INFORMATION ONLY

PERRY OPERATIONS MANUAL

Offsite Dose Calculation Manual

TITLE: OFFSITE DOSE CALCULATION MANUAL

REVISION: 5 EFFECTIVE DATE: 11-27-95

PREPARED: Michael Doty 12-1-94
/ Date

EFFECTIVE PIC's

PIC No.	Type of Change	Effective Date
1	Non-Intent	11-27-95
2	Intent	7-14-96
3	Intent	12-9-96
4	Non-Intent	1-5-98
5	Non-Intent	1-22-98
6	Non-Intent	9-2-98
7	Intent	6-14-99
8	Non-Intent	7-19-99
9	Intent	1-24-00
10	Non-Intent	1-24-00

PIC No.	Type of Change	Effective Date
11	Intent	6-6-00
13	Admin	6-12-00
12	Intent	10-11-00
14	Intent	9-27-01
15	Intent	11-19-01

Offsite Dose Calculation Manual

Table of Contents

Offsite Dose Calculation Manual

Table of Contents (Cont.)

List of Tables

List of Tables (Cont.)

List of Figures

SCOPE OF REVISION:

Rev. 5 - 1. Revised in its entirety, no rev bars needed.
2. This revision incorporates the procedural details of the RETS into the ODCM, in accordance with guidance of G. L. 89-01, Letter PY-CEI/NRR-1655L.

Change History

PIC Number: 1 Affected Pages: 8, 9, 9a, 78, 79, 80, 81, 83, 85, 87, 89, 93, 185

Summary of Change:

1. Incorporate Change 1 of Revision 4 (ESW Radiation Monitor Setpoint Methodology, PORC Meeting 95-067).
2. Clarify and correct typographical errors in REMP program.
3. Remove reference to EPA Crosscheck Program (No longer available).
4. Allow for the use of annual average atmospheric conditions for the determination of gaseous dose. This change will make the entire ODCM reflect what the bases section currently states.

PIC Number: 2 Affected Pages: 1, 2, 3, 4, 5, 6, 7, 8, 9, 9a, 85, 113, 116, 118, 119, 120, 121, 123, 125, 126, 127, 129, 132, 133, 135, 139, 140, 142, 143, 144, 145, 149, 150, 151, 152, 153, 154, 155, 160, 166, 167, 169, 170, 171, 172, 173, 173a, 173b, 173c, 175, 179, 185, 186, 188

Summary of Change:

1. Changes to reflect Improved Technical Specifications.
2. Remove references to Service Water Flow Alarm Setpoint.
3. Add commitment numbers.
4. Correct minor typographical error.
5. Incorporate T.S. position statements associated with RETS change.

PIC Number: 3 Affected Pages: i, viii, 10, 128, 129, 130, 133, 135, 151

Summary of Change:

1. Adds Licensing Commitment number to the applicable sections (Tech Spec position statements, previously incorporated).
2. Removes the G50 Radwaste Low Flow Discharge Header flow as an ODCM Control Instrument.

PIC Number: 4 Affected Pages: i, viii, 37, 89, 133, 134, 135

Summary of Change:

1. Revised the Unit 2 vent flow to accurately reflect system flow; additional 12,000 cfm for Service Building Hot Shop ventilation was omitted from the ODCM.
2. Revised Table 3.3.7.10-1 to provide added guidance on system applicability for flow monitors.
3. Added text to Action Statements 122 and 123 to clarify applicability requirements for flow monitors.
4. Deleted sample location 62 (no longer growing produce); added sample location 37 in ENE sector.

Change History (Cont.)

PIC Number: 5 Affected Pages: i, ix, 131

Summary of Change:
1. Revise Table Notation (4) of Table 4.3.7.9-1 to read "during periods of flow". This will allow channel checking to be accomplished without any release of liquid radioactive effluents.

PIC Number: 6 Affected Pages: i, ix, 36, 40, 68, 69, 70, 71, 93, 94, 97

Summary of Change:
1. Corrected discrepancies in skin dose factors between Table 3.1-1 and Regulatory Guide 1.109 (PIFRA 96-3561-003).
2. Adopted a uniform title for the χ/Q (chi-over-Q) factor throughout the text (PIFRA 96-3658-001).
3. Added notations to clarify the unrestricted area boundaries for liquid and gaseous effluents to Figure 3.2.1 (PIFRA 96-3658-001).
4. Added a note to Figure A-2 to clarify which part of USAR Table 2.3-27 the listed χ/Q values are taken from. (PIFRA 98-0319-001)

PIC Number: 7 Affected Pages: i, ix, 131

Summary of Change:
1. Corrective Action 98-2167-002 to allow performing channel checks with no flow in the system.

PIC Number: 8 Affected Pages: i, ix, 5

Summary of Change:
1. Remove the specific reference to the MPL for OD17K0606 since the alarm/trip for this monitor will be fed from the recorder.

PIC Number: 9 Affected Pages: i, ii, ix, 3, 32, 34

Summary of Change:
1. Converted NOTES in Sections 2.1.1.1 and 3.1 to steps to reword actions in accordance with Inspection 98-0022.
2. Identified actual dose rate limits in Section 3.1.
3. Incorporated a batch gaseous release to reflect USAR revision 99-102.

Change History (Cont.)

PIC Number: 10 Affected Pages: i, x, 89, 135

Summary of Change:
1. Revised Figure 5.1-1 to remove sample location #77 and add sample location #2.
2. Revised Table 3.3.7.10-1, Actions 121 and 125 to read "...analyzed for principal gamma emitters as required by Table 4.11.2.1.2-1."
3. Revised Table 3.3.7.10-1, Action 122 to read "...collected within 4 hours...".

PIC Number: 11 Affected Pages: i, x, 11, 13, 69, 70, 135, 143, 146, 149, 150, 153, 154, 184, 185

Summary of Change:
1. Revised Table 3.3.7.10-1, Action 125 to clarify that it only applies to the M14 System in accordance with TSPS No. 0072 and USAR CR 92-0024 (SE 91-0093).
2. Revised Table 3.11.2.1.2-1, Part A to clarify applicability.
3. The changes removing reference to "calendar quarter" and "calendar year" incorporate Operating License Amendment 111.
4. The change removing the discussion about the initial Annual Radiological Environmental Operating Report from Section 6.9.1.6, ¶1, is strictly administrative and no longer applies to Perry.

PIC Number: 13 Affected Pages: i, x

Summary of Change:
1. Correct change type for PIC-11; should be Intent not Non-Intent.

PIC Number: 12 Affected Pages: i, x, 122

Summary of Change:
1. Revised frequency based on the change in fuel cycle to 24 months.

PIC Number: 14 Affected Pages: i, x, 148

Summary of Change:
1. Allow using grab samples to demonstrate that the effluent release point did not increase greater than three times if the noble gas monitor is INOP.

Change History (Cont.)

PIC Number: 15 Affected Pages: i, xi, 16, 18, 20, 22, 24, 26

Summary of Change:
1. Added dose factors for Au-199.

1.0 INTRODUCTION

This Offsite Dose Calculation Manual (ODCM) contains information and methodologies to be used by the Perry Nuclear Power Plant (PNPP), Unit 1, to ensure compliance with PNPP Radiological Effluent Technical Specifications. The Technical Specifications and this ODCM are written to satisfy 10CFR20, 10CFR50.36 and Appendix I, and 40CFR190 requirements.

Sections 2 and 3 of this manual deal with liquid and gaseous radiological effluents, respectively. Each of these sections contain alarm setpoint determination, radiation dose and dose rate calculation methodologies, as well as limits and requirements. Section 4 covers uranium fuel cycle related radiation dose limits including direct dose.

Also included in this manual, in Section 5, is information relating to the Radiological Environmental Monitoring Program (REMP). The figures and tables contained therein designate specific sample types and locations currently used to satisfy the Technical Specification requirements for the REMP as well as sampling reporting and detection capability limits. The sample types and locations are subject to change based on factors including the results of the annual Land Use Census.

The ODCM has been prepared, as generally as possible, in order to minimize future revisions. However, any such changes will be reviewed and approved as per the Administrative Control Section of the PNPP Technical Specifications.

Supplemental information needed to support calculations is contained in the appendices at the end of this manual. Appendix A contains atmospheric dispersion and deposition parameters and Appendix B presents the methodology for determining the lower limit of detection (LLD).

Appendix C of the ODCM was prepared based on guidance of NUREG-1302, "Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Boiling Water Reactors," Generic Letter 89-01, Supplement No. 1. This appendix along with plant procedures will be used by plant personnel to demonstrate compliance with Specification 5.5.4 (Radioactive Effluent Controls Program) of the PNPP Technical Specifications.

2.0 LIQUID EFFLUENTS

2.1 Batch Releases

A batch release is the discharge liquid radioactive waste of a discrete volume. Batch releases from the liquid radwaste system may occur from any of the following tanks: waste sample tank, floor drain sample tank, chemical waste distillate tank, and detergent drain tank (see Figure 2.1-1). The maximum release rate possible, due to pump capacity, is 200 gallons per minute from all release tanks except the detergent drain tanks, which have a maximum release rate of 50 gallons per minute. All of the above liquid radwaste releases go to the Emergency Service Water discharge which is then released through the discharge tunnel after mixing with Service Water effluent and/or and blowdown from Circulating Water system, if present.

The type and frequency of sampling and analysis required by the ODCM Appendix C is given in Table 4.11.1.1.1-1. Prior to sampling for analysis, each batch should be isolated, and thoroughly mixed to assure representative sampling. For mixing, the contents of the tank are recirculated by isolating the tank and turning on equipment that takes suction from and discharges back into the tank. Recycle lines are provided with one or more mixing eductors located near the bottom of the tanks to promote better mixing as well as reducing recirculation time. This ensures that the water in the tank will be mixed and will be representative of the activity in the tank. The minimum recirculation performed is the equivalent of two volumes of the tank contents.

Monitor alarm setpoints will be determined in order to ensure compliance with 10CFR20. The radioactive content of each batch release will be determined prior to release in accordance with Table 4.11.1.1.1-1 of the ODCM Appendix C. Concentrations for tritium and other non-gamma emitting isotopes will be those most recently determined (previous month/quarter).

2.1.1 Monitor Alarm Setpoint Determination

The following methodology is used to calculate the setpoints for the Radwaste Discharge Radiation Monitor - ESW Discharge and Liquid Radwaste Adjustable High Flow Trip Unit to ensure that liquid radwaste effluent releases from the site to unrestricted areas are below the concentrations specified in 10CFR20, Appendix B, Table 2, Column 2 for radionuclides other than noble gases. An MPC of 2.0E-4 µCi/ml has been established for dissolved and entrained noble gases. The Radwaste Discharge Radiation Monitor - ESW Discharge provides alarm and automatic termination of releases prior to exceeding these limits.

c 2

NOTE: Liquid radwaste discharge flow rate shall be verified at least once per four hours, whenever the flow rate measuring device(s) is inoperable during actual releases.

2.1.1.1 Determination of the Minimum Acceptable Dilution Factor

$$DF_o = \sum_i \frac{C_i}{EC_i} \qquad (2.1\text{-}1)$$

Where:

DF_o = the minimum acceptable dilution factor determined from analysis of the liquid effluent to be released;

C_i = the concentration of radionuclide "i" in the batch to be released, in µCi/ml. If the concentration of a radionuclide is below the lower limit of detection, the radionuclide shall not be included as a source term in the setpoint calculation.

EC_i = the limiting EFFLUENT concentration of radionuclide "i", from Appendix B, Table 2, Column 2 of 10CFR20, in µCi/ml and (2.0E-4 µCi/ml for noble gases).

$$DF = 10\ DF_o \qquad (2.1\text{-}2)$$

Where:

DF = the conservative dilution factor used by PNPP to calculate the maximum release rate prior to release in order to ensure compliance with 10CFR20;

DF_o = the minimum acceptable dilution factor, as per equation 2.1-1;

10 = a factor of ten less than 10CFR20 limits as specified in Appendix B, Table 2, Column 2; this factor represents an order of magnitude of conservatism for liquid radwaste releases from PNPP.

2.1.1.2 Determination of the Maximum Allowable Radwaste Tank Discharge Flow Rate

$$f_{max} = \frac{(0.64)(\text{mdf})}{DF} \qquad (2.1\text{-}3)$$

Where:

f_{max} = the maximum allowable radwaste tank discharge flow rate for the batch to be released, in gpm;

DF = the conservative dilution factor, per equation 2.1-2;

mdf = the minimum dilution flow - supplied by the Service Water system, Emergency Service Water system, or Circulating Water system blowdown;

0.64 = an engineering factor to prevent spurious alarms.

2.1.1.3 Liquid Radwaste Discharge Flow Monitor Alarm Setpoint <L00434>

Monitor alarm setpoints are determined to ensure that the concentration of radionuclides in the liquid radwaste effluent released from PNPP to unrestricted areas does not exceed the limits specified in 10CFR20, Appendix B, Table 2, Column 2 for radionuclides other than dissolved or entrained noble gases. A maximum permissible concentration of 2.0E-4 µCi/ml has been established for noble gases dissolved and entrained in liquid effluents.

$$SP_f = (1.25)(f_{act}) \qquad (2.1\text{-}4)$$

Where:

SP_f = Liquid Radwaste Adjustable High Flow Trip Unit (G50-K805A/B or G50-K926/7) alarm setpoint, in gpm;

f_{act} = the actual allowable radwaste tank discharge flow rate for the batch to be released, not to exceed the maximum allowable radwaste discharge flow rate (f_{max}) as defined in equation 2.1-3;

1.25 = the engineering safety factor to prevent spurious alarms.

The liquid radwaste tank discharge flow should be maintained at or below this f_{act} value by proper regulation of the high volume or low volume discharge throttle valves (G50-F153 or G50-F155).

2.1.1.4 Liquid Radwaste Discharge Radiation Monitor Alarm/Trip Setpoint

Monitor alarm/trip setpoints are determined to ensure that the concentration of radionuclides in the liquid radwaste effluent released from PNPP to unrestricted areas does not exceed the limits specified in 10CFR20, Appendix B, Table 2, Column 2 for radionuclides other than dissolved or entrained noble gases. An EC of 2.0E-4 µCi/ml has been established for noble gases dissolved and entrained in liquid effluents.

$$CR_c = \sum_i (C_i)(E_i) \qquad (2.1\text{-}5)$$

Where:

CR_c = the calculated monitor count rate above background, in cpm;

C_i = the concentration of radionuclide "i" in the batch to be released, in µCi/ml;

E_i = the detector efficiency of the monitor for radionuclide "i" in cpm/(µCi/ml).

OR

$$CR_x = (R_s)(F_x)\Sigma\, C_i \qquad (2.1\text{-}6)$$

Where:

CR_x = the cross-calibrated monitor count rate above background, in cpm;

F_x = the cross-calibration factor used to ratio the Liquid Radwaste Discharge Radiation Monitor actual response to the Cs-137 calibrated response;

R_s = the response of the Liquid Radwaste Discharge Radiation Monitor to a Cs-137 calibrated standard, in cpm/(µCi/ml).

$$SP_r = (1.25)\ (f_{max}/f_{act})\ (CR_n) + BG \qquad (2.1\text{-}7)$$

Where:

SP_r = the Radwaste Discharge Radiation Monitor - ESW Discharge alarm/trip setpoint, in cpm;

BG = the background count rate due to internal contamination and radiation levels in the area of the monitor;

CR_n = the monitor net count rate, either CR_c or CR_x, as per equation 2.1-5 or 2.1-6;

1.25 = the engineering safety factor to prevent spurious alarms;

$\frac{f_{max}}{f_{act}}$ = an adjustment factor (to account for the difference between an actual radwaste discharge flow rate to be used for the discharge and maximum allowable radwaste discharge flow rate) to allow operational flexibility and to minimize spurious alarms;

Where:

f_{act} = the actual radwaste discharge flow rate; this value must always be less than or equal to f_{max};

f_{max} = the maximum allowable radwaste discharge flow rate, per equation 2.1-3.

2.1.2 Compliance with 10CFR20 - Liquid Effluent Concentration

In order to show compliance with 10CFR20, the concentrations of radionuclides in liquid effluents will be determined and compared with the limiting effluent concentrations as defined in Appendix B, Table 2, Column 2 of 10CFR20 (2.0E-4 µCi/ml for entrained and dissolved noble gases). Concentrations of radioactivity in effluents prior to dilution will be determined. Concentration in diluted effluent will be calculated using these results prior to each batch release, and following each batch release. PNPP has no continuous releases.

2.1.2.1 Concentration of Radionuclides in Prerelease

The radioactivity content of each batch release will be determined prior to release. PNPP will show compliance with 10CFR20 in the following manner:

The concentration of the various radionuclides in batch releases prior to dilution is divided by the minimum dilution flow to obtain the concentration at the unrestricted area. This calculation is shown in the following equation:

$$Conc_i = \frac{(C_i)(f)}{mdf} \qquad (2.2\text{-}1)$$

Where:

$Conc_i$ = the concentration of radionuclide "i" at the unrestricted area, in µCi/ml;

C_i = the concentration of radionuclide "i" in the batch to be released, in µCi/ml;

f = the radwaste tank discharge flow rate for the batch to be released, in gpm;

mdf = the minimum dilution flow, per equation 2.1-3, in gpm.

The projected radionuclide concentrations in the unrestricted area are compared to the maximum permissible concentrations in Appendix B, Table 2, Column 2 of 10CFR20 (2.0E-4 µCi/ml for dissolved and entrained noble gases) in order to give a final 10CFR20 compliance check, i.e., the following equation must be met:

$$\sum_i \frac{Conc_i}{EC_i} \leq 1 \qquad (2.2\text{-}2)$$

Where:

$Conc_i$ = the concentration of radionuclide "i" at the unrestricted area, in µCi/ml;

EC_i = the limiting effluent concentration of radionuclide "i", from Appendix B, Table 2, Column 2 of 10CFR20 (2.0E-4 µCi/ml for dissolved and entrained noble gases), in µCi/ml.

2.1.2.2 Post Release

The actual radioactivity content of each batch release will be determined following release to show final compliance with 10CFR20.

The concentration of the various radionuclides in batch releases prior to dilution is divided by the actual dilution to obtain the concentration at the unrestricted area. This calculation is shown in the following equation:

$$Conc_i = \frac{(C_i)(V_{lrt})}{V_{dil}} \qquad (2.2\text{-}3)$$

Where:

$Conc_i$ = the actual concentration of radionuclide "i" at the unrestricted area for the release, in µCi/ml;

C_i = the concentration of radionuclide "i" in the batch released, in µCi/ml;

V_{dil} = the actual volume of dilution water during the release (total plant discharge flow, including Service Water, Emergency Service Water, and cooling tower blowdown), in gallons;

V_{lrt} = the actual volume of the liquid radwaste tank discharged for the batch, in gallons.

The concentrations in the unrestricted area are compared to the maximum permissible concentrations in Appendix B, Table 2, Column 2 of 10CFR20 (2.0E-4 µCi/ml for dissolved and entrained noble gases). In order to demonstrate final compliance with 10CFR20, the following equation must be met: | C 2

$$\sum_i \frac{Conc_i}{EC_i} \leq 1 \qquad (2.2\text{-}4)$$ | C 2

Where:

$Conc_i$ = the concentration of radionuclide "i" at the unrestricted area, in µCi/ml;

EC_i = the limiting effluent concentration of radionuclide "i", from Appendix B, Table 2, Column 2 of 10CFR20, in µCi/ml. | C 2

2.2 Continuous Releases

A continuous release is the discharge of fluid wastes of a non-discrete volume, i.e., from a volume or system that has an input flow during the continuous release. Continuous radioactive releases are not planned for PNPP although the potential does exist for RHR heat exchanger leakage into the Emergency Service Water system.

Potentially contaminated discharges from the ESW are monitored by an installed radiation monitoring system. This system consists of two channels, one for monitoring downstream of equipment in Emergency Service Water System Loop A and the other for Emergency Service Water Loop B. If radiation is detected, the affected Emergency Service Water line can be manually isolated. The decision of whether to isolate or not is dependent upon other conditions. The PNPP staff will take appropriate action to limit release. | a 1

The Emergency Service Water discharged will be sampled and analyzed in accordance with ODCM Appendix C, Table 4.11.1.1.1-1. To show compliance with 10CFR20, the sum of the concentrations of radionuclide "i" in unrestricted areas due to both continuous and batch releases divided by that isotope's MPC must again be less than 1.

2.2.1 Monitor Alarm Setpoint Determination

The following methodology is used to calculate the setpoints for the Emergency Service Water loops A & B Radiation Monitors. This methodology ensures an alarm will be received prior to exceeding the concentration limits listed in Appendix B, Table 2, Column 2 of 10CFR20. C2

1. Emergency Service Water Radiation Monitor Alarm Setpoint

$$CR_C = (BG + MR)(0.75)$$

Where:

CR_C = the calculated monitor count rate in cpm;

BG = the background count rate due to internal contamination and radiation levels in the area of the monitor in cpm;

C1 MR = expected monitor response due to 1.0 MPC of a typical reactor water isotopic mix;

0.75 = engineering safety factor

2. Minimum Allowable Background of the Emergency Service Water Radiation Monitor

$$BG_{min} = CR_C - MR$$

Where:

BG_{min} = minimum allowable background to ensure monitor will alarm prior to exceeding 1.0 EC; C2

CR_C = the calculated monitor count rate in cpm;

MR = expected monitor response due to 1.0 EC of a typical reactor water isotopic mix; C2

3. Determination of the Expected Monitor Response based on the Reactor Water Source Term

$$MR = \Sigma \left[\frac{I_{decayed}}{\Sigma \frac{I_{decayed}}{EC_i}} \times Eff_{mon} \right]$$

Where:

MR = expected monitor response due to 1.0 MPC of a typical reactor water isotopic mix;

$I_{decayed}$ = activity of isotope (I) after decaying a given time;

Eff_{mon} = radiation monitor detector efficiency for isotope (I);

EC_i = Effluent concentration value for isotope (I), Appendix B, Table 2, Column 2, 10CFR20

4. Minimum Allowable Setpoint based on Monitor Background

$$CR_{min} = BG + (2\sqrt{BG/2TC})$$

Where:

CR_{min} = Minimum allowable setpoint for a given monitor background (BG);

BG = the background count rate due to internal contamination and radiation levels in the area of the monitor in cpm;

2 = 95% confidence level;

$2TC$ = two times the instrument time constant where

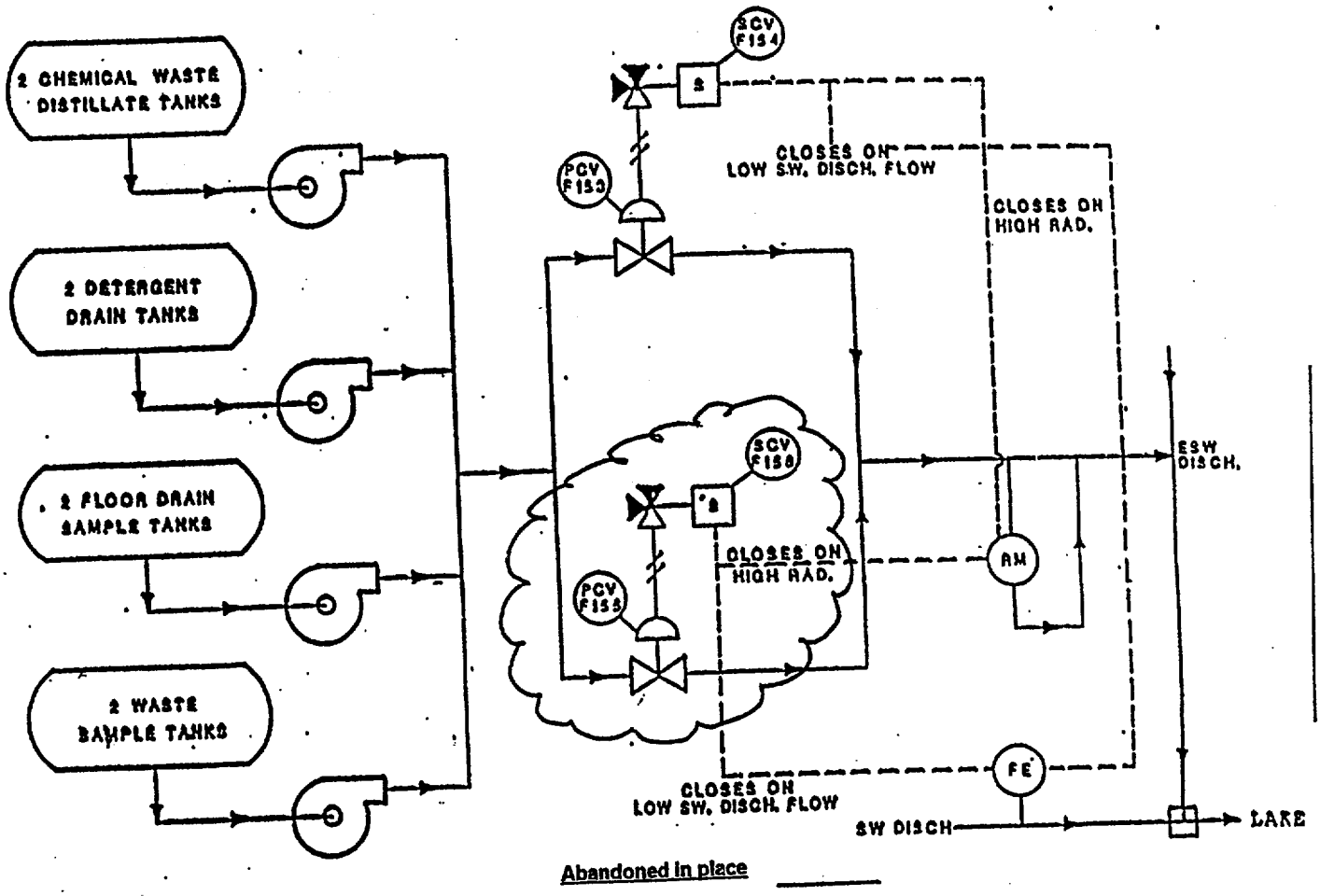
$$TC = \frac{(Log10BG - Log10TC_{locpm})(TC_{hicpm} - TC_{lomin})}{(Log10TC_{hicpm} - Log10TC_{locpm})} + TC_{lomin}$$

Time Constants:

10	cpm - 75 sec.	10000	cpm - 12 sec.
100	cpm - 75 sec.	100000	cpm - 2.5 sec.
1000	cpm - 75 sec.	1000000	cpm - 0.2 sec.

Figure 2.1-1

Liquid Radioactive Waste (LRW) Discharge System



2.3 Compliance with 10CFR50, Appendix I - Liquid Effluent Dose

Doses resulting from liquid effluents will be calculated at least monthly to show compliance with 10CFR50, Appendix I. A cumulative summation of total body and organ doses for the current quarter and current year will be maintained. Additionally, doses due to liquid releases are projected monthly.

2.3.1 Dose Calculations

Radiation doses due to liquid radioactive effluents from PNPP are calculated based on three main dose pathways: potable water, aquatic foods (namely fresh water fish ingestion), and exposure to shoreline deposits. Irrigated food pathways, as discussed in Regulatory Guide 1.109, will not be of concern at PNPP as little or no water from Lake Erie is used for irrigation in the nearby Ohio counties of Lake, Ashtabula, Cuyahoga and Lorain. Nursery businesses and other agricultural activities that require supplemental water generally rely on water drawn from small ponds and streams.

Radiation dose to members of the public for liquid radioactive releases from PNPP will be calculated for the potable water, aquatic food, and shoreline deposit pathways using the following equations:

1. Potable Water:

$$R_{ajp} = 1100 \frac{U_{ap}}{(M_p)(F)} \sum_i (Q_i)(D_{aipj}) \exp(-\lambda_i t_p) \quad (2.3\text{-}1)$$

2. Aquatic Foods:

$$R_{ajp} = 1100 \frac{U_{ap}}{(M_p)(F)} \sum_i (Q_i)(B_{ip})(D_{aipj}) \exp(-\lambda_i t_p) \quad (2.3\text{-}2)$$

3. Shoreline Deposits:

$$R_{ajp} = 110{,}000 \frac{(U_{ap})(W)}{(M_p)(F)} \sum_i (Q_i)(T_i)(D_{aipj}) * [\exp(-\lambda_i t_p)] * [1 - \exp(-\lambda_i t_b)] \quad (2.3\text{-}3)$$

Where:

R_{ajp} = the dose to individuals of age group "a" to organ "j" from all the radionuclides in pathway "p", in mrem;

B_{ip} = the equilibrium biaccumulation factor for radionuclide i in pathway p, expressed as the ratio of the concentration in biota (in pCi/kg) to the radionuclide concentration in water (in pCi/l), from Table 2.3-4, in l/kg;

D_{aipj} = the dose factor, specific to a given age group "a", radionuclide "i", pathway "p", and organ "j", which can be used to calculate the radiation dose from an intake of a radionuclide, in mrem/pCi; or from exposure to a given concentration of a radionuclide in sediment, expressed as a ratio of the dose rate, in mrem/h, and the areal radionuclide concentration, in pCi/m^2, from Tables 2.3-5 through 2.3-9;

F = the flow rate of the liquid effluent in ft^3/s;

NOTE: The normal dilution flow will be between 30,000 and 61,500 gpm (USAR 11.2.3.2)

M_p = the dilution factor at the midpoint of exposure (or the point of withdrawal of drinking water or point of harvest of aquatic food), from Table 2.3-10, dimensionless;

Q_i = the release of radionuclide "i", in Ci;

t_b = the period of time for which the sediment or soil is exposed to the contaminated water, 1.75×10^5 h (20 years);

T_i = the half-life of radionuclide "i", in days;

t_p = the average transit time required for radionuclides to reach the point of exposure, from Table 2.3-11; for internal dose, t_p is the total time elapsed between release of the radionuclides and the ingestion of food or water, in h;

U_{ap} = the usage factor that specifies the exposure time or intake rate for an individual of age group a associated with pathway "p", from Table 2.3-12, in h/yr, 1/yr, or kg/yr;

W = the shoreline width factor, 0.3 (from Regulatory Guide 1.109);

λ_i = the radioactive decay constant of radionuclide "i", in h^{-1};

1100 = a factor to convert from (Ci/yr)/(ft^3/s) to pCi/l;

110,000 = a factor to convert from (Ci/yr)/(ft^3/s) to pCi/l and to account for the proportionality constant used in the sediment radioactivity model.

2.3.2 Cumulation of Doses

The dose contribution from liquid effluents will be calculated at least monthly. Calculations will be performed to determine the maximum total body as well as the maximum organ dose to an individual. These dose calculations will be summed for comparison with quarterly and annual limits. These results will be summed with the doses cumulated from the other months in the quarter of interest and in the year of interest. To assure compliance with the dose limits of 10CFR50, Appendix I the following relationships shall hold:

for the quarter:

Dose ≤ 1.5 mrems total body;

Dose ≤ 5 mrems any organ;

for the year:

Dose ≤ 3 mrems total body;

Dose ≤ 10 mrems any organ.

The quarterly limits given above represent one-half of the annual design objective. If these quarterly or annual limits are exceeded, a special report will be submitted to the NRC, in accordance with ODCM Appendix C controls, stating the reason and corrective action to be taken.

2.3.3 Projection of Doses

Anticipated doses resulting from the release of liquid effluents will be projected monthly. The doses calculated for the present month will be used as the projected doses unless information exists indicating that actual releases could differ significantly in the next month.

If the projected dose, when averaged over 31 days, exceeds 0.06 mrem to the total body or 0.2 mrem to any organ, the liquid radwaste system will be used to process waste. The values for the projected dose impact levels correspond to approximately one forty-eighth of the Appendix I design objective. If continued at this rate for one year, the projected impact would correspond to less than one-fourth of the Appendix I limit. The projected doses will be calculated using equations 2.3-1, 2.3-2, and 2.3-3.

In this case, the source term will be adjusted to reflect this information and the justification for the adjustment noted. This adjustment should account for any radwaste equipment which was operated during the previous month that could be out of service in the coming month.

2.3.4 Population Dose

PNPP's Annual Radioactive Effluent Release Reports, as required by Regulatory Guide 1.21, will include total population dose and average individual doses calculated for radioactive effluent releases. The total population dose and average individual doses will be calculated using average individual transit times and usage factors, Table 2.3-12, (as compared to maximum exposed individual factors used for individual doses). The total population dose will be calculated by dose pathway and organ, with pathway doses being corrected for the fraction of the population assumed to be in each age group (adult, teen, child and infant: 0.71, 0.11, 0.18, 0.0 respectively).

Table 2.3-1

Organs Used for Liquid Effluent Dose Calculations

1. Bone
2. GI Tract
3. Kidney
4. Liver
5. Lung
6. Thyroid
7. Total Body
8. Skin

Table 2.3-2

Age Groups Used for Liquid Effluent Dose Calculations

1. Adult (17 yrs. and older)
2. Teen (11 - 17 yrs)
3. Child (1 - 11 yrs)
4. Infant (0 - 1 yr)

Table 2.3-3

Liquid Effluent Dose Pathways

1. Water Ingestion
2. Shore Exposure
3. Fresh Water Fish Ingestion

Table 2.3-4

Biaccumulation Factors (B_{ip}) (pCi/kg per pCi/liter)

Element	Fish
H	9.0E-01
C	4.6E+03
Na	1.0E+02
P	1.0E+05
Cr	2.0E+02
Mn	4.0E+02
Fe	1.0E+02
Co	5.0E+01
Ni	1.0E+02
Cu	5.0E+01
Zn	2.0E+03
Br	4.2E+02
Rb	2.0E+03
Sr	3.0E+01
Y	2.5E+01
Zr	3.3E+00
Nb	3.0E+04
Mo	1.0E+01
Tc	1.5E+01
Ru	1.0E+01
Rh	1.0E+01
Te	4.0E+02
I	1.5E+01
Cs	2.0E+03
Ba	4.0E+00
La	2.5E+01
Ce	1.0E+00
Pr	2.5E+01
Nd	2.5E+01
W	1.2E+03
Np	1.0E+01
Au	1.0E+01

Table 2.3-5

Ingestion Dose Factors for Adult (mrem/pCi ingested)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
H3	0.00E+00	1.05E-07	1.05E-07	1.05E-07	1.05E-07	1.05E-07	1.05E-07
C14	2.84E-06	5.68E-07	5.68E-07	5.68E-07	5.68E-07	5.68E-07	5.68E-07
NA24	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06
P32	1.93E-04	1.20E-05	7.46E-06	0.00E+00	0.00E+00	0.00E+00	2.17E-05
CR51	0.00E+00	0.00E+00	2.66E-09	1.59E-09	5.86E-10	3.53E-09	6.69E-07
MN54	0.00E+00	4.57E-06	8.72E-07	0.00E+00	1.36E-06	0.00E+00	1.40E-05
MN56	0.00E+00	1.15E-07	2.04E-08	0.00E+00	1.46E-07	0.00E+00	3.67E-06
FE55	2.75E-06	1.90E-06	4.43E-07	0.00E+00	0.00E+00	1.06E-06	1.09E-06
FE59	4.34E-06	1.02E-05	3.91E-06	0.00E+00	0.00E+00	2.85E-06	3.40E-05
CO58	0.00E+00	7.45E-07	1.67E-06	0.00E+00	0.00E+00	0.00E+00	1.51E-05
CO60	0.00E+00	2.14E-06	4.72E-06	0.00E+00	0.00E+00	0.00E+00	4.02E-05
NI63	1.30E-04	9.01E-06	4.36E-06	0.00E+00	0.00E+00	0.00E+00	1.88E-06
NI65	5.28E-07	6.86E-08	3.13E-08	0.00E+00	0.00E+00	0.00E+00	1.74E-06
CU64	0.00E+00	8.33E-08	3.91E-08	0.00E+00	2.10E-07	0.00E+00	7.10E-06
ZN65	4.84E-06	1.54E-05	6.96E-06	0.00E+00	1.03E-05	0.00E+00	9.70E-06
ZN69	1.03E-08	1.97E-08	1.37E-09	0.00E+00	1.28E-08	0.00E+00	2.96E-09
BR83	0.00E+00	0.00E+00	4.02E-08	0.00E+00	0.00E+00	0.00E+00	5.79E-08
BR84	0.00E+00	0.00E+00	5.21E-08	0.00E+00	0.00E+00	0.00E+00	4.09E-13
BR85	0.00E+00	0.00E+00	2.14E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RB86	0.00E+00	2.11E-05	9.83E-06	0.00E+00	0.00E+00	0.00E+00	4.16E-06
RB88	0.00E+00	6.05E-08	3.21E-08	0.00E+00	0.00E+00	0.00E+00	8.36E-19
RB89	0.00E+00	4.01E-08	2.82E-08	0.00E+00	0.00E+00	0.00E+00	2.33E-21
SR89	3.08E-04	0.00E+00	8.84E-06	0.00E+00	0.00E+00	0.00E+00	4.94E-05
SR90	7.58E-03	0.00E+00	1.86E-03	0.00E+00	0.00E+00	0.00E+00	2.19E-04
SR91	5.67E-06	0.00E+00	2.29E-07	0.00E+00	0.00E+00	0.00E+00	2.70E-05
SR92	2.15E-06	0.00E+00	9.30E-08	0.00E+00	0.00E+00	0.00E+00	4.26E-05
Y90	9.62E-09	0.00E+00	2.58E-10	0.00E+00	0.00E+00	0.00E+00	1.02E-04
Y91M	9.09E-11	0.00E+00	3.52E-12	0.00E+00	0.00E+00	0.00E+00	2.67E-10
Y91	1.41E-07	0.00E+00	3.77E-09	0.00E+00	0.00E+00	0.00E+00	7.67E-05
Y92	8.45E-10	0.00E+00	2.47E-11	0.00E+00	0.00E+00	0.00E+00	1.48E-05
Y93	2.68E-09	0.00E+00	7.40E-11	0.00E+00	0.00E+00	0.00E+00	8.50E-05
ZR95	3.04E-08	9.75E-09	6.60E-09	0.00E+00	1.53E-08	0.00E+00	3.09E-05
ZR97	1.68E-09	3.39E-10	1.55E-10	0.00E+00	5.12E-10	0.00E+00	1.05E-04
NB95	6.22E-09	3.46E-09	1.86E-09	0.00E+00	3.42E-09	0.00E+00	2.10E-05
MO99	0.00E+00	4.31E-06	8.20E-07	0.00E+00	9.76E-06	0.00E+00	9.99E-06
TC99M	2.47E-10	6.98E-10	8.89E-09	0.00E+00	1.06E-08	3.42E-10	4.13E-07

Table 2.3-5 (Cont.)

Ingestion Dose Factors for Adult (mrem/pCi ingested)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
TC101	2.54E-10	3.66E-10	3.59E-09	0.00E+00	6.59E-09	1.87E-10	1.10E-21
RU103	1.85E-07	0.00E+00	7.97E-08	0.00E+00	7.06E-07	0.00E+00	2.16E-05
RU105	1.54E-08	0.00E+00	6.08E-09	0.00E+00	1.99E-07	0.00E+00	9.42E-06
RU106	2.75E-06	0.00E+00	3.48E-07	0.00E+00	5.31E-06	0.00E+00	1.78E-04
AG110M	1.60E-07	1.48E-07	8.79E-08	0.00E+00	2.91E-07	0.00E+00	6.04E-05
TE125M	2.68E-06	9.17E-07	3.59E-07	8.06E-07	1.09E-05	0.00E+00	1.07E-05
TE127M	6.77E-06	2.42E-06	8.25E-07	1.73E-06	2.75E-05	0.00E+00	2.27E-05
TE127	1.10E-07	3.95E-08	2.38E-08	8.15E-08	4.48E-07	0.00E+00	8.68E-06
TE129M	1.15E-05	4.29E-06	1.82E-06	3.95E-06	4.80E-05	0.00E+00	5.79E-05
TE129	3.14E-08	1.18E-08	7.65E-09	2.41E-08	1.32E-07	0.00E+00	2.37E-08
TE131M	1.73E-06	8.46E-07	7.05E-07	1.34E-06	8.57E-06	0.00E+00	8.40E-05
TE131	1.97E-08	8.23E-09	6.22E-09	1.62E-08	8.63E-08	0.00E+00	2.79E-09
TE132	2.52E-06	1.63E-06	1.53E-06	1.80E-06	1.57E-05	0.00E+00	7.71E-05
I130	7.56E-07	2.23E-06	8.80E-07	1.89E-04	3.48E-06	0.00E+00	1.92E-06
I131	4.16E-06	5.95E-06	3.41E-06	1.95E-03	1.02E-05	0.00E+00	1.57E-06
I132	2.03E-07	5.43E-07	1.90E-07	1.90E-05	8.65E-07	0.00E+00	1.02E-07
I133	1.42E-06	2.47E-06	7.53E-07	3.63E-04	4.31E-06	0.00E+00	2.22E-06
I134	1.06E-07	2.88E-07	1.03E-07	4.99E-06	4.58E-07	0.00E+00	2.51E-10
I135	4.43E-07	1.16E-06	4.28E-07	7.65E-05	1.86E-06	0.00E+00	1.31E-06
CS134	6.22E-05	1.48E-04	1.21E-04	0.00E+00	4.79E-05	1.59E-05	2.59E-06
CS136	6.51E-06	2.57E-05	1.85E-05	0.00E+00	1.43E-05	1.96E-06	2.92E-06
CS137	7.97E-05	1.09E-04	7.14E-05	0.00E+00	3.70E-05	1.23E-05	2.11E-06
CS138	5.52E-08	1.09E-07	5.40E-08	0.00E+00	8.01E-08	7.91E-09	4.65E-13
BA139	9.70E-08	6.91E-11	2.84E-09	0.00E+00	6.46E-11	3.92E-11	1.72E-07
BA140	2.03E-05	2.55E-08	1.33E-06	0.00E+00	8.67E-09	1.46E-08	4.18E-05
BA141	4.71E-08	3.56E-11	1.59E-09	0.00E+00	3.31E-11	2.02E-11	2.22E-17
BA142	2.13E-08	2.19E-11	1.34E-09	0.00E+00	1.85E-11	1.24E-11	3.00E-26
LA140	2.50E-09	1.26E-09	3.33E-10	0.00E+00	0.00E+00	0.00E+00	9.25E-05
LA142	1.28E-10	5.82E-11	1.45E-11	0.00E+00	0.00E+00	0.00E+00	4.25E-07
CE141	9.36E-09	6.33E-09	7.18E-10	0.00E+00	2.94E-09	0.00E+00	2.42E-05
CE143	1.65E-09	1.22E-06	1.35E-10	0.00E+00	5.37E-10	0.00E+00	4.56E-05
CE144	4.88E-07	2.04E-07	2.62E-08	0.00E+00	1.21E-07	0.00E+00	1.65E-04
PR143	9.20E-09	3.69E-09	4.56E-10	0.00E+00	2.13E-09	0.00E+00	4.03E-05
PR144	3.01E-11	1.25E-11	1.53E-12	0.00E+00	7.05E-12	0.00E+00	4.33E-18
ND147	6.29E-09	7.27E-09	4.35E-10	0.00E+00	4.25E-09	0.00E+00	3.49E-05
W187	1.03E-07	8.61E-08	3.01E-08	0.00E+00	0.00E+00	0.00E+00	2.82E-05
NP239	1.19E-09	1.17E-10	6.45E-11	0.00E+00	3.65E-10	0.00E+00	2.40E-05
Au199	0.00E+00	7.00E-8	5.89E-8	0.00E+00	2.74E-7	0.00E+00	1.13E-5

Table 2.3-6

Ingestion Dose Factors for Teenager (mrem/pCi ingested)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
H3	0.00E+00	1.06E-07	1.06E-07	1.06E-07	1.06E-07	1.06E-07	1.06E-07
C14	4.06E-06	8.12E-07	8.12E-07	8.12E-07	8.12E-07	8.12E-07	8.12E-07
NA24	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06
P32	2.76E-04	1.71E-05	1.07E-05	0.00E+00	0.00E+00	0.00E+00	2.32E-05
CR51	0.00E+00	0.00E+00	3.60E-09	2.00E-09	7.89E-10	5.14E-09	6.05E-07
MN54	0.00E+00	5.90E-06	1.17E-06	0.00E+00	1.76E-06	0.00E+00	1.21E-05
MN56	0.00E+00	1.58E-07	2.81E-08	0.00E+00	2.00E-07	0.00E+00	1.04E-05
FE55	3.78E-06	2.68E-06	6.25E-07	0.00E+00	0.00E+00	1.70E-06	1.16E-06
FE59	5.87E-06	1.37E-05	5.29E-06	0.00E+00	0.00E+00	4.32E-06	3.24E-05
CO58	0.00E+00	9.72E-07	2.24E-06	0.00E+00	0.00E+00	0.00E+00	1.34E-05
CO60	0.00E+00	2.81E-06	6.33E-06	0.00E+00	0.00E+00	0.00E+00	3.66E-05
NI63	1.77E-04	1.25E-05	6.00E-06	0.00E+00	0.00E+00	0.00E+00	1.99E-06
NI65	7.49E-07	9.57E-08	4.36E-08	0.00E+00	0.00E+00	0.00E+00	5.19E-06
CU64	0.00E+00	1.15E-07	5.41E-08	0.00E+00	2.91E-07	0.00E+00	8.92E-06
ZN65	5.76E-06	2.00E-05	9.33E-06	0.00E+00	1.28E-05	0.00E+00	8.47E-06
ZN69	1.47E-08	2.80E-08	1.96E-09	0.00E+00	1.83E-08	0.00E+00	5.16E-08
BR83	0.00E+00	0.00E+00	5.74E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR84	0.00E+00	0.00E+00	7.22E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR85	0.00E+00	0.00E+00	3.05E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RB86	0.00E+00	2.98E-05	1.40E-05	0.00E+00	0.00E+00	0.00E+00	4.41E-06
RB88	0.00E+00	8.52E-08	4.54E-08	0.00E+00	0.00E+00	0.00E+00	7.30E-15
RB89	0.00E+00	5.50E-08	3.89E-08	0.00E+00	0.00E+00	0.00E+00	8.43E-17
SR89	4.40E-04	0.00E+00	1.26E-05	0.00E+00	0.00E+00	0.00E+00	5.24E-05
SR90	8.30E-03	0.00E+00	2.05E-03	0.00E+00	0.00E+00	0.00E+00	2.33E-04
SR91	8.07E-06	0.00E+00	3.21E-07	0.00E+00	0.00E+00	0.00E+00	3.66E-05
SR92	3.05E-06	0.00E+00	1.30E-07	0.00E+00	0.00E+00	0.00E+00	7.77E-05
Y90	1.37E-08	0.00E+00	3.69E-10	0.00E+00	0.00E+00	0.00E+00	1.13E-04
Y91M	1.29E-10	0.00E+00	4.93E-12	0.00E+00	0.00E+00	0.00E+00	6.09E-09
Y91	2.01E-07	0.00E+00	5.39E-09	0.00E+00	0.00E+00	0.00E+00	8.24E-05
Y92	1.21E-09	0.00E+00	3.50E-11	0.00E+00	0.00E+00	0.00E+00	3.32E-05
Y93	3.83E-09	0.00E+00	1.05E-10	0.00E+00	0.00E+00	0.00E+00	1.17E-04
ZR95	4.12E-08	1.30E-08	8.94E-09	0.00E+00	1.91E-08	0.00E+00	3.00E-05
ZR97	2.37E-09	4.69E-10	2.16E-10	0.00E+00	7.11E-10	0.00E+00	1.27E-04
NB95	8.22E-09	4.56E-09	2.51E-09	0.00E+00	4.42E-09	0.00E+00	1.95E-05
MO99	0.00E+00	6.03E-06	1.15E-06	0.00E+00	1.38E-05	0.00E+00	1.08E-05
TC99M	3.32E-10	9.26E-10	1.20E-08	0.00E+00	1.38E-08	5.14E-10	6.08E-07

Table 2.3-6 (Cont.)

Ingestion Dose Factors for Teenager (mrem/pCi ingested)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
TC101	3.60E-10	5.12E-10	5.03E-09	0.00E+00	9.26E-09	3.12E-10	8.75E-17
RU103	2.55E-07	0.00E+00	1.09E-07	0.00E+00	8.99E-07	0.00E+00	2.13E-05
RU105	2.18E-08	0.00E+00	8.46E-09	0.00E+00	2.75E-07	0.00E+00	1.76E-05
RU106	3.92E-06	0.00E+00	4.94E-07	0.00E+00	7.56E-06	0.00E+00	1.88E-04
AG110M	2.05E-07	1.94E-07	1.18E-07	0.00E+00	3.70E-07	0.00E+00	5.45E-05
TE125M	3.83E-06	1.38E-06	5.12E-07	1.07E-06	0.00E+00	0.00E+00	1.13E-05
TE127M	9.67E-06	3.43E-06	1.15E-06	2.30E-06	3.92E-05	0.00E+00	2.41E-05
TE127	1.58E-07	5.60E-08	3.40E-08	1.09E-07	6.40E-07	0.00E+00	1.22E-05
TE129M	1.63E-05	6.05E-06	2.58E-06	5.26E-06	6.82E-05	0.00E+00	6.12E-05
TE129	4.48E-08	1.67E-08	1.09E-08	3.20E-08	1.88E-07	0.00E+00	2.45E-07
TE131M	2.44E-06	1.17E-06	9.76E-07	1.76E-06	1.22E-05	0.00E+00	9.39E-05
TE131	2.79E-08	1.15E-08	8.72E-09	2.15E-08	1.22E-07	0.00E+00	2.29E-09
TE132	3.49E-06	2.21E-06	2.08E-06	2.33E-06	2.12E-05	0.00E+00	7.00E-05
I130	1.03E-06	2.98E-06	1.19E-06	2.43E-04	4.59E-06	0.00E+00	2.29E-06
I131	5.85E-06	8.19E-06	4.40E-06	2.39E-03	1.41E-05	0.00E+00	1.62E-06
I132	2.79E-07	7.30E-07	2.62E-07	2.46E-05	1.15E-06	0.00E+00	3.18E-07
I133	2.01E-06	3.41E-06	1.04E-06	4.76E-04	5.98E-06	0.00E+00	2.58E-06
I134	1.46E-07	3.87E-07	1.39E-07	6.45E-06	6.10E-07	0.00E+00	5.10E-09
I135	6.10E-07	1.57E-06	5.82E-07	1.01E-04	2.48E-06	0.00E+00	1.74E-06
CS134	8.37E-05	1.97E-04	9.14E-05	0.00E+00	6.26E-05	2.39E-05	2.45E-06
CS136	8.59E-06	3.38E-05	2.27E-05	0.00E+00	1.84E-05	2.90E-06	2.72E-06
CS137	1.12E-04	1.49E-04	5.19E-05	0.00E+00	5.07E-05	1.97E-05	2.12E-06
CS138	7.76E-08	1.49E-07	7.45E-08	0.00E+00	1.10E-07	1.28E-08	6.76E-11
BA139	1.39E-07	9.78E-11	4.05E-09	0.00E+00	9.22E-11	6.74E-11	1.24E-06
BA140	2.84E-05	3.48E-08	1.83E-06	0.00E+00	1.18E-08	2.34E-08	4.38E-05
BA141	6.71E-08	5.01E-11	2.24E-09	0.00E+00	4.65E-11	3.43E-11	1.43E-13
BA142	2.99E-08	2.99E-11	1.84E-09	0.00E+00	2.53E-11	1.99E-11	9.18E-20
LA140	3.48E-09	1.71E-09	4.55E-10	0.00E+00	0.00E+00	0.00E+00	9.82E-05
LA142	1.79E-10	7.95E-11	1.98E-11	0.00E+00	0.00E+00	0.00E+00	2.42E-06
CE141	1.33E-08	8.88E-09	1.02E-09	0.00E+00	4.18E-09	0.00E+00	2.54E-05
CE143	2.35E-09	1.71E-06	1.91E-10	0.00E+00	7.67E-10	0.00E+00	5.14E-05
CE144	6.96E-07	2.88E-07	3.74E-08	0.00E+00	1.72E-07	0.00E+00	1.75E-04
PR143	1.31E-08	5.23E-09	6.52E-10	0.00E+00	3.04E-09	0.00E+00	4.31E-05
PR144	4.30E-11	1.76E-11	2.18E-12	0.00E+00	1.01E-11	0.00E+00	4.74E-14
ND147	9.38E-09	1.02E-08	6.11E-10	0.00E+00	5.99E-09	0.00E+00	3.68E-05
W187	1.46E-07	1.19E-07	4.17E-08	0.00E+00	0.00E+00	0.00E+00	3.22E-05
NP239	1.76E-09	1.66E-10	9.22E-11	0.00E+00	5.21E-10	0.00E+00	2.67E-05
Au-199	0.00E+00	9.92E-8	8.41E-8	0.00E+00	3.92E-9	0.00E+00	1.19E-5

Table 2.3-7

Ingestion Dose Factors for Child (mrem/pCi ingested)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
H3	0.00E+00	2.03E-07	2.03E-07	2.03E-07	2.03E-07	2.03E-07	2.03E-07
C14	1.21E-05	2.42E-06	2.42E-06	2.42E-06	2.42E-06	2.42E-06	2.42E-06
NA24	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06
P32	8.25E-04	3.86E-05	3.18E-05	0.00E+00	0.00E+00	0.00E+00	2.28E-05
CR51	0.00E+00	0.00E+00	8.90E-09	4.94E-09	1.35E-09	9.02E-09	4.72E-07
MN54	0.00E+00	1.07E-05	2.85E-06	0.00E+00	3.00E-06	0.00E+00	8.98E-06
MN56	0.00E+00	3.34E-07	7.54E-08	0.00E+00	4.04E-07	0.00E+00	4.84E-05
FE55	1.15E-05	6.10E-06	1.89E-06	0.00E+00	0.00E+00	3.45E-06	1.13E-06
FE59	1.65E-05	2.67E-05	1.33E-05	0.00E+00	0.00E+00	7.74E-06	2.78E-05
CO58	0.00E+00	1.80E-06	5.51E-06	0.00E+00	0.00E+00	0.00E+00	1.05E-05
CO60	0.00E+00	5.29E-06	1.56E-05	0.00E+00	0.00E+00	0.00E+00	2.93E-05
NI63	5.38E-04	2.88E-05	1.83E-05	0.00E+00	0.00E+00	0.00E+00	1.94E-06
NI65	2.22E-06	2.09E-07	1.22E-07	0.00E+00	0.00E+00	0.00E+00	2.56E-05
CU64	0.00E+00	2.45E-07	1.48E-07	0.00E+00	5.92E-07	0.00E+00	1.15E-05
ZN65	1.37E-05	3.65E-05	2.27E-05	0.00E+00	2.30E-05	0.00E+00	6.41E-06
ZN69	4.38E-08	6.33E-08	5.85E-09	0.00E+00	3.84E-08	0.00E+00	3.99E-06
BR83	0.00E+00	0.00E+00	1.71E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR84	0.00E+00	0.00E+00	1.98E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR85	0.00E+00	0.00E+00	9.12E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RB86	0.00E+00	6.70E-05	4.12E-05	0.00E+00	0.00E+00	0.00E+00	4.31E-06
RB88	0.00E+00	1.90E-07	1.32E-07	0.00E+00	0.00E+00	0.00E+00	9.32E-09
RB89	0.00E+00	1.17E-07	1.04E-07	0.00E+00	0.00E+00	0.00E+00	1.02E-09
SR89	1.32E-03	0.00E+00	3.77E-05	0.00E+00	0.00E+00	0.00E+00	5.11E-05
SR90	1.70E-02	0.00E+00	4.31E-03	0.00E+00	0.00E+00	0.00E+00	2.29E-04
SR91	2.40E-05	0.00E+00	9.06E-07	0.00E+00	0.00E+00	0.00E+00	5.30E-05
SR92	9.03E-06	0.00E+00	3.62E-07	0.00E+00	0.00E+00	0.00E+00	1.71E-04
Y90	4.11E-08	0.00E+00	1.10E-09	0.00E+00	0.00E+00	0.00E+00	1.17E-04
Y91M	3.82E-10	0.00E+00	1.39E-11	0.00E+00	0.00E+00	0.00E+00	7.48E-07
Y91	6.02E-07	0.00E+00	1.61E-08	0.00E+00	0.00E+00	0.00E+00	8.02E-05
Y92	3.60E-09	0.00E+00	1.03E-10	0.00E+00	0.00E+00	0.00E+00	1.04E-04
Y93	1.14E-08	0.00E+00	3.13E-10	0.00E+00	0.00E+00	0.00E+00	1.70E-04
ZR95	1.16E-07	2.55E-08	2.27E-08	0.00E+00	3.65E-08	0.00E+00	2.66E-05
ZR97	6.99E-09	1.01E-09	5.96E-10	0.00E+00	1.45E-09	0.00E+00	1.53E-04
NB95	2.25E-08	8.76E-09	6.26E-09	0.00E+00	8.23E-09	0.00E+00	1.62E-05
MO99	0.00E+00	1.33E-05	3.29E-06	0.00E+00	2.84E-05	0.00E+00	1.10E-05
TC99M	9.23E-10	1.81E-09	3.00E-08	0.00E+00	2.63E-08	9.19E-10	1.03E-06

Table 2.3-7 (Cont.)

Ingestion Dose Factors for Child (mrem/pCi ingested)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
TC101	1.07E-09	1.12E-09	1.42E-08	0.00E+00	1.91E-08	5.92E-10	3.56E-09
RU103	7.31E-07	0.00E+00	2.81E-07	0.00E+00	1.84E-06	0.00E+00	1.89E-05
RU105	6.45E-08	0.00E+00	2.34E-08	0.00E+00	5.67E-07	0.00E+00	4.21E-05
RU106	1.17E-05	0.00E+00	1.46E-06	0.00E+00	1.58E-05	0.00E+00	1.82E-04
AG110M	5.39E-07	3.64E-07	2.91E-07	0.00E+00	6.78E-07	0.00E+00	4.33E-05
TE125M	1.14E-05	3.09E-06	1.52E-06	3.20E-06	0.00E+00	0.00E+00	1.10E-05
TE127M	2.89E-05	7.78E-06	3.43E-06	6.91E-06	8.24E-05	0.00E+00	2.34E-05
TE127	4.71E-07	1.27E-07	1.01E-07	3.26E-07	1.34E-06	0.00E+00	1.84E-05
TE129M	4.87E-05	1.36E-05	7.56E-06	1.57E-05	1.43E-04	0.00E+00	5.94E-05
TE129	1.34E-07	3.74E-08	3.18E-08	9.56E-08	3.92E-07	0.00E+00	8.34E-06
TE131M	7.20E-06	2.49E-06	2.65E-06	5.12E-06	2.41E-05	0.00E+00	1.01E-04
TE131	8.30E-08	2.53E-08	2.47E-08	6.35E-08	2.51E-07	0.00E+00	4.36E-07
TE132	1.01E-05	4.47E-06	5.40E-06	6.51E-06	4.15E-05	0.00E+00	4.50E-05
I130	2.92E-06	5.90E-06	3.04E-06	6.50E-04	8.82E-06	0.00E+00	2.76E-06
I131	1.72E-05	1.73E-05	9.83E-06	5.72E-03	2.84E-05	0.00E+00	1.54E-06
I132	8.00E-07	1.47E-06	6.76E-07	6.82E-05	2.25E-06	0.00E+00	1.73E-06
I133	5.92E-06	7.32E-06	2.77E-06	1.36E-03	1.22E-05	0.00E+00	2.95E-06
I134	4.19E-07	7.78E-07	3.58E-07	1.79E-05	1.19E-06	0.00E+00	5.16E-07
I135	1.75E-06	3.15E-06	1.49E-06	2.79E-04	4.83E-06	0.00E+00	2.40E-06
CS134	2.34E-04	3.84E-04	8.10E-05	0.00E+00	1.19E-04	4.27E-05	2.07E-06
CS136	2.35E-05	6.46E-05	4.18E-05	0.00E+00	3.44E-05	5.13E-06	2.27E-06
CS137	3.27E-04	3.13E-04	4.62E-05	0.00E+00	1.02E-04	3.67E-05	1.96E-06
CS138	2.28E-07	3.17E-07	2.01E-07	0.00E+00	2.23E-07	2.40E-08	1.46E-07
BA139	4.14E-07	2.21E-10	1.20E-08	0.00E+00	1.93E-10	1.30E-10	2.39E-05
BA140	8.31E-05	7.28E-08	4.85E-06	0.00E+00	2.37E-08	4.34E-08	4.21E-05
BA141	2.00E-07	1.12E-10	6.51E-09	0.00E+00	9.69E-11	6.58E-10	1.14E-07
BA142	8.74E-08	6.29E-11	4.88E-09	0.00E+00	5.09E-11	3.70E-11	1.14E-09
LA140	1.01E-08	3.53E-09	1.19E-09	0.00E+00	0.00E+00	0.00E+00	9.84E-05
LA142	5.24E-10	1.67E-10	5.23E-11	0.00E+00	0.00E+00	0.00E+00	3.31E-05
CE141	3.97E-08	1.98E-08	2.94E-09	0.00E+00	8.68E-09	0.00E+00	2.47E-05
CE143	6.99E-09	3.79E-06	5.49E-10	0.00E+00	1.59E-09	0.00E+00	5.55E-05
CE144	2.08E-06	6.52E-07	1.11E-07	0.00E+00	3.61E-07	0.00E+00	1.70E-04
PR143	3.93E-08	1.18E-08	1.95E-09	0.00E+00	6.39E-09	0.00E+00	4.24E-05
PR144	1.29E-10	3.99E-11	6.49E-12	0.00E+00	2.11E-11	0.00E+00	8.59E-08
ND147	2.79E-08	2.26E-08	1.75E-09	0.00E+00	1.24E-08	0.00E+00	3.58E-05
W187	4.29E-07	2.54E-07	1.14E-07	0.00E+00	0.00E+00	0.00E+00	3.57E-05
NP239	5.25E-09	3.77E-10	2.65E-10	0.00E+00	1.09E-09	0.00E+00	2.79E-05
Au-199	0.00E+00	2.25E-7	2.51E-7	0.00E+00	8.23E-7	0.00E+00	1.27E-5

Table 2.3-8

Ingestion Dose Factors for Infant (mrem/pCi ingested)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
H3	0.00E+00	3.08E-07	3.08E-07	3.08E-07	3.08E-07	3.08E-07	3.08E-07
C14	2.37E-05	5.06E-06	5.06E-06	5.06E-06	5.06E-06	5.06E-06	5.06E-06
NA24	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05
P32	1.70E-03	1.00E-04	6.59E-05	0.00E+00	0.00E+00	0.00E+00	2.30E-05
CR51	0.00E+00	0.00E+00	1.41E-08	9.20E-09	2.01E-09	1.79E-08	4.11E-07
MN54	0.00E+00	1.99E-05	4.51E-06	0.00E+00	4.41E-06	0.00E+00	7.31E-06
MN56	0.00E+00	8.18E-07	1.41E-07	0.00E+00	7.03E-07	0.00E+00	7.43E-05
FE55	1.39E-05	8.98E-06	2.40E-06	0.00E+00	0.00E+00	4.39E-06	1.14E-06
FE59	3.08E-05	5.38E-05	2.12E-05	0.00E+00	0.00E+00	1.59E-05	2.57E-05
CO58	0.00E+00	3.60E-06	8.98E-06	0.00E+00	0.00E+00	0.00E+00	8.97E-06
CO60	0.00E+00	1.08E-05	2.55E-05	0.00E+00	0.00E+00	0.00E+00	2.57E-05
NI63	6.34E-04	3.92E-05	2.20E-05	0.00E+00	0.00E+00	0.00E+00	1.95E-06
NI65	4.70E-06	5.32E-07	2.42E-07	0.00E+00	0.00E+00	0.00E+00	4.05E-05
CU64	0.00E+00	6.09E-07	2.82E-07	0.00E+00	1.03E-06	0.00E+00	1.25E-05
ZN65	1.84E-05	6.31E-05	2.91E-05	0.00E+00	3.06E-05	0.00E+00	5.33E-05
ZN69	9.33E-08	1.68E-07	1.25E-08	0.00E+00	6.98E-08	0.00E+00	1.37E-05
BR83	0.00E+00	0.00E+00	3.63E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR84	0.00E+00	0.00E+00	3.82E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR85	0.00E+00	0.00E+00	1.94E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RB86	0.00E+00	1.70E-04	8.40E-05	0.00E+00	0.00E+00	0.00E+00	4.35E-06
RB88	0.00E+00	4.98E-07	2.73E-07	0.00E+00	0.00E+00	0.00E+00	4.85E-07
RB89	0.00E+00	2.86E-07	1.97E-07	0.00E+00	0.00E+00	0.00E+00	9.74E-08
SR89	2.51E-03	0.00E+00	7.20E-05	0.00E+00	0.00E+00	0.00E+00	5.16E-05
SR90	1.85E-02	0.00E+00	4.71E-03	0.00E+00	0.00E+00	0.00E+00	2.31E-04
SR91	5.00E-05	0.00E+00	1.81E-06	0.00E+00	0.00E+00	0.00E+00	5.92E-05
SR92	1.92E-05	0.00E+00	7.13E-07	0.00E+00	0.00E+00	0.00E+00	2.07E-04
Y90	8.69E-08	0.00E+00	2.33E-09	0.00E+00	0.00E+00	0.00E+00	1.20E-04
Y91M	8.10E-10	0.00E+00	2.76E-11	0.00E+00	0.00E+00	0.00E+00	2.70E-06
Y91	1.13E-06	0.00E+00	3.01E-08	0.00E+00	0.00E+00	0.00E+00	8.10E-05
Y92	7.65E-09	0.00E+00	2.15E-10	0.00E+00	0.00E+00	0.00E+00	1.46E-04
Y93	2.43E-08	0.00E+00	6.62E-10	0.00E+00	0.00E+00	0.00E+00	1.92E-04
ZR95	2.06E-07	5.02E-08	3.56E-08	0.00E+00	5.41E-08	0.00E+00	2.50E-05
ZR97	1.48E-08	2.54E-09	1.16E-09	0.00E+00	2.56E-09	0.00E+00	1.62E-04
NB95	4.20E-08	1.73E-08	1.00E-08	0.00E+00	1.24E-08	0.00E+00	1.46E-05
MO99	0.00E+00	3.40E-05	6.63E-06	0.00E+00	5.08E-05	0.00E+00	1.12E-05
TC99M	1.92E-09	3.96E-09	5.10E-08	0.00E+00	4.26E-08	2.07E-09	1.15E-06

Table 2.3-8 (Cont.)

Ingestion Dose Factors for Infant (mrem/pCi ingested)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
TC101	2.27E-09	2.86E-09	2.83E-08	0.00E+00	3.40E-08	1.56E-09	4.86E-07
RU103	1.48E-06	0.00E+00	4.95E-07	0.00E+00	3.08E-06	0.00E+00	1.80E-05
RU105	1.36E-07	0.00E+00	4.58E-08	0.00E+00	1.00E-06	0.00E+00	5.41E-05
RU106	2.41E-05	0.00E+00	3.01E-06	0.00E+00	2.85E-05	0.00E+00	1.83E-04
AG110M	9.96E-07	7.27E-07	4.81E-07	0.00E+00	1.04E-06	0.00E+00	3.77E-05
TE125M	2.33E-05	7.79E-06	3.15E-06	7.84E-06	0.00E+00	0.00E+00	1.11E-05
TE127M	5.85E-05	1.94E-05	7.08E-06	1.69E-05	1.44E-04	0.00E+00	2.36E-05
TE127	1.00E-06	3.35E-07	2.15E-07	8.14E-07	2.44E-06	0.00E+00	2.10E-05
TE129M	1.00E-04	3.43E-05	1.54E-05	3.84E-05	2.50E-04	0.00E+00	5.97E-05
TE129	2.84E-07	9.79E-08	6.63E-08	2.38E-07	7.07E-07	0.00E+00	2.27E-05
TE131M	1.52E-05	6.12E-06	5.05E-06	1.24E-05	4.21E-05	0.00E+00	1.03E-04
TE131	1.76E-07	6.50E-08	4.94E-08	1.57E-07	4.50E-07	0.00E+00	7.11E-06
TE132	2.08E-05	1.03E-05	9.61E-06	1.52E-05	6.44E-05	0.00E+00	3.81E-05
I130	6.00E-06	1.32E-05	5.30E-06	1.48E-03	1.45E-05	0.00E+00	2.83E-06
I131	3.59E-05	4.23E-05	1.86E-05	1.39E-02	4.94E-05	0.00E+00	1.51E-06
I132	1.66E-06	3.37E-06	1.20E-06	1.58E-04	3.76E-06	0.00E+00	2.73E-06
I133	1.25E-05	1.82E-05	5.33E-06	3.31E-03	2.14E-05	0.00E+00	3.08E-06
I134	8.69E-07	1.78E-06	6.33E-07	4.15E-05	1.99E-06	0.00E+00	1.84E-06
I135	3.64E-06	7.24E-06	2.64E-06	6.49E-04	8.07E-06	0.00E+00	2.62E-06
CS134	3.77E-04	7.03E-04	7.10E-05	0.00E+00	1.81E-04	7.42E-05	1.91E-06
CS136	4.59E-05	1.35E-04	5.04E-05	0.00E+00	5.38E-05	1.10E-05	2.05E-06
CS137	5.22E-04	6.11E-04	4.33E-05	0.00E+00	1.64E-04	6.64E-05	1.91E-06
CS138	4.81E-07	7.82E-07	3.79E-07	0.00E+00	3.90E-07	6.09E-08	1.25E-06
BA139	8.81E-07	5.84E-10	2.55E-08	0.00E+00	3.51E-10	3.54E-10	5.58E-05
BA140	1.71E-04	1.71E-07	8.81E-06	0.00E+00	4.06E-08	1.05E-07	4.20E-05
BA141	4.25E-07	2.91E-10	1.34E-08	0.00E+00	1.75E-10	1.77E-10	5.19E-06
BA142	1.84E-07	1.53E-10	9.06E-09	0.00E+00	8.81E-11	9.26E-11	7.59E-07
LA140	2.11E-08	8.32E-09	2.14E-09	0.00E+00	0.00E+00	0.00E+00	9.77E-05
LA142	1.10E-09	4.04E-10	9.67E-11	0.00E+00	0.00E+00	0.00E+00	6.86E-05
CE141	7.87E-08	4.80E-08	5.65E-09	0.00E+00	1.48E-08	0.00E+00	2.48E-05
CE143	1.48E-08	9.82E-06	1.12E-09	0.00E+00	2.86E-09	0.00E+00	5.73E-05
CE144	2.98E-06	1.22E-06	1.67E-07	0.00E+00	4.93E-07	0.00E+00	1.71E-04
PR143	8.13E-08	3.04E-08	4.03E-09	0.00E+00	1.13E-08	0.00E+00	4.29E-05
PR144	2.74E-10	1.06E-10	1.38E-11	0.00E+00	3.84E-11	0.00E+00	4.93E-06
ND147	5.53E-08	5.68E-08	3.48E-09	0.00E+00	2.19E-08	0.00E+00	3.60E-05
W187	9.03E-07	6.28E-07	2.17E-07	0.00E+00	0.00E+00	0.00E+00	3.69E-05
NP239	1.11E-08	9.93E-10	5.61E-10	0.00E+00	1.98E-09	0.00E+00	2.87E-05
Au-199	0.00E+00	5.91E-7	5.32E-7	0.00E+00	1.49E-6	0.00E+00	1.28E-5

Table 2.3-9

External Dose Factors for Standing on Contaminated Ground

(mrem/h per pCi/m^2)

Element	Total Body	Skin
H-3	0.0	0.0
C-14	0.0	0.0
NA-24	2.50E-08	2.90E-08
P-32	0.0	0.0
Cr-51	2.20E-10	2.60E-10
Mn-54	5.80E-09	6.80E-09
Mn-56	1.10E-08	1.30E-08
Fe-55	0.0	0.0
Fe-59	8.00E-09	9.40E-09
Co-58	7.00E-09	8.20E-09
Co-60	1.70E-08	2.00E-08
Ni-63	0.0	0.0
Nr-65	3.70E-09	4.30E-09
Cu-64	1.50E-09	1.70E-09
Zn-65	4.00E-09	4.60E-09
Zn-69	0.0	0.0
Br-83	6.40E-11	9.30E-11
Br-84	1.20E-08	1.40E-08
Br-85	0.0	0.0
Rb-86	6.30E-10	7.20E-10
Rb-88	3.50E-09	4.00E-09
Rb-89	1.50E-08	1.80E-08
Sr-89	5.60E-13	6.50E-13
Sr-91	7.10E-09	8.30E-09
Sr-92	9.00E-09	1.00E-08
Y-90	2.20E-12	2.60E-12
Y-91M	3.80E-09	4.40E-09
Y-91	2.40E-11	2.70E-11
Y-92	1.60E-09	1.90E-09
Y-93	5.70E-10	7.80E-10
Zr-95	5.00E-09	5.80E-09
Zr-97	5.50E-09	6.40E-09
Nb-95	5.10E-09	6.00E-09
Mo-99	1.90E-09	2.20E-09
Tc-99M	9.60E-10	1.10E-09
Tc-101	2.70E-09	3.00E-09
Ru-103	3.60E-09	4.20E-09
Ru-105	4.50E-09	5.10E-09
Ru-106	1.50E-09	1.80E-09
Ag-110M	1.80E-08	2.10E-08
Te-125M	3.50E-11	4.80E-11
Te-127M	1.10E-12	1.30E-12
Te-127	1.00E-11	1.10E-11
Te-129M	7.70E-10	9.00E-10
Te-129	7.10E-10	8.40E-10
Te-131M	8.40E-09	9.90E-09
Te-131	2.20E-09	2.60E-06
Te-132	1.70E-09	2.00E-09

Table 2.3-9 (Cont.)

External Dose Factors for Standing on Contaminated Ground

(mrem/h per pCi/m^2)

Element	Total Body	Skin
I-130	1.40E-08	1.70E-08
I-131	2.80E-09	3.40E-09
I-132	1.70E-08	2.00E-08
I-133	3.70E-09	4.50E-09
I-134	1.60E-08	1.90E-08
I-135	1.20E-08	1.40E-08
Cs-134	1.20E-08	1.40E-08
Cs-136	1.50E-08	1.70E-08
Cs-137	4.20E-09	4.90E-09
Cs-138	2.10E-08	2.40E-08
Ba-139	2.40E-09	2.70E-09
Ba-140	2.10E-09	2.40E-09
Ba-141	4.30E-09	4.90E-09
Ba-142	7.90E-09	9.00E-09
La-140	1.50E-08	1.70E-08
La-142	1.50E-08	1.80E-08
Ce-141	5.50E-10	6.20E-10
Ce-143	2.20E-09	2.50E-09
Ce-144	3.20E-10	3.70E-10
Pr-143	0.0	0.0
Pr-144	2.00E-10	2.30E-10
Nd-147	1.00E-09	1.20E-09
W-187	3.10E-09	3.60E-09
Np-239	9.50E-10	1.10E-09
Au-199	1.13E-9	1.39E-9

Table 2.3-10

Liquid Effluent Dilution Factors (M_p)

Maximum Individual Dilution Factors

Pathway	Location	M_p
Potable Water Ingestion	3.9 mile WSW of site	32.2
Fresh Water Fish Ingestion	Near Discharge Structure	10.9
Shoreline Exposure	0.7 mile ENE of Site	14.5

Population Dose Dilution Factors*

Pathway	Location	M_p
Potable Water Ingestion	Population Weighted Average	314
Fresh Water Fish Ingestion	Catch Weighted Average	77.4
Shoreline Exposure	7.7 mile WSW of site	162

Table 2.3-11

Transit Times Required for Nuclides to Reach the Point of Exposure (t_p)

	Maximum Exposed Individual	Average Exposed Individual*
Eventual transit time for water ingestion	12 h	24 h
Eventual transit time for fish ingestion	24 h	168 h
Eventual transit time for shore exposure	0 h	0 h

*for total population and average individual dose calculations

Table 2.3-12

Usage Factors (U_{ap})

	Maximum Exposed Individual	Average Exposed Individual*
Water ingestion (l/yr) Adult	730	370
Water ingestion (l/yr) Teen	510	260
Water ingestion (l/yr) Child	510	260
Water ingestion (l/yr) Infant	330	--
Fresh water fish ingestion (kg/yr) Adult	21	6.9
Fresh water fish ingestion (kg/yr) Teen	16	5.2
Fresh water fish ingestion (kg/yr) Child	6.9	2.2
Fresh water fish ingestion (kg/yr) Infant	--	--
Shore exposure (h/yr) Adult	12	8.3
Shore exposure (h/yr) Teen	67	47
Shore exposure (h/yr) Child	14	9.5
Shore exposure (h/yr) Infant	--	--

*for total population and average individual dose calculations

Table 2.3-13

Dilution Factors for Each of the Potable Water Intakes within 50 Miles of PNPP

The total population dilution factor of 314 is population weighted using dilution factors for each of the potable water intakes within 50 miles of PNPP.

Intake	Dist. (Mi)	Dir	Population	Fraction of Pop	Dilution Factor	Weighted Dil. Factor
Ohio American Water Serv. Co.	20	ENE	38,500	2.12E-2	187.7	3.98E+0
Conneaut	33	ENE	13,500	7.43E-3	238.2	1.77E+0
Avon Lake	50	WSW	99,500	5.48E-2	388.5	2.13E+1
Cleveland	35	SW	1,437,000	7.92E-1	326.7	2.59E+2
Fairport Harbor	7	WSW	3,200	1.76E-3	154.2	2.71E-1
Lake County East	3.5	WSW	10,258	5.65E-3	107.4	6.07E-1
Lake County West	15	WSW	85,000	4.68E-2	220.0	1.03E+1
Ohio Water Serv.	10	WSW	60,000	3.30E-2	181.9	6.00E+0
Painesville	7.5	WSW	27,000	1.49E-2	159.3	2.37E+0
Kent County Water Supply	50	NW	42,000	2.31E-2	388.5	8.97E+0
TOTALS			1,815,958	1.00E+0	TOTAL D.F	3.14E+2

Dist, Dir Population = distance, direction, and population values obtained from the 1989 Engineering Report "Lake Erie Potable Water Facilities and Intakes within 50 Miles of PNPP" (Ref. SO-11552 "E").

Fraction of Population = The ratio of the population receiving drinking water from that intake to the total population number for all drinking water intakes located within 50 miles of PNPP.

Dilution Factor = Values obtained from the Perry Environmental Report - Operating License Stage, Table 5.1-10 "Annual Average Dilution Factors for Lake Water Intakes within 50 Miles of PNPP" and Q&R Page 2.1-2. Lake County West dilution factor per interpolation. Kent County Water Supply dilution factor was estimated.

The Weighted Dilution Factor = (Fraction of Population) x (Dilution Factor), based on the population for each drinking water intake; the sum of which is to be used as the potable water total population dilution factor for radioactive liquid effluent releases from PNPP.

Table 2.3-14

Dilution Factors for the Fish Ingestion Pathway Individual Grid Locations

The total population dilution factor of 77.4 is catch distance and volume weighted using dilution factors at those locations. Fish harvest is based on Ohio Department of Natural Resources the total angler catch (1987 annual) values for Lake Erie within 50 mile of PNPP.

Grid	No. of Fish	Fraction of Fish	Dist. (mi)	Dilution Factor	(FracFish)x (DilFactor)
617	52823	3.91E-2	29	92	3.60E+0
618	76004	5.63E-2	36	100	5.63E+0
714	102522	7.59E-2	9	52	3.96E+0
715	10743	7.95E-3	9	52	4.13E-1
716	19817	1.47E-2	11	56	8.21E-1
717	73401	5.43E-2	24	83	4.51E+0
718	118676	8.78E-2	33	95	8.34E+0
809	0	0.00E+0	48	115	0.00E+0
810	3953	2.93E-3	39	105	3.07E-1
811	13648	1.01E-2	30	92	9.29E-1
812	33923	2.51E-2	22	78	1.96E+0
813	182663	1.35E-1	13	61	8.25E+0
814	164369	1.22E-1	4	34	4.14E+0
909	80753	5.98E-2	50	116	6.93E+0
910	43800	3.24E-2	42	110	3.57E+0
911	117430	8.69E-2	33	95	8.26E+0
912	256529	1.90E-1	24	83	1.58E+1
TOTAL	1351054	1.00E+0		TOTAL D.F.	7.74E+1

Grid No. and No. of Fish = Total angler catch (1987 annual) for each grid location; per letter from Michael R. Rawson, Fairport Fisheries Research Station, Ohio Department of Natural Resources to Richard Cochnar (6/20/88). Commercial harvest data were not used as they were differentiated by harbor location only, not by geographical grid location.

Fraction of Fish = The ratio of the fish caught in that grid to the total number of fish caught in all grids located within 50 miles of PNPP.

Distance = Distance to the center of that grid from PNPP, in miles.

Dilution Factor = Derived, for the appropriate distance (center of each grid), from annual average dilution factor data (non-adjusted), per Perry Environmental Report - Operating License Stage, Table 5.1-10 "Annual Average Dilution Factors for Lake Water Intakes within 50 Miles of PNPP."

(Fraction of Fish) x (Dilution Factor) = The weighted dilution factor, based on catch, for each grid; the sum of which is to be used as the fish ingestion total population dilution factor for radioactive liquid effluent releases from PNPP.

Table 2.3-15

Dilution Factors for the Shore Exposure Pathway

MAXIMUM EXPOSED INDIVIDUAL DILUTION FACTOR

The point of exposure assumed for this pathway is the shoreline at the PNPP site boundary 0.7 miles down shore from the plant discharge structure. Interpolation of the data presented in the Perry Environmental Report - Operating License Stage, Table 5.1-10, "Annual Average Dilution Factors for Lake Water Intakes within 50 Miles of PNPP" yields a maximum individual dose dilution factor of 14.5 (dilution factor unadjusted for current frequency).

TOTAL POPULATION DILUTION FACTOR

The total population dilution factor of 162 is that of the Headlands Beach State Park, 7.7 miles WSW of PNPP (interpolated, adjusted WSW dilution factor). This location was selected because of its lake site location and it has, by far, the highest attendance of any park located in vicinity of PNPP (Perry Environmental Report - Operating License State, Table 2.1-2 "Major Camps and Parks within 10 Miles of the PNPP").

3.0 GASEOUS EFFLUENTS

3.0.1 Batch Releases

A batch release is the discontinuous discharge of gaseous radioactive effluents of known radionuclide concentration(s) and flowrate taking place over a finite period of time, usually hours or days. A batch release to the environment may occur as a result of an effluent flowpath that bypasses treatment or monitoring. Since radioactive releases approaching 10CFR20.106 limits are not anticipated, an ODCM Control is not entered for batch releases. Every reasonable effort will be made to maintain the levels of radioactive material in the gaseous effluents ALARA.

The radioactive gaseous effluent release flowpath is monitored for principal gamma emitters (noble gases, particulates, and halogens) as if the inoperable radioactive effluent monitor requirements of Table 3.3.7.10-1 had been entered. This action ensures the dose to a member of the general public is within the limits of Controls 3.11.2.2 and 3.11.2.3. If radioactivity is detected, the radionuclide concentration(s) is added to the dose calculations for the appropriate radioactive gaseous effluent continuous release point. Administrative instructions are employed to establish minimum monitoring requirements for these batch releases to ensure compliance with all regulatory requirements.

3.0.2 Continuous Releases

There are four environmental release points for gaseous effluents used for Unit 1 operation of the Perry Nuclear Power Plant: Turbine Bldg/Heater Bay Vent, Off-Gas Vent, Unit 1 Vent, and Unit 2 Vent (see Figure 3.0-1). The Unit 1 and Unit 2 Vents are located on the top of the Intermediate Building, Elevation 753'9". The Turbine Bldg/Heater Bay Vent is located on the top of the Heater Bay Building, Elevation 722'0". The Off-Gas Vent is located on the top of the Off-Gas Building, Elevation 723'0". Site ground level elevation is 620'0". Radiological releases from each vent are monitored by a noble gas radiation monitor.

All gaseous effluent releases from PNPP via these vents will be continuous releases, and are considered to be long-term (i.e., greater than 500 hours per year) and ground level. Containment/drywell purges and vents will be considered periods of increased radiological release as they are vented through the Unit 1 Vent, concurrent with normal, continuous releases.

Figure 3.0-1

Gaseous Effluent System Flow Diagram

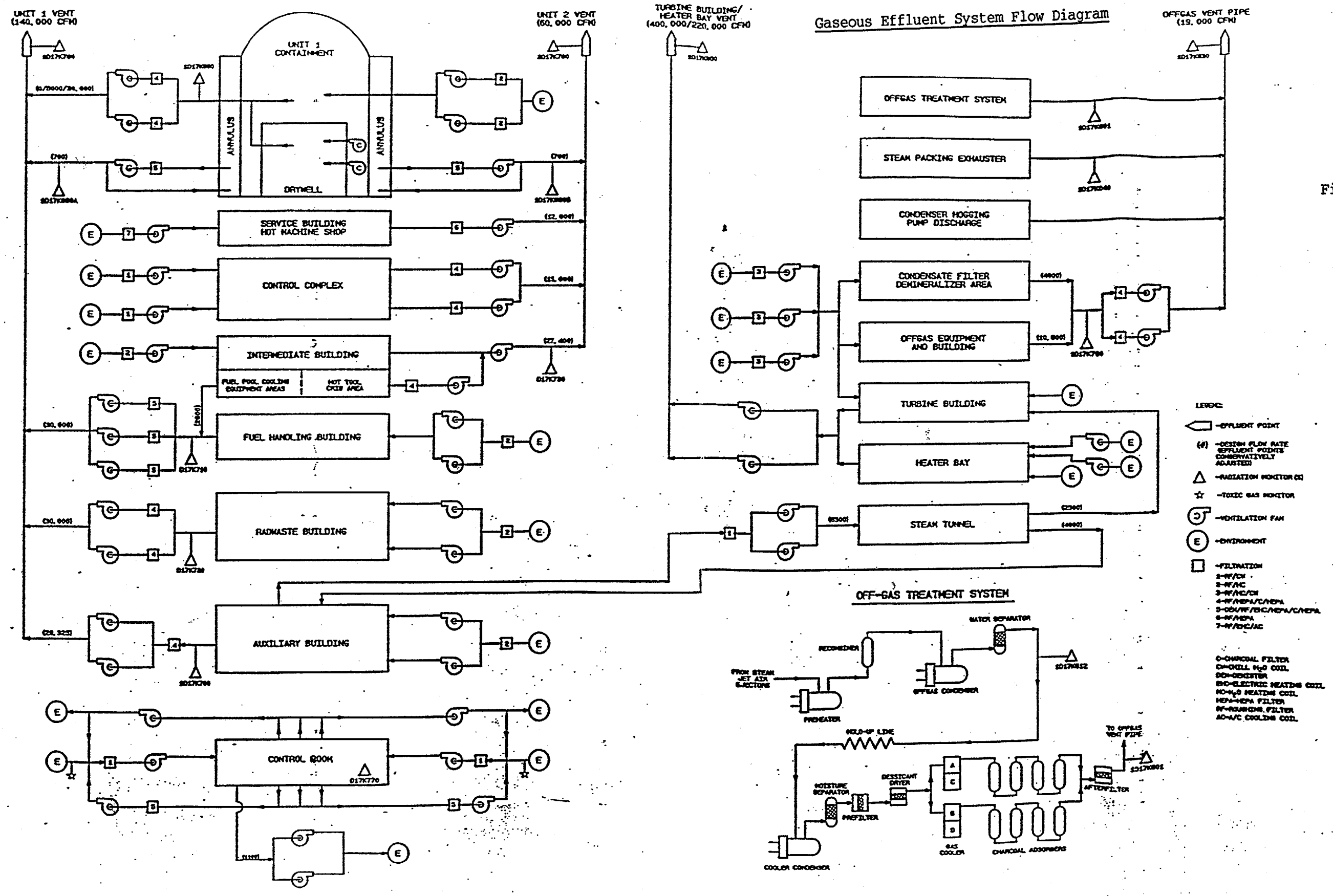


Figure 3.0-1

3.1 Monitor Alarm Setpoint Determination

The following calculation methods provide a means of determining the High Alarm Setpoint (HSP) and the Alert Setpoint (ASP) to ensure compliance with the regulatory dose rate limit to areas at or beyond the site boundary of 500 mRem/yr for the following noble gas monitors:

1. Unit 1 Vent radiation monitor (1D17K0786)

2. Unit 2 Vent radiation monitor (2D17K0786)

3. Off-Gas Vent radiation monitor (1D17K0836)

4. Turbine Building/Heater Bay Vent radiation monitor (1D17K0856)

The Unit 2 Vent radiation monitor is included for the operation of Unit 1 of the Perry Nuclear Power Plant because the second train of the Unit 1 Annulus Exhaust and the Control Complex and Intermediate Building ventilations are exhausted through the Unit 2 Vent.

The High Alarm Setpoint (HSP) for each release point radiation monitor will be set at 70% of the annual dose rate limit (350 mRem/yr) and the Alert Setpoint (ASP) will be at 10% of the annual dose rate limit (50 mRem/yr).

NOTE: These values are set as a small fraction of the total activity that may be released via the monitored pathways to ensure that the site boundary dose rate limits are not exceeded. Any single ASP can be exceeded without exceeding the 500 mRem/yr dose rate limit.

a. Upon receipt of an alert alarm, a sample from the alarming effluent path will be obtained and analyzed. If two or more effluent monitors exceed the ASP, or if any one effluent monitor exceeds the HSP, the potential exists that the 500 mRem/yr dose rate limit may be exceeded. In this case, all four effluent paths will be sampled and analyzed, with the appropriate actions initiated to limit gaseous releases to below the annual dose rate limit.

b. If a single HSP, or two or more ASPs continue to be exceeded, verification shall be made at least once per 4 hours, via the gaseous effluent radiation monitors, that plant releases are below the ODCM Appendix C 3.11.2.1 dose rate limits. Sampling and analysis shall be performed on the four gaseous effluent release points at least once per 12 hours.

This procedure determines the monitor alarm setpoints that indicate if the dose rate beyond the site boundary due to noble gas radionuclides in gaseous effluent released from the site exceeds 500 mRem/year to the total body, or 3000 mRem/year to the skin.

3.1.1 Determination of the "Mix" (Noble Gas Radionuclide Composition) of the Gaseous Effluent

a. The gaseous source terms that are representative of the "mix" of the gaseous effluent are determined. Gaseous source terms are the concentrations of the noble gas radionuclides in the effluent as determined by analysis of the various sources of gaseous effluents. During the early period of plant operation, before a sufficient operational effluent source term data base has been obtained, source terms will be those generated by the GALE code, Revision 0 for PNPP (FSAR Tables 11.3-9 and 11.3-10).

b. Determination of the fraction of the total radioactivity in the gaseous effluent for each noble gas radionuclide in the gaseous effluent.

$$S_i = \frac{A_i}{\sum_i A_i} \qquad (3.1\text{-}1)$$

Where:

S_i = the fraction of the total for radionuclide "i" in the effluent;

A_i = the activity of radionuclide "i" in the gaseous effluent.

NOTE: If the activity of a noble gas radionuclide is below the lower limit of detection the noble gas radionuclide is not included as a source term in this setpoint calculation.

3.1.2 Determination of the Maximum Acceptable Total Activity Release Rate of Noble Gas Radionuclides in Gaseous Effluent Based on Total Body Dose Rate Limit

$$Q_b = \frac{500}{(\chi/Q) \sum_i (K_i)(S_i)} \qquad (3.1\text{-}2)$$

Where:

Q_b = the maximum acceptable total activity release rate of all noble gas radionuclides in the effluent (for total body exposure), in µCi/s;

K_i = the total body dose factor for a semi-infinite cloud of radionuclide "i" (includes the attenuation of 5g/cm^2 of tissue) from Table 3.1-1, in (mrem/yr)/(µCi/m^3);

S_i = the fraction of the total for radionuclide "i", as per equation 3.1.1;

χ/Q = the annual average dispersion factor in s/m^3 (see Appendix A);

NOTE: The dispersion parameters (χ/Q) used in these calculations are the highest calculated site boundary values for any of the land-based sectors only. At PNPP the site boundary locations in the following sectors are totally over water: N, NNE, NNW, NW, W, WNW.

500 = the total body dose rate limit, in mrem/yr.

3.1.3 Determination of the Maximum Acceptable Total Activity Release Rate of Noble Gas Radionuclides in Gaseous Effluent Based on Skin Dose Rate Limit

$$Q_S = \frac{3000}{(\chi/Q) \sum_i (L_i + 1.11\, M_i)\ (S_i)} \qquad (3.1\text{-}3)$$

Where:

Q_S = the maximum acceptable total activity release rate of all noble gas radionuclides in the effluent (for skin exposure), in µCi/s;

L_i = the beta skin dose factor for a semi-infinite cloud of radionuclide "i" (includes attenuation by the outer "dead" layer of skin), in $(mrem/yr)/(\mu Ci/m^3)$;

M_i = the gamma air dose factor for a uniform semi-infinite cloud of radionuclide "i", in $(mrad/yr)/(\mu Ci/m^3)$;

S_i = the fraction of the total for radionuclide "i", per equation 3.1.1;

χ/Q = the annual average dispersion factor in s/m^3 (see Appendix A);

1.11 = the air dose to tissue dose equivalent conversion factor, in mrem/mrad;

3000 = the skin dose rate limit, in mrem/yr.

$(L_i + 1.11\, M_i)$ values are shown in Table 3.1-1.

3.1.4 Determination of the Maximum Acceptable Total Radioactivity Concentration of all Noble Gas Radionuclides in the Gaseous Effluent

$$C_t = \frac{(2.12 \times 10^{-3})(Q_t)}{f} \qquad (3.1\text{-}4)$$

Where:

C_t = the maximum acceptable total radioactivity concentration of all noble gas radionuclides in the effluent, in µCi/cc;

f = the flow rate for the release point from the respective flow rate recorders, in ft^3/min;

NOTE: Design flow rate may be used in lieu of actual flow rate. These design flow rate values incorporate a 10% flow rate inaccuracy correction.

Release Path	Flow Rate (cfm)
- Heater Bay/Turbine Building Vent	400,000 (summer) 220,000 (winter)
- Offgas Vent Pipe	19,000
- Unit 1 Vent	140,000
- Unit 2 Vent	60,000

Q_t = the smaller of Q_b and Q_s, calculated in equations 3.1-2 and 3.1-3, respectively, in µCi/s;

2.12×10^{-3} = the conversion factor to convert (µCi/s) ft^3/min) to µCi/cc.

3.1.5 Determination of the Maximum Acceptable Monitor Count Rate Above Background Attributed to Noble Gas Radionuclides

$$CR_c = (0.8)\ (C_t)$$
$$(E_m^c) \qquad (3.1\text{-}5)$$

Where:

CR_c = the calculated monitor count rate above background attributed to noble gas radionuclides, in cpm;

C_t = the maximum acceptable radioactivity concentration, per equation 3.1-4, in µCi/cc;

E_m = the detector efficiency of the monitor for the "mix" of noble gas radionuclides in the effluent, in cpm/(µCi/cc);

= the total µCi/cc concentration divided into the net monitor count rate taken at the time the sample was taken; during the early period of operation, before a sufficient operational effluent source term data base has been obtained, the value will be calculated using monitor calibration data;

0.8 = an engineering safety factor.

3.1.5.1 Determination of the Monitor High Alarm Setpoint

$$HSP = (0.70)(CR_c) + BG \qquad (3.1\text{-}6)$$

Where:

HSP = the high alarm setpoint (including background), in cpm;

BG = the background count rate due to internal contamination and radiation levels in the area in which the monitor is installed when the monitor chamber is filled with uncontaminated air, in cpm;

CR_c = the calculated monitor net count rate, per equation 3.1-5, in cpm;

0.70 = the fraction of the maximum acceptable activity that may be released from the vent to ensure that the site boundary dose rate limits are not exceeded during concurrent releases from several pathways.

3.1.5.2 Determination of the Monitor Alert Setpoint

$$ASP = (0.10)(CR_c) + BG \qquad (3.1\text{-}7)$$

Where:

ASP = the alert setpoint (including background), in cpm;

BG = the background count rate due to internal contamination and radiation levels in the area in which the monitor is installed when the monitor chamber is filled with uncontaminated air, in cpm;

CR_C = the calculated monitor net count rate, per equation 3.1-5, in cpm;

0.10 = the fraction of the maximum acceptable activity that may be released from the vent to ensure that the site boundary dose rate limits are not exceeded during concurrent releases from several pathways.

Table 3.1-1

Total Body and Skin Dose Factors

Radionuclide	Total Body Dose Factor (K_i) (mrem/yr/μCi/m^3)	Total Skin Dose Factor (L_i+1.11 M_i) (mrem/yr/μCi/m^3)
Kr-83m	7.56E-02	2.14E+01
Kr-85m	1.17E+03	2.83E+03
Kr-85	1.61E+01	1.36E+03
Kr-87	5.92E+03	1.66E+04
Kr-88	1.47E+04	1.92E+04
Kr-89	1.66E+04	2.93E+04
Xe-131m	9.15E+01	6.49E+02
Xe-133m	2.51E+02	1.36E+03
Xe-133	2.94E+02	6.97E+02
Xe-135m	3.12E+03	4.44E+03
Xe-135	1.81E+03	3.99E+03
Xe-137	1.42E+03	1.39E+04
Xe-138	8.83E+03	1.44E+04
Ar-41	8.84E+03	1.30E+04

3.2 Compliance With 10CFR20 - Gaseous Effluent Dose Rate

Dose rates resulting from the release of noble gases, radioiodines, tritium, and radionuclides in particulate form must be calculated to show compliance with 10CFR20. The limits of 10CFR20 are conservatively applied for the release period at the controlling location.

3.2.1 Noble Gases

The dose rate in unrestricted areas resulting from noble gas effluents is limited, by ODCM Appendix C controls, to 500 mrem/yr to the total body and 3000 mrem/yr to the skin. Only the external dose pathway will be considered for noble gases. Because all gaseous effluent releases from PNPP are considered ground level, the controlling location for these dose rate limits is the site boundary location (see Figure 3.2-1) with the highest relative dispersion factor (χ/Q). (See Appendix A for elaboration on atmospheric dispersion.)

The alarm setpoint determinations discussed in the previous section should ensure compliance with these dose rate limits. However, if any one high alarm or two or more alert alarms occur, the dose rates in unrestricted areas resulting from the release of noble gas radionuclides from all vents will be calculated. The calculations will be based on the results of analyses obtained pursuant to the ODCM Appendix C controls.

3.2.2 Radionuclides, Particulates, and Other Radionuclides

The dose rate in unrestricted areas resulting from the release of iodine-131, iodine-133, tritium, and all radionuclides in particulate form with half-lives greater than eight days is limited, by ODCM Appendix C controls, to 1500 mrem/yr to any organ. The calculation of dose rate from these radionuclides will be performed based on results of analyses obtained pursuant to those Appendix C controls. The controlling location for this limit is the location of the highest relative deposition (D/Q) for the period of release as well as the actual receptor pathway. The receptor pathway locations will be reviewed once per year following the performance of the Land Use Census to include consideration of nearest residences, garden, and farm animal locations in each sector.

3.2.3 Dose Rate Calculations

The following is the equation used to calculate the dose rate resultant from the release of radioactive materials in gaseous effluents to areas at or beyond the site boundary for the purpose of showing compliance with ODCM Appendix C controls as related to 10CFR20.

$$D_{ajp} = (3.15 \times 10^{1}) (\chi/Q \text{ or } D/Q) \Sigma (DF_{aijp}) (Q_i) \qquad (3.2\text{-}1)$$

Where:

D_{ajp} = the organ "j" dose rate as a function of age group "a" and pathway "p", in mrem/yr;

DF_{aijp} = the dose factor for organ type "j", age group "a", pathway "p" for isotope "i" (see Tables 3.2-1 through 3.2-3); units and equations used (equations 3.2-2 through 3.2-6) are provided later in this section;

χ/Q or D/Q = the normal or depleted relative dispersion factor $(\chi/Q)_2$ in s/m^3, or relative deposition (D/Q), in m^{-2}, at the receptor distance (see Appendix A);

3.15×10^{1} = the conversion factor to convert (mrem * µCi)/(Ci * s) to mrem/yr;

Q_i = the release rate of isotope "i", (annualized) in µCi/s

$= (472)(C_i)(f)$

Where:

C_i = the concentration of radionuclide "i" in the gaseous effluent, in µCi/cc;

f = the gaseous effluent flow rate during the release, in ft^3/min;

472 = the conversion factor $(cc/ft^3)/(s/min)$.

The following relationships are used to derive the dose factors (DF_{aijp}) for noble gases, tritium, radioiodines and particulates used in equation 3.2-1.

a. Total Body Dose Factors from Exposure to a Semi-Infinite Plume

$$DF_i^T = (S_F)\ (\chi_i)\ (DFB_i) \qquad (3.2\text{-}2)$$

Where:

DF_i^T = the total body factor due to immersion in a semi-infinite cloud of radionuclide "i", in (mrem * m^3)/(Ci * s);

DFB_i = the total body gamma dose factor for a semi-infinite cloud of radionuclide "i" which includes the attenuation of 5g/cm^2 of tissue from Table 3.2-4, in mrem/yr per pCi/m^3;

S_F = the attenuation factor that accounts for the dose reduction due to the shielding provided by residential structures, optional, dimensionless: maximum exposed individual = 0.7, population dose 0.5 (Regulatory Guide 1.109);

χ_i = the annual average concentration of radionuclide "i" in air (pCi/m^3), for a unit release rate (Ci/yr) and a unit χ/Q (s/m^3), in (pCi/m^3)/(Ci/yr)(s/m^3).

b. Skin Dose Factors for Exposure to a Semi-Infinite Plume

$$DF_i^S = (\chi_i)\ [(1.11)\ (S_F)\ (DF_i^\gamma) + (DFS_i)] \qquad (3.2\text{-}3)$$

Where:

DF_i^S = the skin dose factor due to immersion in a semi-infinite cloud of radionuclide "i", in (mrem * m^3)/(Ci * s);

DF_i^γ = the gamma air dose factor for a uniform semi-infinite cloud of radionuclide "i", from Table 3.2-4, in mrad/yr per pCi/m^3;

DFS_i = the beta skin dose factor for a semi-infinite cloud of radionuclide "i" (includes attenuation by the outer "dead" layer of skin), from Table 3.2-4 in mrem/yr per pCi/m^3;

S_F = the attenuation factor that accounts for the dose reduction due to the shielding provided by residential structures, optional, dimensionless:

maximum exposed individual = 0.7, population dose = 0.5 (Regulatory Guide 1.109);

χ_i = the annual average concentration of radionuclide "i" in air (pCi/m^3), for a unit release rate (Ci/yr) and a unit χ/Q (s/m^3), in $(pCi/m^3)/(Ci/yr)(s/m^3)$;

1.11 = the air dose to tissue dose equivalent conversion factor, in mrem/mrad.

c. Dose Factors from External Irradiation from Radionuclides Deposited onto the Ground Surface

$$DF_{ij}^{G} = (8760)\ (C_i^{G})\ (DFG_{ij})\ (S_F) \qquad (3.2\text{-}4)$$

Where:

DF_{ij}^{G} = the dose factor for radionuclide "i" to organ "j" resulting from exposure to radionuclides deposited onto the ground surface, in $(mrem * m^2)/Ci$;

C_i^{G} = the ground plane concentration (pCi/m^2) of radionuclide "i" for a unit release rate (Ci/yr) and a unit D/Q, relative ground deposition (m^{-2}), in $(pCi/m^2)/(Ci/yr)(m^{-2})$;

DFG_{ij} = the open field ground plane dose conversion factor for organ "j" from radionuclide "i", from Table 3.2-5, in mrem/yr per pCi/m^2;

S_F = the attenuation factor that accounts for the dose reduction due to the shielding provided by residential structures, optional, dimensionless: maximum exposed individual = 0.7, population dose = 0.5 (Regulatory Guide 1.109);

8760 = the number of hours in a year.

d. Dose Factors from Inhalation of Radionuclides in Air

$$DF_{aij}^{A} = (DFA_{aij})\ (R_a)\ (\chi_i) \qquad (3.2\text{-}5)$$

Where:

DF^{A}_{aij} = the dose factor for radionuclide "i" to organ "j" of an individual in age group "a" due to inhalation, in (mrem * m^3)/(Ci_3* s) [-- equivalent to (mrem/yr)(yr/Ci)(m^3/s)];

DFA_{aij} = the inhalation dose factor for radionuclide "i", organ "j", and age group "a" (the value for skin is assumed to be 0), from Tables 3.2-6 through 3.2-9, in mrem/pCi;

R_a = the annual air intake for individuals in age group "a", from Table 3.2-14, in m^3/yr;

χ_i = the annual average concentration of radionuclide "i" in air (pCi/m^3), for a unit release rate (Ci/yr) and a unit χ/Q (s/m^3), in (pCi/m^3)/(Ci/yr)(s/m^3).

e. Dose Factors from the Ingestion of Atmospherically Released Radionuclides in Food

$$DF^{D}_{aij} = DFI_{aij}\,[(U^{F}_{a})\,(C^{F}_{i}) + (U_a)(f_L)(C^{L}_{i}) + (U^{M}_{a})(C^{M}_{i}) + (U^{V}_{a})(f_V)(C^{V}_{i})] \qquad (3.2\text{-}6)$$

Where:

DF^{D}_{aij} = the dose factor for radionuclide "i" to organ "j" of an individual in age group "a" from the ingestion of meat, leafy vegetables, milk, and produce (non-leafy vegetables, fruits, and grains) in (mrem * m^2)/Ci, or in the cases of H-3 and C-14 in (mrem * m^3)/(Ci * s);

C^{F}_{i}, C^{L}_{i}, C^{M}_{i}, C^{V}_{i} = the concentrations of radionuclide "i" in meat, leafy vegetables, milk, and produce, respectively (pCi/kg or pCi/l) for a unit release rate (Ci/yr) and a unit D/Q, relative ground deposition (m^{-2}), or in cases of H-3 and C-14, a unit χ/Q, relative ground-level concentration (s/m^3), in (pCi/kg)(Ci/yr)(m^{-2}) or (pCi/kg)/(Ci/yr)(s/m^3) or (pCi/l)/(Ci/yr)(m^{-2}) or (pCi/l)(yr/Ci)(s/m^3/);

DFI_{aij} = the ingestion dose factor for radionuclide "i", organ "j", and age group "a", from Tables 3.2-10 through 3.2-13, in mrem/pCi;

f_L, f_V = the respective fractions of the ingestion rates of leafy vegetables and produce that are produced in the garden of interest, 1.0 and 0.76 respectively (Regulatory Guide 1.109);

U_a^F, U_a^L, U_a^M, U_a^V = the annual intake (usage) of meat, leafy vegetables, milk, and produce respectively, for individuals in age group "a", from Table 3.2-14, in kg/yr or 1/yr.

f. Dose rate example problem:

1) For the purpose of this sample problem, the following assumptions are utilized: a release of Xe133 at 1.0E-5uCi/cc, a flow rate of 1.0E5ft^3/min, and a total body dose factor of 2.94E-4 mrem/yr per pCi/m^3. A dose rate and 1 hour cumulative dose are calculated.

2) Total Body Dose Factor Dose factor per ODCM equation 3.2-2.

$$\frac{2.94E\text{-}4\ \text{mrem}}{\frac{\text{yr}}{\frac{\text{pCi}}{\text{m}^3}}} \times (.7) \times \frac{1.0E\text{-}12\ \text{pCi}}{\frac{\text{m}^3}{\frac{\text{Ci}}{\text{yr}}\ \frac{3.15E7\text{sec}}{\text{m}^3}}} = \frac{6.52\ \text{mrem m}^3}{\text{Ci sec}}$$

3) Dose Rate per ODCM equation 3.2-1.

$$3.15E1 \times \frac{5.8E\text{-}6\text{s}}{\text{m}^3} \times \frac{6.52\text{mrem m}^3}{\text{Ci sec}} \times \frac{472\text{cc min}}{\text{ft}^3\ \text{sec}} \times \text{-->}$$

$$\text{-->}\ \frac{1.0E\text{-}5\text{uCi}}{\text{cc}} \times \frac{1E5\text{ft}^3}{\text{min}} = \frac{\mathbf{0.562\text{mrem}}}{\mathbf{yr}}$$

$$\frac{0.562\text{mrem}}{\text{yr}} \times (1\text{hr}) \times \frac{1\text{yr}}{8760\text{hr}} = 6.42E\text{-}5\text{mrem}$$

Table 3.2-1

Organ Used for Gaseous Effluent Dose Calculations

1. Bone
2. GI Tract
3. Kidney
4. Liver
5. Lung
6. Thyroid
7. Total Body
8. Skin

Table 3.2-2

Age Groups Used for Gaseous Effluent Dose Calculations

1. Adult (17 yr and older)
2. Teen (11-17 yr)
3. Child (1-11 yr)
4. Infant (0-1 yr)

Table 3.2-3

Gaseous Effluent Dose Pathways

1. Plume
2. Ground Shine
3. Vegetables
4. Meat
5. Cow Milk
6. Goat Milk
7. Inhalation

Table 3.2-4

Dose Factors for Exposure to a Semi-Infinite Cloud of Noble Gases

Nuclide	Total Body* Gamma Dose Factor (DFB_i)	Beta Skin* Dose Factor (DFS_i)	Gamma Air** Dose Factor (DF_i^{γ})
Kr-83m	7.56E-08	---	1.93E-05
Kr-85m	1.17E-03	1.46E-03	1.23E-03
Kr-85	1.61E-05	1.34E-03	1.72E-05
Kr-87	5.92E-03	9.73E-03	6.17E-03
Kr-88	1.47E-02	2.37E-03	1.52E-02
Kr-89	1.66E-02	1.01E-02	1.73E-02
Kr-90	1.56E-02	7.29E-03	1.63E-02
Xe-131m	9.15E-05	4.76E-04	1.56E-04
Xe-133m	2.51E-04	9.94E-04	3.27E-04
Xe-133	2.94E-04	3.06E-04	3.53E-04
Xe-135m	3.12E-03	7.11E-04	3.36E-03
Xe-135	1.81E-03	1.86E-03	1.92E-03
Xe-137	1.42E-03	1.22E-02	1.51E-03
Xe-138	8.83E-03	4.13E-03	9.21E-03
Ar-41	8.84E-03	2.69E-03	9.30E-03

* mrem/yr per pCi/m^3
** mrad/yr per pCi/m^3

Table 3.2-5

External Dose Factors for Standing on Contaminated Ground
(mrem/h per pCi/m^2)

Element	Total Body	Skin
H-3	0.0	0.0
C-14	0.0	0.0
NA-24	2.50E-08	2.90E-08
P-32	0.0	0.0
Cr-51	2.20E-10	2.60E-10
Mn-54	5.80E-09	6.80E-09
Mn-56	1.10E-08	1.30E-08
Fe-55	0.0	0.0
Fe-59	8.00E-09	9.40E-09
Co-58	7.00E-09	8.20E-09
Co-60	1.70E-08	2.00E-08
Ni-63	0.0	0.0
Nr-65	3.70E-09	4.30E-09
Cu-64	1.50E-09	1.70E-09
Zn-65	4.00E-09	4.60E-09
Zn-69	0.0	0.0
Br-83	6.40E-11	9.30E-11
Br-84	1.20E-08	1.40E-08
Br-85	0.0	0.0
Rb-86	6.30E-10	7.20E-10
Rb-88	3.50E-09	4.00E-09
Rb-89	1.50E-08	1.80E-08
Sr-89	5.60E-13	6.50E-13
Sr-91	7.10E-09	8.30E-09
Sr-92	9.00E-09	1.00E-08
Y-90	2.20E-12	2.60E-12
Y-91M	3.80E-09	4.40E-09
Y-91	2.40E-11	2.70E-11
Y-92	1.60E-09	1.90E-09
Y-93	5.70E-10	7.80E-10
Zr-95	5.00E-09	5.80E-09
Zr-97	5.50E-09	6.40E-09
Nb-95	5.10E-09	6.00E-09
Mo-99	1.90E-09	2.20E-09
Tc-99M	9.60E-10	1.10E-09
Tc-101	2.70E-09	3.00E-09
Ru-103	3.60E-09	4.20E-09
Ru-105	4.50E-09	5.10E-09
Ru-106	1.50E-09	1.80E-09
Ag-110M	1.80E-08	2.10E-08
Te-125M	3.50E-11	4.80E-11
Te-127M	1.10E-12	1.30E-12
Te-127	1.00E-11	1.10E-11
Te-129M	7.70E-10	9.00E-10
Te-129	7.10E-10	8.40E-10
Te-131M	8.40E-09	9.90E-09
Te-131	2.20E-09	2.60E-06
Te-132	1.70E-09	2.00E-09

Table 3.2-5 (Cont.)

External Dose Factors for Standing on Contaminated Ground
(mrem/h per pCi/m^2)

Element	Total Body	Skin
I-130	1.40E-08	1.70E-08
I-131	2.80E-09	3.40E-09
I-132	1.70E-08	2.00E-08
I-133	3.70E-09	4.50E-09
I-134	1.60E-08	1.90E-08
I-135	1.20E-08	1.40E-08
Cs-134	1.20E-08	1.40E-08
Cs-136	1.50E-08	1.70E-08
Cs-137	4.20E-09	4.90E-09
Cs-138	2.10E-08	2.40E-08
Ba-139	2.40E-09	2.70E-09
Ba-140	2.10E-09	2.40E-09
Ba-141	4.30E-09	4.90E-09
Ba-142	7.90E-09	9.00E-09
La-140	1.50E-08	1.70E-08
La-142	1.50E-08	1.80E-08
Ce-141	5.50E-10	6.20E-10
Ce-143	2.20E-09	2.50E-09
Ce-144	3.20E-10	3.70E-10
Pr-143	0.0	0.0
Pr-144	2.00E-10	2.30E-10
Nd-147	1.00E-09	1.20E-09
W-187	3.10E-09	3.60E-09
Np-239	9.50E-10	1.10E-09

Table 3.2-6

Inhalation Dose Factors for Adult (mrem/pCi inhaled)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	NO DATA	1.58E-07	1.58E-07	1.58E-07	1.58E-07	1.58E-07	1.58E-07
C 14	2.27E-06	4.26E-07	4.26E-07	4.26E-07	4.26E-07	4.26E-07	4.26E-07
NA 24	1.28E-06	1.28E-06	1.28E-06	1.28E-06	1.28E-06	1.28E-06	1.28E-06
P 32	1.65E-04	9.64E-06	6.26E-06	NO DATA	NO DATA	NO DATA	1.08E-05
CR 51	NO DATA	NO DATA	1.25E-08	7.44E-09	2.85E-09	1.80E-06	4.15E-07
MN 54	NO DATA	4.95E-06	7.87E-07	NO DATA	1.23E-06	1.75E-04	9.67E-06
MN 56	NO DATA	1.55E-10	7.29E-11	NO DATA	1.63E-10	1.18E-06	2.53E-06
FE 55	3.07E-06	2.12E-06	4.93E-07	NO DATA	NO DATA	9.01E-06	7.54E-07
FE 59	1.47E-06	3.47E-06	1.32E-06	NO DATA	NO DATA	1.27E-04	2.35E-05
CO 58	NO DATA	1.98E-07	2.59E-07	NO DATA	NO DATA	1.16E-04	1.33E-05
CO 60	NO DATA	1.44E-06	1.85E-06	NO DATA	NO DATA	7.46E-04	3.56E-05
NI 63	5.40E-05	3.93E-06	1.81E-06	NO DATA	NO DATA	2.23E-05	1.67E-06
NI 65	1.92E-10	2.62E-11	1.14E-11	NO DATA	NO DATA	7.00E-07	1.54E-06
CU 64	NO DATA	1.83E-10	7.69E-11	NO DATA	5.78E-10	8.48E-07	6.12E-06
ZN 65	4.05E-06	1.29E-05	5.82E-06	NO DATA	8.62E-06	1.08E-04	6.68E-06
ZN 69	4.23E-12	8.14E-12	5.65E-13	NO DATA	5.27E-12	1.15E-07	2.04E-09
BR 83	NO DATA	NO DATA	3.01E-08	NO DATA	NO DATA	NO DATA	2.90E-08
BR 84	NO DATA	NO DATA	3.91E-08	NO DATA	NO DATA	NO DATA	2.05E-13
BR 85	NO DATA	NO DATA	1.60E-09	NO DATA	NO DATA	NO DATA	LT E-24
RB 86	NO DATA	1.69E-05	7.37E-06	NO DATA	NO DATA	NO DATA	2.08E-06
RB 88	NO DATA	4.84E-08	2.41E-08	NO DATA	NO DATA	NO DATA	4.18E-19
RB 89	NO DATA	3.20E-08	2.12E-08	NO DATA	NO DATA	NO DATA	1.16E-21
SR 89	3.80E-05	NO DATA	1.09E-06	NO DATA	NO DATA	1.75E-04	4.37E-05
SR 90	1.24E-02	NO DATA	7.62E-04	NO DATA	NO DATA	1.20E-03	9.02E-05
SR 91	7.74E-09	NO DATA	3.13E-10	NO DATA	NO DATA	4.56E-06	2.39E-05
SR 92	8.43E-10	NO DATA	3.64E-11	NO DATA	NO DATA	2.06E-06	5.38E-06
Y 90	2.61E-07	NO DATA	7.01E-09	NO DATA	NO DATA	2.12E-05	6.32E-05
Y 91M	3.26E-11	NO DATA	1.27E-12	NO DATA	NO DATA	2.40E-07	1.66E-10
Y 91	5.78E-05	NO DATA	1.55E-06	NO DATA	NO DATA	2.13E-04	4.81E-05
Y 92	1.29E-09	NO DATA	3.77E-11	NO DATA	NO DATA	1.96E-06	9.19E-06
Y 93	1.18E-08	NO DATA	3.26E-10	NO DATA	NO DATA	6.06E-06	5.27E-05
ZR 95	1.34E-05	4.30E-06	2.91E-06	NO DATA	6.77E-06	2.21E-04	1.88E-05
ZR 97	1.21E-08	2.45E-09	1.13E-09	NO DATA	3.71E-09	9.84E-06	6.54E-05
NB 95	1.76E-06	9.77E-07	5.26E-07	NO DATA	9.67E-07	6.31E-05	1.30E-05
MO 99	NO DATA	1.51E-08	2.87E-09	NO DATA	3.64E-08	1.14E-05	3.10E-05
TC 99M	1.29E-13	3.64E-13	4.63E-12	NO DATA	5.52E-12	9.55E-08	5.20E-07

Table 3.2-6 (Cont.)

Inhalation Dose Factors for Adult (mrem/pCi inhaled)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
TC101	5.22E-15	7.52E-15	7.38E-14	NO DATA	1.35E-13	4.99E-08	1.36E-21
RU103	1.91E-07	NO DATA	8.23E-08	NO DATA	7.29E-07	6.31E-05	1.38E-05
RU105	9.88E-11	NO DATA	3.89E-11	NO DATA	1.77E-10	1.37E-06	6.02E-06
RU106	8.64E-06	NO DATA	1.03E-06	NO DATA	1.67E-05	1.17E-03	1.14E-04
AG110M	1.35E-06	1.25E-06	7.43E-07	NO DATA	2.46E-06	5.79E-04	3.78E-05
TE125M	4.27E-07	1.98E-07	5.84E-08	1.31E-07	1.55E-06	3.92E-05	8.83E-06
TE127M	1.58E-06	7.21E-07	1.96E-07	4.11E-07	5.72E-06	1.20E-04	1.87E-05
TE127	1.75E-10	8.03E-11	3.87E-11	1.32E-10	6.37E-10	8.14E-07	7.17E-06
TE129M	1.22E-06	5.84E-07	1.98E-07	4.30E-07	4.57E-06	1.45E-04	4.79E-05
TE129	6.22E-12	2.99E-12	1.55E-12	4.87E-12	2.34E-11	2.42E-07	1.96E-08
TE131M	8.74E-09	5.45E-09	3.63E-09	6.88E-09	3.86E-08	1.82E-05	6.95E-05
TE131	1.39E-12	7.44E-13	4.49E-13	1.17E-12	5.46E-12	1.74E-07	2.30E-09
TE132	3.25E-08	2.69E-08	2.02E-08	2.37E-08	1.82E-07	3.60E-05	6.37E-05
I 130	5.72E-07	1.68E-06	8.60E-07	1.42E-04	2.61E-06	NO DATA	9.61E-07
I 131	3.15E-06	4.47E-06	2.56E-06	1.49E-03	7.66E-06	NO DATA	7.85E-07
I 132	1.45E-07	4.07E-07	1.45E-07	1.43E-05	6.48E-07	NO DATA	5.08E-08
I 133	1.08E-06	1.85E-06	5.65E-07	2.69E-04	3.23E-06	NO DATA	1.11E-06
I 134	8.05E-08	2.16E-07	7.69E-08	3.73E-06	3.44E-07	NO DATA	1.26E-10
I 135	3.35E-07	8.73E-07	3.21E-07	5.60E-05	1.39E-06	NO DATA	6.56E-07
CS134	4.66E-05	1.06E-04	9.10E-05	NO DATA	3.59E-05	1.22E-05	1.30E-06
CS136	4.88E-06	1.83E-05	1.38E-05	NO DATA	1.07E-05	1.50E-06	1.46E-06
CS137	5.98E-05	7.76E-05	5.35E-05	NO DATA	2.78E-05	9.40E-06	1.05E-06
CS138	4.14E-08	7.76E-08	4.05E-08	NO DATA	6.00E-08	6.07E-09	2.33E-13
BA139	1.17E-10	8.32E-14	3.42E-12	NO DATA	7.78E-14	4.70E-07	1.12E-07
BA140	4.88E-06	6.13E-09	3.21E-07	NO DATA	2.09E-09	1.59E-04	2.73E-05
BA141	1.25E-11	9.41E-15	4.20E-13	NO DATA	8.75E-15	2.42E-07	1.45E-17
BA142	3.29E-12	3.38E-15	2.07E-13	NO DATA	2.86E-15	1.49E-07	1.96E-26
LA140	4.30E-08	2.17E-08	5.73E-09	NO DATA	NO DATA	1.70E-05	5.73E-05
LA142	8.54E-11	3.88E-11	9.65E-12	NO DATA	NO DATA	7.91E-07	2.64E-07
CE141	2.49E-06	1.69E-06	1.91E-07	NO DATA	7.83E-07	4.52E-05	1.50E-05
CE143	2.33E-08	1.72E-08	1.91E-09	NO DATA	7.60E-09	9.97E-06	2.83E-05
CE144	4.29E-04	1.79E-04	2.30E-05	NO DATA	1.06E-04	9.72E-04	1.02E-04
PR143	1.17E-06	4.69E-07	5.80E-08	NO DATA	2.70E-07	3.51E-05	2.50E-05
PR144	3.76E-12	1.56E-12	1.91E-13	NO DATA	8.81E-13	1.27E-07	2.69E-18
ND147	6.59E-07	7.62E-07	4.56E-08	NO DATA	4.45E-07	2.76E-05	2.16E-05
W 187	1.06E-09	8.85E-10	3.10E-10	NO DATA	NO DATA	3.63E-06	1.94E-05
NP239	2.87E-08	2.82E-09	1.55E-09	NO DATA	8.75E-09	4.70E-06	1.49E-05

Table 3.2-7

Inhalation Dose Factors for Teenager (mrem/pCi inhaled)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	NO DATA	1.59E-07	1.59E-07	1.59E-07	1.59E-07	1.59E-07	1.59E-07
C 14	3.25E-06	6.09E-07	6.09E-07	6.09E-07	6.09E-07	6.09E-07	6.09E-07
NA 24	1.72E-06	1.72E-06	1.72E-06	1.72E-06	1.72E-06	1.72E-06	1.72E-06
P 32	2.36E-04	1.37E-05	8.95E-06	NO DATA	NO DATA	NO DATA	1.16E-05
CR 51	NO DATA	NO DATA	1.69E-08	9.37E-09	3.84E-09	2.62E-06	3.75E-07
MN 54	NO DATA	6.39E-06	1.05E-06	NO DATA	1.59E-06	2.48E-04	8.35E-06
MN 56	NO DATA	2.12E-10	3.15E-11	NO DATA	2.24E-10	1.90E-06	7.18E-06
FE 55	4.18E-06	2.98E-06	6.93E-07	NO DATA	NO DATA	1.55E-05	7.99E-07
FE 59	1.79E-06	4.62E-06	1.79E-06	NO DATA	NO DATA	1.91E-04	2.23E-05
CO 58	NO DATA	2.59E-07	3.47E-07	NO DATA	NO DATA	1.68E-04	1.19E-05
CO 60	NO DATA	1.89E-06	2.48E-06	NO DATA	NO DATA	1.09E-03	3.24E-05
NI 63	7.25E-05	5.43E-06	2.47E-06	NO DATA	NO DATA	3.84E-05	1.77E-06
NI 65	2.73E-10	3.06E-11	1.59E-11	NO DATA	NO DATA	1.17E-06	4.59E-06
CU 64	NO DATA	2.54E-10	1.06E-10	NO DATA	8.01E-10	1.39E-06	7.68E-06
ZN 65	4.82E-06	1.67E-05	7.80E-06	NO DATA	1.08E-05	1.55E-04	5.83E-06
ZN 69	6.04E-12	1.15E-11	8.07E-13	NO DATA	7.53E-12	1.98E-07	3.56E-08
BR 83	NO DATA	NO DATA	4.30E-08	NO DATA	NO DATA	NO DATA	LT E-24
BR 84	NO DATA	NO DATA	5.41E-08	NO DATA	NO DATA	NO DATA	LT E-24
BR 85	NO DATA	NO DATA	2.29E-09	NO DATA	NO DATA	NO DATA	LT E-24
RB 86	NO DATA	2.38E-05	1.05E-05	NO DATA	NO DATA	NO DATA	2.21E-06
RB 88	NO DATA	6.82E-08	3.40E-08	NO DATA	NO DATA	NO DATA	3.65E-15
RB 89	NO DATA	4.40E-08	2.91E-08	NO DATA	NO DATA	NO DATA	4.22E-17
SR 89	5.43E-05	NO DATA	1.56E-06	NO DATA	NO DATA	3.02E-04	4.64E-05
SR 90	1.35E-02	NO DATA	8.35E-04	NO DATA	NO DATA	2.06E-03	9.56E-05
SR 91	1.10E-08	NO DATA	4.39E-10	NO DATA	NO DATA	7.59E-06	3.24E-05
SR 92	1.19E-09	NO DATA	5.08E-11	NO DATA	NO DATA	3.43E-06	1.49E-05
Y 90	3.73E-07	NO DATA	1.00E-08	NO DATA	NO DATA	3.66E-05	6.99E-05
Y 91M	4.63E-11	NO DATA	1.77E-12	NO DATA	NO DATA	4.00E-07	3.77E-09
Y 91	8.26E-05	NO DATA	2.21E-06	NO DATA	NO DATA	3.67E-04	5.11E-05
Y 92	1.84E-09	NO DATA	5.36E-11	NO DATA	NO DATA	3.35E-06	2.06E-05
Y 93	1.69E-08	NO DATA	4.65E-10	NO DATA	NO DATA	1.04E-05	7.24E-05
ZR 95	1.82E-05	5.73E-06	3.94E-06	NO DATA	8.42E-06	3.36E-04	1.86E-05
ZR 97	1.72E-08	3.40E-09	1.57E-09	NO DATA	5.15E-09	1.62E-05	7.88E-05
NB 95	2.32E-06	1.29E-06	7.08E-07	NO DATA	1.25E-06	9.39E-05	1.21E-05
MO 99	NO DATA	2.11E-08	4.03E-09	NO DATA	5.14E-08	1.92E-05	3.36E-05
TC 99M	1.73E-13	4.83E-13	6.24E-12	NO DATA	7.20E-12	1.44E-07	7.66E-07

Table 3.2-7 (Cont.)

Inhalation Dose Factors for Teenager (mrem/pCi inhaled)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
TC101	7.40E-15	1.05E-14	1.03E-13	NO DATA	1.90E-13	8.34E-08	1.09E-16
RU103	2.63E-07	NO DATA	1.12E-07	NO DATA	9.29E-07	9.79E-05	1.36E-05
RU105	1.40E-10	NO DATA	5.42E-11	NO DATA	1.76E-10	2.27E-06	1.13E-05
RU106	1.23E-05	NO DATA	1.55E-06	NO DATA	2.38E-05	2.01E-03	1.20E-04
AG110M	1.73E-06	1.64E-06	9.99E-07	NO DATA	3.13E-06	8.44E-04	3.41E-05
TE125M	6.10E-07	2.80E-07	8.34E-08	1.75E-07	NO DATA	6.70E-05	9.38E-06
TE127M	2.25E-06	1.02E-06	2.73E-07	5.48E-07	8.17E-06	2.07E-04	1.99E-05
TE127	2.51E-10	1.14E-10	5.52E-11	1.77E-10	9.10E-10	1.40E-06	1.01E-05
TE129M	1.74E-06	8.23E-07	2.81E-07	5.72E-07	6.49E-06	2.47E-04	5.06E-05
TE129	8.87E-12	4.22E-12	2.20E-12	6.48E-12	3.32E-11	4.12E-07	2.02E-07
TE131M	1.23E-08	7.51E-09	5.03E-09	9.06E-09	5.49E-08	2.97E-05	7.76E-05
TE131	1.97E-12	1.04E-12	6.30E-13	1.55E-12	7.72E-12	2.92E-07	1.89E-09
TE132	4.50E-08	3.63E-08	2.74E-08	3.07E-08	2.44E-07	5.61E-05	5.79E-05
I 130	7.80E-07	2.24E-06	8.96E-07	1.86E-04	3.44E-06	NO DATA	1.14E-06
I 131	4.43E-06	6.14E-06	3.30E-06	1.83E-03	1.05E-05	NO DATA	8.11E-07
I 132	1.99E-07	5.47E-07	1.97E-07	1.89E-05	8.65E-07	NO DATA	1.59E-07
I 133	1.52E-06	2.56E-06	7.78E-07	3.65E-04	4.49E-06	NO DATA	1.29E-06
I 134	1.11E-07	2.90E-07	1.05E-07	4.94E-06	4.58E-07	NO DATA	2.55E-09
I 135	4.62E-07	1.18E-06	4.36E-07	7.76E-05	1.86E-06	NO DATA	8.69E-07
CS134	6.28E-05	1.41E-04	6.86E-05	NO DATA	4.69E-05	1.83E-05	1.22E-06
CS136	6.44E-06	2.42E-05	1.71E-05	NO DATA	1.38E-05	2.22E-06	1.36E-06
CS137	8.38E-05	1.06E-04	3.89E-05	NO DATA	3.80E-05	1.51E-05	1.06E-06
CS138	5.82E-08	1.07E-07	5.58E-08	NO DATA	8.28E-08	9.84E-09	3.38E-11
BA139	1.67E-10	1.18E-13	4.87E-12	NO DATA	1.11E-13	8.08E-07	8.06E-07
BA140	6.84E-06	8.38E-09	4.40E-07	NO DATA	2.85E-09	2.54E-04	2.86E-05
BA141	1.78E-11	1.32E-14	5.93E-13	NO DATA	1.23E-14	4.11E-07	9.33E-14
BA142	4.62E-12	4.63E-15	2.84E-13	NO DATA	3.92E-15	2.39E-07	5.99E-20
LA140	5.99E-08	2.95E-08	7.82E-09	NO DATA	NO DATA	2.68E-05	6.09E-05
LA142	1.20E-10	5.31E-11	1.32E-11	NO DATA	NO DATA	1.27E-06	1.50E-06
CE141	3.55E-06	2.37E-06	2.71E-07	NO DATA	1.11E-06	7.67E-05	1.58E-05
CE143	3.32E-08	2.42E-08	2.70E-09	NO DATA	1.08E-08	1.63E-05	3.19E-05
CE144	6.11E-04	2.53E-04	3.28E-05	NO DATA	1.51E-04	1.67E-03	1.08E-04
PR143	1.67E-06	6.64E-07	8.28E-08	NO DATA	3.86E-07	6.04E-05	2.67E-05
PR144	5.37E-12	2.20E-12	2.72E-13	NO DATA	1.26E-12	2.19E-07	2.94E-14
ND147	9.83E-07	1.07E-06	6.41E-08	NO DATA	6.28E-07	4.65E-05	2.28E-05
W 187	1.50E-09	1.22E-09	4.29E-10	NO DATA	NO DATA	5.92E-06	2.21E-05
NP239	4.23E-08	3.99E-09	2.21E-09	NO DATA	1.25E-08	8.11E-06	1.65E-05

Table 3.2-8

Inhalation Dose Factors for Child (mrem/pCi inhaled)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	NO DATA	3.04E-07	3.04E-07	3.04E-07	3.04E-07	3.04E-07	3.04E-07
C 14	9.70E-06	1.82E-06	1.82E-06	1.82E-06	1.82E-06	1.82E-06	1.82E-06
NA 24	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06
P 32	7.04E-04	3.09E-05	2.67E-05	NO DATA	NO DATA	NO DATA	1.14E-05
CR 51	NO DATA	NO DATA	4.17E-08	2.31E-08	6.57E-09	4.59E-06	2.93E-07
MN 54	NO DATA	1.16E-05	2.57E-06	NO DATA	2.71E-06	4.26E-04	6.19E-06
MN 56	NO DATA	4.48E-10	8.43E-11	NO DATA	4.52E-10	3.55E-06	3.33E-05
FE 55	1.28E-05	6.80E-06	2.10E-06	NO DATA	NO DATA	3.00E-05	7.75E-07
FE 59	5.59E-06	9.04E-06	4.51E-06	NO DATA	NO DATA	3.43E-04	1.91E-05
CO 58	NO DATA	4.79E-07	8.55E-07	NO DATA	NO DATA	2.99E-04	9.29E-06
CO 60	NO DATA	3.55E-06	6.12E-06	NO DATA	NO DATA	1.91E-03	2.60E-05
NI 63	2.22E-04	1.25E-05	7.56E-06	NO DATA	NO DATA	7.43E-05	1.71E-06
NI 65	8.08E-10	7.99E-11	4.44E-11	NO DATA	NO DATA	2.21E-06	2.27E-05
CU 64	NO DATA	5.39E-10	2.90E-10	NO DATA	1.63E-09	2.59E-06	9.92E-06
ZN 65	1.15E-05	3.06E-05	1.90E-05	NO DATA	1.93E-05	2.69E-04	4.41E-06
ZN 69	1.81E-11	2.61E-11	2.41E-12	NO DATA	1.58E-11	3.84E-07	2.75E-06
BR 83	NO DATA	NO DATA	1.28E-07	NO DATA	NO DATA	NO DATA	LT E-24
BR 84	NO DATA	NO DATA	1.48E-07	NO DATA	NO DATA	NO DATA	LT E-24
BR 85	NO DATA	NO DATA	6.84E-09	NO DATA	NO DATA	NO DATA	LT E-24
RB 86	NO DATA	5.36E-05	3.09E-05	NO DATA	NO DATA	NO DATA	2.16E-06
RB 88	NO DATA	1.52E-07	9.90E-08	NO DATA	NO DATA	NO DATA	4.66E-09
RB 89	NO DATA	9.33E-08	7.83E-08	NO DATA	NO DATA	NO DATA	5.11E-10
SR 89	1.62E-04	NO DATA	4.66E-06	NO DATA	NO DATA	5.83E-04	4.52E-05
SR 90	2.73E-02	NO DATA	1.74E-03	NO DATA	NO DATA	3.99E-03	9.28E-05
SR 91	3.28E-08	NO DATA	1.24E-09	NO DATA	NO DATA	1.44E-05	4.70E-05
SR 92	3.54E-09	NO DATA	1.42E-10	NO DATA	NO DATA	6.49E-06	6.55E-05
Y 90	1.11E-06	NO DATA	2.99E-08	NO DATA	NO DATA	7.07E-05	7.24E-05
Y 91M	1.37E-10	NO DATA	4.98E-12	NO DATA	NO DATA	7.60E-07	4.64E-07
Y 91	2.47E-04	NO DATA	6.59E-06	NO DATA	NO DATA	7.10E-04	4.97E-05
Y 92	5.50E-09	NO DATA	1.57E-10	NO DATA	NO DATA	6.46E-06	6.46E-05
Y 93	5.04E-08	NO DATA	1.38E-09	NO DATA	NO DATA	2.01E-05	1.05E-04
ZR 95	5.13E-05	1.13E-05	1.00E-05	NO DATA	1.61E-05	6.03E-04	1.65E-05
ZR 97	5.07E-08	7.34E-09	4.32E-09	NO DATA	1.05E-08	3.06E-05	9.49E-05
NB 95	6.35E-06	2.48E-06	1.77E-06	NO DATA	2.33E-06	1.66E-04	1.00E-05
MO 99	NO DATA	4.66E-08	1.15E-08	NO DATA	1.06E-07	3.66E-05	3.42E-05
TC 99M	4.81E-13	9.41E-13	1.56E-11	NO DATA	1.37E-11	7.57E-07	1.30E-06

Table 3.2-8 (Cont.)

Inhalation Dose Factors for Child (mrem/pCi inhaled)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
TC101	2.19E-14	2.30E-14	2.91E-13	NO DATA	3.92E-13	1.58E-07	4.41E-09
RU103	7.55E-07	NO DATA	2.90E-07	NO DATA	1.70E-06	1.79E-04	1.21E-05
RU105	4.13E-10	NO DATA	1.50E-10	NO DATA	3.63E-10	4.30E-06	2.69E-05
RU106	3.68E-05	NO DATA	4.57E-06	NO DATA	4.97E-05	3.87E-03	1.16E-04
AG110M	4.56E-06	3.08E-06	2.47E-06	NO DATA	5.74E-06	1.48E-03	2.71E-05
TE125M	1.82E-06	6.29E-07	2.47E-07	5.20E-07	NO DATA	1.29E-04	9.13E-06
TE127M	6.72E-06	2.31E-06	8.16E-07	1.64E-06	1.72E-05	4.00E-04	1.93E-05
TE127	7.49E-10	2.57E-10	1.65E-10	5.30E-10	1.91E-09	2.71E-06	1.52E-05
TE129M	5.19E-06	1.85E-06	8.22E-07	1.71E-06	1.36E-05	4.76E-04	4.91E-05
TE129	2.64E-11	9.45E-12	6.44E-12	1.93E-11	6.94E-11	7.93E-07	6.89E-06
TE131M	3.63E-08	1.60E-08	1.37E-08	2.64E-08	1.08E-07	5.56E-05	8.32E-05
TE131	5.87E-12	2.28E-12	1.78E-12	4.59E-12	1.59E-11	5.55E-07	3.60E-07
TE132	1.30E-07	7.36E-08	7.12E-08	8.58E-08	4.79E-07	1.02E-04	3.72E-05
I 130	2.21E-06	4.43E-06	2.28E-06	4.99E-04	6.61E-06	NO DATA	1.38E-06
I 131	1.30E-05	1.30E-05	7.37E-06	4.39E-03	2.13E-05	NO DATA	7.68E-07
I 132	5.72E-07	1.10E-06	5.07E-07	5.23E-05	1.69E-06	NO DATA	8.65E-07
I 133	4.48E-06	5.49E-06	2.08E-06	1.04E-03	9.13E-06	NO DATA	1.48E-06
I 134	3.17E-07	5.84E-07	2.69E-07	1.37E-05	8.92E-07	NO DATA	2.58E-07
I 135	1.33E-06	2.36E-06	1.12E-06	2.14E-04	3.62E-06	NO DATA	1.20E-06
CS134	1.76E-04	2.74E-04	6.07E-05	NO DATA	8.93E-05	3.27E-05	1.04E-06
CS136	1.76E-05	4.62E-05	3.14E-05	NO DATA	2.58E-05	3.93E-06	1.13E-06
CS137	2.45E-04	2.23E-04	3.47E-05	NO DATA	7.63E-05	2.81E-05	9.78E-07
CS138	1.71E-07	2.27E-07	1.50E-07	NO DATA	1.68E-07	1.84E-08	7.29E-08
BA139	4.98E-10	2.66E-13	1.45E-11	NO DATA	2.33E-13	1.56E-06	1.56E-05
BA140	2.00E-05	1.75E-08	1.17E-06	NO DATA	5.71E-09	4.71E-04	2.75E-05
BA141	5.29E-11	2.95E-14	1.72E-12	NO DATA	2.56E-14	7.89E-07	7.44E-08
BA142	1.35E-11	9.73E-15	7.54E-13	NO DATA	7.57E-15	4.44E-07	7.41E-10
LA140	1.74E-07	6.08E-08	2.04E-08	NO DATA	NO DATA	4.94E-05	6.10E-05
LA142	3.50E-10	1.11E-10	3.49E-11	NO DATA	NO DATA	2.35E-06	2.05E-05
CE141	1.06E-05	5.28E-06	7.83E-07	NO DATA	2.31E-06	1.47E-05	1.53E-05
CE143	9.89E-08	5.37E-08	7.77E-09	NO DATA	2.26E-08	3.12E-05	3.44E-05
CE144	1.83E-03	5.72E-04	9.77E-05	NO DATA	3.17E-04	3.23E-03	1.05E-04
PR143	4.99E-06	1.50E-06	2.47E-07	NO DATA	8.11E-07	1.17E-04	2.63E-05
PR144	1.61E-11	4.99E-12	8.10E-13	NO DATA	2.64E-12	4.23E-07	5.32E-08
ND147	2.92E-06	2.36E-06	1.84E-07	NO DATA	1.30E-06	8.87E-05	2.22E-05
W 187	4.41E-09	2.61E-09	1.17E-09	NO DATA	NO DATA	1.11E-05	2.46E-05
NP239	1.26E-07	9.04E-09	6.35E-09	NO DATA	2.63E-08	1.57E-05	1.73E-05

Table 3.2-9

Inhalation Dose Factors for Infant (mrem/pCi inhaled)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	NO DATA	4.62E-07	4.62E-07	4.62E-07	4.62E-07	4.62E-07	4.62E-07
C 14	1.89E-05	3.79E-06	3.79E-06	3.79E-06	3.79E-06	3.79E-06	3.79E-06
NA 24	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06
P 32	1.45E-03	8.03E-05	5.53E-05	NO DATA	NO DATA	NO DATA	1.15E-05
CR 51	NO DATA	NO DATA	6.37E-08	4.11E-08	9.45E-09	9.17E-06	2.55E-07
MN 54	NO DATA	1.81E-05	3.56E-06	NO DATA	3.56E-06	7.14E-04	5.04E-06
MN 56	NO DATA	1.10E-09	1.58E-10	NO DATA	7.86E-10	8.95E-06	5.12E-05
FE 55	1.41E-05	8.39E-06	2.38E-06	NO DATA	NO DATA	6.21E-05	7.82E-07
FE 59	9.69E-06	1.68E-05	6.77E-06	NO DATA	NO DATA	7.25E-04	1.77E-05
CO 58	NO DATA	8.71E-07	1.30E-06	NO DATA	NO DATA	5.55E-04	7.95E-06
CO 60	NO DATA	5.73E-06	8.41E-06	NO DATA	NO DATA	3.22E-03	2.28E-05
NI 63	2.42E-04	1.46E-05	8.29E-06	NO DATA	NO DATA	1.49E-04	1.73E-06
NI 65	1.71E-09	2.03E-10	8.79E-11	NO DATA	NO DATA	5.80E-06	3.58E-05
CU 64	NO DATA	1.34E-09	5.53E-10	NO DATA	2.84E-09	6.64E-06	1.07E-05
ZN 65	1.38E-05	4.47E-05	2.22E-05	NO DATA	2.32E-05	4.62E-04	3.67E-05
ZN 69	3.85E-11	6.91E-11	5.13E-12	NO DATA	2.87E-11	1.05E-06	9.44E-06
BR 83	NO DATA	NO DATA	2.72E-07	NO DATA	NO DATA	NO DATA	LT E-24
BR 84	NO DATA	NO DATA	2.86E-07	NO DATA	NO DATA	NO DATA	LT E-24
BR 85	NO DATA	NO DATA	1.46E-08	NO DATA	NO DATA	NO DATA	LT E-24
RB 86	NO DATA	1.36E-04	6.30E-05	NO DATA	NO DATA	NO DATA	2.17E-06
RB 88	NO DATA	3.98E-07	2.05E-07	NO DATA	NO DATA	NO DATA	2.42E-07
RB 89	NO DATA	2.29E-07	1.47E-07	NO DATA	NO DATA	NO DATA	4.87E-08
SR 89	2.84E-04	NO DATA	8.15E-06	NO DATA	NO DATA	1.45E-03	4.57E-05
SR 90	2.92E-02	NO DATA	1.85E-03	NO DATA	NO DATA	8.03E-03	9.36E-05
SR 91	6.83E-08	NO DATA	2.47E-09	NO DATA	NO DATA	3.76E-05	5.24E-05
SR 92	7.50E-09	NO DATA	2.79E-10	NO DATA	NO DATA	1.70E-05	1.00E-04
Y 90	2.35E-06	NO DATA	6.30E-08	NO DATA	NO DATA	1.92E-04	7.43E-05
Y 91M	2.91E-10	NO DATA	9.90E-12	NO DATA	NO DATA	1.99E-06	1.68E-06
Y 91	4.20E-04	NO DATA	1.12E-05	NO DATA	NO DATA	1.75E-03	5.02E-05
Y 92	1.17E-08	NO DATA	3.29E-10	NO DATA	NO DATA	1.75E-05	9.04E-05
Y 93	1.07E-07	NO DATA	2.91E-09	NO DATA	NO DATA	5.46E-05	1.19E-04
ZR 95	8.24E-05	1.99E-05	1.45E-05	NO DATA	2.22E-05	1.25E-03	1.55E-05
ZR 97	1.07E-07	1.83E-08	8.36E-09	NO DATA	1.85E-08	7.88E-05	1.00E-04
NB 95	1.12E-05	4.59E-06	2.70E-06	NO DATA	3.37E-06	3.42E-04	9.05E-06
MO 99	NO DATA	1.18E-07	2.31E-08	NO DATA	1.89E-07	9.63E-05	3.48E-05
TC 99M	9.98E-13	2.06E-12	2.66E-11	NO DATA	2.22E-11	5.79E-07	1.45E-06

Table 3.2-9 (Cont.)

Inhalation Dose Factors for Infant (mrem/pCi inhaled)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
TC101	4.65E-14	5.98E-14	5.80E-13	NO DATA	6.99E-13	4.17E-07	6.03E-07
RU103	1.44E-06	NO DATA	4.85E-07	NO DATA	3.03E-06	3.94E-04	1.15E-05
RU105	8.74E-10	NO DATA	2.93E-10	NO DATA	6.42E-10	1.12E-05	3.46E-05
RU106	6.20E-05	NO DATA	7.77E-06	NO DATA	7.61E-05	8.26E-03	1.17E-04
AG110M	7.13E-06	5.16E-06	3.57E-06	NO DATA	7.80E-06	2.62E-03	2.36E-05
TE125M	3.40E-06	1.42E-06	4.70E-07	1.16E-06	NO DATA	3.19E-04	9.22E-06
TE127M	1.19E-05	4.93E-06	1.48E-06	3.48E-06	2.68E-05	9.37E-04	1.95E-05
TE127	1.59E-09	6.81E-10	3.49E-10	1.32E-09	3.47E-09	7.39E-06	1.74E-05
TE129M	1.01E-05	4.35E-06	1.59E-06	3.91E-06	2.27E-05	1.20E-03	4.93E-05
TE129	5.63E-11	2.48E-11	1.34E-11	4.82E-11	1.25E-10	2.14E-06	1.88E-05
TE131M	7.62E-08	3.93E-08	2.59E-08	6.38E-08	1.89E-07	1.42E-04	8.51E-05
TE131	1.24E-11	5.87E-12	3.57E-12	1.13E-11	2.85E-11	1.47E-06	5.87E-06
TE132	2.66E-07	1.69E-07	1.26E-07	1.99E-07	7.39E-07	2.43E-04	3.15E-05
I 130	4.54E-06	9.91E-06	3.98E-06	1.14E-03	1.09E-05	NO DATA	1.42E-06
I 131	2.71E-05	3.17E-05	1.40E-05	1.06E-02	3.70E-05	NO DATA	7.56E-07
I 132	1.21E-06	2.53E-06	8.99E-07	1.21E-04	2.82E-06	NO DATA	1.36E-06
I 133	9.46E-06	1.37E-05	4.00E-06	2.54E-03	1.60E-05	NO DATA	1.54E-06
I 134	6.58E-07	1.34E-06	4.75E-07	3.18E-05	1.49E-06	NO DATA	9.21E-07
I 135	2.76E-06	5.43E-06	1.98E-06	4.97E-04	6.05E-06	NO DATA	1.31E-06
CS134	2.83E-04	5.02E-04	5.32E-05	NO DATA	1.36E-04	5.69E-05	9.53E-07
CS136	3.45E-05	9.61E-05	3.78E-05	NO DATA	4.03E-05	8.40E-06	1.02E-06
CS137	3.92E-04	4.37E-04	3.25E-05	NO DATA	1.23E-04	5.09E-05	9.53E-07
CS138	3.61E-07	5.58E-07	2.84E-07	NO DATA	2.93E-07	4.67E-08	6.26E-07
BA139	1.06E-09	7.03E-13	3.07E-11	NO DATA	4.73E-13	4.25E-06	3.64E-05
BA140	4.00E-05	4.00E-08	2.07E-06	NO DATA	9.59E-09	1.14E-03	2.74E-05
BA141	1.12E-10	7.70E-14	3.55E-12	NO DATA	4.64E-14	2.12E-06	3.39E-06
BA142	2.84E-11	2.36E-14	1.40E-12	NO DATA	1.36E-14	1.11E-06	4.95E-07
LA140	3.61E-07	1.43E-07	3.68E-08	NO DATA	NO DATA	1.20E-04	6.06E-05
LA142	7.36E-10	2.69E-10	6.46E-11	NO DATA	NO DATA	5.87E-06	4.25E-05
CE141	1.98E-05	1.19E-05	1.42E-06	NO DATA	3.75E-06	3.69E-04	1.54E-05
CE143	2.09E-07	1.38E-07	1.58E-08	NO DATA	4.03E-08	8.30E-05	3.55E-05
CE144	2.28E-03	8.65E-04	1.26E-04	NO DATA	3.84E-04	7.03E-03	1.06E-04
PR143	1.00E-05	3.74E-06	4.99E-07	NO DATA	1.41E-06	3.09E-04	2.66E-05
PR144	3.42E-11	1.32E-11	1.72E-12	NO DATA	4.80E-12	1.15E-06	3.06E-06
ND147	5.67E-06	5.81E-06	3.57E-07	NO DATA	2.25E-06	2.30E-04	2.23E-05
W 187	9.26E-09	6.44E-09	2.23E-09	NO DATA	NO DATA	2.83E-05	2.54E-05
NP239	2.65E-07	2.37E-08	1.34E-08	NO DATA	4.73E-08	4.25E-05	1.78E-05

Table 3.2-10

Ingestion Dose Factor for Adult (mrem/pCi ingested)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
H3	0.00E+00	1.05E-07	1.05E-07	1.05E-07	1.05E-07	1.05E-07	1.05E-07
C14	2.84E-06	5.68E-07	5.68E-07	5.68E-07	5.68E-07	5.68E-07	5.68E-07
NA24	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06
P32	1.93E-04	1.20E-05	7.46E-06	0.00E+00	0.00E+00	0.00E+00	2.17E-05
CR51	0.00E+00	0.00E+00	2.66E-09	1.59E-09	5.86E-10	3.53E-09	6.69E-07
MN54	0.00E+00	4.57E-06	8.72E-07	0.00E+00	1.36E-06	0.00E+00	1.40E-05
MN56	0.00E+00	1.15E-07	2.04E-08	0.00E+00	1.46E-07	0.00E+00	3.67E-06
FE55	2.75E-06	1.90E-06	4.43E-07	0.00E+00	0.00E+00	1.06E-06	1.09E-06
FE59	4.34E-06	1.02E-05	3.91E-06	0.00E+00	0.00E+00	2.85E-06	3.40E-05
CO58	0.00E+00	7.45E-07	1.67E-06	0.00E+00	0.00E+00	0.00E+00	1.51E-05
CO60	0.00E+00	2.14E-06	4.72E-06	0.00E+00	0.00E+00	0.00E+00	4.02E-05
NI63	1.30E-04	9.01E-06	4.36E-06	0.00E+00	0.00E+00	0.00E+00	1.88E-06
NI65	5.28E-07	6.86E-08	3.13E-08	0.00E+00	0.00E+00	0.00E+00	1.74E-06
CU64	0.00E+00	8.33E-08	3.91E-08	0.00E+00	2.10E-07	0.00E+00	7.10E-06
ZN65	4.84E-06	1.54E-05	6.96E-06	0.00E+00	1.03E-05	0.00E+00	9.70E-06
ZN69	1.03E-08	1.97E-08	1.37E-09	0.00E+00	1.28E-08	0.00E+00	2.96E-09
BR83	0.00E+00	0.00E+00	4.02E-08	0.00E+00	0.00E+00	0.00E+00	5.79E-08
BR84	0.00E+00	0.00E+00	5.21E-08	0.00E+00	0.00E+00	0.00E+00	4.09E-13
BR85	0.00E+00	0.00E+00	2.14E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RB86	0.00E+00	2.11E-05	9.83E-06	0.00E+00	0.00E+00	0.00E+00	4.16E-06
RB88	0.00E+00	6.05E-08	3.21E-08	0.00E+00	0.00E+00	0.00E+00	8.36E-19
RB89	0.00E+00	4.01E-08	2.82E-08	0.00E+00	0.00E+00	0.00E+00	2.33E-21
SR89	3.08E-04	0.00E+00	8.84E-06	0.00E+00	0.00E+00	0.00E+00	4.94E-05
SR90	7.58E-03	0.00E+00	1.86E-03	0.00E+00	0.00E+00	0.00E+00	2.19E-04
SR91	5.67E-06	0.00E+00	2.29E-07	0.00E+00	0.00E+00	0.00E+00	2.70E-05
SR92	2.15E-06	0.00E+00	9.30E-08	0.00E+00	0.00E+00	0.00E+00	4.26E-05
Y90	9.62E-09	0.00E+00	2.58E-10	0.00E+00	0.00E+00	0.00E+00	1.02E-04
Y91M	9.09E-11	0.00E+00	3.52E-12	0.00E+00	0.00E+00	0.00E+00	2.67E-10
Y91	1.41E-07	0.00E+00	3.77E-09	0.00E+00	0.00E+00	0.00E+00	7.67E-05
Y92	8.45E-10	0.00E+00	2.47E-11	0.00E+00	0.00E+00	0.00E+00	1.48E-05
Y93	2.68E-09	0.00E+00	7.40E-11	0.00E+00	0.00E+00	0.00E+00	8.50E-05
ZR95	3.04E-08	9.75E-09	6.60E-09	0.00E+00	1.53E-08	0.00E+00	3.09E-05
ZR97	1.68E-09	3.39E-10	1.55E-10	0.00E+00	5.12E-10	0.00E+00	1.05E-04
NB95	6.22E-09	3.46E-09	1.86E-09	0.00E+00	3.42E-09	0.00E+00	2.10E-05
MO99	0.00E+00	4.31E-06	8.20E-07	0.00E+00	9.76E-06	0.00E+00	9.99E-06
TC99M	2.47E-10	6.98E-10	8.89E-09	0.00E+00	1.06E-08	3.42E-10	4.13E-07

Table 3.2-10 (Cont.)

Ingestion Dose Factor for Adult (mrem/pCi ingested)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
TC101	2.54E-10	3.66E-10	3.59E-09	0.00E+00	6.59E-09	1.87E-10	1.10E-21
RU103	1.85E-07	0.00E+00	7.97E-08	0.00E+00	7.06E-07	0.00E+00	2.16E-05
RU105	1.54E-08	0.00E+00	6.08E-09	0.00E+00	1.99E-07	0.00E+00	9.42E-06
RU106	2.75E-06	0.00E+00	3.48E-07	0.00E+00	5.31E-06	0.00E+00	1.78E-04
AG110M	1.60E-07	1.48E-07	8.79E-08	0.00E+00	2.91E-07	0.00E+00	6.04E-05
TE125M	2.68E-06	9.17E-07	3.59E-07	8.06E-07	1.09E-05	0.00E+00	1.07E-05
TE127M	6.77E-06	2.42E-06	8.25E-07	1.73E-06	2.75E-05	0.00E+00	2.27E-05
TE127	1.10E-07	3.95E-08	2.38E-08	8.15E-08	4.48E-07	0.00E+00	8.68E-06
TE129M	1.15E-05	4.29E-06	1.82E-06	3.95E-06	4.80E-05	0.00E+00	5.79E-05
TE129	3.14E-08	1.18E-08	7.65E-09	2.41E-08	1.32E-07	0.00E+00	2.37E-08
TE131M	1.73E-06	8.46E-07	7.05E-07	1.34E-06	8.57E-06	0.00E+00	8.40E-05
TE131	1.97E-08	8.23E-09	6.22E-09	1.62E-08	8.63E-08	0.00E+00	2.79E-09
TE132	2.52E-06	1.63E-06	1.53E-06	1.80E-06	1.57E-05	0.00E+00	7.71E-05
I130	7.56E-07	2.23E-06	8.80E-07	1.89E-04	3.48E-06	0.00E+00	1.92E-06
I131	4.16E-06	5.95E-06	3.41E-06	1.95E-03	1.02E-05	0.00E+00	1.57E-06
I132	2.03E-07	5.43E-07	1.90E-07	1.90E-05	8.65E-07	0.00E+00	1.02E-07
I133	1.42E-06	2.47E-06	7.53E-07	3.63E-04	4.31E-06	0.00E+00	2.22E-06
I134	1.06E-07	2.88E-07	1.03E-07	4.99E-06	4.58E-07	0.00E+00	2.51E-10
I135	4.43E-07	1.16E-06	4.28E-07	7.65E-05	1.86E-06	0.00E+00	1.31E-06
CS134	6.22E-05	1.48E-04	1.21E-04	0.00E+00	4.79E-05	1.59E-05	2.59E-06
CS136	6.51E-06	2.57E-05	1.85E-05	0.00E+00	1.43E-05	1.96E-06	2.92E-06
CS137	7.97E-05	1.09E-04	7.14E-05	0.00E+00	3.70E-05	1.23E-05	2.11E-06
CS138	5.52E-08	1.09E-07	5.40E-08	0.00E+00	8.01E-08	7.91E-09	4.65E-13
BA139	9.70E-08	6.91E-11	2.84E-09	0.00E+00	6.46E-11	3.92E-11	1.72E-07
BA140	2.03E-05	2.55E-08	1.33E-06	0.00E+00	8.67E-09	1.46E-08	4.18E-05
BA141	4.71E-08	3.56E-11	1.59E-09	0.00E+00	3.31E-11	2.02E-11	2.22E-17
BA142	2.13E-08	2.19E-11	1.34E-09	0.00E+00	1.85E-11	1.24E-11	3.00E-26
LA140	2.50E-09	1.26E-09	3.33E-10	0.00E+00	0.00E+00	0.00E+00	9.25E-05
LA142	1.28E-10	5.82E-11	1.45E-11	0.00E+00	0.00E+00	0.00E+00	4.25E-07
CE141	9.36E-09	6.33E-09	7.18E-10	0.00E+00	2.94E-09	0.00E+00	2.42E-05
CE143	1.65E-09	1.22E-06	1.35E-10	0.00E+00	5.37E-10	0.00E+00	4.56E-05
CE144	4.88E-07	2.04E-07	2.62E-08	0.00E+00	1.21E-07	0.00E+00	1.65E-04
PR143	9.20E-09	3.69E-09	4.56E-10	0.00E+00	2.13E-09	0.00E+00	4.03E-05
PR144	3.01E-11	1.25E-11	1.53E-12	0.00E+00	7.05E-12	0.00E+00	4.33E-18
ND147	6.29E-09	7.27E-09	4.35E-10	0.00E+00	4.25E-09	0.00E+00	3.49E-05
W187	1.03E-07	8.61E-08	3.01E-08	0.00E+00	0.00E+00	0.00E+00	2.82E-05
NP239	1.19E-09	1.17E-10	6.45E-11	0.00E+00	3.65E-10	0.00E+00	2.40E-05

Table 3.2-11

Ingestion Dose Factors for Teenager (mrem/pCi ingested)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
H3	0.00E+00	1.06E-07	1.06E-07	1.06E-07	1.06E-07	1.06E-07	1.06E-07
C14	4.06E-06	8.12E-07	8.12E-07	8.12E-07	8.12E-07	8.12E-07	8.12E-07
NA24	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06
P32	2.76E-04	1.71E-05	1.07E-05	0.00E+00	0.00E+00	0.00E+00	2.32E-05
CR51	0.00E+00	0.00E+00	3.60E-09	2.00E-09	7.89E-10	5.14E-09	6.05E-07
MN54	0.00E+00	5.90E-06	1.17E-06	0.00E+00	1.76E-06	0.00E+00	1.21E-05
MN56	0.00E+00	1.58E-07	2.81E-08	0.00E+00	2.00E-07	0.00E+00	1.04E-05
FE55	3.78E-06	2.68E-06	6.25E-07	0.00E+00	0.00E+00	1.70E-06	1.16E-06
FE59	5.87E-06	1.37E-05	5.29E-06	0.00E+00	0.00E+00	4.32E-06	3.24E-05
CO58	0.00E+00	9.72E-07	2.24E-06	0.00E+00	0.00E+00	0.00E+00	1.34E-05
CO60	0.00E+00	2.81E-06	6.33E-06	0.00E+00	0.00E+00	0.00E+00	3.66E-05
NI63	1.77E-04	1.25E-05	6.00E-06	0.00E+00	0.00E+00	0.00E+00	1.99E-06
NI65	7.49E-07	9.57E-08	4.36E-08	0.00E+00	0.00E+00	0.00E+00	5.19E-06
CU64	0.00E+00	1.15E-07	5.41E-08	0.00E+00	2.91E-07	0.00E+00	8.92E-06
ZN65	5.76E-06	2.00E-05	9.33E-06	0.00E+00	1.28E-05	0.00E+00	8.47E-06
ZN69	1.47E-08	2.80E-08	1.96E-09	0.00E+00	1.83E-08	0.00E+00	5.16E-08
BR83	0.00E+00	0.00E+00	5.74E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR84	0.00E+00	0.00E+00	7.22E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR85	0.00E+00	0.00E+00	3.05E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RB86	0.00E+00	2.98E-05	1.40E-05	0.00E+00	0.00E+00	0.00E+00	4.41E-06
RB88	0.00E+00	8.52E-08	4.54E-08	0.00E+00	0.00E+00	0.00E+00	7.30E-15
RB89	0.00E+00	5.50E-08	3.89E-08	0.00E+00	0.00E+00	0.00E+00	8.43E-17
SR89	4.40E-04	0.00E+00	1.26E-05	0.00E+00	0.00E+00	0.00E+00	5.24E-05
SR90	8.30E-03	0.00E+00	2.05E-03	0.00E+00	0.00E+00	0.00E+00	2.33E-04
SR91	8.07E-06	0.00E+00	3.21E-07	0.00E+00	0.00E+00	0.00E+00	3.66E-05
SR92	3.05E-06	0.00E+00	1.30E-07	0.00E+00	0.00E+00	0.00E+00	7.77E-05
Y90	1.37E-08	0.00E+00	3.69E-10	0.00E+00	0.00E+00	0.00E+00	1.13E-04
Y91M	1.29E-10	0.00E+00	4.93E-12	0.00E+00	0.00E+00	0.00E+00	6.09E-09
Y91	2.01E-07	0.00E+00	5.39E-09	0.00E+00	0.00E+00	0.00E+00	8.24E-05
Y92	1.21E-09	0.00E+00	3.50E-11	0.00E+00	0.00E+00	0.00E+00	3.32E-05
Y93	3.83E-09	0.00E+00	1.05E-10	0.00E+00	0.00E+00	0.00E+00	1.17E-04
ZR95	4.12E-08	1.30E-08	8.94E-09	0.00E+00	1.91E-08	0.00E+00	3.00E-05
ZR97	2.37E-09	4.69E-10	2.16E-10	0.00E+00	7.11E-10	0.00E+00	1.27E-04
NB95	8.22E-09	4.56E-09	2.51E-09	0.00E+00	4.42E-09	0.00E+00	1.95E-05
MO99	0.00E+00	6.03E-06	1.15E-06	0.00E+00	1.38E-05	0.00E+00	1.08E-05
TC99M	3.32E-10	9.26E-10	1.20E-08	0.00E+00	1.38E-08	5.14E-10	6.08E-07

Table 3.2-11 (Cont.)

Ingestion Dose Factor for Teenager (mrem/pCi ingested)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
TC101	3.60E-10	5.12E-10	5.03E-09	0.00E+00	9.26E-09	3.12E-10	8.75E-17
RU103	2.55E-07	0.00E+00	1.09E-07	0.00E+00	8.99E-07	0.00E+00	2.13E-05
RU105	2.18E-08	0.00E+00	8.46E-09	0.00E+00	2.75E-07	0.00E+00	1.76E-05
RU106	3.92E-06	0.00E+00	4.94E-07	0.00E+00	7.56E-06	0.00E+00	1.88E-04
AG110M	2.05E-07	1.94E-07	1.18E-07	0.00E+00	3.70E-07	0.00E+00	5.45E-05
TE125M	3.83E-06	1.38E-06	5.12E-07	1.07E-06	0.00E+00	0.00E+00	1.13E-05
TE127M	9.67E-06	3.43E-06	1.15E-06	2.30E-06	3.92E-05	0.00E+00	2.41E-05
TE127	1.58E-07	5.60E-08	3.40E-08	1.09E-07	6.40E-07	0.00E+00	1.22E-05
TE129M	1.63E-05	6.05E-06	2.58E-06	5.26E-06	6.82E-05	0.00E+00	6.12E-05
TE129	4.48E-08	1.67E-08	1.09E-08	3.20E-08	1.88E-07	0.00E+00	2.45E-07
TE131M	2.44E-06	1.17E-06	9.76E-07	1.76E-06	1.22E-05	0.00E+00	9.39E-05
TE131	2.79E-08	1.15E-08	8.72E-09	2.15E-08	1.22E-07	0.00E+00	2.29E-09
TE132	3.49E-06	2.21E-06	2.08E-06	2.33E-06	2.12E-05	0.00E+00	7.00E-05
I130	1.03E-06	2.98E-06	1.19E-06	2.43E-04	4.59E-06	0.00E+00	2.29E-06
I131	5.85E-06	8.19E-06	4.40E-06	2.39E-03	1.41E-05	0.00E+00	1.62E-06
I132	2.79E-07	7.30E-07	2.62E-07	2.46E-05	1.15E-06	0.00E+00	3.18E-07
I133	2.01E-06	3.41E-06	1.04E-06	4.76E-04	5.98E-06	0.00E+00	2.58E-06
I134	1.46E-07	3.87E-07	1.39E-07	6.45E-06	6.10E-07	0.00E+00	5.10E-09
I135	6.10E-07	1.57E-06	5.82E-07	1.01E-04	2.48E-06	0.00E+00	1.74E-06
CS134	8.37E-05	1.97E-04	9.14E-05	0.00E+00	6.26E-05	2.39E-05	2.45E-06
CS136	8.59E-06	3.38E-05	2.27E-05	0.00E+00	1.84E-05	2.90E-06	2.72E-06
CS137	1.12E-04	1.49E-04	5.19E-05	0.00E+00	5.07E-05	1.97E-05	2.12E-06
CS138	7.76E-08	1.49E-07	7.45E-08	0.00E+00	1.10E-07	1.28E-08	6.76E-11
BA139	1.39E-07	9.78E-11	4.05E-09	0.00E+00	9.22E-11	6.74E-11	1.24E-06
BA140	2.84E-05	3.48E-08	1.83E-06	0.00E+00	1.18E-08	2.34E-08	4.38E-05
BA141	6.71E-08	5.01E-11	2.24E-09	0.00E+00	4.65E-11	3.43E-11	1.43E-13
BA142	2.99E-08	2.99E-11	1.84E-09	0.00E+00	2.53E-11	1.99E-11	9.18E-20
LA140	3.48E-09	1.71E-09	4.55E-10	0.00E+00	0.00E+00	0.00E+00	9.82E-05
LA142	1.79E-10	7.95E-11	1.98E-11	0.00E+00	0.00E+00	0.00E+00	2.42E-06
CE141	1.33E-08	8.88E-09	1.02E-09	0.00E+00	4.18E-09	0.00E+00	2.54E-05
CE143	2.35E-09	1.71E-06	1.91E-10	0.00E+00	7.67E-10	0.00E+00	5.14E-05
CE144	6.96E-07	2.88E-07	3.74E-08	0.00E+00	1.72E-07	0.00E+00	1.75E-04
PR143	1.31E-08	5.23E-09	6.52E-10	0.00E+00	3.04E-09	0.00E+00	4.31E-05
PR144	4.30E-11	1.76E-11	2.18E-12	0.00E+00	1.01E-11	0.00E+00	4.74E-14
ND147	9.38E-09	1.02E-08	6.11E-10	0.00E+00	5.99E-09	0.00E+00	3.68E-05
W187	1.46E-07	1.19E-07	4.17E-08	0.00E+00	0.00E+00	0.00E+00	3.22E-05
NP239	1.76E-09	1.66E-10	9.22E-11	0.00E+00	5.21E-10	0.00E+00	2.67E-05

Table 3.2-12

Ingestion Dose Factors for Child (mrem/pCi ingested)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
H3	0.00E+00	2.03E-07	2.03E-07	2.03E-07	2.03E-07	2.03E-07	2.03E-07
C14	1.21E-05	2.42E-06	2.42E-06	2.42E-06	2.42E-06	2.42E-06	2.42E-06
NA24	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06
P32	8.25E-04	3.86E-05	3.18E-05	0.00E+00	0.00E+00	0.00E+00	2.28E-05
CR51	0.00E+00	0.00E+00	8.90E-09	4.94E-09	1.35E-09	9.02E-09	4.72E-07
MN54	0.00E+00	1.07E-05	2.85E-06	0.00E+00	3.00E-06	0.00E+00	8.98E-06
MN56	0.00E+00	3.34E-07	7.54E-08	0.00E+00	4.04E-07	0.00E+00	4.84E-05
FE55	1.15E-05	6.10E-06	1.89E-06	0.00E+00	0.00E+00	3.45E-06	1.13E-06
FE59	1.65E-05	2.67E-05	1.33E-05	0.00E+00	0.00E+00	7.74E-06	2.78E-05
CO58	0.00E+00	1.80E-06	5.51E-06	0.00E+00	0.00E+00	0.00E+00	1.05E-05
CO60	0.00E+00	5.29E-06	1.56E-05	0.00E+00	0.00E+00	0.00E+00	2.93E-05
NI63	5.38E-04	2.88E-05	1.83E-05	0.00E+00	0.00E+00	0.00E+00	1.94E-06
NI65	2.22E-06	2.09E-07	1.22E-07	0.00E+00	0.00E+00	0.00E+00	2.56E-05
CU64	0.00E+00	2.45E-07	1.48E-07	0.00E+00	5.92E-07	0.00E+00	1.15E-05
ZN65	1.37E-05	3.65E-05	2.27E-05	0.00E+00	2.30E-05	0.00E+00	6.41E-06
ZN69	4.38E-08	6.33E-08	5.85E-09	0.00E+00	3.84E-08	0.00E+00	3.99E-06
BR83	0.00E+00	0.00E+00	1.71E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR84	0.00E+00	0.00E+00	1.98E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR85	0.00E+00	0.00E+00	9.12E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RB86	0.00E+00	6.70E-05	4.12E-05	0.00E+00	0.00E+00	0.00E+00	4.31E-06
RB88	0.00E+00	1.90E-07	1.32E-07	0.00E+00	0.00E+00	0.00E+00	9.32E-09
RB89	0.00E+00	1.17E-07	1.04E-07	0.00E+00	0.00E+00	0.00E+00	1.02E-09
SR89	1.32E-03	0.00E+00	3.77E-05	0.00E+00	0.00E+00	0.00E+00	5.11E-05
SR90	1.70E-02	0.00E+00	4.31E-03	0.00E+00	0.00E+00	0.00E+00	2.29E-04
SR91	2.40E-05	0.00E+00	9.06E-07	0.00E+00	0.00E+00	0.00E+00	5.30E-05
SR92	9.03E-06	0.00E+00	3.62E-07	0.00E+00	0.00E+00	0.00E+00	1.71E-04
Y90	4.11E-08	0.00E+00	1.10E-09	0.00E+00	0.00E+00	0.00E+00	1.17E-04
Y91M	3.82E-10	0.00E+00	1.39E-11	0.00E+00	0.00E+00	0.00E+00	7.48E-07
Y91	6.02E-07	0.00E+00	1.61E-08	0.00E+00	0.00E+00	0.00E+00	8.02E-05
Y92	3.60E-09	0.00E+00	1.03E-10	0.00E+00	0.00E+00	0.00E+00	1.04E-04
Y93	1.14E-08	0.00E+00	3.13E-10	0.00E+00	0.00E+00	0.00E+00	1.70E-04
ZR95	1.16E-07	2.55E-08	2.27E-08	0.00E+00	3.65E-08	0.00E+00	2.66E-05
ZR97	6.99E-09	1.01E-09	5.96E-10	0.00E+00	1.45E-09	0.00E+00	1.53E-04
NB95	2.25E-08	8.76E-09	6.26E-09	0.00E+00	8.23E-09	0.00E+00	1.62E-05
MO99	0.00E+00	1.33E-05	3.29E-06	0.00E+00	2.84E-05	0.00E+00	1.10E-05
TC99M	9.23E-10	1.81E-09	3.00E-08	0.00E+00	2.63E-08	9.19E-10	1.03E-06

Table 3.2-12 (Cont.)

Ingestion Dose Factors for Child (mrem/pCi ingested)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
TC101	1.07E-09	1.12E-09	1.42E-08	0.00E+00	1.91E-08	5.92E-10	3.56E-09
RU103	7.31E-07	0.00E+00	2.81E-07	0.00E+00	1.84E-06	0.00E+00	1.89E-05
RU105	6.45E-08	0.00E+00	2.34E-08	0.00E+00	5.67E-07	0.00E+00	4.21E-05
RU106	1.17E-05	0.00E+00	1.46E-06	0.00E+00	1.58E-05	0.00E+00	1.82E-04
AG110M	5.39E-07	3.64E-07	2.91E-07	0.00E+00	6.78E-07	0.00E+00	4.33E-05
TE125M	1.14E-05	3.09E-06	1.52E-06	3.20E-06	0.00E+00	0.00E+00	1.10E-05
TE127M	2.89E-05	7.78E-06	3.43E-06	6.91E-06	8.24E-05	0.00E+00	2.34E-05
TE127	4.71E-07	1.27E-07	1.01E-07	3.26E-07	1.34E-06	0.00E+00	1.84E-05
TE129M	4.87E-05	1.36E-05	7.56E-06	1.57E-05	1.43E-04	0.00E+00	5.94E-05
TE129	1.34E-07	3.74E-08	3.18E-08	9.56E-08	3.92E-07	0.00E+00	8.34E-06
TE131M	7.20E-06	2.49E-06	2.65E-06	5.12E-06	2.41E-05	0.00E+00	1.01E-04
TE131	8.30E-08	2.53E-08	2.47E-08	6.35E-08	2.51E-07	0.00E+00	4.36E-07
TE132	1.01E-05	4.47E-06	5.40E-06	6.51E-06	4.15E-05	0.00E+00	4.50E-05
I130	2.92E-06	5.90E-06	3.04E-06	6.50E-04	8.82E-06	0.00E+00	2.76E-06
I131	1.72E-05	1.73E-05	9.83E-06	5.72E-03	2.84E-05	0.00E+00	1.54E-06
I132	8.00E-07	1.47E-06	6.76E-07	6.82E-05	2.25E-06	0.00E+00	1.73E-06
I133	5.92E-06	7.32E-06	2.77E-06	1.36E-03	1.22E-05	0.00E+00	2.95E-06
I134	4.19E-07	7.78E-07	3.58E-07	1.79E-05	1.19E-06	0.00E+00	5.16E-07
I135	1.75E-06	3.15E-06	1.49E-06	2.79E-04	4.83E-06	0.00E+00	2.40E-06
CS134	2.34E-04	3.84E-04	8.10E-05	0.00E+00	1.19E-04	4.27E-05	2.07E-06
CS136	2.35E-05	6.46E-05	4.18E-05	0.00E+00	3.44E-05	5.13E-06	2.27E-06
CS137	3.27E-04	3.13E-04	4.62E-05	0.00E+00	1.02E-04	3.67E-05	1.96E-06
CS138	2.28E-07	3.17E-07	2.01E-07	0.00E+00	2.23E-07	2.40E-08	1.46E-07
BA139	4.14E-07	2.21E-10	1.20E-08	0.00E+00	1.93E-10	1.30E-10	2.39E-05
BA140	8.31E-05	7.28E-08	4.85E-06	0.00E+00	2.37E-08	4.34E-08	4.21E-05
BA141	2.00E-07	1.12E-10	6.51E-09	0.00E+00	9.69E-11	6.58E-10	1.14E-07
BA142	8.74E-08	6.29E-11	4.88E-09	0.00E+00	5.09E-11	3.70E-11	1.14E-09
LA140	1.01E-08	3.53E-09	1.19E-09	0.00E+00	0.00E+00	0.00E+00	9.84E-05
LA142	5.24E-10	1.67E-10	5.23E-11	0.00E+00	0.00E+00	0.00E+00	3.31E-05
CE141	3.97E-08	1.98E-08	2.94E-09	0.00E+00	8.68E-09	0.00E+00	2.47E-05
CE143	6.99E-09	3.79E-06	5.49E-10	0.00E+00	1.59E-09	0.00E+00	5.55E-05
CE144	2.08E-06	6.52E-07	1.11E-07	0.00E+00	3.61E-07	0.00E+00	1.70E-04
PR143	3.93E-08	1.18E-08	1.95E-09	0.00E+00	6.39E-09	0.00E+00	4.24E-05
PR144	1.29E-10	3.99E-11	6.49E-12	0.00E+00	2.11E-11	0.00E+00	8.59E-08
ND147	2.79E-08	2.26E-08	1.75E-09	0.00E+00	1.24E-08	0.00E+00	3.58E-05
W187	4.29E-07	2.54E-07	1.14E-07	0.00E+00	0.00E+00	0.00E+00	3.57E-05
NP239	5.25E-09	3.77E-10	2.65E-10	0.00E+00	1.09E-09	0.00E+00	2.79E-05

Table 3.2-13

Ingestion Dose Factors for Infant (mrem/pCi ingested)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
H3	0.00E+00	3.08E-07	3.08E-07	3.08E-07	3.08E-07	3.08E-07	3.08E-07
C14	2.37E-05	5.06E-06	5.06E-06	5.06E-06	5.06E-06	5.06E-06	5.06E-06
NA24	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05
P32	1.70E-03	1.00E-04	6.59E-05	0.00E+00	0.00E+00	0.00E+00	2.30E-05
CR51	0.00E+00	0.00E+00	1.41E-08	9.20E-09	2.01E-09	1.79E-08	4.11E-07
MN54	0.00E+00	1.99E-05	4.51E-06	0.00E+00	4.41E-06	0.00E+00	7.31E-06
MN56	0.00E+00	8.18E-07	1.41E-07	0.00E+00	7.03E-07	0.00E+00	7.43E-05
FE55	1.39E-05	8.98E-06	2.40E-06	0.00E+00	0.00E+00	4.39E-06	1.14E-06
FE59	3.08E-05	5.38E-05	2.12E-05	0.00E+00	0.00E+00	1.59E-05	2.57E-05
CO58	0.00E+00	3.60E-06	8.98E-06	0.00E+00	0.00E+00	0.00E+00	8.97E-06
CO60	0.00E+00	1.08E-05	2.55E-05	0.00E+00	0.00E+00	0.00E+00	2.57E-05
NI63	6.34E-04	3.92E-05	2.20E-05	0.00E+00	0.00E+00	0.00E+00	1.95E-06
NI65	4.70E-06	5.32E-07	2.42E-07	0.00E+00	0.00E+00	0.00E+00	4.05E-05
CU64	0.00E+00	6.09E-07	2.82E-07	0.00E+00	1.03E-06	0.00E+00	1.25E-05
ZN65	1.84E-05	6.31E-05	2.91E-05	0.00E+00	3.06E-05	0.00E+00	5.33E-05
ZN69	9.33E-08	1.68E-07	1.25E-08	0.00E+00	6.98E-08	0.00E+00	1.37E-05
BR83	0.00E+00	0.00E+00	3.63E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR84	0.00E+00	0.00E+00	3.82E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR85	0.00E+00	0.00E+00	1.94E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RB86	0.00E+00	1.70E-04	8.40E-05	0.00E+00	0.00E+00	0.00E+00	4.35E-06
RB88	0.00E+00	4.98E-07	2.73E-07	0.00E+00	0.00E+00	0.00E+00	4.85E-07
RB89	0.00E+00	2.86E-07	1.97E-07	0.00E+00	0.00E+00	0.00E+00	9.74E-08
SR89	2.51E-03	0.00E+00	7.20E-05	0.00E+00	0.00E+00	0.00E+00	5.16E-05
SR90	1.85E-02	0.00E+00	4.71E-03	0.00E+00	0.00E+00	0.00E+00	2.31E-04
SR91	5.00E-05	0.00E+00	1.81E-06	0.00E+00	0.00E+00	0.00E+00	5.92E-05
SR92	1.92E-05	0.00E+00	7.13E-07	0.00E+00	0.00E+00	0.00E+00	2.07E-04
Y90	8.69E-08	0.00E+00	2.33E-09	0.00E+00	0.00E+00	0.00E+00	1.20E-04
Y91M	8.10E-10	0.00E+00	2.76E-11	0.00E+00	0.00E+00	0.00E+00	2.70E-06
Y91	1.13E-06	0.00E+00	3.01E-08	0.00E+00	0.00E+00	0.00E+00	8.10E-05
Y92	7.65E-09	0.00E+00	2.15E-10	0.00E+00	0.00E+00	0.00E+00	1.46E-04
Y93	2.43E-08	0.00E+00	6.62E-10	0.00E+00	0.00E+00	0.00E+00	1.92E-04
ZR95	2.06E-07	5.02E-08	3.56E-08	0.00E+00	5.41E-08	0.00E+00	2.50E-05
ZR97	1.48E-08	2.54E-09	1.16E-09	0.00E+00	2.56E-09	0.00E+00	1.62E-04
NB95	4.20E-08	1.73E-08	1.00E-08	0.00E+00	1.24E-08	0.00E+00	1.46E-05
MO99	0.00E+00	3.40E-05	6.63E-06	0.00E+00	5.08E-05	0.00E+00	1.12E-05
TC99M	1.92E-09	3.96E-09	5.10E-08	0.00E+00	4.26E-08	2.07E-09	1.15E-06

Table 3.2-13 (Cont.)

Ingestion Dose Factors for Infant

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
TC101	2.27E-09	2.86E-09	2.83E-08	0.00E+00	3.40E-08	1.56E-09	4.86E-07
RU103	1.48E-06	0.00E+00	4.95E-07	0.00E+00	3.08E-06	0.00E+00	1.80E-05
RU105	1.36E-07	0.00E+00	4.58E-08	0.00E+00	1.00E-06	0.00E+00	5.41E-05
RU106	2.41E-05	0.00E+00	3.01E-06	0.00E+00	2.85E-05	0.00E+00	1.83E-04
AG110M	9.96E-07	7.27E-07	4.81E-07	0.00E+00	1.04E-06	0.00E+00	3.77E-05
TE125M	2.33E-05	7.79E-06	3.15E-06	7.84E-06	0.00E+00	0.00E+00	1.11E-05
TE127M	5.85E-05	1.94E-05	7.08E-06	1.69E-05	1.44E-04	0.00E+00	2.36E-05
TE127	1.00E-06	3.35E-07	2.15E-07	8.14E-07	2.44E-06	0.00E+00	2.10E-05
TE129M	1.00E-04	3.43E-05	1.54E-05	3.84E-05	2.50E-04	0.00E+00	5.97E-05
TE129	2.84E-07	9.79E-08	6.63E-08	2.38E-07	7.07E-07	0.00E+00	2.27E-05
TE131M	1.52E-05	6.12E-06	5.05E-06	1.24E-05	4.21E-05	0.00E+00	1.03E-04
TE131	1.76E-07	6.50E-08	4.94E-08	1.57E-07	4.50E-07	0.00E+00	7.11E-06
TE132	2.08E-05	1.03E-05	9.61E-06	1.52E-05	6.44E-05	0.00E+00	3.81E-05
I130	6.00E-06	1.32E-05	5.30E-06	1.48E-03	1.45E-05	0.00E+00	2.83E-06
I131	3.59E-05	4.23E-05	1.86E-05	1.39E-02	4.94E-05	0.00E+00	1.51E-06
I132	1.66E-06	3.37E-06	1.20E-06	1.58E-04	3.76E-06	0.00E+00	2.73E-06
I133	1.25E-05	1.82E-05	5.33E-06	3.31E-03	2.14E-05	0.00E+00	3.08E-06
I134	8.69E-07	1.78E-06	6.33E-07	4.15E-05	1.99E-06	0.00E+00	1.84E-06
I135	3.64E-06	7.24E-06	2.64E-06	6.49E-04	8.07E-06	0.00E+00	2.62E-06
CS134	3.77E-04	7.03E-04	7.10E-05	0.00E+00	1.81E-04	7.42E-05	1.91E-06
CS136	4.59E-05	1.35E-04	5.04E-05	0.00E+00	5.38E-05	1.10E-05	2.05E-06
CS137	5.22E-04	6.11E-04	4.33E-05	0.00E+00	1.64E-04	6.64E-05	1.91E-06
CS138	4.81E-07	7.82E-07	3.79E-07	0.00E+00	3.90E-07	6.09E-08	1.25E-06
BA139	8.81E-07	5.84E-10	2.55E-08	0.00E+00	3.51E-10	3.54E-10	5.58E-05
BA140	1.71E-04	1.71E-07	8.81E-06	0.00E+00	4.06E-08	1.05E-07	4.20E-05
BA141	4.25E-07	2.91E-10	1.34E-08	0.00E+00	1.75E-10	1.77E-10	5.19E-06
BA142	1.84E-07	1.53E-10	9.06E-09	0.00E+00	8.81E-11	9.26E-11	7.59E-07
LA140	2.11E-08	8.32E-09	2.14E-09	0.00E+00	0.00E+00	0.00E+00	9.77E-05
LA142	1.10E-09	4.04E-10	9.67E-11	0.00E+00	0.00E+00	0.00E+00	6.86E-05
CE141	7.87E-08	4.80E-08	5.65E-09	0.00E+00	1.48E-08	0.00E+00	2.48E-05
CE143	1.48E-08	9.82E-06	1.12E-09	0.00E+00	2.86E-09	0.00E+00	5.73E-05
CE144	2.98E-06	1.22E-06	1.67E-07	0.00E+00	4.93E-07	0.00E+00	1.71E-04
PR143	8.13E-08	3.04E-08	4.03E-09	0.00E+00	1.13E-08	0.00E+00	4.29E-05
PR144	2.74E-10	1.06E-10	1.38E-11	0.00E+00	3.84E-11	0.00E+00	4.93E-06
ND147	5.53E-08	5.68E-08	3.48E-09	0.00E+00	2.19E-08	0.00E+00	3.60E-05
W187	9.03E-07	6.28E-07	2.17E-07	0.00E+00	0.00E+00	0.00E+00	3.69E-05
NP239	1.11E-08	9.93E-10	5.61E-10	0.00E+00	1.98E-09	0.00E+00	2.87E-05

Table 3.2-14

Annual Usage Factors for the Maximum Exposed Individual

Pathway	Infant	Child	Teen	Adult
Fruits, vegetables & grain (kg/yr)*	--	520	630	520
Leafy vegetables (kg/yr)	--	26	42	64
Milk (l/yr)	330	330	400	310
Meat & poultry (kg/yr)	--	41	65	110
Inhalation (m^3/yr)	1400	3700	8000	8000

*Consists of the following (on a mass basis): 22% fruit, 54% vegetables (including leafy vegetables), and 24% grain.

Table 3.2-15

Annual Usage Factors for the Average Individual**

Pathway	Child	Teen	Adult
Fruits, vegetables, & grain (kg/yr)*	200	240	190
Milk (l/yr)	170	200	110
Meat & poultry (kg/yr)	37	59	95
Inhalation (m^3/yr)	3700	8000	8000

* Consists of the following (on a mass basis): 22% fruit, 54% vegetables (including leafy vegetables), and 24% grain.

**For total population and average individual dose calculations.

Figure 3.2-1

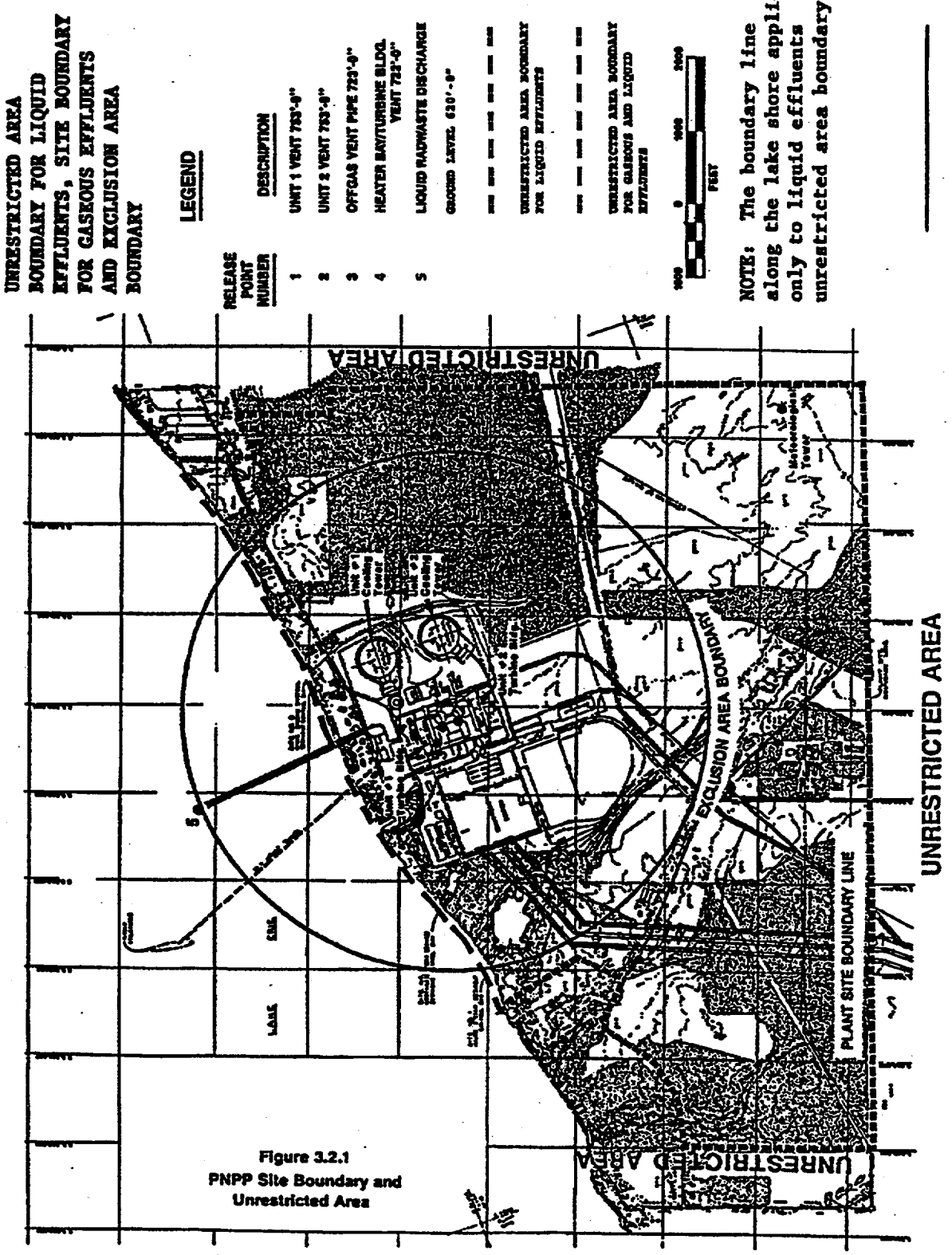


Figure 3.2.1
PNPP Site Boundary and
Unrestricted Area

3.3 Compliance With 10CFR50 Appendix I - Gaseous Effluent Dose

Doses resulting from the release of noble gases, radioiodines, tritium and radionuclides in particulate form must be calculated to show compliance with Appendix I of 10CFR50. The calculations will be performed at least monthly for all gaseous effluents.

3.3.1 Noble Gases

Section II.B.1 of Appendix I of 10CFR50 limits the releases of gaseous effluents from each reactor to unrestricted areas such that the estimated annual gamma air dose is limited to 10 millirads and the beta air dose is limited to 20 millirads. The external dose pathway only will be considered for noble gases. The controlling location for the above stated dose limits is the nearest site boundary location for the period of release.

ODCM Appendix C controls limit the dose resulting from the release of noble gas radionuclides in gaseous effluents to the following:

a. For gamma radiation, during the current quarter:

$D_{air} \leq 5$ mrads,

b. For beta radiation, during the current quarter:

$D_{air} \leq 10$ mrads,

c. For gamma radiation, during the current year:

$D_{air} \leq 10$ mrads,

d. For beta radiation, during the current year:

$D_{air} \leq 20$ mrads.

3.3.2 Radioiodines, Particulates, and Other Radionuclides

Section II.C of Appendix I of 10CFR50 limits the annual release of radioiodines and radioactive materials in particulate form from each reactor such that estimated dose or dose commitment to an individual in an unrestricted area from all pathways of exposure is not in excess of 15 mrem to any organ. The controlling location for this organ dose limit is the nearest site boundary, the deposition (D/Q) for the period of release, and the receptor pathway. Receptor pathway locations will be reviewed once per year following the performance of the Land Use Census to include consideration of nearest residences, garden, and farm animal locations in each sector.

ODCM Appendix C controls limit the dose resultant from the release of iodine-131, iodine-133, tritium, and all radionuclides in particulate form with half-lives greater than eight days to the following:

a. During the current quarter:

Dose to Any Organ ≤ 7.5 mrems

b. During the current year:

Dose to Any Organ ≤ 15 mrems.

3.3.3 Dose Calculations

The following calculations are used to determine gamma and beta air doses resultant from noble gas release to areas at or beyond the site boundary for purpose of showing compliance with 10CFR50, Appendix I. The equations used to calculate organ doses resultant from the release of iodine-131, iodine-133, tritium, and radionuclides in particulate form with half-lives greater than eight days are those found in Section 3.2.3.

Dose values are obtained by applying the dose rates over the appropriate surveillance or sampling time period.

a. Gamma Air Dose from Noble Gas Releases

$$D_{air}^{\gamma} = (3.15)\ (10^{1})\ (\chi/Q)\ \sum_{i}\ (Q_i)\ (DF_i^{\gamma})$$

Where:

D_{air}^{γ} = the annual gamma air dose due to noble gas radionuclides, in mrad/yr;

DF_i^{γ} = the gamma air dose factor for a uniform semi-infinite cloud of radionuclide "i", from Table 3.3-1, in mrad/s per Ci/m^3;

Q_i = the release rate of radionuclide "i", in µCi/s;

χ/Q = the annual average dispersion factor in s/m^3 (see Appendix A);

3.15×10^{1} = the conversion factor to convert (mrad * µCi)/(Ci * s) to mrad/yr.

b. Beta Air dose from Noble Gas Releases

$$D_{air}^{\beta} = (3.15 \times 10^{1})\ (\chi/Q)\ \sum_{i}\ (Q_i)\ (DF_i^{\beta})$$

Where:

D_{air}^{β} = the annual beta air dose due to noble gas radionuclides, in mrad/yr;

DF_i^{β} = the beta air dose factor for a uniform semi-infinite cloud of radionuclide "i", from Table 3.3-1, in mrad/s per Ci/m^3;

Q_i = the release rate of radionuclide "i", in µCi/s;

χ/Q = the annual average dispersion factor in s/m^3 (see Appendix A);

3.15×10^{1} = the conversion factor to convert (mrad * µCi)/(Ci * s) to mrad/yr.

3.3.4 Cumulation of Doses

The dose contribution from gaseous effluents will be calculated at least monthly. Calculations will be performed to determine the maximum air dose as well as the maximum organ dose to an individual. These dose calculations will be summed for comparison with quarterly and annual limits. To assure

compliance with 10CFR50, Appendix I, the dose limits for air dose and organ dose are those found in Sections 3.3.1 and 3.3.2, respectively. The quarterly limits specified in those sections represent one half of the annual design objectives. If these limits are exceeded, a special report will be submitted to the NRC in accordance with ODCM Appendix C controls.

3.3.5 Projection of Doses

Anticipated doses resulting from the release of gaseous effluents will be projected monthly. The doses calculated for the present month will be used as the projected doses unless information exists indicating that actual releases could differ significantly in the next month. In this case the source term will be adjusted to reflect this information and the justification for the adjustment noted.

If the sum of the projected doses for the 31-day period exceeds 0.3 mrem to any organ, appropriate portions of the ventilation exhaust treatment system will be operated to reduce releases. The values for the projected dose impact levels correspond to about one forty-eighth of the Appendix I limits. If continued for a year, these values would correspond to less than one-fourth of the Appendix I limits.

3.4 Population Dose

PNPP's Annual Radioactive Effluent Release Reports, as required by Regulatory Guide 1.21, will include total population dose and average individual doses calculated for all radioactive gaseous effluent releases. The total population dose and average individual dose will be computed, taking into account geographical population distribution and pathway(s) using the equations in Section 3.2. However, the dose factors, DF_{aijp}, differ; total population and average individual doses are calculated in a manner similar to that used for maximum individuals except that Regulatory Guide 1.109, Revision 1 assumptions for average individuals are used rather than for maximum exposed individuals and they are averaged over all age groups after weighting by the fraction of population in each age group.

Table 3.3-1

Gamma and Beta Air Dose Factors for Semi-Infinite Plume

(mrad/s per Ci/m^3)

Nuclide	Gamma Air Dose Factor (DF_i^γ)	Beta Air Dose Factor (DF_i^β)
Ar-41	2.95+2	1.04+2
Kr-83m	6.12-1	9.13+0
Kr-85m	3.90+1	6.24+1
Kr-85	5.45-1	6.18+1
Kr-87	1.96+2	3.27+2
Kr-88	4.82+2	9.29+1
Kr-89	5.48+2	3.36+2
Kr-90	5.14+2	2.48+2
Xe-131m	4.95+0	3.53+1
Xe-133m	1.04+1	4.69+1
Xe-133	1.12+1	3.33+1
Xe-135m	1.07+2	2.34+1
Xe-135	6.09+1	7.80+1
Xe-137	4.79+1	4.03+2
Xe-138	2.92+2	1.51+2

4.0 TOTAL DOSE

4.1 Compliance With 40CFR190 - Uranium Fuel Cycle Dose

Annual dose contributions from liquid and gaseous effluent releases, as discussed in Sections 2.3.2 and 3.3.4, are summed to evaluate compliance with the 40CFR190 annual limit of 25 mrem total body or any organ (except the thyroid, which is 75 mrem).

PNPP does not intend to exceed 40CFR190 limits during normal operation. However, if such a situation should occur, violations would be handled as per ODCM Appendix C Control 3/4.11.4a. which requires the following:

With the calculated doses from the release of radioactive materials in liquid or gaseous effluents exceeding twice the limits of Control 3.11.1.2a., 3.11.1.2b., 3.11.2.2a., 3.11.2.2b., 3.11.2.3a. or 3.11.2.3b., calculations shall be made including direct radiation contributions from the reactor units and from outside storage tanks to determine whether the above limits of Control 3.11.4 have been exceeded. If such is the case, prepare and submit to the Commission within 30 days, pursuant to Control 6.9.2, a Special Report that defines the corrective action to be taken to reduce subsequent releases to prevent recurrence of exceeding the above limits and includes the schedule for achieving conformance with the above limits. This Special Report, as defined in 10CFR20.405c, shall include an analysis that estimates the radiation exposure (dose) to a MEMBER OF THE PUBLIC from uranium fuel cycle sources, including all effluent pathways and direct radiation, for the calendar year that includes the release(s) covered by this report. It shall also describe levels of radiation and concentrations of radioactive material involved, and the cause of the exposure levels or concentrations. If the estimated dose(s) exceeds the above limits, and if the release condition resulting in violation of 40CFR190 has not already been corrected, the Special Report shall include a request for a variance in accordance with the provisions of 40CFR190. Submittal of the report is considered a timely request, and a variance is granted until staff action on the request is complete.

This Special Report shall contain:

1. A determination of which fuel cycle facilities or operations, in addition to the nuclear power reactor unit(s) at the site, contribute to the annual dose to the maximum exposed individual. Nuclear fuel facilities over five miles from PNPP need not be considered in this determination.

2. A determination of the maximum exposed individual.

3. A determination of the total annual dose to this person from all existing pathways and sources of radioactive effluents and direct radiation using the methodologies described in this ODCM. Where additional information on pathways and nuclides is needed, the best available information will be used and documented.

4. A determination of the dose resulting from direct radiation from the plant and storage facilities.

The total body and organ doses resulting from liquid effluents from the PNPP will be summed with the doses resulting from gaseous releases of noble gases, radioiodines, tritium, and particulates with half-lines greater than eight days when any of the dose limits outlined in Sections 2.3.2, 3.3.1 or 3.3.2 are exceeded by a factor of two. The doses from the PNPP will be summed with the dose to the maximum exposed individual contributed from other operations of the uranium fuel cycle.

4.2 Direct Radiation Dose from PNPP

Potential direct radiation dose to individuals outside PNPP will arise from (a) skyshine and direct dose from the turbines, (b) direct dose from the external surfaces of buildings, and (c) direct dose from stored radwaste.

Coolant activation by high energy neutrons, the O^{16} $(n,p)N^{16}$ reaction, is of interest in boiling water reactors, like PNPP, because it can result in turbine skyshine and direct dose. The N-16 present in the steam of a direct cycle BWR is carried with the steam into the turbine moisture separators, and associated equipment. Although N-16 has a 7.13 second half-life, its gamma emission can present a radiation dose problem to the site boundary as a result of the high energy gamma scatter from structures and the atmosphere.

All external walls of buildings at PNPP have been designed to attenuate radiation sources from within the plant to maximum of 0.5 mrem/h outside, with an expected radiation dose not to exceed 0.25 mrem/h.

Projected direct radiation dose assessment for normal operations was performed, based on 80% load factor and 100% occupancy, for the closest site boundary location (WSW sector). Direct dose from turbine skyshine was calculated to be 1.3 mrem/yr and direct dose from the surface of buildings was calculated to be 2.2 E-3 mrem/yr.

Direct radiation doses at PNPP will be measured by self-contained dosimeters encircling the site located in the general area of the site boundary. These self-contained dosimeters will be of the thermoluminescent variety (TLDs) with analyses performed quarterly and annually.

4.3 Dose to Members of the Public While Onsite

ODCM Appendix C Control 6.9.1.7 requires "assessment of the radiation doses from radioactive liquid and gaseous effluents to members of the public due to their activities inside the site boundary." This assessment is included in Annual Radioactive Effluent Release Reporting.

A member of the public is defined in ODCM Appendix C to include anyone who is not occupationally associated with the plant, i.e., not a utility employee, contractor or vendor. Also excluded from this category is any person who enters the site to service equipment or make deliveries.

Maximum dose to member of the public while onsite is conservatively assessed relative to offsite dose values. The assessment methodology incorporates use of appropriate dilution, dispersion, and occupancy factors for onsite activities.

The only liquid effluent dose pathway affecting members of the public while onsite is shore exposure. Fishing on the Lake Erie shoreline is the assumed activity for this exposure. Onsite dose assessment is made via ratio to the maximum calculated offsite shore exposure dose incorporating adjustments for occupancy factor and liquid effluent dilution.

Several cases are considered for gaseous effluent dose assessment to member of the public while onsite including: traversing a public road within the site boundary, lakeshore fishing, non-PNPP related training sessions at the Training and Education Center, car pooling to the Primary Access Control Point (PACP) parking lot, and job applicant interviews. This evaluation is made using "relative χ/Q" (atmospheric dispersion) values. "Relative χ/Q" values are the product of the highest annual average χ/Q for the point of concern, and occupancy factor for the case. An adjustment factor is derived by ratioing this highest onsite "relative χ/Q" to the highest site boundary "relative χ/Q". (A unity occupancy factor is used in the determination of the highest site boundary "relative χ/Q"). Conservative onsite dose determination is made by applying the "relative χ/Q" adjustment factor for the highest potential onsite dose activity to the highest calculated gaseous effluent offsite dose.

5.0 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

5.1 Monitoring Program

Environmental samples shall be collected and analyzed according to Table 5.1-1 at locations shown in Figures 5.1-1, 5.1-2 and 5.1-3. The Radiological Environmental Monitoring Program (REMP) sample locations are controlled by REMP-0013. A list and figures of the specific locations are contained in the Master List of Sampling Locations in the REMP file. Analytical techniques used shall ensure that the detection capabilities in Table 5.1-3 are achieved.

Ground water sampling will not be conducted as part of PNPP's REMP because this source is not tapped for drinking or irrigation purposes in the area of the plant. The position of the plant and the underdrain system with respect to the hydraulic gradient is such that any leakage or overflow from the underdrain system will flow north towards Lake Erie. Local domestic wells outside the exclusion area boundary are up-gradient from the plant. As part of the REMP, samples will be routinely collected from the closest potable water intakes on Lake Erie. C-1

The results of the radiological environmental monitoring program are intended to supplement the results of the radiological effluent monitoring by verifying that the measurable concentrations of radioactive materials and levels of radiation are not higher than expected on the basis of the effluent measurements and modeling of the environmental exposure pathways. Thus, the specified environmental monitoring program provides measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides which lead to the highest potential radiation exposures of individuals resulting from the station operation. The initial radiological environmental monitoring program was conducted for the first three years of commercial operation; program changes may now be proposed based on operational experience.

C-1

5.2 Land Use Census Program

A Land Use Census shall be conducted annually to identify, within a distance of 8 km (5 miles), the location in each of the meteorological sectors of the nearest residence, the nearest garden* greater than 50m^2 (500 ft^2) and the nearest milk-producing animal. |c-1 |c-1

If a Land Use Census identifies a location(s) that yields a calculated dose or dose commitment (via the same exposure pathway) 20% greater than at the location from which samples are currently being obtained the new location(s) will be added to the radiological environmental monitoring program within 30 days. The sampling location(s), excluding the control station location, having the lowest calculated dose or dose commitment(s), via the same exposure pathway, may be deleted from this monitoring program after October 31 of the year in which this Land Use Census was conducted. |c-1

The Land Use Census shall be conducted during the growing season at least once per 12 months using that information that will provide the best results, such as by a door-to-door survey, aerial survey, general observations, or by consulting local agriculture authorities. The results of the Land Use Census shall be included in the Annual Radiological Environmental Operating Report.

* Broad leaf vegetation sampling of at least three different types of vegetation may be performed at the site boundary in each of two different sectors with the highest predicted D/Qs in lieu of the garden census. Specifications for broad leaf vegetation sampling in Table 5.1-1 shall be followed, including analysis of control samples.

5.3 Inter-Laboratory Comparison Program

The laboratories of the licensee and/or licensee's contractors which perform analyses shall participate in an Interlaboratory Comparison Program which has been approved by the Commission. This participation shall include all of the determinations (sample medium-radionuclide combinations) that are included in the monitoring program. The results of analysis of these comparison samples shall be included in the Annual Radiological Environmental Operating Report. C-1

If the results of a determination in the comparison crosscheck program are outside the specified control limits, the laboratory shall investigate the cause of the problem and take steps to correct it. The results of this investigation and corrective action shall be included in the Annual Radiological Environmental Operating Report. C-1

Table 5.1-1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Number of Samples and Sample Location (1)	Sampling and Collection Frequency	Type and Frequency of Analysis
1. Direction Radiation (2)	Twenty eight routine monitoring stations either with two or more dosimeters or with one instrument for measuring and recording dose rate continuously, placed as follows: An inner ring of stations, one in each meteorological sector, other than those sectors entirely over water (N, NE, NNE, NNW, NW, W, WNW), in the general area of the SITE BOUNDARY; An outer ring of stations, one in each meteorological sector, other than those sectors entirely over water (N, NNE, NNW, NW, W, WNW), in the 6- to 8- km range from the site; and The balance of the stations to be placed in special interest areas such as population centers, nearby residences, schools, and in one or two areas to serve as control stations.	Quarterly	Gamma dose quarterly.

Table 5.1-1 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Number of Samples and Sample Location[1]	Sampling and Collection Frequency	Type and Frequency of Analysis
2. Airborne			
Radioiodine and Particulates	Samples from five locations: Three samples from close to the three SITE BOUNDARY locations, in different sectors, of the highest calculated annual average ground-level D/Q; One sample from the vicinity of a community having the highest calculated annual average ground-level D/Q; and One sample from a control location, as for example 15 to 30 km distant and in the least prevalent wind direction.	Continuous sampler operation with sample collection weekly, or more frequently if required by dust loading	Radioiodine Canister: I-131 analysis weekly Particulate Sampler: Gross beta radioactivity analysis following filter change;[3] and gamma isotopic analysis[4] of composite (by location) quarterly.
3. Waterborne			
a. Surface	Two samples	Composite sample over 1-month period.[5]	Gamma isotopic analysis[4] monthly. Composite for tritium analysis quarterly.

Table 5.1-1 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Number of Samples and Sample Location(1)	Sampling and Collection Frequency	Type and Frequency of Analysis
3. Waterborne (Continued)			
b. Drinking	One sample of each of one to three of the nearest water supplies that could be affected by its discharge. One sample from a control location.	Composite sample over 2-week period(5) when I-131 analysis is performed; monthly composite otherwise.	I-131 analysis on each composite when the dose calculated from the consumption of the water is greater than 1 mrem per year.(6) Composite for gross beta and gamma isotopic analysis(4) monthly. Composite for tritium analysis quarterly
c. Sediment from shoreline	One sample from area with existing or potential recreational value.	Semiannually	Gamma isotopic analysis(4) semiannually.
4. Ingestion			
a. Milk	Samples from milking animals in three locations within 5km distance having the highest dose potential. If there are none, then one sample from milking animals in each of three areas between 5 to 8 km distant where doses are calculated to be greater than 1 mrem per yr.(6) One sample from milking animals at a control location 15 to 30 km distant and in the least prevalent wind direction.	Semimonthly when animals are on pasture; Monthly at other times.	Gamma isotopic(4) and I-131 analysis semimonthly when animals are on pasture; monthly at other times.

Table 5.1-1 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Number of Samples and Sample Location(1)	Sampling and Collection Frequency	Type and Frequency of Analysis
4. Ingestion (Continued)			
b. Fish and Invertebrates	On sample of each commercially and recreationally important species in vicinity of plant discharge area.	Sample in season, or semiannually if they are not seasonal.	Gamma isotopic analysis(4) on edible portions.
	One sample of same species in areas not influenced by plant discharge.		
c. Food products	Samples of three different kinds of broad leaf vegetation grown nearest to each of two different offsite locations of highest predicted annual average ground level D/Q if milk sampling is not performed.	Monthly during growing season.	Gamma isotopic(4) and I-131 analysis.
	One sample of each of the similar broad leaf vegetation grown 15 to 30 km distant in the least prevalent wind direction if milk sampling is not performed.	Monthly during growing season.	Gamma isotopic(4) and I-131 analysis.

Table 5.1-1 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Table Notations

(1) Deviations are permitted from the required sampling schedule if specimens are unobtainable due to circumstances such as hazardous conditions, seasonal unavailability, and malfunction of automatic sampling equipment. If specimens are unobtainable due to sampling equipment malfunction, effort shall be made to complete corrective action prior to the end of the next sampling period. All deviations from the sampling schedule shall be documented in the Annual Radiological Environmental Operating Report pursuant to <ODCM Appendix C Control 6.9.1.6>. It is recognized that, at times, it may not be possible or practicable to continue to obtain samples of the media of choice at the most desired location or time. In these instances suitable specific alternative media and locations may be chosen for the particular pathway in question and appropriate substitutions made with in the thirty days. C 2

(2) One or more instruments, such as a pressurized ion chamber, for measuring and recording dose rate continuously may be used in place of, or in addition to, integrating dosimeters. For the purposes of this table, a thermoluminescent dosimeter (TLD) is considered to be one phosphor; two or more phosphors in a packet are considered as two or more dosimeters.

(3) Airborne particulate sample filters shall be analyzed for gross beta radioactivity 24 hours or more after sampling to allow for radon and thoron daughter decay. If gross beta activity in air particulate samples is greater than 10 times the yearly mean of control samples, gamma isotopic analysis shall be performed on the individual samples. C1

(4) Gamma isotopic analysis means the identification and quantification of gamma-emitting radionuclides that may be attributable to the effluents from the facility.

(5) A composite sample is one in which the quantity (aliquot) of liquid sampled is proportional to the quantity of flowing liquid and in which the method of sampling employed results in a specimen that is representative of the liquid flow. In this program composite sample aliquots shall be collected at time intervals that are very short (e.g., hourly) relative to the compositing period (e.g., monthly) in order to assure obtaining a representative sample.

(6) The dose shall be calculated for the maximum organ and age group, using the methodology and parameters within this manual.

Table 5.1-2

Reporting Levels for Radioactivity Concentrations in Environmental Samples

ANALYSIS	WATER (pCi/l)	AIRBORNE PARTICULATE OR GASES (pCi/m^3)	FISH (pCi/kg, wet)	MILK (pCi/l)	FOOD PRODUCTS (pCi/kg, wet)
H-3	2×10^4(a)				
Mn-54	1×10^3		3×10^4		
Fe-59	4×10^2		1×10^4		
Co-58	1×10^3		3×10^4		
Co-60	3×10^2		1×10^4		
Zn-65	3×10^2		2×10^4		
Zr-Nb-95	4×10^2				
I-131	2×10^0	9×10^{-1}		3×10^0	1×10^2
Cs-134	3×10^1	1×10^1	1×10^3	6×10^1	1×10^3
Cs-137	5×10^1	2×10^1	2×10^3	7×10^1	2×10^3
Ba-La-140	2×10^2			3×10^2	

(a) For drinking water samples. The value given is the 40CFR141 value.

Table 5.1-3

Detection Capabilities for Environmental Sample Analysis and Lower Limit of Detection (LLD) (a) (b)

ANALYSIS(c)	WATER (pCi/l)	AIRBORNE PARTICULATE OR GASES (pCi/m^3)	FISH (pCi/kg, wet)	MILK (pCi/l)	FOOD PRODUCTS (pCi/kg, wet)	SEDIMENT (pCi/kg, dry)
Gross Beta	4×10^0	1×10^{-2}				
H-3	2×10^3(d)					
Mn-54	1.5×10^1		1.3×10^2			
Fe-59	3×10^1		2.6×10^2			
Co-58, 60	1.5×10^1		1.3×10^2			
Zn-65	3×10^1		2.6×10^2			
Nb-95	1.5×10^1					
Zr-95	3×10^1					
I-131	1×10^0(e)	7×10^{-2}		1×10^0	6×10^1	
Cs-134	1.5×10^1	5×10^{-2}	1.3×10^2	1.5×10^1	6×10^1	1.5×10^2
Cs-137	1.8×10^1	6×10^{-2}	1.5×10^2	1.8×10^1	8×10^1	1.8×10^2
Ba-140	6×10^1			6×10^1		
La-140	1.5×10^1			1.5×10^1		

Table 5.1-3 (Cont.)

Table Notations

[a] Required detection capabilities for thermoluminescent dosimeters used for environmental measurements shall be in accordance with the recommendations of Regulatory Guide 4.13, except for specification regarding energy dependence. Correction factors shall be provided for energy ranges not meeting the energy dependence specification.

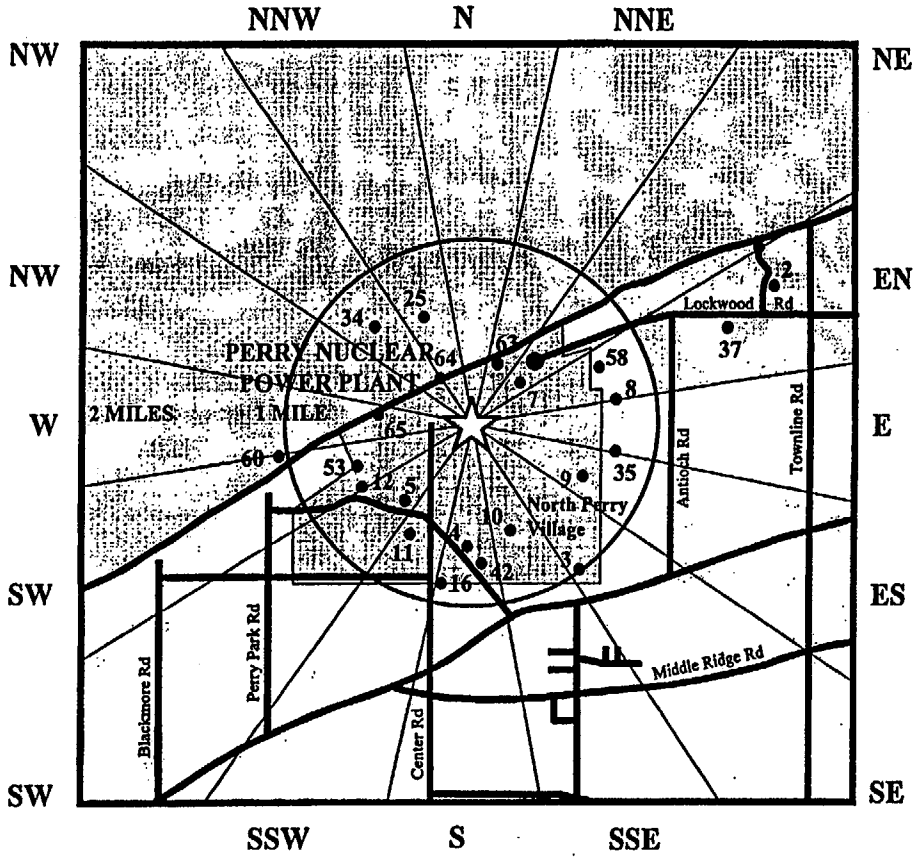
[b] The methodology for determining the LLD is contained in Appendix B.

[c] This list does not mean that only these nuclides are to be considered. Other peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Annual Radiological Environmental Operating Report pursuant to Control 6.9.1.6. For these radionuclides in ODCM Appendix C Table 4.12-1 which are not detected, the typical LLDs for the measurement system will be separately reported in the annual report.

[d] If no drinking water pathway exists, a value of 3×10^3 pCi/l may be used.

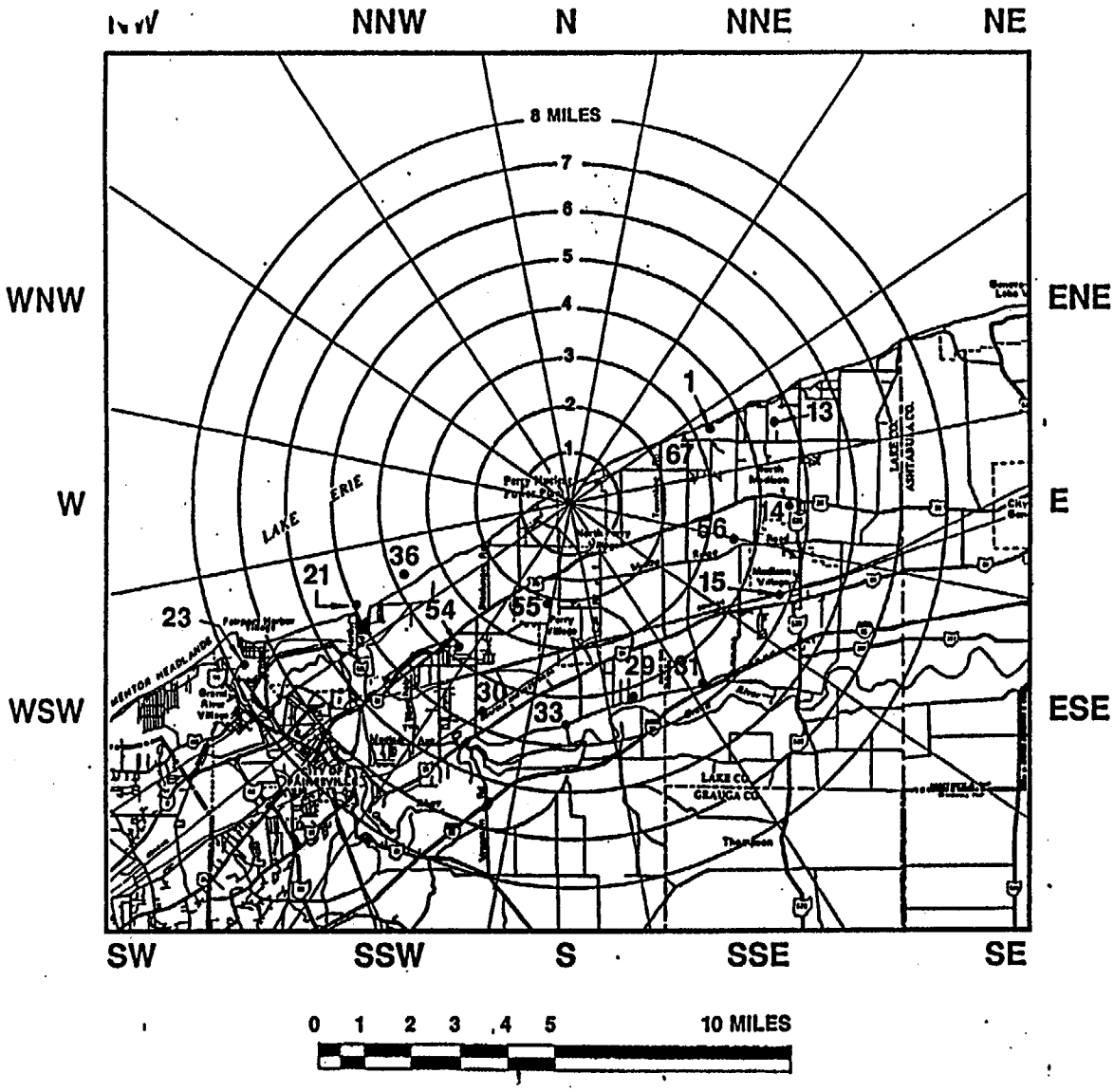
[e] If no drinking water pathway exists, a value of 1.5×10^1 pCi/l may be used.

Figure 5.1-1



LEGEND:		
STATION NO.	MEDIA	DIRECTION
2	FP	NNE
3	TLD	SE
4	AIR, TLD	S
5	TLD	SW
7	AIR, TLD	NE
8	TLD	E
9	TLD	ESE
10	TLD	SSE
11	TLD	WSW
12	TLD	WSW
25	SED, FSH	NNW
34	WTR	NW
35	AIR, TLD	E
37	FP	ENE
53	TLD	ENE
58	TLD	ENE

TECHNICAL SPECIFICATION REQUIRED
REMP SAMPLING LOCATIONS WITHIN TWO MILES OF THE PLANT SITE

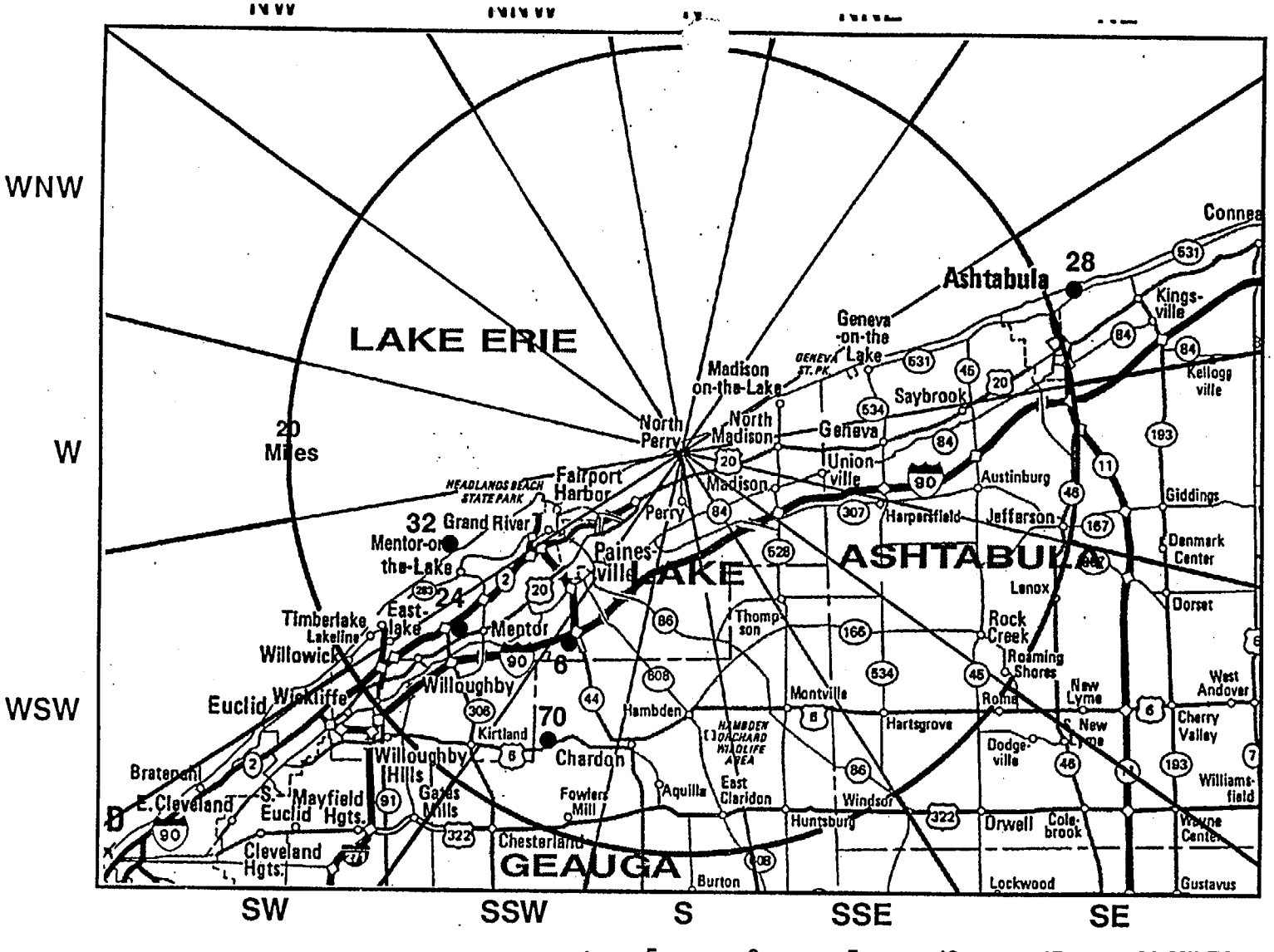


LEGEND:

STATION NO.	MEDIA	DIRECTION
1	AIR, TLD	ENE
13	TLD	ENE
14	TLD	E
15	TLD	ESE
21	TLD	WSW
23	TLD	WSW
29	TLD	SSE
30	TLD	SSW
31	TLD	SE
33	TLD	S
36	WATER, TLD	WSW
54	TLD	SW
55	TLD	S
56	TLD	ESE

Figure 5.1-2

TECHNICAL SPECIFICATION REQUIRED REMP
SAMPLING LOCATIONS BETWEEN TWO AND EIGHT MILES FROM THE PLANT SITE.



LEGEND:		
STATION NO.	MEDIA	DIRECTION
6	AIR, TLD	SSW
24	TLD	SW
28	WATER	ENE
32	FISH	WSW
70	FP	SSW

TECHNICAL SPECIFICATION REQUIRED
REMP SAMPLING LOCATIONS GREATER THAN EIGHT MILES FROM THE PLANT SITE

Figure 5.1-3

Appendix A

Atmospheric Dispersion and Deposition Parameters

The atmospheric dispersion and deposition parameters used to calculate gaseous effluent doses will be calculated using the following equations. Dose calculations will be performed using meteorological conditions concurrent with the time of release of radioactive materials in gaseous effluents or using historical average atmospheric conditions. All atmospheric releases at PNPP are considered to be ground-level releases.

a. Constant Mean Wind Direction Relative Dispersion Factor

$$\chi/Q = \frac{(2.32)\ (T_f)}{(\bar{u})\ (x)\ (\sigma)} \qquad \text{(A-1)}$$

Where:

χ/Q = the annual average dispersion factor in s/m^3;

T_f = the terrain correction factor, from FSAR Table 2.3-26, dimensionless;

$\bar{u}$ = the wind speed (measured at 10m), in m/s;

x = the distance of calculation, in m;

2.032 = $(2/\pi)^{1/2}$ divided by the width in radians of a 22.5° sector

$$\sigma = \text{the lesser of } \left[\sigma_z^2 + \frac{H_c^2}{2\pi}\right]^{1/2} \text{ or } (\sigma_z)\ (3^{1/2})$$

Where:

H_c = the building height (44.8m);

σ_z = the vertical dispersion coefficient, per Regulatory Guide 1.111, in m.

b. Depleted Relative Dispersion Factor

$$\chi/Q_d = (\chi/Q)(DPL_j) \qquad \text{(A-2)}$$

Where:

χ/Q_d = the depleted relative dispersion factor (for airborne halogens and particulates), in s/m^3;

DPL_j = the ground depletion factor for the "j"th distance, interpolated from Table A-1, dimensionless;

χ/Q = the annual average dispersion factor in s/m^3, per equation A-1.

c. Ground Deposition

$$D/Q = \frac{(DEP_j)(T_f)}{(0.3927)\ (x)} \qquad \text{(A-3)}$$

Where:

D/Q = the relative deposition per unit area (for halogens and particulates), in m^{-2};

DEP_j = the ground deposition factor for the "j"th distance, interpolated from Table A-1, in m^{-1};

T_f = terrain correction factor, from FSAR Table 2.3-26, dimensionless;

x = the "j"th distance, in m;

0.3927 = radians per 22.5° sector

Table A-1

Atmospheric Depletion and Deposition Factors

	Pasquill Stability Class	Distance (meters) 200	500	1,000	2,000	3,000	6,000	10,000	30,000	50,000	80,000
Depletion Factors (DPL_j)	All	0.970	0.936	0.900	0.860	0.832	0.770	0.714	0.590	0.517	0.440
Deposition Factors (DEP_j)(m^{-1})	All	1.25E-4	8.0E-5	5.4E-5	3.2E-5	2.6E-5	1.5E-5	9.9E-6	4.5E-6	3.0E-6	2.0E-6

The following tables contain annual average atmospheric dispersion and deposition parameters for long-term releases at PNPP. Long-term releases are those that occur greater than 500 hours per year. The highest annual average relative concentration (χ/Q) value at the site boundary for sectors over land shall be used for radioactive gaseous effluent monitor setpoint calculations. The dispersion model used was XOQDOQ, with PNPP FSAR site-specific terrain adjustment factors included. Dispersion values are based on seven years of meteorological data (May 1, 1972 through April 30, 1974 and September 1, 1977 through August 31, 1982), ground-level releases, sector spread for purge calculations, and twelve wind speed classes.

Table A-2

Site Boundary Atmospheric Dispersion (χ/Q) and Deposition Parameters (D/Q) for PNPP Unit 1

SECTOR	DISTANCE (MILES)	χ/Q (SEC./CUB. METER)	D/Q (PER SQ. METER)
N	0.18	5.7E-05*	1.6E-07
NNE	0.25	1.8E-05*	7.9E-08
NE	0.42	5.8E-06*	3.1E-08
ENE	0.67	2.1E-06*	1.6E-08
E	0.67	2.2E-06	1.8E-08
ESE	0.67	1.6E-06	1.3E-08
SE	0.79	1.4E-06	1.1E-08
SSE	0.82	2.2E-06	1.4E-08
S	0.81	2.7E-06	1.6E-08
SSW	0.80	1.3E-06	6.8E-09
SW	0.65	2.3E-06*	1.1E-08
WSW	0.56	4.2E-06*	1.5E-08
W	0.27	2.5E-05*	4.6E-08
WNW	0.18	5.9E-05*	8.4E-08
NW	0.17	6.6E-05*	1.1E-07
NNW	0.17	5.9E-05*	1.2E-07

NOTE: All χ/Q values are taken from the Updated Safety Analysis Report (USAR) Table 2.3-27. All marked values (*) are from Unit 1 USAR values, and the balance are Unit 2 values. In each case, the most conservative χ/Q value is utilized.

Table A-3

Atmospheric Dispersion (χ/Q) as a Function of Distance (s/m^3)

SECTOR	0.2 (MILES)	0.3 (MILES)	0.4 (MILES)	0.5 (MILES)	0.6 (MILES)
N	4.904E-05	2.453E-05	1.525E-05	1.057E-05	7.918E-06
NNE	2.656E-05	1.360E-05	8.640E-06	6.082E-06	4.612E-06
NE	1.859E-05	9.760E-06	6.293E-06	4.460E-06	3.383E-06
ENE	1.327E-05	7.129E-06	4.636E-06	3.293E-06	2.490E-06
E	1.363E-05	7.362E-06	4.760E-06	3.367E-06	2.538E-06
ESE	1.025E-05	5.566E-06	3.602E-06	2.547E-06	1.916E-06
SE	1.113E-05	6.061E-06	3.935E-06	2.788E-06	2.100E-06
SSE	1.894E-05	1.022E-05	6.647E-06	4.718E-06	3.560E-06
S	2.283E-05	1.227E-05	7.932E-06	5.615E-06	4.238E-06
SSW	1.142E-05	6.079E-06	3.925E-06	2.777E-06	2.097E-06
SW	1.449E-05	7.663E-06	4.928E-06	3.479E-06	2.622E-06
WSW	2.151E-05	1.111E-05	7.031E-06	4.934E-06	3.733E-06
W	4.184E-05	2.081E-05	1.281E-05	8.833E-06	6.606E-06
WNW	4.669E-05	2.298E-05	1.401E-05	9.573E-06	7.093E-06
NW	4.909E-05	2.423E-05	1.482E-05	1.015E-05	7.521E-06
NNW	4.580E-05	2.266E-05	1.390E-05	9.541E-06	7.083E-06

SECTOR	0.7 (MILES)	0.8 (MILES)	0.9 (MILES)	1.0 (MILES)	1.1 (MILES)
N	6.138E-06	4.968E-06	4.203E-06	3.636E-06	1.949E-06
NNE	3.622E-06	2.947E-06	2.481E-06	2.132E-06	1.278E-06
NE	2.662E-06	2.165E-06	1.815E-06	1.552E-06	9.269E-07
ENE	1.957E-06	1.588E-06	1.325E-06	1.129E-06	6.710E-07
E	1.991E-06	1.613E-06	1.343E-06	1.141E-06	6.768E-07
ESE	1.501E-06	1.215E-06	1.010E-06	8.571E-07	5.080E-07
SE	1.647E-06	1.334E-06	1.108E-06	9.402E-07	4.456E-07
SSE	2.796E-06	2.266E-06	1.885E-06	1.601E-06	5.524E-07
S	3.327E-06	2.697E-06	2.247E-06	1.911E-06	7.340E-07
SSW	1.646E-06	1.335E-06	1.114E-06	9.486E-07	5.223E-07
SW	2.053E-06	1.664E-06	1.391E-06	1.188E-06	5.667E-07
WSW	2.927E-06	2.380E-06	2.002E-06	1.719E-06	8.671E-07
W	5.110E-06	4.135E-06	3.504E-06	3.036E-06	1.630E-06
WNW	5.434E-06	4.378E-06	3.719E-06	3.235E-06	1.845E-06
NW	5.764E-06	4.643E-06	3.941E-06	3.425E-06	1.952E-06
NNW	5.439E-06	4.385E-06	3.720E-06	3.230E-06	1.839E-06

Table A-3 (Cont.)

Atmospheric Dispersion (χ/Q) as a Function of Distance (s/m^3)

SECTOR	1.2 (MILES)	1.3 (MILES)	1.4 (MILES)	1.5 (MILES)	1.6 (MILES)
N	1.729E-06	1.549E-06	1.399E-06	1.273E-06	1.166E-06
NNE	1.128E-06	1.006E-06	9.050E-07	8.202E-07	7.485E-07
NE	8.150E-07	7.243E-07	6.494E-07	5.867E-07	5.340E-07
ENE	5.878E-07	5.205E-07	4.652E-07	4.190E-07	3.803E-07
E	5.917E-07	5.230E-07	4.667E-07	4.197E-07	3.804E-07
ESE	4.437E-07	3.919E-07	3.494E-07	3.140E-07	2.843E-07
SE	3.891E-07	3.436E-07	3.062E-07	2.751E-07	2.491E-07
SSE	4.829E-07	4.267E-07	3.807E-07	3.423E-07	3.102E-07
S	6.424E-07	5.684E-07	5.076E-07	4.569E-07	4.145E-07
SSW	4.576E-07	4.054E-07	3.624E-07	3.266E-07	2.965E-07
SW	4.976E-07	4.417E-07	3.955E-07	3.570E-07	3.246E-07
WSW	7.648E-07	6.814E-07	6.125E-07	5.547E-07	5.060E-07
W	1.448E-06	1.299E-06	1.175E-06	1.070E-06	9.809E-07
WNW	1.644E-06	1.479E-06	1.341E-06	1.224E-06	1.124E-06
NW	1.738E-06	1.563E-06	1.416E-06	1.292E-06	1.186E-06
NNW	1.637E-06	1.471E-06	1.332E-06	1.214E-06	1.115E-06

SECTOR	1.7 (MILES)	1.8 (MILES)	1.9 (MILES)	2.0 (MILES)	2.1 (MILES)
N	1.074E-06	9.931E-07	9.226E-07	8.604E-07	8.052E-07
NNE	6.867E-07	6.331E-07	5.864E-07	5.453E-07	5.090E-07
NE	4.886E-07	4.494E-07	4.153E-07	3.854E-07	3.263E-07
ENE	3.471E-07	3.184E-07	2.936E-07	2.718E-07	2.526E-07
E	3.467E-07	3.177E-07	2.925E-07	2.705E-07	2.283E-07
ESE	2.590E-07	2.371E-07	2.182E-07	2.017E-07	1.871E-07
SE	2.268E-07	2.076E-07	1.910E-07	1.765E-07	1.637E-07
SSE	2.827E-07	2.590E-07	2.384E-07	2.205E-07	1.407E-07
S	3.780E-07	3.466E-07	3.194E-07	2.955E-07	1.373E-07
SSW	2.706E-07	2.484E-07	2.290E-07	2.121E-07	1.409E-07
SW	2.968E-07	2.727E-07	2.518E-07	2.335E-07	2.173E-07
WSW	4.639E-07	4.275E-07	3.957E-07	3.678E-07	5.303E-07
W	9.037E-07	8.365E-07	7.777E-07	7.258E-07	1.050E-06
WNW	1.038E-06	9.622E-07	8.960E-07	8.375E-07	1.142E-06
NW	1.095E-06	1.015E-06	9.445E-07	8.826E-07	8.275E-07
NNW	1.028E-06	9.527E-07	8.865E-07	8.281E-07	7.761E-07

Table A-3 (Cont.)

Atmospheric Dispersion (χ/Q) as a Function of Distance (s/m^3)

SECTOR	2.2 (MILES)	2.3 (MILES)	2.4 (MILES)	2.5 (MILES)	2.6 (MILES)
N	7.560E-07	7.118E-07	6.720E-07	6.359E-07	6.033E-07
NNE	4.766E-07	4.477E-07	4.217E-07	3.982E-07	3.770E-07
NE	3.050E-07	2.859E-07	2.688E-07	2.534E-07	2.395E-07
ENE	2.356E-07	2.205E-07	2.069E-07	1.947E-07	1.837E-07
E	2.127E-07	1.988E-07	1.864E-07	1.752E-07	1.652E-07
ESE	1.743E-07	1.628E-07	1.525E-07	1.433E-07	1.351E-07
SE	1.524E-07	1.424E-07	1.334E-07	1.253E-07	1.181E-07
SSE	1.311E-07	1.225E-07	1.149E-07	1.080E-07	1.018E-07
S	1.280E-07	1.197E-07	1.123E-07	1.056E-07	9.963E-08
SSW	1.314E-07	1.230E-07	1.154E-07	1.087E-07	1.025E-07
SW	2.030E-07	1.902E-07	1.787E-07	1.683E-07	1.590E-07
WSW	4.964E-07	4.661E-07	4.388E-07	4.142E-07	3.920E-07
W	9.867E-07	9.296E-07	8.780E-07	8.313E-07	7.891E-07
WNW	1.075E-06	1.014E-06	9.587E-07	9.088E-07	8.636E-07
NW	7.782E-07	7.339E-07	6.939E-07	6.576E-07	6.247E-07
NNW	7.297E-07	6.879E-07	6.502E-07	6.161E-07	5.852E-07

SECTOR	2.7 (MILES)	2.8 (MILES)	2.9 (MILES)	3.0 (MILES)	3.1 (MILES)
N	5.734E-07	5.460E-07	5.208E-07	4.976E-07	4.762E-07
NNE	3.576E-07	3.398E-07	3.235E-07	3.086E-07	2.948E-07
NE	2.268E-07	2.152E-07	2.046E-07	1.949E-07	1.859E-07
ENE	1.737E-07	1.645E-07	1.562E-07	1.485E-07	1.415E-07
E	1.560E-07	1.477E-07	1.401E-07	1.331E-07	1.267E-07
ESE	1.275E-07	1.207E-07	1.144E-07	1.087E-07	9.399E-08
SE	1.115E-07	1.054E-07	9.996E-08	9.493E-08	9.031E-08
SSE	9.613E-08	9.099E-08	8.630E-08	8.200E-08	7.805E-08
S	9.415E-08	8.917E-08	8.462E-08	8.044E-08	7.661E-08
SSW	9.697E-08	9.189E-08	8.725E-08	8.299E-08	7.907E-08
SW	1.505E-07	1.428E-07	1.357E-07	1.291E-07	1.231E-07
WSW	3.716E-07	3.531E-07	3.360E-07	3.204E-07	2.520E-07
W	7.503E-07	7.147E-07	6.820E-07	6.519E-07	5.874E-07
WNW	8.220E-07	7.838E-07	7.487E-07	7.164E-07	7.722E-07
NW	5.945E-07	5.668E-07	5.413E-07	5.178E-07	5.412E-07
NNW	5.567E-07	5.307E-07	5.067E-07	4.846E-07	4.642E-07

Table A-3 (Cont.)

Atmospheric Dispersion (χ/Q) as a Function of Distance (s/m^3)

SECTOR	3.2 (MILES)	3.3 (MILES)	3.4 (MILES)	3.5 (MILES)	3.6 (MILES)
N	4.563E-07	4.379E-07	4.208E-07	4.047E-07	3.899E-07
NNE	2.820E-07	2.702E-07	2.592E-07	2.489E-07	2.395E-07
NE	1.777E-07	1.700E-07	1.629E-07	1.562E-07	1.501E-07
ENE	1.350E-07	1.290E-07	1.234E-07	1.182E-07	1.135E-07
E	1.208E-07	1.154E-07	1.103E-07	1.056E-07	1.013E-07
ESE	8.958E-08	8.550E-08	8.173E-08	7.821E-08	7.499E-08
SE	8.606E-08	8.213E-08	7.849E-08	7.510E-08	7.200E-08
SSE	7.441E-08	7.105E-08	6.794E-08	6.503E-08	6.237E-08
S	7.307E-08	6.980E-08	6.678E-08	6.395E-08	6.136E-08
SSW	7.546E-08	7.212E-08	6.902E-08	6.613E-08	6.348E-08
SW	1.176E-07	1.125E-07	1.077E-07	1.033E-07	9.922E-08
WSW	2.410E-07	2.308E-07	2.214E-07	2.125E-07	2.044E-07
W	5.631E-07	5.406E-07	5.196E-07	4.999E-07	4.818E-07
WNW	7.409E-07	7.118E-07	6.848E-07	6.593E-07	6.359E-07
NW	5.192E-07	4.987E-07	4.797E-07	4.618E-07	4.454E-07
NNW	4.452E-07	4.276E-07	4.112E-07	3.958E-07	3.817E-07

SECTOR	3.7 (MILES)	3.8 (MILES)	3.9 (MILES)	4.0 (MILES)	4.1 (MILES)
N	3.759E-07	3.628E-07	3.504E-07	3.388E-07	2.981E-07
NNE	2.306E-07	2.222E-07	2.144E-07	2.070E-07	1.819E-07
NE	1.444E-07	1.390E-07	1.339E-07	1.292E-07	1.247E-07
ENE	1.090E-07	1.048E-07	1.009E-07	9.718E-08	9.373E-08
E	9.722E-08	9.342E-08	8.987E-08	8.653E-08	8.341E-08
ESE	7.196E-08	6.912E-08	6.647E-08	6.399E-08	6.166E-08
SE	6.908E-08	6.635E-08	6.380E-08	6.140E-08	5.378E-08
SSE	5.987E-08	5.753E-08	5.533E-08	5.328E-08	5.135E-08
S	5.892E-08	5.664E-08	5.451E-08	5.251E-08	5.063E-08
SSW	6.098E-08	5.865E-08	5.646E-08	5.441E-08	5.248E-08
SW	9.537E-08	9.178E-08	8.841E-08	8.525E-08	8.228E-08
WSW	1.967E-07	1.896E-07	1.828E-07	1.765E-07	1.462E-07
W	4.646E-07	4.485E-07	4.334E-07	4.191E-07	3.043E-07
WNW	6.137E-07	5.929E-07	5.733E-07	5.548E-07	4.180E-07
NW	4.298E-07	4.151E-07	4.013E-07	3.883E-07	3.761E-07
NNW	3.682E-07	3.556E-07	3.438E-07	3.326E-07	2.928E-07

Table A-3 (Cont.)

Atmospheric Dispersion (χ/Q) as a Function of Distance (s/m^3)

SECTOR	4.2 (MILES)	4.3 (MILES)	4.4 (MILES)	4.5 (MILES)	4.6 (MILES)
N	2.887E-07	2.798E-07	2.714E-07	2.634E-07	2.559E-07
NNE	1.759E-07	1.703E-07	1.650E-07	1.599E-07	1.552E-07
NE	1.205E-07	1.166E-07	1.128E-07	1.093E-07	1.059E-07
ENE	9.047E-08	8.740E-08	8.451E-08	8.176E-08	7.921E-08
E	8.046E-08	7.769E-08	7.508E-08	7.260E-08	7.030E-08
ESE	5.946E-08	5.740E-08	5.545E-08	5.361E-08	5.189E-08
SE	5.186E-08	5.005E-08	4.835E-08	4.673E-08	4.523E-08
SSE	4.954E-08	4.783E-08	4.622E-08	4.469E-08	4.327E-08
S	4.886E-08	4.719E-08	4.562E-08	4.413E-08	4.274E-08
SSW	5.067E-08	4.896E-08	4.735E-08	4.581E-08	4.439E-08
SW	7.948E-08	7.684E-08	7.435E-08	7.198E-08	6.978E-08
WSW	1.413E-07	1.368E-07	1.325E-07	1.284E-07	1.246E-07
W	2.948E-07	2.858E-07	2.773E-07	2.691E-07	2.616E-07
WNW	4.051E-07	3.930E-07	3.815E-07	3.706E-07	3.603E-07
NW	3.645E-07	3.536E-07	3.432E-07	3.333E-07	3.241E-07
NNW	2.837E-07	2.752E-07	2.671E-07	2.593E-07	2.521E-07

SECTOR	4.7 (MILES)	4.8 (MILES)	4.9 (MILES)	5.0 (MILES)
N	2.487E-07	2.419E-07	2.354E-07	2.292E-07
NNE	1.507E-07	1.464E-07	1.423E-07	1.384E-07
NE	1.028E-07	9.975E-08	9.689E-08	9.416E-08
ENE	7.676E-08	7.443E-08	7.223E-08	7.014E-08
E	6.809E-08	6.600E-08	6.402E-08	6.214E-08
ESE	5.025E-08	4.869E-08	4.722E-08	4.582E-08
SE	4.379E-08	4.244E-08	4.115E-08	3.992E-08
SSE	4.191E-08	4.063E-08	3.941E-08	3.825E-08
S	4.141E-08	4.015E-08	3.896E-08	3.782E-08
SSW	4.302E-08	4.173E-08	4.050E-08	3.934E-08
SW	6.767E-08	6.567E-08	6.377E-08	6.196E-08
WSW	1.210E-07	1.175E-07	1.142E-07	1.110E-07
W	2.543E-07	2.474E-07	2.408E-07	2.345E-07
WNW	3.505E-07	3.411E-07	3.322E-07	3.237E-07
NW	3.152E-07	3.068E-07	2.987E-07	2.910E-07
NNW	2.452E-07	2.386E-07	2.323E-07	2.263E-07

Table A-4

Atmospheric Dispersion (D/Q) as a Function of Distance (m^{-2})

SECTOR	0.2 (MILES)	0.3 (MILES)	0.4 (MILES)	0.5 (MILES)	0.6 (MILES)
N	1.396E-07	7.578E-08	4.836E-08	3.383E-08	2.516E-08
NNE	1.107E-07	6.008E-08	3.834E-08	2.682E-08	1.995E-08
NE	9.733E-08	5.284E-08	3.372E-08	2.359E-08	1.755E-08
ENE	1.067E-07	5.795E-08	3.698E-08	2.587E-08	1.924E-08
E	1.184E-07	6.429E-08	4.103E-08	2.870E-08	2.135E-08
ESE	8.865E-08	4.813E-08	3.071E-08	2.149E-08	1.598E-08
SE	9.402E-08	5.105E-08	3.258E-08	2.279E-08	1.695E-08
SSE	1.338E-07	7.266E-08	4.637E-08	3.244E-08	2.413E-08
S	1.429E-07	7.757E-08	4.951E-08	3.463E-08	2.576E-08
SSW	6.094E-08	3.309E-08	2.111E-08	1.477E-08	1.099E-08
SW	7.267E-08	3.945E-08	2.518E-08	1.761E-08	1.310E-08
WSW	7.117E-08	3.864E-08	2.466E-08	1.725E-08	1.283E-08
W	7.129E-08	3.870E-08	2.470E-08	1.728E-08	1.285E-08
WNW	6.970E-08	3.784E-08	2.415E-08	1.689E-08	1.256E-08
NW	8.904E-08	4.834E-08	3.085E-08	2.158E-08	1.605E-08
NNW	9.623E-08	5.225E-08	3.334E-08	2.332E-08	1.735E-08

SECTOR	0.7 (MILES)	0.8 (MILES)	0.9 (MILES)	1.0 (MILES)	1.1 (MILES)
N	1.954E-08	1.560E-08	1.277E-08	1.068E-08	5.545E-09
NNE	1.549E-08	1.237E-08	1.013E-08	8.465E-09	4.945E-09
NE	1.362E-08	1.088E-08	8.907E-09	7.445E-09	4.350E-09
ENE	1.494E-08	1.193E-08	9.768E-09	8.164E-09	4.770E-09
E	1.658E-08	1.323E-08	1.084E-08	9.058E-09	5.292E-09
ESE	1.241E-08	9.905E-09	8.112E-09	6.781E-09	3.961E-09
SE	1.316E-08	1.051E-08	8.605E-09	7.192E-09	3.361E-09
SSE	1.874E-08	1.496E-08	1.225E-08	1.024E-08	3.480E-09
S	2.000E-08	1.597E-08	1.308E-08	1.093E-08	4.128E-09
SSW	8.531E-09	6.810E-09	5.577E-09	4.662E-09	2.521E-09
SW	1.017E-08	8.120E-09	6.651E-09	5.559E-09	2.598E-09
WSW	9.963E-09	7.953E-09	6.513E-09	5.444E-09	2.678E-09
W	9.980E-09	7.966E-09	6.524E-09	5.453E-09	2.832E-09
WNW	9.757E-09	7.788E-09	6.379E-09	5.332E-09	2.932E-09
NW	1.246E-08	9.949E-09	8.148E-09	6.811E-09	3.745E-09
NNW	1.347E-08	1.075E-08	8.807E-09	7.361E-09	4.047E-09

Table A-4 (Cont.)

Atmospheric Deposition (D/Q) as a Function of Distance (m^{-2})

SECTOR	1.2 (MILES)	1.3 (MILES)	1.4 (MILES)	1.5 (MILES)	1.6 (MILES)
N	4.777E-09	4.163E-09	3.664E-09	3.252E-09	2.910E-09
NNE	4.260E-09	3.713E-09	3.268E-09	2.900E-09	2.595E-09
NE	3.747E-09	3.265E-09	2.874E-09	2.551E-09	2.283E-09
ENE	4.109E-09	3.581E-09	3.151E-09	2.797E-09	2.503E-09
E	4.559E-09	3.973E-09	3.497E-09	3.104E-09	2.777E-09
ESE	3.413E-09	2.974E-09	2.617E-09	2.323E-09	2.079E-09
SE	2.896E-09	2.524E-09	2.221E-09	1.971E-09	1.764E-09
SSE	2.998E-09	2.612E-09	2.299E-09	2.041E-09	1.826E-09
S	3.556E-09	3.099E-09	2.727E-09	2.421E-09	2.166E-09
SSW	2.172E-09	1.892E-09	1.666E-09	1.478E-09	1.323E-09
SW	2.238E-09	1.950E-09	1.717E-09	1.524E-09	1.363E-09
WSW	2.307E-09	2.011E-09	1.770E-09	1.571E-09	1.406E-09
W	2.440E-09	2.126E-09	1.871E-09	1.661E-09	1.486E-09
WNW	2.525E-09	2.201E-09	1.937E-09	1.719E-09	1.538E-09
NW	3.226E-09	2.811E-09	2.474E-09	2.196E-09	1.965E-09
NNW	3.487E-09	3.039E-09	2.674E-09	2.374E-09	2.124E-09

SECTOR	1.7 (MILES)	1.8 (MILES)	1.9 (MILES)	2.0 (MILES)	2.1 (MILES)
N	2.619E-09	2.371E-09	2.158E-09	1.973E-09	1.812E-09
NNE	2.336E-09	2.115E-09	1.925E-09	1.760E-09	1.616E-09
NE	2.055E-09	1.860E-09	1.693E-09	1.548E-09	1.292E-09
ENE	2.253E-09	2.040E-09	1.856E-09	1.697E-09	1.558E-09
E	2.500E-09	2.263E-09	2.059E-09	1.883E-09	1.572E-09
ESE	1.871E-09	1.694E-09	1.542E-09	1.410E-09	1.294E-09
SE	1.588E-09	1.437E-09	1.308E-09	1.196E-09	1.098E-09
SSE	1.644E-09	1.488E-09	1.354E-09	1.238E-09	7.816E-10
S	1.950E-09	1.765E-09	1.606E-09	1.469E-09	6.743E-10
SSW	1.191E-09	1.078E-09	9.810E-10	8.969E-10	5.883E-10
SW	1.227E-09	1.111E-09	1.011E-09	9.244E-10	8.488E-10
WSW	1.265E-09	1.145E-09	1.042E-09	9.530E-10	1.352E-09
W	1.338E-09	1.211E-09	1.102E-09	1.008E-09	1.430E-09
WNW	1.385E-09	1.254E-09	1.141E-09	1.043E-09	1.393E-09
NW	1.769E-09	1.601E-09	1.457E-09	1.333E-09	1.223E-09
NNW	1.912E-09	1.731E-09	1.575E-09	1.440E-09	1.322E-09

Table A-4 (Cont.)

Atmospheric Deposition (D/Q) as a Function of Distance (m^{-2})

SECTOR	2.2 (MILES)	2.3 (MILES)	2.4 (MILES)	2.5 (MILES)	2.6 (MILES)
N	1.670E-09	1.544E-09	1.433E-09	1.334E-09	1.245E-09
NNE	1.489E-09	1.377E-09	1.278E-09	1.189E-09	1.110E-09
NE	1.191E-09	1.101E-09	1.022E-09	9.511E-10	8.879E-10
ENE	1.436E-09	1.328E-09	1.233E-09	1.147E-09	1.071E-09
E	1.449E-09	1.340E-09	1.243E-09	1.157E-09	1.080E-09
ESE	1.193E-09	1.103E-09	1.024E-09	9.528E-10	8.895E-10
SE	1.012E-09	9.362E-10	8.687E-10	8.085E-10	7.548E-10
SSE	7.204E-10	6.663E-10	6.183E-10	5.754E-10	5.372E-10
S	6.215E-10	5.749E-10	5.334E-10	4.964E-10	4.634E-10
SSW	5.422E-10	5.015E-10	4.653E-10	4.331E-10	4.043E-10
SW	7.823E-10	7.236E-10	6.714E-10	6.249E-10	5.834E-10
WSW	1.246E-09	1.153E-09	1.070E-09	9.956E-10	9.294E-10
W	1.318E-09	1.219E-09	1.131E-09	1.053E-09	9.827E-10
WNW	1.284E-09	1.188E-09	1.102E-09	1.026E-09	9.575E-10
NW	1.128E-09	1.043E-09	9.678E-10	9.007E-10	8.409E-10
NNW	1.219E-09	1.127E-09	1.046E-09	9.735E-10	9.089E-10

SECTOR	2.7 (MILES)	2.8 (MILES)	2.9 (MILES)	3.0 (MILES)	3.1 (MILES)
N	1.165E-09	1.092E-09	1.026E-09	9.666E-10	9.120E-10
NNE	1.039E-09	9.742E-10	9.155E-10	8.621E-10	8.134E-10
NE	8.307E-10	7.789E-10	7.320E-10	6.893E-10	6.504E-10
ENE	1.002E-09	9.396E-10	8.830E-10	8.315E-10	7.845E-10
E	1.011E-09	9.477E-10	8.906E-10	8.387E-10	7.913E-10
ESE	8.322E-10	7.804E-10	7.334E-10	6.906E-10	5.923E-10
SE	7.061E-10	6.622E-10	6.223E-10	5.860E-10	5.529E-10
SSE	5.026E-10	4.713E-10	4.429E-10	4.171E-10	3.935E-10
S	4.336E-10	4.066E-10	3.821E-10	3.598E-10	3.395E-10
SSW	3.782E-10	3.547E-10	3.333E-10	3.139E-10	2.961E-10
SW	5.458E-10	5.118E-10	4.810E-10	4.529E-10	4.273E-10
WSW	8.695E-10	8.154E-10	7.663E-10	7.216E-10	5.607E-10
W	9.194E-10	8.621E-10	8.102E-10	7.630E-10	6.775E-10
WNW	8.958E-10	8.400E-10	7.894E-10	7.434E-10	7.890E-10
NW	7.867E-10	7.377E-10	6.933E-10	6.528E-10	6.719E-10
NNW	8.503E-10	7.973E-10	7.493E-10	7.056E-10	6.657E-10

Table A-4 (Cont.)

Atmospheric Deposition (D/Q) as a Function of Distance (m^{-2})

SECTOR	3.2 (MILES)	3.3 (MILES)	3.4 (MILES)	3.5 (MILES)	3.6 (MILES)
N	8.620E-10	8.161E-10	7.739E-10	7.347E-10	6.991E-10
NNE	7.688E-10	7.279E-10	6.902E-10	6.552E-10	6.235E-10
NE	6.147E-10	5.820E-10	5.518E-10	5.239E-10	4.985E-10
ENE	7.415E-10	7.020E-10	6.657E-10	6.320E-10	6.014E-10
E	7.479E-10	7.081E-10	6.714E-10	6.374E-10	6.066E-10
ESE	5.598E-10	5.300E-10	5.026E-10	4.771E-10	4.541E-10
SE	5.225E-10	4.947E-10	4.691E-10	4.454E-10	4.238E-10
SSE	3.719E-10	3.521E-10	3.339E-10	3.170E-10	3.016E-10
S	3.209E-10	3.038E-10	2.880E-10	2.735E-10	2.602E-10
SSW	2.799E-10	2.650E-10	2.513E-10	2.386E-10	2.270E-10
SW	4.039E-10	3.824E-10	3.626E-10	3.442E-10	3.276E-10
WSW	5.299E-10	5.017E-10	4.757E-10	4.516E-10	4.298E-10
W	6.403E-10	6.062E-10	5.749E-10	5.458E-10	5.193E-10
WNW	7.457E-10	7.060E-10	6.695E-10	6.356E-10	6.048E-10
NW	6.351E-10	6.013E-10	5.702E-10	5.413E-10	5.151E-10
NNW	6.292E-10	5.957E-10	5.649E-10	5.363E-10	5.103E-10

SECTOR	3.7 (MILES)	3.8 (MILES)	3.9 (MILES)	4.0 (MILES)	4.1 (MILES)
N	6.657E-10	6.347E-10	6.059E-10	5.791E-10	5.036E-10
NNE	5.937E-10	5.661E-10	5.404E-10	5.165E-10	4.492E-10
NE	4.747E-10	4.526E-10	4.321E-10	4.129E-10	3.951E-10
ENE	5.727E-10	5.460E-10	5.212E-10	4.981E-10	4.766E-10
E	5.776E-10	5.507E-10	5.257E-10	5.024E-10	4.807E-10
ESE	4.324E-10	4.122E-10	3.935E-10	3.761E-10	3.598E-10
SE	4.036E-10	3.848E-10	3.673E-10	3.510E-10	3.053E-10
SSE	2.872E-10	2.739E-10	2.614E-10	2.498E-10	2.390E-10
S	2.478E-10	2.363E-10	2.255E-10	2.155E-10	2.062E-10
SSW	2.162E-10	2.061E-10	1.968E-10	1.880E-10	1.799E-10
SW	3.119E-10	2.974E-10	2.839E-10	2.713E-10	2.596E-10
WSW	4.093E-10	3.902E-10	3.725E-10	3.560E-10	2.919E-10
W	4.945E-10	4.715E-10	4.501E-10	4.302E-10	3.087E-10
WNW	5.759E-10	5.491E-10	5.242E-10	5.010E-10	3.728E-10
NW	4.905E-10	4.677E-10	4.464E-10	4.266E-10	4.082E-10
NNW	4.859E-10	4.633E-10	4.423E-10	4.227E-10	3.676E-10

Table A-4 (Cont.)

Atmospheric Deposition (D/Q) as a Function of Distance (m^{-2})

SECTOR	4.2 (MILES)	4.3 (MILES)	4.4 (MILES)	4.5 (MILES)	4.6 (MILES)
N	4.823E-10	4.624E-10	4.437E-10	4.260E-10	4.097E-10
NNE	4.302E-10	4.124E-10	3.957E-10	3.800E-10	3.654E-10
NE	3.784E-10	3.627E-10	3.480E-10	3.342E-10	3.214E-10
ENE	4.564E-10	4.375E-10	4.198E-10	4.031E-10	3.877E-10
E	4.603E-10	4.413E-10	4.234E-10	4.066E-10	3.910E-10
ESE	3.446E-10	3.303E-10	3.170E-10	3.044E-10	2.927E-10
SE	2.924E-10	2.803E-10	2.690E-10	2.583E-10	2.484E-10
SSE	2.289E-10	2.195E-10	2.106E-10	2.022E-10	1.944E-10
S	1.975E-10	1.893E-10	1.817E-10	1.744E-10	1.677E-10
SSW	1.723E-10	1.652E-10	1.585E-10	1.522E-10	1.463E-10
SW	2.486E-10	2.383E-10	2.287E-10	2.196E-10	2.112E-10
WSW	2.796E-10	2.690E-10	2.572E-10	2.469E-10	2.375E-10
W	2.956E-10	2.834E-10	2.719E-10	2.611E-10	2.511E-10
WNW	3.570E-10	3.422E-10	3.284E-10	3.153E-10	3.032E-10
NW	3.909E-10	3.747E-10	3.596E-10	3.453E-10	3.320E-10
NNW	3.521E-10	3.375E-10	3.239E-10	3.110E-10	2.991E-10

SECTOR	4.7 (MILES)	4.8 (MILES)	4.9 (MILES)	5.0 (MILES)
N	3.941E-10	3.795E-10	3.656E-10	3.525E-10
NNE	3.515E-10	3.384E-10	3.261E-10	3.144E-10
NE	3.092E-10	2.977E-10	2.868E-10	2.765E-10
ENE	3.729E-10	3.591E-10	3.460E-10	3.336E-10
E	3.762E-10	3.622E-10	3.489E-10	3.364E-10
ESE	2.816E-10	2.711E-10	2.612E-10	2.519E-10
SE	2.389E-10	2.300E-10	2.216E-10	2.137E-10
SSE	1.871E-10	1.801E-10	1.735E-10	1.673E-10
S	1.614E-10	1.554E-10	1.497E-10	1.443E-10
SSW	1.408E-10	1.355E-10	1.306E-10	1.259E-10
SW	2.031E-10	1.956E-10	1.884E-10	1.817E-10
WSW	2.285E-10	2.199E-10	2.119E-10	2.043E-10
W	2.415E-10	2.326E-10	2.241E-10	2.160E-10
WNW	2.917E-10	2.809E-10	2.706E-10	2.609E-10
NW	3.194E-10	3.075E-10	2.963E-10	2.857E-10
NNW	2.877E-10	2.770E-10	2.669E-10	2.573E-10

Appendix B

Lower Limit of Detection

The lower limit of detection (LLD) is the smallest concentration of radioactive material in a sample that will be detected with a 95 percent probability with a 5 percent probability of falsely concluding that a blank observation represents a "real" signal.

For a measurement system (which may include radiochemical separation) based on gross beta, gross alpha, liquid scintillation, or other analyses where a background count determined by a separate measurement with no sample (or blank sample) is subtracted from the gross sample count to obtain a net count due to sample activity:

$$LLD = \frac{3.3 \left(\frac{r_b}{t_s} + \frac{r_b}{t_b} \right)^{1/2}}{(C)(E)(V)(Y_c) \exp(-\lambda \Delta t)} \qquad \text{(B-1)}$$

Where:

LLD = the "apriori" lower limit of detection, as defined above;

C = the conversion factor of transformations per unit time per uCi or pCi;

E = the detector efficiency;

r_b = the background count rate in units of transformations per unit time;

t_b = the counting time of background;

t_s = the counting time of the sample;

V = the sample size, in units of mass or volume;

Y_c = the fractional radiochemical sample collection or concentration yield (when applicable);

Δt = for plant effluents, the elapsed time between the midpoint of sample collection and time of counting; for environmental samples, the elapsed time between sample collection (or end of the sample collection period) and time of counting;

λ = the radioactive decay constant for the radionuclide in question.

For the purpose of routine analyses, count times for both the sample(s) and background(s) are equal. This satisfies the given ODCM Appendix C control for lower limit of detection definition, as the numerator of equation B-1 simplifies to 4.66 S_b, where S_b is the standard deviation of the background count rate or the count rate of a blank sample as appropriate.

The LLD is defined as an "apriori" (before the fact) limit representing the capability of a measurement system and not as an "a posteriori" (after the fact) limit for a particular measurement.

For gamma ray spectroscopy analyses:

$$LLD = \frac{L_D \ \exp\ (0.693\ \Delta t / t\ ½)}{(C)(E)(t)(V)(Y_c)(Y\gamma)} \qquad \text{(B-2)}$$

Where:

LLD = the lower limit of detection, in µCi or pCi per unit mass or volume;

C = the conversion factor of transformations per unit time per µCi or pCi;

E = the detector efficiency for the energy in question;

t = the data collection (counting) time of sample;

t ½ = the half-life of the radionuclide in question;

V = the sample size, in units of mass or volume;

Y_c = the fractional radiochemical, sample collection, or concentration yield (when applicable);

Yγ = the yield of the gamma ray in question;

Δt = for plant effluents the elapsed time between midpoint of sample collection and time of counting; for environmental samples, the elapsed time between sample collection (or end of the sample collection period) and the time of counting;

L_D = the detection limit

$$= k^2 + 2k \left(\frac{N}{2n} \quad (1 + \frac{N}{2n}) \quad (B_1 + B_2) + I + \sigma_I^{\ 2} \right)^{½} \qquad \text{(B-2a)}$$

Where:

B_1 = the number of counts in "n" background channels below the peak due to Compton scattering, etc., determined at the same time a photopeak is measured;

B_2 = the number of counts in the "n" background channels above the peak;

k = an abscissa of the normal distribution corresponding to confidence level,

= 1.645 at a confidence level of 95%;

I = the measured value of interference in the photopeak of interest due to environmental background, detector contamination, etc., determined by a separate measurement with no sample;

N = the number of channels in the photopeak of interest;

n = the number of background channels on each side of the photopeak of interest;

σ_I = the standard deviation of I.

Typical values of E, V, Y, and Δt shall be used in the calculation.

In calculating the LLD for a radionuclide determined by gamma-ray spectrometry, the background shall include the typical contributions of other radionuclides normally present in the samples (e.g., potassium-40 in milk samples).

Analyses shall be performed in such a manner that the LLD's listed in Tables 4.11.1.1.1-1, 4.11.2.1.2-1, and 4.12.1-1 of the ODCM Appendix C controls for the Perry Nuclear Power Plant will be achieved under routine conditions. Occasionally, background fluctuations, unavoidably small sample sizes, the presence of interfering nuclides, or other uncontrollable circumstances may render these LLDs unachievable. In such cases, the contributing factors will be identified and described in the Annual Radiological Environmental Operating Report.

Appendix C

Controls

INDEX

DEFINITIONS

SECTION

1.0 DEFINITIONS

C
2

CONTROLS AND SURVEILLANCE REQUIREMENTS

CONTROLS AND SURVEILLANCE REQUIREMENTS

BASES

BASES

ADMINISTRATIVE CONTROLS