CHAPTER V

RADIOLOGICAL IMPACT

Nuclear power plants in the United States are licensed and regulated by the U.S. Nuclear Regulatory Commission. Conditions imposed in the operating licenses for each plant permit the routine discharge of low levels of radioactivity to the environment. These releases must be within the guidelines of the federal regulations contained in 10 CFR 50 Appendix I, and are restricted by limits on the radiation doses received offsite by a hypothetical maximum exposed individual (Table V-1). Annual total body doses cannot exceed 3 mrem per reactor for the aqueous pathway and 5 mrem per reactor for the atmospheric pathway. Aqueous pathway doses are received through ingestion of radioactivity in water and seafood, and exposure to contaminated water and sediments. Atmospheric pathway doses result from inhalation of gaseous and particulate radioactivity and ingestion of radionuclides deposited on, or assimilated by, terrestrial vegetation and animals.

The operator of each nuclear plant is required to conduct environmental monitoring to assure that dose criteria are met. In addition to these programs, state and federal agencies conduct monitoring activities to assure compliance. These radiological monitoring programs are designed to determine actual radionuclide concentrations in environmental media in order to provide estimates of the ultimate dose to man.

Environmental Studies and surveillance activities which define the impact of releases to the atmosphere are:

- Estimation of radionuclides discharged - Samples are collected from in-plant decay tanks and main vent filters to determine radionuclide concentrations in gases prior to release.

- Analysis of air samples - Air is sampled continuously and sample composites are analyzed weekly to detect radioiodine and radionuclides in air particulates.

- Analysis of precipitation - Precipitation is sampled continuously to detect radionuclides which wash out with airborne particulates.

- Analysis of soil and vegetation - These analyses indicate terrestrial radionuclide concentrations derived from deposition of atmospherically released radionuclides.

- Analysis of milk - This analysis indicates I-131 concentrations in dairy products as a result of animal ingestion of atmospheric iodine deposited on pasture grass.

- External radiation measurements - Thermoluminescence dosimeters (TLD) are used to provide an assessment of ambient dose levels and exposure rate variation.

Table V-1

10 CFR 50 Appendix I
Limiting conditions for operation of light-water-cooled nuclear power reactors to keep radioactivity in effluents to unrestricted areas as low as is reasonably achievable.

Type of Dose	Appendix I[a] Design Objectives	Point of Dose Evaluation
Liquid Effluents		
Dose to whole body from all pathways	3 mrem/yr per unit	Location of the highest dose offsite[b]
Dose to any organ	10 mrem/yr per unit	Same as above
Gaseous Effluents[c]		
Gamma dose in air	10 mrad/yr per unit	Location of the highest dose offsite[d]
Beta dose in air	20 mrad/yr per unit	Same as above
Dose to whole body of an individual	5 mrem/yr per unit	Location of the highest dose offsite[b]
Dose to skin of an individual	15 mrem/yr per unit	Same as above
Radioiodines and Particulates[e] Released to the Atmosphere		
Dose to any organ from all pathways	15 mrem/yr per unit	Location of the highest dose offsite[f]

(a) Evaluated for a maximum exposed individual.
(b) Evaluated at a location that is anticipated to be occupied during plant lifetime, or with respect to such potential land and water usage and food pathways as could actually exist during the term of plant operation.
(c) Calculated only for noble gases.
(d) Evaluated at a location that could be occupied during the term of plant operations.
(e) Doses due to carbon-14 and tritium intake from terrestrial food chains are included in this category.
(f) Evaluated at a location where an exposure pathway and dose receptor actually exist at the time of licensing. However, if the applicant determines design objectives with respect to radioactive iodine on the basis of existing conditions and if potential changes in land and water usage and food pathways could result in exposures in excess of the guideline values given above, the applicant should provide reasonable assurance that a monitoring and surveillance program will be performed to determine: (1) the quantities of radioactive iodine actually released to the atmosphere and deposited relative to those estimated in the determination of design objectives; (2) whether changes in land and water usage and food pathways which would result in individual exposures greater than originally estimated have occurred; and (3) the content of radioactive iodine in foods involved in the changes, if they occur.

Those studies which define the impact of liquid effluent releases are:

- Estimation of radionuclides discharged - Samples from in-plant monitor tanks and steam generator blowdown are analyzed to determine radionuclide concentrations in liquid inventory prior to release.

- Analysis of Bay water - Samples of Chesapeake Bay water are analyzed to determine actual radionuclide concentrations.

- Analysis of Bay fishery - Samples of various species of finfish and shellfish are collected and analyzed to measure radionuclide concentations and predict dose to consumers.

- Analysis of other environmental biota - Samples of submerged aquatic vegetation and lower trophic-level fauna are analyzed to determine radionuclide concentrations within the food chain.

- Analysis of sediments - Samples are analyzed to determine temporal and spatial distributions of sediment radionuclide concentrations.

The Maryland Power Plant Siting Program (PPSP) is responsible for assessing the radiological impact of nuclear power plants affecting Maryland. Those currently considered are Calvert Cliffs on the Chesapeake Bay in Maryland, and Peach Bottom and Three Mile Island on the Susquehanna River in Pennsylvania. Determining power plant radiological impact is complicated by the fact that the plant increment must be discerned from environmental concentrations of natural and weapons-test fallout radioactivity which already exist, or, in the case of weapons-test fallout, may be introduced during the monitoring period. Attributing a radiological effect to a specific plant may also be difficult under conditions where impacts may overlap. Such an instance occurred as a result of the Three Mile Island accident.

This chapter presents the PPSP's evaluation of the environmental impact on Maryland of radioactivity released by Calvert Cliffs, Peach Bottom and Three Mile Island during 1978-1980. This assessment is based on monitoring programs conducted by the individual utilities, the Maryland Department of Health and Mental Hygiene (DHMH), and the PPSP. Described herein are the monitoring programs conducted by the various agencies, the effluents released by each plant, and the actual distribution of radioactivity in the environment. Doses to man via the atmospheric and aqueous pathways are calculated. Comparisons with natural background doses, predictions made in Final Environmental Impact Statements, and operating license requirements are made where appropriate. A brief discussion of the quantity of electricity produced, and the wastes generated by each plant is also included.

A. Calvert Cliffs Nuclear Power Plant

The Calvert Cliffs Nuclear Power Plant (CCNPP), owned and operated by the Baltimore Gas and Electric Company (BG&E), is the only nuclear power plant located in Maryland. Each of its two units is a pressurized water reactor. Present ratings are 890 MWe gross each for Units 1 and 2 in winter, and 860 MWe gross in summer, when discharge water temperature restrictions may limit maximum load.

Unit 1 of the CCNPP, placed in commercial service on May 8, 1975, had as of the end of 1980 produced 29,594,233 MWh gross of electrical energy. Unit 2, placed in commercial service April 1, 1977, had as of the end of 1980, produced 22,728,967 MWh gross. Since the inception of commercial operation, Units 1 and 2 had as of the end of 1980, achieved cumulative unit capacity factors of 67.3% and 77.9%, respectively.

Releases to the Environment

Radionuclides discharged to the atmosphere and Chesapeake Bay by the Calvert Cliffs Nuclear Power Plant during 1978-1980 as reported by BG&E are given in Tables V-2 and V-3. Noble gases, which are not of significant environmental concern, comprise virtually 100% of the atmospheric releases. Other than Sr-89, no radionuclides released to the atmosphere were detectable in the environment during this period. Of the aquatic releases, Co-58, Co-60, Zn-65, and Ag-110m are the only bioaccumulable radionuclides routinely detected in the Bay environment. Cr-51 and Fe-59, both with relatively short half-lives (28 days and and 45 days respectively), were detected on two occasions.

Environmental Monitoring Programs

The Baltimore Gas and Electric Company (BG&E), the Maryland Department of Health and Mental Hygiene (DHMH), and the Maryland Power Plant Siting Program (PPSP) each conduct routine radiological monitoring programs designed to define the environmental impact of the releases described above. The BG&E program satisfies the environmental surveillance requirements imposed in its NRC operating license. The DHMH performs assurance monitoring to provide an independent confirmation of the utility program. The Power Plant Siting Program conducts a monitoring program and performs detailed investigations to describe the actual level of impact within ecosystem components. PPSP studies define the locational and trophic-level distribution of power plant radionuclides in the Calvert Cliffs area of the Chesapeake Bay. The programs conducted by the three agencies, described by sample type, collection frequency, and type of analysis, are presented in Tables V-4, V-5, V-6a, and V-6b.

Atmospheric and Terrestrial Radionuclide Distributions

Releases of radioactivity to the atmosphere during 1978-1980 did not contribute measurably to offsite radiation exposure as determined by TLD (7-11). Man-made radionuclides were, however, detected in the atmospheric and terrestrial environment on a few occasions during the period.

Iodine-131 was detected in the atmosphere at low levels during the week of March 20, 1978 by the utility and the State, both in the vicinity of the plant and at farfield locations. Because of its short half life, the presence of I-131 in the environment is indicative of a recent event, although not necessarily a power plant discharge, since it is also produced in the detonation of thermonuclear devices. In this case, its presence was attributed to the atmospheric weapons test conducted on March 10, 1978 by the Peoples Republic of China. Other gamma-emitting radionuclides associated

Table V-2

Total Gaseous Effluents (in Curies) Released by the
Calvert Cliffs Nuclear Power Plant as Reported by BG&E (1-6)

Radionuclide	1978	1979	1980
Tritium	1.63	5.13	27.9
Noble Gases	26800.	10200.	2960.
Halogens	0.200	0.419	0.107
Other	0.064	1.75	0.045
Total Curies	26801.894	10207.299	2988.052
Na-24		0.00000239	
Ar-41	0.914	0.127	0.374
Cr-51	0.00000155	0.00000512	
Mn-54	0.00000395	0.0000232	0.00000183
Mn-56	0.00000906	0.00000327	0.0000205
Co-58	0.00605	0.00247	0.0185
Co-60	0.000318	0.000631	
Br-82	0.0000730	0.000108	0.0000470
Kr-85	31.6	0.961	
Kr-85m	62.8	35.5	7.23
Kr-87		0.00193	0.00280
Kr-88	0.0471	1.24	0.218
Rb-88	0.0566	1.57	0.0130
Sr-85		0.00919	
Sr-89	0.0000599	0.0442	0.0000352
Sr-90	0.00000359	0.0859	0.0000391
Sr-91	0.0000252	0.0000426	0.00000657
Nb-95	0.00000182	0.00000450	
Mo-99	0.0000805	0.00000135	0.00000110
Ru-103	0.000000700	0.000417	0.0000000951
Ru-106		0.00000408	0.00000723
Sb-124	0.00000266		
Sb-125			0.00000155
Te-132		0.0000239	
I-131	0.118	0.300	0.0555
I-132	0.00346	0.00765	0.00170
I-133	0.0749	0.107	0.0213
I-134	0.00270	0.00000197	0.0000238
I-135	0.00105	0.00388	0.0284
Xe-131m	12.1	1.30	6.88
Xe-133	26300.	9820.	2860.
Xe-133m	33.2	3.73	3.51
Xe-135	322.	338.	86.9
Cs-134	0.000280	0.0000226	
Cs-137	0.000593	0.000306	
Cs-138	0.0000934	0.00164	0.0133
Ba-139	0.00000380	0.00000505	0.00000854
Ba-140	0.0000494	0.0329	0.0000679
La-140	0.00000762	0.0000500	0.0000570
Ce-141	0.000171		0.00000700
Np-239	0.000000457		

Table V-3

Total Liquid Effluents (in Curies) Released by the Calvert Cliffs Nuclear Power Plant as Reported by BG&E (1-6)

Radionuclide	1978	1979	1980
Tritium	456.	514.	491.
Dissolved Noble Gases[a]	7.91	15.6	15.8
Other	5.98	7.77	4.79
Total Curies	469.89	537.37	511.59
Na-24	0.00511		
Ar-41	0.000170		
Cr-51	0.770	0.638	0.737
Mn-54	0.130	0.112	0.0867
Mn-56	0.0000236	0.000659	0.00124
Fe-59	0.0593	0.0300	0.00737
Co-57	0.00271	0.00645	0.000817
Co-58	1.97	3.81	2.00
Co-60	0.462	0.325	0.441
Zn-65	0.0000651		0.0240
Kr-85m	0.000885	0.0000748	0.000179
Kr-87		0.000565	
Sr-85	0.000600	0.000724	
Sr-89	0.0244	0.00109	0.0141
Sr-90	0.00387	0.000989	0.0230
Sr-91			0.000613
Nb-95	0.158	0.0163	0.0384
Zr-95	0.162	0.147	0.212
Zr-97	0.000845	0.00112	0.000584
Mo-99	0.111	0.0122	0.00873
Ru-103	0.0376	0.0252	0.0248
Ru-106	0.00369	0.0126	0.000733
Cd-109		0.000102	
Ag-110m	0.0440	0.0953	0.0301
Sn-113		0.00181	0.243
Sb-124	0.0135	0.0329	0.0167
Sb-125	0.187	0.268	0.205
Te-129		0.000172	
Te-132	0.00219		
I-131	0.498	0.648	0.158
I-132	0.00906	0.0118	0.00162
I-133	0.384	0.391	0.0695
I-135	0.00753	0.0345	0.00703
Cs-134	0.308	0.394	0.106
Cs-136	0.0174	0.00318	
Cs-137	0.465	0.568	0.183
Xe-131m	0.00644		
Xe-133	7.20	15.1	15.5
Xe-133m	0.204	0.0952	0.106
Xe-135	0.498	0.420	0.210
Xe-135m		0.00423	0.00322
Xe-138		0.000109	
Ba-140	0.0452	0.0185	0.00605
La-140	0.0677	0.133	0.0313
Ce-141	0.00751	0.00563	0.00269
Ce-144	0.00181		
Np-239	0.0214		
Unidentified		0.0271	0.104

(a) Noble Gas Totals are the summations of the listed noble gas isotope activities.

Table V-4

Radiological Monitoring Conducted by the
Baltimore Gas & Electric Company in the Vicinity of the
Calvert Cliffs Nuclear Power Plant

SAMPLE MEDIA	COLLECTION FREQUENCY	NUMBER OF SAMPLING LOCATIONS	ANALYSES
Aquatic			
Finfish	Quarterly	1	
Flesh			Gamma
Bone			Sr-89/90
Shellfish			
Crabs (Flesh)	Quarterly	3	Gamma
Oysters (Flesh)	Quarterly	2	Gamma
Sediment	Quarterly	4	Gamma, Sr-89/90
Bay Water	Monthly	2	H-3, Gamma, Sr-89/90
Atmospheric			
Air			
Iodine	Weekly	4	I-131
Particulates	Weekly	7	Gamma, Gross Beta, Sr-89/90
Precipitation	Continuous	1	Gamma, H-3, Gross Beta, Sr-89/90
Terrestrial			
Vegetation	At Harvest	3	Gamma, Sr-89/90[a]
Soil	At Harvest	3	Gamma, Sr-89/90
Groundwater	Quarterly	4	H-3, Gamma
External radiation	Monthly	14[b]	TLD

(a) Analysis of cured or dried sample
(b) Includes Baltimore, Md. as a control station

Table V-5

Radiological Monitoring Conducted by the
Maryland Department of Health and Mental Hygiene
in the Vicinity of the Calvert Cliffs Nuclear Power Plant

SAMPLE MEDIA	COLLECTION FREQUENCY	NUMBER OF SAMPLING LOCATIONS	ANALYSES
Aquatic			
Shellfish			
Oysters	Quarterly	1	Gamma
Sediment	Quarterly	1	Gamma
Bay Water	Quarterly	3	Gamma, H-3
Atmospheric			
Air			
iodine	Weekly	4[a]	I-131
particulates	Weekly	4	Gamma, Gross Beta,
Terrestrial			
Vegetation	At Harvest	1	Gamma[b]
Groundwater	Quarterly	15	Gamma, Gross Beta, H-3
External radiation	Monthly	12	TLD

(a) In addition to these, a Baltimore location serves as a control
(b) Analysis of cured or dried sample

Table V-6a

Radiological Monitoring of Aquatic Impact Conducted by the Maryland Power Plant Siting Program in the Vicinity of the Calvert Cliffs Nuclear Power Plant

SAMPLE MEDIA	COLLECTION FREQUENCY	NUMBER OF SAMPLING LOCATIONS	ANALYSES[a]
Shellfish			
Oysters			
Natural bar	Quarterly	2	Gamma, Sr-89/90
Discharge tray	Quarterly, Semi annually, triquarterly, annually	1	Gamma, Sr-89/90
Crab	Spring,fall	2	
Shell			Gamma, Sr-89/90
Flesh			Gamma, Sr-89/90
Clams (Flesh)	Nonroutine	2	Gamma
Finfish			
Forage species	Spring,Fall	2	
Whole			Gamma, Sr-89/90
Edible species	Spring,Fall	2	
Flesh			Gamma, Sr-89/90
Bone			Sr-89/90
Waterfowl	Winter	2	
Flesh			Gamma, Sr-89/90
Bone			Sr-89/90
Grass shrimp	Spring,Fall	2	Gamma, Sr-89/90
Algae	Spring,Fall	2	Gamma, Sr-89/90
Miscellaneous biota (zooplankton benthos, etc.)[b]	Spring,Fall		Gamma, Sr-89/90
Sediments	Quarterly,	14	Gamma, Sr-89/90
	Annually	24	Gamma, Sr-89/90

(a) Routine Sr-89/90 analysis initiated in 1980.
(b) Routine quarterly epifauna program initiated in 1981.

Table V-6b

Radiological Monitoring of Terrestrial Impact Conducted by the Maryland Power Plant Siting Program in the Vicinity of the Calvert Cliffs Nuclear Power Plant

SAMPLE MEDIA	COLLECTION FREQUENCY	NUMBER OF SAMPLING LOCATIONS	ANALYSES[a]
Vegetation crops	At harvest	2	Gamma, Sr-89/90[b]
Lichens, leafy vegetables, lawn grass, pasture grass, etc.	(c)	(c)	Gamma, Sr-89/90
Soils	(c)	2 ≤12	Gamma, Sr-89/90 Sr-89/90
External radiation	Monthly	11[d]	TLD

(a) Routine Sr-89/90 analysis initiated 1980.
(b) Analysis of freshly harvested sample
(c) Non-routine collection to determine specific radiological impact as required.
(d) This program is integrated with DHMH, however, these 11 are in addition to those listed in Table V-5.

with this weapons test were also detected in air particulates at this time (11). In April 1979, DHMH detected a trace atmospheric concentration of I-131 (10 ± 7 fCi/m^3) in the Calvert Cliffs area. This is probably not due to releases by the plant, but is more likely from a remote source (Peach Bottom, TMI) since I-131 was also detected in the atmosphere (11), and in milk (12) in the Peach Bottom vicinity during this period.

As is the case with I-131, Sr-89 and Sr-90 are produced in weapons test explosions as well as power plant operation, and therefore can be introduced into the environment by both weapons test fallout and routine power plant releases. The longer lived Sr-90 has been historically present throughout Maryland, and was not detected in the Calvert Cliffs vicinity at levels significantly higher than those of farfield locations. Sr-89 attributed to power plant operation, however, was detected in air particulates at Calvert Cliffs during the third quarter of 1979 (9). Sr-89 was also detected in soil samples from both Calvert Cliffs and farfield locations in March 1978 (8), and was attributed to the March 1978 Chinese weapons test. The environmental impact of Sr-89 at the very low concentrations detected is inconsequential. Precipitation samples contained no plant-related gamma radionuclides or Sr-89/90, and tritium values were consistent with fallout-associated levels.

No plant-related radionuclides were detected in crop vegetation in 1978. In 1979 a sunflower sample analyzed by BG&E indicated the presence of a low concentration of Sr-89 which may have been the result of plant operation. Sr-90 detected by BG&E in tobacco in concentrations up to 1.8 nCi/kg (wet) may also be plant related. This value is somewhat in question because it varies significantly (on the high side) from the other data. BG&E personnel attribute this to improper laboratory technique (13), and data from other monitoring programs support questioning the validity of this number. Soil and tobacco collected in the fall of 1980, however, show no discernible Sr-90 increase in the vicinity of Calvert Cliffs (7). More detailed radiostrontium investigation is underway; PPSP and BG&E are analyzing fresh (uncured) tobacco and soils from both the plant vicinity and farfield locations in an attempt to detect any possible plant-associated increment.

In summary, of those radionuclides released to the atmosphere during 1978-1980 by the Calvert Cliffs Nuclear Power Plant, only Sr-89 and a trace of I-131 were detected in the atmospheric and terrestrial environment. Detection of fallout from the 1978 Chinese weapons test confirmed the ability of the monitoring programs to discern other small, man-made increments of radioactivity in the airborne pathway. These concentrations provide context for evaluating the minor plant-associated increment, which is regarded as insignificant.

Aquatic Radionuclide Distributions

An annual average of approximately 500 Ci of tritium was released via the liquid pathway during the 1978-1980 period. This represents approximately 96 percent of the activity released to the aqueous environment. Monitoring of Chesapeake Bay water by BG&E and the State occasionally reveals tritium concentrations above the background levels ~1500 pCi/l (11). These higher concentrations, attributed to routine releases by the plant, are localized in the discharge vicinity. Because of dilution and dispersion,

tritium concentrations in Bay water outside the immediate discharge area are at background levels. Because tritium is not a bioaccumulated radionuclide, the resulting radiation doses to aquatic biota are insignificant, and no adverse environmental impact is associated with these levels.

Radionuclides with potentially significant environmental impact are those which may, through chemical and biological processes, be retained and accumulated in the Chesapeake Bay ecosystem. Cycling and trophic level assimilation of these radionuclides will provide an additional radiation dose to Bay organisms, and could ultimately contribute some radiation dose to man.

A variety of such bioaccumulable radionuclides have been introduced into the Bay as a result of atmospheric weapons testing. Since 1978, three Chinese atmospheric detonations have produced detectable concentrations of fallout in Bay samples. The relatively short-lived Ce-141, Ce-144, Ru-103, Ru-106, Zr-95 and Nb-95 are episodically detected in sediments and finfish following these events and during the annual Spring washout of weapons-test debris. The long-lived fallout product Cs-137 is ubiquitously distributed in the environment and is consistently detected in sediments and biota of the Chesapeake Bay. Calvert Cliffs also discharges small quantities of these radionuclides. However, concentrations detected in environmental samples collected near the plant are within the statistical distribution of concentrations present in the same media at locations beyond the plant's influence. The plant-related contributions are indistinguishable and therefore not quantifiable. These very low levels of fallout radionuclide concentrations are insignificant contributors to the dose received by Bay biota and human consumers.

Other radionuclides which are not fallout constituents, but are routinely released by Calvert Cliffs, have been detected in Bay samples (7-10, 14). Nearfield biota and sediments periodically contain low levels of Co-58, Co-60, Zn-65, and Ag-110m. Because of the physically and biologically dynamic character of the Chesapeake Bay Estuary, and variations in radioactivity released by the plant, radionuclide concentrations within individual sample media vary greatly. Table V-7 presents maximum concentrations of plant-associated radionuclides detected in the PPSP monitoring program.

Naturally ocurring radionuclides of the thorium and uranium decay products and potassium-40, as well as weapon test fallout radionuclides, are present in sediments in the Calvert Cliffs area and throughout the Bay. Radionuclides detected in sediments which are attributed to Calvert Cliffs are Co-58, Co-60, and Ag-110m. Ag-110m was detected at extremely low levels in nearfield sampling locations through November 1979, but not later (7, 15). Co-58 and Co-60 have been detected consistently in area sediments during the reporting period (1978-1980). Prior to 1978, Co-58 was not detected in sediments and Co-60 was present at a barely detectable concentration at one sampling location. The Co-60 detected at that time may not be related to Calvert Cliffs since it was found in sediments prior to plant operation (15). Concentrations of Co-58 and Co-60 in sediments fluctuate over time, but a constant localized increase of radiocobalt in area sediments is not apparent. However, the increased incidence of Co-58 at the transect extremes (7) indicates an expansion of the impact area.

Table V-7

Maximum Concentrations of Radionuclides Attributed to Calvert Cliffs Operation in Various Environmental Media for the Period 1978-1980 as Determined by PPSP Monitoring Program Counting Uncertainty @ 95% Confidence Level

MEDIA	Radionuclide Concentration (pCi/kg, wet)[a]			
	Co-58	Co-60	Zn-65	Ag-110m
Seaduck				
Flesh	11±9	-	-	-
Gut	472±38	50±24		
Edible Finfish	-	-	-	-
Forage Finfish[b]	186±4	15±2	-	3±2
Oysters	73±4	6±2	31±6	350±20
Clams (Mya arenaria)	3±3	2±2	-	65±6
Crab				
Meat	-	-	-	22±6
Shell	-	-	-	119±32
Grass Shrimp				25±11
Zooplankton	28±6	5±5	-	-
Algae	141±14	3±8	-	-
Sediment				
Sand	287±11	33±6	-	9±5
Clay	450±14	179±16	-	13±7

(a) Concentrations for crab shell and sediments are in pCi/kg, dry. Concentrations for zooplankton are in pCi/l.

(b) This collection of menhaden also contained 82±15 pCi/kg Cr-51 and 8±3 pCi/kg of Fe-59.

The mobile and transitory nature of finfish results in a short term exposure to Calvert Cliffs discharges. This reduces the extent to which these species can assimilate discharged radioactivity through direct uptake or food chain transport. Resident benthic and epibenthic biota such as clams and oysters which are present (and therefore exposed) year-round are impacted to a greater extent and serve as indicators of upper concentration limits. Macro-algae and fouling organisms which are present or metabolically active on a seasonal basis reflect shorter term radioecological impact.

Edible finfish (primarily bluefish) collected in the Calvert Cliffs vicinity have contained fallout-attributed Cs-137 but no detectable power plant-related radionuclides (7-10). Samples of certain forage finfish (anchovies and silversides) have likewise contained no detectable power plant radioactivity. Radionuclides attributed to the plant have, however, been detected on occasion in the filter-feeding menhaden, a primary prey species for important predator finfish, e.g., bluefish and weakfish (7). The presence of the short-lived Cr-51 (half-life 28 days) and Fe-59 (half-life 45 days) in these samples indicates that the population was in the nearfield during a discharge, and collection and analysis took place soon after exposure to and uptake of, the released radioactivity.

Radionuclides attributed to Calvert Cliffs have been detected in shellfish: periodically in blue crabs (7) and consisently in oysters (8-10, 14). As previously mentioned, oysters resident in the Calvert Cliffs vicinity are exposed to radioactivity to a greater extent than transient biota such as finfish and crabs, and may provide a higher potential dose to man through seafood consumption. PPSP monitors oysters from a natural bed 3/4 mile north of the discharge, and conducts a submerged tray study in which groups of oysters are exposed directly to Calvert Cliffs discharges for selected time periods. The assimilation and depuration of radionuclides in oysters is affected not only by the availability of radionuclides, but also a multitude of chemical and biological conditions. The tray study provides a more thorough understanding of the controlling parameters than is possible through quarterly monitoring of the natural bed. Significantly, this study indicated that uptake was totally inhibited during the winter season (14). The most noteworthy radionuclide present in oysters during the previous period was Ag-110m (16). Concentrations of Ag-110m in continuously exposed oysters peaked in the fall of 1977 at approximately 600 pCi/kg (wet) (17) and have been decreasing throughout the 1978-1980 period to approximately 60 pCi/kg (wet) (8-10, 14). As of this publication date, concentrations were ~20 pCi/kg (wet) (7, 11). Evidence of the sensitivity of using oysters as biological indicators of potential radioecological impact is provided by the fact that very low levels of Zn-65 are sporadically detected in these organisms (11, 14) while the quantities of this radionuclide remain so low as to be undetectable by BG&E in their analysis of releases.

Sea ducks (Old Squaw) collected in the discharge vicinity have contained Co-58 associated with plant releases (7). These birds overwinter on the Bay and feed extensively on small clams found in the Calvert Cliffs area. While these low levels have no significant radiological impact, they serve to demonstrate upper trophic level assimilation of power plant radioactivity.

Radiation Dose to Man

The estimate of the dose commitment[1] to an individual consuming seafood harvested in the vicinity of Calvert Cliffs has been calculated using the maximum radionuclide concentrations detected in shellfish taken from this area (Table V-7). Calculated dose commitments to adults, teenagers and children are given in Table V-8. Table V-9 contains a comparison of doses predicted in the Final Environmental Impact Statement for CCNPP and those doses calculated using the maximum concentrations from Table V-8.

Summary

Of the radioactivity detected via monitoring of the atmospheric pathway during 1978-1980, only Sr-89 detected at low levels in air particulate and vegetation samples was attributed to plant operation. A trace of atmospheric I-131 may be plant related, or due to releases from a remote source. At these levels, environmental impact is negligible.

Radioactivity dicharged via the aqueous pathway has been detected in the Chesapeake Bay ecosystem. Sediments have contained low levels of Co-58, Co-60, and Ag-110m. Ag-110m has not been detected in sediments since 1979. Co-58, which had not been detected prior to 1978, is consistently found in area sediments. The range of concentration varies over time, and while no significant build-up is apparent in the nearfield, sediment dispersion appears to be expanding the impact area.

Radionuclides attributed to aqueous releases by Calvert Cliffs have been detected at low levels in all sampled Bay biota with the exception of edible predator finfish. The maximum detected concentrations would result in radiation doses to the various organisms which are still orders of magnitude lower than doses resulting from naturally radioactive sources present in the Bay environment such as thorium and uranium decay products and potassium-40. Due to their year-round residence, oysters in the Calvert Cliffs vicinity represent the greatest potential human radiation dose through seafood consumption. Employing the maximum detected concentration in seafood, the estimated dose to the maximum exposed individual through consumption would be 0.11 mrem to an adult's G.I. tract. The plant operates well within 10 CFR 50 Appendix I design criteria which limit a maximum exposed individual to 3 mrem annually per reactor for the aqueous pathway.

B. Peach Bottom Atomic Power Station

The Peach Bottom Atomic Power Station (PBAPS), owned and operated by the Philadelphia Electric Company (PECO), is located approximately three miles north of the Pennsylvania-Maryland border on the Susquehanna River. Although it is outside Maryland, it has the potential for impact in Maryland because

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[1]The dose commitment from the ingestion of a given quantity of some radionuclide is the total dose that will be received by the individual before the radioactive material is removed from the body by excretion and/or radioactive decay. These estimates employ Regulatory Guide 1.109 dose conversions (24).

Table V-8

Maximum Dose Commitment in mrem to an Individual Consuming Shellfish[a] Exclusively from the Vicinity of the Calvert Cliffs Nuclear Power Plant (Utilizing Radionuclide Concentrations Given in Table V-7)

	Age Group	Adult	Teen	Child
Quantity Consumed[b]	Oysters	29 dozen	22 dozen	10 dozen
	Clams	29 dozen	22 dozen	10 dozen
	Crabs	15 dozen	11 dozen	5 dozen
Total Body Dose	Co-58	.000610	.000621	.000684
	Co-60	.000142	.000144	.000159
	Zn-65	.001079	.001099	.001196
	Ag-110m	.000154	.000157	.000173
	TOTAL	.00198	.00202	.00221
Bone Dose	Co-58	(c)	(c)	(c)
	Co-60	(c)	(c)	(c)
	Zn-65	.000750	.000679	.000722
	Ag-110m	.000280	.000273	.000321
	TOTAL	.00103	.00095	.00104
Liver Dose	Co-58	.000272	.000270	.000223
	Co-60	.000064	.000064	.000054
	Zn-65	.002387	.002356	.001924
	Ag-110m	.000259	.000258	.000217
	TOTAL	.00298	.00295	.00242
Kidney Dose	Co-58	(c)	(c)	(c)
	Co-60	(c)	(c)	(c)
	Zn-65	.001597	.001508	.001212
	Ag-110m	.000509	.000492	.000403
	TOTAL	.00211	.00200	.00162
GI-LLI Dose	Co-58	.005511	.003717	.001303
	Co-60	.001206	.000834	.000299
	Zn-65	.001504	.000998	.000338
	Ag-110m	.105700	.072485	.025764
	TOTAL	.11392	.07803	.02770

(a) No power-plant radioactivity has been detected in edible finfish.
(b) The numbers of each type of shellfish consumed corresponds to 5kg/yr, 3.8kg/yr, and 1.7kg/yr for an adult, teen, and child, respectively. These are recommended values (Reg. Guide 1.109) used in lieu of site specific data to determine the dose commitment to the maximum exposed individual.
(c) Dose/concentration conversion factors not available.

Table V-9

Comparison of Predicted[a] and Calculated[b] Dose Commitments in mrem to a Maximum Exposed Individual from Consuming Seafood Exclusively from the Vicinity of the Calvert Cliffs Nuclear Power Plant

Seafood Consumed	Total Body		G.I.-LLI Tract		Thyroid		Bone	
	Predicted	Calculated	Predicted	Calculated	Predicted	Calculated	Predicted	Calculated
Finfish	0.037	(c)	0.078	(c)	0.087	(c)	0.021	(c)
Crustacea	0.20	0.000017	1.62	0.011960	0.22	(d)	0.022	0.000032[e]
Molluscs	0.043	0.003571	0.42	0.205058	0.22	(d)	0.037	0.001854[e]

(a) Predicted doses taken from the Final Environmental Impact Statement for Calvert Cliffs (18).

(b) Calculated doses are derived assuming an annual consumption of 18 kg of finfish, and 9 kg of crustacea or molluscs; radionuclide concentrations utilized are those found in Table V-7.

(c) No power plant radionuclide have been detected in edible finfish.

(d) Thyroid dose conversion factors not available.

(e) These values include no dose commitment for Co-58 or Co-60 as conversion factor were unavailable for these isotopes.

of its location on the Susquehanna River. Each of the two units remaining in operation (Unit 1, a 40 MWe High Temperature Gas Cooled Reactor, was decommissioned in January 1975) is a boiling water reactor with a maximum dependable capacity of 1098 MWe.

Unit 2 of the PBAPS, placed in commercial service in July 1974, had produced 42,405,440 MWh gross of electrical energy as of the end of 1980. Unit 3, placed in commercial service in December 1974, had produced 39,745,940 MWh gross. Since the inception of commercial operation, Units 2 and 3 have achieved cumulative unit capacity factors of 62.3% and 62.7%, respectively.

Releases to the Environment

Radionuclides discharged to the atmosphere and the Conowingo Pond (Susquehanna River) from the Peach Bottom Atomic Power Station as reported by PECO during 1978-1980 are given in Tables V-10 and V-11. Noble gasses, chiefly the Xenon isotopes, comprise nearly 100 percent of the radioactivity released to the atmosphere. These radioisotopes have very little environmental impact due to their inert nature. Iodine-131, which is an isotope of environmental significance, is routinely released in small quantities. Actual releases to the atmosphere for the three year period are considerably lower than estimated in the Final Environmental Impact Statement for Peach Bottom (18).

Of the liquid releases, tritium and dissolved noble gases accounted for about 70 percent and 10 percent, respectively, of the total activity released during the three year period. Environmentally significant radionuclides (other than tritium and noble gases) accounted for about 20 percent of the total activity released over the three year period, with I-131, Co-60, Zn-65, Cs-134 and Cs-137 being of primary importance. Due to the short half-lives of the Iodines, they are only sporadically detected in the aquatic environment and do not accumulate in environmental media. Co-60, Zn-65, Cs-134, and Cs-137 are consistently detected in Conowingo Pond sediments. Zn-65, Cs-134 and Cs-137 are routinely detected in biota of the Conowingo Pond, Susquehanna River, and Susquehanna Flats.

Environmental Monitoring Programs

PECO, the Maryland DHMH, and PPSP all conduct extensive monitoring programs to assess the impact of PBAPS. To define the atmospheric pathway impact, PECO contractors analyze samples of air, precipitation, terrestrial vegetation, soils, and milk. Monitoring of ambient radiation levels provides an assessment of the external dose delivered by noble gasses through the atmospheric pathway. The DHMH maintains air particulate and air iodine samplers in the Peach Bottom vicinity for assessing atmospheric impact, and conducts jointly with PPSP an ambient radiation monitoring program.

The utility's aquatic environmental monitoring program is designed to quantify radionuclide concentrations in water, sediment and finfish. Sampling is restricted to the Conowingo Pond except for a spring collection of shad from the Conowingo Dam tailrace; Maryland impact beyond the Conowingo Dam is

Table V-10

Total Gaseous Releases (Curies) from the Peach Bottom Atomic Power Station as Reported by PECO (19-24)

Radionuclide	1978	1979	1980
Tritium	20.0	27.3	12.9
Noble Gases	49700.	122500.	12900.
Halogens	1.44	1.36	1.14
Other	0.038	0.122	0.096
Total Curies	49721.478	122528.782	12914.136
Na-24	0.000437	0.00249	
Cr-51	0.000288	0.000674	
Co-58			0.0000825
Co-60	0.00469	0.000940	0.00870
Zn-65	0.00310	0.000853	0.0151
Kr-85	1.91		
Kr-85m	66.6	433.	16.6
Kr-87		112.	3.72
Kr-88		84.9	6.13
Rb-88		0.0103	0.00356
Rb-89		0.000379	0.0000746
Y-91m	0.000917	0.00247	0.00318
Sr-89	0.00241	0.00209	0.00210
Sr-90	0.000106	0.0000927	0.0000659
Sr-91	0.00220	0.000326	0.00145
Sr-92		0.0000426	
Mo-99	0.0000747		
Tc-99m		0.00121	
Ag-110m	0.000156		
I-131	0.0839	0.258	0.0294
I-133	0.645	0.631	0.569
I-135	0.711	0.475	0.543
Cs-134	0.000570	0.00165	0.00177
Cs-137	0.000942	0.00152	0.00450
Cs-138	0.0211	0.0962	0.0535
Xe-131m		136.	
Xe-133	45440.	106000.	11000.
Xe-133m	4197.	194.	115.
Xe-135		15400.	1600.
Xe-135m		86.9	76.5
Xe-138		23.1	107.
Ba-140	0.0000855	0.000334	0.00129
La-140	0.00104	0.000188	0.000925
Np-239	0.0000687		

Table V-11
Total Liquid Releases (Curies) from the Peach Bottom
Atomic Power Station as Reported by PECO (19-24)

Radionuclide	1978	1979	1980
Tritium	32.4	42.7	37.3
Dissolved Noble Gases	7.10	6.53	1.35
Other	9.78	21.10	3.65
Total Curies	49.28	73.33	42.30
Na-24	4.45	9.27	0.578
P-32		0.0719	0.0170
Cr-51	0.00445	0.0649	0.0965
Fe-55		0.203	0.0220
Mn-54	0.0879	0.00735	0.00879
Mn-56			0.000627
Co-58	0.0273	0.0240	0.0234
Co-60	0.155	0.162	0.156
Ni-63		0.0319	0.00511
Zn-65	0.424	0.460	0.306
Kr-85m		0.0528	0.000403
Kr-87		0.0298	
Kr-88		0.0851	
Y-91m		0.0230	0.0139
Sr-89	0.0189	0.0202	0.00757
Sr-90	0.000944	0.000813	0.000380
Sr-91		0.00763	0.00711
Sr-92	0.000127	0.00142	0.000734
Nb-95		0.000471	0.000570
Zr-95			0.000416
Mo-99	0.000416	0.000160	
Te-99m	0.00262	0.101	0.0218
Ru-103		0.000177	
Cd-109		0.0858	0.00171
Ag-110m		0.000114	
Sb-122		0.194	
Sb-124		0.000536	0.0000315
Te-132	0.0505	0.0151	0.0238
I-131	0.227	0.964	0.0639
I-132	0.00746	0.00322	0.000784
I-133	0.300	0.446	0.0721
I-134	0.136		0.000721
I-135		0.118	0.0236
Xe-131m		0.103	0.0185
Xe-133		1.17	0.313
Xe-133m		0.000718	0.00222
Xe-135		3.08	0.521
Xe-135m	0.103	0.0185	
Xe-133		1.17	0.313
Xe-133m		0.000718	0.00222
Xe-135		3.08	0.521
Xe-135m		0.0705	0.0546
Cs-134	2.86	3.92	0.568
Cs-137	0.810	3.26	0.691
Ba-140		0.000963	0.00740
La-140		0.0237	0.0107
Np-239	0.115	0.0286	0.0116

not addressed. PPSP conducts an extensive monitoring program to assess the actual distribution of PBAPS radionuclides, focussing on the aquatic environment because this pathway has the greatest potential for a significant impact in Maryland. Samples are collected from Conowingo Pond, the Susquehanna River and the Upper Chesapeake Bay to determine radionuclide concentrations in sediments, aquatic vegetation, forage and commercially significant finfish, shellfish, waterfowl and aquatic mammals (Figure V-1). The programs conducted by the three agencies, described by sample type, collection frequency and type of analysis, are presented in Tables V-12, V-13, V-14, and V-15.

Atmospheric and Terrestrial Radionuclide Distributions

Except for I-131, relatively small quantities of environmentally significant radioactivity are released via the atmospheric pathway, a fact which is supported by the general lack of detectable PBAPS radionuclides in atmospheric and terrestrial samples. TLD measurements indicate that the ambient radiation level is no higher in the PBAPS vicinity than at farfield locations (12, 25, 26). The frequent detection of natural and weapons test fallout radioactivity in air particulate, precipitation, soil and milk samples demonstrates the efficacy of the surveillance network. Cosmically-activated Be-7, the ubiquitous and routinely detected Cs-137, and the episodically present Zr-95 and Nb-95 are natural and weapons test fallout products whose concentrations peak with seasonal precipitation and atmospheric washout (11, 12, 25-29).

In March 1978, an atmospheric weapons test by the Peoples Republic of China produced detectable fallout, which included I-131, in the Peach Bottom vicinity (11, 25) as well as at farfield locations (11). Some, or all of the I-131 detected at this time in milk and air particulates (by PECO contractors), and in atmospheric and particulate samples (by DHMH) can be attributed to this event, since fresh fission radionuclides (I-132/Te-132, Ba/La-140) were also in evidence (11). PBAPS did release I-131 in April (the fifth highest monthly I-131 release over the 3 year subject period, 20.5 mCi) and may also have been an unquantifiable contributor to the detected concentrations. PECO contractors again detected I-131 in milk later in the year (October and November), an event which is attributed solely to releases by PBAPS (25). The maximum detected spring concentration in milk was 9.1 ± 0.9 pCi/l, and in the fall, 0.84 ± 0.08 pCi/l.

In 1979, I-131 was detected in milk in the Peach Bottom vicinity throughout the month of April to a maximum concentration of 0.53 ± 0.06 pCi/l (26). The Maryland DHMH (11) also detected I-131 in air samples from Harford County in the second and third weeks of April (Maximum of 30 ± 10 fCi/m^3)[1]. The TMI accident in late March and subsequent atmospheric releases has been regarded as the source of this I-131 because similiar levels were present in milk from near and distant farms suggesting a regional effect from a distant source (26). However it should be noted that the second highest total monthly release of I-131 from PBAPS for the three-year subject period also

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[1] DHMH also detected a trace (10 ± 7 fCi/m^3) of I-131 in the atmosphere in the Calvert Cliffs area during the second week of April which may be due to TMI, PBAPS, Calvert Cliffs or a combination.

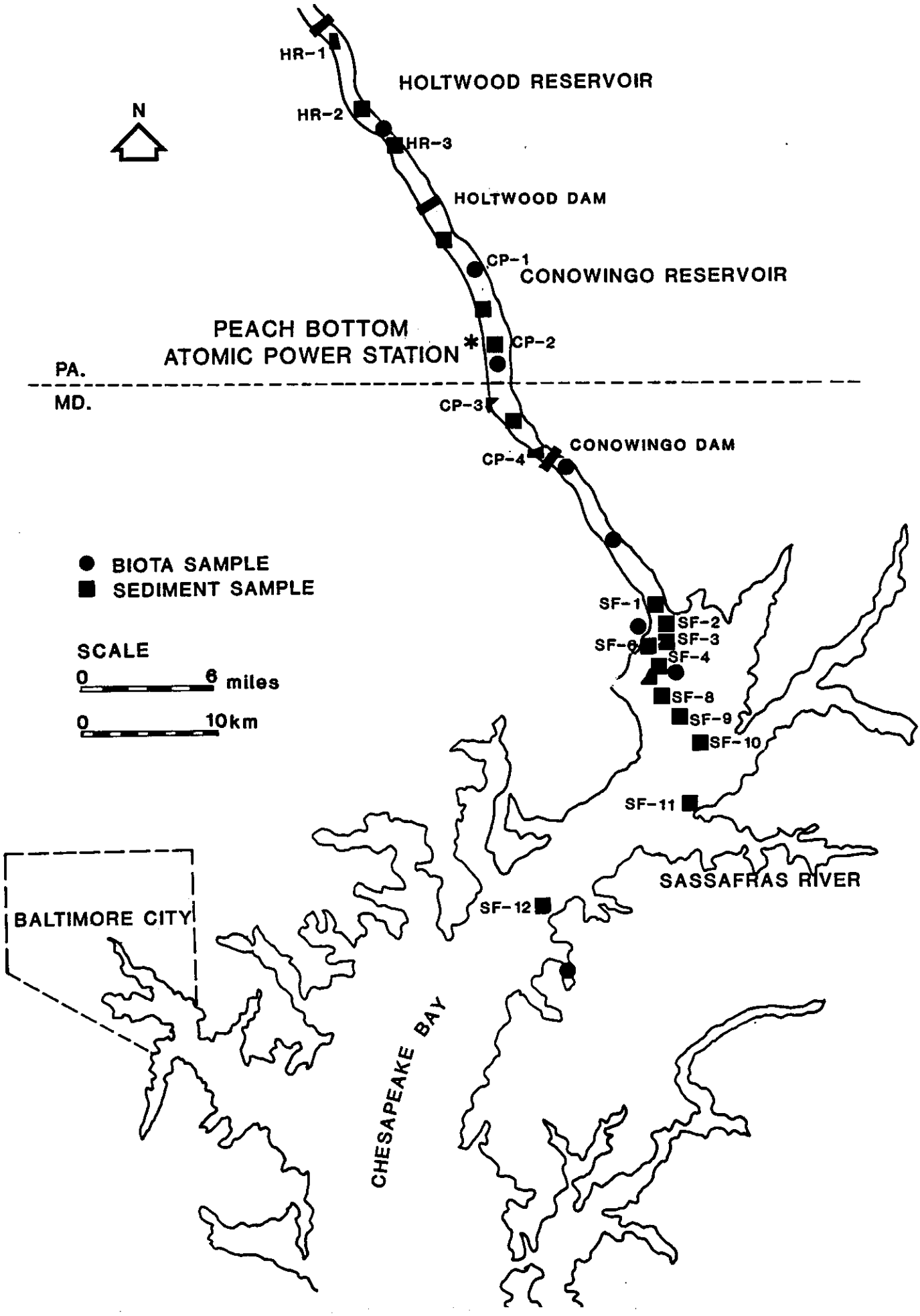

Fig. V-1. PPSP Susquehanna River/Upper Bay Sampling Locations

Table V-12

Radiological Monitoring Conducted by
Philadelphia Electric Contractor Interex Corporation
in the Vicinity of the Peach Bottom Atomic Power Station

SAMPLE MEDIA	COLLECTION FREQUENCY	NUMBER OF SAMPLING LOCATIONS	ANALYSES
Air particulate	Continuous samples composited weekly/monthly	17	Gamma (monthly);, Gross Beta (weekly)
Precipitation	Continuously	3	Gross Beta; Sr-89/90, Cs-137
Milk	Quarterly	11	Gross Beta; Sr-89/90;Cs-134/137, I-131, K-40
Vegetation	Spring, summer, fall	7	Gross Beta; Sr-89/90; Cs-134/137,K-40
Soil	Semiannually	6	Gross Beta; Sr-89/90;Cs-134/137, K-40
Small mammal thyroid muscle bone	Semiannually	1	Gross Beta; I-131; Sr-89/90
Well water	Quarterly	4	Gross Alpha; Gross Beta; Cs-137; Sr-89/90
Surface water	Monthly	8	Gross Alpha; Gross Beta
Discharge water	Monthly	2	Gross Alpha; Gross Beta
Sediments	Semiannually	6	Gamma; Gross Alpha; Gross Beta;Cs-134/137
Finfish	Quarterly	5	Gamma; Gross Beta; Sr-89/90; K-40

Table V-13

Radiological Monitoring Conducted by Philadelphia Electric Contractor Radiation Management Corporation in the Vicinity of the Peach Bottom Atomic Power Station

SAMPLE MEDIA	COLLECTION FREQUENCY	NUMBER OF SAMPLING LOCATIONS	ANALYSES
Air Particulate	Continuous samples composited weekly	2	Gross Beta (weekly), Gamma (monthly)
Iodine[a]	Continuous samples composited weekly	7	I-131
Precipitation	Continuous samples composited monthly	2	Gamma, Gross Beta
Milk	Weekly while cows on pasture, otherwise monthly; quarterly	11 8;3	I-131, Sr-89/90[b], H-3[c], Gamma[d]
Soil	Semiannually	3	Gamma, Sr-89/90
Ambient radiation	Monthly, quarterly	47	TLD
Well water	Quarterly	4	Gross Beta, H-3
Surface water	Monthly	9	Gamma, Gross Beta, H-3, Gross alpha[e]
Discharge water	Monthly	2	Gamma, Gross Beta H-3

(a) Initiated in March, 1980
(b) One farm
(c) Four farms
(d) One farm
(e) Four stations

Table V-14

Radiological Monitoring Conducted by the Maryland Department of Health and Mental Hygiene in the Vicinity of the Peach Bottom Atomic Power Station

SAMPLE MEDIA	NUMBER OF COLLECTION FREQUENCY	SAMPLING LOCATIONS	ANALYSES
Air particulates	Continuous samples composited weekly	2(b)	Gamma, Gross Beta, Gross Alpha(a)
iodine	Continuous samples composited weekly	2(b)	Gamma
Ambient radiation	Monthly	12	TLD
Surface water	Weekly	1	Gamma, Gross Beta, H-3

(a) PPSP initiated Sr-89/90 analysis on these samples in 1981.
(b) An additional, Baltimore location serves as control.

Table V-15

Radiological Monitoring Conducted by the Maryland Power Plant Siting Program in the Vicinity of the Peach Bottom Atomic Power Station

SAMPLE MEDIA	COLLECTION FREQUENCY	NUMBER OF SAMPLING LOCATIONS	ANALYSES
Mammals (muskrat, otter, raccoon)	Annual	2	
Flesh			Gamma, Sr-89/90
Bone			Sr-89/90
Waterfowl	(a)	2	
Flesh			Gamma, Sr-89/90
Bone			Sr-89/90
Finfish			
Forage species	Spring, Fall	4	
Whole			Gamma, Sr-89/90
Edible species	Spring, fall	4	
Flesh			Gamma, Sr-89/90
Bone			Sr-89/90
Shellfish			
Crabs (Flesh)	(a)	1	Gamma, Sr-89/90
Clams (Flesh)	(a)	1	Gamma, Sr-89/90
Oysters (Flesh)	(a)	1	Gamma, Sr-89/90
Mussels (Flesh)	Spring, fall	1	Gamma, Sr-89/90
Submerged Aquatic Vegetation	Spring, fall	3	Gamma, Sr-89/90
Sediments	Spring, fall	35	Gamma, Sr-89/90

(a) Non-routine collection to determine specific radiological impact as required.

occurred in March 1979 (42.3 mCi). It is possible that some fraction or all of the I-131 detected at this time was due to PBAPS releases. The third highest monthly release of I-131 for the subject period (39.3 mCi) occured in June and its presence in milk detected by RMC in June (max 0.65±0.04 pCi/1) and July and August (max 0.06±0.03 pCi/1) is attributed to releases by PBAPS during this period. In September and October, I-131 detected in milk to a maximum of 0.5±0.1 pCi/1 was attributed solely to PBAPS (26).

During 1980, I-131 was detected in milk in October, November and December by RMC (12) to a maximum concentration of 0.33 pCi/1. PBAPS released very little I-131 during this period; however, fallout from the Chinese weapons test on October 15 was reported by numerous agencies to have contributed I-131 throughout the mid-atlantic region. Maryland DHMH also detected I-131 in atmospheric samples at this time. The I-131 in milk in the PBAPS vicinity is attributed to this fallout event.

Other than I-131, radionuclides attributed to PBAPS atmospheric releases were detected only once during the 1978-1980 period at an onsite air monitoring station. Low levels of Co-60, Zn-65, Cs-134 and Cs-137 were detected at this location in air particulates in July 1980 (12).

Aquatic Radionuclide Distributions

As indicated in Table V-16, relatively low levels of radionuclides attributed to PBAPS have been detected in sediments, finfish, freshwater mussels, aquatic vegetation, waterfowl, and in one otter (30). While these low concentrations do not represent a human health concern, the diverse distribution of PBAPS radionuclides within the ecosystem is nonetheless confirmed.

Radionuclide concentrations in finfish are highest in the plant vicinity in the Conowingo Pond and in the Susquehanna River below the Conowingo Dam. Finfish collected from the Susquehanna Flats have occasionally contained PBAPS attributed radioactivity (Cs-134). The highest concentration of PBAPS radioactivity detected in submerged aquatic vegetation (SAV) occurred on the Susquehanna Flats (the closest sampling location for SAV); however, Cs-134 was found associated with an SAV (milfoil) sample from an area below the Sassafras River, some thirty miles from the PBAPS (30). Because of cesium's high affinity for organic material, it was likely bound to suspended particulate material attached to the sample, rather than actually incorporated in the SAV itself.

Freshwater mussels from the Flats have been found to contain Zn-65 and Cs-134 attributed to PBAPS discharges, while crabs and oysters from the Swan Point area (the northernmost distribution limit for oysters in commercial abundance) have contained no detectable PBAPS radioactivity. Fish-eating waterfowl (mergansers) from the Susquehanna below the Dam have contained PBAPS radioactivity; muskrats and raccoons collected from the Susquehanna River below the Dam have contained no radioactivity attributed to PBAPS; however, a river otter taken in the Sassafras River area in 1980 did contain a trace of Cs-134 attributed to aquatic releases by PBAPS (30). As these animals are known to travel considerable distances, it is not unlikely that radionuclide uptake took place during residence closer to PBAPS, e.g., on the Susquehanna Flats or in the Susquehanna River.

Table V-16

Maximum Concentrations of Radionuclides Attributed to Peach Bottom Atomic Power Station in Various Aquatic Media for the Period 1978-1980 as Determined Through PPSP Monitoring Program (30). Counting Uncertainty @ 95% Confidence Level

Media	Radionuclide Concentration (pCi/kg, wet)[a] Co-60	Zn-65	Cs-134	Cs-137[b]
Mammals				
Otter				
Flesh	-	-	2±3	22±5
Gut	-	20±11	-	14±6
Raccoon				
Flesh	-	-	-	23±8
Gut	-	-	-	135±16
Muskrat				
Flesh	-	-	-	21±7
Gut	-	-	-	-
Waterfowl				
Merganser				
Flesh	-	-	20±9	35±9
Gut	-	-	13±16	60±24
Finfish				
Edible Species	-	60±20	230±26	316±26
Forage Species	-	197±23	173±14	203±16
Invertebrates				
Crab				
Meat	-	-	-	-
Shell	-	-	-	8±14
Oyster (Meat)	-	-	-	-
Rangia cuneata	-	-	-	-
Elliptio complanata	-	17±6	24±3	27±4
Submerged Aquatic Vegetation	-	9±4	134±5	155±5
Sediment	70±2	132±20	796±62	967±18

(a) Concentrations for crab shell and sediments are in pCi/kg, dry.

(b) Primarily attributable to weapons testing fallout; however the detection of Cs-134 indicates that power plant produced Cs-137 is present as well.

Zn-65 has been detected in Conowingo Pond sediments, but not in samples from below the Conowingo Dam. Cs-134 and a generally unquantifiable concentration of Cs-137 have been detected in sediments from Conowingo Pond and the Upper Chesapeake Bay, distributed as far out as the mouth of the Sassafras River.[1] Maximum concentrations occur in the Pond and the mouth of the Susquehanna River (30).

Most of the radioactivity released to the Susquehanna River by the PBAPS is dispersed and diluted to an extent that it is undetectable in the environment. Some radionuclides, however, are incorporated within the Susquehanna River/Upper Chesapeake Bay ecosystem, and trophic-level transport is apparent. Periodic fluctuations in environmental radionuclide concentrations occur as functions of a multitude of parameters such as discharge rate, stream flow, organic loading, and organism metabolism. The range of radionuclide concentrations in the various environmental media reflect the total system, and assuming that the radioactive discharges from the plant do not vary significantly from year to year, maximum concentrations detected probably represent upper environmental concentration limits. In other words, there is no indication that a localized "buildup" of radioactivity is occurring over time.

Radiation Dose to Man

The principal contributor to dose via the airborne-to-food chain pathway is I-131 ingestion though milk consumption. Doses projected in the Final Environmental Impact Statement (FEIS) published by the Nuclear Regulatory Commission are unrealistically high as they assume far greater I-131 releases and subsequent concentrations in milk (0.2 μCi/l) than actually occur. (The maximum concentration detected during the subject period was due to fallout, and was 5 pCi/l or 5×10^{-6} μCi/l; the maximum attributed to PBAPS was 8×10^{-7} μCi/l.) Utilizing this maximum concentration detected during November 1978, and attributable to PBAPS, the maximum hypothetical dose from milk consumption would be 0.11 mrem to an infant's thyroid (25). Consumption of milk containing the maximum concentrations of I-131 ocurring during the 1979 period would have produced a dose to an infant thyroid estimated to be 0.11 mrem (26). The 1980 Chinese weapons test would have produced a maximum annual dose to an infant thyroid of 0.05 mrem through I-131 ingestion by milk consumption. These dose estimates are based on Regulatory Guide 1.109 consumption factors and dose conversions (31).

The annual adult total body dose associated with the consumption of drinking water is calculated for an individual consuming 2 liters of Conowingo Pond water daily, based upon the release radionuclides given in Table V-11. H-3, Cs-134, and Cs-137 would produce a dose of 0.14 mrem for an annual Susquehanna River low flow of 2500 cfs and 0.01 mrem under average

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[1] As noted in the previous table, Cs-137 is introduced into the environment not only by power plants, but also by fallout from nuclear weapons testing. Cs-134, however, is introduced into the environment exclusively as a result of power plant operation, and its presence infers that at least some percentage of the Cs-137 was contributed by the power plant. Because the two isotopes behave identically in the environment, the power plant Cs-137 increment may be estimated from the ratio of Cs-137 to Cs-134 in the plant discharge.

flow (36,000 cfs). Although these estimates exceed the doses projected by the FEIS for Peach Bottom of .03 mrem for low flow and .003 mrem for an average flow these levels are considered insignificant. It should be noted that the 0.14 mrem estimate is almost totally due to those cesium isotopes, which would in actuality be organically bound and settle out (hence the radiocesium concentrations in sediments) or be removed in drinking water treatment plants prior to ingestion. Doses calculated utilizing release data are therefore considered to be unrealistic overestimates. The other radionuclides listed in Table V-11 are insignificant contributors to dose.

The annual whole body dose commitment to an adult consuming the PBAPS radioactivity in finfish from the plant vicinity was predicted in Peach Bottoms FEIS to be 0.37 mrem (assuming 21 kg of finfish are consumed annually). The consumption of this quantity of finfish containing the maximum concentration detected by the PPSP study would result in a whole body dose commitment to an adult of 1.07 mrem/yr. Table V-17 summarizes dose commitments to an individual consuming finfish containing these maximum radionuclide concentrations. These values illustrate maximum ingestion doses and do not reflect actual conditions. Even these overestimates, however, indicate a trivial dose increment by comparison with that attributed to ingestion of natural radioactivity (~21 mrem/yr). More realistic estimates of ingestion dose commitments are provided by utilizing the mean of radionuclide concentrations detected in edible finfish by the PPSP study. These doses are in the range of 0.05 mrem/yr to 0.08 mrem/yr for consumption of fish from the Conowingo Pond and 0.29 mrem/yr to 0.40 mrem/yr for consumption of fish from the Conowingo Dam tailrace[1].

Summary

During the 1978-1980 period, atmospheric releases of radioactivity from the Peach Bottom facility produced detectable radionuclide concentration at low levels in an air particulate sample from an onsite location on only one occasion. I-131 was detected in cows' milk and air samples from the PBAPS vicinity on numerous occasions throughout the 1978-1980 period. The source of this radionuclide might be attributed to Chinese weapons tests during the spring of 1978, and the fall of 1980. Releases from TMI in the first week of April 1979 may have been a source of I-131 detected in the PBAPS vicinity about this time. I-131 detected in milk in the fall and winter of 1978, and June, August, September and October 1979 is attributed exclusively to atmospheric releases by PBAPS. PBAPS could also have been a source of I-131 detected during the weapons test fallout and TMI event episodes as well. Radiation doses associated with these low I-131 levels are nonetheless well within 10 CFR 50 Appendix I guidelines.

Liquid effluents containing PBAPS radionuclides have produced detectable concentrations of Zn-65, Cs-134 and Cs-137 in sediments and biota of the Conowingo Pond, the lower Susquehanna River, and the Upper Chesapeake Bay. Maximum concentrations in finfish occur in the Conowingo Pond and just below

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[1]The mean depends upon the manner in which samples without detectable radionuclide concentrations are treated in the calculation. The range estimated herein was developed by assuming that undetectable concentrations lie between zero and the mean of concentration actually detected.

Table V-17

Maximum Dose Commitment[(a)] in mrem for an Individual Consuming Seafood Affected by PBAPS Effluents Exclusively (Assume Finfish Radionuclide Concentrations Given in Table V-16). Calculations Based Upon Conversion Factors of USNRC Reg. Guide 1.109

Age Group	Adult	Teen	Child
Consumption:			
Finfish	21 kg/yr	16 kg/yr	6.9 kg/yr
Total Body Dose:			
Zn-65	.008770	.008957	.009398
Cs-134	.584430	.336352	.128547
Cs-137	.473810	.262406	.100716
TOTAL	1.067	0.608	0.239
Bone Dose:			
Zn-65	.006098	.005526	.005673
Cs-134	.300426	.308016	.371358
Cs-137	.528889	.566272	.712860
TOTAL	0.835	0.880	1.090
Liver Dose:			
Zn-65	.01940	.019200	.01511
Cs-134	.71484	.724960	.609408
Cs-137	.72332	.753344	.682340
TOTAL	1.458	1.498	1.307
Kidney Dose:			
Zn-65	.012978	.012288	.009522
Cs-134	.231357	.230368	.188853
Cs-137	.245532	.256339	.222360
TOTAL	0.490	0.499	0.421
GI Tract Dose:			
Zn-65	.012222	.008131	.002650
Cs-134	.001251	.009016	.003285
Cs-137	.014002	.010710	.004273
TOTAL	0.027	0.028	0.010

(a) The dose commitment from ingestion of a given quantity of a radionuclide is the total dose that will be received by the individual before the radioactive material is removed from the body by excretion and/or radioactive decay.

the Conowingo Dam. Maximum sediment concentrations occur in the Conowingo Pond and at the Susquehanna River mouth. The maximum dose resulting from the ingestion of finfish containing the highest recorded concentrations is estimated to be 1.5 mrem/yr to a teenager's liver.

The dose increment resulting from operation of PBAPS is within the 10 CFR 50 Appendix I design criteria, which limits a maximum exposed individual to 3 mrem per year per reactor for the liquid pathway. An assessment of these exposure levels is given some context by a comparison with dose from natural radiation background. In the Peach Bottom vicinity a dose to the total body and internal organs averages about 100 mrem per year. The Peach Bottom plant-related increment obtained by consuming Conowingo Pond water exclusively (2 liters/day) and Peach Bottom contaminated finfish exclusively (21 kg/yr) at the highest radionuclide concentrations would represent about 1 percent of the natural background radiation dose.

C. Three Mile Island

The Three Mile Island Nuclear Station (TMINS), owned by Metropolitan Edison Co, Pennsylvania Electric Co and Jersey Central Power and Light Co is operated by the GPU Nuclear Corporation. The plant is situated on an island in the Susquehanna River approximately 8 miles Southeast of Harrisburg, Pennsylvania. This location is about 30 air miles and approximately 42 river miles from the Maryland border. Each of its two units is a pressurized water reactor with a maximum dependable capacity of 840 MWe. Neither of these units has been in operation since the March 28, 1979 accident at Unit 2.

Unit 1 of the TMINS, placed in commercial service on September 2, 1974, has produced 25,484,330 MWh of gross electrical energy. Unit 2, placed in commercial service on December 30, 1978 and in operation for only 95 full power days prior to the accident, has produced 2,125,528 MWh of gross electrical energy.

Accident

The loss of coolant accident which occurred on March 28, 1979 (described in detail in several references, cf. ref. 32) produced a large volume of radioactive water. The containment building was flooded with approximately 750,000 gallons of highly radioactive water, and surface areas within the building were also contaminated. The Auxilliary and Fuel Handling Building was flooded by approximately 600,000 gallons of radioactive water. This water was not nearly as radioactive as that in the containment building since it never came in direct contact with the damaged fuel, and has since been cleaned by the EPICOR II decontamination system.

During the accident, some radioactive effluent was discharged to the Susquehanna River in order to prevent overflowing the Auxilliary and Fuel Handling Building sump. This discharge was via a usually "clean" pathway, and because of the potential for impact in Maryland, was a primary concern. Although the utility and the State of Pennsylvania had monitoring programs in place, PPSP and DHMH initiated monitoring to assess potential effects and environmental consequences in Maryland of these releases to the Susquehanna River.

Since the termination of these accidental liquid discharges PPSP has conducted an extensive program of radioecological monitoring and assessment in the Susquehanna River and Upper Chesapeake Bay in conjunction with its radiological monitoring program for Peach Bottom. The TMI event affirmed the need for continuing radiological sampling to provide baseline radioecological data for assessment of the potential and real impact of the TMINS on the Maryland environment.

Releases to the Environment

Radionuclides discharged to the atmosphere and Susquehanna River by the Three Mile Island Nuclear Station during 1978 and 1979 as reported by Metropolitan Edison are given in Tables V-18 and V-19. As a result of the March 28, 1979 accident, normal plant operation was terminated in 1979. Uncontrolled atmospheric discharges associated with the event are apparent through a comparison of the quantity of radioactivity released during the two years. The principal radionuclides released were isotopes of the noble gas Xenon, I-131 and I-133. Both Xe-133 and I-131 were detected in the environment by utility monitoring programs in place at the time of the accident. In the clean-up process, approximately 43,000 Curies of the noble gas Krypton-85 were vented from the Unit 2 containment building from June 28, 1980 through July 10, 1980.

During the accident, water containing higher than normal levels of radioactivity was discharged into the Susquehnna River (35, 37). The dissolved noble gas Xe-133 was detected in spot samples of river water as far downstream as Columbia, Pennsylvania (approximately 17 miles downstream) during the accident's early stages (38); however, TMI-attributed radionuclides were not detected in the Susquehanna River in Maryland. Water samples collected every two hours by DHMH at the Holtwood and Conowingo Dams (see Figure V-1) revealed only natural radioactivity. Numerous agencies in addition to Metropolitan Edison began monitoring the Susquehanna in the TMI discharge vicinity to check for accidental releases during clean up operations (39).

Atmospheric and Terrestrial Radionuclide Distributions

This section contains a discussion of the TMI radioactive discharges only as they affect Maryland. The results and interpretation of all monitoring activities conducted by various agencies following the TMI-accident are available elsewhere (11, 38, 40).

Atmospheric releases of radioactivity (principally Xenon isotopes and I-131) during and immediately following the accident were detected in the environment in Pennsylvania as well as in Maryland. During the period March 30 through April 1, the DHMH detected I-131 and Xe-133 in the atmosphere at fixed sampling locations in Harford County near the Pennsylvania border. The maximum recorded atmospheric concentration of I-131 was 90 ± 30 fCi/m^3. Iodine-131 was again detected in this region from April 11 through April 18 with a maximum concentration of 30 ± 10 fCi/m^3 (11). These incidents have been attributed to TMI, (26) although, as previousely mentioned, the Peach Bottom plant may have been a contributing source. I-131 detected subsequently in Harford

Table V-18

Total Gaseous Releases from the Three Mile Nuclear Station
as Reported by Met. Ed. (33-36)

Radionuclide	1978	1979
Tritium	234.	189.
Noble Gases	15700.	9940000.
Halogens	0.027	16.6
Other	0.111	0.002
Total Curies	15934.138	9940205.602
K-40	0.00172	
Ar-41	97.0	18.5
Co-58	0.0322	0.000871
Co-60	0.0000133	0.000123
Kr-85	0.439	0.113
Kr-85m	1.03	0.0893
Kr-88		0.000610
Sr-85		0.000000430
Sr-89	0.000000265	0.000109
Sr-90	0.00000143	0.0000329
Nb-95	0.00000555	0.0000179
Ru-103	0.0000547	0.0000545
Ru-106		0.0000985
I-131	0.0272	14.2
I-133		2.39
Cs-134	0.00897	0.00000996
Cs-136		0.000000246
Cs-137	0.0677	0.000377
Cs-138		0.0000166
Xe-131m	11.4	2.52
Xe-133	15400.	8210000.
Xe-133m	49.8	11900.
Xe-135	183.	1580000.
Xe-135m		141000.
Ba/La-140	0.00000545	0.000200

Table V-19

Total Liquid Releases from the Three Mile Island Nuclear Station as Reported by Met. Ed. (33-36)

Radionuclide	1978	1979[a]
Tritium	194	104
Dissolved Noble Gases[b]	0.358	0.054
Other	1.00	0.681
Total Curies	195.358	104.735
Na-24	0.0533	
Ar-41	0.00356	
Cr-51	0.00497	0.00889
Mn-54	0.0362	0.0123
Mn-56	0.00300	
Fe-59	0.00398	0.00152
Co-57	0.00000860	
Co-58	0.481	0.0786
Co-60	0.0204	0.0142
Zn-65		0.000394
Ga-72	0.000721	
Kr-85	0.000988	
Kr-88	0.000188	
Rb-88	0.000117	
Sr-89	0.00134	0.0775
Sr-90	0.00045	0.00475
Nb/Zr-95	0.0109	0.00358
Zr-97	0.000303	0.0000888
Mo-99	0.000502	0.0000471
Ru-103	0.000292	0.000284
Ag-110		0.00199
Ag-110m	0.0123	0.000198
Sb-122	0.000326	0.000159
Sb-124		0.000130
I-131	0.0235	0.369
I-133		0.0470
I-134	0.00963	
I-135	0.000608	
Xe-133	0.349	0.0534
Xe-133m	0.000809	
Xe-135	0.00337	0.000398
Cs-134	0.144	0.0115
Cs-136	0.000459	0.00158
Cs-137	0.191	0.0238
Ba/La-140	0.000690	0.0235
Ce-141	0.0000539	0.0000315
Ce-144	0.00102	
W-187	0.00251	0.000343

(a) Listed activities are for the first half of 1979.
(b) Noble Gas totals are the summations of the listed noble gas isotope activities.

County is attributed to Peach Bottom and weapons test fallout events (11). The deposition of atmospheric concentrations of I-131 produced low but detectable concentrations of this isotope in cows' milk in some Pennsylvania localities (25, 27) but not in Maryland (11).

During the TMI clean-up period, several agencies were involved in monitoring the impact of Kr-85 vented from the containment building. During this period the PPSP maintained a network of Beta-sensitive dosimeters along the Pennsylvania-Maryland border and in the TMI vicinity. No dose increment attributable to the venting was discernible in Maryland (41).

Aquatic Radionuclide Distributions

To evaluate the impact of TMI discharges in Maryland, the PPSP collected and analyzed a series of sediment and biota samples collected during the spring and summer of 1979, from the Susquehanna River between TMI and the mouth of the River, as well as from the Upper Chesapeake Bay. With the exception of Cs-137 attributable to fallout, no man-made radioactivity was detected in finfish or sediments collected upstream of the Peach Bottom influence. Sediment, finfish and other biota collected from below Peach Bottom (in the Conowingo Pond, Lower Susquehanna River and Upper Chesapeake Bay) contain man-made radionuclides attributed to both fallout and routine releases of radionuclides from Peach Bottom.[1]

Summary

Xe-133 and I-131 released to the atmosphere by TMI during the accident were detected at low levels in early April 1979 in air samples (11). I-131 was not detected in cows' milk in Maryland. Radionuclides attributed to TMI have not been detected in the Susquehanna River in Maryland. Continued DHMH surveillance and the extensive monitoring PPSP is conducting to characterize the radioecology of the lower Susquehanna River and Upper Chesapeake Bay will provide the necessary data base for evaluating the effect of any future releases from TMI. The plant is currently prohibited from discharging any accident-related water. The NRC's Final programatic Environmental Impact Statement (FPEIS) on decontamination (40) addresses potential effects of discharging decontaminated water.

The major issue associated with the discharge option is not an environmental or radiological concern, but rather the public's perception of the effects of such a discharge. This perception could result in consumer avoidance of Bay seafood products, severely damaging commercial and recreational fisheries.

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[1] It is recognized that some fraction of TMI-related radioactivity, particularly Cs-134 and Cs-137, would ultimately be deposited in the Upper Bay. However, the absence of any detectable concentrations in samples taken from the Holtwood Reservoir (upstream and beyond PBAPS influence) indicates that TMI has made no significant contribution to man-made radioactivity detected in Maryland.

The State of Maryland opposes any such discharge pending the completion, evaluation and public review of studies designed to assess the potential social and economic consequences of the discharge option. The Maryland position and PPSP assessment of the potential environmental effects of a processed water discharge are detailed in Appendix A to the FPEIS

D. Radiological Emergency Planning

While the greatest environmental impact associated with the operation of most power plants occurs during normal day-to-day operation, nuclear power plants are distinguished by their potential for severe environmental impact in the event of an accident. While there have been no accidents causing such an impact in Maryland (or at any nuclear power plant), there has been a heightened interest in the preparation of Radiological Emergency Plans to cope with any such accident. This was, of course, motivated by the accident at Three Mile Island.

Required by Federal regulations are both off-site and on-site Radiological Emergency Plans. Preparation of the off-site portion is the responsibility of the State, while the on-site portion is the responsibility of the utility company. Preparation of the State of Maryland Radiological Emergency Plan was underway prior to the accident at Three Mile Island, while BG&E had in effect a plan as required by its license.

The development of the State's plan was redirected, and vast revision necessary in the Company's plan as a result of the new Federal Regulations promulgated as a response to TMI. The Nuclear Regulatory Commission has published its Final Rule on Emergency Planning (42), and, in conjunction with the Federal Emergency Management Agency, has published plan development criteria for state, local and utility planners (43). Both on-site and off-site portions of the plan have been designed to comply with these regulations, and were successfully tested in the presence of Federal observers on November 17, 1981. This was a complete test of both the onsite and offsite portion of the Radiological Emergency Plan (REP) for the Calvert Cliffs Nuclear Power Plant, thereby involving the Baltimore Gas and Electric Company.

An important basis for planning is the concept of Emergency Planning Zones (EPZ), defined as "areas for which planning is needed to assure that prompt and effective actions can be taken to protect the public in the event of an accident" (43). There are two types of EPZs: the plume exposure pathway (that area within a 10 mile radius of the plant) and the ingestion exposure pathway (that area within a 50 mile radius of the plant).

Maryland must prepare an REP for each nuclear power plant having any part of its plume exposure pathway within the State. Thus an REP must be prepared for the Peach Bottom Atomic Power Station (Delta, Pennsylvania) as well as Calvert Cliffs. The overall REP for the State (44) and that appendix applying to Calvert Cliffs (45) have been completed; while the appendix for Peach Bottom is still under preparation. BG&E has completed development and testing of the on-site plan for Calvert Cliffs (46) while PECO is nearing completion of the on-site plan for Peach Bottom.

E. Spent Fuel Accumulation

From the spring of 1977 until October 1981 the commercial reprocessing of spent fuel was prohibited in this country.[1] Because of this, spent fuel generated at nuclear power plants across the country is stored on site in spent fuel storage pools. It will be necessary to continue this policy until one of three events occurs:

1) Reprocessing of spent fuel is undertaken, either by the Federal government or within the private sector;
2) Permanent or long-term retrievable storage of spent fuel is made available by the Federal government; or
3) Away from reactor storage becomes available.

It is unrealistic to expect any of the options to exist before the middle to late 1980s at the earliest.

These spent fuel pools were never expected to serve their present function of storing spent fuel for indefinite periods of time. On-site spent fuel pools were designed to hold spent fuel for cool-down for approximately one year pending shipment to a reprocessing facility. Fortunately, the storage of fuel for these unanticipated periods poses no significant environmental threat because fuel elements are at far lower temperatures in the spent fuel pool than they were in the reactor.

The most significant problem associated with on-site spent fuel storage is that the finite capacity of spent fuel pools limits how long utilities can store spent fuel on-site and continue to operate their plants. The current capacities of and amounts of fuel stored in the spent fuel pools at Calvert Cliffs and Peach Bottom are given in Table V-20. Assuming present licensed capacity, and retaining the capacity to discharge one full core, the projected date of the last refueling that can be discharged to the spent fuel pool at Calvert Cliffs is April 1990. Under the same conditions, Peach Bottom has ability to store fuel on-site until 1986 for Unit 2, and 1987 for Unit 3.

Table V-20
Capacity (in Fuel Assemblies) of Spent Fuel Pools at Calvert Cliffs Nuclear Power Plant and Peach Bottom Atomic Power Station, and Amount of Spent Fuel Presently Stored

	Calvert Cliffs	Peach Bottom	
	Both Units	Unit 2	Unit 3
Licensed Capacity	1760	2608	2608
Installed Capacity	1358	2608	2608
Spent Fuel in Storage	584	896	712

[1] This policy has been reversed by order of President Reagan and commerical reprocessing is now permitted. No group, however, has expressed an interest to undertake reprocessing, given the uncertainty of Federal policy remaining constant through succeeding Administrations.

BG&E is planning an addition to its spent fuel pool which will require relicensing. PECO has the ability to install additional racks, thereby increasing the volume of its spent fuel pool. This change would require relicensing.

F. Radioactive Materials Transportation

Radioactive waste shipments for nuclear power plants in and around Maryland are presented in Tables V-21 and V-22. Since January 1978 there have been 109 and 922 shipments offsite of radioactive waste from Calvert Cliffs and Peach Bottom, respectively. All of those non-spent fuel shipments from Calvert Cliffs and Peach Bottom have been to Barnwell, South Carolina. Three Mile Island also shipped waste to Barnwell prior to the March 28, 1979 accident, but has been prohibited from doing so since then. Shipments of radioactive waste from Three Mile Island now go to Hanford, Washington.

Table V-21

Solid Waste Shipped Offsite for Disposal from the Calvert Cliffs Nuclear Power Plant.

Type of Waste	1978		1979		1980	
	m^3	Ci	m^3	Ci	m^3	Ci
Spent resin, filter sludge, evaporator bottoms, etc.	80.9	1055	41.1	294.5	47.3	504
Dry compressor waste, contaminated equipment, etc.	155.3	59.3	306	53.4	134.3	1.1
Irradiated components, control rods, etc.	367	2.18	84.9	623	69.2	14,268

Table V-22

Solid Waste Shipped Offsite for Disposal from the Peach Bottom Atomic Power Station

1978		1979		1980	
m^3	Ci	m^3	Ci	m^3	Ci
6.91×10^4	4970	8.47×10^4	8030	9.27×10^4	6686

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