PROCEDURE/INSTRUCTION CHANGE

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ODCM	5	Offsite Dose Calculation Manual

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___ PERIODIC REVIEW

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_X_ OTHER __See Reason section_

REASON

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

INFORMATION ONLY

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APPROVAL

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DISAP

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The Cleveland Electric Illuminating Company

PERRY OPERATIONS MANUAL

Offsite Dose Calculation Manual

TITLE: OFFSITE DOSE CALCULATION MANUAL

REVISION: 5 EFFECTIVE DATE: 11-27-95

PREPARED: Michael Doty 12-1-94 / Date

IN-DEPTH REVIEWER: James J. Batchelor 12/8/94 / Date

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APPROVED: John J. Grimm John J. Grimm 3/24/95 / Date

APPROVED: Joseph K Hoppe JRS PP 3/28/95 / Date

APPROVED: [signature] 3/29/95 / Date

Offsite Dose Calculation Manual

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SCOPE OF REVISION:

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

1.0 INTRODUCTION

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

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

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

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

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

Appendix C of the ODCM was prepared based on guidance of NUREG-1302, "Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Boiling Water Reactors," Generic Letter 89-01, Supplement No. 1. This appendix along with plant procedures will be used by plant personnel to demonstrate compliance with Specifications 6.8.4.d (Radiological Effluent Controls Program) and 6.8.4.e (Radiological Environmental Monitoring Program) of the PNPP Technical Specifications.

2.0 LIQUID EFFLUENTS

2.1 Batch Releases

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

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

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

2.1.1 Monitor Alarm Setpoint Determination

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

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

2.1.1.1 Determination of the Minimum Acceptable Dilution Factor

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

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 µCi/ml;

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

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

Where:

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

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

10 = a factor of ten less than 10CFR20 limits as specified in Appendix B, Table 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.

2.1.1.2 Determination of the Maximum Allowable Radwaste Tank Discharge Flow Rate

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

Where:

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

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

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

0.64 = an engineering factor to prevent spurious alarms.

2.1.1.3 Liquid Radwaste Discharge Flow Monitor Alarm Setpoint

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

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

Where:

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

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

1.25 = the engineering safety factor to prevent spurious alarms.

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

2.1.1.4 Liquid Radwaste Discharge Radiation Monitor Alarm/Trip Setpoint

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

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

Where:

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

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

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

OR

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

Where:

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

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

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

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

Where:

SP_r = the Radwaste Discharge Radiation Monitor - ESW Discharge (OD17K0606) alarm/trip setpoint, in cpm;

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

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

1.25 = the engineering safety factor to prevent spurious alarms;

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

Where:

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

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

2.1.2 Compliance with 10CFR20 - Liquid Effluent Concentration

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

2.1.2.1 Concentration of Radionuclides in Prerelease

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

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

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

Where:

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

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

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

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

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

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

Where:

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

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

2.1.2.2 Post Release

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

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

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

Where:

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

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

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

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

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

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

Where:

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

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

2.2 Continuous Releases

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

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

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

2.2.1 Monitor Alarm Setpoint Determination

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

1. Emergency Service Water Radiation Monitor Alarm Setpoint

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

Where:

CR_C = the calculated monitor count rate in cpm;

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

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

0.75 = engineering safety factor

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

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

Where:

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

CR_C = the calculated monitor count rate in cpm;

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

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

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

Where:

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

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

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

MPC_i = MPC value for isotope (I), Appendix B, Table II, Column 2, 10CFR20

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4. Minimum Allowable Setpoint based on Monitor Background

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

Where:

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

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

2 = 95% confidence level;

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

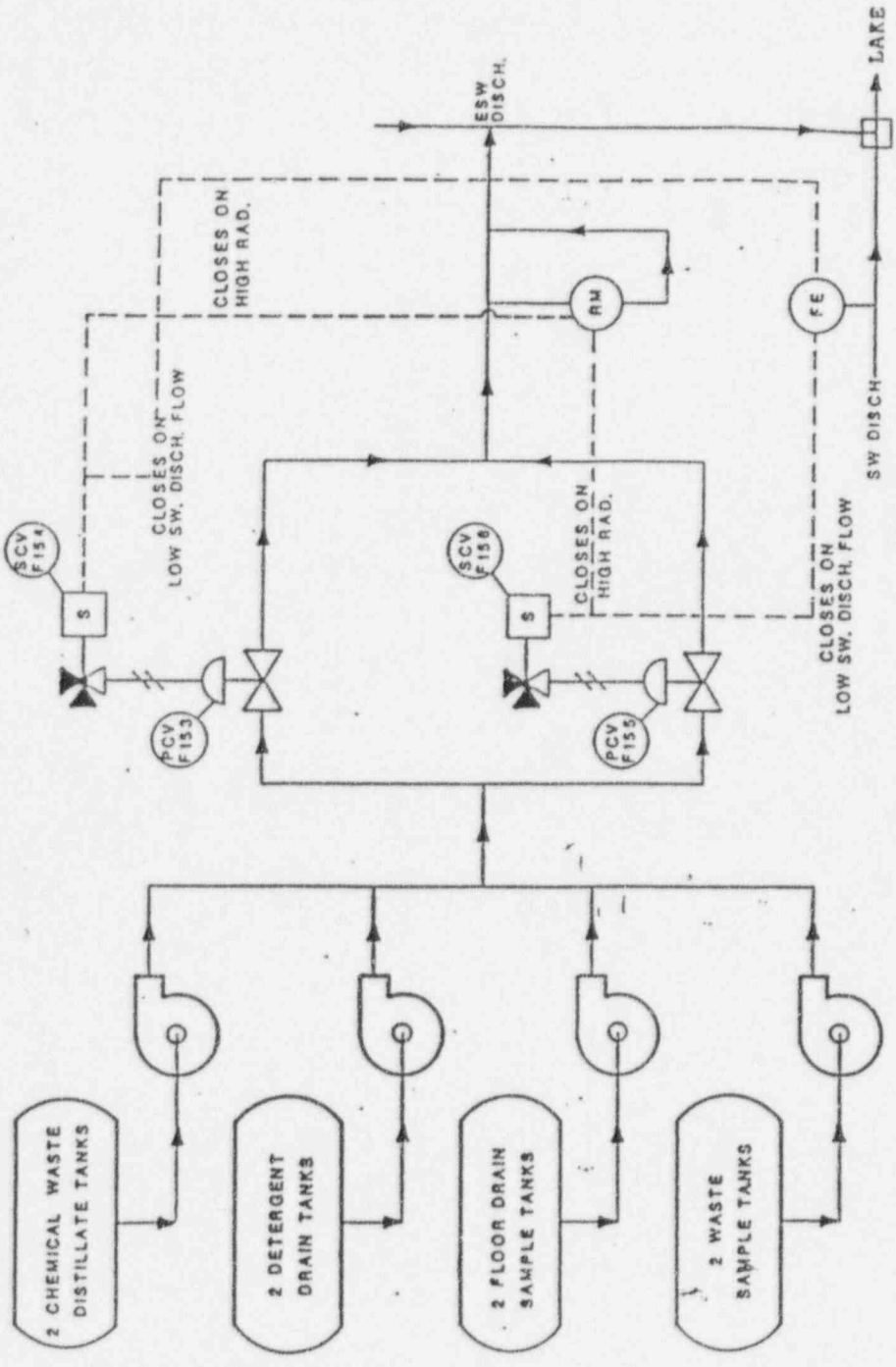
$$TC = \frac{(Log10BG - Log10TC_{locpm})(TC_{hicpm} - TC_{lomin})}{(Log10TC_{hicpm} - Log10TC_{locpm})} + TC_{lomin}$$

Time Constants:

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

Figure 2.1-1

Liquid Radioactive Waste (LRW) Discharge System



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

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

2.3.1 Dose Calculations

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

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

1. Potable Water:

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

2. Aquatic Foods:

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

3. Shoreline Deposits:

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

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

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 ft^3/s;

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

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

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

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

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

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

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

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

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

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

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

2.3.2 Cumulation of Doses

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

for the quarter:

Dose ≤ 1.5 mrems total body;

Dose ≤ 5 mrems any organ;

for the calendar year:

Dose ≤ 3 mrems total body;

Dose ≤ 10 mrems any organ.

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

2.3.3 Projection of Doses

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

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

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

2.3.4 Population Dose

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

Table 2.3-1

Organs Used for Liquid Effluent Dose Calculations

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

Table 2.3-2

Age Groups Used for Liquid Effluent Dose Calculations

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

Table 2.3-3

Liquid Effluent Dose Pathways

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

Table 2.3-4

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

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

Table 2.3-5

Ingestion Dose Factors for Adult (mrem/pCi ingested)

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

Table 2.3-5 (Cont.)

Ingestion Dose Factors for Adult (mrem/pCi ingested)

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

Table 2.3-6

Ingestion Dose Factcrs for Teenager (mrem/pCi ingested)

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

Table 2.3-6 (Cont.)

Ingestion Dose Factors for Teenager (mrem/pCi ingested)

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

Table 2.3-7

Ingestion Dose Factors for Child (mrem/pCi ingested)

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

Table 2.3-7 (Cont.)

Ingestion Dose Factors for Child (mrem/pCi ingested)

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

Table 2.3-8

Ingestion Dose Factors for Infant (mrem/pCi ingested)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
H3	0.00E+00	3.08E-07	3.08E-07	3.08E-07	3.08E-07	3.08E-07	3.08E-07
C14	2.37E-05	5.06E-06	5.06E-06	5.06E-06	5.06E-06	5.06E-06	5.06E-06
NA24	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05
P32	1.70E-03	1.00E-04	6.59E-05	0.00E+00	0.00E+00	0.00E+00	2.30E-05
CR51	0.00E+00	0.00E+00	1.41E-08	9.20E-09	2.01E-09	1.79E-08	4.11E-07
MN54	0.00E+00	1.99E-05	4.51E-06	0.00E+00	4.41E-06	0.00E+00	7.31E-06
MN56	0.00E+00	8.18E-07	1.41E-07	0.00E+00	7.03E-07	0.00E+00	7.43E-05
FE55	1.39E-05	8.98E-06	2.40E-06	0.00E+00	0.00E+00	4.39E-06	1.14E-06
FE59	3.08E-05	5.38E-05	2.12E-05	0.00E+00	0.00E+00	1.59E-05	2.57E-05
CO58	0.00E+00	3.60E-06	8.98E-06	0.00E+00	0.00E+00	0.00E+00	8.97E-06
CO60	0.00E+00	1.08E-05	2.55E-05	0.00E+00	0.00E+00	0.00E+00	2.57E-05
NI63	6.34E-04	3.92E-05	2.20E-05	0.00E+00	0.00E+00	0.00E+00	1.95E-06
NI65	4.70E-06	5.32E-07	2.42E-07	0.00E+00	0.00E+00	0.00E+00	4.05E-05
CU64	0.00E+00	6.09E-07	2.82E-07	0.00E+00	1.03E-06	0.00E+00	1.25E-05
ZN65	1.84E-05	6.31E-05	2.91E-05	0.00E+00	3.06E-05	0.00E+00	5.33E-05
ZN69	9.33E-08	1.68E-07	1.25E-08	0.00E+00	6.98E-08	0.00E+00	1.37E-05
BR83	0.00E+00	0.00E+00	3.63E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR84	0.00E+00	0.00E+00	3.82E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR85	0.00E+00	0.00E+00	1.94E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RB86	0.00E+00	1.70E-04	8.40E-05	0.00E+00	0.00E+00	0.00E+00	4.35E-06
R888	0.00E+00	4.98E-07	2.73E-07	0.00E+00	0.00E+00	0.00E+00	4.85E-07
RB89	0.00E+00	2.86E-07	1.97E-07	0.00E+00	0.00E+00	0.00E+00	9.74E-08
SR89	2.51E-03	0.00E+00	7.20E-05	0.00E+00	0.00E+00	0.00E+00	5.16E-05
SR90	1.85E-02	0.00E+00	4.71E-03	0.00E+00	0.00E+00	0.00E+00	2.31E-04
SR91	5.00E-05	0.00E+00	1.81E-06	0.00E+00	0.00E+00	0.00E+00	5.92E-05
SR92	1.92E-05	0.00E+00	7.13E-07	0.00E+00	0.00E+00	0.00E+00	2.07E-04
Y90	8.69E-08	0.00E+00	2.33E-09	0.00E+00	0.00E+00	0.00E+00	1.20E-04
Y91M	8.10E-10	0.00E+00	2.76E-11	0.00E+00	0.00E+00	0.00E+00	2.70E-06
Y91	1.13E-06	0.00E+00	3.01E-08	0.00E+00	0.00E+00	0.00E+00	8.10E-05
Y92	7.65E-09	0.00E+00	2.15E-10	0.00E+00	0.00E+00	0.00E+00	1.46E-04
Y93	2.43E-08	0.00E+00	6.62E-10	0.00E+00	0.00E+00	0.00E+00	1.92E-04
ZR95	2.06E-07	5.02E-08	3.56E-08	0.00E+00	5.41E-08	0.00E+00	2.50E-05
ZR97	1.48E-08	2.54E-09	1.16E-09	0.00E+00	2.56E-09	0.00E+00	1.62E-04
NB95	4.20E-08	1.73E-08	1.00E-08	0.00E+00	1.24E-08	0.00E+00	1.46E-05
MO99	0.00E+00	3.40E-05	6.63E-06	0.00E+00	5.08E-05	0.00E+00	1.12E-05
TC99M	1.92E-09	3.96E-09	5.10E-08	0.00E+00	4.26E-08	2.07E-09	1.15E-06

Table 2.3-8 (Cont.)

Ingestion Dose Factors for Infant (mrem/pCi ingested)

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

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

Liquid Effluent Dilution Factors (M_p)

Maximum Individual Dilution Factors

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

Population Dose Dilution Factors*

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

Table 2.3-11

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

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

*for total population and average individual dose calculations

Table 2.3-12

Usage Factors (U_{ap})

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

*for total population and average individual dose calculations

Table 2.3-13

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

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

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

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

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

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

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

Table 2.3-14

Dilution Factors for the Fish Ingestion Pathway Individual Grid Locations

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

Grid	No. of Fish	Fraction of Fish	Dist. (mi)	Dilution Factor	(FracFish)x (DilFactor)
617	52823	3.91E-2	29	92	3.60E+0
618	76004	5.63E-2	36	100	5.63E+0
714	102522	7.59E-2	9	52	3.96E+0
715	10743	7.95E-3	9	52	4.13E-1
716	19817	1.47E-2	11	56	8.21E-1
717	73401	5.43E-2	24	83	4.51E+0
718	118676	8.78E-2	33	95	8.34E+0
809	0	0.00E+0	48	115	0.00E+0
810	3953	2.93E-3	39	105	3.07E-1
811	13648	1.01E-2	30	92	9.29E-1
812	33923	2.51E-2	22	78	1.96E+0
813	182663	1.35E-1	13	61	8.25E+0
814	164369	1.22E-1	4	34	4.14E+0
909	807[illegible]	5.98E-2	50	116	6.93E+0
910	43800	3.24E-2	42	110	3.57E+0
911	117430	.69E-2	33	95	8.26E+0
912	256529	1.90E-1	24	83	1.58E+1
TOTAL	1351054	1.00E+0		TOTAL D.F.	7.74E+1

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

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

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

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

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

Table 2.3-15

Dilution Factors for the Shore Exposure Pathway

MAXIMUM EXPOSED INDIVIDUAL DILUTION FACTOR

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

TOTAL POPULATION DILUTION FACTOR

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

3.0 GASEOUS EFFLUENTS

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

All gaseous effluent releases from PNPP 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 Vent concurrent with normal, continuous releases. All releases are considered to be long-term, i.e., greater than 500 hours per year, and ground level.

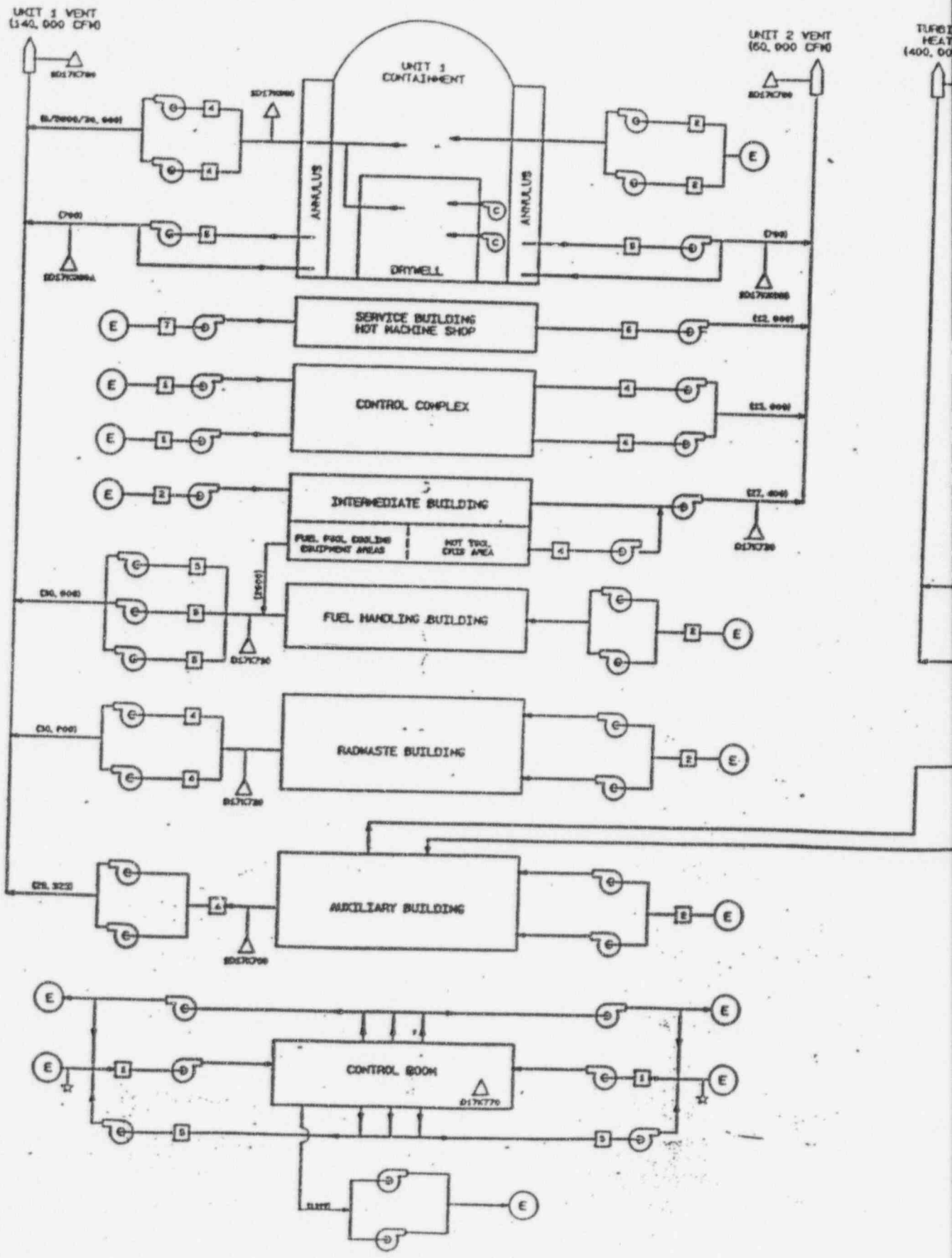
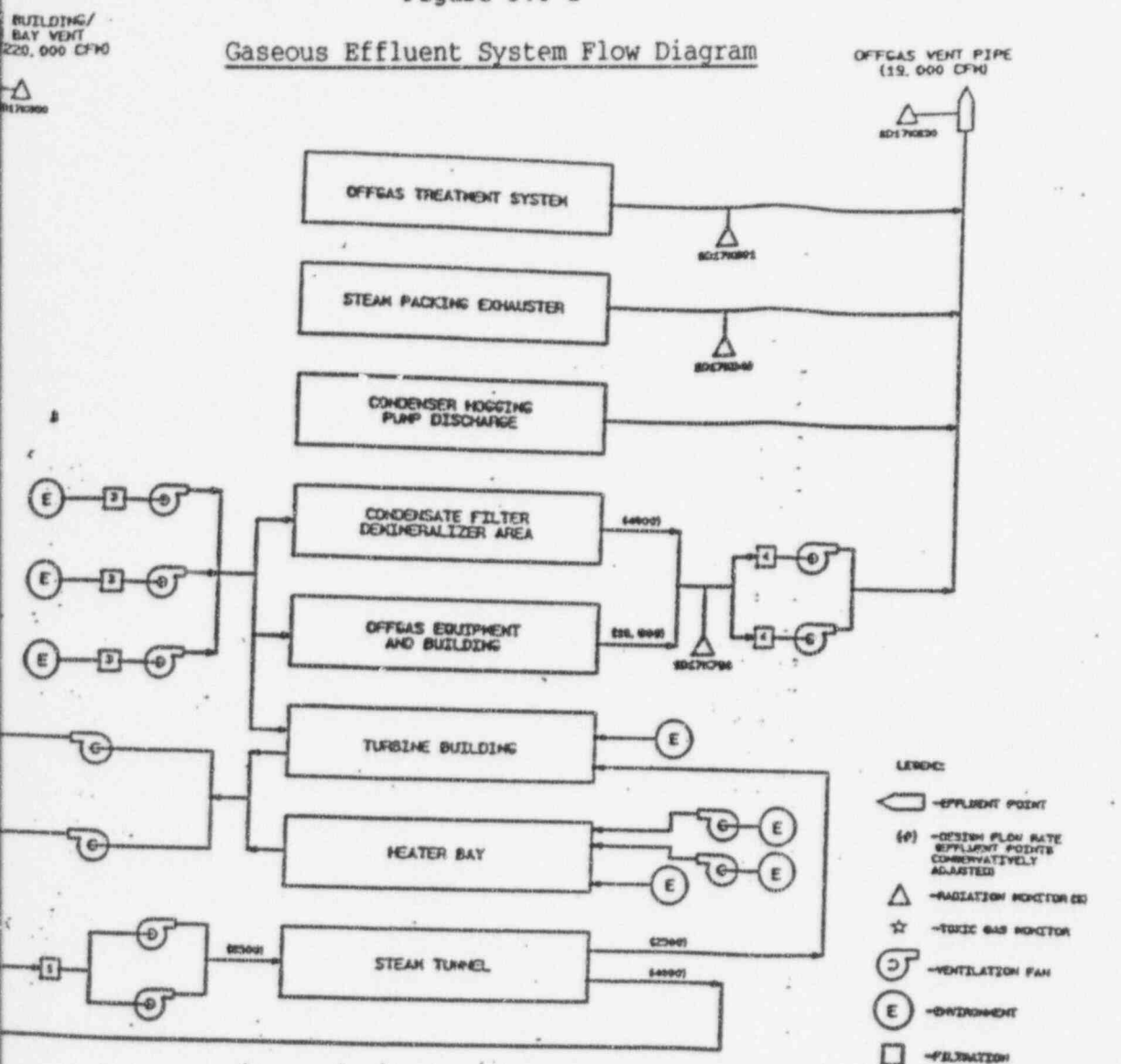
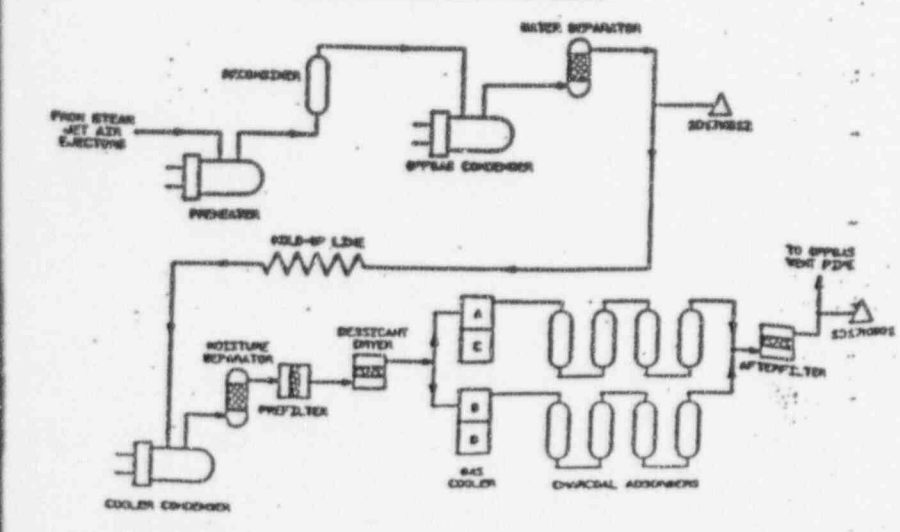

UNIT 1 VENT
(140, 000 CFM)
UNIT 2 VENT
(60, 000 CFM)
UNIT 1
CONTAINMENT
ANNULUS
ANNULUS
DRYWELL
SERVICE BUILDING
HOT MACHINE SHOP
CONTROL COMPLEX
INTERMEDIATE BUILDING
FUEL HANDLING BUILDING
RADWASTE BUILDING
AUXILIARY BUILDING
CONTROL ROOM

Figure 3.0-1

Gaseous Effluent System Flow Diagram





C=CHARCOAL FILTER
CW=CHILL H2O COIL
DES=DESICCATOR
EHC=ELECTRIC HEATING COIL
HC=H2O HEATING COIL
HEPA=HEPA FILTER
RF=ROUGHING FILTER
AC=A/C COOLING COIL

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 following noble gas monitors:

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

2. Offgas Vent Pipe radiation monitor (1D17K0836)

3. Unit 1 Vent radiation monitor (1D17K0786)

4. Unit 2 Vent radiation monitor (2D17K0786).

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

The High Alarm Setpoint (HSP) for each release point radiation monitor will be set at 70 percent of the 10CFR20 dose rate limits and the Alert Setpoint (ASP) will be set at 10 percent of these limits.

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

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. Upon receipt of an alert alarm a sample from the alarming effluent path will be obtained and analyzed. If two or more monitors exceed the ASP, or any one monitor exceeds the HSP, it is possible that the limits have been exceeded. In this case all four effluent paths will be sampled and analyzed. Appropriate action will be taken to limit gaseous releases to below 10CFR20 limits.

NOTE: If an HSP or two or more ASP's continue to be exceeded, verification shall be made at least once per 4 hours via the gaseous effluent radiation monitors that plant releases are below ODCM Appendix C 3.11.2.1 dose rate limits, and sampling and analysis shall be performed on the four gaseous effluent release points at least once per 12 hours.

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

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

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

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

Where:

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

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

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

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

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

Where:

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

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

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

χ/Q = the highest annual average relative dispersion factor for areas at the site boundary = 5.8×10^{-6} s/m^3 (from Appendix A, NE direction at the site boundary);

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

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

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

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

Where:

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

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

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

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

χ/Q = the highest annual average relative dispersion factor = 5.8×10^{-6} s/m^3, per equation 3.1-2

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

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

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

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

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

Where:

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

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

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

Release Path	Flow Rate (cfm)
- Heater Bay/Turbine Building Vent	400,000 (summer) 220,000 (winter)
- Offgas Vent Pipe	19,000
- Unit 1 Vent	140,000
- Unit 2 Vent	47,000

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

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

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

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

Where:

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

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

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

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

0.8 = an engineering safety factor.

3.1.5.1 Determination of the Monitor High Alarm Setpoint

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

Where:

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

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

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

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

3.1.5.2 Determination of the Monitor Alert Setpoint

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

Where:

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

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

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

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

Table 3.1-1

Total Body and Skin Dose Factors

Radionuclide	Total Body Dose Factor (K_i) (mrem/yr/μCi/m^3)	Total Skin Dose Factor (L_i+1.11 M_i) (mrem/yr/μCi/m^3)
Kr-83m	7.56E-02	2.14E+01
Kr-85m	1.17E+03	2.82E+03
Kr-85	1.61E+01	1.36E+03
Kr-87	5.92E+03	1.66E+04
Kr-88	1.47E+04	1.92E+04
Kr-89	1.66E+04	2.93E+04
Xe-131m	9.15E+01	6.49E+02
Xe-133m	2.51E+02	1.36E+03
Xe-133	2.94E+02	6.97E+02
Xe-135m	3.12E+03	4.44E+03
Xe-135	1.81E+03	3.99E+03
Xe-137	1.42E+03	1.39E+04
Xe-138	8.83E+03	1.44E+04
Ar-41	8.84E+03	1.30E+04

3.2 Compliance With 10CFR20 - Gaseous Effluent Dose Rate

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

3.2.1 Noble Gases

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

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

3.2.2 Radionuclides, Particulates, and Other Radionuclides

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

3.2.3 Dose Rate Calculations

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

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

Where:

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

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

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

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

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

Where:

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

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

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

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

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

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

Where:

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

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

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

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

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

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

Where:

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

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

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

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

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

χ_i = the annual average concentration of radionuclide "i" in air (pCi/m^3), for a unit release rate $(Ci/yr)_3$ and a unit χ/Q (s/m^3), in $(pCi/m^3)/(Ci/yr)(s/m^3)$;

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

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

$$DF^G_{ij} = (8760)\ (C^G_i)\ (DFG_{ij})\ (S_F) \qquad (3.2\text{-}4)$$

Where:

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

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

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

8760 = the number of hours in a year.

d. Dose Factors from Inhalation of Radionuclides in Air

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

Where:

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

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

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

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

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

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

Where:

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

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

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

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

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

f. Dose rate example problem:

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

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

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

3) Dose Rate per ODCM equation 3.2-1.

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

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

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

Table 3.2-1

Organ Used for Gaseous Effluent Dose Calculations

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

Table 3.2-2

Age Groups Used for Gaseous Effluent Dose Calculations

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

Table 3.2-3

Gaseous Effluent Dose Pathways

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

Table 3.2-4

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

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

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

Table 3.2-5

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

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

Table 3.2-5 (Cont.)

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

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

Table 3.2-6

Inhalation Dose Factors for Adult (mrem/pCi inhaled)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	NO DATA	1.58E-07	1.58E-07	1.58E-07	1.58E-07	1.58E-07	1.58E-07
C 14	2.27E-06	4.26E-07	4.26E-07	4.26E-07	4.26E-07	4.26E-07	4.26E-07
NA 24	1.28E-06	1.28E-06	1.28E-06	1.28E-06	1.28E-06	1.28E-06	1.28E-06
P 32	1.65E-04	9.64E-06	6.26E-06	NO DATA	NO DATA	NO DATA	1.08E-05
CR 51	NO DATA	NO DATA	1.25E-08	7.44E-09	2.85E-09	1.80E-06	4.15E-07
MN 54	NO DATA	4.95E-06	7.87E-07	NO DATA	1.23E-06	1.75E-04	9.67E-06
MN 56	NO DATA	1.55E-10	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	1.47E-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	1.56E-05
NI 63	5.40E-05	3.93E-06	1.81E-06	NO DATA	NO DATA	2.23E-05	1.67E-06
NI 65	1.92E-10	2.62E-11	1.14E-11	NO DATA	NO DATA	7.00E-07	1.54E-06
CU 64	NO DATA	1.83E-10	7.69E-11	NO DATA	5.78E-10	8.48E-07	6.12E-06
ZN 65	4.05E-06	1.29E-05	5.82E-06	NO DATA	8.62E-06	1.08E-04	6.68E-06
ZN 69	4.23E-12	8.14E-12	5.65E-13	NO DATA	5.27E-12	1.15E-07	2.04E-09
BR 83	NO DATA	NO DATA	3.01E-08	NO DATA	NO DATA	NO DATA	2.90E-08
BR 84	NO DATA	NO DATA	3.91E-08	NO DATA	NO DATA	NO DATA	2.05E-13
BR 85	NO DATA	NO DATA	1.60E-09	NO DATA	NO DATA	NO DATA	LT E-24
RB 86	NO DATA	1.69E-05	7.37E-06	NO DATA	NO DATA	NO DATA	2.08E-06
RB 88	NO DATA	4.84E-08	2.41E-08	NO DATA	NO DATA	NO DATA	4.18E-19
RB 89	NO DATA	3.20E-08	2.12E-08	NO DATA	NO DATA	NO DATA	1.16E-21
SR 89	3.80E-05	NO DATA	1.09E-06	NO DATA	NO DATA	1.75E-04	4.37E-05
SR 90	1.24E-02	NO DATA	7.62E-04	NO DATA	NO DATA	1.20E-03	9.02E-05
SR 91	7.74E-09	NO DATA	3.13E-10	NO DATA	NO DATA	4.56E-06	2.39E-05
SR 92	8.43E-10	NO DATA	3.64E-11	NO DATA	NO DATA	2.06E-06	5.38E-06
Y 90	2.61E-07	NO DATA	7.01E-09	NO DATA	NO DATA	2.12E-05	6.32E-05
Y 91M	3.26E-11	NO DATA	1.27E-12	NO DATA	NO DATA	2.40E-07	1.66E-10
Y 91	5.78E-05	NO DATA	1.55E-06	NO DATA	NO DATA	2.13E-04	4.81E-05
Y 92	1.29E-09	NO DATA	3.77E-11	NO DATA	NO DATA	1.96E-06	9.19E-06
Y 93	1.18E-08	NO DATA	3.26E-10	NO DATA	NO DATA	6.06E-06	5.27E-05
ZR 95	1.34E-05	4.30E-06	2.91E-06	NO DATA	6.77E-06	2.21E-04	1.88E-05
ZR 97	1.21E-08	2.45E-09	1.13E-09	NO DATA	3.71E-09	9.84E-06	6.54E-05
NB 95	1.76E-06	9.77E-07	5.26E-07	NO DATA	9.67E-07	6.31E-05	1.30E-05
MO 99	NO DATA	1.51E-08	2.87E-09	NO DATA	3.64E-08	1.14E-05	3.10E-05
TC 99M	1.29E-13	3.64E-13	4.63E-12	NO DATA	5.52E-12	9.55E-08	5.20E-07

Table 3.2-6 (Cont.)

Inhalation Dose Factors for Adult (mrem/pCi inhaled)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
TC101	5.22E-15	7.52E-15	7.38E-14	NO DATA	1.35E-13	4.99E-08	1.36E-21
RU103	1.91E-07	NO DATA	8.23E-08	NO DATA	7.29E-07	6.31E-05	1.38E-05
RU105	9.88E-11	NO DATA	3.89E-11	NO DATA	1.77E-10	1.37E-06	6.02E-06
RU106	8.64E-06	NO DATA	1.07E-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	9.69E-12	NO DATA	NO DATA	7.91E-07	2.64E-07
CE141	2.49E-06	1.69E-06	1.91E-07	NO DATA	7.83E-07	4.52E-05	1.50E-05
CE143	2.33E-08	1.72E-08	1.91E-09	NO DATA	7.60E-09	9.97E-06	2.83E-05
CE144	4.29E-04	1.79E-04	2.30E-05	NO DATA	1.06E-04	9.72E-04	1.02E-04
PR143	1.17E-06	4.69E-07	5.80E-08	NO DATA	2.70E-07	3.51E-05	2.50E-05
PR144	3.76E-12	1.56E-12	1.91E-13	NO DATA	8.81E-13	1.27E-07	2.69E-18
ND147	6.59E-07	7.62E-07	4.56E-08	NO DATA	4.45E-07	2.76E-05	2.16E-05
W 187	1.06E-09	8.85E-10	3.10E-10	NO DATA	NO DATA	3.63E-06	1.94E-05
NP239	2.87E-08	2.82E-09	1.55E-09	NO DATA	8.75E-09	4.70E-06	1.49E-05

Table 3.2-7

Inhalation Dose Factors for Teenager (mrem/pCi inhaled)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	NO DATA	1.59E-07	1.59E-07	1.59E-07	1.59E-07	1.59E-07	1.59E-07
C 14	3.25E-06	6.09E-07	6.09E-07	6.09E-07	6.09E-07	6.09E-07	6.09E-07
NA 24	1.72E-06	1.72E-06	1.72E-06	1.72E-06	1.72E-06	1.72E-06	1.72E-06
P 32	2.36E-04	1.37E-05	8.95E-06	NO DATA	NO DATA	NO DATA	1.16E-05
CR 51	NO DATA	NO DATA	1.69E-08	9.37E-09	3.84E-09	2.62E-06	3.75E-07
MN 54	NO DATA	6.39E-06	1.05E-06	NO DATA	1.59E-06	2.48E-04	8.35E-06
MN 56	NO DATA	2.12E-10	3.15E-11	NO DATA	2.24E-10	1.90E-06	7.18E-06
FE 55	4.18E-06	2.98E-06	6.93E-07	NO DATA	NO DATA	1.55E-05	7.99E-07
FE 59	1.79E-06	4.62E-06	1.79E-06	NO DATA	NO DATA	1.91E-04	2.23E-05
CO 58	NO DATA	2.59E-07	3.47E-07	NO DATA	NO DATA	1.68E-04	1.19E-05
CO 60	NO DATA	1.87E-06	2.48E-06	NO DATA	NO DATA	1.09E-03	3.24E-05
NI 63	7.25E-05	5.43E-06	2.47E-06	NO DATA	NO DATA	3.84E-05	1.77E-06
NI 65	2.73E-10	3.06E-11	1.59E-11	NO DATA	NO DATA	1.17E-06	4.59E-06
CU 64	NO DATA	2.54E-10	1.06E-10	NO DATA	8.01E-10	1.39E-06	7.68E-06
ZN 65	4.82E-06	1.67E-05	7.80E-06	NO DATA	1.08E-05	1.55E-04	5.83E-06
ZN 69	6.04E-12	1.15E-11	8.07E-13	NO DATA	7.53E-12	1.98E-07	3.56E-08
BR 83	NO DATA	NO DATA	4.30E-08	NO DATA	NO DATA	NO DATA	LT E-24
BR 84	NO DATA	NO DATA	5.41E-08	NO DATA	NO DATA	NO DATA	LT E-24
BR 85	NO DATA	NO DATA	2.29E-09	NO DATA	NO DATA	NO DATA	LT E-24
RB 86	NO DATA	2.38E-05	1.05E-05	NO DATA	NO DATA	NO DATA	2.21E-06
RB 88	NO DATA	6.82E-08	3.40E-08	NO DATA	NO DATA	NO DATA	3.65E-15
RB 89	NO DATA	4.40E-08	2.91E-08	NO DATA	NO DATA	NO DATA	4.22E-17
SR 89	5.43E-05	NO DATA	1.56E-06	NO DATA	NO DATA	3.02E-04	4.64E-05
SR 90	1.35E-02	NO DATA	8.35E-04	NO DATA	NO DATA	2.06E-03	9.56E-05
SR 91	1.10E-08	NO DATA	4.39E-10	NO DATA	NO DATA	7.59E-06	3.24E-05
SR 92	1.19E-09	NO DATA	5.08E-11	NO DATA	NO DATA	3.43E-06	1.49E-05
Y 90	3.73E-07	NO DATA	1.00E-08	NO DATA	NO DATA	3.66E-05	6.99E-05
Y 91M	4.63E-11	NO DATA	1.77E-12	NO DATA	NO DATA	4.00E-07	3.77E-09
Y 91	8.26E-05	NO DATA	2.21E-06	NO DATA	NO DATA	3.67E-04	5.11E-05
Y 92	1.84E-09	NO DATA	5.36E-11	NO DATA	NO DATA	3.35E-06	2.06E-05
Y 93	1.69E-08	NO DATA	4.65E-10	NO DATA	NO DATA	1.04E-05	7.24E-05
ZR 95	1.82E-05	5.73E-06	3.94E-06	NO DATA	8.42E-06	3.36E-04	1.86E-05
ZR 97	1.72E-08	3.40E-09	1.57E-09	NO DATA	5.15E-09	1.62E-05	7.88E-05
NB 95	2.32E-06	1.29E-06	7.08E-07	NO DATA	1.25E-06	9.39E-05	1.21E-05
MO 99	NO DATA	2.11E-08	4.03E-09	NO DATA	5.14E-08	1.92E-05	1.36E-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	2.77E-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	8.54E-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	7.52E-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	2.96E-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	1.04E-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	7.69E-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-05
RB 88	NO DATA	1.52E-07	9.90E-08	NO DATA	NO DATA	NO DATA	4.66E-09
RB 89	NO DATA	9.33E-08	7.83E-08	NO DATA	NO DATA	NO DATA	5.11E-10
SR 89	1.62E-04	NO DATA	4.66E-06	NO DATA	NO DATA	5.83E-04	4.52E-05
SR 90	2.73E-02	NO DATA	1.74E-03	NO DATA	NO DATA	3.99E-03	9.28E-05
SR 91	3.28E-08	NO DATA	1.24E-09	NO DATA	NO DATA	1.44E-05	4.70E-05
SR 92	3.54E-09	NO DATA	1.42E-10	NO DATA	NO DATA	6.49E-06	6.55E-05
Y 90	1.11E-06	NO DATA	2.99E-08	NO DATA	NO DATA	7.07E-05	7.24E-05
Y 91M	1.37E-10	NO DATA	4.98E-12	NO DATA	NO DATA	7.60E-07	4.64E-07
Y 91	2.47E-04	NO DATA	6.59E-06	NO DATA	NO DATA	7.10E-04	4.97E-05
Y 92	5.50E-09	NO DATA	1.37E-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	7.84E-09	4.32E-09	NO DATA	1.05E-08	3.06E-05	9.49E-05
NB 95	6.35E-06	2.48E-06	1.77E-06	NO DATA	2.33E-06	1.66E-04	1.00E-05
MO 99	NO DATA	4.66E-08	1.15E-08	NO DATA	1.06E-07	3.66E-05	3.42E-05
TC 99M	4.81E-13	9.41E-13	1.56E-11	NO DATA	1.37E-11	7.57E-07	1.30E-06

Table 3.2-8 (Cont.)

Inhalation Dose Factors for Child (mrem/pCi inhaled)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
TC101	2.19E-14	2.30E-14	2.91E-13	NO DATA	3.97E-13	1.58E-07	4.41E-09
RU103	7.55E-07	NO DATA	2.90E-07	NO DATA	1.70E-06	1.79E-04	1.21E-05
RU105	4.13E-10	NO DATA	1.50E-10	NO DATA	3.63E-10	4.30E-06	2.69E-05
RU106	3.68E-05	NO DATA	4.57E-06	NO DATA	4.97E-05	3.87E-03	1.16E-04
AG110M	4.56E-06	3.08E-06	2.47E-06	NO DATA	5.74E-06	1.48E-03	2.71E-05
TE125M	1.82E-06	6.29E-07	2.47E-07	5.20E-07	NO DATA	1.29E-04	9.13E-06
TE127M	6.72E-06	2.31E-06	8.10E-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	1.54E-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-05	1.53E-05
CE143	9.89E-08	5.37E-08	7.77E-09	NO DATA	2.26E-08	3.12E-05	3.44E-05
CE144	1.83E-03	5.72E-04	9.77E-05	NO DATA	3.17E-04	3.23E-03	1.05E-04
PR143	4.99E-06	1.50E-06	2.47E-07	NO DATA	8.11E-07	1.17E-04	2.63E-05
PR144	1.61E-11	4.99E-12	8.10E-13	NO DATA	2.64E-12	4.23E-07	9.32E-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	5.55E-05	NO DATA	NO DATA	NO DATA	1.15E-05
CR 51	NO DATA	NO DATA	6.37E-08	4.11E-08	9.45E-09	9.17E-06	2.55E-07
MN 54	NO DATA	1.81E-05	3.56E-06	NO DATA	3.56E-06	7.14E-04	5.04E-06
MN 56	NO DATA	1.10E-09	1.58E-10	NO DATA	7.86E-10	8.95E-06	5.12E-05
FE 55	1.41E-05	8.39E-06	2.38E-06	NO DATA	NO DATA	6.21E-05	7.82E-07
FE 59	9.49E-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	2.36E-04	6.30E-05	NO DATA	NO DATA	NO DATA	2.17E-06
RB 88	NO DATA	3.9 E-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	4.73E-13	4.25E-06	3.64E-05
BA140	4.00E-05	4.00E-08	2.07E-06	NO DATA	9.59E-09	1.14E-03	2.74E-05
BA141	1.12E-10	7.70E-14	3.55E-12	NO DATA	4.64E-14	2.12E-06	3.39E-06
BA142	2.84E-11	2.36E-14	1.40E-12	NO DATA	1.36E-14	1.11E-06	4.95E-07
LA140	3.61E-07	1.43E-07	3.68E-08	NO DATA	NO DATA	1.20E-04	6.06E-05
LA142	7.36E-10	2.69E-10	6.46E-11	NO DATA	NO DATA	5.87E-06	4.25E-05
CE141	1.98E-05	1.19E-05	1.42E-06	NO DATA	3.75E-06	3.69E-04	1.54E-05
CE143	2.09E-07	1.38E-07	1.58E-08	NO DATA	4.03E-08	8.30E-05	3.55E-05
CE144	2.28E-03	8.65E-04	1.26E-04	NO DATA	3.84E-04	7.03E-03	1.06E-04
PR143	1.00E-05	3.74E-06	4.99E-07	NO DATA	1.41E-06	3.09E-04	2.66E-05
PR144	3.42E-11	1.32E-11	1.72E-12	NO DATA	4.80E-12	1.15E-06	3.06E-06
ND147	5.67E-06	5.81E-06	3.57E-07	NO DATA	2.25E-06	2.30E-04	2.23E-05
W 187	9.26E-09	6.44E-09	2.23E-09	NO DATA	NO DATA	2.83E-05	2.54E-05
NP239	2.65E-07	2.37E-08	1.34E-08	NO DATA	4.73E-08	4.25E-05	1.78E-05

Table 3.2-10

Ingestion Dose Factor for Adult (mrem/pCi ingested)

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

Table 3.2-10 (Cont.)

Ingestion Dose Factor for Adult (mrem/pCi ingested)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
TC101	2.54E-10	3.66E-10	3.59E-09	0.00E+00	6.59E-09	1.87E-10	1.10E-21
RU103	1.85E-07	0.00E+00	7.97E-08	0.00E+00	7.06E-07	0.00E+00	2.16E-05
RU105	1.54E-08	0.00E+00	6.08E-09	0.00E+00	1.99E-07	0.00E+00	9.42E-06
RU106	2.75E-06	0.00E+00	3.48E-07	0.00E+00	5.31E-06	0.00E+00	1.78E-04
AG110M	1.60E-07	1.48E-07	8.79E-08	0.00E+00	2.91E-07	0.00E+00	6.04E-05
TE125M	2.68E-06	9.17E-07	3.59E-07	8.06E-07	1.09E-05	0.00E+00	1.07E-05
TE127M	6.77E-06	2.42E-06	8.25E-07	1.73E-06	2.75E-05	0.00E+00	2.27E-05
TE127	1.10E-07	3.95E-08	2.38E-08	8.15E-08	4.48E-07	0.00E+00	8.68E-06
TE129M	1.15E-05	4.29E-06	1.82E-06	3.95E-06	4.80E-05	0.00E+00	5.79E-05
TE129	3.14E-08	1.18E-08	7.65E-09	2.41E-08	1.32E-07	0.00E+00	2.37E-08
TE131M	1.73E-06	8.46E-07	7.05E-07	1.34E-06	8.57E-06	0.00E+00	8.40E-05
TE131	1.97E-08	8.23E-09	6.22E-09	1.62E-08	8.63E-08	0.00E+00	2.79E-09
TE132	2.52E-06	1.63E-06	1.53E-06	1.80E-06	1.57E-05	0.00E+00	7.71E-05
I130	7.56E-07	2.23E-06	8.80E-07	1.89E-04	3.48E-06	0.00E+00	1.92E-06
I131	4.16E-06	5.95E-06	3.41E-06	1.95E-03	1.02E-05	0.00E+00	1.57E-06
I132	2.03E-07	5.43E-07	1.90E-07	1.90E-05	8.65E-07	0.00E+00	1.02E-07
I133	1.42E-06	2.47E-06	7.53E-07	3.63E-04	4.31E-06	0.00E+00	2.22E-06
I134	1.06E-07	2.88E-07	1.03E-07	4.99E-06	4.58E-07	0.00E+00	2.51E-10
I135	4.43E-07	1.16E-06	4.28E-07	7.65E-05	1.86E-06	0.00E+00	1.31E-06
CS134	6.22E-05	1.48E-04	1.21E-04	0.00E+00	4.79E-05	1.59E-05	2.59E-06
CS136	6.51E-06	2.57E-05	1.85E-05	0.00E+00	1.43E-05	1.96E-06	2.92E-06
CS137	7.97E-05	1.09E-04	7.14E-05	0.00E+00	3.70E-05	1.23E-05	2.11E-06
CS138	5.52E-08	1.09E-07	5.40E-08	0.00E+00	8.01E-08	7.91E-09	4.65E-13
BA139	9.70E-08	6.91E-11	2.84E-09	0.00E+00	6.46E-11	3.92E-11	1.72E-07
BA140	2.03E-05	2.55E-08	1.33E-06	0.00E+00	8.67E-09	1.46E-08	4.18E-05
BA141	4.71E-08	3.56E-11	1.59E-09	0.00E+00	3.31E-11	2.02E-11	2.22E-17
BA142	2.13E-08	2.19E-11	1.34E-09	0.00E+00	1.85E-11	1.24E-11	3.00E-26
LA140	2.50E-09	1.26E-09	3.33E-10	0.00E+00	0.00E+00	0.00E+00	9.25E-05
LA142	1.28E-10	5.82E-11	1.45E-11	0.00E+00	0.00E+00	0.00E+00	4.25E-07
CE141	9.36E-09	6.33E-09	7.18E-10	0.00E+00	2.94E-09	0.00E+00	2.42E-05
CE143	1.65E-09	1.22E-06	1.35E-10	0.00E+00	5.37E-10	0.00E+00	4.56E-05
CE144	4.88E-07	2.04E-07	2.62E-08	0.00E+00	1.21E-07	0.00E+00	1.65E-04
PR143	9.20E-09	3.69E-09	4.56E-10	0.00E+00	2.13E-09	0.00E+00	4.03E-05
PR144	3.01E-11	1.25E-11	1.53E-12	0.00E+00	7.05E-12	0.00E+00	4.33E-18
ND147	6.29E-09	7.27E-09	4.35E-10	0.00E+00	4.25E-09	0.00E+00	3.49E-05
W187	1.03E-07	8.61E-08	3.01E-08	0.00E+00	0.00E+00	0.00E+00	2.82E-05
NP239	1.19E-09	1.17E-10	5.45E-11	0.00E+00	3.65E-10	0.00E+00	2.40E-05

Table 3.2-11

Ingestion Dose Factors for Teenager (mrem/pCi ingested)

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

Table 3.2-11 (Cont.)

Ingestion Dose Factor for Teenager (mrem/pCi ingested)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
TC101	3.60E-10	5.12E-10	5.03E-09	0.00E+00	9.26E-09	3.12E-10	8.75E-17
RU103	2.55E-07	0.00E+00	1.09E-07	0.00E+00	8.99E-07	0.00E+00	2.13E-05
RU105	2.18E-08	0.00E+00	8.46E-09	0.00E+00	2.75E-07	0.00E+00	1.76E-05
RU106	3.92E-06	0.00E+00	4.94E-07	0.00E+00	7.56E-06	0.00E+00	1.88E-04
AG110M	2.05E-07	1.94E-07	1.18E-07	0.00E+00	3.70E-07	0.00E+00	5.45E-05
TE125M	3.83E-06	1.38E-06	5.12E-07	1.07E-06	0.00E+00	0.00E+00	1.13E-05
TE127M	9.67E-06	3.43E-06	1.15E-06	2.30E-06	3.92E-05	0.00E+00	2.41E-05
TE127	1.58E-07	5.60E-08	3.40E-08	1.09E-07	6.40E-07	0.00E+00	1.22E-05
TE129M	1.63E-05	6.05E-06	2.58E-06	5.26E-06	6.82E-05	0.00E+00	6.12E-05
TE129	4.48E-08	1.67E-08	1.09E-08	3.20E-08	1.88E-07	0.00E+00	2.45E-07
TE131M	2.44E-06	1.17E-06	9.76E-07	1.76E-06	1.22E-05	0.00E+00	9.39E-05
TE131	2.79E-08	1.15E-08	8.72E-09	2.15E-08	1.22E-07	0.00E+00	2.29E-09
TE132	3.49E-06	2.21E-06	2.08E-06	2.33E-06	2.12E-05	0.00E+00	7.00E-05
I130	1.03E-06	2.98E-06	1.19E-06	2.43E-04	4.59E-06	0.00E+00	2.29E-06
I131	5.85E-06	8.19E-06	4.40E-06	2.39E-03	1.41E-05	0.00E+00	1.62E-06
I132	2.79E-07	7.30E-07	2.62E-07	2.46E-05	1.15E-06	0.00E+00	3.18E-07
I133	2.01E-06	3.41E-06	1.04E-06	4.76E-04	5.98E-06	0.00E+00	2.58E-06
I134	1.46E-07	3.87E-07	1.39E-07	6.45E-06	6.10E-07	0.00E+00	5.10E-09
I135	6.10E-07	1.57E-06	5.82E-07	1.01E-04	2.48E-06	0.00E+00	1.74E-06
CS134	8.37E-05	1.97E-04	9.14E-05	0.00E+00	6.26E-05	2.39E-05	2.45E-06
CS136	8.59E-06	3.38E-05	2.27E-05	0.00E+00	1.84E-05	2.90E-06	2.72E-06
CS137	1.12E-04	1.49E-04	5.19E-05	0.00E+00	5.07E-05	1.97E-05	2.12E-06
CS138	7.76E-08	1.49E-07	7.45E-08	0.00E+00	1.10E-07	1.28E-08	6.76E-11
BA139	1.39E-07	9.78E-11	4.05E-09	0.00E+00	9.22E-11	5.74E-11	1.24E-06
BA140	2.84E-05	3.48E-08	1.83E-06	0.00E+00	1.18E-08	2.34E-08	4.38E-05
BA141	6.71E-08	5.01E-11	2.24E-09	0.00E+00	4.65E-11	3.43E-11	1.43E-13
BA142	2.99E-08	2.99E-11	1.84E-09	0.00E+00	2.53E-11	1.99E-11	9.18E-20
LA140	3.48E-09	1.71E-09	4.55E-10	0.00E+00	0.00E+00	0.00E+00	9.82E-05
LA142	1.79E-10	7.95E-11	1.98E-11	0.00E+00	0.00E+00	0.00E+00	2.42E-06
CE141	1.33E-08	8.88E-09	1.02E-09	0.00E+00	4.18E-09	0.00E+00	2.54E-05
CE143	2.35E-09	1.71E-06	1.91E-10	0.00E+00	7.67E-10	0.00E+00	5.14E-05
CE144	6.96E-07	2.88E-07	3.74E-08	0.00E+00	1.72E-07	0.00E+00	1.75E-04
PR143	1.31E-08	5.23E-09	6.52E-10	0.00E+00	3.04E-09	0.00E+00	4.31E-05
PR144	4.30E-11	1.76E-11	2.18E-12	0.00E+00	1.01E-11	0.00E+00	4.74E-14
ND147	9.38E-09	1.02E-08	6.11E-10	0.00E+00	5.99E-09	0.00E+00	3.68E-05
W187	1.46E-07	1.19E-07	4.17E-08	0.00E+00	0.00E+00	0.00E+00	3.22E-05
NP239	1.76E-09	1.66E-10	9.22E-11	0.00E+00	5.21E-10	0.00E+00	2.67E-05

Table 3.2-12

Ingestion Dose Factors for Child (mrem/pCi ingested)

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

Table 3.2-12 (Cont.)

Ingestion Dose Factors for Child (mrem/pCi ingested)

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

Table 3.2-13

Ingestion Dose Factors for Infant (mrem/pCi ingested)

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

Table 3.2-13 (Cont.)

Ingestion Dose Factors for Infant

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

Table 3.2-14

Annual Usage Factors for the Maximum Exposed Individual

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

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

Table 3.2-15

Annual Usage Factors for the Average Individual**

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

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

**For total population and average individual dose calculations.

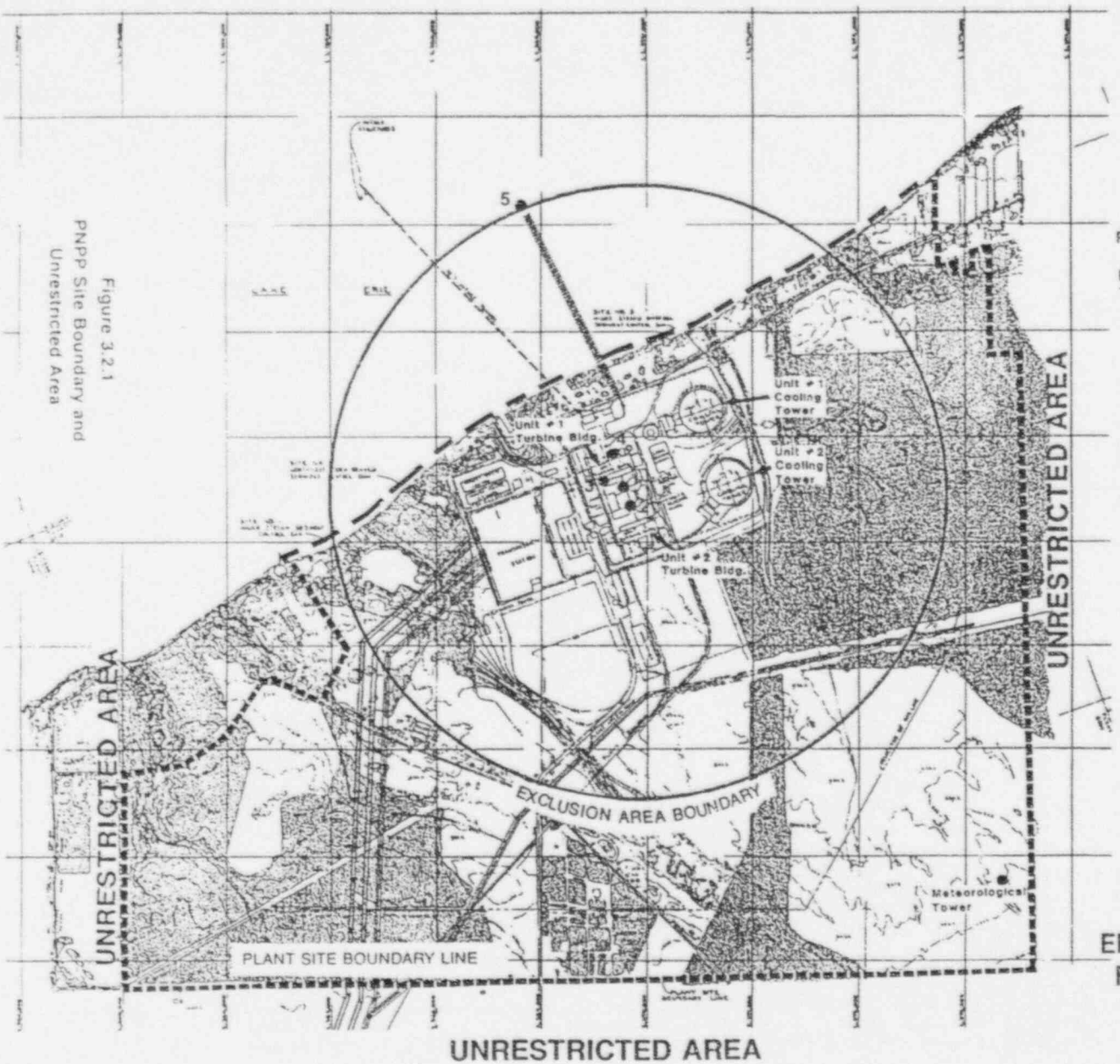


Figure 3.2.1
PNPP Site Boundary and
Unrestricted Area

LEGEND

RELEASE POINT NUMBER	DESCRIPTION
1	UNIT 1 VENT 753'-9"
2	UNIT 2 VENT 753'-9"
3	OFFGAS VENT PIPE 723'-0"
4	HEATER BAY/TURBINE BLDG. VENT 722'-0"
5	LIQUID RADWASTE DISCHARGE

GROUND LEVEL 620'-0"

UNRESTRICTED AREA BOUNDARY FOR LIQUID EFFLUENTS AND UNRESTRICTED AREA BOUNDARY FOR GASEOUS EFFLUENTS

1000 0 1000 2000
FEET

UNRESTRICTED AREA BOUNDARY FOR LIQUID EFFLUENTS, SITE BOUNDARY FOR GASEOUS EFFLUENTS AND EXCLUSION AREA BOUNDARY

Figure 3.2-1

3.3 Compliance With 10CFR50 Appendix I - Gaseous Effluent Dose

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

3.3.1 Noble Gases

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

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

a. For gamma radiation, during any calendar quarter:

$D_{air} \leq 5$ mrads,

b. For beta radiation, during any calendar quarter:

$D_{air} \leq 10$ mrads,

c. For gamma radiation, during any calendar year:

$D_{air} \leq 10$ mrads,

d. For beta radiation, during any calendar year:

$D_{air} \leq 20$ mrads.

3.3.2 Radioiodines, Particulates, and Other Radionuclides

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

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

a. During any calendar quarter:

Dose to Any Organ $\leq$ 7.5 mrems

b. During any calendar year:

Dose to Any Organ $\leq$ 15 mrems.

3.3.3 Dose Calculations

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

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

a. Gamma Air Dose from Noble Gas Releases

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

Where:

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

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

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

χ/Q = the normal relative dispersion factor, in s/m^3 (see Appendix A);

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

b. Beta Air dose from Noble Gas Releases

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

Where:

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

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

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

χ/Q = the normal relative dispersion factor, in s/m^3; (see Appendix A);

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

3.3.4 Cumulation of Doses

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

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

3.3.5 Projection of Doses

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

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

3.4 Population Dose

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

Table 3.3-1

Gamma and Beta Air Dose Factors for Semi-Infinite Plume

(mrad/s per Ci/m^3)

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

4.0 TOTAL DOSE

4.1 Compliance With 40CFR190 - Uranium Fuel Cycle Dose

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

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

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

This Special Report shall contain:

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

2. A determination of the maximum exposed individual.

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

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

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

4.2 Direct Radiation Dose from PNPP

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

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

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

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

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

4.3 Dose to Members of the Public While Onsite

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

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

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

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

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

5.0 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

5.1 Monitoring Program

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

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

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

C-1

5.2 Land Use Census Program

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

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

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

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

5.3 Inter-Laboratory Comparison Program

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

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

Table 5.1-1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

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

Table 5.1-1 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

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

Table 5.1-1 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

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

Table 5.1-1 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

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

Table 5.1-1 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Table Notations

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

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

(3) Airborne particulate sample filters shall be analyzed for gross beta radioactivity 24 hours or more after sampling to allow for radon and thoron daughter decay. If gross beta activity in air particulate samples is greater than 10 times the yearly mean of control samples, gamma isotopic analysis shall be performed on the individual samples. C-1

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

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

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

Table 5.1-2

Reporting Levels for Radioactivity Concentrations in Environmental Samples

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

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

Table 5.1-3

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

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

Table 5.1-3 (Cont.)

Table Notations

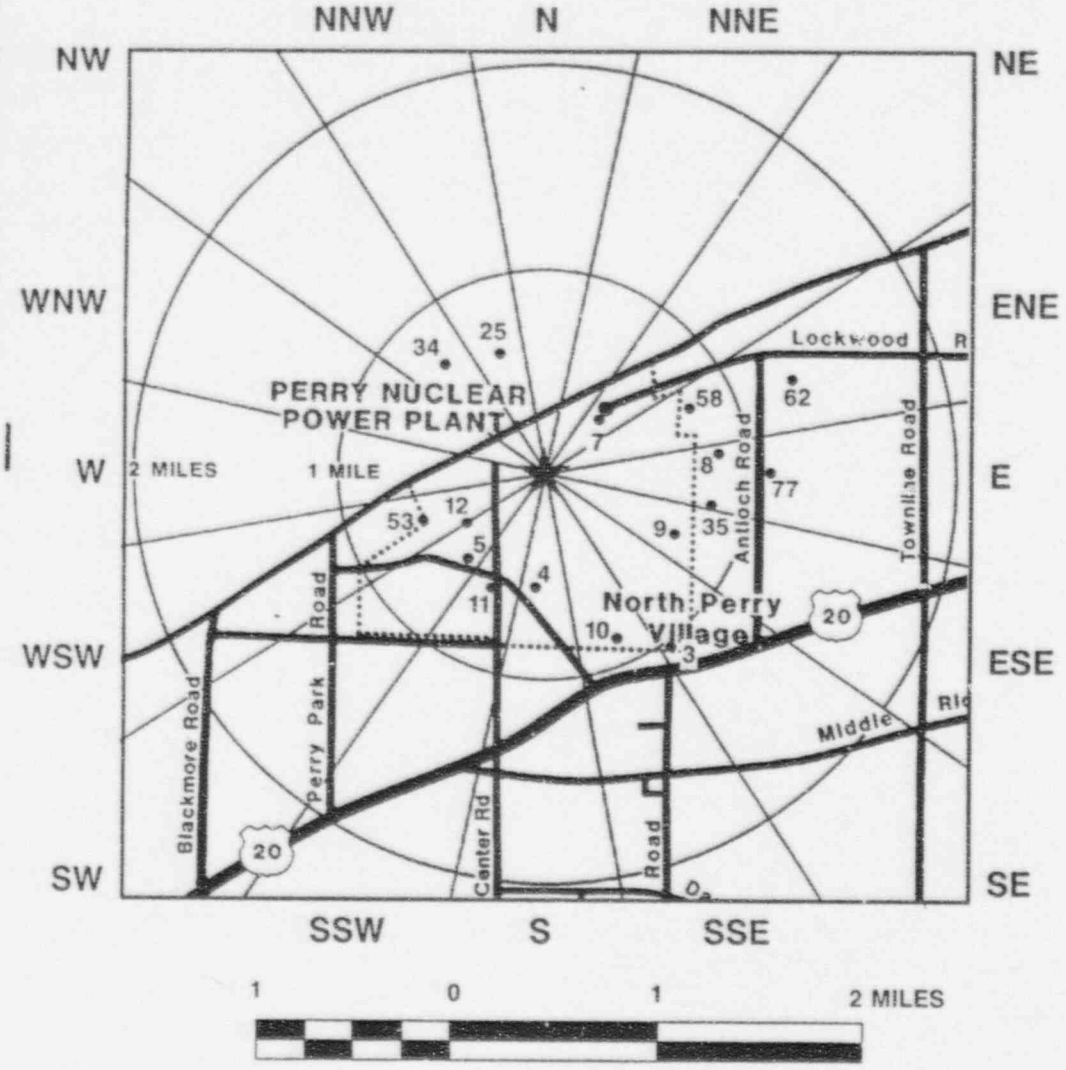
[a] Required detection capabilities for thermoluminescent dosimeters used for environmental measurements shall be in accordance with the recommendations of Regulatory Guide 4.13, except for specification regarding energy dependence. Correction factors shall be provided for energy ranges not meeting the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

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

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

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

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



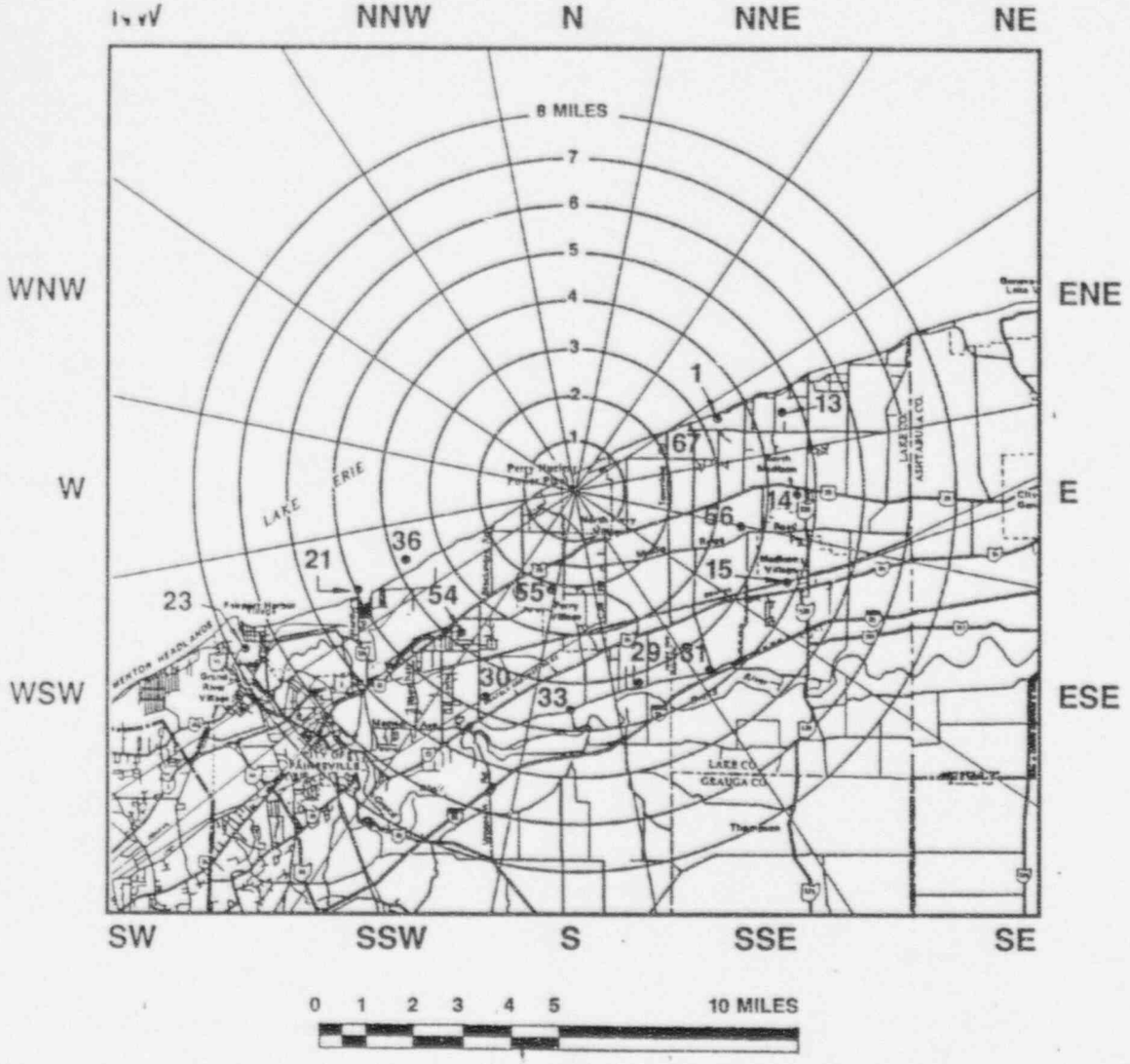
LEGEND:

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

Figure 5.1-1

TECHNICAL SPECIFICATION REQUIRED

REMP SAMPLING LOCATIONS WITHIN TWO MILES OF THE PLANT SITE

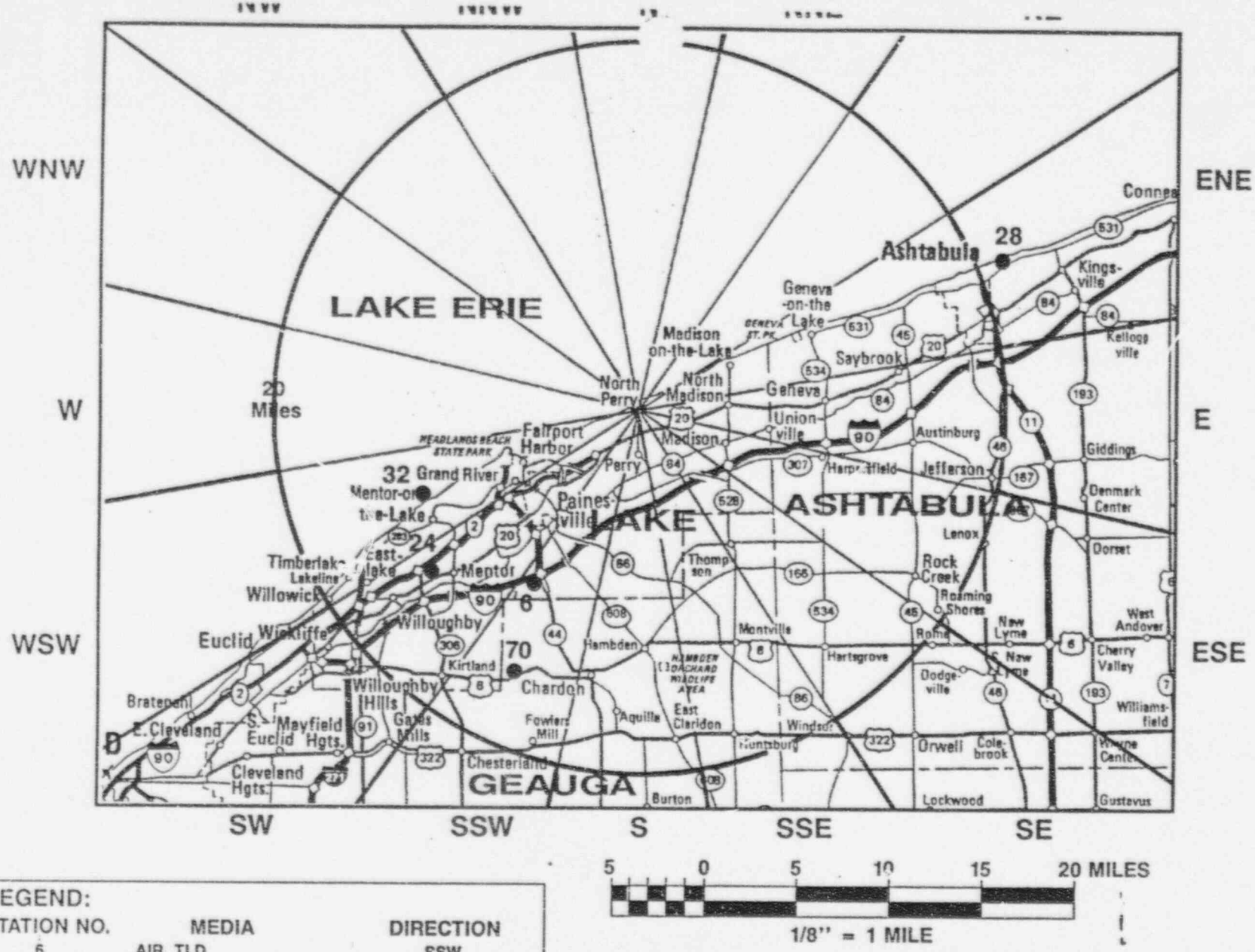


LEGEND:

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

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

Figure 5.1-2



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

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

Figure 5.1-3

Appendix A

Atmospheric Dispersion and Deposition Parameters

The atmospheric dispersion and deposition parameters used to calculate gaseous effluent doses will be calculated using the following equations. Dose calculations will be performed using meteorological conditions concurrent with the time of release of radioactive materials in gaseous effluents or using historical average atmospheric conditions. All atmospheric releases at PNPP are considered to be ground-level releases. C-1

a. Constant Mean Wind Direction Relative Dispersion Factor

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

Where:

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

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

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

x = the distance of calculation, in m;

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

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

Where:

H_c = the building height (44.8m);

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

b. Depleted Relative Dispersion Factor

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

Where:

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

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

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

c. Ground Deposition

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

Where:

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

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

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

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

0.3927 = radians per 22.5° sector

Table A-1

Atmospheric Depletion and Deposition Factors

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

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

Table A-2

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

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

Table A-3

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

SECTOR	0.2 (MILES)	0.3 (MILES)	0.4 (MILES)	0.5 (MILES)	0.6 (MILES)
N	4.904E-05	2.453E-05	1.525E-05	1.057E-05	7.918E-06
NNE	2.656E-05	1.360E-05	8.640E-06	6.082E-06	4.612E-06
NE	1.859E-05	9.760E-06	6.293E-06	4.460E-06	3.383E-06
ENE	1.327E-05	7.129E-06	4.636E-06	3.293E-06	2.490E-06
E	1.363E-05	7.362E-06	4.760E-06	3.367E-06	2.536E-06
ESE	1.025E-05	5.566E-06	3.602E-06	2.547E-06	1.916E-06
SE	1.113E-05	6.061E-06	3.935E-06	2.788E-06	2.100E-06
SSE	1.894E-05	1.022E-05	6.647E-06	4.718E-06	3.560E-06
S	2.288E-05	1.227E-05	7.932E-06	5.615E-06	4.238E-06
SSW	1.142E-05	6.079E-06	3.925E-06	2.777E-06	2.097E-06
SW	1.449E-05	7.663E-06	4.928E-06	3.479E-06	2.622E-06
WSW	2.151E-05	1.111E-05	7.031E-06	4.934E-06	3.733E-06
W	4.184E-05	2.081E-05	1.281E-05	8.873E-06	6.606E-06
WNW	4.669E-05	2.298E-05	1.401E-05	9.573E-06	7.093E-06
NW	4.908E-05	2.423E-05	1.482E-05	1.015E-05	7.521E-06
NNW	4.580E-05	2.266E-05	1.390E-05	9.541E-06	7.083E-06

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

Table A-3 (Cont.)

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

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

SECTOR	1.7 (MILES)	1.8 (MILES)	1.9 (MILES)	2.0 (MILES)	2.1 (MILES)
N	1.074E-06	9.931E-07	9.226E-07	8.604E-07	8.052E-07
NNE	6.867E-07	6.331E-07	5.864E-07	5.453E-07	5.090E-07
NE	4.886E-07	4.494E-07	4.153E-07	3.854E-07	3.263E-07
ENE	3.471E-07	3.184E-07	2.936E-07	2.718E-07	2.526E-07
E	3.467E-07	3.177E-07	2.925E-07	2.705E-07	2.283E-07
ESE	2.590E-07	2.371E-07	2.182E-07	2.017E-07	1.871E-07
SE	2.268E-07	2.076E-07	1.910E-07	1.765E-07	1.637E-07
SSE	2.827E-07	2.590E-07	2.384E-07	2.205E-07	1.407E-07
S	3.780E-07	3.466E-07	3.194E-07	2.955E-07	1.373E-07
SSW	2.706E-07	2.494E-07	2.290E-07	2.121E-07	1.409E-07
SW	2.968E-07	2.727E-07	2.518E-07	2.335E-07	2.173E-07
WSW	4.639E-07	4.275E-07	3.957E-07	3.678E-07	5.303E-07
W	9.037E-07	8.365E-07	7.777E-07	7.258E-07	1.050E-06
WNW	1.038E-06	9.622E-07	8.960E-07	8.375E-07	1.142E-06
NW	1.095E-06	1.015E-06	9.445E-07	8.826E-07	8.275E-07
NNW	1.028E-06	9.527E-07	8.865E-07	8.281E-07	7.761E-07

Table A-3 (Cont.)

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

SECTOR	2.2 (MILES)	2.3 (MILES)	2.4 (MILES)	2.5 (MILES)	2.6 (MILES)
N	7.560E-07	7.118E-07	6.720E-07	6.359E-07	6.033E-07
NNE	4.766E-07	4.477E-07	4.217E-07	3.982E-07	3.770E-07
NE	3.050E-07	2.859E-07	2.688E-07	2.534E-07	2.395E-07
ENE	2.356E-07	2.205E-07	2.069E-07	1.947E-07	1.837E-07
E	2.127E-07	1.988E-07	1.864E-07	1.752E-07	1.652E-07
ESE	1.743E-07	1.628E-07	1.525E-07	1.433E-07	1.351E-07
SE	1.524E-07	1.424E-07	1.334E-07	1.253E-07	1.181E-07
SSE	1.311E-07	1.225E-07	1.149E-07	1.080E-07	1.018E-07
S	1.280E-07	1.197E-07	1.123E-07	1.056E-07	9.963E-08
SSW	1.314E-07	1.230E-07	1.154E-07	1.087E-07	1.025E-07
SW	2.030E-07	1.902E-07	1.787E-07	1.683E-07	1.590E-07
WSW	4.964E-07	4.651E-07	4.388E-07	4.142E-07	3.920E-07
W	9.867E-07	9.296E-07	8.780E-07	8.313E-07	7.891E-07
WNW	1.075E-06	1.014E-06	9.587E-07	9.088E-07	8.636E-07
NW	7.782E-07	7.339E-07	6.939E-07	6.576E-07	6.247E-07
NNW	7.297E-07	6.879E-07	6.502E-07	6.161E-07	5.852E-07

SECTOR	2.7 (MILES)	2.8 (MILES)	2.9 (MILES)	3.0 (MILES)	3.1 (MILES)
N	5.734E-07	5.460E-07	5.208E-07	4.976E-07	4.762E-07
NNE	3.576E-07	3.398E-07	3.235E-07	3.086E-07	2.948E-07
NE	2.268E-07	2.152E-07	2.046E-07	1.949E-07	1.859E-07
ENE	1.737E-07	1.645E-07	1.562E-07	1.485E-07	1.415E-07
E	1.560E-07	1.477E-07	1.401E-07	1.331E-07	1.267E-07
ESE	1.275E-07	1.207E-07	1.144E-07	1.087E-07	9.399E-08
SE	1.115E-07	1.054E-07	9.996E-08	9.493E-08	9.031E-08
SSE	9.613E-08	9.099E-08	8.630E-08	8.200E-08	7.805E-08
S	9.415E-08	8.917E-08	8.462E-08	8.044E-08	7.661E-08
SSW	9.697E-08	9.189E-08	8.725E-08	8.299E-08	7.907E-08
SW	1.305E-07	1.428E-07	1.357E-07	1.291E-07	1.231E-07
WSW	3.716E-07	3.531E-07	3.360E-07	3.204E-07	2.520E-07
W	7.503E-07	7.147E-07	6.820E-07	6.519E-07	5.874E-07
WNW	8.220E-07	7.838E-07	7.487E-07	7.164E-07	7.722E-07
NW	5.945E-07	5.668E-07	5.413E-07	5.178E-07	5.412E-07
NNW	5.567E-07	5.307E-07	5.067E-07	4.846E-07	4.642E-07

Table A-3 (Cont.)

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

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

SECTOR	3.7 (MILES)	3.8 (MILES)	3.9 (MILES)	4.0 (MILES)	(MILES)
N	3.759E-07	3.628E-07	3.504E-07	3.388E-07	2.981E-07
NNE	2.306E-07	2.222E-07	2.144E-07	2.070E-07	1.819E-07
NE	1.441E-07	1.390E-07	1.339E-07	1.292E-07	1.247E-07
ENE	1.090E-07	1.048E-07	1.009E-07	9.718E-08	9.373E-08
E	9.722E-08	9.342E-08	8.987E-08	8.653E-08	8.341E-08
ESE	7.196E-08	6.912E-08	6.647E-08	6.399E-08	6.166E-08
SE	6.908E-08	6.635E-08	6.380E-08	6.140E-08	5.378E-08
SSE	5.987E-08	5.753E-08	5.533E-08	5.328E-08	5.135E-08
S	5.892E-08	5.664E-08	5.451E-08	5.251E-08	5.063E-08
SSW	6.098E-08	5.865E-08	5.646E-08	5.441E-08	5.248E-08
SW	9.537E-08	9.178E-08	8.841E-08	8.525E-08	8.228E-08
WSW	1.967E-07	1.896E-07	1.828E-07	1.765E-07	1.462E-07
W	4.646E-07	4.485E-07	4.334E-07	4.191E-07	3.043E-07
WNW	6.137E-07	5.929E-07	5.733E-07	5.548E-07	4.180E-07
NW	4.298E-07	4.151E-07	4.013E-07	3.883E-07	3.761E-07
NNW	3.682E-07	3.556E-07	3.438E-07	3.326E-07	2.928E-07

Table A-3 (Cont.)

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

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

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

Table A-4

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

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

SECTOR	0.7 (MILES)	0.8 (MILES)	0.9 (MILES)	1.0 (MILES)	1.1 (MILES)
N	1.954E-08	1.560E-08	1.277E-08	1.068E-08	5.545E-09
NNE	1.549E-08	1.237E-08	1.013E-08	8.465E-09	4.945E-09
NE	1.362E-08	1.088E-08	8.907E-09	7.445E-09	4.350E-09
ENE	1,494E-08	1.193E-08	9.768E-09	8.164E-09	4.770E-09
E	1.658E-08	1.323E-08	1.084E-08	9.058E-09	5.292E-09
ESE	1.241E-08	9.905E-09	8.112E-09	6.781E-09	3.961E-09
SE	1.316E-08	1.051E-08	8.605E-09	7.192E-09	3.361E-09
SSE	1.874E-08	1.496E-08	1.225E-08	1.024E-08	3.480E-09
S	2.000E-08	1.597E-08	1.308E-08	1.093E-08	4.128E-09
SSW	8.531E-09	6.810E-09	5.577E-09	4.662E-09	2.521E-09
SW	1.017E-08	8.120E-09	6.651E-09	5.559E-09	2.598E-09
WSW	9.963E-09	7.953E-09	6.513E-09	5.444E-09	2.678E-09
W	9.980E-09	7.966E-09	6.524E-09	5.453E-09	2.832E-09
WNW	9.757E-09	7.788E-09	6.379E-09	5.332E-09	2.932E-09
NW	1.246E-08	9.949E-09	8.148E-09	6.811E-09	3.745E-09
NNW	1.347E-08	1.075E-08	8.807E-09	7.361E-09	4.047E-09

Table A-4 (Cont.)

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

SECTOR	1.2 (MILES)	1.3 (MILES)	1.4 (MILES)	1.5 (MILES)	1.6 (MILES)
N	4.777E-09	4.163E-09	3.664E-09	3.252E-09	2.910E-09
NNE	4.260E-09	3.713E-09	3.268E-09	2.900E-09	2.595E-09
NE	3.747E-09	3.265E-09	2.874E-09	2.551E-09	2.283E-09
ENE	4.109E-09	3.581E-09	3.151E-09	2.797E-09	2.503E-09
E	4.559E-09	3.973E-09	3.497E-09	3.104E-09	2.777E-09
ESE	3.413E-09	2.974E-09	2.617E-09	2.323E-09	2.079E-09
SE	2.896E-09	2.524E-09	2.221E-09	1.971E-09	1.764E-09
SSE	2.998E-09	2.612E-09	2.299E-09	2.041E-09	1.826E-09
S	3.556E-09	3.099E-09	2.727E-09	2.421E-09	2.166E-09
SSW	2.172E-09	1.892E-09	1.666E-09	1.478E-09	1.323E-09
SW	2.239E-09	1.950E-09	1.717E-09	1.524E-09	1.363E-09
WSW	2.307E-09	2.011E-09	1.770E-09	1.571E-09	1.406E-09
W	2.440E-09	2.126E-09	1.871E-09	1.661E-09	1.486E-09
WNW	2.525E-09	2.201E-09	1.937E-09	1.719E-09	1.538E-09
NW	3.226E-09	2.811E-09	2.474E-09	2.196E-09	1.965E-09
NNW	3.487E-09	3.039E-09	2.674E-09	2.374E-09	2.124E-09

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

Table A-4 (Cont.)

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

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

SECTOR	2.7 (MILES)	2.8 (MILES)	2.9 (MILES)	3.0 (MILES)	3.1 (MILES)
N	1.165E-09	1.092E-09	1.026E-09	9.666E-10	9.120E-10
NNE	1.039E-09	9.742E-10	9.155E-10	8.621E-10	8.134E-10
NE	8.307E-10	7.789E-10	7.320E-10	6.893E-10	6.504E-10
ENE	1.002E-09	9.396E-10	8.830E-10	8.315E-10	7.845E-10
E	1.011E-09	9.477E-10	8.906E-10	8.387E-10	7.913E-10
ESE	8.322E-10	7.804E-10	7.334E-10	6.906E-10	5.923E-10
SE	7.061E-10	6.622E-10	6.223E-10	5.860E-10	5.529E-10
SSE	5.026E-10	4.713E-10	4.429E-10	4.171E-10	3.935E-10
S	4.336E-10	4.066E-10	3.821E-10	3.598E-10	3.395E-10
SSW	3.782E-10	3.547E-10	3.333E-10	3.139E-10	2.961E-10
SW	5.459E-10	5.118E-10	4.810E-10	4.529E-10	4.273E-10
WSW	8.695E-10	8.154E-10	7.663E-10	7.216E-10	5.607E-10
W	9.194E-10	8.621E-10	8.102E-10	7.630E-10	6.775E-10
WNW	8.958E-10	8.400E-10	7.894E-10	7.434E-10	7.890E-10
NW	7.867E-10	7.377E-10	6.933E-10	6.528E-10	6.719E-10
NNW	8.503E-10	7.973E-10	7.493E-10	7.056E-10	6.657E-10

Table A-4 (Cont.)

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

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

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

Table A-4 (Cont.)

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

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

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

Appendix B

Lower Limit of Detection

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

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

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

Where:

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

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

E = the detector efficiency;

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

t_b = the counting time of background;

t_s = the counting time of the sample;

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

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

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

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

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

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

For gamma ray spectroscopy analyses:

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

Where:

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

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

E = the detector efficiency for the energy in question;

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

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

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

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

Yγ = the yield of the gamma ray in question;

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

L_D = the detection limit

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

Where:

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

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

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

= 1.645 at a confidence level of 95%;

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

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

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

σ_I = the standard deviation of I.

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

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

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

Appendix C

Controls

INDEX

DEFINITIONS

SECTION

CONTROLS AND SURVEILLANCE REQUIREMENTS

CONTROLS AND SURVEILLANCE REQUIREMENTS

BASES

BASES

ADMINISTRATIVE CONTROLS

SECTION 1.0

DEFINITIONS

1.0 DEFINITIONS

The following terms are defined so that uniform interpretation of these Controls may be achieved. The defined terms appear in capitalized type and shall be applicable throughout these Controls.

ACTION

1.1 ACTION shall be that part of a Control which prescribes remedial measures required under designated conditions.

CHANNEL CALIBRATION

1.4 A CHANNEL CALIBRATION shall be the adjustment, as necessary, of the channel output such that it responds with the necessary range and accuracy to known values of the parameter which the channel monitors. The CHANNEL CALIBRATION shall encompass the entire channel including the sensor and alarm and/or trip functions, and shall include the CHANNEL FUNCTIONAL TEST. The CHANNEL CALIBRATION may be performed by any series of sequential, overlapping or total channel steps such that the entire channel is calibrated.

CHANNEL CHECK

1.5 A CHANNEL CHECK shall be the qualitative assessment of channel behavior during operation by observation. This determination shall include, where possible, comparison of the channel indication and/or status with other indications and/or status derived from independent instrument channels measuring the same parameter.

CHANNEL FUNCTIONAL TEST

1.6 A CHANNEL FUNCTIONAL TEST shall be:

a. Analog channels - the injection of a simulated signal into the channel as close to the sensor as practicable to verify OPERABILITY including alarm and/or trip functions and channel failure trips.

b. Bistable channels - the injection of a simulated signal into the sensor to verify OPERABILITY including alarm and/or trip functions.

The CHANNEL FUNCTIONAL TEST may be performed by any series of sequential, overlapping or total channel steps such that the entire channel is tested.

DOSE EQUIVALENT I-131

1.10 DOSE EQUIVALENT I-131 shall be that concentration of I-131, microcuries per gram, which alone would produce the same thyroid dose as the quantity and isotopic mixture of I-131, I-132, I-133, I-134, and I-135 actually present. The thyroid dose conversion factors used for this calculation shall be those listed in Table III of TID-14844, "Calculation of Distance Factors for Power and Test Reactor Sites."

DEFINITIONS

FREQUENCY NOTATION

1.17 The FREQUENCY NOTATION specified for the performance of Surveillance Requirements shall correspond to the intervals defined in Table 1.1.

GASEOUS RADWASTE TREATMENT (OFFGAS) SYSTEM

1.19 THE GASEOUS RADWASTE TREATMENT (OFFGAS) SYSTEM is the system designed and installed to reduce radioactive gaseous effluents by collecting primary coolant system offgasses from the main condenser evacuation system and providing for delay or holdup for the purpose of reducing the total radioactivity prior to release to the environment.

LIQUID RADWASTE TREATMENT SYSTEM

1.24 The LIQUID RADWASTE TREATMENT SYSTEM is any process or control equipment used to reduce the amount or concentration of liquid radioactive materials prior to their discharge to UNRESTRICTED AREAS. It involves all the installed and available liquid radwaste management system equipment, as well as their controls, power instrumentation, and services that make the system functional.

MEMBER(S) OF THE PUBLIC

1.26 MEMBER(S) OF THE PUBLIC shall include all persons who are not occupationally associated with the plant. This category does not include employees of the utility, its contractors, or vendors. Also excluded from this category are persons who enter the site to service equipment or to make deliveries. This category does include persons who use portions of the site for recreational, occupational, or other purposes not associated with the plant.

OFFSITE DOSE CALCULATION MANUAL (ODCM)

1.28 The OFFSITE DOSE CALCULATION MANUAL shall contain the methodology and parameters used in the calculation of offsite doses due to radioactive gaseous and liquid effluents, in the calculation of gaseous and liquid effluent monitoring alarm/trip setpoints, and in the conduct of the radiological environmental monitoring program. The ODCM shall also contain (1) the Radioactive Effluent Controls and Radiological Environmental Monitoring Programs required by Specification 6.8.4 and (2) descriptions of the information that should be included in the Annual Radiological Environmental Operating and Annual Radioactive Effluent Release Reports required by Technical Specifications 6.9.1.6 and 6.9.1.7.

OPERABLE - OPERABILITY

1.29 A system, subsystem, train, component or device shall be OPERABLE or have OPERABILITY when it is capable of performing its specified function(s) and when all necessary attendant instrumentation, controls, electrical power, cooling or seal water, lubrication or other auxiliary equipment that are required for the system, subsystem, train, component or device to perform its function(s) are also capable of performing their related support function(s).

OPERATIONAL CONDITION - CONDITION

1.30 An OPERATIONAL CONDITION, i.e., CONDITION, shall be any one inclusive combination of mode switch position and average reactor coolant temperature as specified in Table 1.2.

PURGE - PURGING

1.35 PURGE OR PURGING is the controlled process of discharging air or gas from a confinement to maintain temperature, pressure, humidity, concentration or other operating condition, in such a manner that replacement air or gas is required to purify the confinement.

RATED THERMAL POWER

1.36 RATED THERMAL POWER shall be a total reactor core heat transfer rate to the reactor coolant of 3579 MWT.

REPORTABLE EVENT

1.38 A REPORTABLE EVENT shall be any of those conditions specified in 10 CFR 50.73.

SITE BOUNDARY

1.42 The SITE BOUNDARY shall be that line beyond which the land is neither owned, nor leased, nor otherwise controlled by the licensee.

SOURCE CHECK

1.44 A SOURCE CHECK shall be the qualitative assessment of channel response when the channel sensor is exposed to a source of increased radioactivity.

THERMAL POWER

1.46 THERMAL POWER shall be the total reactor core heat transfer rate to the reactor coolant.

UNRESTRICTED AREA

1.49 An UNRESTRICTED AREA shall be any area at or beyond the SITE BOUNDARY access to which is not controlled by the licensee for purposes of protection of MEMBERS OF THE PUBLIC from exposure to radiation and radioactive materials, or any area within the SITE BOUNDARY used for residential quarters or for industrial, commercial, institutional, and/or recreational purposes.

DEFINITIONS

VENTILATION EXHAUST TREATMENT SYSTEMS

1.50 A VENTILATION EXHAUST TREATMENT SYSTEM is any system designed and installed to reduce gaseous radioiodine or radioactive material in particulate form in effluents by passing ventilation or vent exhaust gases through charcoal adsorbers and/or HEPA filters for the purpose of removing iodines or particulates from the gaseous exhaust stream prior to the release to the environment (such a system is not considered to have any effect on noble gas effluents). Engineered Safety Feature (ESF) atmospheric cleanup systems are not considered to be VENTILATION EXHAUST TREATMENT SYSTEM components provided the ESF system is not utilized to treat normal releases.

VENTING

1.51 VENTING is the controlled process of discharging air or gas from a confinement to maintain temperature, pressure, humidity, concentration or other operating condition, in such a manner that replacement air or gas is not provided or required during VENTING. Vent, used in system names, does not imply a VENTING process.

TABLE 1.1

SURVEILLANCE FREQUENCY NOTATION

NOTATION	FREQUENCY
S	At last once per 12 hours.
D	At least once per 24 hours.
W	At least once per 7 days.
M	At least once per 31 days.
Q	At least once per 92 days.
SA	At least once per 184 days.
A	At least once per 366 days.
R	At least once per 18 months (550 days).
S/U	Prior to each reactor startup.
P	Completed prior to each release
N.A.	Not applicable.

TABLE 1.2

OPERATIONAL CONDITIONS

CONDITION	MODE SWITCH POSITION	AVERAGE REACTOR COOLANT TEMPERATURE
1. POWER OPERATION	Run	Any temperature
2. STARTUP	Startup/Hot Standby**	Any temperature
3. HOT SHUTDOWN	Shutdown#,***	> 200°F
4. COLD SHUTDOWN	Shutdown#,##,***	≤ 200°F
5. REFUELING*	Shutdown or Refuel**,#	≤ 140°F

#The reactor mode switch may be placed in the Run, Startup/Hot Standby, or Refuel position to test the switch interlock functions and related instrumentation provided that the control rods are verified to remain fully inserted by a second licensed operator or other technically qualified member of the unit technical staff.

##The reactor mode switch may be placed in the Refuel position while a single control rod drive is being removed from the reactor pressure vessel per PNPP Unit 1 Technical Specification 3.9.10.1.

*Fuel in the reactor vessel with the vessel head closure bolts less than fully tensioned or with the head removed.

**See Special Test Exceptions 3.10.1 and 3.10.3 of PNPP Unit 1 Technical Specifications.

***The reactor mode switch may be placed in the Refuel position while a single control rod is being recoupled or withdrawn provided that the one-rod-out interlock is OPERABLE.

SECTIONS 3.0 and 4.0

CONTROLS

AND

SURVEILLANCE REQUIREMENTS

3/4.0 APPLICABILITY

CONTROLS

3.0.1 Compliance with the Controls contained in the succeeding controls is required during the OPERATIONAL CONDITIONS or other conditions specified therein; except that upon failure to meet the Control, the associated ACTION requirements shall be met.

3.0.2 Noncompliance with a control shall exist when the requirements of the Control and associated ACTION requirements are not met within the specified time intervals. If the Control is restored prior to expiration of the specified time intervals, completion of the Action requirements is not required.

3.0.3 When a Control is not met, except as provided in the associated ACTION requirements, within one hour action shall be initiated to place the unit in an OPERATIONAL CONDITION in which the control does not apply by placing it, as applicable, in:

1. At least STARTUP within the next 6 hours,
2. At least HOT SHUTDOWN within the following 6 hours, and
3. At least COLD SHUTDOWN within the subsequent 24 hours.

Where corrective measures are completed that permit operation under the ACTION requirements, the ACTION may be taken in accordance with the specified time limits as measured from the time of failure to meet the Control. Exceptions to these requirements are stated in the individual controls.

This control is not applicable in OPERATIONAL CONDITIONS 4 or 5.

3.0.4 Entry into an OPERATIONAL CONDITION or other specified condition shall not be made when the conditions for the Control are not met and the associated ACTION requires a shutdown if they are not met within a specified time interval. Entry into an OPERATIONAL CONDITION or other specified condition may be made in accordance with the ACTION requirements when conformance to them permits continued operation of the facility for an unlimited period of time. This provision shall not prevent passage through or to OPERATIONAL CONDITIONS as required to comply with ACTION requirements. Exceptions to these requirements are stated in the individual controls.

APPLICABILITY

SURVEILLANCE REQUIREMENTS

4.0.1 Surveillance Requirements shall be met during the OPERATIONAL CONDITIONS or other conditions specified for individual Controls unless otherwise stated in an individual Surveillance Requirement.

4.0.2 Each Surveillance Requirement shall be performed within the specified surveillance interval with a maximum allowable extension not to exceed 25 percent of the specified surveillance interval.

4.0.3 Failure to perform a Surveillance Requirement within the allowed surveillance interval, defined by control 4.0.2, shall constitute noncompliance with the OPERABILITY requirements for a Control. The time limits of the ACTION requirements are applicable at the time it is identified that a Surveillance Requirement has not been performed. The ACTION requirements may be delayed for up to to 24 hours to permit the completion of the surveillance when the allowable outage time limits of the ACTION requirements are less than 24 hours. Surveillance Requirements do not have to be performed on inoperable equipment.

4.0.4 Entry into an OPERATIONAL CONDITION or other specified applicable condition shall not be made unless the Surveillance Requirement(s) associated with the Control have been performed within the applicable surveillance interval or as otherwise specified. This provision shall not prevent passage through or to OPERATIONAL CONDITIONS as required to comply with ACTION requirements.

INSTRUMENTATION

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

CONTROLS

3.3.7.9 In accordance with Perry Nuclear Power Plant Unit 1 TS 6.8.4.d.1, the radioactive liquid effluent monitoring instrumentation channels shown in Table 3.3.7.9-1 shall be OPERABLE with their alarm/trip setpoints set to ensure that the limits of Control 3.11.1.1 are not exceeded. The alarm/trip setpoints of these channels shall be determined and adjusted in accordance with the OFFSITE DOSE CALCULATION MANUAL (ODCM).

APPLICABILITY: At all times.

ACTION:

a. With a radioactive liquid effluent monitoring instrumentation channel alarm/trip setpoint less conservative than required by the above Control, immediately suspend the release of radioactive liquid effluents monitored by the affected channel or declare the channel inoperable, or change the setpoint so it is acceptably conservative.

b. With less than the minimum number of radioactive liquid effluent monitoring instrumentation channels OPERABLE, take the ACTION shown in Table 3.3.7.9-1. Restore the inoperable instrumentation to OPERABLE status within 30 days and, if unsuccessful, explain why this inoperability was not corrected in a timely manner in the next Annual Radioactive Effluent Release Report.

c. The provisions of Control 3.0.3 are not applicable.

SURVEILLANCE REQUIREMENTS

4.3.7.9 Each radioactive liquid effluent monitoring instrumentation channel shall be demonstrated OPERABLE by performance of the CHANNEL CHECK, SOURCE CHECK, CHANNEL CALIBRATION and CHANNEL FUNCTIONAL TEST operations at the frequencies shown in Table 4.3.7.9-1.

TABLE 3.3.7.9-1

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENT	MINIMUM CHANNELS OPERABLE	ACTION
1. GROSS RADIOACTIVITY MONITORS PROVIDING ALARM AND AUTOMATIC TERMINATION OF RELEASE		
a. Liquid Radwaste Discharge Radiation Monitor - ESW Discharge	1	110
2. GROSS BETA OR GAMMA RADIOACTIVITY MONITORS PROVIDING ALARM BUT NOT PROVIDING AUTOMATIC TERMINATION OF RELEASE		
a. Emergency Service Water Loop A Radiation Monitor	1	111
b. Emergency Service Water Loop B Radiation Monitor	1	111
3. FLOW RATE MEASUREMENT DEVICES		
a. Radwaste Discharge Header		
1. Radwaste High Flow Discharge Header Flow	1	112
2. Radwaste Low Flow Discharge Header Flow	1	112
b. Service Water Discharge Header Flow	1	113
c. Unit 1 Emergency Service Water Flow Monitor	1	113

TABLE 3.3.7.9-1 (Continued)

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

ACTION STATEMENTS

ACTION 110 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases from this pathway may continue provided that prior to initiating a release:

a. At least two independent samples are analyzed in accordance with Control 4.11.1.1.1, and

b. At least two technically qualified members of the Facility Staff independently verify the release rate calculations and discharge line valving:

Otherwise, suspend release of radioactive effluents via this pathway.

ACTION 111 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided that, at least once per 12 hours, grab samples are collected and analyzed for gross radioactivity (beta or gamma) at a limit of detection of at least 10^{-7} microcuries/ml.

ACTION 112 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided the discharge valve position is verified to be consistent with the flow rate provisions of the release permit at least once per 4 hours during actual releases. Prior to initiating another release, at least two technically qualified members of the Facility Staff shall independently verify the discharge line valving and that the discharge valve position corresponds to the desired flow rate. Otherwise, suspend release of radioactive effluents via this pathway.

ACTION 113 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided the flow rate is estimated at least once per 4 hours during actual releases. Pump performance curves generated in place may be used to estimate flow.

TABLE 4.3.7.9-1

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

INSTRUMENT	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	CHANNEL FUNCTIONAL TEST
1. GROSS RADIOACTIVITY MONITORS PROVIDING ALARM AND AUTOMATIC TERMINATION OF RELEASE				
a. Liquid Radwaste Discharge Radiation Monitor - ESW Discharge	D	P	R(3)	Q(1)
2. GROSS BETA OR GAMMA RADIOACTIVITY MONITORS PROVIDING ALARM BUT NOT PROVIDING AUTOMATIC TERMINATION OF RELEASE				
a. Emergency Service Water Loop A Radiation Monitor	D	M	R(3)	Q(2)
b. Emergency Service Water Loop B Radiation Monitor	D	M	R(3)	Q(2)
3. FLOW RATE MEASUREMENT DEVICES				
a. Radwaste Discharge Header				
1. Radwaste High Flow Discharge Header Flow	D(4)	N.A.	R	Q
2. Radwaste Low Flow Discharge Header Flow	D(4)	N.A.	R	Q
b. Service Water Discharge Header Flow	D(4)	N.A.	R	Q
c. Unit 1 Emergency Service Water Flow Monitor	D(4)	N.A.	R	Q

TABLE 4.3.7.9-1 (Continued)

RADIOACTIVE LIQUID EFFLUENT MONITORING
INSTRUMENTATION SURVEILLANCE REQUIREMENTS

TABLE NOTATION

(1) The CHANNEL FUNCTIONAL TEST shall also demonstrate that automatic isolation of this pathway and control room alarm annunciation occur if any of the following conditions exists:

1. Instrument indicates measured levels above the alarm/trip setpoint.
2. Instrument indicates a downscale failure.
3. Instrument controls not set in operate mode except in high voltage position.

(2) The CHANNEL FUNCTIONAL TEST shall also demonstrate that control room alarm annunciation occurs if any of the following conditions exists:

1. Instrument indicates measured levels above the alarm setpoint.
2. Instrument indicates a downscale failure.
3. Instrument controls not set in operate mode, except in high voltage position.

(3) The initial CHANNEL CALIBRATION shall be performed using one or more of the reference standards certified by the National Bureau of Standards or using standards that have been obtained from suppliers that participate in measurement assurance activities with NBS. These standards shall permit calibrating the system over its intended range of energy and measurement range. For subsequent CHANNEL CALIBRATION, sources that have been related to the initial calibration shall be used.

(4) CHANNEL CHECK shall consist of verifying indication of flow during periods of release. CHANNEL CHECK shall be made at least once per 24 hours on days which continuous, periodic or batch releases are made.

INSTRUMENTATION

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

CONTROLS

3.3.7.10 In accordance with Perry Nuclear Power Plant Unit 1 TS 6.8.4.d.1, the radioactive gaseous effluent monitoring instrumentation channels shown in Table 3.3.7.10-1 shall be OPERABLE with their alarm/trip setpoints set to ensure that the limits of Control 3.11.2.1 are not exceeded. The alarm/trip setpoints of applicable channels shall be determined and adjusted in accordance with the methodology and parameters in the ODCM.

APPLICABILITY: As shown in Table 3.3.7.10-1

ACTION:

a. With a radioactive gaseous effluent monitoring instrumentation channel alarm/trip setpoint less conservative than required by the above specification, declare the channel inoperable, or change the setpoint so it is acceptably conservative.

b. With less than the minimum number of radioactive gaseous effluent monitoring instrumentation channeis OPERABLE, take the ACTION shown in Table 3.3.7.10-1. Restore the inoperable instrumentation to OPERABLE status within 30 days and, if unsuccessful, explain why this inoperability was not corrected in a timely manner in the next Annual Radioactive Effluent Release Report.

c. The provisions of Control 3.0.3 are not applicable.

SURVEILLANCE REQUIREMENTS

4.3.7.10 Each radioactive gaseous effluent monitoring instrumentation channel shall be demonstrated OPERABLE by performance of the CHANNEL CHECK, SOURCE CHECK, CHANNEL CALIBRATION and CHANNEL FUNCTIONAL TEST operations at the frequencies shown in Table 4.3.7.10-1.

TABLE 3.3.7.10-1

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENT	MINIMUM CHANNELS OPERABLE	APPLICABILITY	ACTION
1. OFFGAS VENT RADIATION MONITOR			
a. Noble Gas Activity Monitor	1	*	121
b. Iodine Sampler	1	*	122
c. Particulate Sampler	1	*	122
d. Effluent System Flow Rate Monitor	1	*	123
e. Sampler Flow Rate Monitor	1	*	123
2. UNIT 1 VENT RADIATION MONITOR			
a. Noble Gas Activity Monitor	1	1, 2, 3 4, 5	125 121
b. Iodine Sampler	1	*	122
c. Particulate Sampler	1	*	122
d. Effluent System Flow Rate Monitor	1	*	123
e. Sampler Flow Rate Monitor	1	*	123

TABLE 3.3.7.10-1 (Continued)

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENT	MINIMUM CHANNELS OPERABLE	APPLICABILITY	ACTION
3. UNIT 2 VENT RADIATION MONITOR			
a. Noble Gas Activity Monitor	1	*	121
b. Iodine Sampler	1	*	122
c. Particulate Sampler	1	*	122
d. Effluent System Flow Rate Monitor	1	*	123
e. Sampler Flow Rate Monitor	1	*	123
4. HEATER BAY/TURBINE BUILDING VENT RADIATION MONITOR			
a. Noble Gas Activity Monitor	1	*	121
b. Iodine Sampler	1	*	122
c. Particulate Sampler	1	*	122
d. Effluent System Flow Rate Monitor	1	*	123
e. Sampler Flow Rate Monitor	1	*	123

TABLE 3.3.7.10-1 (Continued)

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

TABLE NOTATION

* At all times.

** During main condenser offgas treatment system operation.

ACTION 121 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided grab samples are taken at least once per 12 hours and these samples are analyzed for gross activity within 24 hours.

ACTION 122 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided samples are continuously collected within 8 hours with auxiliary sampling equipment as required by Table 4.11.2.1.2-1.

ACTION 123 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent release via this pathway may continue provided the flow rate is estimated at least once per 4 hours.

ACTION 124 - NOT USED

ACTION 125 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, except as a result of a non-conservative setpoint, immediately suspend containment/drywell purge and vent. Prior to resuming containment/drywell purge and vent, ensure compliance with the requirements of Control 3.11.2.1. If compliance with Control 3.11.2.1 is met, containment/drywell purge and vent may continue provided grab samples are taken at least once per 12 hours and these samples are analyzed for gross activity within 24 hours.

TABLE 4.3.7.10-1

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

INSTRUMENT	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	CHANNEL FUNCTIONAL TEST	MODES IN WHICH SURVEILLANCE REQUIRED
1. OFFGAS VENT RADIATION MONITOR					
a. Noble Gas Activity Monitor	D	M	R(2)	Q(1)	*
b. Iodine Sampler	W(4)	N.A.	N.A.	N.A.	*
c. Particulate Sampler	W(4)	N.A.	N.A.	N.A.	*
d. Effluent System Flow Rate Monitor	D	N.A.	R	Q	*
e. Sampler Flow Rate Monitor	D	N.A.	R	Q	*
2. UNIT 1 VENT RADIATION MONITOR					
a. Noble Gas Activity Monitor	D	M	R(2)	Q(1)	*
b. Iodine Sampler	W(4)	N.A.	N.A.	N.A.	*
c. Particulate Sampler	W(4)	N.A.	N.A.	N.A.	*
d. Effluent System Flow Rate Monitor	D	N.A.	R	Q	*
e. Sampler Flow Rate Monitor	D	N.A.	R	Q	*

TABLE 4.3.7.10-1 (Continued)

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

INSTRUMENT	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	CHANNEL FUNCTIONAL TEST	MODES IN WHICH SURVEILLANCE REQUIRED
3. UNIT 2 VENT RADIATION MONITOR					
a. Noble Gas Activity Monitor	D	M	R(2)	Q(1)	*
b. Iodine Sampler	W(4)	N.A.	N.A.	N.A.	*
c. Particulate Sampler	W(4)	N.A.	N.A.	N.A.	*
d. Effluent System Flow Rate Monitor	D	N.A.	R	Q	*
e. Sampler Flow Rate Monitor	D	N.A.	R	Q	*
4. HEATER BAY/TURBINE BUILDING VENT RADIATION MONITOR					
a. Noble Gas Activity Monitor	D	M	R(2)	Q(1)	*
b. Iodine Sampler	W(4)	N.A.	N.A.	N.A.	*
c. Particulate Sampler	W(4)	N.A.	N.A.	N.A.	*
d. Effluent System Flow Rate Monitor	D	N.A.	R	Q	*
e. Sampler Flow Rate Monitor	D	N.A.	R	Q	*

TABLE 4.3.7.10-1 (Continued)

RADIOACTIVE GASEOUS EFFLUENT MONITORING
INSTRUMENTATION SURVEILLANCE REQUIREMENTS

TABLE NOTATION

* At all times.

** During main condenser offgas treatment system operation.

(1) The CHANNEL FUNCTIONAL TEST shall also demonstrate that control room alarm annunciation occurs if any of the following conditions exists:

1. Instrument indicates measured levels above the alarm setpoint.

2. Instrument indicates a downscale failure.

3. Instrument controls not set in operate mode.

(2) The initial CHANNEL CALIBRATION shall be performed using one or more of the reference standards certified by the National Bureau of Standards (NBS) or using standards that have been obtained from suppliers that participate in measurement assurance activities with NBS. These standards shall permit calibrating the system over its intended energy and measurement range. For subsequent CHANNEL CALIBRATION, sources that have been related to the initial calibration shall be used.

(3) NOT USED

(4) The iodine cartridges and particulate filters will be changed at least once per 7 days. Performance of this CHANNEL CHECK does not render the system inoperable, and the applicable ACTION statements need not be entered.

3/4.11 RADIOACTIVE EFFLUENTS

3/4.11.1 LIQUID EFFLUENTS

CONCENTRATION

CONTROLS

3.11.1.1 In accordance with Perry Nuclear Power Plant TS 6.8.4.d.2 and d.3, the concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS (see Figure 5.1.1-1 of Technical Specifications) shall be limited to the concentrations specified in 10 CFR Part 20, Appendix B, Table II, Column 2 for radionuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the concentration shall be limited to 2×10^{-4} microcuries/ml total activity.

APPLICABILITY: At all times.

ACTION:

With the concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS exceeding the above limits, immediately restore the concentration to within the above limits.

SURVEILLANCE REQUIREMENTS

4.11.1.1.1 The radioactivity content of each batch of radioactive liquid waste shall be determined prior to release by sampling and analysis in accordance with Table 4.11.1.1.1-1. The results of pre-release analyses shall be used with the calculational methods in the ODCM to assure that the concentration at the point of release is maintained within the limits of Control 3.11.1..

4.11.1.1.2 Post-release analyses of samples composited from batch releases shall be performed in accordance with Table 4.11.1.1.1-1. The results of the radioactivity analysis shall be used in accordance with the methodology and parameters in the ODCM to assure that the concentrations at the point of release are maintained within the limits of Control 3.11.1.1.

4.11.1.1.3 Continuous releases of radioactive liquid effluents shall be sampled and analyzed in accordance with Table 4.11.1.1.1-1. The results of the radioactivity analyses shall be used in accordance with the methodology and parameters in the ODCM to assure that the concentrations at the point of release are maintained within the limits of Control 3.11.1.1.

TABLE 4.11.1.1.1-1

RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

Liquid Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) (μCi/ml)[a]
A. Batch Waste Release Tanks[c]	P Each batch	P Each batch	Principal Gamma Emitters[d]	5×10^{-7}
			I-131	1×10^{-6}
	P One Batch/M	M	Dissolved and Entrained Gases (Gamma emitters)	1×10^{-5}
	P Each Batch	M Composite[b]	H-3	1×10^{-5}
			Gross Alpha	1×10^{-7}
	P Each Batch	Q Composite[b]	Sr-89, Sr-90	5×10^{-8}
			Fe-55	1×10^{-6}
B. Continuous Releases[e] RHR Heat Exchanger ESW Outlet	D Grab Sample[f]	W Composite[b,f]	Principal Gamma Emitters[d]	5×10^{-7}
			I-131	1×10^{-6}
	M Grab Sample	M	Dissolved and Entrained Gases (Gamma Emitters)	1×10^{-5}
	D Grab Sample	M Composite[b]	H-3	1×10^{-5}
			Gross Alpha	1×10^{-7}
	D Grab Sample	Q Composite[b]	Sr-89, Sr-90	5×10^{-8}
			Fe-55	1×10^{-6}

TABLE 4.11.1.1.1-1 (Continued)

RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

TABLE NOTATION

a. The LLD is the smallest concentration of radioactive material in a sample that will yield a net count (above system background) that will be detected with 95% probability with only 5% probability of falsely concluding that a blank observation represents a "real" signal.

For a particular measurement system (which may include radiochemical separation):

$$LLD = \frac{4.66\ s_b}{E \cdot V \cdot 2.22 \times 10^6 \cdot Y \cdot \exp(-\lambda \Delta t)}$$

where

LLD is the "a priori" lower limit of detection as defined above (as μCi per unit mass or volume).

s_b is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute)

E is the counting efficiency (as counts per disintegration)

V is the sample size (in units of mass or volume)

2.22×10^6 is the number of disintegrations per minute per microcurie

Y is the fractional radiochemical yield (when applicable)

λ is the radioactive decay constant for the particular radionuclide (sec^{-1})

Δt is the elapsed time between sample collection (or end of the sample collection period) and time of counting (sec)

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

It should be recognized that the LLD is defined as an a priori (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.

TABLE 4.11.1.1.1-1 (Continued)

RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

TABLE NOTATION (Continued)

b. A composite sample is one in which the quantity of liquid sampled is proportional to the quantity of liquid waste discharged and in which the method of sampling employed results in a specimen which is representative of the liquids released.

c. A batch release is the discharge of liquid wastes of a discrete volume. Prior to sampling for analyses, each batch shall be isolated, and then thoroughly mixed to assure representative sampling.

d. The principal gamma emitters for which the LLD specification applies exclusively are the following radionuclides: Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, and Ce-141. Ce-144 shall also be measured, but with an LLD of 5×10^{-6}. This list does not mean that only these nuclides are to be detected and reported. Other peaks which are measurable and identifiable, together with the above nuclides, shall also be identified and reported in the Annual Radioactive Effluent Release Report pursuant to Specification 6.9.1.7 in the format outlined in Regulatory Guide 1.21, Appendix B, Revision 1, June 1974.

e. A continuous release is the discharge of liquid wastes of a nondiscrete volume, e.g., from a volume of a system that has an input flow during the continuous release. Sampling/Analysis of RHR Heat Exchanger is only applicable when there is ESW flow thru the RHR Heat Exchanger.

f. Sampling and analysis is required of the RHR heat exchanger ESW outlet every 12 hours when the samples indicate levels greater than LLD.

RADIOACTIVE EFFLUENTS

DOSE

CONTROLS

3.11.1.2 In accordance with Perry Nuclear Power Plant Unit 1 TS 6.8.4.d.4 and d.5, the dose or dose commitment to a MEMBER OF THE PUBLIC from radioactive materials in liquid effluents released, from each reactor unit, to UNRESTRICTED AREAS (see Figure 5.1.1-1 of Technical Specifications) shall be limited:

a. During any calendar quarter to less than or equal to 1.5 mrems to the total body and to less than or equal to 5 mrems to any organ, and

b. During any calendar year to less than or equal to 3 mrems to the total body and to less than or equal to 10 mrems to any organ.

APPLICABILITY: At all times.

ACTION:

a. With the calculated dose from the release of radioactive materials in liquid effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days, pursuant to Control 6.9.2, a Special Report which identifies the cause(s) for exceeding the limit(s) and defines the corrective actions that have been taken to reduce the releases and the corrective actions to be taken to ensure that future releases will be in compliance with the above limits.

b. The provisions of Control 3.0.3 are not applicable.

SURVEILLANCE REQUIREMENTS

4.11.1.2 Dose Calculations. Cumulative dose contributions from liquid effluents for the current calendar quarter and the current calendar year shall be determined in accordance with the methodology and parameters of the ODCM at least once per 31 days.

RADIOACTIVE EFFLUENTS

LIQUID RADWASTE TREATMENT SYSTEM

CONTROLS

3.11.1.3 In accordance with Perry Nuclear Power Plant Unit 1 TS 6.8.4.d.6, the LIQUID RADWASTE TREATMENT SYSTEM shall be OPERABLE and appropriate portions of the system shall be used to reduce the release of radioactivity when the projected doses due to the liquid effluent from each reactor unit to UNRESTRICTED AREAS (see Figure 5.1.1-1 of Technical Specifications) would exceed 0.06 mrem to the total body or 0.2 mrem to any organ, in a 31-day period.

APPLICABILITY: At all times.

ACTION:

a. With radioactive liquid waste being discharged without treatment and in excess of the above limits, and any portion of the liquid radwaste treatment system not in operation, prepare and submit to the Commission, within 30 days pursuant to Control 6.9.2, a Special Report which includes the following information:

   1. Explanation of why liquid radwaste was being discharged without treatment, identification of any inoperable equipment or subsystems, and the reason for the inoperability, and

   2. Action(s) taken to restore the inoperable equipment to OPERABLE status, and

   3. Summary description of action(s) taken to prevent a recurrence.

b. The provisions of Control 3.0.3 are not applicable.

SURVEILLANCE REQUIREMENTS

4.11.1.3.1 Doses due to liquid releases from each reactor unit to UNRESTRICTED AREAS shall be projected at least once per 31 days, in accordance with methodology and parameters in the ODCM.

4.11.1.3.2 The installed LIQUID RADWASTE TREATMENT SYSTEM shall be demonstrated OPERABLE by meeting Controls 3.11.1.1 and 3.11.1.2.

RADIOACTIVE EFFLUENTS

3/4.11.2 GASEOUS EFFLUENTS

DOSE RATE

CONTROLS

3.11.2.1 In accordance with Perry Nuclear Power Plant Unit 1 TS 6.8.4.d.3 and d.7, the dose rate due to radioactive materials released in gaseous effluents from the site to areas at and beyond the SITE BOUNDARY (see Figure 5.1.1-1 of Technical Specifications) shall be limited to the following:

a. For noble gases: Less than or equal to 500 mrems/yr to the total body and less than or equal to 3000 mrems/yr to the skin, and

b. For all iodine-131, iodine-133, tritium and all radionuclides in particulate form with half lives greater than 8 days: Less than or equal to 1500 mrems/yr to any organ.

APPLICABILITY: At all times.

ACTION:

With the dose rate(s) exceeding the above limits, immediately decrease the release rate(s) to within the above limit(s).

SURVEILLANCE REQUIREMENTS

4.11.2.1.1 The dose rate due to noble gases in gaseous effluents shall be determined to be within the above limits in accordance with the methodology and parameters of the ODCM.

4.11.2.1.2 The dose rate due to iodine-131, iodine-133, tritium and to radionuclides in particulate form with half lives greater than 8 days in gaseous effluents shall be determined to be within the above limits in accordance with the methodology and parameters of the ODCM by obtaining representative samples and performing analyses in accordance with the sampling and analysis program specified in Table 4.11.2.1.2-1.

TABLE 4.11.2.1.2-1

RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM

GASEOUS RELEASE PATH	SAMPLING FREQUENCY	MINIMUM ANALYSIS FREQUENCY	TYPE OF ACTIVITY ANALYSIS	LOWER LIMIT OF DETECTION (LLD)[a] (μCi/mL)
A. Drywell and Primary Containment PURGE and VENT	Each PURGE[b] and VENT Grab Sample	Each PURGE[b] and VENT	Principal Gamma Emitters[e]	$1x10^{-4}$
	M Grab Sample	M	H-3	$1x10^{-6}$
B. Offgas Vent, Unit 1 Vent, Unit 2 Vent and Turbine Building/Heater Bay Vent	M[b] Grab Sample	M[b]	Principal Gamma Emitters[b], [e]	$1x10^{-4}$
			H-3	1×10^{-6}
C. All Release Paths as listed in B above	Continuous [d]	W[c] Charcoal Sample	I-131	$1x10^{-12}$
			I-133	$1x10^{-10}$
	Continuous [d]	W[c] Particulate Sample	Principal Gamma Emitters[e]	$1x10^{-11}$
	Continuous (d)	M Composite Particulate Sample	Gross Alpha	$1x10^{-11}$
	Continuous (d)	Q Composite Particulate Sample	Sr-89, Sr-90	$1x10^{-11}$
	Continuous [d]	Noble Gas Monitor(f)	Noble Gases Gross Beta or Gamma	$1x10^{-6}$ (Xe-133 equivalent)

TABLE 4.11.2.1.2-1 (Continued)

RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM

TABLE NOTATION

a. The LLD is the smallest concentration of radioactive material in a sample that will yield a net count (above system background) that will be detected with 95% probability with only 5% probability of falsely concluding that a blank observation represents a "real" signal.

For a particular measurement system (which may include radiochemical separation):

$$LLD = \frac{4.66\ s_b}{E \cdot V \cdot 2.22 \times 10^6 \cdot Y \cdot \exp(-\lambda \Delta t)}$$

where

LLD is the "a priori" lower limit of detection as defined above (as μCi per unit mass or volume).

s_b is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute)

E is the counting efficiency (as counts per disintegration)

V is the sample size (in units of mass or volume)

2.22×10^6 is the number of disintegrations per minute per microcurie

Y is the fractional radiochemical yield (when applicable)

λ is the radioactive decay constant for the particular radionuclide (sec^{-1})

Δt is the elapsed time between sample collection (or end of the sample collection period) and time of counting (sec)

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

It should be recognized that the LLD is defined as an a priori (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.

TABLE 4.11.2.1.2-1 (Continued)

RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM

TABLE NOTATION (Continued)

b. Analyses shall also be performed following startup, shutdown, or a THERMAL POWER change exceeding 15 percent of the RATED THERMAL POWER within a one hour period. This requirement does not apply if (1) analysis shows that the DOSE EQUIVALENT I-131 concentration in the primary coolant has not increased more than a factor of 3; and (2) the noble gas monitor shows that effluent activity has not increased more than a factor of 3.

c. Samples shall be changed at least once per 7 days and analyses shall be completed within 48 hours after changing or after removal from sampler. Sampling and analyses shall also be performed at least once per 24 hours for at least 7 days following each shutdown, startup or THERMAL POWER change exceeding 15 percent of RATED THERMAL POWER in one hour. When samples collected for 24 hours are analyzed, the corresponding LLD's may be increased by a factor of 10. This requirement does not apply if (1) analysis shows that the DOSE EQUIVALENT I-131 concentration in the primary coolant has not increased more than a factor of 3; and (2) the noble gas monitor shows that effluent activity has not increased more than a factor of 3.

d. The ratio of the sample flow rate to the sampled stream flow rate shall be known for the time period covered by each dose or dose rate calculation made in accordance with Control 3.11.2.1, 3.11.2.2 and 3.11.2.3.

e. The principal gamma emitters for which the LLD specification applies exclusively are the following radionuclides: Kr-87, Kr-88, Xe-133, Xe-133m, Xe-135, and Xe-138 for gaseous emissions and Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, I-131, Cs-134, Cs-137, Ce-141 and Ce-144 for particulate emissions. This list does not mean that only these nuclides are to be detected and reported. Other peaks which are measurable and identifiable, together with the above nuclides, shall also be identified and reported in the Annual Radiological Effluent Release Report pursuant to Control 6.9.1.7 in the format outlined in Regulatory Guide 1.21, Appendix B, Revision 1, June 1974.

f. Sampling and analysis of gaseous release points shall be performed initially whenever a high alarm setpoint is exceeded or whenever two or more of the alert setpoints are exceeded. If the high alarm setpoint or two or more of the alert setpoints continue to be exceeded, verify at least once per 4 hours via the radiation monitors that plant releases are below the Control 3.11.2.1 dose rate limits and sampling and analysis shall be performed at least once per 12 hours.

RADIOACTIVE EFFLUENTS

DOSE - NOBLE GASES

CONTROLS

3.11.2.2 In accordance with Perry Nuclear Power Plant Unit 1 TS 6.8.4.d.5 and d.8, the air dose due to noble gases released in gaseous effluents, from each reactor unit, from the site to areas at and beyond the SITE BOUNDARY (see Figure 5.1.1-1 of Technical Specifications) shall be limited to the following:

a. During any calendar quarter: Less than or equal to 5 mrads for gamma radiation and less than or equal to 10 mrads for beta radiation, and

b. During any calendar year: Less than or equal to 10 mrads for gamma radiation and less than or equal to 20 mrads for beta radiation.

APPLICABILITY: At all times.

ACTION:

a. With the calculated air dose from the radioactive noble gases in gaseous effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days, pursuant to Control 6.9.2, a Special Report which identifies the cause(s) for exceeding the limit(s) and defines the corrective actions to be taken to ensure that future releases will be in compliance with Control 3.11.2.2.

b. The provisions of Control 3.0.3 are not applicable.

SURVEILLANCE REQUIREMENTS

4.11.2.2 Dose Calculations. Cumulative dose contributions for noble gases for the current calendar quarter and current calendar year shall be determined in accordance with the methodology and parameters in the ODCM at least once per 31 days.

RADIOACTIVE EFFLUENTS

DOSE - IODINE-131, IODINE-133, TRITIUM AND RADIONUCLIDES IN PARTICULATE FORM

CONTROLS

3.11.2.3 In accordance with Perry Nuclear Power Plant Unit 1 TS 6.8.4.d.5 and d.9, the dose to a MEMBER OF THE PUBLIC from iodine-131, iodine-133, tritium and radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents released, from each reactor unit, from the site to areas at and beyond the SITE BOUNDARY (see Figure 5.1.1-1 of Technical Specifications) shall be limited to the following:

a. During any calendar quarter: Less than or equal to 7.5 mrems to any organ, and

b. During any calendar year: Less than or equal to 15 mrems to any organ.

APPLICABILITY: At all times.

ACTION:

a. With the calculated dose from the release of iodine-131, iodine-133, tritium and radionuclides in particulate form, with half-lives greater than 8 days, in gaseous effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days, pursuant to Control 6.9.2, a Special Report which identifies the cause(s) for exceeding the limit and defines the corrective actions that have been taken to reduce releases and the proposed corrective actions to be taken to ensure that future releases will be in compliance with Control 3.11.2.3.

b. The provisions of Control 3.0.3 are not applicable.

SURVEILLANCE REQUIREMENTS

4.11.2.3 Dose Calculations. Cumulative dose contributions from iodine-131, iodine-133, tritium and radionuclides in particulate form with half-lives greater than 8 days for the current calendar quarter and current calendar year shall be determined in accordance with the methodology and parameters in the ODCM at least once per 31 days.

RADIOACTIVE EFFLUENTS

GASEOUS RADWASTE (OFFGAS) TREATMENT

CONTROLS

3.11.2.4 The GASEOUS RADWASTE TREATMENT (OFFGAS) SYSTEM shall be in operation. The Charcoal bypass mode shall not be used unless the offgas post-treatment radiation monitor is OPERABLE as specified in Table 3.3.7.1-1.

APPLICABILITY: Whenever the main condenser air ejector evacuation system is in operation.

ACTION:

a. With gaseous radwaste from the main condenser air ejector system being discharged without treatment for more than 7 consecutive days, prepare and submit to the Commission within 30 days, pursuant to Control 6.9.2, a Special Report which includes the following information:

   1. Explanation of why gaseous radwaste was being discharged without treatment, identification of the inoperable equipment or subsystems which resulted in gaseous radwaste being discharged without treatment, and the reason for inoperability.

   2. Action(s) taken to restore the inoperable equipment to OPERABLE status, and

   3. Summary description of action(s) taken to prevent a recurrence.

b. The provisions of Control 3.0.3 are not applicable.

SURVEILLANCE REQUIREMENTS

4.11.2.4 The readings of relevant instrumentation shall be checked at least once per 12 hours when the main condenser air ejector is in use to ensure that the gaseous radwaste treatment system is functioning.

RADIOACTIVE EFFLUENTS

VENTILATION EXHAUST TREATMENT SYSTEMS

CONTROLS

3.11.2.5 The VENTILATION EXHAUST TREATMENT SYSTEMS shall be OPERABLE and appropriate portions of the system shall be used to reduce releases of radioactivity when the projected dose due to gaseous effluent releases from each reactor unit to areas at and beyond the SITE BOUNDARY (see Figure 5.1.1-1 of Technical Specifications) in a 31 day period would exceed 0.3 mrem to any organ of a MEMBER OF THE PUBLIC.

APPLICABILITY: At all times.

ACTION:

a. With radioactive gaseous waste being discharged without treatment and in excess of the above limits, prepare and submit to the Commission within 30 days, pursuant to Control 6.9.2, a Special Report which includes the following information:

   1. Explanation of why gaseous radwaste was being discharged without treatment, identification of any inoperable equipment or subsystems which resulted in gaseous radwaste being discharged without treatment, and the reason for the inoperability,

   2. Action(s) taken to restore the inoperable equipment to OPERABLE status, and

   3. Summary description of action(s) taken to prevent a recurrence.

b. The provisions of Control 3.0.3 are not applicable.

SURVEILLANCE REQUIREMENTS

4.11.2.5.1 Doses due to gaseous releases from each reactor unit to areas at and beyond the SITE BOUNDARY shall be projected at least once per 31 days in accordance with the methodology and parameters in the ODCM.

4.11.2.5.2 The installed VENTILATION EXHAUST TREATMENT SYSTEMS shall be demonstrated OPERABLE by meeting Controls 3.11.2.1 and 3.11.2.3.

RADIOACTIVE EFFLUENTS

3/4.11.4 TOTAL DOSE

CONTROLS

3.11.4 In accordance with Perry Nuclear Power Plant Unit 1 TS 6.8.4.d.10, the annual (calendar year) dose or dose commitment to any MEMBER or THE PUBLIC, due to releases of radioactivity and radiation, from uranium fuel cycle sources shall be limited to less than or equal to 25 mrems to the total body or any organ, except the thyroid, which shall be limited to less than or equal to 75 mrems.

APPLICABILITY: At all times.

ACTION:

a. With the calculated doses from the release of radioactive materials in liquid or gaseous effluents exceeding twice the limits of Control 3.11.1.2a., 3.11.1.2b., 3.11.2.2a., 3.11.2.2b., 3.11.2.3a, or 3.11.2.3b., calculations shall be made including direct radiation contributions from the reactor units and from outside storage tanks to determine whether the above limits of Control 3.11.4 have been exceeded. If such is the case, prepare and submit to the Commission within 30 days, pursuant to Control 6.9.2, a Special Report that defines the corrective action to be taken to reduce subsequent releases to prevent recurrence of exceeding the above limits and includes the schedule for achieving conformance with the above limits. This Special Report, as defined in 10 CFR 20.405c, shall include an analysis that estimates the radiation exposure (dose) to a MEMBER OF THE PUBLIC from uranium fuel cycle sources, including all effluent pathways and direct radiation, for the calendar year that includes the release(s) covered by this report. It shall also describe levels of radiation and concentrations of radioactive material involved, and the cause of the exposure levels or concentrations. If the estimated dose(s) exceeds the above limits, and if the release condition resulting in violation of 40 CFR Part 190 has not already been corrected, the Special Report shall include a request for a variance in accordance with the provisions of 40 CFR Part 190. Submittal of the report is considered a timely request, and a variance is granted until staff action on the request is complete.

b. The provisions of Control 3.0.3 are not applicable.

SURVEILLANCE REQUIREMENTS

4.11.4.1 Cumulative dose contributions from liquid and gaseous effluents shall be determined in accordance with Controls 4.11.1.2, 4.11.2.2, and 4.11.2.3, and in accordance with the methodology and parameters in the ODCM.

4.11.4.2 If the cumulative dose contributions exceed the limits defined in 3.11.4, ACTION a, cumulative dose contributions from direct radiation from unit operation including outside storage tanks shall be determined in accordance with the methodology and parameters in the ODCM.

3/4.12 RADIOLOGICAL ENVIRONMENTAL MONITORING

3/4.12.1 MONITORING PROGRAM

CONTROLS

3.12.1 In accordance with Perry Nuclear Power Plant Unit 1 TS 6.8.4.e.1, the radiological environmental monitoring program shall be conducted as specified in Table 3.12.1-1.

APPLICABILITY: At all times.

ACTION:

a. With the radiological environmental monitoring program not being conducted as specified in Table 3.12.1-1, prepare and submit to the Commission, in the annual Radiological Environmental Operating Report per Control 6.9.1.6, a description of the reasons for not conducting the program as required and the plans for preventing a recurrence.

b. With the level of radioactivity as the result of plant effluents in an environmental sampling medium at a specified location exceeding the reporting levels of Table 3.12.1-2 when averaged over any calendar quarter, prepare and submit to the Commission within 30 days pursuant to Control 6.9.2 a Special Report that identifies the cause(s) for exceeding the limit(s) and defines the corrective actions to be taken to reduce radioactive effluents so that the potential annual dose to a MEMBER OF THE PUBLIC is less than the calendar year limits of Control 3.11.1.2, 3.11.2.2 and 3.11.2.3. When more than one of the radionuclides in Table 3.12.1-2 are detected in the sampling medium, this report shall be submitted if:

$$\frac{\text{concentration (1)}}{\text{reporting level (1)}} + \frac{\text{concentration (2)}}{\text{reporting level (2)}} + \ldots \geq 1.0$$

When radionuclides other than those in Table 3.12.1-2 are detected and are the result of plant effluents, this report shall be submitted if the potential annual dose* to a MEMBER OF THE PUBLIC is equal to or greater than the calendar year limits of Control 3.11.1.2, 3.11.2.2 and 3.11.2.3. This report is not required if the measured level of radioactivity was not the result of plant effluents; however, in such an event, the condition shall be reported and described in the Annual Radiological Environmental Operating Report required by Control 6.9.1.6.

*The methodology and parameters used to estimate the potential annual dose to a MEMBER OF THE PUBLIC shall be indicated in this report.

RADIOLOGICAL ENVIRONMENTAL MONITORING

CONTROLS

c. With milk or broad leaf vegetation samples unavailable from one or more of the sample locations required by Table 3.12.1-1, identify specific locations for obtaining replacement samples and add them within 30 days to the Radiological Environmental Monitoring Program given in the ODCM. The specific locations from which samples were unavailable may then be deleted from the monitoring program. Pursuant to Control 6.14, submit in the next Annual Radioactive Effluent Release Report documentation for a change in the ODCM including a revised figure(s) and table for the ODCM reflecting the new location(s) with supporting information identifying the cause of the unavailability of samples and justifying the selection of the new location(s) for obtaining samples.

d. The provisions of Control 3.0.3 are not applicable.

SURVEILLANCE REQUIREMENTS

4.12.1 The radiological environmental monitoring samples shall be collected pursuant to Table 3.12.1-1 from the specific locations given in the table and figures in the ODCM and shall be analyzed pursuant to the requirements of Table 3.12.1-1 and the detection capabilities required by Table 4.12.1-1.

TABLE 3.12.1-1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM*

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

TABLE 3.12.1-1 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

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

TABLE 3.12.1-1 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

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

TABLE 3.12.1-1 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

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

TABLE 3.12.1-1 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

TABLE NOTATIONS

* Sample locations are given on the figure and the table in the ODCM.

(1) Specific parameters of distance and direction sector from the centerline of one reactor, and additional description where pertinent, shall be provided for each and every sample location in Table 3.12-1 in a table and figure(s) in the ODCM. Refer to NUREG-0133, "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants," October 1978, and to Radiological Assessment Branch Technical Position, Revision 1, November 1979. Deviations are permitted from the required sampling schedule if specimens are unobtainable due to circumstances such as hazardous conditions, seasonal unavailability, and malfunction of automatic sampling equipment. If specimen's are unobtainable due to sampling equipment malfunction, effort shall be made to complete corrective action prior to the end of the next sampling period. All deviations from the sampling schedule shall be documented in the Annual Radiological Environmental Operating Report pursuant to Control 6.9.1.6. It is recognized that, at times, it may not be possible or practicable to continue to obtain samples of the media of choice at the most desired location or time. In these instances suitable specific alternative media and locations may be chosen for the particular pathway in question and appropriate substitutions made with 30 days in the Radiological Environmental Monitoring Program given in the ODCM. Pursuant to Control 6.14, submit in the next Annual Radioactive Effluent Release Report documentation for a change in the ODCM, including a revised figure(s) and table for the ODCM reflecting the new location(s) with supporting information identifying the cause of the unavailability of samples for that pathway and justifying the selection of the new location(s) for obtaining samples.

(2) One or more instruments, such as a pressurized ion chamber, for measuring and recording dose rate continuously may be used in place of, or in addition to, integrating dosimeters. For the purposes of this table, a thermoluminescent dosimeter (TLD) is considered to be one phosphor; two or more phosphors in a packet are considered as two or more dosimeters. Film badges shall not be used as dosimeters for measuring direct radiation. (The frequency of analysis or readout for TLD systems will depend upon the characteristics of the specific system used and should be selected to obtain optimum dose information with minimal fading.)

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

TABLE 3.12.1-1 (Continued)

TABLE NOTATIONS (Continued

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

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

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

TABLE 3.12.1-2

REPORTING LEVELS FOR RADIOACTIVITY CONCENTRATIONS IN ENVIRONMENTAL SAMPLES

Reporting Levels

Analysis	Water (pCi/l)	Airborne Particulate or Gases (pCi/m^3)	Fish (pCi/Kg, wet)	Milk (pCi/l)	Food Products (pCi/kg, wet)
H-3	2×10^4 [a]	NA	NA	NA	NA
Mn-54	1×10^3	NA	3×10^4	NA	NA
Fe-59	4×10^2	NA	1×10^4	NA	NA
Co-58	1×10^3	NA	3×10^4	NA	NA
Co-60	3×10^2	NA	1×10^4	NA	NA
Zn-65	3×10^2	NA	2×10^4	NA	NA
Zr-Nb-95	4×10^2	NA	NA	NA	NA
I-131	2	0.9	NA	3	1×10^2
Cs-134	30	10	1×10^3	60	1×10^3
Cs-137	50	20	2×10^3	70	2×10^3
Ba-La-140	2×10^2	NA	NA	3×10^2	NA

[a] For drinking water samples. This is a 40 CFR Part 141 value.

TABLE 4.12.1-1

MAXIMUM VALUES FOR THE LOWER LIMITS OF DETECTION (LLD) (a), (b), (c)
IN ENVIRONMENTAL SAMPLES

Analysis	Water (pCi/l)	Airborne Particulate or Gas (pCi/m^3)	Fish (pCi/kg,wet)	Milk (pCi/l)	Broad Leaf Vegetation (pCi/kg,wet)	Sediment (pCi/kg,dry)
Gross beta	4	1×10^{-2}	NA	NA	NA	NA
H-3	2000*	NA	NA	NA	NA	NA
Mn-54	15	NA	130	NA	NA	NA
Fe-59	30	NA	260	NA	NA	NA
Co-58,60	15	NA	130	NA	NA	NA
Zn-65	30	NA	260	NA	NA	NA
Zr-95	30	NA	NA	NA	NA	NA
Nb-95	15	NA	NA	NA	NA	NA
I-131	1**	7×10^{-2}	NA	1	60	NA
Cs-134	15	5×10^{-2}	130	15	60	150
Cs-137	18	6×10^{-2}	150	18	80	180
Ba-140	60	NA	NA	60	NA	NA
La-140	15	NA	NA	15	NA	NA

*If no drinking water pathway exists, a value of 3000 pCi/l may be used.
**If no drinking water pathway exists, a value of 15 pCi/l may be used.

TABLE 4.12.1-1 (Continued)

MAXIMUM VALUES FOR THE LOWER LIMITS OF DETECTION (LLD)

TABLE NOTATION

[a]Acceptable detection capabilities for thermoluminescent dosimeters used for environmental measurements are given in Regulatory Guide 4.13.

[b]Table 4.12-1 indicates acceptable detection capabilities for radioactive materials in environmental samples. These detection capabilities are tabulated in terms of the lower limits of detection (LLDs). The LLD is defined, for purposes of this guide, as the smallest concentration of radioactive material in a sample that will yield a net count (above system background) that will be detected with 95% probability with only 5% probability of falsely concluding that a blank observation represents a "real" signal.

For a particular measurement system (which may include radiochemical separation):

$$LLD = \frac{4.66\ s_b}{E \cdot V \cdot 2.22 \cdot Y \cdot \exp(-\lambda \Delta t)}$$

where

LLD is the "a priori" lower limit of detection as defined above (as pCi per unit mass or volume).

s_b is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute)

E is the counting efficiency (as counts per disintegration)

V is the sample size (in units of mass or volume)

2.22 is the number of disintegrations per minute per picocurie

Y is the fractional radiochemical yield (when applicable)

λ is the radioactive decay constant for the particular radionuclide

Δt is the elapsed time between sample collection (or end of the sample collection period) and time of counting

The value of s_b used in the calculation of the LLD for a particular measurement system should be based on the actual observed variance of the background counting rate or of the counting rate of the blank samples (as appropriate) rather than on an unverified theoretically predicated variance.

TABLE 4.12.1-1 (Continued)

MAXIMUM VALUES FOR THE LOWER LIMITS OF DETECTION (LLD)

TABLE NOTATION (continued)

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

It should be recognized that the LLD is defined as an a priori (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. Occasionally background fluctuations, unavoidable small sample size, the presence of interfering nuclides, or other uncontrollable circumstances may render these LLDs unachievable. In such cases, the contributing factors should be identified and described in the Annual Radiological Environmental Operating Report pursuant to Control 6.9.1.6.

[c]This list does not mean that only these nuclides are to be considered. Other peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Annual Radiological Environmental Operating Report pursuant to Control 6.9.16.

RADIOLOGICAL ENVIRONMENTAL MONITORING

3/4.12.2 LAND USE CENSUS

CONTROLS

3.12.2 In accordance with Perry Nuclear Power Plant Unit 1 TS 6.8.4.e.2, a land use census shall be conducted and shall identify within a distance of 8 km (5 miles) the location in each of the 16 meteorological sectors of the nearest milk animal, the nearest residence and the nearest garden* of greater than 50 m^2 (500 ft^2) producing broad leaf vegetation.

APPLICABILITY: At all times.

ACTION:

a. With a land use census identifying a location(s) which yields a calculated dose or dose commitment greater than the values currently being calculated in Control 4.11.2.3, identify the new location(s)* in the next Annual Radioactive Effluent Release Report, pursuant to Control 6.9.1.7.

b. With a land use census identifying a location(s) which yields a calculated dose or dose commitment (via the same exposure pathway) 20 percent greater than at a location from which milk and/or broad leaf vegetation samples are currently being obtained in accordance with Control 3.12.1, add the new location(s) to the radiological environmental monitoring program within 30 days. If no milk and/or broad leaf vegetation samples are identified in the new sector with the highest D/Q value, then the next sector with the highest D/Q value will be considered and so on until a sampling location can be established. 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.* Identify the new location(s) in the next Annual Radioactive Effluent Release Report and also include in the report a revised figure(s) and table(s) for the ODCM reflecting the new location(s).

c. The provisions of Control 3.0.3 are not applicable.

SURVEILLANCE REQUIREMENTS

4.12.2 The land use census shall be conducted during the growing season at least once per 12 months using that information that will provide the best results, such as by a door-to-door survey, aerial survey, or by consulting local agriculture authorities. The results of the land use census shall be included in the Annual Radiological Environmental Operating Report pursuant to Control 6.9.1.6.

*Broad leaf vegetation sampling of at least three different kinds of vegetation may be performed at the site boundary in each of two different direction sectors with the highest predicted D/Qs in lieu of the garden census. Controls for broad leaf vegetation sampling in Table 3.12.1-1 shall be followed, including analysis of control samples.

RADIOLOGICAL ENVIRONMENTAL MONITORING

3/4.12.3 INTERLABORATORY COMPARISON PROGRAM

CONTROLS

3.12.3 In accordance with Perry Nuclear Power Plant Unit 1 TS 6.8.4.e.3, analyses shall be performed on radioactive materials that correspond to samples required by Table 3.12.1-1. These materials are supplied as part of an Interlaboratory Comparison Program which has been approved by the Commission.

APPLICABILITY: At all times.

ACTION:

a. With analyses not being performed as required above, report the corrective actions taken to prevent a recurrence to the Commission in the Annual Radiological Environmental Operating Report pursuant to Control 6.9.1.6.

b. The provisions of Control 3.0.3 are not applicable.

SURVEILLANCE REQUIREMENTS

4.12.3 A summary of the results obtained as part of the above required Interlaboratory Comparison Program shall be included in the Annual Radiological Environmental Operating Report pursuant to Control 6.9.1.6.

BASES FOR

SECTIONS 3.0 AND 4.0

CONTROLS

AND

SURVEILLANCE REQUIREMENTS

NOTE

The BASES contained in succeeding pages summarize the reasons for the Controls in Section 3.0 and 4.0, but are not part of these Controls.

3/4 CONTROLS AND SURVEILLANCE REQUIREMENTS

3/4.0 APPLICABILITY

BASES

Controls 3.0.1 through 3.0.4 establish the general requirements applicable to the Appendix C Controls. These requirements are derived from the requirements for Limiting Conditions for Operation stated in the Code of Federal Regulations, 10 CFR 50.36(c)(2) for plant Technical Specifications.

Control 3.0.1 establishes the Applicability statement within each individual control as the requirement for when (i.e., in which OPERATIONAL CONDITIONS or other specified conditions) conformance to the Control is required for safe operation of the facility. The ACTION requirements establish those remedial measures that must be taken within specified time limits when the requirements of a Control are not met. It is not intended that the shutdown ACTION requirements be used as an operational convenience which permits (routine) voluntary removal of a system(s) or component(s) from service in lieu of other alternatives that would not result in redundant systems or components being inoperable.

There are two basic types of ACTION requirements. The first specifies the remedial measures that permit continued operation of the facility which is not further restricted by the time limits of the ACTION requirements. In this case, conformance to the ACTION requirements provides an acceptable level of safety for unlimited continued operation as long as the ACTION requirements continue to be met. The second type of ACTION requirement specifies a time limit in which conformance to the conditions of the Control must be met. This time limit is the allowable outage time to restore an inoperable system or component to OPERABLE status or for restoring parameters within specified limits. If these actions are not completed within the allowable outage time limits, a shutdown is required to place the facility in an OPERATIONAL CONDITION or other specified condition in which the control no longer applies.

The specified time limits of the ACTION requirements are applicable from the point in time it is identified that a Control is not met. The time limits of the ACTION requirements are also applicable when a system or component is removed from service for surveillance testing or investigation of operational problems. Individual controls may include a specified time limit for the completion of a Surveillance Requirement when equipment is removed from service. In this case, the allowable outage time limits of the ACTION requirements are applicable when this limit expires if the surveillance has not been completed. When a shutdown is required to comply with ACTION requirements, the plant may have entered an OPERATIONAL CONDITION in which a new control becomes applicable. In this case, the time limits of the ACTION requirements would apply from the point in time that the new control becomes applicable if the requirements of the Control are not met.

3/4.0 APPLICABILITY

BASES (Continued)

Control 3.0.2 establishes that noncompliance with a control exists when the requirements of the Control are not met and the associated ACTION requirements have not been implemented within the specified time interval. The purpose of this control is to clarify that (1) implementation of the ACTION requirement within the specified time interval constitutes compliance with a control, and (2) completion of the remedial measures of the ACTION requirements is not required when compliance with a Control is restored within the time interval specified in the associated ACTION requirements.

Control 3.0.3 establishes the shutdown ACTION requirements that must be implemented when a Control is not met and the condition is not specifically addressed by the associated ACTION requirements. The purpose of this control is to delineate the time limits for placing the unit in a safe shutdown CONDITION when plant operation cannot be maintained within the limits for safe operation defined by the Control and its ACTION requirements. It is not intended to be used as an operational convenience which permits (routine) voluntary removal of redundant systems or components from service in lieu of other alternatives that would not result in redundant systems or components being inoperable. One hour is allowed to prepare for an orderly shutdown before initiating a change in plant operation. This time permits the operator to coordinate the reduction in electrical generation with the load dispatcher to ensure the stability and availability of the electrical grid. The time limits specified to reach lower CONDITIONS of operation permit the shutdown to proceed in a controlled and orderly manner that is well within the specified maximum cooldown rate and within the cooldown capabilities of the facility assuming only the minimum required equipment is OPERABLE. This reduces thermal stresses on components of the primary coolant system and the potential for a plant upset that could challenge safety systems under conditions for which this control applies.

If remedial measures permitting limited continued operation of the facility under the provisions of the ACTION requirement are completed, the shutdown may be terminated. The time limits of the ACTION requirements are applicable from the point in time there was a failure to meet a Control. Therefore, the shutdown may be terminated if the ACTION requirements have been met or the time limits of the ACTION requirements have not expired, thus providing an allowance for the completion of the required actions.

The time limits of Control 3.0.3 allow 37 hours for the plant to be in COLD SHUTDOWN when a shutdown is required during POWER operation. If the plant is in a lower CONDITION of operation when a shutdown is required, the time limit for reaching the next lower CONDITION of operation applies. However, if a lower CONDITION of operation is reached in less time than allowed, the total allowable time to reach COLD SHUTDOWN, or other OPERATIONAL CONDITION, is not reduced. For example, if STARTUP is reached in 2 hours, the time allowed to reach HOT SHUTDOWN is the next 11 hours because the total time to reach HOT SHUTDOWN is not reduced from the allowable limit of 13 hours. Therefore, if remedial measures are completed that would permit a return to POWER operation, a penalty is not incurred by having to reach a lower CONDITION of operation in less than the total time allowed.

3/4.0 APPLICABILITY

BASES (Continued)

The same principle applies with regard to the allowable outage time limits of the ACTION requirements, if compliance with the ACTION requirements for one control results in entry into an OPERATIONAL CONDITION or condition of operation for another control in which the requirements of the Control are not met. If the new control becomes applicable in less time than specified, the difference may be added to the allowable outage time limits of the second control. However, the allowable outage time limits of ACTION requirements for a higher CONDITION of operation may not be used to extend the allowable outage time that is applicable when a Control is not met in a lower CONDITION of operation.

The shutdown requirements of Control 3.0.3 do not apply in CONDITIONS 4 and 5, because the ACTION requirements of individual controls define the remedial measures to be taken.

Control 3.0.4 establishes limitations on a change in OPERATIONAL CONDITIONS when a Control is not met. It precludes placing the facility in a higher CONDITION of operation when the requirements for a Control are not met and continued noncompliance to these conditions would result in a shutdown to comply with the ACTION requirements if a change in CONDITIONS were permitted. The purpose of this control is to ensure that facility operation is not initiated or that higher CONDITIONS of operation are not entered when corrective action is being taken to obtain compliance with a control by restoring equipment to OPERABLE status or parameters to specified limits. Compliance with ACTION requirements that permit continued operation of the facility for an unlimited period of time provides an acceptable level of safety for continued operation without regard to the status of the plant before or after a change in OPERATIONAL CONDITION or other specified condition may be made in accordance with the provisions of the ACTION requirements. The provisions of this control should not, however, be interpreted as endorsing the failure to exercise good practice in restoring systems or components to OPERABLE status before plant startup.

When a shutdown is required to comply with ACTION requirements, the provisions of Control 3.0.4 do not apply because they would delay placing the facility in a lower CONDITION of operation.

Controls 4.0.1 through 4.0.5 establish the general requirements applicable to Surveillance Requirements. These requirements are derived from those for Surveillance Requirements stated in the Code of Federal Regulations, 10 CFR 50.36(c)(3) for plant Technical Specifications.

Control 4.0.1 establishes the requirement that surveillances must be performed during the OPERATIONAL CONDITIONS or other conditions for which the requirements of the Controls apply unless otherwise stated in an individual Surveillance Requirement. The purpose of this control is to ensure that surveillances are performed to verify the operational status of systems and components and that parameters are within specified limits to ensure safe operation of the facility when the plant is in an OPERATIONAL CONDITION or other specified condition for which the individual Controls are applicable.

3/4.0 APPLICABILITY

BASES

Surveillance Requirements do not have to be performed when the facility is in an OPERATIONAL CONDITION for which the requirements of the associated Control do not apply unless otherwise specified. The Surveillance Requirements associated with a Special Test Exception are only applicable when the Special Test Exception is used as an allowable exception to the requirements of a control.

Control 4.0.2 establishes the limit for which the specified time interval for Surveillance Requirements may be extended. It permits an allowable extension of the specified surveillance interval to facilitate surveillance scheduling and consideration of plant operating conditions that may not be suitable for conducting the surveillance; e.g., transient conditions or other ongoing surveillance or maintenance activities. It also provides flexibility to accommodate the length of a fuel cycle for surveillances that are performed at each refueling outage and are specified with an 18 month surveillance interval.

It is not intended that this provision be used repeatedly as a convenience to extend surveillance intervals beyond that specified for surveillances that are not performed during refueling outages. The limitation of Control 4.0.2 is based on engineering judgment and the recognition that the most probable result of any particular surveillance being performed is the verification of conformance with the Surveillance Requirements. This provision is sufficient to ensure that the reliability ensured through surveillance activities is not significantly degraded beyond that obtained from the specified surveillance interval.

Control 4.0.3 establishes that the failure to perform a Surveillance Requirement within the allowed surveillance interval, defined by the provisions of Control 4.0.2, is a condition that constitutes a failure to meet the OPERABILITY requirements for a Control. Under the provisions of this control, systems and components are assumed to be OPERABLE when Surveillance Requirements have been satisfactorily performed within the specified time interval. However, nothing in this provision is to be construed as implying that systems or components are OPERABLE when they are found or known to be inoperable although still meeting the Surveillance Requirements. This control also clarifies that the ACTION requirements are applicable when Surveillance Requirements have not been completed within the allowed surveillance interval and that the time limits of the ACTION requirements apply from the point in time it is identified that a surveillance has not been performed and not at the time that the allowed surveillance interval was exceeded. Completion of the Surveillance Requirement within the allowable outage time limits of the ACTION requirements restores compliance with the requirements of Control 4.0.3. However, this does not negate the fact that the failure to have performed the surveillance within the allowed surveillance interval, defined by the provisions of Control 4.0.2., constitutes a failure to meet the OPERABILITY requirements for a Control and any reports required by 10 CFR 50.73 shall be determined based on the length of time the surveillance interval has been exceeded, and the corresponding Control ACTION time requirements, similar to those discussed in NUREG-1022, Supplement 1.

3/4.0 APPLICABILITY

BASES (Continued)

If the allowable outage time limits of the ACTION requirements are less than 24 hours or a shutdown is required to comply with ACTION requirements, e.g., Control 3.0.3, a 24-hour allowance is provided to permit a delay in implementing the ACTION requirements. This provides an adequate time limit to complete Surveillance Requirements that have not been performed. The purpose of this allowance is to permit the completion of a surveillance before a shutdown would be required to comply with ACTION requirements or before other remedial measures would be required that may preclude the completion of a surveillance. The basis for this allowance includes consideration for plant conditions, adequate planning, availability of personnel, the time required to perform the surveillance, and the safety significance of the delay in completing the required surveillance. This provision also provides a time limit for the completion of Surveillance Requirements that become applicable as a consequence of CONDITION changes imposed by ACTION requirements and for completing Surveillance Requirements that are applicable when an exception to the requirements of Control 4.0.4 is allowed. If a surveillance is not completed within the 24-hour allowance, the time limits of the ACTION requirements are applicable at that time. When a surveillance is performed within the 24-hour allowance and the Surveillance requirements are not met, the time limits of the ACTION requirements are applicable at the time that the surveillance is terminated.

Surveillance Requirements do not have to be performed on inoperable equipment because the ACTION requirements define the remedial measures that apply. However, the Surveillance Requirements have to be met to demonstrate that inoperable equipment has been restored to OPERABLE status.

Control 4.0.4 establishes the requirement that all applicable surveillances must be met before entry into an OPERATIONAL CONDITION or other condition of operation specified in the Applicability statement. The purpose of this control is to ensure that system and component OPERABILITY requirements or parameter limits are met before entry into an OPERATIONAL CONDITION or other specified condition for which these systems and components ensure safe operation of the facility. This provision applies to changes in OPERATIONAL CONDITIONS or other specified conditions associated with plant shutdown as well as startup.

Under the provisions of this control, the applicable Surveillance Requirements must be performed within the specified surveillance interval to assume that the Controls are met during initial plant startup or following a plant outage.

When a shutdown is required to comply with ACTION requirements, the provisions of Control 4.0.4 do not apply because this would delay placing the facility in a lower CONDITION of operation.

INSTRUMENTATION

BASES

3/4.3.7 MONITORING INSTRUMENTATION

3/4.3.7.9 RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

The radioactive liquid effluent instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in liquid effluents during actual or potential releases of liquid effluents. The alarm/trip setpoints for these instruments shall be calculated in accordance with the procedures in the ODCM to ensure that the alarm/trip will occur prior to exceeding the limits of 10 CFR Part 20. The OPERABILITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10 CFR Part 50.

3/4.3.7.10 RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

The radioactive gaseous effluent instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in gaseous effluents during actual or potential releases of gaseous effluents. The alarm setpoints for these instruments shall be calculated in accordance with the procedures in the ODCM to ensure that the alarm will occur prior to exceeding the limits of 10 CFR Part 20. The OPERABILITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10 CFR Part 50.

3/4.11 RADIOACTIVE EFFLUENTS

BASES

3/4.11.1 LIQUID EFFLUENTS

3/4.11.1.1 CONCENTRATION

This Control is provided to ensure that the concentration of radioactive materials released in liquid waste effluents to UNRESTRICTED AREAS will be less than the concentration levels specified in 10 CFR Part 20, Appendix B, Table II, Column 2. This limitation provides additional assurance that the levels of radioactive materials in bodies of water in UNRESTRICTED AREAS will result in exposures within (1) the Section II.A. design objectives of Appendix I, 10 CFR 50, to a MEMBER OF THE PUBLIC, and (2) the limits of 10 CFR 20.106(e) to the population. The concentration limit for dissolved or entrained noble gases is based upon the assumption that Xe-135 is the controlling radioisotope and its MPC in air (submersion) was converted to an equivalent concentration in water using the methods described in International Commission on Radiological Protection (ICRP) Publication 2.

This Control applies to the release of radioactive materials in liquid effluents from all units at the site.

The required detection capabilities for radioactive materials in liquid waste samples are tabulated in terms of the lower limits of detection (LLDs). Detailed discussion of the LLD, and other detection limits, can be found in:

(1) Currie, L. A.., "Lower Limit of Detection: Definition and Elaboration of a Proposed Position for Radiological Effluent and Environmental Measurements," NUREG/CR-4007 (September, 1984).

(2) HASL Procedures Manual, HASL-300 (revised annually).

3/4.11.1.2 DOSE

This Control is provided to implement the requirements of Sections II.A, III.A and IV.A of Appendix I, 10 CFR Part 50. The Control implements the guides set forth in Section II.A of Appendix I. The ACTION statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I which assure that the releases of radioactive material in liquid effluents to UNRESTRICTED AREAS will be kept "as low as is reasonably achievable." Also, for fresh water sites with drinking water supplies which can be potentially affected by plant operations, there is reasonable assurance that the operation of the facility will not result in radionuclide concentrations in the finished drinking water that are in excess of the requirements of 40 CFR 141. The dose calculations in the ODCM implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data, such that the actual exposure of a MEMBER OF THE PUBLIC through appropriate pathways is unlikely to be substantially underestimated. The equations specified in the ODCM for calculating the doses due to the actual release rates of radioactive

3/4.11.1.2 DOSE (Continued)

materials in liquid effluents are consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision I, October 1977 and Regulatory Guide 1.113, "Estimating Aquatic Dispersion of Effluent from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I," April 1977.

This Control applies to the release of liquid effluents from each reactor at the site. For units with shared radwaste treatment systems, the liquid effluents from the shared system are proportioned among the units sharing that system.

3/4.11.1.3 LIQUID RADWASTE TREATMENT SYSTEM

The OPERABILITY of the liquid radwaste treatment system ensures that this system will be available for use whenever liquid effluents require treatment prior to release to the environment.

The requirement that the appropriate portions of this system be used when specified provides assurance that the releases of radioactive materials in liquid effluents will be kept "as low as is reasonably achievable." This Control implements the requirements of 10 CFR Part 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50 and the design objective given in Section II.D of Appendix I to 10 CFR Part 50. The specified limit governing the use of appropriate portions of the liquid radwaste treatment system were specified as a suitable fraction of the dose design objectives set forth in Section II.A of Appendix I, 10 CFR Part 50, for liquid effluents.

This Control applies to the release of liquid effluents from each reactor at the site. For units with shared radwaste treatment systems, the liquid effluents from the shared system are proportioned among the units sharing the system.

RADIOACTIVE EFFLUENTS

BASES

3/4.11.2 GASEOUS EFFLUENTS

3/4.11.2.1 DOSE RATE

This Control is provided to ensure that the dose any time at and beyond the SITE BOUNDARY from gaseous effluents from all units on the site will be within the annual dose limits of 10 CFR Part 20 for UNRESTRICTED AREAS. The annual dose rate limits are those associated with the concentrations of those MPCs as described in Regulatory Guide 1.109. These limits provide reasonable assurance that radioactive material discharged in gaseous effluents will not result in the exposure of a MEMBER OF THE PUBLIC in an UNRESTRICTED AREA, either within or outside the SITE BOUNDARY, to annual average concentrations exceeding the limits specified in Appendix B, Table II of 10 CFR Part 20 (10 CFR Part 20.106(b)). For MEMBERS OF THE PUBLIC who may at times be within the SITE BOUNDARY, the occupancy of the MEMBER OF THE PUBLIC will be sufficiently low to compensate for any increase in the atmospheric diffusion factor above that for the SITE BOUNDARY. Examples of calculations for such MEMBERS OF THE PUBLIC, with appropriate occupancy factors, shall be given in the ODCM. The specified release rate limits restrict, at all times, the corresponding gamma and beta dose rates above background to a MEMBER OF THE PUBLIC at or beyond the SITE BOUNDARY to less than or equal to 500 mrems/year to the total body or to less than or equal to 3000 mrems/year to the skin. These release rate limits also restrict, at all times, the corresponding thyroid dose rate above background to a child via the inhalation pathway to less than or equal to 1500 mrems/year.

This Control applies to the release of radioactive materials in gaseous effluents from all reactors at the site. The required detection capabilities for radioactive material in gaseous waste samples are tabulated in terms of the lower limit of detection (LLDs). Detailed discussion of the LLD and other detection limits can be found in:

(1) Currie, L. A., "Lower Limit of Detection: Definition and Elaboration of a Proposed Position for Radiological Effluent and Environmental Measurements," NUREG/CR-4007 (September 1984).

(2) HASL Procedures Manual, HASL-300 (revised annually).

3/4.11.2.2 DOSE - NOBLE GASES

This Control is provided to implement the requirements of Sections II.B, III.A and IV.A of Appendix I, 10 CFR Part 50. The Control implements the guides set forth in Section II.B of Appendix I. The ACTION statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in gaseous effluents to UNRESTRICTED AREAS will be kept "as low as is reasonably achievable." The Surveillance Requirements implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data such that the actual exposure of a MEMBER OF THE PUBLIC through appropriate pathways

3/4.11.2.2 DOSE - NOBLE GASES (Continued)

is unlikely to be substantially underestimated. The dose calculations established in the ODCM for calculating the doses due to the actual release rates of radioactive noble gases in gaseous effluents are consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1, October 1977 and Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water Cooled Reactors," Revision 1, July 1977. The ODCM equations provided for determining the air doses at and beyond the SITE BOUNDARY are made using meteorological conditions concurrent with the time of release of radioactive materials in gaseous effluents or are based upon the historical average atmospheric conditions.

This Control applies to the release of radioactive materials in gaseous effluents from each reactor at the site. For units with shared radwaste treatment systems, the gaseous effluents from the shared system are proportioned among the units sharing that system.

3/4.11.2.3 DOSE - IODINE-131, IODINE-133, TRITIUM AND RADIONUCLIDES IN PARTICULATE FORM

This Control is provided to implement the requirements of Sections II.C, III.A and IV.A of Appendix I, 10 CFR Part 50. The Controls are the guides set forth in Section II.C of Appendix I. The ACTION statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive materials in gaseous effluents to UNRESTRICTED AREAS will be kept "as low as is reasonably achievable." The ODCM calculational methods specified in the Surveillance Requirements implement the requirements in Section III.A. of Appendix I that conformance with the guides of Appendix I be shown by calculational procures based on models and data, such that the actual exposure of a MEMBER OF THE PUBLIC through appropriate pathways is unlikely to be substantially underestimated. The ODCM calculational methods for calculating the doses due to the actual release rates of the subject materials are consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1, October 1977 and Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," Revision 1, July 1977. These equations also provide for determining the actual doses using meteorological conditions concurrent with the time of release of radioactive materials in gaseous effluents or are based upon the historical average atmospheric conditions. The release rate specifications for iodine-131, iodine-133, tritium and radionuclides in particulate form are dependent on the existing radionuclide pathway to man in the areas at and beyond the SITE BOUNDARY. The pathways which were examined in the development of these

RADIOACTIVE EFFLUENTS

BASES

3/4.11.2.3 DOSE - IODINE-131, IODINE-133, TRITIUM AND RADIONUCLIDES IN PARTICULATE FORM (Continued)

calculations were: (1) individual inhalation of airborne radionuclides, (2) deposition of radionuclides onto green leafy vegetation with subsequent consumption by man, (3) deposition onto grassy areas where milk animals and meat-producing animals graze with consumption of the milk and meat by man, and (4) deposition on the ground with subsequent exposure of man.

This Control applies to the release of radioactive materials in gaseous effluents from each reactor at the site. For units with shared radwaste treatment systems, the gaseous effluents from the shared system are proportioned among the units sharing that system.

3/4.11.2.4 AND 3/4.11.2.5 GASEOUS RADWASTE TREATMENT (OFFGAS) SYSTEM AND VENTILATION EXHAUST TREATMENT SYSTEMS

The OPERABILITY OF THE GASEOUS RADWASTE TREATMENT (OFFGAS) SYSTEM and the VENTILATION EXHAUST TREATMENT SYSTEMS ensures that the systems will be available for use whenever gaseous effluents require treatment prior to release to the environment. The requirement that the appropriate portions of the systems be used, when specified, provides reasonable assurance that the releases of radioactive materials in gaseous effluents will be kept "as low as is reasonably achievable." This Control implements the requirements of 10 CFR Part 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50, and the design objectives given in Section II.D of Appendix I to 10 CFR Part 50. The specified limits governing the use of appropriate portions of the systems were specified as a suitable fraction of the dose design objectives set forth in Sections II.B and II.C of Appendix I, 10 CFR Part 50, for gaseous effluents.

This Control applies to the release of radioactive materials in gaseous effluents from each reactor at the site. For units with shared radwaste treatment systems, the gaseous effluents from the shared system are proportional among the units sharing that system.

RADIOACTIVE EFFLUENTS

BASES

3/4.11.4 TOTAL DOSE

This Control is provided to meet the dose limitations of 40 CFR Part 190 that have been incorporated into 10 CFR Part 20 by 46 FR 18525. The Control requires the preparation and submittal of a Special Report whenever the calculated doses due to releases of radioactivity and to radiation from uranium fuel cycle sources exceed 25 mrems to the whole body or any organ, except the thyroid, which shall be limited to less than or equal to 75 mrems. For sites containing up to four reactors, it is highly unlikely that the resultant dose to a MEMBER OF THE PUBLIC will exceed the dose limits of 40 CFR Part 190 if the individual reactors remain within twice the dose design objectives of Appendix I, and if direct radiation doses from the units including outside storage tanks, etc. are kept small. The Special Report will describe a course of action that should result in the limitation of the annual dose to a MEMBER OF THE PUBLIC to within the 40 CFR Part 190 limits. For the purposes of the Special Report, it may be assumed that the dose commitment to the MEMBER OF THE PUBLIC from other uranium fuel cycle sources is negligible, with the exception that dose contributions from other nuclear fuel cycle facilities at the same site or within a radius of 8 km must be considered. If the dose to any MEMBER OF THE PUBLIC is estimated to exceed the requirements of 40 CFR Part 190, the Special Report with a request for a variance (provided the release conditions resulting in violation of 40 CFR Part 190 have not already been corrected), in accordance with the provisions of 40 CFR 190.11 and 10 CFR 20.405c, is considered to be a timely request and fulfills the requirements of 40 CFR Part 190 until NRC staff action is completed. The variance only relates to the limits of 40 CFR Part 190, and does not apply in any way to the other requirements for dose limitation of 10 CFR Part 20, as addressed in Controls 3.11.1.1 and 3.11.2.1. An individual is not considered a MEMBER OF THE PUBLIC during any period in which he/she is engaged in carrying out any operation that is part of the nuclear fuel cycle.

3/4.12 RADIOLOGICAL ENVIRONMENTAL MONITORING

BASES

3/4.12.1 MONITORING PROGRAM

The Radiological Environmental Monitoring Program required by this Control provides representative measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides that lead to the highest potential radiation exposures of MEMBERS OF THE PUBLIC resulting from the plant operation. This monitoring program implements Section IV.B.2 of Appendix I to 10 CFR Part 50 and thereby supplements the Radiological Effluent Monitoring Program 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 the modeling of the environmental exposure pathways. Guidance for this monitoring program is provided by the Radiological Assessment Branch Technical Position on Environmental Monitoring, Revision 1, November 1979. The initially specified monitoring program will be effective for at least the first 3 years of commercial operation. Following this period, program changes may be initiated based on operational experience.

The required detection capabilities for environmental sample analyses are tabulated in terms of the lower limits of detection (LLDs). The LLDs required by Table 4.12-1 are considered optimum for routine environmental measurements in industrial laboratories. It should be recognized that the LLD is defined as an a priori (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.

Detailed discussion of the LLD, and other detection limits, can be found in:

(1) Currie, L. A. "Lower Limit of Detection: Definition and Elaboration of a Proposed Position for Radiological Effluent and Environmental Measurements," NUREG/CR-4007 (September 1984).

(2) HASL Procedure Manual, HASL-300 (revised annually).

3/4.12.2 LAND USE CENSUS

This Control is provided to ensure that changes in the use of areas at and beyond the SITE BOUNDARY are identified and that modifications to the radiological environmental monitoring program given in the ODCM are made if required by the results of the census. The best information from door-to-door survey, visual or aerial survey or from consulting with local agricultural authorities shall be used. This census satisfies the requirements of Section IV.B.3 of Appendix I to 10 CFR Part 50. Restricting the census to gardens of greater than 50 m^2 provides assurance that significant exposure pathways via leafy vegetables will be identified and monitored since a garden of this size is the minimum required to produce the quantity (26 kg/year) of leafy vegetables assumed in Regulatory Guide 1.109 for consumption by a child. To determine this minimum garden size, the following assumptions were made: (1) 20% of the garden was used for growing broad leaf vegetation (i.e., similar to lettuce and cabbage), and (2) a vegetation yield of 2 kg/m^2.

RADIOLOGICAL ENVIRONMENTAL MONITORING

BASES

3/4.12.3 INTERLABORATORY COMPARISON PROGRAM

The requirement for participation in an approved Interlaboratory Comparison Program is provided to ensure that independent checks on the precision and accuracy of the measurements of radioactive material in environmental sample matrices are performed as part of the quality assurance program for environmental monitoring in order to demonstrate that the results are valid for the purposes of Section IV.B.2 of Appendix I to 10 CFR Part 50.

6.0

ADMINISTRATIVE CONTROLS

ANNUAL REPORTS

ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

6.9.1.6 Routine radiological environmental operating reports covering the operation of the unit during the previous calendar year shall be submitted prior to May 1 of each year. The initial report shall be submitted prior to May 1 of the year following initial criticality and shall include copies of reports of the preoperational Radiological Environmental Monitoring Program of the unit for at least two years prior to initial criticality in addition to the following.

The Annual Radiological Environmental Operating Reports shall include summaries, interpretations, and an analysis of trends of the results of the radiological environmental surveillance activities for the report period, including a comparison with preoperational studies, operational controls (as appropriate). and previous environmental surveillance reports and an assessment of the observed impacts of the plant operation on the environment. The reports shall also include the results of land use censuses required by Control 3.12.2.

The Annual Radiological Environmental Operating Reports shall include the results of analysis of all radiological environmental samples and of all locations specified in the table and figures in the Offsite Dose Calculation Manual, as well as summarized and tabulated results of these analyses and measurements in the format of the table in the Radiological Assessment Branch Technical Position, Revision 1, November 1979. In the event that some individual results are not available for inclusion with the report, the report shall be submitted noting and explaining the reasons for the missing results. The missing data shall be submitted as soon as possible in a supplementary report.

The reports shall also include the following: a summary description of the Radiological Environmental Monitoring Program; at least two legible maps* covering all sampling locations keyed to a table giving distances and directions from the centerline of one reactor; the results of licensee participation in the Interlaboratory Comparison Program and the corrective action taken if the specified program is not being performed as required by Control 3.12.3; reasons for not conducting the Radiological Environmental Monitoring Program as required by Control 3.12.1, and discussion of all deviations from the sampling schedule of Table 3.12.1-1; discussion of environmental sample measurements that exceed the reporting levels of Table 3.12.1-2 but are not the result of plant effluents, pursuant to ACTION b of Control 3.12.1; and discussion of all analyses in which the the LLD required by Table 4.12.1-1 was not achievable.

ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT

6.9.1.7 Routine radioactive release reports covering the operation of the unit during the previous calendar year shall be submitted annually. The report must be submitted as specified in 10CFR50.4 and the time between submission of reports must be no longer than 12 months.

*One map shall cover stations near the SITE BOUNDARY; a second shall include the more distant stations.

ADMINISTRATIVE CONTROLS

ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT (Continued)

The Annual Radioactive Effluent Release Report shall include a summary of the quantities of radioactive liquid and gaseous effluents released from the unit as outlined in Regulatory Guide 1.21, "Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants," Revision 1, June 1974, with data summarized on a quarterly basis following the format of Appendix B thereof.

The Annual Radioactive Effluent Release Report submitted each year shall include a summary of hourly meteorological data collected over the previous calendar year. This annual summary may be either in the form of an hour-by-hour listing on magnetic tape of wind speed, wind direction, atmospheric stability, and precipitation (if measured), or in the form of joint frequency distributions of wind speed, wind direction, and atmospheric stability.* This report shall include an assessment of the radiation doses due to the radioactive liquid and gaseous effluents released from the unit or station during the previous calendar year. This report shall also include an assessment of the radiation doses from radioactive liquid and gaseous effluents to MEMBERS OF THE PUBLIC due to their activities inside the SITE BOUNDARY (Figure 5.1.1-1 of Technical Specifications) during the report period. All assumptions used in making these assessments, i.e., specific activity, exposure time, and location, shall be included in these reports. The assessment of radiation doses shall be performed in accordance with the methodology and parameters in the OFFSITE DOSE CALCULATION MANUAL (ODCM). C-1

The Annual Radioactive Effluent Release Report submitted each year shall also include an assessment of radiation doses to the likely most exposed MEMBER OF THE PUBLIC from reactor releases and other nearby uranium fuel cycle sources, including doses from primary effluent pathways and direct radiation, for the previous calendar year to show conformance with 40 CFR Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operation." Acceptable methods for calculating the dose contribution from liquid and gaseous effluents are given in Regulatory Guide 1.109, Rev. 1, October 1977.

The Annual Radioactive Effluent Release Report shall include a list and description of unplanned releases from the site to UNRESTRICTED AREAS of radioactive materials in gaseous and liquid effluents made during the reporting period.

*In lieu of submission with the Annual Radioactive Effluent Release Report, the licensee has the option of retaining this summary of required meteorological data on site in a file that shall be provided to the NRC upon request.

ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT (Continued)

The Annual Radioactive Effluent Release Report shall include any changes made during the reporting period to the OFFSITE DOSE CALCULATION MANUAL (ODCM), pursuant to PNPP Technical Specification 6.14, as well as any major change to Liquid or Gaseous Treatment Systems pursuant to Control 6.15. It shall also include a listing of new locations for dose calculations and/or environmental monitoring identified by the Land Use Census pursuant to Control 3.12.2.

The Annual Radioactive Effluent Release Report shall also include the following: an explanation as to why the inoperability of liquid or gaseous effluent monitoring instrumentation was not corrected within the time specified in Control 3.3.7.9 or 3.3.7.10, respectively; and description of the events leading to liquid holdup tanks exceeding the limits of Specification 3.11.1.4.

SPECIAL REPORTS

6.9.2 Special reports shall be submitted in accordance with 10 CFR50.4 within the time period specified for each report.

6.10 RECORD RETENTION

6.10.1 In addition to the applicable record retention requirements of Title 10 Code of Federal Regulations, the following records shall be retained for at least the minimum period indicated.

6.10.2 The following records shall be retained for at least 5 years:

a. Records of surveillance activities, inspections, and calibrations required by these Controls.

6.15 MAJOR CHANGES TO RADIOACTIVE WASTE TREATMENT SYSTEMS*

6.15.1 Licensee initiated major changes to the radioactive waste systems, liquid, gaseous and solid:

*Licensee may choose to submit the information called for in this Control as part of the annual USAR update.

MAJOR CHANGES TO RADIOACTIVE WASTE TREATMENT SYSTEMS (Continued)

1. Shall be reported to the Commission in the Annual Radioactive Effluent Release Report for the period in which the evaluation was reviewed by the PORC. The discussion of each change shall contain:

   a. A summary of the evaluation that led to the determination that the change could be made in accordance with 10CFR50.59;
   b. Sufficient detailed information to totally support the reason for the change without benefit of additional or supplemental information;
   c. A detailed description of the equipment, components and processes involved and the interfaces with other plant systems
   d. An evaluation of the change which shows the predicted releases of radioactive materials in liquid and gaseous effluents and/or quantity of solid waste that differ from those previously predicted in the license application and amendments thereto;
   e. An evaluation of the change which shows the expected maximum exposures to MEMBERS OF THE PUBLIC in the UNRESTRICTED AREA and to the general population that differ from those previously estimated in the license application and amendments thereto;
   f. A comparison of the predicted releases of radioactive materials, in liquid and gaseous effluents and in solid waste, to the actual releases for the period prior to when the changes are to be made;
   g. An estimate of the exposure to plant operating personnel as a result of the change; and
   h. Documentation of the fact that the change was reviewed and found acceptable by the PORC.

2. Shall become effective upon review and acceptance by the PORC.

Records

The following records are generated by this document:

Quality Assurance Records

Annual Radioactive Effluent Release Report

Non-Quality Records

None

REFERENCES

1. Title 10, "Energy," Chapter 1, Code of Federal Regulations; Part 20, U.S. Government Printing Office, Washington, D.C. 20402, January 1, 1984.

2. Title 10, "Energy," Chapter 1, Code of Federal Regulations; Part 50; U.S. Government Printing Office, Washington, D.C. 20402, January 1, 1984.

3. Title 40, "Protection of Environment," Chapter 1, Code of Federal Regulations, Part 190, Federal Register, Vol. 42, Washington, D.C. 20402, January 13, 1977.

4. U.S. Nuclear Regulatory Commission, "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants," USNRC NUREG-0133, Washington, D.C. 20555, October, 1981.

5. U.S. Nuclear Regulatory Commission, "Draft Radiological Effluent Technical Specifications for PWR's," USNRC NUREG-0473, Revision 2, Washington, D.C. 20555, February, 1980.

6. Regulatory Guide 1.21, "Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants," Revision 1, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, June 1974.

7. Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10CFR Part 50, Appendix I," Revision 0, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, March 1976.

8. Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10CFR Part 50, Appendix I," Revision 1, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, October 1977.

9. Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," Revision 1, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, July 1977.

10. Regulatory Guide 1.113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I," Revision 1, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, April 1977.

REFERENCES (Cont.)

11. Regulatory Guide 4.15, "Quality Assurance for Radiological Monitoring Programs (Normal Operation) - Effluent Streams and the Environment," U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, February 1979.

12. U.S. Nuclear Regulatory Commission, "Branch Technical Position," Revision 1, Washington, D.C. 20555, November 1979.

13. Perry Nuclear Power Plant, Unit 1 and 2, "Final Safety Analysis Report," Amendment 14, The Cleveland Electric Illuminating Company, Perry, Ohio 44081, August 1984.

14. Perry Nuclear Power Plant, Units 1 and 2, "Environmental Report, Operating License Stage," Supplement 3, The Cleveland Electric Illuminating Company, Perry, Ohio 44081, November 1981.

15. Perry Nuclear Power Plant, Units 1 and 2, "Radiological Environmental Monitoring Program Manual," The Cleveland Electric Illuminating Company, Perry, Ohio 44081, February 1985.

16. "Midas User's Manual, for the Cleveland Electric Illuminating Company, Perry Nuclear Power Plant," Pickard, Lowe and Garrick, Washington, D.C. 20036, July 1983.

17. Kocher, D.C., "Radioactive Decay Data Tables," Technical Information Center, U.S. Department of Energy, Springfield, Virginia 22161, September 1985.

18. 1989 Engineering Report "Lake Erie Potable Water Facilities and Intakes within 50 Miles of PNPP, (Ref. SO-11552 "E").

19. Perry Environmental Report Operating License Stage, Table 5.1-10 "Annual Average Dilution Factors for Lake Water Intakes within 50 Miles of PNPP and Q&R Page 2.1-2.

20. PNPP Ohio Power Siting Commission application of August 1974, Appendix 1304-C-2, Table IV-A-2.

21. Total Angler Catch (1987 annual) for Each Grid Location; per letter from Michael R. Rawson, Fairport Fisheries Research Station, Ohio Department of Natural Resources (6-20-88).