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.

Calvert Cliffs on the Chesapeake Bay is the only nuclear power plant in Maryland. However, Peach Bottom and Three Mile Island on the Susquehanna River in Pennsylvania have the potential for impact on Maryland. This chapter presents the Power Plant Siting Program's evaluation of the environmental impact on Maryland of radioactivity released by these plants during 1981-1982. This assessment is based upon results of surveillance programs and radioecological studies conducted by the individual utilities, the Maryland Department of Health and Mental Hygiene (DHMH), and the PPSP. Included are descriptions of monitoring programs, radioactivity discharged by each plant, and the actual distribution of radionuclides in the environment. Doses to man via the atmospheric and aqueous pathways are calculated. Comparisons with natural background doses, operating license restrictions and environmental radionuclide concentrations present the previous reporting period (1978-1980) are made where appropriate. Brief discussions of nuclear waste disposal and the emergency plans for each plant are also included.

Environmental radiation levels result from natural radioactive materials and man-made radioactive materials. Man-made sources of environmental radioactivity include reactors and nuclear weapons tests. Determination of a source of man-made radioactivity may be complicated by the introduction of nuclear test fallout, as occurred from an atmospheric detonation by the People's Republic of China on October 15, 1980. In such instances inspection of radionuclide ratios and consideration of geographic distribution of specific radionuclides is employed to reveal the source of this man-made radioactivity. Where radiological effects of two plants may overlap, sampling patterns are designed to minimize ambiguity in the determination of the true source. This situation occurs in Maryland with respect to the impacts of Peach Bottom and Three Mile Island.

Table V-1. 10 CFR 50 Appendix I Guidelines: 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	Design Objectives[a]	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 Released to the Atmosphere[e]		
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.

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 1982 produced 42,000,943 MWh gross of electrical energy. Unit 2, placed in commercial service April 1, 1977, had as of the end of 1982, produced 33,656,204 MWh gross. Since the beginning of commercial operation, Units 1 and 2 had as of the end of 1982, achieved cumulative unit capacity factors of 70.0% and 75.3%, respectively.

Releases to the Environment

Radionuclides discharged to the atmosphere and Chesapeake Bay by the Calvert Cliffs Nuclear Power Plant during 1981-1982 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. No radionuclides detected in terrestrial or atmospheric sampling are attributed to releases by the plant. Of the aquatic releases, Co-58, Co-60, Zn-65, and Ag-110m are the only bioaccumulable radionuclides detected in the Bay environment.

Environmental Monitoring Programs

BG&E, DHMH (Maryland Department of Health and Mental Hygiene), and PPSP each conduct routine radiological monitoring programs designed to define the environmental impact of the releases described above. The BG&E program is structured to conform to environmental surveillance requirements imposed in its NRC operating license. The DHMH performs assurance monitoring to provide an independent confirmation of the utility program. The program conducted by PPSP is focused primarily on aqueous pathway impact, and is designed to define the areal and trophic-level distribution and concentration of power plant radionuclides in the Calvert Cliffs vicinity of Chesapeake Bay. These three programs are described in tables V-4 and V-5.

Atmospheric and Terrestrial Radionuclide Distributions

The October 15, 1980 Chinese weapons test resulted in elevated levels of radioactivity detected in atmospheric and terrestial samples collected through the first three quarters of 1981. These levels peaked during spring washout. No evidence of the test was found in samples collected in 1982.

Table V-2. Total Gaseous Effluents (in Curies) Released by the Calvert Cliffs Nuclear Power Plant as Reported by BG&E (4-7).

Radionuclide	1981	1982
Tritium	5.81	6.81
Noble Gases	2160.00	8030.00
Halogens	0.06	0.09
Other	0.01	0.23
Total Curies	2165.88	8037.13
Kr-85m	57.00	55.00
Kr-88	0.52	0.57
Xe-131m	110.00	68.00
Xe-133	1900.00	7800.00
Xe-133m	26.00	23.00
Xe-135	62.00	79.00
Ar-41	1.10	0.28
Kr-87	0.28	0.11
I-131	0.04	0.05
I-132	0.0016	0.0000059
I-133	.02	0.01
I-135	0.0019	0.03
Br-82	0.000048	0.000036
Co-58	0.00000098	0.01
Co-60	0.0003	0.00
Sr-89	0.00014	0.00017
Sr-90	0.000062	0.000081
Rb-88	0.01	0.22
Cs-138	0.000089	0.0028
Cs-134	0.00000061	0.0000043
Cs-137	0.0000015	0.000013
Ba-140	0.00014	0.00088
La-140	0.00029	0.00027
Ba-139	0.000000016	0.0000013
Ce-141	0.00000058	0.00
Ce-139	0.00000011	0.00

Table V-3. Total Aqueous Effluents (in Curies) Released by the Calvert Cliffs Nuclear Power Plant as Reported by BG&E (4-7).

Radionuclide	1981	1982
Tritium	1001.00	435.1
Dissolved Noble Gases[a]	3.97	4.34
Other	2.74	5.22
Total Curies	1007.71	444.66
Sr-89	0.02	0.03
Sr-90	0.03	0.06
Cs-134	0.05	0.44
Cs-137	0.10	0.80
I-131	0.31	0.68
Co-58	1.30	1.50
Co-60	0.21	0.19
Mn-56	0.00028	0.00
Mn-54	0.38	0.04
Cr-51	0.04	0.35
Zr-95	0.02	0.08
Nb-95	0.02	0.14
Mo-99	0.0017	0.02
Ba-140	0.0041	0.01
Sb-124	0.00029	0.05
Co-57	0.00084	0.0017
Sn-113	0.0031	0.01
Ru-103	0.00045	0.01
I-133	0.06	0.17
Sb-125	0.08	0.27
Zr-97	0.00054	0.00
Ce-144	0.0029	0.00
Ru-106	0.011	0.03
Ce-141	0.0000066	0.00
Ag-110M	0.02	0.22
La-140	0.04	0.02
Xe-133	3.90	4.30
Xe-135	0.03	0.01
Xe-133M	0.01	0.02
Xe-131M	0.03	0.01
I-132	0.00	0.0016
Na-24	0.00	0.0001
Cd-103	0.00	0.0066
Zn-65	0.00	0.0014
Np-239	0.00	0.0015
Sb-122	0.00	0.07
Ar-41	0.00	0.0015

(a) Noble Gas Totals are summations of noble gas isotope activities listed in this Table.

Table V-4. Radiological Monitoring Conducted by Various Agencies in the Vicinity of the CCNPP to assess Atmospheric Pathway Impact; 1981, 1982.

Sample Media	Annual Frequency and (No. of Stations) BG&E	DHMH	PPSP
Air			
Iodine	52(4)	52(4)	--
Particulates	52(4)	52(4)	--
Precipitation	Continuous (1)	--	--
Vegetation	1(3)	1(1)	1(2)
Soil	1(3)	--	1(2)
Groundwater	4(4)	4(15)	--
External radiation	12(14)	12(12)[a]	(a)

[a] Discontinued in 1982

Table V-5. Radiological Monitoring Conducted by Various Agencies in the Vicinity of the CCNPP to Assess Aqueous Pathway Impact; 1981, 1982.

Sample Media	Annual Frequency, (No. of Stations) BG&E	DHMH	PPSP
Waterfowl	--	--	1(2)
Finfish			
Forage species	--	--	2(2)
Edible species	4(1)	--	2(2)
Shellfish			
Oysters			
Natural Bar	4(2)	4(1)	4(2)
Discharge Tray	--	--	1,2,4(1)
Crab			
Flesh	4(3)	--	2(2)
Shell	--	--	2(2)
Grass Shrimp	--	--	2(2)
Epifauna	--	--	3(3)
Algae	--	--	2(2)
Sediments	4(4)	4(1)	4(28)[a];1(24)
Bay water	12(2)	4(3)	--

(a) Expanded in 1982 from 14 stations.

Releases of radioactivity to the atmosphere during 1981-1982 did not contribute measurably to offsite radiation as determined by thermoluminesence dosimetry (TLD). Radiation associated with the Chinese weapons test was also not detectable in TLD monitoring (2, 3, 8). Specific radionuclides associated with this event were however detected in the atmospheric and terrestrial environment during the period (2, 3, 8).

Fallout radionuclides detected in atmospheric particulates during the first three quarters of 1981 included Mn-54, Sr-89, Sr-90, Nb-95, Zr-95, Ru-106, Cs-137, Ce-141 and Ce-144 (2, 8). The uniformity of concentrations among near-field and control locations indicates that there was no discernible contribution to this inventory by Calvert Cliffs. No radioactive iodine was detected in the atmosphere during the entire two-year period. Sporadic detection of Sr-89 and Sr-90 continued through 1982 at levels near the threshold of detection (2, 3).

During 1981, radionuclides detected in precipitation followed a temporal pattern similar to atmospheric particulates with respect to fallout-attributed levels of gross beta activity as well as Nb-95, Zr-95, Ru-103, Sr-89 and Sr-90. In 1982, Sr-90 and Cs-137 were each detected only once, and at values near detection thresholds (2, 3).

Crop samples collected in the fourth quarter of 1981 also contained the weapons test fallout nuclides Sr-89, Sr-90, Mn-54, Nb-95, Cs-137, and Ce-144 (2). Vegetation samples collected in late 1982 revealed Cs-137 and Sr-90 at levels expected from the continuing presence of aged fallout from weapons tests of the 1960's (3). There were also three samples showing the presence of Sr-89. The two highest of these came from control locations (3). These measurements of Sr-89 are probably in error since calculations of atmospheric transport of Calvert Cliffs Sr-89 emissions to these locations indicates that plant-induced concentrations would be on the order of ten thousand to one hundred thousand times too dilute to account for the concentrations measured (9).

Aquatic Radionuclide Distributions

Both releases by Calvert Cliffs and weapons test fallout have been detected in the Chesapeake Bay system. Radionuclides include Cs-137 and, more recently (1980), Zr/Nb-95, Ce-141, and Ce-144. Very low levels of these nuclides were detected in sediments during 1981 and 1982 (10). Although Calvert Cliffs contributes small quantities of these nuclides, a comparison of concentrations in the nearfield with those in remote locations indicates that weapons test fallout is the predominant source.

The routine release of tritium by Calvert Cliffs may occasionally produce concentrations in nearfield Bay water which exceed levels attributable to weapons-testing if collection occurs soon after the release. Dilution and dispersion reduce these concentrations to ambient levels in a short time. During 1981, CCNPP released a total of about 1000Ci of tritium to the

Bay, and about 435Ci in 1982 (4-7). Monthly grab samples by BG&E indicated the presence of plant attributable tritium on only two occasions in 1981 (max. 1600 pCi/l) and none in 1982 (2, 3). Because tritium is not bioaccumulated and release quantities are relatively low, no adverse environmental impact has resulted.

CCNPP also releases small quantities of bioaccumulable radionuclides to the Bay. Through food chain transport and bioconcentration, upper trophic levels, including man, may ultimately receive a dose increment attributable to Calvert Cliffs.

Bioaccummulable radionuclides detected in the environment attributed solely to Calvert Cliffs during 1981, 1982 included Co-58, Co-60, Zn-65, and Ag-110m (2, 3, 10). Radiocobalt may occasionally be found in nearfield oysters; however, it is more generally associated with sediments. During this reporting period, Zn-65 and Ag-110m were detected in oysters and Ag-110m was detected in blue crabs and epifauna as well. Table V-6 lists maximum concentrations of Calvert Cliffs-attributed radionuclides detected in Bay samples by the PPSP program.

- Sediments

  Co-58 and Co-60 were consistently detected in Bay sediments in the Calvert Cliffs area, primarily associated with the silt and clay. Variations in radionuclide concentrations occur over time as a result of physical processes which disperse sediment particles, and chemical and biological processes which may partition environmental radionuclide concentrations. The dispersion of radiocobalt-labelled sediment particles has resulted in a slight expansion down-bay of the area where Co-58 can be detected in sediments. Co-58 has been detected sporadically in sediments along the Western Shore as far as 3 miles to the south. Nuclide decay and particle dilution appears to have reduced concentrations to non-detectable levels beyond this point. No increase in the concentration of Co-58 or Co-60 in sediments is apparent during this reporting period compared with previous years.

- Biota

  No Calvert Cliffs radionuclides were detected in any edible finfish collected during 1981 or 1982 by either BG&E or PPSP. Co-58 was the only Calvert Cliffs radionuclide detected in forage finfish, and occurred on a single occasion and only in Menhaden (Table V-6). Co-58 and Co-60 were detected in epifauna samples (chiefly barnacles) during 1981 and 1982, with

slightly higher levels of each in the second year.[1] Low levels of Ag-110m were also detected during 1982 in these organisms, and in blue crabs as well (3, 10).

Of biota harvested for human consumption in the Calvert Cliffs area, oysters are the principal indicators of radiological impact because they are non-mobile and have a tendency to concentrate metals, including radionuclides. Oysters have consistently contained Zn-65 and Ag-110m, and have sporadically contained low levels of power plant-related Co-58 and Co-60

Oysters immersed quarterly in trays in the discharge vicinity showed a slight uptake of Ag-110m in 1981, reflecting the low levels released during that year (10). Oysters collected from a natural bar (immersed for a period of over three years) showed slightly higher levels (maximum 30 pCi/kg wet). During the third quarter of 1982 the plant release of Ag-110m was an order of magnitude higher than any previous release during the subject period (Figure V-1). The result was a pulse of Ag-110m in tray oysters which reached a reporting period maximum of 600 pCi/kg (wet) (10). Levels in natural bar oysters increased from 10 to 450 pCi/kg (Figure V-2). This concentration exceeded the previous reporting period maximum of 350 pCi/kg (1).

The plant reported no release of Zn-65 during 1981, a fact supported by the absence of the nuclide in PPSP's tray oysters (10). Bar oysters had low but detectable concentrations during the first quarter of 1981, apparently a residual concentration associated with 1980 releases. In 1982, a reported Zn-65 release in the second quarter produced the highest recorded level for the reporting period (Table V-6), with concentrations still detectable in subsequent 1982 quarters. The maximum Zn-65 concentration recorded during the subject period in natural bar oysters was 75 pCi/kg occurring in the second and fourth quarters of 1982 (10).

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[1] Radiocobalt may be associated with fine sediment and organic detritus trapped by the substrate, rather than incorporated within the organisms themselves.

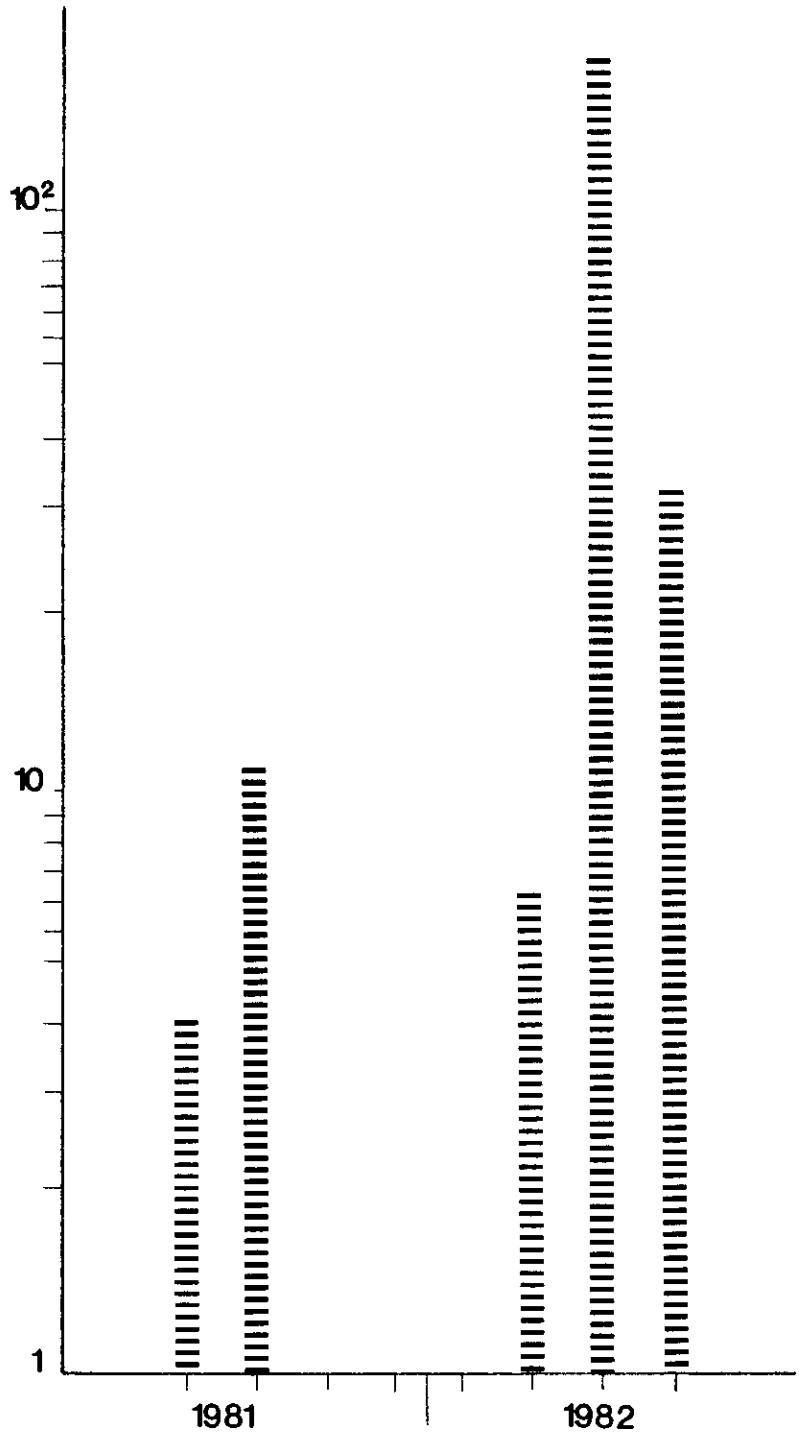

FIGURE V-1 Ag-110m released by CCNPP:, 1981, 1982 in mCi.

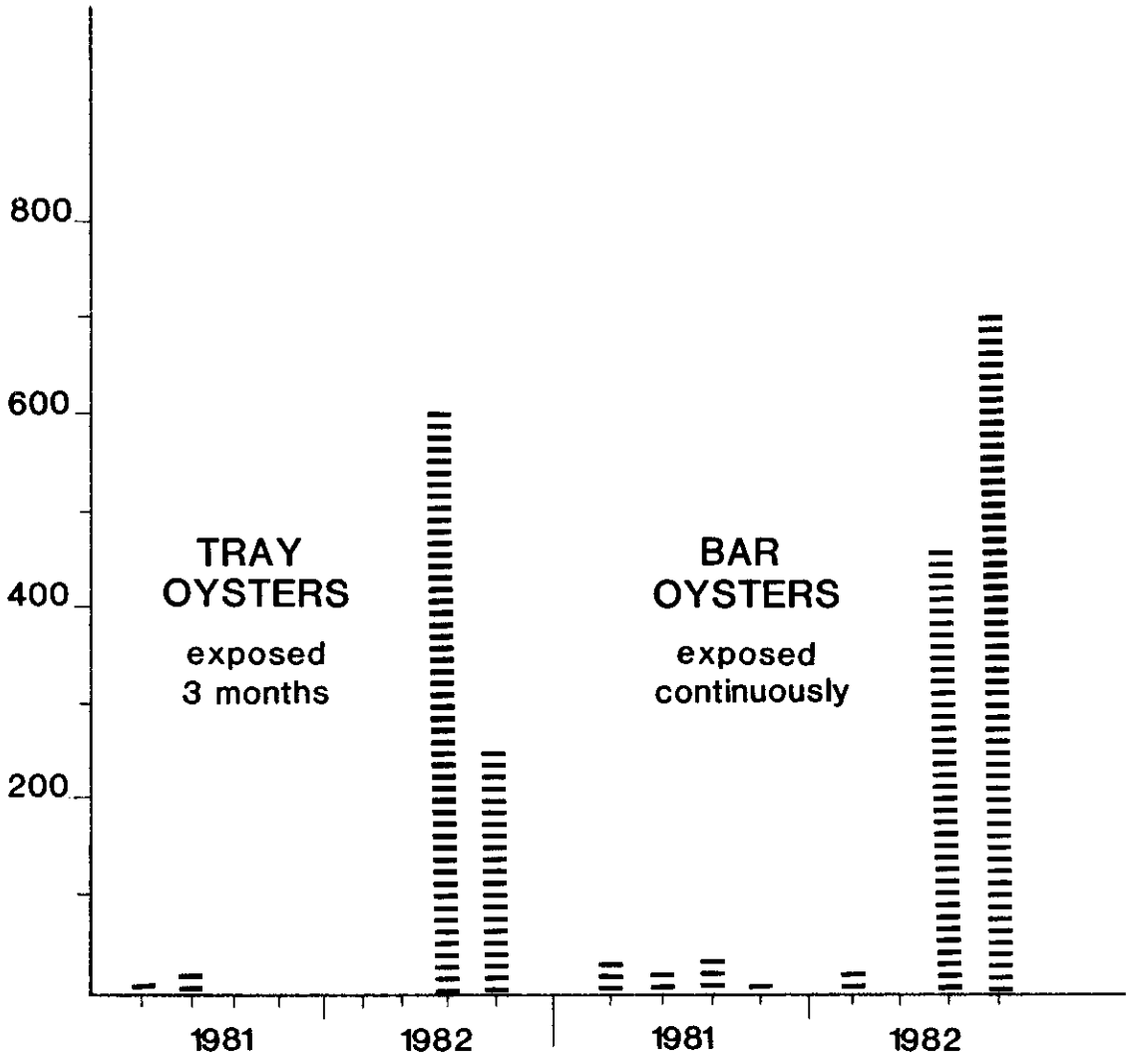

FIGURE V-2 Ag-110m concetrations in oysters, pCi/kg (wet wt.)

Table V-6. Maximum Concentration of Calvert Cliffs - Related Radionuclides in Samples Associated with the Chesapeake Bay. PPSP Data; 1981, 1982.

Sample Type	Radionuclide Concentration pCi/kg[a]							
	Co-58		Co-60		Zn-65		Ag-110m	
	1981	1982	1981	1982	1981	1982	1981	1982
Seaduck (Flesh)	<12		<12		<25		<27	
Edible Finfish (Flesh)	<3	<3	<3	<3	<5	<5	<4	<4
Forage Finfish (Whole)	10±6	<5	<5	<5	<7	<7	<5	<5
Oyster Meat	19±5	18±8	<5	8±7	3±5	76±13 697±18	29±6	
Crab Meat	<6	<6	<6	<6	<10	<10	<9	98±9
Crab Shell	<14	22±10	<10	<10	<15	<15	<17	<19
Grass Shrimp	<16	<16	<15	<15	<20	<20	<20	<20
Epifauna	1058±210 1724±119		30±31 369±75		<60	<60	<80	763±136
Macro Algae	<10	<10	<10	<10	<12	<12	<10	<10
Bay Sediment								
Clay	83±7	15±12	183±24 146±23		<10	<10	<10	<10
Sand	29±5	10±7	46±8	7±5	<8	<8	<6	<6

(a) All concentrations per wet weight except crab shell and sediment (dry weight).

Radiation Dose to Man

Estimates of the dose commitments[1] to individuals consuming seafood harvested in the vicinity of Calvert Cliffs have been calculated using the maximum radionuclide concentrations detected in shellfish taken from this area (Table V-6). Calculated dose commitments to adults, teenagers and children are given in Table V-7. Table V-8 contains a comparison of doses calculated for this reporting period, with those of the previous reporting period (CEIR III). A slightly elevated dose commitment is apparent, attributable primarily to the slightly higher levels of Zn-65 detected in oysters during 1982. These doses are still trivial and represent small fractions of those permitted under Calvert Cliffs' operating license (see Table V-1).

Summary

No radioactivity detected by monitoring of the atmospheric pathway during 1981-1982, is attributed to plant operation.

Discharges via the aqueous pathway have produced detectable radionuclide conentrations in the Chesapeake Bay ecosystem. Sediments have contained low levels of Co-58, and Co-60. The range of concentration varies over time, and no significant build-up is apparent in the nearfield. The down-bay migration of radiocobalt-labelled sediments has produced an area of radiocobalt detectability during this reporting period which extends to approximately 3 miles south of the plant.

Radionuclides attributed to aqueous releases by Calvert Cliffs have been detected at low levels in some sampled Bay biota. These included forage finfish, oysters, crabs and epifauna. The maximum detected concentrations would produce radiation doses to the various organisms which are still orders of magnitude lower than doses resulting from the naturally radioactive sources present in the Bay environment. Biota which have contained Calvert Cliffs radionuclides previously (1), but not during this reporting period, includes waterfowl, grass shrimp, and algae.

Employing the maximum detected concentration in seafood (oysters and crabs), the estimated dose to a maximum exposed individual through consumption would be 0.25 mrem to an adult's G.I. tract. This is well within 10 CFR 50 Appendix I design criteria limiting a maximum exposed individual to 3 mrem annually per reactor for the aqueous pathway.

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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 (11).

Table V-7. Maximum Dose Commitment (in mrem) to an Individual Consuming Shellfish[a] Exclusively from the Vicinity of the Calvert Cliffs Nuclear Power Plant (Utilizing Maximum Radionuclide Concentrations Given for 1981-1982 in Table V-6).

	Age Group	Adult	Teen	Child
Quantity Consumed[b]	Oysters	29 dozen	22 dozen	10 dozen
	Crabs	15 dozen	11 dozen	5 dozen
Total Body Dose	Co-58	.000159	.000161	.000178
	Co-60	.000189	.000192	.000212
	Zn-65	.002640	.002700	.002933
	Ag-110m	.000350	.000357	.000394
	TOTAL	.003338	.003410	.003717
Bone Dose	Co-58	(c)	(c)	(c)
	Co-60	(c)	(c)	(c)
	Zn-65	.001839	.001665	.001770
	Ag-110m	.001040	.000619	.000729
	TOTAL	.002879	.002284	.002499
Liver Dose	Co-58	.000071	.000070	.0000581
	Co-60	.000086	.000085	.0000719
	Zn-65	.010000	.010000	.004716
	Ag-110m	.000589	.000586	.000492
	TOTAL	.010746	.010741	.006508
Kidney Dose	Co-58	(c)	(c)	(c)
	Co-60	(c)	(c)	(c)
	Zn-65	.003910	.003700	.002972
	Ag-110m	.001150	.001118	.000492
	TOTAL	.005060	.004818	.003464
GI-LLI[d] Dose	Co-58	.001430	.000965	.000339
	Co-60	.001610	.001113	.000398
	Zn-65	.003690	.002448	.000827
	Ag-110m	.240000	.160000	.060000
	TOTAL	.246730	.164526	.061564

(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.
(d) Gastrointestinal tract - lower large intestine.

Table V-8. Comparison of 1978-1980 and 1981-1982 Dose Commitments (in mrem) to an Individual Consuming Shellfish Exclusively from the CCNP Vicinity.[a]

	1978-1980			1981-1982		
	Adult	Teen	Child	Adult	Teen	Child
Total Body	0.002	0.002	0.002	0.003	0.003	0.004
Bone	0.001	0.001	0.001	0.003	0.002	0.002
Liver	0.003	0.003	0.002	0.011	0.011	0.007
Kidney	0.002	0.002	0.002	0.005	0.005	0.003
GI-LLI	0.114	0.078	0.028	0.247	0.165	0.062

(a) PPSP derived data.

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 outside Maryland, it has an impact potential because 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 48,827,168 MWh gross of electrical energy as of the end of 1982. Unit 3, placed in commercial service in December 1974, had produced 47,547,888 MWh gross. Since the beginning of commercial operation, Units 2 and 3 have achieved cumulative unit capacity factors of 62.2% and 64.1%, 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 1981-1982 are given in Tables V-9 and V-10. Noble gases, 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. The gaseous release of principal environmental significance is I-131. The annual average of this nuclide released during 1981 and 1982 was extremely small, similar to the 1980 release quantity, and about an order of magnitude lower than was released in 1979. With the exception of a low concentration of Co-60 detected on site, no radionuclides released to the atmosphere were detected in environmental sampling (16-19).

Of releases to the Susquehanna River, tritium, which does not concentrate in the environment, comprised greater than 90% of the aqueous release inventory in 1981 and 70% in 1982. Environmentally significant radionuclides detected in the aquatic ecosystem included Co-60, Zn-65, I-131, Cs-134 and Cs-137. Release quantities of these nuclides for 1981 and 1982 are compared with prior releases in Table V-11.

Table V-9. Total Gaseous Releases (in Curies) from the Peach Bottom Atomic Power Station as Reported by PECO (12-15).

Radionuclide	1981	1982
Tritium	28.508	24.92
Noble Gases	15935.86	13105.00
Halogens	1.495	1.280
Other	2.015	.060
Total Curies	15967.9	13131.26
N-13	1.95	0.0
Na-24	0.00021	0.000546
Ar-41	4.70	0.00
Cr-51	0.000318	0.000386
Mn-54	0.0000176	0.0000077
Co-58	0.000205	0.00021
Co-60	0.00156	0.00115
Zn-65	0.00183	0.00221
Kr-85m	34.57	77.740
Kr-87	13.13	9.05
Kr-88	14.34	22.610
Rb-89	0.000175	0.00
Y-91m	0.00635	0.010
Sr-89	0.00166	0.00147
Sr-90	0.0000892	0.000065
Sr-91	0.000819	0.00163
Nb-95	0.00000135	0.00
Tc-99m	0.0000811	0.000130
Cd-109	0.000206	0.000263
I-131	0.0334	0.030
I-133	0.995	0.770
I-135	0.467	0.480
Cs-134	0.000653	0.00045
Cs-137	0.00104	0.00076
Cs-138	0.0479	0.040
Xe-133	14079.2	9097.0
Xe-133m	383.80	172.80
Xe-135	1250.3	3218.0
Xe-135m	46.31	105.11
Xe-138	109.51	59.70
Ba-140	0.00102	0.00146
La-140	0.000732	0.00106

Table V-10. Total Liquid Releases (in Curies) from the Peach Bottom Atomic Power Station as Reported by PECO (12-15)

Radionuclide	1981	1982
Tritium	36.8	23.63
Dissolved Noble Gases	0.801	0.790
Other	1.60	8.460
Total Curies	39.2	32.88
Na-24	0.648	3.560
P-32	0.0174	0.040
Cr-51	0.0233	0.250
Fe-55	0.00244	0.00219
Mn-54	0.00257	0.010
Mn-56	0.00	0.00328
Co-58	0.00975	0.130
Co-60	0.130	0.650
Ni-63	0.00398	0.020
Cu-64	0.00	0.060
Zn-65	0.290	1.960
Kr-85m		0.00048
Y-91m	0.00272	0.020
Sr-89	0.00148	0.020
Sr-90	0.00159	0.00060
Sr-91	0.00146	0.00143
Sr-92	0.00105	0.001840
Nb-95	0.000498	0.000835
Tc-99m	0.00706	0.060
Ru-103	0.00	0.00007
Cd-109	0.00	0.01112
Ag-110m	0.00184	0.00029
Te-132	0.00804	0.020
I-131	0.0539	0.150
I-132	0.00276	0.010
I-133	0.0812	0.230
I-135	0.0228	0.080
Xe-131m	0.000414	0.02320
Xe-133	0.531	0.430
Xe-133m	0.00125	0.00037
Xe-135	0.234	0.180
Xe-135m	0.0346	0.160
Cs-134	0.0993	0.460
Cs-137	0.170	0.650
Ba-140	0.000371	0.010
La-140	0.00481	0.020
Np-239	0.0127	0.020
Mo-99	0.00	0.00961

Table V-11. Comparison of Annual Release Quantities (in Curies) of Radionuclides Which Have Been Detected in the Aqueous Environment. (19-24)

Radionuclide	Curies Released 1978	1979	1980	1981	1982
I-131	0.227	0.964	0.0639	0.0539	0.150
Co-60	0.155	0.162	0.156	0.13	0.65
Zn-65	0.424	0.460	0.306	0.29	1.96
Cs-134	2.86	3.92	0.568	0.0993	0.46
Cs-137	0.81	3.26	0.691	0.17	0.65

Environmental Monitoring Programs

PECO, DHMH, and PPSP all conduct separate monitoring programs to assess the impact of PBAPS. The PECO program is defined by NRC operating license requirements. Their contractors analyze samples of air, precipitation, terrestrial vegetation, soils, and milk to monitor atmospheric pathway impact. The monitoring of ambient radiation levels provides an assessment of the external dose increment that might be attributable to noble gases on the natural dose background. The DHMH also analyzes air samples from the Peach Bottom vicinity.

With regard to aquatic impact, the utility's monitoring program is designed to quantify radionuclide concentrations in water, sediment and finfish. However, because sampling is restricted to the Conowingo Pond, Maryland impact is not addressed. The PPSP program describes the actual aquatic/estuarine distribution of PBAPS radionuclides. The program focuses on the aqueous pathway because it represents the greatest potential for a significant impact in Maryland. Samples are collected from Conowingo Pond, the Susquehanna River and the Upper Chesapeake Bay (Figure V-3) to determine radionuclide concentrations in sediments, aquatic vegetation, forage and commercially significant finfish, shellfish, waterfowl and aquatic mammals. The programs conducted by the three agencies are described by sample type and collection frequency in Tables V-12 and V-13.

Atmospheric and Terrestrial Radionuclide Distributions

Fallout radioactivity from the Chinese weapons test was evident in the Peach Bottom vicinity in atmospheric and terrestrial samples. Mn-54, Zr-95, Nb-95, Ru-103, Ru-106, Cs-137, Ce-147 and Ce-144 were detected routinely in air particulates both by PECO contractors and DHMH during the first three quarters of 1981 (8, 16-19). Co-60 was detected once at an on-site location (2 ± 2 fCi/m^3) and is probably attributable to the plant. Offsite measurements of atmospheric gross beta and gamma isotope do not indicate any contribution of radioactivity by Peach Bottom.

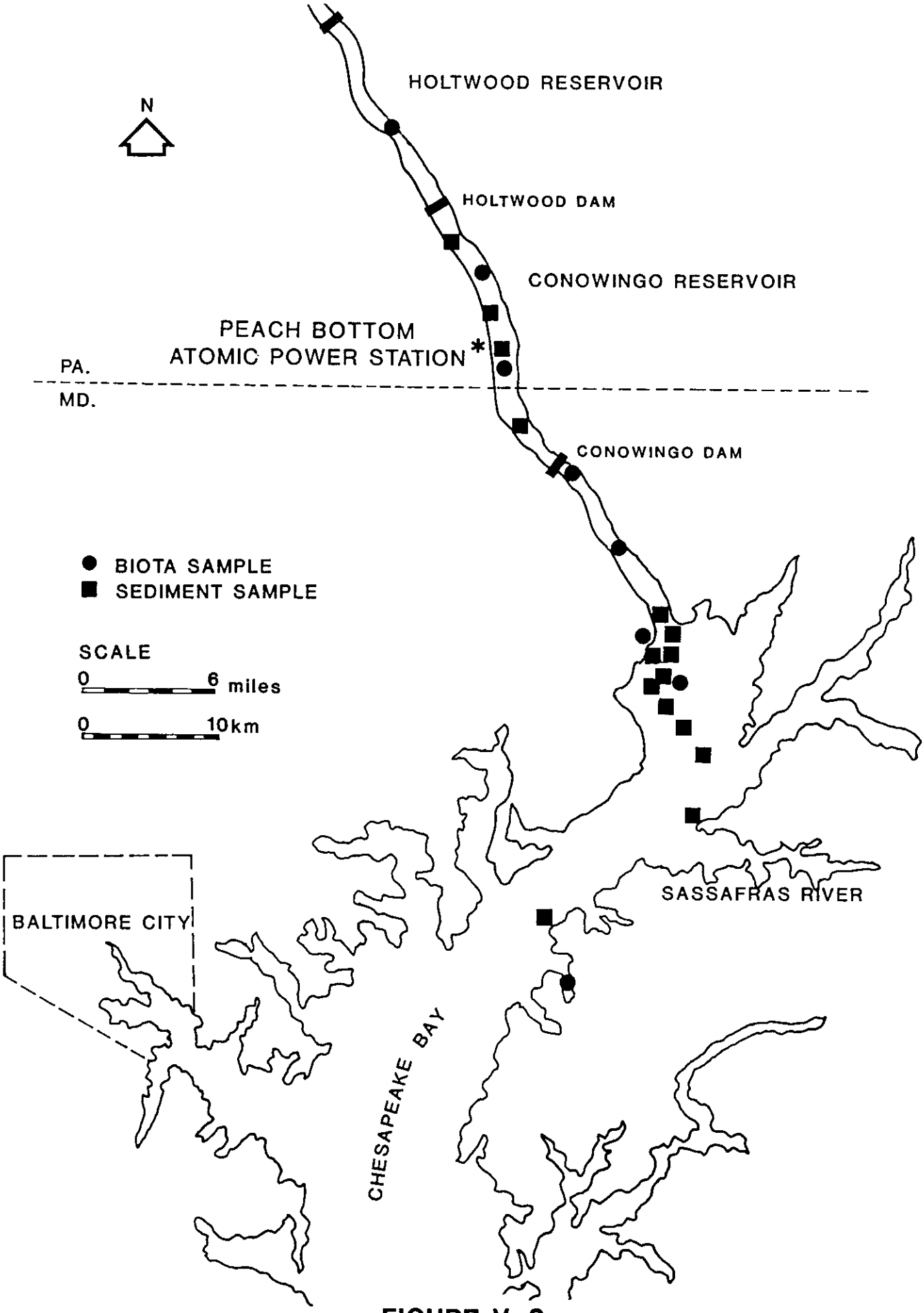

FIGURE V-3
PPSP SUSQUEHANNA RIVER/UPPER BAY SAMPLING LOCATIONS

Table V-12. Radiological Monitoring Conducted by Various Agencies in the Vicinity of the PBAPS to Assess Atmospheric Pathway impact in 1981 and 1982

Sample Media	Annual Frequency and (No. of Stations)		
	CWM(a)	RMC(b)	DHMH
Air particulate	52(16)	52(2)	52(3)(d)
Air iodine	--	52(8)	52(3)(d)
Precipitation	Continuously(3)	Continously(3)	--
Milk	4(11)	(c)(11)	12(2)
Vegetation	3(7)	--	--
Soil	2(6)	2(3)	--
Terrestrial small mammal	2(1)	--	--
Well water	4(4)	4(4)	--
Ambient radiation	--	12(47)	--

(a) Chemical Waste Management, Inc., a PECO contractor.
(b) Radiation Management Corporation, a PECO contractor.
(c) Weekly while cows on pasture, otherwise monthly and quarterly.
(d) A fourth station was added in October, 1982.

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Table V-13. Radiological Monitoring Conducted by Various Agencies in the Vicinity of the PBAPS to Assess Aqueous Pathway Impact in 1981 and 1982

Sample Media	Annual Frequency and (No. of Stations)			
	CWM(a)	RMC(b)	DHMH	PPSP
Surface water	12(8)	12(9)	52(1)	--
Discharge water	12(2)	12(2)	--	--
Mammals (muskrat, otter and raccoon)	--	--	--	2(2)
Waterfowl	--	--	--	1(2)
Finfish				
Forage species	--	--	--	2(4)
Edible species	4(5)	--	--	2(4)
Shellfish	--	--	--	
Crabs	--	--	--	(c)
Oysters	--	--	--	(c)
Mussels	--	--	--	(d)(3)
Submerged Aquatic vegetation	--	--	--	2(3)
Sediments	2(6)	--	--	2(35); 12(3)

(a) Chemical Waste Management, Inc., a PECO contractor.
(b) Radiation Management Corporation, a PECO contractor.
(c) Non-routine collection to determine specific radiological impact as required.
(d) Tray studies April-December; monthly retrievals.

Precipitation samples intermittently contained Sr-90, Zr-95, Nb-95, Ru-103, Cs-137, Ce-141 and Ce-144 during the first three quarters of 1981. Sr-89 was also detectable in precipitation collected in May 1981. Gross beta measurements reached maxima at the same time (16-19). A comparison of near-field and far-field stations shows similar concentrations and time variations, indicating that the radionuclides are the result of weapons test fallout, not plant releases.

No radioiodine was detected in any air or milk samples in 1981 or 1982. Sr-89 was frequently detected in milk during the first three quarters of 1981, but not thereafter (16-19). Its distribution with respect to the plant's location and its correlation with presence of other radionuclides from the Chinese weapons test indicates that the Sr-89 is probably from that source, not PBAPS. Sr-90 was routinely detected in milk in concentrations of about 5 pCi/kg, and Cs-137 was frequently detected in similar concentrations (16-19). These two isotopes have half-lives of about 30 years, and their presence at these levels is expected as a result of atmospheric nuclear testing during the 1960's. Cs-134 was reported at 3±3 pCi/l in one milk sample taken in May 1981 (18). The presence of Cs-134 in an environmental sample would normally be attributed to power plant operation. The result is considered in error because of the small amount of Cs-134 released atmospherically by PBAPS, and the absence of Cs-137 in the same sample.[1]

Crop and wild vegetation samples collected during 1981 and 1982 by PECO contractors in the Peach Bottom vicinity contained Cs-137 and Sr-90, at levels expected from 1960's nuclear tests. Sr-89 also intermittently detected during 1981 is probably associated with the 1980 atmospheric weapons test because releases of this nuclide by PBAPS are far too low to account for the concentrations observed in vegetation.

Aquatic Radionuclide Distributions

As indicated in Table V-14, low levels of radionuclides attributed to PBAPS have been detected in sediments, finfish, freshwater mussels, aquatic vegetation, and in one otter (21).

During 1981-1982, radionuclides detected in finfish by PPSP and attributed to PBAPS included Co-60, Zn-65, I-131, Cs-134 and Cs-137 (16, 17, 21). As in prior reporting years, concentrations were highest in collections from the Conowingo Pond, and also consistently detected in finfish collected below the Conowingo Dam (21). Edible finfish species with detectable concentrations of these nuclides included channel catfish, carp,

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[1]Calculation of atmospheric dispersion between PBAPS and the monitored farm indicates that, if released as a puff with the wind blowing toward this sampling site, the entire annual release of Cs-134 would produce a concentration of only 0.005 pCi/l (20). Even though Cs-137 atmospheric releases were about three times the Cs-134 activity released, Cs-137 was not detected in the sample.

Table V-14. Maximum Concentrations of Radionuclides Attributed to Peach Bottom Atomic Power Station in Various Aquatic Media for the Period 1981-1982 as Determined through PPSP Monitoring Program (21). Counting Uncertainty @ 95% Confidence Level.

Media	Radionuclide Concentration (pCi/kg, wet)[a] Co-60	Zn-65	Cs-134	Cs-137[b]
Mammals				
Otter				
Flesh	-	-	-	18±7
Gut	-	20±11	-	14±6
Raccoon				
Flesh	-	-	-	116±11
Gut	-	-	-	135±16
Muskrat				
Flesh	-	-	-	21±7
Gut	-	-	-	-
Waterfowl				
Merganser				
Flesh	-	-	-	-
Gut	-	-	-	-
Duck				
Flesh	-	-	-	-
Gut	-	-	-	-
Finfish[c]				
Edible species	-	123±80	48±7	132±10
Forage species	47±9	975±40	45±6	100±11
Invertebrates				
Elliptio complanata	664±39	15±4	30±4	
Submerged Aquatic Vegetation[c]	-	62±12	7±4	48±10
Sediment	97±16	49±10	227±12	733±22

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

(b) Primarily attributable to weapons testing fallout; however where Cs-134 was also present, a power plant produced Cs-137 increment is also indicated.

(c) Iodine-131 also detected in Quillback flesh (7/1/81) at 7±13 pCi/kg and in a Milfoil sample (6/3/82) at 23±9 pCi/kg.

hybrids (white bass x striped bass), walleye, and smallmouth bass. Low levels of the short lived Cr-51 were also detected in white crappie collected in May and September 1981, and I-131 in September 1981 (18). I-131 was also detected in quillback, collected in July, 1981 (21). In prior years, finfish collections from the Susquehanna Flats have occasionally contained Cs-134 attributed to PBAPS. During this subject period, Cs-134 was not detected, however low levels of Zn-65 were detected on two occasions in two samples (white perch; Notropis sp.).

Low levels of Zn-65 and Cs-134 have been detected in submerged aquatic vegetation (SAV) collected in Susquehanna River just above the river mouth and on the Susquehanna Flats (21). These nuclides are likely bound to organic material and trapped by, rather than incorporated within, the SAV. I-131 was also detected in SAV collected by PPSP in June 1982 (21).

Freshwater mussels from the Susquehanna Flats were found to contain very low levels of Zn-65 and Cs-134 in the prior reporting period (1). Samples collected during 1981 and 1982 contained only low levels of Zn-65. In 1982, PPSP instituted a caging study, emplacing mussels above the PBAPS influence (in Holtwood Reservoir), and within its influence (Conowingo Pond). No man-made radionuclides were ever detected in the Holtwood mussel stock. Zn-65 was, however, bioaccumulated by the Conowingo Pond stock to a maximum of 660 pCi/kg wet weight (Fig. V-4). Concentrations in mussels located here began to decrease in the fall, a function of reduction in Zn-65 released by the plant (Fig. V-5), depuration of the metal, and nuclide decay. Mussels collected concurrently from the natural population on the Susquehanna Flats sporadically contained barely detectable concentrations of Zn-65, in a pattern which indicated about an order of magnitude downstream decline in Zn-65 availability to the organism (21).

Prior year collections of waterfowl (mergansers) have contained radiocesium attributed to PBAPS (1). 1981-1982 collections of these birds and other waterfowl have not contained any PBAPS radioactivity (21).

In a pattern reflective of the prior reporting period (1978-1980), Zn-65 was detected in Conowingo Pond sediments, but not in samples from below the Conowingo Dam. Cs-134[1] and a generally unquantifiable concentration of Cs-137 have been

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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 implies 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.

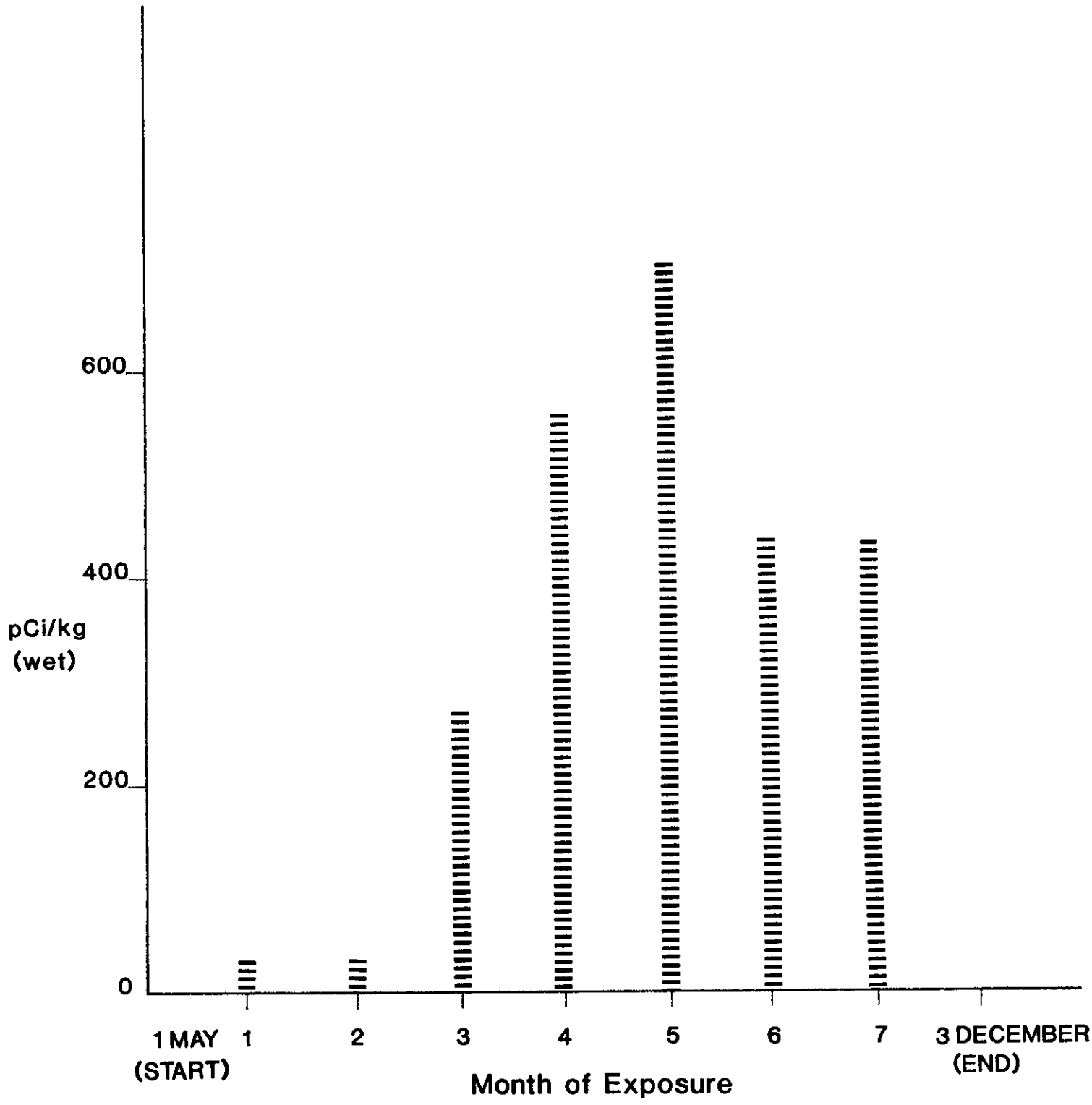

FIGURE V-4 Zn-65 IN CONOWINGO POND MUSSELS

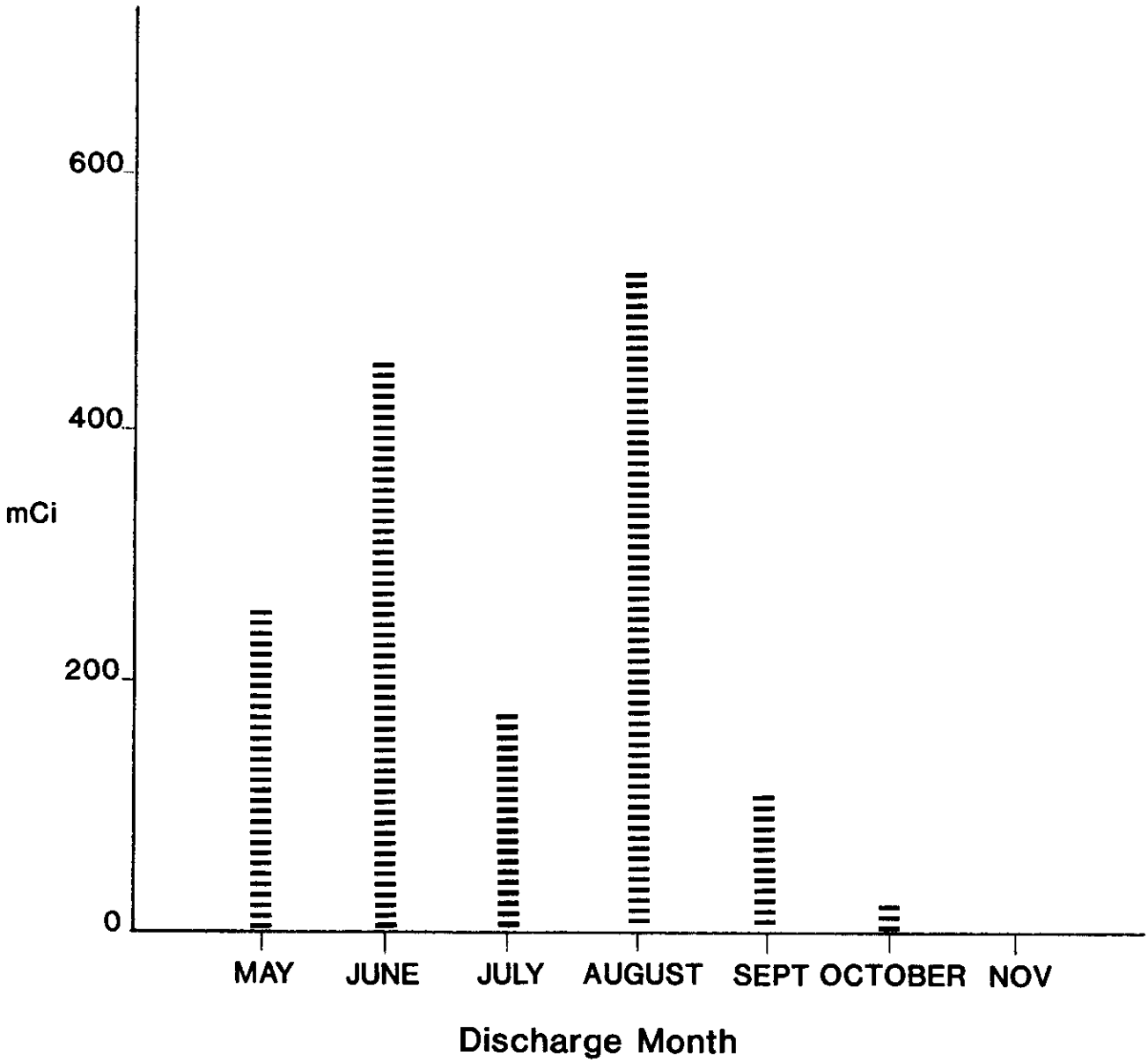

FIGURE V-5 Zn-65 RELEASES (mCi)

detected in sediments from Conowingo Pond and the Upper Chesapeake Bay, distributed as far down-bay as the mouth of the Sassafras River (21).

Radiation Dose to Man

No radioactivity attributed to Peach Bottom atmospheric releases was found offsite in air or terrestrial samples taken from the Peach Bottom vicinity in 1981 or 1982 with the possible exception of a questionable concentration of 3±3 pCi/l of Cs-134 reported in one quarterly milk sample. If this concentration were real and representative of the entire 90-day period, ingestion by an infant would have resulted in a whole body dose of 0.02 mrem and a liver dose of 0.2 mrem.

For the aqueous pathway, the annual total body dose associated with consumption of drinking water was calculated for an individual consuming two liters of Conowingo Pond water daily, based upon a concentration of radionuclides calculated for the 1981 and 1982 release quantities given in Table V-11. Concentrations of H-3, Zn-65, Cs-134 and Cs-137 could produce a plant-related dose increment of 0.02 mrem assuming an annual Susquehanna River, however, at the low-flow level of 2500 cfs. An average flow (36000 cfs) would produce a plant-related dose increment of 0.002 mrem. In actuality, most of the zinc and cesium would be removed by physical and chemical processes prior to ingestion. A drinking water total body dose attributable to plant-released tritium alone would be on the order of 0.001 mrem per year. By way of comparison, the dose attributable to tritium from weapons testing fallout would be about 22 times greater.

The annual whole body dose commitment to an adult consuming PBAPS related radioactivity in finfish, utilizing the maximum concentrations of each radionuclide detected in the PPSP monitoring program (Table V-14) would be 0.34 mrem per year.[1] The highest calculated dose commitment would be 0.5 mrem per year to a teenager's liver. Table V-15 summarizes dose commitments to a maximum exposed individual consuming finfish containing the maximum radionuclide concentrations from Table V-14. A comparison with dose commitments calculated for the prior reporting year is presented in Table V-16.

The plant-attributed total body dose increment associated with ingestion of Conowingo Pond water and finfish is calculated to be less than 0.5 mrem. By comparison, that attributable to ingestion of natural radioactivy is about 21 mrem/year.

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[1]It should be noted that these dose estimates assume that the maximum radionuclide concentrations in finfish exist for a full year, and that all Cs-137 is due to PBAPS (some fraction is due to weapons test fallout). Therefore, these values overestimate the dose commitment attributable to PBAPS releases.

Summary

Atmospheric releases of radioactivity are not believed to have produced detectable radionuclide concentrations off-site during the 1981-1982 period. A possible exception was a very low concentration of Cs-134 in one milk sample. On site, one very low concentration of Co-60 was reported in an atmospheric particulate sample, and is attributed to plant operation. No I-131 was detected in the atmospheric/terrestrial environment during the period.

Liquid effluents containing PBAPS radionuclides have consistently resulted in detectable concentrations of Zn-65, Cs-134, and Cs-137 in sediments and biota of the Conwingo Pond, the lower Susquehanna River, and the Upper Chesapeake Bay. Maximum concentrations in finfish occur in the Conowingo Pond and just below 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 0.5 mrem/year 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 (see Table V-I). An assessment of these exposure levels is given some context by a comparison with doses from the natural radiation background which, in the Peach Bottom vicinity, averages about 100 mrem per year to the total body and internal organs.

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 the 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.

Table V-15. Maximum Dose Commitment[a] (in mrem) for an Individual Consuming Seafood Affected by PBAPS Effluents Exclusively (Assume Finfish Radionuclide Concentrations Given in Table V-14). Calculations Based Upon Conversion Factors of USNRC Reg. Guide 1.109.

	Adult	Teen	Child
Consumption: Finfish	21 kg/yr	16 kg/yr	6.9 kg/yr
Total Body Dose:			
Zn-65	.02	.02	.02
Cs-134	.12	.07	.03
Cs-137	.20	.11	.04
TOTAL	0.34	0.20	0.09
Bone Dose:			
Zn-65	.01	.01	.01
Cs-134	.06	.06	.08
Cs-137	.22	.24	.30
TOTAL	0.29	0.31	0.39
Liver Dose:			
Zn-65	.04	.04	.03
Cs-134	.15	.15	.13
Cs-137	.3	.31	.29
TOTAL	0.49	0.50	0.45
Kidney Dose:			
Zn-65	.03	.03	.02
Cs-134	.05	.05	.04
Cs-137	.10	.11	.09
TOTAL	0.18	0.19	0.15
GI Tract Dose:			
Zn-65	.03	.02	.01
Cs-134	.00261	.0019	.00069
Cs-137	.01	.0045	.00179
TOTAL	0.043	0.0264	0.01248

(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.

Table V-16. Comparison of 1981-1982 Maximum Annual Dose Commitments in mrem Associated with Consumption of Finfish (Assumes Maximum Radionuclide Concentations Given in Table V-15) with Prior Reporting (1978-1980) Period.

	Adult		Teen		Child	
	78-80	81-82	78-80	81-82	78-80	81-82
Whole Body	1.07	0.34	0.61	0.20	0.24	0.09
Bone	0.84	0.29	0.88	0.31	1.09	0.39
Liver	1.46	0.49	1.50	0.50	1.31	0.45
Kidney	0.49	0.18	0.50	0.19	0.42	0.15
GI Tract	0.03	0.04	0.03	0.03	0.01	0.01

Decontamination of Accident-Generated Water

The cleanup of Unit 2 had through 1982 been going on for almost four years and is expected to continue through 1988. The greatest concern to Maryland, relative to environmental impact, is the potential for an aqueous release to the Susquehanna River. For this reason, the disposition of water generated by the accident has been monitored closely by the PPSP. The following section describes cleanup activities pertinent to decontamination of the water and the removal of radioactivity from the island.

The accident flooded the containment building with approximately 650,000 gallons of high activity waste water, and the Auxiliary and Fuel Handling building with 565,000 gallons of intermediate level waste water.[1] All intermediate level waste water has now been decontaminated. Processing of high activity waste water in the containment building was completed in early 1982, although the reuse of this water in the decontamination of the containment building surfaces will continue to generate waste water which will require further processing.

Because of this reuse of previously decontaminated water the total inventory of radioactivity in processed water stored at TMI is constantly changing. Estimates of the total inventory are made regularly, and as of the end of 1982, the processed water was estimated to contain the levels given in Table V-17.

Table V-17
Estimated Total Curie Content of
Decontaminated Containment Building Water (23).

Isotope	Total curies
Cs-137	0.024
Sr-90	0.119
H-3	1800
Other	0.016

PPSP collected two samples[2] of processed containment building water to confirm concentration estimates. Analysis of these samples indicated reasonable agreement with licensee and federal agency results, and this independent check was therefore discontinued. Based on these analyses and estimates made prior

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[1]High activity waste water is defined as water containing either I-131 or Cs-137 in concentrations greater than 100 uCi/ml. Intermediate level waste water is defined as water having I-131 and Cs-137 concentrations greater than 1 uCi/ml but less than 100 uCi/ml (22).

[2]Samples collected October 15, 1981 and February, 15, 1982.

to processing, the achieved decontamination factors are on the order of 10^8 to 10^9 for cesium and 10^5 to 10^7 for strontium.[1] The processing system exceeded expectations of providing decontamination factors of up to 10^7 for cesium and 10^5 for strontium (24).

The other significant volume of water requiring decontamination is the reactor coolant. Processing of this water is continuing.

At this time, all decontaminated water is stored onsite, and no action regarding its ultimate disposition has been taken. Any proposal to dispose of processed accident-generated water must be approved by the NRC (25). The disposal option that would most affect Maryland is a controlled discharge to the Susquehanna River. Based upon assessment of the radiological impact of the PBAPS, and an estimation of radionuclide concentrations in the decontaminated water, PPSP has determined that the water could be discharged to the River in a manner which would produce no significant radiological impact in Maryland. Therefore, the major issue associated with this discharge option is not a radiological concern, but rather the public's perception - or misperception - of the radiological effects of such a discharge. This perception could result in consumer avoidance of Bay seafood products, thus adversely affecting commercial and recreational fisheries.

For this reason 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 a discharge to the Susquehanna. The Maryland position and PPSP assessment of the potential environmental effects of a discharge are detailed in Appendix A to the NRC's Final Programmatic Environmental Statement on the cleanup (26).

Releases to the Environment

Radionuclides discharged to the atmosphere and Susquehanna River by TMINS during 1981 and 1982, as reported by the GPU Nuclear Corporation, are given in Tables V-18 and V-19. Because neither unit was operating during the subject period, quantities of radionuclides in gaseous and liquid releases were very small.

Atmospheric and Terrestrial Radionuclide Distributions

Because Atmospheric releases from Three Mile Island were virtually non-existent during the 1981-1982 period, and the Maryland border is 30 miles distant, there has been no radiological impact in Maryland.

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[1]Decontamination factors are given as ranges because of the variation between samples analyzed.

Aquatic Radionuclide Distributions

Low levels of TMI-related radioactivity were detected by the utility in their monitoring of biota and sediments during 1981-1982 (28, 29). These levels are strictly confined to the immediate plant vicinity and are likely associated with pre-shutdown, operational discharges. To discern a possible TMI-associated increment to the radionuclide inventory in Maryland, PPSP continues to analyze collections of sediment and biota from the Holtwood (Pa.) Reservoir. This location is upstream and outside the influence of PBAPS aqueous releases. No radionuclides attributable to a source upstream of PBAPS were detected in any environmental collection during the 1981-1982 period (21).

Summary

The ongoing cleanup of TMI Unit 2 and routine, non-operational maintenance of Unit 1 resulted in releases of extremely low levels of radioactivity to the atmospheric and aquatic environment during 1981-1982. While very low levels of plant-attributable radioactivity were detected in the plant vicinity no environmental impact to Maryland has occurred during this period (1981-1982) or previously (1, 21).

D. Radiological Emergency Planning

All licensees of nuclear power plants are required to develop, and submit for Federal review, radiological emergency plans (REP). The licencee's REP must incoporate offsite plans, the preparation of which is the responsibility of State and local government. The NRC will review the plans and "make a finding as to whether the state of onsite and offsite emergency preparedness provides reasonable assurance that adequate protective measures can and will be taken in the event of a radiological emergency" (30). The NRC finding will be partially based on an assessment by the Federal Emergency Management Agency (FEMA) as to the adequacy of State and local plans. NRC and FEMA reviews will be based on criteria published in 1980 (31).

One of the bases 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" (31). There are two types of EPZs: the plume zone (that area within a 10 mile radius of the plant) and the ingestion zone (that area within a 50 mile radius of the plant). Radiation doses in the plume zone are received from immersion, inhalation and external exposure to radioactivity deposited by the plume. Ingestion pathway doses result from consumption of contaminated water or food.

Table V-18. Total Gaseous Releases (in Curies) from the Three Mile Island Nuclear Station as Reported by GPU Nuclear (27-28).

Radionuclide	Unit 1		Unit 2	
	1981	1982	1981	1982
Gross Alpha	.000000277	.00000290	.000000146	.000000111
Kr-85	.058	.00756	472.0	915.0
Cs-134			.000000108	.00000394
Cs-137	.000473	.000129	.00000812	.0000539
H-3	.049	.000225	65.6	112.0
Co-60	.00000516		.0000000692	.0000000129
Nb-95			.0000000013	
Sr-89	.00000687	.0000242		
Sr-90	.0000124	.00000956	.0000000010	.0000000922

Table V-19. Total Liquid Releases (in Curies) from the Three Mile Island Nuclear Station as Reported by GPU Nuclear (27-28)

Radionuclide	Unit 1		Unit 2	
	---1981---	---1982---	--1981--	--1982--
H-3	7.11	3.67	.050	.0720
Ag-110m	.000436			
Co-57	.00000299			
Co-58	.0000340			
Co-60	.00591	.00333		
Cs-134	.0129	.00800		
Cs-137	.0632	.0400	.0000141	.0000358
Fe-55	.00125	.000332		
Mn-54	.000123	.0000121		
P-32	.00000027			
Sb-125	.00210	.000333		
Sr-89		.00000310		
Sr-90	.0000505	.0000451		
Zn-65	.00000445			

The State of Maryland has prepared a radiological emergency plan (REP) for each nuclear power plant having any part of its plume exposure pathway within the State (Calvert Cliffs Nuclear Power Plant and Peach Bottom Atomic Power Station). The onsite plans for both plants have been completed and reviewed by the NRC. A full scale exercise of the onsite and offsite plans for CCNPP involving licensee, State and local government personnel was conducted on November 17, 1981. A full scale exercise of the onsite and offsite plans for PBAPS was conducted June 16, 1982. Based on onsite and offsite plans and full scale exercises, the NRC has determined that, for both plants, emergency preparedness is adequate, and that prompt protective measures necessary to protect the public can and will be taken (32 and 33).

E. Radioactive Waste Disposal

On December 22, 1980 Congress passed the Low-Level Radioactive Waste Policy Act, granting individual states the authority to form regional compacts to provide for the establishment of regional facilities for low-level radioactive waste disposal. A program to provide for the permanent disposal of high-level radioactive waste and spent fuel was established by the Nuclear Waste Policy Act of 1982, signed into law January 7, 1983.

Low-Level Radioactive Waste

The passage of the Low-Level Radioactive Waste Policy Act is significant in that it places the responsibility for the disposal of low-level radioactive wastes on the individual states. It also establishes as Federal policy that these wastes can be best managed on a regional basis. To implement these policy changes, the Act authorizes States to establish regional compacts. All compacts so established require Congressional ratification. In addition, as of January 1, 1986, any compact region may restrict the use of low-level radioactive waste disposal sites to low-level radioactive waste generated within the region. This is very important in that it will essentially close the three existing disposal sites (located in Washington, Nevada and South Carolina) to wastes generated outside the compact regions in which they are located.

After negotiating with three interstate compact groups: Mid-Atlantic, Midwest and Northeast, Maryland has become a member of the Northeast Compact, becoming the first state to pass legislation authorizing participation in the Northeast Compact. The other states participating in the Northeast Compact are Vermont, New Hampshire, Maine, Connecticut, Massachusetts, Rhode Island, Pennsylvania, New Jersey, New York and Delaware.

All low-level waste generated at the Calvert Cliffs Nuclear Power Plant is presently shipped to Barnwell, South Carolina for disposal. The volume and activity levels of waste shipped are given in Table V-20. The Peach Bottom Atomic Power Station ships low-level radioactive waste to both Hanford,

Washington and Barnwell (see Table V-21 for amounts shipped). The Three Mile Island Nuclear Station ships the majority of low-level radioactive waste it generates to Hanford for disposal, but made one shipment to Barnwell during the subject period. (See Table V-22 for amounts shipped.) In addition to low-level radioactive waste, TMINS shipped several EPICOR-II prefilters and one SDS liner offsite in 1982. All of these were shipped to DOE facilities in Richland, Washington.

Table V-20. Low-Level Solid Waste Shipped Offsite for Disposal from CCNPP as reported by BG&E (4-7).

Type of Waste	1981 Volume (m^3)	1981 Activity (Ci)	1982 Volume (m^3)	1982 Activity (Ci)
Spent resin, filter sludge, evaporator bottoms, etc.	52.9	94	47.4	144
Dry compressor waste, contaminated equipment, etc.	291.6	2.4	82.8	11.9
Irradiated components, control rods, etc.	155.9	2.2	26.4	760
Number of Shipments	42		25	

Table V-21. Low-Level Solid Waste Shipped Offsite for Disposal from PBAPS as reported by PEPCO (12-15).

	1981	1982
Volume (m^3)	2330	3230
Activity (Ci)	5330	4510
Number of Shipments	336	340

Table V-22. Low-Level Solid Waste Shipped Offsite for Disposal from TMINS - Unit 2[1] as reported by GPU Nuclear (34-37)

Type of Waste	1981 Volume (m^3)	1981 Activity (Ci)	1982 Volume (m^3)	1982 Activity (Ci)
Spent resins, filter sludge, evaporator bottoms, etc.	4.42	0.04	4.248	0.14
Dry compressible waste, contaminated equipment, etc.	266.7	47.82	176.1	12.03
Other	3.16	3.17	--	--
Number of Shipments	8		8	

[1] Does not include EPICOR-II and SDS liners.

High-Level Radioactive Waste and Spent Fuel

The Nuclear Waste Policy Act of 1982 is very important in that it establishes federal responsibility for disposal of radioactive waste and spent fuel, as well as establishing a schedule for siting permanent disposal facilities. (The Act is described in detail in Reference 38.) Under the provisions of the Act, the U.S. Department of Energy (DOE) must, by January 1, 1985, recommend to the President three sites for characterization for the first repository. The President must recommend to Congress a site for the first repository by March 31, 1987. The deadline for DOE to begin disposing of spent fuel is January 31, 1998.

The Act contains provisions for the State or Indian tribe in which a site is located to disapprove the selection. The affected State or Indian tribe must submit a notice of disapproval to Congress within 60 days of the Presidential recommendation of a site. This veto takes effect unless overturned within 90 days by both houses of Congress.

The Act also provides for utilities to be able to ship spent fuel offsite prior to the availability of permanent disposal sites. It is the responsibility of nuclear power plant operators to provide for storage of spent fuel until permanent disposal is available. The Act does however permit away-from-reactor (AFR) storage (of up to a total of 1900 metric tons in federal facilities) if necessary to prevent disruption of operation at nuclear power plants. Reactor operators will be required to demonstrate that they cannot reasonably provide the onsite storage necessary for ensuring continued operation prior to being permitted to utilize federal AFR facilities.

It is expected that the passage of the Act will ultimately relieve nuclear power plant operators of the burden of storing spent fuel onsite. Virtually all spent fuel generated at nuclear power plants across the country is presently stored onsite in spent fuel storage pools. These spent fuel pools were not designed for indefinite storage, but rather to temporarily store spent fuel for "cool-down", pending its shipment offsite. For this reason, spent fuel pools were constructed with limited capacities.

The limited capacities of spent fuel pools at Calvert Cliffs and Peach Bottom[1] could eventually compromise continued operation. Although both plants have expanded original spent fuel pool capacity by reracking, present capacities will be exhausted in a few years. 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. Peach Bottom has the ability to store fuel onsite until March 1990 for unit 2, and September 1990 for Unit 3. The current capacities of the spent fuel pools is compared to the fuel assemblies actually stored there in Table V-23.

Table V-23. Capacity of Spent Fuel Pools and Amount of Fuel Actually Stored (in Fuel Assemblies)

	Calvert Cliffs	Peach Bottom	
	Both Units	Unit 2	Unit 3
Licensed Capacity	1760	2816	2816
Installed Capacity	1358	2816	2816
Spent Fuel in Storage	584	1170 +58 rods	1212 +6 rods

[1]Three Mile Island is not considered here because neither unit is presently operating.

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