Consumers Power Company
Big Rock Point Plant
Docket 50-155

BIG ROCK POINT NUCLEAR POWER PLANT
OFFSITE DOSE CALCULATION MANUAL

August 26 , 1985

TABLE OF CONTENTS

I. GASEOUS EFFLUENTS

A. ALARM/TRIP SETPOINT METHOD

Specification 13.1.3.1 requires that MPC is not exceeded when averaged over a period not to exceed 1 hour. Based on the definition of MPC, the dose rate in unrestricted areas due to gaseous effluents from the site shall be limited at all times 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 setpoints to ensure that offsite concentrations, when averaged over 1 hour, will not be greater than MPC. This section of the ODCM describes the methodology that will be used to determine these setpoints.

The methodology for determining alarm/trip setpoints 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.

1.0 Allowable Concentration

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

$$R_{(k)} = \left(\frac{X}{Q}\right) (F) \sum_{i_k} \frac{Ci}{MPC}_{k} = \leq 1.0 \qquad (I.1)$$

Ci = Concentration, at ambient temperature and pressure of nuclide i (μCi/cc)

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

$R_{(k)}$ = The total MPC-fraction for release point k

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.

2.0 Monitor Response

Normal radioactivity releases consist predominately of 30-minute decayed fission gasses. Therefore, stack monitor response calibrations are performed to fission gas typical of normal releases (30-minute decayed offgas). Air ejector offgas monitor measures only slightly decayed gasses, 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 $1/R_k$ (Equation 1.1) times the allowed 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 setpoints 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 R/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, setpoints are established as in 1) above.

B. DOSE RATE CALCULATION

1.0 The first step involves calculating a dose rate based on the design objective source term mix used in Appendix I licensing calculations. Recent meteorological data obtained from current meteorological monitoring instrumentation are used in this calculation. Doses are determined for (1) noble gases and (2) iodines and particulates. Dose rates as defined in this section are

in terms of 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.

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

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 73m.
6. Meteorological data expressed as joint-frequency distribution of wind speed, wind direction, and atmospheric stability for the period resulting in χ/Q's and D/Q's shown in Table 1.3.
7. Raw meteorological data consist of wind speed and direction measurements at 71m.
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.

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:

$$X_i = \sum_{j=1}^{9} \sum_{K=1}^{7} \left(\frac{2}{\pi}\right)^{1/2} \frac{f_{jk}\ Q_i\ p}{\Sigma_{zk}\ u_j\ (2\pi x/n)} \left[\exp\left(-\lambda_i \frac{x}{u_j}\right)\right]$$

$$X \quad \left[\exp\left(\frac{-h^2}{2\sigma_z{}^2}\right)\right] \qquad (I.3)$$

where:

X_i = Air concentration of radionuclide i, μCi/m³.

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, μCi/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.

For determining the total body dose rate:

$$D_{TB} = \sum_i X_i \, DFB_i \tag{I.4}$$

where:

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

X_i = Air concentration of radionuclide i, μCi/m³.

DFB_i = Total body dose factor due to gamma radiation, mrem/y per μCi/m³ (Table 1.5).

For determining the skin dose rate:

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

where:

D_s = Skin dose rate, mrem/y.

X_i = Air concentration of radionuclide i, μCi/m³.

DFS_i = Skin dose factor due to beta radiation, mrem/y per μCi/m³ (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 μCi/m³ (Table 1.5).

For determining dose rate to a point in air:

$$D_a = 3.17E\text{-}02 \sum_i X_i \; (DFY_i \text{ or } DFB_i) \qquad (I.6)$$

where:

D_a = Air dose rate mrem/yr

DFB - Air dose factor for beta radiation (Table 1.5)

3.17E-02 = Conversion from release/yr (Ci) to μCi/m³ divided by seconds/yr.

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

1.2.1 Assumptions

1. Dose is to be calculated for the critical organ, thyroid, and the critical age groups, 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.

4. Basic radionuclide data are given in Table 1.2.
5. All releases are treated as elevated (73m).
6. Annual average X/Q's are given in Table 1.3.
7. Raw meteorological data for elevated releases consist of wind speed and direction measurements at 71m.
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.
15. Credit is taken for shielding by residence (factor of 0.7).

1.2.2 Equations

To calculate the dose for any one of the potential maximum-exposure points, the equations of Sections 1.2.2.1 - 1.2.2.4 are used.

1.2.2.1 Inhalation

Equation for calculating air concentration, X, is the same as in the Noble Gas Section 1.1.2 (Equation 1.1).

For determining the organ dose rate:

$$D_I = 1x10^6 \sum_i X_i \; DFI_i \; BR \qquad (I.7)$$

where:

D_I = Organ dose rate 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 1400 m^3/y, infant; 5500 m^3/y, child; or 8400 m^3/y adult.

1×10^6 = pCi/µCi conversion factor.

1.2.2.2 Ground Contamination

For determining the ground concentration of any nuclide:

$$G_i = 3.15x10^7 \sum_{k=1}^{7} \frac{f_k \; Q_i \; DR}{(2\pi x/n) \; \lambda_i} \; [1-\exp -(\lambda_i \; t_b)] \quad \left[\exp\left(\frac{-h^2}{2\sigma^2_z}\right)\right] \qquad (I.8)$$

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, µCi/s.

DR = Relative deposition rate, m^{-2} (Table 1.3 for DR/2πX).

x = Downwind distance, m.

n = Number of sectors, 16.

2πx/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.

$3.15x10^7$ = s/y conversion factor.

h = Stack height (73m)

σ^2 = Vertical dispersion coefficient (m)

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

$$D_G = (8,760)(1\times10^6)(0.7) \sum_i G_i \, DFG_i \qquad (I.9)$$

where:

D_G = Dose rate 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.

1.2.2.3 Milk Ingestion

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

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

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 (73m)

σ_z = Vertical dispersion coefficient (m)

t_h = Hold-up time between harvest and consumption of food, 0 h for pasture grass or 2160 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, μCi/kg.

X_{14} = Air concentration of C-14, μCi/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:

$$CV_T = 1x10^3 \; X_T \; (0.75)(0.5/H) \qquad (I.10a)$$

where:

CV_T = Concentration of H-3 in vegetation, μCi/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.

$1x10^3$ = 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, μCi/l.

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

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

t_f = Transport time of activity from feed to milk to receptor, 2 days.

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

$$D = 1x10^6 \sum_i CM_i \; DF_i \; UM \qquad (I.13)$$

where:

D = Organ dose rate 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; for vegetables 26 kg/y (child), no ingestion by infant.

$1x10^6$ = pCi/μCi conversion factor.

1.2.2.4 Organ Dose Rates

For determining the total thyroid dose rate from iodines and particulates:

$$D = D_I + D_G + D_M + D_V \quad \text{(I.14)}$$

where:

D = Total organ dose rate, mrem/y.

D_I = Dose rate due to inhalation, mrem/y.

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

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

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

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 (Sec 1.2.2) are used to calculate design basis quantities as described in Section 1.3.

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:

a. 15 millirem to any organ of an individual from iodines and particulates.

b. 15 millirem to skin of an individual from noble gas.

c. 5 millirem to the total body of an individual from noble gas.

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):

$$DBQ = \frac{D_{AI}}{D_c} (C_c) \quad (I.15)$$

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.

The inverse of the ratio C_c/D_c in the above equation (i.e., D_c/C_c) is a useful value, since it represents the most limiting dose per unit quantity of each nuclide released. Use of the D_c/C_c ratio in quarterly evaluation of offsite dose is discussed in section D. Values of D_c/C_c are given in Table 1.9.

1.4 Land Use Census and DBQ Changes

Specifications 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

C. DESIGN OBJECTIVE QUANTITY (DBQ) LIMITS ON CONTINUOUS RELEASES

1.0 Continuous Releases

Low level continuous releases from the stack are totaled on a weekly basis and summed with any batch released for the week in order to establish the cumulative DBQ fraction from continuous releases for the year to date. The quantity of each nuclide identified is summed with the quantity of that nuclide released since the first of the current calendar year. The cumulative total for each nuclide (from Table 1.9) and the resultant fractions are summed in order to assure that the sum fraction of all nuclides does not exceed 1.0:

$$\sum_i \frac{Ai}{(DBQ)_i} < 1.0 \qquad (I.16)$$

the amount in any calendar quarter should not exceed 0.5. This is checked by subtracting the value obtained at the end of the previous quarter from the value obtained from the cumulative total to date, including the batch to be released.

2.0 Exceeding DBQ Limits

As discussed under B.1.3, the DBQ is a very conservative estimate of activity which could give doses at 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 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 GASPAR computer code or by analysis of appropriate release data via the segmented gaussian dose model used in emergency planning (inhalation dose, total body external dose, and boundary dose in air). See also Section D.1.2.

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 10 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.

4.0 Releasing Radionuclides Not Listed in Table 1.9

Table 1.9 contains all nuclides identified to date as routine constituents of gaseous releases at Palisades Plant, plus those

common to PWRs 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.

D. OPTIONAL QUARTERLY DOSE CALCULATIONS

1.0 Methodology for Optional Quarterly Dose Calculations

This option may be used in place of, or in addition to, the design basis quantity (DBQ) fraction calculation described by Equation 1.4. This optional conservative calculation relates the DBQ fraction to the doses from which it was originally derived. Use of this method may assist in identification of the critical dose pathway or characteristics of the assumed critical individual (infant, child, adult), since Table 1.9 indicates these parameters.

1.1 Simplified Conservative Approach

This method utilizes a limiting dose concept such that the limiting dose for each nuclide is summed with the limiting dose for each other nuclide, regardless if such sum is physically possible. It also assumes critical pathways, such as milk and vegetables, are in effect even in winter when the pathway is absent.

As such, the method is highly conservative and significantly overestimates dose. If limits appear to be exceeded by this method, Section D.1.2 (a concise method, but requiring computer support) will be utilized.

1.1.1 Assumptions

1. All assumptions of Section 1.1 are utilized.
2. Limiting doses for each gaseous nuclide are summed, regardless of limiting decay mode (gamma or beta).
3. Limiting doses for each particulate and iodine nuclide are summed, regardless of dose point location, exposure pathway or organ affected.
4. Doses are summed for detected nuclides such that all nuclides which contribute greater than 10% individually or 25% in aggregate, to the MPC of released radioactivity, are included in the dose calculation.

1.1.2 Equations

For determining gaseous effluent dose:

$$D_G = \sum_{o}^{i} A_{iG}(D_c/C_c)_{iG} \qquad (I.17)$$

D_G <5 millirad/quarter, 10 mrad/yr

where:

D_G = Dose from gaseous effluents (mrad).

A_{iG} = Quantity of gaseous nuclide i released (Ci).

$(D_c/C_c)_{iG}$ = Dose per Ci factor for gaseous nuclide i (mrad/Ci).

The limit for this mixture is conservatively taken as that for gamma exposure (5 mrem/quarter, 10 mrem/year) although as indicated in Table 1.9, a majority of the gaseous effluents are beta-limiting and on an individual basis have the higher limit of 10 millirem/quarter and 20 millirem/year.

For determining iodine and particulate dose to organs:

$$D_{PI} = \sum_{0}^{i} A_{PIi}(D_c/C_c)_{PIi} < 7.5 \text{ mrem/q, } 15 \text{ mrem/y} \quad \text{(I.18)}$$

where:

D_{PI} = Dose from particulates and iodines (mrem).

A_{PIi} = Quantity of particulate or iodine nuclide i released (Ci).

$(D_c/C_c)_{PIi}$ = Dose per Ci factor for particulate or iodine nuclide i (mrad/Ci).

1.2 Realistic Calculations

This methodology is to be used if the highly conservative calculations described in C.1.1, C.1.2 or D.1.0 yield values that appear to exceed applicable limits.

Doses for released particulates, iodines and noble gases will be determined 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.

E. GASEOUS RADWASTE TREATMENT SYSTEM OPERATION

1. System Description

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

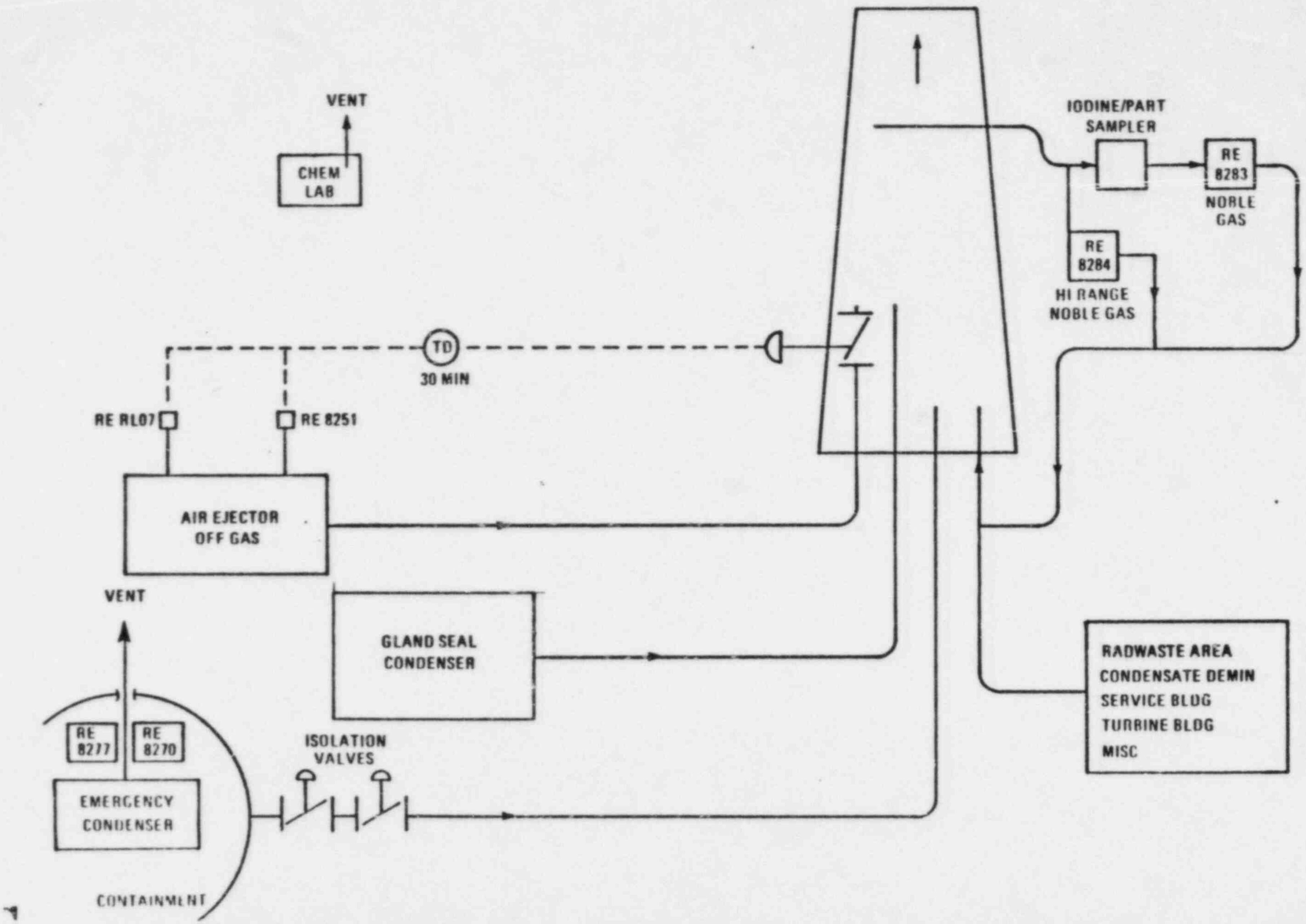
Condenser offgas represents more than 95% of the total gaseous source term. The other minor sources are gland seal condenser exhaust, containment ventillation, radwaste system vents and miscellaneous turbine building system leakage. All these sources are ducted to the stack for release.

2. Determination of Satisfactory Operations

Operability requirements for the gaseous waste treatment are not specified. This is because the delay line is an integral part of the release path piping for condenser offgas.

BIG ROCK POINT GASEOUS EFFLUENT FLOW PATHS

Figure 1-1



F. RELEASE RATE FOR OFFSITE MPC (500 mRem/yr)

10 CFR 20.106 requires radioactive effluent releases to unrestricted areas be in concentrations less than the limits specified in Appendix B, Table II when averaged over a period not to exceed one year. (Note: There are no unrestricted areas anywhere within the site boundary as defined by Figure 2.1.) Concentrations at this level if present for one year will result in a dose of 500 mrem due to external exposure or inhalation depending on the nuclide(s) released. 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 higher 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 operations 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 organ of the person assumed to be residing at the site boundary with highest X/Q, is (TBD) (for one year). The release rate which would result in a dose rate equivalent to 500 mrem/year (using the more conservative total body limit) is the Curies/year given in Table 1.1 multiplied by 500(TBD) or (TBD) Ci/sec.

G. 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 an 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.

H. NOBLE GAS SAMPLING

Condenser air ejector offgas 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 a LLD of 1E-06 μCi/cc.

I. 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
Ag-110m	1.57E-05	6.8[illegible]E-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)	BETA[1] (MEV/DIS)	GAMMA[1] (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	1.27E-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-[illegible]	1.24E-02	6.47E-04	2.06E 00	6.26E-01
25	RB-8[illegible]	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 (CON'T)

BASIC RADIONUCLIDE DATA

	NUCLIDE	HALF-LIFE (days)	LAMBDA (1/s)	BETA[1] (MEV/DIS)	GAMMA[1] (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

REMOVED

INTENTIONALLY

(Includes Pages 28-36)

TABLE 1.5

* DOSE FACTORS FOR SUBMERSION IN NOBLE GASES

	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. $1.17(+3) = 1.17 \times 10^3$

* 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).

TABLE 1.6

STABLE ELEMENT TRANSFER DATA

ELEMENT	F_m - MILK (COW)	F_m - MILK (GOAT)	F_f - MEAT	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	3.0E-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)
Page 1 of 3

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	NO DATA	4.62E-07	4.62E-07	4.62E-07	4.62E-07	4.62E-07	4.62E-07
C 14	1.89E-05	3.79E-06	3.79E-06	3.79E-06	3.79E-06	3.79E-06	3.79E-06
NA 24	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06
P 32	1.45E-03	8.03E-05	5.53E-05	NO DATA	NO DATA	NO DATA	1.15E-05
CR 51	NO DATA	NO DATA	6.39E-08	4.11E-08	9.45E-09	9.17E-06	2.55E-07
MN 54	NO DATA	1.81E-05	3.56E-06	NO DATA	3.56E-06	7.14E-04	5.04E-06
MN 56	NO DATA	1.10E-09	1.58E-10	NO DATA	7.86E-10	8.95E-06	5.12E-05
FE 55	1.41E-05	8.39E-06	2.38E-06	NO DATA	NO DATA	6.21E-05	7.82E-07
FE 59	9.69E-06	1.68E-05	6.77E-06	NO DATA	NO DATA	7.25E-04	1.77E-05
CO 58	NO DATA	8.71E-07	1.30E-06	NO DATA	NO DATA	5.55E-04	7.95E-06
CO 60	NO DATA	5.73E-06	8.41E-06	NO DATA	NO DATA	3.22E-03	2.28E-05
NI 63	2.42E-04	1.46E-05	8.29E-06	NO DATA	NO DATA	1.49E-04	1.73E-06
NI 65	1.71E-09	2.03E-10	8.79E-11	NO DATA	NO DATA	5.80E-06	3.58E-05
CU 64	NO DATA	1.34E-09	5.53E-10	NO DATA	2.84E-09	6.64E-06	1.07E-05
ZN 65	1.38E-05	4.47E-05	2.22E-05	NO DATA	2.32E-05	4.62E-04	3.67E-05
ZN 69	3.85E-11	6.91E-11	5.13E-12	NO DATA	2.87E-11	1.05E-06	9.44E-06
BR 83	NO DATA	NO DATA	2.72E-07	NO DATA	NO DATA	NO DATA	LT E-24
BR 84	NO DATA	NO DATA	2.86E-07	NO DATA	NO DATA	NO DATA	LT E-24
BR 85	NO DATA	NO DATA	1.46E-08	NO DATA	NO DATA	NO DATA	LT E-24
RB 86	NO DATA	1.36E-04	6.30E-05	NO DATA	NO DATA	NO DATA	2.17E-06
RB 88	NO DATA	3.98E-07	2.05E-07	NO DATA	NO DATA	NO DATA	2.42E-07
RB 89	NO DATA	2.29E-07	1.47E-07	NO DATA	NO DATA	NO DATA	4.87E-08
SR 89	2.84E-04	NO DATA	8.15E-06	NO DATA	NO DATA	1.45E-03	4.57E-05
SR 90	2.92E-02	NO DATA	1.85E-03	NO DATA	NO DATA	8.03E-03	9.36E-05
SR 91	6.83E-08	NO DATA	2.47E-09	NO DATA	NO DATA	3.76E-05	5.24E-05
SR 92	7.50E-09	NO DATA	2.79E-10	NO DATA	NO DATA	1.70E-05	1.00E-04
Y 90	2.35E-06	NO DATA	6.30E-08	NO DATA	NO DATA	1.92E-04	7.43E-05
Y 91m	2.91E-10	NO DATA	9.90E-12	NO DATA	NO DATA	1.99E-06	1.68E-06
Y 91	4.20E-04	NO DATA	1.12E-05	NO DATA	NO DATA	1.75E-03	5.02E-05
Y 92	1.17E-08	NO DATA	3.29E-10	NO DATA	NO DATA	1.75E-05	9.04E-05

TABLE 1.7 (CONT'D)

INHALATION DOSE FACTORS FOR INFANT
(MREM PER PCI INHALED)
Page 2 of 3

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
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
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	3.46E-05
RU106	6.20E-05	NO DATA	7.77E-06	NO DATA	7.61E-05	8.26E-03	1.17E-04
AG110m	7.13E-06	5.16E-06	3.57E-06	NO DATA	7.80E-06	2.62E-03	2.36E-05
TE125m	3.40E-06	1.42E-06	4.70E-07	1.16E-06	NO DATA	3.19E-04	9.22E-06
TE127m	1.19E-05	4.93E-06	1.48E-06	3.48E-06	2.68E-05	9.37E-04	1.95E-05
TE127	1.59E-09	6.81E-10	3.49E-10	1.32E-09	3.47E-09	7.39E-06	1.74E-05
TE129m	1.01E-05	4.35E-06	1.59E-06	3.91E-06	2.27E-05	1.20E-03	4.93E-05
TE129	5.63E-11	2.48E-11	1.34E-11	4.82E-11	1.25E-10	2.14E-06	1.88E-05
TE131m	7.62E-08	3.93E-08	2.59E-08	6.38E-08	1.89E-07	1.42E-04	8.51E-05
TE131	1.24E-11	5.87E-12	3.57E-12	1.13E-11	2.85E-11	1.47E-06	5.87E-06
TE132	2.66E-07	1.69E-07	1.26E-07	1.99E-07	7.39E-07	2.43E-04	3.15E-05
I 130	4.54E-06	9.91E-06	3.98E-06	1.14E-03	1.09E-05	NO DATA	1.42E-06
I 131	2.71E-05	3.17E-05	1.40E-05	1.06E-02	3.70E-05	NO DATA	7.56E-07
I 132	1.21E-06	2.53E-06	8.99E-07	1.21E-04	2.82E-06	NO DATA	1.36E-06
I 133	9.46E-06	1.37E-05	4.00E-06	2.54E-03	1.60E-05	NO DATA	1.54E-06
I 134	6.58E-07	1.34E-06	4.75E-07	3.18E-05	1.49E-06	NO DATA	9.21E-07
I 135	2.76E-06	5.43E-06	1.98E-06	4.97E-04	6.05E-06	NO DATA	1.31E-06
CS134	2.83E-04	5.02E-04	5.32E-05	NO DATA	1.36E-04	5.69E-05	9.53E-07
CS136	3.45E-05	9.61E-05	3.78E-05	NO DATA	4.03E-05	8.40E-06	1.02E-06
CS137	3.92E-04	4.37E-04	3.25E-05	NO DATA	1.23E-04	5.09E-05	9.53E-07
CS138	3.61E-07	5.58E-07	2.84E-07	NO DATA	2.93E-07	4.67E-08	6.26E-07
BA139	1.06E-09	7.03E-13	3.07E-11	NO DATA	4.23E-13	4.25E-06	3.64E-05

TABLE 1.7 (CONT'D)

INHALATION DOSE FACTORS FOR INFANT
(MREM PER PCI INHALED)
Page 3 of 3

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
BA140	4.00E-05	4.00E-08	2.07E-06	NO DATA	9.59E-09	1.14E-03	2.74E-05
BA141	1.12E-10	7.70E-14	3.55E-12	NO DATA	4.64E-14	2.12E-06	3.39E-06
BA142	2.84E-11	2.36E-14	1.40E-12	NO DATA	1.36E-14	1.11E-06	4.95E-07
LA140	3.61E-07	1.43E-07	3.68E-08	NO DATA	NO DATA	1.20E-04	6.06E-05
LA142	7.36E-10	2.69E-10	6.46E-11	NO DATA	NO DATA	5.87E-06	4.25E-05
CE141	1.98E-05	1.19E-05	1.42E-06	NO DATA	3.75E-06	3.69E-04	1.54E-05
CE143	2.09E-07	1.38E-07	1.58E-08	NO DATA	4.03E-08	8.30E-05	3.55E-05
CE144	2.28E-03	8.65E-04	1.26E-04	NO DATA	3.84E-04	7.03E-03	1.06E-04
PR143	1.00E-05	3.74E-06	4.99E-07	NO DATA	1.41E-06	3.09E-04	2.66E-05
PR144	3.42E-11	1.32E-11	1.72E-12	NO DATA	4.80E-12	1.15E-06	3.06E-06
ND147	5.67E-06	5.81E-06	3.57E-07	NO DATA	2.25E-06	2.30E-04	2.23E-05
W 187	9.26E-09	6.44E-09	2.23E-09	NO DATA	NO DATA	2.83E-05	2.54E-05
NP239	2.65E-07	2.37E-08	1.34E-08	NO DATA	4.73E-08	4.25E-05	1.78E-05

TABLE 1.7 (CON'T)

INHALATION DOSE FACTORS FOR CHILD
(MREM PER PCI INHALED)
Page 1 of 3

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	NO DATA	3.04E-07	3.04E-07	3.04E-07	3.04E-07	3.04E-07	3.04E-07
C 14	9.70E-06	1.82E-06	1.82E-06	1.82E-06	1.82E-06	1.82E-06	1.82E-06
NA 24	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06
P 32	7.04E-04	3.09E-05	2.67E-05	NO DATA	NO DATA	NO DATA	1.14E-05
CR 51	NO DATA	NO DATA	4.17E-08	2.31E-08	6.57E-09	4.59E-06	2.93E-07
MN 54	NO DATA	1.16E-05	2.57E-06	NO DATA	2.71E-06	4.26E-04	6.19E-06
MN 56	NO DATA	4.48E-10	8.43E-11	NO DATA	4.52E-10	3.55E-06	3.33E-05
FE 55	1.28E-05	6.80E-06	2.10E-06	NO DATA	NO DATA	3.00E-05	7.75E-07
FE 59	5.59E-06	9.04E-06	4.51E-06	NO DATA	NO DATA	3.43E-04	1.91E-05
CO 58	NO DATA	4.79E-07	8.55E-07	NO DATA	NO DATA	2.99E-04	9.29E-06
CO 60	NO DATA	3.55E-06	6.12E-06	NO DATA	NO DATA	1.91E-03	2.60E-05
NI 63	2.22E-04	1.25E-05	7.56E-06	NO DATA	NO DATA	7.43E-05	1.71E-06
NI 65	8.08E-10	7.99E-11	4.44E-11	NO DATA	NO DATA	2.21E-06	2.27E-05
CU 64	NO DATA	5.39E-10	2.90E-10	NO DATA	1.63E-09	2.59E-06	9.92E-06
ZN 65	1.15E-05	3.06E-05	1.90E-05	NO DATA	1.93E-05	2.69E-04	4.41E-06
ZN 69	1.81E-11	2.61E-11	2.41E-12	NO DATA	1.58E-11	3.84E-07	2.75E-06
BR 83	NO DATA	NO DATA	1.28E-07	NO DATA	NO DATA	NO DATA	LT E-24
BR 84	NO DATA	NO DATA	1.48E-07	NO DATA	NO DATA	NO DATA	LT E-24
BR 85	NO DATA	NO DATA	6.84E-09	NO DATA	NO DATA	NO DATA	LT E-24
RB 86	NO DATA	5.36E-05	3.09E-05	NO DATA	NO DATA	NO DATA	2.16E-06
RB 88	NO DATA	1.52E-07	9.90E-08	NO DATA	NO DATA	NO DATA	4.66E-09
RB 89	NO DATA	9.33E-08	7.85E-08	NO DATA	NO DATA	NO DATA	5.11E-10
SR 89	1.62E-04	NO DATA	4.66E-06	NO DATA	NO DATA	5.83E-04	4.52E-05
SR 90	2.73E-02	NO DATA	1.74E-03	NO DATA	NO DATA	3.99E-03	9.28E-05
SR 91	3.28E-08	NO DATA	1.24E-09	NO DATA	NO DATA	1.44E-05	4.70E-05
SR 92	3.54E-09	NO DATA	1.42E-10	NO DATA	NO DATA	6.49E-06	6.55E-05
Y 90	1.11E-06	NO DATA	2.99E-08	NO DATA	NO DATA	7.07E-05	7.24E-05
Y 91m	1.37E-10	NO DATA	4.98E-12	NO DATA	NO DATA	7.60E-07	4.64E-07
Y 91	2.47E-04	NO DATA	6.59E-06	NO DATA	NO DATA	7.10E-04	4.97E-05
Y 92	5.50E-09	NO DATA	1.57E-10	NO DATA	NO DATA	6.46E-06	6.46E-05

TABLE 1.7 (CONT'D)

INHALATION DOSE FACTORS FOR CHILD
(MREM PER PCI INHALED)
Page 2 of 3

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
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
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	1.65E-10	5.30E-10	1.91E-09	2.71E-06	1.52E-05
TE129m	5.19E-06	1.85E-06	8.22E-07	1.71E-06	1.36E-05	4.76E-04	4.91E-05
TE129	2.64E-11	9.45E-12	6.44E-12	1.93E-11	6.94E-11	7.93E-07	6.89E-06
TE131m	3.63E-08	1.60E-08	1.37E-08	2.64E-08	1.08E-07	5.56E-05	8.32E-05
TE131	5.87E-12	2.28E-12	1.78E-12	4.59E-12	1.59E-11	5.55E-07	3.60E-07
TE132	1.30E-07	7.36E-08	7.12E-08	8.58E-08	4.79E-07	1.02E-04	3.72E-05
I 130	2.21E-06	4.43E-06	2.28E-06	4.99E-04	6.61E-06	NO DATA	1.38E-06
I 131	1.30E-05	1.30E-05	7.37E-06	4.39E-03	2.13E-05	NO DATA	7.68E-07
I 132	5.72E-07	1.10E-06	5.07E-07	5.23E-05	1.69E-06	NO DATA	8.65E-07
I 133	4.48E-06	5.49E-06	2.08E-06	1.04E-03	9.13E-06	NO DATA	1.48E-06
I 134	3.17E-07	5.84E-07	2.69E-07	1.37E-05	8.92E-07	NO DATA	2.58E-07
I 135	1.33E-06	2.36E-06	1.12E-06	2.14E-04	3.62E-06	NO DATA	1.20E-06
CS134	1.76E-04	2.74E-04	6.07E-05	NO DATA	8.93E-05	3.27E-05	1.04E-06
CS136	1.76E-05	4.62E-05	3.14E-05	NO DATA	2.58E-05	3.93E-06	1.13E-06
CS137	2.45E-04	2.23E-04	3.47E-05	NO DATA	7.63E-05	2.81E-05	9.78E-07
CS138	1.71E-07	2.27E-07	1.50E-07	NO DATA	1.68E-07	1.84E-08	7.29E-08
BA139	4.98E-10	2.66E-13	1.45E-11	NO DATA	2.33E-13	1.56E-06	1.56E-05

TABLE 1.7 (CONT'D)

INHALATION DOSE FACTORS FOR CHILD
(MREM PER PCI INHALED)
Page 3 of 3

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
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 (CON'T)

INHALATION DOSE FACTORS FOR ADULTS
(MREM PER PCI INHALED)
Page 1 of 3

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	NO DATA	1.58E-07	1.58E-07	1.58E-07	1.58E-07	1.58E-07	1.58E-07
C 14	2.27E-06	4.26E-07	4.26E-07	4.26E-07	4.26E-07	4.26E-07	4.26E-07
NA 24	1.28E-06	1.28E-06	1.28E-06	1.28E-06	1.28E-06	1.28E-06	1.28E-06
P 32	1.65E-04	9.64E-06	6.26E-06	NO DATA	NO DATA	NO DATA	1.08E-05
CR 51	NO DATA	NO DATA	1.25E-08	7.44E-09	2.85E-09	1.80E-06	4.15E-07
MN 54	NO DATA	4.95E-06	7.87E-07	NO DATA	1.23E-06	1.75E-04	9.67E-06
MN 56	NO DATA	1.55E-10	2.29E-11	NO DATA	1.63E-10	1.18E-06	2.53E-06
FE 55	3.07E-06	2.12E-06	4.93E-07	NO DATA	NO DATA	9.01E-06	7.54E-07
FE 59	1.47E-06	3.47E-06	1.32E-06	NO DATA	NO DATA	1.27E-04	2.35E-05
CO 58	NO DATA	1.98E-07	2.59E-07	NO DATA	NO DATA	1.16E-04	1.33E-05
CO 60	NO DATA	1.44E-06	1.85E-06	NO DATA	NO DATA	7.46E-04	3.56E-05
NI 63	5.40E-05	3.93E-06	1.81E-06	NO DATA	NO DATA	2.23E-05	1.67E-06
NI 65	1.92E-10	2.62E-11	1.14E-11	NO DATA	NO DATA	7.00E-07	1.54E-06
CU 64	NO DATA	1.83E-10	7.69E-11	NO DATA	5.78E-10	8.48E-07	6.12E-06
ZN 65	4.05E-06	1.29E-05	5.82E-06	NO DATA	8.62E-06	1.08E-04	6.68E-06
ZN 69	4.23E-12	8.14E-12	5.65E-13	NO DATA	5.27E-12	1.15E-07	2.04E-09
BR 83	NO DATA	NO DATA	3.01E-08	NO DATA	NO DATA	NO DATA	2.90E-08
BR 84	NO DATA	NO DATA	3.91E-08	NO DATA	NO DATA	NO DATA	2.05E-[illegible]
BR 85	NO DATA	NO DATA	1.60E-09	NO DATA	NO DATA	NO DATA	LT E-24
RB 86	NO DATA	1.69E-05	7.37E-06	NO DATA	NO DATA	NO DATA	2.08E-06
RB 88	NO DATA	4.84E-08	2.41E-08	NO DATA	NO DATA	NO DATA	4.18E-19
RB 89	NO DATA	3.20E-08	2.12E-08	NO DATA	NO DATA	NO DATA	1.16E-21
SR 89	3.80E-05	NO DATA	1.09E-06	NO DATA	NO DATA	1.75E-04	4.37E-05
SR 90	1.24E-02	NO DATA	7.62E-04	NO DATA	NO DATA	1.20E-03	9.02E-05
SR 91	7.74E-09	NO DATA	3.13E-10	NO DATA	NO DATA	4.56E-06	2.39E-05
SR 92	8.43E-10	NO DATA	3.64E-11	NO DATA	NO DATA	2.06E-06	5.38E-06
Y 90	2.61E-07	NO DATA	7.01E-09	NO DATA	NO DATA	2.12E-05	6.32E-05
Y 91m	3.26E-11	NO DATA	1.27E-12	NO DATA	NO DATA	2.40E-07	1.66E-10
Y 91	5.78E-05	NO DATA	1.55E-06	NO DATA	NO DATA	2.13E-04	4.81E-05
Y 92	1.29E-09	NO DATA	3.77E-11	NO DATA	NO DATA	1.96E-06	9.19E-06

TABLE 1.7 (CONT'D)

INHALATION DOSE FACTORS FOR ADULTS
(MREM PER PCI INHALED)
Page 2 of 3

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
Y 93	1.18E-08	NO DATA	3.26E-10	NO DATA	NO DATA	6.06E-06	5.27E-05
ZR 95	1.34E-05	4.30E-06	2.91E-06	NO DATA	6.77E-06	2.21E-04	1.88E-05
ZR 97	1.21E-08	2.45E-09	1.13E-09	NO DATA	3.71E-09	9.84E-06	6.54E-05
NB 95	1.76E-06	9.77E-07	5.26E-07	NO DATA	9.67E-07	6.31E-05	1.30E-05
MO 99	NO DATA	1.51E-08	2.87E-09	NO DATA	3.64E-08	1.14E-05	3.10E-05
TC 99m	1.29E-13	3.64E-13	4.63E-12	NO DATA	5.52E-12	9.55E-08	5.20E-07
TC101	5.22E-15	7.52E-15	7.38E-14	NO DATA	1.35E-13	4.99E-08	1.36E-21
RU103	1.91E-07	NO DATA	8.23E-08	NO DATA	7.29E-07	6.31E-05	1.38E-05
RU105	9.88E-11	NO DATA	3.89E-11	NO DATA	1.27E-10	1.37E-06	6.02E-06
RU106	8.64E-06	NO DATA	1.09E-06	NO DATA	1.67E-05	1.17E-03	1.14E-04
AG110m	1.35E-06	1.25E-06	7.43E-07	NO DATA	2.46E-06	5.79E-04	3.78E-05
TE125m	4.27E-07	1.98E-07	5.84E-08	1.31E-07	1.55E-06	3.92E-05	8.83E-06
TE127m	1.58E-06	7.21E-07	1.96E-07	4.11E-07	5.72E-06	1.20E-04	1.87E-05
TE127	1.75E-10	8.03E-11	3.87E-11	1.32E-10	6.37E-10	8.14E-07	7.17E-06
TE129m	1.22E-06	5.84E-07	1.98E-07	4.30E-07	4.57E-06	1.45E-04	4.79E-05
TE129	6.22E-12	2.99E-12	1.55E-12	4.87E-12	2.34E-11	2.42E-07	1.96E-08
TE131m	8.74E-09	5.45E-09	3.63E-09	6.88E-09	3.86E-08	1.82E-05	6.95E-05
TE131	1.39E-12	7.44E-13	4.49E-13	1.17E-12	5.46E-12	1.74E-07	2.30E-09
TE132	3.25E-08	2.69E-08	2.02E-08	2.37E-08	1.82E-07	3.60E-05	6.37E-05
I 130	5.72E-07	1.68E-06	6.60E-07	1.42E-04	2.61E-06	NO DATA	9.61E-07
I 131	3.15E-06	4.47E-06	2.56E-06	1.49E-03	7.66E-06	NO DATA	7.85E-07
I 132	1.45E-07	4.07E-07	1.45E-07	1.43E-05	6.48E-07	NO DATA	5.08E-08
I 133	1.08E-06	1.85E-06	5.65E-07	2.69E-04	3.23E-06	NO DATA	1.11E-06
I 134	8.05E-08	2.16E-07	7.69E-08	3.73E-06	3.44E-07	NO DATA	1.26E-10
I 135	3.35E-07	8.73E-07	3.21E-07	5.60E-05	1.39E-06	NO DATA	6.56E-07
CS134	4.66E-05	1.06E-04	9.10E-05	NO DATA	3.59E-05	1.22E-05	1.30E-06
CS136	4.88E-06	1.83E-05	1.38E-05	NO DATA	1.07E-05	1.50E-06	1.46E-06
CS137	5.98E-05	7.76E-05	5.35E-05	NO DATA	2.78E-05	9.40E-06	1.05E-06
CS138	4.14E-08	7.76E-08	4.05E-08	NO DATA	6.00E-08	6.07E-09	2.33E-13
BA139	1.17E-10	8.32E-14	3.42E-12	NO DATA	7.78E-14	4.70E-07	1.12E-07

TABLE 1.7 (CONT'D)

INHALATION DOSE FACTORS FOR ADULTS
(MREM PER PCI INHALED)
Page 3 of 3

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
BA140	4.88E-06	6.13E-09	3.21E-07	NO DATA	2.09E-09	1.59E-04	2.73E-05
BA141	1.25E-11	9.41E-15	4.20E-13	NO DATA	8.75E-15	2.42E-07	1.45E-17
BA142	3.29E-12	3.38E-15	2.07E-13	NO DATA	2.86E-15	1.49E-07	1.96E-26
LA140	4.30E-08	2.17E-08	5.73E-09	NO DATA	NO DATA	1.70E-05	5.73E-05
LA142	8.54E-11	3.88E-11	9.65E-12	NO DATA	NO DATA	7.91E-07	2.64E-07
CE141	2.49E-06	1.69E-06	1.91E-07	NO DATA	7.83E-07	4.52E-05	1.50E-05
CE143	2.33E-08	1.72E-08	1.91E-09	NO DATA	7.60E-09	9.97E-06	2.83E-05
CE144	4.29E-04	1.79E-04	2.30E-05	NO DATA	1.06E-04	9.72E-04	1.02E-04
PR143	1.17E-06	4.69E-07	5.80E-08	NO DATA	2.70E-07	3.51E-05	2.50E-05
PR144	3.76E-12	1.56E-12	1.91E-13	NO DATA	8.81E-13	1.27E-07	2.69E-18
ND147	6.59E-07	7.62E-07	4.56E-08	NO DATA	4.45E-07	2.76E-05	2.16E-05
W 187	1.06E-09	8.85E-10	3.10E-10	NO DATA	NO DATA	3.63E-06	1.94E-05
NP239	2.87E-08	2.82E-09	1.55E-09	NO DATA	8.75E-09	4.70E-06	1.49E-05

TABLE 1.8

EXTERNAL DOSE FACTORS FOR STANDING ON CONTAMINATED GROUND

(mrem/hr per pci/m^2)

ELEMENT	TOTAL BODY	SKIN
H-3	0.0	0.0
C-14	0.0	0.0
Na-24	2.50E-08	2.90E-08
P-32	0.0	0.0
Cr-51	2.20E-10	2.60E-10
Mn-54	5.80E-09	6.80E-09
Mn-56	1.10E-08	1.30E-08
Fe-55	0.0	0.0
Fe-59	8.00E-09	9.40E-09
Co-58	7.00E-09	8.20E-09
Co-60	1.70E-08	2.00E-08
Ni-63	0.0	0.0
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

TABLE 1.8 (CON'T)

ELEMENT	TOTAL BODY	SKIN
Te-129m	7.70E-10	9.00E-10
Te-129	7.10E-10	8.40E-10
Te-131m	8.40E-09	9.90E-09
Te-131	2.20E-09	2.60E-06
Te-132	1.70E-09	2.00E-09
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

BIG ROCK POINT
1985 GASEOUS DESIGN OBJECTIVE ANNUAL QUANTITIES

Nuclide	Pathway-Site - Age*	Organ	Dc/Cc Dose Factor mrem/Ci	Design Objective Annual Quantity (Ci)
H-3	V-1-C	Total Body	6.76E-06	7.40E+05
N-13	M-2-I	Total Body	1.53E-51	3.27E+51
C-14	V-1-C	Bone	5.91E-03	2.54E+03
Na-24	M-2-I	Total Body	1.10E-04	4.55E+04
Ar-41	P-1-γ	Total Body	1.08E-05	4.63E+05
Cr-51	V-1-A&T	GI Tract	2.22E-04	6.76E+04
Mn-54	V-1-T	GI Tract	2.29E-02	6.55E+02
Fe-55	V-1-C	Bone	1.95E-02	7.69E+02
Mn-56	V-1-C	GI Tract	2.32E-08	6.47E+08
Co-57	V-1-T	GI Tract	8.02E-03	1.87E+03
Co-58	V-1-C	Total Body	4.76E-03	1.05E+03
Fe-59	V-1-T	GI Tract	2.27E-02	6.61E+02
Co-60	V-1-C	Total Body	2.84E-02	1.76E+02
Ni-65	V-1-C	GI Tract	1.03E-08	1.46E+09
Zn-65	M-2-I	Total Body	7.24E-02	6.91E+01
Br-82	M-2-I	Total Body	1.38E-03	3.62E+03
Kr-83m	P-1-β	Skin	2.61E-08	5.75E+08
Kr-85	P-1-β	Skin	2.36E-06	6.36E+06
Kr-85m	P-1-γ	Total Body	1.43E-06	3.50E+06
Kr-87	P-1-β	Skin	2.53E-05	5.93E+05
Kr-88	P-1-γ	Total Body	1.79E-05	2.79E+05
Rb-88	V-1-C	Total Body	2.07E-33	2.42E+33
Kr-89	P-1-γ	Total Body	2.03E-05	2.46E+05
Sr-89	V-1-C	Bone	8.57E-01	1.75E+01
Sr-90	V-1-C	Bone	3.52E+01	4.26E-01
Sr-91	V-1-A	GI Tract	1.28E-05	1.17E+06
Sr-92	V-1-C	GI Tract	1.18E-07	1.27E+08
Nb-95	B-3-A	GI Tract	4.41E-02	3.40E+02
Zr-95	V-1-T	GI Tract	3.00E-02	5.00E+02
Mo-99	M-2-I	Kidney	2.19E-03	6.85E+03
Tc-99m	M-2-I	GI Tract	1.16E-07	1.29E+08
Tc-101	V-1-C	Total Body	1.26E-40	3.97E+40
Ru-103	B-3-A	GI Tract	7.04E-02	2.13E+02
Ag-110m	M-2-T	GI Tract	1.91E-01	7.85E+01
Sb-124	V-1-T	GI Tract	7.30E-02	2.05E+02
Sb-125	V-1-T	GI Tract	4.12E-02	3.64E+02
Te-127	V-1-A	GI Tract	4.11E-06	3.65E+06
I-131	M-2-I	Thyroid	3.64E+00	4.12E+00
Xe-131m	P-1-β	Skin	1.04E-06	1.44E+07
I-132	V-1-C	Thyroid	3.34E-08	4.49E+08
I-133	M-2-I	Thyroid	3.37E-02	4.45E+02
Xe-133	P-1-γ	Total Body	3.59E-07	1.39E+07
Xe-133m	P-1-β	Skin	2.18E-06	6.88E+06
Cs-134	V-1-C	Liver	6.53E-01	2.30E+01
I-134	V-1-C	Thyroid	2.58E-14	5.81E+14
I-135	M-2-I	Thyroid	7.09E-05	2.12E+05
Xe-135	P-1-γ	Total Body	2.21E-06	2.26E+06
Xe-135m	P-1-γ	Total Body	3.81E-06	1.31E+06

Nuclide	Pathway-Site - Age*	Organ	Dose Factor mrem/Ci	Design Objective Annual Quantity (Ci)
Cs-136	M-2-I	Total Body	1.46E-02	3.42E+02
Cs-137	V-1-C	Bone	6.38E-01	2.35E+01
Xe-137	P-1-β	Skin	2.33E-05	6.44E+05
Cs-138	V-1-C	Total Body	4.32E-22	1.16E+22
Xe-138	P-1-γ	Total Body	1.08E-05	4.63E+05
Ba-139	V-1-C	GI Tract	2.38E-11	6.30E+11
Ba-140	V-1-C	Bone	4.32E-03	3.47E+03
La-140	V-1-A	GI Tract	6.41E-04	2.34E+04
Ce-141	V-1-T	GI Tract	1.19E-02	1.26E+03
Ce-144	V-1-T	GI Tract	3.17E-01	4.73E+01
Np-239	V-1-A	GI Tract	2.52E-04	5.95E+04

*Codes are as follow:

Pathways

V - Green leafy vegetable ingestion
P - Plume submersion
M - Milk ingestion
B - Beef Ingestion

Site locations

1 - Residence with garden, 1.4 mi, East sector
2 - Milk (cow), 2.5 miles, East sector
3 - Beef, 2.5 miles, East sector

Age Groups

A - Adult
T - Teen
C - Child
I - Infant
β - All ages, beta skin exposure
γ - All ages, gamma total body exposure

II. LIQUID EFFLUENTS

A. CONCENTRATION

1. RETS Requirement

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 Maximum Permissible Concentration (MPC) specified in 10 CFR 20, Appendix B, Table II, Column 2 for nuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the concentration shall be limited to 2×10^{-4} μCi/ml total activity. To ensure compliance, the following approach will be used for each release.

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.

$$C = \sum_{i=1}^{n} C_i \qquad (2.1)$$

where:

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

C_i = Concentration of a single radionuclide i, μCi/ml.

3. Total MPC-Fraction

The Total MPC-Fraction (R_j) for each release point will be calculated by the relationship defined by Note 1 of Appendix B, 10 CFR 20:

$$R_{(j)} = \sum_i \frac{C_i}{MPC_{i_i}} \qquad (2.2)$$

where:

C_i = Undiluted effluent concentration of radionuclide i, as determined in Section 2.1.2, μC/ml.

MPC_i = The MPC of radionuclide i, as specified in Section 2.1.1, μCi/ml.

R_j = The Total MPC-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:

$$f_1(R_1-1) + f_2(R_2-1) + f_3(R_3-1) \leq F \qquad (2.3)$$

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 MPC-Fractions for the respective releases as determined by Equation 2.2.

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

B. INSTRUMENT SETPOINTS

1. Setpoint Determination

The setpoint 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 setpoint 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.

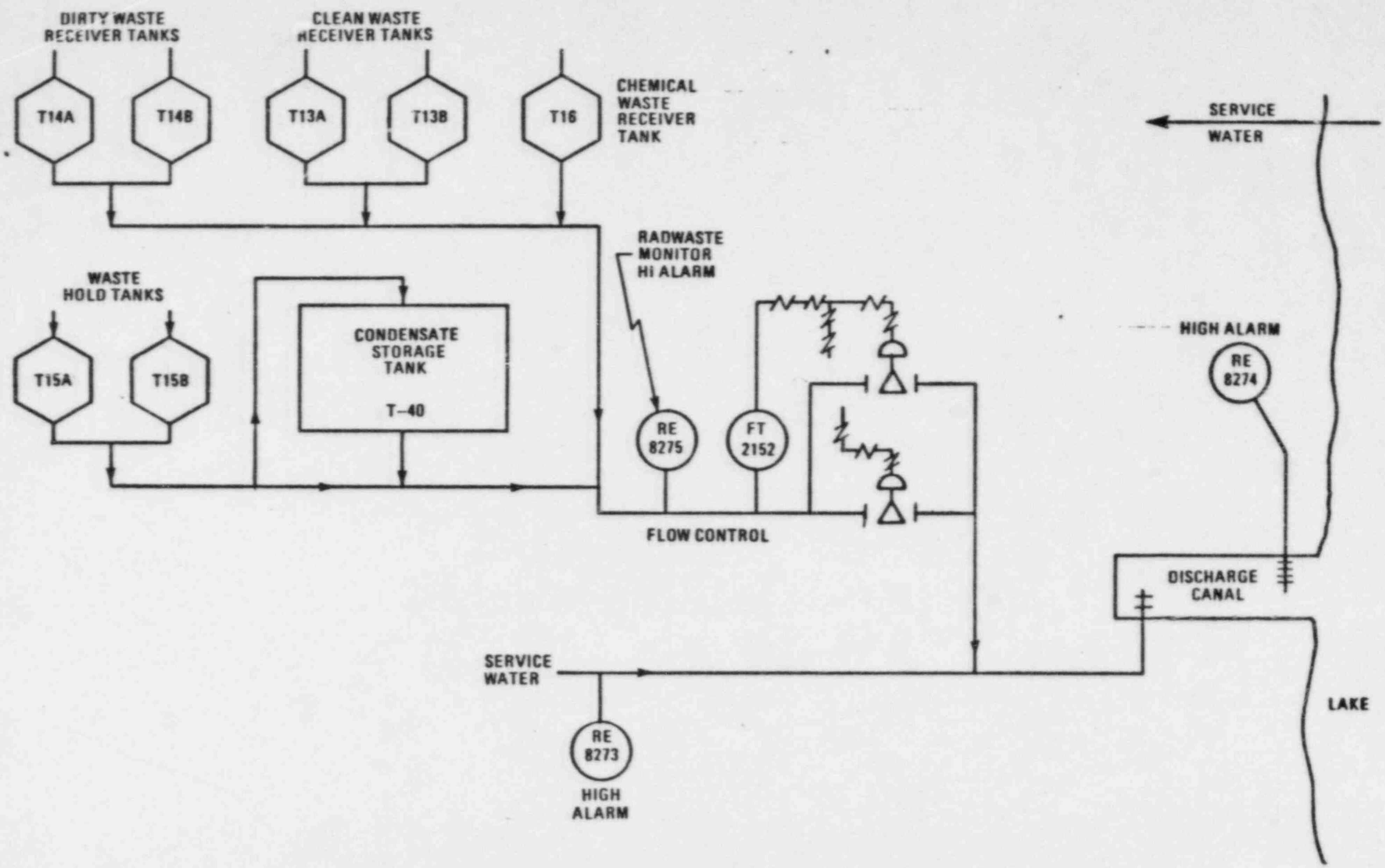
The respective alarm/trip setpoints at each release point will be set such that the sum of the ratios at each point, as calculated by Equation 2.2, will not be exceeded. The value of R is directly related to the total concentration calculated by Equation 2.1. An increase in the concentration would indicate an increase in the value of R. A large increase would cause the limits specified in Section 2.1.1 to be exceeded. The minimum alarm/trip setpoint value is equal to the release concentration, but for ease of operation it may be desired that the setpoint (S) be set above the effluent concentration (C) by the same factor (b) utilized in setting dilution flow. That is:

$$S = b \times C \qquad (2.4)$$

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

2. Post-Release Analysis

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



BIG ROCK POINT – LIQUID RELEASE FLOWS

A composite list of concentrations (C_i), by isotope, will be used with the actual liquid radwaste (f) and dilution (F) flow rates (or volumes) during the release. The data will be substituted into Equation 2.3 to demonstrate compliance with the limits in Section 1. This data and setpoints will be recorded in auditable records by plant personnel.

C. DOSE

1. RETS Requirement

Specification 13.1.4.1 the Radiological Effluent Technical Specification (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:

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

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

To ensure compliance, quantities of activity of each radionuclide released will be summed for each release and accumulated for each quarter as follows:

2. Release Analysis

Calculations shall be performed for each batch release, and weekly for continuous releases according to the formula:

$$\sum A_i/C_i \leq 0.5 \qquad (2.5)$$

where:

A_i = Cumulative quarterly activity of nuclide i identified in liquid release (Ci).

C_i = Design objective annual quantity of radionuclide i from Table 2.2.

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.

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 Palisades Plant technical specifications do not require monthly dose projections. Instead, if at any time, calculations by Equation (2.5) 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 Specification 13.1.4.1 has been met.

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:

2.1 Water Ingestion

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

$$D_j = \sum_{i=1}^{i} (DCF)_{ij} \times I_i \text{ rem} \qquad (2.6)$$

where:

- D_j = Dose for the j^{th} organ from radionuclides released, rem.
- j = The organ of interest.
- $(DCF)_{ij}$ = Adult 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 is described by:

$$I_i = \frac{(A_i)(V)(365)}{(800)(d)} \ \mu\text{Ci} \qquad (2.7)$$

where:

- 365 = Days per year.
- A_i = Annual activity released of i^{th} radionuclide, μCi.
- V = Average rate of water consumption (730 ml/d ICRP 23, p. 358).
- d = Dilution water flow for year (ml).
- 800 = Dispersion factor from discharge to nearest drinking water supply.

The dose equation then becomes:

$$D_j = \frac{333}{d} \sum_{i=1}^{i} (DCF)_{ij} \times A_i \text{ Rem} \qquad (2.8)$$

2.2 Fish Ingestion

The dose to an individual from the consumption of fish is described by Equation 2.13. In this case the activity ingested of the i^{th} radionuclide (I_i) is described by:

$$I_i = \frac{A_i \; B_i \; F}{15d} \; \mu Ci \qquad (2.9)$$

where:

- A_i = Annual 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 (21 kg).
- 15 = Dispersion factor from discharge to fish exposure point.
- d = Dilution water flow for year (ml).

Substitution of Equation 2.14 into Equation 2.11 gives:

$$D_j = \frac{1400}{d} \sum_{i=1}^{i} A_i \times B_i \times DCF_i \text{ Rem} \qquad (2.10)$$

3. 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:

$$D_j = \sum_{i=1}^{m} D_{ij} \text{ rem} \tag{2.11}$$

$$= \sum_{i=1}^{m} (DCF)_{ij} \times I_i \text{ rem} \tag{2.12}$$

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).
- $(DCF)_{ij}$ = Adult 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:

$$I_i = \frac{A_i V\tau}{\nu d} \ \mu\text{Ci} \tag{2.13}$$

and for fish ingestion I_i is described by:

$$I_i = \frac{A_i B_i F\tau}{\nu d} \ \mu\text{Ci} \tag{2.14}$$

where:

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

V = Average rate of water consumption (730 ml/d).

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

ν = Dispersion factor from point of discharge to point of exposure.

d = Dilution water volume (ml).

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

F = Amount of fish eaten per day (57.5 gm/d).

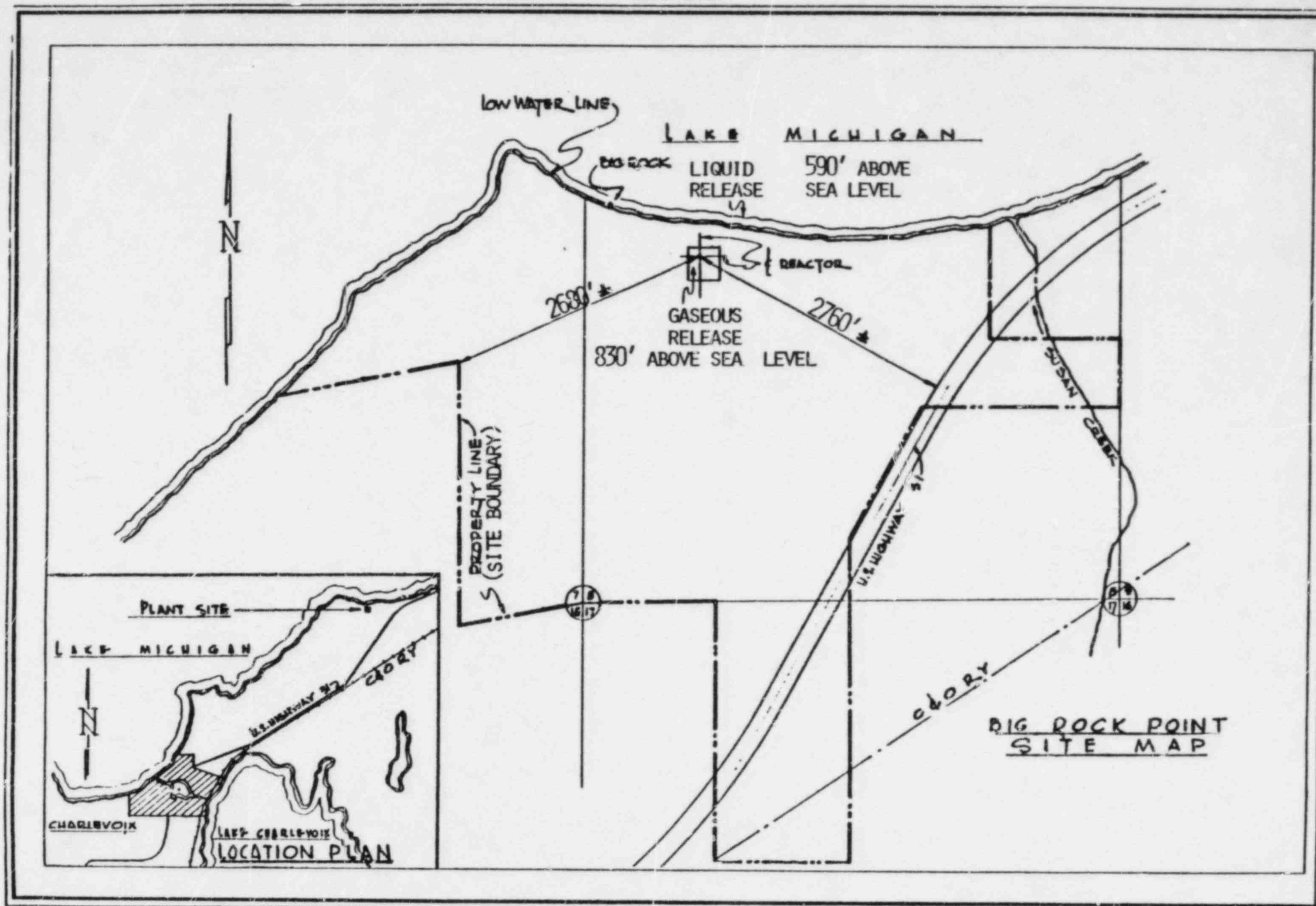
D. OPERABILITY OF LIQUID RADWASTE EQUIPMENT

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 Specification 13.1.4.1. Maintaining the cumulative fraction of allowable release for each batch release and weekly for continuous releases assures compliance with this requirement. In addition, 13 years of operating experience (to the date this ODCM was first adopted) has shown that design basis quantities never have been exceeded.

E. RELEASE RATE FOR OFFSITE MPC (500 mRem/yr)

10 CFR 20.106 requires radioactive effluent releases to unrestricted areas be less than the limits specified in Appendix B, Table II when averaged over a period not to exceed one year. Concentrations at this level, if ingested for one year, will result in a dose of 500 millirem to the total body or its equivalent to internal organs. In addition, 10 CFR 50.36a requires that the release of radioactive materials be kept as low as is reasonably achievable. However, the section further states that the licensee is permitted the flexibility

FIGURE 2.1


LOW WATER LINE
LAKE MICHIGAN
BIG ROCK
LIQUID RELEASE
590' ABOVE SEA LEVEL
REACTOR
2680' ±
2760' ±
GASEOUS RELEASE
830' ABOVE SEA LEVEL
PROPERTY LINE (SITE BOUNDARY)
SUSAN CREEK
U.S. HIGHWAY 31
PLANT SITE
LAKE MICHIGAN
LAKE CHARLEVOIX
CHARLEVOIX
LOCATION PLAN
BIG ROCK POINT SITE MAP

of operation, to assure a dependable source of power, to release quantities of material higher 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 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 (1,000 x nearest drinking water intake concentration). The source term used is given in Table 1.1. Dose to the most limiting organ of the person hypothetically drinking this water is (TBD) mrem. The release rate which would result in a dose rate equivalent to 500 mrem/year (using the more conservative total body limit) is the Curies/year given in Table 1.1 (TBD) times 500(TBD) or (TBD) Ci/yr = (TBD) Ci/sec.

III. URANIUM FUEL CYCLE DOSE

A. SPECIFICATION

In accordance with Specification 13.2.6.1 if either liquid or gaseous quarterly releases exceed the quantity which would cause offsite doses more than twice the limit of Specifications 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. The dose is to be determined for the member of the public projected to be the most highly exposed to these combined sources.

B. ASSUMPTIONS

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.2.1 and II C.2.2.

2. Amount of shoreline fishing (at accessible shoreline adjacent to site security fence) is conservatively assumed as 48 hours per quarter (average of approximately ½ 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.

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:

$$D_{40} = D_G + D_L + (R_T)(T) \quad (2.15)$$

where:

D_{40} = 40 CFR 190 Dose (mrem)

D_G = Limiting dose to an individual from gaseous source term (mrem)

D_L = Limiting dose to an individual from liquid source term (mrem)

R_T = Mean dose rate 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).

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE 2.0

BIOACCUMULATION FACTORS

(pCi/kg per pCi/liter)

ELEMENT	FRESHWATER FISH
H	9.0E-01
C	4.6E+03
NA	1.0E+02
P	1.0E+05
CR	2.0E+02
MN	4.0E+02
FE	1.0E+02
CO	5.0E+01
NI	1.0E+02
CU	5.0E+01
ZN	2.0E+03
BR	4.2E+02
RB	2.0E+03
SR	3.0E+01
Y	2.5E+01
ZR	3.3E+00
NB	3.0E+04
MO	1.0E+01
TC	1.5E+01
RU	1.0E+01
RH	1.0E+01
TE	4.0E+02
I	1.5E+01
CS	2.0E+03
BA	4.0E+00
LA	2.5E+01
CE	1.0E+00
PR	2.5E+01
ND	2.5E+01
W	1.2E+03
NP	1.0E+01

TABLE 2.1

ADULT INGESTION DOSE FACTORS
(MREM/PCI INGESTED)
Page 1 of 3

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

TABLE 2.1 (CONT'D)

ADULT INGESTION DOSE FACTORS
(MREM/PCI INGESTED)
Page 2 of 3

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
Y 93	2.68E-09	NO DATA	7.40E-11	NO DATA	NO DATA	NO DATA	8.50E-05
ZR 95	3.04E-08	9.75E-09	6.60E-09	NO DATA	1.53E-08	NO DATA	3.09E-05
ZR 97	1.68E-09	3.39E-10	1.55E-10	NO DATA	5.12E-10	NO DATA	1.05E-04
NB 95	6.22E-09	3.46E-09	1.86E-09	NO DATA	3.42E-09	NO DATA	2.10E-05
MO 99	NO DATA	4.31E-06	8.20E-07	NO DATA	9.76E-06	NO DATA	9.99E-06
TC 99m	2.47E-10	6.98E-10	8.89E-09	NO DATA	1.06E-08	3.42E-10	4.13E-07
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	[illegible].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

TABLE 2.1 (CONT'D)

ADULT INGESTION DOSE FACTORS
(MREM/PCI INGESTED)
Page 3 of 3

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
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 2.2

BIG ROCK POINT
Liquid Effluent

Design Objective Annual Quantity

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	1.69E+00	Adult/Bone	5.92
Sr-91	2.90E-03	Teen/GI (LLI)	3,448.28
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

TABLE 2.2 (Contd)

Design Objective Annual Quantity

Nuclide	Dose Conversion Factors (mrem/Ci)	Individual/Organ	Design Objective Annual Quantity (Curies)
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