Offsite Dose Calculation Manual

Limerick Generating Station
Units 1 and 2

Philadelphia Electric Company
Docket Nos. 50-352 & 50-353

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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 effluent from Limerick Generating Station and establishing setpoints for radioactive effluent monitoring instrumentation. The results of these calculations are required to determine compliance with Appendix A to Operating Licenses (numbers to be assigned), "Technical Specification and Bases for Limerick Generating Station Units No. 1 and 2.

Liquid Pathway Dose Calculations

A. Surveillance Requirement 4.11.1.1.2 - Liquid Radwaste Release Compliance with 10CFR20 Limits

Limerick Generating Station Units 1 and 2 have one common discharge point for liquid releases under normal circumstances. In the event of heat exchanger leakage, additional release pathways are possible through the plant service water system and the RHR service water system. 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 the dissolved or entrained noble gases and $2x10^{-4}$ uCi/ml total activity concentration for all dissolved or entrained noble gases as specified in Technical Specification 3.11.1.1. Each tank of radioactive waste is sampled prior to release and is quantitatively analyzed for identifiable gamma emitters as specified in Table 4.11-1 of the Technical Specification. 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

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*MPC_i = The MPC specified in 10 CFR 20, Appendix B, Table II, Column 2 for radionuclides other than dissolved or entrained noble gases or 2×10^{-4} uCi/ml for dissolved or entrained noble gases. Any unidentified concentration is assigned an MPC value of 1×10^{-7} uCi/ml.

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

$$\text{Release Rate (gpm)} = \frac{A}{B \times \text{Dilution Factor}}$$

A = The cooling tower blowdown volume which will provide dilution. Maximum flow rate is 10,000 gpm.

B = margin of assurance which includes consideration of the maximum error in the activity setpoint and the maximum error in the flow setpoint and the possibility of multiple release pathways.

B. Surveillance Requirement 4.11.1.2

The primary method of calculating dose contributions from liquid effluents released to areas at or beyond the SITE BOUNDARY will be by using a computer-based calculational program developed using the equations and parameters of R.G. 1.109, Rev. 1, October, 1977 (see bases Note 4) for all organs and age groups. The A_i values used for this calculation are located in the Appendix, Table 1.

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 as a minimum those appropriate radionuclides listed in Table II.A.1. These radionuclides account for virtually 100 percent of the total body dose and bone dose from liquid effluents.

$$D_\tau = \sum_i R \sum_i \left[A_{i\tau} \sum_{i=1}^{m} \Delta t_1 \; C_{i1} \; F_1 \right]$$

where:

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

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R_i = reported release points

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

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 4.11.1.1-1), in uCi/ml.

$A_{i\tau}$ = the site related ingestion dose commitment factor to the total body or organ, τ, for each radionuclide listed in Table II.A.1, in mrem-ml per hr-uCi. 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 from the discharge structure to the Schuylkill River.

I.C Surveillance Requirement 4.11.1.3.1

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

To estimate expected concentration of the various radionuclides (C_{il}) in the undiluted liquid effluent, the duration of liquid release (Δt), and the near field average dilution factor (F_{ℓ}), the expected plant operating status shall be reviewed. If no operational changes are expected which would affect C_{il}, Δt, or F_{ℓ} the same values as used to evaluate Section II.B may be used.

If any operational changes are expected during the following 31 days which could affect C_{il}, Δt or F_{ℓ}, the values used shall be based on plant history. During the initial stages of plant operation, the values for C_{il}, Δt, and F_{ℓ} as given in LGS FSAR Section 11.2 and EROL Section 5.2 may be used.

* See Note 1 in Bases

TABLE II.A.1

LIQUID EFFLUENT INGESTION DOSE FACTORS
(Decay Corrected)

A_i Dose Factor (mrem-ml per hr-uci)

adionuclide	Total Body	Bone
Cs-137	3.42×10^5	3.82×10^5
Cs-134	5.79×10^5	2.98×10^5
P-32	5.11×10^4	2.05×10^5
Cs-136	8.42×10^4	2.97×10^4
Zn-65	3.32×10^4	2.31×10^4
Sr-90	1.35×10^5	5.52×10^5
H-3	3.29×10^{-1}	*
Na-24	1.35×10^2	1.35×10^2
I-131	1.16×10^2	1.40×10^2
Co-60	5.70×10^2	*
I-133	1.23×10^1	2.31×10^1
[illegible]-55	1.06×10^2	6.61×10^2
Sr-89	6.36×10^2	2.21×10^4
Te-129m	1.70×10^3	1.08×10^4
Mn-54	8.34×10^2	8.34×10^2
o-58	2.00×10^2	*
Fe-59	9.26×10^2	1.02×10^3
e-131m	3.88×10^2	9.53×10^2
a-140	1.33×10^1	2.03×10^2
e-132	1.21×10^3	1.99×10^3

OTE: 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, an adult.

There is no bone dose factor given in R.G. 1.109 for these nuclides.

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II. Gaseous Pathway Dose Calculations

The controling receptor locations for the gaseous pathway dose calculations are based on a land-use census performed in 1975 to 1976 which has been periodically updated. The most recent update was in 1983.

A. Surveillance Requirement 4.11.2.1.1

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 Isotopic Analysis Method, utilizes the results of noble gas analysis required by specification 4.11.2.1.1 and 4.11.2.1.2. Method (b), 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.

For normal operations, it is expected that method (a) will be used. However, if isotopic release data are not available method (b) can be used. Method (a) allows more operating flexibility by using data that more accurately reflect actual releases.

a. Isotopic Analysis Method

$$D_{TB} = \sum_i (K_i \, (X/Q)_v \, Q_{iv})$$

$$D_s = \sum_i [(L_i + 1.1M_i) \, (X/Q)_v]$$

where:

The location is the site boundary, 790m NE 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.

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K_i = the total body dose factor due to gamma emissions for each identified noble gas radionuclide. Values are listed on Table III.A.1 and are taken from R.G. 1.109, in mrem/yr per uCi/m^3.

$(X/Q)_v$ = 1.1×10^{-5} sec/m^3; the highest calculated annual average relative concentration for any area at or beyond the SITE BOUNDARY for all vent releases (NE boundary).

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 III.A.1 and are taken from R.G. 1.109, in mrem/yr per uCi/m^3.

M_i = the air dose factor due to gamma emissions for each identified noble gas radionuclide. Values are listed on Table III.A.1 and are taken from R.G. 1.109, in mrad/yr per uCi/m^3.

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

b. Gross Release Method

$$D_{TB} = K \, (X/Q)_V \, \dot{Q}_{NV}$$

$$D_s = (L + 1.1M) \, (X/Q) \, \dot{Q}_{NV}$$

where:

The location is the site boundary, 790m NE from the vents. This location results in the highest calculated dose to an individual form noble gas releases.

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

D_s = skin dose rate, in mrem yr.

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

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$(X/Q)_v$ = $1.1x10^{-5}$ sec/m^3; the highest calculated annual average relative concentration for any area at or beyond the SITE BOUNDARY for all vent releases (NE boundary).

$\dot{Q}_{MV}$ = 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 = $9.73x10^3$ mrem/yr per Ci/m^3; the skin dose factor due to beta emissions for Kr-87 (Reg. Guide 1.109, Table B-1).

M = $6.17x10^3$ mrad/yr per uCi/m^3; the air dose factor due to gamma emissions for Kr-87 (Reg. Guide 1.109, Table B-1).

2. The primary method of calculating dose contribution from Iodine-131, Iodine-133, tritium, and radioactive material in particulate form, other than noble gases, with half-lives greater than eight days will be by using a computer-based calculational program developed using the equations and parameters of R.G. 1.109, Rev. 1, October, 1977 (see bases Note 4) for all organs and age groups.

If the computer model is not available, the dose contributions from Iodine-131, Iodine-133, tritium, and radioactive materials in particulate form, other than noble gases, with half-lives greater than eight days will be calculated using the equation below:

$$D_T = (CF) \quad P_i \, [W_v \dot{Q}_{iv}]$$

where:

The location is the site boundary, 762m ESE from the vents.

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

CF = 1.02; the correction factor accounting for the use of iodine-131 and iodine-133 in lieu of all radionuclides released in gaseous effluents.

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P_{I-131} = 1.62×10^{7} mrem/yr per uCi/m^3; the inhalation dose parameter for I-131 inhalation pathway. 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).**

P_{I-133} = 3.85×10^{6} mrem/yr per uCi/m^3; the inhalation dose parameter for I-133 inhalation pathway. 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_v = 1.00×10^{-5} sec/m^3; the highest calculated annual average relative concentration for any area at or beyond the SITE BOUNDARY for all vent releases (NE boundary).

$\dot{Q}_{IV}$ = the release rate of iodine-131 and/or iodine-133 in gaseous effluents from all vent releases, determined by the effluent sampling and analysis program (Technical Specification Table 4.8.2) in uCi/sec.

II.B <u>Surveillance Requirement 4.11.2.2</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 dose rate from radioactive noble gas releases shall be determined by either of two methods. Method (a), the Isotopic Analysis Method, utilizes the results of noble gas analysis required by specification 4.11.2.1.1 and 4.11.2.1.2, Method (b), 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.

For normal operations, it is expected that method (a) will be used. However, if isotopic release data are not available method (b) can be used. Method (a) allows more operating flexibility by using data that more accurately reflect actual releases.

* See Note 2 in Bases

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1.* for gamma radiation

a) Isotopic Analysis Method

$$D_\gamma = 3.17\times10^{-8} \sum_i \left[M_i \, (X/Q)_v \, Q_{iv} \right]$$

where:

The location is the SITE BOUNDARY, 762m ESE from the vents. This location results in the highest calculated gamma air dose from noble gas releases.

where:

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 III.A.1 and are taken from R.G. 1.109 in mrad/yr per uCi/m³.

$(X/Q)_V$ = 1.1×10^{-5} sec/m³; the highest calculated average relative concentration from vent releases for any area at or beyond the SITE BOUNDARY.

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. Gross Release Method

$$D_\gamma = 3.17\times10^{-8} \; (M \; (X/Q)_v \; Q_v)$$

where:

The location is the SITE BOUNDARY 790m NE 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).

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$(X/Q)_V$ = 1.1×10^{-5} sec/m^3; the highest calculated annual average relative concentration from vent releases for any area at or beyond the SITE BOUNDARY.

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.

2. for beta radiation

a. Isotopic Analysis

$$D_\beta = 3.17 \times 10^{-8} \sum_i \left[N_i \quad (X/Q)_v \; Q_{iv} \right]$$

where:

The location is the SITE BOUNDARY 790m NE from the vents. This location is the highest calculated gamma air dose from noble gas releases.

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 III.A.1 and are taken from Reg. Guide 1.109, in mrad/yr per uCi/m^3.

$(X/Q)_v$ = 1.1×10^{-5} sec/m^3; the highest calculated annual average relative concentration from vent releases for any area at or beyond the SITE BOUNDARY.

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.

b. Gross Release Method

$$D_\beta = 3.17 \times 10^{-8} \; N \quad (X/Q)_v \; Q_v$$

where:

The location is the SITE BOUNDARY 790m NE from the vents. This location results in the highest calculated gamma air dose from noble gas releases.

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D_{β} = beta air dose, in mrad.

3.17×10^{-8} = years per second.

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

$(\chi/Q)_v$ = 1.1×10^{-5} sec/m^3; the highest calculated annual average relative concentration from vent releases for any area at or beyond the SITE BOUNDARY.

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.

II.C Surveillance Requirement 4.11.2.3

The primary method of calculating dose to an individual from Iodine-131, Iodine-133, tritium, and radioactive materials in particulate form, other than noble gases, with half-lives greater than eight days in gaseous effluents released to areas at and beyond the SITE BOUNDARY, will be by using a computer-based calculational program developed using the equations and parameters of R.G. 1.109, Rev. 1, October, 1977 (see based Note 4) for all organs and age groups.

If the computer model is not available, the following expression will be used:

$$D = 3.17 \times 10^{-8} \ (CF) \ (0.5) \sum_I \left[R_I \ W_v \ Q_{IV} \right]$$

where:

Location is the critical pathway dairy 1770m ESE from vents.

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

3.17×10^{-8} = years per second.

CF = 1.00; the correction factor accounting for the use of Iodine-131 and Iodine-133 in lieu of all radionuclides released in gaseous effluents.

0.5 = fraction of iodine releases which are nonelemental.

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R_{I-131} = $9.51\times10^{11}m^2$ (mrem/yr) per uCi/sec; the dose factor for Iodine-131. The dose factor is based on the critical individual organ, thryoid, and most restrictive age group, infant. See Site Specific Data.**

R_{I-133} = $8.13\times10^{9}m^2$ (mrem/yr) per uCi/sec; the dose factor factor for Iodine-133. The dose factor is based on the critical individual organ, thyroid, and most restrictive age group, infant. See Site Specific Data.**

W_v = 1.82×10^{-9} meters^{-2}; (D/Q) for the food pathway for vent releases.

Q_{IV} = the release of Iodine-131 and/or Iodine-133 determined by the effluent sampling and analysis program (Technical Specification Table 4.11.2.1.2-1) in uCi. Releases shall be cumulative over the calendar quarter or year, as appropriate.

II.D <u>Surveillance Requirement 4.11.2.5.1</u>

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 - III.B.1

b. beta air dose - III.B.2

c. organ dose - III.C

The projected dose calculation shall be based on expected releases 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.

To estimate the expected releases of noble gases and radioiodines in gaseous effluents, the expected plant operating status shall be reviewed. If no operational changes are expected which would affect the magnitude or type of releases the same values used to evaluate Sections III.B.1, III.B.2 and III.C may be used.

If any operational changes are expected during the following 31 days which could affect the magnitude or type of releases, the values used shall be based on plant history. During the initial stages of plant operation the values for releases expected as given in LGS FSAR Section 11.3 may be used.

** See Note 3 in Bases

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TABLE III.A.1

DOSE FACTORS FOR EXPOSURE TO A SEMI-INFINITE CLOUD OF NOBLE GASES

uclide	β-air*(Ni)	β-Skin**(Li)	γ-Air*(Mi)	γ-Body**(Ki)
r-83m	2.88E-04***	---	1.93E-05	7.56E-08
r-85m	1.97E-03	1.46E-03	1.23E-03	1.17E-03
Kr-85	1.95E-03	1.34E-03	1.72E-05	1.61E-05
Kr-87	1.03E-02	9.73E-03	6.17E-03	5.92E-03
Kr-88	2.93E-03	2.37E-03	1.52E-02	1.47E-02
Kr-89	1.06E-02	1.01E-02	1.73E-02	1.66E-02
Kr-90	7.83E-03	7.29E-03	1.63E-02	1.56E-02
Xe-131m	1.11E-03	4.76E-04	1.56E-04	9.15E-05
Xe-133m	1.48E-03	9.94E-04	3.27E-04	2.51E-04
Xe-133	1.05E-03	3.06E-04	3.53E-04	2.94E-04
Xe-135m	7.39E-04	7.11E-04	3.36E-03	3.12E-03
e-135	2.46E-03	1.86E-03	1.92E-03	1.81E-03
e-137	1.27E-02	1.22E-02	1.51E-03	1.42E-03
e-138	4.75E-03	4.13E-03	9.21E-03	8.83E-03
r-41	3.28E-03	2.69E-03	9.30E-03	8.84E-03

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* $\frac{\text{mrad-m}^3}{\text{pCi-yr}}$

** $\frac{\text{mrem-m}^3}{\text{pCi-yr}}$

***2.88E-04 = 2.88×10^{-4}

EFERENCE: Regulatory Guide 1.109, Revision 1, October 1977

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V. TOTAL DOSE

A. Surveillance Requirement 4.11.4.1

If the doses as calculated by the equations in this manual do not exceed the limits given in Technical Specifications 3.11.1.2.a, 3.11.2.b, 3.11.2.a, 3.11.2.2.b, 3.11.2.3.a, or 3.11.2.3.b by more than two times, the conditions of Technical Specification 3.11.4.2 have been met.

B. Surveillance Requirement 4.11.4.2

If the doses as calculated by the equations in this manual exceed the limits given in Technical Specifications 3.11.1.2.a, 3.11.1.2.b, 3.11.2.2.a, 3.11.2.2.b, 3.11.2.3.a, or 3.11.2.3.b 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 3.11.4.1.

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 above).

The method provided in the second paragraph above is used only to evaluate the contribution from direct radiation dose. The direct radiation dose is then added to the dose or dose commitment determined in accordance with the methods in the first paragraph above to determine total dose from all pathways.

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%.

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.A Unique Reporting Requirement (6.9.1.12) - Dose Calculations for the Radioactive Effluent Release 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 Radioactive Effluent Release Report shall be submitted within 60 days after January 1 of each year.

I.A Surveillance Requirement 4.12.1

The radiological environmental monitoring samples shall be collected pursuant to Table VI.A.1 from the locations shown on Figures VI.A.1, VI.A.2 and VI.A.3 and shall be analyzed pursuant to the requirements of Table 3.12-1 of the LGS Technical Specifications.

II.A Surveillance Requirement 4.12.3

Pursuant to Section 4.12.3 of the LGS Technical Specifications, the laboratory performing the radiological environmental analyses shall participate in an interlaboratory comparison program which has been approved by the NRC. This program is the Environmental Protection Agency's (EPA's) Environmental Laboratory Intercomparison Studies (cross check) Program. Our participation code is CJ. Participation includes all of the determinations (sample medium-radionuclide combination) that are offered by the EPA and that are also included in the monitoring program. The results of the analysis of these cross check samples will be included in the Annual Radiological Environmental Operating Report.

TABLE VI.A.1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF SAMPLES AND SAMPLE STATION NAME	STATION CODE	STATION SECTOR	DISTANCE (MILES)	COMMENTS
Direct Radiation (a)	40 LOCATIONS				(a) TLD sites were chosen in accordance with Limerick Generating Station's Technical Specifications Table 3.12-7, Item 1. The inner ring and outer ring stations cover all sectors.
	INNER RING LOCATIONS				The control and special interest stations provide information on population centers and other special interest locations.
	1) Evergreen & Sanatoga Road	36S1	N	0.6	
	2) Sanatoga Road	3S1	NNE	0.6	
	3) Possum Hollow Road	5S1	NE	0.4	
	4) LGS Training Center	7S1	ENE	0.5	
	5) Keen Road	10S3	E	0.5	
	6) LGS Information Center	11S1	ESE	0.5	
	7) Longview Road, SE Sector Site Boundary	14S1	SE	0.6	
	8) Longview Road, SSE Sector Site Boundary	16S2	SSE	0.6	
	9) Railroad Track Along Longview Road	18S1	S	0.3	
	10) Impounding Basin, SSW Sector Site Boundary	21S1	SSW	0.5	
	11) Transmission Tower, SW Sector Site Boundary	23S2	SW	0.5	
	12) WSW Sector, Site Boundary	25S1	WSW	0.5	
	13) Meteorological Tower 2 Site	26S3	W	0.4	
	14) WNW Sector Site Boundary	29S1	WNW	0.5	
	15) NW Sector Site Boundary	32S1	NW	0.6	
	16) Meteorological Tower 1 Site	34S2	NNW	0.6	
	OUTER RING LOCATIONS				
	1) Ringing Rock Substation	35F1	N	4.2	
	2) Laughing Waters GSC	2E1	NNE	5.1	
	3) Neiffer Road	4E1	NE	4.6	
	4) Pheasant Road, Game Farm Site	7E1	ENE	4.2	
	5) Transmission Corrider,	10E1	E	3.9	
	6) Trappe Substation	10F3	ESE	5.5	
	7) Vaughn Substation	13E1	SE	4.3	
	8) Pikeland Substation	16F1	SSE	4.9	
	9) Showden Substation	19D1	S	3.6	
	10) Sheeder Substation	20F1	SSW	5.2	
	11) Porter's Mill Substation	24D1	SW	3.9	
	12) Transmission Corrider, Hoffecker and Keim Streets	25D1	WSW	4.0	
	13) Transmission Corrider, W. Cedarville Road	28D2	W	3.8	
	14) Prince Street	29E1	WNW	4.9	
	15) Poplar Substation	31D2	NW	3.9	
	16) Yarnell Road	34E1	NNW	4.6	

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	CONTROL AND SPECIAL INTEREST LOCATIONS				
	1) Birch Substation (control)	5H1	NE	25.8	
	2) Pottstown Landing Field	6C1	ENE	2.1	
	3) Reed Road	9C1	E	2.2	
	4) King Road	13C1	SE	2.9	
	5) Spring City Substation	15D1	SE	3.2	
	6) Linfield Substation	17B1	S	1.6	
	7) Ellis Woods Road	20D1	SSW	3.1	
	8) Lincoln Substation	31D1	NW	3.0	
	5 LOCATIONS				
2. Airborne	1) Keen Road	10S3	E	0.5	(b) These stations provide for coverage of the highest annual ground level D/Q, and a control location. Radioiodine cartridges which have been tested for performance by the manufacturer are used at all times
	2) LGS Information Center	11S1	ESE	0.5	
Radioiodine and Particulates (b)	3) Longview Road	14S1	SE	0.6	
	4) King Road	13C1	SE	2.9	
	5) 2301 Market Street, Philadelphia, PA (control)	13H4	SE	28.8	
3. Waterborne (c)	9 LOCATIONS				(c) All surface and drinking stations have continuous samplers.
Surface	1) Limerick Intake (control)	24S1	WSW	0.3	
	2) Linfield Bridge	16B2	SSE	1.1	
Ground	1) LGS Information Center	11S1	ESE	0.5	
	2) South Sector Farm Near Site	18A1	S	1.0	
Drinking	1) Phoenixville Water Works	15F7	SSE	5.2	
	2) Pottstown Water Authority (control)	28F3	WNW	5.9	
	3) Philadelphia Suburban Water Company	15F4	SSE	7.8	
	4) Citizens Home Water Company	16C2	SSE	2.4	
Sediment From Shoreline	1) Vincent Dam Pool Area	16C4	S	1.9	
4. Ingestion	6 LOCATIONS				
Milk (d)	1) Control Station	22F1			(d) Milk samples are taken from several farms surrounding LGS. These farms include those with the highest dose potential from which samples are routinely available, as well as a control station. The locations of the farms is not listed herein due to a longstanding agreement with the farmers involved. In return for being allowed to sample and analyze the milk, PECo has agreed not to divulge the location of the farms.
	2)	5C1			
	3)	10B1			
	4)	25B1			

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Fish (e)	1) Middle of Vincent Pool Upstream to Pigeon Creek	16C5	SSE	1.9	(e) Two species of recretionally important fish, sunfish and brown bullhead, will be sampled if available.
	2) Upsteam of LGS, Keim Street Bridge to Hanover Street Bridge (control)	29C1	WNW	3.2	
Food Products (f)	1) LGS Information Center	11S1	ESE	0.5	(f) Food products are to be samples as part of the LGS Technical Specification Program only if milk sampling is not performed. The milk pathway, which results in a higher maximum dose to humans than the vegetation pathway, is monitored at location near the site, and is a better indicator than vegetation samples. In addition, no crops grown in the vicinity of LGS are irrigated with water in which liquid plant wastes have been discharged.

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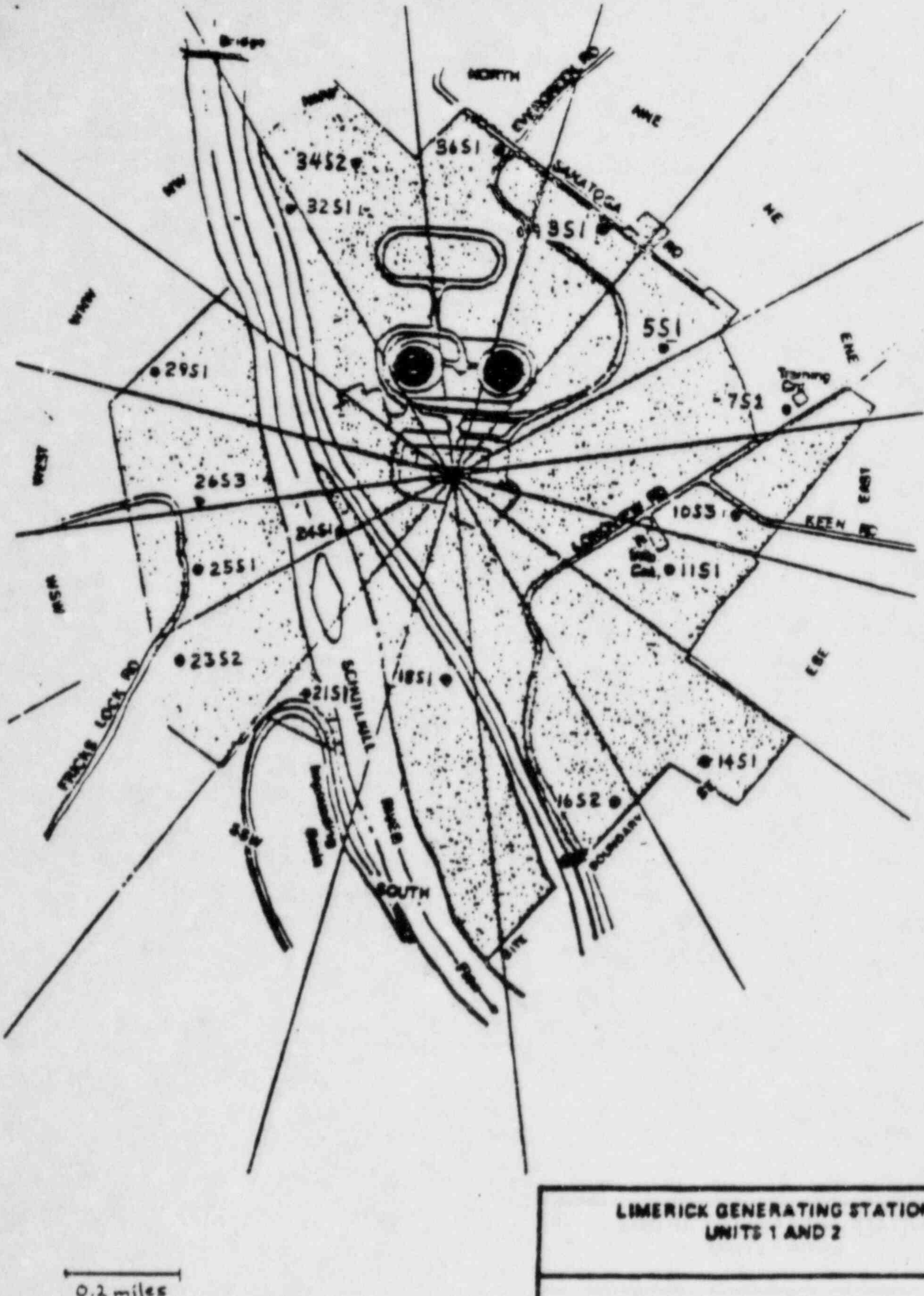

LIMERICK GENERATING STATION
UNITS 1 AND 2

ENVIRONMENTAL SAMPLING STATIONS
SITE BOUNDARY

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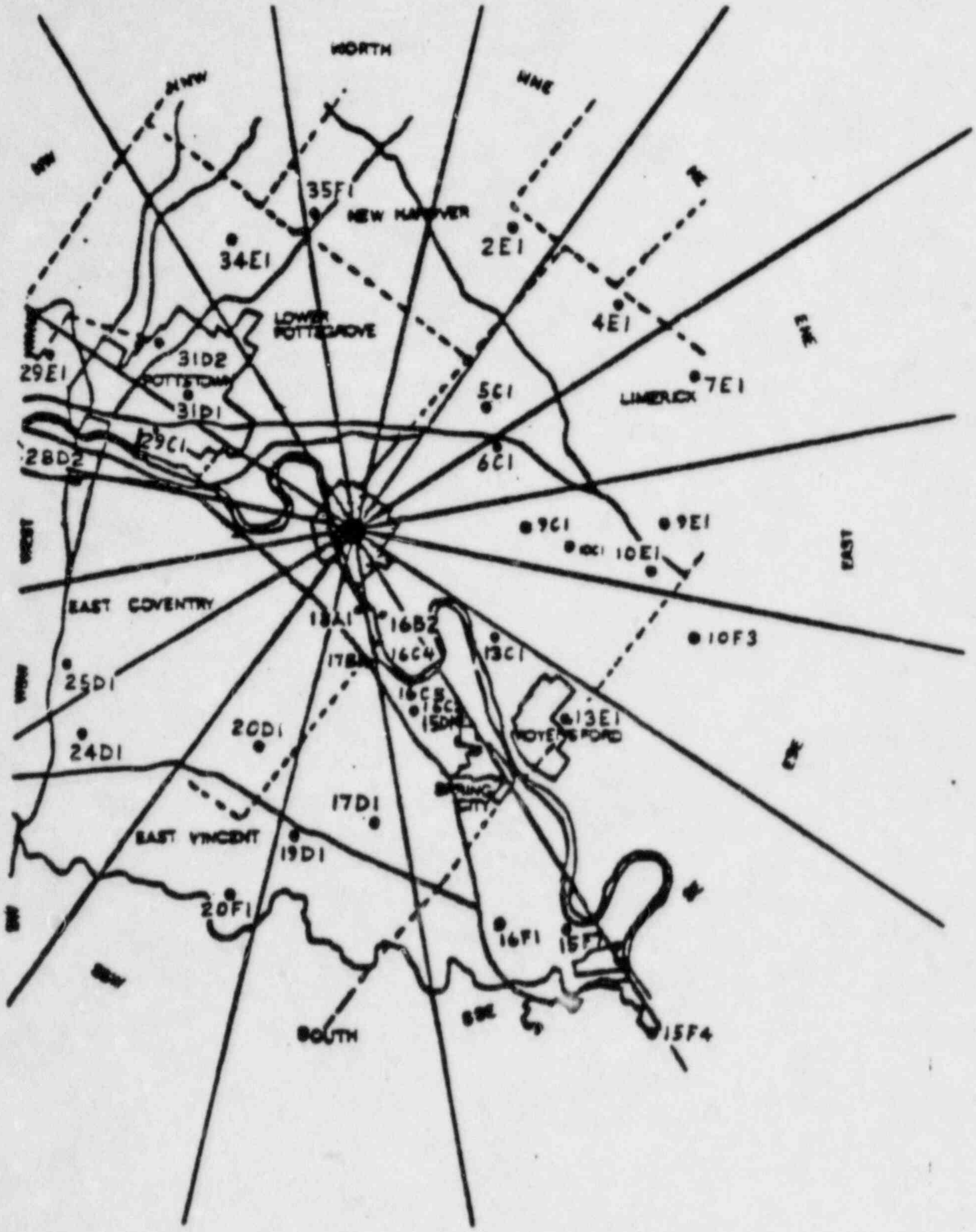
FIGURE VI.A.1



LIMERICK GENERATING STATION
UNITS 1 AND 2

ENVIRONMENTAL SAMPLING STATIONS
INTERMEDIATE DISTANCE

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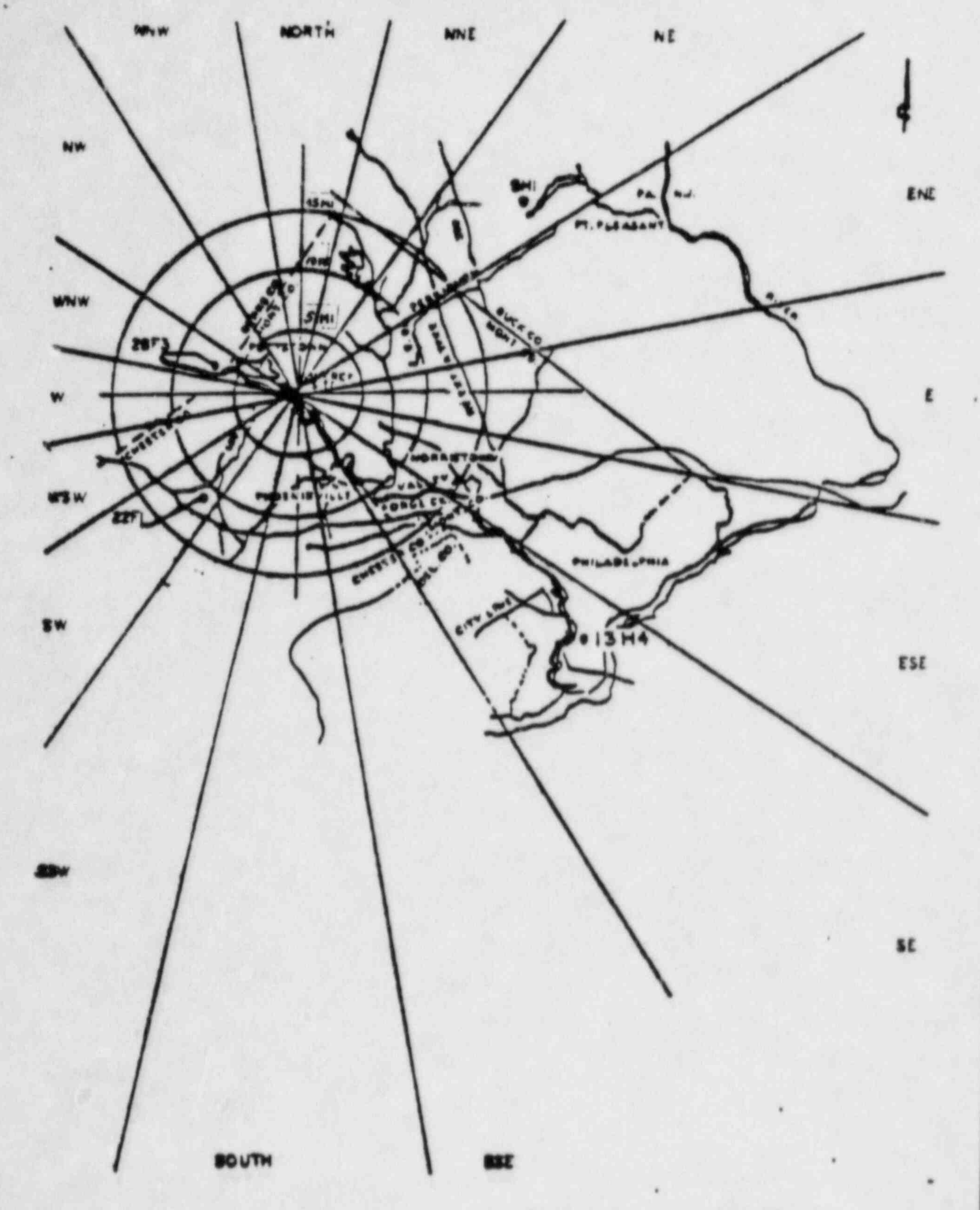
FIGURE VI.A.2



LIMERICK GENERATING STATION
UNITS 1 AND 2

ENVIRONMENTAL SAMPLING STATIONS
DISTANT LOCATIONS

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FIGURE VI.A.3

II. Effluent Radiation Monitor Setpoint Calculations

A. Liquid Effluents

1. Radwaste Discharge Line Radiation Monitor - Monitor alarm setpoints will be determined in order to assure compliance with 10CFR20. The setpoints will indicate if the concentration of radionuclides in the liquid effluent at the site boundary is approaching the concentrations specified in 10CFR20, Appendix B, Table II, Column 2 for radionuclides other than dissolved or entrained noble gases. The setpoints will also assure that a concentrations listed on Technical Specification Table 3.11.1.1-1 for dissolved or entrained noble gases is not exceeded. The following method applies to liquid releases from the plant via the cooling tower blowdown line when determining the high-high alarm setpoint for the Liquid Radwaste Effluent Monitor during all operational conditions. When the high-high alarm setpoint is reached or exceeded, the releases will be automatically terminated.

   a. The setpoint for the Liquid Radwaste Effluent monitor will be calculated as follows:

      1) Determine C_t

$$C_t = \frac{\sum C_i \times D}{5\sum \frac{C_i}{MPC_i}} \times F_i$$

where:

C_t = concentration at the liquid radwaste discharge line monitor (prior to dilution to assure 10CFR20.106 limits are not exceeded; uCi/cc

$\sum C_i$ = total concentration of liquid effluent discharge prior to dilution with cooling tower blowdown; uCi/cc

5 = margin of safety factor including F_i uncertainty, to assure that the high-high alarm will terminate the discharge before 10CFR20 limits are exceeded.

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$\sum_i \frac{Ci'}{MPC}$ = sum of the ratio of the isotopic concentrations divided by their respective MPC.

D = dilution factor due to blowdown from the cooling tower; calculated by dividing the total flow (cooling tower blowdown plus radwaste discharge flow) by the radwaste discharge flow.

F_i = Ratio of MPC-weighted releases in the liquid radwaste effluent monitor flow path divided by the total MPC-weighted liquid releases;

e.g.

$$\frac{\left[\sum \frac{Ci}{MPC}\right]_i \text{ release of flow path of interest}}{\sum \left[\sum \frac{Ci}{MPC}\right]_i \text{ all release flow paths}}$$

2) Determine C.R.

$$C.R. = \frac{C_t}{E}$$

where:

C.R. = the calculated monitor count rate above background attributable to the radionuclides; CPS

E = the detection efficiency of the monitor; uCi/cc/cps.

3) The monitor high-high alarm setpoint above background should be set at the C.R. value.

b. The monitor high-high alarm setpoint will be calculated monthly. The calculation will be based on isotopes detected in the liquid radwaste sample tanks during the previous month. If there were no isotopes detected during the previous month then the annual average concentrations (EROL Table 3.5-3) of those isotopes listed in Table II.A.1 will be used to determine the setpoint.

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If the calculated setpoint is less than the existing monitor setpoint, the setpoint will be reduced to the new value. If the calculated setpoint is greater than the existing monitor setpoint, the setpoint may remain at the lower value or increased to the new value.

2. Plant Service Water Monitor - Monitor alarm setpoint will be determined in order to be able to identify and rectify any potential problem due to excessive leakage of heat exchangers. This setpoint results in concentrations at the site boundary far below 10CFR20, Appendix B, Table II limits. The service water side of the fuel pool heat exchangers is kept at higher pressure than the shell side to prevent potential radioactive contamination of the service water.

   a. The setpoint for the Plant Service Water monitor will be calculated as follows:

      1) Determine $C.R._s$

$$C.R._s = Z \times C.R._B$$

where:

$C.R._s$ = the calculated monitor setpoint count rate attributable to system leakage plus background; CPM

Z = multiplier to establish monitor setpoint count rate above background count rate

$C.R._B$ = monitor count rate attributable to background radiation; CPM

   b. The monitor high alarm setpoint will be calculated monthly. The calculation will be based on the background count rate during the previous month. If the calculated setpoint is less than the existing monitor setpoint, the setpoint will be reduced to the new value. If the calculated setpoint is greater than the existing setpoint, the setpoint may remain at the lower value or increased at the new value.

3. RHR Service Water Monitor - Monitor alarm setpoints will be determined in order to be able to identify and rectify any potential problem due to excessive leakage of heat exchangers. This

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setpoint results in concentrations at the site boundary far below 10CFR20, Appendix B, Table II limits. The following method applies to liquid releases from the plant to the spray pond when determining the high-high alarm setpoint for the RHR Service Water Monitor during all operational conditions. When the high-high alarm setpoint is reached or exceeded, the releases will be automatically terminated.

a. The setpoint for the RHR Service Water monitor will be calculated as follows:

1) Determine C.R.

$$C.R._S = Z \times C.R._B$$

where:

$C.R._S$ = the calculated monitor count rate above background attributable to system leakage plus background; CPM

Z = multiplier to establish monitor setpoint count rate above background count rate.

$C.R._B$ = monitor count rate attributable to background radiation; CPM

E = the detection efficiency of the monitor; uCi/cc/CPM.

3) The monitor high-high alarm setpoint above background should be set at the C.R. value.

b. The monitor high-high alarm setpoint will be calculated monthly. The calculation will be based on the background count rate during the previous month. If the calculated setpoint is less than the existing monitor setpoint, the setpoint will be reduced to the new value. If the calculated setpoint is greater than the existing monitor setpoint, the setpoint may remain at the lower value or increased to the new value.

B. Gaseous Effluents

1. North and South Stack Vent Radiation Monitors - Monitor alarm setpoints will be determined in order to assure compliance with 10CFR20. The setpoints will indicate if the dose rate at or beyond the site boundary due to radionuclides in the gaseous effluent released from the site is

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approaching 500 mrem/yr to the whole body and 3000 mrem/yr to the skin from noble gases, or 1500 mrem/yr to the thyroid from I-131 and I-133 (inhalation pathway only). The alarm setpoint for the gaseous effluent radiation monitors will be calculated as follows:

a. North and South Stack Vent Noble Gas Channel

1) Determine C_t

$$C_t = \frac{2.12E-3\ Q_t}{F}$$

where:

C_t = the concentration at the vent noble gas radiation monitor which indicates that the 10CFR20 dose rate limit at the site boundary has been reached; uCi/cc

2.12E-3 = unit conversion factor to convert uCi/sec/CFM to uCi/cc.

Q_t = the total release rate of all noble gas radionuclides in the gaseous effluent (uCi/sec) based on the lower of either the whole body exposure limit (500mrem/yr) or the skin exposure (3000mrem/yr) Q_t will be calculated as shown in Attachment 1.

F = anticipated maximum vent flow rate; CFM

2) Determine the noble gas channel alarm setpoint (S_N)

$$S_N = VF_i\ C_t$$

where:

VF_i = fraction of total gaseous releases on an MPC-weighted basis for the previous month that are from the release point of interest;

e.g. $\frac{\text{north vent releases}}{\text{releases from all plant release points}}$

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b. North and South Stack Vent Iodine Channel

1) Determine C_t

$$C_t = \frac{2.12E-3\ Q_t}{F}$$

where:

C_t = the concentration at the vent iodine radiation monitor which indicates that the 10CFR20 dose rate limit at the site boundary has been reached; uCi/cc.

2.12E-3 = unit converstion factor to convert uCi/sec/CFM to uCi/cc.

Q_t = the total release rate of radioiodines in the gaseous effluents (uCi/sec) Q_t will be calculated as shown in Attachment 1.

F = maximum antcipated vent flow; CFM.

2) Determine the iodine channel alarm setpoint (S_I)

$$S_I = VF_i\ C_t$$

where:

VF_i = fraction of iodine releases on an MPC-weighted basis for the previous month that are from the release point of interest; e.g. $\frac{\text{north vent releases}}{\text{releases from all plant release points}}$

2. The monitor alarm setpoints will be calculated monthly. These calculations will be based on isotopic analysis of releases made during the previous month. If there were no isotopes detected during the previous month then isotopic concentrations calculated from the expected annual average noble gas and iodine-131 and 133 isotopic release rates (EROL Table 3.5-6) will be used to determine the setpoint. If any calculated setpoint is less than the existing monitor setpoint, the setpoint will be reduced to the new value. If the calculated setpoint is greater than the existing value, the setpoint may

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remain at the lower value or increased to the new value.

Due to the fact that I-131 and I-133 comprise 98.5% of the total dose based on expected annual average releases (LGS FSAR Table 11.3-1) and particulates contribute a minor fraction of the total dose, a particulate channel setpoint will not be calculated for purposes of the ODCM.

3. Containment Purge Isolation

a. Monitor alarm setpoints will be determined for the North Stack Vent Wide Range Gas Monitor to initiate closure of the containment purge supply and exhaust lines in the event that high radioactivity releases are detected. The setpoint will be determined to alarm and isolate containment in the event that 10CFR20 dose rates at the site boundary are approached or exceeded. The setpoint for the Wide Range Gas Monitor will be calculated as follows:

1) Determine C_t

$$C_t = \frac{2.12E-3\ Q_t}{F}$$

where:

C_t = the concentration at the Wide Range Gas Radiation Monitor which indicates that the 10CFR20 dose rate limit at the site boundary has been reached; uCi/cc

2.12E-3 = unit conversion factor to convert uCi/cc/CFM to uCi/sec.

Q = the total release rate of all noble gas radionuclides in the gaseous effluent (uCi/sec) based on the lower of either the whole body exposure limit (500mrem/yr) or the skin exposure limit (3000mrem/yr).

F = maximum anticipated vent flow rate; CFM.

2) Determine the Wide Range Gas Monitor trip setpoint (S_N)

$$S_N = VF_i\ C_t N$$

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where:

WF_i = fraction of total gaseous releases on an MPC-weighted basis previous month that are from the release point of interest;

e.g. $\frac{\text{north vent releases}}{\text{releases from all plant release points}}$

b. Prior to containment purge and venting, the monitor setpoint will be recalculated. The calculations will be based on the noble gases detected by isotopic analysis of the containment atmosphere. If the calculated setpoint is less than the existing monitor setpoint, the setpoint will be reduced to the new value. If the calculated setpoint is greater than the existing value, the setpoint may remain at the lower value or increased to the new value.

ATTACHMENT 1

Q_t Calculations

$$Q_{t(\text{whole body})} = \frac{500}{(X/Q)_v \; K_i S_i}$$

where:

Q_t = the total release rate of all noble gas radionuclides in the gaseous effluent; uCi/sec.

$(X/Q)_v$ = 1.1×10^{-5} sec/m^3; the highest calculated annual average relative concentration for an area at or beyond the site boundary for all vent releases (NE boundary).

K_i = whole body gamma dose factors due to noble gases listed on Table III.A.1 (from Reg. Guide 1.109, Table B-1).

S_i = the fraction of the total radioactivity in the gaseous effluent comprised by noble gas radionuclide "i".

$$Q_{t(\text{skin})} = \frac{3000}{(X/Q)_v \sum_i (L_i + 1.1M_i)S_i}$$

$(X/Q)_v$ = 1.1×10^{-5} sec/m^3; the highest calculated annual average relative concentration for an area at or beyond the site boundary for all vent releases (NE boundary).

L_i = beta skin dose factor due to noble gases, listed on Table III.A.1 (from Reg. Guide 1.109, Table B-1).

M_i = air dose factor due to noble gases, listed on Table III.A.1 (from Reg. Guide 1.109, Table B-1).

S_i = the fraction of the total radioactivity in the gaseous effluent comprised by noble gas radionuclide "i".

$$Q_{t(\text{thyroid})} = \frac{1500}{(X/Q)_d \sum P_i A_i}$$

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where;

Q_t = the total release rate of radioiodines in the gaseous effluent; uCi/sec.

$(X/Q)_d$ = $1.0x10^{-5} sec/m^3$; the highest calculated annual average depleted concentration for an area at or beyond the site boundary for all vent releases (NE boundary).

P_i = inhalation dose factor for child thyroid for radioiodines mrem-m^3/uCi-yr; $1.62x10x10^7$ for I-131 and $3.85x10^6$ for I-133

A_i = the fraction of the total radioactivity in the gaseous effluent (iodine channel) comprised by radionuclide "i".

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Site Specific Data

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

$A_{i\tau}$ = $(U_w/D_w + U_F \times BF_i)\, K_0 \times DF_i$

U_w = 730 liters per year; maximum adult usage of drinking water (Reg. Guide 1.109, Table 3-5).

D_w = 85; average annual dilution at Phoenixville Water Authority 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 fresh-water fish. Reg. Guide 1.109, Table A-1, except P-32 which uses a value of 3.0E03 pCi/kg per pCi/liter.

K_0 = 1.14×10^5(10^6 pCi/uCi x 10^3ml/kg x 8760 hr/yr) units conversion factor.

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

The data for D was taken from data published in Limerick Generating Station Units 1 and 2 Environmental Report Operating License Stage, Volume 3. All other data except P-32 BF and DFi were used as given in Reg. Guide 1.109, Revision 1, October 1977. A P-32 BFi value was taken from Kahn, B. and K. S. Turgeon, "The Bioaccumulation Factor for Phosphorus-32 in Edible Fish Tissue", NUREG-CR-1336, March, 1980. A P-32 DF value was taken from Limits for Intakes of Radionuclides by Workers, International Commission on Radiological Protection ICRP Publication 30, Supplement to Part 1, 1979.

ote 2: To develop constant P_{I-131} for Section III.A, the following data were used:

P_{I-131} = K' (BR) (DFA)

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

BR = 3700 m^3/yr; child's inhalation rate.

DFA I-131 = 4.39×10^{-3} mrem/pCi; the thyroid inhalation dose factor for I-131 in the child.

The pathway is the inhalation pathway for a child. All values are taken from Regulatory Guide 1.109, Revision 1, October 1977.

Note 3: To develop constant R for section III.C, the following site specific data were used:

$$R_i^G (D/Q) = \frac{K' Q_F (U_{ap})}{\lambda_i + \lambda_w} F_m \times r \times (DFL_i)_a \frac{f_p (1-f_s)}{Y_p} e^{-\lambda_i t_f}$$

K' = 10^6 pCi/uCi unit conversion factor

Q_F = 6Kg/day; goat's consumption rate

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

λ_i = 9.97×10^{-7} sec^{-1} decay constant for I-131; 9.48×10^{-6} for I-133.

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

F_m = 6.0×10^{-2} day/liter, the stable element transfer coefficient for I-131.

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

DFL_i = 1.39×10^{-2}mrem/pCi - the thyroid ingestion dose factor for I-131 in the infant; 3.31×10^{-3} mrem/pCi for I-133.

f_p = 0.75; the fraction of the year the goat is on pasture (average of all farms).

f_s = 0.0; the fraction of goat feed that is stored feed while the goat is on pasture (average of all farms).

Y_p = 0.7 Kg/m^2 - the agricultural productivity of pasture feed grass.

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

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The pathway is the grass-goat milk ingestion pathway. These data were derived from data published in Limerick Generating Station Units 1 and 2 Environmental Report Operating Stage, Volume 3. All other data were used as given in Reg. Guide 1.109, Revision 1, October 1977. Similar data were used to develop the constant R for I-133.

Note 4: The methodology described herein will be implemented via computer codes. These codes have been verified as documented in:

1. G.A. Technologies, RM-21A Computational Models, Document No. E-115-1241, June 1984.

2. G. A. Technologies, Meteorological Monitoring, Display and Reporting System/RM-21A, Document No. 0375-9032, January, 1984.

Surveillance Requirement 4.11.1.2 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 10CFRPart 50, Appendix I", Revision 1, October 1977 and NUREG-0133 "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants". October 1978.

Surveillance Requirement 4.11.2.1.1 and 4.11.2.1.2 - 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", October 1978, and Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," Revision 1, July 1977 with site specific dispersion curves and disperion methodology. 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 Limerick Generating Station Units 1 and 2 Environmental Report Operating License Stage, Volume 3, the values calculated

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by the Gross Release Method for total body dose rate and skin dose rate are 4.8 times and 3.25 times, respectively, the values calculated by the Isotopic Analysis Method.

For the Gross Release Method, Kr-87 and Kr-88 are used for the limiting skin and total body dose factors respectively, due to half life considerations. Kr-89, the nuclide with the highest dose factors per Regulatory Guide 1.109 Table B-1 has a half-life of 3.2 minutes while the half-lives of Kr-87 and Kr-88 are 76 minutes and 2.8 hours respectively. Therefore, by the time that gaseous effluents have been transported offsite, Kr-89 will have decayed enough so that Kr-87 and Kr-88 are effectively the most limiting nuclides.

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 and iodine-133 through the inhalation pathway will be used. Since the expected annual releases presented in LGS FSAR Table 11.3-1 indicate that iodine-131 and iodine-133 releases have the major dose impact this approach is appropriate. The value calculated is multiplied by 1.02 to account for the thyroid dose from all other nuclides. This allows for expedited analysis and calculation of compliance with the LCO.

Surveillance Requirement 4.11.2.2 and 4.11.2.3 - 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", October 1978, and Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors", Revision 1. July 1977 with site specific dispersion curves and dispersion methodology. 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 Limerick Generating Station Units 2 and 3 Environmental Report Operating License Stage, Volume 3, the values calculated by the Gross Release Method for total body dose rate and skin dose rate are 4.8 times and 3.7 times, respectively, the values calculated by the Isotopic Analysis Method.

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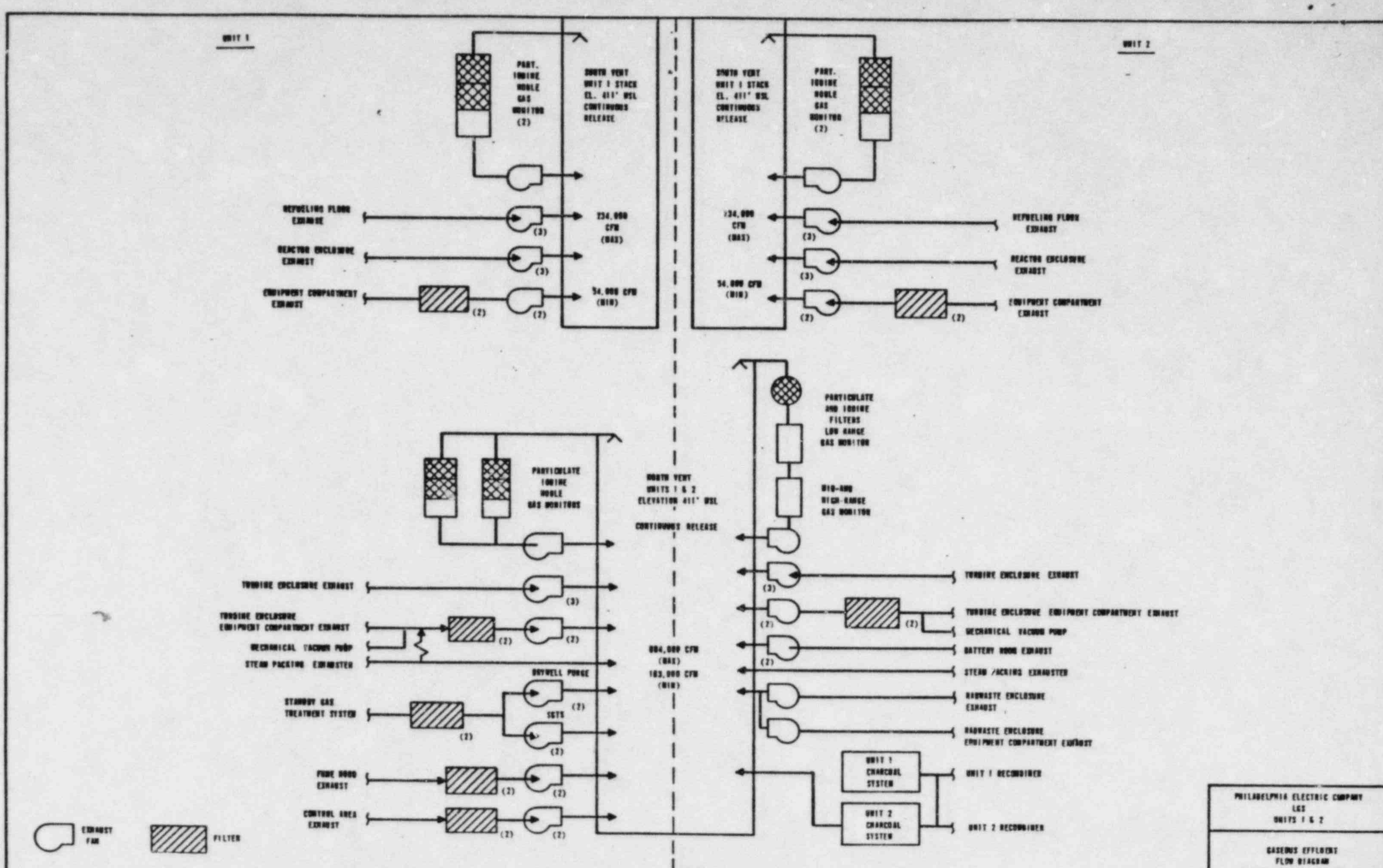
Dose, Iodine-131, Tritium, and Radioactive Material in Particulate Form

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 Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors", Revision 1, July 1977 with site specific dispersion curves and dispersion methodology. 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 and iodine-133 releases. Since the iodine-131 and iodine-133 dose accounts for 99.97 percent of the total dose to the thyroid, the value calculated is not increased.


UNIT 1
UNIT 2
PART. IODINE NOBLE GAS MONITOR (2)
SOUTH VENT UNIT 1 STACK EL. 411' MSL CONTINUOUS RELEASE
234,000 CFM (MAX)
54,000 CFM (MIN)
REFUELING FLOOR EXHAUST
REACTOR ENCLOSURE EXHAUST
EQUIPMENT COMPARTMENT EXHAUST
PARTICULATE AND IODINE FILTERS LOW RANGE GAS MONITOR
MID-AND HIGH-RANGE GAS MONITOR
PARTICULATE IODINE NOBLE GAS MONITORS
SOUTH VENT UNITS 1 & 2 ELEVATION 411' MSL
CONTINUOUS RELEASE
884,000 CFM (MAX)
183,000 CFM (MIN)
TURBINE ENCLOSURE EXHAUST
TURBINE ENCLOSURE EQUIPMENT COMPARTMENT EXHAUST
MECHANICAL VACUUM PUMP
STEAM PACKING EXHAUSTER
DRYWELL PURGE
SGTS
STANDBY GAS TREATMENT SYSTEM
FUME HOOD EXHAUST
CONTROL AREA EXHAUST
BATTERY ROOM EXHAUST
STEAM PACKING EXHAUSTER
RADWASTE ENCLOSURE EXHAUST
RADWASTE ENCLOSURE EQUIPMENT COMPARTMENT EXHAUST
UNIT 1 CHARCOAL SYSTEM
UNIT 2 CHARCOAL SYSTEM
UNIT 1 RECOMBINER
UNIT 2 RECOMBINER
EXHAUST FAN
FILTER
PHILADELPHIA ELECTRIC COMPANY
LGS
UNITS 1 & 2
GASEOUS EFFLUENT FLOW DIAGRAM
FIGURE 10.4.1
REV. 1

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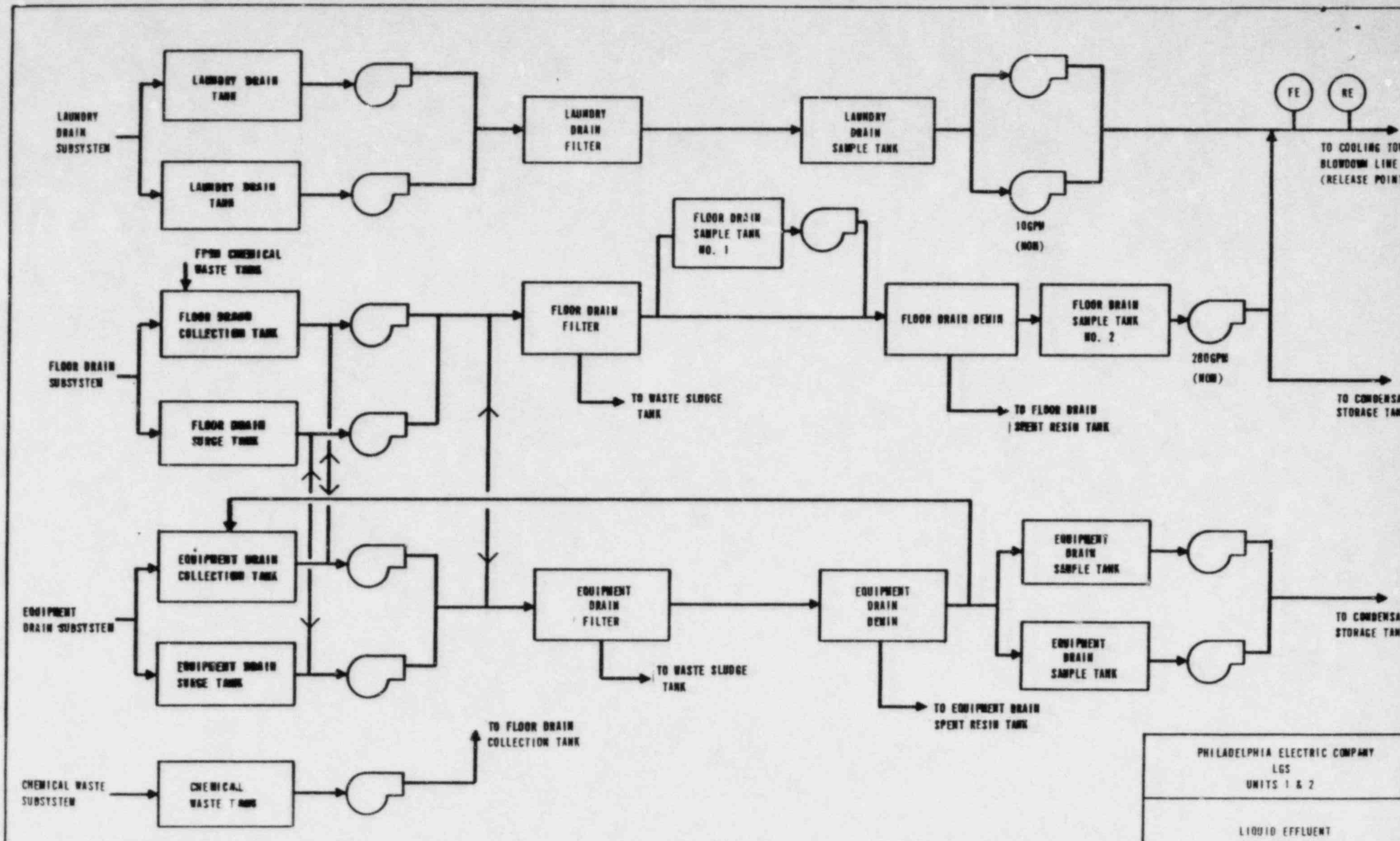

NOTE: COOLING TOWER BLOWDOWN LINE PROVIDES DILUTION FLOW OF 10,000 GPM FOR BOTH UNITS.

PHILADELPHIA ELECTRIC COMPANY
LGS
UNITS 1 & 2

LIQUID EFFLUENT FLOW DIAGRAM

FIGURE IX.A.2 REV. 1

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MAP DEFINING UNRESTRICTED AREAS AND SITE BOUNDARY FOR RADIOACTIVE GASEOUS AND LIQUID EFFLUENTS

FIGURE IX.A.3

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PHILADELPHIA ELECTRIC COMPANY
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PHILADELPHIA, PA. 19101
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JOHN S. KEMPER
VICE-PRESIDENT
ENGINEERING AND RESEARCH

SEP 14 1984

Mr. A. Schwencer, Chief
Licensing Branch No. 2
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Docket Nos.: 50-352
50-353

Subject: Limerick Generating Station, Unit 1 and 2
Revision of Offsite Dose Calculation Manual (ODCM)

Reference: 1) Telecopy, R. E. Martin to T. Robb, dated 9/6/84

2) PECo and NRC Telecon dated 9/10/84

File: GOVT 1-1 (NRC)

Dear Mr. Schwencer:

In accordance with discussions in the reference conference call, the Limerick ODCM has been revised and is included as Attachment 1.

During the conference call, Philadelphia Electric Company committed to supply as an Appendix to the ODCM, the computer model dose parameters for the various age groups and organs for sections II.B, III.A.2, and II.C of the ODCM. This Appendix will be supplied by October 22, 1984.

Sincerely,

V. S. Boyer
for JSK.

JWB/dg/09068403

Attachment

Copy to: See Attached Service List

A009
1/1

cc: Judge Lawrence Brenner (w/enclosure)
Judge Peter A. Morris (w/enclosure)
Judge Richard F. Cole (w/enclosure)
Judge Christine N. Kohl (w/enclosure)
Judge Gary J. Edles (w/enclosure)
Judge Reginald L. Gotchy (w/enclosure)
Troy B. Conner, Jr., Esq. (w/enclosure)
Ann P. Hodgdon, Esq. (w/enclosure)
Mr. Frank R. Romano (w/enclosure)
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Charles W. Elliot, Esq. (w/enclosure)
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Spence W. Perry, Esq. (w/enclosure)
Jay M. Gutierrez, Esq. (w/enclosure)
Atomic Safety & Licensing Appeal Board (w/enclosure)
Atomic Safety & Licensing Board Panel (w/enclosure)
Docket & Service Section (w/enclosure)
Mr. James Wiggins (w/enclosure)
Mr. Timothy R. S. Campbell (w/enclosure)