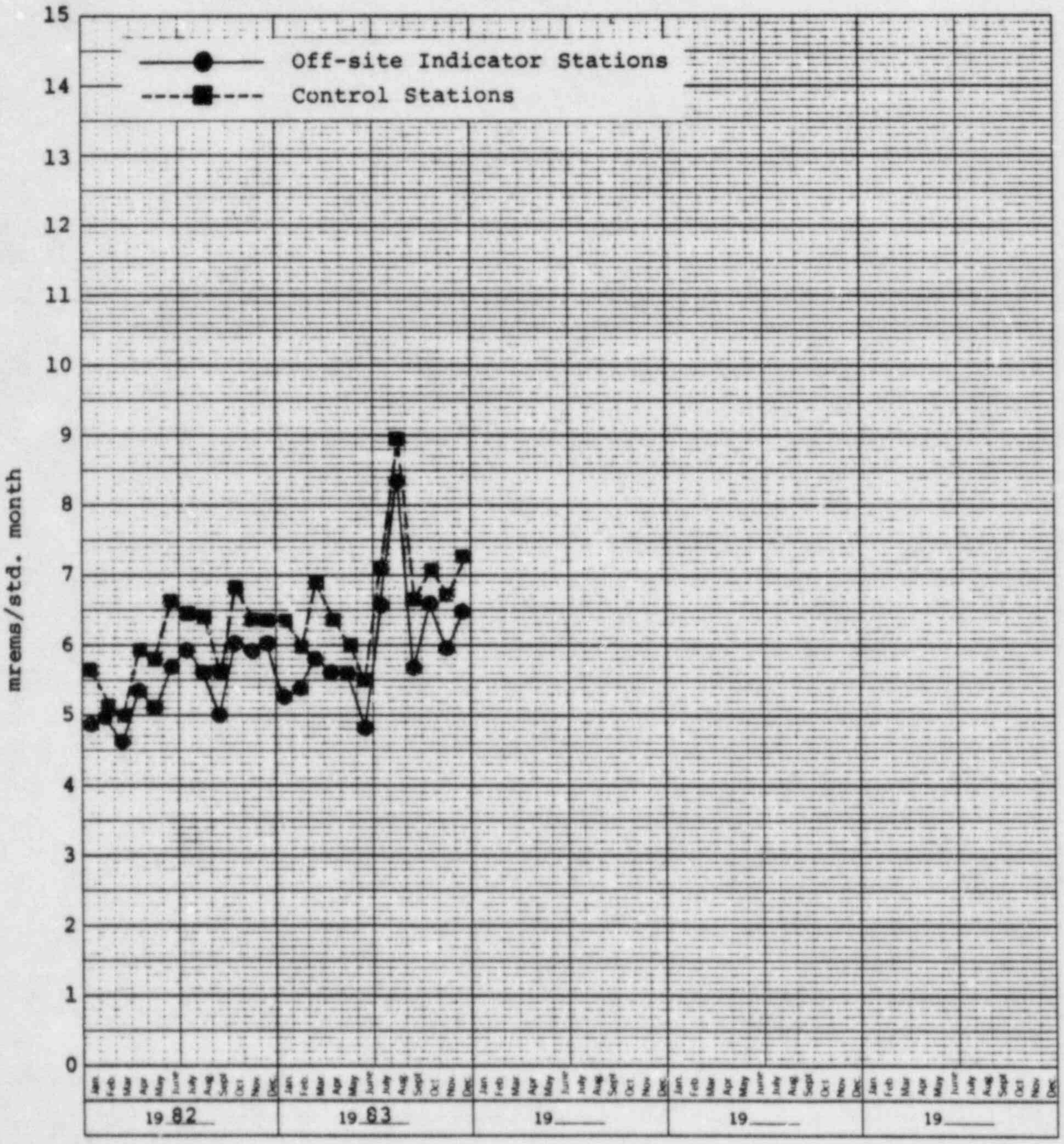


FIGURE 2A

COMPARISON OF AMBIENT RADIATION LEVELS OF
OFF-SITE INDICATOR STATIONS VS. CONTROL STATIONS,
1982 THROUGH 1983



Gamma spectrometry showed detectable concentrations of K-40 in all samples and Cs-137 in nineteen of the sixty indicator locations and in five of the twelve samples from the control location. The annual mean concentration of K-40 for the indicator locations was 1358 pCi/L with a range of 1100 to 1600 pCi/L; K-40 mean for the control location was 1300 pCi/L with a range of 1000 to 1400 pCi/L. The annual mean of Cs-137 for the indicator locations was 2.1 pCi/L with a range of 1.1 to 4.7 pCi/L; Cs-137 for the control location was 1.4 pCi/L with a range of 1.2 to 1.7 pCi/L. Traces of Co-60 at location 15F1 (5.5 pCi/L), Ce-141 at 13E1 (2.4 pCi/L), and Th-232 at location 5F2 (8.1 pCi/L), were detected; sensitivities for these radionuclides were: Co-60 - <1.3 to <6.2 pCi/L; Ce-141 - <1.4 to <13 pCi/L; Th-232 - <3.0 to <15 pCi/L.

The results of all radionuclide analyses were within the range of values found in 1982 and throughout the preoperational program. Thus, no contribution from the operation of SGS is indicated.

In order to maintain continuity of the program, an alternate location (3G2) supplied the control samples from the second collection in June through the second collection in August while the farmer at location 3G1 replaced his entire dairy herd.

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 0.4 to 2.1 pCi/L were detected in seven of the indicator samples, with LLD sensitivities for the other analyses ranging from <0.2 to <3.4 pCi/L. Gross beta activity was detected in all of the samples. The mean activity for the indicator locations was 13 pCi/L with a range of 7.9 to 16 pCi/L; mean activity for the control location was 10 pCi/L with a range of 7.6 to 14 pCi/L. K-40 in each monthly sample was determined by atomic absorption spectroscopy. Mean activity for the indicator locations was 15 pCi/L with a range of 9 to 27 pCi/L, and mean activity for the control location was 11 pCi/L with a range of 7.2 to 16 pCi/L. A comparison of the gross beta with K-40 results indicates that all the beta activity was due to the K-40 beta emission.

All tritium results, except one, were at LLD levels of <120 to <140 pCi/L. In one control sample for October, a level of 430 pCi/L was measured; this is considered an anomaly since subsequent samples were below the LLD.

FIGURE 3

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

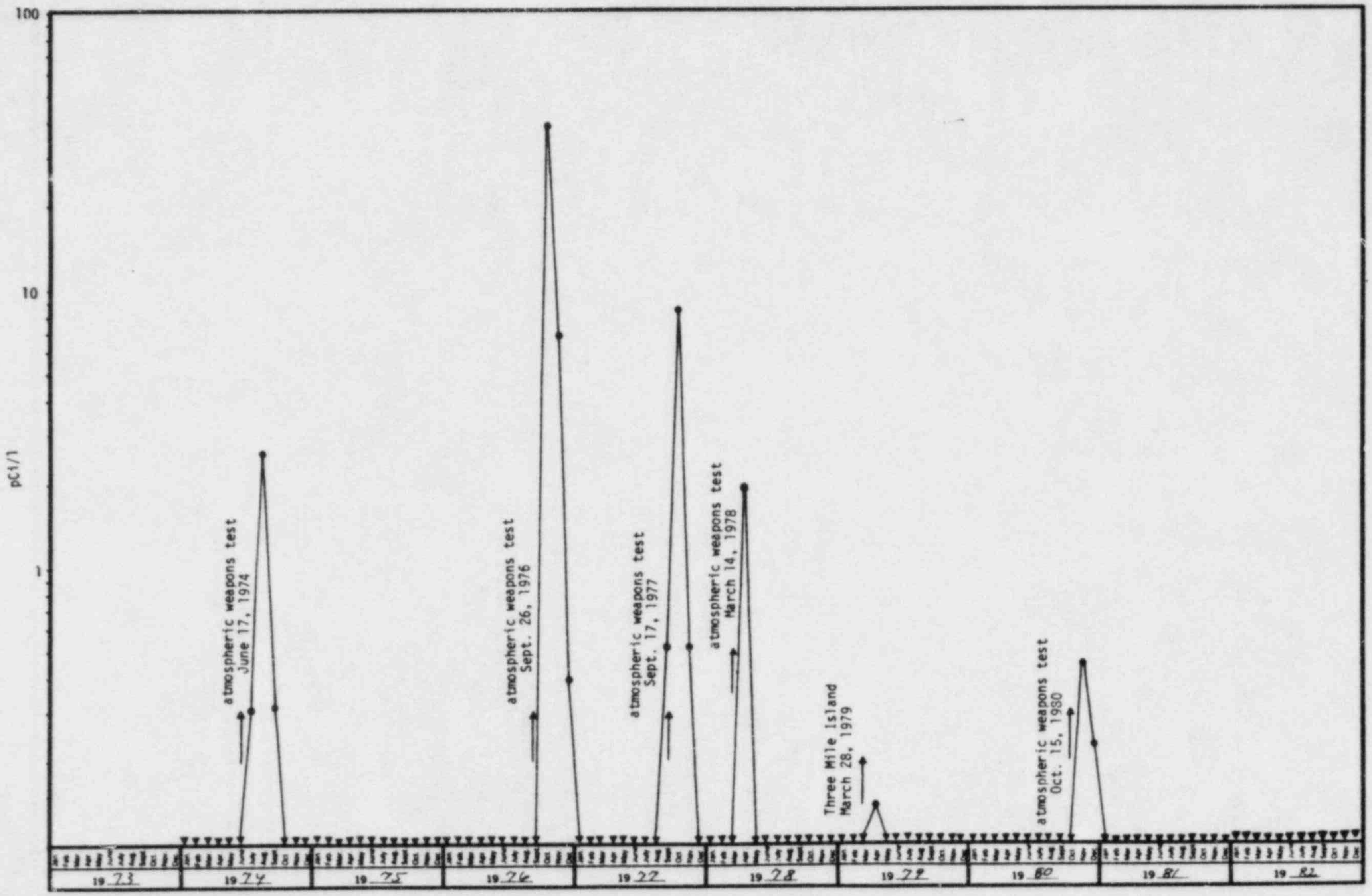
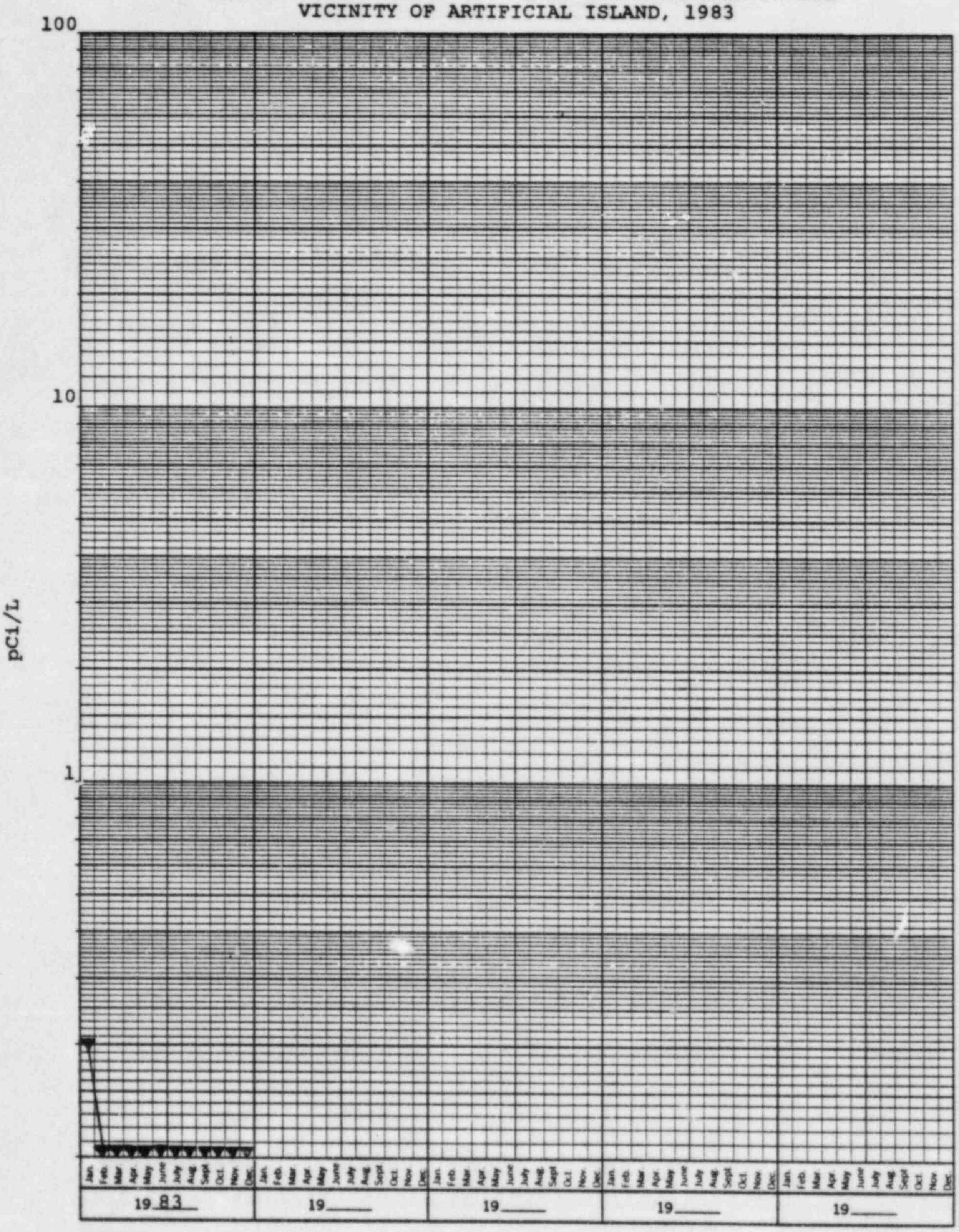


FIGURE 3 (cont'd)

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



Radiostrontium was not detected in the quarterly composites; Sr-89 LLD's were from <0.5 to <0.7, and Sr-90 LLD's were from <0.4 to <0.6. Potassium-40 at four indicator locations was the only gamma emitter which was detected; activity ranged from 14 to 16 pCi/L, with LLD's from <7.8 to <14. Results for all analyses showed no significant variation from those of 1982 and the preoperational program.

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

Both raw and treated water samples were collected from the Salem water treatment plant. Each sample consisted of daily aliquots composited into monthly samples. 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 seven raw and five treated water samples with ranges of 0.8 to 3.1 pCi/L (raw), and 0.8 to .2.7 pCi/L (treated), and average for each of 1.4 pCi/L. Beta activity was observed in all 24 of the monthly samples with ranges of 2.4 to 3.9 pCi/L (raw), and 1.5 to 2.6 (treated), and averages of 3.0 pCi/L (raw) and 2.2 pCi/L (treated). K-40 concentrations for raw and treated samples were practically identical except for one treated sample with an activity of 19 pCi/L which is inconsistent with the beta activity of 2.2 pCi/L. K-40 averages were 2.2 pCi/L (raw) and 3.5 pCi/L (treated). Tritium activity was observed in six of the twenty-four ranging from 140 to 220 pCi/L.

Sr-90 was observed in one of the quarterly composites at 0.6 pCi/L; no Sr-89 was found. LLD's ranged from 0.5 to 1.7 pCi/L for Sr-89, and from 0.4 to 0.7 pCi/L for Sr-90. No gamma emitters were detected in any of the samples.

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, tomatoes, and cucumbers. Each sample was analyzed for Sr-89, Sr-90, and gamma emitters. Sr-89 was not found in any of the fifteen samples; Sr-89 LLD's ranged from <20 to <37 pCi/kg-wet. Sr-90 was detected in one cabbage (31 pCi/kg-wet), one sweet corn (control location, 17 pCi/kg-wet), and one cucumber (control location, 19 pCi/kg-wet) sample; LLD's ranged from <10 to <15 pCi/kg. All samples contained K-40 at concentrations from 1300 to 3100 pCi/kg-wet, with an average for all samples of 2000 pCi/kg-wet. A trace of Ra-226 was seen in one control station tomato sample and traces of T-232 were noted in an indicator station tomato sample and in a control station sweet corn sample.

Game (Table C-19)

Two muskrat samples were taken in January. Bones from both samples were analyzed for Sr-89 and -90 while the flesh was analyzed for gamma emitters. Sr-89 for each sample was below an LLD of 36 pCi/kg-dry. Sr-90 at 47 pCi/kg-dry was detected in one sample and the other was <29 pCi/kg-dry. Gamma scans of the flesh indicated the presence of naturally-occurring K-40, only, at levels of 2700 and 3000 pCi/kg-wet.

Normally, muskrat samples are also obtained during November or December of the year. However, because of weather conditions and the poor quality of the pelts, muskrat samples were not available from the trappers.

Beef and Bovine Thyroid (Table C-19)

Two beef samples and the thyroid gland from each were collected. Analysis of the flesh for gamma emitters indicated only the presence of naturally-occurring K-40 at concentrations of 2300 and 2700 pCi/kg-wet.

Analysis of the thyroids for gamma emitters indicated only K-40 at concentrations of 1200 and 1900 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 and soil sampling stations, one of these also supplied a beef/thyroid sample, and the sixth supplied the second beef/thyroid sample. Samples collected for wet gamma analysis included cured hay, corn silage, green chop, barley, and soybeans.

K-40 was detected in all of the eleven samples at concentrations from 400 to 14000 pCi/kg-wet, with an average of 6500 pCi/kg. Be-7, from the atmosphere, was found in eight of the samples at concentrations from 32 to 590 pCi/kg-wet, with an average of 320 pci/kg. Traces of Ra-226 or Th-232 were detected in barley, hay, silage, and soybeans at three indicator stations. Co-60 at 46 pCi/kg-wet, and Zr-95 at 92 pCi/kg-wet were detected in one control station soybean sample. Preoperational levels for Zr-95 ranged from 30 to 6300 pCi/kg. Nothing is known of the composition of fertilizers which may have been applied to the soil in which these crops were grown.

Soil (Table C-21)

Soil is sampled every three years at 15 locations, including two controls, and analyzed for Sr-90 and gamma emitters. Samples are collected at each station in areas that have been relatively undisturbed since the last collection in order to determine any change in the radionuclide inventory of the area.

The concentrations of Sr-90 for the indicator stations ranged from 46 to 260 pCi/kg-dry with an average of 125 pCi/kg. The two control stations were 120 and 250 pCi/kg-dry with an average of 185 pCi/kg. Averages for the indicator stations were 220 pCi/kg in 1977 and 149 pCi/kg in 1980. Averages for the control stations were 430 pCi/kg in 1977 and 195 pCi/kg in 1980. This indicates a continuing decrease in the Sr-90 concentration in the soils.

Gamma spectrometry of these samples showed detectable concentrations of the naturally occurring radionuclides (K-40,Ra-226, and Th-232) and the fission product Cs-137. The Cs-137 at the indicator stations ranged from 120 to 1600 pCi/kg with an average of 440 pCi/kg. The two control stations were 320 and 910 pCi/kg with an average of 615 pCi/kg. Averages for the indicator stations were 710 pCi/kg in 1977 and 445 pCi/kg in 1980. Averages for the control stations were 620 pCi/kg in 1977 and 650 pCi/kg in 1980.

Aquatic

Surface Water (Tables C-23, C-24, C-25, C-26)

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

Alpha concentrations were detected in six of the 48 indicator samples and in none of the control samples. Levels ranged from 0.2 to 1.7 pCi/L. All the other samples were at or below the LLD, which ranged from <0.2 to <5.0. Beta concentrations for the indicator stations ranged from 4.1 pCi/L to 120 pCi/L with an average of 46 pCi/L, and, for the control station, from 9.9 pCi/L to 86 pCi/L with an average of 37 pCi/L. Nearly all of

FIGURE 4

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

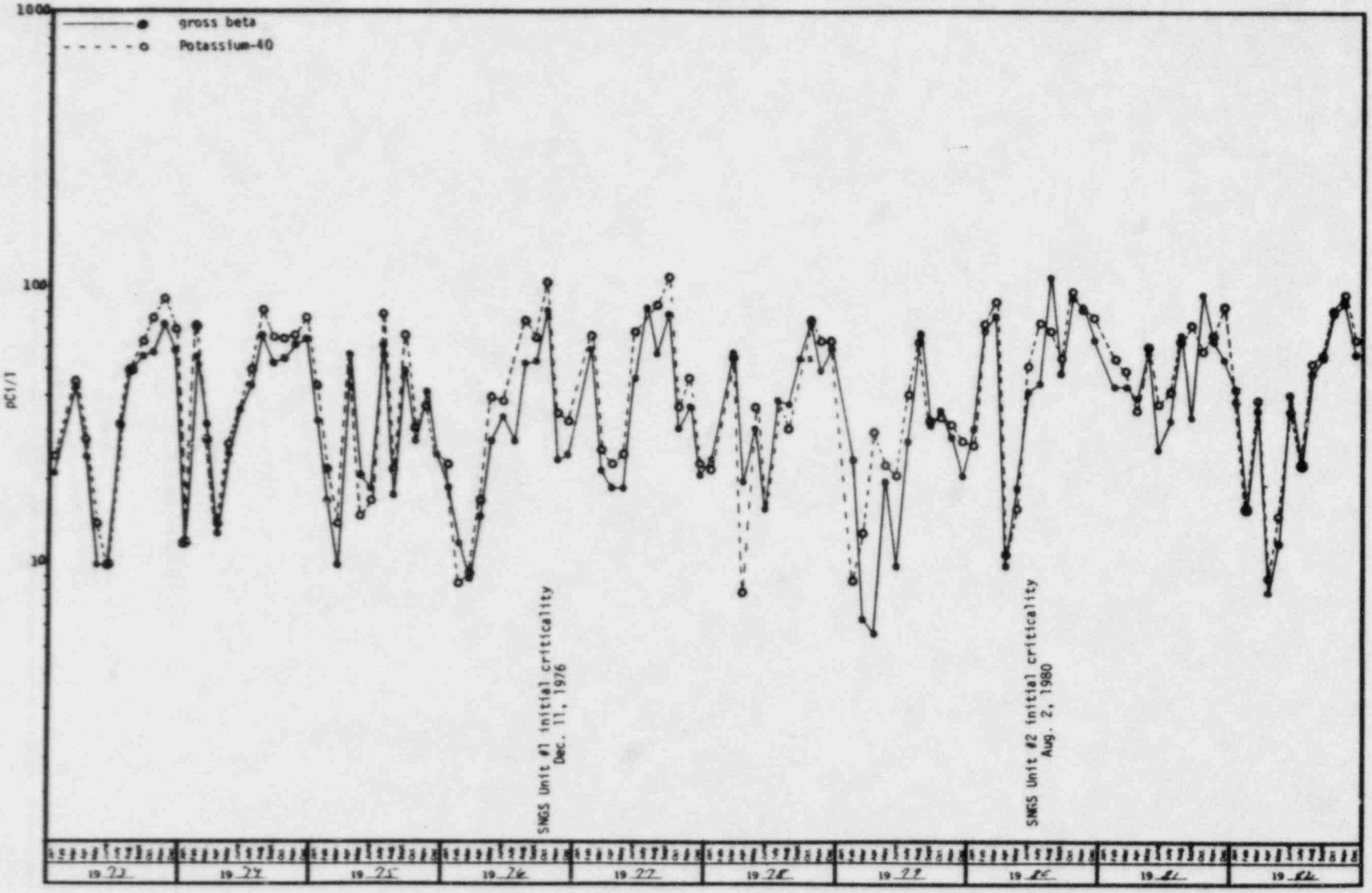
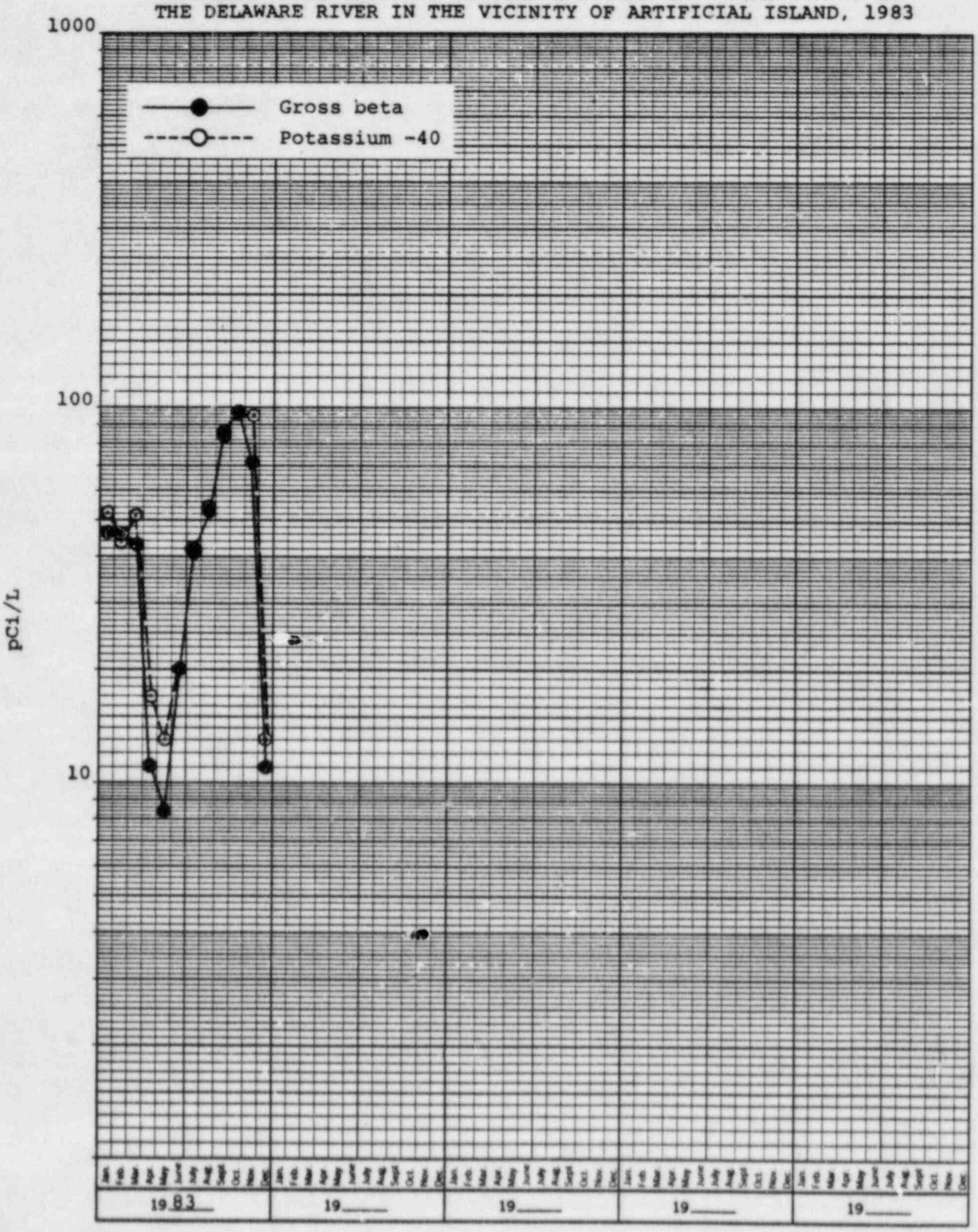


FIGURE 4 (cont'd)

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



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 150 to 510 pCi/L with one analysis in August at the outfall of 1260 pCi/L. There is no reason to doubt the validity of this result for the sample analyzed. The average of the 18 indicator samples with detectable levels of tritium was 323 pCi/L. Tritium was detected in six of the twelve control samples and ranged from 160 to 450 pCi/L with an average of 227 pCi/L. Levels for the years 1973 through 1983 are plotted in Figure 5.

Gamma spectrometric analysis of surface water samples showed detectable concentrations in forty-eight of the sixty samples. The average K-40 concentration at the indicator stations was 60 pCi/L with a range of 14 to 120 pCi/L. Average K-40 concentration at the control station was 44 pCi/L with a range of 10 to 92 pCi/L. Co-58, Co-60, Mo-99, and La-140 was detected at levels near the LLD in six of the sixty samples analyzed.

Neither Sr-89 nor Sr-90 was detected in any of the twenty quarterly composited samples. LLD sensitivities for Sr-89 ranged from <0.6 to <1.2 pCi/L and, for Sr-90 from <0.4 to <0.9 pCi/L.

Fish (Tables C-37, C-28)

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 spot, channel catfish, Atlantic croaker, white perch, summer flounder, brown bullhead, and weakfish.

Gamma spectrometry of these samples indicated K-40 in all six samples at an average concentration of 3000 pCi/kg-wet with a range of 2700 to 3400 pCi/kg-wet. Cs-137 was noted in one sample at 14 pCi/kg-wet, with LLD sensitivities for the other five samples from <14 to <22 pCi/kg-wet. Ra-226 at 37 pCi/kg was detected in the second semi-annual sample from location 7E1.

All six bone samples analyzed for Sr-89 were below LLD of <64 to <270 pCi/kg-dry. All of the second semi-annual samples analyzed for Sr-90 had detectable concentrations ranging from 110 to 600 pCi/kg-dry with an average of 347 pCi/kg-dry. In 1982 the Sr-90 concentration ranged from 50 to 210 pCi/kg-dry with an average of 120 pCi/kg-dry. The maximum level detected during the preoperational period was 940 pCi/kg-dry.

Tritium analyses were performed on both aqueous and organic fractions of the flesh portions of these samples. Only one sample had detectable concentration of tritium for the aqueous

FIGURE 5

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

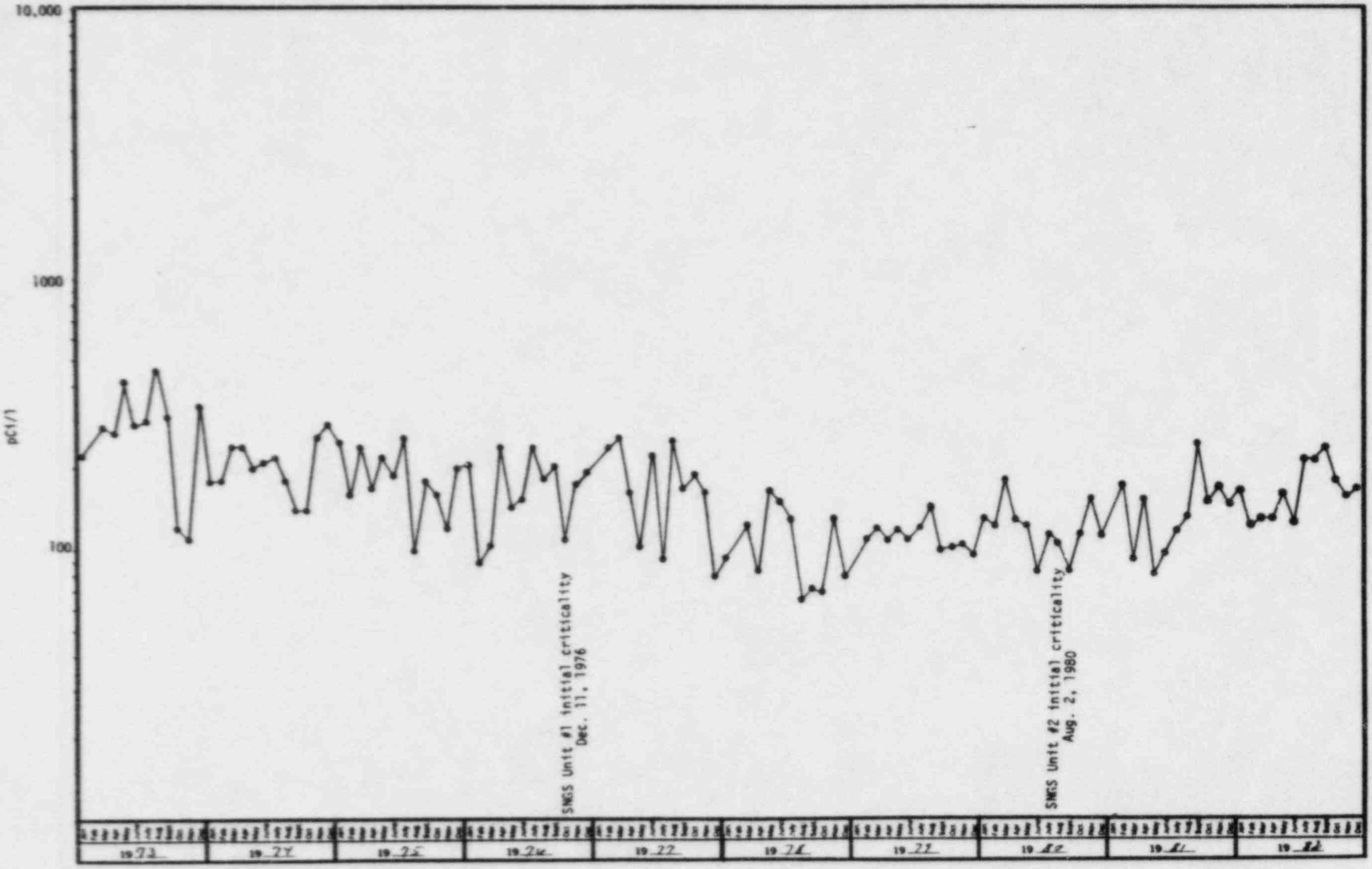
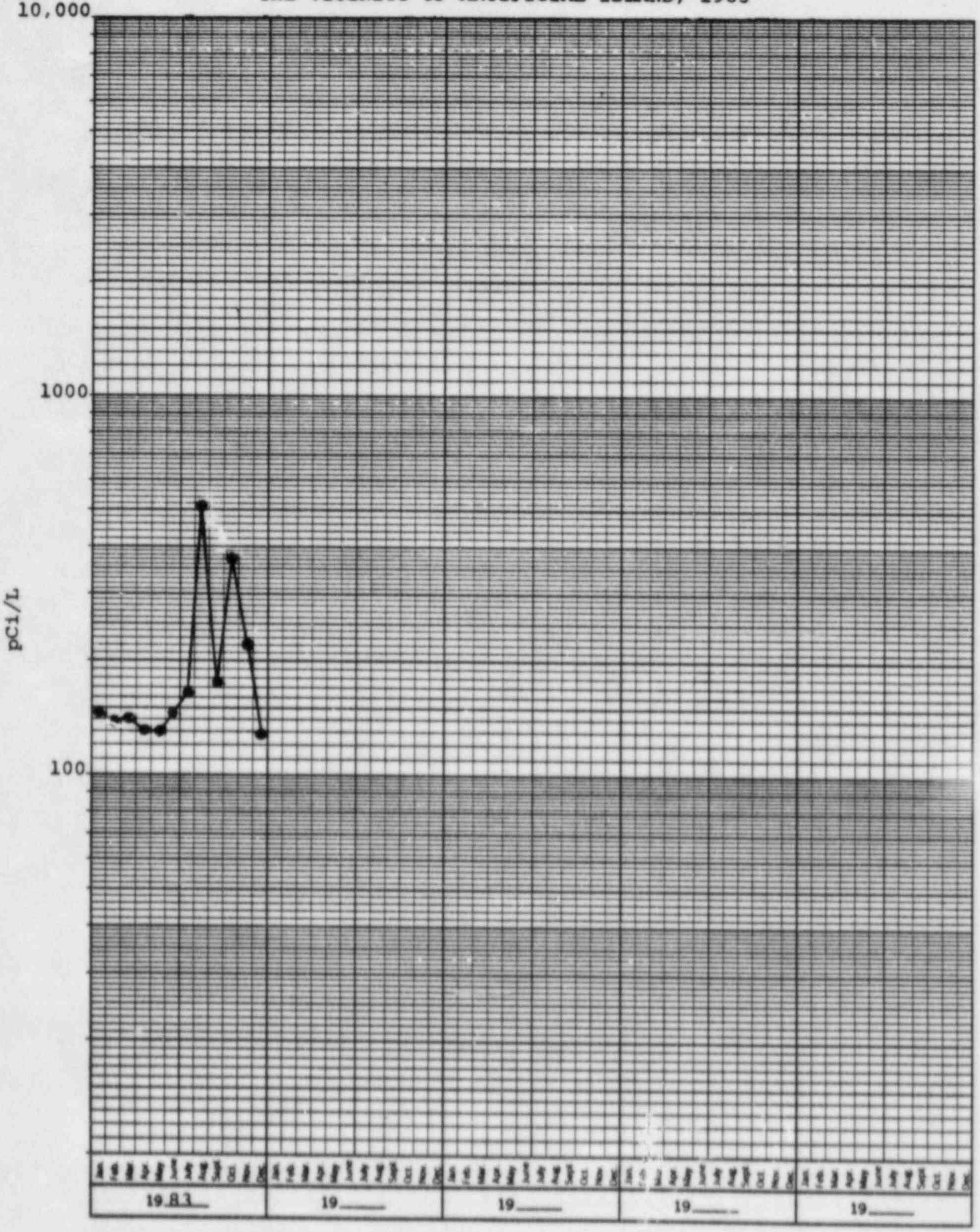


FIGURE 5 (cont'd)

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



fraction with a result of 84 pCi/L. Three of the six samples analyzed for the organic fraction of tritium showed detectable activity of 140 pCi/L at the outfall station: 11A1, 220 pCi/L at the downstream station: 7E1, and 400 pCi/L at the control station. These results probably cannot be attributed to plant operation since the closest indicator station had the lowest level of tritium in the organic fraction.

Blue Crab (Table C-29)

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 Ra-226 in two samples and K-40 in all four samples were the only gamma emitters detected. K-40 levels ranged from 1800 to 3000 pCi/kg-wet with an average of 2400 pCi/kg-wet.

Sr-89 was not detected in either the flesh or the shell. Insufficient sample size resulted in high LLD's for two analyses. Sr-90 was detected in two flesh and all four of the shell samples at concentrations of 25 to 35 pCi/kg-wet (flesh) and 250 to 570 pCi/kg-wet (shell). Preoperational average for the shell was 614 pCi/kg.

Tritium activity in the aqueous fraction of the flesh was detected at levels of 180, 190, and 200 pCi/kg-wet in the first semi-annual samples with an average of 190 pCi/L This was also the average for the preoperational program. There was insufficient sample for the second semi-annual analysis.

Benthic Organisms and Sediment (Tables C-30, C-31)

As required by the Technical Specifications, benthic organisms were separated from the bottom sediment and analyzed for Sr-89 and -90, and gamma emitters. In one sample, Sr-90 was detected (250 pCi/kg-dry), along with the gamma emitters Mn-54, Ra-226, and Th-232. It should be noted that, due to the very small sample sizes for all samples (0.1 gram to 0.7 gram), satisfactory strontium sensitivities could not be achieved. The small sample size was also responsible for the extremely high 2-sigma uncertainties for the gamma emitters.

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-89 and -90, and gamma emitters. The sensitivity requirements of the Salem Environmental Technical Specifications were met.

Levels of Sr-89 were below LLD (<23 to <46 pCi/kg-dry) in all eight samples analyzed.

Results of gamma spectrometry indicated the presence of naturally-occurring Ra-226 and Th232 at expected levels. Co-60 was detected in three of the samples at levels ranging from 48 to 83 pCi/kg-dry with an average of 63 pCi/kg-dry. Co-60 LLD's for the others were from <44 to <88 pCi/kg-dry. Cs-137 was seen at concentrations from 35 to 160 pCi/kg-dry in four samples.

PROGRAM DEVIATIONS

In June the entire dairy herd at milk control Station 3G1 was replaced. An alternate location, 3G2, in the same sector supplied the control milk samples from the second collection in June through through the second sampling period in August. Sampling was resumed at Station 3G1 with the first milk collection in September.

The second semi-annual collection of muskrat samples was not obtained. Muskrats are normally trapped during November and December each year. However, in 1983, because of weather conditions and the poor quality of the pelts, muskrats were not available from the trappers.

CONCLUSIONS

The Radiological Environmental Monitoring Program for Salem Generating Station was conducted during 1983 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 6.2 mrad/std. month. No other unusual radiological characteristics were observed in the environs of Artifical Island. The operation of SGS Units #1 and #2 had no discernable effect on the radiological characteristics of the environs of Artifical Island.

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

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

REFERENCES (Cont.)

(14) Public Service Electric and Gas Company. "Updated Final Safety Analysis Report - Salem Nuclear Generating Station, Units 1 and 2". 1982.

(15) 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.

(16) 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.

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

(18) PSE&G Research Corporation, Research and Testing Laboratory. "Environmental Division Quality Assurance Manual." September, 1980.

(19) PSE&G Research Corporation, Research and Testing Laboratory. "Environmental Division Procedures Manual." February, 1981.

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, 1983 to DECEMBER 31, 1983

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 MEAN (RANGE)	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Air Particulates (10^{-3} pCi/m^3)	Alpha	382	0.4	1.8 (280/330) (0.5-14)	2S2 0.4 mi NNE	2.2 (49/52) (0.8-14)	1.8 (40/52) (0.9-4.1)	0
	Beta	416	3.0***	24 (363/364) (7.[illegible]-70)	2S2 0.4 mi NNE	26 (51/51) (8.6-70)	23 (52/52) (5.9-49)	0
	Sr-89	32	0.2	<LLD	-	<LLD	<LLD	0
	Sr-90	32	0.1	<LLD	-	<LLD	<LLD	0
	Gamma							
	Be-7	32	-	46 (28/28) (27-69)	2S2 0.4 mi NNE	58 (4/4) (48-69)	50 (4/4) (40-60)	0
	Co-60	32	0.3	0.6 (2/28) (0.6-0.7)	2S2 0.4 mi NNE	0.7 (1/4) (0.7)	<LLD	0
	Ra-226	32	0.6	0.6 (3/28) (0.3-0.9)	16E1 4.1 mi NNW	0.9 (1/4) (0.9)	<LLD	0
	Th-232	30	1.0	0.8 (1/26) (0.8)	1F1 5.8 mi N	0.8 (1/4) (0.8)	<LLD	0
Air Iodine (10^{-3} pCi/m^3)	I-131	414	2.0	<LLD	-	<LLD	<LLD	0
Precipitation (pCi/L)	Alpha	12	0.4	1.6 (4/12) (0.5-4.6)	2F2 8.7 mi NNE	1.6 (4/12) (0.5-4.6)	No Control Location	0
	Beta	12	1.4	5.2 (10/12) (1.4-19)	2F2 8.7 mi NNE	5.2 (10/12) (1.4-19)	No Control Location	0
	H-3	12	120	190 (1/12) (190)	2F2 8.7 mi NNE	190 (1/12) (190)	No Control Location	0
	Sr-89	2	0.3	<LLD	-	<LLD	No Control Location	0
	Sr-90	2	0.2	<LLD	-	<LLD	No Control Location	0
	Gamma							
	Be-7	4	-	38 (4/4) (15-63)	2F2 8.7 mi NNE	38 (4/4) (15-63)	No Control Location	0

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Direct Radiation (mrad/std. month)	Gamma 294 Dose (monthly)	-	6.1 (252/252) (3.7-12.1)	3H3 110 mi NE	6.9 (12/12) (5.7-9.5)	6.7 (42/42) (5.1-9.5)	0
	Gamma 166 Dose (qtrly.)	-	5.3 (140/140) (3.5-8.1)	1G3 19 mi N	6.4 (4/4) (5.9-6.8)	6.0 (26/26) (5.3-7.1)	0
Milk (pCi/L)	I-131 143	0.06	<LLD	-	<LLD	<LLD	0
	Sr-89 72	1.0	<LLD	-	<LLD	<LLD	0
	Sr-90 72	-	2.7 (60/60) (0.8-5.9)	5F2 7.0 mi E	4.2 (12/12) (2.7-5.9)	3.3 (12/12) (2.2-4.2)	0
	Gamma K-40 72	-	1358 (60/60) (1100-1600)	2F4 6.3 mi NNE	1392 (12/12) (1100-1600)	1300 (12/12) (1000-1400)	0
	Co-60 72	1.3	5.5 (1/60) (5.5)	15F1 5.4 mi NW	5.5 (1/12) (5.5)	<LLD	0
	Cs-137 72	1.0	2.1 (19/60) (1.1-4.7)	13E3 4.9 mi W	2.4 (5/12) (1.2-4.7)	1.4 (2/12) (1.2-1.7)	0
	Ce-141 72	1.4	2.4 (1/60) (2.4)	14F1 5.5 mi WNW	2.4 (1/12) (2.4)	<LLD	0
	Th-232 66	3.0	8.1 (1/55) (8.1)	5F2 7.0 mi E	8.1 (1/11) (8.1)	<LLD	0
Well Water (pCi/L)	Alpha 36	0.2	1.2 (7/24) (0.4-2.1)	5D1 3.5 mi E	1.2 (4/12) (0.4-2.1)	<LLD	0
	Beta 36	1.0***	13 (24/24) (7.9-16)	5D1 3.5 mi E	13 (12/12) (7.9-16)	10 (12/12) (7.6-14)	0
	K-40 36	-	15 (24/24) (9.0-27)	4S1 1400ft ENE	16 (12/12) (9.0-27)	11 (12/12) (7.2-16)	0
	H-3 36	120	<LLD	3E1 4.1 mi NE	430 (1/12) (430)	430 (1/12) (430)	0
	Sr-89 12	0.5	<LLD	-	<LLD	<LLD	0
	Sr-90 12	0.4	<LLD	-	<LLD	<LLD	0
	Gamma K-40 12	7.8	23 (4/8) (14-46)	5D1 3.5 mi E	31 (2/4) (16-46)	<LLD	0

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Potable Water Raw-Treated (pCi/L)	Alpha	24	0.5	1.4 (12/24) (0.8-3.1)	2F3 8.0 mi NNE	1.4 (12/24) (0.8-3.1)	No Control Location	0
	Beta	24	1.0***	2.6 (24/24) (1.5-3.9)	2F3 8.0 mi NNE	2.6 (24/24) (1.5-3.9)	No Control Location	0
	K-40	24	-	2.8 (24/24) (1.5-19)	2F3 8.0 mi NNE	2.8 (24/24) (1.5-19)	No Control Location	0
	H-3	24	120	178 (6/24) (140-220)	2F3 8.0 mi NNE	178 (6/24) (140-220)	No Control Location	0
	Sr-89	8	0.5	<LLD	-	<LLD	No Control Location	0
	Sr-90	8	0.4	0.6 (1/8) (0.6)	2F3 8.0 mi NNE	0.6 (1/8) (0.6)	No Control Location	0
	Gamma	8		<LLD	-	<LLD	No Control Location	0
Fruit & Vegetables (pCi/kg-wet)	Sr-89	15	20	<LLD	-	<LLD	<LLD	0
	Sr-90	15	10	31 (1/8) (31)	1F3 5.9 mi N	31 (1/2) (31)	18 (2/7) (17-19)	0
	Gamma K-40	15	-	1975 (8/8) (1300-2400)	2E1 4.4 mi NNE	2400 (1/1) (2400)	2086 (7/7) (1400-3100)	0
					5F1 6.5 mi E	2400 (1/1) (2400)		
	Ra-226	15	3.7	<LLD	3H4 88 mi NE	37 (1/4) (37)	37 (1/7) (37)	0
	Th-232	15	6.7	39 (1/8) (39)	1G1 10.3 mi N	41 (1/3) (41)	41 (1/7) (41)	0
Game (pCi/kg-dry)	Sr-89 (bones)	2	36	<LLD	-	<LLD	<LLD	0
	Sr-90 (bones)	2	29	47 (1/1) (47)	3E1 4.1 mi NE	47 (1/1) (47)	<LLD	0
(pCi/kg-wet)	Gamma (flesh) K-40	2	-	3000 (1/1) (3000)	3E1 4.1 mi NE	3000 (1/1) (3000)	2700 (1/1) (2700)	0

ARTIFICIAL ISLAND RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

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

SALEM COUNTY, NEW JERSEY JANUARY 1, 1983 to DECEMBER 31, 1983

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		CONTROL LOCATION MEAN (RANGE)	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
					NAME DISTANCE AND DIRECTION	MEAN (RANGE)		
Beef (pCi/kg-wet)	Gamma K-40	2	-	2700 (1/1) (2700)	3E1 4.1 mi NE	2700 (1/1) (2700)	2300 (1/1) (2300)	0
Bovine Thyroid (pCi/kg-wet)	Gamma K-40	2	-	1200 (1/1) (1200)	14F1 5.5 mi WNW	1900 (1/1) (1900)	1900 (1/1) (1900)	0
Fodder Crops (pCi/kg-wet)	Gamma Be-7	11	140	290 (6/9) (32-590)	5F2 7.0 mi E	590 (1/1) (590)	415 (2/2) (290-540)	0
	K-40	11	-	5924 (9/9) (400-14000)	3E1 4.1 mi NE	10233 (3/3) (3700-14000)	9100 (2/2) (4200-14000)	0
	Co-60	11	2.3	<LLD	3G1 17 mi NE	46 (1/2) (46)	46 (1/2) (46)	0
	Zr-95	11	6.0	<LLD	3G1 17 mi NE	92 (1/2) (92)	92 (1/2) (92)	0
	Ra-226	11	4.2	50 (2/9) (40-59)	5F2 7.0 mi E	59 (1/1) (59)	<LLD	0
	Th-232	11	7.0	113 (2/9) (113)	15F1 5.4 mi NW	117 (1/3) (117)	<LLD	0
Soil (pCi/kg-dry)	Sr-90	15	-	125 (13/13) (46-260)	15F1 5.4 mi NW	260 (1/1) (260)	185 (2/2) (120-250)	0
	Gamma K-40	15	-	8069 (13/13) (3800-13000)	14F1 5.5 mi WNW	13000 (1/1) (13000)	9050 (2/2) (8600-9100)	0
	Cs-137	15	-	440 (13/13) (120-1600)	1F1 5.8 mi N	1600 (1/1) (1600)	615 (2/2) (320-910)	0
	Ra-226	15	-	1055 (13/13) (390-2600)	16E1 4.1 mi NNW	2600 (1/1) (2600)	2100 (2/2) (2000-2200)	0
	Th-232	15	-	718 (13/13) (340-1200)	16E1 4.1 mi NNW	1200 (1/1) (1200)	855 (2/2) (810-900)	0
					15F1 5.4 mi NW	1200 (1/1) (1200)		

ARTIFICIAL ISLAND RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

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

SALEM COUNTY, NEW JERSEY JANUARY 1, 1983 to DECEMBER 31, 1983

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		CONTROL LOCATION MEAN (RANGE)	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
					NAME DISTANCE AND DIRECTION	MEAN (RANGE)		
Surface Water (pCi/L)	Alpha	60	0.2	0.6 (5/48) (0.2-1.7)	1F2 7.1 mi N	1.6 (2/12) (0.4-1.7)	<LLD	0
	Beta	60	4.0***	46 (48/48) (4.1-120)	7E1 4.5 mi SE	63 (12/12) (9.7-120)	37 (12/12) (9.9-86)	0
	H-3	60	120	323 (18/48) (160-1260)	11A1 0.2 mi SW	418 (6/12) (160-1260)	227 (6/12) (160-450)	0
	Sr-89	20	0.5	<LLD	-	<LLD	<LLD	0
	Sr-90	20	0.4	<LLD	-	<LLD	<LLD	0
	Gamma							
	K-40	60	8.6	60 (37/48) (14-120)	7E1 4.5 mi SE	73 (11/12) (16-120)	44 (11/12) (10-92)	0
	Co-58	60	0.4	1.4 (2/48) (0.8-2.1)	11A1 0.2 mi SW	1.4 (2/12) (0.8-2.1)	<LLD	0
	Co-60	60	0.4	0.9 (2/48) (0.5-1.3)	1F2 7.1 mi N	1.3 (1/12) (1.3)	<LLD	0
	Mo-99	30	27	120 (1/24) (120)	11A1 0.2 mi SW	120 (1/6) (120)	<LLD	0
	La-140	60	0.7	<LLD	12C1 2.5 mi WSW	1.3 (1/12) (1.3)	1.3 (1/12) (1.3)	0
	Ra-226	60	0.9	0.9 (1/48) (0.9)	16F1 6.9 mi NNW	0.9 (1/12) (0.9)	<LLD	0
	Th-232	60	0.8	1.6 (1/48) (1.6)	7E1 4.5 mi SE	1.6 (1/12) (1.6)	<LLD	0
Edible Fish (pCi/L)	H-3 (aqueous)	6	110	84 (1/4) (84)	11A1 0.2 mi SW	84 (1/2) (84)	<LLD	0
	H-3 (organic)	6	120	180 (2/4) (140-220)	12C1 2.5 mi WSW	400 (1/2) (400)	400 (1/2) (400)	0
(pCi/kg-dry)	Sr-89 (bones)	6	64	<LLD	-	<LLD	<LLD	0
	Sr-90 (bones)	6	26	355 (2/4) (110-600)	11A1 0.2 mi SW	600 (1/2) (600)	330 (1/2) (330)	0
(pCi/kg-wet)	Gamma							
	Na-24	3	15	25 (1/2) (25)	7E1 4.5 mi SE	25 (1/1) (25)	<LLD	0
	K-40	6	-	3075 (4/4) (2800-3400)	7E1 4.5 mi SE	3100 (2/2) (2800-3400)	2700 (2/2) (2700-2700)	0
	Cs-137	6	13	14 (1/4) (14)	11A1 0.2 mi SW	14 (1/2) (14)	<LLD	0
	Ra-226	6	18	37 (1/4) (37)	7E1 4.5 mi SE	37 (1/2) (37)	<LLD	0

ARTIFICIAL ISLAND RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

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

SALEM COUNTY, NEW JERSEY JANUARY 1, 1983 to DECEMBER 31, 1983

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 MEAN (RANGE)	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Blue Crabs (pCi/L)	H-3 (flesh)	2	-	200 (1/1) (200)	11A1 0.2 mi SW	200 (1/1) (200)	180 (1/1) (180)	0
(pCi/kg-dry)	Sr-89 (shells)	4	110	<LLD	-	<LLD	<LLD	0
	Sr-90 (shells)	4	-	385 (2/2) (250-520)	12C1 2.5mi WSW	555 (2/2) (540-570)	555 (2/2) (540-570)	0
Blue Crabs (pCi/kg-wet)	Sr-89 (flesh)	4	46	<LLD	-	<LLD	<LLD	0
	Sr-90 (flesh)	4	19	35 (1/2) (35)	11A1 0.2 mi SW	35 (1/2) (35)	25 (1/2) (25)	0
	Gamma K-40	4	-	2200 (2/2) (1800-2600)	12C1 2.5 mi WSW	2500 (2/2) (2000-3000)	2500 (2/2) (2000-3000)	0
	Ra-226	4	63	47 (1/2) (47)	12C1 2.5mi WSW	52 (1/2) (52)	52 (1/2) (52)	0
Benthic Organisms (pCi/kg-dry)	Sr-89	8	1300	<LLD	-	<LLD	<LLD	0
	Sr-90	8	300	250 (1/6) (250)	11A1 0.2 mi SW	250 (1/2) (250)	<LLD	0
	Gamma Mn-54	4	3700	34000 (1/3) (34000)	16F1 6.9 mi NNW	34000 (1/1) (34000)	<LLD	0
	Ra-226	4	8600	15000 (1/3) (15000)	11A1 0.2 mi SW	15000 (1/1) (15000)	<LLD	0
	Th-232	4	16000	11000 (1/3) (11000)	7E1 4.5 mi SE	11000 (1/1) (11000)	<LLD	0

ARTIFICIAL ISLAND RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

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

SALEM COUNTY, NEW JERSEY JANUARY 1, 1983 to DECEMBER 31, 1983

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		CONTROL LOCATION MEAN (RANGE)	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
					NAME DISTANCE AND DIRECTION	MEAN (RANGE)		
Sediment (pCi/kg-dry)	Sr-90	8	23	<LLD	-	<LLD	<LLD	0
	Gamma							
	K-40	8	-	13050 (6/6) (8300-16000)	16F1 6.9 mi NNW	15500 (2/2) (15000-16000)	15000 (2/2) (14000-16000)	0
	Co-58	8	44	44 (1/6) (44)	16F1 6.9 mi NNW	44 (1/2) (44)	<LLD	0
	Co-60	8	36	63 (3/6) (48/83)	11A1 0.2 mi SW	70 (2/2) (58-83)	<LLD	0
	Cs-137	8	31	120 (3/6) (100-160)	11A1 0.2 mi SW	130 (2/2) (100-160)	35 (1/2) (35)	0
	Ra-226	8	-	922 (6/6) (570-1600)	16F1 6.9 mi NNW	1085 (2/2) (570-1600)	690 (2/2) (690-690)	0
	Th-232	8	-	875 (6/6) (590-1000)	16F1 6.9 mi NNW	985 (2/2) (970-1000)	970 (2/2) (840-1100)	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
APT = Air Particulates
ECH = Hard Shell Blue Crab
ESB = Benthic Organisms
ESF = Edible Fish
ESS = Sediment
FPB = Beef
FPV = Food Products, Various
FPG = Grains
FPL = Green Leafy Vegetables
GAM = Game
IDM = Immersion Dose (TLD)
MLK = Milk
PWR = Potable Water (Raw)
PWT = Potable Water (Treated)
RWA = Rain Water
SOL = Soil
SWA = Surface Water
THB = Bovine Thyroid
VGT = Fodder Crops; Vegetation
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
A = 0-1 miles off-site
B = 1-2 miles off-site
C = 2-3 miles off-site
D = 3-4 miles off-site
E = 4-5 miles off-site
F = 5-10 miles off-site
G = 10-20 miles off-site
H = >20 miles off-site

The last number is the station numerical designation within each sector and zone; e.g., 1,2,3,... For example, the designation SA-WWA-5D1 would indicate a sample in the SNGS program (SA), consisting of well water (WWA), which had been collected in 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 1983 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
4S1	1400 ft. ENE of vent; Production well #5	WWA
5S1	1.0 mi. E of vent; site access road	AIO,APT,IDM
6S1	0.2 mi. ESE of vent; observation bldg area	SOL
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,FPG, FPV,IDM,SOL,WWA
10D1	3.9 mi. SSW of vent; Taylor's Bridge Spur	AIO,APT,IDM,SOL
11D1	3.5 mi. SW of vent	GAM
14D1	3.4 mi. WNW of vent; Bay View, Delaware	IDM
2E1	4.4 mi. NNE of vent; local farm	FPV,IDM,SOL
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

TABLE B-1 (cont'd)

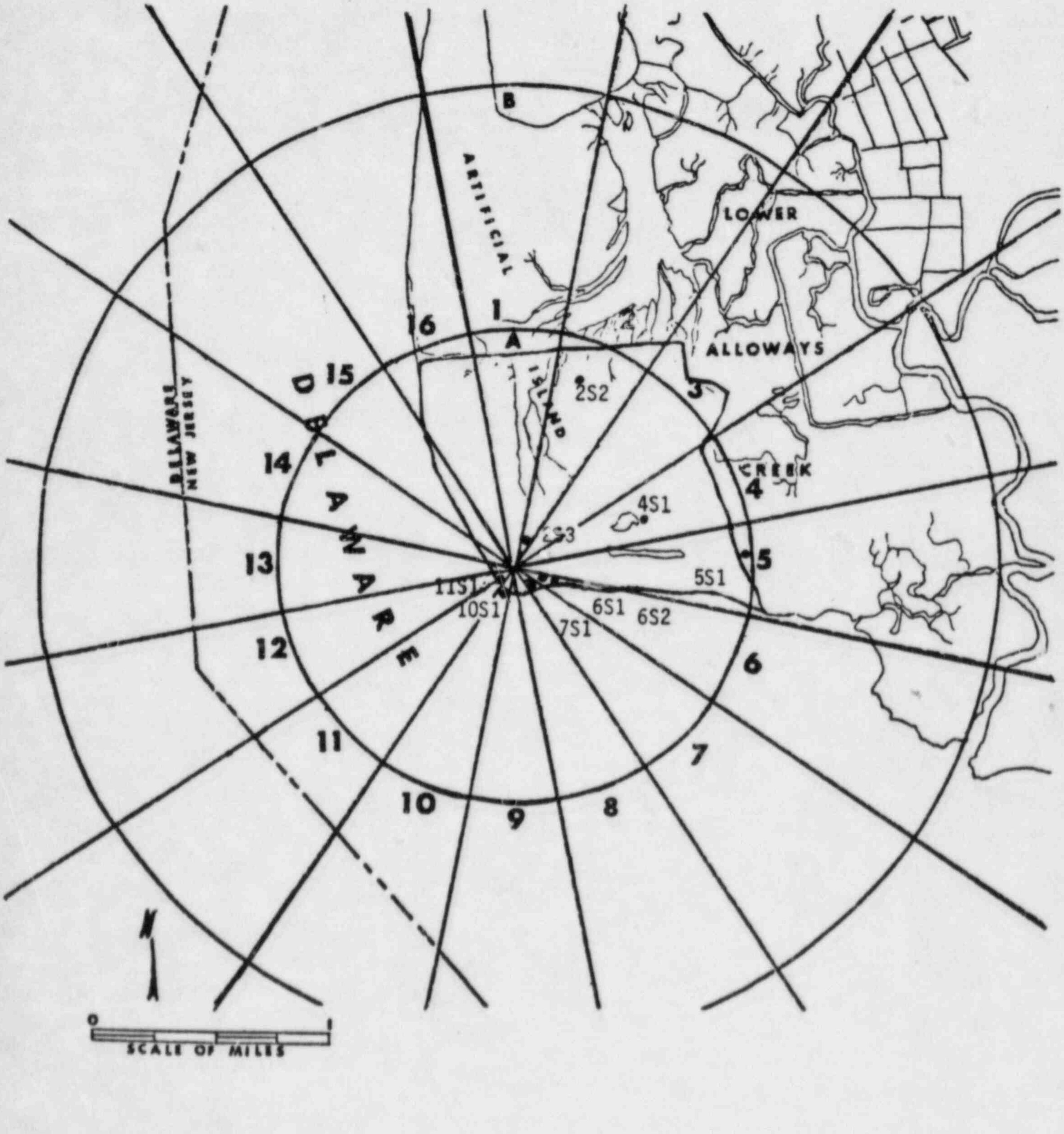
STATION CODE	STATION LOCATION	SAMPLE TYPES
9E1	4.2 mi. S of vent	IDM
11E2	5.0 mi. SW of vent	IDM
12E1	4.4 mi. WSW of vent; Thomas Landing	IDM
13E1	4.2 mi. W of vent; Diehl House Lab	IDM
13E3	4.9 mi. W of vent; local farm	MLK
16E1	4.1 mi. NNW of vent; Port Penn	APT,AIO,IDM,SOL
1F1	5.8 mi. N of vent; Fort Elfsborg	AIO,APT,IDM,SOL
1F2	7.1 mi. N of vent; midpoint of Delaware River	SWA
1F3	5.9 mi. N of vent; local farm	FPL,FPV
2F1	5.0 mi. NNE of vent; local farm	SOL
2F2	8.7 mi. NNE of vent; Salem Substation	AIO,APT,IDM, RWA,SOL
2F3	8.0 mi. NNE of vent; Salem Water Company	PWR,PWT
2F4	6.3 mi. NNE of vent; local farm	MLK,SOL,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
5F1	6.5 mi. E of vent	FPV,IDM,SOL
5F2	7.0 mi. E of vent; local farm	MLK,SOL,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

TABLE B-1 (cont'd)

STATION CODE	STATION LOCATION	SAMPLE TYPES
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
13F3	9.3 mi. W of vent; Redding Middle School, Middletown, DE	IDM
14F1	5.5 mi. WNW of vent; local farm	FPB,MLK,SOL,THB, VGT
14F2	6.6 mi. WNW of vent; Boyds Corner	IDM
14F3	5.4 mi. WNW of vent; local farm	FPG,FPV
15F1	5.4 mi. NW of vent; local farm	FPG,MLK,SOL,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,SOL, VGT
3G2	14 mi. NE of vent; local farm	MLK
10G1	12 mi. SSW of vent; Smyrna, Delaware	IDM
16G1	15 mi. NNW of vent; Greater Wilmington Airport	IDM
2H1	34 mi. NNE of vent; RMC, Phila.	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,SOL
3H4	88 mi. NE of vent; local farm	FPG,FPV

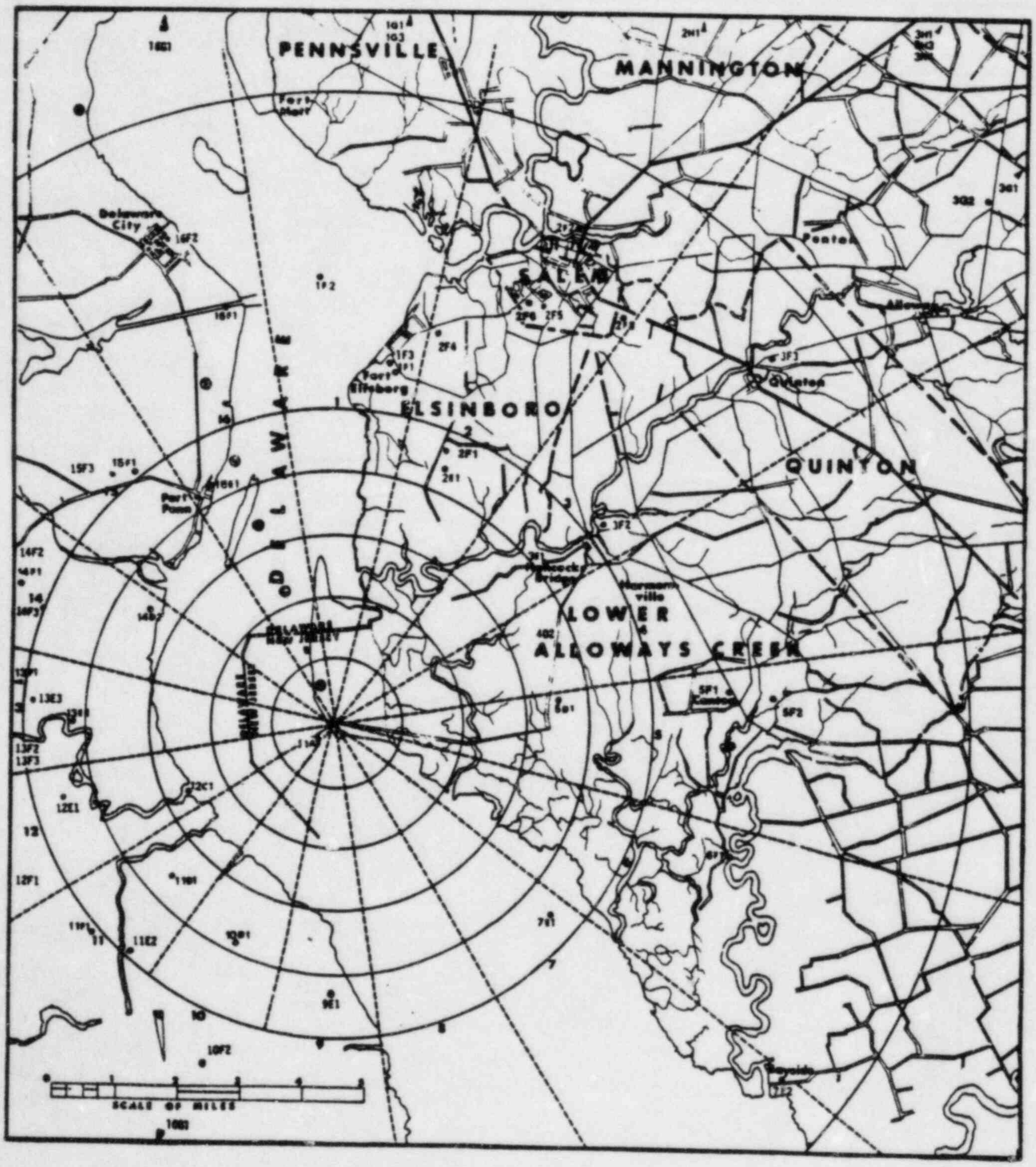
MAP B-1

ON SITE SAMPLING LOCATIONS ARTIFICIAL ISLAND



MAP B-2

OFF-SITE SAMPLING LOCATIONS
ARTIFICIAL ISLAND



APPENDIX C

1983 DATA TABLES

DATA TABLES

Appendix C presents the analytical results of the 1983 Artificial Island Radiological Environmental Monitoring Program for the period of January 1 to December 31, 1983.

DATA TABLES (Cont.)

TERRESTRIAL ENVIRONMENT

MILK

WELL WATER

POTABLE WATER

FOOD PRODUCTS

FODDER CROPS

SOIL

DATA TABLES (Cont.)

TABLE C-1

1983 CONCENTRATIONS OF GROSS ALPHA EMITTERS IN AIR PARTICULATES

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

(Results by PSE&G Research Corporation)

	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	2.2±0.8	1.5±0.7	<0.8	0.9±0.7	2.2±1.0	1.7±0.8	1.2±0.7	1.7±0.8	1.5±1.1
	1.5±0.6	1.0±0.6	1.6±0.7	1.0±0.5	1.2±0.6	0.9±0.5	1.6±0.7	<0.7	1.2±0.7
	1.5±0.6	1.5±0.6	1.3±0.6	0.9±0.6	0.8±0.6	1.5±0.7	0.9±0.6	1.0±0.6	1.2±0.6
	1.9±0.7	1.2±0.7	0.9±0.6	<0.6	1.2±0.6	0.9±0.6	<0.7	<0.8	1.0±0.8
	3.5±1.8	1.2±0.6	<0.7	1.0±0.6	0.7±0.6	1.2±0.7	<0.7	<0.8	1.2±1.9
FEBRUARY	1.3±0.5	0.5±0.4	0.6±0.4	1.0±0.5	0.8±0.5	1.0±0.5	1.3±0.6	1.2±1.0	1.0±0.6
	0.9±0.5	0.9±0.5	1.1±0.6	<0.6	1.0±0.6	1.1±0.6	0.9±0.6	1.1±0.6	1.0±0.3
	2.1±0.6	1.3±0.5	2.0±0.7	1.3±0.6	1.4±0.6	1.4±0.6	2.1±0.7	1.2±0.6	1.6±0.8
	1.8±0.7	<0.7	<0.8	0.7±0.5	0.9±0.6	0.8±0.6	1.3±0.7	<0.9	1.0±0.8
MARCH	1.4±0.7	1.6±0.7	1.3±0.7	<0.8	<0.8	0.8±0.6	1.7±0.8	<0.7	1.1±0.8
	<0.6	<0.5	<0.6	0.6±0.4	0.8±0.5	<0.7	0.7±0.5	<0.6	-
	<0.8	<0.7	<0.7	<0.7	<0.8	<0.7	<0.7	<0.7	-
	1.2±0.6	0.8±0.5	1.4±0.6	0.8±0.5	0.9±0.5	1.4±0.6	1.0±0.5	1.0±0.6	1.1±0.5
APRIL	1.5±0.6	1.4±0.6	1.4±0.6	0.8±0.5	1.4±0.6	1.4±0.6	1.3±0.6	2.0±1.0	1.4±0.6
	0.8±0.5	<0.4	<0.5	0.7±0.4	0.9±0.5	0.6±0.5	1.0±0.5	<0.5	0.7±0.4
	0.8±0.5	<0.6	0.7±0.5	1.2±0.6	<0.7	<0.6	<0.6	<0.6	-
	<0.8	0.9±0.6	1.3±0.7	1.0±0.6	<0.7	1.3±0.7	1.0±0.6	0.9±0.6	1.0±0.4
	1.6±0.6	1.8±0.6	2.2±0.7	2.2±0.7	2.2±0.7	1.3±0.5	2.0±0.7	1.8±0.7	1.9±0.6
MAY	1.0±0.6	0.7±0.5	<0.7	1.4±0.6	1.2±0.6	0.8±0.6	1.2±0.6	<0.7	1.0±0.6
	1.9±0.8	1.3±0.7	0.9±0.7	<0.9	1.5±0.8	<0.8	<0.8	<0.9	1.1±0.8
	1.6±0.6	<0.4	<0.5	0.7±0.4	0.8±0.5	<0.5	0.9±0.5	1.3±0.6	0.8±0.8
	14±11(1)	1.0±0.4	1.3±0.5	1.2±0.4	1.2±0.5	1.1±0.4	1.1±0.5	1.0±0.5	2.7±9.1
JUNE	1.9±0.9	1.1±0.6	0.9±0.7	<0.8	1.1±0.9	1.0±0.7	<0.8	1.2±0.7	1.1±0.7
	(2)	(2)	(2)	(2)	2.0±0.9	(2)	(2)	1.5±0.8	-
	(2)	(2)	(2)	(2)	3.9±1.4	(2)	(2)	2.6±1.1	-
	(2)	(2)	(2)	(2)	2.9±0.8	(2)	(2)	2.3±0.8	-

TABLE C-1 (cont'd)

1983 CONCENTRATIONS OF GROSS ALPHA EMITTERS IN AIR PARTICULATES

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

(Results by PSE&G Research Corporation)

	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)	(2)	(3)	(2)	<0.9	(2)	(2)	1.0±0.6	-
	1.9±0.8	1.3±0.7	<3.0	3.4±1.0	6.0±1.3	1.2±0.7	0.9±0.7	0.9±0.7	2.3±3.5
	2.3±0.9	2.2±0.9	<2.0	<3.2	1.5±1.1	<0.8	1.2±0.8	1.1±0.7	1.8±1.6
	(2)	(2)	1.4±1.2	(2)	1.8±0.7	(2)	(2)	2.3±0.9	-
	(2)	(2)	<2.0	(2)	2.6±1.0	(2)	(2)	4.1±1.1	-
AUGUST	2.0±0.7	1.4±0.7	1.5±1.2	1.4±0.7	1.5±0.7	1.4±0.7	1.2±0.6	1.4±0.7	1.5±0.5
	2.2±0.9	2.5±1.0	1.6±1.3	2.4±1.1	3.3±1.1	3.4±1.1	3.4±1.3	<1.1	2.5±1.7
	2.6±0.8	2.7±0.9	1.9±1.5	2.4±0.7	2.5±0.8	2.5±0.8	2.6±0.9	2.6±0.9	2.5±0.5
	2.6±0.9	1.9±0.8	3.7±1.8	2.7±0.9	3.1±1.0	1.7±0.8	2.6±0.9	1.8±0.8	2.5±1.4
SEPTEMBER	2.7±0.7	2.1±0.7	1.4±1.2	2.3±0.7	2.8±0.8	2.2±0.6	2.3±0.7	3.0±0.8	2.4±1.0
	3.0±1.0	2.7±1.2	2.9±1.6	1.9±0.8	3.5±1.0	1.9±0.9	4.1±1.3	1.6±0.9	2.7±1.7
	1.8±0.7	1.9±0.8	1.7±1.4	1.1±0.7	2.2±0.9	1.0±0.6	1.7±1.0	1.5±0.7	1.6±0.8
	2.8±0.9	1.7±0.7	1.5±1.3	3.3±0.9	2.6±0.8	2.2±0.8	1.3±0.7	2.4±0.9	2.2±1.4
OCTOBER	1.6±0.7	2.1±0.8	<2.0	2.4±0.8	1.8±0.8	9.6±5.9(1)	2.6±0.9	1.8±0.7	3.0±5.4
	3.3±0.8	2.6±0.8	3.4±1.8	2.6±0.8	3.0±0.8	3.7±1.1	2.7±0.8	2.4±0.9	3.0±0.9
	1.6±0.7	2.0±0.8	<1.0	1.1±0.6	1.1±0.7	1.4±0.7	2.3±0.8	1.7±0.7	1.5±0.9
	1.7±0.8	1.7±0.7	2.7±1.5	0.9±0.5	1.6±0.7	1.6±0.8	2.0±0.8	1.8±0.9	1.8±1.0
	2.3±0.8	1.9±0.8	<1.0	1.2±0.7	1.8±0.8	1.8±0.8	1.7±0.7	2.2±0.8	1.7±0.9
NOVEMBER	2.3±0.9	1.3±0.7	1.1±0.9	1.8±0.8	2.0±0.8	1.6±1.0	1.4±0.8	1.7±0.8	1.6±0.8
	2.2±0.8	1.0±0.6	1.6±1.2	1.3±0.6	1.2±0.7	1.3±0.7	2.0±0.8	1.6±0.7	1.5±0.8
	1.2±0.8	1.2±0.7	2.0±1.4	<1.1	1.8±1.0	1.5±1.0	1.6±0.9	2.1±0.8	1.6±0.8
	2.3±0.8	3.3±0.9	1.5±1.1	2.9±0.8	2.9±0.8	2.5±0.8	3.9±1.0	2.9±0.9	2.8±1.4
DECEMBER	1.5±0.7	2.1±0.7	1.2±1.0	1.5±0.7	1.5±0.7	1.9±0.7	2.0±0.8	1.1±0.6	1.6±0.7
	2.1±0.7	2.1±0.6	<4.0	1.6±0.6	1.8±0.6	1.5±0.6	2.1±0.8	1.9±0.7	2.1±1.6
	1.9±1.0	1.7±0.8	1.4±1.2	1.6±1.0	1.7±1.0	1.6±0.9	<1.4	2.2±0.9	1.7±0.5
	1.9±0.7	2.2±0.7	1.0±0.9	1.6±0.7	2.0±0.6	1.4±0.6	2.0±0.7	2.1±0.7	1.8±0.8
AVERAGE	2.1±3.8	1.5±1.4	1.5±1.6	1.5±1.6	1.8±2.0	1.6±2.8	1.6±1.7	1.5±1.5	
								Grand Average	1.6±2.2

* Sampling dates can be found in Table C-5.
** Results by Teledyne Isotopes.
(1) High uncertainty due to low sample volume.
(2) Not analyzed for gross alpha emitters.
(3) Not analyzed by Teledyne Isotopes.

TABLE C-2

1983 CONCENTRATIONS OF GROSS BETA EMITTERS IN AIR PARTICULATES

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

(Results by PSE&G Research Corporation)

	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	32±3	27±3	27±3	28±3	25±3	30±3	28±3	28±3	28±4
	25±2	22±2	22±3	16±2	17±2	20±2	22±2	22±3	21±6
	18±2	14±2	14±2	16±2	14±2	13±2	12±2	13±2	14±4
	18±2	14±2	17±2	14±2	15±2	15±2	15±2	20±3	16±4
	70±7	22±2	24±2	24±2	21±2	23±2	24±2	23±3	29±33
FEBRUARY	21±2	19±2	21±2	19±2	19±2	20±2	23±2	25±5	21±4
	26±2	23±2	25±3	25±2	26±2	23±2	25±2	23±2	24±3
	25±2	22±2	23±2	20±2	21±2	22±2	25±2	25±2	23±4
	22±2	21±2	23±2	19±2	20±2	21±2	22±2	25±3	22±4
MARCH	20±3	18±2	18±3	18±3	17±3	16±2	18±3	20±3	18±3
	8.6±1.9	9.1±1.9	8.8±2.0	9.6±1.8	12±2	9.3±2.2	9.0±2.0	5.9±1.9	9.0±3.3
	14±2	9.2±1.9	10±2	7.7±2.0	9.0±2.1	11±2	9.1±2.1	11±2	10±4
	24±2	19±2	18±2	16±2	17±2	21±2	20±2	22±2	20±5
APRIL	25±2	22±2	26±3	25±3	25±3	23±2	25±3	43±5	27±13
	11±2	11±2	11±2	8.9±1.7	9.1±2.0	11±2	10±2	10±2	10±2
	12±2	12±2	13±2	12±2	14±2	11±2	13±2	9.9±2.1	12±2
	21±2	19±2	19±2	19±2	21±2	20±2	20±2	19±2	20±2
	37±3	31±3	33±3	38±3	35±3	36±3	34±3	32±3	34±5
MAY	25±3	20±2	20±3	20±2	21±2	19±3	22±3	20±3	21±4
	21±2	19±2	21±2	17±2	18±2	20±2	18±2	14±2	18±5
	17±2	12±2	13±2	13±2	15±2	12±2	14±2	18±2	14±4
	<75(1)	11±2	12±2	11±2	12±2	12±2	14±2	11±2	12±2
JUNE	20±3	19±3	20±3	17±3	21±4	17±3	21±3	17±3	19±4
	28±3	26±2	23±3	30±2	38±3	29±3	33±3	28±3	29±8
	54±8	42±7	40±7	39±7	48±9	48±7	36±7	49±8	44±12
	29±6	33±5	30±5	33±5	27±5	26±5	35±6	31±6	30±6

TABLE C-2 (cont'd)

1983 CONCENTRATIONS OF GROSS BETA EMITTERS IN AIR PARTICULATES

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

(Results by PSE&G Research Corporation)

	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	25±3	20±2	19±3	21±3	22±3	21±3	24±3	27±3	22±5
	26±3	22±3	20±4	30±3	31±3	21±3	22±3	20±3	24±9
	39±3	38±3	19±6	24±8	39±4	34±3	39±4	29±3	33±16
	28±3	30±4	22±3	27±2	22±3	28±3	28±3	25±3	26±6
	33±3	34±3	32±5	27±3	32±3	30±3	32±3	26±3	31±6
AUGUST	26±3	23±3	21±3	21±2	24±3	22±2	25±3	22±3	23±4
	28±3	26±3	23±3	20±3	26±3	25±3	24±3	20±3	24±6
	34±3	38±3	49±3	30±2	32±3	32±3	40±3	36±3	36±12
	26±3	24±3	29±3	22±3	29±3	25±3	29±3	25±3	26±5
SEPTEMBER	27±2	26±3	28±3	25±2	28±3	26±2	30±3	34±3	28±6
	37±3	37±4	32±4	30±3	35±3	37±4	41±4	31±4	35±7
	29±3	29±3	28±4	26±3	28±3	24±2	24±4	21±3	26±6
	34±3	28±3	33±4	31±3	35±3	32±3	31±3	33±3	32±4
OCTOBER	25±3	26±3	31±4	14±2	28±3	34±17(2)	27±3	22±3	26±12
	33±3	33±3	37±4	30±3	31±2	33±4	31±3	35±3	33±4
	14±3	13±3	16±3	10±3	11±3	15±3	14±3	12±3	13±4
	20±3	21±2	23±3	16±2	21±2	22±3	22±3	23±3	21±4
	16±2	18±2	16±3	17±2	19±3	18±3	14±2	14±2	16±4
NOVEMBER	15±2	15±2	16±3	13±3	13±2	13±3	15±3	11±2	14±3
	21±2	20±2	24±3	22±2	20±2	22±2	22±2	24±2	22±3
	21±3	19±3	27±4	20±3	24±3	21±3	22±3	25±3	22±5
	36±3	36±3	35±4	34±3	35±3	33±3	41±3	34±3	36±5
DECEMBER	26±3	24±2	27±4	22±3	28±3	24±3	28±3	25±2	26±4
	29±3	28±2	23±3	23±3	25±2	25±3	30±3	29±3	26±6
	25±3	25±2	24±3	26±3	25±3	24±3	27±3	24±3	25±2
	30±2	32±2	33±3	28±2	32±2	27±2	29±3	30±2	30±4
AVERAGE	26±20	23±16	23±16	22±15	24±17	23±16	24±16	23±17	
								Grand Average	24±17

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

** Results by Teledyne Isotopes.

(1) Result not included in any averages. High LLD due to low sample volume.

(2) High uncertainty due to low sample volume.

TABLE C-3

1983 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

(Results by PSE&G Research Corporation)

STATION NO. AND DATES	Sr-89	Sr-90	Be-7	Co-60	Ra-226	Th-232
<u>SA-APT-2S2</u>						
12-27-82 to 3-28-83	<0.2	<0.2	48±4	<0.4	<0.6	<1.6
3-28-83 to 6-28-83	<0.5	<0.3	69±5	<0.5	<1.1	<1.3
6-28-83 to 9-26-83	<0.4	<0.3	69±5	0.7±0.3	<1.1	<1.9
9-26-83 to 12-27-83	<0.3	<0.2	48±4	<0.4	<0.6	<1.2
<u>SA-APT-5S1</u>						
12-27-82 to 3-28-83	<0.2	<0.2	35±4	<0.5	<0.9	<1.8
3-28-83 to 6-28-83	<0.4	<0.2	46±4	<0.4	<0.9	<2.2
6-28-83 to 9-26-83	<0.4	<0.3	53±5	<0.7	<1.5	<3.0
9-26-83 to 12-27-83	<0.3	<0.2	40±4	<0.4	<0.9	<1.5
<u>SA-APT-5D1</u>						
12-27-82 to 3-28-83	<0.3	<0.2	32±3	<0.5	<1.0	<1.2
3-28-83 to 6-28-83	<0.5	<0.3	48±4	<0.4	<1.2	<1.6
7-05-83 to 9-26-83(1)	<0.6	<0.3	69±16	<1.0	<10	(2)
9-26-83 to 12-27-83(1)	<0.3	<0.1	57±7	<0.5	<8	(2)
<u>SA-APT-10D1</u>						
12-28-82 to 3-29-83	<0.3	<0.2	28±4	<0.6	<1.2	<1.5
3-29-83 to 6-29-83	<0.4	<0.2	36±3	<0.4	<0.6	<1.1
6-29-83 to 9-27-83	<0.4	<0.3	32±3	<0.4	<0.7	<1.3
9-27-83 to 12-27-83	<0.3	<0.2	38±4	<0.5	<0.9	<1.9

TABLE C-3 (cont'd)

1983 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

(Results by PSE&G Research Corporation)

STATION NO. AND DATES	Sr-89	Sr-90	Be-7	Co-60	Ra-226	Th-232
SA-APT-16E1						
12-28-82 to 3-29-83	<0.3	<0.2	27±3	<0.3	<1.0	<1.6
3-29-83 to 6-29-83	<0.5	<0.3	42±5	<0.6	<1.0	<2.1
6-29-83 to 9-27-83	<0.4	<0.3	54±5	<0.6	0.9±0.5	<1.0
9-27-83 to 12-27-83	<0.3	<0.2	43±4	<0.4	<1.0	<1.7
SA-APT-1F1						
12-27-82 to 3-28-83	<0.3	<0.2	33±3	<0.4	0.3±0.2	0.8±0.4
3-28-83 to 6-28-83	<0.6	<0.3	47±5	<0.6	<1.6	<2.2
6-28-83 to 9-26-83	<0.4	<0.3	43±4	<0.5	<1.0	<1.6
9-26-83 to 12-27-83	<0.4	<0.2	51±5	0.6±0.3	<1.1	<2.2
SA-APT-2F2						
12-27-82 to 3-28-83	<0.2	<0.2	36±4	<0.6	0.6±0.4	<2.0
3-28-83 to 6-28-83	<0.5	<0.3	58±5	<0.5	<1.3	<2.2
6-28-83 to 9-26-83	<0.4	<0.3	60±6	<0.7	<1.5	<1.0
9-26-83 to 12-27-83	<0.3	<0.2	48±5	<0.6	<1.5	<2.2
SA-APT-3H3 (Control)						
12-27-82 to 3-28-83	<0.3	<0.2	40±5	<0.6	<1.4	<2.2
3-28-83 to 6-28-83	<0.5	<0.3	60±5	<0.5	<1.5	<2.2
6-28-83 to 9-26-83	<0.4	<0.4	57±5	<0.4	<0.9	<2.0
9-26-83 to 12-27-83	<0.3	<0.2	43±4	<0.4	<0.9	<1.5
AVERAGE	-	-	46±23	-	-	-

* Strontium-89 results are corrected for decay to sample stop date.
** All other gamma emitters searched for were LLD, typical LLDs are given in Table C-33.
(1) Results by Teledyne Isotopes
(2) Not analyzed for Th-232

TABLE C-4

1983 CONCENTRATIONS OF IODINE-131 IN FILTERED AIR

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

Results* by Radiation Management Corporation

STATION NO.

MONTH****	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	<13	<30	<36	< 8.2	<41	<13	<18	<20
	<86$^{(1)}$	<90$^{(1)}$	<95$^{(1)}$	<78$^{(1)}$	<42	< 9.3	<72$^{(1)}$	<77$^{(1)}$
	<46	<44	<48	<52	<48	<10	<43	<23
	<38	<39	<38	<29	<16	< 9.4	<50	<57
	<98$^{(1)}$	<34	<42	<38	<39	<13	<40	<27
FEBRUARY	<23	<24	<26	<27	<42	<10	<38	<39
	<21	<15	<33	<29	<28	<10	<31	<31
	<13	<14	<10	<12	<12	< 8.8	<12	<12
	< 9.8	< 8.6	<10	< 8.6	< 9.0	<10	<10	<14
MARCH	<10	< 9.1	<11	<13	<12	<12	<12	<12
	< 8.8	< 9.8	<11	< 8.4	< 8.3	<11	< 9.8	<12
	<13	<10	<11	<12	<12	<14	<13	<12
	<12	<13	<11	<11	<12	<11	<12	<14
APRIL	<12	<13	<12	<13	<12	<14	<13	<27
	<11	<11	<11	<10	<13	<16	<13	<14
	< 9.8	<11	<11	<11	<13	<12	<14	<15
	<12	<10	<12	<10	<10	<13	<13	<10
	<17	<18	<21	<20	<25	< 8.2	<22	<19
MAY	<16	<15	<20	<15	<16	< 8.5	<18	<18
	<12	<13	<14	<14	<15	< 8.0	<14	<11
	<13	<12	<16	<12	<14	< 8.8	<16	<15
	<302$^{(2)}$	<10	<11	< 9.5	<12	< 6.7	<12	<14
JUNE	<18	<15	<17	<18	<24	<11	<19	<16
	<12	<12	<14	<11	<15	< 8.6	<14	(3)
	<14	<14	<16	<15	<18	< 8.8	<18	<17
	<14	<11	<13	<10	<16	<14	<16	<18

TABLE C-4 (cont'd)

1983 CONCENTRATIONS OF IODINE-131 IN FILTERED AIR

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

Results* by PSE&G Research Corporation

STATION NO.

MONTH****	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)
JULY	< 8.7	< 9.9	< 2.0	<12	<17	<14	<18	<12
	< 7.4	< 9.4	<10	< 9.3	<14	<13	<16	<20
	< 7.0	< 9.4	< 3.0	<28(4)	<15	<11	<16	<14
	< 6.1	<13	< 2.0	< 6.4	< 3.1	< 7.7	< 6.3	< 6.9
	< 3.2	< 9.5	<10	< 7.7	< 5.7	< 3.7	< 7.1	< 4.3
AUGUST	< 7.8	< 6.2	< 3.0	<12	< 6.7	< 6.4	< 5.9	< 7.3
	< 5.1	< 6.1	<30	< 6.2	< 5.5	< 6.4	< 8.5	< 9.0
	< 3.9	< 4.8	<20	< 6.7	< 5.9	< 7.4	< 7.8	< 6.4
	< 7.2	< 9.4	<30	< 6.8	< 9.3	< 5.8	< 5.9	< 6.7
SEPTEMBER	< 5.3	< 8.2	<10	< 5.4	< 7.5	< 4.8	< 5.0	< 6.9
	< 8.1	<10	<20	< 6.7	< 5.3	< 9.5	< 8.9	<12
	< 6.0	< 9.0	<60	< 6.8	< 7.1	< 5.1	< 8.7	< 5.1
	< 5.9	< 8.2	<20	< 5.8	< 5.5	(4)	< 9.0	< 5.6
OCTOBER	< 8.6	< 9.4	<30	< 5.5	< 7.1	<99(2)	< 8.4	< 7.4
	< 6.9	< 4.7	<10	< 5.5	< 6.7	< 6.0	< 7.5	< 6.6
	< 5.5	< 6.0	<30	< 8.1	<11	< 9.2	< 7.2	< 4.4
	< 6.9	< 8.0	<20	< 6.7	< 5.6	< 5.9	< 8.0	< 9.4
	< 7.5	< 4.6	<20	< 6.5	< 8.0	< 6.2	< 6.3	< 6.3
NOVEMBER	< 6.9	< 6.1	<20	< 7.0	< 7.4	<11	< 6.8	< 6.0
	< 7.1	< 7.7	<20	< 4.8	< 4.1	< 4.7	< 6.4	< 7.0
	< 9.0	< 6.5	<20	<10	< 8.5	< 8.3	< 5.9	< 7.6
	< 5.6	< 7.5	<20	< 3.7	< 5.2	< 5.5	< 7.2	< 5.9
DECEMBER	< 6.5	< 6.2	<20	< 7.2	<10	< 6.2	<12	< 5.3
	< 5.9	< 4.9	<40	< 6.5	< 3.8	< 6.1	< 9.3	< 4.2
	< 5.8	< 4.9	<40	< 7.5	<10	< 5.9	<10	< 5.5
	< 5.2	< 6.0	<20	< 5.6	< 6.5	< 4.1	< 6.6	< 3.9

* I-131 results are corrected for decay to sample stop date.
** Results by PSE&G Research Corporation.
*** Results by Teledyne Isotopes.
**** Sampling dates can be found in Table C-5.
(1) Does not meet sensitivity requirements.
(2) High LLD due to low sample volume.
(3) Data lost due to computer malfunction.
(4) Sample lost.

TABLE C-5

1983 SAMPLING DATES FOR AIR SAMPLES

	STATION NO.							
MONTH	2S2	5S1	5D1	10D1	16E1	1F1	2F2	3H3
JANUARY	12-27-82 to 1-03-83	12-27-82 to 1-03-83	12-27-82 to 1-03-83	12-28-82 to 1-03-83	12-28-82 to 1-03-83	12-27-82 to 1-03-83	12-27-82 to 1-03-83	12-27-82 to 1-03-83
	1-03-83 to 1-10-83	1-03-83 to 1-10-83	1-03-83 to 1-10-83	1-03-83 to 1-11-83	1-03-83 to 1-11-83	1-03-83 to 1-10-83	1-03-83 to 1-10-83	1-03-83 to 1-10-83
	1-10-83 to 1-17-83	1-10-83 to 1-17-83	1-10-83 to 1-17-83	1-11-83 to 1-17-83	1-11-83 to 1-17-83	1-10-83 to 1-17-83	1-10-83 to 1-17-83	1-10-83 to 1-17-83
	1-17-83 to 1-24-83	1-17-83 to 1-24-83	1-17-83 to 1-24-83	1-17-83 to 1-25-83	1-17-83 to 1-25-83	1-17-83 to 1-24-83	1-17-83 to 1-24-83	1-17-83 to 1-24-83
	1-24-83 to 1-31-83	1-24-83 to 1-31-83	1-24-83 to 1-31-83	1-25-83 to 2-01-83	1-25-83 to 2-01-83	1-24-83 to 1-31-83	1-24-83 to 1-31-83	1-24-83 to 1-31-83
FEBRUARY	1-31-83 to 2-07-83	1-31-83 to 2-07-83	1-31-83 to 2-07-83	2-01-83 to 2-07-83	2-01-83 to 2-07-83	1-31-83 to 2-07-83	1-31-83 to 2-07-83	1-31-83 to 2-07-83
	2-07-83 to 2-14-83	2-07-83 to 2-14-83	2-07-83 to 2-14-83	2-07-83 to 2-15-83	2-07-83 to 2-15-83	2-07-83 to 2-14-83	2-07-83 to 2-14-83	2-07-83 to 2-14-83
	2-14-83 to 2-22-83	2-14-83 to 2-22-83	2-14-83 to 2-22-83	2-15-83 to 2-22-83	2-15-83 to 2-22-83	2-14-83 to 2-22-83	2-14-83 to 2-22-83	2-14-83 to 2-22-83
	2-22-83 to 3-01-83	2-22-83 to 3-01-83	2-22-83 to 3-01-83	2-22-83 to 3-02-83	2-22-83 to 3-02-83	2-22-83 to 3-01-83	2-22-83 to 3-01-83	2-22-83 to 2-28-83
MARCH	3-01-83 to 3-07-83	3-01-83 to 3-07-83	3-01-83 to 3-07-83	3-02-83 to 3-07-83	3-02-83 to 3-07-83	3-01-83 to 3-07-83	3-01-83 to 3-07-83	2-28-83 to 3-07-83
	3-07-83 to 3-14-83	3-07-83 to 3-14-83	3-07-83 to 3-14-83	3-07-83 to 3-15-83	3-07-83 to 3-15-83	3-07-83 to 3-14-83	3-07-83 to 3-14-83	3-07-83 to 3-14-83

TABLE C-5 (cont'd)

1983 SAMPLING DATES FOR AIR SAMPLES

MONTH	STATION NO. 2S2	5S1	5D1	10D1	16E1	1F1	2F2	3H3
MARCH	3-14-83 to 3-21-83	3-14-83 to 3-21-83	3-14-83 to 3-21-83	3-15-83 to 3-21-83	3-15-83 to 3-21-83	3-14-83 to 3-21-83	3-14-83 to 3-21-83	3-14-83 to 3-21-83
	3-21-83 to 3-28-83	3-21-83 to 3-28-83	3-21-83 to 3-28-83	3-21-83 to 3-29-83	3-21-83 to 3-29-83	3-21-83 to 3-28-83	3-21-83 to 3-28-83	3-21-83 to 3-28-83
APRIL	3-28-83 to 4-04-83	3-28-83 to 4-04-83	3-28-83 to 4-04-83	3-29-83 to 4-04-83	3-29-83 to 4-05-83	3-28-83 to 4-04-83	3-28-83 to 4-04-83	3-28-83 to 4-04-83
	4-04-83 to 4-11-83	4-04-83 to 4-11-83	4-04-83 to 4-11-83	4-04-83 to 4-12-83	4-05-83 to 4-12-83	4-04-83 to 4-11-83	4-04-83 to 4-11-83	4-04-83 to 4-11-83
	4-11-83 to 4-18-83	4-11-83 to 4-18-83	4-11-83 to 4-18-83	4-12-83 to 4-18-83	4-12-83 to 4-18-83	4-11-83 to 4-18-83	4-11-83 to 4-18-83	4-11-83 to 4-18-83
	4-18-83 to 4-25-83	4-18-83 to 4-25-83	4-18-83 to 4-25-83	4-18-83 to 4-26-83	4-18-83 to 4-26-83	4-18-83 to 4-25-83	4-18-83 to 4-25-83	4-18-83 to 4-25-83
	4-25-83 to 5-02-83	4-25-83 to 5-02-83	4-25-83 to 5-02-83	4-26-83 to 5-02-83	4-26-83 to 5-02-83	4-25-83 to 5-02-83	4-25-83 to 5-02-83	4-25-83 to 5-02-83
MAY	5-02-83 to 5-09-83	5-02-83 to 5-09-83	5-02-83 to 5-09-83	5-02-83 to 5-10-83	5-02-83 to 5-10-83	5-02-83 to 5-09-83	5-02-83 to 5-09-83	5-02-83 to 5-09-83
	5-09-83 to 5-16-83	5-09-83 to 5-16-83	5-09-83 to 5-16-83	5-10-83 to 5-16-83	5-10-83 to 5-16-83	5-09-83 to 5-16-83	5-09-83 to 5-16-83	5-09-83 to 5-16-83
	5-16-83 to 5-23-83	5-16-83 to 5-23-83	5-16-83 to 5-23-83	5-16-83 to 5-24-83	5-16-83 to 5-24-83	5-16-83 to 5-23-83	5-16-83 to 5-23-83	5-16-83 to 5-23-83
	5-23-83 to 5-23-83	5-23-83 to 5-31-83	5-23-83 to 5-31-83	5-24-83 to 6-01-83	5-24-83 to 6-01-83	5-23-83 to 5-31-83	5-23-83 to 5-31-83	5-23-83 to 5-31-83

TABLE C-5 (cont'd)

1983 SAMPLING DATES FOR AIR SAMPLES

MONTH	STATION NO.							
	2S2	5S1	5D1	10D1	16E1	1F1	2F2	3H3
JUNE	6-01-83 to 6-06-83	5-31-83 to 6-06-83	5-31-83 to 6-06-83	6-01-83 to 6-06-83	6-01-83 to 6-06-83	5-31-83 to 6-06-83	5-31-83 to 6-06-83	5-31-83 to 6-06-83
	6-06-83 to 6-13-83	6-06-83 to 6-13-83	6-06-83 to 6-13-83	6-06-83 to 6-14-83	6-06-83 to 6-14-83	6-06-83 to 6-13-83	6-06-83 to 6-13-83	6-06-83 to 6-13-83
	6-13-83 to 6-20-83	6-13-83 to 6-20-83	6-13-83 to 6-20-83	6-14-83 to 6-20-83	6-14-83 to 6-20-83	6-13-83 to 6-20-83	6-13-83 to 6-20-83	6-13-83 to 6-20-83
	6-20-83 to 6-28-83	6-20-83 to 6-28-83	6-20-83 to 6-28-83	6-20-83 to 6-29-83	6-20-83 to 6-29-83	6-20-83 to 6-28-83	6-20-83 to 6-28-83	6-20-83 to 6-28-83
JULY	6-28-83 to 7-05-83	6-28-83 to 7-05-83	6-28-83 to 7-05-83	6-29-83 to 7-05-83	6-29-83 to 7-05-83	6-28-83 to 7-05-83	6-28-83 to 7-05-83	6-28-83 to 7-05-83
	7-05-83 to 7-11-83	7-05-83 to 7-11-83	7-05-83 to 7-11-83	7-05-83 to 7-12-83	7-05-83 to 7-12-83	7-05-83 to 7-11-83	7-05-83 to 7-11-83	7-05-83 to 7-11-83
	7-11-83 to 7-18-83	7-11-83 to 7-18-83	7-11-83 to 7-18-83	7-12-83 to 7-18-83	7-12-83 to 7-18-83	7-11-83 to 7-18-83	7-11-83 to 7-18-83	7-11-83 to 7-18-83
	7-18-83 to 7-25-83	7-18-83 to 7-25-83	7-18-83 to 7-25-83	7-18-83 to 7-26-83	7-18-83 to 7-26-83	7-18-83 to 7-25-83	7-18-83 to 7-25-83	7-18-83 to 7-25-83
	7-25-83 to 8-01-83	7-25-83 to 8-01-83	7-25-83 to 8-01-83	7-26-83 to 8-02-83	7-26-83 to 8-02-83	7-25-83 to 8-01-83	7-25-83 to 8-01-83	7-25-83 to 8-01-83
AUGUST	8-01-83 to 8-08-83	8-01-83 to 8-08-83	8-01-83 to 8-08-83	8-02-83 to 8-09-83	8-02-83 to 8-09-83	8-01-83 to 8-08-83	8-01-83 to 8-09-83	8-01-83 to 8-08-83
	8-08-83 to 8-15-83	8-08-83 to 8-15-83	8-08-83 to 8-15-83	8-09-83 to 8-15-83	8-09-83 to 8-15-83	8-08-83 to 8-15-83	8-09-83 to 8-15-83	9-08-83 to 8-15-83

TABLE C-5 (cont'd)

1983 SAMPLING DATES FOR AIR SAMPLES

MONTH	STATION NO. 2S2	5S1	5D1	10D1	16E1	1F1	2F2	3H3
AUGUST	8-15-83 to 8-23-83	8-15-83 to 8-22-83	8-15-83 to 8-22-83	8-15-83 to 8-23-83	8-15-83 to 8-23-83	8-15-83 to 8-22-83	8-15-83 to 8-22-83	8-15-83 to 8-22-83
	8-23-83 to 8-29-83	8-22-83 to 8-29-83	8-22-83 to 8-29-83	8-23-83 to 8-30-83	8-23-83 to 8-30-83	8-22-83 to 8-29-83	8-22-83 to 8-29-83	8-22-83 to 8-29-83
SEPTEMBER	8-29-83 to 9-06-83	8-29-83 to 9-06-83	8-29-83 to 9-06-83	8-30-83 to 9-06-83	8-30-83 to 9-06-83	8-29-83 to 9-06-83	8-29-83 to 9-06-83	8-29-83 to 9-06-83
	9-06-83 to 9-12-83	9-06-83 to 9-12-83	9-06-83 to 9-13-83	9-06-83 to 9-13-83	9-06-83 to 9-13-83	9-06-83 to 9-12-83	9-06-83 to 9-12-83	9-06-83 to 9-12-83
	9-12-83 to 9-19-83	9-12-83 to 9-19-83	9-13-83 to 9-19-83	9-13-83 to 9-19-83	9-13-83 to 9-19-83	9-12-83 to 9-19-83	9-12-83 to 9-19-83	9-12-83 to 9-19-83
	9-19-83 to 9-26-83	9-19-83 to 9-26-83	9-19-83 to 9-26-83	9-19-83 to 9-27-83	9-19-83 to 9-27-83	9-19-83 to 9-26-83	9-19-83 to 9-26-83	9-19-83 to 9-26-83
OCTOBER	9-26-83 to 10-03-83	9-26-83 to 10-03-83	9-26-83 to 10-03-83	[illegible] 10-03-83	9-27-83 to 10-03-83	9-26-83 to 10-03-83	9-26-83 to 10-03-83	9-26-83 to 10-03-83
	10-03-83 to 10-11-83	10-03-83 to 10-11-83	10-03-83 to 10-11-83	10-03-83 to 10-12-83	10-03-83 to 10-12-83	10-04-83 to 10-11-83	10-03-83 to 10-11-83	10-03-83 to 10-11-83
	10-11-83 to 10-17-83	10-11-83 to 10-17-83	10-11-83 to 10-17-83	10-12-83 to 10-17-83	10-12-83 to 10-17-83	10-11-83 to 10-17-83	10-11-83 to 10-17-83	10-11-83 to 10-17-83
	10-17-83 to 10-24-83	10-17-83 to 10-24-83	10-17-83 to 10-24-83	10-17-83 to 10-25-83	10-17-83 to 10-25-83	10-17-83 to 10-24-83	10-17-83 to 10-24-83	10-17-83 to 10-24-83
	10-24-83 to 10-31-83	10-24-83 to 10-31-83	10-24-83 to 10-31-83	10-25-83 to 10-31-83	10-25-83 to 10-31-83	10-24-83 to 10-31-83	10-24-83 to 10-31-83	10-24-83 to 10-31-83

TABLE C-5 (cont'd)

1983 SAMPLING DATES FOR AIR SAMPLES

	STATION NO.							
MONTH	2S2	5S1	5D1	10D1	16E1	1F1	2F2	3H3
NOVEMBER	10-31-83 to 11-07-83	10-31-83 to 11-07-83	10-31-83 to 11-07-83	10-31-83 to 11-07-83	10-31-83 to 11-07-83	10-31-83 to 11-07-83	10-31-83 to 11-07-83	10-31-83 to 11-07-83
	11-07-83 to 11-14-83	11-07-83 to 11-14-83	11-07-83 to 11-14-83	11-07-83 to 11-15-83	11-07-83 to 11-15-83	11-07-83 to 11-14-83	11-07-83 to 11-14-83	11-07-83 to 11-14-83
	11-14-83 to 11-21-83	11-14-83 to 11-21-83	11-14-83 to 11-21-83	11-15-83 to 11-21-83	11-15-83 to 11-21-83	11-14-83 to 11-21-83	11-14-83 to 11-21-83	11-14-83 to 11-21-83
	11-21-83 to 11-28-83	11-21-83 to 11-28-83	11-21-83 to 11-28-83	11-21-83 to 11-29-83	11-21-83 to 11-29-83	11-21-83 to 11-28-83	11-21-83 to 11-28-83	11-21-83 to 11-28-83
DECEMBER	11-28-83 to 12-05-83	11-28-83 to 12-05-83	11-28-83 to 12-05-83	11-29-83 to 12-05-83	11-29-83 to 12-05-83	11-28-83 to 12-05-83	11-28-83 to 12-05-83	11-28-83 to 12-05-83
	12-05-83 to 12-12-83	12-05-83 to 12-12-83	12-05-83 to 12-12-83	12-05-83 to 12-13-83	12-05-83 to 12-13-83	12-05-83 to 12-12-83	12-05-83 to 12-12-83	12-05-83 to 12-12-83
	12-12-83 to 12-19-83	12-12-83 to 12-19-83	12-12-83 to 12-19-83	12-13-83 to 12-19-83	12-13-83 to 12-19-83	12-12-83 to 12-19-83	12-12-83 to 12-19-83	12-12-83 to 12-19-83
	12-19-83 to 12-27-83	12-19-83 to 12-27-83	12-19-83 to 12-27-83	12-19-83 to 12-27-83	12-19-83 to 12-27-83	12-19-83 to 12-27-83	12-19-83 to 12-27-83	12-19-83 to 12-27-83

TABLE C-6

1983 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

Results by Radiation Management Corporation

COLLECTION PERIOD	ALPHA	BETA	TRITIUM*
12-28-82 to 2-01-83	<1.1	4.5±2.2	190±80
2-01-83 to 3-02-83	<0.7	<3.0	<140
3-02-83 to 3-28-83	0.8±0.7	4.0±1.2	<130
3-28-83 to 4-25-83	<1.3	3.6±2.1	<130
4-25-83 to 6-01-83	<1.0	3.8±2.3	<120
6-01-83 to 6-29-83	<0.7	3.3±2.1	<130

Results by PSE&G Research Corporation

COLLECTION PERIOD	ALPHA	BETA	TRITIUM
6-29-83 to 8-01-83	4.6±1.6	19±2	<130
8-01-83 to 8-30-83	<1.2	6.1±0.9	<130
8-30-83 to 9-27-83	<1.9	2.4±0.7	<130
9-27-83 to 11-01-83	0.5±0.4	1.4±1.0	<130
11-01-83 to 11-29-83	0.6±0.5	3.9±1.2	<120
11-29-83 to 12-27-83	<0.4	<1.4	<140
AVERAGE	-	4.7±9.4	-

* January through June tritium results by PSE&G Research Corporation.

TABLE C-7

1983 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	RESULTS BY RADIATION MANAGEMENT CORPORATION 12-28-82 to 3-28-83	RESULTS BY RADIATION MANAGEMENT CORPORATION 3-28-83 to 6-29-83	RESULTS BY PSE&G RESEARCH CORPORATION 6-29-83 to 9-27-83	RESULTS BY PSE&G RESEARCH CORPORATION 9-27-83 to 12-27-83	AVERAGE
Sr-89	<0.3	<3.0(1)	(2)	(4)	-
Sr-90	<0.3	<0.2(1)	(2)	(4)	-
Be-7	28±6	15±5	63±28(3)	47±25(5)	38±42

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

** All other gamma emitters searched for were <LLD; typical LLDs are given in Tables C-32 (RMC) and C-33 (PSE&G).

(1) Second quarter Sr-89 and -90 analysis performed by Teledyne Isotopes.

(2) Insufficient rainfall collected to perform this analysis.

(3) Results for gamma taken from one sample collected 8/1-30/83 due to insufficient rainfall over the entire 3rd quarter of 1983.

(4) Sample lost during analysis.

(5) This is a mathematical composite of 3 monthly rainfall gamma results for the months of October, November and December, 1983.

TABLE C-8

1983 DIRECT RADIATION MEASUREMENTS - QUARTERLY TLD RESULTS

Results in mrad/standard month*

	RESULTS BY RADIATION MANAGEMENT CORPORATION		RESULTS BY TELEDYNE ISOTOPES		
STATION NO.	JANUARY to MARCH	APRIL to JUNE	JULY to SEPTEMBER	OCTOBER to DECEMBER	AVERAGE
SA-IDM-2S2	4.9±0.4	5.4±0.1	6.0±0.5	5.5±0.2	5.4±0.9
SA-IDM-5S1	4.4±0.5	3.9±0.5	4.2±0.9	4.1±0.1	4.2±0.4
SA-IDM-6S2	5.3±0.4	4.5±0.2	5.4±0.6	4.9±0.3	5.0±0.8
SA-IDM-7S1	6.0±0.4	5.7±0.7	6.5±0.5	5.7±0.1	6.0±0.8
SA-IDM-10S1	6.7±0.5	5.5±0.8	6.1±0.7	5.3±0.1	5.9±1.3
SA-IDM-11S1	8.1±2.0	4.9±0.6	5.4±0.5	4.1±0.1	5.6±3.5
SA-IDM-4D2	5.2±0.6	4.8±0.3	5.2±0.7	5.6±0.2	5.2±0.6
SA-IDM-5D1	4.8±0.6	4.2±0.1	5.1±0.5	4.7±0.2	4.7±0.7
SA-IDM-10D1	5.5±0.4	4.8±0.4	5.6±0.2	5.2±0.4	5.3±0.7
SA-IDM-14D1	5.4±0.9	5.2±0.9	5.9±0.7	5.3±0.2	5.4±0.6
SA-IDM-2E1	5.2±0.5	5.2±0.1	5.4±0.7	5.0±0.1	5.2±0.3
SA-IDM-3E1	4.8±0.3	4.8±0.5	5.6±0.3	4.7±0.0	5.0±0.8
SA-IDM-9E1	6.2±0.9	6.2±0.4	6.6±0.8	6.5±0.3	6.4±0.4
SA-IDM-11E2	6.3±0.4	6.0±1.0	6.3±0.5	6.0±0.2	6.2±0.3
SA-IDM-12E1	5.9±0.3	5.6±0.6	5.9±0.8	6.0±0.2	5.8±0.3
SA-IDM-13E1	5.1±0.6	5.0±0.4	5.2±0.7	5.2±0.3	5.1±0.2
SA-IDM-16E1	5.5±0.3	5.6±0.7	6.1±0.3	5.1±0.3	5.6±0.8
SA-IDM-1F1	5.4±0.5	5.2±0.7	5.5±0.7	5.0±0.4	5.3±0.4
SA-IDM-2F2	4.3±0.3	4.0±0.4	4.3±0.5	3.9±0.2	4.1±0.4
SA-IDM-2F5	5.6±0.4	5.5±0.7	5.7±0.7	5.6±0.2	5.6±0.2
SA-IDM-2F6	5.2±0.8	5.0±0.2	5.6±0.3	4.8±0.7	5.2±0.7
SA-IDM-3F2	4.7±0.8	4.8±0.6	4.7±0.6	4.9±0.2	4.8±0.2
SA-IDM-3F3	4.5±0.6	4.5±0.1	5.1±0.5	4.9±0.4	4.8±0.4
SA-IDM-5F1	4.4±0.2	4.7±0.5	5.0±0.9	4.7±0.2	4.7±0.5
SA-IDM-6F1	4.4±0.2	4.3±0.4	4.4±0.5	3.9±0.2	4.2±0.5
SA-IDM-7F2	4.9±0.9	3.9±0.1	4.1±0.5	3.5±0.0	4.1±1.2
SA-IDM-10F2	5.5±0.5	5.2±0.5	6.0±0.9	5.6±0.2	5.6±0.7
SA-IDM-11F1	6.0±0.8	5.6±0.5	5.9±0.5	5.5±0.1	5.8±0.5
SA-IDM-12F1	5.3±0.5	4.7±0.4	5.9±0.7	5.6±0.2	5.4±1.0
SA-IDM-13F1	5.2±0.4	5.1±0.9	5.4±0.3	4.9±0.1	5.2±0.4
SA-IDM-13F2	5.5±0.4	5.0±0.6	5.4±0.9	5.4±0.2	5.3±0.4
SA-IDM-13F3	5.5±0.6	5.6±0.9	6.1±0.5	5.5±0.3	5.7±0.6
SA-IDM-14F2	5.2±0.8	5.0±0.2	5.9±0.9	5.4±0.2	5.4±0.8
SA-IDM-15F3	6.0±0.5	5.5±0.8	6.9±0.7	6.2±0.2	6.2±1.2
SA-IDM-16F2	5.5±0.4	4.7±0.4	5.9±0.5	5.2±0.0	5.3±1.0
SA-IDM-1G3 (C)	6.8±0.7	5.9±0.5	6.6±0.9	6.3±0.1	6.4±0.8
SA-IDM-3G1 (C)	5.6±0.2	5.7±0.7	6.0±0.9	5.7±0.2	5.7±0.3
SA-IDM-10G1 (C)	5.7±0.9	5.7±0.8	6.4±0.3	6.1±0.5	6.0±0.7
SA-IDM-16G1 (C)	6.0±0.4	5.6±1.0	7.1±0.8	6.3±0.2	6.2±1.3
SA-IDM-2H1 (C)	6.0±0.6	6.2±0.3	(1)	(1)	6.1±0.3
SA-IDM-3H1 (C)	6.0±0.4	5.8±0.7	5.8±0.6	5.5±0.1	5.8±0.4
SA-IDM-3H3 (C)	5.8±0.4	5.6±0.4	5.9±0.7	5.3±0.2	5.6±0.5
AVERAGE	5.5±1.5	5.1±1.2	5.7±1.4	5.2±1.4	5.4±1.4

* The standard month = 30.4 days.

(C) Control station

(1) Station SA-IDM-2H1 was terminated on 6-28-83.

TABLE C-9

1983 DIRECT RADIATION MEASUREMENTS - MONTHLY TLD RESULTS

Results in mrad/standard month*

Results by Radiation Management Corporation

STATION NO.	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE
SA-IDM-2S2	4.5±0.3	5.1±0.4	6.2±0.3	6.4±0.2	6.2±0.3	4.8±0.2
SA-IDM-5S1	4.4±0.4	4.7±0.4	4.7±0.7	5.0±0.2	5.0±0.2	4.9±2.0
SA-IDM-6S2	5.3±0.2	5.6±0.2	5.9±0.7	6.3±0.5	4.8±0.3	5.3±0.9
SA-IDM-7S1	6.6±0.6	6.8±0.2	7.0±0.2	6.3±0.5	6.6±0.7	5.5±0.8
SA-IDM-10S1	8.0±0.7	6.3±1.3	7.0±0.7	5.9±0.9	6.6±0.6	5.6±1.0
SA-IDM-11S1	12.1±0.8	8.6±1.2	5.6±0.4	5.3±0.4	5.6±0.9	5.4±0.5
SA-IDM-5D1	4.9±0.3	5.1±0.2	5.6±2.0	5.6±0.9	5.2±0.4	4.1±0.5
SA-IDM-10D1	5.7±0.4	5.9±1.1	6.3±1.3	6.2±0.2	6.3±0.5	5.8±0.6
SA-IDM-14D1	5.4±0.4	6.2±0.5	6.1±0.7	6.1±0.6	6.2±0.3	5.3±1.0
SA-IDM-2E1	5.4±0.7	5.6±0.4	5.6±1.0	5.8±0.3	5.7±0.9	5.0±0.7
SA-IDM-3E1	5.6±0.5	5.2±0.4	5.5±1.0	5.7±0.4	5.4±0.5	5.2±0.4
SA-IDM-13E1	5.1±0.7	6.0±0.6	6.2±0.4	5.8±0.3	5.4±0.7	5.2±0.2
SA-IDM-16E1	5.8±0.4	6.0±0.3	6.0±0.7	6.0±0.5	5.9±0.6	5.0±0.7
SA-IDM-1F1	5.8±0.3	5.6±0.2	6.2±0.5	6.0±0.8	6.0±1.0	4.8±0.4
SA-IDM-2F2	4.2±0.4	4.4±0.4	4.9±0.4	5.0±0.2	4.9±0.8	4.4±0.9
SA-IDM-2F6	5.7±0.5	5.4±0.6	6.8±0.1	6.2±0.8	6.2±0.4	4.6±0.3
SA-IDM-5F1	4.9±0.6	5.1±0.2	5.6±0.6	5.3±0.4	5.2±0.4	4.6±0.6
SA-IDM-6F1	4.6±0.4	4.8±0.2	5.0±0.3	4.6±0.6	5.1±0.4	4.1±0.9
SA-IDM-7F2	3.9±0.5	4.3±0.6	4.6±0.4	4.3±0.6	4.2±0.2	3.7±0.6
SA-IDM-11F1	6.2±1.1	6.2±0.6	6.5±0.7	6.3±1.0	6.4±0.6	5.1±0.8
SA-IDM-13F1	5.5±1.2	5.5±0.6	6.2±0.2	5.4±0.6	5.8±0.5	5.5±0.4
SA-IDM-3G1 (C)	6.0±0.9	5.6±0.3	7.0±0.8	6.6±1.3	6.1±0.6	5.7±0.6
SA-IDM-2H1 (C)**	5.9±1.0	5.8±0.4	7.0±0.3	6.4±0.3	5.7±0.8	5.6±1.0
SA-IDM-3H1 (C)	7.0±1.0	6.1±0.6	6.7±0.2	6.0±0.9	5.9±0.5	5.1±1.3
SA-IDM-3H3 (C)	6.5±0.4	6.4±0.2	6.9±0.7	6.5±1.4	6.5±1.1	5.7±1.0
AVERAGE	5.8±3.2	5.7±1.7	6.0±1.5	5.8±1.2	5.7±1.2	5.0±1.1

TABLE C-9 (cont'd)

1983 DIRECT RADIATION MEASUREMENTS - MONTHLY TLD RESULTS

Results in mrad/standard month*

STATION NO.	Results by Teledyne Isotopes JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	AVERAGE
SA-IDM-2S2	7.2±0.2	8.8±0.9	7.1±0.9	7.4±0.2	6.1±0.2	7.3±0.2	6.4±2.5
SA-IDM-5S1	5.6±0.2	7.6±1.7	5.3±0.7	6.3±2.0	8.3±5.5	5.9±0.1	5.6±2.4
SA-IDM-6S2	6.6±0.4	8.0±0.9	5.9±0.9	6.5±0.2	6.2±0.4	6.3±0.1	6.0±1.6
SA-IDM-7S1	7.2±0.2	8.9±0.9	6.2±0.4	7.0±0.3	6.4±0.2	7.4±0.4	6.8±1.6
SA-IDM-10S1	7.3±0.4	8.7±0.7	6.6±0.2	6.9±0.0	6.3±0.2	7.1±0.3	6.8±1.7
SA-IDM-11S1	7.2±0.4	8.5±0.4	5.6±0.4	5.5±0.3	5.5±0.2	5.9±0.1	6.7±4.1
SA-IDM-5D1	6.0±0.2	8.1±0.7	5.6±0.4	6.2±0.2	5.8±0.2	6.2±0.2	5.7±1.9
SA-IDM-10D1	7.3±0.2	8.6±1.1	6.4±0.4	7.0±0.3	6.4±0.4	6.9±0.2	6.6±1.6
SA-IDM-14D1	7.3±0.4	9.8±1.3	5.9±0.4	7.1±0.2	5.8±0.2	6.9±0.2	6.4±1.9
SA-IDM-2E1	6.8±0.2	9.1±2.0	6.1±0.2	6.7±0.0	5.9±0.2	6.8±0.3	6.2±2.1
SA-IDM-3E1	6.4±0.4	8.1±0.9	5.8±0.4	7.1±2.0	6.0±0.4	6.3±0.1	6.0±1.7
SA-IDM-13E1	6.7±0.4	8.0±0.9	5.5±0.4	6.3±0.2	6.0±0.4	6.4±0.1	6.0±1.6
SA-IDM-16E1	6.9±0.2	8.8±1.3	5.5±0.4	7.8±1.9	6.6±0.4	6.9±0.2	6.4±2.1
SA-IDM-1F1	6.7±0.2	8.7±1.1	6.3±0.4	6.8±0.2	6.2±0.2	6.8±0.3	6.3±1.9
SA-IDM-2F2	5.6±0.2	7.0±0.9	5.2±0.2	7.0±0.2	4.0±0.2	5.7±0.3	5.2±2.0
SA-IDM-2F6	6.6±1.4	8.3±0.7	6.2±0.4	5.5±0.2	6.1±0.2	6.8±0.2	6.2±1.8
SA-IDM-5F1	6.4±0.4	8.4±0.4	5.8±0.4	6.3±0.2	6.7±1.5	6.4±0.3	5.9±2.1
SA-IDM-6F1	5.8±0.2	7.9±0.9	4.9±0.4	5.7±0.2	5.7±1.3	5.6±0.2	5.3±1.9
SA-IDM-7F2	5.4±0.4	7.1±0.4	3.9±0.7	4.9±0.2	4.9±0.2	5.2±0.1	4.7±1.8
SA-IDM-11F1	7.7±0.7	9.6±0.9	6.6±0.2	7.0±0.2	6.6±0.2	7.4±0.8	6.8±2.2
SA-IDM-13F1	6.9±0.2	8.6±1.3	5.5±0.4	7.3±1.9	6.6±0.6	6.9±0.2	6.3±1.9
SA-IDM-3G1 (C)	7.2±0.5	8.6±1.1	6.7±0.4	7.1±0.3	6.7±0.4	7.3±0.3	6.7±1.6
SA-IDM-3H1 (C)	7.3±0.7	8.8±0.4	6.7±0.2	7.1±0.2	6.8±0.2	6.9±0.1	6.7±1.8
SA-IDM-3H3 (C)	6.8±1.3	9.5±0.7	6.6±0.4	7.1±0.2	6.7±0.4	7.6±0.2	6.9±1.9
AVERAGE	6.7±1.3	8.4±1.3	5.9±1.4	6.6±1.4	6.2±1.6	6.6±1.3	6.2±2.3

* The standard month = 30.4 days.

** Station SA-IDM-2H1 was terminated on 6-28-83.

(C) Control station

TABLE C-10

1983 CONCENTRATIONS OF IODINE-131 IN MILK

Results in Units of pCi/L

Results* by Radiation Management Corporation

STATION NO.***	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE
SA-MLK-13E3	<0.2 <0.08	<0.1 <0.1	<0.08 <0.07	<0.09 <0.1	<0.1 <0.09	<0.07 <0.1
SA-MLK-2F4	<0.5 <0.09	<0.2 <0.08	<0.08 <0.07	<0.08 <0.09	<0.1 <0.09	<0.09 <0.1
SA-MLK-5F2	<0.2 (2)	<0.2 <0.1	<0.1 <0.1	<0.07 <0.08	<0.2 <0.09	<0.09 <0.1
SA-MLK-14F1	<0.2 <0.1	<0.2 <0.1	<0.1 <0.09	<0.09 <0.09	<0.1 <0.09	<0.1 <0.1
SA-MLK-15F1	<0.2 <0.1	<0.2 <0.1	<0.1 <0.1	<0.1 <0.1	<0.1 <0.1	<0.09 <0.1
SA-MLK-3G1 (Control)	<0.3 <0.1	<0.2 <0.2	<0.1 <0.09	<0.1 <0.2	<0.1 <0.1	<0.1 <0.1(1)

Results** by PSE&G Research Corporation

STATION NO.***	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
SA-MLK-13E3	<0.1 <0.1	<0.1 <0.07	<0.06 <0.09	<0.1 <0.1	<0.06 <0.09	<0.09 <0.1
SA-MLK-2F4	<0.1 <0.1	<0.2 <0.06	<0.06 <0.09	<0.1 <0.1	<0.06 <0.09	<0.09 <0.1
SA-MLK-5F2	<0.2 <0.2	<0.1 <0.06	<0.06 <0.1	<0.1 <0.1	<0.07 <0.10	<0.09 <0.1
SA-MLK-14F1	<0.2 <0.1	<0.1 <0.06	<0.06 <0.1	<0.1 <0.1	<0.07 <0.09	<0.09 <0.1
SA-MLK-15F1	<0.2 <0.1	<0.1 <0.07	<0.07 <0.1	<0.1 <0.1	<0.09 <0.09	<0.09 <0.1
SA-MLK-3G1 (Control)	<0.2(1) <0.1(1)	<0.2(1) <0.06(1)	<0.07 <0.08	<0.1 <0.1	<0.06 <0.1	<0.1 <0.1

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

** I-131 results are corrected for decay to midpoint of collection period.

*** Sampling dates can be found in Table C-13.

(1) Station SA-MLK-3G2 supplied the milk sample while station SA-MLK-3G1 replaced its entire herd.

(2) Analysis spectrum and results lost due to computer malfunction.

TABLE C-11

1983 CONCENTRATIONS OF STRONTIUM-89* and -90 IN MILK

Results in Units of pCi/L ± 2 sigma

(All Results by PSE&G Research Corporation)

STATION NO.**	NUCLIDE	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE
SA-MLK-13E3	Sr-89	<1.6	<2.0	<1.9	<1.8	<1.6	<1.5
	Sr-90	2.6±0.6	3.0±0.7	3.2±0.8	2.4±0.7	2.3±0.6	2.3±0.5
SA-MLK-2F4	Sr-89	<1.4	<1.8	<2.0	<1.4	<1.6	<1.2
	Sr-90	2.0±0.5	1.8±0.6	2.2±0.8	1.9±0.5	2.0±0.6	1.3±0.4
SA-MLK-5F2	Sr-89	<1.7	<2.1	<2.2	<1.9	<1.9	<1.9
	Sr-90	3.3±0.6	2.9±0.7	2.7±0.8	3.7±0.8	4.9±0.8	5.8±0.7
SA-MLK-14F1	Sr-89	<1.6	<1.8	<1.9	<1.5	<1.7	<1.5
	Sr-90	2.6±0.6	2.7±0.7	2.1±0.7	2.4±0.6	2.6±0.7	3.1±0.6
SA-MLK-15F1	Sr-89	<1.6	<2.3	<2.1	<1.6	<1.9	<1.5
	Sr-90	2.8±0.6	2.4±0.8	3.0±0.8	2.0±0.6	2.4±0.7	2.7±0.6
SA-MLK-3G1	Sr-89	<1.8	<2.4	<2.2	<1.8	<1.7	<1.7
(Control)	Sr-90	3.3±0.7	3.2±0.8	2.2±0.8	2.8±0.7	3.2±0.7	3.8±0.6

STATION NO.**	NUCLIDE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	AVERAGE
SA-MLK-13E3	Sr-89	<1.7	<2.1	<2.0	<1.3	<1.3	<1.1	-
	Sr-90	3.1±0.7	3.0±0.8	3.0±0.8	2.5±0.5	2.3±0.5	2.1±0.4	2.6±0.8
SA-MLK-2F4	Sr-89	<3.1	<1.6	<1.0	<1.2	<1.1	<1.0	-
	Sr-90	1.9±0.8	1.5±0.6	0.8±0.3	1.7±0.5	1.8±0.4	1.6±0.4	1.7±0.8
SA-MLK-5F2	Sr-89	<2.2	<2.0	<2.1	<1.5	<1.5	<1.3	-
	Sr-90	5.9±0.8	4.3±0.8	5.0±0.8	4.6±0.6	4.0±0.5	4.0±0.5	4.2±2.1
SA-MLK-14F1	Sr-89	<1.6	<1.8	<1.6	<1.5	<1.4	<1.1	-
	Sr-90	2.0±0.6	2.2±0.7	1.7±0.7	2.4±0.6	2.7±0.5	2.8±0.4	2.4±0.8
SA-MLK-15F1	Sr-89	<1.8	<1.8	<1.8	<1.3	<1.4	<1.4	-
	Sr-90	1.8±0.6	2.2±0.7	2.3±0.7	1.6±0.5	2.8±0.5	2.1±0.6	2.3±0.8
SA-MLK-3G1	Sr-89	<1.9(1)	<2.0(1)	<1.9	<1.4	<1.3	<1.2	-
(Control)	Sr-90	3.4±0.7	4.2±0.8	3.0±0.8	3.6±0.6	3.3±0.5	3.7±0.5	3.3±1.0
						Grand Average	Sr-89	-
							Sr-90	2.8±2.0

* 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.

(1) Station SA-MLK-3G2 supplied the milk sample while station SA-MLK-3G1 replaced its entire herd.

TABLE C-12

1983 CONCENTRATIONS OF GAMMA EMITTERS* IN MILK

Results in Units of pCi/L ± 2 sigma

Results by Radiation Management Corporation

STATION NO.**	NUCLIDE	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE
SA-MLK-13E3	K-40	1200±120	1400±140	1300±130	1400±140	1200±120	1500±150
	Co-60	<5.3	<1.6	<1.3	<2.0	<1.4	<1.7
	Cs-137	<5.5	2.8±1.0	1.2±0.7	1.8±0.9	4.7±0.9	1.4±0.8
	Ce-141	<9.8	<7.7	<3.8	<3.7	<2.9	<1.4
	Th-232	(1)	<4.4	<3.1	<5.0	<3.1	<3.6
SA-MLK-2F4	K-40	1100±110	1200±120	1500±150	1500±150	1600±160	1500±150
	Co-60	<6.2	<2.0	<1.9	<1.5	<1.8	<1.7
	Cs-137	<7.2	<1.6	<1.4	<1.0	<1.5	<1.3
	Ce-141	<13	<8.0	<3.7	<3.6	<1.9	<1.5
	Th-232	(1)	<5.1	<3.9	<3.1	<3.6	<3.6
SA-MLK-5F2	K-40	1300±130	1300±130	1300±130	1300±130	1500±150	1500±150
	Co-60	<6.2	<1.5	<1.7	<1.8	<1.6	<1.5
	Cs-137	<6.7	1.1±0.7	1.3±0.7	1.2±0.8	1.6±1.0	4.0±1.0
	Ce-141	<12	<6.1	<2.6	<2.3	<3.7	<2.9
	Th-232	(1)	<3.0	<3.6	<3.6	<4.2	<4.3
SA-MLK-14F1	K-40	1200±120	1200±120	1200±120	1400±140	1500±150	1500±150
	Co-60	<5.4	<1.6	<1.5	<1.8	<1.9	<1.5
	Cs-137	<6.0	<1.1	<1.3	1.3±0.8	<1.7	1.3±0.8
	Ce-141	<12	<5.4	<4.7	<2.2	<3.8	<2.5
	Th-232	(1)	<3.6	<4.1	<3.7	<5.1	<3.2
SA-MLK-15F1	K-40	1200±120	1400±140	1200±120	1600±160	1300±130	1400±140
	Co-60	<4.8	<1.7	<2.1	<1.7	<1.4	<2.0
	Cs-137	<6.1	<1.2	<1.6	1.7±0.9	1.3±0.7	<1.6
	Ce-141	<6.6	<3.9	<5.3	<4.6	<3.1	<2.3
	Th-232	(1)	<3.6	<5.0	<4.4	<3.1	<3.9
SA-MLK-3G1 (Control)	K-40	1000±100	1400±140	1400±140	1400±140	1200±120	1300±130
	Co-60	<6.3	<1.7	<1.4	<1.5	<1.6	<1.7
	Cs-137	<7.0	<1.4	1.7±0.8	<1.4	<1.0	1.2±0.7
	Ce-141	<13	<7.7	<3.9	<4.3	<1.8	<1.5
	Th-232	(1)	<4.3	<3.0	<4.0	<3.5	<3.5

TABLE C-12 (cont'd)

1983 CONCENTRATIONS OF GAMMA EMITTERS* IN MILK

Results in Units of pCi/L ± 2 sigma

Results by PSE&G Research Corporation

STATION NO.**	NUCLIDE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	AVERAGE
SA-MLK-13E3	K-40	1300±57	1300±68	1300±68	1400±69	1500±71	1400±69	1400±200
	Co-60	<3.7	<2.6	<3.0	<4.0	<3.4	<2.7	-
	Cs-137	<3.6	<2.7	<2.3	<3.5	<2.2	<3.4	-
	Ce-141	<8.1	<2.7	<2.8	<2.3	<2.0	<3.1	-
	Th-232	<11	<9.3	<7.4	<6.9	<11	<7.4	-
SA-MLK-2F4	K-40	1400±55	1300±59	1400±55	1400±59	1400±60	1400±60	1400±280
	Co-60	<3.8	<3.4	<2.9	<3.2	<3.0	<3.5	-
	Cs-137	<2.6	<2.3	<1.8	<2.2	<2.2	<2.6	-
	Ce-141	<4.8	<3.1	<2.3	<3.2	<3.1	<2.4	-
	Th-232	<10	<8.0	<7.2	<10	<8.2	<9.0	-
SA-MLK-5F2	K-40	1400±55	1300±67	1300±56	1300±54	1400±60	1300±53	1400±160
	Co-60	<4.1	<3.4	<2.5	<2.5	<3.2	<3.4	-
	Cs-137	4.4±1.8	2.6±1.4	<3.1	<2.2	2.2±1.1	<3.0	2.8±3.3
	Ce-141	<5.4	<2.8	<2.5	<2.2	<3.5	<3.0	-
	Th-232	<13	<9.8	<8.7	8.1±4.7	<8.0	<9.6	-
SA-MLK-14F1	K-40	1400±59	1300±60	1300±57	1400±67	1400±60	1400±61	1400±220
	Co-60	<3.0	<3.0	<5.2	<3.6	<3.2	<3.2	-
	Cs-137	<2.3	<1.9	<3.4	<2.4	1.9±1.1	<2.4	-
	Ce-141	<3.5	<3.4	<4.5	<2.9	2.4±1.5	<3.1	-
	Th-232	<8.4	<7.8	<15	<8.9	<8.4	<8.9	-
SA-MLK-15F1	K-40	1300±54	1400±60	1400±54	1400±54	1200±52	1400±67	1400±230
	Co-60	<4.9	<3.1	<3.2	5.5±2.3	<4.2	<3.6	-
	Cs-137	2.6±1.7	<2.4	<2.6	<3.7	<2.6	<2.6	-
	Ce-141	<7.3	<3.2	<2.9	<3.0	<4.0	<2.8	-
	Th-232	<8.6	<8.0	<9.5	<11	<8.5	<9.3	-
SA-MLK-3G1 (Control)	K-40	1200±65(2)	1200±53(2)	1300±68	1400±61	1400±68	1400±66	1300±260
	Co-60	<5.1	<3.1	<5.1	<3.0	<3.5	<3.7	-
	Cs-137	<4.3	<2.0	<3.2	<2.4	<2.6	<2.4	-
	Ce-141	<5.1	<3.3	<2.7	<3.1	<2.9	<2.8	-
	Th-232	<15	<8.1	<11	<8.4	<9.3	<9.3	-
						Grand Average	K-40	1300±220
							Co-60	-
							Cs-137	-
							Ce-141	-
							Th-232	-

* All other gamma emitters searched for were <LLD; typical LLDs are given in Tables C-32 (RMC) and C-33 (PSE&G).

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

(1) Not analyzed for Th-232.

(2) Station SA-MLK-3G2 supplied the milk sample while station SA-MLK-3G1 replaced its entire herd.

TABLE C-13

1983 SAMPLING DATES FOR MILK SAMPLES

	STATION NO.					
MONTH	13E3	2F4	5F2	14F1	15F1	3G1
JANUARY	1-02-83 to 1-03-83	1-03-83 to 1-04-83	1-03-83 to 1-03-83	1-02-83 to 1-03-83	1-03-83 to 1-04-83	1-02-83 to 1-03-83
	1-16-83 to 1-17-83	1-17-83 to 1-18-83	1-17-83 to 1-17-83	1-16-83 to 1-17-83	1-17-83 to 1-18-83	1-16-83 to 1-17-83
FEBRUARY	2-07-83 to 2-08-83	2-06-83 to 2-07-83	2-06-83 to 2-07-83	2-06-83 to 2-07-83	2-06-83 to 2-07-83	2-07-83 to 2-08-83
	2-21-83 to 2-22-83	2-22-83 to 2-23-83	2-22-83 to 2-22-83	2-22-83 to 2-23-83	2-22-83 to 2-23-83	2-21-83 to 2-22-83
MARCH	3-07-83 to 3-08-83	3-06-83 to 3-07-83	3-06-83 to 3-07-83	3-06-83 to 3-07-83	3-06-83 to 3-07-83	3-07-83 to 3-08-83
	3-21-83 to 3-22-83	3-20-83 to 3-21-83	3-20-83 to 3-21-83	3-20-83 to 3-21-83	3-20-83 to 3-21-83	3-21-83 to 3-22-83
APRIL	4-04-83 to 4-05-83	4-03-83 to 4-04-83	4-03-83 to 4-04-83	4-03-83 to 4-04-83	4-03-83 to 4-04-83	4-04-83 to 4-05-83
	4-18-83 to 4-19-83	4-17-83 to 4-18-83	4-17-83 to 4-18-83	4-17-83 to 4-18-83	4-17-83 to 4-18-83	4-18-83 to 4-19-83
MAY	5-02-83 to 5-03-83	5-01-83 to 5-02-83	5-01-83 to 5-02-83	5-01-83 to 5-02-83	5-01-83 to 5-02-83	5-02-83 to 5-03-83
	5-16-83 to 5-17-83	5-15-83 to 5-16-83	5-15-83 to 5-16-83	5-15-83 to 5-16-83	5-15-83 to 5-16-83	5-16-83 to 5-17-83
JUNE	6-05-83 to 6-07-83	6-06-83 to 6-07-83	6-06-83 to 6-07-83	6-06-83 to 6-06-83	6-06-83 to 6-06-83	6-05-83 to 6-06-83
	6-19-83 to 6-20-83	6-20-83 to 6-21-83	6-20-83 to 6-21-83	6-20-83 to 6-21-83	6-20-83 to 6-20-83	6-20-83(1) to 6-21-83

TABLE C-13 (cont'd)

1983 SAMPLING DATES FOR MILK SAMPLES

MONTH	STATION NO. 13E3	2F4	5F2	14F1	15F1	3G1
JULY	7-05-83 to 7-06-83	7-04-83 to 7-05-83	7-04-83 to 7-05-83	7-06-83 to 7-06-83	7-04-83 to 7-05-83	7-04-83(1) to 7-05-83
	7-17-83 to 7-18-83	7-18-83 to 7-19-83	7-18-83 to 7-19-83	7-18-83 to 7-19-83	7-18-83 to 7-19-83	7-18-83(1) to 7-19-83
AUGUST	7-31-83 to 8-01-83	8-01-83 to 8-02-83	8-01-83 to 8-02-83	8-01-83 to 8-01-83	8-01-83 to 8-02-83	8-01-83(1) to 8-02-83
	8-14-83 to 8-15-83	8-15-83 to 8-16-83	8-15-83 to 8-16-83	8-15-83 to 8-15-83	8-15-83 to 8-16-83	8-15-83(1) to 8-16-83
SEPTEMBER	9-05-83 to 9-07-83	9-06-83 to 9-07-83	9-06-83 to 9-07-83	9-06-83 to 9-06-83	9-06-83 to 9-06-83	9-05-83 to 9-06-83
	9-19-83 to 9-20-83	9-18-83 to 9-19-83	9-18-83 to 9-19-83	9-18-83 to 9-19-83	9-18-83 to 9-19-83	9-19-83 to 9-20-83
OCTOBER	10-03-83 to 10-04-83	10-02-83 to 10-03-83	10-02-83 to 10-03-83	10-02-83 to 10-03-83	10-02-83 to 10-03-83	10-03-83 to 10-04-83
	10-17-83 to 10-18-83	10-16-83 to 10-17-83	10-16-83 to 10-17-83	10-16-83 to 10-17-83	10-16-83 to 10-17-83	10-17-83 to 10-18-83
NOVEMBER	11-06-83 to 11-07-83	11-05-83 to 11-07-83	11-05-83 to 11-06-83	11-05-83 to 11-06-83	11-05-83 to 11-06-83	11-06-83 to 11-07-83
	11-20-83 to 11-22-83	11-21-83 to 11-22-83	11-21-83 to 11-21-83	11-21-83 to 11-22-83	11-21-83 to 11-22-83	11-20-83 to 11-21-83
DECEMBER	12-05-83 to 12-06-83	12-05-83 to 12-06-83	12-05-83 to 12-06-83	12-05-83 to 12-06-83	12-05-83 to 12-06-83	12-04-83 to 12-05-83
	12-18-83 to 12-19-83	12-18-83 to 12-19-83	12-17-83 to 12-18-83	12-17-83 to 12-18-83	12-17-83 to 12-18-83	12-18-83 to 12-19-83

(1) Station SA-MLK-3G2 supplied the milk sample while station SA-MLK-3G1 replaced its entire herd.

TABLE C-14

1983 CONCENTRATIONS OF GROSS ALPHA & GROSS BETA EMITTERS, POTASSIUM-40 AND TRITIUM IN WELL WATER

Results in Units of pCi/L ± 2 sigma

STATION NO. RADIOACTIVITY	Results* by Radiation Management Corporation 1-10-83	2-14-83	3-14-83	4-11-83	5-09-83	6-13-83
SA-WWA-4S1						
Alpha	<2.4	<1.5	<3.4	<1.9	1.5±1.4	<2.6
Beta	13±3	12±2	14±3	13±4(1)	13±3	14±2
K-40	13±1	14±1	14±1	13±1	10±1	13±1
H-3	<140	<140	<140	<120	<130	<130
SA-WWA-5D1						
Alpha	<1.9	1.2±1.2	<2.5	<1.6	1.3±1.1	2.1±1.7
Beta	16±3	12±2	14±3	16±3	13±3	13±2
K-40	14±1	13±1	14±1	13±1	9.9±1.0	13±1
H-3	<140	<140	<130	<130	<120	<130
SA-WWA-3E1 (Control)						
Alpha	<2.1	<1.2	<2.6	<1.4	<0.9	<2.6
Beta	14±3	9.5±1.6	10±3	9.8±2.2	7.6±2.3	12±2
K-40	9.4±0.9	8.8±0.9	9.5±1.0	7.2±0.7	7.2±0.7	9.4±0.9
H-3	<140	<140	<130	<120	<120	<130

TABLE C-14 (cont'd)

1983 CONCENTRATIONS OF GROSS ALPHA & GROSS BETA EMITTERS,
POTASSIUM-40 AND TRITIUM IN WELL WATER

Results in Units of pCi/L ± 2 sigma

STATION NO. RADIOACTIVITY	Results by PSE&G Research Corporation 7-11-83	8-08-83	9-12-83	10-11-83	11-14-83	12-05-83	AVERAGE
<u>SA-WWA-4S1</u> (July-Sept.) <u>SA-WWA-2S3</u>** (Oct.-Dec.)							
Alpha	0.4±0.2	<1.1	<1.6	<2.6(2)	1.6±1.2	<1.6	-
Beta	14±1	13±1	11±1	15±2	15±2	8.6±1.1	13±4
K-40	20±2	20±2	17±2	27±3	18±2	9.0±0.9	16±10
H-3	<130	<130	<130	<130	<130	<130	-
<u>SA-WWA-5D1</u>							
Alpha	0.4±0.3	<1.3	<1.4	<2.4	<1.8	<1.4	-
Beta	15±1	14±1	13±1	10±1	12±1	7.9±1.1	13±5
K-40	19±2	18±2	19±2	20±2	14±1	11±1	15±7
H-3	<120	<130	<140	<130	<130	<130	-
<u>SA-WWA-3E1</u> (Control)							
Alpha	<0.2	<1.5	<1.7	<2.4	<1.5	<1.4	-
Beta	9.8±1.1	8.8±1.1	9.9±1.1	8.4±1.1	9.3±1.1	12±1	10±4
K-40	14±2	14±1	14±1	16±2	9.2±0.9	8.9±0.9	11±6
H-3	<120	<130	<130	430±80	<140	<130	-

* Tritium results by PSE&G Research Corporation.
** Location 2S3 replaced 4S1.
(1) Results by Teledyne Isotopes.
(2) Station SA-WWA-2S3 was collected on 10-24-83.

TABLE C-15

1983 CONCENTRATIONS OF STRONTIUM-89* AND -90 AND GAMMA EMITTERS** IN QUARTERLY COMPOSITES OF WELL WATER

Results in Units of pCi/L ± 2 sigma

(Results*** by PSE&G Research Corporation)

STATION NUMBER RADIOACTIVITY	1-10-83 to 3-14-83	4-11-83 to 6-13-83	7-11-83 to 9-12-83	10-11-83 to 12-05-83
SA-WWA-4S1				
Sr-89	<0.6	<0.6	<0.5	<0.5(1)
Sr-90	<0.5	<0.5	<0.4	<0.4(1)
K-40	<7.8	15±10	<9.4	14±6(1)
SA-WWA-5D1				
Sr-89	<0.6	<0.7	<0.5	<0.5
Sr-90	<0.4	<0.6	<0.4	<0.4
K-40	16±7	<11	<8.9	46±25
SA-WWA-3E1 (Control)				
Sr-89	<0.6	<0.7	<0.5	<0.5
Sr-90	<0.5	<0.6	<0.4	<0.4
K-40	<8.9	<9.3	<14	<9.8

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

** All other gamma emitters searched for were <LLD; typical LLDs are given in Tables C-32 (RMC) and C-33 (PSE&G).

*** First and second quarter gamma results by Radiation Management Corporation.

(1) Sample collected from station SA-WWA-2S3 on 10-24-83.

TABLE C-16

1983 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

Results by Radiation Management Corporation

RADIOACTIVITY		JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE
Alpha	(Raw)	0.9±0.5	0.8±0.6	0.8±0.6	1.8±0.7	<0.8	1.2±0.8
	(Treated)	1.2±0.7	<0.8	1.4±0.6	0.8±0.5	<0.9	<1.0
Beta	(Raw)	3.0±0.5	3.2±0.5	2.6±0.4	3.2±0.4	3.0±0.4	3.8±0.5
	(Treated)	2.6±0.5	2.3±0.5	2.4±0.4	2.1±0.4	2.3±0.4	2.1±0.4
K-40	(Raw)	1.9±0.2	1.5±0.2	1.8±0.2	1.7±0.2	1.5±0.2	1.7±0.2(1)
	(Treated)	2.0±0.2	1.5±0.2	2.0±0.2	1.5±0.2	1.5±0.2	1.7±0.2(1)
H-3*	(Raw)	<140	<140	<130	<130	<130	140±80
	(Treated)	<140	<140	<130	<130	<130	<120

Results by PSE&G Research Corporation

RADIOACTIVITY		JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	AVERAGE
Alpha	(Raw)	3.1±1.6	<1.7	<2.6	<1.7	1.4±0.8	<0.5	1.4±1.6
	(Treated)	<1.4	<1.6	<2.4	<1.5	2.7±1.2	0.9±0.8	-
Beta	(Raw)	2.6±0.6	2.7±0.7	3.0±0.7	2.4±0.7	2.9±0.7	3.9±0.8	3.0±0.9
	(Treated)	1.8±0.6	2.4±0.6	2.2±0.7	1.5±0.6	2.3±0.7	2.3±0.6	2.2±0.6
K-40	(Raw)	3.7±0.4	3.2±0.3	2.9±0.3	2.4±0.2	1.7±0.2	2.0±0.2	2.2±1.4
	(Treated)	3.5±0.4	3.0±0.3	19±1.9	2.5±0.3	1.6±0.2	2.0±0.2	3.5±9.8
H-3	(Raw)	<130	160±80	200±80	<130	190±80	<130	-
	(Treated)	<130	<130	160±80	220±80	<130	<130	-

* Tritium results by PSE&G Research Corporation.
(1) K-40 results by Teledyne Isotopes.

TABLE C-17

1983 CONCENTRATIONS OF STRONTIUM-89* AND -90 AND GAMMA EMITTERS** IN QUARTERLY COMPOSITES OF POTABLE WATER

Results in Units of pCi/L ± 2 sigma

(Results*** by PSE&G Research Corporation)

STATION NUMBER RADIOACTIVITY	1-01-83 to 3-31-83	4-01-83 to 6-30-83	7-01-83 to 9-30-83	10-01-83 to 12-31-83
SA-PWR-2F3 (Raw)				
Sr-89	<0.8	<0.9	<1.7	<0.5
Sr-90	<0.6	<0.7	<0.6	<0.4
Gamma	LLD	LLD	LLD	LLD
SA-PWT-2F3 (Treated)				
Sr-89	<0.8	<0.8	<0.8	<0.5
Sr-90	0.6±0.2	<0.7	<0.6	<0.4
Gamma	LLD	LLD	LLD	LLD

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

** All gamma emitters searched for were <LLD; typical LLDs are given in Tables C-32 (RMC) and C-33 (PSE&G).

*** First and second quarter gamma results by Radiation Management Corporation.

TABLE C-18

1983 CONCENTRATIONS OF STRONTIUM-89* AND -90 AND GAMMA EMITTERS** IN VEGETABLES

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

(Results by PSE&G Research Corporation)

STATION NO.	COLLECTION DATE(S)	SAMPLE TYPE	Sr-89	Sr-90	K-40	Ra-226	Th-232
SA-FPG-5D1	8-01-83	Corn	<26	<14	1300±700	<41	<64
SA-FPV-5D1	8-01-83	Peppers	<24	<15	2300±230	<31	<50
SA-FPV-2E1***	5-15-83	Asparagus	<20	<10	2400±240	<14	<23
SA-FPL-1F3	7-25-83	Cabbage	<37	31±9	2200±210	<30	<56
SA-FPV-1F3	7-25-83	Peppers	<29	<15	1800±62	< 3.7	< 6.7
SA-FPV-5F1	8-01-83	Tomatoes	<20	<11	2400±240	<19	<52
SA-FPG-14F3	8-01-83	Corn	<20	<12	2000±240	<32	<46
SA-FPV-14F3	7/29-30/83	Tomatoes	<25	<15	1400±170	<36	39±22
SA-FPG-1G1(C)	7-25-83	Corn	<24	17±6	2400±230	<29	41±27
SA-FPV-1G1(C)	7-25-83	Peppers	<23	<12	1500±53	<25	< 7.4
SA-FPV-1G1(C)	7-25-83	Tomatoes	<21	<11	2100±55	<23	< 7.2
SA-FPG-3H4(C)	8-02-83	Corn	<22	<12	3100±310	<23	<58
SA-FPV-3H4(C)	8-02-83	Cucumbers	<22	19±6	1400±190	<17	<43
SA-FPV-3H4(C)	8-02-83	Peppers	<22	<15	2100±220	<29	<49
SA-FPV-3H4(C)	8-02-83	Tomatoes	<28	<15	2000±210	37±18	<42
Average			-	-	2000±980	-	-

* Sr-89 results are corrected for decay to sample stop date.
** All other gamma emitters searched for were <LLD; typical LLDs are given in Tables C-32 (RMC) and C-33 (PSE&G).
*** Results by Radiation Management Corporation.
(C) Control station

TABLE C-19

1983 CONCENTRATIONS OF STRONTIUM-89* AND -90 AND GAMMA EMITTERS** IN GAME, MEAT AND BOVINE THYROID

(Results by Radiation Management Corporation)

STATION NO.	COLLECTION DATE(S)	SAMPLE TYPE	Results in Units of pCi/kg (dry) ± 2 sigma Sr-89	Results in Units of pCi/kg (dry) ± 2 sigma Sr-90	Results in Units of pCi/kg (wet) ± 2 sigma K-40
SA-GAM-11D1 (Control)	1/01-31/83	Muskrat	<36	<29	2700±270
SA-GAM-3E1	1/22-31/83	Muskrat	<36	47±28	3000±300
SA-FPB-3E1	2-07-83	Beef	(1)	(1)	2700±290
SA-THB-3E1	2-07-83	Bovine Thyroid	(1)	(1)	1200±250
SA-FPB-14F1***	12-20-83	Beef	(1)	(1)	2300±160
SA-THB-14F1 (Control)	12-20-83	Bovine Thyroid	(1)	(1)	1900±500
AVERAGE		Muskrat	-	-	2800±210
		Beef	-	-	2500±280
		Bovine Thyroid	-	-	1600±500

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

** All other gamma emitters searched for were <LLD; typical LLDs are given in Tables C-32 (RMC) and C-33 (PSE&G).

*** Station No. 14F1 results by PSE&G Research Corporation.

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

TABLE C-20

1983 CONCENTRATIONS OF GAMMA EMITTERS* IN FODDER CROPS

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

(All Results by PSE&G Research Corporation)

STATION NO.	COLLECTION DATE(S)	SAMPLE TYPE	Be-7	K-40	Co-60	Zr-95	Ra-226	Th-232
SA-FPG-3E1	7-10-83	Barley	430±130	3700±340	<28	<38	40±26	<75
SA-FPG-3E1	11-14-83	Soybeans	<230	14000±720	<44	<52	<41	<108
SA-VGT-3E1	7-12-83	Hay	520±110	13000±550	<28	<15	<36	109±52
SA-VGT-2F4	9-02-83	Corn Silage	32±20	2200±73	< 4.4	< 6.8	<35	< 9.3
SA-VGT-5F2	10-23-83	Corn Silage	590±170	3800±440	<32	<48	59±35	<99
SA-VGT-14F1	8/22-26/83	Corn Silage	<580	3400±340	<33	<95	<48	<110
SA-FPG-15F1	12/17-18/83	Soybeans	<140	12000±550	<30	<34	<32	117±49
SA-VGT-15F1	9-30-83	Corn Silage	68±13	400±36	< 3.1	< 4.0	< 4.2	< 9.5
SA-VGT-15F1	10-02-83	Green Chop	100±17	820±44	< 2.3	< 4.2	<32	< 7.0
SA-FPG-3G1 (C)	11-14-83	Soybeans	290±140	14000±640	46±22	92±32	<52	<95
SA-VGT-3G1 (C)	9-06-83	Corn Silage	540±130	4200±440	<29	<41	<37	<78
Average			320±440	6500±11000	-	-	-	-

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

(C) Control station

TABLE C-21

1983 CONCENTRATIONS OF STRONTIUM-90 AND GAMMA EMITTERS* IN SOIL

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

(All Results by PSE&G Research Corporation)

STATION NO.	COLLECTION DATE	Sr-90	K-40	Cs-137	Ra-226	Th-232
SA-SOL-6S1	5-23-83	49±15	9300±460	120±19	500±37	550±71
SA-SOL-5D1	5-23-83	140±20	6500±420	280±26	780±47	660±75
SA-SOL-10D1	5-24-83	220±22	8600±460	510±30	880±50	870±82
SA-SOL-2E1	5-23-83	64±25	6600±350	420±25	1500±290	640±69
SA-SOL-16E1	5-24-83	110±18	12000±530	180±26	2600±390	1200±94
SA-SOL-1F1	5-23-83	99±21	4300±300	1600±43	390±31	340±47
SA-SOL-2F1	5-23-83	160±32	9500±440	370±27	1900±280	890±81
SA-SOL-2F2	5-23-83	46±13	7600±440	190±20	480±39	430±60
SA-SOL-2F4	5-24-83	100±20	7800±450	400±27	950±50	700±79
SA-SOL-5F1	5-23-83	200±19	3900±300	560±28	560±36	410±53
SA-SOL-5F2	5-23-83	120±18	3800±320	370±25	570±39	450±59
SA-SOL-14F1	5-24-83	62±17	13000±550	170±20	1200±52	1000±85
SA-SOL-15F1	5-24-83	260±25	12000±620	550±35	1400±67	1200±100
SA-SOL-3G1 (Control)	5-24-83	120±16	8600±430	320±28	2200±380	810±80
SA-SOL-3H3 (Control)	5-26-83	250±24	9100±450	910±38	2000±400	900±88
Average		130±140	8200±5700	460±750	1200±1400	740±550

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

TABLE C-22

1983 CONCENTRATIONS OF GROSS ALPHA EMITTERS IN SURFACE WATER

Results in Units of pCi/L ± 2 sigma

Results by Radiation Management Corporation

STATION NO.	1-03-83	2-09-83	3-09-83	4-05-83	5-05-83	6-08-83
SA-SWA-11A1	<0.4	<0.2	<0.5	0.5±0.3	<0.8	0.4±0.2
SA-SWA-12C1 (Control)	<0.3	<0.2	<0.5	<0.5	<0.8	<0.2
SA-SWA-7E1	<0.4	<0.2	<0.4	<0.3	<0.6	0.2±0.2
SA-SWA-1F2	<0.4	0.4±0.3	<0.5	<0.4	<0.6	<0.2
SA-SWA-16F1	<0.3	<0.2	<0.4	<0.4	<0.7	<0.2

Results by PSE&G Research Corporation

STATION NO.	7-07-83	8-03-83	9-07-83	10-04-83	11-07-83	12-08-83
SA-SWA-11A1	<2.0	<3.5	<5.0	<3.8	<4.3	<4.9
SA-SWA-12C1 (Control)	<1.5	<2.2	<1.8	<3.0	<3.8	<3.8
SA-SWA-7E1	<1.3	<1.8	<2.5	<3.5	<3.5	<3.8
SA-SWA-1F2	<1.5	1.7±1.4	<2.0	<2.8	<1.9	<3.6
SA-SWA-16F1	<2.0	<1.8	<3.6	<4.3	<4.9	<3.8

TABLE C-23

1983 CONCENTRATIONS OF GROSS BETA EMITTERS IN SURFACE WATER

Results in Units of pCi/L ± 2 sigma

Results by Radiation Management Corporation

STATION NO.	1-03-83	2-09-83	3-09-83	4-05-83	5-05-83	6-08-83
SA-SWA-11A1	48±6	69±7	47±6	11±3	7.8±2.6	24±2
SA-SWA-12C1 (Control)	40±5	27±3	31±4	9.9±2.7	11±3	20±2
SA-SWA-7E1	78±8	58±6	63±7	24±4	9.7±2.8	37±4
SA-SWA-1F2	25±4	33±3	36±5	4.1±2.2	8.3±2.6	6.8±1.4
SA-SWA-16F1	38±5	43±4	39±5	8.3±2.5	5.0±2.4	11±2
Average	46±40	46±35	43±25	11±15	8.4±4.5	20±24

Results by PSE&G Research Corporation

STATION NO.	7-07-83	8-03-83	9-07-83	10-04-83	11-07-83	12-08-83	AVERAGE
SA-SWA-11A1	53±6	59±6	110±10	120±11	84±9	12±3	54±75
SA-SWA-12C1 (Control)	31±4	45±6	71±8	86±9	66±8	10±3	37±51
SA-SWA-7E1	65±7	91±9	120±11	120±11	77±9	17±3	63±74
SA-SWA-1F2	21±4	31±4	63±7	73±8	52±6	8.6±2.4	30±46
SA-SWA-16F1	34±5	40±5	65±7	85±9	74±8	7.6±2.3	37±54
Average	41±36	53±47	86±54	97±44	71±24	11±7	44±64

TABLE C-24

1983 CONCENTRATIONS OF TRITIUM IN SURFACE WATER

Results in Units of pCi/L ± 2 sigma

(All Results by PSE&G Research Corporation)

STATION NO.	1-03-83	2-09-83	3-09-83	4-05-83	5-05-83	6-08-83
SA-SWA-11A1	<130	<140	<140	<130	<130	160±80
SA-SWA-12C1 (Control)	<130	<140	<140	<130	<130	160±80
SA-SWA-7E1	180±100	<130	<140	<130	<130	<140
SA-SWA-1F2	<140	<140	<140	<130	<130	<130
SA-SWA-16F1	<140	<140	<140	<130	<130	<130
Average	-	-	-	-	-	-

STATION NO.	7-07-83	8-03-83	9-07-83	10-04-83	11-07-83	12-08-83
SA-SWA-11A1	180±80	1260±100	230±80	330±80	350±80	<130
SA-SWA-12C1 (Control)	170±80	450±80	180±80	200±80	200±80	<130
SA-SWA-7E1	160±80	150±80	<130	600±90	180±80	<130
SA-SWA-1F2	<120	170±80	<140	520±80	<130	<120
SA-SWA-16F1	190±80	510±80	190±90	210±80	250±80	<130
Average	160±54	500±900	170±81	370±360	220±170	-

TABLE C-25

1983 CONCENTRATIONS OF GAMMA EMITTERS* IN SURFACE WATER

Results in Units of pCi/L ± 2 sigma

Results by Radiation Management Corporation

STATION NO.	NUCLIDE	1-03-83	2-09-83	3-09-83	4-05-83	5-05-83	6-08-83
SA-SWA-11A1	K-40	67±7	87±10	29±12	<16	<16	16±7
	Co-58	<1.8	<1.0	<1.3	<1.3	<1.3	<0.6
	Co-60	<0.8	<0.7	<0.8	<1.0	<1.1	<0.7
	Mo-99	(1)	(1)	(1)	(1)	(1)	(1)
	La-140	<66	<22	<9.8	<7.6	<6.2	<2.3
	Ra-226	<1.7	<1.0	<1.6	<1.9	<1.8	<1.1
	Th-232	<2.7	<1.8	<2.6	<3.3	<3.1	<2.0
SA-SWA-12C1 (Control)	K-40	45±6	20±8	46±13	19±5	<10	14±7
	Co-58	<1.3	<1.2	<1.5	<0.7	<0.9	<0.7
	Co-60	<0.8	<1.1	<1.1	<0.6	<1.1	<0.7
	Mo-99	(1)	(1)	(1)	(1)	(1)	(1)
	La-140	<48	<26	<14	<5.2	<5.1	<2.9
	Ra-226	<1.3	<1.3	<1.8	<1.1	<1.3	<1.2
	Th-232	<1.9	<2.2	<3.4	<1.7	<2.4	<2.0
SA-SWA-7E1	K-40	88±9	66±9	94±11	18±8	<11	30±8
	Co-58	<1.8	<1.0	<0.8	<0.8	<0.8	<0.6
	Co-60	<0.9	<0.7	<0.6	<0.8	<0.7	<0.7
	Mo-99	(1)	(1)	(1)	(1)	(1)	(1)
	La-140	<50	<21	<9.0	<5.7	<4.9	<2.0
	Ra-226	<1.7	<1.1	<1.1	<1.4	<1.3	<1.2
	Th-232	<2.8	<1.8	<1.7	<2.1	<2.1	<1.9
SA-SWA-1F2	K-40	21±4	23±9	53±10	<15	<14	<9.7
	Co-58	<1.3	<1.2	<1.1	<1.0	<1.0	<0.8
	Co-60	<0.8	<1.1	<1.1	<0.7	<0.8	<1.1
	Mo-99	(1)	(1)	(1)	(1)	(1)	(1)
	La-140	<56	<30	<10	<6.0	<5.4	<2.1
	Ra-226	<1.4	<1.4	<1.3	<1.6	<1.6	<1.4
	Th-232	<2.1	<2.4	<2.3	<2.6	<2.6	<2.5
SA-SWA-16F1	K-40	38±4	22±9	32±10	<16	<16	<8.6
	Co-58	<2.0	<1.1	<1.0	<1.4	<1.3	<0.6
	Co-60	<1.1	<0.8	<0.8	<1.0	<1.0	<0.8
	Mo-99	(1)	(1)	(1)	(1)	(1)	(1)
	La-140	<60	<27	<8.7	<7.9	<6.4	<2.1
	Ra-226	<1.9	<1.4	<1.4	<1.8	<1.8	<1.2
	Th-232	<2.9	<2.0	<2.1	<3.3	<3.3	<1.9
Average	K-40	52±52	44±62	51±52	-	-	16±17

TABLE C-25 (Cont'd)

1983 CONCENTRATIONS OF GAMMA EMITTERS* IN SURFACE WATER

Results in Units of pCi/L ± 2 sigma

Results by PSE&G Research Corporation

STATION NO.	NUCLIDE	7-07-83	8-03-83	9-07-83	10-04-83	11-07-83	12-08-83	Average
SA-SWA-11A1	K-40	60±9	68±8	100±10	120±11	110±10	14±6	58±80
	Co-58	2.1±0.5	<0.5	0.8±0.4	<0.7	<0.4	<0.5	-
	Co-60	<0.7	<0.7	<1.0	<0.9	<0.7	<0.7	-
	Mo-99	<63	<36	<180	<190	120±45	<120	-
	La-140	<1.3	<1.0	<1.9	<1.5	<1.3	<1.3	-
	Ra-226	<1.2	<1.0	<11	<13	<11	<1.0	-
	Th-232	<2.4	<1.9	<2.4	<2.6	<2.1	<1.9	-
SA-SWA-12C1 (Control)	K-40	23±7	53±9	75±9	92±9	89±9	10±6	41±61
	Co-58	<0.6	<0.5	<0.7	<0.6	<0.5	<0.5	-
	Co-60	<0.5	<0.5	<0.8	<0.7	<0.5	<0.6	-
	Mo-99	<130	<29	<180	<210	<130	<78	-
	La-140	<1.1	<1.0	<1.8	<1.4	<1.2	1.3±0.6	-
	Ra-226	<9.1	<1.3	<9.5	<10	<8.5	<11	-
	Th-232	<2.1	<2.3	<2.2	<2.3	<2.3	<2.2	-
SA-SWA-7E1	K-40	74±9	75±10	110±11	110±11	120±11	16±7	68±79
	Co-58	<0.6	<0.7	<0.7	<0.8	<0.5	<0.8	-
	Co-60	<0.7	<0.8	<0.7	<0.8	<0.8	<0.7	-
	Mo-99	<130	<44	<170	<200	<59	<120	-
	La-140	<1.6	<1.0	<2.0	<1.6	<1.2	<1.2	-
	Ra-226	<11	<1.3	<1.4	<1.3	<1.1	<0.9	-
	Th-232	<2.4	1.6±0.9	<3.1	<2.7	<2.5	<2.3	-
SA-SWA-1F2	K-40	26±6	24±6	68±8	77±10	70±9	<8.8	34±51
	Co-58	<0.5	<0.5	<0.4	<0.7	<0.7	<0.8	-
	Co-60	<0.6	<0.4	1.3±0.5	<0.7	<0.6	<0.6	-
	Mo-99	<120	<	<120	<180	<64	<150	-
	La-140	<1.5	<0.7	<1.1	<1.6	<1.3	<1.3	-
	Ra-226	<1.0	<7.5	<9.3	<1.1	<10	<0.9	-
	Th-232	<1.9	<2.1	<2.2	<2.3	<2.1	<2.0	-
SA-SWA-16F1	K-40	28±8	38±8	66±9	72±10	85±10	<8.6	36±51
	Co-58	<0.8	<0.6	<0.5	<0.5	<0.6	<0.4	-
	Co-60	<0.8	<0.7	0.5±0.3	<0.6	<0.7	<0.7	-
	Mo-99	<150	<95	<200	<150	<130	<71	-
	La-140	<1.3	<1.1	<1.3	<1.1	<1.1	<1.9	-
	Ra-226	<1.3	<1.3	0.9±0.4	<1.1	<1.2	<9.8	-
	Th-232	<2.3	<2.3	<0.8	<2.7	<2.1	<2.0	-
Average	K-40	42±46	52±42	84±40	94±41	95±40	11±7	
							Grand Average K-40	48±69

* All other gamma emitters searched for were <LLD; typical LLDs are given in Tables C-32 (RMC) and C-33 (PSE&G).

(1) Not analyzed for Mo-99 by Radiation Management Corporation.

TABLE C-26

1983 CONCENTRATIONS OF STRONTIUM-89* AND -90 IN SURFACE WATER

Results in Units of pCi/L ± 2 sigma

(All Results by PSE&G Research Corporation)

STATION NO.	1-03-83 to 3-09-83		4-05-83 to 6-08-83		7-07-83 to 9-07-83		10-04-83 to 12-08-83	
	Sr-89	Sr-90	Sr-89	Sr-90	Sr-89	Sr-90	Sr-89	Sr-90
SA-SWA-11A1	<0.6	<0.5	<1.1	<0.8	<0.7	<0.5	<0.8	<0.6
SA-SWA-12C1 (Control)	<0.7	<0.5	<1.0	<0.7	<0.6	<0.5	<0.7	<0.6
SA-SWA-7E1	<1.0	<0.5	<1.2	<0.9	<0.7	<0.6	<0.8	<0.7
SA-SWA-1F2	<0.7	<0.5	<1.0	<0.7	<0.7	<0.6	<0.7	<0.6
SA-SWA-16F1	<0.7	<0.5	<1.2	<0.9	<0.5	<0.4	<0.8	<0.7

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

TABLE C-27

1983 CONCENTRATIONS OF STRONTIUM-89* AND -90 AND TRITIUM IN EDIBLE FISH

				TRITIUM (FLESH)	
		STRONTIUM (BONES) pCi/kg (dry) ± 2 sigma		AQUEOUS FRACTION pCi/L ± 2 sigma	ORGANIC FRACTION pCi/L ± 2 sigma
STATION NO.	COLLECTION PERIOD	Sr-89	Sr-90	H-3	H-3
SA-ESF-11A1	2-15-83 to 4-27-83**	<82	<35	84±71	140±71
	8-25-83 to 10-17-83***	<140	600±41	<140	<120
SA-ESF-12C1 (Control)	2-15-83 to 4-27-83**	<79	<34	<110	400±75
	8-25-83 to 10-17-83***	<170	330±45	<140	<120
SA-ESF-7E1	2-15-83 to 4-27-83**	<64	<26	<110	220±72
	8-25-83 to 10-17-83***	<270	110±38	<140	<120

* Sr-89 results are corrected for decay to sample stop date.
** All results by Radiation Management Corporation.
*** Strontium results by PSE&G Research Corporation.
Tritium results by NUS Corporation.

TABLE C-28

1983 CONCENTRATIONS OF GAMMA EMITTERS* IN EDIBLE FISH

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

STATION NO.	COLLECTION PERIOD	Na-22	K-40	Cs-137	Ra-226
SA-ESF-11A1	2-15-83 to 4-27-83	(1)	3200±320	<14	<32
	8-25-83 to 10-17-83	<18	2900±260	14±8	<32
SA-ESF-12C1 (Control)	2-15-83 to 4-27-83	(1)	2700±330	<22	<43
	8-25-83 to 10-17-83	<15	2700±240	<13	<18
SA-ESF-7E1	2-15-83 to 4-27-83	(1)	2800±280	<14	<26
	8-25-83 to 10-17-83	25±10	3400±280	<16	37±21
AVERAGE		-	3000±580	-	-

* All other gamma emitters searched for were <LLD; typical LLDs are given in Tables C-32 (RMC) and C-33 (PSE&G).

** Results for 2-15-83 to 4-27-83 samples by Radiation Management Corporation.
Results for 8-25-83 to 10-17-83 samples by PSE&G Research Corporation.

(1) Not analyzed for Na-22.

TABLE C-29

1983 CONCENTRATIONS OF STRONTIUM-89* AND -90; GAMMA EMITTERS** AND TRITIUM IN BLUE CRABS

STATION NO.	COLLECTION DATE	SAMPLE	Results in Units of pCi/kg (wet) ± 2 sigma Sr-89	Sr-90	K-40	Ra-226	Results in Units of pCi/L ± 2 sigma H-3
SA-ECH-11A1	6-24-83(1)	Flesh	<500	35±12	2600±450	<63	200±72
		Shell(3)	<1000	520±40	(4)	(4)	(4)
	9-19-83(2)	Flesh	<52	<20	1800±280	47±17	(5)
		Shell(3)	<110	250±21	(4)	(4)	(4)
SA-ECH-12C1 (Control)	6-24-83(1)	Flesh	<300	25±17	3000±840	<130	180±72
		Shell(3)	<1000	540±30	(4)	(4)	(4)
	9-19-83(2)	Flesh	<46	<19	2000±250	52±25	(5)
		Shell(3)	<130	570±27	(4)	(4)	(4)
AVERAGE		Flesh	-	-	2400±1100	-	190±28
		Shell	-	470±300	(4)	(4)	(4)

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

** All other gamma emitters searched for were <LLD; typical LLDs are given in Tables C-32 (RMC) and C-33 (PSE&G).

(1) Strontium results by Teledyne Isotopes.
Gamma and tritium results by Radiation Management Corporation.

(2) Strontium and gamma results by PSE&G Research Corporation.
Tritium results by NUS Corporation.

(3) Strontium results in units of pCi/kg (dry).
High Sr-89 LLD due to insufficient sample.

(4) Gamma and tritium analysis not required.

(5) Not analyzed due to insufficient sample.

TABLE C-30

1983 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	Mn-54	Ra-226	Th-232
SA-ESB-11A1	5-10-83	<10000	250±130	(1)	(1)	(1)
	9-19-83	<5800	<2700	<9900	15000±9500	<25000
SA-ESB-12C1 (Control)	5-10-83	<100000	<2000	(1)	(1)	(1)
	9-19-83	<1400	<690	<5000	<8600	<16000
SA-ESB-7E1	5-10-83	<20000	<300	(1)	(1)	(1)
	9-19-83	<1300	<600	<3700	<67000	11000±5600
SA-ESB-16F1	5-10-83	<700000	<10000	(1)	(1)	(1)
	9-19-83	<18000	<8600	34000±16000	<490000	<120000

NOTE: Analyses performed on benthic organisms have extremely high uncertainties and sensitivities due to the unavailability of an adequate sample. Sample sizes ranged from 0.1 grams to 0.7 grams.

* Sr-89 results are corrected for decay to sample stop date.
** All other gamma emitters searched for were <LLD; typical LLDs are given in Table C-33.
*** Results for May samples by Teledyne Isotopes.
Results for September samples by PSE&G Research Corporation.
(1) Not analyzed for gamma emitters by Teledyne Isotopes.

TABLE C-31

1983 CONCENTRATIONS OF STRONTIUM-90 AND GAMMA EMITTERS* IN SEDIMENT**

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

STATION NO. DATE	Sr-90	K-40	Co-58	Co-60	Cs-137	Ra-226	Th-232
SA-ESS-11A1							
5-11-83	<31	15000±1500	<57	83±35	160±38	640±74	910±110
9-19-83	<23	12000±630	<44	58±23	100±20	720±50	830±99
SA-ESS-12C1 (Control)							
5-11-83	<33	14000±1400	<54	<36	35±21	690±69	840±100
9-19-83	<25	16000±810	<50	<54	<37	690±60	1100±110
SA-ESS-7E1							
5-11-83	<30	12000±1200	<56	<45	100±27	800±80	950±95
9-19-83	<34	8300±520	<45	<43	<42	1200±380	590±84
SA-ESS-16F1							
5-11-83	<46	15000±1500	<88	<81	<61	570±110	1000±160
9-19-83	<27	16000±690	44±27	48±29	<31	1600±410	970±110
AVERAGE	-	14000±5300	-	-	-	860±710	900±300

* All other gamma emitters searched for were <LLD; typical LLDs are given in Tables C-32 (RMC) and C-33 (PSE&G).

** Sediment samples which include benthic organisms constitute the benthos sample.

*** Results for May samples by Radiation Management Corporation.
Results for September samples by PSE&G Research Corporation.

TABLE C-32

RADIATION MANAGEMENT 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/g-wet)	MEAT AND GAME (pCi/g-wet)
Be-7	-	8.1	7.6	6.3	0.02	0.04
Na-22	0.3	0.8	1.0	0.8	0.003	0.006
K-40	5.5	7.8	-	7.0	-	0.6
Cr-51	3.2	7.8	7.9	5.9	0.02	0.06
Mn-54	0.3	0.7	1.0	0.6	0.003	0.006
Co-57	*	2.0	*	*	*	*
Co-58	0.4	0.8	1.1	0.7	0.002	0.007
Fe-59	0.7	1.7	2.0	1.4	0.007	0.008
Co-60	0.3	0.8	0.9	0.6	0.002	0.003
Zn-65	0.7	1.5	1.7	1.4	0.005	0.006
Zr-95	0.7	*	*	*	*	*
Nb-95	0.4	*	*	*	*	*
ZrNb-95	*	0.6	0.9	0.6	0.002	0.002
Mo-99	17	160	87	52	0.4	0.4
Ru-103	0.4	*	*	*	*	*
Ru-106	3.4	6.5	8.0	6.3	0.2	0.06
Ag-110m	0.3	0.7	1.0	0.6	0.002	0.006
Sb-125	0.7	*	*	*	*	*
Te-129m	3.4	17	19	13	0.05	0.08
I-131	0.6	3.5	1.9	1.4	0.01	0.009
Te-132	1.3	11	4.9	3.7	0.03	0.03
I-133	*	*	*	*	0.06	0.8
Cs-134	0.3	0.6	1.0	0.6	0.002	0.002
Cs-136	0.5	2.3	2.6	1.6	0.1	0.01
Cs-137	0.4	0.8	1.1	0.6	0.002	0.006
Ba-140	1.5	*	*	*	*	*
La-140	0.7	*	*	*	*	*
BaLa-140	*	2.4	1.7	1.3	0.006	0.01
Ce-141	0.5	*	*	*	*	*
Ce-144	1.6	3.3	3.2	1.6	0.007	0.02
Ra-226	1.0	1.2	1.6	1.2	0.003	0.003
Th-232	1.5	3.1	3.1	3.1	0.008	0.03

TABLE C-32 (Cont'd)

RADIATION MANAGEMENT CORPORATION LLDs FOR GAMMA SPECTROMETRY

NUCLIDES	FODDER CROPS (pCi/g-wet)	SURFACE WATER (pCi/L)	FISH (pCi/g-wet)	SHELLFISH (pCi/g-wet)	SEDIMENT (pCi/g-dry)
Be-7	0.2	5.2	0.1	0.1	0.3
Na-22	0.02	0.6	0.01	0.02	*
K-40	-	7.8	-	-	-
Cr-51	0.2	5.6	0.1	0.1	0.5
Mn-54	0.02	0.6	0.01	0.01	0.02
Co-57	*	*	*	*	0.02
Co-58	0.02	0.7	0.01	0.02	0.03
Fe-59	0.07	1.4	0.02	0.04	0.08
Co-60	0.03	0.6	0.01	0.02	0.03
Zn-65	0.06	1.4	0.02	0.03	0.05
Zr-95	*	*	*	*	0.05
Nb-95	*	*	*	*	0.05
ZrNb-95	0.03	0.6	0.009	0.02	*
Mo-99	0.4	27	36	3.6	*
Ru-103	*	*	*	*	0.04
Ru-106	0.3	6.3	0.08	0.1	0.2
Ag-110m	0.03	0.6	0.01	0.02	0.02
Sb-125	*	*	*	*	0.06
Te-129m	0.5	11	0.2	0.2	1.5
I-131	0.04	1.1	0.07	0.04	0.6
Te-132	0.04	2.1	1.4	0.2	*
I-133	0.6	*	*	*	*
Cs-134	0.03	0.6	0.01	0.01	0.02
Cs-136	0.06	1.4	0.05	0.03	0.2
Cs-137	0.03	0.6	0.009	0.02	0.03
Ba-140	*	*	*	*	0.8
La-140	*	*	*	*	0.2
BaLa-140	0.04	1.0	0.04	0.03	*
Ce-141	*	*	*	*	0.06
Ce-144	0.09	1.6	0.03	0.05	0.1
Ra-226	0.05	1.1	0.02	0.03	-
Th-232	0.1	3.1	0.03	0.06	-

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

TABLE C-33

1983 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)
Be-7	-	-	20	6.7	180	110	260
Na-22	0.8	1.1	6.0	2.0	21	13	80
K-40	14	15	-	16	-	-	-
Cr-51	6.1	14	18	10	190	130	240
Mn-54	0.8	0.7	2.8	0.81	22	11	30
Co-58	0.7	0.9	2.6	0.92	22	7.6	37
Fe-59	1.6	2.3	6.6	2.9	50	42	100
Co-60	0.7	1.0	4.2	0.85	52	12	42
Zn-65	1.7	1.9	7.0	1.6	51	24	93
Nb-95	0.8	1.7	2.7	0.96	23	19	52
Zr-95	1.5	1.8	4.8	1.5	35	23	63
Mo-99	44	*	28	1300	3500	580	*
Ru-103	7.4	1.4	2.3	0.96	21	12	40
Ru-106	6.2	6.8	23	8.4	200	80	240
Ag-110m	10	0.80	2.6	0.78	19	13	60
Sb-125	1.9	2.0	6.6	1.8	53	28	67
Te-129m	32	27	90	40	790	100	1800
I-131	1.4	18	2.8	13	46	19	230
Te-132	4.9	2400	3.0	1400	210	41	*
Cs-134	7.9	1.0	3.0	0.90	20	13	33
Cs-136	1.2	5.0	3.0	3.8	30	17	95
Cs-137	1.0	0.80	3.0	0.76	22	14	38
Ba-140	3.7	2.2	9.7	15	110	71	280
La-140	1.6	6.5	3.0	6.6	34	20	91
Ce-141	0.9	1.8	3.4	1.3	29	19	40
Ce-144	2.7	3.8	14	3.6	100	47	150
Ra-226	1.8	18	5.7	15	44	170	41
Th-232	2.5	3.4	11	3.2	70	39	110

TABLE C-33 (cont'd)

1983 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)	SOIL (pCi/kg-dry)	NUCLIDES	AIR IODINE (10^{-3}pCi/m^3)
Be-7	6.7	160	330	570	1100	I-131	7.3
Na-22	0.97	27	27	68	48	I-132	12
K-40	-	-	-	-	-	I-133	24
Cr-51	6.9	210	570	880	2300	I-135	2.7
Mn-54	0.76	18	31	62	45		
Co-58	0.90	18	33	72	63		
Fe-59	1.8	46	110	180	26		
Co-60	0.94	20	30	78	57		
Zn-65	1.8	40	51	130	100		
Nb-95	0.9	24	82	99	220		
Zr-95	1.6	33	51	140	210		
Mo-99	*	*	*	*	*		
Ru-103	0.82	19	43	78	120		
Ru-106	6.5	150	260	490	500		
Ag-110m	0.87	15	22	64	130		
Sb-125	1.7	45	65	130	140		
Te-129m	37	740	370	2700	5500		
I-131	1.7	1300	1000	600	4300		
Te-132	9.8	*	*	*	*		
Cs-134	0.66	17	21	48	62		
Cs-136	1.2	190	210	300	960		
Cs-137	0.91	18	22	52	38		
Ba-140	4.3	690	720	940	3600		
La-140	2.2	220	300	350	1100		
Ce-141	1.0	29	64	130	240		
Ce-144	3.5	82	100	320	250		
Ra-226	12	340	52	-	-		
Th-232	3.4	59	120	-	-		

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

* Indicates that no LLD was calculated for that nuclide in that media.

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 1983 Artificial Island Radiological Environmental Monitoring Program samples.

LAB*	TABLE OF CONTENTS	PAGE

GROSS ALPHA

GROSS BETA

POTASSIUM-40

TRITIUM

IODINE-131

SYNOPSIS OF ANALYTICAL PROCEDURES (cont'd)

* PSE&G - PSE&G Research Corporation
TI - Teledyne Isotopes
RMC - Radiation Management Corporation
NUS - NUS Corporation

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:

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

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

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

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

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

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

Calculation of lower limit of detection:

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

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

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 RADIATION MANAGEMENT CORPORATION PROCEDURE

GROSS ALPHA ANALYSIS OF SAMPLES

Total Water (A0, A1)

A 250 ml (A0) or one l (A1) aliquot of the sample is evaporated to dryness on a hot plate in a preweighed, 2" X 1/4" ringed planchet, allowed to cool, and reweighed. The planchet is counted in a low-background, gas flow proportional counter. Self-absorption corrections are made based on the measured sample weight and calculated thickness. The calibration standard used is Pu-239. A 250 ml or one l sample of distilled water is evaporated in the same manner and used as a blank.

Total Salt Water (AA)

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

Calculations are made utilizing the following equations:

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

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

where:

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

Calculation of lower limit of detection (LLD)

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

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

where:

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

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

Calculation of Gross Beta Activity:

Air flow is corrected first by using the following equations:

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

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

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

A = Gross beta activity, $\mathrm{pCi/m^3}$
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.

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

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:

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

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 RADIATION MANAGEMENT CORPORATION PROCEDURE

GROSS BETA ANALYSIS OF SAMPLES

Total Water (B0, B1)

A 250 ml (B0) or one l (B1) aliquot is evaporated to dryness on a hot plate in a preweighed, 2" X 1/4", ringed planchet and reweighed. The planchet is then counted in a low background gas-flow proportional counter. Self-absorption corrections are made based on the measured residue weight and calculated thickness. The calibration standard used is Sr-90 - Y-90. A 250 ml or one l sample of distilled water is evaporated in the same manner and used as a blank.

Calculations are made utilizing the following equations:

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

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

where:

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

Calculation of lower limit of detection (LLD)

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

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

where:

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

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 RADIATION MANAGEMENT CORPORATION PROCEDURE

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

Sample Preparation

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

Calculations are made using the following equations:

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

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

where:

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

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^R 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 RADIATION MANAGEMENT CORPORATION PROCEDURE

ANALYSIS OF SAMPLES FOR TRITIUM

Water (H2)

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

Calculations are made utilizing the following equations:

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

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

where:

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

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

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

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

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

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

where:

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

Calculation of lower limit of detection (LLD)

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

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

where:

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

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

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

a. Aqueous H-3 in Food Products

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

b. Organic Bound H-3 in Food Products

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

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

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

Calculations are made utilizing the following equations:

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

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

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

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

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

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

where:

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

Calculation of lower limit of detection (LLD)

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

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

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

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

where:

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

SYNOPSIS OF NUS CORPORATION PROCEDURE

TRITIUM ANALYSIS OF AQUEOUS FRACTION OF BIOLOGICAL MATERIALS

Approximately 150g of food product is weighed and placed into a 300ml round bottomed flask for freeze drying. The freeze drying appartus is set up and run until the sample is dry to touch. The collector is then allowed to warm to room temperature, and a graduated cylinder is used to measure the collected water volume. An 8ml aliquot of distillate is mixed with 10ml of scintillation counting solution in an ultralow-potassium counting vial, and the specimen is counted for an appropriate time in a liquid scintillation counter.

A low tritium-background water sample is treated identically to the samples and used as a blank.

Calculations:

$$\text{Result } (\mu\text{Ci/ml distillate}) = \left(\frac{C(s+b)}{T(s+b)} - \frac{C(b)}{T(b)}\right) \times \frac{1}{2.22\times10^6}\ \frac{1}{E} \times \frac{1}{V} = A$$

$$\text{Error (2 sigma)} (\mu\text{Ci/ml distillate}) = 2\sqrt{\frac{C(s+b)}{T(s+b)^2} + \frac{C(b)}{T(b)^2}} \times \frac{1}{2.22\times10^6} \times \frac{1}{E} \times \frac{1}{V} = B$$

Result (μCi/g original sample) = A x YF

Error (2 sigma) (μCi/g orignal sample) = B x YF

C(s+b) = Gross counts of sample
C(b) = Blank counts
E = Tritium counting efficiency
YF = ml water recovered/g of sample aliquot taken, typically 0.75 for fish

T(s+b) = Sample counting time
T(b) = Blank counting time
V = volume of distillate counted

SYNOPSIS OF NUS CORPORATION PROCEDURE

TRITIUM ANALYSIS OF ORGANIC FRACTION OF BIOLOGICAL MATERIALS

Approximately 150g of food product in weighed and freeze-dried to remove all water. The residue is reweighed to determine the dry weight, then 15-20g of dried sample is combusted in a closed system and the product water collected. The volume of water is measured and the entire volume is then vacuum distilled from alkaline potassium permanganate solution. The entire final distillate or 8ml thereof, whichever is less, is mixed with 10ml of scintillation counting solution, and the specimen is counted for an appropriate time in a liquid scintillation counter.

A low tritium-background water sample is treated identically to the samples and used as a blank.

Calculations:

Result (μCi/ml distillate) $= \left(\frac{C(s+b)}{T(s+b)} - \frac{C(b)}{T(b)} \right) \times \frac{1}{2.2210^6} \times \frac{1}{E} \times \frac{1}{V} = A$

Error (2 sigma) (μCi/ml distillate) $= 2\sqrt{\frac{C(s+b)}{T(s+b)^2} + \frac{C(b)}{T(b)^2}} \times \frac{1}{2.22 \times 10^6} \times \frac{1}{E} \times \frac{1}{V} = B$

Result (μCi/g freeze-dried sample) = A x YI

Error (2 sigma) (μCi/g freeze-dried sample) = B x YI

Result (μCi/g original sample) = A x YF

Error (2 sigma) (μCi/g original sample) = B + YF

C(s+b) = Gross counts of sample
C(b) = Blank counts
E = Tritium counting efficiency
T(s+b) = Sample counting time
T(b) = Blank counting time

V = Volume of distillate counted
YI = ml water recovered/g of freeze-dried sample
YF = ml water recovered/g of original sample aliquot

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:

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

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

2 sigma error (pCi/m^3) = $2*(\sigma_k{}^2+\sigma_s{}^2)^{1/2}$

$$\sigma_k = \left[\frac{1}{\sum_{i=1}^{n} \frac{1}{\sigma_i^2} *A(Y)_i^2}\right]^{1/2}$$

σ_k = statistical error of the activity measurement. It is determined from the accuracy of the least squares evaluation performed on the peaks of a particular nuclide.
n = number of peaks in the nuclide of question

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

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

= gamma abundance factor for the ith peak under consideration, for a given nuclide

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

All other variables are as defined earlier.

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

Again, all other variables are as defined earlier.

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 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 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:

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

G = Sample gross counts
B = Background counts (from blank sample)
T = Count time of sample and blank
E = $E_0*\text{EXP}(-\lambda*M)$ = 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

2-sigma error (pCi/kg wet) = $2*(\sigma_k{}^2+\sigma_s{}^2)^{1/2}$

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

σ_k = statistical error of the activity measurement. It is determined from the accuracy of the least squares evaluation performed on the peaks of a particular nuclide.
n = number of peaks in the nuclide of question

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

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

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

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

All other variables are as defined earlier.

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

All quantities are as defined earlier.

SYNOPSIS OF RADIATION MANAGEMENT CORPORATION PROCEDURE

ANALYSIS OF SAMPLES FOR IODINE-131

Milk or Water (I0)

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

Calculations are made utilizing the following equations:

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

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

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

where:

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

Air Cartridges (I1)

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

Calculation of results and two sigma error

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

Calculations are made utilizing the following equations:

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

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

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

where:

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

SYNOPSIS OF PSE&G RESEARCH CORPORATION PROCEDURE

RADIOSTRONTIUM ANALYSIS OF AIR FILTERS

The air filters are placed in a small beaker and just enough concentrated 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 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 its 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:

$$^{90}\text{Sr Results (pCi/m}^3) = \frac{N4/R}{(2.22)*(E)*(E(15)/E')*(S6)*(V)*(U)} = W2$$

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:

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

$$= W3$$

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 80mg/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 $^{9'}$ 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 $15 mg/cm^2$ to ^{90}Sr counting standard efficiency run at the time of instrument calibration (This standard is run with each group of environmental strontium samples)

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 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 precipitatd as its 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:

$$^{90}\mathrm{Sr\ Results\ (pCi/L)} = \frac{N4/R}{(2.22)*(E)*(E(15)/E')*(S6)*(V)*(U)} = W2$$

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 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) = $2* \dfrac{(S8^2+S9^2)^{1/2} *W3}{(N1 - N7*(1+R1*I1))}$

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

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

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:

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

$$= W2$$

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:

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

$$= W3$$

$S7 = G + H*M + I*M^2$ (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) = $\frac{2* \left(S8^2+S9^2\right)^{1/2} *W3}{(N1 - N7*(1+R1*I1))}$

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

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

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 with nitric acid and the sample filtered.

A portion of the filtrate is removed for stable strontium determination and the remaining sample treated with fuming nitric acid to precipitate strontium nitrate. The strontium nitrate is freed of calcium by treatment with anhydrous acetone. 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:

$$^{90}\text{Sr Results (pCi/kg dry)} = \frac{N4/R}{(2.22)*(E)*(E(15)/E')*(S6)*(V)*(U)} = W2$$

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:

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

$$= W3$$

$S7 = G + H*M + I*M^2$ (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. A portion of the filtrate is removed for stable strontium determination and the remainder is evaporated to near dryness and the residue dissolved in concentrated HCl before being passed through an anion exchange column to remove impurities. The resultant eluate is evaporated to dryness, then dissolved in 6N nitric acid (HNO_3). Fuming (90%) HNO_3 is added to bring the HNO_3 concentration to approximately 70%. Subsequently, radioactive impurities are removed by two precipitation steps, using ferric hydroxide and barium chromate as carriers. The strontium is precipitated as strontium carbonate before being dried and weighed. The samples are counted for beta activity in a low background gas proportional counter (Count time will vary, depending on the desired sensitivity.). There is a second count at least 14 days later. The basis for this two-count method is that ^{90}Sr and ^{89}Sr are both unknown quantities requiring two simultaneous equations to solve for them.

Calculation of ^{90}Sr Activity:

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

$$= W2$$

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) = $2* \dfrac{(S8^2+S9^2)^{1/2} *W3}{(N1 - N7*(1+R1*I1))}$

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

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

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 10 percent of a known volume of sample filtrate or leachate after the strontium carrier has been added to the sample. This aliquot is transferred to a 25ml volumetric flask and brought up to volume with distilled water. These aliquots are always in a hydrochloric acid (HCl) medium. Those which are not must first be evaporated to dryness, reconstituted with concentrated HCl and evaporated to dryness once more before being brought back to their original volume with concentrated HCl. These latter aliquots can then be transferred to volumetric flasks and brought to volume with distilled water. They are then 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 and the quantity of strontium intrinsic to the sample.

Sample Calculation of Corrected Chemical Recovery of Strontium in Biological and Mineral Media:

Reported concentration of stable strontium (mg/L):119
Volume of specimen (ml):25
Proportion of sample used for aliquot: 0.10

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

Since 2.98mg Sr represents the quantity of stable strontium in 10 percent of the sample, total strontium (stable + carrier) in the full sample =

$$\frac{2.98\text{mg Sr}}{0.1} = 29.8 \text{ mg}$$

Net weight of $SrCO_3$ precipitate (mg): 35.2
Percent of Sr in precipitate: 59.35
Quantity of strontium recovered = (35.2mg) x (.5935) = 20.9

$$\text{Corrected Chemical Recovery of strontium} = \frac{20.9}{29.8} = 0.701$$

Sample Calculation of Corrected Chemical Recovery of Strontium in Water:

Reported concentrations of stable strontium (ppm): 1.65
Volume of radiochemical water sample (liters): 2.0

1.65ppm is equivalent to 1.65mg/L

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 RADIATION MANAGEMENT CORPORATION PROCEDURE
ANALYSIS OF SAMPLES FOR STRONTIUM-89 AND -90

Total Water (S0, T0)

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

Milk (S4, T4)

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

Bones and Shells (S5, T5)

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

Soil and Sediment (S6, T6)

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

Organic Solids (S8, T8)

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

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

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

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

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

where:

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

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

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

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

where:

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

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, active area facing down, with the oldest filter at the bottom, nearest the detector, and the newest one on top. The Petri dish is closed and the sample counted on a 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 $\dfrac{\lambda t1*EXP(\lambda t2)}{1-EXP(-\lambda t1)}$
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

$$\text{2-sigma error (pCi/m}^3) = 2*(\sigma_k{}^2+\sigma_s{}^2)^{1/2}$$

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

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

n = number of peaks in the nuclide of question

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

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

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

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

All other variables are as defined earlier.

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

Again, all quantities are as defined earlier.

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

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

$$\text{2-sigma error (pCi/L)} = 2*(\sigma_k{}^2+\sigma_s{}^2)^{1/2}$$

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

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

n = number of peaks in the nuclide of question

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

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

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

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

All other variables are as defined earlier.

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

All quantities are as defined earlier.

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

$$\text{2-sigma error (pCi/L)} = 2*(\sigma_k{}^2+\sigma_S{}^2)^{1/2}$$

$$\sigma_k = \left[\frac{1}{\sum_{i=1}^{n} \frac{1}{\sigma_i^2} *A(Y)_i^2}\right]^{1/2}$$

σ_k = Statistical error of the activity measurement. It is determined from the accuracy of the least squares evaluation performed on the peaks of a particular nuclide.
n = number of peaks in the nuclide of question

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

$$A(\gamma)i = \frac{N*D}{(E)*(R)*(2.22)*(T)*(V)}$$ = gamma abundance factor for the i^{th} peak under consideration, for a given nuclide

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

All other variables are as defined earlier.

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

Again, all other variables are as defined earlier.

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 ($1 g/cm^3$), 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 $\dfrac{\lambda t1*EXP(\lambda t2)}{1-EXP(-\lambda t1)}$

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

2-sigma error (pCi/kg) = $2*(\sigma_k{}^2+\sigma_s{}^2)^{1/2}$

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

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

n = number of peaks in the nuclide of question i = $(GC+BC)^{1/2}$, where GC and BC are gross counts and background counts, respectively

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

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

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

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

All other variables are as defined earlier.

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

Again, all other variables are as defined earlier.

SYNOPSIS OF RADIATION MANAGEMENT CORPORATION PROCEDURE
GAMMA SPECTROMETRY OF SAMPLES

Water (N1)

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

Milk (N7)

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

Dried Solids (N8, G8)

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

Air Dried Solids (NA)

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

Calculation of results and two sigma error

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

Calculations are made utilizing the following equations:

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

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

where:

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

Calculation of lower limit of detection (LLD) for G8

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

where:

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

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

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

where:

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

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 formula

$$\mathrm{DOSE} = \mathrm{R} * (\mathrm{REDOSE}/\mathrm{RR}) - \mathrm{AVC}$$

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

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

N = Total number of control dosimeters

$$\mathrm{CDOSE} = \mathrm{CR} * (\mathrm{CREDOSE}/\mathrm{CRR})$$

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

SYNOPSIS OF RADIATION MANAGEMENT CORPORATION PROCEDURE

ENVIRONMENTAL DOSIMETRY (D0, D1, D2)

Measurement Techniques

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

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

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

Calculations are made utilizing the following equations:

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

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

$$N = T-I$$

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

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

where:

T = Individual TLD reading corrected to standard instrument conditions
G = Gross reading of dosimeter i
Z = Zero for dosimeter, i
R = Correction factor of reader (see Procedure T-6)
C = Calibration factor dosimeter i
I = In-transit dose
SZ = Mean of n dosimeters in site lead shield
RZ = Mean of n dosimeters in RMC lead shield
DL = Exposure period of location (days)
DR = Exposure period of RMC0 (days)

ENVIRONMENTAL DOSIMETRY (cont.)

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

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 1983 USEPA Environmental Radioactivity Laboratory Intercomparison Studies Program.

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.
1/83	EPA-WAT-AB49	Water	Alpha	21±6	29±7	26±6
	83-104		Beta	28±1	31±5	32±5
3/83	EPA-WAT-AB55	Water	Alpha	32±2	31±8	27±8
	83-349		Beta	23±3	28±5	28±4
3/83	EPA-APT-GABS57	APT	Alpha	29±1	26±6	28±4
	83-471		Beta	76±1	68±5	69±6
5/83	EPA-BLD-Z59	Water	Alpha	54±2	64±16	58±16
	83-569		Beta	111±7	149±8	136±17
5/83	EPA-WAT-AB61	Water	Alpha	12±1	11±5	11±3
	83-594		Beta	55±2	57±5	54±8
7/83	EPA-WAT-AB66	Water	Alpha	7±2	7±5	8±2
	83-944		Beta	18±2	22±5	22±4
8/83	EPA-APT-GABS69	APT	Alpha	15±1	13±5	14±3
	83-1014		Beta	47±1	36±5	39±6
9/83	EPA-WAT-AB72	Water	Alpha	4±1	5±5	5±2
	83-1127		Beta	8±1	9±5	10±3
11/83	EPA-WAT-AB79	Water	Alpha	11±1	14±5	13±3
	83-1573		Beta	15±1	16±5	17±4
11/83	EPA-BLD-Z77	Water	Alpha	19±2	(1)	(1)
	83-1511		Beta	53±1	(1)	(1)
11/83	EPA-APT-GABS82	APT	Alpha	24±1	(1)	(1)
	83-1618		Beta	68±2	(1)	(1)

(1) Results not received.

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.
2/83	EPA-WAT-G51	Water	Cr-51	55±6	45±5	48±10
	83-180		Co-60	24±2	22±5	23±3
			Zn-65	23±4	21±5	22±5
			Ru-106	56±2	48±5	47±10
			Cs-134	21±1	20±5	20±3
			Cs-137	21±1	19±5	19±3
2/83	EPA-MLK-GS52	Milk	I-131	56±1	54±6	54±5
	83-213		Cs-137	27±3	26±5	26±4
			K(*)	1570±10	1512±76	1517±172
			Ba-140	<14	0	0
3/83	EPA-ORG-GS53	Food	I-131	38±1	37±6	37±4
	83-238		Cs-137	34±1	31±5	33±3
			Ba-140	<18	0	0
			K(*)	2690±120	2590±130	2650±280
3/83	EPA-APT-GABS57	APT	Cs-137	35±1	27±5	31±5
	83-471					
5/83	EPA-BLD-Z59	Water	Co-60	30±2	30±5	31±4
	83-569		Cs-134	31±2	33±5	31±4
			Cs-137	26±1	27±5	27±4
6/83	EPA-MLK-GS62	Milk	I-131	30±2	30±6	30±4
	83-738		Cs-137	48±1	47±5	47±3
			Ba-140	<14	0	0
			K(*)	1520±50	1486±74	1494±148
6/83	EPA-WAT-G64	Water	Cr-51	71±13	60±5	62±11
	83-782		Co-60	13±1	13±5	14±2
			Zn-65	39±3	36±5	37±6
			Ru-106	42±11	40±5	40±7
			Cs-134	45±1	47±5	44±4
			Cs-137	27±1	26±5	28±5
8/83	EPA-APT-GABS69	APT	CS-137	16±1	15±5	19±4
	83-1014					

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.
10/83	EPA-WAT-G75 83-1305	Water	Cr-51	68±13	51±5	48±9
			Co-60	19±2	19±5	19±2
			Zn-65	39±3	40±5	40±6
			Ru-106	57±2	52±5	48±8
			Cs-134	14±2	15±5	15±3
			Cs-137	23±1	22±5	22±3
10/83	EPA-MLK-GS76 83-1423	Milk	I-131	37±6	40±6	(1)
			Cs-137	34±1	33±5	(1)
			Ba-140	-	-	-
			K(*)	1540±35	1550±75	(1)
11/83	EPA-BLD-Z77 83-1511	Water	Co-60	12±2	(1)	(1)
			Cs-134	15±1	(1)	(1)
			Cs-137	15±1	(1)	(1)
11/83	EPA-APT-GABS82	APT	Cs-137	22±2	(1)	(1)

(*) Reported as mg/L of Potassium

(1) Results not received.

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.
2/83	EPA-WAT-H50 83-181	Water	H-3	2760±50	2560±350	2530±270
6/83	EPA-WAT-H63 83-739	Water	H-3	1500±50	1530±340	1550±200
8/83	EPA-WAT-H68 83-1013	Water	H-3	1850±60	1836±342	1864±207
10/83	EPA-WAT-H74 83-1304	Water	H-3	2920±40	1210±329	1226±185
12/83	EPA-WAT-H81 83-1607	Water	H-3	2350±60	2389±351	2341±262

TABLE E-4

USEPA ENVIRONMENTAL RADIOACTIVITY LABORATORY INTERCOMPARSION STUDY PROGRAM

Iodine 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.
4/83	EPA-WAT-I56 83-367	Water	I-131	26±1	27±6	26±5
8/83	EPA-WAT-I67 83-969	Water	I-131	13±2	14±6	14±3
12/83	EPA-WAT-I78 83-1572	Water	I-131	20±1	20±6	20±4

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.
1/83	EPA-WAT-S48	Water	Sr-89	28±2	29±5	27±7
	83-87		Sr-90	14±1	17±2	17±2
2/83	EPA-MLK-GS52	Milk	Sr-89	33±2	37±5	32±7
	83-213		Sr-90	17±1	18±2	17±4
3/83	EPA-ORG-GS53	Food	Sr-89	35±1	35±5	33±6
	83-238		Sr-90	30±1	28±2	29±2
3/83	EPA-APT-GABS57	APT	Sr-90	19±2	20±2	19±2
	83-471					
5/83	EPA-BLD-Z59	Water	Sr-89	26±1	24±5	25±5
	83-569		Sr-90	12±1	13±2	13±2
5/83	EPA-WAT-S60	Water	Sr-89	56±2	57±5	57±10
	83-593		Sr-90	39±1	38±2	37±5
6/83	EPA-MLK-GS62	Milk	Sr-89	23±1	25±5	23±4
	83-738		Sr-90	15±1	16±2	15±2
8/83	EPA-WAT-GABS69	APT	Sr-90	10±1	10±2	10±1
	83-1014					
9/83	EPA-WAT-S71	Water	Sr-89	15±2	15±5	15±3
	83-1126		Sr-90	10±1	10±2	10±2
10/83	EPA-MLK-GS76	Milk	Sr-89	17±1	15±5	(1)
	83-1423		Sr-90	13±1	14±2	(1)
11/83	EPA-BLD-Z77	Water	Sr-89	15±2	(1)	(1)
	83-1511		Sr-90	6±1	(1)	(1)

(1) Results not received.

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.
3/83	EPA-WAT-R54	Water	Ra-226	11±1	13±2	12±2
	83-348		Ra-228	<6	0	1±2
5/83	EPA-BLD-Z59	Water	Ra-226	22±1	8±1	8±1
	83-569		Ra-228	5.0±1	5±1	6±3
6/83	EPA-WAT-R65	Water	Ra-226	4.1±1	4.8±1	5±1
	83-836		Ra-228	<1	0	1±3
9/83	EPA-WAT-R73	Water	Ra-226	3.4±1	3.1±0.5	3.1±0.6
	83-1227		Ra-228	<2	2.0±0.3	2.3±1.1
12/83	EPA-WAT-R83	Water	Ra-226	9.4±1	(1)	(1)
	83-1617		Ra-228	4.0±1	(1)	(1)

(1) **Results not received.**

APPENDIX F

SYNOPSIS OF DAIRY AND VEGETABLE GARDEN SURVEY

APPENDIX F

SYNOPSIS OF 1983 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 Nuclear Generating Station (SNGS) was performed in April and July, 1983.

The result of the April survey were as follows:

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

One dairy farm, situated 5.0 miles NNE of SNGS was located.

The result of the July survey were as follows:

No change from the April survey.

VEGETABLE GARDEN SURVEY

A survey of vegetable gardens conducted out to a distance of one mile of the SNGS was performed in September 1983.

No vegetable gardens were found within this area.