BIG ROCK POINT NUCLEAR POWER PLANT
PROCEDURE APPROVAL AND AUTHORIZATION

Procedure No. VOLUME 25 Rev No. 13

Procedure Title BIG ROCK POINT RADIOLOGICAL EFFLUENT T/S REQUIRED DOCUMENTS
A. OFFSITE DOSE CALCULATIONS
B. PROCESS CONTROL PROGRAM

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BEFORE USING THIS PROCEDURE FOR WORK ACTIVITIES, VERIFY WITH THE RESPECTIVE PROCEDURE CONTROLLING DEPARTMENT THERE ARE NO OUTSTANDING TEMPORARY CHANGES

When applicable:

PROCEDURE IMPLEMENTATION HISTORY

Reviewed for System or Component Operability

Performed by	Completed/Reviewed by	Method of Verification
Title	Title	☐ Functional Test
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		☐ Administrative Review

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PURPOSE

The purpose of this manual is to provide the methodologies and parameters used to:

1. Calculate offsite doses consistent with 10 CFR 50, Appendix I, during routine operations.

2. Determine alarm/trip set points of effluent monitoring instrumentation.

REQUIREMENTS

This manual is required per Technical Specifications:

6.9.2.2.A.4 - Radiological Impact on Man

13.1.1 - Radioactive Effluent Monitoring Instrumentation Operability and Surveillance Requirements

13.1.2 - Liquid Effluent Concentration

13.1.3 - Gaseous Effluent Dose Rate

13.1.4 - Effluent Dose

Review, approval, issue and control is performed per Volume 1, Administrative Procedure 1.2.

Changes to this manual shall be submitted to the Commission in accordance with Technical Specification Administrative Controls, Section 6.15.

NOTE: Format of ODCM is such to be consistent with other plants ODCM.

NOTE: Whenever MPC and 10 CFR 20 are mentioned in this ODCM, it means MPC values from the old 10 CFR 20 (prior to the NRC final rule published on May 21, 1991) unless specifically stated otherwise. The NRC has not changed the dose conversion factors of Regulatory Guide 1.109 which is the basis for demonstrating compliance with 10 CFR 50, Appendix I doses, the tables of this ODCM, and gaseous effluent dose rate limits of Technical Specification 13.1.3. The use of the old MPC values of 10 CFR 20 are appropriate for use with these dose conversion factors and design basis quantities. Use of the new 10 CFR 20 effluent concentrations without changes to Regulatory Guide 1.109 will give incorrect results.

I. GASEOUS EFFLUENTS

I.A ALARM/TRIP SET POINT METHOD

Technical Specification 13.1.3.1 requires that the dose in unrestricted areas due to gaseous effluents from the site shall be limited when averaged over a period not to exceed one hour to the following values:

1. 500 mrem/y to the total body and 3,000 mrem/y to the skin from noble gases.

2. 1,500 mrem/y to any organ from radioiodines and particulates, due to inhalation.

Specification 13.1.1.1 requires gaseous effluent monitors to have alarm/trip set points to ensure that release rates, when averaged over one hour, will not exceed the dose rate limits of Specification 13.1.3.1. This section of the ODCM describes the methodology that will be used to determine these set points.

The methodology for determining alarm/trip set points is divided into two major parts. The first consists of calculating an allowable concentration for the nuclide mixture to be released. The second consists of determining monitor response to this mixture in order to establish the physical settings on the monitors.

I.A.1 Allowable Concentration

The total MPC-fraction (R) for the stack release point will be calculated by the relationship defined by Note 1 of Appendix B, 10 CFR 20.

$$R = \left(\frac{X}{Q}\right)(F) \sum_i \frac{Ci_i}{MPC_i} = \leq 1.0 \qquad (I.1)$$

where:

Ci_i = The measured or calculated concentration, at ambient temperature and pressure, of nuclide i (μCi/cc) at the stack.

MPC_i = The MPC of nuclide i from 10 CFR 20, Appendix B.

R = The total MPC-fraction for the stack release point.

X/Q = Most conservative sector site boundary dispersion (9.12E-08 sec/m^3).

F = Release flow rate (39,000 cfm = 18.4 m^3/sec) for stack monitor considerations; variable for other monitors.

I.A.2 Monitor Response

Normal radioactivity releases consist predominantly of 30-minute decayed fission gases. Therefore, stack monitor response calibrations are performed to fission gas typical of normal releases (30-minute-decayed off-gas). Air ejector off-gas monitor measures only slightly decayed gases, however, so is calibrated to provide accurate response to relatively fresh fission gasses. Response monitors used to define fission product release rates under accident conditions may vary from that of these mixes, however. Monitor response for the two categories of monitor is determined as follows:

1. Normal Releases (30-minute-decayed fission gasses)

   Total gas concentration (μCi/cc) at the monitor is calculated. The calibration curve or constant for cpm/(μCi/cc) is applied to determine cpm expected. The setting for monitor alarms is established at some factor (b) greater than 1 but less than 1/R (Equation I.1) times the measured concentration (c):

$$s = b \times c \qquad (I.2)$$

2. Accident Releases

Monitors are preset to alarm at or before precalculated offsite dose rates would be achieved under hypothetical accident conditions. These set points are established in accordance with Emergency Plan requirements for defining Emergency Action Levels and associated actions. Emergency Implementing Procedures contain monitor-specific curves or calibration constants for conversion between cpm and μCi/cc (or rem/hr and μCi/cc), depending on monitor type, for fission product mixtures as a function of mixture decay time.

When these monitors are utilized for other than accident conditions, either an appropriately decayed "accident" conversion curve may be used, or a decayed fission gas calibration factor may be applied. In these cases, set points are established as in 1 above.

I.B DOSE CALCULATION

I.B.1 Doses are calculated for (1) noble gases and (2) iodines and particulates. Doses as defined in this section are based on 10 CFR 50, Appendix I limits of mrem per quarter and millirem per year. All dose pathways of major importance in the Big Rock environs are considered.

I.B.1.1 Equations and assumptions for calculating doses from noble gases are as follows:

I.B.1.1.1 Assumptions

1. Doses to be calculated are the maximum offsite point in air, total body and skin.

2. Exposure pathway is submersion within a cloud of noble gases.

3. Noble gas radionuclide mix is based on the historically observed source term given in Table 1.1, plus additional nuclides.

4. Basic radionuclide data are given in Table 1.2.

5. All releases are treated as elevated at 73 m.

6. Meteorological data expressed as joint-frequency distribution of wind speed, wind direction, and atmospheric stability for the period resulting in X/Qs and D/Qs are shown in Table 1.3.

7. Raw meteorological data consist of wind speed and direction measurements at 71 m.

8. Dose is to be evaluated at the offsite exposure points where maximum concentrations are expected to exist, and nearest residents.

9. Potential maximum population (resident) exposure points are identified in Table 1.4.

10. A semi-infinite cloud model is used.

11. For person exposures, credit is taken for shielding by residence (factor of 0.7).

12. Radioactive decay is considered for the plume.

13. A sector-average dispersion equation is used.

14. The wind speed classes that are used are as follows:

Wind Speed Class Number	Range (m/s)	Midpoint (m/s)
1	0.0-0.4	0.0
2	0.4-1.5	0.95
3	1.5-3.0	2.25
4	3.0-5.0	4.0
5	5.0-7.5	6.25
6	7.5-10.0	8.75
7	>10.0	-

15. The stability classes that will be used are the Standard A through G classifications. The stability Classes 1-7 will correspond to A = 1, B = 2...G = 7.

16. Terrain effects are not considered, and no open terrain recirculation factors are applied.

I.B.1.1.2 Equations

To calculate the dose for any one of the exposure points, the following equations are used:

For determining the air concentration of any radionuclide:

$$X_i = \sum_{j=1}^{7} \sum_{K=1}^{7} \left(\frac{2}{\pi}\right)^{\frac{1}{2}} \frac{f_{jk}\, Q_i\, P}{\Sigma_{zk}\, u_j\, (2\pi x/n)} \exp\left(-\lambda_i \frac{x}{u_j}\right) X \exp\left(\frac{-h^2}{2\sigma_{zk}^2}\right) \qquad (I.3)$$

where:

X_i = Air concentration of radionuclide i, $\mu Ci/m^3$.

f_{jk} = Joint relative frequency of occurrence of winds in wind speed class j, stability class k, blowing toward this exposure point, expressed as a fraction.

Q_i = Average release rate of radionuclide i, $\mu Ci/s$.

P = Fraction of radionuclide remaining in plume.

Σ_{zk} = Vertical dispersion coefficient for stability class k (m).

u_j = Midpoint value of wind speed class interval j, m/s.

x = Downwind distance, m.

n = Number of sectors, 16.

λ_i = Radioactive decay coefficient of radionuclide i, s^{-1}.

$2\pi x/n$ = Sector width at point of interest, m.

h = Stack height (73 meters).

σ_{zk}^2 = Vertical dispersion coefficient of stability class k.

For determining the total body dose:

$$D_{TB} = \sum_i X_i \, DFB_i \qquad (I.4)$$

where:

D_{TB} = Total body dose mrem/y.

X_i = Air concentration of radionuclide i, $\mu Ci/m^3$.

DFB_i = Total body dose factor due to gamma radiation, mrem/y per $\mu Ci/m^3$ (Table 1.5).

For determining the skin dose:

$$D_s = \sum_i X_i \, (DFS_i + 1.11 \, DFY_i) \qquad (I.5)$$

where:

D_s = Skin dose mrem/y.

X_i = Air concentration of radionuclide i, $\mu Ci/m^3$.

DFS_i = Skin dose factor due to beta radiation, mrem/y per $\mu Ci/m^3$ (Table 1.5).

1.11 = The average ratio of tissue-to-air energy absorption coefficients, mrem/mrad.

DFY_i = Gamma-to-air dose factor for radionuclide i, mrad/y per $\mu Ci/m^3$ (Table 1.5).

For determining dose rate to a point in air:

$$D_a = \sum X_i \, (DFY_i \text{ or } DFB_i) \qquad (I.6)$$

where:

D_a = Air dose mrad/y.

DFB = Air dose factor for beta radiation (Table 1.5).

I.B.1.2 Equations and assumptions for calculating doses from radioiodines and particulates are as follows:

I.B.1.2.1 Assumptions

1. Dose is to be calculated for the critical organ, thyroid, and the critical age groups (adult, teen, child, infant), infant (milk) and child (green, leafy vegetables).

2. Exposure pathways from iodines and particulates are milk ingestion, ground contamination, green leafy vegetables from home gardens and inhalation.

3. The radioiodine and particulate mix is based on the historically observed source term given in Table 1.1.

   NOTE: Source term(s) may be changed if radionuclide mix differs significantly from the historical source terms per Technical Specification 13.1.3.3 - Sampling and Analysis.

4. Basic radionuclide data are given in Table 1.2.

5. All releases are treated as elevated (73 m).

6. Annual average X/Qs are given in Table 1.3.

7. Raw meteorological data for elevated releases consist of wind speed and direction measurements at 71 m.

8. Dose is to be evaluated at the potential offsite exposure points where maximum doses to man are expected to exist.

9. Actual cow, goat and garden locations are considered.

10. Potential maximum exposure points (Table 1.4) considered are the nearest cow, goat and home garden locations in each sector.

11. Terrain effects are not considered.

12. Plume depletion and radioactive decay are considered for air-concentration calculations.

13. Radioactive decay is considered for ground-concentration calculations.

14. Milk cows and goats obtain 100% of their food from pasture grass May through October of each year. Use default values of 0.58 for cows and 0.67 for goats for fraction of year on pasture.

15. Credit is taken for shielding by residence (factor of 0.7).

I.B.1.2.2 Equations

To calculate the dose for any one of the potential maximum-exposure points, the equations of Sections I.B.1.2.2.1-I.B.1.2.2.5 are used.

I.B.1.2.2.1 Inhalation

Equation for calculating air concentration, X, is the same as in the Noble Gas Section I.B.1.1.2 (Equation I.3).

For determining the organ dose rate:

$$D_I = 1 \times 10^6 \sum_i X_i \; DFI_i \; BR \qquad (I.7)$$

where:

D_I = Organ dose due to inhalation, mrem/y.

X_i = Air concentration of radionuclide i, $\mu Ci/m^3$.

DFI_i = Inhalation dose factor, mrem/pCi (Table 1.7).

BR = Breathing rate 1,400 m^3/y, infant; 3,700 m^3/y, child; or 8,000 m^3/y, adult and teen.

1×10^6 = pCi/μCi conversion factor.

I.B.1.2.2.2 Ground Contamination

For determining the ground concentration of any nuclide:

$$G_i = 3.15 \times 10^7 \sum_{k=1}^{7} \frac{f_k\, Q_i\, DR_k}{(2\pi x/n)\, \lambda_i} [1 - \exp - (\lambda_i\, t_b)] [\exp (\frac{-h^2}{2\sigma^2_{zk}})] \qquad (I.8)$$

where:

G_i = Ground concentration of radionuclide i, $\mu Ci/m^2$.

k = Stability class.

f_k = Joint relative frequency of occurrence of winds in stability class k blowing toward this exposure point, expressed as a fraction.

Q_i = Average release rate of radionuclide i, $\mu Ci/s$.

DR_k = Relative deposition rate, 1/m.

x = Downwind distance, m.

n = Number of sectors, 16.

$2\pi x/n$ = Sector width at point of interest, m.

λ_i = Radioactive decay coefficient of radionuclide i, y^{-1}.

t_b = Time for buildup of radionuclides on the ground, 35 y.

3.15×10^7 = s/y conversion factor.

h = Stack height (73 m).

σ^2_{zk} = Vertical dispersion coefficient (m^2) of stability class.

For determining the total body or organ dose from ground contamination:

$$D_G = (8,760)(1 \times 10^6)(0.7) \sum_i G_i \, DFG_i \qquad (I.9)$$

where:

D_G = Dose due to ground contamination, mrem/y.

G_i = Ground concentration of radionuclide i, $\mu Ci/m^2$.

DFG_i = Dose factor for standing on contaminated ground, mrem/h per pCi/m^2 (Table 1.8).

8,760 = Occupation time, h/y.

1×10^6 = pCi/μCi conversion factor.

0.7 = Shielding factor accounting for a distance of 1.0 meter above ordinary ground, dimensionless.

I.B.1.2.2.3 Milk and Vegetation Ingestion

For determining the concentration of any nuclide (except C-14 and H-3) in and on vegetation:

$$CV_i = 3{,}600 \sum_{k=1}^{7} \frac{f_k\, Q_i\, DR_k}{(2\pi x/n)} \left(\frac{r[1 - \exp(-\lambda_{Ei}\, t_e)]}{Y_v\, \lambda_{Ei}} + \frac{B_{iv}\,[1 - \exp(-\lambda_i\, t_b)]}{P\lambda_i} \right) \exp\left(\frac{-h^2}{2\sigma^2_{zk}}\right) \exp(-\lambda_i\, t_h) \qquad (I.10)$$

where:

CV_i = Concentration of radionuclide i in and on vegetation, μCi/kg.

k = Stability class.

f_k = Frequency of this stability class and wind direction combination, expressed as a fraction.

Q_i = Average release rate of radionuclide i, μCi/s.

DR_k = Relative deposition rate as a function of wind speed, stability class and downwind distance, m^{-1} (Figures 7 through 10 of Regulatory Guide 1.111).

x = Downwind distance, m.

n = Number of sectors, 16.

$2\pi x/n$ = Sector width at point of interest, m.

r = Fraction of deposited activity retained on vegetation (1.0 for iodines, 0.2 for particulates).

λ_{Ei} = Effective removal rate constant, $\lambda_{Ei} = \lambda_i + \lambda_w$, where λ_i is the radioactive decay coefficient, h^{-1}, and λ_w is a measure of physical loss by weathering ($\lambda_w = .0021\ h^{-1}$).

t_e = Period over which deposition occurs, 720 h.

Y_v = Agricultural yield, 0.7 kg/m^2.

B_{iv} = Transfer factor from soil to vegetation of radionuclide i (Table 1.6).

λ_i = Radioactive decay coefficient of radionuclide i, h^{-1}.

t_b = Time for buildup of radionuclides on the ground, 3.07×10^5 h (35y).

p = Effective surface density of soil, 240 kg/m^2.

3,600 = s/h conversion factor.

h = Stack height (73 m).

σ_z = Vertical dispersion coefficient (m).

t_h = Holdup time between harvest and consumption of food, 0 h for pasture grass or 2,160 h for storage feed.

For determining the concentration of C-14 in vegetation:

$$CV_{14} = 1 \times 10^3 \, X_{14} \, (0.11/0.16) \qquad (I.11)$$

where:

CV_{14} = Concentration of C-14 in vegetation, $\mu Ci/kg$.

X_{14} = Air concentration of C-14, $\mu Ci/m^3$.

0.11 = Fraction of total plant mass that is natural carbon.

0.16 = Concentration of natural carbon in the atmosphere, g/m^3.

1×10^3 = g/kg conversion factor.

For determining the concentration of H-3 in vegetation:

$$CV_T = 1 \times 10^3 \, X_T \, (0.75)(0.5/H) \qquad (I.11a)$$

where:

CV_T = Concentration of H-3 in vegetation, $\mu Ci/kg$.

X_T = Air concentration of H-3, $\mu Ci/m^3$.

0.75 = Fraction of total plant mass that is water.

0.5 = Ratio of tritium concentration in plant water to tritium concentration in atmospheric water.

H = Absolute humidity of the atmosphere, g/m^3.

1×10^3 = g/kg conversion factor.

For determining the concentration of any nuclide in cow's or goat's milk:

$$CM_i = CV_i \, FM_i \, Q_f \exp(-\lambda_i \, t_f) \qquad (I.12)$$

where:

CM_i = Concentration of radionuclide i (including C-14 and H-3) in milk, $\mu Ci/l$.

CV_i = Concentration of radionuclide i in and on vegetation, $\mu Ci/kg$.

FM_i = Transfer factor from feed to milk for radionuclide i, d/l (Table 1.6).

Q_f = Amount of feed consumed by the milk animal per day, cow - 50 kg/d, goat - 6 kg/d.

λ_i = Radioactive decay coefficient of radionuclide i, d^{-1}.

t_f = Transport time of activity from feed to milk to receptor, two days.

For determining the organ dose from ingestion of green leafy vegetables and milk:

$$D = 1 \times 10^6 \sum_i CM_i \, DF_i \, UM \qquad (I.13)$$

where:

D = Organ dose due to ingestion, mrem/y.

CM_i = Concentration of radionuclide i in vegetables or milk, μCi/kg (or liters).

DF_i = Ingestion dose factor, mrem/pCi (Table 2.1).

UM = Ingestion rate for milk, 330 l/y - infant and child, 400 l/y - teen, and 310 l/y - adult.

Ingestion rate for vegetables, 26 kg/y - child, 42 kg/y - teen, and 64 kg/y - adult.

1×10^6 = pCi/μCi conversion factor.

I.B.1.2.2.4 Meat Ingestion (Beef)

To calculate the concentration of a nuclide in animal flesh:

$$C_{fi} = F_{fi} \, CV_i \, Q_f \exp(-\lambda_i \, t_s) \qquad (I.14)$$

where:

C_{fi} = Concentration of nuclide i in the animal flesh, pCi/kg.

F_{fi} = Fraction of animal's daily intake which appears in each kg of flesh, days/kg (Table 1.6).

CV_i = Concentration of radionuclide i in the animal's feed (Equation I.10).

Q_f = Amount of feed consumed by the cow per day, 50 kg/d.

t_s = Average time from slaughter to consumption, 20 days.

To determine the organ dose from ingestion of beef:

$$D_F = \sum_i C_{fi} D_{fi} U_f \qquad (I.15)$$

where:

D_{fi} = Ingestion dose factor for age group, mrem/pCi (Table 2.1) for nuclide i.

U_f = Ingestion rate of meat for age group, kg/y (child - 41, teen - 65, adult -110).

I.B.1.2.2.5 Organ Dose Rates

For determining the total body, organ and/or thyroid dose rate from iodines and particulates:

$$D = D_I + D_G + D_M + D_V + D_F \qquad (I.16)$$

where:

D = Total organ dose, mrem/y.

D_I = Dose due to inhalation, mrem/y.

D_G = Dose due to ground contamination, mrem/y.

D_M = Dose due to milk ingestion, mrem/y.

D_V = Dose due to vegetable ingestion, mrem/y.

D_F = Dose due to meat ingestion, mrem/y.

I.B.1.2.3 The maximum organ dose rate, maximum total body dose rate, maximum skin dose rate plus beta and gamma air doses calculated in the previous section (Section I.B.1.2.2) are used to calculate design basis quantities as described in Section I.B.1.3.

I.B.1.3 Design Basis Quantities

The design basis quantity of a radionuclide emitted to the atmosphere is the amount of that nuclide, when released in one year, which would result in a dose not exceeding any of the following:

1. 15 millirems to any organ of an individual from iodines and particulates with half life greater than 8 days.

2. 20-millirad air dose for beta radiation from noble gas (see note below).

3. 10-millirad air dose for gamma radiation from noble gas (see note below).

Design basis quantity (Ci) is the smallest value for each nuclide, calculated by dividing the dose limits (a through c above) by the appropriate dose calculated in Step 1; the result then is multiplied by the amount of radionuclide (Ci) used to conservatively estimate the doses of Section D, as listed in Table 1.1 (or assumed a hypothetical 1 Ci/year for nuclides not actually present):

$$DBQ = \frac{D_{AI}}{D_c} (C_c) \qquad (I.17)$$

where:

D_{AI} = Appendix I dose limit (mrem or mrad).

D_c = Calculated dose from Step 1 (mrem or mrad).

C_c = Quantity of nuclide resulting in dose D_c (Ci).

DBQ = Design Basis Quantity (Ci).

The limiting values for Design Basis Quantities for radionuclides released to the atmosphere are given in Table 1.9.

NOTE: For conservative calculations the DBQs listed in Table 1.9 are based on:

1. 15 millirems to any organ of an individual from iodines and particulates with a half life greater than eight days.

2. 15-millirad air dose for beta radiation from noble gas.

3. 5-millirad air dose for gamma radiation from noble gas.

The inverse of the ratio C_c/D_c in the above equation (ie, D_c/C_c) is a useful value, since it represents the most limiting dose per unit quantity of each nuclide released.

I.B.1.4 Land Use Census and DBQ Changes

Technical Specification 13.2.3 describes the requirements for an annual land use census and revision of the ODCM for use in the following calendar year. Areas of the ODCM which will be reviewed and changed, if appropriate, are Table 1.4 (Land Use Census Data by Sector) and Table 1.9 (Gaseous Design Basis Objective Annual Quantities). Changes will be effective on January 1 of the year following the year of the survey.

I.C DESIGN BASIS QUANTITY (DBQ) LIMITS

I.C.1 Design Basis Quantity Fraction

Per Technical Specification 13.1.4.4 the cumulative DBQ fraction for nuclides released is summed at least every 31 days to assure that the sum of the fractions of all nuclides released does not exceed 1.0 year to date and 0.5 in any calendar quarter.

$$\sum_i \frac{A_i}{(DBQ)_i} < 1.0 \qquad (I.18)$$

I.C.2 Exceeding DBQ Limits

As discussed under I.B.1.3, the DBQ is a very conservative estimate of activity which could give doses at 10 CFR 50, Appendix I limits. Because different organs are summed together and doses to different people are summed, the DBQ typically overestimates dose by about a factor of five. Thus, if calculations of the DBQ fraction exceed 1.0 for year to date or 0.5 for the quarter, Technical Specifications probably still would not be exceeded. However, further discretionary releases should be deferred until an accurate assessment of dose is made by use of the NRC GASPAR computer code. The computer run will utilize the annual average joint frequency meteorological data based on not less than 3 years of meteorological measurement, and will reflect demographic and land use information from the land use survey generated in the most recent prior year. Where appropriate, seasonal adjustments will be applied to obtain realistic dose estimates since both recreational and agricultural activities can vary greatly in relation to season of the year.

It should be noted that Big Rock Point to date (based on review of semiannual effluent data) has never exceeded the annual or quarterly DBQ fraction, despite its conservatism, at any time in the past ten years (since stainless steel fuel cladding was replaced by zircaloy and other engineering changes were made). Thus, it is not expected that an alternate to the DBQ method will be required unless the plant is in a significantly off-normal condition.

I.C.3 Releasing Radionuclides Not Listed in Table 1.9

Table 1.9 contains all nuclides identified to date as routine constituents of gaseous releases at Big Rock Point Plant, plus those common to boiling water reactors in general, even if not previously detected at Big Rock Point. From time to time, however, other nuclides may be detected.

If the unlisted nuclide constitutes less than 10% of the MPC-fraction for the release, and all unlisted nuclides total less than 25% of the MPC-fraction, the nuclide may be considered not present.

If the unlisted nuclide constitutes greater than 10% of the MPC-fraction, or all unlisted nuclides together constitute greater than 25%, then each nuclide should be assigned a DBQ equal to the most conservative value listed for the physical form of the nuclide involved (noble gas, halogen or particulate).

Should a nuclide not listed in Table 1.9 begin to appear in significant quantities on a routine basis, revision to this ODCM should be made in order to include a design basis quantity specific to that nuclide.

I.D GASEOUS RADWASTE TREATMENT SYSTEM OPERATION

I.D.1 System Description

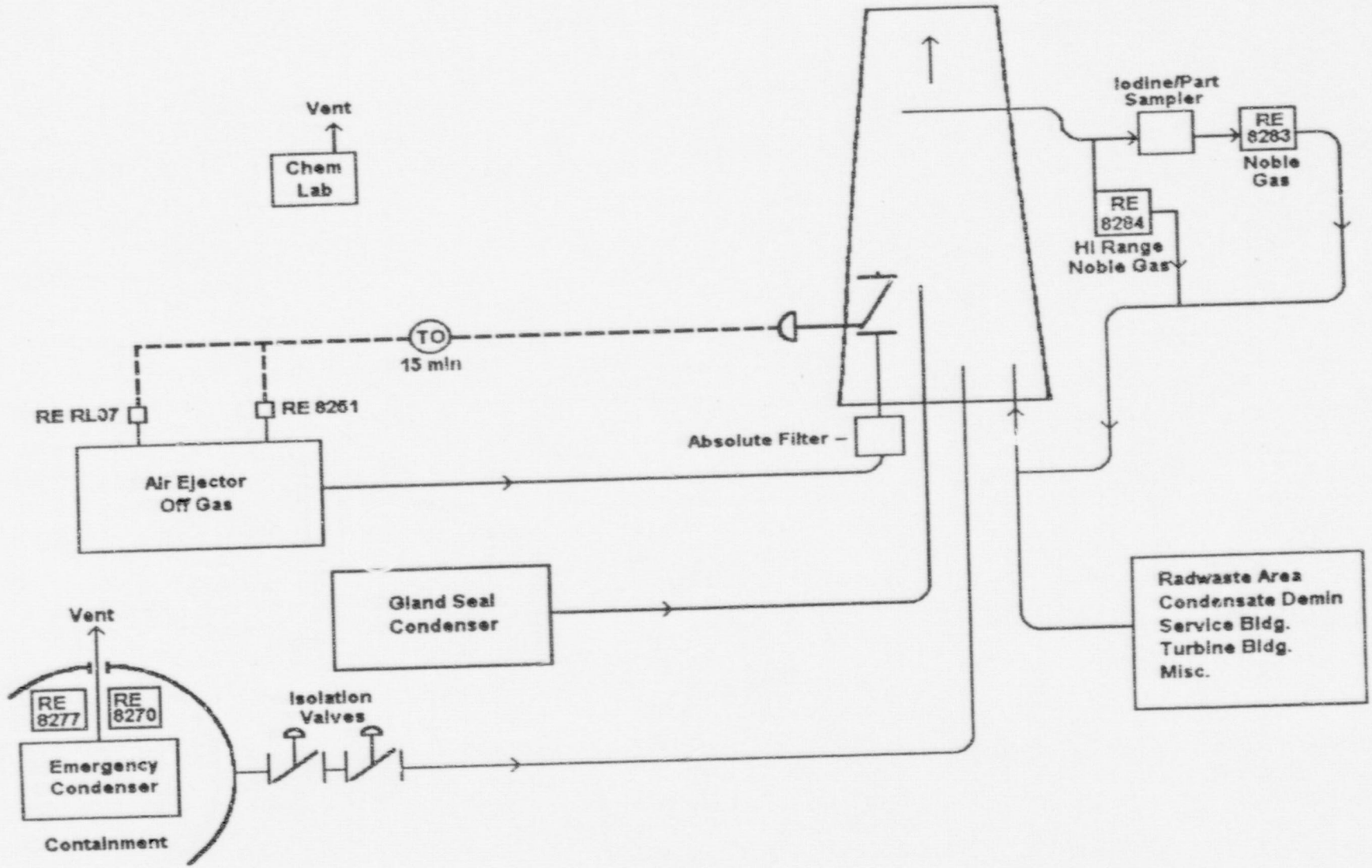
The gaseous radwaste system consists of a delay line for condenser off-gas which provides approximately 30 minutes of decay time prior to release via the 73 m stack. A flow diagram of gaseous waste release paths is shown in Figure 1-1.

Condenser off-gas represents more than 95% of the total gaseous source term. The other minor sources are gland seal condenser exhaust, containment ventilation, radwaste system vents and miscellaneous turbine building system leakage. All these sources are ducted to the stack for release.

I.D.2 Determination of Satisfactory Operations

Operability requirements for the gaseous waste treatment are not specified. This is because the decay line is an integral part of the release path piping for condenser off-gas.

FIGURE 1-1
BIG ROCK POINT GASEOUS
EFFLUENT FLOW PATHS



I.E OFFSITE RELEASE RATE

10 CFR 50.36a requires that the release of radioactive materials be kept as low as reasonably achievable. However, the section further states that the licensee is permitted the flexibility of operation, to assure a dependable source of power, to release quantities of material at higher rates than a small percentage of 10 CFR 20 limits but not exceeding those limits under unusual operating conditions. Appendix I to 10 CFR 50 provides the numerical guidelines on limiting conditions for operation to meet the as low as reasonably achievable requirement.

The GASPAR code has been run to determine the dose due to external radiation and inhalation. The source term used is listed in Table 1.1. The meteorology data is given in Table 1.3. Dose using annual average meteorology, to the most limiting offsite dose (whole body) assumed to be residing at the residence with highest X/Q, is 0.105 mrem for one year. The release rate which would result in a dose equivalent to 500 mrem/y (using the total body limit of Technical Specification 13.1.3.1) is the Curies/Year given in Table 1.1 (1.29E04) multiplied by 500/.105 or 1.95 Ci/sec.

The above calculation is informational as a typical exposure using average releases from Big Rock Point. Actual exposure calculations are described in Section I.A.

I.F PARTICULATE AND IODINE SAMPLING

Particulate and iodine samples are obtained from the continuous sample stream pulled from the plant stack. Samples typically are obtained to represent the integrated release from the stack.

Gamma analytical results for particulate and halogen filters are combined for determination of total activity of particulates and halogens released. Beta and alpha counting also is performed on the particulate filters. Beta yields of the gamma isotopes detected on particulate filters are applied to determine "identified" beta, and the "identified" count rate is subtracted from the observed count rate to give "unidentified" beta. The "unidentified" beta is assumed to be Sr-90 until results on actual Sr-90 (chemically separated from a quarterly composite of filters) are obtained. Similarly, alpha activity not identified as natural radium or thorium or their daughters is assumed as Pu-239 until results of detailed analyses are obtained from quarterly composites.

The "Stackgas" Program, used to calculate the release rates when analyzing the stack's particulate and iodine samples, takes the total release rate and ratios it to the allowable Sr 90 (most restrictive nuclide) release rate. If the ratio is $\geq$ 0.5, it warns that the Technical Specification 13.1.3.1.b limit may have been exceeded.

I.G NOBLE GAS SAMPLING

Condenser air ejector off-gas will be sampled at least weekly and used to calculate monthly noble gas releases. Nonroutine releases will be quantified from the stack noble gas monitor (RE 8283) which has an LLD of 1E-06 μCi/cc.

I.H TRITIUM SAMPLING

Tritium has a low dose consequence to the public because of low production rates. The major contributors to tritium effluents are evaporation from the fuel pool and reactor cavity (when flooded). Because of the low dose impact, gaseous tritium sampling will not be required. Tritium effluents will be estimated using conservative evaporation rate calculations from the fuel pool and reactor cavity.

TABLE 1.1

BIG ROCK POINT GASEOUS AND LIQUID SOURCE TERMS, CURIES/YEAR(1)

Nuclide	Gaseous(2)	Liquid(2)
H-3	1.21E+01	8.63E+00
N-13	1.53E+03	NA
Na-24	3.52E-04	1.12E-06
Cr-51	2.82E-04	6.84E-03
Mn-54	5.50E-05	2.60E-02
Mn-56	1.70E-04	NA
Co-58	1.65E-06	6.17E-04
Fe-59	2.81E-06	9.05E-03
Co-60	1.89E-04	4.21E-02
Zn-65	3.16E-05	9.01E-04
Br-82	8.11E-03	NA
Kr-83m	2.61E+02	NA
Kr-85	9.55E-01	NA
Kr-85m	3.12E+02	NA
Kr-87	1.19E+03	NA
Kr-88	7.80E+02	NA
Kr-89	6.96E+02	NA
Sr-89	NA	2.27E-04
Kr-90	7.76E+02	NA
Sr-90	NA	2.22E-03
Kr-91	6.68E+00	NA
Sr-91	5.61E-03	NA
Sr-92	NA	1.54E-06
Nb-95	1.91E-06	NA
Mo-99	3.10E-05	NA
Ag110m	1.57E-05	6.88E-05
Sb-124	NA	4.01E-04
I-131	1.94E-03	1.57E-04
Xe-131m	4.38E-01	NA
I-132	8.07E-03	NA
I-133	1.99E-02	NA
Xe-133	2.01E+02	8.86E-05
Xe-133m	6.00E+00	NA
Cs-134	4.04E-07	1.75E-02
I-134	1.24E-02	NA
I-135	3.00E-02	NA
Xe-135	1.11E+03	NA
Xe-135m	1.15E+03	NA
Cs-136	4.74E-05	NA
Cs-137	1.51E-04	2.04E-01
Xe-137	1.11E+03	NA
Cs-138	3.17E-01	NA
Xe-138	6.03E+03	NA
Ba-139	1.32E-03	NA
Xe-139	1.04E+03	NA
Ba-140	1.86E-03	NA
La-140	7.80E-03	5.04E-05
Xe-140	7.23E+01	NA
Hg-203	1.32E-06	NA
Np-239	1.44E-04	NA
Unidentified Beta	2.42E-03	6.76E-02

(1) Data derived from taking the effluents released during Jan-June 1980 through July-December 1983 and dividing by 4.

(2) Nuclide values listed as NA have not been observed at detectable levels in these waste streams.

TABLE 1.2

BASIC RADIONUCLIDE DATA

	NUCLIDE	HALF-LIFE (days)	LAMBDA (1/s)	[1] BETA (MEV/DIS)	[1] GAMMA (MEV/DIS)
1	Tritium	4.49E 03	1.79E-09	5.68E-03	0.0
2	C-14	2.09E 06	3.84E-12	4.95E-02	0.0
3	N-13	6.94E-03	1.16E-03	4.91E-01	1.02E 00
4	O-19	3.36E-04	2.39E-02	1.02E 00	1.05E 00
5	F-18	7.62E-02	1.05E-04	2.50E-01	1.02E 00
6	NA-24	6.33E-01	1.273-05	5.55E-01	4.12E 00
7	P-32	1.43E 01	5.61E-07	6.95E-01	0.0
8	AR-41	7.63E-02	1.05E-04	4.64E-01	1.28E 00
9	CR-51	2.78E 01	2.89E-07	3.86E-03	3.28E-02
10	MN-54	3.03E 02	2.65E-08	3.80E-03	8.36E-01
11	MN-56	1.07E-01	7.50E-05	8.29E-01	1.69E 00
12	FE-59	4.50E 01	1.78E-07	1.18E-01	1.19E 00
13	CO-58	7.13E 01	1.12E-07	3.41E-02	9.78E-01
14	CO-60	1.92E 03	4.18E-09	9.68E-02	2.50E 00
15	ZN-69m	5.75E-01	1.39E-05	2.21E-2	4.16E-01
16	ZN-69	3.96E-02	2.03E-04	3.19E-01	0.0
17	BR-84	2.21E-02	3.63E-04	1.28E 00	1.77E 00
18	BR-85	2.08E-03	3.86E-03	1.04E 00	6.60E-02
19	KR-85m	1.83E-01	4.38E-05	2.53E-01	1.59E-01
20	KR-85	3.93E 03	2.04E-09	2.51E-01	2.21E-03
21	KR-87	5.28E-02	1.52E-04	1.32E 00	7.93E-01
22	KR-88	1.17E-01	6.86E-05	3.61E-01	1.96E 00
23	KR-89	2.21E-03	3.63E-03	1.36E 00	1.83E 00
24	RB-88	1.24E-02	6.47E-04	2.06E 00	6.26E-01
25	RB-89	1.07E-02	7.50E-04	1.01E 00	2.05E 00
26	SR-89	5.20E 01	1.54E-07	5.83E-01	8.45E-05
27	SR-90	1.03E 04	7.79E-10	1.96E-01	0.0
28	SR-91	4.03E-01	1.99E-05	6.50E-01	6.95E-01
29	SR-92	1.13E-01	7.10E-05	1.95E-01	1.34E 00
30	SR-93	5.56E-03	1.44E-03	9.20E-01	2.24E 00
31	Y-90	2.67E 00	3.00E-06	9.36E-01	0.0
32	Y-91m	3.47E-02	2.31E-04	2.73E-02	5.30E-01
33	Y-91	5.88E 01	1.36E-07	6.06E-01	3.61E-03
34	Y-92	1.47E-01	5.46E-05	1.44E 00	2.50E-01
35	Y-93	4.29E-01	1.87E-05	1.17E 00	8.94E-02
36	ZR-95	6.50E 01	1.23E-07	1.16E-01	7.35E-01
37	NB-95m	3.75E 00	2.14E-06	1.81E-01	6.06E-02
38	NB-95	3.50E 01	2.29E-07	4.44E-02	7.64E-01
39	MO-99	2.79E 00	2.87E-06	3.96E-01	1.50E-01
40	TC-99m	2.50E-01	3.21E-05	1.56E-02	1.26E-01
41	TC-99	7.74E 07	1.04E-13	8.46E-02	0.0
42	TC-104	1.25E-02	6.42E-04	1.60E 00	1.95E 00

TABLE 1.2
(continued)

BASIC RADIONUCLIDE DATA

	NUCLIDE	HALF-LIFE (days)	LAMBDA (1/s)	[1] BETA (MEV/DIS)	[1] GAMMA (MEV/DIS)
43	RU-106	3.67E 02	2.19E-08	1.01E-02	0.0
44	TE-132	3.24E 00	2.48E-06	1.00E-01	2.33E-01
45	I-129	6.21E 09	1.29E-15	5.43E-02	2.46E-02
46	I-131	8.05E 00	9.96E-07	1.90E-01	3.81E-01
47	I-132	9.58E-02	8.37E-05	4.89E-01	2.24E 00
48	I-133	8.75E-01	9.17E-06	4.08E-01	6.02E-01
49	I-134	3.61E-02	2.22E-04	6.16E-01	2.59E 00
50	I-135	2.79E-01	2.87E-05	3.68E-01	1.55E 00
51	XE-131m	1.18E 01	6.80E-07	1.43E-01	2.01E-02
52	XE-133m	2.26E 00	3.55E-06	1.90E-01	4.15E-02
53	XE-133	5.27E 00	1.52E-06	1.35E-01	4.60E-02
54	XE-135m	1.08E-02	7.43E-04	9.58E-02	4.32E-01
55	XE-135	3.83E-01	2.09E-05	3.17E-01	2.47E-01
56	XE-137	2.71E-03	2.96E-03	1.77E 00	1.88E-01
57	XE-138	9.84E-03	8.15E-04	6.65E-01	1.10E 00
58	CS-134	7.48E 02	1.07E-08	1.63E-01	1.55E 00
59	CS-135	1.10E 09	7.29E-15	5.63E-02	0.0
60	CS-136	1.30E 01	6.17E-07	1.37E-01	2.15E 00
61	CS-137	1.10E 04	7.29E-10	1.71E-01	5.97E-01
62	CS-138	2.24E-02	3.58E-04	1.20E 00	2.30E 00
63	BA-139	5.76E-02	1.39E-04	8.96E-01	3.53E-02
64	BA-140	1.28E 01	6.27E-07	3.15E-01	1.71E-01
65	LA-140	1.68E 00	4.77E-06	5.33E-01	2.31E 00
66	CE-144	2.84E 02	2.82E-08	9.13E-02	1.93E-02
67	PR-143	1.36E 01	5.90E-07	3.14E-01	0.0
68	PR-144	1.20E-02	6.68E-04	1.21E 00	3.18E 02

[1] Average energy per disintegration values were obtained from ICRP Publication No 38, Radionuclide Transformations: Energy and Intensity of Emissions, 1983 and NUREG/CR-1413 (ORNL/NUREG-70), A Radionuclide Decay Data Base - Index and Summary Table, D. C. Kocher, May 1980.

TABLE 1.3

USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 940629
**** BIG ROCK POINT XOQDOQ82 *** USING 01/01/89 - 12/31/93 MET DATA ****
ELEVATED RELEASE - 240' STACK
NO DECAY, UNDEPLETED

ANNUAL AVERAGE CHI/Q (SEC/METER CUBED)

SECTOR	DISTANCE IN MILES FROM THE SITE 0.250	0.500	0.750	1.000	1.500	2.000	2.500	3.000	3.500	4.000	4.500
S	1.622E-08	2.278E-08	2.181E-08	2.523E-08	3.221E-08	3.376E-08	3.263E-08	3.055E-08	2.827E-08	2.607E-08	2.40[illegible]E-08
SSW	1.108E-08	1.837E-08	2.036E-08	2.326E-08	2.729E-08	2.735E-08	2.571E-08	2.362E-08	2.153E-08	1.962E-08	1.793E-08
SW	1.451E-09	3.735E-09	6.197E-09	9.996E-09	1.617E-08	1.839E-08	1.846E-08	1.765E-08	1.654E-08	1.538E-08	1.427E-08
WSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
W	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
WNW	0.000E+00	0.000E+00	9.790E-30	7.312E-22	2.710E-15	1.615E-12	4.919E-11	3.936E-10	1.556E-09	4.068E-09	8.195E-09
NW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+0[illegible]	0.000E+00	0.000E+00	0.000E+00
N	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NNE	1.742E-09	6.368E-09	1.629E-08	2.768E-08	4.150E-08	4.474E-08	4.348E-08	4.073E-08	3.765E-08	3.468E-08	3.195E-08
NE	1.191E-08	2.817E-08	3.802E-08	4.400E-08	4.637E-08	4.265E-08	3.778E-08	3.322E-08	2.929E-08	2.600E-08	2.324E-08
ENE	2.041E-08	3.354E-08	4.267E-08	4.986E-08	5.331E-08	4.903E-08	4.327E-08	3.788E-08	3.327E-08	2.942E-08	2.620E-08
E	2.734E-08	4.924E-08	5.329E-08	5.445E-08	5.101E-08	4.409E-08	3.754E-08	3.210E-08	2.771E-08	2.418E-08	2.131E-08
ESE	2.341E-08	4.274E-08	4.371E-08	4.257E-08	3.840E-08	3.285E-08	2.790E-08	2.386E-08	2.062E-08	1.801E-08	1.589E-08
SE	2.155E-08	3.271E-08	3.285E-08	3.400E-08	3.415E-08	3.100E-08	2.731E-08	2.394E-08	2.107E-08	1.867E-08	1.667E-08
SSE	1.167E-08	2.173E-08	2.610E-08	3.085E-08	3.595E-08	3.531E-08	3.262E-08	2.954E-08	2.663E-08	2.404E-08	2.179E-08

ANNUAL AVERAGE CHI/Q (SEC/METER CUBED)

SECTOR	DISTANCE IN MILES FROM THE SITE 5.000	7.500	10.000	15.000	20.000	25.000	30.000	35.000	40.000	45.000	50.000
S	2.224E-08	1.575E-08	1.193E-08	7.828E-09	5.723E-09	4.459E-09	3.624E-09	3.035E-09	2.600E-09	2.267E-09	2.004E-09
SSW	1.644E-08	1.130E-08	8.402E-09	5.390E-09	3.892E-09	3.005E-09	2.426E-09	2.020E-09	1.723E-09	1.496E-09	1.318E-09
SW	1.325E-08	9.465E-09	7.184E-09	4.707E-09	3.430E-09	2.664E-09	2.159E-09	1.803E-09	1.541E-09	1.340E-09	1.182E-09
WSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
W	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
WNW	1.387E-08	5.328E-08	8.642E-08	1.119E-07	1.096E-07	9.946E-08	8.828E-08	7.802E-08	6.912E-08	6.154E-08	5.512E-08
NW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
N	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NNE	2.951E-08	2.080E-08	1.572E-08	1.030E-08	7.524E-09	5.862E-09	4.766E-09	3.994E-09	3.423E-09	2.985E-09	2.640E-09
NE	2.093E-08	1.354E-08	9.701E-09	5.946E-09	4.172E-09	3.156E-09	2.507E-09	2.061E-09	1.738E-09	1.495E-09	1.306E-09
ENE	2.352E-08	1.501E-08	1.066E-08	6.454E-09	4.491E-09	3.376E-09	2.669E-09	2.186E-09	1.838E-09	1.576E-09	1.374E-09
E	1.897E-08	1.180E-08	8.260E-09	4.926E-09	3.410E-09	2.556E-09	2.017E-09	1.650E-09	1.386E-09	1.188E-09	1.035E-09
ESE	1.417E-08	8.872E-09	6.237E-09	3.748E-09	2.611E-09	1.966E-09	1.557E-09	1.278E-09	1.076E-09	9.247E-10	8.073E-10
SE	1.500E-08	9.690E-09	6.938E-09	4.252E-09	2.988E-09	2.263E-09	1.800E-09	1.481E-09	1.251E-09	1.077E-09	9.421E-10
SSE	1.985E-08	1.334E-08	9.770E-09	6.145E-09	4.376E-09	3.344E-09	2.677E-09	2.215E-09	1.878E-09	1.622E-09	1.423E-09

VENT AND BUILDING PARAMETERS:

RELEASE HEIGHT	(METERS)	73.10
DIAMETER	(METERS)	1.14
EXIT VELOCITY	(METERS)	18.21
REP. WIND HEIGHT	(METERS)	71.3
BUILDING HEIGHT	(METERS)	31.4
BLDG.MIN.CRS.SEC.AREA	(SQ.METERS)	1000.0
HEAT EMISSION RATE	(CAL/SEC)	0.0

ALL ELEVATED RELEASES

Data in sectors WSW through N are not valid. Refer to note at the end of Table 1.3.

TABLE 1.3

USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 940629
**** BIG ROCK POINT XOQDOQ82 *** USING 01/01/89 - 12/31/93 MET DATA ****
ELEVATED RELEASE - 240' STACK
********** RELATIVE DEPOSITION PER UNIT AREA (M**-2) BY DOWNWIND SECTORS **********
SEGMENT BOUNDARIES IN MILES

DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	3.420E-10	1.846E-10	1.019E-10	6.491E-11	4.430E-11	2.037E-11	6.875E-12	3.168E-12	2.007E-12	1.592E-12
SSW	3.468E-10	1.824E-10	9.959E-11	6.325E-11	4.315E-11	1.987E-11	6.719E-12	3.049E-12	1.905E-12	1.351E-12
SW	1.015E-10	6.439E-11	3.817E-11	2.475E-11	1.694E-11	7.759E-12	2.583E-12	1.144E-12	7.065E-13	5.054E-13
WSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
W	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
WNW	2.658E-09	2.850E-09	1.961E-09	1.317E-09	9.073E-10	4.130E-10	1.348E-10	5.622E-11	3.152E-11	2.038E-11
NW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
N	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NNE	3.167E-10	2.392E-10	1.482E-10	9.669E-11	6.613E-11	3.002E-11	9.778E-12	4.199E-12	2.521E-12	1.775E-12
NE	8.955E-10	5.397E-10	3.047E-10	1.933E-10	1.314E-10	5.961E-11	1.945E-11	8.397E-12	4.942E-12	3.313E-12
ENE	9.358E-10	5.731E-10	3.297E-10	2.111E-10	1.440E-10	6.560E-11	2.160E-11	9.408E-12	5.596E-12	3.800E-12
E	1.054E-09	5.749E-10	3.155E-10	1.998E-10	1.361E-10	6.229E-11	2.077E-11	9.226E-12	5.576E-12	3.806E-12
ESE	8.940E-10	4.518E-10	2.376E-10	1.485E-10	1.008E-10	4.620E-11	1.547E-11	6.959E-12	4.263E-12	2.934E-12
SE	6.733E-10	3.611E-10	1.945E-10	1.220E-10	8.284E-11	3.778E-11	1.251E-11	5.570E-12	3.426E-12	2.402E-12
SSE	4.472E-10	2.569E-10	1.453E-10	9.294E-11	6.343E-11	2.906E-11	9.708E-12	4.367E-12	2.764E-12	2.022E-12

VENT AND BUILDING PARAMETERS:

RELEASE HEIGHT	(METERS)	73.10
DIAMETER	(METERS)	1.14
EXIT VELOCITY	(METERS)	18.21

REP. WIND HEIGHT	(METERS)	71.3
BUILDING HEIGHT	(METERS)	31.4
BLDG.MIN.CRS.SEC.AREA	(SQ.METERS)	1000.0
HEAT EMISSION RATE	(CAL/SEC)	0.0

ALL ELEVATED RELEASES

Data in sectors WSW through N are not valid. Refer to note at the end of Table 1.3.

TABLE 1.3

USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 940629
**** BIG ROCK POINT XOQDOQ82 *** USING 01/01/89 - 12/31/93 MET DATA ****
ELEVATED RELEASE - 240' STACK

RELATIVE DEPOSITION PER UNIT AREA (M**-2) AT FIXED POINTS BY DOWNWIND SECTORS

DISTANCES IN MILES

DIRECTION FROM SITE	0.25	0.50	0.75	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50
S	5.619E-10	4.414E-10	3.474E-10	2.883E-10	1.834E-10	1.337E-10	1.022E-10	8.055E-11	6.490E-11	5.320E-11	4.424E-11
SSW	5.881E-10	4.557E-10	3.524E-10	2.882E-10	1.806E-10	1.309E-10	9.979E-11	7.853E-11	6.323E-11	5.182E-11	4.309E-11
SW	1.397E-10	1.162E-10	1.022E-10	9.367E-11	6.506E-11	4.925E-11	3.840E-11	3.059E-11	2.478E-11	2.036E-11	1.693E-11
WSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
W	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
WNW	2.016E-10	1.209E-09	2.575E-09	3.445E-09	2.987E-09	2.449E-09	1.986E-09	1.615E-09	1.322E-09	1.091E-09	9.073E-10
NW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
N	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NNE	2.582E-10	2.925E-10	3.194E-10	3.269E-10	2.463E-10	1.901E-10	1.494E-10	1.194E-10	9.683E-11	7.954E-11	6.608E-11
NE	1.100E-09	1.037E-09	9.169E-10	8.088E-10	5.464E-10	4.002E-10	3.055E-10	2.403E-10	1.933E-10	1.581E-10	1.312E-10
ENE	1.216E-09	1.083E-09	9.518E-10	8.501E-10	5.792E-10	4.299E-10	3.311E-10	2.618E-10	2.112E-10	1.731E-10	1.438E-10
E	1.630E-09	1.338E-09	1.074E-09	8.957E-10	5.733E-10	4.156E-10	3.161E-10	2.484E-10	1.997E-10	1.635E-10	1.358E-10
ESE	1.482E-09	1.191E-09	9.155E-10	7.297E-10	4.470E-10	3.165E-10	2.375E-10	1.852E-10	1.483E-10	1.212E-10	1.006E-10
SE	1.016E-09	8.583E-10	6.899E-10	5.683E-10	3.605E-10	2.580E-10	1.946E-10	1.521E-10	1.219E-10	9.961E-11	8.269E-11
SSE	6.714E-10	5.503E-10	4.540E-10	3.907E-10	2.573E-10	1.897E-10	1.458E-10	1.152E-10	9.295E-11	7.621E-11	6.335E-11

DISTANCES IN MILES

DIRECTION FROM SITE	5.00	7.50	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00
S	3.723E-11	1.962E-11	1.251E-11	6.635E-12	4.237E-12	3.131E-12	2.485E-12	2.078E-12	1.797E-12	1.584E-12	1.435E-12
SSW	3.628E-11	1.914E-11	1.222E-11	6.495E-12	4.135E-12	3.024E-12	2.345E-12	1.897E-12	1.581E-12	1.345E-12	1.171E-12
SW	1.423E-11	7.468E-12	4.742E-12	2.491E-12	1.573E-12	1.130E-12	8.693E-13	7.026E-13	5.878E-13	5.030E-13	4.417E-13
WSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
W	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
WNW	7.608E-10	3.974E-10	2.508E-10	1.297E-10	8.053E-11	5.540E-11	4.069E-11	3.128E-11	2.486E-11	2.028E-11	1.689E-11
NW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
N	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NNE	5.546E-11	2.887E-11	1.816E-11	9.393E-12	5.874E-12	4.136E-12	3.134E-12	2.504E-12	2.076E-12	1.766E-12	1.543E-12
NE	1.102E-10	5.731E-11	3.603E-11	1.869E-11	1.172E-11	8.308E-12	6.256E-12	4.914E-12	3.981E-12	3.300E-12	2.791E-12
ENE	1.208E-10	6.310E-11	3.986E-11	2.080E-11	1.308E-11	9.309E-12	7.044E-12	5.565E-12	4.537E-12	3.785E-12	3.225E-12
E	1.143E-10	5.995E-11	3.805E-11	2.004E-11	1.268E-11	9.151E-12	6.987E-12	5.551E-12	4.539E-12	3.792E-12	3.232E-12
ESE	8.471E-11	4.446E-11	2.825E-11	1.493E-11	9.484E-12	6.912E-12	5.315E-12	4.246E-12	3.488E-12	2.925E-12	2.500E-12
SE	6.955E-11	3.634E-11	2.297E-11	1.205E-11	7.621E-12	5.519E-12	4.245E-12	3.410E-12	2.826E-12	2.392E-12	2.071E-12
SSE	5.328E-11	2.797E-11	1.777E-11	9.361E-12	5.937E-12	4.317E-12	3.361E-12	2.750E-12	2.327E-12	2.012E-12	1.786E-12

Data in sectors WSW through N are not valid. Refer to note at the end of Table 1.3.

TABLE 1.3

USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 940629
**** BIG ROCK POINT XOQDOQ82 *** USING 01/01/89 - 12/31/93 MET DATA ****
ELEVATED RELEASE - 240' STACK
8.000 DAY DECAY, DEPLETED

CHI/Q (SEC/METER CUBED) FOR EACH SEGMENT

	SEGMENT BOUNDARIES IN MILES FROM THE SITE									
DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	2.315E-08	3.081E-08	3.151E-08	2.749E-08	2.342E-08	1.505E-08	7.499E-09	4.238E-09	2.857E-09	2.113E-09
SSW	2.082E-08	2.585E-08	2.469E-08	2.079E-08	1.730E-08	1.070E-08	5.097E-09	2.798E-09	1.855E-09	1.356E-09
SW	7.250E-09	1.562E-08	1.790E-08	1.618E-08	1.399E-08	9.099E-09	4.556E-09	2.568E-09	1.725E-09	1.273E-09
WSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
W	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
WNW	3.224E-22	6.933E-13	1.638E-10	2.003E-09	8.150E-09	4.868E-08	7.625E-08	6.192E-08	4.304E-08	3.013E-08
NW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
N	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NNE	1.902E-08	3.951E-08	4.220E-08	3.684E-08	3.131E-08	2.004E-08	9.986E-09	5.667E-09	3.841E-09	2.857E-09
NE	3.794E-08	4.329E-08	3.624E-08	2.818E-08	2.229E-08	1.279E-08	5.572E-09	2.882E-09	1.848E-09	1.320E-09
ENE	4.324E-08	4.965E-08	4.148E-08	3.195E-08	2.506E-08	1.413E-08	5.991E-09	3.035E-09	1.921E-09	1.359E-09
E	5.198E-08	4.742E-08	3.577E-08	2.635E-08	2.013E-08	1.095E-08	4.446E-09	2.191E-09	1.363E-09	9.504E-10
ESE	4.217E-08	3.580E-08	2.657E-08	1.960E-08	1.503E-08	8.251E-09	3.405E-09	1.702E-09	1.068E-09	7.489E-10
SE	3.274E-08	3.191E-08	2.610E-08	2.018E-08	1.591E-08	9.093E-09	3.934E-09	2.023E-09	1.290E-09	9.165E-10
SSE	2.681E-08	3.390E-08	3.143E-08	2.582E-08	2.113E-08	1.273E-08	5.863E-09	3.141E-09	2.052E-09	1.484E-09

Data in sectors WSW through N are not valid. Refer to note at the end of Table 1.3.

TABLE 1.3

USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 940629
**** BIG ROCK POINT XOQDOQ82 *** USING 01/01/89 - 12/31/93 MET DATA ****
ELEVATED RELEASE - 240' STACK
8.000 DAY DECAY, DEPLETED

ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) — DISTANCES IN MILES FROM THE SITE

SECTOR	0.250	0.500	0.750	1.000	1.500	2.000	2.500	3.000	3.500	4.000	4.500
S	1.622E-08	2.255E-08	2.139E-08	2.478E-08	3.168E-08	3.319E-08	3.203E-08	2.995E-08	2.768E-08	2.549E-08	2.349E-08
SSW	1.107E-08	1.819E-08	1.996E-08	2.278E-08	2.671E-08	2.673E-08	2.508E-08	2.299E-08	2.092E-08	1.903E-08	1.735E-08
SW	1.450E-09	3.700E-09	6.108E-09	9.883E-09	1.601E-08	1.819E-08	1.824E-08	1.741E-08	1.630E-08	1.514E-08	1.404E-08
WSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
W	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
WNW	0.000E+00	0.000E+00	9.731E-30	7.253E-22	2.652E-15	1.558E-12	4.679E-11	3.694E-10	1.441E-09	3.719E-09	7.398E-09
NW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
N	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NNE	1.741E-09	6.326E-09	1.616E-08	2.750E-08	4.116E-08	4.428E-08	4.296E-08	4.016E-08	3.709E-08	3.412E-08	3.141E-08
NE	1.191E-08	2.793E-08	3.745E-08	4.331E-08	4.547E-08	4.166E-08	3.675E-08	3.220E-08	2.831E-08	2.505E-08	2.233E-08
ENE	2.040E-08	3.324E-08	4.205E-08	4.914E-08	5.233E-08	4.790E-08	4.208E-08	3.669E-08	3.210E-08	2.827E-08	2.510E-08
E	2.734E-08	4.877E-08	5.231E-08	5.334E-08	4.972E-08	4.274E-08	3.619E-08	3.078E-08	2.644E-08	2.296E-08	2.014E-08
ESE	2.341E-08	4.233E-08	4.285E-08	4.159E-08	3.731E-08	3.177E-08	2.686E-08	2.286E-08	1.966E-08	1.711E-08	1.504E-08
SE	2.154E-08	3.239E-08	3.223E-08	3.330E-08	3.333E-08	3.015E-08	2.646E-08	2.311E-08	2.027E-08	1.790E-08	1.594E-08
SSE	1.167E-08	2.152E-08	2.565E-08	3.033E-08	3.531E-08	3.463E-08	3.194E-08	2.886E-08	2.597E-08	2.341E-08	2.118E-08

ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) — DISTANCES IN MILES FROM THE SITE

SECTOR	5.000	7.500	10.000	15.000	20.000	25.000	30.000	35.000	40.000	45.000	50.000
S	2.170E-08	1.529E-08	1.154E-08	7.519E-09	5.464E-09	4.234E-09	3.425E-09	2.855E-09	2.434E-09	2.112E-09	1.858E-09
SSW	1.588E-08	1.084E-08	8.012E-09	5.091E-09	3.644E-09	2.792E-09	2.238E-09	1.853E-09	1.570E-09	1.356E-09	1.186E-09
SW	1.302E-08	9.265E-09	7.012E-09	4.571E-09	3.316E-09	2.565E-09	2.071E-09	1.724E-09	1.468E-09	1.273E-09	1.118E-09
WSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
W	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
WNW	1.237E-08	4.502E-08	6.958E-08	8.259E-08	7.482E-08	6.314E-08	5.229E-08	4.324E-08	3.592E-08	3.024E-08	2.538E-08
NW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
N	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NNE	2.898E-08	2.035E-08	1.534E-08	1.001E-08	7.288E-09	5.662E-09	4.591E-09	3.838E-09	3.281E-09	2.856E-09	2.519E-09
NE	2.005E-08	1.284E-08	9.127E-09	5.522E-09	3.831E-09	2.870E-09	2.260E-09	1.843E-09	1.542E-09	1.318E-09	1.143E-09
ENE	2.245E-08	1.415E-08	9.946E-09	5.924E-09	4.065E-09	3.019E-09	2.362E-09	1.915E-09	1.595E-09	1.357E-09	1.172E-09
E	1.785E-08	1.091E-08	7.521E-09	4.374E-09	2.962E-09	2.177E-09	1.688E-09	1.358E-09	1.123E-09	9.493E-10	8.136E-10
ESE	1.336E-08	8.232E-09	5.712E-09	3.355E-09	2.290E-09	1.693E-09	1.318E-09	1.065E-09	8.827E-10	7.480E-10	6.427E-10
SE	1.430E-08	9.123E-09	6.467E-09	3.896E-09	2.696E-09	2.014E-09	1.582E-09	1.287E-09	1.074E-09	9.156E-10	7.912E-10
SSE	1.926E-08	1.286E-08	9.369E-09	5.841E-09	4.126E-09	3.131E-09	2.491E-09	2.049E-09	1.726E-09	1.483E-09	1.292E-09

VENT AND BUILDING PARAMETERS:

RELEASE HEIGHT	(METERS)	73.10
DIAMETER	(METERS)	1.14
EXIT VELOCITY	(METERS)	18.21
REP. WIND HEIGHT	(METERS)	71.3
BUILDING HEIGHT	(METERS)	31.4
BLDG.MIN.CRS.SEC.AREA	(SQ.METERS)	1000.0
HEAT EMISSION RATE	(CAL/SEC)	0.0

ALL ELEVATED RELEASES

Data in sectors WSW through N are not valid. Refer to note at the end of Table 1.3.

TABLE 1.3

USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 940629
**** BIG ROCK POINT XOQDOQ82 *** USING 01/01/89 - 12/31/93 MET DATA ****
ELEVATED RELEASE - 240' STACK
2.260 DAY DECAY, UNDEPLETED

CHI/Q (SEC/METER CUBED) FOR EACH SEGMENT

	SEGMENT BOUNDARIES IN MILES FROM THE SITE									
DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	2.344E-08	3.120E-08	3.191E-08	2.787E-08	2.375E-08	1.527E-08	7.592E-09	4.268E-09	2.859E-09	2.101E-09
SSW	2.112E-08	2.630E-08	2.515E-08	2.122E-08	1.769E-08	1.097E-08	5.226E-09	2.859E-09	1.886E-09	1.371E-09
SW	7.319E-09	1.573E-08	1.802E-08	1.630E-08	1.410E-08	9.161E-09	4.563E-09	2.549E-09	1.696E-09	1.239E-09
WSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
W	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
WNW	3.158E-22	6.786E-13	1.602E-10	1.955E-09	7.931E-09	4.587E-08	6.623E-08	4.773E-08	2.868E-08	1.710E-08
NW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
N	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NNE	1.912E-08	3.978E-08	4.258E-08	3.724E-08	3.168E-08	2.030E-08	1.009E-08	5.699E-09	3.839E-09	2.837E-09
NE	3.841E-08	4.407E-08	3.711E-08	2.900E-08	2.304E-08	1.333E-08	5.862E-09	3.052E-09	1.960E-09	1.400E-09
ENE	4.373E-08	5.049E-08	4.247E-08	3.293E-08	2.597E-08	1.479E-08	6.362E-09	3.256E-09	2.071E-09	1.468E-09
E	5.274E-08	4.851E-08	3.691E-08	2.741E-08	2.109E-08	1.163E-08	4.836E-09	2.431E-09	1.532E-09	1.079E-09
ESE	4.285E-08	3.671E-08	2.744E-08	2.039E-08	1.572E-08	8.733E-09	3.672E-09	1.867E-09	1.184E-09	8.382E-10
SE	3.321E-08	3.257E-08	2.678E-08	2.081E-08	1.648E-08	9.493E-09	4.152E-09	2.152E-09	1.377E-09	9.806E-10
SSE	2.716E-08	3.441E-08	3.196E-08	2.632E-08	2.157E-08	1.304E-08	6.020E-09	3.224E-09	2.101E-09	1.516E-09

Data in sectors WSW through N are not valid. Refer to note at the end of Table 1.3.

TABLE 1.3

USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 940629
**** BIG ROCK POINT XOQDOQ82 *** USING 01/01/89 - 12/31/93 MET DATA ****
ELEVATED RELEASE - 240' STACK
2.260 DAY DECAY, UNDEPLETED

ANNUAL AVERAGE CHI/Q (SEC/METER CUBED)

	DISTANCES IN MILES FROM THE SITE										
SECTOR	0.250	0.500	0.750	1.000	1.500	2.000	2.500	3.000	3.500	4.000	4.500
S	1.620E-08	2.267E-08	2.170E-08	2.513E-08	3.207E-08	3.359E-08	3.244E-08	3.035E-08	2.806E-08	2.585E-08	2.383E-08
SSW	1.107E-08	1.829E-08	2.028E-08	2.317E-08	2.717E-08	2.720E-08	2.555E-08	2.344E-08	2.135E-08	1.944E-08	1.7743-08
SW	1.450E-09	3.723E-09	6.181E-09	9.971E-09	1.612E-08	1.832E-08	1.837E-08	1.754E-08	1.643E-08	1.526E-08	1.415E-08
WSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
W	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
WNW	0.000E+00	0.000E+00	9.582E-30	7.106E-22	2.596E-15	1.525E-12	4.580E-11	3.613E-10	1.408E-09	3.629E-09	7.207E-09
NW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
N	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NNE	1.741E-09	6.362E-09	1.627E-08	2.764E-08	4.142E-08	4.463E-08	4.334E-08	4.058E-08	3.749E-08	3.451E-08	3.178E-08
NE	1.190E-08	2.811E-08	3.794E-08	4.391E-08	4.625E-08	4.252E-08	3.763E-08	3.306E-08	2.914E/08	2.584E-08	2.308E-08
ENE	2.039E-08	3.344E-08	4.257E-08	4.975E-08	5.316E-08	4.886E-08	4.308E-08	3.770E-08	3.308E-08	2.922E-08	2.601E-08
E	2.732E-08	4.908E-08	5.313E-08	5.429E-08	5.082E-08	4.389E-08	3.734E-08	3.189E-08	2.750E-08	2.397E-08	2.110E-08
ESE	2.339E-08	4.260E-08	4.358E-08	4.244E-08	3.825E-08	3.269E-08	2.774E-08	2.369E-08	2.045E-08	1.785E-08	1.573E-08
SE	2.153E-08	3.258E-08	3.272E-08	3.388E-08	3.400E-08	3.085E-08	2.715E-08	2.377E-08	2.090E-08	1.851E-08	1.651E-08
SSE	1.166E-08	2.166E-08	2.602E-08	3.076E-08	3.583E-08	3.517E-08	3.247E-08	2.939E-08	2.647E-08	2.388E-08	2.162E-08

ANNUAL AVERAGE CHI/Q (SEC/METER CUBED)

	DISTANCES IN MILES FROM THE SITE										
SECTOR	5.000	7.500	10.000	15.000	20.000	25.000	30.000	35.000	40.000	45.000	50.000
S	2.202E-08	1.552E-08	1.171E-08	7.614E-09	5.518E-09	4.264E-09	3.437E-09	2.856E-09	2.427E-09	2.100E-09	1.842E-09
SSW	1.625E-08	1.111E-08	8.220E-09	5.220E-09	3.732E-09	2.854E-09	2.282E-09	1.883E-09	1.591E-09	1.369E-09	1.1963-09
SW	1.313E-08	9.332E-09	7.051E-09	4.579E-09	3.307E-09	2.546E-09	2.046E-09	1.694E-09	1.435E-09	1.238E-09	1.083E-09
WSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
W	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
WNW	1.202E-08	4.300E-08	6.495E-08	7.288E-08	6.189E-08	4.870E-08	3.748E-08	2.872E-08	2.206E-08	1.702E-08	1.322E-08
NW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
N	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NNE	2.933E-08	2.061E-08	1.554E-08	1.012E-08	7.350E-09	5.694E-09	4.603E-09	3.836E-09	3.269E-09	2.835E-09	2.494E-09
NE	2.077E-08	1.339E-08	9.558E-09	5.815E-09	4.050E-09	3.040E-09	2.397E-09	1.956E-09	1.637E-09	1.398E-09	1.212E-09
ENE	2.333E-08	1.483E-08	1.049E-08	6.299E-09	4.347E-09	3.241E-09	2.542E-09	2.065E-09	1.722E-09	1.466E-09	1.268E-09
E	1.877E-08	1.162E-08	8.083E-09	4.767E-09	3.263E-09	2.419E-09	1.887E-09	1.527E-09	1.269E-09	1.077E-09	9.285E-10
ESE	1.401E-08	8.726E-09	6.100E-09	3.623E-09	2.496E-09	1.858E-09	1.455E-09	1.181E-09	9.840E-10	8.366E-10	7.229E-10
SE	1.484E-08	9.533E-09	6.789E-09	4.116E-09	2.861E-09	2.143E-09	1.687E-09	1.374E-09	1.148E-09	9.790E-10	8.479E-10
SSE	1.968E-08	1.317E-08	9.613E-09	6.000E-09	4.239E-09	3.215E-09	2.554E-09	2.097E-09	1.765E-09	1.514E-09	1.381E-09

VENT AND BUILDING PARAMETERS:

RELEASE HEIGHT	(METERS)	73.10
DIAMETER	(METERS)	1.14
EXIT VELOCITY	(METERS)	18.21

REP. WIND HEIGHT	(METERS)	71.3
BUILDING HEIGHT	(METERS)	31.4
BLDG.MIN.CRS.SEC.AREA	(SQ.METERS)	2000.0
HEAT EMISSION RATE	(CAL/SEC)	0.0

ALL ELEVATED RELEASES

Data in sectors WSW through N are not valid. Refer to note at the end of Table 1.3.

VOLUME 25 BIG ROCK POINT RADIOLOGICAL
EFFLUENT T/S REQUIRED DOCUMENTS
A. OFFSITE DOSE CALCULATIONS

TABLE 1.3

USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 940629
**** BIG ROCK POINT XOQDOQ82 *** USING 01/01/89 - 12/31/93 MET DATA ****
ELEVATED RELEASE - 240' STACK
NO DECAY, UNDEPLETED

CHI/Q (SEC/METER CUBED) FOR EACH SEGMENT

SEGMENT BOUNDARIES IN MILES FROM THE SITE

DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	2.355E-08	3.135E-08	3.210E-08	2.808E-08	2.398E-08	1.550E-08	7.804E-09	4.462E-09	3.038E-09	2.268E-09
SSW	2.121E-08	2.642E-08	2.531E-08	2.140E-08	1.788E-08	1.115E-08	5.393E-09	3.010E-09	2.023E-09	1.497E-09
SW	7.338E-09	1.579E-08	1.812E-08	1.641E-08	1.422E-08	9.293E-09	4.690E-09	2.666E-09	1.805E-09	1.341E-09
WSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
W	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
WNW	3.250E-22	7.185E-13	1.743E-10	2.181E-09	3.074E-09	5.925E-08	1.052E-07	9.768E-08	7.756E-08	6.141E-08
NW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
N	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NNE	1.915E-08	3.987E-08	4.271E-08	3.740E-08	3.186E-08	2.048E-08	1.027E-08	5.867E-09	3.997E-09	2.987E-09
NE	3.849E-08	4.419E-08	3.725E-08	2.916E-08	2.320E-08	1.347E-08	5.992E-09	3.167E-09	2.065E-09	1.497E-09
ENE	4.384E-08	5.064E-08	4.265E-08	3.312E-08	2.616E-08	1.497E-08	6.516E-09	3.391E-09	2.191E-09	1.579E-09
E	5.290E-08	4.870E-08	3.711E-08	2.762E-08	2.129E-08	1.182E-08	4.993E-09	2.568E-09	1.654E-09	1.190E-09
ESE	4.299E-08	3.686E-08	2.760E-08	2.055E-08	1.588E-08	8.878E-09	3.796E-09	1.975E-09	1.281E-09	9.261E-10
SE	3.333E-08	3.272E-08	2.695E-08	2.098E-08	1.665E-08	9.648E-09	4.287E-09	2.271E-09	1.485E-09	1.079E-09
SSE	2.724E-08	3.453E-08	3.211E-08	2.648E-08	2.174E-08	1.320E-08	6.164E-09	3.352E-09	2.218E-09	1.624E-09

AVERAGE EFFECTIVE STACK HEIGHT IN METERS FOR EACH SEGMENT

DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	8.573E+01	8.574E+01	8.574E+01	8.574E+01	8.574E+01	8.574E+01	8.574E+01	8.574E+01	8.574E+01	8.574E+01
SSW	8.831E+01	8.833E+01	8.833E+01	8.833E+01	8.833E+01	8.833E+01	8.833E+01	8.833E+01	8.833E+01	8.833E+01
SW	8.604E+01	8.604E+01	8.604E+01	8.604E+01	8.604E+01	8.604E+01	8.604E+01	8.604E+01	8.604E+01	8.604E+01
WSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
W	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
WNW	3.817E+02	3.853E+02	3.853E+02	3.853E+02	3.853E+02	3.853E+02	3.853E+02	3.853E+02	3.853E+02	3.853E+02
NW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
N	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NNE	8.296E+01	8.296E+01	8.296E+01	8.296E+01	8.296E+01	8.296E+01	8.296E+01	8.296E+01	8.296E+01	8.296E+01
NE	8.487E+01	8.487E+01	8.487E+01	8.487E+01	8.487E+01	8.487E+01	8.487E+01	8.487E+01	8.487E+01	8.487E+01
ENE	8.562E+01	8.563E+01	8.563E+01	8.563E+01	8.563E+01	8.563E+01	8.563E+01	8.563E+01	8.563E+01	8.563E+01
E	8.863E+01	8.865E+01	8.865E+01	8.865E+01	8.865E+01	8.865E+01	8.865E+01	8.865E+01	8.865E+01	8.865E+01
ESE	8.846E+01	8.848E+01	8.848E+01	8.848E+01	8.848E+01	8.848E+01	8.848E+01	8.848E+01	8.848E+01	8.848E+01
SE	8.756E+-1	8.759E+01	8.759E+01	8.759E+01	8.759E+01	8.759E+01	8.759E+01	8.759E+01	8.759E+01	8.759E+01
SSE	8.506E+01	8.506E+01	8.506E+01	8.506E+01	8.506E+01	8.506E+01	8.506E+01	8.506E+01	8.506E+01	8.506E+01

Data in sectors WSW through N are not valid. Refer to note at the end of Table 1.3.

TABLE 1.3

USNRC COMPUTER CODE - XOQDOQ. VERSION 2.0 RUN DATE: 940629
**** BIG ROCK POINT XOQDOQ82 **** USING 01/01/89 - 12/31/93 MET DATA ****
ELEVATED RELEASE - 240' STACK
SPECIFIC POINTS OF INTEREST

RELEASE ID	TYPE OF LOCATION	DIRECTION FROM SITE	DISTANCE (MILES)	DISTANCE (METERS)	X/Q (SEC/CUB.METER) NO DECAY UNDEPLETED	X/Q (SEC/CUB.METER) 2.260 DAY DECAY UNDEPLETED	X/Q (SEC/CUB.METER) 8.000 DAY DECAY DEPLETED	D/Q (PER SQ.METER)
A	SITE BOUNDARY	E	0.57	917.	4.91E-08	4.90E-08	4.85E-08	1.25E-09
A	SITE BOUNDARY	ESE	0.52	837.	4.11E-08	4.10E-08	4.07E-08	1.16E-09
A	SITE BOUNDARY	SE	0.55	885.	3.09E-08	3.08E-08	3.05E-08	8.19E-10
A	SITE BOUNDARY	SSE	0.58	933.	2.25E-08	2.24E-08	2.22E-08	5.12E-10
A	SITE BOUNDARY	S	0.68	1094.	2.07E-08	2.06E-08	2.03E-08	3.68E-10
A	SITE BOUNDARY	SSW	0.71	1143.	1.95E-08	1.94E-08	1.91E-08	3.65E-10
A	SITE BOUNDARY	SW	0.50	805.	3.58E-09	3.57E-09	3.55E-09	1.16E-10
A	RESIDENCE/GARDEN	ENE	2.30	3701.	4.55E-08	4.54E-08	4.44E-08	3.66E-10
A	RESIDENCE/GARDEN	E	1.40	2253.	5.20E-08	5.18E-08	5.07E-08	6.23E-10
A	RESIDENCE/GARDEN	ESE	1.50	2414.	3.82E-08	3.81E-08	3.72E-08	4.47E-10
A	RESIDENCE/GARDEN	SE	1.70	2736.	3.29E-08	3.28E-08	3.21E-08	3.07E-10
A	RESIDENCE/GARDEN	SSE	1.70	2736.	3.61E-08	3.59E-08	3.54E-08	2.22E-10
A	RESIDENCE/GARDEN	S	1.90	3058.	3.37E-08	3.35E-08	3.31E-08	1.42E-10
A	RESIDENCE/GARDEN	SSW	1.30	2092.	2.62E-08	2.61E-08	2.56E-08	2.15E-10
A	RESIDENCE/GARDEN	SW	1.10	1770.	1.15E-08	1.15E-08	1.14E-08	8.66E-11
A	DAIRY COW	E	2.50	4023.	3.75E-08	3.73E-08	3.61E-08	3.16E-10
A	DAIRY COW	ESE	2.60	4184.	2.70E-08	2.68E-08	2.59E-08	2.25E-10
A	DAIRY COW	SE	4.50	7242.	1.67E-08	1.65E-08	1.59E-08	8.27E-11
A	DAIRY COW	SSE	3.50	5633.	2.66E-08	2.65E-08	2.60E-08	9.29E-11
A	BEEF COW	E	2.50	4023.	3.75E-08	3.73E-08	3.61E-08	3.16E-10
A	BEEF COW	ESE	2.60	4184.	2.70E-08	2.68E-08	2.59E-08	2.25E-10
A	BEEF COW	SE	2.00	3219.	3.09E-08	3.08E-08	3.01E-08	2.58E-10
A	BEEF COW	SSE	3.50	5633.	2.66E-08	2.65E-08	2.60E-08	9.29E-11
A	BEEF COW	S	2.50	4023.	3.26E-08	3.24E-08	3.20E-08	1.02E-10
A	GOAT	SE	4.00	6437.	1.87E-08	1.85E-08	1.79E-08	9.96E-11
A	MAXIMUM CHI/Q	S	2.00	3219.	3.37E-08	3.35E-08	3.31E-08	1.34E-10
A	MAXIMUM CHI/Q	SSW	2.00	3219.	2.73E-08	2.71E-08	2.67E-08	1.31E-10
A	MAXIMUM CHI/Q	SW	2.50	4023.	1.85E-08	1.84E-08	1.82E-08	3.84E-11
A	MAXIMUM CHI/Q	WSW	50.00	80467.	0.00E+00	0.00E+00	0.00E+00	0.00E+00
A	MAXIMUM CHI/Q	W	50.00	80467.	0.00E+00	0.00E+00	0.00E+00	0.00E+00
A	MAXIMUM CHI/Q	WNW	15.00	24140.	1.12E-07	7.29E-08	8.26E-08	1.30E-10
A	MAXIMUM CHI/Q	NW	50.00	80467.	0.00E+00	0.00E+00	0.00E+00	0.00E+00
A	MAXIMUM CHI/Q	NNW	50.00	80467.	0.00E+00	0.00E+00	0.00E+00	0.00E+00
A	MAXIMUM CHI/Q	N	50.00	80467.	0.00E+00	0.00E+00	0.00E+00	0.00E+00
A	MAXIMUM CHI/Q	NNE	2.00	3219.	4.47E-08	4.46E-08	4.43E-08	1.90E-10
A	MAXIMUM CHI/Q	NE	1.50	2414.	4.63E-08	4.62E-08	4.54E-08	5.46E-10
A	MAXIMUM CHI/Q	ENE	1.50	2414.	5.32E-08	5.30E-08	5.22E-08	5.79E-10
A	MAXIMUM CHI/Q	E	1.00	1609.	5.40E-08	5.39E-08	5.30E-08	8.96E-10
A	MAXIMUM CHI/Q	ESE	0.75	1207.	4.29E-08	4.28E-08	4.21E-08	9.15E-10
A	MAXIMUM CHI/Q	SE	1.50	2414.	3.40E-08	3.38E-08	3.32E-08	3.60E-10
A	MAXIMUM CHI/Q	SSE	1.50	2414.	3.59E-08	3.58E-08	3.52E-08	2.57E-10

VENT AND BUILDING PARAMETERS:
RELEASE HEIGHT (METERS) 73.10 REP. WIND HEIGHT (METERS) 71.3

TABLE 1.3 NOTES

Big Rock Point gathers meteorological data from sensors mounted on the 73 meter stack. A wind speed and wind direction sensor is mounted into the prevailing wind direction. Because of interference to the wind flow by the stack when winds are from the 71° to 159° sector (flowing towards Lake Michigan), the meteorological data recorded in these sectors are considered invalid. For dose calculational purposes, this effectively invalidates six (6) sectors (WSW, W, WNW, NW, NNW, and N). Therefore zeros are recorded in Table 1.3 for these sectors. However, the program which calculates the annual average Chi/Q requires input of the full years met data. Any data recorded for these six sectors are input in the WNW sector to satisfy the program. Values of Chi/Q listed in the WNW sector are invalid.

During emergencies with wind directions into the above six sectors, the dose assessor is directed to alternate meteorological information by Emergency Procedures.

TABLE 1.4

1996 BIG ROCK POINT LAND USE CENSUS REPORT

Distance to the nearest residence, garden, milk cow, beef cow and goat in each sector.

Sector	Residence	Garden	Dairy Cow	Beef Cattle	Goat
WSW	2.5 mi	> 5 mi	> 5 mi	> 5 mi	> 5 mi
SW	1.1 mi	2.7 mi	> 5 mi	> 5 mi	> 5 mi
SSW	1.3 mi	> 5 mi	> 5 mi	> 5 mi	> 5 mi
S	1.9 mi	2.1 mi	> 5 mi	> 5 mi	> 5 mi
SSE	1.7 mi	1.7 mi	> 5 mi	1.7 mi	> 5 mi
SE	1.8 mi	1.8 mi	4.5 mi	1.8 mi	> 5 mi
ESE	1.5 mi	1.8 mi	*2.8 mi	3.2 mi	> 5 mi
E	1.4 mi	2.4 mi	3.5 mi	2.7 mi	> 5 mi
ENE	2.3 mi	> 5 mi	> 5 mi	> 5 mi	> 5 mi

*NOTE: Farm bisected by E/ESE boundary line.

TABLE 1.4a

1997 BIG ROCK POINT GASPAR INPUT PARAMETERS

Critical Receptors

Location	Sector	Distance (miles)	X/Q (sec/m³)	X/Q Decay (sec/m³)	X/Q Decay and Dep (sec/m³)	D/Q (1/m²)
Residence/Garden	E	1.40	5.20E-08	5.18E-08	5.07E-08	6.23E-10
Site Boundary	E	0.57	4.91E-08	4.90E-08	4.85E-08	1.25E-09
Beef Cattle	SSE	1.70	3.57E-08	3.56E-08	3.50E-08	2.30E-10
Dairy Cow	E	2.80	3.43E-08	3.41E-08	3.29E-08	2.75E-10

DOSE FACTORS FOR SUBMERSION IN NOBLE GASES*
Table 1.5

	DFB[1]	DFY[2]	DFS[1]	DFB[2]
Kr-85m	1.17(+3)[3]	1.23(+3)	1.46(+3)	1.97(+3)
Kr-85	1.61(+1)	1.72(+1)	1.34(+3)	1.95(+3)
Kr-87	5.92(+3)	6.17(+3)	9.73(+3)	1.03(+4)
Kr-88	1.47(+4)	1.52(+4)	2.37(+3)	2.93(+3)
Kr-89	1.66(+4)	1.73(+4)	1.01(+4)	1.06(+4)
Xe-131m	9.15(+1)	1.56(+2)	4.76(+2)	1.11(+3)
Xe-133m	2.51(+2)	3.27(+2)	9.94(+2)	1.48(+3)
Xe-133	2.94(+2)	3.53(+2)	3.06(+2)	1.05(+3)
Xe-135m	3.12(+3)	3.36(+3)	7.11(+2)	7.39(+3)
Xe-135	1.81(+3)	1.92(+3)	1.86(+3)	2.46(+3)
Xe-137	1.42(+3)	1.51(+3)	1.22(+4)	1.27(+4)
Xe-138	8.83(+3)	9.21(+3)	4.13(+3)	4.75(+3)
Ar-41	8.84(+3)	9.30(+3)	2.69(+3)	3.28(+3)

1. mrem/y per $\mu Ci/m^3$

2. mrad/y per $\mu Ci/m^3$

3. 1.17(+3) = 1.17×10^3

*Dose factors for exposure to a semi-infinite cloud of noble gases. Values were obtained from US NRC Regulatory Guide 1-109, Revision 1 (October 1977).

STABLE ELEMENT TRANSFER DATA
Table 1.6

Element	F_m - Milk (d/L) (Cow)	F_m - Milk (d/L) (Goat)	F_f - Meat (d/kg)	B_{iv} Veg/Soil
H	1.0E-02	1.7E-01	1.2E-02	4.8E-00
C	1.2E-02	1.0E-01	3.1E-02	5.5E-00
Na	4.0E-02	4.0E-02	3.0E-02	5.2E-02
P	2.5E-02	2.5E-01	4.6E-02	1.1E-00
Cr	2.2E-03	2.2E-03	2.4E-03	2.5E-04
Mn	2.5E-04	2.5E-04	8.0E-04	2.9E-02
Fe	1.2E-03	1.3E-04	4.0E-02	6.6E-04
Co	1.0E-03	1.0E-03	1.3E-02	9.4E-03
Ni	6.7E-03	6.7E-03	5.3E-02	1.9E-02
Cu	1.4E-02	1.3E-02	8.0E-03	1.2E-01
Zn	3.9E-02	3.9E-02	E.0E-02	4.0E-01
Rb	3.0E-02	3.0E-02	3.1E-02	1.3E-01
Sr	8.0E-04	1.4E-02	6.0E-04	1.7E-02
Y	1.0E-05	1.0E-05	4.6E-03	2.6E-03
Zr	5.0E-06	5.0E-06	3.4E-02	1.7E-04
Nb	2.5E-03	2.5E-03	2.8E-01	9.4E-03
Mo	7.5E-03	7.5E-03	8.0E-03	1.2E-01
Tc	2.5E-02	2.5E-02	4.0E-01	2.5E-01
Ru	1.0E-06	1.0E-06	4.0E-01	5.0E-02
Rh	1.0E-02	1.0E-02	1.5E-03	1.3E+01
Ag	5.0E-02	5.0E-02	1.7E-02	1.5E-01
Te	1.0E-03	1.0E-03	7.7E-02	1.3E-00
I	6.0E-03	6.0E-02	2.9E-03	2.0E-02
Cs	1.2E-02	3.0E-01	4.0E-03	1.0E-02
Ba	4.0E-04	4.0E-04	3.2E-03	5.0E-03
La	5.0E-06	5.0E-06	2.0E-04	2.5E-03
Ce	1.0E-04	1.0E-04	1.2E-03	2.5E-03
Pr	5.0E-06	5.0E-06	4.7E-03	2.5E-03
Nd	5.0E-06	5.0E-06	3.3E-03	2.4E-03
W	5.0E-04	5.0E-04	1.3E-03	1.8E-02
Np	5.0E-06	5.0E-06	2.0E-04	2.5E-03

TABLE 1.7

INHALATION DOSE FACTORS FOR INFANT
(MREM PER 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
MA 24	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06
P 32	1.45E-03	8.03E-05	5.53E-05	NO DATA	NO DATA	NO DATA	1.15E-05
CR 51	NO DATA	NO DATA	6.39E-08	4.11E-06	9.45E-09	9.17E-06	2.55E-07
MN 54	NO DATA	1.81E-05	3.56E-06	NO DATA	3.56E-06	7.14E-04	5.04E-06
MN 56	NO DATA	1.10E-09	1.58E-10	NO DATA	7.86E-10	8.95E-06	5.12E-05
FE 55	1.41E-05	8.39E-06	2.38E-06	NO DATA	NO DATA	6.21E-05	7.82E-07
FE 59	9.69E-06	1.68E-05	6.77E-06	NO DATA	NO DATA	7.25E-04	1.77E-05
CO 58	NO DATA	8.71E-07	1.30E-06	NO DATA	NO DATA	5.55E-04	7.95E-06
CO 60	NO DATA	5.73E-06	8.41E-06	NO DATA	NO DATA	3.22E-03	2.28E-05
NI 63	2.42E-04	1.46E-05	8.29E-06	NO DATA	NO DATA	1.49E-04	1.73E-06
NI 65	1.71E-09	2.03E-10	8.79E-11	NO DATA	NO DATA	5.80E-06	3.58E-05
CU 64	NO DATA	1.34E-09	5.53E-10	NO DATA	2.84E-09	6.64E-06	1.07E-05
ZN 65	1.38E-05	4.47E-05	2.22E-05	NO DATA	2.32E-05	4.62E-04	3.67E-05
ZN 69	3.85E-11	6.91E-11	5.13E-12	NO DATA	2.87E-11	1.05E-06	9.44E-06
BR 83	NO DATA	NO DATA	2.72E-07	NO DATA	NO DATA	NO DATA	LT E-24
BR 84	NO DATA	NO DATA	2.86E-07	NO DATA	NO DATA	NO DATA	LT E-24
BR 85	NO DATA	NO DATA	1.46E-08	NO DATA	NO DATA	NO DATA	LT E-24
RB 86	NO DATA	1.36E-04	6.30E-05	NO DATA	NO DATA	NO DATA	2.17E-06
RB 88	NO DATA	3.98E-07	2.50E-07	NO DATA	NO DATA	NO DATA	2.42E-07
RB 89	NO DATA	2.29E-07	1.47E-07	NO DATA	NO DATA	NO DATA	4.87E-08
SR 89	2.84E-04	NO DATA	8.15E-06	NO DATA	NO DATA	1.45E-03	4.57E-05
SR 90	2.92E-02	NO DATA	1.85E-03	NO DATA	NO DATA	8.03E-03	9.36E-05
SR 91	6.83E-08	NO DATA	2.47E-09	NO DATA	NO DATA	3.76E-05	5.24E-05
SR 92	7.50E-09	NO DATA	2.79E-10	NO DATA	NO DATA	1.70E-05	1.00E-04
Y 90	2.35E-06	NO DATA	6.30E-08	NO DATA	NO DATA	1.92E-04	7.43E-05
Y 91m	2.91E-10	NO DATA	9.90E-12	NO DATA	NO DATA	1.99E-06	1.68E-06
Y 91	4.20E-04	NO DATA	1.12E-05	NO DATA	NO DATA	1.75E-03	5.02E-05
Y 92	1.17E-08	NO DATA	3.29E-10	NO DATA	NO DATA	1.75E-05	9.04E-05
Y 93	1.07E-07	NO DATA	2.91E-09	NO DATA	NO DATA	5.46E-05	1.19E-04
ZR 95	8.24E-05	1.99E-05	1.45E-05	NO DATA	2.22E-05	1.25E-03	1.55E-05
ZR 97	1.07E-07	1.83E-08	8.36E-09	NO DATA	1.85E-08	7.88E-05	1.00E-04
NB 95	1.12E-05	4.59E-06	2.70E-06	NO DATA	3.37E-06	3.42E-04	9.05E-06
MO 99	NO DATA	1.18E-07	2.31E-08	NO DATA	1.89E-07	9.63E-05	3.48E-05
TC 99m	9.98E-13	2.06E-12	2.66E-11	NO DATA	2.22E-11	5.79E-07	1.45E-06

TABLE 1.7

INHALATION DOSE FACTORS FOR INFANT
(MREM PER PCI INHALED)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
TC101	4.65E-14	5.88E-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	7.46E-08
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-06	6.38E-08	1.89E-07	1.42E-04	8.51E-05
TE131	1.24E-11	5.87E-12	3.57E-12	1.13E-11	2.85E-11	1.47E-06	5.87E-06
TE132	2.66E-07	1.69E-07	1.26E-07	1.99E-07	7.39E-07	2.43E-04	3.15E-05
I 130	4.54E-06	9.91E-06	3.98E-06	1.14E-03	1.09E-05	NO DATA	1.42E-06
I 131	2.71E-05	3.17E-05	1.40E-05	1.06E-02	3.70E-05	NO DATA	7.56E-07
I 132	1.21E-06	2.53E-06	8.99E-07	1.21E-04	2.82E-06	NO DATA	1.36E-06
I 133	9.46E-06	1.37E-05	4.00E-06	2.54E-03	1.60E-05	NO DATA	1.54E-06
I 134	6.58E-07	1.34E-06	4.75E-07	3.18E-05	1.49E-06	NO DATA	9.21E-07
I 135	2.76E-06	5.43E-06	1.98E-06	4.97E-04	6.05E-06	NO DATA	1.31E-06
CS134	2.83E-04	5.02E-04	5.32E-05	NO DATA	1.36E-04	5.69E-05	9.53E-07
CS136	3.45E-05	9.61E-05	3.78E-05	NO DATA	4.03E-05	8.40E-06	1.02E-06
CS137	3.92E-04	4.37E-04	3.25E-05	NO DATA	1.23E-04	5.09E-05	9.53E-07
CS138	3.61E-07	5.58E-07	2.84E-07	NO DATA	2.93E-07	4.67E-08	6.26E-07
BA139	1.06E-09	7.03E-13	3.07E-11	NO DATA	4.23E-13	4.25E-06	3.64E-05
BA140	4.00E-05	4.00E-08	2.07E-05	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 1.7

INHALATION DOSE FACTORS FOR CHILD
(MREM PER 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-008	6.57E-09	4.59E-06	2.93E-07
MN 54	NO DATA	1.16E-05	2.57E-06	NO DATA	2.71E-06	4.26E-04	6.19E-06
MN 56	NO DATA	4.48E-10	8.43E-11	NO DATA	4.52E-10	3.55E-06	3.33E-05
FE 55	1.28E-05	6.80E-06	2.10E-06	NO DATA	NO DATA	3.00E-05	7.75E-07
FE 59	5.59E-06	9.04E-06	4.51E-06	NO DATA	NO DATA	3.43E-04	1.91E-05
CO 58	NO DATA	4.79E-07	8.55E-07	NO DATA	NO DATA	2.99E-04	9.29E-06
CO 60	NO DATA	3.55E-06	6.12E-06	NO DATA	NO DATA	1.91E-03	2.60E-05
NI 63	2.22E-04	1.25E-05	7.56E-06	NO DATA	NO DATA	7.43E-05	1.71E-06
NI 65	8.08E-10	7.99E-11	4.44E-11	NO DATA	NO DATA	2.21E-06	2.27E-05
CU 64	NO DATA	5.39E-10	2.90E-10	NO DATA	1.63E-09	2.59E-06	9.92E-06
ZN 65	1.15E-05	3.06E-05	1.90E-05	NO DATA	1.93E-05	2.69E-04	4.41E-06
ZN 69	1.81E-11	2.61E-11	2.41E-12	NO DATA	1.58E-11	3.84E-07	2.75E-05
BR 83	NO DATA	NO DATA	1.28E-07	NO DATA	NO DATA	NO DATA	LT E-24
BR 84	NO DATA	NO DATA	1.48E-07	NO DATA	NO DATA	NO DATA	LT E-24
BR 85	NO DATA	NO DATA	6.84E-09	NO DATA	NO DATA	NO DATA	LT E-24
RB 86	NO DATA	5.36E-05	3.09E-05	NO DATA	NO DATA	NO DATA	2.16E-06
RB 88	NO DATA	1.52E-07	9.90E-08	NO DATA	NO DATA	NO DATA	4.66E-09
RB 89	NO DATA	9.33E-08	7.85E-08	NO DATA	NO DATA	NO DATA	5.11E-10
SR 89	1.62E-04	NO DATA	4.66E-06	NO DATA	NO DATA	5.83E-04	4.52E-05
SR 90	2.73E-02	NO DATA	1.74E-03	NO DATA	NO DATA	3.99E-03	9.28E-05
SR 91	3.28E-08	NO DATA	1.24E-09	NO DATA	NO DATA	1.44E-05	4.70E-05
SR 92	3.54E-09	NO DATA	1.42E-10	NO DATA	NO DATA	6.49E-06	6.55E-05
Y 90	1.11E-06	NO DATA	2.99E-08	NO DATA	NO DATA	7.07E-05	7.24E-05
Y 91m	1.37E-10	NO DATA	4.98E-12	NO DATA	NO DATA	7.60E-07	4.64E-07
Y 91	2.47E-04	NO DATA	6.59E-06	NO DATA	NO DATA	7.10E-04	4.97E-05
Y 92	5.50E-09	NO DATA	1.57E-10	NO DATA	NO DATA	6.46E-06	6.46E-05
Y 93	5.04E-08	NO DATA	1.38E-09	NO DATA	NO DATA	2.01E-05	1.05E-04
ZR 95	5.13E-05	1.13E-05	1.00E-05	NO DATA	1.61E-05	6.03E-04	1.65E-05
ZR 97	5.07E-08	7.34E-09	4.32E-09	NO DATA	1.05E-08	3.06E-05	9.49E-05
NB 95	6.35E-06	2.48E-06	1.77E-06	NO DATA	2.33E-06	1.66E-04	1.00E-05
MO 99	NO DATA	4.66E-08	1.15E-08	NO DATA	1.06E-07	3.66E-05	3.42E-05
TC 99m	4.81E-13	9.41E-13	1.56E-11	NO DATA	1.37E-11	2.57E-07	1.30E-06

TABLE 1.7

INHALATION DOSE FACTORS FOR CHILD
(MREM PER PCI INHALED)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
TC101	2.19E-14	2.30E-14	2.91E-13	NO DATA	3.92E-13	1.58E-07	4.41E-09
RU103	7.55E-07	NO DATA	2.90E-07	NO DATA	1.90E-06	1.79E-04	1.21E-05
RU105	4.13E-10	NO DATA	1.50E-10	NO DATA	3.63E-10	4.30E-06	2.69E-05
RU106	3.68E-05	NO DATA	4.57E-06	NO DATA	4.97E-05	3.87E-03	1.16E-04
AG110m	4.56E-06	3.08E-06	2.47E-06	NO DATA	5.74E-06	1.48E-03	2.71E-05
TE125m	1.82E-06	6.29E-07	2.47E-07	5.20E-07	NO DATA	1.29E-04	9.13E-06
TE127m	6.72E-06	2.31E-06	8.16E-07	1.64E-06	1.72E-05	4.00E-04	1.93E-05
TE127	7.49E-10	2.57E-10	1.67E-10	5.30E-10	1.91E-09	2.71E-06	1.52E-05
TE129m	5.19E-06	1.85E-06	8.22E-07	1.71E-06	1.36E-05	4.76E-04	4.91E-05
TE129	2.64E-11	9.45E-12	6.44E-12	1.93E-11	6.94E-11	7.93E-07	6.89E-06
TE131m	3.63E-08	1.60E-08	1.37E-08	2.64E-08	1.08E-07	5.56E-05	8.32E-05
TE131	5.87E-12	2.28E-12	1.78E-12	4.59E-12	1.59E-11	5.55E-07	3.60E-07
TE132	1.30E-07	7.36E-08	7.12E-08	8.58E-08	4.79E-07	1.02E-04	3.72E-05
I 130	2.21E-06	4.43E-06	2.28E-06	4.99E-04	6.61E-06	NO DATA	1.38E-06
I 131	1.30E-05	1.30E-05	7.37E-06	4.39E-03	2.13E-05	NO DATA	7.68E-07
I 132	5.72E-07	1.10E-06	5.07E-07	5.23E-05	1.69E-06	NO DATA	8.65E-07
I 133	4.48E-06	5.49E-06	2.08E-06	1.04E-03	9.13E-06	NO DATA	1.48E-06
I 134	3.17E-07	5.84E-07	2.69E-07	1.37E-05	8.92E-07	NO DATA	2.58E-07
I 135	1.33E-06	2.36E-06	1.12E-06	2.14E-04	3.62E-06	NO DATA	1.20E-06
CS134	1.76E-04	2.74E-04	6.07E-05	NO DATA	8.93E-05	3.27E-05	1.04E-06
CS136	1.76E-05	4.62E-05	3.14E-05	NO DATA	2.58E-05	3.93E-06	1.13E-06
CS137	2.45E-04	2.23E-04	3.47E-05	NO DATA	7.63E-05	2.81E-05	9.78E-07
CS138	1.71E-07	2.27E-07	1.50E-07	NO DATA	1.68E-07	1.84E-08	7.29E-08
BA139	4.98E-10	2.66E-13	1.45E-11	NO DATA	2.33E-13	1.56E-06	1.56E-05
BA140	2.00E-05	1.75E-08	1.17E-06	NO DATA	5.71E-09	4.71E-04	2.75E-05
BA141	5.29E-11	2.95E-14	1.72E-12	NO DATA	2.56E-14	7.89E-07	7.44E-08
BA142	1.35E-11	9.73E-15	7.54E-13	NO DATA	7.87E-15	4.44E-07	7.41E-10
LA140	1.74E-07	6.08E-08	2.04E-08	NO DATA	NO DATA	4.94E-05	6.10E-05
LA142	3.50E-10	1.11E-10	3.49E-11	NO DATA	NO DATA	2.35E-06	2.05E-05
CE141	1.06E-05	5.28E-06	7.83E-07	NO DATA	2.31E-06	1.47E-04	1.53E-05
CE143	9.89E-08	5.37E-08	7.77E-09	NO DATA	2.26E-08	3.12E-05	3.44E-05
CE144	1.83E-03	5.72E-04	9.77E-05	NO DATA	3.17E-04	3.23E-03	1.05E-04
PR143	4.99E-06	1.50E-06	2.47E-07	NO DATA	8.11E-07	1.17E-04	2.63E-05
PR144	1.61E-11	4.99E-12	8.10E-13	NO DATA	2.64E-12	4.23E-07	5.32E-08
ND147	2.92E-06	2.36E-06	1.84E-07	NO DATA	1.30E-06	8.87E-05	2.22E-05
W 187	4.41E-09	2.61E-09	1.17E-09	NO DATA	NO DATA	1.11E-05	2.46E-05
NP239	1.26E-07	9.04E-09	6.35E-09	NO DATA	2.63E-08	1.57E-05	1.73E-05

TABLE 1.7

INHALATION DOSE FACTORS FOR TEENAGER
(MREM PER PCI INHALED)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	NO DATA	1.59E-07	1.59E-07	1.59E-07	1.59E-07	1.59E-07	1.59E-07
C 14	3.25E-06	6.09E-07	6.09E-07	6.09E-07	6.09E-07	6.09E-07	6.09E-07
NA 24	1.72E-06	1.72E-06	1.72E-06	1.72E-06	1.72E-06	1.72E-06	1.72E-06
P 32	2.36E-04	1.37E-05	8.95E-06	NO DATA	NO DATA	NO DATA	1.16E-05
CR 51	NO DATA	NO DATA	1.69E-08	9.37E-09	3.84E-09	2.62E-06	3.75E-07
MN 54	NO DATA	6.39E-06	1.05E-06	NO DATA	1.59E-06	2.48E-04	8.35E-06
MN 56	NO DATA	2.12E-10	3.15E-11	NO DATA	2.24E-10	1.90E-06	7.18E-06
FE 55	4.18E-06	2.98E-06	6.93E-07	NO DATA	NO DATA	1.55E-05	7.99E-07
FE 59	1.09E-06	4.62E-06	1.79E-06	NO DATA	NO DATA	1.91E-04	2.23E-05
CO 58	NO DATA	2.59E-07	3.47E-07	NO DATA	NO DATA	1.68E-04	1.19E-05
CO 60	NO DATA	1.89E-06	2.48E-06	NO DATA	NO DATA	1.09E-03	3.24E-05
NI 63	7.25E-05	5.43E-06	2.47E-06	NO DATA	NO DATA	3.84E-05	1.77E-06
NI 65	2.73E-10	3.66E-11	1.59E-11	NO DATA	NO DATA	1.17E-06	4.59E-06
CU 64	NO DATA	2.54E-10	1.06E-10	NO DATA	8.01-10	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	7.55E-06	3.24E-05
SR 92	1.19E-09	NO DATA	5.08E-11	NO DATA	NO DATA	3.43E-06	1.49E-05
Y 90	3.73E-07	NO DATA	1.00E-08	NO DATA	NO DATA	3.66E-05	6.99E-05
Y 91m	4.63E-11	NO DATA	1.77E-12	NO DATA	NO DATA	4.00E-07	3.77E-09
Y 91	8.26E-05	NO DATA	2.21E-06	NO DATA	NO DATA	3.67E-04	5.11E-05
Y 92	1.84E-09	NO DATA	5.36E-11	NO DATA	NO DATA	3.35E-06	2.06E-05
Y 93	1.69E-08	NO DATA	4.65E-10	NO DATA	NO DATA	1.04E-05	7.24E-05
ZR 95	1.82E-05	5.73E-06	3.94E-06	NO DATA	8.42E-06	3.36E-04	1.86E-05
ZR 97	1.72E-08	3.40E-09	1.57E-09	NO DATA	5.15E-09	1.62E-05	7.88E-05
NB 95	2.32E-06	1.29E-06	7.08E-07	NO DATA	1.25E-06	9.39E-05	1.21E-05
MO 99	NO DATA	2.11E-08	4.03E-09	NO DATA	5.14E-08	1.92E-05	3.36E-05
TC 99m	1.73E-13	4.83E-13	6.24E-12	NO DATA	7.20E-12	1.44E-07	7.66E-07

TABLE 1.7

INHALATION DOSE FACTORS FOR TEENAGER
(MREM PER PCI INHALED)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
TC101	7.40E-15	1.05E-14	1.03E-13	NO DATA	1.90E-13	8.34E-08	1.09E-16
RU103	2.63E-07	NO DATA	1.12E-07	NO DATA	9.29E-07	9.79E-05	1.36E-05
RU105	1.40E-10	NO DATA	5.42E-11	NO DATA	1.76E-10	2.27E-06	1.13E-05
RU106	1.23E-05	NO DATA	1.55E-06	NO DATA	2.38E-05	2.01E-03	1.20E-04
AG110m	1.73E-06	1.64E-06	9.99E-07	NO DATA	3.13E-06	8.44E-04	3.41E-05
TE125m	6.10E-07	2.80E-07	8.34E-08	1.75E-07	NO DATA	6.70E-05	9.38E-06
TE127m	2.25E-06	1.02E-06	2.73E-07	5.48E-07	8.17E-06	2.07E-04	1.99E-05
TE127	2.51E-10	1.14E-10	5.52E-11	1.77E-10	9.10E-10	1.40E-06	1.01E-05
TE129m	1.74E-06	8.23E-07	2.81E-07	5.72E-07	6.49E-06	2.47E-04	5.06E-05
TE129	8.87E-12	4.22E-12	2.20E-12	6.48E-12	3.32E-11	4.12E-07	2.02E-07
TE131m	1.23E-08	7.51E-09	5.03E-09	9.06E-09	5.49E-08	2.97E-05	7.76E-05
TE131	1.97E-12	1.04E-12	6.30E-13	1.55E-12	7.72E-12	2.92E-07	1.89E-09
TE132	4.50E-08	3.63E-08	2.74E-08	3.07E-08	2.44E-07	5.61E-05	5.79E-05
I 130	7.80E-07	2.24E-06	8.96E-07	1.86E-04	3.44E-06	NO DATA	1.14E-06
I 131	4.43E-06	6.14E-06	3.30E-06	1.83E-03	1.05E-05	NO DATA	8.11E-07
I 132	1.99E-07	5.47E-07	1.97E-07	1.89E-05	8.65E-07	NO DATA	1.59E-07
I 133	1.52E-06	2.56E-06	7.78E-07	3.65E-04	4.49E-06	NO DATA	1.29E-06
I 134	1.11E-07	2.90E-07	1.05E-07	4.94E-06	4.58E-07	NO DATA	2.55E-09
I 135	4.62E-07	1.18E-06	4.36E-07	7.76E-05	1.86E-06	NO DATA	8.69E-07
CS134	6.28E-05	1.41E-04	6.86E-05	NO DATA	4.69E-05	1.83E-05	1.22E-06
CS136	6.44E-06	2.42E-05	1.71E-05	NO DATA	1.38E-05	2.22E-06	1.36E-06
CS137	8.38E-05	1.06E-04	3.89E-05	NO DATA	3.80E-05	1.51E-05	1.06E-06
CS138	5.82E-08	1.07E-07	5.58E-08	NO DATA	8.28E-08	9.84E-09	3.38E-11
BA139	1.67E-10	1.18E-13	4.87E-12	NO DATA	1.11E-13	8.08E-07	8.06E-07
BA140	6.84E-06	8.38E-09	4.40E-07	NO DATA	2.85E-09	2.54E-04	2.86E-05
BA141	1.78E-11	1.32E-14	5.93E-13	NO DATA	1.23E-14	4.11E-07	9.33E-14
BA142	4.62E-12	4.63E-15	2.84E-13	NO DATA	3.92E-15	2.39E-07	5.99E-20
LA140	5.99E-08	2.95E-08	7.82E-09	NO DATA	NO DATA	2.68E-05	6.09E-05
LA142	1.20E-10	5.31E-11	1.32E-11	NO DATA	NO DATA	1.27E-06	1.50E-06
CE141	3.55E-06	2.37E-06	2.71E-07	NO DATA	1.11E-06	7.67E-05	1.58E-05
CE143	3.32E-08	2.42E-08	2.70E-09	NO DATA	1.08E-08	1.63E-05	3.19E-05
CE144	6.11E-04	2.53E-04	3.28E-05	NO DATA	1.51E-04	1.67E-03	1.08E-04
PR143	1.67E-06	6.64E-07	8.28E-08	NO DATA	3.86E-07	6.04E-05	2.67E-05
PR144	5.37E-12	2.20E-12	2.72E-13	NO DATA	1.26E-12	2.19E-07	2.94E-14
ND147	9.83E-07	1.07E-06	6.41E-08	NO DATA	6.28E-07	4.65E-05	2.28E-05
W 187	1.50E-09	1.22E-09	4.29E-10	NO DATA	NO DATA	5.92E-06	2.21E-05
NP239	4.23E-08	3.99E-09	2.21E-09	NO DATA	1.25E-08	8.11E-06	1.65E-05

Table 1.8

EXTERNAL DOSE FACTORS FOR STANDING ON CONTAMINATED GROUND
(mrem/hr per pCi/m²)

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
Ni-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

Table 1.8

EXTERNAL DOSE FACTORS FOR STANDING ON CONTAMINATED GROUND
(mrem/hr per pCi/m²)

Element	Total Body	Skin
Te-131	2.20E-09	2.60E-06
Te-132	1.70E-09	2.00E-09
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 1.9

1997 BIG ROCK POINT GASEOUS DESIGN

OBJECTIVE ANNUAL QUANTITIES

Nuclide	Organ	Dose Factor mrem/Ci	Design Objective Annual Quantity (Ci)
Ar-41	Total Body	9.10E-06	5.50E+05
Kr-83m	Skin	2.21E-08	6.79E+08
Kr-85	Skin	2.23E-06	6.73E+06
Kr-85m	Total Body	1.29E-06	3.88E+06
Kr-87	Skin	2.07E-05	7.25E+05
Kr-88	Total Body	1.58E-05	3.16E+05
Kr-89	Total Body	2.27E-06	2.20E+06
H-3	Total Body-C	8.24E-06	6.07E+05
C-14	Bone-C	5.59E-03	2.68E+03
Cr-51	GI Tract-T	2.62E-04	5.73E+04
Mn-54	GI Tract-T	4.45E-02	3.37E+02
Fe-55	Bone-C	1.45E-02	1.03E+03
Co-58	GI Tract-T	1.82E-02	8.24E+02
Fe-59	GI Tract-T	2.25E-02	6.67E+02
Co-60	GI Tract-T	4.86E-01	3.09E+01
Zn-65	Liver-I	1.13E-01	1.33E+02
Sr-89	Bone-C	6.37E-01	2.35E+01
Sr-90	Bone-C	2.64E+01	5.68E-01
Zr-95	GI Tract-T	2.75E-02	5.45E+02
Sb-124	GI Tract-T	6.66E-02	2.25E+02
I-131	Thyroid-I	2.46E+00	6.10E+00
Xe-131m	Skin	9.84E-07	1.52E+07
Xe-133	Total Body	3.39E-07	1.47E+07
Xe-133m	Skin	2.05E-06	7.32E+06
Xe-135	Total Body	2.04E-06	2.45E+06
Xe-135m	Total Body	2.22E-06	2.25E+06
Xe-137	Skin	3.80E-06	3.95E+06
Xe-138	Total Body	6.02E-06	8.31E+05
I-133	Thyroid-I	2.60E-02	5.77E+02
Cs-134	Liver-C	6.22E-01	2.41E+01
Cs-136	Total Body-I	1.11E-02	4.50E+02
Cs-137	Bone-C	6.78E-01	2.21E+01
Ba-140	Bone-C	3.74E-03	4.01E+03
Ce-141	GI Tract-T	9.33E-03	1.61E+03
Ce-144	GI Tract-T	2.39E-01	6.28E+01
Mn-56	GI Tract-C	2.00E-04	7.50E+04
Co-57	GI Tract-T	6.01E-03	2.50E+03
Ni-63	Bone-C	8.63E-01	1.74E+01
Ni-65	GI Tract-C	1.29E-04	1.16E+05
Rb-88	Total Body-C	6.14E-07	8.14E+06
Nb-95	GI Tract-A	3.20E-02	4.69E+02
Mo-99	Kidney-I	1.50E-03	1.00E+04
Tc-99	GI Tract-A	8.75E-02	1.71E+02

TABLE 1.9

1997 BIG ROCK POINT GASEOUS DESIGN

OBJECTIVE ANNUAL QUANTITIES

Nuclide	Organ	Dose Factor mrem/Ci	Design Objective Annual Quantity (Ci)
Tc-99m	GI Tract-T	1.31E-05	1.14E+06
Ru-103	GI Tract-A	4.89E-02	3.07E+02
Sb-125	GI Tract-T	3.08E-02	4.87E+02
Te-127	GI Tract-T	1.30E-04	1.15E+05
I-129	Thyroid-A	2.59E+01	5.79E-01
I-132	Thyroid-C	2.99E-04	5.02E+04
I-134	Thyroid-C	6.91E-05	2.17E+05
I-135	Thyroid-C	1.29E-03	1.16E+04
La-140	GI Tract-T	1.49E-03	1.01E+04
N-13	Total Body-C	6.81E-08	7.34E+07
Na-24	Total Body-C	2.62E-04	1.91E+04
Br-82	Total Body-I	1.05E-03	4.76E+03
Sr-91	Bone-I	6.44E-02	2.33E+02
Sr-92	GI Tract-C	3.75E-04	4.00E+04
Tc-101	GI Tract-I	4.92E-06	3.05E+06
Ag-110m	GI Tract-T	1.95E-01	7.69E+01
Cs-138	Total Body-C	4.82E-03	1.04E+03
Ba-139	GI Tract-C	8.20E-05	1.83E+05
Np-239	GI Tract-T	3.82E-04	3.93E+04
Ru-105	GI Tract-C	1.65E-04	9.09E+04
Pu-238	Bone-T	3.80E+01	3.95E-01
Pu-239	Bone-T	4.39E+01	3.42E-01
Pu-241	Bone-T	9.26E-01	1.62E+01
Am-241	Bone-T	1.50E+01	1.00E+00
Cm-242	Lung-T	8.70E-01	1.72E+01
Cm-244	Bone-T	9.18E+00	1.63E+00

II. LIQUID EFFLUENTS

II.A ALLOWABLE CONCENTRATION (Sections II.A and II.B use the new 10 CFR 20 values)

II.A.1 RETS Requirement

Technical Specification 13.1.2.1 of the Radiological Effluent Technical Specifications (RETS) requires that the concentration of radioactive material released at any time from the site to unrestricted areas shall be limited to the effluent concentration specified in 10 CFR 20, Appendix B, Table 2, Column 2 for nuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the concentration shall be limited to 1.4×10^{-4} μCi/ml total activity. To ensure compliance, the following approach will be used for each release.

II.A.2 Prerelease Analysis

Most tanks will be recirculated through two volume changes prior to sampling for release to the environment to ensure that a representative sample is obtained. The appropriate recirculation time for those tanks too large to provide two volume changes will be the time that the suspended particulate concentration reaches steady state. Either a one-time test, or prior sampling data, may be used to determine appropriate recirculation time.

Prior to release, a grab sample will be analyzed for each release, and the concentration of each radionuclide determined.

$$C_j = \sum_{i=1}^{n} C_{ij} \qquad \text{(II.1)}$$

where:

C_j = Total concentration in the liquid effluent at the release point, μCi/ml, at release point j.

C_{ij} = Concentration of a single radionuclide i, μCi/ml, at release point j.

II.A.3 Total Release-Fraction

The total release-fraction (R_j) for each release point will be calculated by the relationship defined as:

$$R_{(j)} = \sum_i \frac{C_{ij}}{MPC_i} \qquad (II.2)$$

where:

C_{ij} = Undiluted effluent concentration of radionuclide i, as determined in Section II.A.2, μCi/ml, at release point j.

MPC_i = The effluent concentration of radionuclide i, as specified in Section II.A.1, μCi/ml. (Big Rock Point still uses MPC terminology in Liquid Analyses Programs.)

R_j = The total release-fraction for the release point.

The sum of the ratios at the discharge to the lake must be ≤1 due to the releases from any or all concurrent releases. The following relationship will assure this criterion is met:

$$f_1(R_1 - 1) + f_2(R_2 - 1) + f_3(R_3 - 1) \leq F \qquad (II.3)$$

where:

f_1, f_2, f_3 = The effluent flow rate (gallons/minute) for the respective releases, determined by plant personnel.

R_1, R_2, R_3 = The total release-fractions for the respective releases as determined by Equation II.2.

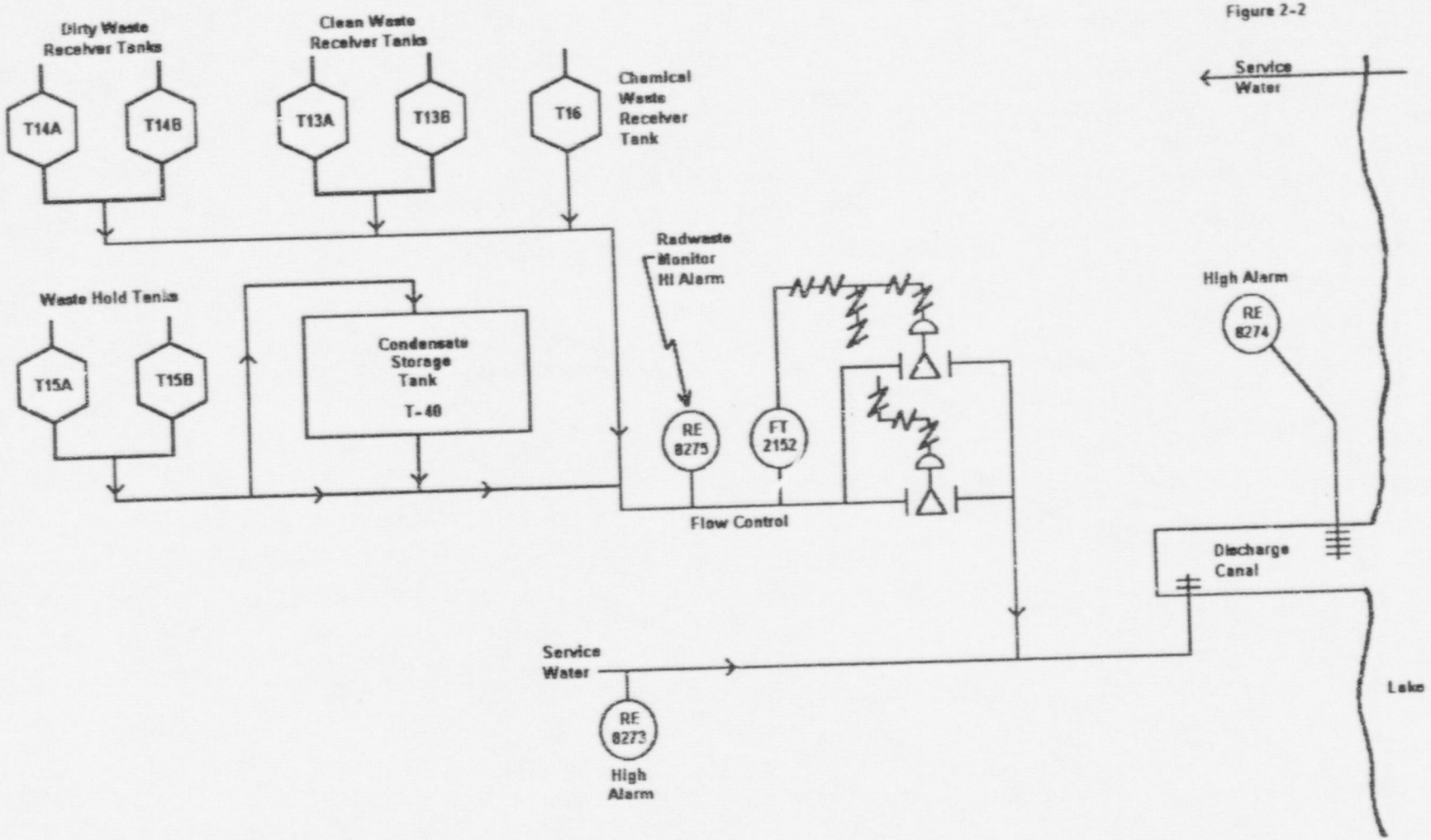
F = Minimum required dilution flow rate. Normally, a conservatively high dilution flow rate is used, that is, flow rate used = (b)(F) where b is a conservative factor greater than 1.0.

II.B INSTRUMENT ALARM SET POINTS

II.B.1 Set Point Determination

The set point for each liquid effluent monitor will be established using plant instructions. Concentration, flow rate, dilution, principal gamma emitter, geometry and detector efficiency are combined to give an equivalent set point in counts per minute (cpm). The physical and technical description, location and identification number for each liquid effluent radiation detector is contained in Figure 2-2.

Figure 2-2



BIG ROCK POINT - LIQUID RELEASE FLOWS

The respective alarm/trip set points at each release point will be set such that the sum of the ratios at each point, as calculated by Equation II.2, will not exceed 1. The value of R is directly related to the total concentration calculated by Equation II.1. An increase in the concentration would indicate an increase in the value of R. A large increase would cause the limits specified in Section II.A.1 to be exceeded. The minimum alarm/trip set point value is equal to the release concentration, but for ease of operation it may be desired that the set point (S) be set above the effluent concentration (C) by the same factor (b) utilized in setting dilution flow. That is:

$$S = b \times C \qquad \text{(II.4)}$$

Liquid effluent flow paths and release points are indicated in Figure 2.1.

II.B.2 Post-Release Analysis

A post-release analysis will be done using actual release data to ensure that the limits specified in Section II.A.1 were not exceeded.

A composite list of concentrations (C_{ij}), by isotope, will be used with the actual liquid radwaste (f_j) and dilution (F) flow rates (or volumes) during the release. The data will be substituted into Equation II.3 to demonstrate compliance with the limits in Section II.A.1. This data and set points will be recorded in auditable records by plant personnel.

II.C DOSE

II.C.1 RETS Requirement

Technical Specification 13.1.4.1 of the Radiological Effluent Technical Specifications (RETS) requires that the quantity of radionuclides released be limited such that the dose or dose commitment to an individual from radioactive materials in liquid effluents released to unrestricted areas from each reactor (see Figure 2.1) will not exceed:

1. During any calendar quarter, 1.5 mrem to the total body and 5 mrem to any organ, and

2. During any calendar year, 3 mrem to the total body and 10 mrem to any organ.

II.C.2 Release Analysis (Design Basis Quantity Fraction)

Per Technical Specification 13.1.4.4 the cumulative DBQ fraction for nuclides released is summed at least every 31 days to assure that the sum of the fractions of all nuclides released does not exceed 1.0 year to date and 0.5 in any calendar quarter.

Calculations shall be performed according to the formula:

$$\sum_i \frac{A_i}{(DBQ)_i} = \text{Fraction of DBQ} \qquad \text{(II.5)}$$

where:

A_i = Cumulative quarterly or annual activity of nuclide i identified in liquid release (C_i).

$(DBQ)_i$ = Design objective annual quantity of radionuclide i from Table 2.2 (Ci).

Radionuclides may be omitted from the summation if they fall under the criteria of allowed omission specified by Note 5 to Appendix B, 10 CFR 20.

II.C.3 Exceeding DBQ Limits

The design basis quantities are derived in such a conservative manner that doses may be greatly overestimated by this technique. As a consequence of this conservatism, and in light of historically consistent operations with releases well below annual design basis quantities, the Big Rock Point Plant Technical Specifications do not require montnly dose projections. However, Technical Specification 13.1.4.4 requires a cumulative dose contribution to be determined for current quarter and year every 31 days. If at any time this calculation, by Equation II.5, results in values greater than 0.5 for a given quarter or 1.0 for year to date, the NRC LADTAP code will be run to ensure that Technical Specification 13.1.4.1 has been met.

II.C.4 Dose Calculation

Values for the design basis quantities (Ci), and the dose per curie $(D_c/C_c)_i$ for each nuclide i shown in Table 2.2, were calculated as follows.

II.C.4.1 Water Ingestion

The dose to an individual from ingestion of radioactivity from any source is described by the following equation:

$$D_j = \sum_{i=1}^{i} (DCF)_{ij} \times I_i = \text{mrem} \qquad \text{(II.6)}$$

where:

D_j = Dose for the j^{th} organ from radionuclides released, mrem.

j = The organ of interest.

$(DCF)_{ij}$ = Ingestion dose commitment factor for the j^{th} organ from the i^{th} radionuclide mrem/pCi (see Table 2.i).

I_i = Activity ingested of the i^{th} radionuclide, pCi.

I_i is described by:

$$I_i = \frac{(A_i)(V)(365)(10^6)}{(800)(d)} = \text{pCi} \qquad \text{(II.7)}$$

where:

365 = Days per year.

A_i = Annual activity released of i^{th} radionuclide, μCi.

V = Average rate of water consumption; adult - 2,000 ml/d, teen and child - 1,400 ml/d, infant - 900 ml/d (Reg Guide 1.109).

d = Dilution water flow for year (ml).

800 = Dispersion factor from discharge to nearest drinking water supply.

10^6 = Converts μCi to pCi.

The dose equation then becomes:

$$D_j = \frac{(4.56E5)(V)}{d} \sum_{i=1}^{i} (DCF)_{ij} \times A_i = \text{mrem} \qquad \text{(II.8)}$$

II.C.4.2 Fish Ingestion

The dose to an individual from the consumption of fish is described by Equation II.10. In this case the activity ingested of the i^{th} radionuclide (I_i) is described by:

$$I_i = \frac{A_i\ B_i\ F}{15d}\ (10^9) = pCi \qquad (II.9)$$

where:

A_i = Annual activity released of i^{th} radionuclide, μCi.

B_i = Fish concentration factor of i^{th} radionuclide, $\frac{\mu Ci/gm}{\mu Ci/ml}$ (see Table 2.0).

F = Amount of fish eaten per year; adult - 21 kg, teen - 16 kg, child - 6.9 kg and infant - none.

15 = Dispersion factor from discharge to fish exposure point.

d = Dilution water flow for year (ml).

10^9 = Converts μCi to pCi and gm to kgm.

Substitution of Equation II.9 into Equation II.6 gives:

$$D_j = \frac{(6.7E07)(F)}{d} \sum_{i=1}^{i} (A_i)(B_i)(DCF_{ij}) = mrem \qquad (II.10)$$

II.C.4.3 Releasing Radionuclides Not Listed in Table 2.2

Table 2.2 contains all nuclides identified to date as routine constituents of liquid releases at Big Rock Point Plant, plus those common to boiling water reactors in general, even if not previously detected at Big Rock Point. From time to time, however, other nuclides may be detected.

If the unlisted nuclide constitutes less than 10% of the MPC-fraction for the release, and all unlisted nuclides total less than 25% of the MPC-fraction, the nuclide may be considered not present.

If the unlisted nuclide constitutes greater than 10% of the MPC-fraction, or all unlisted nuclides together constitute greater than 25%, then each nuclide should be assigned a DBQ equal to the most conservative value listed for the physical form of the nuclide involved (noble gas, halogen or particulate).

Should a nuclide not listed in Table 2.2 begin to appear in significant quantities on a routine basis, revision to this ODCM should be made in order to include a design basis quantity specific to that nuclide.

II.C.5 Annual Analysis

A complete analysis utilizing the NRC computer code LADTAP with the total source release will be done annually in conjunction with the annual environmental report. This analysis will provide estimates of dose to the total body and various organs in addition to the dose limiting organs considered in the method of Section 2. The following approach is utilized in LADTAP. The dose to the j^{th} organ from m radionuclides, D_j, is described by:

$$D_j = \sum_{i=1}^{m} D_{ij} = \text{rem} \qquad \text{(II.11)}$$

$$D_j = \sum_{i=1}^{m} (DCF)_{ij} \times I_i = \text{rem} \qquad \text{(II.12)}$$

where:

D_{ij} = Dose to the j^{th} organ from the i^{th} radionuclide, rem.

j = The organ of interest (bone, GI tract, thyroid, liver, kidney, lung or total body).

$(DCF)_{ij}$ = Ingestion dose commitment factor for the j^{th} organ from the i^{th} radionuclide, rem/μCi (see Table 2.1).

I_i = Activity ingested of the i^{th} radionuclide, μCi.

I_i for water ingestion is described by:

$$I_i = \frac{A_i \, V\tau}{\nu \, d} \, \mu C \qquad \text{(II.13)}$$

and for fish ingestion I_i is described by:

$$I_i = \frac{A_i \, B_i \, F\tau}{\nu \, d} \, \mu Ci \qquad \text{(II.14)}$$

where:

A_i = Activity released of j^{th} radionuclide during the year, μCi.

V = Average rate of water consumption (Table 2.2).

τ = Number of days during the year (365 d).

ν = Dispersion factor from point of discharge to point of exposure (Table 2.2).

d = Dilution water volume (ml).

B_i = Fish concentration factor of the i^{th} radionuclide, $\frac{\mu Ci/gm}{\mu Ci/ml}$ (Table 2.0).

F = Amount of fish eaten per day (Table 2.2).

II.D OPERABILITY OF LIQUID RADWASTE EQUIPMENT

The Big Rock Point liquid radwaste system is designed to reduce the radioactive materials in liquid wastes prior to their discharge (by recycle or shipment for disposal) so that radioactivity in liquid effluent releases to unrestricted areas (see Figure 2.1) will not exceed Technical Specification 13.1.4.1. Maintaining the cumulative DBQ fraction of releases assures compliance with this requirement. In addition, more than 13 years of operating experience (to the date this ODCM was first adopted) has shown that design basis quantities never have been exceeded.

II.E OFFSITE RELEASE RATE

10 CFR 50.36a requires that the release of radioactive materials be kept as low as is reasonably achievable. Appendix I to 10 CFR 50 provides the numerical guidelines on limiting conditions for operations to meet the as low as is reasonably achievable requirement.

The LADTAP code has been run to determine the dose due to drinking water at plant discharge concentration (800 x nearest drinking water intake concentration). The source term used is given in Table 1.1. The most limiting dose of the person hypothetically drinking this water is 4.89E-01 mrem, whole body. The release rate which would result in a dose rate equivalent to 500 mrem/y (the total body limit of Technical Specification 13.1.3.1) is the Curies/Year given in Table 1.1 (8.94) times 500/.489 or 9141 Ci/Yr = 2.9E-04 Ci/sec.

The above calculation is informational as a typical exposure using the drinking water pathway and an average release from Big Rock Point. Per Section II.C.5 annual analyses are run using LADTAP to calculate estimates of dose to the total body and limiting organs.

BIOACCUMULATION FACTORS
Table 2.0

(μCi/gm per μCi/ml)

Element	Freshwater Fish
H	9.0E-01
C	4.6E+03
Na	1.0E+02
P	3.0E+03
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 2.1

ADULT INGESTION DOSE FACTORS
(MREM PER PCI INGESTED)

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

TABLE 2.1

ADULT INGESTION DOSE FACTORS
(MREM PER PCI INGESTED)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
TC101	2.54E-10	3.66E-10	3.59E-09	NO DATA	6.59E-09	1.87E-10	1.10E-21
RU103	1.85E-07	NO DATA	7.97E-08	NO DATA	7.06E-07	NO DATA	2.16E-05
RU105	1.54E-08	NO DATA	6.08E-09	NO DATA	1.99E-07	NO DATA	9.42E-06
RU106	2.75E-06	NO DATA	3.48E-07	NO DATA	5.31E-06	NO DATA	1.78E-04
AG110m	1.60E-07	1.48E-07	8.79E-08	NO DATA	2.91E-07	NO DATA	6.04E-05
TE125m	2.68E-06	9.71E-07	3.59E-07	8.06E-07	1.09E-05	NO DATA	1.07E-05
TE127m	6.77E-06	2.42E-06	8.25E-07	1.73E-06	2.75E-05	NO DATA	2.27E-05
TE127	1.10E-07	3.95E-08	2.38E-08	8.15E-08	4.48E-07	NO DATA	8.68E-06
TE129m	1.15E-05	4.29E-06	1.82E-06	3.95E-06	4.80E-05	NO DATA	5.79E-05
TE129	3.14E-08	1.18E-08	7.65E-09	2.41E-08	1.32E-07	NO DATA	2.37E-08
TE131m	1.73E-06	8.46E-07	7.05E-07	1.34E-06	8.57E-06	NO DATA	8.40E-05
TE131	1.97E-08	8.23E-09	6.22E-09	1.62E-08	8.63E-08	NO DATA	2.79E-09
TE132	2.52E-06	1.63E-06	1.53E-06	1.80E-06	1.57E-05	NO DATA	7.71E-05
I 130	7.56E-07	2.23E-06	8.80E-07	1.89E-04	3.48E-06	NO DATA	1.92E-06
I 131	4.16E-06	5.95E-06	3.41E-06	1.95E-03	1.02E-05	NO DATA	1.57E-06
I 132	2.03E-07	5.43E-07	1.90E-07	1.90E-05	8.65E-07	NO DATA	1.02E-07
I 133	1.42E-06	2.47E-06	7.53E-07	3.63E-04	4.31E-06	NO DATA	2.22E-06
I 134	1.06E-07	2.88E-07	1.03E-07	4.99E-06	4.58E-07	NO DATA	2.51E-10
I 135	4.43E-07	1.16E-06	4.28E-07	7.65E-05	1.86E-06	NO DATA	1.31E-06
CS134	6.22E-05	1.48E-04	1.21E-04	NO DATA	4.79E-05	1.59E-05	2.59E-06
CS136	6.51E-06	2.57E-05	1.85E-05	NO DATA	1.43E-05	1.96E-06	2.92E-06
CS137	7.97E-05	1.09E-04	7.14E-05	NO DATA	3.70E-05	1.23E-05	2.11E-06
CS138	5.52E-08	1.09E-07	5.40E-08	NO DATA	8.01E-08	7.91E-09	4.65E-13
BA139	9.70E-08	6.91E-11	2.84E-09	NO DATA	6.46E-11	3.92E-11	1.72E-07
BA140	2.03E-05	2.55E-08	1.33E-06	NO DATA	8.67E-09	1.46E-08	4.18E-05
BA141	4.71E-08	3.56E-11	1.59E-09	NO DATA	3.31E-11	2.02E-11	2.22E-17
BA142	2.13E-08	2.19E-11	1.34E-09	NO DATA	1.85E-11	1.24E-11	3.00E-26
LA140	2.50E-09	1.26E-09	3.33E-10	NO DATA	NO DATA	NO DATA	9.25E-05
LA142	1.28E-10	5.82E-11	1.45E-11	NO DATA	NO DATA	NO DATA	4.25E-07
CE141	9.36E-09	6.33E-09	7.18E-10	NO DATA	2.94E-09	NO DATA	2.42E-05
CE143	1.65E-09	1.22E-06	1.35E-10	NO DATA	5.37E-10	NO DATA	4.56E-05
CE144	4.88E-07	2.04E-07	2.62E-08	NO DATA	1.21E-07	NO DATA	1.65E-04
PR143	9.20E-09	3.69E-09	4.56E-10	NO DATA	2.13E-09	NO DATA	4.03E-05
PR144	3.01E-11	1.25E-11	1.53E-12	NO DATA	7.05E-12	NO DATA	4.33E-18
ND147	6.29E-09	7.27E-09	4.35E-10	NO DATA	4.25E-09	NO DATA	3.49E-05
W 187	1.03E-07	8.61E-08	3.01E-08	NO DATA	NO DATA	NO DATA	2.82E-05
NP239	1.19E-09	1.17E-10	6.45E-11	NO DATA	3.65E-10	NO DATA	2.40E-05

TABLE 2.1

INGESTION DOSE FACTORS FOR TEENAGER
(MREM PER PCI INGESTED)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	NO DATA	1.06E-07	1.06E-07	1.06E-07	1.06E-07	1.06E-07	1.06E-07
C 14	4.06E-06	8.12E-07	8.12E-07	8.12E-07	8.12E-07	8.12E-07	8.12E-07
NA 24	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06
P 32	2.76E-04	1.71E-05	1.07E-05	NO DATA	NO DATA	NO DATA	2.32E-05
CR 51	NO DATA	NO DATA	3.60E-09	2.00E-09	7.89E-10	5.14E-09	6.05E-07
MN 54	NO DATA	5.90E-06	1.17E-06	NO DATA	1.76E-06	NO DATA	1.21E-05
MN 56	NO DATA	1.58E-07	2.81E-08	NO DATA	2.00E-07	NO DATA	1.04E-05
FE 55	3.78E-06	2.68E-06	6.25E-07	NO DATA	NO DATA	1.70E-06	1.16E-06
FE 59	5.87E-06	1.37E-05	5.29E-06	NO DATA	NO DATA	4.32E-06	3.24E-05
CO 58	NO DATA	9.72E-07	2.24E-06	NO DATA	NO DATA	NO DATA	1.34E-05
CO 60	NO DATA	2.81E-06	6.33E-06	NO DATA	NO DATA	NO DATA	3.66E-05
NI 63	1.77E-04	1.25E-05	6.00E-06	NO DATA	NO DATA	NO DATA	1.99E-06
NI 65	7.49E-07	9.57E-08	4.36E-08	NO DATA	NO DATA	NO DATA	5.19E-06
CU 64	NO DATA	1.15E-07	5.41E-08	NO DATA	2.91E-07	NO DATA	8.92E-06
ZN 65	5.76E-06	2.00E-05	9.33E-06	NO DATA	1.28E-05	NO DATA	8.47E-06
ZN 69	1.47E-08	2.80E-08	1.96E-09	NO DATA	1.83E-08	NO DATA	5.16E-08
BR 83	NO DATA	NO DATA	5.74E-08	NO DATA	NO DATA	NO DATA	LT E-24
BR 84	NO DATA	NO DATA	7.22E-08	NO DATA	NO DATA	NO DATA	LT E-24
BR 85	NO DATA	NO DATA	3.05E-09	NO DATA	NO DATA	NO DATA	LT E-24
RB 86	NO DATA	2.98E-05	1.40E-05	NO DATA	NO DATA	NO DATA	4.41E-06
RB 88	NO DATA	8.52E-08	4.54E-08	NO DATA	NO DATA	NO DATA	7.30E-15
RB 89	NO DATA	5.50E-08	3.89E-08	NO DATA	NO DATA	NO DATA	8.43E-17
SR 89	4.40E-04	NO DATA	1.26E-05	NO DATA	NO DATA	NO DATA	5.24E-05
SR 90	8.30E-03	NO DATA	2.05E-03	NO DATA	NO DATA	NO DATA	2.33E-04
SR 91	8.07E-06	NO DATA	3.21E-07	NO DATA	NO DATA	NO DATA	3.66E-05
SR 92	3.05E-06	NO DATA	1.30E-07	NO DATA	NO DATA	NO DATA	7.77E-05
Y 90	1.37E-08	NO DATA	3.69E-10	NO DATA	NO DATA	NO DATA	1.13E-04
Y 91m	1.29E-10	NO DATA	4.93E-12	NO DATA	NO DATA	NO DATA	6.09E-09
Y 91	2.01E-07	NO DATA	5.39E-09	NO DATA	NO DATA	NO DATA	8.24E-05
Y 92	1.21E-09	NO DATA	3.50E-11	NO DATA	NO DATA	NO DATA	3.32E-05
Y 93	3.83E-09	NO DATA	1.05E-10	NO DATA	NO DATA	NO DATA	1.17E-04
ZR 95	4.12E-08	1.30E-08	8.94E-09	NO DATA	1.91E-08	NO DATA	3.00E-05
ZR 97	2.37E-09	4.69E-10	2.16E-10	NO DATA	7.11E-10	NO DATA	1.27E-04
NB 95	8.22E-09	4.56E-09	2.51E-09	NO DATA	4.42E-09	NO DATA	1.95E-05
MO 99	NO DATA	6.03E-06	1.15E-06	NO DATA	1.38E-05	NO DATA	1.08E-05
TC 99m	3.32E-10	9.26E-10	1.20E-08	NO DATA	1.38E-08	5.14E-10	6.08E-07

TABLE 2.1

INGESTION DOSE FACTORS FOR CHILD
(MREM PER PCI INGESTED)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	NO DATA	2.03E-07	2.03E-07	2.03E-07	2.03E-07	2.03E-07	2.03E-07
C 14	1.21E-05	2.42E-06	2.42E-06	2.42E-06	2.42E-06	2.42E-06	2.42E-06
NA 24	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06
P 32	8.25E-04	3.86E-05	3.18E-05	NO DATA	NO DATA	NO DATA	2.28E-05
CR 51	NO DATA	NO DATA	8.90E-09	4.94E-09	1.35E-09	9.02E-09	4.72E-07
MN 54	NO DATA	1.07E-05	2.85E-06	NO DATA	3.00E-06	NO DATA	8.98E-06
MN 56	NO DATA	3.34E-07	7.54E-08	NO DATA	4.04E-07	NO DATA	4.84E-05
FE 55	1.15E-05	6.10E-06	1.89E-06	NO DATA	NO DATA	3.45E-06	1.13E-06
FE 59	1.65E-05	2.67E-05	1.33E-05	NO DATA	NO DATA	7.74E-06	2.78E-05
CO 58	NO DATA	1.80E-06	5.51E-06	NO DATA	NO DATA	NO DATA	1.05E-05
CO 60	NO DATA	5.29E-06	1.56E-05	NO DATA	NO DATA	NO DATA	2.93E-05
NI 63	5.38E-04	2.88E-05	1.83E-05	NO DATA	NO DATA	NO DATA	1.94E-06
NI 65	2.22E-06	2.09E-07	1.22E-07	NO DATA	NO DATA	NO DATA	2.56E-05
CU 64	NO DATA	2.45E-07	1.48E-07	NO DATA	5.92E-07	NO DATA	1.15E-05
ZN 65	1.37E-05	3.65E-05	2.27E-05	NO DATA	2.30E-05	NO DATA	6.41E-06
ZN 69	4.38E-08	6.33E-08	5.85E-09	NO DATA	3.84E-08	NO DATA	3.99E-06
BR 83	NO DATA	NO DATA	1.71E-07	NO DATA	NO DATA	NO DATA	LT E-24
BR 84	NO DATA	NO DATA	1.98E-07	NO DATA	NO DATA	NO DATA	LT E-24
BR 85	NO DATA	NO DATA	9.12E-09	NO DATA	NO DATA	NO DATA	LT E-24
RB 86	NO DATA	6.70E-05	4.12E-05	NO DATA	NO DATA	NO DATA	4.31E-06
RB 88	NO DATA	1.90E-07	1.32E-07	NO DATA	NO DATA	NO DATA	9.32E-09
RB 89	NO DATA	1.17E-07	1.04E-07	NO DATA	NO DATA	NO DATA	1.02E-09
SR 89	1.32E-03	NO DATA	3.77E-05	NO DATA	NO DATA	NO DATA	5.11E-05
SR 90	1.70E-02	NO DATA	4.31E-03	NO DATA	NO DATA	NO DATA	2.29E-04
SR 91	2.40E-05	NO DATA	9.06E-07	NO DATA	NO DATA	NO DATA	5.30E-05
SR 92	9.03E-06	NO DATA	3.62E-07	NO DATA	NO DATA	NO DATA	1.71E-04
Y 90	4.11E-08	NO DATA	1.10E-09	NO DATA	NO DATA	NO DATA	1.17E-04
Y 91m	3.82E-10	NO DATA	1.39E-11	NO DATA	NO DATA	NO DATA	7.48E-07
Y 91	6.02E-07	NO DATA	1.61E-08	NO DATA	NO DATA	NO DATA	8.02E-05
Y 92	3.60E-09	NO DATA	1.03E-10	NO DATA	NO DATA	NO DATA	1.04E-04
Y 93	1.14E-08	NO DATA	3.13E-10	NO DATA	NO DATA	NO DATA	1.70E-04
ZR 95	1.16E-07	2.55E-08	2.27E-08	NO DATA	3.65E-08	NO DATA	2.66E-05
ZR 97	6.99E-09	1.01E-09	5.96E-10	NO DATA	1.45E-09	NO DATA	1.53E-04
NB 95	2.25E-08	8.76E-09	6.26E-09	NO DATA	8.23E-09	NO DATA	1.62E-05
MO 99	NO DATA	1.33E-05	3.29E-06	NO DATA	2.84E-05	NO DATA	1.10E-05
TC 99m	9.23E-10	1.81E-09	3.00E-08	NO DATA	2.63E-08	9.19E-10	1.03E-06

TABLE 2.1

INGESTION DOSE FACTORS FOR CHILD
(MREM PER PCI INGESTED)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
TC101	1.07E-09	1.12E-09	1.42E-08	NO DATA	1.01E-08	5.92E-10	3.56E-09
RU103	7.31E-07	NO DATA	2.81E-07	NO DATA	1.84E-06	NO DATA	1.89E-05
RU105	6.45E-08	NO DATA	2.34E-08	NO DATA	5.67E-07	NO DATA	4.21E-05
RU106	1.17E-05	NO DATA	1.46E-06	NO DATA	1.58E-05	NO DATA	1.82E-04
AG110m	5.39E-07	3.64E-07	2.91E-07	NO DATA	6.78E-07	NO DATA	4.33E-05
TE125m	1.14E-05	3.09E-06	1.52E-06	3.20E-06	NO DATA	NO DATA	1.10E-05
TE127m	2.89E-05	7.78E-06	3.43E-06	6.91E-06	8.24E-05	NO DATA	2.34E-05
TE127	4.71E-07	1.27E-07	1.01E-07	3.26E-07	1.34E-06	NO DATA	1.84E-05
TE129m	4.87E-05	1.36E-05	7.56E-06	1.57E-05	1.43E-04	NO DATA	5.94E-05
TE129	1.34E-07	3.74E-08	3.18E-08	9.56E-08	3.92E-07	NO DATA	8.34E-06
TE131m	7.20E-06	2.49E-06	2.65E-06	5.12E-06	2.41E-05	NO DATA	1.01E-04
TE131	8.30E-08	2.53E-08	2.47E-08	6.35E-08	2.51E-07	NO DATA	4.36E-07
TE132	1.01E-05	4.47E-06	5.40E-06	6.51E-06	4.15E-05	NO DATA	4.50E-05
I 130	2.92E-06	5.90E-06	3.04E-06	6.50E-04	8.82E-06	NO DATA	2.76E-06
I 131	1.72E-05	1.73E-05	9.83E-06	5.72E-03	2.84E-05	NO DATA	1.54E-06
I 132	8.00E-07	1.47E-06	6.76E-07	6.82E-05	2.25E-06	NO DATA	1.73E-06
I 133	5.92E-06	7.32E-06	2.77E-06	1.36E-03	1.22E-05	NO DATA	2.95E-06
I 134	4.19E-07	7.78E-07	3.58E-07	1.79E-05	1.19E-06	NO DATA	5.16E-07
I 135	1.75E-06	3.15E-06	1.49E-06	2.79E-04	4.83E-06	NO DATA	2.40E-06
CS134	2.34E-04	3.84E-04	8.10E-05	NO DATA	1.19E-04	4.27E-05	2.07E-06
CS136	2.35E-05	6.46E-05	4.18E-05	NO DATA	3.44E-05	5.13E-06	2.27E-06
CS137	3.27E-04	3.13E-04	4.62E-05	NO DATA	1.02E-04	3.67E-05	1.96E-06
CS138	2.28E-07	3.17E-07	2.01E-07	NO DATA	2.23E-07	2.40E-08	1.46E-07
BA139	4.14E-07	2.21E-10	1.20E-08	NO DATA	1.93E-10	1.30E-10	2.39E-05
BA140	8.31E-05	7.28E-08	4.85E-06	NO DATA	2.37E-08	4.34E-08	4.21E-05
BA141	2.00E-07	1.12E-10	6.51E-09	NO DATA	9.69E-11	6.58E-10	1.14E-07
BA142	8.74E-08	6.29E-11	4.88E-09	NO DATA	5.09E-11	3.70E-11	1.14E-09
LA140	1.01E-08	3.53E-09	1.10E-09	NO DATA	NO DATA	NO DATA	9.84E-05
LA142	5.24E-10	1.67E-10	5.23E-11	NO DATA	NO DATA	NO DATA	3.31E-05
CE141	3.97E-08	1.98E-08	2.94E-09	NO DATA	8.68E-09	NO DATA	2.47E-05
CE143	6.99E-09	3.79E-06	5.49E-10	NO DATA	1.59E-09	NO DATA	5.55E-05
CE144	2.08E-06	6.52E-07	1.11E-07	NO DATA	3.61E-07	NO DATA	1.70E-04
PR143	3.93E-08	1.18E-08	1.95E-09	NO DATA	6.39E-09	NO DATA	4.24E-05
PR144	1.29E-10	3.99E-11	6.49E-12	NO DATA	2.11E-11	NO DATA	8.59E-08
ND147	2.79E-08	2.26E-08	1.75E-09	NO DATA	1.24E-08	NO DATA	3.58E-05
W 187	4.29E-07	2.54E-07	1.14E-07	NO DATA	NO DATA	NO DATA	3.57E-05
NP239	5.25E-09	3.77E-10	2.65E-10	NO DATA	1.09E-09	NO DATA	2.79E-05

TABLE 2.1

INGESTION DOSE FACTORS FOR INFANT
(MREM PER PCI INGESTED)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	NO DATA	3.08E-07	3.08E-07	3.08E-07	3.08E-07	3.08E-07	3.08E-07
C 14	2.37E-05	5.06E-06	5.06E-06	5.06E-06	5.06E-06	5.06E-06	5.06E-06
NA 24	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05
P 32	1.70E-03	1.00E-04	6.59E-05	NO DATA	NO DATA	NO DATA	2.30E-05
CR 51	NO DATA	NO DATA	1.41E-08	9.20E-09	2.01E-09	1.79E-08	4.11E-07
MN 54	NO DATA	1.99E-05	4.51E-06	NO DATA	4.41E-06	NO DATA	7.31E-06
MN 56	NO DATA	8.18E-07	1.41E-07	NO DATA	7.03E-07	NO DATA	7.43E-05
FE 55	1.39E-05	8.98E-06	2.40E-06	NO DATA	NO DATA	4.39E-06	1.14E-06
FE 59	3.08E-05	5.38E-05	2.12E-05	NO DATA	NO DATA	1.59E-05	2.57E-05
CO 58	NO DATA	3.60E-06	8.93E-06	NO DATA	NO DATA	NO DATA	8.97E-06
CO 60	NO DATA	1.08E-05	2.55E-05	NO DATA	NO DATA	NO DATA	2.57E-05
NI 63	6.34E-04	3.92E-05	2.20E-05	NO DATA	NO DATA	NO DATA	1.95E-06
NI 65	4.70E-06	5.32E-07	2.42E-07	NO DATA	NO DATA	NO DATA	4.05E-05
CU 64	NO DATA	6.09E-07	2.82E-07	NO DATA	1.03E-06	NO DATA	1.25E-05
ZN 65	1.84E-05	6.31E-05	2.91E-05	NO DATA	3.06E-05	NO DATA	5.33E-05
ZN 69	9.33E-08	1.68E-07	1.25E-08	NO DATA	6.98E-08	NO DATA	1.37E-05
BR 83	NO DATA	NO DATA	3.63E-07	NO DATA	NO DATA	NO DATA	LT E-24
BR 84	NO DATA	NO DATA	3.82E-07	NO DATA	NO DATA	NO DATA	LT E-24
BR 85	NO DATA	NO DATA	1.94E-08	NO DATA	NO DATA	NO DATA	LT E-24
RB 86	NO DATA	1.70E-04	8.40E-05	NO DATA	NO DATA	NO DATA	4.35E-06
RB 88	NO DATA	4.98E-07	2.73E-07	NO DATA	NO DATA	NO DATA	4.85E-07
RB 89	NO DATA	2.86E-07	1.97E-07	NO DATA	NO DATA	NO DATA	9.74E-08
SR 89	2.51E-03	NO DATA	7.20E-05	NO DATA	NO DATA	NO DATA	5.16E-05
SR 90	1.85E-02	NO DATA	4.71E-03	NO DATA	NO DATA	NO DATA	2.31E-04
SR 91	5.00E-05	NO DATA	1.81E-06	NO DATA	NO DATA	NO DATA	5.92E-05
SR 92	1.92E-05	NO DATA	7.13E-07	NO DATA	NO DATA	NO DATA	2.07E-04
Y 90	8.69E-08	NO DATA	2.33E-09	NO DATA	NO DATA	NO DATA	1.20E-04
Y 91m	8.10E-10	NO DATA	2.76E-11	NO DATA	NO DATA	NO DATA	2.70E-06
Y 91	1.13E-06	NO DATA	3.01E-08	NO DATA	NO DATA	NO DATA	8.10E-05
Y 92	7.65E-09	NO DATA	2.15E-10	NO DATA	NO DATA	NO DATA	1.46E-04
Y 93	2.43E-08	NO DATA	6.62E-10	NO DATA	NO DATA	NO DATA	1.92E-04
ZR 95	2.06E-07	5.02E-08	3.56E-08	NO DATA	5.41E-08	NO DATA	2.50E-05
ZR 97	1.48E-08	2.54E-09	1.16E-09	NO DATA	2.56E-09	NO DATA	1.62E-04
NB 95	4.20E-08	1.73E-08	1.00E-08	NO DATA	1.24E-08	NO DATA	1.46E-05
MO 99	NO DATA	3.40E-05	6.63E-06	NO DATA	5.08E-05	NO DATA	1.12E-05
TC 99m	1.92E-09	3.96E-09	5.10E-08	NO DATA	4.26E-08	2.07E-09	1.15E-06

TABLE 2.1

INGESTION DOSE FACTORS FOR INFANT
(MREM PER PCI INGESTED)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
TC101	2.27E-09	2.86E-09	2.83E-08	NO DATA	3.40E-08	1.56E-09	4.86E-07
RU103	1.48E-06	NO DATA	4.95E-07	NO DATA	3.08E-06	NO DATA	1.80E-05
RU105	1.36E-07	NO DATA	4.58E-08	NO DATA	1.00E-06	NO DATA	5.41E-05
RU106	2.41E-05	NO DATA	3.01E-06	NO DATA	2.85E-05	NO DATA	1.83E-04
AG110m	9.96E-07	7.27E-07	4.81E-07	NO DATA	1.04E-06	NO DATA	3.77E-05
TE125m	2.33E-05	7.79E-06	3.15E-06	7.84E-06	NO DATA	NO DATA	1.11E-05
TE127m	5.58E-05	1.94E-05	7.08E-06	1.69E-05	1.44E-04	NO DATA	2.36E-05
TE127	1.00E-06	3.35E-07	2.15E-07	8.14E-07	2.44E-06	NO DATA	2.10E-05
TE129m	1.00E-04	3.43E-05	1.54E-05	3.84E-05	2.50E-04	NO DATA	5.97E-05
TE129	2.84E-07	9.79E-08	6.63E-08	2.38E-07	7.07E-07	NO DATA	2.27E-05
TE131m	1.52E-05	6.12E-06	5.05E-06	1.24E-05	4.21E-05	NO DATA	1.03E-04
TE131	1.76E-07	6.50E-08	4.94E-08	1.57E-07	4.50E-07	NO DATA	7.11E-06
TE132	2.08E-05	1.03E-05	9.61E-06	1.52E-05	6.44E-05	NO DATA	3.81E-05
I 130	6.00E-06	1.32E-05	5.30E-06	1.48E-03	1.45E-05	NO DATA	2.83E-06
I 131	3.59E-05	4.23E-05	1.86E-05	1.39E-02	4.94E-05	NO DATA	1.51E-06
I 132	1.66E-06	3.37E-06	1.20E-06	1.58E-04	3.76E-06	NO DATA	2.73E-06
I 133	1.25E-05	1.82E-05	5.33E-06	3.31E-03	2.14E-05	NO DATA	3.08E-06
I 134	8.69E-07	1.78E-06	6.33E-07	4.15E-05	1.99E-06	NO DATA	1.84E-06
I 135	3.64E-06	7.24E-06	2.64E-06	6.49E-04	8.07E-06	NO DATA	2.62E-06
CS134	3.77E-04	7.03E-04	7.10E-05	NO DATA	1.81E-04	7.42E-05	1.91E-06
CS136	4.59E-05	1.35E-04	5.04E-05	NO DATA	5.38E-05	1.10E-05	2.05E-06
CS137	5.22E-04	6.11E-04	4.33E-05	NO DATA	1.64E-04	6.64E-05	1.91E-06
CS138	4.81E-07	7.82E-07	3.79E-07	NO DATA	3.90E-07	6.09E-08	1.25E-06
BA139	8.81E-07	5.84E-10	2.55E-08	NO DATA	3.51E-10	3.54E-10	5.58E-05
BA140	1.71E-04	1.71E-07	8.81E-06	NO DATA	4.06E-08	1.05E-07	4.20E-05
BA141	4.25E-07	2.91E-10	1.34E-08	NO DATA	1.75E-10	1.77E-10	5.19E-06
BA142	1.84E-07	1.53E-10	9.06E-09	NO DATA	8.81E-11	9.26E-11	7.59E-07
LA140	2.11E-08	8.32E-09	2.14E-09	NO DATA	NO DATA	NO DATA	9.77E-05
LA142	1.10E-09	4.04E-10	9.67E-11	NO DATA	NO DATA	NO DATA	6.86E-05
CE141	7.87E-08	4.80E-08	5.65E-09	NO DATA	1.48E-08	NO DATA	2.48E-05
CE143	1.48E-08	9.82E-06	1.12E-09	NO DATA	2.86E-09	NO DATA	5.73E-05
CE144	2.98E-06	1.22E-06	1.67E-07	NO DATA	4.93E-07	NO DATA	1.71E-04
PR143	8.13E-08	3.04E-08	4.03E-09	NO DATA	1.13E-08	NO DATA	4.29E-05
PR144	2.74E-10	1.06E-10	1.38E-11	NO DATA	3.84E-11	NO DATA	4.93E-06
ND147	5.53E-08	5.68E-08	3.48E-09	NO DATA	2.19E-08	NO DATA	3.60E-05
W 187	9.03E-07	6.28E-07	2.17E-07	NO DATA	NO DATA	NO DATA	3.69E-05
NP239	1.11E-08	9.93E-10	5.61E-10	NO DATA	1.98E-09	NO DATA	2.87E-05

Table 2.2

BIG ROCK POINT DESIGN OBJECTIVE ANNUAL QUANTITIES FOR LIQUID EFFLUENTS AS DETERMINED BY LADTAP

Design objective annual quantities for liquid effluents were calculated utilizing the computer code LADTAP, a program for calculating radiation exposure to man from routine releases of nuclear reactor liquid effluents (reference NUREG/CR-1276).

Input parameters used are as follows:

Pathway	Age Group	Usage	Dilution	Process Times (Hr)
Fish	Adult	21.0 kg/yr	15.0	24.0
	Teen	16.0	15.0	24.0
	Child	6.9	15.0	24.0
	Infant	0.0	15.0	24.0
Drinking	Adult	730.0 L/yr	800.0	16.6
	Teen	510.0	800.0	16.6
	Child	510.0	800.0	16.6
	Infant	330.0	800.0	16.6
Shoreline	Adult	12.0 hr/yr	2.0	0.0
	Teen	67.0	2.0	0.0
	Child	14.0	2.0	0.0
	Infant	0.0	2.0	0.0
Swimming	Adult	12.0 hr/yr	2.0	0.0
	Teen	67.0	2.0	0.0
	Child	14.0	2.0	0.0
	Infant	0.0	2.0	0.0
Boating	Adult	100.0 hr/yr	15.0	0.0
	Teen	100.0	15.0	0.0
	Child	50.0	15.0	0.0
	Infant	0.0	15.0	0.0

The usage figures are obtained from Regulatory Guide 1.109 and are default values. Dilutions and the process time for drinking water were taken from the NUS study dated June 4, 1976. The minimum process times that can be utilized for fish and drinking are 24.0 hours and 12.0 hours respectively.

The federal limit to unrestricted areas for any individual through the liquid pathway is 3 mrem, total body, and 10 mrem to any organ (Reference Part 50, Appendix I).

The attached table lists the design quantities as calculated from LADTAP.

Table 2.2

BIG ROCK POINT DESIGN OBJECTIVE ANNUAL QUANTITIES FOR LIQUID EFFLUENTS AS DETERMINED BY LADTAP

The following input parameters are used when running LADTAP for BRP:

1. 50-mile population - 1.54E05
2. Shore width factor - 0.3
3. Total discharge (ft^3/sec) - 109
4. Transit time for all pathways - 4.6
5. Sport fish harvest (kg/yr) - 3.29E05
6. Commercial fish harvest (kg/yr) - 1.70E05
7. Invertebrate and algae consumption - 0
8. Drinking water population - 7.07E03
9. Shoreline population usage (man-hours) - 3.8E07
10. Swimming population usage (man-hours) - 1.2E07
11. Boating population usage (man-hours) - 3.7E07

Table 2.2

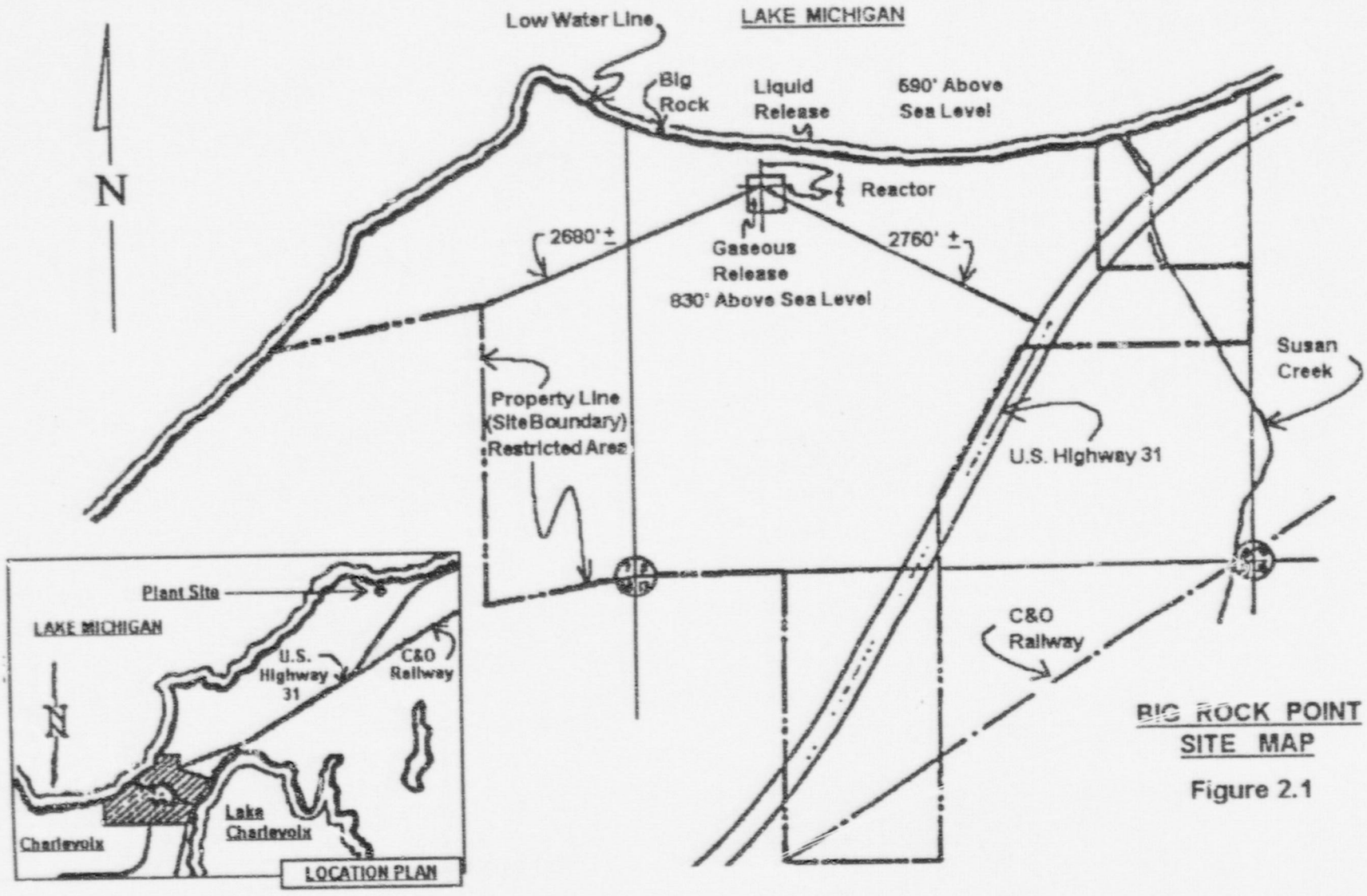
BIG ROCK POINT DESIGN OBJECTIVE ANNUAL QUANTITIES FOR LIQUID EFFLUENTS AS DETERMINED BY LADTAP

Nuclide	Dose Conversion Factors (mrem/Ci)	Individual/Organ	Design Objective Annual Quantity (Curies)
H-3	2.34E-06	Adult/TB	1.282×10^6
Na-24	3.95E-03	Teen/TB	759.49
Sc-46	1.24E-02	Teen/TB	241.94
Cr-51	1.90E-03	Adult/GI (LLI)	5,263.16
Mn-54	8.39E-02	Adult/GI (LLI)	119.19
Fe-55	5.50E-03	Child/Bone	1,818.18
Mn-56	1.22E-03	Teen/TB	2,459.02
Co-57	2.80E-03	Teen/TB	1,071.43
Co-58	6.95E-03	Teen/TB	431.66
Fe-59	4.93E-02	Adult/GI (LLI)	202.84
Co-60	2.90E-01	Teen/TB	10.34
Cu-64	1.48E-03	Teen/GI (LLI)	6,756.76
Ni-65	3.82E-04	Teen/TB	7,853.4
Zn-65	2.16E-01	Child/TB	13.89
Br-84	1.33E-03	Teen/TB	2,255.64
Rb-86	3.75E-01	Child/TB	8.0
Rb-88	4.54E-04	Teen/TB	6,607.93
Sr-89	1.93E-01	Child/Bone	51.81
Sr-90	3.34E+00	Adult/Bone	2.99
Sr-91	2.90E-03	Teen/GI (LLI)	3,448.28

Table 2.2

BIG ROCK POINT DESIGN OBJECTIVE ANNUAL QUANTITIES FOR LIQUID EFFLUENTS AS DETERMINED BY LADTAP

Nuclide	Dose Conversion Factors (mrem/Ci)	Individual/Organ	Design Objective Annual Quantity (Curies)
Sr-92	9.94E-04	Teen/TB	3,018.11
Y-92	1.76E-04	Teen/TB	17,045.5
Nb-95	8.88E+00	Adult/GI (LLI)	1.13
Zr-95	3.82E-03	Teen/TB	785.34
Nb-97	4.56E-04	Teen/TB	6,578.95
Zr-97	2.74E-03	Teen/GI (LLI)	3,649.64
Mo-99	1.31E-03	Teen/Kidney	7,633.59
Tc-99m	9.33E-05	Teen/TB	32,154.3
Ru-103	1.69E-03	Teen/TB	1,775.15
Ag-110m	4.76E-02	Teen/TB	63.03
Cd-113m	7.38E-02	Adult/GI (LLI)	135.50
Sb-124	9.34E-03	Teen/TB	321.20
Sb-125	3.13E-02	Teen/TB	95.85
Te-127	9.04E-03	Teen/GI (LLI)	1,106.19
Te-127m	1.71E-01	Teen/Kidney	58.48
Te-129m	3.27E-01	Adult/GI (LLI)	30.58
I-130	1.40E-02	Child/Thyroid	714.29
I-131	4.07E-01	Child/Thyroid	24.57
Te-131m	2.78E-01	Adult/GI (LLI)	35.97
I-132	1.95E-05	Teen/TB	1.538×10^5
Te-132	3.59E-01	Adult/GI (LLI)	27.86
I-133	4.85E-02	Child/Thyroid	206.19
Cs-134	3.49E+00	Adult/TB	0.8596
I-134	1.59E-03	Teen/TB	1,886.79
I-135	1.91E-03	Child/Thyroid	5,235.6
Cs-136	5.05E-01	Adult/TB	5.94
Cs-137	2.08E+00	Adult/TB	1.44
Cs-138	1.52E-03	Teen/TB	1,973.68
Ba-139	3.05E-05	Teen/TB	98,360.7
Ba-140	2.75E-03	Adult/GI (LLI)	3,636.36
La-140	2.27E-02	Adult/GI (LLI)	440.53
Ce-141	2.30E-04	Teen/TB	13,043.5
Ce-144	4.08E-03	Adult/GI (LLI)	2,450.98
Eu-152	1.99E-01	Teen/TB	15.08
W-187	2.43E-01	Adult/GI (LLI)	41.15
Np-239	2.78E-03	Adult/GI (LLI)	3,597.12



BIG ROCK POINT
SITE MAP

Figure 2.1

III. URANIUM FUEL CYCLE DOSE

III.A SPECIFICATION

In accordance with Technical Specification 13.1.6.1, if either liquid or gaseous quarterly releases exceed the quantity which would cause offsite doses more than twice the limit of Technical Specification 13.1.4, then the cumulative dose contributions from combined release plus direct radiation sources (from the reactor unit and radwaste storage tanks) shall be calculated. This calculation is performed to ensure that the annual (calendar year) dose or dose commitment to any member of the public is ≤25 mrem to the total body or any organ, except the thyroid, which shall be ≤75 mrem. The dose is to be determined for the member of the public projected to be the most highly exposed to these combined sources. If the results of this calculation show the dose to exceed either the 25 or 75 mrem limit, a special report shall be prepared and submitted to the Commission within 30 days, as described in Technical Specification 13.1.6.1.

III.B ASSUMPTIONS

III.B.1 The full time resident determined to be the maximally exposed individual (excluding infant) is assumed also to be a fisherman. This individual is assumed to drink water and ingest local fish at the rates specified in Sections II.C.4.1 and II.C.4.2.

III.B.2 Amount of shoreline fishing (at accessible shoreline adjacent to site security fence) is conservatively assumed as 48 hours per quarter (average of approximately 1/2 hour per day each day of the quarter) for the second and third quarters of the year, 36 hours for the fourth quarter and 18 hours for the first quarter.

III.B.3 The dose contribution due to uranium fuel cycle sources other than the plant is ignored in the calculation. This is based on the lack of any operations that fall in the "cycles" definition within a 5 mile radius of Big Rock Point.

III.C DOSE CALCULATION

Maximum doses to the total body and internal organs of an individual shall be determined by use of LADTAP and GASPAR computer codes, and doses to like organs and total body summed. Added to this sum will be a mean dose rate, calculated or measured for the shoreline due to plant presence during the quarter in question, times the assumed fishing time:

$$D_{40_i} = D_G + D_L + (R_T)(T) \qquad \text{(III.1)}$$

where:

D_{40_i} = 40 CFR 190 dose to organ (i) (mrem).

D_G = Cumulative dose to an individual organ from gaseous releases (mrem).

D_L = Cumulative dose to an individual organ from liquid releases (mrem).

R_T = Mean dose rate (direct radiation component) calculated to be applicable to Lake Michigan shoreline adjacent to plant site (mrem/hr).

T = Assumed shoreline fishing time for the quarter in question (hours) (see Section III.B.2).

NOTE: For this calculation, total body is considered as an organ.

APPENDIX A

DISCHARGE CANAL DREDGING COMMITMENTS AND REPORTING REQUIREMENTS

APPENDIX A
DISCHARGE CANAL DREDGING COMMITMENTS AND REPORTING REQUIREMENTS

I. COMMITMENTS AND REPORTING REQUIREMENTS

Commitments related to Discharge Canal Dredging are given in the CPCo December 29, 1989 Application for Disposal of Dredged Discharge Canal Sediment and in the NRC Safety Evaluation dated August 31, 1990.

I.A COMMITMENTS

I.A.1 Prior to dredging the canal, radionuclide concentrations and environmental exposure pathway doses must be evaluated in a manner equivalent to that described in the CPCo December 29, 1989 application.

This evaluation must include a comparison of resultant doses with the following NRC staff guidelines for onsite disposal:

1. The radioactive material should be disposed in a manner such that it is unlikely that material would be recycled.

2. Doses to the total body and any body organ of the maximally exposed individual (a member of the general public or a non-occupationally exposed worker) from the probable pathways of exposure to the disposed material should be less than 1 mrem/yr.

3. Doses to the total body and any body organ of an inadvertent intruder from the probable pathways of exposure should be less than 5 mrem/yr.

4. Doses to the total body and any body organ of an individual from assumed recycling of the disposed material at the time the disposal site is released from regulatory control from all likely pathways of exposure should be less than 1 mrem.

I.A.2 The dredging spoils will be thoroughly surveyed using a gamma-sensitive instrument prior to release for public use.

Release for public access will be contingent upon confirmation that post-disposal area dose rate has not increased above pre-disposal area background, as defined by criterion that pre- and post-disposal levels vary by not more than 25%. The value of 25% allows for temporal variations observed in monthly environmental TLD background data.

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I.A.3 Quality Control surveillance will be performed to ensure the dredge material is deposited in the location specified in the Dredging Permit and is graded accordingly.

I.A.4 Confirmatory measurements of the dredged materials will be recorded after the dredgings are land-spread.

I.B REPORTING REQUIREMENTS

I.B.1 If the NRC staff guidelines in I.A.1 cannot be met, a new application per 10 CFR 20.2002 must be submitted for the disposal.

I.B.2 Should the measurement of I.A.2 and I.A.4 indicate that the levels of radioactivity measured in the pre-operational (pre-dredging) sediment samples were significant underestimates (greater than 25%) of the actual radioactivity of the dredging spoils, CPCo will notify the NRC. The NRC will then reassess possible radiation doses and require appropriate remedial actions as appropriate.

II. PRE-DREDGING REQUIREMENTS

Mechanical dredging of Big Rock Point's Discharge Canal introduces a potential of re-releasing radionuclides absorbed on sediment to the environment in a manner not already accounted for in release records.

II.A Disposal of dredging spoils by relocation from the plant discharge canal to an unrestricted area onshore as specified by Corps of Engineers Permits Numbers 88-56-143 and 87-56-185 has been reviewed in the approved NRC Safety Evaluation dated August 31, 1990. If a new permit is to be used for dredging, review the permit requirements to ensure no unreviewed exposure pathway has been created.

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II.B Prior to dredging the canal, a minimum of 10 sediment samples should be collected. The distribution of the sample points should be representative of the area to be dredged. Sediment sample collection should be coordinated with plant operations to ensure there are no radioactive liquid batch releases during or within the 24 hours previous to sediment sampling.

II.B.1 The concentration and total activity of the material to be dredged will be determine for each isotope identified in the sediment samples. Results of semi-annual sediment samples taken from the canal discharge since the time of the previous canal dredging may be used to aid in evaluation of the sediment activity below the immediate surface.

II.B.2 These expected activity concentrations will be compared to the activities given in Table A-1 and will be used as the basis for comparison to the total exposures given in Table A-2.

II.C If any isotopes not listed above are present in the sediment samples, the dose contribution from these isotopes must be determined for all exposure pathways in a manner equivalent to the calculations used in the December 29, 1989 application which are outlined in Section V.

II.D The calculated doses will be compared to the NRC staff guidelines given in Section I.A.1. If any of these guidelines cannot be met, the disposal of the particular dredging will be deemed to be outside the scope of the 10 CFR 20.302 review already approved by the NRC in the Safety Evaluation dated August 31, 1990. In this event, a new application for disposal will be submitted to the NRC for this particular dredging or an alternative disposal method will be pursued.

II.E A pre-dredging survey of the disposal area should be provided no more than 10 days prior to dredging to provide a baseline for comparison to post-dredging survey.

II.F Dredging operations should be coordinated with plant operations to ensure no liquid batch releases within 24 hours prior to dredging and no liquid batch releases during the time period of the dredging.

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III. POST-DREDGING REQUIREMENTS

III.A A post-dredging survey of the area should be provided no more than 10 days after the spoils are land-spread. Should these measurements indicate the activity in the disposal area has increased greater than 25% of the pre-dredging activity, the NRC will be notified.

III.B Sediment samples will be analyzed and recorded as confirmatory measurements of the dredged materials after the dredgings are land-spread. Should these measurements indicate that the levels of radioactivity measured in the pre-operational (pre-dredging) sediment samples were significant underestimates (greater than 25%) of the actual radioactivity of the dredging spoils, the NRC will be notified. The NRC will reassess possible radiation doses and require remedial actions as appropriate.

IV. DOCUMENTATION REQUIREMENTS

Records of survey and sampling results shall be maintained until the NRC authorizes disposition.

V. EVALUATION OF THE RADIOLOGICAL IMPACTS OF SEDIMENT DISPOSAL

Potential dose pathways due to dredging and disposing of sediment from the BRP Discharge Canal include:

1. external dose from the sediment during dredging,
2. groundshine in the disposal area,
3. inhalation of re-suspended isotopes from dried sediment blown by the wind,
4. dose from assumed infiltration and contamination of groundwater, and
5. internal dose from ingestion of food grown on the disposal site.

The maximum dose to workers will be to those workers involved in grading the sediment in the disposal area during the dredging operations. The dose to these workers is determined as groundshine in the disposal area (exposure pathway 2).

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Dose from assumed infiltration and contamination of groundwater is of minimal concern in this case on the basis of location adjacent to Lake Michigan. There are no wells in either potential disposal area or between the disposal area and Lake Michigan (direction of groundwater flow). Exposure to the general public from activity released to Lake Michigan via this pathway is accounted for in Big Rock Point Semiannual Radioactive Effluent Release Reports based on data at the time of the original liquid radioactive releases from which the dredged activity is derived. The activity absorbed on the sediment removed from the canal and re-released to Lake Michigan via this pathway will not increase those original exposure estimates. Even though these doses have been accounted for previously, estimates due to potential radionuclide release from the spoils is included in radiological impact calculations.

Internal exposure from ingestion of food grown on the disposal site is not of concern due to lack of nutrient content within this washed stone/gravel/sand mixture. The disposal sites also are unprotected from harsh offshore winds. Cultivatable vegetation is not supported in either area.

Conservative calculations of external exposure during dredging, liquid pathways, groundshine in the disposal area, and inhalation of dried windblown sediment are detailed below.

V.A External Dose from the Sediment during Dredging and Groundshine in the Disposal Area

Assume the worker is exposed a total of 24 hours.

The disposal area may be part of a nature trail open to the public.

Assume time spent on the nature trial is half the average time spent for shoreline recreation (per Regulatory Guide 1.109).

Child 7 hr/yr
Teen 34 hr/yr
(this is taken as maximum public exposure time)
Adult 6 hr/yr

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It is reasonable to assume plant personnel using the trail for walks during work breaks also will frequent the area often.

t = 2 walks/day x .25 hr/walk x 5 days/week x 50 week/yr
t = 125 hr/yr

However; due to weather conditions, the trails will be accessible only 3 months per year.

t = 31 hr/yr (since this is not as long as the teen usage time calculated above, the 34 hours for teen exposure is used for dose to public.)

Using methods and parameters described in Regulatory Guide 1.109, the dose D_j^G (r, 0) to the worker is given as:

$$D_j^G (r, 0) = 24 \text{ hours SF} \sum_i C_i^G (r, 0) DFG_{ij}$$

Where C_i is in [pCi/m²]

DFG = open field groundplane dose conversion factor [mrem-m²/pCi hr].

Valves of DFG are given in ODCM Table 1.8.

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SF = Shielding Factors

The thickness of sediment graded out in the disposal area will range from 2 to 4 inches. Assuming the minimal shielding (ie, 2 inch thickness), there will be approximately 1 inch of sediment as shielding.

From American Institute of Steel Construction (AISC) Manual of Steel Construction 7th Edition

ρ dry sediment = 90 to 105 lb/ft^3 for excavated sand and gravel

dry and loose

taking ρ dry sediment as 98 lb/ft^3 => ρ = 1.57 g/cc

$(\mu/\rho)^{Co60}_{dry\ sediment}$ = 0.0578 cm^2/g

μ dry sediment = 1.57 g/cc x 0.578 cm^2/g

μ dry sediment = 9.07E-02 cm^{-1}

SF = $e^{-\mu x}$ = $e^{-9.07E-02/cm\ (2.54\ cm)}$

SF = 0.79

C_i = ground activity [pC_i/m^2]

= activity [pC_i/g] x ρ dry sediment [g/cc] x 10^6 cc/m^3 x thickness of layer (2" or 5.08E-02 m)

C_i [pC_i/m^2] = 7.98E+04 x activity [pC_i/g]

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Assuming dredging is performed annually and each year the new sediment is deposited and spread to 2" over the previous sediment, the groundshine exposure each year will increase as

$$\text{total } D_J^G \text{ year two} = D_J^G \text{ year one } Be^{-\lambda(1\ yr)}e^{-\mu(2")} + D_J^G \text{ year two}$$

$$\text{total } D_J^G \text{ year three} = D_J^G \text{ year one } Be^{-\lambda(2\ yr)}e^{-\mu(4")} + D_J^G \text{ year two } Be^{-\lambda(1\ yr)}e^{-\mu(2")} + D_J^G \text{ year three}$$

etc

But D_J^G year n = D_J^G year one

Therefore

$$\text{total } D_J^G \text{ year ten} = D_J^G \text{ year one } \sum_{n=1}^{10} e^{-\lambda(n-1)}\ e^{-\mu(2")(n-1)}\ B[2(n-1)\mu]$$

The accumulative dose each year will increase as

$$D_J^G \text{ year } x = \sum_{n=1}^{X} D_J^G \text{ year n}$$

$$B = \text{Buildup} = 1 + a\ (\mu X) + b\ (\mu X)^2 + c\ (\mu X)^3$$

Where for Mn54	a = 1.04	b = 0.21	c = 0
Co60	a = 0.78	b = 0.08	c = 0
Cs134	a = 1.07	b = 0.28	c = 0
Cs137	a = 1.07	b = 0.14	c = 0

Doses to the most exposed member of the public (teen exposed 34hrs/yr) are 34/24 = 1.42 times the worker doses.

Buildup factors for gamma emitters not listed above can be obtained using the Table A-3.

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V.B Inhalation of Re-Suspended Isotopes from Dried Sediment Blown by Wind

Using methodology of Regulatory Guide 1.109, the annual organ dose from inhalation of radionuclides in air is:

$$D^{A}_{ja}(r,0) = R_a \sum_{1} X_i (r,0)\, DFA_{ija}$$

Where DFA_{ija} = inhalation dose factor [mrem/pC_i]

Values of DFA given in ODCM Table 1.7.

Ra = annual intake for individual [m^3/yr]

Ra infant = 1400 m^3/yr
Ra child = 3700 m^3/yr
Ra teen, Ra adult = 8000 m^3/yr

X_i = annual average concentration of radionuclide in air [pC_i/m^3]

From Mark's Standard Handbook for Mechanical Engineers (pg. 18-12). The amount of suspended matter in normal city air = 1.37 mg/m^3 and the amount of suspended matter in manufacturing plant = 4.58 mg/m^3

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Using the value for suspended matter in normal city air would be conservative considering that fresh clean air blows off Lake Michigan across the disposal site to re-suspend isotopes from the dried sediment. Assuming a gentle breeze throughout the year since individuals would not remain in the area if higher winds blowing the sand were present. For added conservatism the value for suspended matter in a manufacturing plant is used.

The maximum time an individual would be in the area is 260 hours/yr as determined for fisherman by the discharge canal (RAE 81-53). Therefore the annual intake for each individual is reduced by the factor f.

$$f = \frac{260 hr/yr}{8760 hr/yr}$$

$$f = 0.03$$

Then,

$$X_i \ [pC_i/m^3] = 4.58 \ mg/m^3 \times .001 \ g/mg \times activity_i \ [pC_i/gm] \times .03$$

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V.C Dose from Infiltration and Contamination of Groundwater

There are no wells in or near the disposal sites.

Ground water flow is toward Lake Michigan at a rate of 0.05 ft/day (per FHSR).

The distance from the nearest edge of the west side disposal site (Permit Number 87-56-185) to Lake Michigan is ~14 ft.

The distance from the nearest edge of the east side disposal site (Permit Number 88-56-143) to Lake Michigan is 25 ft.

The retention time for radionuclides deposited at the west side disposal site is:

14 ft ÷ 0.05 ft/day = 280 days minimum

and for the east side disposal site is

25 ft ÷ 0.05 ft/day = 500 days minimum

In the interest of conservatism, we assume all the radionuclides from a single dredging will be released from the disposal area into Lake Michigan, 280 days after dredging.

Dose calculational methods from the Big Rock Point Radiological Effluents Technical Specifications Offsite Dose Calculations Manual (ODCM) for liquid effluents are used to determine the annual dose to individuals exposed via this pathway.

The total dose from this pathway is calculated in the 1989 10 CFR 20.302 Submittal, using the ratio of annual DBQ fraction representing activity of dredging to annual DBQ fraction representing total annual liquid release activity. This fraction is used to determine total exposure based on the annual liquid effluent exposure determined using the LADTAP code.

$$\text{Dose from dredging}^2 \quad \frac{\text{DBQ dredging}}{\text{DBA annual release}} \quad \text{annual liquid dose from LADTAP}$$

This method is conservative. A more accurate method to estimate dose from infiltration and contamination of ground water is provided in ODCM Section II C for all liquid exposure pathways.

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TABLE A-1: RADIOLOGICAL PROPERTIES OF SEDIMENT (pC_i/gm)

NUCLIDE	VARIATION (MIN) TO (MAX)	AVERAGE	VARIANCE(S)	TOTAL † ACTIVITY (mC_i)
Sr 90	0-0.108	0.015	0.032	0.001
Mn 65	0-1.996	0.202	0.312	0.147
Co 60	0-4.904	0.431	0.785	0.314
Cs 134	0-0.070	0.001	0.002	0.001
Cs 137	0.170-1.583	0.605	0.309	0.441
Gross Beta*	5.90-17.50	9.696	3.225	7.07

* Average Gross Beta at control sampling location (Ludington) = 8.19 with variance of 3.07 [pC_i/gm wet]. Therefore, no unidentified beta emitters present. Dose due to beta activity is taken into account in dose calculations for specific isotopes.

† Total Activity = Average Concentration (pC_i/gm wet) x max mass excavated (gm) x ($1mC_i/10^9\ pC_i$).

Assuming 500 cubic yards excavated with density of 119 lb/ft^3 (density of excavated sand, gravel wet = 118 to 120 lb/ft^3 per AISC Manual of Steel Construction 7th Edition)

Max mass excavated = 500 cu yard (27 ft^3/cu yard) 119 lb/ft^3 x

(453.592 g/lb) = 7.29E+08 gm.

These analyses include samples taken annually from 1985 through 1989 as part of Big Rock Point's Radiological Environmental Monitoring Program as well as ten (10) samples taken in June 1989 to ensure samples are representative of activity distributed throughout the canal. The results of these analyses provide a conservative estimate of the activity which may be contained in the sediment at the time of dredging. The total activity of the sediment is based on the average activity concentration encountered in surface samples (see Appendix 1).

APPENDIX A
DISCHARGE CANAL DREDGING COMMITMENTS
AND REPORTING REQUIREMENTS

TABLE A-2: RADIOLOGICAL IMPACT OF SEDIMENT DISPOSAL - SUMMARY OF VALUES CALCULATED IN APPENDIX 2

Exposure Pathway	Dose due to Single Dredging (mrem/yr)	Integrated Dose Due to Annual Dredging through 1998 (mrem)
External Dose to Sediment During Dredging (worker)	2.13E-02	5.83E-01
External Dose Due to Groundshine in the Disposal Area (public)	3.02E-02	8.27E-01
Internal Dose Due to Inhalation of Resuspended Isotopes	8.67E-04	8.67E-03
Dose from Assumed Infiltration and Contamination of Groundwater	3.33E-03	3.33E-02
Total Dose	5.57E-02 mrem* first year	1.44 mrem/10 yrs

* NOTE: The total dose is extremely conservative since no individual will receive the total dose from each pathway.

NRC did not include external dose to sediment during dredging (worker) in the totals approved in the Safety Evaluation dated August 31, 1990. Total doses to the general public of 3.57E-02 mrem/year and 8.57E-01 mrem/ten years were accepted.

APPENDIX A
DISCHARGE CANAL DREDGING COMMITMENTS
AND REPORTING REQUIREMENTS

TABLE A-3: BUILDUP FACTOR PARAMETERS

Average Gamma Energy (MeV)	PARAMETER		
	A	B	C
0.5	1.10	0.385	0
1.0	1.02	0.122	0
2.0	0.76	0.046	0
4.0	0.55	0.008	0
6.0	0.52	0.007	0
8.0	0.33	0.006	0
10.0	0.28	0.006	0

These valves are based on results from MLTobias, DRVondy, and MPLietzke; Nightmare Program; Oak Ridge National Laboratory, February 26, 1972. Parameter valves have been interpolated for concrete (z of material = 11).

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