Offsite Dose Calculation Manual
Revision 5

Peach Bottom Atomic Power Station
Units 2 and 3

Philadelphia Electric Company
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Table of Contents

I. Purpose

II. Instrument Setpoints

III. Liquid Pathway Dose Calculations

A. Liquid Radwaste Release Flow Rate Determination
B. Surveillance Requirement 4.8.B.2
C. Surveillance Requirement 4.8.B.4a

IV. Gaseous Pathway Dose Calculations

A. Surveillance Requirement 4.8.C.1
B. Surveillance Requirement 4.8.C.2
C. Surveillance Requirement 4.8.C.3
D. Surveillance Requirement 4.8.C.5a
E. Surveillance Requirement 4.8.C.6b

V. Nuclear Fuel Cycle Dose Assessment - 40 CFR 190

A. Surveillance Requirement 4.8.D

VI. Calendar Year Dose Calculations

A. Unique Reporting Requirement 6.9.2.h

VII. Radiological Environmental Monitoring Program

A. Surveillance Requirement 4.8.E

VIII. Bases

I. Purpose

The purpose of the Offsite Dose Calculation Manual is to establish methodologies and procedures for calculating doses to individuals in areas at and beyond the SITE BOUNDARY due to radioactive effluents from Peach Bottom Atomic Power Station. The results of these calculations are required to determine compliance with Appendix A to Operating Licenses DPR-44 and DPR-56, "Technical Specification and Bases for Peach Bottom Atomic Power Station Units No. 2 and 3".

II. Setpoint Determination for Liquid & Gaseous Monitors

II.A Liquid Radwaste Activity Monitor Setpoint

Each tank of radioactive waste is sampled prior to release. A small liquid volume of this sample is analyzed for gross gamma activity in a NaI well counter. This NaI well counter activity is then converted to an equivalent liquid radwaste monitor reading.

CPS (R/W Monitor) = [Net CPM/ml (well) x Eff W/RW] + Background CPS

Where:

CPS (R/W Monitor)	=	liquid radwaste gross activity monitor reading in CPS
Net CPM/ml (well)	=	gross gamma activity for the radwaste sample tank [determined by the well counter]
Eff W/RW	=	conversion factor between well counter and liquid radwaste gross activity monitor [determined by calibrating both detectors with the same liquid radioactive source]
Background CPS	=	background reading of the liquid radwaste gross activity monitor in CPS

Exceeding the expected response would indicate that an incorrect sample had been obtained for that release and the release is automatically stopped.

The alarm and trip pot setpoints for the liquid radwaste activity monitor are determined from a calibration curve for the alarm pot and trip pot. The alarm pot setting includes a factor of 1.25 to allow for analysis error, pot setting error, instrument error and calibration error. The trip pot setting includes a factor of 1.35 to allow for analysis error, pot setting error, instrument error and calibration error.

II.B Liquid Radwaste Release Flowrate Setpoint Determination

The trip pot setpoint for the liquid radwaste release flowrate is determined by multiplying the liquid radwaste flowrate (from Section III.A) by 1.2 and using this value on the appropriate calibration curve for the discharge flow meter to be used. The Peach Bottom radwaste system has two flow monitors - high flow (5 to 300 gpm) and low flow (0.8 to 15 gpm). The factor of 1.2 allows for pot setting error and instrument error. The flow rate determination includes a margin of assurance which includes consideration of this error such that the instantaneous release limit of 10 CFR 20 is not exceeded.

II.C Setpoint Determination for Gaseous Radwaste

The high and high-high alarm setpoints for the main stack radiation monitor, Unit 2 roof vent radiation monitor and Unit 3 roof vent radiation monitor are determined as follows:

High Alarm - the high alarm setpoint is set at approximately 3 x the normal monitor reading.

High-High Alarm - the high-high alarm setpoint is set at a release rate from this vent of approximately 30% of the instantaneous release limit of 10 CFR 20 as specified in Technical Specification 3.8.C.1.a for the most restrictive case (skin or total body) on an unidentified basis. To determine these setpoints, solve the gaseous effluent dose rate equations in section IV.A of the ODCM to determine what main stack release rate and roof vent release rate will produce a dose rate of 150 mrem/yr to the total body (30% of the limit of 500 mrem/yr) and a dose rate of 900 mrem/yr to the skin (30% of the limit of 3000 mrem/yr) from each release point. Using the smallest (most restrictive) release rate for each release point determine monitor response required to produce this release rate assuming a normal vent flow rate and pressure correction factor. Set the high-high alarm for approximately this monitor response.

II.D. Setpoint Determination for Gaseous Radwaste

Flow Monitors

The alarm setpoint for the main stack flow monitor is as follows:

Low Flow Alarm - 10,000 CFM. - This setting ensures that the main stack minimum dilution flow as specified in Technical Specification 3.8.C.4.a is maintained.

II.D. (Cont'd)

The alarm setpoints for the roof vent flow monitors are as follows:

Low Flow Alarm - 1.5×10^5 cfm

High Flow Alarm - 5.4×10^5 cfm

III. Liquid Pathway Dose Calculations

III.A Liquid Radwaste Release Flow Rate Determination

Peach Bottom Atomic Power Station Units 2 and 3 have one common discharge point for liquid releases. The following calculation assures that the radwaste release limits are met.

The flow rate of liquid radwaste released from the site to areas at and beyond the SITE BOUNDARY shall be such that the concentration of radioactive material after dilution shall be limited to the concentration specified in 10 CFR 20, Appendix B, Table II, Column 2 for radionuclides other than noble gases and 2E-4 μCi/ml total activity concentration for all noble gases as specified in Technical Specification 3.8.B.1. Each tank of radioactive waste is sampled prior to release and is quantitatively analyzed for identifiable gamma emitters as specified in Table 4.8.1 of the Technical Specifications. From this gamma isotopic analysis the maximum permissible release flow rate is determined as follows:

Determine a Dilution Factor by:

$$\text{Dilution Factor} = \sum_i \frac{\mu Ci/ml\ i}{ECLi}$$

μCi/ml i = the activity of each identified gamma emitter in μCi/ml

ECLi = The effluent concentration specified in 10 CFR 20, Appendix B, Table II, Column 2 for radionuclides other than noble gases or 2×10^{-4} μCi/ml for noble gases.

III.A (Cont'd)

Determine the Maximum Permissible Release Rate with this Dilution Factor by:

$$\text{Release Rate (gpm)} = \frac{A \times 2.0 \times 10^5}{B \times C \times \text{Dilution Factor}}$$

A = The number of circulating water pumps running which will provide dilution

2.0×10^5 = the flow rate in gpm for each circulating water pump running

B = margin of assurance which includes consideration of the maximum error in the activity setpoint, the maximum error in the flow setpoint, and possible loss of 5 out of the 6 possible circulating water pumps during a release. The value used for B is 10.0.

C = concentration gradient factor. The value used for C is 5.0 for discharge canal water levels less than 104' and 3.0 for canal water levels greater than 104'.

III.B Surveillance Requirement 4.8.B.2

Dose contributions from liquid effluents released to areas at and beyond the SITE BOUNDARY shall be calculated using the equation below. This dose calculation uses those appropriate radionuclides listed in Table III.A.1. These radionuclides account for virtually 100 percent of the total body dose and organ dose from liquid effluents.

The dose for each age group and each organ should be calculated to determine the maximum total body dose and organ dose for each quarter and the year, as appropriate. Cumulative dose files for quarterly and yearly doses should be maintained separately and the maximum total body and organ dose reported in each case.

$$D = \sum_i \left[A_i \tau \sum_{l=1}^{m} \Delta t_l \, C_{il} \, F_l \right]$$

where:

D = The cumulative dose commitment to the total body or any organ, from liquid effluents for the total time period $\sum_{l=1}^{m} \Delta t_l$, in mrem.

Δt_l = The length of the lth time period over which C_{il} and F_l are averaged for the liquid release, in hours.

III.B (Cont'd)

C_{il} = The average concentration of radionuclide, i, in undiluted liquid effluent during time period Δt from any liquid release, (determined by the effluent sampling analysis program, Technical Specification Table 4.8.1), in μCi/ml.

$A_{i}\tau$ = The site related ingestion dose commitment factor to the total body or organ, τ, for each radionuclide listed in Table III.A.1, in mrem-ml per hr-μCi. See Site Specific Data.**

F_{l} = The near field average dilution factor for C_{il} during any liquid effluent release. Defined as the ratio of the maximum undiluted liquid waste flow during release to the average flow through the discharge structure.

III.C <u>Surveillance Requirement 4.8.B.4a</u>

Projected dose contributions from liquid effluents shall be calculated using the methodology described in section III.B.

** See Note 1 in Bases

TABLE III.A.1

LIQUID EFFLUENT INGESTION DOSE FACTORS
(DECAY CORRECTED)
$A_{i\tau}$ DOSE FACTOR (MREM-ML PER HR-μCi)

TOTAL BODY

RADIO-NUCLIDE	ADULT	TEEN	CHILD
H-3	2.13E+00	1.53E+00	2.70E+00
NA-24	1.65E+02	1.70E+02	1.98E+02
P-32	5.93E+04	6.49E+04	8.33E+04
MN-54	9.82E+02	1.00E+03	1.08E+03
FE-55	1.31E+02	1.40E+02	1.96E+02
FE-59	1.14E+03	1.17E+03	1.36E+03
CO-58	2.59E+02	2.62E+02	3.17E+02
CO-60	7.40E+02	7.48E+02	9.07E+02
ZN-65	3.87E+04	3.95E+04	4.16E+04
SR-89	8.83E+02	9.45E+02	1.48E+03
SR-90	1.88E+05	1.56E+05	1.72E+05
TE-129M	2.01E+03	2.17E+03	2.79E+03
TE-131M	4.57E+02	4.81E+02	5.74E+02
TE-132	1.40E+03	1.44E+03	1.65E+03
I-131	1.86E+02	1.79E+02	2.36E+02
I-133	1.97E+01	2.03E+01	3.20E+01
CS-134	6.74E+05	3.88E+05	1.49E+05
CS-136	9.79E+04	9.15E+04	7.30E+04
CS-137	3.98E+05	2.20E+05	8.49E+04
BA-140	3.66E+01	3.62E+01	7.42E+01

NOTE: The listed dose factors are for radionuclides that may be detected in liquid effluents and have significant dose consequences. The factors are decayed for one day to account for the time between effluent release and ingestion of fish by the maximum exposed individual.

TABLE III.A.1
LIQUID EFFLUENT INGESTION DOSE FACTORS
(DECAY CORRECTED)

$A_{i\tau}$ DOSE FACTOR (MREM-ML PER HR-μCi)

LIVER

RADIO-NUCLIDE	ADULT	TEEN	CHILD
H-3	2.13E+00	1.53E+00	2.70E+00
NA-24	1.65E+02	1.70E+02	1.98E+02
P-32	9.55E+04	1.04E+05	1.01E+05
MN-54	5.15E+03	5.06E+03	4.03E+03
FE-55	5.62E+02	6.01E+02	6.33E+02
FE-59	2.96E+03	3.02E+03	2.73E+03
CO-58	1.16E+02	1.14E+02	1.04E+02
CO-60	3.35E+02	3.32E+02	3.07E+02
ZN-65	8.55E+04	8.46E+04	6.69E+04
SR-89	no data	no data	no data
SR-90	no data	no data	no data
TE-129M	4.74E+03	5.09E+03	5.02E+03
TE-131M	5.48E+02	5.77E+02	5.40E+02
TE-132	1.48E+03	1.53E+03	1.36E+03
I-131	3.25E+02	3.32E+02	4.16E+02
I-133	6.48E+01	6.66E+01	8.45E+01
CS-134	8.25E+05	8.36E+05	7.06E+05
CS-136	1.36E+05	1.36E+05	1.13E+05
CS-137	6.07E+05	6.32E+05	5.75E+05
BA-140	7.00E-01	6.90E-01	1.11E+00

NOTE: The listed dose factors are for radionuclides that may be detected in liquid effluents and have significant dose consequences. The factors are decayed for one day to account for the time between effluent release and ingestion of fish by the maximum exposed individual.

TABLE III.A.1

LIQUID EFFLUENT INGESTION DOSE FACTORS
(DECAY CORRECTED)
$A_{i\tau}$ DOSE FACTOR (MREM-ML PER HR-μCi)

BONE

RADIO-NUCLIDE	ADULT	TEEN	CHILD
H-3	no data	no data	no data
NA-24	1.65E+02	1.70E+02	1.98E+02
P-32	2.38E+05	2.58E+05	3.35E+05
MN-54	no data	no data	no data
FE-55	8.12E+02	8.47E+02	1.19E+03
FE-59	1.26E+03	1.30E+03	1.68E+03
CO-58	no data	no data	no data
CO-60	no data	no data	no data
ZN-65	2.69E+04	2.43E+04	2.51E+04
SR-89	3.08E+04	3.30E+04	5.19E+04
SR-90	7.67E+05	6.31E+05	6.78E+05
TE-129M	1.27E+04	1.37E+04	1.80E+04
TE-131M	1.12E+03	1.21E+03	1.56E+03
TE-132	2.29E+03	2.42E+03	3.07E+03
I-131	2.28E+02	2.38E+02	4.13E+02
I-133	3.72E+01	3.92E+01	6.84E+01
CS-134	3.47E+05	3.55E+05	4.30E+05
CS-136	3.45E+04	3.46E+04	4.10E+04
CS-137	4.44E+05	4.75E+05	6.01E+05
BA-140	5.57E+02	5.63E+02	1.27E+03

NOTE: The listed dose factors are for radionuclides that may be detected in liquid effluents and have significant dose consequences. The factors are decayed for one day to account for the time between effluent release and ingestion of fish by the maximum exposed individual.

TABLE III.A.1

LIQUID EFFLUENT INGESTION DOSE FACTORS
(DECAY CORRECTED)
$A_{i\tau}$ DOSE FACTOR (MREM-ML PER HR-μCi)

KIDNEY

RADIO-NUCLIDE	ADULT	TEEN	CHILD
H-3	2.13E+00	1.53E+00	2.70E+00
NA-24	1.65E+02	1.70E+02	1.98E+02
P-32	no data	no data	no data
MN-54	1.53E+03	1.51E+03	1.13E+03
FE-55	no data	no data	no data
FE-59	no data	no data	no data
CO-58	no data	no data	no data
CO-60	no data	no data	no data
ZN-65	5.72E+04	5.41E+04	4.22E+04
SR-89	no data	no data	no data
SR-90	no data	no data	no data
TE-129M	5.31E+04	5.74E+04	5.29E+04
TE-131M	5.55E+03	6.01E+03	5.22E+03
TE-132	1.43E+04	1.47E+04	1.27E+04
I-131	5.57E+02	5.73E+02	6.82E+02
I-133	1.12E+02	1.16E+02	1.41E+02
CS-134	2.67E+05	2.66E+05	2.19E+05
CS-136	7.57E+04	7.42E+04	6.00E+04
CS-137	2.06E+05	2.15E+05	1.87E+05
BA-140	2.38E-01	2.34E-01	3.62E-01

NOTE: The listed dose factors are for radionuclides that may be detected in liquid effluents and have significant dose consequences. The factors are decayed for one day to account for the time between effluent release and ingestion of fish by the maximum exposed individual.

TABLE III.A.1

LIQUID EFFLUENT INGESTION DOSE FACTORS
(DECAY CORRECTED)
$A_{i\tau}$ DOSE FACTOR (MREM-ML PER HR-μCi)

GI-LLI

RADIO-NUCLIDE	ADULT	TEEN	CHILD
H-3	2.13E+00	1.53E+00	2.70E+00
NA-24	1.65E+02	1.70E+02	1.98E+02
P-32	1.73E+05	1.41E+05	5.98E+04
MN-54	1.58E+04	1.04E+04	3.38E+03
FE-55	3.22E+02	2.60E+02	1.17E+02
FE-59	9.90E+03	7.15E+03	2.84E+03
CO-58	2.35E+03	1.56E+03	6.04E+02
CO-60	6.30E+03	4.33E+03	1.70E+03
ZN-65	5.38E+04	3.58E+04	1.18E+04
SR-89	4.94E+03	3.93E+03	2.01E+03
SR-90	2.22E+04	1.77E+04	9.13E+03
TE-129M	6.40E+04	5.15E+04	2.19E+04
TE-131M	5.44E+04	4.63E+04	2.19E+04
TE-132	7.02E+04	4.85E+04	1.37E+04
I-131	8.58E+01	6.57E+01	3.70E+01
I-133	5.82E+01	5.03E+01	3.40E+01
CS-134	1.44E+04	1.04E+04	3.80E+03
CS-136	1.55E+04	1.09E+04	3.96E+03
CS-137	1.18E+04	9.00E+03	3.60E+03
BA-140	1.15E+03	8.69E+02	6.43E+02

NOTE: The listed dose factors are for radionuclides that may be detected in liquid effluents and have significant dose consequences. The factors are decayed for one day to account for the time between effluent release and ingestion of fish by the maximum exposed individual.

IV. Gaseous Pathway Dose Calculations

IV.A. Surveillance Requirement 4.8.C.1

The dose rate in areas at and beyond the SITE BOUNDARY due to radioactive materials released in gaseous effluents shall be determined by the expressions below:

IV.A.1 Noble Gases:

The dose rate from radioactive noble gas releases shall be determined by either of two methods. Method (a), the Gross Release Method, assumes that all noble gases released are the most limiting nuclide - Kr-88 for total body dose (vent and stack releases) and skin dose (vent releases) and Kr-87 for skin dose (stack releases). Method (b), the Isotopic Analysis Method, utilizes the results of noble gas analyses required by specification 4.8.C.1a.

For normal operations, it is expected that method (a) will be used. However, if noble gas releases are close to the limits as calculated by method (a), method (b) can be used to allow more operating flexibility by using data that more accurately reflect actual releases.

a. Gross Release Method

$$D_{TB} = V \dot{Q}_{NS} + K\ (\overline{X/Q})_V\ \dot{Q}_{NV}$$

$$D_S = [L_S(\overline{X/Q})_S + 1.1B]\dot{Q}_{NS} + [L_V + 1.1M]\ (\overline{X/Q})_V\ \dot{Q}_{NV}$$

where:

The location is the site boundary, 1097m SSE from the vents. This location results in the highest calculated dose to an individual from noble gas releases.

D_{TB} = total body dose rate, in mrem/yr.

D_S = skin dose rate, in mrem/yr.

V = 4.72 X 10^{-4} mrem/yr per μCi/sec; the constant for Kr-88 accounting for the gamma radiation from the elevated finite plume. This constant was developed using MARE program with plant specific inputs for PBAPS.

IV.A.1.a (Cont'd)

$\dot{Q}_{NS}$ = The gross release rate of noble gases from the stack determined by gross activity stack monitors averaged over one hour, in μCi/sec.

K = 1.47 X 10^4 mrem/yr per $\mu Ci/m^3$; the total body dose factor due to gamma emissions for Kr-88 (Reg. Guide 1.109, Table B-1).

$(\overline{X/Q})_V$ = 5.33 X 10^{-7} sec/m^3; the highest calculated annual average relative concentration for any area at or beyond the SITE BOUNDARY for all vent releases.

$\dot{Q}_{NV}$ = The gross release rate of noble gases in gaseous effluents from vent releases determined by gross activity vent monitors averaged over one hour,in μCi/sec.

L_V = 2.37 x 10^3 mrem/yr per $\mu Ci/m^3$; the skin dose factor due to beta emissions for Kr-88. (Reg. Guide 1.109, Table B-1).

L_S = 9.73 X 10^3 mrem/yr per $\mu Ci/m^3$; the skin dose factor due to beta emissions for Kr-87. (Reg. Guide 1.109, Table B-1).

$(\overline{X/Q})_S$ = 9.97 X 10^{-8} sec/m^3; the highest calculated annual average relative concentration from the stack releases for any area at or beyond the SITE BOUNDARY.

B = 1.74 X 10^{-4} mrad/yr per μCi/sec; the constant for Kr-87 accounting for the gamma radiation from the elevated finite plume. This constant was developed using MARE program with plant specific inputs for PBAPS.

M = 1.52 X 10^4 mrad/yr per $\mu Ci/m^3$; the air dose factor due to gamma emissions for Kr-88. (Reg. Guide 1.109, Table B-1).

1.1 = Unit conversion, converts air dose to skin dose, mrem/mrad.

IV.A.1. b. Isotopic Analysis Method

$$D_{TB} = \sum_i (V_i \dot{Q}_{is} + K_i (\overline{X/Q})_v \dot{Q}_{iv})$$

$$D_s = \sum_i [(L_i(\overline{X/Q})_s + 1.1B_i) \dot{Q}_{is} + (L_i + 1.1M_i) (\overline{X/Q})_v (\dot{Q}_{iv})]$$

where:

The location is the site boundary, 1097m SSE from the vents. This location results in the highest calculated dose to an individual from noble gas releases.

D_{TB} = total body dose rate, in mrem/yr.

D_S = skin dose, in mrem/yr.

V_i = The constant for each identified noble gas radionuclide for the gamma radiation from the elevated finite plume. The constants were developed using the MARE program with plant specific inputs for PBAPS. Values are listed on Table IV.A.1, in mrem/yr per μCi/sec.

$\dot{Q}_{is}$ = The release rate of noble gas radionuclide, i, in gaseous effluents from the stack determined by isotopic analysis averaged over one hour, in μCi/sec.

K_i = The total body dose factor due to gamma emissions for each identified noble gas radionuclide. Values are listed on Table IV.A.1, in mrem/yr per μCi/m^3.

$(\overline{X/Q})_V$ = 5.33 X 10^{-7} sec/m^3; the highest calculated annual average relative concentration for any area at or beyond the SITE BOUNDARY for all vent releases.

$\dot{Q}_{iV}$ = The release rate of noble gas radionuclide, i, in gaseous effluents from all vent releases determined by isotopic analysis averaged over one hour, in μCi/sec.

L_i = The skin dose factor due to beta emissions for each identified noble gas radionuclide. Values are listed on Table IV.A.1, in mrem/yr per μCi/m^3.

IV.A.1.b (Cont'd)

$(\overline{X/Q})_s$ = 9.97×10^{-8} sec/m^3; the highest calculated annual average relative concentration from the stack releases for any area at or beyond the SITE BOUNDARY.

B_i = The constant for each identified noble gas radionuclide accounting for the gamma radiation from the elevated finite plume. The constants were developed using MARE program with plant specific inputs for PBAPS. Values are listed on Table IV.A.1, in mrad/yr per μCi/sec.

M_i = The air dose factor due to gamma emissions for each identified noble gas radionuclide. Values are listed on Table IV.A.1, in mrad/yr per μCi/m^3.

1.1 = Unit conversion, coverts air dose to skin dose, mrem/mrad.

TABLE IV.A.1 - Constants for Isotopic Analysis Method
(corrected for decay during transit)

Radionuclide	Plume-Air Dose Factor B_i (mrad/yr per μCi/sec)	Total Body Dose Factor K_i (mrem/yr per μCi/m^3)	Skin Dose Factor L_i (mrem/yr per μCi/m^3)	Gamma Air Dose Factor M_i (mrad/yr per μCi/m^3)	Beta Air Dose Factor N_i (mrad/yr per μCi/m^3)	Plume-Body Dose Factor V_i (mrem/yr per μCi/sec)
Kr-85m	4.02E-05	1.17E+03	1.46E+03	1.23E+03	1.97E+03	3.76E-05
Kr-87	1.74E-04	5.92E+03	9.73E+03	6.17E+03	1.03E+04	1.66E-04
Kr-88	4.90E-04	1.47E+04	2.37E+03	1.52E+04	2.93E+03	4.72E-04
Xe-133	1.19E-05	2.94E+02	3.06E+02	3.53E+02	1.05E+03	1.11E-05
Xe-133m	1.09E-05	2.51E+02	9.94E+02	3.27E+02	1.48E+03	1.01E-05
Xe-135	6.37E-05	1.81E+03	1.86E+03	1.92E+03	2.46E+03	5.95E-05
Xe-135m	6.61E-05	2.53E+03	5.76E+02	2.72E+03	5.99E+02	6.17E-05
Xe-138	1.52E-04	6.98E+03	3.26E+03	7.28E+03	3.75E+03	1.46E-04

The values K_i, L_i, M_i, and N_i are taken from Reg. Guide 1.109, Table B-1. The values B_i and V_i were developed using the MARE program with plant specific inputs for PBAPS.

IV.A.2 Iodine-131, iodine-133, tritium and radioactive materials in particulate form, other than noble gases, with half-lives greater than eight days.

The dose rate shall be determined by either of two methods. Method (a), the Iodine-131 Method, uses the iodine-131 releases and a correction factor to calculate the dose rate from all nuclides released. Method (b), the Isotopic Analysis Method, utilizes all applicable nuclides.

For normal operations, it is expected that Method (a) will be used since iodine-131 dominates the critical pathway - thyroid. However, in the event iodine-131 releases are minimal (e.g., during long term shutdown) Method (b) will be used to provide accurate calculations. In the absence of iodine-131 releases, the lung is the critical organ.

a. Iodine-131 Method

$$D_T = (CF)\, P_I \left[W_S\, \dot{Q}_{IS} + W_V\, \dot{Q}_{IV}\right]$$

where:

The location is the site boundary, 1097m SSE from the vents.

D_T = dose rate to the thyroid, in mrem/yr.

CF = 1.09; the correction factor accounting for the use of iodine-131 in lieu of all radionuclides released in gaseous effluents including iodine-133.

P_I = 1.624×10^7 mrem/yr per $\mu Ci/m^3$; the dose parameter for I-131 via the inhalation pathways. The dose factor is based on the critical individual organ, thyroid, and most restrictive age group, child. All values are from Reg. Guide 1.109 (Tables E-5 and E-9).

W_S = 1.03×10^{-7} sec/m^3; the highest calculated annual average relative concentration for any area at or beyond the SITE BOUNDARY from stack releases. (SSE boundary)

$\dot{Q}_{IS}$ = The release rate of iodine-131 in gaseous effluents from the stack determined by the effluent sampling and analysis program (Technical Specification Table 4.8.2) in μCi/sec.

W_V = 4.78×10^{-7} sec/m^3; the highest calculated annual average relative concentration for any area at or beyond the SITE BOUNDARY for all vent releases (SSE boundary).

IV.A.2. a. (Cont'd)

$\dot{Q}_{IV}$ = The release rate of iodine-131 in gaseous effluents from all vent releases, determined by the effluent sampling and analysis program (Technical Specification Table 4.8.2) in μCi/sec.

IV.A.2. b. Isotopic Analysis Method

$$D_L = \sum_i P_i \left[W_S \dot{Q}_{iS} + W_V \dot{Q}_{iV}\right]$$

where:

The location is the site boundary, 1097m SSE from the vents.

D_L = dose rate to the lung, in mrem/yr.

P_i = The dose parameter for radionuclides other than noble gases for the inhalation pathway. The dose factors are based on the critical individual organ-lung, and most restrictive age group-child. All values are from Reg. Guide 1.109 (Tables E-5 and E-9). Values are listed on Table IV.A.2, in mrem/yr per $\mu Ci/m^3$.

W_S = 1.03×10^{-7} sec/m^3; the highest calculated annual average relative concentration for any area at or beyond the SITE BOUNDARY from stack releases. (SSE boundary)

$\dot{Q}_{iS}$ = The release rate of radionuclides; i, in gaseous effluents from the stack determined by the effluent sampling and analysis program (Technical Specification Table 4.8.2) in μCi/sec.

W_V = 4.78×10^{-7} sec/m^3; the highest calculated annual average relative concentration for any area at or beyond the SITE BOUNDARY for all vent releases. (SSE boundary)

$\dot{Q}_{iV}$ = The release rate of radionuclides, i, in gaseous effluents from all vent releases, determined by the effluent sampling and analysis program (Technical Specification Table 4.8.2) in μCi/sec.

TABLE IV.A.2 - CONSTANTS FOR ISOTOPIC ANALYSIS METHOD

(mrem/yr per $\mu Ci/m^3$)

Radionuclide	Pi - Inhalation Lung Dose Factor
Mn-54	$1.58X10^6$
Cr-51	$1.70x10^4$
Co-58	$1.11x10^6$
Co-60	$7.07x10^6$
Zn-65	$9.95x10^5$
Sr-89	$2.16x10^6$
Sr-90	$1.48x10^7$
Ce-141	$5.44x10^5$
Cs-134	$1.21x10^5$
Cs-137	$1.04x10^5$
Ba-140	$1.74x10^6$

IV.B. <u>Surveillance Requirement 4.8.C.2</u>

The air dose in areas at and beyond the SITE BOUNDARY due to noble gases released in gaseous effluents shall be determined by the expressions below.

The air dose shall be determined by either of two methods. Method (a), the Gross Release Method, assumes that all noble gases released are the most limiting nuclide - Kr-88 for gamma radiation and Kr-87 for beta radiation. Method (b), the Isotopic Analysis Method, utilizes the results of noble gas analyses required by specification 4.8.C.1a.

For normal operations, it is expected that Method (a) will be used. However, if noble gas releases are close to the limits as calculated by Method (a), Method (b) can be used to allow more operating flexibility by using data that more accurately reflect actual releases.

IV.B.1 for gamma radiation:

a. Gross Release Method

$$D_\gamma = 3.17 \times 10^{-8} \left[M \, (\overline{X/Q})_V \, \overline{Q}_V + B\overline{Q}_B\right]$$

where:

The location is the SITE BOUNDARY 1097m SSE from the vents. This location results in the highest calculated gamma air dose from noble gas releases.

D_γ = gamma air dose, in mrad.

3.17×10^{-8} = years per second.

M = 1.52×10^4 mrad/yr per μCi/m^3; the air dose factor due to gamma emissions for Kr-88. (Reg. Guide 1.109, Table B-1)

$(\overline{X/Q})_V$ = 5.33×10^{-7} sec/m^3; the highest calculated annual average relative concentration from vent releases for any area at or beyond the SITE BOUNDARY.

$\overline{Q}_V$ = The gross release of noble gas radionuclides in gaseous effluents from all vents, determined by gross activity vent monitors, in μCi. Releases shall be cumulative over the calendar quarter or year as appropriate.

IV.B.1. a (Cont'd)

B = 4.90×10^{-4} mrad/year per μCi/sec; the constant for Kr-88 accounting for the gamma radiation from the elevated finite plume. The constant was developed using the MARE program with plant specific inputs for PBAPS.

$\overline{Q}_S$ = The gross release of noble gas radionuclides in gaseous releases from the stack determined by gross activity stack monitor in μCi. Releases shall be cumulative over the calendar quarter or year as appropriate.

b. Isotopic Analysis Method

$$D_\gamma = 3.17 \times 10^{-8} \sum_i \left[M_i \,(\overline{X/Q})_v \,\overline{Q}_{iv} + B_i \,\overline{Q}_{is}\right]$$

where:

The location is the SITE BOUNDARY, 1097m SSE from the vents. This location results in the highest calculated gamma air dose from noble gas releases.

D_γ = gamma air dose, in mrad.

3.17×10^{-8} = years per second.

M_i = The air dose factor due to gamma emissions for each identified noble gas radionuclide. Values are listed on Table IV.A.1, in mrad/yr per $\mu Ci/m^3$.

$(\overline{X/Q})_v$ = 5.33×10^{-7} sec/m^3; the highest calculated average relative concentration from vent releases for any area at or beyond the SITE BOUNDARY.

$\overline{Q}_{iv}$ = The release of noble gas radionuclides, i, in gaseous effluents from all vents as determined by isotopic analysis, in μCi. Releases shall be cumulative over the calendar quarter or year, as appropriate.

B_i = The constant for each identified noble gas radionuclide accounting for the gamma radiation for the elevated finite plume. The constants were developed using the MARE program with plant specific inputs for PBAPS. Values are listed on Table IV.A.1, in mrad/yr per μCi/sec.

IV.B.1. b. (Cont'd)

$\overline{Q}_{is}$ = The release of noble gas radionuclides, i, in gaseous effluents from the stack determined by isotopic analysis, in μCi. Releases shall be cumulative over the calendar quarter or year, as appropriate.

IV.B.2. for beta radiation:

a. Gross Release Method

$$D_\beta = 3.17 \times 10^{-8} N [(\overline{X/Q})_V \overline{Q}_V + (\overline{X/Q})_S \overline{Q}_S]$$

where:

The location is the SITE BOUNDARY 1097m SSE from the vents. This location results in the highest calculated gamma air dose from noble gas releases.

D_B = beta air dose, in mrad.

3.17×10^{-8} = years per second.

N = 1.03×10^4 mrad/yr per $\mu Ci/m^3$; the air dose factor due to beta emissions for Kr-87. (Reg. Guide 1.109, Table B-1)

$(\overline{X/Q})_V$ = 5.33×10^{-7} sec/m^3; the highest calculated annual average relative concentration from vent releases for any area at or beyond the SITE BOUNDARY.

$\overline{Q}_V$ = The gross release of noble gas radionuclides in gaseous effluents from all vents determined by gross activity vent monitors, in μCi. Releases shall be cumulative over the calendar quarter or year, as appropriate.

$(\overline{X/Q})_S$ = 9.97×10^{-8} sec/m^3; the highest calculated annual average relative concentration from the stack releases for any area at or beyond the SITE BOUNDARY.

$\overline{Q}_S$ = The gross release of noble gas radionuclides in gaseous releases from the stack determined by gross activity stack monitors, in μCi. Releases shall be cumulative over the calendar quarter or year, as appropriate.

IV.B.2. b. Isotopic Analysis Method

$$D_\beta = 3.17 \times 10^{-8} \sum_i N_i \left[(\overline{X/Q})_v \overline{Q}_{iv} + (\overline{X/Q})_s \overline{Q}_{is} \right]$$

3.17×10^{-8} = years per second.

N_i = The air dose factor due to beta emissions for each identified noble gas radionuclide. Values are listed on Table IV.A.1, in mrad/yr per $\mu Ci/m^3$.

$(\overline{X/Q})_v$ = 5.33×10^{-7} sec/m^3; the highest calculated annual average relative concentration from vent releases for any area at or beyond the SITE BOUNDARY.

$\overline{Q}_{iv}$ = The release of noble gas radionuclide, i, in gaseous effluents from all vents as determined by isotopic analysis, in μCi. Releases shall be cumulative over the calendar quarter or year, as appropriate.

$(\overline{X/Q})_s$ = 9.97×10^{-8} sec/m^3; the highest calculated annual average relative concentration from the stack releases for any area at or beyond the SITE BOUNDARY.

$\overline{Q}_{is}$ = The release of noble gas radionuclide, i, in gaseous effluents from the stack as determined by isotopic analysis, in μCi. Releases shall be cumulative over the calendar quarter or year, as appropriate.

IV.C <u>Surveillance Requirement 4.8.C.3</u>

The dose to an individual from iodine-131, iodine-133, tritium and radioactive materials in particulate form and radionuclides other than noble gases with half-lives greater than eight days in gaseous effluents released to areas at and beyond the SITE BOUNDARY.

The dose shall be determined by one of two methods. Method (a), the Iodine-131 Method, uses the iodine-131 releases and a correction factor to calculate the dose from all nuclides released. Method (b), the Isotopic Analysis Method, utilizes all applicable nuclides.

For normal operation, it is expected that Method (a) will be used since iodine-131 dominates the critical pathway - thyroid. However, in the event iodine-131 releases are minimal (e.g. during long term shutdown) Method (b) will be used to provide accurate calculations. In the absence of iodine-131 releases, the liver is the critical organ.

IV.C. a. Iodine - 131 Method

$$D_T = 3.17 \times 10^{-8}\ (CF)\ (0.5)\ R\left[W_S\,\overline{Q}_{IS} + W_V\,\overline{Q}_{IV}\right]$$

where:

Location is the critical pathway dairy 2103m SSW from vents.

D_T = critical organ dose, thyroid, from all pathways, in mrem.

3.17×10^{-8} = years per second.

CF = 1.09; the correction factor accounting for the use of Iodine-131 in lieu of all radionuclides released in gaseous effluents including Iodine-133.

0.5 = fraction of iodine releases which are nonelemental.

R = 3.08×10^{11} m^2 (mrem/yr) per μCi/sec; the dose factor for iodine-131. The dose factor is based on the critical individual organ, thyroid, and most restrictive age group, infant. See Site Specific Data.**

W_S = 4.95×10^{-10} meters^{-2}; $(\overline{D/Q})$ for the food pathway for stack releases.

$\overline{Q}_{IS}$ = The release of iodine-131 from the stack determined by the effluent sampling and analysis program (Technical Specification Table 4.8.2), in μCi. Releases shall be cumulative over the calendar quarter or year, as appropriate.

W_V = 1.14×10^{-9} meters^{-2}; $(\overline{D/Q})$ for the food pathway for vent releases.

$\overline{Q}_{IV}$ = The release of iodine-131 from the vent determined by the effluent sampling and analysis program (Technical Specification Table 4.8.2), in μCi. Releases shall be cumulative over the calendar quarter or year, as appropriate.

**See Note 2 in Bases.

IV.C. b. Isotopic Analysis Method

$$D_L = 3.17 \times 10^{-8} \sum_i R_i \left[W_S \overline{Q}_{iS} + W_V \overline{Q}_{iV}\right]$$

where:

Location is the critical pathway dairy 2103m SSW from vents.

D_L = critical organ dose, liver, from all pathways, in mrem.

3.17×10^{-8} = years per second.

R_i = The dose factor for each identified radionuclide, i, based on the critical individual organ, liver and most restrictive age group, infant. Values are listed on Table IV.C.1, in m^2 (mrem/yr) per μCi/sec.

W_S = 4.95×10^{-10} meters^{-2}; $(\overline{D/Q})$ for the food pathway for stack releases.

$\overline{Q}_{iS}$ = The release of radionuclides, i, in gaseous effluents from the vents determined by the effluent sampling (Technical Specification Table 4.8.2), in μCi. Releases shall be cumulative over the calendar quarter or year, as appropriate.

W_V = 1.14×10^{-9} meters^{-2}; $(\overline{D/Q})$ for the food for vent releases.

$\overline{Q}_{iV}$ = The release of radionuclides, i, in gaseous effluents from the vents determined by the effluent sampling and analysis program (Technical Specification Table 4.8.2) in μCi. Release shall be cumulative over the calendar quarter or year, as appropriate.

TABLE IV.C.1 - CONSTANTS FOR ISOTOPIC ANALYSIS METHOD

(m^2 (mrem/yr) per μCi/sec)

RADIONUCLIDE	Ri
Mn-54	1.93×10^{7}
Cr-51	5.14×10^{4}*
Co-58	9.58×10^{6}
Co-60	4.69×10^{7}
Zn-65	9.21×10^{9}
Sr-89	1.31×10^{8}*
Sr-90	1.67×10^{10}*
Ce-141	8.68×10^{3}
Cs-134	3.54×10^{10}
Cs-137	3.24×10^{10}
Ba-140	7.09×10^{4}

* There is no liver dose factor given in R.G. 1.109 for these nuclides. Therefore, the whole body dose factor was used.

IV.D Surveillance Requirement 4.8.C.5a

The projected doses from releases of gaseous effluents to areas at and beyond the SITE BOUNDARY shall be calculated in accordance with the following sections of this manual:

a. gamma air dose - IV.B.1

b. beta air dose - IV.B.2

c. organ dose - IV.C

The projected dose calculation shall be based on expected release from plant operation. The normal release pathways result in the maximum releases from the plant. Any alternative release pathways result in lower releases and, therefore, lower doses.

IV.E Surveillance Requirement 4.8.C.6.b

IV.E.1 The two types of recombiner hydrogen analyzers used at Peach Bottom are:

a. Hays Thermal Conductivity type (Analyzers 20S192L, 20S192H, 20S222, 20S223, 30S192L, 30S192H, 30S222, 30S223)

b. Scott Series 9000 Helium-Immune type (Analyzers 20S192L, 20S222, 30S192L, and 30S222)

IV.E.2 The calibration gases for the two types are:

a. Hays Analyzers
Zero Gas - Air
Calibration Gas - 4% Hydrogen, Balance Nitrogen

b. Scott Analyzers
Zero Gas - Air
Calibration Gas - 2% Hydrogen, Balance Air

V.A. Surveillance Requirement 4.8.D

If the doses as calculated by the equations in this manual do not exceed the limits given in Technical Specifications 3.8.B.2, 3.8.C.2, or 3.8.C.3 by more than two times, the conditions of Technical Specification 3.8.D have been met.

If the doses as calculated by the equations in this manual exceed the limits given in Technical Specifications 3.8.B.2, 3.8.C.2, or 3.8.C.3 by more than two times, the maximum dose or dose commitment to a real individual shall be determined utilizing the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I", Revision 1, October 1977. Any deviations from the methodology provided in Regulatory Guide 1.109 shall be documented in the Special Report to be prepared in accordance with Technical Specification 3.8.D.

V.A. (Cont'd)

The cumulative dose contribution from direct radiation from the two reactors at the site and from radwaste storage shall be determined by the following methods:

> Cumulative dose contribution from direct radiation =
> Total dose at the site of interest (as evaluated by TLD measurement) -
> Mean of background dose (as evaluated by TLD's at background sites) -
> Effluent contribution to dose (as evaluated by surveillance requirement 4.8.D).

This evaluation is in accordance with ANSI/ANS 6.6.1-1979 Section 7. The error using this method is estimated to be approximately 8%.

VI.A. <u>Unique Reporting Requirement 6.9.2.h(3) Dose Calculations for the Radiation Dose Assessment Report</u>

The assessment of radiation doses for the radiation dose assessment report shall be performed utilizing the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses To Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I", Revision 1, October 1977. Any deviations from the methodology provided in Regulatory Guide 1.109 shall be documented in the radiation dose assessment report.

The meteorological conditions concurrent with the time of release of radioactive materials (as determined by sampling frequency of measurement) or approximate methods shall be used as input to the dose model.

The Radiation Dose Assessment Report shall be submitted within 120 days after January 1 of each year in order to allow time for the calculation of radiation doses following publication of radioactive releases in the Radioactive Effluent Release Report. There is a very short turnaround time between the determination of all radioactive releases and publication of the Radioactive Effluent Release Report. This would not allow time for calculation of radiation doses in time for publication in the same report.

VII.A <u>Surveillance Requirement 4.8.E</u>

The radiological environment monitoring samples shall be collected pursuant to Table VII.A.1 from the locations shown on Figures VII.A.1, VII.A.2, VII.A.3, and VII.A.4, and shall be analyzed pursuant to the requirements of Table VII.A.1.

TABLE VII.A.1
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Number of Samples and Sample Station Name	Station Location-Direction and Distance from Peach Bottom	Discussion
1. Direct Radiation (47 locations)	Site Boundary Vicinity		TLD sites were chosen in accordance with Peach Bottom Technical Specifications Table 4.8.3a Item 1. Site Boundary stations all sectors except several along Conowingo Pond. These sectors are monitored by stations on the east side of Conowingo Pond. The 5 mile vicinity stations cover all sectors. The distant and special interest stations, as well as several of the site boundary and 5 mile vicinity stations provide information in population centers, nearby residences, schools, and control locations.
	1A Peach Bottom Weather Station #1	On Site, 0.3 miles SE of Units 2 & 3	
	1B Peach Bottom Weatner Station #2	On Site, 0.5 miles NW of Units 2 & 3	
	1C Peach Bottom South Substation Rd	On Site, 0.9 miles SSE of Units 2 & 3	
	1D Peach Bottom 140 Sector Site Boundary	On Site, 0.7 miles SE of Units 2 & 3	
	1E Peach Bottom 350 Sector Site Boundary	On Site, 0.6 miles NNW of Units 2 & 3	
	1F Peach Bottom 200 Sector Hill	On Site, 0.6 miles SSW of Units 2 & 3	
	1G Peach Bottom North Substation	On Site, 0.7 miles WNW of Units 2 & 3	
	1H Peach Bottom Site 270 Sector	On Site, 0.6 miles W of Units 2 & 3	
	1I Peach Bottom South Substation	On Site, 0.6 miles SSE of Units 2 & 3	

TABLE VII.A.1
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Number of Samples and Sample Station Name	Station Location-Direction and Distance from Peach Bottom	Discussion
1. Direct Radiation (Cont'd)	1J Peach Bottom Site 180 Sector Hill	On Site, 0.7 miles S of Units 2 & 3	
	1L Peach Bottom Unit 3 Intake	Located near Unit 3 Intake Structure; 0.2 miles ENE of Units 2 & 3	
	1M Peach Bottom Canal Discharge	Located near Canal Discharge structure; 1.0 miles SE of Units 2 & 3	
	1NN Peach Bottom Site	On Site, 0.5 miles WSW of Units 2 & 3	
	2 Peach Bottom Site 130 Sector Hill	On Site, 0.9 miles SE of Units 2 & 3	
	40 Peach Bottom Site Area	In Site Area about 1.2 miles SW of Units 2 & 3	
	5 Mile Vicinity		
	3A Delta, PA Substation	3.6 miles SW of Units 2 & 3	
	5 Wakefield, PA	At Wakefield, PA 4.6 miles E of Units 2 & 3	
	6B Holtwood Dam Hydroelectric Station	On roof of Hydroelectric Station, 5.8 Miles NW of Units 2 & 3	
	15 Silver Spring Road	3.6 miles N of Units 2 & 3 near Silver Spring Road	
	17 Riverview Road	4.0 miles ESE of Units 2 & 3	

TABLE VII.A.1
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Number of Samples and Sample Station Name	Station Location-Direction and Distance from Peach Bottom	Discussion
1. Direct Radiation (Cont'd)	26 Slab Road	4.2 miles NW of Units 2 & 3 near Slab Road	
	31A Eckman Road	4.8 miles SE of Units 2 & 3 near Pilotown Road	
	42 Muddy Run Environmental Lab	4.2 miles NNW of Units 2 & 3	
	43 Drumore Township School	5.0 miles NNE of Units 2 & 3	
	44 Goshen Hill Road	5.1 miles NE of Units 2 & 3	
	45 PB - Keeney Line	3.3 miles ENE of Units 2 & 3	
	46 Broad Creek	4.5 miles SSE of Units 2 & 3 near Flintville Road	
	47 Broad Creek Scout Camp	4.3 miles S of Units 2 & 3	
	48 Macton Substation	5.0 miles SSW of Units 2 & 3	
	49 PB-Conastone Line	4.1 miles WSW of Units 2 & 3	
	50 TRANSCO Pumping Station	4.9 miles W of Units 2 & 3	
	51 Fin Substation	4.0 miles WNW of Units 2 & 3	

TABLE VII.A.1
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Number of Samples and Sample Station Name	Station Location-Direction and Distance from Peach Bottom	Discussion
1. Direct Radiation (Cont'd)	Distant		
	12D Philadelphia PA	62 miles ENE of Units 2 & 3 on the roof of 2301 Market St.	
	16 Nottingham, PA Substation	12.8 miles E of Units 2 & 3 Nottingham Substation	
	18 Fawn Grove, PA	10 miles W of Units 2 & 3 at Fawn Grove, PA	
	19 Red Lion, PA	20.6 miles WNW of Units 2 & 3 at Red Lion, PA	
	20 Bel Air, MD Area	15.1 miles SSw of Units 2 & 3 near Bel Air, MD	
	21B Lancaster, PA Area	19 miles NNW of Units 2 & 3 near Lancaster, PA	
	24 Harrisville, MD Substation	10.9 miles ESE of Units 2 & 3 at Harris Substation	
	Special Interest		
	4K Conowingo Dam Powerhouse Roof	On roof of Conowingo Powerhouse, 8.6 miles SE of Units 2 & 3	
	14 Peters Creek	1.9 miles ESE of Units 2 & 3 near the mouth of Peters Creek	
	22 Eagle Road	2.4 miles NNE of Units 2 & 3 near Eagle Road	
	23 Peach Bottom 150 Sector Hill Offsite	Off-site Hill 1.0 miles SSE of Units 2 & 3	

TABLE VII.A.1
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

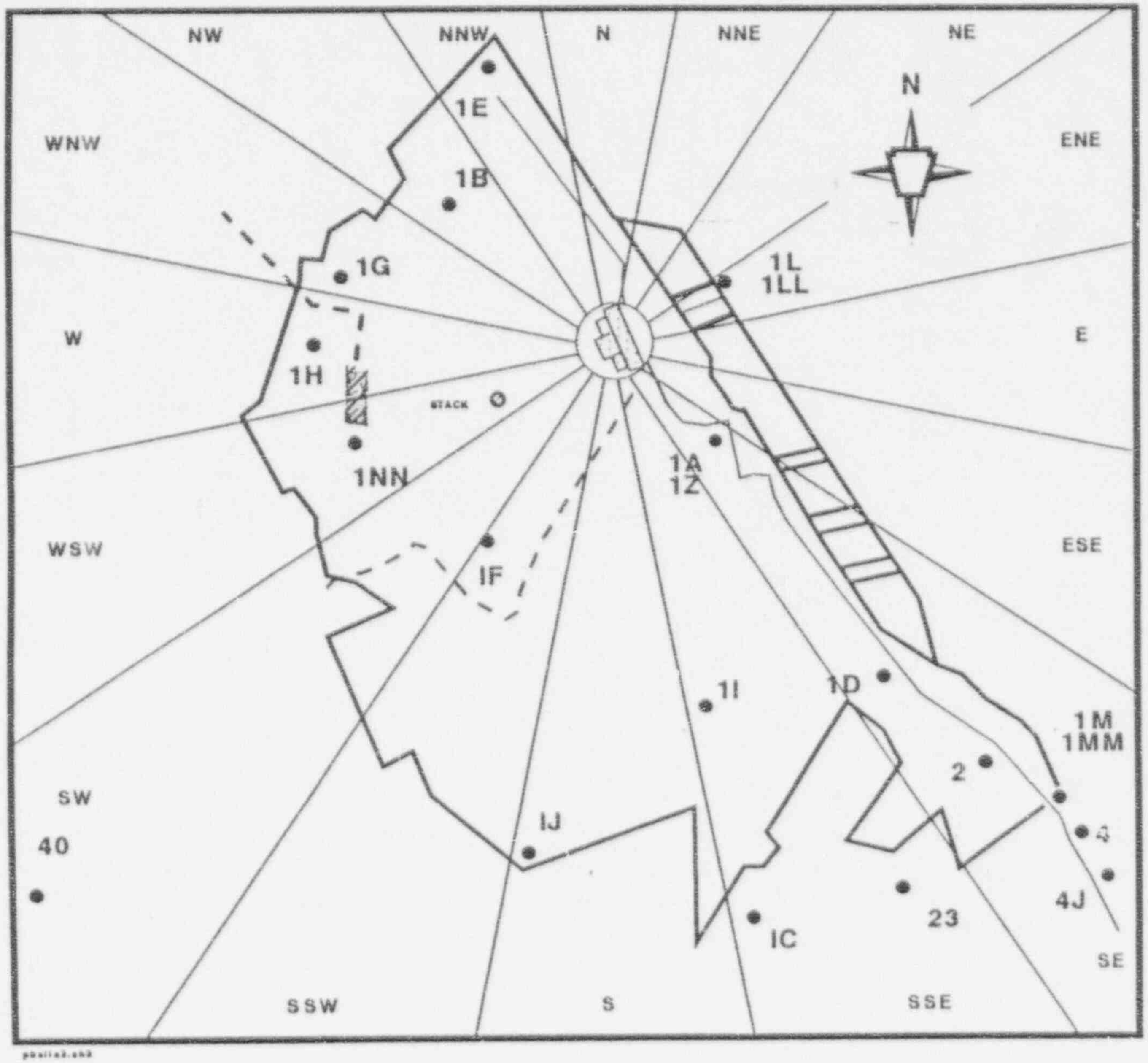
Exposure Pathway and/or Sample	Number of Samples and Sample Station Name	Station Location-Direction and Distance from Peach Bottom	Discussion
1. Direct Radiation (Cont'd)	27 N. Cooper Road	2.6 miles S of Units 2 & 3 near N. Cooper Road	
	32 Slate Hill Road	2.7 miles ENE of Units 2 & 3 near Slate Hill Road	
	33A Fulton Main Weather Station	1.7 miles ENE of Units 2 & 3	
	38 Peach Bottom Road	3.0 miles E of Units 2 & 3 near Peach Bottom Road	
2. <u>Airborne</u> Radioiodine & Particulates	<u>5 Locations</u>		
	1Z Peach Bottom - (1A) Weather Station 1	On Site at Weather Station 0.3 miles SE of units 2 & 3	These stations provide for coverage of the highest annual average ground level D/Q near the site boundary, the community with the highest annual average D/Q, and a control location.
	1B Peach Bottom - Weather Station 2	On Site at Weather Station 2, 0.5 miles NW of Units 2 & 3	
	2 Peach Bottom Site - 130 Sector Hill	On Site, 0.9 miles SE of Units 2 & 3	
	3A Delta, PA Substation	3.6 miles SW of Units 2 & 3 0.5 miles N of Maryland border	
	12D Philadelphia, PA	62 miles ENE of Units 2 & 3 on the roof of 2301 Market St.	

TABLE VII.A.1
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Number of Samples and Sample Station Name	Station Location-Direction and Distance from Peach Bottom	Discussion
3. Waterborne			
a. Surface	1LL Peach Bottom Units 2 & 3 Intake - Composite	Continuous Sampler on Site at Units 2 & 3 Intake, 1200' ENE of Units 2 & 3	
	1MM Peach Bottom - Canal Discharge-Composite	Continuous Sampler on Site at Canal Discharge 1.0 miles SE of Units 2 & 3	
b. Drinking	4L Conowingo Dam - El. 33 (ft.) Composite	Continuous sampler in the Conowingo Hydro-Electric Station, about 8.6 miles SE of Units 2 & 3	
	61 Holtwood Dam - Hydro-Electric Station - composite	Continuous sampler at Holtwood Hydro-Electric Station intake about 5.8 miles NW of Units 2 & 3	Station 61 is a control location for both surface and drinking water.
c. Sediment from Shoreline	4J Conowingo Pond Net Trap 15	Located in Conowingo Pond about 1.4 miles SE of Units 2 & 3	
4. Ingestion			
a. Milk	Four locations - three indicator, one control		Milk samples are taken from several farms surrounding PBAPS. These farms include those with the highest dose potential, as well as control locations. However, the location of the farms is not listed herein due to longstanding agreement with the farms involved. In return for being allowed to sample and analyze the milk, PECo has agreed not to divulge the farms' location.

TABLE VII.A.1
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

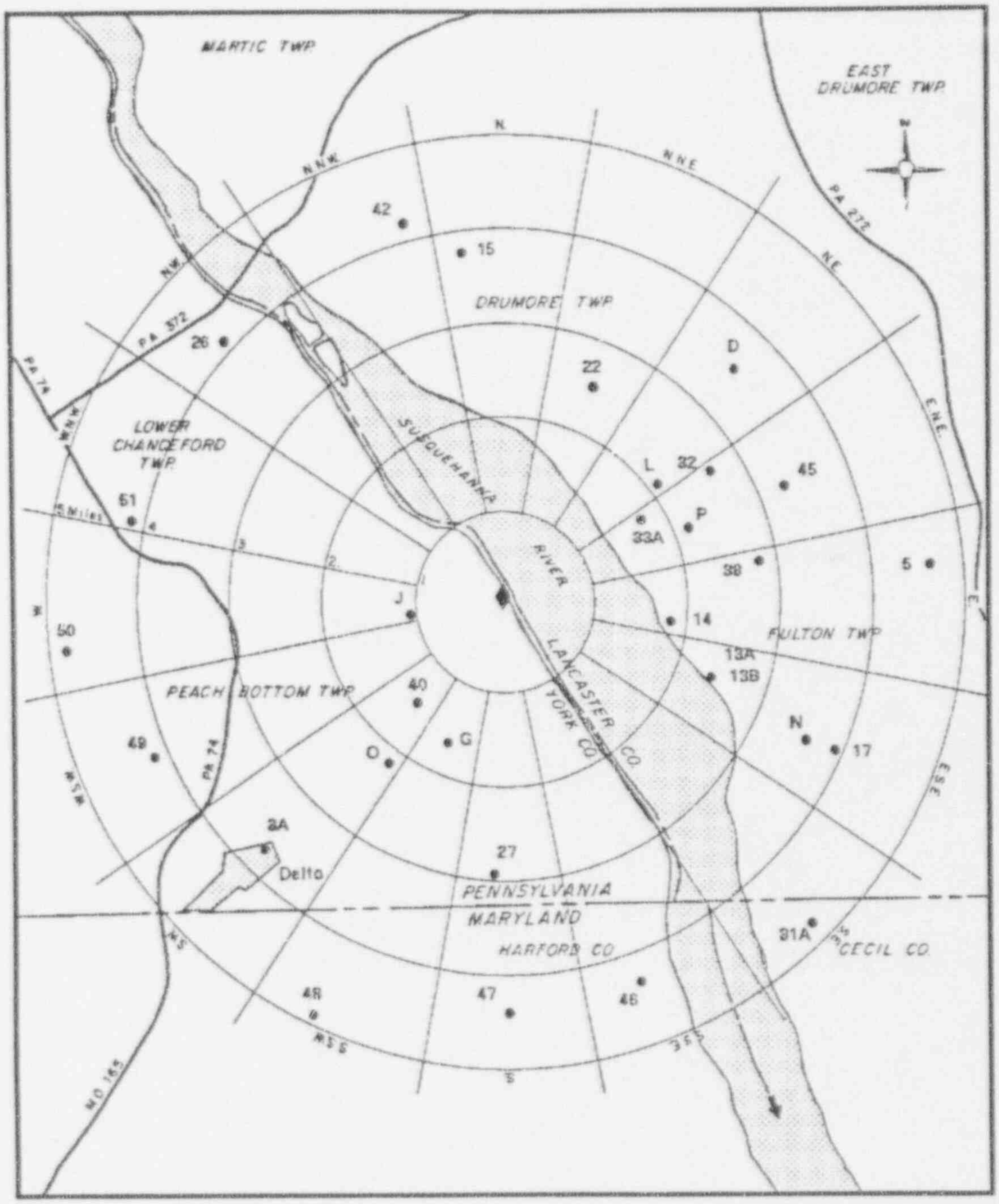
Exposure Pathway and/or Sample	Number of Samples and Sample Station Name	Station Location-Direction and Distance from Peach Bottom	Discussion
4. Ingestion (Cont'd)			
b. Fish	Two locations		Station 4-Conowingo Pond fish are indicator samples, while station 6-Holtwood Pond fish are control samples
	4 Conowingo Pond		
	6 Holtwood Pond		
	2 species each location, if available: bottom feeder and predator.		
c. Food Products	2 locations		
	1 Peach Bottom Site Area	Site area, 0.9 miles SE of Unit 2 & 3	Food products are to be sampled as part of the PBAPS Technical Specification program only if milk sampling is not performed. The milk pathway, which results in a greater maximum dose to humans than the vegetation pathway, is monitored at locations near the site, and is a better indicator than vegetation samples. In addition, no crops grown in the vicinity of Peach Bottom are irrigated with water in which liquid plant wastes have been discharged.
	Control	15 to 30 kilometers in the least prevalent wind direction	
	3 types of broadleaf vegetation each location, if available. Only if milk sampling is not performed.		



1A APT, TLD
1B APT/AIO, TLD
1C TLD
1D TLD
1E TLD
1F TLD
1G TLD
1H TLD
1I TLD
1J TLD
1L TLD
1LL WATER
1M TLD
1MM WATER
1NN TLD
1Z APT/AIO, TLD
2 APT, TLD
4 FISH
4J SEDIMENT
23 TLD
40 TLD

Environmental Sampling Locations at the Site Boundary Area to Peach Bottom

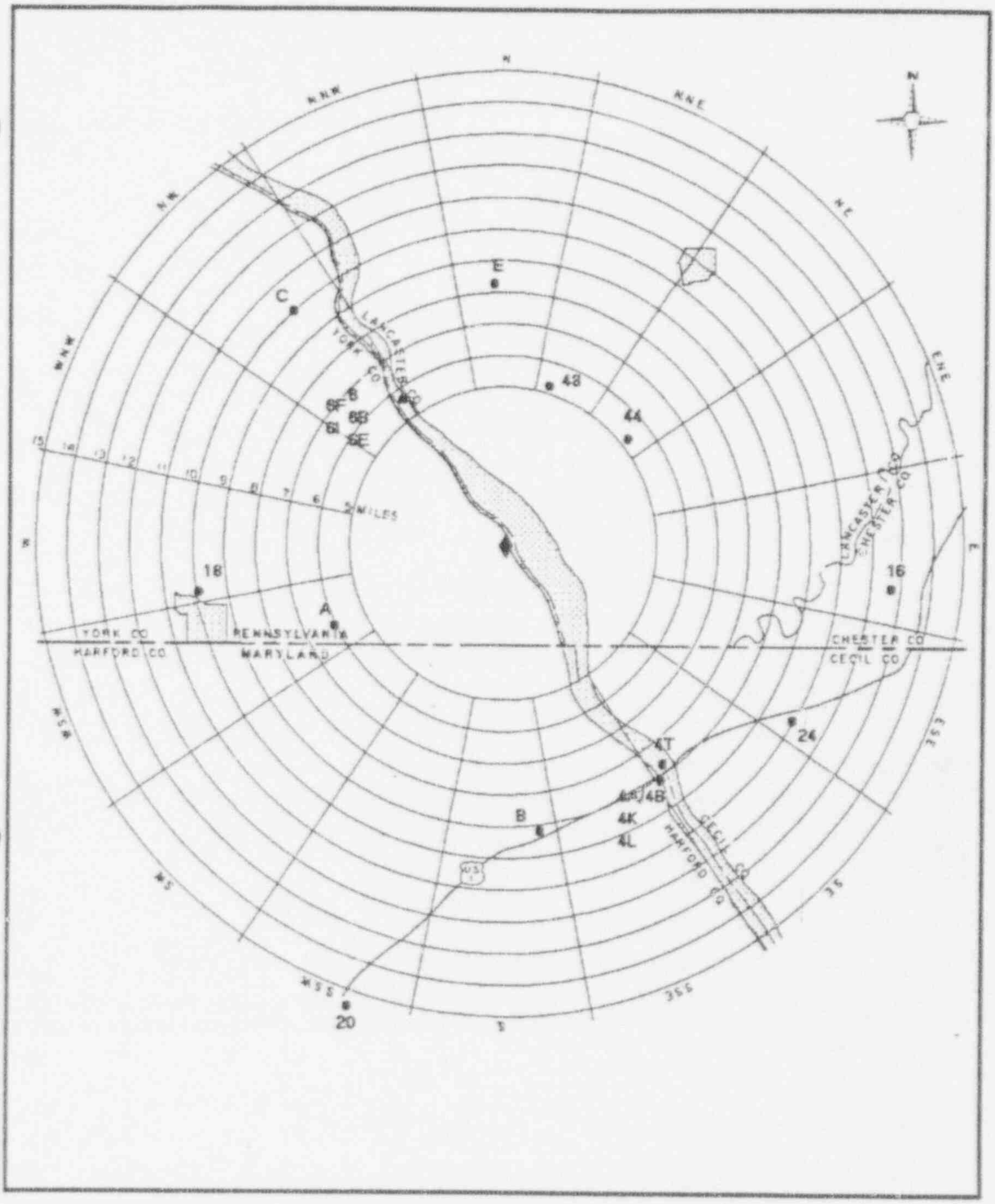
FIGURE VII.A.1



D	MILK
G	MILK
J	MILK
L	MILK
N	MILK
O	MILK
P	MILK
13A	WATER
13B	WATER
3A	APT/AIO, TLD
5	APT, TLD
14	APT, TLD
15	APT, TLD
17	APT, TLD
22	TLD
26	TLD
27	TLD
31A	TLD
32	APT,TLD
33A	TLD
38	APT, TLD
40	TLD
42	TLD
45	TLD
46	TLD
47	TLD
48	TLD
49	TLD
50	TLD
51	TLD

Environmental Sampling Locations
Within A Five Mile Distance Of
Peach Bottom Atomic Power Station

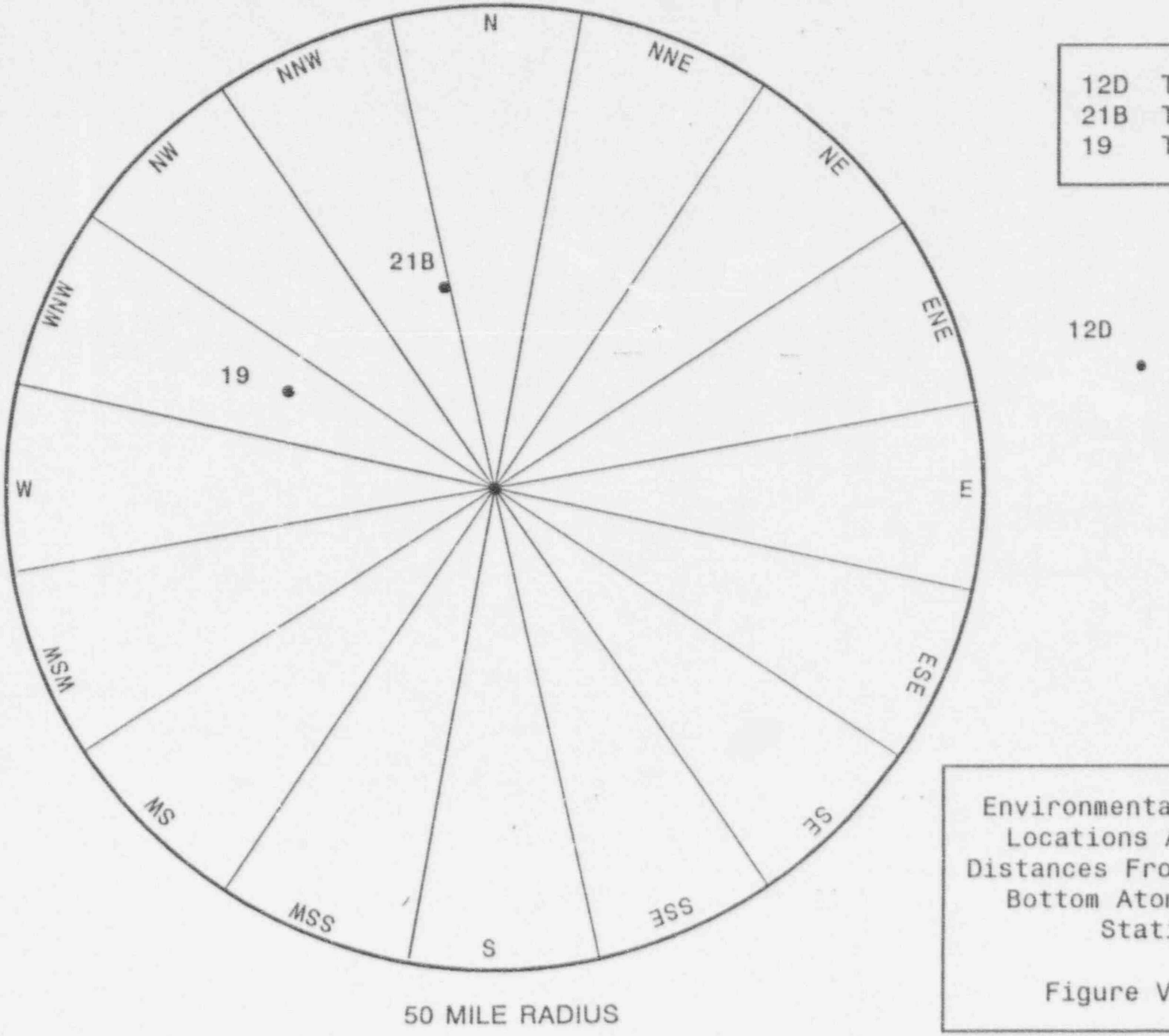
Figure VII.A.2



Environmental Sampling Locations At A Distance Of Five To Fifteen Miles From The Peach Bottom Atomic Power Station

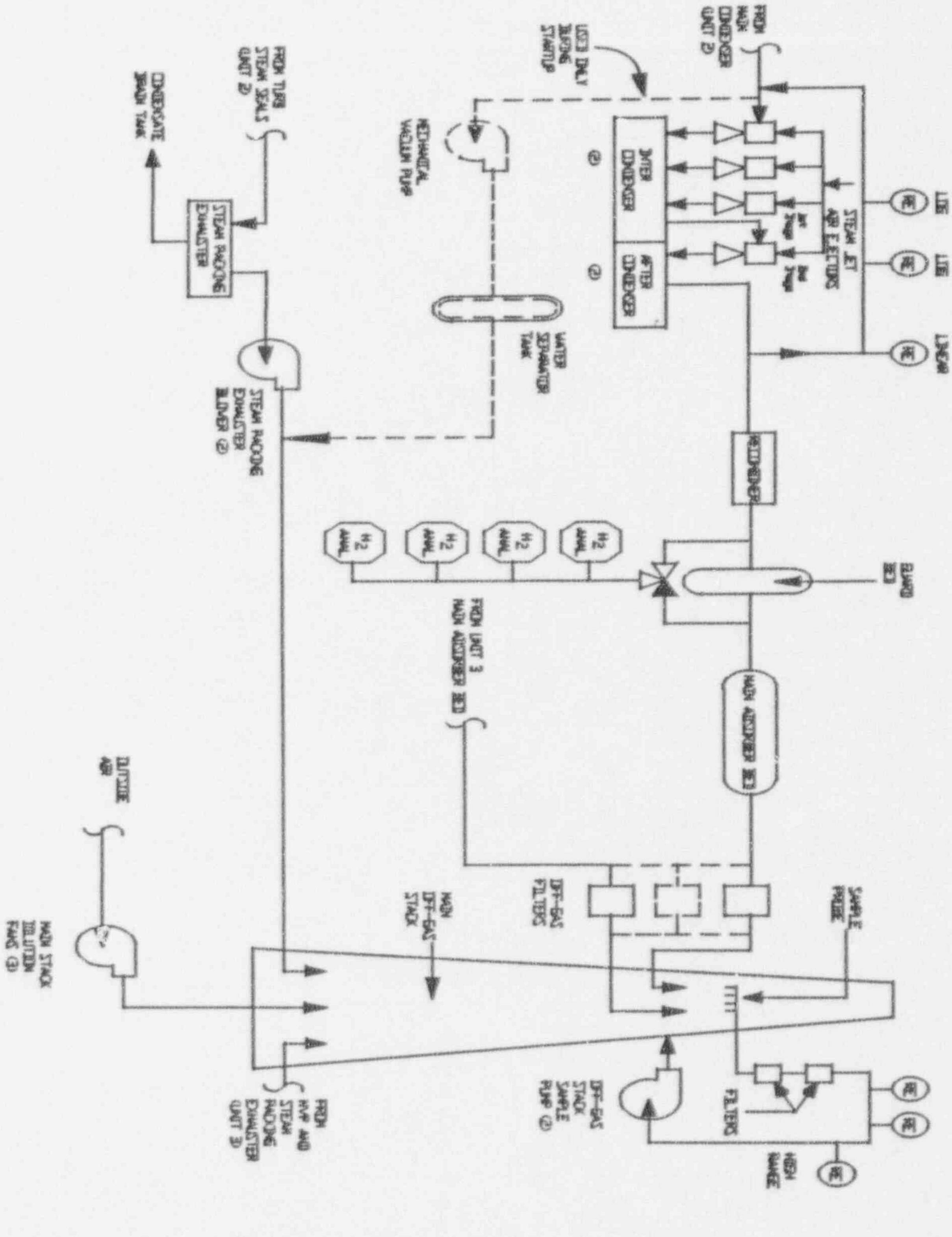
Figure VII.A.3

12D TLD, APT/AIO
21B TLD
19 TLD



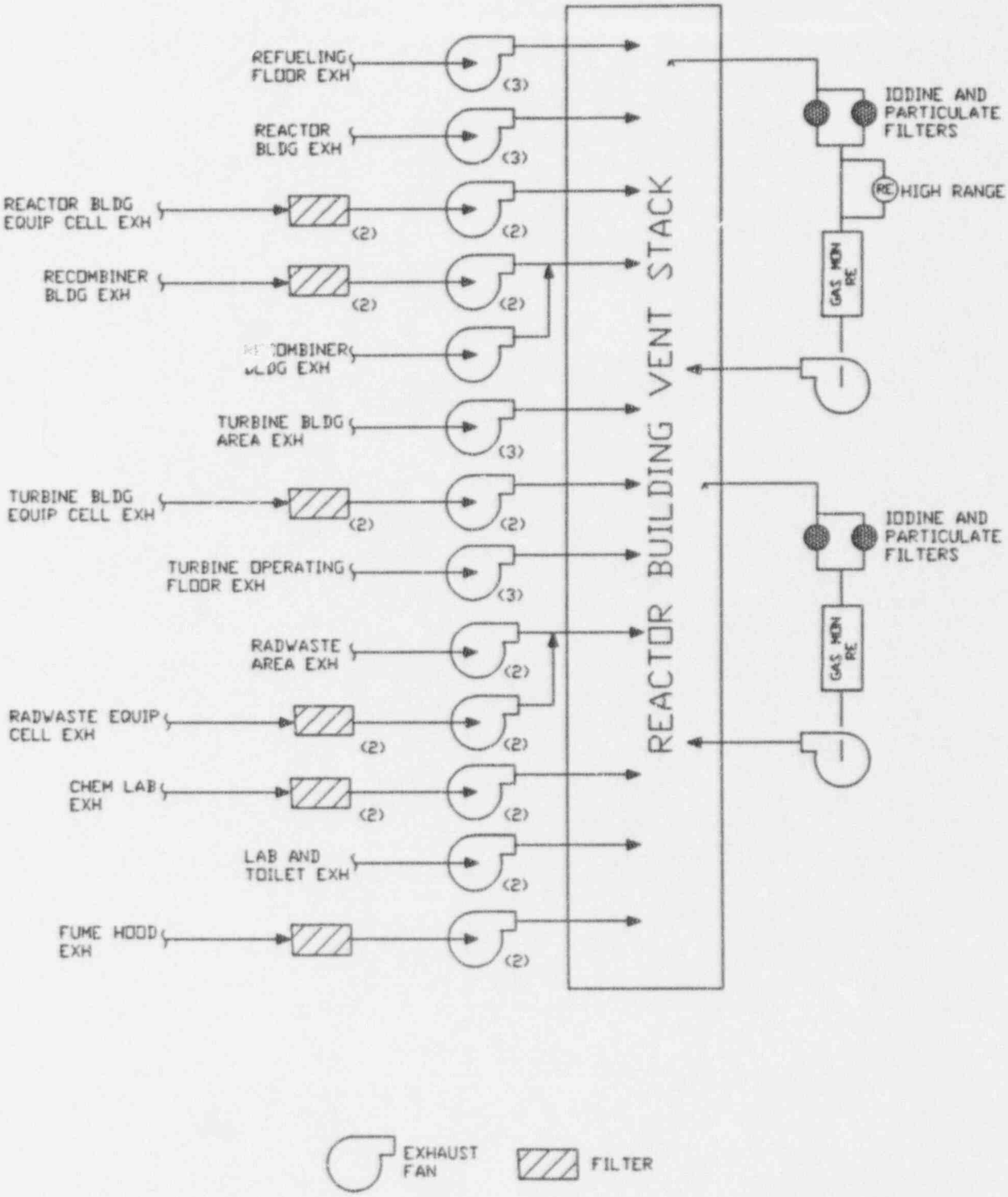
Environmental Sampling Locations At Remote Distances From The Peach Bottom Atomic Power Station

Figure VII.A.4



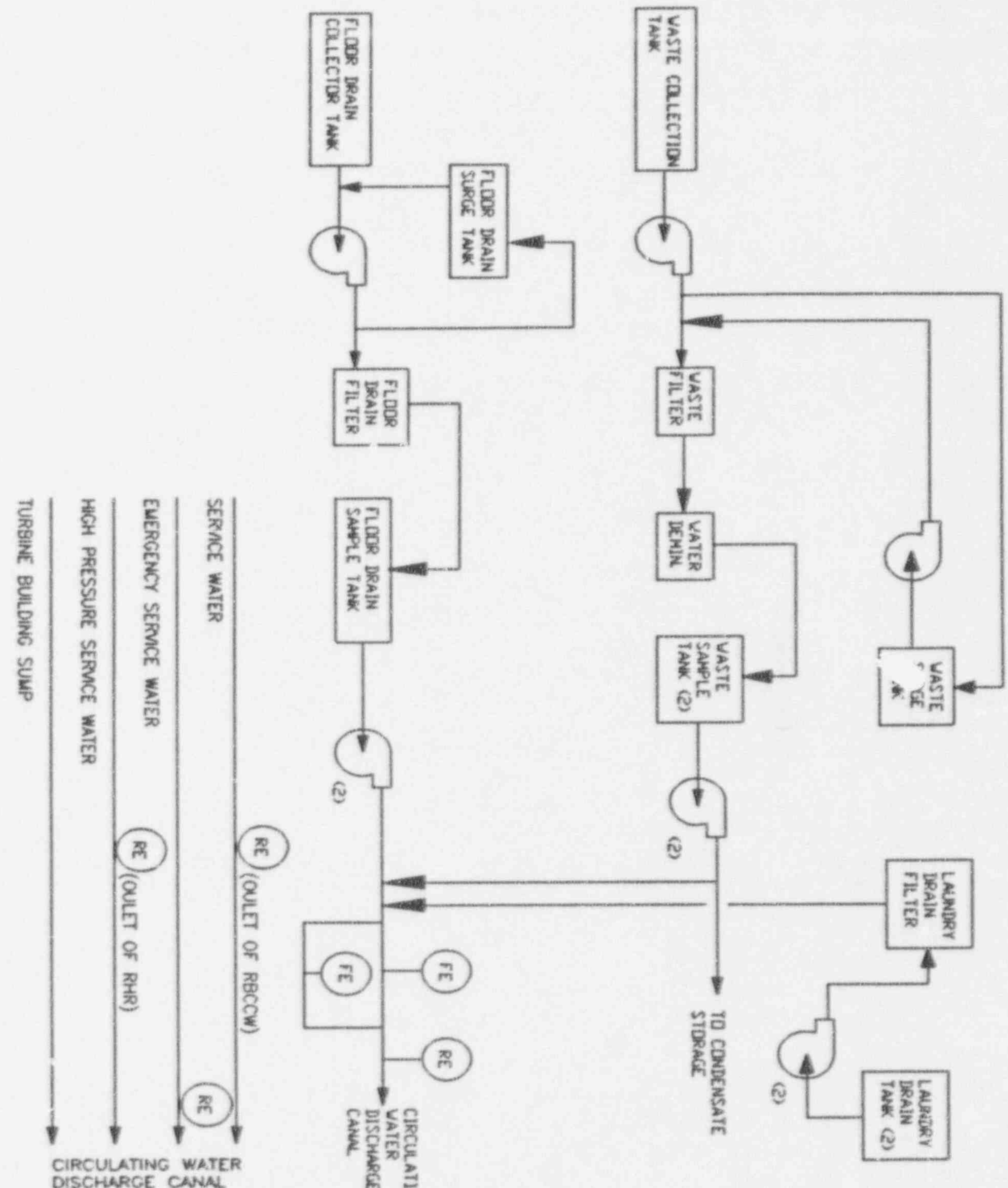
PHILADELPHIA ELECTRIC COMPANY
PBAPS UNITS 2 & 3

OFFGAS RADWASTE TREATMENT
SYSTEM



PHILADELPHIA ELECTRIC CO.
PBAPS UNITS 2 & 3

VENTILATION EXHAUST WASTE
TREATMENT SYSTEM



PHILADELPHIA ELECTRIC CO.
PBAPS UNITS 2 & 3

LIQUID RADWASTE
TREATMENT SYSTEM

VIII. Bases

Site Specific Data

> NOTE 1
>
> Liquid dose factors, $A_i\tau$, for section III.B were developed using the following site specific data. The liquid pathways involved are drinking water and fish.

$A_i\tau$ = $(U_W/D_W + U_F \times BF_i)\ K_0 \times DF_i \times RC$

U_W = liters per year; maximum age group usage of drinking water (Reg. Guide 1.109, Table E-5)

D_W = 5.4; average annual dilution at Conowingo intake

U_F = kg per year; maximum age group usage of fish (Reg. Guide 1.109, Table E-5)

BF_i = bioaccumulation factor for nuclide, i, in freshwater fish. Reg. Guide 1.109, Table A-1, except P-32 which uses a value of 3.0×10^3 pCi/kg per pCi/liter.

K_o = $1.14 \times 10^5 = (10^6$ pCi/uCi $\times 10^3$ ml/1 $\div$ 8760 hr/yr) units conversion factor.

DF_i = dose conversion factor for nuclide, i, for the age group in total body or organ, as applicable. Reg. Guide 1.109, Table E-11, except P-32 bone which uses a value as indicated below.

3.0×10^{-5} mrem/pCi

RC = 1.16; reconcentration from PBAPS discharge back through PBAPS intake.

The data for D_W and RC were derived from data published in Peach Bottom Atomic Power Station Units 2 and 3 (Docket Nos. 50-277 and 50-278) Radioactive Effluent Dose Assessment, Enclosure A, September 30, 1976. All other data except P-32 BF and DF were used as given in Reg. Guide 1.109, Revision 1, October 1977. The P-32 BF and DF were used in accordance with information supplied in Branagan, E.F., Nichols, C.R., and Willis, C.A., "The Importance of P-32 in Nuclear Reactor Liquid Effluents", NRC, 6/82. The teen and child dose factors were derived by the ratio of the adult bone dose factors in Reg. Guide 1.109 and Branagan, et al.

VIII. (Cont'd)

NOTE 2

To develop constant R for section IV.C, the following site specific data were used:

$$R_i^C(D/Q) = K'\frac{Q_F(U_{ap})}{\lambda_i+\lambda_w}F_m(r)\ (DFL_i)\left[\frac{f_p f_s}{Y_p} + \frac{(1-f_p f_s)\ e^{-\lambda_i t_h}}{Y_s}\right]e^{-\lambda_i t_f}$$

where:

K' = 10^6 pCi/μCi; unit conversion factor

Q_F = 50 kg/day; cow's consumption rate

U_{ap} = 330 l/yr; yearly milk consumption by an infant

λ_i = radioactive decay constant for nuclide of interest, sec^{-1} (e.g. 9.97×10^{-7} sec^{-1} for I-131)

λ_w = 5.73×10^{-7} sec^{-1}; decay constant for removal of activity in leaf and plant surfaces

F_m = stable element transfer coefficient for nuclide of interest, day/liter (e.g. 6.0×10^{-3} day/liter for I-131)

r = fraction of deposited nuclide retained in cow's feed grass, 1.0 for radioiodine; 0.2 for particulates

DFL_i = ingestion dose factor in infant for nuclide of interest, mrem/pCi (e.g. 1.39×10^{-2} mrem/pCi for I-131)

f_p = 0.6; the fraction of the year the cow is on pasture (average of all farms)

f_s = 0.487; the fraction of cow feed that is pasture grass while the cow is on pasture (average of all farms)

Y_p = 0.7 kg/m^2; the agricultural productivity of pasture feed grass

Y_s = 2.0 kg/m^2; the agricultural productivity of stored feed

t_f = 1.73×10^5 sec (2 days); the transport time from pasture, to cow, to milk, to receptor

t_h = 7.78×10^6 sec (90 days); the transport time from pasture, to harvest, to cow, to milk, to receptor

VIII. (Cont'd)

The pathway is the grass-cow-milk ingestion pathway. These data were derived from data published in Peach Bottom Atomic Power Station Units 2 and 3 (Docket Nos. 50-277 and 50-278) Radioactive Effluent Dose Assessment, Enclosure A, September 30, 1976. All other data were used as given in Reg. Guide 1.109, Revision 1, October 1977.

Surveillance Requirement 4.8.B.2 Liquid Pathway Dose Calculations

The equations for calculating the doses due to the actual release rates of radioactive materials in liquid effluents were developed from the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I", Revision 1, October 1977 and NUREG-0133 "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants", October 1978.

Surveillance Requirement 4.8.C.1

Dose Noble Gases

The equations for calculating the doses due to the actual release rates of radioactive noble gases in gaseous effluents were developed from the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I", Revision 1, October 1977, NUREG-0133 "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants", August 1978, and the atmospheric dispersion model presented in Information Requested in Enclosure 2 to letter from George Lear to E. G. Bauer dated February 17, 1976, September 30, 1976. The specified equations provide for determining the air doses in areas at and beyond the SITE BOUNDARY based upon the historical average atmospheric conditions.

The dose due to noble gas release as calculated by the Gross Release Method is much more conservative than the dose calculated by the Isotopic Analysis Method. Assuming the release rates given in Radioactive Effluent Dose Assessment, September 30, 1976, the values calculated by the Gross Release Method for total body dose rate and skin dose rate are 6.0 times and 5.7 times, respectively, the values calculated by the Isotopic Analysis Method.

VIII. (Cont'd)

The model Technical specification LCO for all radionuclides and radioactive materials in particulate form and radionuclides other than noble gases requires that the instantaneous dose rate be less than the equivalent of 1500 mrem per year. For the purpose of calculating this instantaneous dose rate, thyroid dose from iodine-131 through the inhalation pathway will be used. Since the operating history to date indicates that iodine-131 releases have had the major dose impact, this approach is appropriate. The value calculated is increased by nine per cent to account for the thyroid dose from all other nuclides. This allows for expedited analysis and calculation of compliance with the LCO.

In the event that the plant is shutdown long enough so that iodine-131 is no longer present in gaseous effluents, an Isotopic Analysis Method is available. Since no iodines are present, the critical organ changes from the thyroid to the lung.

Surveillance Requirement 4.8.C.2

Dose Noble Gases

The equations for calculating the doses due to the actual release rates of radioactive noble gases in gaseous effluents were developed from the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I", Revision 1, October 1977, NUREG-0133 "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants", August 1978, and the atmospheric dispersion model presented in Information Requested in Enclosure 2 to letter from George Lear to E. G. Bauer dated February 17, 1976, September 30, 1976. The specified equations provide for determining the air doses in areas at and beyond the SITE BOUNDARY based upon the historical average atmospheric conditions.

The dose due to noble gas releases as calculated by the Gross Release Method is much more conservative than the dose calculated by the Isotopic Analysis Method. Assuming the releases rates given in Radioactive Effluent Dose Assessment, September 30, 1976, the values calculated by the Gross Release Method for total body dose rate and skin dose rate are 4.3 times and 7.2 times, respectively, the values calculated by the Isotopic Analysis Method.

VIII. (Cont'd)

Surveillance Requirement 4.8.C.3

Dose, Iodine-131, Iodine-133, Tritium, and Radioactive Material in Particulate Form

The equations for calculating the doses due to the actual release rates of radioiodines, radioactive material in particulate form, and radionuclides other than noble gases with half-lives greater than 8 days were developed using the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I", Revision 1, October 1977, NUREG-0133, "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants", October 1978, and the atmospheric dispersion model presented in Information Requested in Enclosure 2 to Letter from George Lear to E. G. Bauer dated February 17, 1976, September 30, 1976. These equations provide for determing the actual doses based upon the historical average atmospheric conditions.

Compliance with the 10 CFR 50 limits for radioiodines, radioactive materials in particulate form and radionuclides other than noble gases with half lives greater than eight days is to be determined by calculating the thyroid dose from iodine-131 releases. Since the iodine-131 dose accounts for 92 percent of the total dose to the thyroid, the value calculated is increased by nine percent to account for the dose from all other nuclides.

In the event that the plant is shutdown long enough so that iodine-131 is no longer present in gaseous effluents, an Isotopic Analysis Method is available. Since no iodines are present, the critical organ changes from the thyroid to the liver.