

2840010450

Onsite Dose Calculation Manual

Peach Bottom Atomic Power Station
Units 2 and 3

Philadelphia Electric Company
Docket Nos. 50-277 & 50-278

8403270067 840308
PDR ADOCK 05000277
P PDR

- 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
- V. Nuclear Fuel Cycle Dose Assessment - 40 CFR 190
 - A. Surveillance Requirement 4.8.D
- VI. Calendar Year Dose Calculations
 - A. Unique Reporting Requirement 6.9.3.2
- VII. Radiological Environmental Monitoring Program
 - A. Surveillance Requirement 4.8.E
- VIII. Bases

2840010450

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

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 (well count) activity. This analysis is performed in a NAI well counter. This well counter has a counting efficiency similar to the liquid radwaste discharge gross activity monitor. The well counter and liquid radwaste discharge gross activity monitor are calibrated against the same liquid radioactivity source in the geometry to be used by each detector. An efficiency is determined for each radwaste tank to be released. Exceeding the expected response would indicate that an incorrect sample had been obtained for that release and the release is automatically stopped.

$$\text{S.P.} = (\text{Net CPM/ml(well)} \times \text{Eff W/RW}) + \text{Background CPS}$$

$$\text{S.P.} = \text{Liquid Radwaste gross activity monitor setpoint in CPS}$$

$$\text{Net CPM/ml(well)} = \text{gross gamma activity for the radwaste sample tank determined by the well counter.}$$

$$\text{Eff W/RW} = \text{conversion factor between well counter and liquid radwaste gross activity monitor (CPS (R/W monitor) - CPM/ml(well))}.$$

$$\text{Background CPS} = \text{Background reading of the liquid radwaste gross activity monitor (CPS)}.$$

2840010450

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. The flow rate determination includes a margin of assurance which includes consideration of these errors such that the instantaneous release limit of 10 CFR 20 is not exceeded.

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 determined above 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.

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 rate of 150 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.

D. Setpoint Determination for Gaseous Radwaste

Flow Monitors

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

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

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

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 20.106(a) for radionuclides other than noble gases and 2×10^4 uCi/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:

$$\text{Dilution Factor} = \sum_i \frac{\text{uCi/ml } i}{\text{MPC}_i}$$

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

MPC $_i$ = The MPC specified in 10 CFR 20, Appendix B, Table II, Column 2 for radionuclides

-4

other than noble gases or 2×10^4 uCi/ml for noble gases.

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

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

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

5

2.0×10^5 = the flow rate in qpm 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

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 bone dose from liquid effluents.

$$D = \sum_i \left[A_i \mathcal{T}_i \sum_{1=1}^m \Delta t_1 C_{i1} F_1 \right]$$

where:

D = the cumulative dose commitment to the total body or any organ, \mathcal{T} , from liquid effluents for the total time period $\sum_{1=1}^m \Delta t_1$, in mrem

Δt_1 = the length of the 1th time period over which C_{i1} and F_1 are averaged for the liquid release, in hours.

C_{i1} = The average concentration of radionuclide, i , in undiluted liquid effluent during time period Δt_1 from any liquid release, (determined by the effluent sampling analysis program, Technical Specification Table 4.8.1), in uCi/ml.

A_i = the site related ingestion dose commitment factor to the total body or organ, \mathcal{T} , for each radionuclide listed in Table III.A.1, in mrem-ml per hr-uCi. See Site Specific Data.**

F_1 = the near field average dilution factor for C_{i1} during any liquid effluent release. Defined as the ratio of the maximum undiluted liquid waste flow during release to the average flow from the discharge structure to Conowingo Pond.

III.C Surveillance Requirement 4.8.B.4a

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.1LIQUID EFFLUENT INGESTION DOSE FACTORS
(Decay Corrected)A \mathcal{T} Dose Factor (mrem-ml per hr-uci)
i

<u>Radionuclide</u>	<u>Total Body</u>	<u>Bone</u>
	5	5
Cs-137	3.98x10	4.44x10
	5	5
Cs-134	6.74x10	3.47x10
	4	5
P-32	5.93x10	3.28x10
	4	4
Cs-136	9.83x10	3.45x10
	4	4
Zn-65	3.87x10	2.69x10
	5	5
Sr-90	1.88x10	7.67x10
	0	0
H-3	2.13x10	2.13x10 *
	2	2
Na-24	2.24x10	4.41x10
	2	2
I-131	1.86x10	2.28x10
	2	2
Co-60	7.40x10	7.40x10 *
	2	2
I-133	1.97x10	2.28x10
	2	2
Fe-55	1.31x10	8.12x10
	2	4
Sr-89	8.83x10	3.08x10
	3	4
Te-129m	2.01x10	1.27x10
	2	2
Mn-54	9.82x10	9.82x10
	2	2
Co-58	2.59x10	2.59x10 *
	3	3
Fe-59	1.14x10	1.26x10
	2	3
Te-131m	4.57x10	1.12x10
	1	2
Ba-140	3.66x10	5.57x10
	3	3
Te-132	1.40x10	2.29x10

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

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

IV. Gaseous Pathway Dose CalculationsA. 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:

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 and Kr-87 for skin dose. 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

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

$$D_S = (L \frac{\overline{(X/Q)}}{S} + 1.1B) \dot{Q}_{NS} + (L + 1.1M) \frac{\overline{(X/Q)}}{V} \dot{Q}_{NV}$$

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.

- 4
- V = 4.72×10^{-4} mrem/yr per uCi/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.
- Q
NS = the gross release rate of noble gases from the stack determined by gross activity stack monitors averaged over one hour, in uCi/sec.
- K = 1.47×10^{-4} mrem/yr per uCi/m³; the total body dose factor due to gamma emissions for Kr-88 (Reg Guide 1.109, Table B-1).
- (X/Q)
v = 5.33×10^{-7} sec/m³; the highest calculated annual average relative concentration for any area at or beyond the SITE BOUNDARY for all vent releases.
- 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 uCi/sec.
- L = 9.73×10^{-3} mrem/yr per uCi/m³; the skin dose factor due to beta emissions for Kr-87. (Reg Guide 1.109, Table B-1).
- (X/Q)
s = 9.97×10^{-8} sec/m³; the highest calculated annual average relative concentration from the stack releases for any area at or beyond the SITE BOUNDARY.
- B = 1.74×10^{-4} mrad/yr per uCi/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 = 6.17×10^{-3} mrad/yr per uCi/m³; the air dose factor due to gamma emissions for Kr-87. (Reg Guide 1.109, Table B-1).

b. Isotopic Analysis Method

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

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

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 PRAPS. Values are listed on Table III.A., in mrem/yr per uCi/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 uCi/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.,
in mrem/yr per uCi/m³.

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

2840010450

- \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 uCi/sec.
- L_i = the skin dose factor due to beta emissions for each identified noble gas radionuclide. Values are listed on Table IV.A., in $\frac{3}{\text{mrem/yr per uCi/m}}$.
- $\overline{(X/Q)}_s$ = $9.97 \times 10^{-8} \frac{3}{\text{sec/m}}$; 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., in $\text{mrad/yr per uCi/sec}$.
- M_i = the air dose factor due to gamma emissions for each identified noble gas radionuclide. Values are listed on Table IV.A., in $\frac{3}{\text{mrad/yr per uCi/m}}$.
- 1.1 = unit conversion, converts air dose to skin dose, mrem/mrad .

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

<u>Radionuclide</u>	Plume-Air Dose Factor B i (mrad/yr per uCi/sec)	Total Body Dose Factor K i (mrem/yr per uCi/m ³)	Skin Dose Factor L i (mrem/yr per uCi/m ³)	Gamma Air Dose Factor M i (mrad/yr per uCi/m ³)	Beta Air Dose Factor N i (mrad/yr per uCi/m ³)	Plume- Body Dose Factor V i (mrad/yr per uCi/sec)
Kr-87	1.74E-04	5.92E+03	9.73E+03	6.17E+03	1.03E+04	1.66E-04
Kr-88	3.15E-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	7.33E+03	3.43E+03	7.54E+03	3.94E+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 PRAPS.

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

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

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 = 1.484×10^{-7} mrem/yr per uCi/m³; 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/m³; the highest calculated annual average relative concentration for any area at or beyond the SITE BOUNDARY from stack releases. (SSF 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 uCi/sec.

W_V = 2.31×10^{-8} sec/m³; 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 iodine-131 in gaseous effluents from all vent releases, determined by the effluent sampling and analysis program (Technical Specification Table 4.8.2) in uCi/sec.

IV.B Surveillance Requirement 4.8.C.2

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.

1. for gamma radiation:

a) Gross Release Method

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

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 uCi/m³; the air dose factor due to gamma emissions for Kr-88. (Reg Guide 1.109, Table B-1)

$\left(\overline{X/Q} \right)_v$ = 5.33×10^{-7} sec/m³; the highest calculated annual average relative concentration from vent releases for any area at or beyond the SITE BOUNDARY.

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

B = 3.15×10^{-4} mrad/year per uCi/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.

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

b) Isotopic Analysis Method

$$D_r = 3.17 \times 10^{-8} \sum_i \left[M_i (\bar{X}/\bar{Q}) \bar{Q}_v + F_i \bar{Q}_{is} \right]$$

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_r = 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 III.A, in mrad/yr³ per uCi/m.

$\overline{(X/Q)}_V$ = $5.33 \times 10^{-7} \text{ sec/m}^3$; 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 uCi. 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, in mrad/yr per uCi/sec.

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

2. for beta radiation:

a) Gross Release Method

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

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_{β} = beta air dose, in mrad.

3.17×10^{-8} = years per second.

N $= 1.03 \times 10^4$ mrad/yr per uCi/m³; the air dose factor due to beta emissions for Kr-87. (Reg Guide 1.109, Table B-1)

$(\overline{X/Q})_v$ $= 5.33 \times 10^{-7}$ sec/m³; 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 uCi. Releases shall be cumulative over the calendar quarter or year, as appropriate.

$(\overline{X/Q})_s$ $= 9.97 \times 10^{-8}$ sec/m³; 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 uCi. Releases shall be cumulative over the calendar quarter or year, as appropriate.

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, in mrad/yr per uCi/m³.

2840010450

$\overline{(X/Q)}_v$ = $5.33 \times 10^{-7} \text{ sec/m}^3$; 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 uCi. Releases shall be cumulative over the calendar quarter or year, as appropriate.

$\overline{(X/Q)}_s$ = $9.97 \times 10^{-8} \text{ sec/m}^3$; 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 uCi. Releases shall be cumulative over the calendar quarter or year, as appropriate.

IV.C Surveillance Requirement 4.8.C.3

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 shall be determined by the following expression:

$$D = 3.17 \times 10^{-8} (CF) (0.5) R \left[\frac{W \overline{Q}_S}{S_{IS}} + \frac{W \overline{Q}_v}{V_{IV}} \right]$$

where:

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

D = 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 = $2.61 \times 10^{11} \text{ m}^2$ (mrem/yr) per uCi/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 = 4.95×10^{-10} meters⁻² ; ($\overline{D/Q}$) for the food
S 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 uCi. Releases shall be cumulative over the calendar quarter or year, as appropriate.
- W = 1.14×10^{-9} meters⁻² ; ($\overline{D/Q}$) for the food
V pathway for stack releases.
- \overline{Q}_{IV} = the release of Iodine-131 determined by the effluent sampling and analysis program (Technical Specification Table 4.8.2), in uCi. Releases shall be cumulative over the calendar quarter or year, as appropriate.

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.

** See Note 2 in Basis

2840010450

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.

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 Unique Reporting Requirement 6.9.3.h.(3) Dose Calculations for the Radiation Dose Assessment Report

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 Surveillance Requirement 4.8.E

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

TABLE VI.A.1

2840010450

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

<u>Exposure Pathway and/or Sample</u>	<u>Number of Samples and Sample Station Name</u>	<u>Station Location-Direction and Distance from Peach Bottom</u>	<u>Discussion</u>
1. Direct Radiation	47 Locations Site Boundary Vicintiy		
	1A Peach Bottom Weather Station #1	On Site, 0.3 miles SE of Units 2 & 3	TLD sites were chosen in accordance with Peach Bottom Technical Specifications Table 3.12-1, 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.
	1B Peach Bottom Weather 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	Units 2 & 3	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 On Site, 0.6 miles SSW of control locations.
	1F Peach Bottom 200 Sector Hill	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 VI.A.1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

<u>Exposure Pathway and/or Sample</u>	<u>Number of Samples and Sample Station Name</u>	<u>Station Location-Direction and Distance from Peach Bottom</u>	<u>Discussion</u>
	1I 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	

TABLE VI.A.1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

<u>Exposure Pathway and/or Sample</u>	<u>Number of Samples and Sample Station Name</u>	<u>Station Location-Direction and Distance from Peach Bottom</u>	<u>Discussion</u>
	17 Riverview Road	4.0 miles ESE of Units 2 & 3	
	26 Slab Road	4.2 miles NW of Units 2 & 3 near Slab Road	
	31 Pilotown Road	4.9 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 VI.A.1

2840010450

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

<u>Exposure Pathway and/or Sample</u>	<u>Number of Samples and Sample Station Name</u>	<u>Station Location-Direction and Distance from Peach Bottom</u>	<u>Discussion</u>
	<u>Distant</u>		
	12B Phila., PA 3508 Market Street	On roof of Radiation Management Corp., Phila., PA, 64 miles E of Units 2 & 3	
	16 Nottingham, PA Substation	12.8 miles E of Units 2 & 3 at 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	
	<u>Special Interest</u>		
	4K Conowingo Dam Powerhouse Roof	On roof of Conowingo Power- house, 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	

TABLE VI.A.1

2840010450

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

<u>Exposure Pathway and/or Sample</u>	<u>Number of Samples and Sample Station Name</u>	<u>Station Location-Direction and Distance from Peach Bottom</u>	<u>Discussion</u>
	23 Peach Bottom 150 Sector Hill Offsite	Off-site Hill 1.0 miles SSE of Units 2 & 3	
	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>		
	1A Peach Bottom - (1Z) Weather Station 1	On Site at Weather Station 0.3 miles SE of Units 2 & 3	These stations provide for cover- age 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 N of Units 2 & 3	
	2 Peach Bottom Site - 130 Sector Hill	On Site, 0.9 miles SE of Units 2 & 3	For radioiodine samples, station 1Z is used instead of station 1A. It is the same location. Radioiodine cartridges which have been tested for performance by the manufacturer are used at all times.
	3A Delta, PA Substation	3.6 miles SW of Units 2 & 3 0.5 miles N of Maryland border	

2840010450

TABLE VI.A.1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

<u>Exposure Pathway and/or Sample</u>	<u>Number of Samples and Sample Station Name</u>	<u>Station Location-Direction and Distance from Peach Bottom</u>	<u>Discussion</u>
	120 Philadelphia, PA	62 miles ENE of Units 2 & 3 on the roof of 2301 Market Street	
3. <u>Waterborne</u>			
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 SE of Units 2 & 3	Continuous sampler in the Conowingo Hydro-Electric Station, about 8.6 miles	
	6I Holtwood Dam - Hydro-Electric Station - composite	Continuous sampler at Holtwood Hydro-Electric Station intake about 5.8 miles NW of Units 2 & 3	Station 6I 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. <u>Ingestion</u>			
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

TABLE VI.A.1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

2840010450

<u>Exposure Pathway and/or Sample</u>	<u>Number of Samples and Sample Station Name</u>	<u>Station Location-Direction and Distance from Peach Bottom</u>	<u>Discussion</u>
b. Fish	Two locations 4 Conowingo Pond 6 Holtwood Pond 2 species each location, if available: channel catfish and white crappie		farms involved. In return for being allowed to sample and analyze the milk, PECO has agreed not to divulge the farms' location. Station 4-Conowingo Pond fish are indicator samples, while station 6-Holtwood Pond fish are control samples.
c. Food Products	3 locations 1 Peach Bottom Site Area 6D Holtwood, PA 3 types of broadleaf vegetation each location, if available. Only if milk sampling is not performed	Site area, 0.9 miles SE of Unit 2 & 3 5.8 miles NW of Units 2 & 3 near Holtwood Dam.	Food products are to be samples as part of the PBAPS Technical Specification program only if milk sampling is not performed. The milk pathway, which results in a greater maximum close 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.

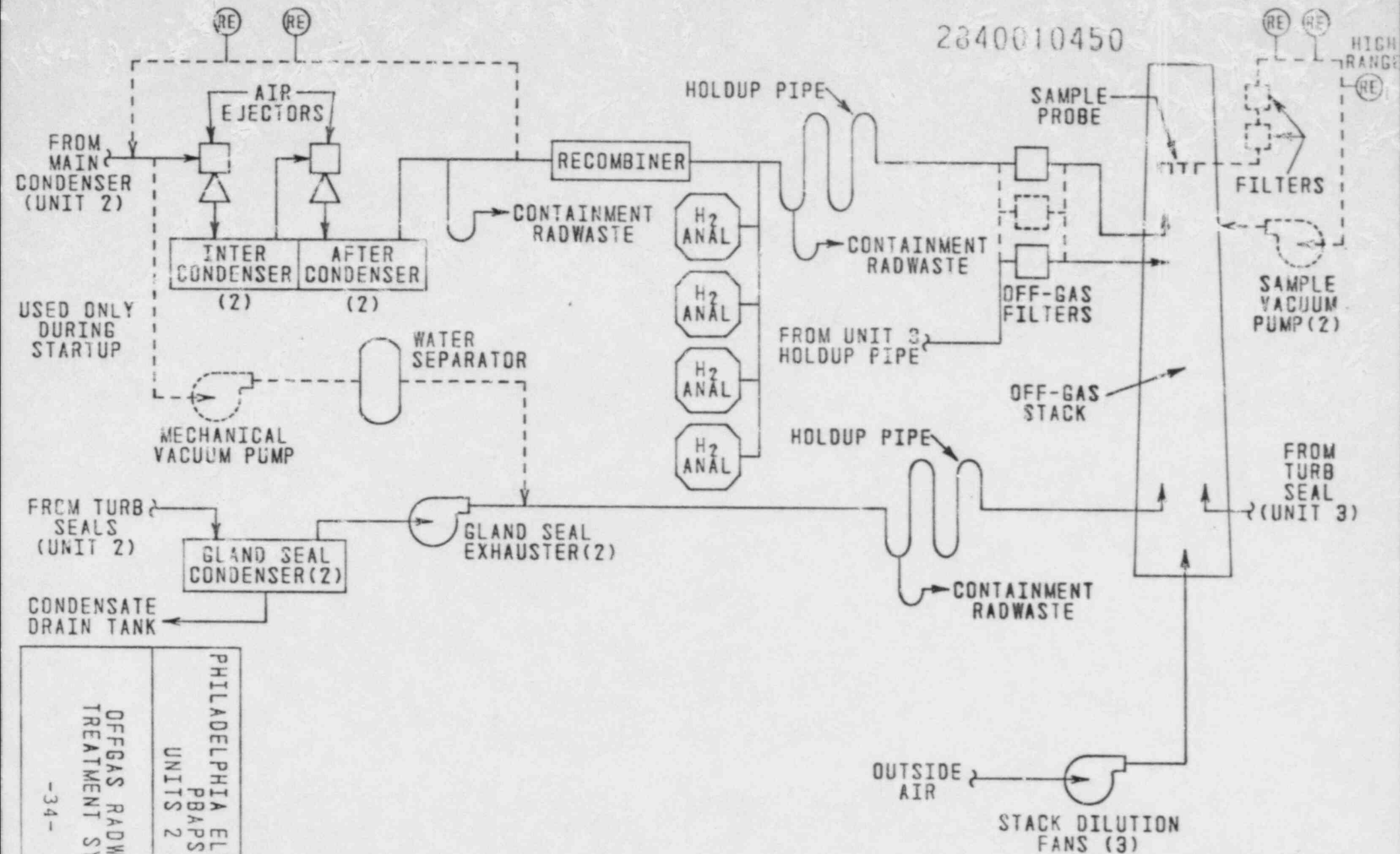


ENVIRONMENTAL SAMPLING STATIONS
AT INTERMEDIATE DISTANCES FROM PEACH BOTTOM SITE
FIGURE VIIA.2

Rev. 0



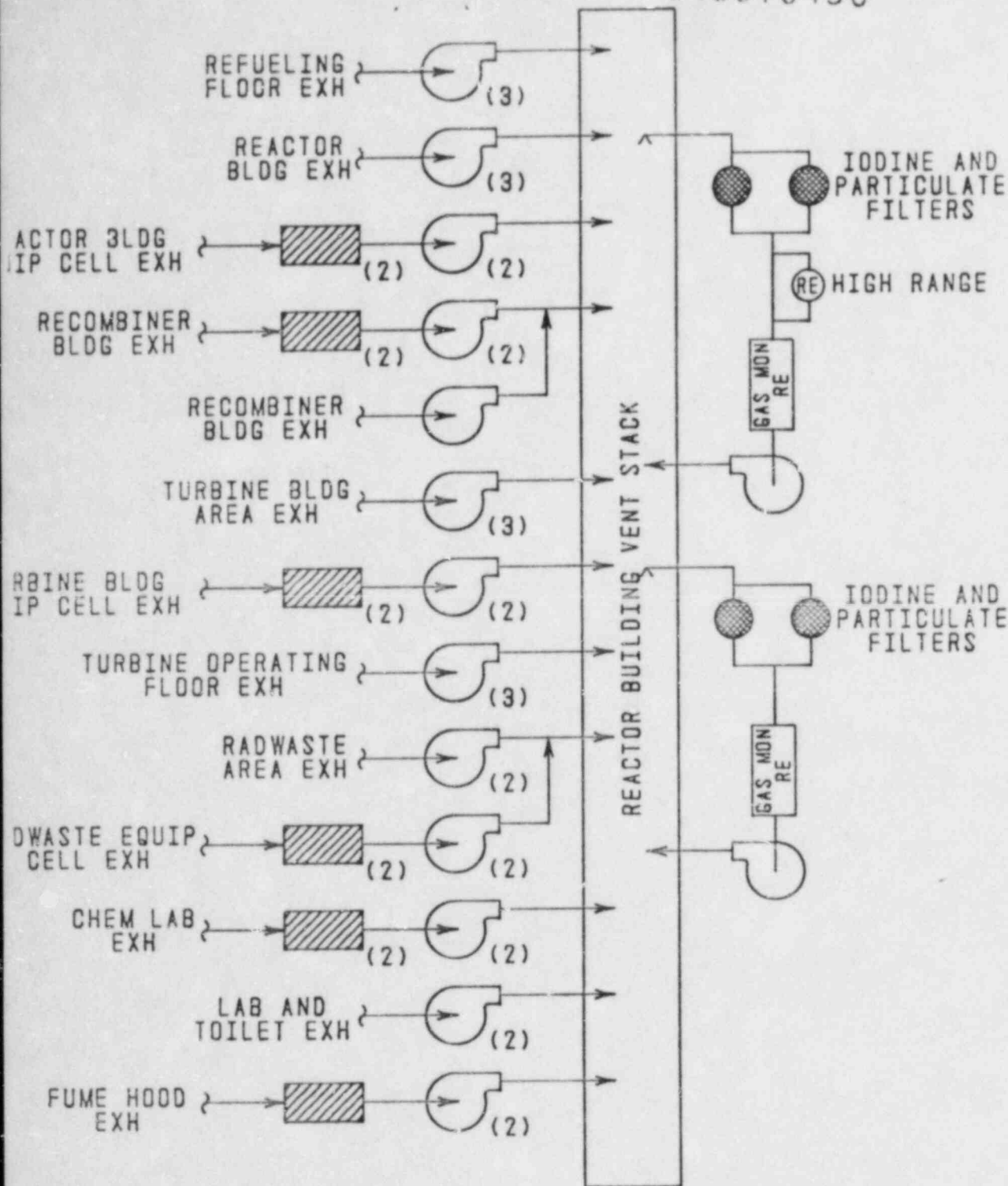
2840010450



PHILADELPHIA ELECTRIC CO.,
PBAPS
UNITS 2 & 3

OFFGAS RADWASTE
TREATMENT SYSTEM

2840010450



1984

ensitive
rocedures.

eing

to develop

hvironmental
om E.A.
taken by E.A.

proved

derway

tment has

of site

EXHAUST FAN

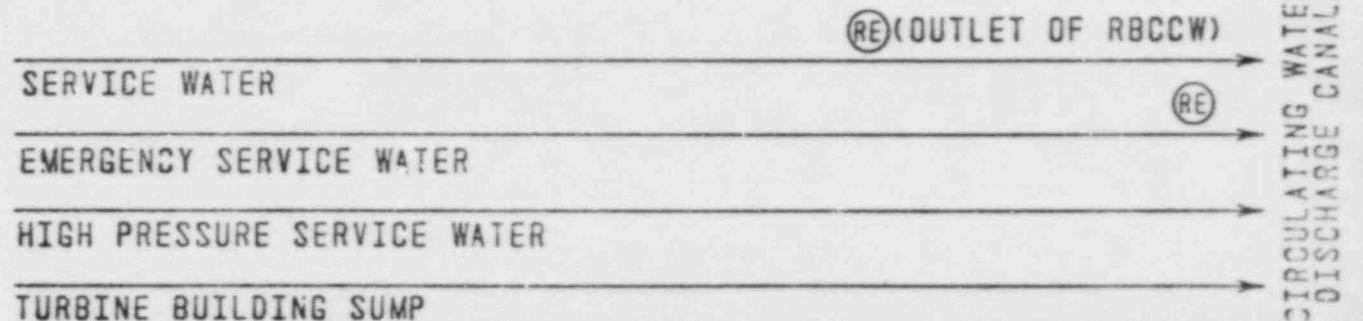
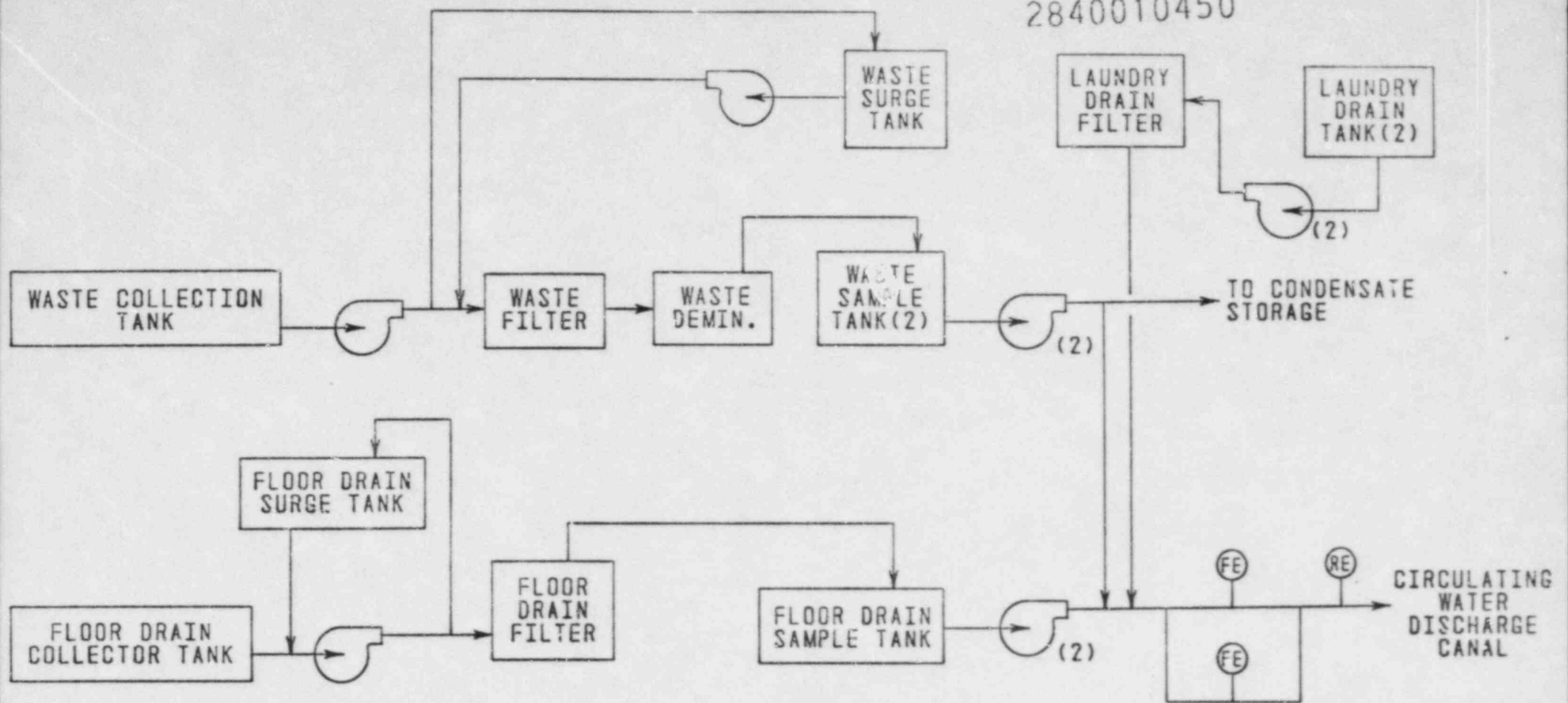
FILTER

PHILADELPHIA ELECTRIC CO.
PBAPS
UNITS 2 & 3

VENTILATION EXHAUST
WASTE TREATMENT
SYSTEM

ital Affairs

2840010450



PHILADELPHIA ELECTRIC CO.
PBAPS
UNITS 2 & 3

LIQUID RADWASTE
TREATMENT SYSTEM

2840010450

VIII. BASESSite Specific Data

Note 1: Liquid dose factors, A_i , for section III.9 were developed using the following site specific data. The liquid pathways involved are drinking water and fish. The maximum exposed individual is an adult.

$$A_i = (U_w / D_w + U_F \times BF_i) K_O \times DP_i \times RC$$

U_w = 730 liters per year; maximum adult usage of drinking water (Reg Guide 1.109, Table E-5)

D_w = 5.4; average annual dilution at Conowingo intake

U_F = 21 kg per year; maximum adult 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, expect P-32 which uses a value of $3.0E03$ pCi/kg per pCi/liter.

K_O = 1.14×10^5 (10⁶ pCi/uCi x 10³ ml/kg x 8760 hr/yr) units conversion factor.

DP_i = dose conversion factor for nuclide, i , for adults in total body or bone, as applicable. Reg Guide 1.109, Table E-11, expect P-32 bone which uses a value of 3.0×10^{-5} .

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

The data for D 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 DP were used as given in Reg Guide 1.109, Revision 1, October 1977. The P-32 BF and DP 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.

Note 2 To develop constant k for section IV.C, the following site specific data were used:

$$H_i (D/Q) = K' Q \frac{(U)}{F \frac{ap}{\lambda_i + \lambda_w}} \times r \times DPL_i \frac{(P Cl - P)}{Y \frac{p}{p}} e^{-\lambda_i t}$$

$K' = 10^6$ pCi/ Ci unit conversion factor

$Q = 40$ Kg/day; cow's consumption rate

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

$\lambda_i = 9.97 \times 10^{-7} \text{ sec}^{-1}$ decay constant for I-131

$\lambda_w = 5.73 \times 10^{-7} \text{ sec}^{-1}$ decay constant for removal of activity in leaf and plant surfaces.

$F_m = 6.0 \times 10^{-3}$ day/liter, the stable element transfer coefficient for I-131.

$r = 1.0$ fraction of deposited radioiodine retained in cow's feed grass.

$DPL = 1.39 \times 10^{-2}$ mrem/pCi - the thyroid ingestion dose factor for I-131 in the infant.

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

$f_s = 0.484$; the fraction of cow feed that is stored feed while the cow is on pasture (average of all farms).

$Y_p = 0.7 \text{ Kg/m}^2$ - the agricultural productivity of pasture feed grass.

$t_f = 2$ days - the transport time from pasture to cow, to milk, to receptor.

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 F. 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.

The model Technical specification LCO for all radionuclides and radioactive materials in particulate from 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.

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 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 4.3 times and 7.2 times, respectively, the values calculated by the Isotopic Analysis Method.

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 determining 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.