RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL REPORT FOR THE CALVERT CLIFFS NUCLEAR PLANT UNITS 1 AND 2 JANUARY 1 - DECEMBER 31, 1979

L. J. Bartal
A. Rafi
E. C. Reichert
J. W. Stout, Jr.

BALTIMORE GAS AND ELECTRIC COMPANY

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TABLE OF CONTENTS

	PAGE
LIST OF FIGURES	ii
LIST OF TABLES	ii
A. SUMMARY	1
B. INTRODUCTION	3
C. PROGRAM	3
C. 1 Objectives	3
C. 2 Sample Collection	4
C. 3 Data Interpretation	4
C. 4 Program Exceptions	4
D. RESULTS AND DISCUSSIONS	5
D. 1 Aquatic Environment	5
D. 2 Atmospheric Environment	7
D. 3 Terrestrial Environment	9
D. 4 External Radiation	10
E. CONCLUSION	11
F. REFERENCES	20
APPENDIX A - Environmental Sampling Location	22
APPENDIX B - Analytical Data Tables	26

LIST OF FIGURES

FIGURE	TITLE	PAGE
A-1	Map of Southern Maryland and Chesapeake Bay Showing Location of Calvert Cliffs Nuclear Power Plant	24
A-2	Radiological Environmental Monitoring Stations in the Vicinity of the Calvert Cliffs Nuclear Power Plant	25

LIST OF TABLES

TABLE	TITLE	PAGE
1	Synopsis of the 1979 Calvert Cliffs Nuclear Power Plant Radiological Environmental Monitoring Program	12
2	Annual Summary of Radioactivity in the Environs of the Calvert Cliffs Nuclear Power Plant Units 1 and 2	15
A-1	Locations of Environmental Sampling Stations for the Calvert Cliffs Nuclear Power Plant	23

A. SUMMARY

During this operating period for Calvert Cliffs Unit 1 and Unit 2, Radiation Management Corporation (RMC) and Baltimore Gas and Electric Company (BG&E) analyzed samples from the aquatic, atmospheric, and terrestrial environments. Baltimore Gas and Electric Company made measurements of external radiation. A total of 1,044 analyses were performed on 746 environmental samples during the period covered by this report. In addition, BG&E personnel analyzed 612 thermoluminescent dosimeters (TLD's) for ambient radiation dose rates.

Samples of the aquatic environment included bay water, fish, shellfish (oysters, crabs) and sediment. Bay water was analyzed for tritium, Sr-89 and Sr-90 and gamma emitting nuclides. Fish, shellfish and sediment were analyzed for gamma emitting nuclides. Fish bones and sediment were also analyzed for Sr-89 and Sr-90.

Samples from the atmospheric environment included air and precipitation. Air particulates and gaseous iodine were collected on glass fiber filters and silver zeolite molecular sieve cartridges, respectively. The particulate filters were analyzed for gross beta activity and for gamma emitting nuclides while the molecular sieve cartridges were analyzed for I-131. Quarterly composite analyses for Sr-89 and Sr-90 on air particulate filters are reported. Precipitation was analyzed for gross beta, H-3, Sr-89, Sr-90 and gamma emitting nuclides.

Monitoring of the terrestrial environment included vegetation, soil, and ground water samples. The vegetation and soil samples were analyzed for gamma emitters and Sr-89 and Sr-90. The ground water samples were analyzed for H-3 and gamma emitting nuclides.

Measurements of external radiation were performed by analyzing thermoluminescent dosimeters from 13 locations surrounding the plant.

Low levels of various radionuclides were occasionally observed in the environment surrounding the plant during 1979. Most of these observations were attributed to the fallout from recent and past atmospheric nuclear bomb testing. A few of these observations, however, may be directly related to the operation of the plant. Tritium was observed in three samples taken from the discharge area in concentrations greater than that generally observed in previous years. Silver-110m was observed in oyster samples from Camp Conoy in concentrations comparable to previous years. And Co-58 and Co-60 appeared in sediment samples taken from the intake area where they had only sporadically appeared in the past. In all of these cases, the activity was low and consequently would have had little impact on the surrounding environment.

The results of the dose calculations performed by using the plant effluent release data, on site meteorological data and appropriate pathways indicate: (a) thyroid inhalation maximum dose of 0.133 mrem (at the On Site location 18 about 2000 feet southeast from the plant vent) which is less than 1% of the permissible limit of 15 mrem/reactor-year specified in Appendix I 10 CFR 50, and less than 0.2% of the

acceptable limit of 75 mrem/year specified in 40 CFR 190 Environmental Radiation Protection Standards For Nuclear Power Operations; (b) thyroid dose (maximum via inhalation and milk pathway) of 0.24 mrem (at the farm location 16) which is less than 2% of the permissible limit of 15 mrem/reactor-yr (Appendix I 10 CFR 50) and less than 0.4% of the acceptable limit of 75 mrem/year specified in 40 CFR 190; (c) a total body gamma immersion maximum dose of 0.026 mrem (at the On Site location 18) which is less than 1% of the permissible dose of 5 mrem/reactor-year specified in Appendix I 10 CFR 50, and less than 0.2% of the acceptable dose of 25 mrem/year specified in 40 CFR 190; (d) a total body dose (maximum via all liquid pathways) of 0.015 mrem which is less than 1% of the permissible limit of 3 mrem/reactor-year (Appendix I 10 CFR 50) and less than 0.1% of the acceptable limit of 25 mrem/yr specified in 40 CFR 190.

Thus it is concluded, based upon the levels of radioactivity observed and the various dose calculations, that the operation of the Calvert Cliffs Nuclear Power Plant Units 1 and 2 did not cause any significant changes in the observed concentrations of environmental radioactivity or ambient radiation levels.

B. INTRODUCTION

Baltimore Gas and Electric Company (BG&E) has been conducting a radiological environmental monitoring program in the environs of the Calvert Cliffs Nuclear Power Plant since the summer of 1970. Results of the analyses of environmental samples for the preoperational and operational periods through December 31, 1978 have been reported in a series of documents (1-15).

This report presents the type and number of samples analyzed, the analyses performed (see Table 1 for a summary of the surveillance program) and the data generated during 1979. Interpretation of the data and conclusions are presented.

Appendix A summarizes the sample media and relative sampling locations with respect to the Calvert Cliffs Nuclear Power Plant (Table A-1 and Figure A-1). Figure A-2 shows the location of the Calvert Cliffs Nuclear Site in relation to the Chesapeake Bay and Southern Maryland. The Calvert Cliffs site is an operating nuclear generating station consisting of two PWR Units. Unit 1 achieved criticality on October 7, 1974, and commenced commercial operation in May 1975. Unit 2 achieved criticality on November 30, 1976, and went into commercial operation April 1, 1977. Since July 29, 1977, we have been operating under combined Environmental Technical Specifications for Units 1 and 2 (16). Prior to this date, separate Environmental Technical Specifications (17, 18) were in effect for each unit.

C. PROGRAM

The environmental surveillance data collected during this reporting period were compared with that generated in previous periods to assess the environmental radiological impact of the operation of Calvert Cliffs Nuclear Power Plant Units 1 and 2.

C.1 Objectives

The objectives of the operational radiological environmental program are:

a. To determine whether any statistically significant increase occurs in the concentration of radionuclides in important pathways.

b. To detect any possible buildup of long-lived radionuclides in the environment.

c. To monitor and evaluate ambient radiation levels.

d. To verify that radioactivity and ambient radiation levels attributable to the plant are within the limits specified in the Technical Specifications (16).

C.2 Sample Collection

The locations of the individual sampling stations are listed in Table A-1 and shown in Figure A-2. All samples were collected by consultants to, or personnel of, Baltimore Gas and Electric Company according to BG&E operating procedures (19). Radiochemical analyses were performed by RMC and BG&E.

Ambient radiation measurements were made by Baltimore Gas and Electric Company personnel in accordance with an operating procedure (22). These measurements were made with thermoluminescent dosimeters as previously described (10).

C.3 Data Interpretation

Analytical data generated during the program are routinely evaluated. In the interpretation of the data several factors are important and are discussed here to avoid repetition in the sections that follow.

It is characteristic of environmental monitoring data that many results occur at or below the minimum detectable level (MDL). In this report, all results occurring at or below the relevant MDL are reported as being "less than" the MDL value.

Annual means, range and typical MDL's are presented for each type of analysis for every sample media. Results of individual analyses are also presented with applicable standard deviations.

In the case of gamma spectrometry, if no activity of a particular nuclide was found, no average was calculated for that nuclide.

C.4 Program Exceptions

Surveys conducted in April and October 1979 determined that there was a milk cow within five miles of the plant, but the owner was unwilling to provide milk samples. Therefore, no milk samples were analyzed during this reporting period.

A shore line search for rooted aquatics is conducted at the Flag Ponds area every month. Additionally, the area of shallow water at Flag Ponds is swept by shore seine every month. For 1979 there were no rooted aquatic plants obtained.

The commercial pound nets south of Cove Point were not successfully deployed during 1979 and the commercial fisherman, therefore, could not make any catch during the year. Samples of edible fish were, however, obtained during August and October from our monthly benthic trawl surveys. The fish collected were obtained from sampling locations in the vicinity of the Plant.

Samples of crabs were not available during the first quarter of 1979 for reasons previously described (10).

D. RESULTS AND DISCUSSIONS

All the environmental samples were either analyzed by RMC laboratory procedures (20) or BG&E laboratory procedures (21). The analytical results for this reporting period, presented in Appendix B and also summarized on an annual basis in Table 2, have been divided into four categories--aquatic, atmospheric, and terrestrial environment, and external radiation.

D.1 Aquatic Environment

The aquatic environment surrounding the plant was monitored by analyzing samples of bay water, aquatic organisms, and bottom sediment. These samples were obtained from various sampling locations on the Chesapeake Bay near the plant.

D.1.a Bay Water

Monthly bay water samples were taken from two locations; the Plant Intake area (location 8) and the Plant Outfall area (location 7). These samples were analyzed for H-3, gamma emitters, and Sr-89 and Sr-90.

Monthly analyses for H-3 in these samples exhibited concentrations ranging from <108 to 1328 ± 133 pCi/l for location 7 and from <108 to 206 ± 97 pCi/l for location 8. Most of the results were well within the ranges observed in both the preoperational (6) and previous operation (15) periods; however three results, all from location 7, were outside these ranges (viz., 1106 ± 111 pCi/l in February, 875 ± 137 pCi/l in June, and 1328 ± 133 pCi/l in September). These outlying results are probably related to routine releases of tritium from the plant.

Monthly analyses for gamma emitters in these samples revealed that no detectable concentrations of activation or fission products were present.

Quarterly analyses for radiostrontium in these samples showed no detectable concentrations of Sr-89 and two detectable concentrations of Sr-90 (viz., 0.50 ± 0.37 pCi/l in the second quarter from location 8 and 0.70 ± 0.67 pCi/l in the third quarter sample from location 7). Both of these detectable concentrations of Sr-90 are comparable to the concentrations observed in the preoperational (6) and previous operational periods (15).

D.1.b Aquatic Organisms

Quarterly samples of aquatic organisms were taken from five locations; the vicinity of the power plant - from Kenwood Beach to Rocky Point, Kenwood Beach (location 3), Rocky Point (location 4), Camp Conoy (location 5) and Plant Intake area (location 8). The edible portions of these samples were analyzed for gamma emitters, and samples of fish bones were analyzed for Sr-89 and Sr-90.

Quarterly analyses for gamma emitters in all the fish and crab samples, and the oyster samples from location 3 revealed that no detectable concentrations of fission and activation products were present. However, the analyses of the oyster samples from location 5 showed detectable concentrations of Ag-110m ranging from 88±4 to 266±11 pCi/kg. The presence of Ag-110m in these samples is most probably due to a bioaccumulation of this nuclide, present in routine releases from the plant.

Quarterly radiostrontium analyses of the bones from the fish samples showed only one detectable concentration of Sr-89 (26±9 pCi/l in the fourth quarter spot sample) and showed detectable concentrations of Sr-90, ranging from 16±3 to 37±14 pCi/kg, in all the samples analyzed. The single positive Sr-89 result may be related to plant operation. It is also possible that this positive value is a spurious statistical result of the radiochemical procedure for determining strontium. The Sr-90 results, on the other hand, fall into the same general patterns observed in both the preoperational (6) and previous operational periods (15).

D.1.c <u>Sediment</u>

Quarterly sediment samples were taken from four locations; Camp Conoy (location 5), Long Beach (location 6), Plant Intake area (location 8), and Plant Outfall area (location 7). These samples were analyzed for gamma emitters and Sr-89 and Sr-90.

Quarterly analyses for gamma emitters in these samples revealed the presence of Cs-137 in all samples from all locations (ranging from 191±21 pCi/kg to 1163±77 pCi/kg); the presence of Co-58 in all samples from location 8 (ranging from 54±19 pCi/kg to 553±76 pCi/kg); the presence of Co-60 in all samples from location 8 (ranging from 23±23 pCi/kg to 701±115 pCi/kg); and the presence of Ce-144 in the samples from locations 6 and 8 (ranging from 398±92 pCi/kg to 1225±192 pCi/kg). The ranges of Cs-137 exhibited are typical of the ranges observed in the preoperational (6) and previous operational periods (15) and are probably related to past nuclear bomb testing. In addition, the presence of Ce-144 at location 8 and at the control location 6 are also most probably related to past atmospheric testing, since this nuclide was one of the "main fallout nuclides" of the nuclear bomb testing conducted in 1977 and 1978 (14, 15), and it has long enough half-life to still linger in the environment. On the other hand, the presence of Co-58 and Co-60 exclusively in the vicinity of the plant suggests that they are plant-related.

Quarterly radiostrontium analyses showed no detectable concentrations of Sr-89 in any of these samples and only the sporadic presence of Sr-90 in the samples taken from all locations. The Sr-90 results ranged from 25±23 pCi/kg to 103±79 pCi/kg, and they are typical of the ranges observed in the preoperational (6) and previous operational (15) periods.

D.1.d Discussion

Dose calculations, utilizing the plant's effluent release data (23) and the appropriate regulatory guide (24), were made to assess the plant's radiological impact on the surrounding aquatic environment. The calculations included dose estimates received from the liquid pathways of fish and invertebrate ingestion and from shore line exposures. The results are: (a) a total body dose of about 0.015 m rem which is less than 1% of the permissible total body dose of 3 mrem/reactor/year (Appendix I to 10 CFR Part 50) and less than 0.1% of the whole body dose of 25 mrem/year as specified in 40 CFR Part 190 Environmental Radiation Protection Standards for Nuclear Power Operations; and (b) a thyroid dose of about 0.05 m rem which is less than 1% of the permissible dose of 10 mrem/reactor/year to any organ (Appendix I to 10 CFR Part 50) and less than 0.1% of the thyroid dose of 75 mrem/year as specified in 40 CFR Part 190 Environmental Radiation Protection Standards for Nuclear Power Operations.

Thus, it is apparent, based upon the results of the monitoring program and the dose calculations performed, that the plant's contribution to the radioactivity of the surrounding aquatic environment was insignificant during the year 1979.

D.2 Atmospheric Environment

The atmospheric environment was monitored by analyzing samples of air particulate filters, silver zeolite cartridges, and precipitation samples. These samples were collected from various locations surrounding the plant.

D.2.a Air Particulate Filters

Weekly composite air filters were collected from seven locations; On Site (location 17), On Site (location 18), Knotty Pine (location 19), Lusby (location 20), Long Beach (location 21), Cove Point (location 22), and Taylors Island (location 23). These samples were analyzed for beta activity, gamma emitters, and Sr-89 and Sr-90.

Weekly analyses for beta activity in air filters revealed that the range of data for each site followed similar trends. The ranges started with a maximum value at the beginning of the year, then diminished gradually and consistently throughout the succeeding weeks until a minimum value was reached at the end of the year. These trends are probably due to the decay and "washout" of residual activity from the atmospheric nuclear testing carried out during 1977 and 1978.

Monthly analyses for gamma emitters showed only the sporadic presence of the fission by-products Cs-137 and Ce-144, both of which appeared exclusively in the first part of the year. These two radionuclides were typically present in the fallout patterns observed after the nuclear bomb testing of the preceding year (14, 15), and both have half-lives sufficiently long enough to reappear in samples almost a year later.

Quarterly radiostrontium analyses showed detectable concentrations of Sr-89 at four locations during the third quarter [viz., $(1.75 \pm 0.79) \times 10^{-3}$ at location 17, $(0.91 \pm 0.78) \times 10^{-3}$ pCi/m^3 at location 19, $(0.88 \pm 0.32) \times 10^{-3}$ pCi/m^3 at location 20, and $(1.10 \pm 0.84) \times 10^{-3}$ pCi/m^3 at location 21] and detectable concentrations of Sr-90 at all sites during the first and second quarters, ranging from $(0.22 \pm 0.21) \times 10^{-3}$pCi/m^3 to $(0.75 \pm 0.31) \times 10^{-3}$ pCi/m^3. In view of the short half-life of Sr-89, its presence is due to a source recent in origin, and probably related to the releases from the plant. The Sr-90 concentrations in large part, are most probably related to past nuclear weapons testing, since the concentration ranges are typical of previous years (14,15), and the trend of data exhibited (from maximum at the beginning of the year to the minimum at the end) mirror the trend in beta activity.

D.2.b Air Iodine

Weekly composite radioiodine samples were collected from five locations; On Site (location 17), On Site (location 18), Lusby (location 20), Cove Point (location 22), and Taylors Island (location 23).

Radioiodine analyses performed on the samples from all locations exhibited no detectable concentrations of I-131.

D.2.c Precipitation

Monthly composite preceiptation samples were collected from one site, On Site (location IS), and were analyzed for gross beta, H-3, gamma emitters, and Sr-89 and Sr-90.

The results of the monthly analyses of the precipitation samples for beta activity, and the quarterly analyses for tritium and Sr-89 seem to fall into the same general pattern as the results of air particulate filters for beta activity and Sr-90 (i.e., a maximum at the geginning of the year, decreasing to minimum at year's end). This pattern, as discussed previously, indicates that the observed activity is probably due to past nuclear testing. The analyses for gamma emitters and Sr-90 revealed that no detectable concentrations of either were observed in any of the precipitation samples.

D.2.d Discussion

Whole body and thyroid dose calculations were performed for various receptor stations surrounding the plant, utilizing the plant's effluent release data (23), the prevailing meteorological conditions, and the appropriate regulatory guides (24,25). The results are: (a) that on site location 18 was the recepotr station with the highest overall doses; (b) a total body doe of about 0.026 mrem which is less than 1% of the permissible total body dose of 5 mrem/reactor/year (Appendix I to 10 CRF Part 50) and less than 0.2% of the whole body dose of 25 mrem/year as specified in 40 CRF Part 190 Environmental Radiation Protection Standards for Nuclear Power Operations; and (c) a thyroid dose of 0.133 mrem which is less than 1% of the permissible thyroid dose of 15 mrem/reactor/year (Appendix I to 10 CFR 50) and less than 0.2% of the thyroid dose of 75 mrem/year as specified in 40 CFR Part 190 Environmental Radiation Protection Standards for Nuclear Power Operation.

Again it is apparent, based upon the results of the monitoring program and the dose calculations performed, that the plant's contribution to the radioactivity of the surrounding atmospheric environment was insignificant during the year 1979.

D.3 Terrestrial Environment

The terrestrial environment was monitored by analyzing samples of vegetation, soil, and well water. These samples were collected from various sampling locations near the plant.

D.3.a Vegetation

Vegetation samples were collected from three locations; On Site (location 14), a nearby farm (location 15), and another nearby farm (location 16). These samples included cabbage, corn, radishes, sunflower, and tobacco. They were analyzed for gamma emitters and Sr-89 and Sr-90.

Analyses for gamma emitters in these samples revealed that only naturally occurring radionuclides were present in detectable concentrations.

Radiostrontium sanalyses of these samples showed only one detectable concentration of Sr-89 (viz., 274±190 pCi/kg in the October sunflower samples from location 14) and showed detectable concentrations of Sr-90, ranging from 29±26 pCi/kg to 1840±280 pCi/kg, in almost all of the samples analyzed. The single positive Sr-89 result may have been plant related, though the rest of the vegetation sample results do not readily support this. It is also possible that this positive value is a spurious statistical result of the radiochemical procedure for determining strontium. The Sr-90 results, on the other hand, fall into the same general pattern observed in the preceding years when there were nuclear weapons testing (14, 15). In addition to this, the half-life of Sr-90 is long enough to linger in the environment for extended periods. Thus, these Sr-90 results are most probably attributable to the fallout from the past atmospheric testing.

D.3.b Soil

Semiannual soil samples were taken from three On Site locations; 11,12, and 13. These samples were analyzed for gamma emitters and Sr-89 and Sr-90.

Analyses for gamma emitters in these samples revealed a single detectable concentration of Ce-144 (VIZ., 289±59 pCi/kg in the March sample from location 13) and revealed detectable concentrations of Cs-137, ranging from 64±26 pCi/kg to 293±35 pCi/kg, in five out of the six samples analyzed.

As cited earlier, both of these radionuclides were observed in air particulate filter samples during the year, and it was suggested then that these two radionuclides were related to past nuclear testing. In conjunction with this, the appearance of these nuclides in soil samples and sediment samples, taken during the year, would reflect an atmospheric "washout" phenomenon of the long-lived by-products from previous nuclear bomb tests.

Radiostrontium analyses of these samples exhibited no detectable concentrations of Sr-89 and only the sporadic presence of Sr-90 in the samples analyzed, ranging from 36±23 pCi/kg to 84±35 pCi/kg. This range of Sr-90 results is comparable to the ranges observed in the preceding years of 1977 and 1978, and it is most probably the result of past nuclear weapons testing (6, 15).

D.3.c Well Water

Quarterly well water samples were collected from five locations; Chesapeake County Club (location 2), On Site (location 10), Long Beach (location 21), and White Sands Club (locations 25A and 25B). These samples were analyzed for H-3 and gamma emitters.

Both the quarterly analyses for tritium and the quarterly analyses for gamma emitters in these samples revealed that no detectable concentration of any fission or activation by-products were present.

D.3.d Discussion

As with the aquatic and atmospheric environment, the analytical results suggest that the plant's contribution to the natural and man-made radionuclide inventory of the terrestrial environment was minimal. There were a few fission by-products, namely Sr-89, Sr-90, Cs-137, and Ce-144, which could be attributable to either plant operation or past nuclear testing. Regardless of which of these was the source of the nuclides in question, dose calculations were performed for pathways of interest to assess the plant's radiological impact on the surrounding terrestrial environment. Plant effluent release data for batch and continuous releases (23) and on site meteorological data were utilized in conformance with appropriate regulatory guides (24, 25). The result of these calculations was an estimated thyroid dose of 0.24 m rem which is less than 2% of the allowable dose of 15 mrem/reactor/yr to any organ as specified in Appendix I to 10 CFR Part 50, and less than 0.4% of the permissible thyroid dose of 75 mrem/yr (40 CFR Part 190 Environmental Radiation Protection Standards for Nuclear Power Operations).

Thus it is apparent from the above discussion that the plant operation during 1979 did not make any significant contribution to radioactivity in the surrounding terrestrial environment.

D.4 External Radiation

Monthly thermoluminescent dosimeters were taken from 13 locations surrounding the plant, namely: Plant Outfall (location 7), On Site (location 17), On Site (location 18), Knotty Pine (location 19), Lusby (location 20), Long Beach

(location 21), Cove Point (location 22), Taylors Island (location 23), On Site (location 24), White Sands Club Sign (location 25), St. Leonard (location 26), Solomons (location 27), and Bertha (location 28). The dosimeters were read for mrems of external radiation dose.

The TLD data for each site are compiled in Table B-15 and are presented on an annual basis in Table 2. The means and ranges expressed in Table 2 were compared with the means and ranges for the previous years of 1977 and 1978. This comparison revealed that means and ranges for 1979 were less than those observed in the two preceding years.

In order to assess the contribution of the plant to ambient radiation levels, gamma immersion dose calculation, utilizing the plant's gaseous release data (23) and on site meteorological data, were made. The maximum plant contribution is estimated to have been 0.026 mrem at location 18 which is less than 1% of the allowable whole-body dose of 5 mrem/reactor/year as specified in Appendix I to 10 CFR Part 50, and less than 0.2% of the whole-body dose of 25 mrem/yr (40 CFR Part 190 Environmental Radiation Protection Standards for Nuclear Power Operations).

It is apparent from the above discussion that the plant operation during 1979 did not make any significant contribution to ambient radiation levels.

E. Conclusion

Detectable levels of radicactivity were observed occasionally in samples from various locations during the year. The majority of these observations are attributable to the atmospheric nuclear bomb testing conducted in 1977 and 1978. However, a few of these observations may be directly related to the operation of the plant (e.g., H-3 in bay water, Co-58 and Co-60 in sediment, and Ag-110m in oysters).

The results of the dose calculations performed by using the plant effluent release data, on site meteorological data and appropriate pathways indicate: (a) thyroid inhalation maximum dose of 0.133 m rem (at the On Site location 18 about 2000 feet southeast from the plant vent) which is less than 1% of the permissible limit of 15 mrem/reactor-year specified in Appendix I 10 CFR 50, and less than 0.2% of the acceptable limit of 75 mrem/year specified in 40 CFR 190 Environmental Radiation Protection Standards For Nuclear Power Operations; (b) thyroid dose (maximum via inhalation and milk pathway) of 0.24 m rem (at the farm location 16) which is less than 2% of the permissible limit of 15 mrem/reactor-yr (Appendix I 10 CFR 50) and less than 0.4% of the acceptable limit of 75 mrem/year specified in 40 CFR 190, (c) a total body gamma immersion maximum dose of 0.026 m rem (at the On Site location 18) which is less than 1% of the permissible dose of 5 mrem/reactor-year specified in Appendix I 10 CFR 50, and less than 0.2% of the acceptable dose of 25 mrem/year specified in 40 CFR 190; (d) a total body dose (maximum via all liquid pathways) of 0.015 m rem which is less than 1% of the permissible limit of 3 mrem/reactor-year (Appendix I 10 CFR 50) and less than 0.1% of the acceptable limit of 25 mrem/yr specified in 40 CFR 190.

Thus it can be concluded that the observed activities, coupled with appropriate dose calculations, indicate that plant operation during 1979 had no significant radiological impact on the environment.

TABLE 1

SYNOPSIS OF THE 1979 CALVERT CLIFFS NUCLEAR POWER PLANT RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM
Docket Nos. 50-317/318

SAMPLE TYPE	SAMPLING* FREQUENCY	NUMBER OF LOCATIONS	NUMBER COLLECTED	ANALYSIS	ANALYSIS* FREQUENCY	NUMBER PERFORMED
AQUATIC ENVIRONMENT						
Bay Water	M	2	24	H-3	M	24
				Gamma (GeLi)	M	24
				Sr-89	QC	8
				Sr-90	QC	8
Fish(1)	Q	1	6	Flesh		
				Gamma (GeLi)	Q	6
				Bones		
				Sr-89	Q	6
				Sr-90	Q	6
Shell Fish(2) (Crabs, Oysters)	Q	4	17	Flesh		
				Gamma (GeLi)	Q	17
Bottom Sediments	Q	4	16	Gamma (GeLi)	Q	16
				Sr-89	Q	16
				Sr-90	Q	16
Rooted Aquatic Plant (3)	Spring & Fall	1	-	Gamma (GeLi)	2/A	-
				Sr-89	2/A	-
				Sr-90	2/A	-

TABLE 1 (CONT.)

SYNOPSIS OF THE 1979 CALVERT CLIFFS NUCLEAR POWER PLANT RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM
Docket Nos. 50-317/318

SAMPLE TYPE	SAMPLING* FREQUENCY	NUMBER OF LOCATIONS	NUMBER COLLECTED	ANALYSIS	ANALYSIS* FREQUENCY	NUMBER PERFORMED
ATMOSPHERIC ENVIRONMENT						
Air Iodine(4)	W	4	265	I-131	W	265
Air Particulates(5)	W	7	371	Gross Beta	W	371
				Gamma (GeLi)	MQ	84
				Sr-89	QC	28
				Sr-90	QC	28
Precipitation(6)	Continuous	1	12	H-3	QC	4
				Gross Beta	M	12
				Gamma (GeLi)	M	12
				Sr-89	QC	4
				Sr-90	QC	4
TERRESTRIAL ENVIRONMENT						
Vegetation(7)	At Harvest	3	9	Gamma (NaI)	A	9
				Sr-89	A	9
				Sr-90	A	9
Soil	SA	3	6	Gamma (GeLi)	SA	6
				Sr-89	SA	6
				Sr-90	SA	6

TABLE 1 (CONT.)

SYNOPSIS OF THE 1979 CALVERT CLIFFS NUCLEAR POWER PLANT RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM
Docket Nos. 50-317/318

SAMPLE TYPE	SAMPLING* FREQUENCY	NUMBER OF LOCATIONS	NUMBER COLLECTED	ANALYSIS	ANALYSIS* FREQUENCY	NUMBER PERFORMED
TERRESTRIAL ENVIRONMENT (CONT.)						
Ground Water	Q	5	20	H-3	Q	20
				Gamma (GeLi)	Q	20
External Radiation	M	13	612	TLD	M	612

* W - weekly, M - monthly, Q - quarterly, SA - semi-annual, A - annual, C - composite.

(1) Edible species are sampled when available.
(2) The location of crab samples may vary depending upon their availability.
(3) Sampling may be interrupted when no rooted aquatic plants are available.
(4) The collection devices contain silver zeolite.
(5) After a minimum decay period of 72 hrs, beta counts are performed. Gamma spectrometry is performed on monthly composites of weekly samples. Strontium-89 and -90 analyses are performed on quarterly composites of weekly samples.
(6) All analyses subject to sufficient sample collection.
(7) Predominant food crops (corn & small grains) are sampled when available.

TABLE 2

ANNUAL SUMMARY OF RADIOACTIVITY IN THE ENVIRONS
OF THE CALVERT CLIFFS NUCLEAR POWER PLANT
UNITS 1 AND 2 (Jan.-Dec. 1979)

Docket Nos. 50-317/318

Sample Type	Site	Radioactivity	Typical MDL's	Annual Results Mean (f)*	Annual Results Range***
Aquatic Environment					
Bay Water				pCi/l	
	7 Plant Outfall	H-3	114	517 (8/12)	(<108-1328)
		Sr-90	0.80	0.70 (1/4)	(<0.56-0.70)
	8 Plant Intake	H-3	119	177 (5/12)	(<108-206)
		Sr-90	0.90	0.50 (1/4)	-
Fish				pCi/Kg (Wet)	
Flounder	Plant Site	Sr-90	-	22 (2/2)	-
Spot	Plant Site	Sr-90	-	34 (2/2)	-
Shell Fish				pCi/Kg (Wet)	
Oysters	5 Camp Conoy	Ag-110m	7	195 (4/4)	(<7-266)
Bottom Sediment				pCi/Kg (Dry)	
	5 Camp Conoy	Co-60	85	58 (1/4)	-
		Sr-90	44	44 (1/4)	(<33-47)
		Cs-137	-	633 (4/4)	-
		Ce-144	240	543 (1/4)	(<240-543)
	6 Long Beach**	Sr-90	51	25 (1/4)	-
		Cs-137	-	757 (4/4)	-
		Ce-144	240	589 (4/4)	(<240-764)
	7 Plant Outfall	Co-58	69	26 (1/4)	-
		Sr-90	79	44 (1/4)	-
		Cs-137	-	602 (4/4)	-

TABLE 2 (CONTINUED)

Sample Type	Site	Radioactivity	Typical MDL's	Annual Results Mean (f)*	Annual Results Range***
Bottom Sediment (Continued)				pCi/Kg (Dry)	
	8 Plant Intake	Co-58	69	382 (4/4)	(<69-553)
		Co-60	85	376 (4/4)	(<85-701)
		Sr-90	44	72 (2/4)	(<44-103)
		Cs-137	-	618 (4/4)	-
		Ce-144	240	1011 (3/4)	(<240-1110)
Atmospheric Environment					
Air Particulates				10^{-2} pCi/m^3	
	17 On Site	Gross Beta	0.2	1.8 (52/53)	(<0.2-6.5)
		Sr-89	0.07	0.18 (1/4)	(<0.05-0.18)
		Sr-90	0.03	0.05 (2/4)	(<0.03-0.05)
	18 On Site	Gross Beta	0.2	1.5 (50/53)	(<0.2-3.4)
		Sr-90	0.03	0.03 (2/4)	(<0.03-0.03)
		Cs-137	0.07	0.08 (1/12)	(<0.07-0.08)
	19 Knotty Pine	Gross Beta	0.2	2.0 (53/53)	(<0.2-4.0)
		Sr-89	0.07	0.09 (1/4)	(<0.05-0.09)
		Sr-90	0.03	0.04 (2/4)	(<0.03-0.06)
	20 Lusby	Gross Beta	0.2	2.0 (53/53)	(<0.2-4.6)
		Sr-89	0.10	0.09 (1/4)	(<0.06-0.09)
		Sr-90	0.04	0.05 (1/4)	(<0.04-0.08)
		Ce-141	-	0.23 (1/12)	-
		Ce-144	0.21	0.39 (1/12)	(<0.21-0.39)
	21 Long Beach	Gross Beta	0.2	1.7 (53/53)	(<0.2-3.5)
		Sr-89	0.07	0.11 (1/4)	(<0.05-0.11)
		Sr-90	0.03	0.04 (2/4)	(<0.03-0.04)
		Ce-144	0.21	0.39 (1/12)	(<0.21-0.39)

TABLE 2 (CONTINUED)

Sample Type	Site	Radioactivity	Typical MDL's	Annual Results Mean (f)*	Range***
Air Particulates (Continued)				10^{-2} pCi/m^3	
	22 Cove Point	Gross Beta	o.2	1.9 (53/53)	(<0.2-3.7)
		Sr-90	0.04	0.06 (2/4)	(<0.04-0.07)
	23 Taylors Island**	Gross Beta	0.2	1.4 (53/53)	(<0.2-3.0)
		Sr-90	0.04	0.03 (2/4)	-
Precipitation				pCi/l	
	IS On Site	Gross Beta	0.2	5.4 (12/12)	(<0.2-13)
		H-3	133	194 (1/4)	(<130-194)
		Sr-89	2.1	0.9 (1/4)	-
Terrestrial Environment					
Vegetation				pCi/Kg (Wet)	
Cabbage	14 Old Bay Farm	Sr-90	32	153 (1/1)	-
Radish	14 Old Bay Farm	Sr-90	32	64 (1/1)	-
Corn	14 Old Bay Farm	Sr-90	32	80 (1/1)	-
Tobacco	14 Old Bay Farm	Sr-90	32	1840 (1/1)	-
Tobacco	15 Farm	Sr-90	32	444 (1/1)	-
Corn	16 Parren Farm	Sr-90	32	29 (1/1)	-
Tobacco	16 Parren Farm	Sr-90	32	363 (1/1)	(<32-363)
Sunflower	14 Old Bay Farm	Sr-90	32	1050 (1/1)	(<32-1050)
Soil				pCi/Kg (Dry)	
	11 On Site	Sr-90	33	78 (1/2)	(<33-78)
		Cs-137	20	179 (2/2)	(<20-293)

TABLE 2 (CONTINUED)

Sample Type	Site	Radioactivity	Typical MDL's	Annual Results Mean (f)*	Annual Results Range***
Terrestrial Environment					
Soil (Continued)				pCi/Kg (Dry)	
	12 On Site	Sr-90	35	60 (2/2)	(<35-84)
		Cs-137	20	166 (1/2)	(<20-166)
	13 On Site	Cs-137	20	201 (2/2)	(<20-201)
		Ce-144	106	289 (1/2)	(<106-289)
External Radiation				mR/30 Days	****
	7 Plant Outfall			3.14 (12/12)	(2.96-3.23)
	17 On Site			5.23 (12/12)	(4.84-5.54)
	18 On Site			4.57 (12/12)	(4.14-5.12)
	19 Knotty Pine			4.09 (12/12)	(3.91-4.31)
	20 Lusby			4.36 (12/12)	(3.80-4.75)
	21 Flag Harbor			3.73 (12/12)	(3.44-3.99)
	22 Cove Point			4.00 (11/12)	(3.71-4.26)
	23 Taylors Island			5.62 (12/12)	(5.00-6.16)
	24 On Site			5.29 (12/12)	(4.85-5.75)
	25 White Sands Club Sign			4.81 (12/12)	(4.66-5.01)
	26 St. Leonard			4.09 (12/12)	(3.69-4.42)

TABLE 2 (CONTINUED)

Sample Type	Site	Radioactivity	Typical MDL's	Annual Results Mean (f)*	Range***
External Radiation (Continued)				mR/30 Days	****
	27 Solomons			3.98 (10/12)	(3.57-4.25)
	28 Bertha			4.63 (12/12)	(4.29-4.96)

*Mean encompasses only detectable quantities; fractions in parenthesis represent the proportion of detectable quantities to total quantities in a data set. For External Radiation, the fractions represent the proportion of TLDs recovered to the total placed in the field.

**Control lcoations.

***Minimum observable to maximum observed.

****Minimum to maximum observed.

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APPENDIX A

Appendix A contains information concerning the environmental samples which were collected during the period January 1, 1979-December 31, 1979.

Samples locations and specific information about the individual locations are given in Table A-1. Figure A-2 shows the locations of sampling stations with respect to the plant site. Figure A-1 shows the location of the Calvert Cliffs Nuclear Power Plant with respect to Southern Maryland and the Chesapeake Bay.

TABLE A-1

LOCATIONS OF ENVIRONMENTAL SAMPLING STATIONS
FOR THE CALVERT CLIFFS NUCLEAR POWER PLANT

Docket Nos. 50-317/318

STATION	DESCRIPTION	DISTANCE* (FEET)	DIRECTION (SECTOR)
1	Pound Nets South of Cove Point	38,000	SE
2	Chesapeake Country Club	20,000	SSE
3	Kenwood Beach	35,000	NNW
4	Rocky Point	10,000	NNW
5	Camp Conoy	3,000	SE
6	Long Beach	15,000	NNW
7	Plant Outfall Area	2,500	NE
8	Plant Intake Area	5,000	E
10	Onsite Well	600	SE
11	On Site	1,300	WNW
12	On Site	1,600	WSW
13	On Site	2,400	SSE
14	Cultivated Field on Site	1,200	W
15	Farm	24,000	WSW
16	Farm	22,000	SW
17	On Site	1,200	NW
18	On Site	2,000	SE
19	Knotty Pine	8,900	WSW
20	Lusby	9,900	SSW
21	Long Beach	14,000	NW
22	Cove Point	24,000	SE
23	Taylor's Island	40,000	ENE
24	On Site	1,800	NW
25	White Sands Club Sign	7,300	WSW
26	St. Leonard	27,000	NW
27	Solomons	42,000	S
28	Bertha	17,000	S
29	Flag Ponds	7,500	NW
30	Store (Lusby)	9,900	SSW
IS	On Site	1,400	SSW
PS	Plant Site	4,600	NNW

* Distance measured from plant vent.

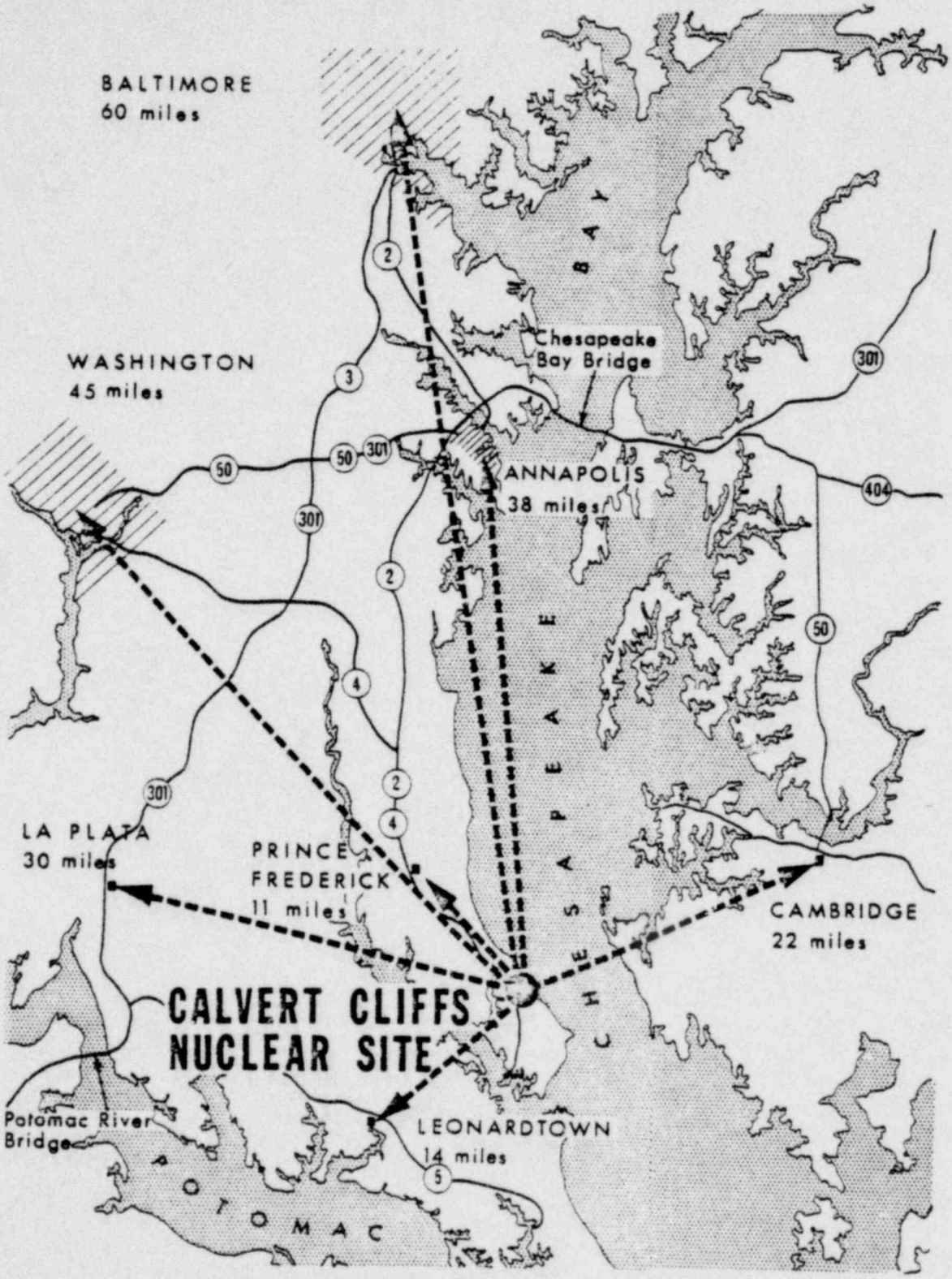

FIGURE A-1

Map of Southern Maryland and Chesapeake Bay Showing
Location of Calvert Cliffs Nuclear Power Plant

POOR ORIGINAL

APPENDIX B

Data Tables

Appendix B is a presentation of the analytical results of the 1979 Calvert Cliffs Nuclear Power Plant Radiological Environmental Monitoring Program.

TABLE NO.	TABLE TITLE	PAGE
B-1	Concentrations of Tritium, Gamma Emitters, and Strontium-89 and -90 in Bay Water	27
B-2	Concentrations of Gamma Emitters and Strontium-89 and -90 in Flesh and Bones of Edible Fish	28
B-3	Concentrations of Gamma Emitters in Shellfish Samples	29
B-4	Concentrations of Gamma Emitters and Strontium-89 and -90 in Bottom Sediment	30
B-5	Concentrations of Iodine-131 in Filtered Air	31, 32
B-6	Concentrations of Beta Emitters in Air Particulates	33, 34
B-7	Concentrations of Gamma Emitters and Strontium-89 and -90 in Air Particulates	35
B-8	Concentrations of Beta and Gamma Emitters and Strontium-89 and -90 in Precipitation - Station IS (On Site)	36
B-9	Deposition of Beta and Gamma Emitters and Strontium-89 and -90 in Precipitation - Station IS (On Site)	37
B-10	Concentrations of Gamma Emitters and Strontium-89 and -90 in Vegetation	38
B-11	Concentrations of Gamma Emitters and Strontium-89 and -90 in Soil	39
B-12	Deposition of Gamma Emitters and Strontium-89 and -90 in Soil	40
B-13	Concentrations of Tritium and Gamma Emitters in Ground Water	41
B-14	Typical MDL's for Gamma Spectrometry	42, 43
B-15	External Radiation	44, 45

TABLE B-1
CONCENTRATIONS OF TRITIUM, GAMMA EMITTERS,
AND STRONTIUM-89 AND -90 IN BAY WATER
(Results in Units of pCi/l ± 2 σ)

Date	Station No.	H-3	Gamma Emitters	Sr-89**	Sr-90**
1/16/79	7	294±115	*		
	8	177±115	*		
2/28/79	7	1106±111	*	<2.57	<0.96
	8	<109	*	<2.40	<0.88
3/16/79	7	147±106	*		
	8	<111	*		
4/05/79	7	<110	*		
	8	188±105	*		
5/10/79	7	<108	*	<3.39	<0.56
	8	114±103	*	<2.10	0.50±0.37
6/06/79	7	874±135	*		
	8	<139	*		
7/11/79	7	148±121	*		
	8	<129	*		
8/15/79	7	127±98	*	<3.47	0.70±0.67
	8	200±98	*	<2.47	<0.78
9/12/79	7	1328±133	*		
	8	206±97	*		
10/08/79	7	<130	*		
	8	<131	*		
11/07/79	7	110±101	*	<2.14	<0.87
	8	<109	*	<2.37	<1.01
12/07/79	7	<108	*		
	8	<108	*		

*Naturally occurring K-40 was observed in all samples. All other gamma emitters not cited were <MDL; typical MDL's are given in Table B-14.
**Analyses done on quarterly composites of monthly samples.

TABLE B-2
CONCENTRATIONS OF GAMMA EMITTERS AND STRONTIUM-89
AND -90 IN FLESH AND BONES OF EDIBLE FISH
(Results in Units of pCi/Kg ± 2 σ)

Station No.	Sampling Date	Sample Type	Gamma Emitters	Sr-89	Sr-90
1 (Pound Nets South of Cove Point)	First Quarter	*	*	*	*
1	Second Quarter	*	*	*	*
Plant Site***	9/21/79	Flounder	**	<39	27±11
		Spot	**	<57	37±14
Plant Site***	11/6/79	Flounder	**	<10	16±3
		Spot	**	26±9	32±4

*Samples unavailable
**Naturally occurring K-40 was observed in all samples. All other gamma emitters were <MDL; typical MDL's are given in Table B-14.
***Samples were obtained from monthly benthic trawl surveys of locations in the vicinity of the power plant from Kenwood Beach to Rocky Point.

TABLE B-3
CONCENTRATIONS OF GAMMA EMITTERS* IN
SHELLFISH SAMPLES
(Results in Units of pCi/kg (Wet) ± 2 σ)

Station No.	Quarter	Sample Type	Ag-110m
3	1	Oysters	<MDL
(Kenwood		Crabs	**
Beach-	2	Oysters	<MDL
Control		Crabs	<MDL
Location)	3	Oysters	<MDL
		Crabs	<MDL
	4	Oysters	<MDL
		Crabs	<MDL
4	1	Crabs	**
(Rocky	2	Crabs	<MDL
Point)	3	Crabs	<MDL
	4	Crabs	<MDL
5	1	Oysters	88±4
(Camp	2	Oysters	172±9
Conoy)	3	Oysters	266±11
	4	Oysters	253±12
8	1	Crabs	**
(Plant	2	Crabs	<MDL
Intake)	3	Crabs	<MDL
	4	Crabs	<MDL

*Naturally occurring K-40 observed in all samples.
All other gamma emitters not cited were <MDL; typical MDL's are given in Table B-14.

**Samples unavailable.

TABLE B-4
CONCENTRATIONS OF GAMMA EMITTERS* AND
STRONTIUM-89 AND -90 IN BOTTOM SEDIMENT
(Results in Units of pCi/kg (Dry) ± 2 σ)

Station No.	Date	Sr-89	Sr-90	Co-58	Co-60	Cs-137	Ce-144
5	3/22/79	<100	<33	<MDL	58±19	344±21	<MDL
(Camp	6/13/79	<151	<42	<MDL	<MDL	282±40	<MDL
Conoy)	8/27/79	<232	<57	<MDL	<MDL	913±70	543±186
	10/30/79	<179	47±34	<MDL	<MDL	993±75	<MDL
6	3/22/79	<107	25±23	<MDL	<MDL	660±31	603±101
(Long**	6/13/79	<179	<52	<MDL	<MDL	272±41	398±92
Beach)	8/27/79	<179	<43	<MDL	<MDL	1163±77	589±218
	10/30/79	<193	<59	<MDL	<MDL	993±85	764±232
7	3/22/79	<155	44±32	<MDL	<MDL	195±21	<MDL
(Plant	6/13/79	<365	<102	<MDL	<MDL	256±51	<MDL
Outfall)	8/27/79	<278	<65	<MDL	<MDL	1143±74	<MDL
	10/30/79	<229	<70	<MDL	<MDL	815±70	<MDL
8	3/27/79	<102	<33	54±19	23±23	191±18	<MDL
(Plant	6/13/79	<193	<55	553±76	701±115	795±73	1224±192
Intake)	8/27/79	<527	103±79	528±100	350±82	818±74	1110±199
	10/30/79	<201	40±37	392±67	430±83	666±77	698±174

*Naturally occurring K-40, Ra-226, and Th232 were observed in all samples. All other gamma emitters were <MDL; typical MDL's are given in Table B-14.
**Control location.

TABLE B-5
CONCENTRATIONS OF IODINE-131 IN FILTERED AIR
(Results in Units of 10^{-3} pCi/m^3 ± 2 σ)

Start Date	Stop Date	On Site #17	On Site #18	Lusby #20	Cove Point #22	Taylors Island* #23
12/26/78	1/02/79	<3.5	<3.0	<3.4	<4.5	<3.1
1/02/79	1/08/79	<4.0	<3.6	<3.2	<2.8	<3.8
1/08/79	1/15/79	<3.5	<3.4	<3.7	<4.2	<3.4
1/15/79	1/22/79	<3.5	<3.3	<3.4	<4.4	<3.4
1/22/79	1/29-79	<3.5	<3.3	<3.4	<3.9	<3.5
1/29/79	2/05/79	<3.3	<3.3	<3.7	<4.1	<3.4
2/05/79	2/12/79	<3.5	<3.3	<3.5	<4.2	<3.4
2/12/79	2/21/79	<2.6	**	<2.9	<3.1	<2.9
2/21/79	2/26/79	<5.3	<1.7	<5.4	<5.7	<3.9
2/26/79	3/05/79	<3.3	<3.4	<3.6	<4.1	<3.5
3/05/79	3/12/79	<3.4	<3.5	<3.4	<4.1	<3.6
3/12/79	3/19/79	<2.9	<3.4	<3.5	<4.0	<3.5
3/19/79	3/26/79	<3.8	<3.5	<3.6	<4.0	<4.2
3/26/79	4/02/79	<3.7	<3.4	<3.7	<4.2	<3.7
4/02/79	4/09/79	<3.6	<3.8	<3.6	<4.2	<3.7
4/09/79	4/16/79	<3.5	<3.4	<3.6	<4.0	<3.2
4/16/79	4/23/79	<3.6	<3.4	<3.5	<4.1	<3.7
4/23/79	4/30/79	<2.6	<3.4	<3.7	<4.0	<3.7
4/30/79	5/07/79	<3.6	<4.1	<3.7	<4.3	<3.4
5/07/79	5/14/79	<3.6	<3.7	<3.7	<4.2	<4.2
5/14/79	5/21/79	<3.6	<3.0	<3.5	<4.2	<4.0
5/21/79	5/29/79	<3.1	<2.4	<3.4	<3.1	<3.5
5/29/79	6/04/79	<4.1	<3.1	<4.4	<4.4	<3.6
6/04/79	6/11/79	<3.8	<2.9	<3.8	<3.6	<3.3
6/11/79	6/18/79	<6.7	<2.8	<3.5	<4.0	<3.4
6/18/79	6/25/79	<3.2	<2.6	<3.5	<3.8	<3.5
6/25/79	7/02/79	<3.2	<2.8	<3.6	<3.7	<3.5
7/02/79	7/09/79	<3.3	<3.0	<3.7	<3.9	<3.5
7/09/79	7/16/79	<3.1	<3.0	<3.8	<3.9	<3.2
7/16/79	7/23/79	<3.3	<2.9	<3.8	<4.0	<3.6
7/23/79	7/30/79	<3.6	<3.1	<4.0	<4.2	<3.7
7/30/79	8/06/79	<3.6	<3.1	<3.9	<3.9	<4.7
8/06/79	8/13/79	<3.5	<3.4	<4.0	<4.1	<3.2
8/13/79	8/20/79	**	<3.7	<4.1	<3.9	<3.1
8/20/79	8/27/79	<3.1	<2.5	<4.1	<4.3	<3.5

TABLE B-5 (CONTINUED)
CONCENTRATIONS OF IODINE-131 IN FILTERED AIR
(Results in Units of 10^{-3} pCi/m^3 ± 2 σ)

Start Date	Stop Date	On Site #17	On Site #18	Lusby #20	Cove Point #22	Taylors Island* #23
8/27/79	9/04/79	<3.2	<3.5	<3.3	<3.6	<3.4
9/04/79	9/10/79	<4.3	**	<4.7	**	<3.4
9/10/79	9/17/79	<3.6	**	<4.1	<3.8	<3.9
9/17/79	9/24/79	<3.6	<2.8	<4.7	<3.9	<3.7
9/24/79	10/01/79	<4.0	<2.8	<4.3	<4.0	<3.4
10/01/79	10/08/79	<3.7	<2.8	<4.4	<4.0	<3.7
10/08/79	10/15/79	<3.6	<2.9	<4.5	<4.0	<3.3
10/15/79	10/22/79	<3.8	<2.9	<5.6	<3.9	<3.5
10/22/79	10/29/79	<3.7	<2.8	<3.5	<3.9	<3.8
10/29/79	11/05/79	<4.2	<3.0	<4.2	<5.6	<3.7
11/05/79	11/12/79	<4.0	<3.2	<3.8	**	<3.4
11/12/79	11/19/79	<4.4	<4.9	<3.5	<4.1	<3.7
11/19/79	11/26/79	<3.0	<3.5	<3.5	<3.7	<3.9
11/26/79	12/03/79	<2.7	<3.5	<3.5	<3.6	<3.1
12/03/79	12/10/79	<2.7	<4.6	<3.6	<3.7	<3.8
12/10/79	12/17/79	<2.7	<4.1	<3.5	<3.9	<3.4
12/17/79	12/26/79	<2.3	<2.8	<3.0	<2.9	<3.9
12/26/79	12/31/79	<3.9	<5.3	<5.3	<5.5	<3.4

*Control location
**Air sampler malfunction.

TABLE B-6
CONCENTRATIONS OF BETA EMITTERS IN AIR PARTICULATES
(Results in Units of 10^{-2} pCi/m^3 ± 2 σ)

Start Date	Stop Date	On Site #17	On Site #18	Knotty Pine #19	Lusby #20	Long Beach #21	Cove Point #22	Taylors Island* #23
12/26/78	1/02/79	5.4±0.5	3.3±0.3	3.8±0.4	3.7±0.4	2.8±0.3	3.7±0.4	3.0±0.3
1/02/79	1/08/79	2.5±0.3	2.9±0.3	3.7±0.4	3.2±0.3	3.2±0.3	3.0±0.4	1.2±0.3
1/08/79	1/15/79	3.4±0.3	2.8±0.3	3.7±0.4	3.9±0.4	3.5±0.3	3.3±0.3	1.7±0.2
1/15/79	1/22/79	2.8±0.3	2.0±0.3	3.4±0.3	4.6±0.5	2.7±0.3	3.1±0.4	1.8±0.3
1/22/79	1/29/79	1.0±0.2	0.9±0.2	1.5±0.2	2.0±0.3	1.3±0.2	1.4±0.3	1.3±0.2
1/29/79	2/05/79	2.7±0.3	2.5±0.3	3.2±0.3	3.0±0.3	2.4±0.2	2.1±0.3	2.1±0.3
2/05/79	2/12/79	3.7±0.4	3.4±0.3	4.0±0.4	3.8±0.4	3.5±0.4	3.2±0.3	1.8±0.2
2/12/79	2/21/79	2.9±0.3	**	3.3±0.3	3.7±0.4	2.6±0.3	2.3±0.3	0.8±0.2
2/21/79	2/26/79	1.1±0.3	2.2±0.2	1.3±0.3	1.8±0.4	1.8±0.3	1.5±0.4	0.9±0.3
2/26/79	3/05/79	1.1±0.2	1.2±0.2	1.4±0.3	1.7±0.3	1.0±0.2	1.1±0.3	1.6±0.3
3/05/79	3/12/79	2.2±0.3	1.9±0.3	2.2±0.3	2.4±0.3	2.3±0.2	1.9±0.3	2.3±0.3
3/12/79	3/19/79	3.6±0.4	2.5±0.3	3.5±0.3	3.3±0.3	3.2±0.3	2.5±0.3	1.8±0.3
3/19/79	3/26/79	1.1±0.2	1.1±0.2	1.5±0.3	1.7±0.3	1.4±0.2	1.2±0.3	0.7±0.2
3/26/79	4/02/79	2.5±0.3	2.7±0.3	3.6±0.4	3.6±0.4	2.8±0.3	3.7±0.4	2.3±0.3
4/02/79	4/09/79	2.8±0.3	2.7±0.3	3.5±0.4	3.9±0.4	2.6±0.3	3.4±0.4	1.6±0.3
4/09/79	4/16/79	1.6±0.3	1.0±0.2	1.6±0.3	1.1±0.2	1.3±0.2	1.4±0.3	1.1±0.2
4/16/79	4/23/79	3.4±0.3	2.6±0.3	3.7±0.4	3.6±0.4	3.1±0.3	3.0±0.3	2.1±0.3
4/23/79	4/30/79	1.8±0.3	1.4±0.2	2.3±0.3	2.5±0.3	1.9±0.2	2.0±0.3	1.6±0.3
4/30/79	5/07/79	3.1±0.3	1.8±0.3	3.2±0.3	2.4±0.3	2.7±0.3	2.6±0.3	2.3±0.3
5/07/79	5/14/79	1.3±0.2	0.9±0.2	1.6±0.3	1.3±0.3	1.1±0.2	1.6±0.3	1.6±0.3
5/14/79	5/21/79	1.0±0.2	1.0±0.2	1.7±0.3	1.4±0.3	1.2±0.2	1.7±0.3	1.1±0.2
5/21/79	5/29/79	1.1±0.2	0.8±0.2	1.6±0.2	1.0±0.2	1.1±0.2	1.4±0.2	1.1±0.2
5/29/79	6/04/79	1.6±0.3	0.4±0.2	1.5±0.3	1.0±0.3	1.1±0.2	1.7±0.3	1.0±0.2
6/04/79	6/11/79	6.5±0.7	2.7±0.3	3.2±0.3	1.7±0.3	2.8±0.3	2.8±0.3	2.4±0.3
6/11/79	6/18/79	3.2±0.5	1.5±0.2	2.0±0.3	1.4±0.3	1.4±0.2	2.8±0.3	2.8±0.3
6/18/79	6/25/79	2.2±0.3	1.0±0.2	2.3±0.3	2.7±0.3	0.7±0.2	2.0±0.3	2.1±0.3
6/25/79	7/02/79	1.5±0.3	0.7±0.2	1.7±0.2	0.7±0.2	0.8±0.2	1.9±0.3	0.6±0.2
7/02/79	7/09/79	1.5±0.3	0.9±0.2	1.7±0.2	2.2±0.3	1.7±0.2	1.5±0.3	1.2±0.2
7/09/79	7/16/79	1.3±0.2	0.6±0.2	1.7±0.3	1.7±0.3	1.7±0.2	1.5±0.3	1.4±0.2
7/16/79	7/23/79	1.1±0.2	1.0±0.2	1.6±0.3	1.5±0.3	1.4±0.2	1.8±0.3	1.0±0.3
7/23/79	7/30/79	0.8±0.2	0.5±0.2	1.0±0.2	0.9±0.3	0.9±0.2	1.0±0.3	0.4±0.2
7/30/79	8/06/79	1.1±0.2	0.6±0.2	1.9±0.3	1.3±0.3	1.8±0.2	1.7±0.3	1.8±0.3
8/06/79	8/13/79	1.4±0.2	0.5±0.2	1.6±0.3	1.6±0.3	1.5±0.2	1.8±0.3	0.8±0.2
8/13/79	8/20/79	**	<0.2	1.2±0.2	0.8±0.2	1.4±0.2	1.7±0.3	1.4±0.3
8/20/79	8/27/79	1.2±0.2	0.2±0.1	1.5±0.3	1.6±0.3	0.6±0.2	1.2±0.3	0.8±0.2

TABLE B-6 (CONTINUED)
CONCENTRATIONS OF BETA EMITTERS IN AIR PARTICULATES
(Results in Units of 10^{-2} pCi/m^3 ± 2 σ)

Start Date	Stop Date	On Site #17	On Site #18	Knotty Pine #19	Lusby #20	Long Beach #21	Cove Point #22	Taylors Island* #23
8/27/79	9/04/79	0.8±0.2	0.5±0.2	0.8±0.2	1.0±0.2	1.1±0.2	1.3±0.2	0.8±0.2
9/04/79	9/10/79	1.1±0.3	3.4±1.2	1.0±0.3	0.8±0.3	0.6±0.2	1.2±0.6	1.4±0.3
9/10/79	9/17/79	0.6±0.2	**	0.8±0.2	0.4±0.2	1.1±0.2	1.3±0.3	0.8±0.2
9/17/79	9/24/79	0.6±0.2	1.3±0.2	0.9±0.3	0.5±0.3	1.1±0.2	1.1±0.3	0.8±0.2
9/24/79	10/01/79	0.7±0.2	1.2±0.2	1.2±0.2	0.9±0.3	1.1±0.2	1.4±0.3	1.1±0.2
10/01/79	10/08/79	0.8±0.2	0.9±0.2	1.3±0.2	0.7±0.3	1.3±0.2	1.3±0.3	0.9±0.2
10/08/79	10/15/79	0.4±0.2	0.8±0.2	1.2±0.2	0.5±0.3	1.0±0.2	1.0±0.3	0.6±0.2
10/15/79	10/22/79	0.5±0.2	0.7±0.2	0.7±0.2	0.6±0.3	1.3±0.2	2.0±0.3	1.7±0.3
10/22/79	10/29/79	0.6±0.2	0.8±0.2	0.4±0.2	2.4±0.3	1.3±0.2	1.4±0.3	1.7±0.3
10/29/79	11/05/79	0.7±0.3	0.6±0.2	0.6±0.3	2.0±0.3	1.2±0.2	0.9±0.3	1.0±0.2
11/05/79	11/12/79	0.6±0.2	0.5±0.2	0.6±0.2	2.0±0.3	1.1±0.2	1.9±0.3	0.5±0.2
11/12/79	11/19/79	0.7±0.3	0.4±0.2	2.6±0.3	2.6±0.3	1.5±0.2	1.8±0.3	0.9±0.2
11/19/79	11/26/79	2.4±0.3	4.2±0.4	4.0±0.4	3.6±0.4	1.7±0.2	2.7±0.3	1.2±0.2
11/26/79	12/03/79	1.3±0.2	2.0±0.3	2.1±0.2	2.3±0.3	2.4±0.2	1.7±0.3	1.4±0.2
12/03/79	12/10/79	1.4±0.2	2.2±0.3	2.2±0.2	2.2±0.2	1.7±0.2	2.1±0.3	0.6±0.2
12/10/79	12/17/79	1.0±0.2	1.8±0.3	3.4±0.3	1.9±0.3	1.2±0.2	1.8±0.3	1.2±0.2
12/17/79	12/26/79	0.8±0.1	1.4±0.2	1.5±0.2	1.5±0.2	1.5±0.2	1.6±0.2	1.2±0.2
12/26/79	12/31/79	0.6±0.2	1.3±0.3	0.9±0.2	1.2±0.3	1.5±0.3	1.3±0.3	1.2±0.2

*Control Location
**Air Sampler Malfunction

TABLE B-7
CONCENTRATIONS OF GAMMA EMITTERS* AND
STRONTIUM-89 AND -90 IN AIR PARTICULATES
(Results in Units of 10^{-3} pCi/m^3 ± 2 σ)

Station No.	Quarter Composited	Sr-89	Sr-90
17 (On Site)	1	<0.85	0.42±0.20
	2	<0.81	0.51±0.24
	3	1.75±0.79	<0.37
	4	<0.46	<0.28
18 (On Site)	1	<0.90	0.33±0.21
	2	<0.83	0.34±0.22
	3	<1.13	<0.33
	4	<0.47	<0.29
19 (Knotty Pine)	1	<0.81	0.35±0.20
	2	<0.92	0.55±0.26
	3	0.91±0.78	<0.36
	4	<0.46	<0.27
20 (Lusby)	1	<1.17	0.47±0.27
	2	<1.22	0.75±0.31
	3	0.88±0.82	<0.38
	4	<0.56	0.22±0.21
21 (Long Beach)	1	<0.88	0.24±0.20
	2	<0.74	0.54±0.21
	3	1.10±0.84	<0.37
	4	<0.48	<0.29
22 (Cove Point)	1	<1.20	0.40±0.27
	2	<0.91	0.69±0.27
	3	<1.74	<0.51
	4	<0.67	<0.39
23** (Taylors Island)	1	<1.02	0.27±0.23
	2	<0.89	0.32±0.24
	3	<1.41	<0.40
	4	<0.92	<0.53

*Naturally occurring K-40 and Be-7 were observed in most samples. Sporadic presences of Cs-137, Ce-141 and Ce-144 were also observed; viz.,

Cs-137 = (0.81±0.37)x10^{-3} pCi/m^3 from location #18 during 4/79
Ce-141 = (2.34±0.84)x10^{-3} pCi/m^3 from location #20 during 6/79
Ce-144 = (3.87±1.37)x10^{-3} pCi/m^3 from location #20 during 4/79
Ce-144 = (3.90±1.06)x10^{-3} pCi/m^3 from location #21 during 4/79

All other gamma emitters not cited were <MDL; typical MDL's are given in Table B-14.

**Control location

TABLE B-8
CONCENTRATIONS OF BETA AND GAMMA EMITTERS* AND STRONTIUM-89 AND -90 IN PRECIPITATION - STATION IS (ON SITE)
(Results in Units of pCi/l ± 2 σ)

Date	Beta	H-3**	Sr-89**	Sr-90**
1/79	11±1			
2/79	4.2±0.6	194±105	0.91±0.80	<0.40
3/79	7.0±0.7			
4/79	4.0±0.6			
5/79	2.1±0.5	<138	<3.46	<0.52
6/79	4.2±0.6			
7/79	1.8±0.5			
8/79	13±1	<130	<1.59	<0.54
9/79	2.4±0.5			
10/79	6.1±0.7			
11/79	5.0±0.6	<134	<1.29	<0.49
12/79	4.4±0.6			

*Naturally occurring K-40 and Be-7 was observed in most samples. All other gamma emitters not cited were <MDL; typical MDL's are given in Table B-14.

**Quaterly analyses of composited monthly samples.

TABLE B-9
DEPOSITION OF BETA AND GAMMA EMITTERS AND
STRONTIUM-89 AND -90 IN PRECIPITATION - STATION IS (ON SITE)
(Results in Units of 10^3 pCi/m^2)

Date	Beta	H-3	Sr-89
1/79	1.24		
2/79	0.61	64.55	0.30
3/79	0.52		
4/79	0.23		
5/79	0.07	-	-
6/79	0.57		
7/79	0.23		
8/79	2.44	-	-
9/79	0.49		
10/79	0.52		
11/79	0.60	-	-
12/79	0.07		

TABLE B-10
CONCENTRATIONS OF GAMMA EMITTERS* AND STRONTIUM-89
AND -90 IN VEGETATION
(Results in Units of pCi/kg (Wet) ± 2 σ)

Station No.	Date	Sample Type	Sr-89	Sr-90
14	7/16/79	Cabbage	<45	153±21
		Radish	<121	64±13
14	9/17/79	Corn	<99	80±25
		Tobacco	<1020**	1840±280
15	9/19/79	Corn	<83	<32
		Tobacco	<309	444±59
16	9/19/79	Corn	<99	29±26
		Tobacco	<390	363±71
14	10/03/79	Sunflower	274±190	1050±110

*Naturally occurring K-40 was observed in all samples. All other gamma emitters were <MDL; typical MDL's are given in Table B-14.

**Low chemical yield in analysis.

TABLE B-11
CONCENTRATIONS OF GAMMA EMITTERS* AND STRONTIUM-89
AND -90 IN SOIL
(Results in pCi/kg (Dry) ± 2 σ)

Date	3/27/79			11/5/79		
Station No.	11 (On Site)	12 (On Site)	13 (On Site)	11 (On Site)	12 (On Site)	13 (On Site)
Sr-89	<94	<101	<100	<146	<158	<144
Sr-90	<33	36±23	<36	78±33	84±35	<47
Cs-137	64±26	<MDL	222±16	293±35	166±35	180±31
Ce-144	<MDL	<MDL	289±59	<MDL	<MDL	<MDL

*Naturally occurring Ra-226, Th232, and K-40 were observed in all samples. All other gamma emitters not cited were <MDL; typical MDL's are given in Table B-14.

TABLE B-12
DEPOSITION* OF GAMMA EMITTERS AND STRONTIUM-89
AND -90 IN SOIL
(Results in Units of 10^3 pCi/m^2)

Date	3/27/79			11/5/79		
Station No.	11 (On Site)	12 (On Site)	13 (On Site)	11 (On Site)	12 (On Site)	13 (On Site)
Sr-89	-	-	-	-	-	-
Sr-90	-	0.58	-	1.24	1.33	-
Cs-137	1.02	-	3.52	4.65	2.64	2.86
Ce-144	-	-	4.59	-	-	-

*Deposition was calculated using a soil density of 1.27 g/cm^3 and a soil depth of 1.25 cm.

TABLE B-13
CONCENTRATIONS OF TRITIUM AND GAMMA EMITTERS* IN GROUND WATER
(Results in pCi/l ± 2 σ)

Station No.	Quarter Composited	H-3	Gamma Emitters*
2** (Chesapeake Country Club)	1	<112	<MDL
	2	<137	<MDL
	3	<128	<MDL
	4	<131	<MDL
10 (On Site Well)	1	<111	<MDL
	2	<138	<MDL
	3	<126	<MDL
	4	<131	<MDL
21** (Long Beach)	1	<112	<MDL
	2	<138	<MDL
	3	<128	<MDL
	4	<129	<MDL
25A** (White Sands Club)	1	<112	<MDL
	2	<139	<MDL
	3	<128	<MDL
	4	<130	<MDL
25B** (White Sands Club)	1	<112	<MDL
	2	<139	<MDL
	3	<128	<MDL
	4	<130	<MDL

*Naturally occurring K-40 was observed in most samples. All other gamma emitters not cited were <MDL; typical MDL's are given in Table B-14.

**Control locations.

TABLE B-14
TYPICAL MDL'S FOR GAMMA SPECTROMETRY

Selected Nuclides	Bay Water pCi/l	Fish pCi/kg (Wet)	Shellfish pCi/kg (Wet)	Sediment pCi/kg (Dry)
Na-22	1.7	11	8.2	72
Cr-51	8.5	41	33	383
Mn-54	1.4	9	7.0	67
Co-58	1.6	9	6.3	69
Fe-59	2.3	17	16	134
Co-60	1.5	14	9.0	85
Zn-65	3.4	18	16	101
ZrNb-95	2.2	12	10	83
Zr-95	3.2	17	13	109
Mo-99	0.8	3.1	2.5	27
Ru-Rh-106	1.1	57	45	518
Ag110m	1.3	7.5	6.7	54
Te-129m	1.0	5.1	4.6	134
I-131	1.0	4.9	4.4	47
Te-132	1.6	12	8.9	69
I-133	1.2	8.0	5.6	57
Cs-134	1.5	10	7.6	54
Cs-137	1.4	10	6.8	-
BaLa-140	2.2	12	12	69
Ce-144	7.0	25	18	240

TABLE B-14 (CONTINUED)
TYPICAL MDL'S FOR GAMMA SPECTROMETRY

Selected Nuclides	Air Particulates 10^{-2} pCi/m^3	Precipitation pCi/l	Vegetation pCi/kg (Wet)	Soil pCi/kg (Dry)	Well Water pCi/l
Na-22	0.08	3.3	11	23	1.0
Cr-51	0.44	22	38	141	6.3
Mn-54	0.08	4.1	8.3	23	1.0
Co-58	0.08	3.3	8.5	21	1.4
Fe-59	0.21	4.2	19	41	1.0
Co-60	0.12	4.7	13	27	1.1
Zn-65	0.15	7.1	24	46	1.4
ZrNb-95	0.13	5.7	12	35	1.6
Nb-95	0.07	7.8	7.2	22	2.2
Zr-95	0.19	3.6	18	48	1.0
Mo-99	0.03	2.1	2.6	11	0.6
RuRh-106	0.63	25	64	206	9.2
Ag110m	0.08	3.2	6.5	23	2.2
Te-129m	0.04	2.8	5.0	17	2.1
I-131	0.05	3.0	5.5	20	0.9
Te-132	0.09	4.4	8.7	30	0.8
I-133	0.06	3.7	6.3	21	0.8
Cs-134	0.09	4.4	9.6	28	1.0
Cs-137	0.07	4.2	9.5	20	1.1
BaLa-140	0.14	4.5	11	37	1.7
Ce-144	0.21	192	22	106	5.2

TABLE B-15
EXTERNAL RADIATION
(Results in Units of mR/30 Days)

Location #7	Jan. 3.19±0.02	Jul. 2.96±0.18
	Feb. 3.18±0.14	Aug. 3.23±0.03
	Mar. 2.95±0.17	Sep. 3.23±0.18
	Apr. 3.14±0.26	Oct. 2.98±0.16
	May 3.33±0.07	Nov. 2.97±0.08
	Jun. 3.38±0.10	Dec. 3.16±0.12
Location #17	Jan. 5.17±0.36	Jul. 5.07±0.16
	Feb. 5.23±0.06	Aug. 5.54±0.37
	Mar. 5.23±0.24	Sep. 5.47±0.03
	Apr. 5.10±0.25	Oct. 5.45±0.19
	May 5.30±0.19	Nov. 4.85±0.01
	Jun. 5.23±0.10	Dec. 5.14±0.48
Location #18	Jan. 5.13±0.31	Jul. 4.26±0.19
	Feb. 4.46±0.15	Aug. 4.56±0.24
	Mar. 4.57±0.30	Sep. 4.85±0.54
	Apr. 4.61±0.03	Oct. 4.71±0.51
	May 4.61±0.31	Nov. 4.15±0.17
	Jun. 4.60±0.42	Dec. 4.44±0.30
Location #19	Jan. 4.32±0.36	Jul. 3.92±0.09
	Feb. 4.14±0.10	Aug. 4.14±0.21
	Mar. 3.94±0.09	Sep. 4.18±0.17
	Apr. 4.01±0.14	Oct. 4.23±0.20
	May 4.18±0.17	Nov. 3.91±0.13
	Jun. 4.12±0.00	Dec. 4.00±0.05
Location #20	Jan. 4.63±0.16	Jul. 4.52±0.13
	Feb. 4.07±0.17	Aug. 4.72±0.18
	Mar. 4.20±0.10	Sep. 4.75±0.07
	Apr. 4.15±0.18	Oct. 4.60±0.21
	May 4.28±0.03	Nov. 3.80±0.07
	Jun. 4.57±0.36	Dec. 4.02±0.28
Location #21	Jan. 4.00±0.03	Jul. 3.48±0.09
	Feb. 3.76±0.16	Aug. 3.97±0.16
	Mar. 3.67±0.10	Sep. 3.69±0.13
	Apr. 3.85±0.19	Oct. 3.78±0.12
	May 3.75±0.11	Nov. 3.45±0.02
	Jun. 3.84±0.26	Dec. 3.66±0.18
Location #22	Jan. 4.27±0.01	Jul. 3.78±0.22
	Feb. 3.93±0.27	Aug. 4.17±0.10
	Mar. 3.97±0.16	Sep. 4.13±0.26
	Apr. 4.02±0.07	Oct. 4.11±0.31
	May Stolen	Nov. 3.72±0.14
	Jun. 4.18±0.15	Dec. 3.74±0.23

TABLE B-15 (CONTINUED)
EXTERNAL RADIATION
(Results in Units of mR/30 Days)

Location #23	Jan. 5.72±0.41	Jul. 5.78±0.39
	Feb. 5.01±0.09	Aug. 5.88±0.27
	Mar. 5.55±0.20	Sep. 5.87±0.19
	Apr. 5.35±0.13	Oct. 5.71±0.26
	May 6.16±0.23	Nov. 5.40±0.26
	Jun. 5.85±0.01	Dec. 5.28±0.34
Location #24	Jan. 5.76±0.50	Jul. 4.86±0.16
	Feb. 5.18±0.43	Aug. 5.44±0.13
	Mar. 5.12±0.20	Sep. 5.14±0.12
	Apr. 5.36±0.25	Oct. 5.38±0.22
	May 5.58±0.25	Nov. 5.06±0.18
	Jun. 5.66±0.55	Dec. 4.98±0.23
Location #25	Jan. 4.99±0.35	Jul. 4.90±0.15
	Feb. 4.67±0.01	Aug. 5.02±0.12
	Mar. 4.67±0.39	Sep. 5.02±0.17
	Apr. 4.67±0.26	Oct. 4.83±0.31
	May 4.84±0.38	Nov. 4.66±0.48
	Jun. 4.83±0.11	Dec. 4.69±0.30
Location #26	Jan. 4.43±0.14	Jul. 4.02±0.11
	Feb. 4.12±0.21	Aug. 4.13±0.19
	Mar. 4.16±0.03	Sep. 4.06±0.01
	Apr. 4.03±0.20	Oct. 4.16±0.19
	May 4.32±0.20	Nov. 3.70±0.10
	Jun. 4.15±0.37	Dec. 3.93±0.04
Location #27	Jan. 4.26±0.29	Jul. Stolen
	Feb. 4.26±0.46	Aug. 3.93±0.07
	Mar. 3.91±0.23	Sep. 3.95±0.36
	Apr. 3.90±0.18	Oct. 3.57±0.12
	May 4.19±0.13	Nov. Stolen
	Jun. 4.21±0.21	Dec. 3.68±0.28
Location #28	Jan. 4.96±0.09	Jul. 4.76±0.30
	Feb. 4.36±0.10	Aug. 4.57±0.11
	Mar. 4.30±0.29	Sep. 5.72±0.58
	Apr. 4.54±0.15	Oct. 4.69±0.09
	May 4.55±0.11	Nov. 4.32±0.19
	Jun. 4.51±0.36	Dec. 4.37±0.25