PERRY NUCLEAR POWER PLANT

UNIT 1

OFFSITE DOSE CALCULATION MANUAL

The Cleveland Electric Illuminating Company

Perry, Ohio

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THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

PERRY NUCLEAR POWER PLANT OPERATIONS MANUAL

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1.0 INTRODUCTION

This Office 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 Technical Specifications. The Technical Specifications 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 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, both in this document and in the accompanying Radiological Effluent Technical Specifications 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).

2.0 LIQUID EFFLUENTS

All liquid radwaste discharges from Perry Nuclear Power Plant will be batch releases, that is, 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. The maximum release rate possible, due to pump capacity, is 200 gallons per minute from all release tanks except the detergent drain tank, which has 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 canal after mixing with Service Water effluent, and blowdown from Circulating Water system if present.

The type and frequency of sampling and analysis required by the PNPP Technical Specifications 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. This procedures 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.

2.1 Monitor Alarm Setpoint Determination

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 PNPP Technical Specifications. This method will be used to calculate the setpoint for the Radwaste Discharge Radiation Monitor - ESW Discharge (D17K606) which provides alarm and automatic termination of liquid effluent releases from the site to unrestricted areas before concentrations specified in 10CFR20, Appendix B, Table II, Column 2 for radionuclides other than noble gases are exceeded.

2.1.1 Determination of the Minimum Acceptable Dilution Factor

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

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 uCi/ml;

MPC_i = the maximum permissible concentration of radionuclide i, from Appendix B, Table II, Column 2 of 10CFR20, in uCi/ml.

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

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 II, Column 2. This factor represents an order of magnitude of conservatism for liquid radwaste releases from PNPP.

NOTE: 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.

2.1.2 Determination of the Maximum Allowable Radwaste Tank Discharge Flow Rate

$$f_{max} = \frac{0.8\ mdf}{DF} \qquad (2.1\text{-}3)$$

Where:

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

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

mdf = the minimum dilution flow - supplied by the Service Water system, i.e., the low flow alarm setpoint of the Service Water Flow Transmitter P41-N443 = 30,000 gpm;

0.8 = an engineering factor to prevent spurious alarms.

The liquid radwaste tank discharge flow should be maintained at or below this f_{max} valve by proper regulation of the high volume or low volume discharge throttle valves (PCVF153 or PCVF155).

2.1.3 Liquid Radwaste Discharge Radiation Monitor Alarm/Trip Setpoint

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

$$CR = \sum_i C_i E_i \qquad (2.1\text{-}4)$$

Where:

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

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

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

$$SP = 1.25\ CR + BG \qquad (2.1\text{-}5)$$

Where:

SP = the Radwaste Discharge Radiation Monitor - ESW Discharge (D17K606) alarm/trip setpoint, in cpm;

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

CR = the monitor count rate, as per equation 2.1-4;

1.25 = the engineering safety factor to prevent spurious alarms. (The inverse of 0.8).

2.2 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 maximum permissible concentrations (MPC) as defined in Appendix B, Table II, Column 2 of 10CFR20. 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.

2.2.1 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 the batch release 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 uCi/ml;

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

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

mdf = the minimum dilution flow, as 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 II, Column 2 of 10CFR20 in order to give a final 10CFR compliance check, i.e., the following equation must be met:

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

Where:

$Conc_i$ = the concentration of radionuclide i at the unrestricted area. in uCi/ml;

MPC_i = the maximum permissible concentration of radionuclide i, from Appendix B, Table II, Column 2 of 10CFR20, in uCi/ml.

2.2.2 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 the batch release 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 uCi/ml;

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

V_{dil} = the actual volume of dilution water during the release (the sum of all dilution flows: 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 II, Column 2 of 10CFR20 in order to demonstrate final compliance with 10CFR20, i.e., the following equation must be met:

$$\sum_i \frac{Conc_i}{MPC_i} \leq 1 \qquad (2.2\text{-}4)$$

Where:

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

MPC_i = the maximum permissible concentration of radionuclide i, from Appendix B, Table II, Column 2 of 10CFR20, in uCi/ml.

2.3 Compliance With 10CFR50 Appendix I - Liquid Effluent Dose

Doses resulting from liquid effluents will be calculated monthly to show compliance with 10CFR50. A cumulative summation of total body and organ doses for each calendar quarter and calendar year will be maintained, as well as projected doses for the remainder of the quarter and year.

2.3.1 Dose Calculations

Radiation doses due to 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, 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 radwaste releases from PNPP will be calculated for the potable water, aquatic food, and shoreline deposit pathways using the following equation:

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:

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

$$[1 - \exp(-\lambda_i t_b)]$$

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 f^3/s;

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), 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, 1.31×10^5 h (from RG 1.109);

T_i = the halflife of radionuclide i, in days;

t_p = the average transit time required for radionuclides to reach the point of exposure, from Table 2.3-10; 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 2.3-11, in h/yr, 1/hr, or kg/hr;

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

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

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

110,000 = a factor to convert from $(Ci/yr)/(f^3/s)$ 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 monthly. Calculations will be performed to determine the maximum total body as well as the maximum organ dose to an individual. These monthly dose calculations will be summed for comparison with quarterly and annual limits. The monthly results should be added to 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 should hold:

for the quarter:

Dose $\leq$ 1.5 mrem total body;

Dose $\leq$ 5 mrem any organ;

for the calendar year:

Dose $\leq$ 3 mrem total body;

Dose $\leq$ 10 mrem 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 PNPP Technical Specifications, stating the reason and corrective action to be taken. This report will include results of analyses of Lake Erie water and an analysis of possible impacts through the drinking water pathway with regards to the requirements of 40CFR141.

2.3.3 Projection of Doses

Anticipated doses resulting from the release of liquid effluents will be projected monthly. 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 impact 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 to 2.3-3.

The total source term utilized for the most recent calculation should be used for the projections unless information exists indicating that actual releases could differ significantly in the next month. In this case, the source term should 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

As required by Regulatory Guide 1.21, for Semiannual Radioactive Effluent Release Reporting, a population dose is

calculated for doses received from all radioactive liquid effluent releases. This population dose is calculated using average individual transit times and usage factors (as compared to maximum exposed individual factors used for individual doses). The population dose is 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. Fish ingestion

Table 2.3-4

Bioaccumulation 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

Table 2.3-5

Ingestion Dose Factors for Adult (mrem/pCi ingested)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	NO DATA	1.05E-07	1.05E-07	1.05E-07	1.05E-07	1.05E-07	1.05E-07
C 14	2.84E-06	5.68E-07	5.68E-07	5.68E-07	5.68E-07	5.68E-07	5.68E-07
NA 24	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06
P 32	1.93E-04	1.20E-05	7.46E-06	NO DATA	NO DATA	NO DATA	2.17E-05
CR 51	NO DATA	NO DATA	2.66E-09	1.59E-09	5.86E-10	3.53E-09	6.69E-07
MN 54	NO DATA	4.57E-06	8.72E-07	NO DATA	1.36E-06	NO DATA	1.40E-05
MN 56	NO DATA	1.15E-07	2.04E-08	NO DATA	1.46E-07	NO DATA	3.67E-06
FE 55	2.75E-06	1.90E-06	4.43E-07	NO DATA	NO DATA	1.06E-06	1.09E-06
FE 59	4.34E-06	1.02E-05	3.91E-06	NO DATA	NO DATA	2.85E-06	3.40E-05
CO 58	NO DATA	7.45E-07	1.67E-06	NO DATA	NO DATA	NO DATA	1.51E-05
CO 60	NO DATA	2.14E-06	4.72E-06	NO DATA	NO DATA	NO DATA	4.02E-05
NI 63	1.30E-04	9.01E-06	4.36E-06	NO DATA	NO DATA	NO DATA	1.88E-06
NI 65	5.28E-07	6.86E-08	3.13E-08	NO DATA	NO DATA	NO DATA	1.74E-06
CU 64	NO DATA	8.33E-08	3.91E-08	NO DATA	2.10E-07	NO DATA	7.10E-06
ZN 65	4.84E-06	1.54E-05	6.96E-06	NO DATA	1.03E-05	NO DATA	9.70E-06
ZN 69	1.03E-08	1.97E-08	1.37E-09	NO DATA	1.28E-08	NO DATA	2.96E-09
BR 83	NO DATA	NO DATA	4.02E-08	NO DATA	NO DATA	NO DATA	5.79E-08
BR 84	NO DATA	NO DATA	5.21E-08	NO DATA	NO DATA	NO DATA	4.09E-13
BR 85	NO DATA	NO DATA	2.14E-09	NO DATA	NO DATA	NO DATA	LT E-24
RB 86	NO DATA	2.11E-05	9.83E-06	NO DATA	NO DATA	NO DATA	4.16E-06
RB 88	NO DATA	6.05E-08	3.21E-08	NO DATA	NO DATA	NO DATA	8.36E-19
RB 89	NO DATA	4.01E-08	2.82E-08	NO DATA	NO DATA	NO DATA	2.33E-21
SR 89	3.08E-04	NO DATA	8.84E-06	NO DATA	NO DATA	NO DATA	4.94E-05
SR 90	7.58E-03	NO DATA	1.86E-03	NO DATA	NO DATA	NO DATA	2.19E-04
SR 91	5.67E-06	NO DATA	2.29E-07	NO DATA	NO DATA	NO DATA	2.70E-05
SR 92	2.15E-06	NO DATA	9.30E-08	NO DATA	NO DATA	NO DATA	4.26E-05
Y 90	9.62E-09	NO DATA	2.58E-10	NO DATA	NO DATA	NO DATA	1.02E-04
Y 91M	9.09E-11	NO DATA	3.52E-12	NO DATA	NO DATA	NO DATA	2.67E-10
Y 91	1.41E-07	NO DATA	3.77E-09	NO DATA	NO DATA	NO DATA	7.76E-05
Y 92	8.45E-10	NO DATA	2.47E-11	NO DATA	NO DATA	NO DATA	1.48E-05
Y 93	2.68E-09	NO DATA	7.40E-11	NO DATA	NO DATA	NO DATA	8.50E-05
ZR 95	3.04E-08	9.75E-09	6.60E-09	NO DATA	1.53E-08	NO DATA	3.09E-05
ZR 97	1.68E-09	3.39E-10	1.55E-10	NO DATA	5.12E-10	NO DATA	1.05E-04
NB 95	6.22E-09	3.46E-09	1.86E-09	NO DATA	3.42E-09	NO DATA	2.10E-05
MO 99	NO DATA	4.31E-06	8.20E-07	NO DATA	9.76E-06	NO DATA	9.99E-06
TC 99M	2.47E-10	6.98E-10	8.89E-09	NO DATA	1.06E-08	3.42E-10	4.13E-07

Table 2.3-5 (Cont.)

Ingestion Dose Factors for Adult (mrem/pCi ingested)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
TC101	2.54E-10	3.66E-10	3.59E-09	NO DATA	6.59E-09	1.87E-10	1.10E-21
RU103	1.85E-07	NO DATA	7.97E-08	NO DATA	7.06E-07	NO DATA	2.16E-05
RU105	1.54E-08	NO DATA	6.08E-09	NO DATA	1.99E-07	NO DATA	9.42E-06
RU106	2.75E-06	NO DATA	3.48E-07	NO DATA	5.31E-06	NO DATA	1.78E-04
AG110M	1.60E-07	1.48E-07	8.79E-08	NO DATA	2.91E-07	NO DATA	6.04E-05
TE125M	2.69E-06	9.71E-07	3.59E-07	8.06E-07	1.09E-05	NO DATA	1.07E-05
TE127M	6.77E-06	2.42E-06	8.25E-07	1.73E-06	2.75E-05	NO DATA	2.27E-05
TE127	1.10E-07	3.95E-08	2.38E-08	8.15E-08	4.48E-07	NO DATA	8.68E-06
TE129M	1.15E-05	4.29E-06	1.82E-06	3.95E-06	4.80E-05	NO DATA	5.79E-05
TE129	3.14E-08	1.18E-08	7.65E-09	2.41E-08	1.32E-07	NO DATA	2.37E-08
TE131M	1.73E-06	8.46E-07	7.05E-07	1.34E-06	8.57E-06	NO DATA	8.40E-05
TE131	1.97E-08	8.23E-09	6.22E-09	1.62E-08	8.63E-08	NO DATA	2.79E-09
TE132	2.52E-06	1.63E-06	1.53E-06	1.80E-06	1.57E-05	NO DATA	7.71E-05
I 130	7.56E-07	2.23E-06	8.80E-07	1.89E-04	3.48E-06	NO DATA	1.92E-06
I 131	4.16E-06	5.95E-06	3.41E-06	1.95E-03	1.02E-05	NO DATA	1.57E-06
I 132	2.03E-07	5.43E-07	1.90E-07	1.90E-05	8.65E-07	NO DATA	1.02E-07
I 133	1.42E-06	2.47E-06	7.53E-07	3.63E-04	4.31E-06	NO DATA	2.22E-06
I 134	1.06E-07	2.88E-07	1.03E-07	4.99E-06	4.58E-07	NO DATA	2.51E-10
I 135	4.43E-07	1.16E-06	4.29E-07	7.65E-05	1.86E-06	NO DATA	1.31E-06
CS134	6.22E-05	1.48E-04	1.21E-04	NO DATA	4.79E-05	1.59E-05	2.59E-06
CS136	6.51E-06	2.57E-05	1.85E-05	NO DATA	1.43E-05	1.96E-06	2.92E-06
CS137	7.97E-05	1.09E-04	7.14E-05	NO DATA	3.70E-05	1.23E-05	2.11E-06
CS138	5.52E-08	1.09E-07	5.40E-08	NO DATA	8.01E-08	7.91E-09	4.65E-13
BA139	9.70E-08	6.91E-11	2.84E-09	NO DATA	6.46E-11	3.92E-11	1.72E-07
BA140	2.03E-05	2.55E-08	1.33E-06	NO DATA	8.67E-09	1.46E-08	4.18E-05
BA141	4.71E-08	3.56E-11	1.59E-09	NO DATA	3.31E-11	2.02E-11	2.22E-17
BA142	2.13E-08	2.19E-11	1.34E-09	NO DATA	1.85E-11	1.24E-11	3.00E-26
LA140	2.50E-09	1.26E-09	3.33E-10	NO DATA	NO DATA	NO DATA	9.25E-05
LA142	1.28E-10	5.82E-11	1.45E-11	NO DATA	NO DATA	NO DATA	4.25E-07
CE141	9.36E-09	6.33E-09	7.18E-10	NO DATA	2.94E-09	NO DATA	2.42E-05
CE143	1.65E-09	1.22E-06	1.35E-10	NO DATA	5.37E-10	NO DATA	4.56E-05
CE144	4.88E-07	2.04E-07	2.62E-08	NO DATA	1.21E-07	NO DATA	1.65E-04
PR143	9.20E-09	3.69E-09	4.56E-10	NO DATA	2.13E-09	NO DATA	4.03E-05
PR144	3.01E-11	1.25E-11	1.53E-12	NO DATA	7.05E-12	NO DATA	4.33E-18
ND147	6.29E-09	7.27E-09	4.35E-10	NO DATA	4.25E-09	NO DATA	3.49E-05
W 187	1.03E-07	8.61E-08	3.01E-08	NO DATA	NO DATA	NO DATA	2.82E-05
NP239	1.19E-09	1.17E-10	6.45E-11	NO DATA	3.65E-10	NO DATA	2.40E-05

Table 2.3-6

Ingestion Dose Factors for Teenager (mrem/pCi ingested)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	NO DATA	1.06E-07	1.06E-07	1.06E-07	1.06E-07	1.06E-07	1.06E-07
C 14	4.06E-06	8.12E-07	8.12E-07	8.12E-07	8.12E-07	8.12E-07	8.12E-07
NA 24	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06
P 32	2.76E-04	1.71E-05	1.07E-05	NO DATA	NO DATA	NO DATA	2.32E-05
CR 51	NO DATA	NO DATA	3.60E-09	2.00E-09	7.89E-10	5.14E-09	6.05E-07
MN 54	NO DATA	5.90E-06	1.17E-06	NO DATA	1.76E-06	NO DATA	1.21E-05
MN 56	NO DATA	1.58E-07	2.81E-08	NO DATA	2.00E-07	NO DATA	1.04E-05
FE 55	3.78E-06	2.68E-06	6.25E-07	NO DATA	NO DATA	1.70E-06	1.16E-06
FE 59	5.87E-06	1.37E-05	5.29E-06	NO DATA	NO DATA	4.32E-06	3.24E-05
CO 58	NO DATA	9.72E-07	2.24E-06	NO DATA	NO DATA	NO DATA	1.34E-05
CO 60	NO DATA	2.81E-06	6.33E-06	NO DATA	NO DATA	NO DATA	3.66E-05
NI 63	1.77E-04	1.25E-05	6.00E-06	NO DATA	NO DATA	NO DATA	1.99E-06
NI 65	7.49E-07	9.57E-08	4.36E-08	NO DATA	NO DATA	NO DATA	5.19E-06
CU 64	NO DATA	1.15E-07	5.41E-08	NO DATA	2.91E-07	NO DATA	8.92E-06
ZN 65	5.76E-06	2.00E-05	9.33E-06	NO DATA	1.28E-05	NO DATA	8.47E-06
ZN 69	1.47E-08	2.60E-08	1.96E-09	NO DATA	1.83E-08	NO DATA	5.16E-08
BR 83	NO DATA	NO DATA	5.74E-08	NO DATA	NO DATA	NO DATA	LT E-24
BR 84	NO DATA	NO DATA	7.22E-08	NO DATA	NO DATA	NO DATA	LT E-24
BR 85	NO DATA	NO DATA	3.05E-09	NO DATA	NO DATA	NO DATA	LT E-24
RB 86	NO DATA	2.98E-05	1.40E-05	NO DATA	NO DATA	NO DATA	4.41E-06
RB 88	NO DATA	8.52E-08	4.54E-08	NO DATA	NO DATA	NO DATA	7.30E-15
RB 89	NO DATA	5.50E-08	3.89E-08	NO DATA	NO DATA	NO DATA	8.43E-17
SR 89	4.40E-04	NO DATA	1.26E-05	NO DATA	NO DATA	NO DATA	5.24E-05
SR 90	8.30E-03	NO DATA	2.05E-03	NO DATA	NO DATA	NO DATA	2.33E-04
SR 91	8.07E-06	NO DATA	3.21E-07	NO DATA	NO DATA	NO DATA	3.66E-05
SR 92	3.05E-06	NO DATA	1.30E-07	NO DATA	NO DATA	NO DATA	7.77E-05
Y 90	1.37E-08	NO DATA	3.69E-10	NO DATA	NO DATA	NO DATA	1.13E-04
Y 91M	1.29E-10	NO DATA	4.93E-12	NO DATA	NO DATA	NO DATA	6.09E-09
Y 91	2.01E-07	NO DATA	5.39E-09	NO DATA	NO DATA	NO DATA	8.24E-05
Y 92	1.21E-09	NO DATA	3.50E-11	NO DATA	NO DATA	NO DATA	3.32E-05
Y 93	3.83E-09	NO DATA	1.05E-10	NO DATA	NO DATA	NO DATA	1.17E-04
ZR 95	4.12E-08	1.30E-08	8.94E-09	NO DATA	1.91E-08	NO DATA	3.00E-05
ZR 97	2.37E-09	4.69E-10	2.16E-10	NO DATA	7.11E-10	NO DATA	1.27E-04
NB 95	8.22E-09	4.56E-09	2.51E-09	NO DATA	4.42E-09	NO DATA	1.95E-05
MO 99	NO DATA	6.03E-06	1.15E-06	NO DATA	1.38E-05	NO DATA	1.08E-05
TC 99M	3.32E-10	9.26E-10	1.20E-08	NO DATA	1.38E-08	5.14E-10	6.08E-07

Table 2.3-6 (Cont.)

Ingestion Dose Factors for Teenager (mrem/pCi ingested)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
TC101	3.60E-10	5.12E-10	5.03E-09	NO DATA	9.26E-09	3.12E-10	8.75E-17
RU103	2.55E-07	NO DATA	1.09E-07	NO DATA	8.99E-07	NO DATA	2.13E-05
RU105	2.18E-08	NO DATA	8.46E-09	NO DATA	2.75E-07	NO DATA	1.76E-05
RU106	3.92E-06	NO DATA	4.94E-07	NO DATA	7.56E-06	NO DATA	1.88E-04
AG110M	2.05E-07	1.94E-07	1.18E-07	NO DATA	3.70E-07	NO DATA	5.45E-05
TE125M	3.83E-06	1.38E-06	5.12E-07	1.07E-06	NO DATA	NO DATA	1.13E-05
TE127M	9.67E-06	3.43E-06	1.15E-06	2.30E-06	3.92E-05	NO DATA	2.41E-05
TE127	1.58E-07	5.60E-08	3.40E-08	1.09E-07	6.40E-07	NO DATA	1.22E-05
TE129M	1.63E-05	6.05E-06	2.58E-06	5.26E-06	6.82E-05	NO DATA	6.12E-05
TE129	4.48E-08	1.67E-08	1.09E-08	3.20E-08	1.88E-07	NO DATA	2.45E-07
TE131M	2.44E-06	1.17E-06	9.76E-07	1.76E-06	1.22E-05	NO DATA	9.39E-05
TE131	2.79E-08	1.15E-08	8.72E-09	2.15E-08	1.22E-07	NO DATA	2.29E-09
TE132	3.49E-06	2.21E-06	2.08E-06	2.33E-06	2.12E-05	NO DATA	7.00E-05
I 130	1.03E-06	2.98E-06	1.19E-06	2.43E-04	4.59E-06	NO DATA	2.29E-06
I 131	5.85E-06	8.19E-06	4.40E-06	2.39E-03	1.41E-05	NO DATA	1.62E-06
I 132	2.79E-07	7.30E-07	2.62E-07	2.46E-05	1.15E-06	NO DATA	3.18E-07
I 133	2.01E-06	3.41E-06	1.04E-06	4.76E-04	5.98E-06	NO DATA	2.58E-06
I 134	1.46E-07	3.87E-07	1.39E-07	6.45E-06	6.10E-07	NO DATA	5.10E-09
I 135	6.10E-07	1.57E-06	5.82E-07	1.01E-04	2.48E-06	NO DATA	1.74E-06
CS134	8.37E-05	1.97E-04	9.14E-05	NO DATA	6.26E-05	2.39E-05	2.45E-06
CS136	8.59E-06	3.38E-05	2.27E-05	NO DATA	1.84E-05	2.90E-06	2.72E-06
CS137	1.12E-04	1.49E-04	5.19E-05	NO DATA	5.07E-05	1.97E-05	2.12E-06
CS138	7.76E-08	1.49E-07	7.45E-08	NO DATA	1.10E-07	1.28E-08	6.76E-11
BA139	1.39E-07	9.78E-11	4.05E-09	NO DATA	9.22E-11	6.74E-11	1.24E-06
BA140	2.84E-05	3.48E-08	1.83E-06	NO DATA	1.18E-08	2.34E-08	4.38E-05
BA141	6.71E-08	5.01E-11	2.24E-09	NO DATA	4.65E-11	3.43E-11	1.43E-13
BA142	2.99E-08	2.99E-11	1.84E-09	NO DATA	2.53E-11	1.99E-11	9.18E-20
LA140	3.48E-09	1.71E-09	4.55E-10	NO DATA	NO DATA	NO DATA	9.82E-05
LA142	1.79E-10	7.95E-11	1.98E-11	NO DATA	NO DATA	NO DATA	2.42E-06
CE141	1.33E-08	8.88E-09	1.02E-09	NO DATA	4.18E-09	NO DATA	2.54E-05
CE143	2.35E-09	1.71E-06	1.91E-10	NO DATA	7.67E-10	NO DATA	5.14E-05
CE144	6.96E-07	2.88E-07	3.74E-08	NO DATA	1.72E-07	NO DATA	1.75E-04
PR143	1.31E-08	5.23E-09	6.52E-10	NO DATA	3.04E-09	NO DATA	4.31E-05
PR144	4.30E-11	1.76E-11	2.18E-12	NO DATA	1.01E-11	NO DATA	4.74E-14
ND147	9.38E-09	1.02E-08	6.11E-10	NO DATA	5.99E-09	NO DATA	3.68E-05
W 187	1.46E-07	1.19E-07	4.17E-08	NO DATA	NO DATA	NO DATA	3.22E-05
NP239	1.76E-09	1.66E-10	9.22E-11	NO DATA	5.21E-10	NO DATA	2.67E-05

Table 2.3-7

Ingestion Dose Factors for Child (mrem/pCi ingested)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	NO DATA	2.03E-07	2.03E-07	2.03E-07	2.03E-07	2.03E-07	2.03E-07
C 14	1.21E-05	2.42E-06	2.42E-06	2.42E-06	2.42E-06	2.42E-06	2.42E-06
NA 24	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06
P 32	8.25E-04	3.86E-05	3.10E-05	NO DATA	NO DATA	NO DATA	2.28E-05
CR 51	NO DATA	NO DATA	8.90E-09	4.94E-09	1.35E-09	9.02E-09	4.72E-07
MN 54	NO DATA	1.07E-05	2.85E-06	NO DATA	3.00E-06	NO DATA	8.98E-06
MN 56	NO DATA	3.34E-07	7.54E-08	NO DATA	4.04E-07	NO DATA	4.84E-05
FE 55	1.15E-05	6.10E-06	1.89E-06	NO DATA	NO DATA	3.45E-06	1.13E-06
FE 59	1.65E-05	2.67E-05	1.33E-05	NO DATA	NO DATA	7.74E-06	2.78E-05
CO 58	NO DATA	1.80E-06	5.51E-06	NO DATA	NO DATA	NO DATA	1.05E-05
CO 60	NO DATA	5.29E-06	1.56E-05	NO DATA	NO DATA	NO DATA	2.93E-05
NI 63	5.38E-04	2.88E-05	1.83E-05	NO DATA	NO DATA	NO DATA	1.94E-06
NI 65	2.22E-06	2.09E-07	1.22E-07	NO DATA	NO DATA	NO DATA	2.56E-05
CU 64	NO DATA	2.45E-07	1.48E-07	NO DATA	5.92E-07	NO DATA	1.15E-05
ZN 65	1.37E-05	3.65E-05	2.27E-05	NO DATA	2.30E-05	NO DATA	6.41E-06
ZN 69	4.38E-08	6.33E-08	5.85E-09	NO DATA	3.84E-08	NO DATA	3.99E-06
BR 83	NO DATA	NO DATA	1.71E-07	NO DATA	NO DATA	NO DATA	LT E-24
BR 84	NO DATA	NO DATA	1.98E-07	NO DATA	NO DATA	NO DATA	LT E-24
BR 85	NO DATA	NO DATA	9.12E-09	NO DATA	NO DATA	NO DATA	LT E-24
RB 86	NO DATA	6.70E-05	4.12E-05	NO DATA	NO DATA	NO DATA	4.31E-06
RB 88	NO DATA	1.90E-07	1.32E-07	NO DATA	NO DATA	NO DATA	9.32E-09
RB 89	NO DATA	1.17E-07	1.04E-07	NO DATA	NO DATA	NO DATA	1.02E-09
SR 89	1.32E-03	NO DATA	3.77E-05	NO DATA	NO DATA	NO DATA	5.11E-05
SR 90	1.70E-02	NO DATA	4.31E-03	NO DATA	NO DATA	NO DATA	2.29E-04
SR 91	2.40E-05	NO DATA	9.06E-07	NO DATA	NO DATA	NO DATA	5.30E-05
SR 92	9.03E-06	NO DATA	3.62E-07	NO DATA	NO DATA	NO DATA	1.71E-04
Y 90	4.11E-08	NO DATA	1.10E-09	NO DATA	NO DATA	NO DATA	1.17E-04
Y 91M	3.82E-10	NO DATA	1.39E-11	NO DATA	NO DATA	NO DATA	7.48E-07
Y 91	6.02E-07	NO DATA	1.61E-08	NO DATA	NO DATA	NO DATA	8.02E-05
Y 92	3.60E-09	NO DATA	1.03E-10	NO DATA	NO DATA	NO DATA	1.04E-04
Y 93	1.14E-08	NO DATA	3.13E-10	NO DATA	NO DATA	NO DATA	1.70E-04
ZR 95	1.16E-07	2.55E-08	2.27E-08	NO DATA	3.65E-08	NO DATA	2.66E-05
ZR 97	6.99E-09	1.01E-09	5.96E-10	NO DATA	1.45E-09	NO DATA	1.53E-04
NB 95	2.25E-08	8.[illegible]5E-09	6.26E-09	NO DATA	8.23E-09	NO DATA	1.62E-05
MO 99	NO DATA	1.[illegible]3E-05	3.29E-06	NO DATA	2.84E-05	NO DATA	1.10E-05
TC 99M	9.23E-10	1.[illegible]1E-09	3.00E-08	NO DATA	2.63E-08	9.19E-10	1.03E-06

Table 2.3-7 (Cont.)

Ingestion Dose Factors for Child (mrem/pCi ingested)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
TC101	1.07E-09	1.12E-09	1.42E-08	NO DATA	1.91E-08	5.92E-10	3.56E-09
RU103	7.31E-07	NO DATA	2.81E-07	NO DATA	1.84E-06	NO DATA	1.89E-05
RU105	6.45E-08	NO DATA	2.34E-08	NO DATA	5.67E-07	NO DATA	4.21E-05
RU106	1.17E-05	NO DATA	1.46E-06	NO DATA	1.58E-05	NO DATA	1.82E-04
AG110M	5.39E-07	3.64E-07	2.91E-07	NO DATA	6.78E-07	NO DATA	4.33E-05
TE125M	1.14E-05	3.09E-06	1.52E-06	3.20E-06	NO DATA	NO DATA	1.10E-05
TE127M	2.89E-05	7.78E-06	3.43E-06	6.91E-06	8.24E-05	NO DATA	2.34E-05
TE127	4.71E-07	1.27E-07	1.01E-07	3.26E-07	1.34E-06	NO DATA	1.84E-05
TE129M	4.87E-05	1.36E-05	7.56E-06	1.57E-05	1.43E-04	NO DATA	5.94E-05
TE129	1.34E-07	3.74E-08	3.18E-08	9.56E-08	3.92E-07	NO DATA	8.34E-06
TE131M	7.20E-06	2.49E-06	2.65E-06	5.12E-06	2.41E-05	NO DATA	1.01E-04
TE131	8.30E-08	2.53E-08	2.47E-08	6.35E-08	2.51E-07	NO DATA	4.36E-07
TE132	1.01E-05	4.47E-06	5.40E-06	6.51E-06	4.13E-05	NO DATA	4.50E-05
I 130	2.92E-06	5.90E-06	3.04E-06	6.50E-04	8.82E-06	NO DATA	2.76E-06
I 131	1.72E-05	1.73E-05	9.83E-06	5.72E-03	2.84E-05	NO DATA	1.54E-06
I 132	8.00E-07	1.47E-06	6.76E-07	6.82E-05	2.25E-06	NO DATA	1.73E-06
I 133	5.92E-06	7.32E-06	2.77E-06	1.36E-03	1.22E-05	NO DATA	2.95E-06
I 134	4.19E-07	7.78E-07	3.58E-07	1.79E-05	1.19E-06	NO DATA	5.16E-07
I 135	1.75E-06	3.15E-06	1.49E-06	2.79E-04	4.83E-06	NO DATA	2.40E-06
CS134	2.34E-04	3.84E-04	8.10E-05	NO DATA	1.19E-04	4.27E-05	2.07E-06
CS136	2.35E-05	6.46E-05	4.18E-05	NO DATA	3.44E-05	5.13E-06	2.27E-06
CS137	3.27E-04	3.13E-04	4.62E-05	NO DATA	1.02E-04	3.67E-05	1.96E-06
CS138	2.28E-07	3.17E-07	2.01E-07	NO DATA	2.23E-07	2.40E-08	1.46E-07
BA139	4.14E-07	2.21E-10	1.20E-08	NO DATA	1.93E-10	1.30E-10	2.39E-05
BA140	8.31E-05	7.28E-08	4.85E-06	NO DATA	2.37E-08	4.34E-08	4.21E-05
BA141	2.00E-07	1.12E-10	6.51E-09	NO DATA	9.69E-11	6.58E-10	1.14E-07
BA142	8.74E-08	6.29E-11	4.88E-09	NO DATA	5.09E-11	3.70E-11	1.14E-09
LA140	1.01E-08	3.53E-09	1.17E-09	NO DATA	NO DATA	NO DATA	9.84E-05
LA142	5.24E-10	1.67E-10	5.23E-11	NO DATA	NO DATA	NO DATA	3.31E-05
CE141	3.97E-08	1.98E-08	2.94E-09	NO DATA	8.68E-09	NO DATA	2.47E-05
CE143	6.99E-09	3.79E-06	5.49E-10	NO DATA	1.59E-09	NO DATA	5.55E-05
CE144	2.08E-06	6.52E-07	1.11E-07	NO DATA	3.61E-07	NO DATA	1.70E-04
PR143	3.93E-08	1.18E-08	1.95E-09	NO DATA	6.39E-09	NO DATA	4.24E-05
PR144	1.29E-10	3.99E-11	6.49E-12	NO DATA	2.11E-11	NO DATA	8.59E-08
ND147	2.79E-08	2.26E-08	1.75E-09	NO DATA	1.24E-08	NO DATA	3.58E-05
W 187	4.29E-07	2.54E-07	1.14E-07	NO DATA	NO DATA	NO DATA	3.57E-05
NP239	5.25E-09	3.77E-10	2.65E-10	NO DATA	1.09E-09	NO DATA	2.79E-05

Table 2.3-8

Ingestion Dose Factors for Infant (mrem/pCi ingested)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	NO DATA	3.08E-07	3.08E-07	3.08E-07	3.08E-07	3.08E-07	3.08E-07
C 14	2.37E-05	5.06E-06	5.06E-06	5.06E-06	5.06E-06	5.06E-06	5.06E-06
NA 24	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05
P 32	1.70E-03	1.00E-04	6.59E-05	NO DATA	NO DATA	NO DATA	2.30E-05
CR 51	NO DATA	NO DATA	1.41E-08	9.20E-09	2.01E-09	1.79E-08	4.11E-07
MN 54	NO DATA	1.99E-05	4.51E-06	NO DATA	4.41E-06	NO DATA	7.31E-06
MN 56	NO DATA	8.18E-07	1.41E-07	NO DATA	7.03E-07	NO DATA	7.43E-05
FE 55	1.39E-05	8.98E-06	2.40E-06	NO DATA	NO DATA	4.39E-06	1.14E-06
FE 59	3.08E-05	5.38E-05	2.12E-05	NO DATA	NO DATA	1.59E-05	2.57E-05
CO 58	NO DATA	3.60E-06	8.93E-06	NO DATA	NO DATA	NO DATA	8.97E-06
CO 60	NO DATA	1.08E-05	2.55E-05	NO DATA	NO DATA	NO DATA	2.57E-05
NI 63	6.34E-04	3.92E-05	2.20E-05	NO DATA	NO DATA	NO DATA	1.95E-06
NI 65	4.70E-06	5.32E-07	2.42E-07	NO DATA	NO DATA	NO DATA	4.05E-05
CU 64	NO DATA	6.09E-07	2.82E-07	NO DATA	1.03E-06	NO DATA	1.25E-05
ZN 65	1.94E-05	6.31E-05	2.91E-05	NO DATA	3.06E-05	NO DATA	5.33E-05
ZN 69	9.33E-08	1.68E-07	1.25E-08	NO DATA	6.98E-08	NO DATA	1.37E-05
BR 83	NO DATA	NO DATA	3.63E-07	NO DATA	NO DATA	NO DATA	LT E-24
BR 84	NO DATA	NO DATA	3.82E-07	NO DATA	NO DATA	NO DATA	LT E-24
BR 85	NO DATA	NO DATA	1.94E-08	NO DATA	NO DATA	NO DATA	LT E-24
RB 86	NO DATA	1.70E-04	8.40E-05	NO DATA	NO DATA	NO DATA	4.35E-06
RB 88	NO DATA	4.98E-07	2.73E-07	NO DATA	NO DATA	NO DATA	4.85E-07
RB 89	NO DATA	2.86E-07	1.97E-07	NO DATA	NO DATA	NO DATA	9.74E-08
SR 89	2.51E-03	NO DATA	7.20E-05	NO DATA	NO DATA	NO DATA	5.16E-05
SR 90	1.05E-02	NO DATA	4.71E-03	NO DATA	NO DATA	NO DATA	2.31E-04
SR 91	5.00E-05	NO DATA	1.81E-06	NO DATA	NO DATA	NO DATA	5.92E-05
SR 92	1.92E-05	NO DATA	7.13E-07	NO DATA	NO DATA	NO DATA	2.07E-04
Y 90	8.69E-08	NO DATA	2.33E-09	NO DATA	NO DATA	NO DATA	1.20E-04
Y 91M	8.10E-10	NO DATA	2.76E-11	NO DATA	NO DATA	NO DATA	2.70E-06
Y 91	1.13E-06	NO DATA	3.01E-08	NO DATA	NO DATA	NO DATA	8.10E-05
Y 92	7.65E-09	NO DATA	2.15E-10	NO DATA	NO DATA	NO DATA	1.46E-04
Y 93	2.43E-08	NO DATA	6.62E-10	NO DATA	NO DATA	NO DATA	1.92E-04
ZR 95	2.06E-07	5.02E-08	3.56E-08	NO DATA	5.41E-08	NO DATA	2.50E-05
ZR 97	1.48E-08	2.54E-09	1.16E-09	NO DATA	2.56E-09	NO DATA	1.62E-04
NB 95	4.20E-08	1.73E-08	1.00E-08	NO DATA	1.24E-08	NO DATA	1.46E-05
MO 99	NO DATA	3.40E-05	6.63E-06	NO DATA	5.08E-05	NO DATA	1.12E-05
TC 99M	1.92E-09	3.96E-09	5.10E-08	NO DATA	4.26E-08	2.07E-09	1.15E-06

Table 2.3-8 (Cont.)

Ingestion Dose Factors for Infant (mrem/pCi ingested)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
TC101	2.27E-09	2.86E-09	2.83E-08	NO DATA	3.40E-08	1.56E-09	4.86E-07
RU103	1.48E-06	NO DATA	4.95E-07	NO DATA	3.08E-06	NO DATA	1.80E-05
RU105	1.36E-07	NO DATA	4.58E-08	NO DATA	1.00E-06	NO DATA	5.41E-05
RU106	2.41E-05	NO DATA	3.01E-06	NO DATA	2.85E-05	NO DATA	1.83E-04
AG110M	9.96E-07	7.27E-07	4.81E-07	NO DATA	1.04E-06	NO DATA	3.77E-05
TE125M	2.33E-05	7.79E-06	3.15E-06	7.84E-06	NO DATA	NO DATA	1.11E-05
TE127M	5.85E-05	1.94E-05	7.08E-06	1.69E-05	1.44E-04	NO DATA	2.36E-05
TE127	1.00E-06	3.35E-07	2.15E-07	8.14E-07	2.44E-06	NO DATA	2.10E-05
TE129M	1.00E-04	3.43E-05	1.54E-05	3.84E-05	2.50E-04	NO DATA	5.97E-05
TE129	2.84E-07	9.79E-08	6.63E-08	2.38E-07	7.07E-07	NO DATA	2.27E-05
TE131M	1.52E-05	6.12E-06	5.05E-06	1.24E-05	4.21E-05	NO DATA	1.03E-04
TE131	1.76E-07	6.50E-08	4.94E-08	1.57E-07	4.50E-07	NO DATA	7.11E-06
TE132	2.08E-05	1.03E-05	9.61E-06	1.52E-05	6.44E-05	NO DATA	3.81E-05
I 130	6.00E-06	1.32E-05	5.30E-06	1.48E-03	1.45E-05	NO DATA	2.83E-06
I 131	3.59E-05	4.23E-05	1.86E-05	1.39E-02	4.94E-05	NO DATA	1.51E-06
I 132	1.66E-06	3.37E-06	1.20E-06	1.58E-04	3.76E-06	NO DATA	2.73E-06
I 133	1.25E-05	1.82E-05	5.33E-06	3.31E-03	2.14E-05	NO DATA	3.08E-06
I 134	8.69E-07	1.78E-06	6.33E-07	4.15E-05	1.99E-06	NO DATA	1.84E-06
I 135	3.64E-06	7.24E-06	2.64E-06	6.49E-04	8.07E-06	NO DATA	2.62E-06
CS134	3.77E-04	7.03E-04	7.10E-05	NO DATA	1.81E-04	7.42E-05	1.91E-06
CS136	4.59E-05	1.35E-04	5.04E-05	NO DATA	5.38E-05	1.10E-05	2.05E-06
CS137	5.22E-04	6.11E-04	4.33E-05	NO DATA	1.64E-04	6.64E-05	1.91E-06
CS138	4.81E-07	7.82E-07	3.79E-07	NO DATA	3.90E-07	6.09E-08	1.25E-06
BA139	8.81E-07	5.84E-10	2.55E-08	NO DATA	3.51E-10	3.54E-10	5.58E-05
BA140	1.71E-04	1.71E-07	8.81E-06	NO DATA	4.06E-08	1.05E-07	4.20E-05
BA141	4.25E-07	2.91E-10	1.34E-08	NO DATA	1.75E-10	1.77E-10	5.19E-06
BA142	1.84E-07	1.53E-10	9.06E-09	NO DATA	8.81E-11	9.26E-11	7.59E-07
LA140	2.11E-08	8.32E-09	2.14E-09	NO DATA	NO DATA	NO DATA	9.77E-05
LA142	1.10E-09	4.04E-10	9.67E-11	NO DATA	NO DATA	NO DATA	6.86E-05
CE141	7.87E-08	4.80E-08	5.65E-09	NO DATA	1.48E-08	NO DATA	2.48E-05
CE143	1.48E-08	9.82E-06	1.12E-09	NO DATA	2.86E-09	NO DATA	5.73E-05
CE144	2.98E-06	1.22E-06	1.67E-07	NO DATA	4.93E-07	NO DATA	1.71E-04
PR143	8.13E-08	3.04E-08	4.03E-09	NO DATA	1.13E-08	NO DATA	4.29E-05
PR144	2.74E-10	1.06E-10	1.38E-11	NO DATA	3.84E-11	NO DATA	4.93E-06
ND147	5.53E-08	5.68E-08	3.48E-09	NO DATA	2.19E-08	NO DATA	3.60E-05
W 187	9.03E-07	6.28E-07	2.17E-07	NO DATA	NO DATA	NO DATA	3.69E-05
NP239	1.11E-08	9.93E-10	5.61E-10	NO DATA	1.98E-09	NO DATA	2.87E-05

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

Table 2.3-10

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 population dose calculations

Table 2.3-11

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 population dose calculations

3.0 GASEOUS EFFLUENTS

There are four environmental release points for gaseous effluents used for Unit 1 operation of Perry Nuclear Power Plant: Heater Bay/Turbine Building Vent, Offgas Vent Pipe, Unit 1 and Unit 2 Vents. Radiological releases from each vent will be monitored by a noble gas radiation monitor.

All gaseous effluent releases from PNPP will be continuous releases. Containment/drywell purges and vents will be considered periods of increased radiological release as they are vented through the Unit 1 concurrent with normal, continuous releases. All releases are considered to be long-term, i.e., greater than 500 hours per year, and ground level. Containment/drywell purge and vent will be limited to 3000 hours per year during operational conditions 1, 2, and 3 (power operation, startup, and hot shutdown).

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 10CFR20 dose rate limits to areas at or beyond the site boundary for the noble gas channels of the following monitors:

1. Heater Bay/Turbine Building Vent Radiaton Monitor (1D17K856)

2. Offgas Vent Pipe Radiation Monitor (1D17K836)

3. U1 Vent Radiation Monitor (1D17K786)

4. U2 Vent Radiation Monitor (2D17K786).

The Unit 2 Vent Radiation Monitor is included in the operation of Unit 1 methodology 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 percent of the 10CFR20 dose rate limits and the alert setpoint (ASP) will be set at 10 percent of these limits.

NOTE: The values of 70 percent for the HSP and 10 percent for the ASP are set as fractions 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 the 10CFR20 limits being exceeded. If any two monitors exceed the ASP or

any one exceeds the HSP it is possible that the limits have been exceeded.

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 whole body or 3000 mrem/year to the skin.

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

a. Determine the gaseous source terms that are representative of the "mix" of the gaseous effluent. Gaseous source terms are the concentrations of the noble gas radionuclides in the effluent as determined by routine analysis of the various sources of gaseous effluents. During the early period of 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.

b. Determine 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 shall not be 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 Whole Body Dose Rate Limit

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

Where.

Q_b = the maximum acceptable total activity release rate of all noble gas radionuclides in the effluent (for whole body exposure), in uCi/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)/(uCi/m^3);

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

X/Q = the highest annual average relative dispersion factor for areas at the site boundary = 6.53 x 10^{-6} s/m^3 (from Appendix A, NE direction at the site boundary);

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

500 = the whole 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

$$Q_s = \frac{3000}{(X/Q) \sum_i (L_i + 1.1\, M_i)\, S_i} \qquad (3.1\text{-}3)$$

Where:

Q_s = the maximum acceptable total activity release rate of all noble gas radionuclides in the effluent (for skin exposure), in uCi/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)/(uCi/m^3);

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

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

X/Q = the highest annual average relative dispersion factor, as per equation 3.1-2 = 6.53×10^{-6} s/m^3;

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

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

$(L_i + 1.1\ M_i)$ 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 uCi/cc;

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

NOTE: When actual flow rates are not available, the following design flow assumptions will be used:

Vent	Flow Rate ft^3/min
- Heater Bay/Turbine Building	360,000 (summer) 198,000 (winter)
- Offgas	16,700
- Unit 1	124,500
- Unit 2 (Control Complex and Intermediate Building Ventilations)	42,400

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

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

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

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

Where:

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

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

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

= the total uCi/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, as 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;

CR_c = the calculated monitor net count rate, as 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

Whole Body and Skin Dose Factors

Radionuclide	Total Whole Body Dose Factor (K_i) (mrem/yr/ μCi/m^3)	Total Skin Dose Factor (L_i+1.1M_i) (mrem/yr/ μCi/m^3)
Kr-83m	7.56E-02	2.12E+01
Kr-85m	1.17E+03	2.81E+03
Kr-85	1.61E+01	1.36E+03
Kr-87	5.92E+03	1.65E+04
Kr-88	1.47E+04	1.91E+04
Kr-89	1.66E+04	2.91E+04
Xe-131m	9.15E+01	6.48E+02
Xe-133m	2.51E+02	1.35E+03
Xe-133	2.94E+02	6.94E+02
Xe-135m	3.12E+03	4.41E+03
Xe-135	1.81E+03	3.97E+03
Xe-137	1.42E+03	1.39E+04
Xe-138	8.83E+03	1.43E+04
Ar-41	8.84E+03	1.29E+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 on an instantaneous basis at the controlling location.

3.2.1 Noble Gases

The dose rate in unrestricted areas resulting from noble gas effluents is limited 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 with the highest relative dispersion factor (X/Q) for the period of release. (See Appendix A for elaboration.)

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 PNPP Technical Specifications.

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 to 1500 mrem/yr to any organ by PNPP Technical Specifications. The calculation of dose rate from these radionuclides will be performed weekly based on results of analyses obtained persuant to those Technical Specificatons. The controlling location for this limit is a function of the noble gas controlling location, i.e., the location of the highest relative deposition (D/Q) for the period of release (See Appendix A), 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 residences in each sector, and garden and farm animal locations.

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 gasecus effluents to areas at or beyond the site boundary for the purpose of showing compliance with 10CFR20.

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

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;

X/Q or D/Q = the normal or depleted relative dispersion factor (X/Q), 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 * uCi)/(Ci * s) to mrem/yr;

Q_i = the release rate of isotope i, in uCi/s

$= 472\ C_i f$

Where:

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

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

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

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-Inifinite Plume

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

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 $5 g/cm^2$ of tissue from Table 3.2-4, in $(mrem * m^3)/(pCi * yr)$;

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

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

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

$$DF_i^S = X_i \ (1.1 \ S_F \ DF_i^\gamma + DFS_i) \qquad (3.2\text{-}3)$$

Where:

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

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 * m^3)/(pCi * yr);

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

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

1.1 = 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 gound 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 $(mrem * m^2)/(pCi * hr)$;

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

8760 = the number of hours in a year.

d. Dose Factors from Inhalation of Radionuclides in Air

$$DF^{A}_{aij} = DFA_{aij} \; R_a \; X_i \qquad (3.2\text{-}5)$$

Where:

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

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;

X_i = the annual average concentration of radionuclide i in air (pCi/m^3), for a unit release rate (Ci/yr) and a unit X/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

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

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 X/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)(Ci/yr)(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 (RG 1.109);

U^{F}_{a}, U^{L}_{a}, U^{M}_{a}, U^{V}_{a} = the annual intake (usage) of meat, leafy vegetables, milk, and produce respectively, for individuals in age group a, from Table 3.2-15, in kg/yr or l/yr.

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. Cows
6. Goats
7. Inhalation

Table 3.2-4

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

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

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

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

Table 3.2-5

External Dose Factors for Standing on Contaminated Ground

(mrem/hr 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/hr 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	2.29E-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	1.27E-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	6.60E-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	1.09E-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	3.66E-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	7.85E-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	2.57E-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	1.90E-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	8.10E-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	7.87E-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-04	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	6.39E-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	1.50E-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	3.17E-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	4.23E-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)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	NO DATA	1.05E-07	1.05E-07	1.05E-07	1.05E-07	1.05E-07	1.05E-07
C 14	2.84E-06	5.68E-07	5.68E-07	5.68E-07	5.68E-07	5.68E-07	5.68E-07
NA 24	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06
P 32	1.93E-04	1.20E-05	7.46E-06	NO DATA	NO DATA	NO DATA	2.17E-05
CR 51	NO DATA	NO DATA	2.66E-09	1.59E-09	5.86E-10	3.53E-09	6.69E-07
MN 54	NO DATA	4.57E-06	8.72E-07	NO DATA	1.36E-06	NO DATA	1.40E-05
MN 56	NO DATA	1.15E-07	2.04E-08	NO DATA	1.46E-07	NO DATA	3.67E-06
FE 55	2.75E-06	1.90E-06	4.43E-07	NO DATA	NO DATA	1.06E-06	1.09E-06
FE 59	4.34E-06	1.02E-05	3.91E-06	NO DATA	NO DATA	2.85E-06	3.40E-05
CO 58	NO DATA	7.45E-07	1.67E-06	NO DATA	NO DATA	NO DATA	1.51E-05
CO 60	NO DATA	2.14E-06	4.72E-06	NO DATA	NO DATA	NO DATA	4.02E-05
NI 63	1.30E-04	9.01E-06	4.36E-06	NO DATA	NO DATA	NO DATA	1.88E-06
NI 65	5.28E-07	6.86E-08	3.13E-08	NO DATA	NO DATA	NO DATA	1.74E-06
CU 64	NO DATA	8.33E-08	3.91E-08	NO DATA	2.10E-07	NO DATA	7.10E-06
ZN 65	4.84E-06	1.54E-05	6.96E-06	NO DATA	1.03E-05	NO DATA	9.70E-06
ZN 69	1.03E-08	1.97E-08	1.37E-09	NO DATA	1.28E-08	NO DATA	2.96E-09
BR 83	NO DATA	NO DATA	4.02E-08	NO DATA	NO DATA	NO DATA	5.79E-08
BR 84	NO DATA	NO DATA	5.21E-08	NO DATA	NO DATA	NO DATA	4.09E-13
BR 85	NO DATA	NO DATA	2.14E-09	NO DATA	NO DATA	NO DATA	LT E-24
RB 86	NO DATA	2.11E-05	9.83E-06	NO DATA	NO DATA	NO DATA	4.16E-06
RB 88	NO DATA	6.05E-08	3.21E-08	NO DATA	NO DATA	NO DATA	8.36E-19
RB 89	NO DATA	4.01E-08	2.82E-08	NO DATA	NO DATA	NO DATA	2.33E-21
SR 89	3.08E-04	NO DATA	8.84E-06	NO DATA	NO DATA	NO DATA	4.94E-05
SR 90	7.58E-03	NO DATA	1.86E-03	NO DATA	NO DATA	NO DATA	2.19E-04
SR 91	5.67E-06	NO DATA	2.29E-07	NO DATA	NO DATA	NO DATA	2.70E-05
SR 92	2.15E-06	NO DATA	9.30E-08	NO DATA	NO DATA	NO DATA	4.26E-05
Y 90	9.62E-09	NO DATA	2.58E-10	NO DATA	NO DATA	NO DATA	1.02E-04
Y 91M	9.09E-11	NO DATA	3.52E-12	NO DATA	NO DATA	NO DATA	2.67E-10
Y 91	1.41E-07	NO DATA	3.77E-09	NO DATA	NO DATA	NO DATA	7.76E-05
Y 92	8.45E-10	NO DATA	2.47E-11	NO DATA	NO DATA	NO DATA	1.48E-05
Y 93	2.68E-09	NO DATA	7.40E-11	NO DATA	NO DATA	NO DATA	8.50E-05
ZR 95	3.04E-08	9.75E-09	6.60E-09	NO DATA	1.53E-08	NO DATA	3.09E-05
ZR 97	1.68E-09	3.39E-10	1.55E-10	NO DATA	5.12E-10	NO DATA	1.05E-04
NB 95	6.22E-09	3.46E-09	1.86E-09	NO DATA	3.42E-09	NO DATA	2.10E-05
MO 99	NO DATA	4.31E-06	8.20E-07	NO DATA	9.76E-06	NO DATA	9.99E-06
TC 99M	2.47E-10	6.98E-10	8.89E-09	NO DATA	1.06E-08	3.42E-10	4.13E-07

Table 3.2-10 (Cont.)

Ingestion Dose Factor for Adult (mrem/pCi ingested)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
TC101	2.54E-10	3.66E-10	3.59E-09	NO DATA	6.59E-09	1.87E-10	1.10E-21
RU103	1.85E-07	NO DATA	7.97E-08	NO DATA	7.06E-07	NO DATA	2.16E-05
RU105	1.54E-08	NO DATA	6.08E-09	NO DATA	1.99E-07	NO DATA	9.42E-06
RU106	2.75E-06	NO DATA	3.48E-07	NO DATA	5.31E-06	NO DATA	1.78E-04
AG110M	1.60E-07	1.48E-07	8.79E-08	NO DATA	2.91E-07	NO DATA	6.04E-05
TE125M	2.69E-06	9.71E-07	3.59E-07	8.06E-07	1.09E-05	NO DATA	1.07E-05
TE127M	6.77E-06	2.42E-06	8.25E-07	1.73E-06	2.75E-05	NO DATA	2.27E-05
TE127	1.10E-07	3.95E-08	2.38E-08	8.15E-08	4.48E-07	NO DATA	8.68E-06
TE129M	1.15E-05	4.29E-06	1.82E-06	3.95E-06	4.80E-05	NO DATA	5.79E-05
TE129	3.14E-08	1.18E-08	7.65E-09	2.41E-08	1.32E-07	NO DATA	2.37E-08
TE131M	1.73E-06	8.46E-07	7.05E-07	1.34E-06	8.57E-06	NO DATA	8.40E-05
TE131	1.97E-08	8.23E-09	6.22E-09	1.62E-08	8.63E-08	NO DATA	2.79E-09
TE132	2.52E-06	1.63E-06	1.53E-06	1.80E-06	1.57E-05	NO DATA	7.71E-05
I 130	7.56E-07	2.23E-06	8.80E-07	1.89E-04	3.48E-06	NO DATA	1.92E-06
I 131	4.16E-06	5.95E-06	3.41E-06	1.95E-03	1.02E-05	NO DATA	1.57E-06
I 132	2.03E-07	5.43E-07	1.90E-07	1.90E-05	8.65E-07	NO DATA	1.02E-07
I 133	1.42E-06	2.47E-06	7.53E-07	3.63E-04	4.31E-06	NO DATA	2.22E-06
I 134	1.06E-07	2.88E-07	1.03E-07	4.99E-06	4.58E-07	NO DATA	2.51E-10
I 135	4.43E-07	1.16E-06	4.28E-07	7.65E-05	1.86E-06	NO DATA	1.31E-06
CS134	6.22E-05	1.48E-04	1.21E-04	NO DATA	4.79E-05	1.59E-05	2.59E-06
CS136	6.51E-06	2.57E-05	1.85E-05	NO DATA	1.43E-05	1.96E-06	2.92E-06
CS137	7.97E-05	1.09E-04	7.14E-05	NO DATA	3.70E-05	1.23E-05	2.11E-06
CS138	5.52E-08	1.09E-07	5.40E-08	NO DATA	8.01E-08	7.91E-09	4.65E-13
BA139	9.70E-08	6.91E-11	2.84E-09	NO DATA	6.46E-11	3.92E-11	1.72E-07
BA140	2.03E-05	2.55E-08	1.33E-06	NO DATA	8.67E-09	1.46E-08	4.18E-05
BA141	4.71E-08	3.56E-11	1.59E-09	NO DATA	3.31E-11	2.02E-11	2.22E-17
BA142	2.13E-08	2.19E-11	1.34E-09	NO DATA	1.85E-11	1.24E-11	3.00E-26
LA140	2.50E-09	1.26E-09	3.33E-10	NO DATA	NO DATA	NO DATA	9.25E-05
LA142	1.28E-10	5.82E-11	1.45E-11	NO DATA	NO DATA	NO DATA	4.25E-07
CE141	9.36E-09	6.33E-09	7.18E-10	NO DATA	2.94E-09	NO DATA	2.42E-05
CE143	1.65E-09	1.22E-06	1.35E-10	NO DATA	5.37E-10	NO DATA	4.56E-05
CE144	4.88E-07	2.04E-07	2.62E-08	NO DATA	1.21E-07	NO DATA	1.65E-04
PR143	9.20E-09	3.69E-09	4.56E-10	NO DATA	2.13E-09	NO DATA	4.03E-05
PR144	3.01E-11	1.25E-11	1.53E-12	NO DATA	7.05E-12	NO DATA	4.33E-18
ND147	6.29E-09	7.27E-09	4.35E-10	NO DATA	4.25E-09	NO DATA	3.49E-05
W 187	1.03E-07	8.61E-08	3.01E-08	NO DATA	NO DATA	NO DATA	2.82E-05
NP239	1.19E-09	1.17E-10	6.45E-11	NO DATA	3.65E-10	NO DATA	2.40E-05

Table 3.2-11

Ingestion Dose Factors for Teenager (mrem/pCi ingested)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	NO DATA	1.06E-07	1.06E-07	1.06E-07	1.06E-07	1.06E-07	1.06E-07
C 14	4.06E-06	8.12E-07	8.12E-07	8.12E-07	8.12E-07	8.12E-07	8.12E-07
NA 24	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06
P 32	2.76E-04	1.71E-05	1.07E-05	NO DATA	NO DATA	NO DATA	2.32E-05
CR 51	NO DATA	NO DATA	3.60E-09	2.00E-09	7.89E-10	5.14E-09	6.05E-07
MN 54	NO DATA	5.90E-06	1.17E-06	NO DATA	1.76E-06	NO DATA	1.21E-05
MN 56	NO DATA	1.58E-07	2.81E-08	NO DATA	2.00E-07	NO DATA	1.04E-05
FE 55	3.78E-06	2.68E-06	6.25E-07	NO DATA	NO DATA	1.70E-06	1.16E-06
FE 59	5.87E-06	1.37E-05	5.29E-06	NO DATA	NO DATA	4.32E-06	3.24E-05
CO 58	NO DATA	9.72E-07	2.24E-06	NO DATA	NO DATA	NO DATA	1.34E-05
CO 60	NO DATA	2.81E-06	6.33E-06	NO DATA	NO DATA	NO DATA	3.66E-05
NI 63	1.77E-04	1.25E-05	6.00E-06	NO DATA	NO DATA	NO DATA	1.99E-06
NI 65	7.49E-07	9.57E-08	4.36E-08	NO DATA	NO DATA	NO DATA	5.19E-06
CU 64	NO DATA	1.15E-07	5.41E-08	NO DATA	2.91E-07	NO DATA	8.92E-06
ZN 65	5.76E-06	2.00E-05	9.33E-06	NO DATA	1.28E-05	NO DATA	8.47E-06
ZN 69	1.47E-08	2.60E-08	1.96E-09	NO DATA	1.83E-08	NO DATA	5.16E-08
BR 83	NO DATA	NO DATA	5.74E-08	NO DATA	NO DATA	NO DATA	LT E-24
BR 84	NO DATA	NO DATA	7.22E-08	NO DATA	NO DATA	NO DATA	LT E-24
BR 85	NO DATA	NO DATA	3.05E-09	NO DATA	NO DATA	NO DATA	LT E-24
RB 86	NO DATA	2.98E-05	1.40E-05	NO DATA	NO DATA	NO DATA	4.41E-06
RB 88	NO DATA	8.52E-08	4.54E-08	NO DATA	NO DATA	NO DATA	7.30E-15
RB 89	NO DATA	5.50E-08	3.89E-08	NO DATA	NO DATA	NO DATA	8.43E-17
SR 89	4.40E-04	NO DATA	1.26E-05	NO DATA	NO DATA	NO DATA	5.24E-05
SR 90	8.30E-03	NO DATA	2.05E-03	NO DATA	NO DATA	NO DATA	2.33E-04
SR 91	8.07E-06	NO DATA	3.21E-07	NO DATA	NO DATA	NO DATA	3.66E-05
SR 92	3.05E-06	NO DATA	1.30E-07	NO DATA	NO DATA	NO DATA	7.77E-05
Y 90	1.37E-08	NO DATA	3.69E-10	NO DATA	NO DATA	NO DATA	1.13E-04
Y 91M	1.29E-10	NO DATA	4.93E-12	NO DATA	NO DATA	NO DATA	6.09E-09
Y 91	2.01E-07	NO DATA	5.39E-09	NO DATA	NO DATA	NO DATA	8.24E-05
Y 92	1.21E-09	NO DATA	3.50E-11	NO DATA	NO DATA	NO DATA	3.32E-05
Y 93	3.83E-09	NO DATA	1.05E-10	NO DATA	NO DATA	NO DATA	1.17E-04
ZR 95	4.12E-08	1.30E-08	8.94E-09	NO DATA	1.91E-08	NO DATA	3.00E-05
ZR 97	2.37E-09	4.69E-10	2.16E-10	NO DATA	7.11E-10	NO DATA	1.27E-04
NB 95	8.22E-09	4.56E-09	2.51E-09	NO DATA	4.42E-09	NO DATA	1.95E-05
MO 99	NO DATA	6.03E-06	1.15E-06	NO DATA	1.38E-05	NO DATA	1.08E-05
TC 99M	3.32E-10	9.26E-10	1.20E-08	NO DATA	1.38E-08	5.14E-10	6.08E-07

Table 3.2-11 (Cont.)

Ingestion Dose Factor for Teenager (mrem/pCi ingested)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
TC101	3.60E-10	5.12E-10	5.03E-09	NO DATA	9.26E-09	3.12E-10	8.75E-17
RU103	2.55E-07	NO DATA	1.09E-07	NO DATA	8.99E-07	NO DATA	2.13E-05
RU105	2.18E-08	NO DATA	8.46E-09	NO DATA	2.75E-07	NO DATA	1.76E-05
RU106	3.02E-06	NO DATA	4.94E-07	NO DATA	7.56E-06	NO DATA	1.88E-04
AG110M	2.05E-07	1.94E-07	1.18E-07	NO DATA	3.70E-07	NO DATA	5.45E-05
TE125M	3.83E-06	1.38E-06	5.12E-07	1.07E-06	NO DATA	NO DATA	1.13E-05
TE127M	9.67E-06	3.43E-06	1.15E-06	2.30E-06	3.92E-05	NO DATA	2.41E-05
TE127	1.58E-07	5.60E-08	3.40E-08	1.09E-07	6.40E-07	NO DATA	1.22E-05
TE129M	1.63E-05	6.05E-06	2.58E-06	5.26E-06	6.82E-05	NO DATA	6.12E-05
TE129	4.48E-08	1.67E-08	1.09E-08	3.20E-08	1.88E-07	NO DATA	2.45E-07
TE131M	2.44E-06	1.17E-06	9.76E-07	1.76E-06	1.22E-05	NO DATA	9.39E-05
TE131	2.79E-08	1.15E-08	8.72E-09	2.15E-08	1.22E-07	NO DATA	2.29E-09
TE132	3.49E-06	2.21E-06	2.08E-06	2.33E-06	2.12E-05	NO DATA	7.00E-05
I 130	1.03E-06	2.98E-06	1.19E-06	2.43E-04	4.59E-06	NO DATA	2.29E-06
I 131	5.85E-06	8.19E-06	4.40E-06	2.39E-03	1.41E-05	NO DATA	1.62E-06
I 132	2.79E-07	7.30E-07	2.62E-07	2.46E-05	1.15E-06	NO DATA	3.18E-07
I 133	2.01E-06	3.41E-06	1.04E-06	4.76E-04	5.98E-06	NO DATA	2.58E-06
I 134	1.46E-07	3.87E-07	1.39E-07	6.45E-06	6.10E-07	NO DATA	5.10E-09
I 135	6.10E-07	1.57E-06	5.82E-07	1.01E-04	2.48E-06	NO DATA	1.74E-06
CS134	8.37E-05	1.97E-04	9.14E-05	NO DATA	6.26E-05	2.39E-05	2.45E-06
CS136	8.59E-06	3.38E-05	2.27E-05	NO DATA	1.84E-05	2.90E-06	2.72E-06
CS137	1.12E-04	1.49E-04	5.19E-05	NO DATA	5.07E-05	1.97E-05	2.12E-06
CS138	7.76E-08	1.49E-07	7.45E-08	NO DATA	1.10E-07	1.28E-08	6.76E-11
BA139	1.39E-07	9.78E-11	4.05E-09	NO DATA	9.22E-11	6.74E-11	1.24E-06
BA140	2.84E-05	3.48E-08	1.83E-06	NO DATA	1.18E-08	2.34E-08	4.38E-05
BA141	6.71E-08	5.01E-11	2.24E-09	NO DATA	4.65E-11	3.43E-11	1.43E-13
BA142	2.99E-08	2.99E-11	1.84E-09	NO DATA	2.53E-11	1.99E-11	9.18E-20
LA140	3.48E-09	1.71E-09	4.55E-10	NO DATA	NO DATA	NO DATA	9.82E-05
LA142	1.79E-10	7.95E-11	1.98E-11	NO DATA	NO DATA	NO DATA	2.42E-06
CE141	1.33E-08	8.88E-09	1.02E-09	NO DATA	4.18E-09	NO DATA	2.54E-05
CE143	2.35E-09	1.71E-06	1.91E-10	NO DATA	7.67E-10	NO DATA	5.14E-05
CE144	6.96E-07	2.88E-07	3.74E-08	NO DATA	1.72E-07	NO DATA	1.75E-04
PR143	1.31E-08	5.23E-09	6.52E-10	NO DATA	3.04E-09	NO DATA	4.31E-05
PR144	4.30E-11	1.76E-11	2.18E-12	NO DATA	1.01E-11	NO DATA	4.74E-14
ND147	9.38E-09	1.02E-08	6.11E-10	NO DATA	5.99E-09	NO DATA	3.68E-05
W 187	1.46E-07	1.19E-07	4.17E-08	NO DATA	NO DATA	NO DATA	3.22E-05
NP239	1.76E-09	1.66E-10	9.22E-11	NO DATA	5.21E-10	NO DATA	2.67E-05

Table 3.2-12

Ingestion Dose Factors for Child (mrem/pCi ingested)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	NO DATA	2.03E-07	2.03E-07	2.03E-07	2.03E-07	2.03E-07	2.03E-07
C 14	1.21E-05	2.42E-06	2.42E-06	2.42E-06	2.42E-06	2.42E-06	2.42E-06
NA 24	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06
P 32	8.25E-04	3.86E-05	3.10E-05	NO DATA	NO DATA	NO DATA	2.28E-05
CR 51	NO DATA	NO DATA	8.90E-09	4.94E-09	1.35E-09	9.02E-09	4.72E-07
MN 54	NO DATA	1.07E-05	2.85E-06	NO DATA	3.00E-06	NO DATA	8.98E-06
MN 56	NO DATA	3.34E-07	7.54E-08	NO DATA	4.04E-07	NO DATA	4.84E-05
FE 55	1.15E-05	6.10E-06	1.89E-06	NO DATA	NO DATA	3.45E-06	1.13E-06
FE 59	1.65E-05	2.67E-05	1.35E-05	NO DATA	NO DATA	7.74E-06	2.78E-05
CO 58	NO DATA	1.80E-06	5.51E-06	NO DATA	NO DATA	NO DATA	1.05E-05
CO 60	NO DATA	5.29E-06	1.56E-05	NO DATA	NO DATA	NO DATA	2.93E-05
NI 63	5.38E-04	2.88E-05	1.83E-05	NO DATA	NO DATA	NO DATA	1.94E-06
NI 65	2.22E-06	2.09E-07	1.22E-07	NO DATA	NO DATA	NO DATA	2.56E-05
CU 64	NO DATA	2.45E-07	1.48E-07	NO DATA	5.92E-07	NO DATA	1.15E-05
ZN 65	1.37E-05	3.65E-05	2.27E-05	NO DATA	2.30E-05	NO DATA	6.41E-06
ZN 69	4.38E-08	6.33E-08	5.85E-09	NO DATA	3.84E-08	NO DATA	3.99E-06
BR 83	NO DATA	NO DATA	1.71E-07	NO DATA	NO DATA	NO DATA	LT E-24
BR 84	NO DATA	NO DATA	1.98E-07	NO DATA	NO DATA	NO DATA	LT E-24
BR 85	NO DATA	NO DATA	9.12E-09	NO DATA	NO DATA	NO DATA	LT E-24
RB 86	NO DATA	6.70E-05	4.12E-05	NO DATA	NO DATA	NO DATA	4.31E-06
RB 88	NO DATA	1.90E-07	1.32E-07	NO DATA	NO DATA	NO DATA	9.32E-09
RB 89	NO DATA	1.17E-07	1.04E-07	NO DATA	NO DATA	NO DATA	1.02E-09
SR 89	1.32E-03	NO DATA	3.77E-05	NO DATA	NO DATA	NO DATA	5.11E-05
SR 90	1.70E-02	NO DATA	4.31E-03	NO DATA	NO DATA	NO DATA	2.29E-04
SR 91	2.40E-05	NO DATA	9.06E-07	NO DATA	NO DATA	NO DATA	5.30E-05
SR 92	9.03E-06	NO DATA	3.62E-07	NO DATA	NO DATA	NO DATA	1.71E-04
Y 90	4.11E-08	NO DATA	1.10E-09	NO DATA	NO DATA	NO DATA	1.17E-04
Y 91M	3.82E-10	NO DATA	1.39E-11	NO DATA	NO DATA	NO DATA	7.48E-07
Y 91	6.02E-07	NO DATA	1.61E-08	NO DATA	NO DATA	NO DATA	8.02E-05
Y 92	3.60E-09	NO DATA	1.03E-10	NO DATA	NO DATA	NO DATA	1.04E-04
Y 93	1.14E-08	NO DATA	3.13E-10	NO DATA	NO DATA	NO DATA	1.70E-04
ZR 95	1.16E-07	2.35E-08	2.27E-08	NO DATA	3.65E-08	NO DATA	2.66E-05
ZR 97	6.99E-09	1.01E-09	5.96E-10	NO DATA	1.45E-09	NO DATA	1.53E-04
NB 95	2.25E-08	8.76E-09	6.26E-09	NO DATA	8.23E-09	NO DATA	1.62E-05
MO 99	NO DATA	1.33E-05	3.29E-06	NO DATA	2.84E-05	NO DATA	1.10E-05
TC 99M	9.23E-10	1.81E-09	3.00E-08	NO DATA	2.63E-08	9.19E-10	1.03E-06

Table 3.2-12 (Cont.)

Ingestion Dose Factors for Child (mrem/pCi ingested)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
TC101	1.07E-09	1.12E-09	1.42E-08	NO DATA	1.91E-08	5.92E-10	3.56E-09
RU103	7.31E-07	NO DATA	2.81E-07	NO DATA	1.84E-06	NO DATA	1.89E-05
RU105	6.45E-08	NO DATA	2.34E-08	NO DATA	5.67E-07	NO DATA	4.21E-05
RU106	1.17E-05	NO DATA	1.46E-06	NO DATA	1.58E-05	NO DATA	1.82E-04
AG110M	5.39E-07	3.64E-07	2.91E-07	NO DATA	6.78E-07	NO DATA	4.33E-05
TE125M	1.14E-05	3.09E-06	1.52E-06	3.20E-06	NO DATA	NO DATA	1.10E-05
TE127M	2.89E-05	7.78E-06	3.43E-06	6.91E-06	8.24E-05	NO DATA	2.34E-05
TE127	4.71E-07	1.27E-07	1.01E-07	3.26E-07	1.34E-06	NO DATA	1.84E-05
TE129M	4.87E-05	1.36E-05	7.56E-06	1.57E-05	1.43E-04	NO DATA	5.94E-05
TE129	1.34E-07	3.74E-08	3.18E-08	9.56E-08	3.92E-07	NO DATA	8.34E-06
TE131M	7.20E-06	2.49E-06	2.65E-06	5.12E-06	2.41E-05	NO DATA	1.01E-04
TE131	8.30E-08	2.53E-08	2.47E-08	6.35E-08	2.51E-07	NO DATA	4.36E-07
TE132	1.01E-05	4.47E-06	5.40E-06	6.51E-06	4.15E-05	NO DATA	4.50E-05
I 130	2.92E-06	5.90E-06	3.04E-06	6.50E-04	8.82E-06	NO DATA	2.76E-06
I 131	1.72E-05	1.73E-05	9.83E-06	5.72E-03	2.84E-05	NO DATA	1.54E-06
I 132	8.00E-07	1.47E-06	6.76E-07	6.82E-05	2.25E-06	NO DATA	1.73E-06
I 133	5.92E-06	7.32E-06	2.77E-06	1.36E-03	1.22E-05	NO DATA	2.95E-06
I 134	4.19E-07	7.78E-07	3.58E-07	1.79E-05	1.19E-06	NO DATA	5.16E-07
I 135	1.75E-06	3.15E-06	1.49E-06	2.79E-04	4.83E-06	NO DATA	2.40E-06
CS134	2.34E-04	3.84E-04	8.10E-05	NO DATA	1.19E-04	4.27E-05	2.07E-06
CS136	2.35E-05	6.46E-05	4.18E-05	NO DATA	3.44E-05	5.13E-06	2.27E-06
CS137	3.27E-04	3.13E-04	4.62E-05	NO DATA	1.02E-04	3.67E-05	1.96E-06
CS138	2.28E-07	3.17E-07	2.01E-07	NO DATA	2.23E-07	2.40E-08	1.46E-07
BA139	4.14E-07	2.21E-10	1.20E-08	NO DATA	1.93E-10	1.30E-10	2.39E-05
BA140	8.31E-05	7.28E-08	4.85E-06	NO DATA	2.37E-08	4.34E-08	4.21E-05
BA141	2.00E-07	1.12E-10	6.51E-09	NO DATA	9.69E-11	6.58E-10	1.14E-07
BA142	8.74E-08	6.29E-11	4.88E-09	NO DATA	5.09E-11	3.70E-11	1.14E-09
LA140	1.01E-08	3.53E-09	1.19E-09	NO DATA	NO DATA	NO DATA	9.84E-05
LA142	5.24E-10	1.67E-10	5.23E-11	NO DATA	NO DATA	NO DATA	3.31E-05
CE141	3.97E-08	1.98E-08	2.94E-09	NO DATA	8.68E-09	NO DATA	2.47E-05
CE143	6.99E-09	3.79E-06	5.49E-10	NO DATA	1.59E-09	NO DATA	5.55E-05
CE144	2.08E-06	6.52E-07	1.11E-07	NO DATA	3.61E-07	NO DATA	1.70E-04
PR143	3.93E-08	1.18E-08	1.95E-09	NO DATA	6.39E-09	NO DATA	4.24E-05
PR144	1.29E-10	3.99E-11	6.49E-12	NO DATA	2.11E-11	NO DATA	8.59E-08
ND147	2.79E-08	2.26E-08	1.75E-09	NO DATA	1.24E-08	NO DATA	3.58E-05
W 187	4.29E-07	2.54E-07	1.14E-07	NO DATA	NO DATA	NO DATA	3.57E-05
NP239	5.25E-09	3.77E-10	2.65E-10	NO DATA	1.09E-09	NO DATA	2.79E-05

Table 3.2-13

Ingestion Dose Factors for Infant (mrem/pCi ingested)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	NO DATA	3.08E-07	3.08E-07	3.08E-07	3.08E-07	3.08E-07	3.08E-07
C 14	2.37E-05	5.06E-06	5.06E-06	5.06E-06	5.06E-06	5.06E-06	5.06E-06
NA 24	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05
P 32	1.70E-03	1.00E-04	6.59E-05	NO DATA	NO DATA	NO DATA	2.30E-05
CR 51	NO DATA	NO DATA	1.41E-08	9.20E-09	2.01E-09	1.79E-08	4.11E-07
MN 54	NO DATA	1.99E-05	4.51E-06	NO DATA	4.41E-06	NO DATA	7.31E-06
MN 56	NO DATA	8.18E-07	1.41E-07	NO DATA	7.03E-07	NO DATA	7.43E-05
FE 55	1.39E-05	8.98E-06	2.40E-06	NO DATA	NO DATA	4.39E-06	1.14E-06
FE 59	3.08E-05	5.38E-05	2.12E-05	NO DATA	NO DATA	1.59E-05	2.57E-05
CO 58	NO DATA	3.60E-06	8.93E-06	NO DATA	NO DATA	NO DATA	8.97E-06
CO 60	NO DATA	1.08E-05	2.55E-05	NO DATA	NO DATA	NO DATA	2.57E-05
NI 63	6.34E-04	3.92E-05	2.20E-05	NO DATA	NO DATA	NO DATA	1.95E-06
NI 65	4.70E-06	5.32E-07	2.42E-07	NO DATA	NO DATA	NO DATA	4.05E-05
CU 64	NO DATA	6.09E-07	2.82E-07	NO DATA	1.03E-06	NO DATA	1.25E-05
ZN 65	1.94E-05	6.31E-05	2.91E-05	NO DATA	3.06E-05	NO DATA	5.33E-05
ZN 69	9.33E-08	1.68E-07	1.25E-08	NO DATA	6.98E-08	NO DATA	1.37E-05
BR 83	NO DATA	NO DATA	3.63E-07	NO DATA	NO DATA	NO DATA	LT E-24
BR 84	NO DATA	NO DATA	3.82E-07	NO DATA	NO DATA	NO DATA	LT E-24
BR 85	NO DATA	NO DATA	1.94E-08	NO DATA	NO DATA	NO DATA	LT E-24
RB 86	NO DATA	1.70E-04	8.40E-05	NO DATA	NO DATA	NO DATA	4.35E-06
RB 88	NO DATA	4.98E-07	2.73E-07	NO DATA	NO DATA	NO DATA	4.85E-07
RB 89	NO DATA	2.86E-07	1.97E-07	NO DATA	NO DATA	NO DATA	9.74E-08
SR 89	2.51E-03	NO DATA	7.20E-05	NO DATA	NO DATA	NO DATA	5.16E-05
SR 90	1.05E-02	NO DATA	4.71E-03	NO DATA	NO DATA	NO DATA	2.31E-04
SR 91	5.00E-05	NO DATA	1.81E-06	NO DATA	NO DATA	NO DATA	5.92E-05
SR 92	1.92E-05	NO DATA	7.13E-07	NO DATA	NO DATA	NO DATA	2.07E-04
Y 90	8.69E-08	NO DATA	2.33E-09	NO DATA	NO DATA	NO DATA	1.20E-04
Y 91M	8.10E-10	NO DATA	2.76E-11	NO DATA	NO DATA	NO DATA	2.70E-06
Y 91	1.13E-06	NO DATA	3.01E-08	NO DATA	NO DATA	NO DATA	8.10E-05
Y 92	7.65E-09	NO DATA	2.15E-10	NO DATA	NO DATA	NO DATA	1.46E-04
Y 93	2.43E-08	NO DATA	6.62E-10	NO DATA	NO DATA	NO DATA	1.92E-04
ZR 95	2.06E-07	5.02E-08	3.56E-08	NO DATA	5.41E-08	NO DATA	2.50E-05
ZR 97	1.48E-08	2.54E-09	1.16E-09	NO DATA	2.56E-09	NO DATA	1.62E-04
NB 95	4.20E-08	1.73E-08	1.00E-08	NO DATA	1.24E-08	NO DATA	1.46E-05
MO 99	NO DATA	3.40E-05	6.63E-06	NO DATA	5.08E-05	NO DATA	1.12E-05
TC 99M	1.92E-09	3.96E-09	5.10E-08	NO DATA	4.26E-08	2.07E-09	1.15E-06

Table 3.2-13 (Cont.)

Ingestion Dose Factors for Infant

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
TC101	2.27E-09	2.86E-09	2.83E-08	NO DATA	3.40E-08	1.56E-09	4.86E-07
RU103	1.48E-06	NO DATA	4.95E-07	NO DATA	3.08E-06	NO DATA	1.80E-05
RU105	1.36E-07	NO DATA	4.58E-08	NO DATA	1.00E-06	NO DATA	5.41E-05
RU106	2.41E-05	NO DATA	3.01E-06	NO DATA	2.85E-05	NO DATA	1.83E-04
AG110M	9.96E-07	7.27E-07	4.81E-07	NO DATA	1.04E-06	NO DATA	3.77E-05
TE125M	2.33E-05	7.79E-06	3.15E-06	7.84E-06	NO DATA	NO DATA	1.11E-05
TE127M	5.85E-05	1.94E-05	7.08E-06	1.69E-05	1.44E-04	NO DATA	2.36E-05
TE127	1.00E-06	3.35E-07	2.15E-07	8.14E-07	2.44E-06	NO DATA	2.10E-05
TE129M	1.00E-04	3.43E-05	1.54E-05	3.84E-05	2.50E-04	NO DATA	5.97E-05
TE129	2.84E-07	9.79E-08	6.63E-08	2.38E-07	7.07E-07	NO DATA	2.27E-05
TE131M	1.52E-05	6.12E-06	5.05E-06	1.24E-05	4.21E-05	NO DATA	1.03E-04
TE131	1.76E-07	6.50E-08	4.94E-08	1.57E-07	4.50E-07	NO DATA	7.11E-06
TE132	2.08E-05	1.03E-05	9.61E-06	1.52E-05	6.44E-05	NO DATA	3.81E-05
I 130	6.00E-06	1.32E-05	5.30E-06	1.48E-03	1.45E-05	NO DATA	2.83E-06
I 131	3.59E-05	4.23E-05	1.86E-05	1.39E-02	4.94E-05	NO DATA	1.51E-06
I 132	1.66E-06	3.37E-06	1.20E-06	1.58E-04	3.76E-06	NO DATA	2.73E-06
I 133	1.25E-05	1.82E-05	5.33E-06	3.31E-03	2.14E-05	NO DATA	3.08E-06
I 134	8.69E-07	1.78E-06	8.33E-07	4.15E-05	1.99E-06	NO DATA	1.84E-06
I 135	3.64E-06	7.24E-06	2.64E-06	6.49E-04	8.07E-06	NO DATA	2.62E-06
CS134	3.77E-04	7.03E-04	7.10E-05	NO DATA	1.81E-04	7.42E-05	1.91E-06
CS136	4.59E-05	1.35E-04	5.04E-05	NO DATA	5.38E-05	1.10E-05	2.05E-06
CS137	5.22E-04	6.11E-04	4.33E-05	NO DATA	1.64E-04	6.64E-05	1.91E-06
CS138	4.81E-07	7.82E-07	3.79E-07	NO DATA	3.90E-07	6.09E-08	1.25E-06
BA139	8.81E-07	5.84E-10	2.55E-08	NO DATA	3.51E-10	3.54E-10	5.58E-05
BA140	1.71E-04	1.71E-07	8.81E-06	NO DATA	4.06E-08	1.05E-07	4.20E-05
BA141	4.25E-07	2.91E-10	1.34E-08	NO DATA	1.75E-10	1.77E-10	5.19E-06
BA142	1.84E-07	1.53E-10	9.06E-09	NO DATA	8.81E-11	9.26E-11	7.59E-07
LA140	2.11E-08	8.32E-09	2.14E-09	NO DATA	NO DATA	NO DATA	9.77E-05
LA142	1.10E-09	4.04E-10	9.67E-11	NO DATA	NO DATA	NO DATA	6.86E-05
CE141	7.87E-08	4.80E-08	5.65E-09	NO DATA	1.48E-08	NO DATA	2.48E-05
CE143	1.48E-08	9.82E-06	1.12E-09	NO DATA	2.86E-09	NO DATA	5.73E-05
CE144	2.98E-06	1.22E-06	1.67E-07	NO DATA	4.93E-07	NO DATA	1.71E-04
PR143	8.13E-08	3.04E-08	4.03E-09	NO DATA	1.13E-08	NO DATA	4.29E-05
PR144	2.74E-10	1.06E-10	1.38E-11	NO DATA	3.84E-11	NO DATA	4.93E-06
ND147	5.53E-08	5.68E-08	3.48E-09	NO DATA	2.19E-08	NO DATA	3.60E-05
W 187	9.03E-07	6.28E-07	2.17E-07	NO DATA	NO DATA	NO DATA	3.69E-05
NP239	1.11E-08	9.93E-10	5.61E-10	NO DATA	1.98E-09	NO DATA	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% vegtables (including leafy vegetables), and 24% grain.

Table 3.2-15

Annual Usage Factors for the Average Individual Calculations

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.

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 calcualted to show compliance with Appendix I of 10CFR50. The calculations will be performed 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 site boundary location with the highest relative dispersion factor (X/Q) for the period of release.

PNPP Technical Specifications limit the dose resulting from the release of noble gas radionuclides in gaseous effluents to the following:

a. For gamma radiation, during any calendar quarter:

$$D^{\gamma}_{air} \leq 5 \text{ mrad},$$

b. For beta radiation, during any calendar quarter:

$$D^{\beta}_{air} \leq 10 \text{ mrad},$$

c. For gamma radiation, during any calendar year:

$$D^{\gamma}_{air} \leq 10 \text{ mrad},$$

d. For beta radiation, during any calendar year:

$$D^{\beta}_{air} \leq 20 \text{ mrad}.$$

3.3.2 Radioiodines, Particulates, and Other Radionuclides

Section II.C of Appendix I of 10CFR50 limits the 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 a function of the noble gas controlling location, i.e., 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 residences in each sector, and garden and farm animal locations.

PNPP Technical Specifications 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 any calendar quarter: dose to any organ $\leq$ 7.5 mrem and,
b. During any calendar year: dose to any organ $\leq$ 15 mrem.

3.3.3 Dose Calculations

The following calculations are used to calculate gamma and beta air doses resultant from noble gas releases 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 the found in Section 3.2.3. The dose rate obtained is integrated over the appropriate surveillance or sampling time period.

a. Gamma Air Dose from Noble Gas Releases

$$D^{\gamma}_{air} = 3.15 \times 10^{1} * X/Q * \sum_i Q_i \, DF^{\gamma}_i \qquad (3.3\text{-}1)$$

Where:

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

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

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

X/Q = the normal relative dispersion factor, in s/m^3;

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

b. Beta Air dose from Noble Gas Releases

$$D^{\beta}_{air} = 3.15 \times 10^{1} * X/Q * \sum_i Q_i \, DF^{\beta}_i$$

Where:

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

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

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

X/Q = the normal relative dispersion factor, in s/m^3;

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

3.3.4 Cumulation of Doses

The dose contribution from gaseous effluents will be calculated monthly. Calculations will be performed to determine the maximum air dose as well as the maximum organ dose to an individual. These monthly dose calculations will be summed for comparison with quarterly and annual limits. The monthly results should be added to the doses cumulated

from other months in the quarter of interest and in the year of interest. 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 PNPP Technical Specifications.

3.3.5 Projection of Doses

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 should be adjusted to reflect this information and the justifcation 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 impact 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

As required by Regulatory Guide 1.21, for Semiannual Radioactive Effluent Release Reporting, a population dose is calculated for the doses received resultant of all gaseous effluent releases. The population dose is computed, taking into account geographically population distribution and pathway using the equations in Section 3.2. However, the dose factors, DF_{aijp}, differ. The population dose factors are calculated in a manner similar to that used for 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.

Figure 3.3-1

Gamma and Beta Air Dose Factors for Semi-Infinite Plume

$$\left(\frac{\text{mrad} * \text{m}^3}{\text{Ci} * \text{s}}\right)$$

Nuclide	DF_i	DF_i
Ar-41	2.95+2	1.04+2
Kr-83m	6.12-1	9.13
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	3.52+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).

Additionally, the Technical Specifications require that when the calculated doses associated with the effluent releases exceed twice the limit of Specifications 3.11.1.2.a, 3.11.1.2.b, 3.11.2.2.a, 3.11.2.2.b, 3.11.2.3.a, or 3.11.2.3.b, calculations shall be made including the direct radiation component to determine whether the limits of Specification 3.11.4 have been exceeded, i.e., that the dose or dose commitment to a real individual from all uranium fuel cycle sources is limited to 25 mrem to the total body or any organ (except the thyroid, which is limited to 75 mrem) over 12 consecutive months. If such is the case, the licensee shall prepare and submit a special report to the Commission within 30 days and limit subsequent release to prevent reoccurrence of exceeding the above limits.

This special report is to include an analysis which demonstrates that radiation exposure to all real individuals from all uranium fuel cycle sources (including all liquid and gaseous effluent pathways and direct radiation) are less than the standards in 40CFR Part 190, Environmental Radiation Protection Standards for Nuclear Power Operations. If analysis indicates that releases resulting in doses that exceed the 40CFR190 standard could have occurred, then a variance from the Commission to permit such releases will be requested or if possible, action will be taken to reduce subsequent releases. This 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, and particulates. These doses will be based upon releases from the PNPP during the past 3 quarters and from the quarter in which twice the specification was exceeded. The doses from the PNPP will be summed with the doses 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 BWRs 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 of the secondary cycle. 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 of 0.25 mrem/h. All radwaste will be stored in the radwaste storage area which is part of the total building complex. All radwaste storage areas have outside walls that are 4 feet thick and they too are designed for an outside radiation zone of 0.5 mrem/h.

Direct radiation dose analyses for normal operations, were performed based on 80% load factor and 100% occupancy at the closest site boundary location NSW 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 2.2×10^{-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.

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 and 5.1-2. Table 5.1-4 describes sample locations, associated media, and approximate distances and directions from the site. Analytical techniques used shall ensure that the detection capabilities in Table 5.1-3 are achieved.

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 should be conducted for the first three years of commercial operation; following this period, program changes may be proposed based on operational experience.

Deviations are permitted from the required sampling schedule if specimens are unobtainable due to hazardous conditions, seasonal unavailability, malfunction of automatic sampling equipment and other legitimate reasons. If specimens are unobtainable due to sampling equipment malfunction, every reasonable 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 report.

5.2 Land Use Census Program

A land use census will be conducted annually to identify the location of the nearest residence, the nearest vegetable garden greater than 500 square feet, and the nearest milk-producing animal in each of the 22½° meteorological sectors within a distance of five miles.

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. Any location from which milk can no longer be obtained may be dropped from the surveillance program after notifying the NRC in writing that they are no longer obtainable at that location.

The land use census shall be conducted during the growing season at least once per calendar year 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 census shall be included in the Annual Radiological Environmental Operating Report.

5.3 Inter Laboratory Comparison Program

The laboratories of the licensee and/or licensee's contractors which perform analyses shall participate in the Environmental Protection Agency's (EPA's) Environmental Radioactivity Laboratory Intercomparisons Studies (Crosscheck) Program or equivalent program. This participation shall include all of the determinations (sample medium-radionuclide combination) that are offered by EPA and that also are included in the monitoring program. The results of analysis of these crosscheck samples shall be included in the Annual Radiological Environmental Operating Report.

If the results of a determination in the EPA crosscheck program (or equivalent 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.

Table 5.1-1
PNPP Radiological Environmental Monitoring Program

Sample Media	Locations*	Sampling Frequency	Analysis Type	Analysis Frequency
Airborne radioiodine[a] and particulates[b]	1, 3, 4, 5, 6, 35	Continuous sampler operation with collection weekly or as required by dust loading, loading, whichever is more frequent	Radioiodine I-131	Weekly following canister change
			Particulates Gross Beta[d]	Weekly following filter change
			Gamma Isotopic[e]	Composite, by location quarterly
Direct Radiation[c] (3 TLDs/location)	At each airborne monitoring location 1 through 24, 35, 41, 42, 43	Continuous sampling, one TLD exchanged quarterly	Gamma Dose	Quarterly
		Continuous sampling, one TLD exchanged annually	Gamma Dose	Annually
		Continuous sampling, one TLD exchanged quarterly or under emergency situations	Gamma Dose	Quarterly or under emergency situations
Waterborne surface[b] drinking[b]	28, 34, 36, 37	Composite[f]	H-3	Composite, by location, quarterly
			Gross Beta	Monthly
			Gamma Isotopic	Monthly
Sediment from shoreline[c]	25, 26, 27, 32	Semiannually -- Spring and Fall as weather permits	Gamma Isotopic	Semiannually

See footnotes at end of table.

Table 5.1-1 (Cont.)
PNPP Radiological Environmental Monitoring Program

Sample Media	Locations*	Sampling Frequency	Analysis Type	Analysis Frequency
Ingestion Milk[b]	29, 30, 31, 33	Monthly when animals are not on pasture	I-131[a], Gamma Isotopic[b]	Monthly
	29, 30, 31, 33	Semimonthly when animals are on pasture	I-131[a], Gamma Isotopic[b]	Semimonthly
Fish[c]	25, 32	Semiannually -- Spring and Fall as weather permits	Gamma Isotopic (edible portion)	Semiannually
Food Products[c]	38, 39, 40	Annually, at the time of harvest, broad leaf vegetation, and fruits	I-131[a], Gamma Isotopic[b]	Annually
Silage[c]	29, 30, 31, 33	Annually, location determined by annual milk - animal and garden census	Gamma Isotopic	Annually

(a) Sampling begins at least six months prior to PNPP operation, including one pasture season.
(b) Sampling begins at least one year prior to PNPP operation.
(c) Sampling begins at least two years prior to PNPP operation.
(d) Particulate sample filters will be analyzed for gross beta 24 hours or more after sampling to allow for radon and thoron daughter decay.
(e) Gamma isotopic analysis means the identification and quantification of gamma-emitting radionuclides that may be attributable to the effluents from the facility. If gross beta activity in air or water is greater than ten times the mean of control samples for any medium, gamma isotopic analysis will be performed on the individual samples.
(f) Composite samples will be collected with equipment that is capable of collecting an aliquot at time intervals that are very short (e.g., hourly) relative to the compositing period (e.g., monthly).

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(1)	2×10^4				
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	0.9	1×10^3	3	1×10^2
Cs-134	30	10	2×10^3	60	1×10^3
Cs-137	50	20		70	2×10^3
Ba-La-140	2×10^2			3×10^2	

(1) For drinking water samples. The value given is the 40CFR part 141 value.

Table 5.1-3

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

ANALYSIS	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	1×10^{-2}				
H-3	2000					
Mn-54	15		130			
Fe-59	30		260			
Co-58, 60	15		130			
Zn-65	30					
Zr-95	15					
I-131	1	7×10^{-2}		1	60	150
Cs-134	15	5×10^{-2}	130	15	60	180
Cs-137	18	6×10^{-2}	150	18	80	
Ba-140	60			60		
La-140	15			15		

Table 5.1-3 (Cont.)

Table Notations

[a]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 Specification 6.9.1.10. For these radionuclides in Table 4.12-1 which are not detected, the typical LLDs for the measurement system will be separately reported in the annual report.

[b]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.

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

Table 5.1-4
Sample Locations and Media for the Radiological Environmental Monitoring Program
Perry Nuclear Power Plant

ocation No.	Description	Distance (Miles)	Direction	Media (1)
1	Redbird (Haines Road, North of West Chapel Road) On pole 3303609; first pole south of first driveway on left	3.4	ENE	APT,AI,TLD,PR, SO
2	Site boundary; Tree Line Ash tree 1000 feet NNW of second transmission tower from road	0.7	E	TLD,SO
3	Meteorological tower On fence surrounding the equipment shelter	1.0	SE	APT,AI,TLD
4	Site Boundary On pole #W79/ SPG5-30; inside auxiliary road gate of Parmly Road	0.7	S	APT,AI,TLD,SO
5	Site Boundary, Quincy Substation On pole #L1283/9300, east side of substation	0.6	SW	APT,AI,TLD
6	Concord Service Center (Control) Auburn Road south of Rt. 90; on inside rear fence next to gate	11.0	SSW	APT,AI,TLD,PR, SO
7	Site Boundary; Lockwood Road Bus turnaround On tree on right, 100 feet past the turnaround	0.6	NE	TLD
8	Site Boundary; Tree Line 1000 feet N of location #2 on tree near rusted manure spreader	0.8	ENE	TLD
9	Site Boundary; Transmission Line Tower Third tower from Antioch Road toward the plant	0.7	ESE	TLD
10	Site Boundary; Southsoutheast Corner Security Fence On pole at turn in the fence	0.8	SSE	TLD
11	Site Boundary; Transmission Line Tower On tower at SW corner of Center and Parmly Roads	0.6	SSW	TLD
12	Site Boundary; Transmission Line Tower Access road from N side of Parmly just W of location #5	0.6	WSW	TLD,PR,SO
13	Madison-on-the-Lake At end of Whitewood Drive, N of Chapel Road, NW side of turnaround on pole #835803	4.7	ENE	TLD
14	Hubbard Road (South of North Ridge Road) On pole #28974 on W side of road, S side of McMackin Creek	4.9	E	TLD,SO
15	Madison Substation (Eagle Street) First pole next to substation near railroad tracks	5.1	ESE	TLD

Table 5.1-4 (Cont.)
Sample Locations and Media for the Radiological Environmental Monitoring Program
Perry Nuclear Power Plant

Location No.	Description	Distance (Miles)	Direction	Media (1)
16	Dayton Road (North of Interstate 90) On pole #572203 on left after dirt driveway which is just after the sharp left on Dayton after crossing I-90	5.0	SE	TLD
17	Chadwick Road (Cul de Sac South of Interstate 90) On pole #276222/118Z011; last pole on left	5.2	SSE	TLD
18	Blair Road On pole on left just after road makes 90 degree left curve from south to east heading toward Grand River Bridge	5.0	S	TLD,SO
19	Lane Road and South Ridge Road On pole #PC5648, 100 feet north of intersection	5.3	SSW	TLD
20	Nursery Road at Route 2 Overpass On pole #828976 across from entrance to Route 2	5.3	SW	TLD,SO
21	Hardy Road at Painesville Township Park On pole #378345, east of park entrance	5.1	WSW	TLD
22	Painesville On S side of Main Street across from Evergreen Cemetery entrance, on tree 60 feet west of pole #DBPG296	6.9	SW	TLD
23	Fairport Harbor (High Street and New Street) On pole on street side of substation	7.9	WSW	TLD
24	St. Clair Avenue Substation (Control) In mentor; on rear fence corner near railroad tracks	15.1	SW	TLD
25	PNPP Discharge	0.6	NNW	SED,FSH
26	Offshore at Redbird, vicinity of Ohio Water Service Company Intake	4.2	ENE	SED
27	Offshore, vicinity of Fairport Harbor Water Supply System Intake	7.9	WSW	SED
28	Ashtabula (Control), CEI Generating Station Intake	22.0	ENE	WTR
29	Milk Farm	1.4	ESE	MLK
30	Milk Farm	2.3	SSW	MLK
31	Milk Farm	1.4	ESE	MLK
32	Mentor-on-the-Lake (Control)	15.8	WSW	SED,FSH
33	Brookglen Farm (Control)	10.2	S	MLK
34	PNPP Intake	0.7	NW	WTR
35	Site Boundary, Center of Sector, follow Tree Line around	0.6	E	APT,AI,TLD

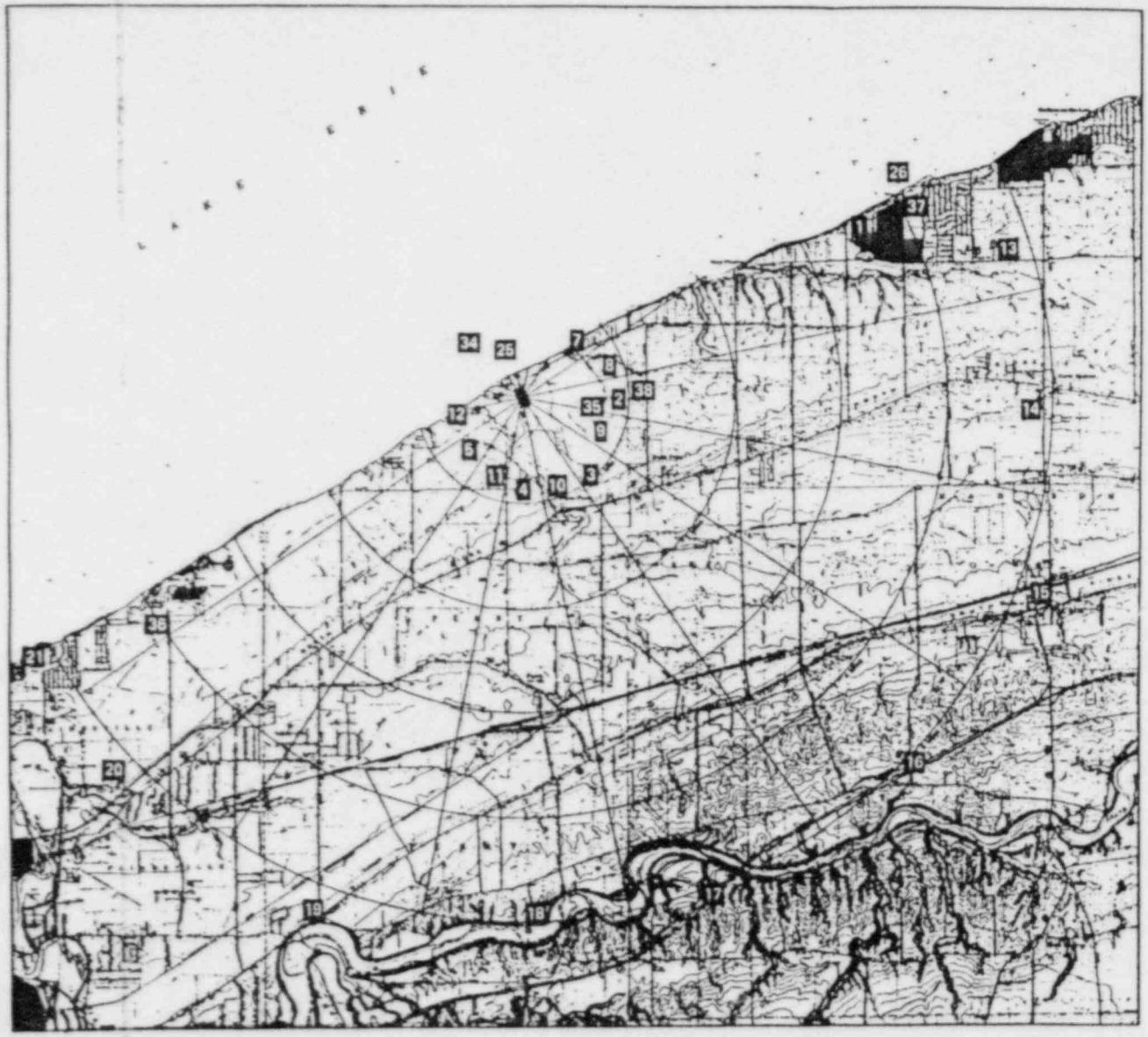
Table 5.1-4 (Cont.)
Sample Locations and Media for the Radiological Environmental Monitoring Program
Perry Nuclear Power Plant

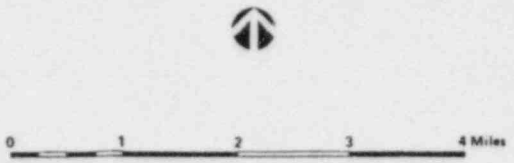
Location No.	Description	Distance (Miles)	Direction	Media (1)
36	Painesville Water Supply Intake	3.9	WSW	WTR
37	Ohio Water Service Company, Lake Erie East, Madison; at end of Green Road in Redbird	4.1	ENE	WTR
38	Farm at site boundary, off Antioch Road	1.1	E	FP
39	Goldings, 3515 North Ridge Road	1.8	SSW	FP
40	Antioch Road	1.1	E	FP
41	Clark Road One-half mile from Center Road. Located ten feet from road on tree.	1.1	SW	TLD
42	Parmly Road Approximately one-half mile from Center Road located on utility pole 582923 near southwest corner of plant fence.	0.8	SSW	TLD
43	Parmly Road Approxmiately 0.6 miles from Center Road. Approach stream crossing under Parmly Road. Approximately 50 ft. from road located on tree.	0.8	SSE	TLD

(1) APT = Air particulate
AI = Air iodine
TLD = Ambient gamma dose rate
SED = Sediment
WTR = Water
FSH = Fish
MLK = Milk
FP = Food Products
SO = Soil
PR = Precipitation

Figure 5.1-1

Radiological Environmental Monitoring Program Sampling Locations within 5 miles of PNPP





LEGEND

Station No.	Media	Direction
1	Air – TLD	ENE
2	TLD	E
3	Air – TLD	SE
4	Air – TLD	S
5	Air – TLD	SW
7	TLD	NE
8	TLD	ENE
9	TLD	ESE
10	TLD	SSE
11	TLD	SSW
12	TLD	WSW
13	TLD	ENE
14	TLD	E
15	TLD	ESE
16	TLD	SE
17	TLD	SSE
18	TLD	S
19	TLD	SSW
20	TLD	SW
21	TLD	WSW
25	Sediment – Fish	NNW
26	Sediment	ENE
34	Water	NW
35	Air – TLD	E
36	Water	WSW
37	Water	ENE
38	Food Products	E

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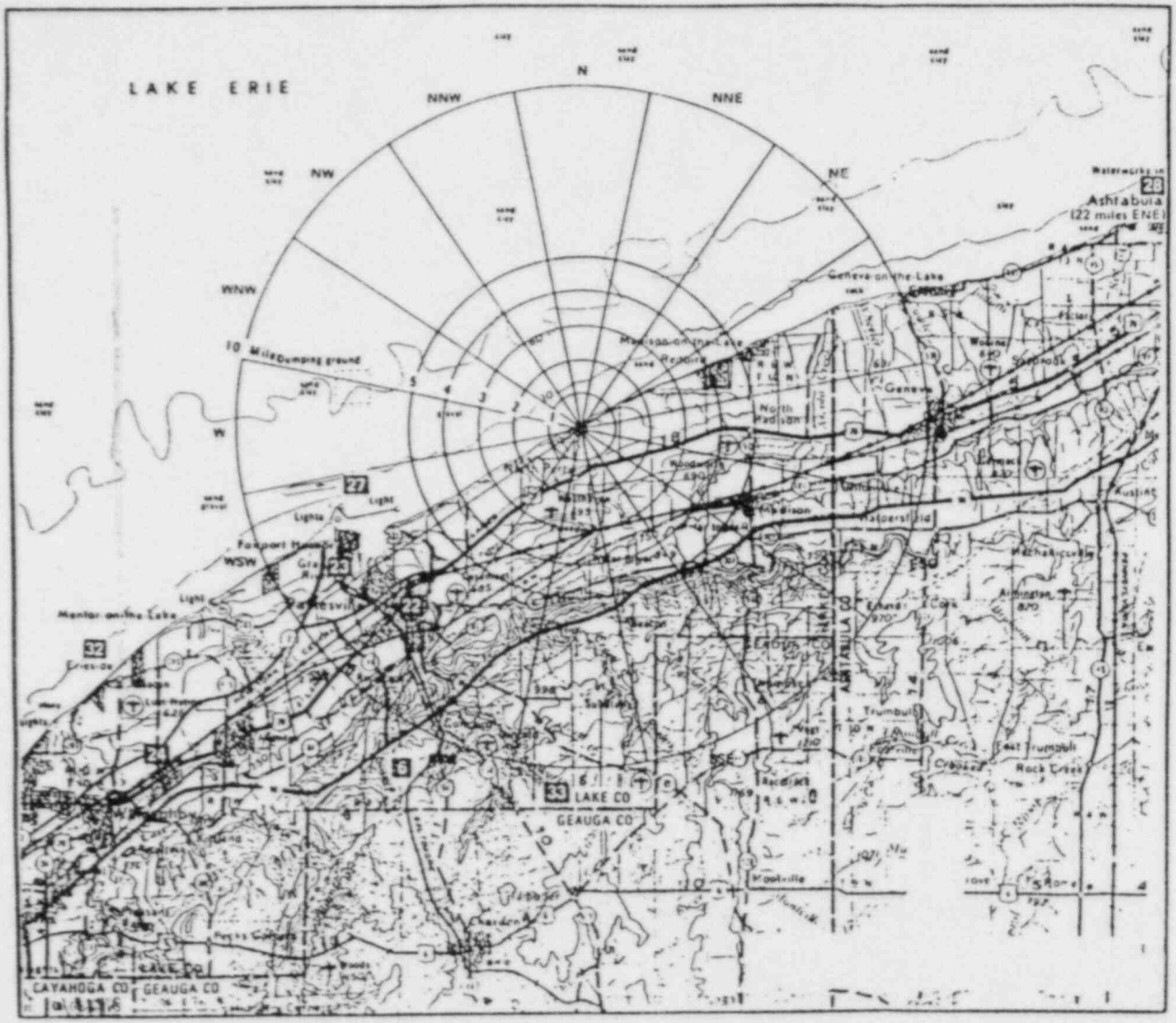
Figure 5.1-2

Radiological Environmental Monitoring Program Sampling Locations Greater than 5 Miles from PNPP



LEGEND

Station No.	Media	Direction
6	Air – TLD – (Control)	SSW
22	TLD	SW
23	TLD	WSW
24	TLD (Control)	SW
27	Sediment	WSW
28	Water (Control)	ENE
32	Fish – Sediment (Control)	WSW
33	Milk (Control)	S

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 hourly based on hourly meteorological and effluent data. All atmospheric releases at PNPP are considered to be ground-level releases.

a. Constant Mean Wind Direction Relative Dispersion Factor

$$X/Q = \frac{2.032\ T_f}{(\bar{u})\ (x)\ (\sigma)} \qquad \text{(A-1)}$$

Where:

X/Q = the relative dispersion factor at ground level, in s/m^3;

T_f = the terrain correction factor, dimensionless;

$\bar{u}$ = the wind speed, 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

σ = the lesser of $\left(\sigma_z^2 + \frac{H_c^2}{2\pi}\right)^{1/2}$ or $\sigma_z^* 3^{1/2}$

Where:

H_c = the building height, in m;

σ_z = the vertical dispersion coefficient, in m.

b. Depleted Relative Dispersion Factor

$$X/Q_d = (X/Q)(DPL_j) \qquad (A-2)$$

Where:

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

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

X/Q = the relative dispersion factor, as per equation A-1.

c. Ground Deposition

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

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, dimensionless;

x = the j^{th} distance, in m;

0.3927 = radians per $22\frac{1}{2}°$ 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 (X/Q) value at the sight boundary for sectors overland 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 the three FSAR years of meteorological data, ground-level releases, sector spread for purge calculations, and twelve wind speed classes.

Table A-2
Site Boundary Atmospheric Dispersion and Deposition Parameters
for PNPP Unit 1

SECTOR	DISTANCE (MILES)	X/Q (SEC./CUB. METER)	D/Q (PER SQ. METER)
N	0.18	5.863E-05	1.636E-07
NNE	0.25	1.808E-05	7.555E-08
NE	0.42	6.530E-06	3.291E-08
ENE	0.67	2.023E-06	1.633E-08
E	0.69	2.177E-06	1.626E-08
ESE	0.70	1.425E-06	1.028E-08
SE	0.84	1.277E-06	8.144E-09
SSE	0.90	1.958E-06	1.205E-08
S	0.88	2.325E-06	1.370E-08
SSW	0.90	1.112E-06	5.215E-09
SW	0.65	2.598E-06	1.291E-08
WSW	0.56	4.622E-06	1.447E-08
W	0.27	3.273E-05	5.301E-08
WNW	0.18	6.859E-05	8.426E-08
NW	0.17	7.902E-05	1.283E-07
NNW	0.17	6.151E-05	1.220E-07

Table A-3
Atmospheric Dispersion and Deposition Parameters at the
Nearest Residences for PNPP Unit 1

SECTOR	DISTANCE (MILES)	X/Q (SEC./CUB. METER)	D/Q (PER SQ. METER)
S	0.79	2.754E-06	1.649E-08
SSW	0.61	2.042E-06	9.976E-09
SW	1.22	9.859E-07	4.415E-09
WSW	1.04	1.031E-06	2.943E-09
NE	0.63	3.537E-06	1.735E-08
ENE	0.79	1.560E-06	1.236E-08
E	1.10	7.163E-07	4.987E-09
ESE	1.15	4.544E-07	3.062E-09
SE	1.19	4.042E-07	2.438E-09
SSE	0.85	2.130E-06	1.321E-08

Table A-4
Atmospheric Dispersion (X/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	5.005E-05	2.518E-05	1.574E-05	1.097E-05	8.265E-06
NNE	2.635E-05	1.355E-05	8.634E-06	6.091E-06	4.628E-06
NE	2.091E-05	1.099E-05	7.073E-06	5.007E-06	3.793E-06
ENE	1.293E-05	6.949E-06	4.504E-06	3.192E-06	2.410E-06
E	1.459E-05	7.824E-06	5.044E-06	3.564E-06	2.690E-06
ESE	9.899E-06	5.327E-06	3.443E-06	2.433E-06	1.830E-06
SE	1.157E-05	6.226E-06	4.033E-06	2.856E-06	2.153E-06
SSE	1.964E-05	1.054E-05	6.844E-06	4.860E-06	3.676E-06
S	2.342E-05	1.246E-05	8.011E-06	5.654E-06	4.262E-06
SSW	1.145E-05	6.111E-06	3.955E-06	2.800E-06	2.110E-06
SW	1.612E-05	8.585E-06	5.543E-06	3.921E-06	2.956E-06
WSW	2.404E-05	1.244E-05	7.857E-06	5.498E-06	4.144E-06
W	5.411E-05	2.692E-05	1.657E-05	1.142E-05	8.537E-06
WNW	5.461E-05	2.689E-05	1.639E-05	1.119E-05	8.266E-06
NW	5.907E-05	2.920E-05	1.790E-05	1.228E-05	9.112E-06
NNW	4.811E-05	2.383E-05	1.464E-05	1.006E-05	7.482E-06

SECTOR	0.7 (MILES)	0.8 (MILES)	0.9 (MILES)	1.0 (MILES)	1.1 (MILES)
N	6.444E-06	5.231E-06	4.420E-06	3.816E-06	2.042E-06
NNE	3.641E-06	2.965E-06	2.494E-06	2.141E-06	1.283E-06
NE	2.982E-06	2.424E-06	2.032E-06	1.738E-06	1.038E-06
ENE	1.892E-06	1.534E-06	1.279E-06	1.088E-06	6.461E-07
E	2.111E-06	1.711E-06	1.426E-06	1.213E-06	7.206E-07
ESE	1.433E-06	1.160E-06	9.651E-07	8.199E-07	4.864E-07
SE	1.689E-06	1.368E-06	1.138E-06	9.670E-07	4.590E-07
SSE	2.892E-06	2.346E-06	1.952E-06	1.658E-06	5.722E-07
S	3.341E-06	2.707E-06	2.256E-06	1.921E-06	7.380E-07
SSW	1.653E-06	1.339E-06	1.116E-06	9.505E-07	5.231E-07
SW	2.316E-06	1.877E-06	1.568E-06	1.337E-06	6.371E-07
WSW	3.238E-06	2.628E-06	2.209E-06	1.897E-06	9.570E-07
W	6.602E-06	5.342E-06	4.527E-06	3.923E-06	2.106E-06
WNW	6.316E-06	5.080E-06	4.316E-06	3.755E-06	2.142E-06
NW	6.995E-06	5.639E-06	4.785E-06	4.156E-06	2.367E-06
NNW	5.756E-06	4.644E-06	3.938E-06	3.417E-06	1.945E-06

Table A-4 (Cont.)
Atmospheric Dispersion (X/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	1.809E-06	1.618E-06	1.460E-06	1.327E-06	1.214E-06
NNE	1.131E-06	1.008E-06	9.058E-07	8.203E-07	7.482E-07
NE	9.123E-07	8.107E-07	7.268E-07	6.567E-07	5.977E-07
ENE	5.656E-07	5.005E-07	4.470E-07	4.024E-07	3.650E-07
E	6.307E-07	5.581E-07	4.984E-07	4.487E-07	4.070E-07
ESE	4.253E-07	3.760E-07	3.355E-07	3.018E-07	2.735E-07
SE	4.013E-07	3.547E-07	3.165E-07	2.846E-07	2.580E-07
SSE	5.003E-07	4.422E-07	3.945E-07	3.549E-07	3.216E-07
S	6.463E-07	5.722E-07	5.113E-07	4.605E-07	4.179E-07
SSW	4.582E-07	4.058E-07	3.627E-07	3.267E-07	2.966E-07
SW	5.588E-07	4.955E-07	4.433E-07	3.998E-07	3.632E-07
WSW	8.441E-07	7.521E-07	6.761E-07	6.123E-07	5.585E-07
W	1.871E-06	1.678E-06	1.518E-06	1.382E-06	1.267E-06
WNW	1.909E-06	1.718E-06	1.558E-06	1.422E-06	1.307E-06
NW	2.107E-06	1.893E-06	1.715E-06	1.564E-06	1.436E-06
NNW	1.730E-06	1.553E-06	1.406E-06	1.282E-06	1.176E-06

SECTOR	1.7 (MILES)	1.8 (MILES)	1.9 (MILES)	2.0 (MILES)	2.1 (MILES)
N	1.116E-06	1.031E-06	9.573E-07	8.920E-07	8.341E-07
NNE	6.860E-07	6.321E-07	5.852E-07	5.439E-07	5.074E-07
NE	5.469E-07	5.030E-07	4.648E-07	4.313E-07	3.652E-07
ENE	3.329E-07	3.053E-07	2.813E-07	2.603E-07	2.419E-07
E	3.712E-07	3.403E-07	3.136E-07	2.902E-07	2.451E-07
ESE	2.493E-07	2.285E-07	2.104E-07	1.946E-07	1.807E-07
SE	2.351E-07	2.154E-07	1.984E-07	1.835E-07	1.703E-07
SSE	2.931E-07	2.686E-07	2.473E-07	2.287E-07	1.460E-07
S	3.813E-07	3.498E-07	3.225E-07	2.985E-07	1.387E-07
SSW	2.707E-07	2.484E-07	2.290E-07	2.120E-07	1.408E-07
SW	3.318E-07	3.047E-07	2.811E-07	2.605E-07	2.423E-07
WSW	5.120E-07	4.718E-07	4.368E-07	4.060E-07	5.854E-07
W	1.168E-06	1.081E-06	1.005E-06	9.377E-07	1.357E-06
WNW	1.206E-06	1.119E-06	1.042E-06	9.740E-07	1.329E-06
NW	1.324E-06	1.227E-06	1.142E-06	1.067E-06	1.000E-06
NNW	1.084E-06	1.005E-06	9.345E-07	8.727E-07	8.177E-07

Table A-4 (Cont.)
Atmospheric Dispersion (X/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	7.825E-07	7.362E-07	6.945E-07	6.568E-07	6.228E-07
NNE	4.750E-07	4.459E-07	4.199E-07	3.963E-07	3.751E-07
NE	3.413E-07	3.200E-07	3.008E-07	2.836E-07	2.680E-07
ENE	2.255E-07	2.109E-07	1.979E-07	1.861E-07	1.756E-07
E	2.285E-07	2.137E-07	2.005E-07	1.886E-07	1.779E-07
ESE	1.683E-07	1.574E-07	1.476E-07	1.387E-07	1.308E-07
SE	1.587E-07	1.484E-07	1.391E-07	1.308E-07	1.233E-07
SSE	1.360E-07	1.272E-07	1.192E-07	1.121E-07	1.057E-07
S	1.294E-07	1.211E-07	1.136E-07	1.069E-07	1.009E-07
SSW	1.313E-07	1.229E-07	1.153E-07	1.085E-07	1.024E-07
SW	2.262E-07	2.118E-07	1.989E-07	1.873E-07	1.768E-07
WSW	5.479E-07	5.144E-07	4.843E-07	4.572E-07	4.327E-07
W	1.275E-06	1.201E-06	1.134E-06	1.074E-06	1.019E-06
WNW	1.250E-06	1.179E-06	1.116E-06	1.058E-06	1.005E-06
NW	9.402E-07	8.865E-07	8.380E-07	7.941E-07	7.543E-07
NNW	7.686E-07	7.245E-07	6.847E-07	6.486E-07	6.159E-07

SECTOR	2.7 (MILES)	2.8 (MILES)	2.9 (MILES)	3.0 (MILES)	3.1 (MILES)
N	5.915E-07	5.629E-07	5.367E-07	5.125E-07	4.902E-07
NNE	3.556E-07	3.378E-07	3.216E-07	3.066E-07	2.928E-07
NE	2.538E-07	2.409E-07	2.290E-07	2.181E-07	2.080E-07
ENE	1.659E-07	1.571E-07	1.491E-07	1.418E-07	1.350E-07
E	1.681E-07	1.592E-07	1.511E-07	1.436E-07	1.368E-07
ESE	1.236E-07	1.170E-07	1.110E-07	1.055E-07	9.127E-08
SE	1.165E-07	1.103E-07	1.046E-07	9.939E-08	9.461E-08
SSE	9.984E-08	9.452E-08	8.965E-08	8.520E-08	8.111E-08
S	9.536E-08	9.034E-08	8.575E-08	8.155E-08	7.769E-08
SSW	9.685E-08	9.176E-08	8.712E-08	8.286E-08	7.894E-08
SW	1.673E-07	1.586E-07	1.506E-07	1.433E-07	1.366E-07
WSW	4.102E-07	3.897E-07	3.709E-07	3.537E-07	2.781E-07
W	9.693E-07	9.234E-07	8.812E-07	8.423E-07	7.589E-07
WNW	9.568E-07	9.125E-07	8.717E-07	8.341E-07	8.991E-07
NW	7.177E-07	6.841E-07	6.533E-07	6.248E-07	6.529E-07
NNW	5.859E-07	5.584E-07	5.331E-07	5.097E-07	4.882E-07

Table A-4 (Cont.)
Atmospheric Dispersion (X/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	4.695E-07	4.503E-07	4.325E-07	4.158E-07	4.004E-07
NNE	2.800E-07	2.682E-07	2.572E-07	2.470E-07	2.376E-07
NE	1.988E-07	1.902E-07	1.822E-07	1.748E-07	1.680E-07
ENE	1.288E-07	1.230E-07	1.177E-07	1.127E-07	1.082E-07
E	1.305E-07	1.246E-07	1.192E-07	1.142E-07	1.096E-07
ESE	8.702E-08	8.310E-08	7.947E-08	7.608E-08	7.299E-08
SE	9.021E-08	8.615E-08	8.238E-08	7.886E-08	7.565E-08
SSE	7.733E-08	7.385E-08	7.062E-08	6.761E-08	6.485E-08
S	7.412E-08	7.083E-08	6.778E-08	6.492E-08	6.232E-08
SSW	7.532E-08	7.198E-08	6.889E-08	6.599E-08	6.335E-08
SW	1.304E-07	1.247E-07	1.194E-07	1.144E-07	1.099E-07
WSW	2.660E-07	2.548E-07	2.444E-07	2.346E-07	2.256E-07
W	7.275E-07	6.984E-07	6.713E-07	6.458E-07	6.225E-07
WNW	8.628E-07	8.290E-07	7.975E-07	7.679E-07	7.408E-07
NW	6.263E-07	6.015E-07	5.785E-07	5.568E-07	5.369E-07
NNW	4.682E-07	4.496E-07	4.323E-07	4.160E-07	4.011E-07

SECTOR	3.7 (MILES)	3.8 (MILES)	3.9 (MILES)	4.0 (MILES)	4.1 (MILES)
N	3.859E-07	3.723E-07	3.594E-07	3.474E-07	3.055E-07
NNE	2.286E-07	2.203E-07	2.125E-07	2.051E-07	1.802E-07
NE	1.615E-07	1.555E-07	1.498E-07	1.445E-07	1.395E-07
ENE	1.039E-07	9.984E-08	9.608E-08	9.255E-08	8.924E-08
E	1.052E-07	1.011E-07	9.731E-08	9.374E-08	9.038E-08
ESE	7.007E-08	6.733E-08	6.478E-08	6.238E-08	6.013E-08
SE	7.262E-08	6.978E-08	6.713E-08	6.465E-08	5.665E-08
SSE	6.226E-08	5.983E-08	5.756E-08	5.543E-08	5.343E-08
S	5.985E-08	5.755E-08	5.540E-08	5.338E-08	5.148E-08
SSW	6.085E-08	5.852E-08	5.633E-08	5.428E-08	5.235E-08
SW	1.056E-07	1.015E-07	9.779E-08	9.426E-08	9.094E-08
WSW	2.172E-07	2.092E-07	2.018E-07	1.948E-07	1.614E-07
W	6.003E-07	5.795E-07	5.600E-07	5.416E-07	3.932E-07
WNW	7.150E-07	6.907E-07	6.679E-07	6.464E-07	4.870E-07
NW	5.181E-07	5.003E-07	4.837E-07	4.680E-07	4.532E-07
NNW	3.869E-07	3.736E-07	3.611E-07	3.494E-07	3.075E-07

Table A-4 (Cont.)
Atmospheric Dispersion (X/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	2.958E-07	2.866E-07	2.779E-07	2.696E-07	2.618E-07
NNE	1.742E-07	1.686E-07	1.633E-07	1.583E-07	1.536E-07
NE	1.348E-07	1.304E-07	1.262E-07	1.222E-07	1.185E-07
ENE	8.612E-08	8.319E-08	8.042E-08	7.779E-08	7.534E-08
E	8.723E-08	8.425E-08	8.144E-08	7.878E-08	7.630E-08
ESE	5.802E-08	5.603E-08	5.415E-08	5.236E-08	5.071E-08
SE	5.465E-08	5.278E-08	5.100E-08	4.932E-08	4.776E-08
SSE	5.154E-08	4.977E-08	4.810E-08	4.652E-08	4.504E-08
S	4.969E-08	4.801E-08	4.642E-08	4.491E-08	4.351E-08
SSW	5.054E-08	4.883E-08	4.722E-08	4.568E-08	4.426E-08
SW	8.782E-08	8.488E-08	8.211E-08	7.947E-08	7.701E-08
WSW	1.560E-07	1.510E-07	1.463E-07	1.418E-07	1.376E-07
W	3.809E-07	3.692E-07	3.582E-07	3.477E-07	3.380E-07
WNW	4.721E-07	4.580E-07	4.447E-07	4.319E-07	4.200E-07
NW	4.392E-07	4.260E-07	4.134E-07	4.015E-07	3.903E-07
NNW	2.980E-07	2.890E-07	2.804E-07	2.723E-07	2.647E-07

SECTOR	4.7 (MILES)	4.8 (MILES)	4.9 (MILES)	5.0 (MILES)
N	2.544E-07	2.473E-07	2.406E-07	2.342E-07
NNE	1.491E-07	1.448E-07	1.408E-07	1.369E-07
NE	1.150E-07	1.116E-07	1.084E-07	1.053E-07
ENE	7.300E-08	7.078E-08	6.868E-08	6.668E-08
E	7.393E-08	7.168E-08	6.955E-08	6.753E-08
ESE	4.912E-08	4.762E-08	4.619E-08	4.484E-08
SE	4.626E-08	4.484E-08	4.350E-08	4.222E-08
SSE	4.363E-08	4.230E-08	4.103E-08	3.983E-08
S	4.216E-08	4.089E-08	3.968E-08	3.854E-08
SSW	4.290E-08	4.161E-08	4.038E-08	3.921E-08
SW	7.466E-08	7.243E-08	7.031E-08	6.830E-08
WSW	1.335E-07	1.297E-07	1.261E-07	1.226E-07
W	3.285E-07	3.196E-07	3.111E-07	3.029E-07
WNW	4.086E-07	3.977E-07	3.873E-07	3.774E-07
NW	3.796E-07	3.694E-07	3.597E-07	3.504E-07
NNW	2.574E-07	2.504E-07	2.438E-07	2.375E-07

Table A-5
Atmospheric Deposition (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	1.432E-07	7.772E-08	4.960E-08	3.470E-08	2.580E-08
NNE	1.052E-07	5.711E-08	3.645E-08	2.550E-08	1.896E-08
NE	1.031E-07	5.596E-08	3.572E-08	2.498E-08	1.858E-08
ENE	1.086E-07	5.894E-08	3.762E-08	2.631E-08	1.957E-08
E	1.124E-07	6.100E-08	3.893E-08	2.723E-08	2.025E-08
ESE	7.390E-08	4.012E-08	2.560E-08	1.791E-08	1.332E-08
SE	7.853E-08	4.263E-08	2.721E-08	1.903E-08	1.416E-08
SSE	1.312E-07	7.124E-08	4.546E-08	3.180E-08	2.365E-08
S	1.449E-07	7.865E-08	5.019E-08	3.511E-08	2.611E-08
SSW	5.725E-08	3.108E-08	1.984E-08	1.388E-08	1.032E-08
SW	8.160E-08	4.430E-08	2.827E-08	1.978E-08	1.471E-08
WSW	7.160E-08	3.887E-08	2.481E-08	1.735E-08	1.291E-08
W	8.173E-08	4.437E-08	2.832E-08	1.981E-08	1.473E-08
WNW	6.974E-08	3.786E-08	2.416E-08	1.690E-08	1.257E-08
NW	1.008E-07	5.471E-08	3.491E-08	2.442E-08	1.816E-08
NNW	9.945E-08	5.399E-08	3.446E-08	2.410E-08	1.793E-08

SECTOR	0.7 (MILES)	0.8 (MILES)	0.9 (MILES)	1.0 (MILES)	1.1 (MILES)
N	2.004E-08	1.600E-08	1.310E-08	1.095E-08	5.686E-09
NNE	1.473E-08	1.176E-08	9.627E-09	8.047E-09	4.701E-09
NE	1.443E-08	1.152E-08	9.434E-09	7.885E-09	4.607E-09
ENE	1.520E-08	1.213E-08	9.936E-09	8.305E-09	4.852E-09
E	1.573E-08	1.255E-08	1.028E-08	8.594E-09	5.021E-09
ESE	1.034E-08	8.258E-09	6.763E-09	5.653E-09	3.302E-09
SE	1.099E-08	8.775E-09	7.187E-09	6.007E-09	2.807E-09
SSE	1.837E-08	1.466E-08	1.201E-08	1.004E-08	3.412E-09
S	2.028E-08	1.619E-08	1.326E-08	1.108E-08	4.185E-09
SSW	8.014E-09	6.397E-09	5.239E-09	4.379E-09	2.368E-09
SW	1.142E-08	9.119E-09	7.468E-09	6.242E-09	2.917E-09
WSW	1.002E-08	8.001E-09	6.552E-09	5.477E-09	2.694E-09
W	1.144E-08	9.133E-09	7.480E-09	6.252E-09	3.247E-09
WNW	9.763E-09	7.793E-09	6.383E-09	5.335E-09	2.933E-09
NW	1.411E-08	1.126E-08	9.222E-09	7.708E-09	4.238E-09
NNW	1.392E-08	1.111E-08	9.102E-09	7.607E-09	4.183E-09

Table A-5 (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	4.899E-09	4.269E-09	3.757E-09	3.335E-09	2.984E-09
NNE	4.050E-09	3.529E-09	3.106E-09	2.757E-09	2.467E-09
NE	3.968E-09	3.458E-09	3.044E-09	2.702E-09	2.418E-09
ENE	4.180E-09	3.642E-09	3.206E-09	2.845E-09	2.546E-09
E	4.325E-09	3.769E-09	3.317E-09	2.945E-09	2.635E-09
ESE	2.845E-09	2.479E-09	2.182E-09	1.937E-09	1.733E-09
SE	2.418E-09	2.108E-09	1.855E-09	1.646E-09	1.473E-09
SSE	2.939E-09	2.561E-09	2.254E-09	2.001E-09	1.790E-09
S	3.605E-09	3.142E-09	2.765E-09	2.454E-09	2.196E-09
SSW	2.040E-09	1.778E-09	1.565E-09	1.389E-09	1.243E-09
SW	2.513E-09	2.190E-09	1.928E-09	1.711E-09	1.531E-09
WSW	2.321E-09	2.023E-09	1.780E-09	1.580E-09	1.414E-09
W	2.797E-09	2.437E-09	2.145E-09	1.904E-09	1.704E-09
WNW	2.527E-09	2.202E-09	1.938E-09	1.720E-09	1.539E-09
NW	3.651E-09	3.182E-09	2.800E-09	2.486E-09	2.224E-09
NNW	3.603E-09	3.140E-09	2.764E-09	2.453E-09	2.195E-09

SECTOR	1.7 (MILES)	1.8 (MILES)	1.9 (MILES)	2.0 (MILES)	2.1 (MILES)
N	2.686E-09	2.432E-09	2.213E-09	2.023E-09	1.858E-09
NNE	2.221E-09	2.010E-09	1.830E-09	1.673E-09	1.536E-09
NE	2.176E-09	1.970E-09	1.793E-09	1.639E-09	1.368E-09
ENE	2.292E-09	2.075E-09	1.888E-09	1.726E-09	1.585E-09
E	2.372E-09	2.147E-09	1.954E-09	1.786E-09	1.491E-09
ESE	1.560E-09	1.412E-09	1.285E-09	1.175E-09	1.079E-09
SE	1.326E-09	1.201E-09	1.093E-09	9.989E-10	9.172E-10
SSE	1.612E-09	1.459E-09	1.328E-09	1.214E-09	7.663E-10
S	1.977E-09	1.790E-09	1.629E-09	1.489E-09	6.836E-10
SSW	1.119E-09	1.013E-09	9.216E-10	8.426E-10	5.526E-10
SW	1.378E-09	1.248E-09	1.135E-09	1.038E-09	9.531E-10
WSW	1.273E-09	1.152E-09	1.049E-09	9.587E-10	1.360E-09
W	1.534E-09	1.388E-09	1.264E-09	1.155E-09	1.639E-09
WNW	1.386E-09	1.254E-09	1.142E-09	1.044E-09	1.394E-09
NW	2.002E-09	1.812E-09	1.649E-09	1.508E-09	1.385E-09
NNW	1.976E-09	1.789E-09	1.628E-09	1.488E-09	1.367E-09

Table A-5 (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	1.712E-09	1.584E-09	1.470E-09	1.368E-09	1.277E-09
NNE	1.416E-09	1.309E-09	1.215E-09	1.131E-09	1.056E-09
NE	1.261E-09	1.166E-09	1.082E-09	1.007E-09	9.404E-10
ENE	1.461E-09	1.351E-09	1.254E-09	1.167E-09	1.089E-09
E	1.374E-09	1.271E-09	1.180E-09	1.098E-09	1.025E-09
ESE	9.944E-10	9.198E-10	8.535E-10	7.943E-10	7.416E-10
SE	8.454E-10	7.819E-10	7.256E-10	6.752E-10	6.304E-10
SSE	7.063E-10	6.533E-10	6.062E-10	5.641E-10	5.267E-10
S	6.301E-10	5.828E-10	5.408E-10	5.033E-10	4.699E-10
SSW	5.093E-10	4.711E-10	4.371E-10	4.068E-10	3.798E-10
SW	8.785E-10	8.126E-10	7.540E-10	7.017E-10	6.551E-10
WSW	1.254E-09	1.160E-09	1.076E-09	1.002E-09	9.350E-10
W	1.511E-09	1.398E-09	1.297E-09	1.207E-09	1.127E-09
WNW	1.285E-09	1.188E-09	1.103E-09	1.026E-09	9.581E-10
NW	1.276E-09	1.180E-09	1.095E-09	1.019E-09	9.517E-10
NNW	1.260E-09	1.165E-09	1.081E-09	1.006E-09	9.393E-10

SECTOR	2.7 (MILES)	2.8 (MILES)	2.9 (MILES)	3.0 (MILES)	3.1 (MILES)
N	1.195E-09	1.120E-09	1.053E-09	9.913E-10	9.353E-10
NNE	9.876E-10	9.261E-10	8.703E-10	8.195E-10	7.732E-10
NE	8.797E-10	8.250E-10	7.753E-10	7.301E-10	6.888E-10
ENE	1.019E-09	9.557E-10	8.982E-10	8.458E-10	7.980E-10
E	9.588E-10	8.991E-10	8.450E-10	7.957E-10	7.507E-10
ESE	6.937E-10	6.505E-10	6.114E-10	5.757E-10	4.938E-10
SE	5.898E-10	5.530E-10	5.197E-10	4.894E-10	4.618E-10
SSE	4.927E-10	4.620E-10	4.342E-10	4.089E-10	3.858E-10
S	4.396E-10	4.122E-10	3.874E-10	3.648E-10	3.442E-10
SSW	3.553E-10	3.332E-10	3.131E-10	2.949E-10	2.782E-10
SW	6.129E-10	5.747E-10	5.401E-10	5.086E-10	4.798E-10
WSW	8.748E-10	8.203E-10	7.709E-10	7.259E-10	5.640E-10
W	1.054E-09	9.884E-10	9.289E-10	8.747E-10	7.767E-10
WNW	8.963E-10	8.405E-10	7.899E-10	7.438E-10	7.895E-10
NW	8.903E-10	8.349E-10	7.846E-10	7.388E-10	7.604E-10
NNW	8.787E-10	8.240E-10	7.744E-10	7.292E-10	6.880E-10

Table A-5 (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	8.840E-10	8.369E-10	7.936E-10	7.534E-10	7.170E-10
NNE	7.308E-10	6.919E-10	6.561E-10	6.229E-10	5.927E-10
NE	6.510E-10	6.164E-10	5.845E-10	5.549E-10	5.280E-10
ENE	7.542E-10	7.141E-10	6.771E-10	6.428E-10	6.117E-10
E	7.096E-10	6.718E-10	6.370E-10	6.048E-10	5.755E-10
ESE	4.667E-10	4.419E-10	4.190E-10	3.978E-10	3.785E-10
SE	4.364E-10	4.132E-10	3.918E-10	3.720E-10	3.540E-10
SSE	3.646E-10	3.452E-10	3.273E-10	3.108E-10	2.957E-10
S	3.253E-10	3.080E-10	2.920E-10	2.772E-10	2.638E-10
SSW	2.629E-10	2.489E-10	2.361E-10	2.241E-10	2.133E-10
SW	4.535E-10	4.294E-10	4.072E-10	3.865E-10	3.678E-10
WSW	5.331E-10	5.047E-10	4.786E-10	4.544E-10	4.324E-10
W	7.341E-10	6.950E-10	6.591E-10	6.257E-10	5.954E-10
WNW	7.462E-10	7.065E-10	6.699E-10	6.360E-10	6.052E-10
NW	7.187E-10	6.805E-10	6.453E-10	6.126E-10	5.829E-10
NNW	6.503E-10	6.156E-10	5.838E-10	5.542E-10	5.274E-10

SECTOR	3.7 (MILES)	3.8 (MILES)	3.9 (MILES)	4.0 (MILES)	4.1 (MILES)
N	6.827E-10	6.509E-10	6.214E-10	5.939E-10	5.165E-10
NNE	5.644E-10	5.382E-10	5.137E-10	4.910E-10	4.270E-10
NE	5.028E-10	4.794E-10	4.576E-10	4.373E-10	4.184E-10
ENE	5.825E-10	5.554E-10	5.302E-10	5.067E-10	4.847E-10
E	5.480E-10	5.225E-10	4.988E-10	4.767E-10	4.560E-10
ESE	3.604E-10	3.437E-10	3.281E-10	3.135E-10	3.000E-10
SE	3.371E-10	3.214E-10	3.068E-10	2.932E-10	2.550E-10
SSE	2.816E-10	2.685E-10	2.563E-10	2.449E-10	2.343E-10
S	2.512E-10	2.395E-10	2.287E-10	2.185E-10	2.091E-10
SSW	2.031E-10	1.936E-10	1.848E-10	1.766E-10	1.690E-10
SW	3.503E-10	3.340E-10	3.188E-10	3.047E-10	2.915E-10
WSW	4.117E-10	3.926E-10	3.747E-10	3.581E-10	2.937E-10
W	5.670E-10	5.406E-10	5.160E-10	4.932E-10	3.539E-10
WNW	5.763E-10	5.495E-10	5.245E-10	5.013E-10	3.730E-10
NW	5.551E-10	5.293E-10	5.052E-10	4.828E-10	4.619E-10
NNW	5.022E-10	4.788E-10	4.571E-10	4.368E-10	3.799E-10

Table A-5 (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	4.947E-10	4.742E-10	4.550E-10	4.369E-10	4.202E-10
NNE	4.089E-10	3.920E-10	3.762E-10	3.612E-10	3.474E-10
NE	4.007E-10	3.841E-10	3.686E-10	3.539E-10	3.404E-10
ENE	4.642E-10	4.450E-10	4.270E-10	4.100E-10	3.943E-10
E	4.367E-10	4.187E-10	4.017E-10	3.857E-10	3.710E-10
ESE	2.873E-10	2.754E-10	2.642E-10	2.537E-10	2.440E-10
SE	2.442E-10	2.341E-10	2.246E-10	2.157E-10	2.074E-10
SSE	2.244E-10	2.151E-10	2.064E-10	1.982E-10	1.906E-10
S	2.002E-10	1.919E-10	1.842E-10	1.768E-10	1.701E-10
SSW	1.618E-10	1.552E-10	1.489E-10	1.429E-10	1.375E-10
SW	2.792E-10	2.676E-10	2.568E-10	2.466E-10	2.371E-10
WSW	2.813E-10	2.696E-10	2.587E-10	2.484E-10	2.389E-10
W	3.389E-10	3.249E-10	3.117E-10	2.993E-10	2.879E-10
WNW	3.572E-10	3.425E-10	3.286E-10	3.155E-10	3.034E-10
NW	4.424E-10	4.241E-10	4.069E-10	3.907E-10	3.758E-10
NNW	3.639E-10	3.488E-10	3.347E-10	3.214E-10	3.091E-10

SECTOR	4.7 (MILES)	4.8 (MILES)	4.9 (MILES)	5.0 (MILES)
N	4.042E-10	3.892E-10	3.749E-10	3.615E-10
NNE	3.342E-10	3.217E-10	3.100E-10	2.989E-10
NE	3.274E-10	3.153E-10	3.037E-10	2.929E-10
ENE	3.793E-10	3.652E-10	3.519E-10	3.393E-10
E	3.569E-10	3.436E-10	3.311E-10	3.192E-10
ESE	2.347E-10	2.260E-10	2.178E-10	2.100E-10
SE	1.996E-10	1.921E-10	1.851E-10	1.785E-10
SSE	1.834E-10	1.766E-10	1.701E-10	1.640E-10
S	1.636E-10	1.575E-10	1.518E-10	1.463E-10
SSW	1.323E-10	1.273E-10	1.227E-10	1.183E-10
SW	2.281E-10	2.196E-10	2.116E-10	2.040E-10
WSW	2.298E-10	2.213E-10	2.132E-10	2.056E-10
W	2.769E-10	2.666E-10	2.569E-10	2.477E-10
WNW	2.919E-10	2.810E-10	2.708E-10	2.611E-10
NW	3.615E-10	3.480E-10	3.353E-10	3.233E-10
NNW	2.973E-10	2.863E-10	2.758E-10	2.659E-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:

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

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.

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 (Canberra Spectran - F Version 2):

$$LLD = \frac{L_D \quad \exp\ (0.693\ \Delta t/t_{\frac{1}{2}})}{(C)(E)(t)(V)(Y_c)(Y_\gamma)} \qquad \text{(B-2)}$$

Where:

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

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

E = the detector efficiency for the energy in question;

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

$t_{\frac{1}{2}}$ = 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);

Y_γ = 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

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

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, 4.11-2 and 4.12-1 of the Radiological Effluent Technical Specifications 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 or the Semiannual Radioactive Effluent Release Report.

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THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

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February 28, 1985
PY-CEI/NRR-0196 L

Mr. B. J. Youngblood, Chief
Licensing Branch No. 1
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Perry Nuclear Power Plant
Docket Nos. 50-440; 50-441
Offsite Dose Calculation Manual

Dear Mr. Youngblood:

In accordance with your request, Cleveland Electric Illuminating Company is submitting the attached copy of the Perry Nuclear Power Plant Offsite Dose Calculation Manual, Rev. 1.

We look forward to working with the NRC Staff during the review of the Offsite Dose Calculation Manual. Please call if you have any questions.

Very truly yours,

Murray R. Edelman
Vice President
Nuclear Group

MRE:njc

Attachment

cc: Jay Silberg, Esq.
John Stefano (2)
J. Grobe
S. Brown

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