CONSUMERS POWER COMPANY

PALISADES PLANT - 50-255

DRAFT OFFSITE DOSE CALCULATION MANUAL

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54 PAGES

1. Gaseous Effluents

1.1 Alarm/Trip Setpoints

Specification 3.11.2.1 requires that 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.

Specification 3.3.3.10 requires gaseous effluent monitors to have alarm/trip setpoints to ensure that the above dose rates are not exceeded. 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 backcalculating from a dose rate to a release rate limit, in μCi/s, for each nuclide and release point. The second consists of using the release rate limits to determine the physical settings on the monitors.

1.1.1 Release Rate Limit Methodology - μCi/s

Step 1

The first step involves calculating a dose rate based on the design objective source term mix used in Appendix I licensing calculations. Historical meteorological data used in licensing are also used in this calculation. Doses are determined for (1) noble gases and (2) iodines and particulates. Depending on the pathway involved, either air concentrations or ground concentrations are calculated.

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

Assumptions

1. Doses to be calculated are 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.
4. Basic radionuclide data are given in Table 1.2.
5. All releases are treated as ground-level.
6. Meteorological data are expressed as a joint-frequency distribution of wind speed, wind direction, and atmospheric stability for the period (Table 1.3).
7. Raw meteorological data consist of wind speed and direction measurements at 10m and temperature measurements at 10m and 50m.
8. Dose is to be evaluated at the offsite exposure point where maximum concentrations are expected to exist.
9. Potential maximum-exposure points are identified in Table 1.4.
10. A semi-infinite cloud model is used.
11. credit is taken for shielding by residence (factor of 0.7)
12. Plume depletion and radioactive decay are considered.
13. Building wake effects on effluent dispersion are considered.
14. A sector-average dispersion equation is used.
15. The wind speed classes that are used are as follows:

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Wind Speed Number	Range (m/s)	Midpoint (m/s)
1	<0.3	0.13
2	0.3-0.6	0.45
3	0.7-1.5	1.10
4	1.6-2.4	1.99
5	2.5-3.3	2.80
6	3.4-5.5	4.45
7	5.6-8.2	6.91
8	>10.9	13.00

16. 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.
17. Terrain effects are not considered.

Equations

To calculate the dose for any one of the 16 potential maximum-exposure points, the following equations are used.

For determining the air concentration of any radionuclide:

$$\chi_i = \sum_{j=1}^{9} \sum_{k=1}^{7} \left(\frac{2}{\pi}\right)^{1/2} \frac{f_{jk}\, Q_i\, P}{\Sigma_{zk}\, u_j\, (2\pi x/n)} \exp\left(-\lambda_i \frac{x}{u_j}\right) \qquad (1.1)$$

where

χ_i = air concentration of radionuclide i, uCi/m³.

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

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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 which includes a building wake adjustment, $\Sigma_{zk} = \left(\sigma_{zk}^2 + cA/\pi\right)^{1/2}$, where σ_{zk} is the vertical dispersion coefficient for stability class k (m), c is a building shape factor (c = 0.5), and A is the minimum building cross-sectional area (2200 m^2), 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

$$D_{TB} = \sum_i X_i \, DFB_i \qquad (1.2)$$

where

D_{TB} = total body dose rate, 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 rate

$$D_s = \sum_i X_i \left[DFS_i + 1.11 \, DF\gamma_i\right] \qquad (1.3)$$

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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.

$DF\gamma_i$ = gamma-to-air dose factor for radionuclide i, mrad/y per μCi/m³ (Table 1.5).

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

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 ground-level.
6. Annual average χ/Q's are given in Table 1.3.
7. Raw meteorological data for ground-level releases consist of wind speed and direction measurements at 10m and temperature measurements at 10m and 50m.
8. Dose is to be evaluated at the potential offsite exposure point where maximum doses to man are expected to exist.
9. Real 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.

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11. Terrain effects are not considered.
12. Building wake effects on effluent dispersion are considered.
13. Plume depletion and radioactive decay are considered for air-concentration calculations.
14. Radioactive decay is considered for ground-concentration calculations.
15. Deposition is calculated based on the curves given in Figure 1.1.
16. Milk cows and goats obtain 100% of their food from pasture grass May through October of each year.
17. Credit is taken for shielding by residence (factor of 0.7).

Equations

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

1. Inhalation -

   Equation for calculating air concentration, χ, is the same as in the Noble Gas Section, 1.1.1.A.

   For determining the organ dose rate:

$$D_I = 1\times10^6 \sum_i \chi_i \, DFI_i \, BR \qquad (1.4)$$

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where:

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

χ_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; 3700 m^3y, child; or 8000 m^3/y adult.

1×10^6 = pCi/μCi conversion factor.

2. Ground Contamination

For determining the ground concentration of any nuclide:

$$G_i = 3.15\times10^7 \sum_{k=1}^{7} \frac{f_k\, Q_i\, DR}{(2\pi x/n)\, \lambda_i} \left[1-\exp -(\lambda_i\, t_b)\right] \qquad (1.5)$$

where

G_i = ground concentration of radionuclide i, $\mu Ci/m^3$.

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^{-1} (Figure 1.1 for $DR/2\pi\chi$).

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, 35y.

3.15×10^7 = s/y conversion factor.

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

$$D_G = (8,760)(1\times10^6) \sum_i G_i \, DFG_i \qquad (1.6)$$

where:

D_G = l 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.

3. Milk Ingestion

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

$$CV_i = 3,600 \sum_{k=1}^{7} \frac{f_k \, Q_i \, DR}{(2\pi x/n)} \left(\frac{r[1-\exp(-\lambda_{Ei} t_e)]}{Y_v \lambda_{Ei}} + \frac{B_{iv}[1-\exp(-\lambda_i t_b)]}{P \lambda_i} \right) \qquad (1.7)$$

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 = relative deposition rate, m^{-2} (Figure 1.1).

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 1.9).

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.

For determining the concentration of C-14 in vegetation:

$$CV_{14} = 1\times10^3\ \chi_{14}\ (0.11/0.16) \qquad (1.8)$$

where

CV_{14} = concentration of C-14 in vegetation, μCi/kg.

χ_{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:

$$CV_T = 1x10^3 \chi_T (0.75)(0.5/H) \quad (1.9)$$

where

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

χ_T = air concentration of H-3, Ci/m³.

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/m³.

$1x10^3$ = g/kg conversion factor.

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

$$CM_i = CV_i \, FM_i \, Q_f \exp(-\lambda_i \, t_f) \quad (1.10)$$

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:

$$D = 1x10^6 \sum_i CM_i \, DF_i \quad UM \quad (1.11)$$

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where

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

CM_i = concentration of radionuclide i in vegetables or milk, µCi/Kg (or liters)

DFG_i = ingestion dose factor, mrem/pCi (Table 1.7).

UM = ingestion rate for milk, 330 l/y; for vegetables 26 Kg/yr (child), no ingestion by infant.

$1x10^6$ = pCi/µCi conversion factor.

4. Organ Dose Rates

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

$$D = D_I + D_G + D_M + D_v \quad (1.12)$$

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.

The maximum organ **dose rate**, maximum total body dose rate, and maximum skin dose rate calculated in this step will be used in step 2.

5. Design Basis Quantities

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

a) 20 millirad beta dose in air at ground level beyond the site boundary from noble gas

b) 10 millirad gamma dose in air at ground level beyond the site boundary from noble gas

c) 15 millirem to any organ of an individual from iodines and particulates

d) 15 millirem to skin of an individual from noble gas

) 5 millirem to the total body of an indivudual from noble gas

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Design basis quantities (Ci) are calculated by dividing the dose limits (a through e, above) by the appropriate dose calculated in step 1; the result then is multiplied by the amount of radionuclide (Ci) used to calculate the doses of step 1, as listed in Table 1.1:

$$DBQ = \frac{D_{AI}}{D_c} (C_c)$$

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) and

DBQ = Design Basis Quantity (Ci)

Design Basis Quantities for radionuclide 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 dose per unit quantity of each nuclide released. Use of the D_c/C_c ratio in monthly evaluation of offsite dose is discussed in section 1.2. Values of D_c/C_c are given in Table 1.9.

Step 2

The dose rate limits of interest for setpoints (10CFR20) are

Total body = 500 mrem/y

Skin = 3,000 mrem/y

Maximum Organ = 1,500 mrem/y

Dividing the above limits by the appropriate dose calculated in step 1 yields a useful ratio.

$$\frac{\text{Dose limit}}{\text{Dose step 1}} = R$$

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This ratio, R, represents how far above or below the guidelines the step 1 calculation 'as. Multiplying the original source term by R will give release rates that should correspond to the dose limits given above.

Appropriate release rate limits in μCi/s for each nuclide will be provided for use in establishing monitor setpoints. The setpoint for each gaseous effluent monitor is established using plant instructions. Release rate limit, principal gamma emitter, geometry and detector efficiency are combined to give an equivalent setpoint in counts per minute (cpm). An added safety facror is applied if necessary to account for radionuclides not detected by the monitor, variations in flow rates, or monitor background fluctuations. The physical and technical description, location and identification number for each gaseous radiation detector is contained in plant documentation.

1.2 Monthly Dose Calculations

Dose calculations will be performed monthly to determine compliance with specifications. These specifications require that the dose rate in unrestricted areas due to gaseous effluents from each reactor at the site shall be limited to the following values:

For noble gases,

1. During any calendar quarter, 5 mrad to air and 2.5 mrem to an individual for gamma radiation and 10 mrad to air and 7.5 millirem to skin of an individual for beta radiation.
2. During any calendar year, 10 mrad to air and 5 mrem to an individual for gamma radiation, 20 mrad to air and 15 millirem to skin of an individual for beta radiation.

For iodines and particulates,

1. During any calendar quarter, 7.5 mrem to any organ.
2. During any calendar year, 15 mrem to any organ.

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This section of the ODCM describes the methodology that will be used to perform these monthly calculations.

Doses will first be calculated by a simplified conservative approach (step 1). If these exceed the specification limits, more realistic calculations will be performed (step 2.)

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Step 1

Doses will be calculated using the methodology described in this step. The 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.

As such, the method is highly conservative and significantly overestimates dose. If limits appear to be exceeded by this method, step 2 (a concise method, but requiring computer support) will be performed.

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 released radioactivity, are included in the dose calculation.

Equations

For determining gaseous effluent dose:

$$D_G = \sum_{o}^{i} A_{iG}(D_c/C_c)_{iG} \quad < \text{ 5 millirad/quarter, 10 mrad/yr}$$

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.

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For determining iodine and particulate dose to organs:

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

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)

Step 2.

This methodology is to be used if the highly conservative calculations in step 1 yield doses that appear to exceed applicable limits.

Doses for released particulates, iodines and noble gasses will be determined by use of the NRC GASPAR computer code. The computer run will utilize the most recently compiled joint frequency meteorological data available for the appropriate interval (not less than a calendar quarter; normally an annual average) 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.

An alternative to GASPAR for offsite dose calculation is use of the Palisades Emergency Radiation Assessment System (ERAS) offsite dose calculation program. This system allows evaluation of dose under the actual meteorological conditions present at the time of release. It is anticipated that the system may be used if major short-term releases such as containment purges are to be made under conditions which depart significantly from mean annual conditions.

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1.3 Gaseous Radwaste Treatment System Operation

The gaseous radwaste treatment system (GRTS) described below shall be maintained and operated to keep releases ALARA.

1.3.1 System Description

A flow diagram for the GRTS is given in Figure   The system consists of three waste-gas compressor packages, six gas decay tanks, and the associated piping, valves, and instrumentation. Gaseous wastes are received from the following: degassing of the reactor coolant and purging of the volume control tank prior to a cold shutdown, displacing of cover gases caused by liquid accumulation in the tanks connected to the vent header, and boron recycle process operation.

1.3.2 Dose Calculations

Doses will be calculated monthly using the methodology described in Section 1.2 These doses will be used to ensure that the GRTS is operating as designed.

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2. Liquid Effluents

2.1 Concentration

2.1.1 RETS Requirement

Specification 3.9.2 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 10CFR20, 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.

2.1.2 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. 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.

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

where:

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

C_i = concentration of radionuclide i, µCi/ml.

2.1.3 MPC-Sum of the Ratios

The sum of the ratios (R_j) for each release point will be calculated by the following relationship.

$$R_j = \frac{C_A}{MPC_A} + \frac{C_B}{MPC_B} + \ldots + \frac{C_i}{MPC_i} \ldots + \frac{C_n}{MPC_n} \quad (2.2)$$

where:

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

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

R_j = the sum of the ratios for release point j.

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:

$$f_1(R_1-1) + f_2(R_2-1) + f_3(R_3-1) + f_4(R_4-1) \leq F \quad (2.3)$$

where:

f_1, f_2, f_3, f_4 = The effluent flow rate (gallons/minute) for the respective releases, determined by plant personnel.

R_1, R_2, R_3, R_4 = the sum of the ratios of the respective releases as determined by Equation 2.2.

F = minimum required dilution flow rate,

2.2 Instrument Setpoints

2.2.1 Setpoint Determination

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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 plant documentation.

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 R_j is directly related to the total concentration calculated by Equation 2.1. An increase in the concentration would indicate an increase in the respective R_j. 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_j). That is,

$$S_j = b_j \times C_j \quad (2.4)$$

Liquid effluent flow paths and release points are indicated in Figure 2.2.

2.2.2 Post-Release Analysis

A post-release analysis will be done using actual release data to ensure that the limits specified in Section 2.1.1 were not exceeded.

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 2.1.1. This data and setpoints will be recorded in auditable records by plant personnel.

2.3 Dose

2.3.1 RETS Requirement

Specification 3.9.1 of 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 2.2.) will not exceed:

a. During any calender 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:

2.3.2 Release Analysis

Calculations shall be performed for each batch release, and weekly for continuous releases according to the formula $\Sigma\ A_i/Ci \leq 0.5$

where A_i = cummulative quarterly activity of nuclide i identified in liquid release (Ci)

Ci = 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, 10CFR20.

Values for the design basis quantities (Ci), and the dose per Curie $(D_c/C_c)_{iL}$ for each nuclide i shown in Table 2.2 , were calculated as follows:

2.3.2.1 Water Ingestion

The dose to an individual from ingestion of water is described by the following equation.

$$D_j = \sum_{i=1}^{i} (DCF)_{ij} \times I_i \text{ rem} \qquad (2.11)$$

where:

D_j = dose for the j^{th} organ from radionuclides released rem.

j = the organ of interest (thyroid or total body).

DCF_{ij} = adult ingestion dose commitment factor for the j^{th} organ from the i^{th} radionuclide rem/µCi, see attached as Table 2.1.

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

I_i is described by

$$I_i = \frac{(A_i)(V)(365)}{1000d} \ \mu Ci \qquad (2.12)$$

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

1000 = dispersion factor from discharge to nearest drinking water supply.

The dose equation then becomes

$$D_j = \frac{266}{d} \sum_{i=1}^{i} (DCF)_{ij} \times A_i \text{ mrem} \qquad (2.13)$$

2.3.2.2 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 j^{th} radionuclide (I_i) is described by

$$I_i = \frac{A_i \ B_i \ F}{15d}, \ \mu Ci \qquad (2.14)$$

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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 day (57.5 gm)

15 = Dispersion factor from discharge to fish exposure point

d = dilution water flow, year to date (ml)

t = Days to date of release (to adjust F for period of calculation)

The dose equation then becomes:

$$Dg = \frac{3.8\ t}{d} \sum_{i=1}^{i} A_i \times B_i \times DCF_i \text{ mrem} \quad (2.15)$$

2.3.3 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 thyroid considered in the method of Section 2.3.2. The following approach is utilized in LADTAP. The dose to the j^{th} organ from m radionuclides, D_j, is described by

$$D_j = \sum_{i=1}^{m} D_{ij},\ \text{rem} \quad (2.16)$$

$$= \sum_{i=1}^{m} (DCF)_{ij} \times I_i,\ \text{rem} \quad (2.17)$$

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where:

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

j = the organ of interest (bone, GI tract, thyroid, 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

$$I_i = \frac{A_i V\tau}{\upsilon d}, \ \mu Ci \quad (2.18)$$

and for fish ingestion I_i is described by

$$I_i = \frac{A_i B_i F\tau}{\upsilon d}, \ \mu Ci \quad (2.19)$$

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)

υ = 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)

2.4 Operability of Liquid Radwaste Equipment

Specification 3.9.5 of the Radiological Effluent Technical Specifications requires that the liquid radwaste system be used to reduce the radioactive materials in liquid wastes prior to their discharge (by recycle or shipment for disposal) whenever liquid effluent releases to unrestricted areas (see Figure 2.1) would exceed Specification 3.9.1. Maintaining the cumulative fraction of allowable release for each batch release and weekly for continuous releases assures compliance with this requirement.

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Table 1.1 GASEOUS SOURCE TERMS

	PRIMARY COOLANT (MICROCI/GM)	SECONDARY COOLANT (MICROCI/GM)	GAS STRIPPING SHUTDOWN	GAS STRIPPING CONTINUOUS	BUILDING VENTILATION REACTOR	BUILDING VENTILATION AUXILIARY	BUILDING VENTILATION TURBINE	BLOWDOWN VENT OFFGAS	AIR EJECTOR EXHAUST	TOTAL
					GASEOUS RELEASE RATE - CURIES PER YEAR					
KR-83M	1.856E-02	6.635E-09	0.	0.	0.	0.	0.	0.	0.	0.
KR-85M	9.712E-02	3.539E-08	0.	0.	0.	2.0E+00	0.	0.	1.0E+00	3.0E+00
KR-85	8.374E-02	3.092E-08	3.6E+01	1.8E+02	5.3E+01	2.0E+00	0.	0.	1.0E+00	2.7E+02
KR-87	5.310E-02	1.831E-08	0.	0.	0.	1.0E+00	0.	0.	0.	1.0E+00
KR-88	1.768E-01	6.287E-08	0.	0.	0.	4.0E+00	0.	0.	2.0E+00	6.0E+00
KR-89	4.429E-03	1.604E-09	0.	0.	0.	0.	0.	0.	0.	0.
XE-131M	8.394E-02	3.061E-08	6.0E+00	2.4E+01	1.2E+01	2.0E+00	0.	0.	1.0E+00	4.5E+01
XE-133M	1.875E-01	6.834E-08	0.	0.	5.0E+00	4.0E+00	0.	0.	3.0E+00	1.2E+01
XE-133	1.471E+01	5.282E-06	1.1E+02	3.5E+02	9.8E+02	3.1E+02	0.	0.	1.9E+02	1.9E+03
XE-135M	1.151E-02	4.123E-09	0.	0.	0.	0.	0.	0.	0.	0.
XE-135	3.079E-01	1.103E-07	0.	0.	1.0E+00	7.0E+00	0.	0.	4.0E+00	1.2E+01
XE-137	7.973E-03	2.864E-09	0.	0.	0.	0.	0.	0.	0.	0.
XE-138	3.847E-02	1.374E-08	0.	0.	0.	0.	0.	0.	0.	0.
TOTAL NOBLE GASES										2.2E+03
I-131	3.734E-01	1.637E-04	0.	0.	9.6E-04	5.9E-02	8.9E-03	0.	3.7E-02	1.1E-01
I-133	4.468E-01	1.070E-04	0.	0.	5.7E-04	7.1E-02	5.8E-03	0.	4.4E-02	1.2E-01
TRITIUM GASEOUS RELEASE			530	CURIES/YR						

0. APPEARING IN THE TABLE INDICATES RELEASE IS LESS THAN 1.0 CI/YR FOR NOBLE GAS, 0.0001 CI/YR FOR I

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Table 1.1 (Continued)

AIRBORNE PARTICULATE RELEASE RATE-CURIES PER YEAR

NUCLIDE	WASTE GAS SYSTEM	BUILDING VENTILATION REACTOR	BUILDING VENTILATION AUXILIARY	TOTAL
MN-54	4.5E-05	2.1E-06	1.8E-04	2.3E-04
FE-59	1.5E-05	7.1E-07	6.0E-05	7.6E-05
CO-58	1.5E-04	7.1E-06	6.0E-04	7.6E-04
CO-60	7.0E-05	3.2E-06	2.7E-04	3.4E-04
SR-89	3.3E-06	1.6E-07	1.3E-05	1.6E-05
SR-90	6.0E-07	2.9E-08	2.4E-06	3.0E-06
CS-134	4.5E-05	2.1E-06	1.8E-04	2.3E-04
CS-137	7.5E-05	3.6E-06	3.0E-04	3.8E-04

C-14 8 Curies/yr

Ar-41 25 Curies/yr

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TABLE 1.2 BASIC RADIONUCLIDE DATA

NUCLIDE		HALF-LIFE (DAYS)	LAMDA (1/S)	T	C	BETA (MEV/DIS)	GAMMA (MEV/DIS)	WASH (1/S)
1 TRITIUM	101	4.49E 03	1.79E-09	2	1	5.68E-03	0.0	2.85E-07
2 C-14	604	2.09E 06	3.84E-12	2	1	5.17E-02	0.0	0.0
3 N-13	702	6.94E-03	1.16E-03	2	1	4.91E-01	1.02E 00	1.00E-02
4 O-19	804	3.26E-04	2.34E-02	2	1	1.02E 00	1.05E 00	1.00E-02
5 F-18	902	7.62E-02	1.05E-04	2	1	2.41E-01	4.66E-01	1.00E-04
6 NA-24	1104	6.33E-01	1.27E-05	5	1	5.55E-01	4.12E 00	1.00E-04
7 P-32	1504	1.43E 01	5.61E-07	5	1	6.94E-01	0.0	1.00E-04
8 AR-41	1805	7.63E-02	1.05E-04	2	1	3.63E-01	1.28E 00	0.0
9 CR-51	2405	2.78E 01	2.89E-07	5	1	3.75E-03	3.28E-02	1.00E-04
10 MN-54	2508	3.03E 02	2.65E-08	5	1	4.17E-03	8.30E-01	1.00E-04
11 MN-56	2509	1.07E-01	7.50E-05	5	1	7.95E-01	1.70E 00	1.00E-04
12 FE-59	2604	4.50E 01	1.78E-07	5	1	1.10E-01	1.19E 00	1.00E-04
13 CO-58	2706	7.13E 01	1.12E-07	5	1	2.05E-01	9.76E-01	1.00E-04
14 CO-60	2708	1.92E 03	4.18E-09	5	1	9.68E-02	2.50E 00	1.00E-04
15 ZN-69M	3007	5.75E-01	1.39E-05	5	1	0.0	4.15E 00	1.00E-04
16 ZN-69	3006	3.96E-02	2.03E-04	5	1	3.19E-01	0.0	1.00E-04
17 BR-84	3516	2.21E-02	3.63E-04	2	1	1.28E 00	1.68E 00	1.00E-04
18 BR-85	3518	2.08E-03	3.86E-03	2	2	1.04E 00	8.40E-01	1.00E-04
19 KR-85M	3611	1.83E-01	4.38E-05	1	2	2.53E-01	1.59E-01	1.00E-11
20 KR-85	3610	3.93E 03	2.04E-09	1	1	2.51E-01	2.21E-03	1.00E-11
21 KR-87	3612	5.28E-02	1.52E-04	1	1	1.32E 00	7.93E-01	1.00E-11
22 KR-88	3613	1.17E-01	6.86E-05	1	1	3.75E-01	1.96E 00	1.00E-11
23 KR-89	3614	2.21E-03	3.63E-03	1	1	1.23E 00	2.08E 00	1.00E-11
24 RB-88	3713	1.24E-02	6.47E-04	5	1	2.05E 00	6.60E-01	1.00E-04
25 RB-89	3714	1.07E-02	7.50E-04	5	1	0.0	2.40E 00	1.00E-04
26 SR-89	3808	5.20E 01	1.54E-07	5	1	5.73E-01	1.36E-04	2.67E-07
27 SR-90	3810	1.03E 04	7.79E-10	5	1	1.96E-01	0.0	2.67E-07
28 SR-91	3811	4.03E-01	1.99E-05	5	2	6.50E-01	6.95E-01	2.67E-07
29 SR-92	3812	1.13E-01	7.10E-05	5	1	1.95E-01	1.34E 00	2.67E-07
30 SR-93	3813	5.56E-03	1.44E-03	5	1	1.61E 00	6.28E-01	2.67E-07
31 Y-90	3916	2.67E 00	3.00E-06	5	1	9.36E-01	0.0	1.00E-04
32 Y-91M	3919	3.47E-02	2.31E-04	5	1	0.0	5.56E-01	1.00E-04
33 Y-91	3918	5.88E 01	1.36E-07	5	1	6.06E-01	3.61E-03	1.00E-04
34 Y-92	3920	1.47E-01	5.46E-05	5	1	1.44E 00	2.50E-01	1.00E-04
35 Y-93	3921	4.29E-01	1.87E-05	5	1	1.17E 00	8.94E-02	1.00E-04
36 ZR-95	4014	6.50E 01	1.23E-07	5	2	1.20E-01	7.35E-01	1.00E-04
37 NB-95M	4115	3.75E 00	2.14E-06	5	1	2.65E-01	5.47E-02	1.00E-04
38 NB-95	4114	3.50E 01	2.29E-07	5	1	4.50E-02	7.64E-01	1.00E-04
39 MO-99	4209	2.79E 00	2.87E-06	5	2	3.96E-01	1.62E-01	1.00E-04
40 TC-99M	4314	2.50E-01	3.21E-05	5	1	4.65E-03	1.43E-01	1.00E-04
41 TC-99	4313	7.74E 07	1.04E-13	5	1	8.38E-02	0.0	1.00E-04
42 TC-104	4320	1.25E-02	6.42E-04	5	1	0.0	0.0	1.00E-04
43 RU-106	4407	3.67E 02	2.19E-08	5	1	1.01E-02	0.0	1.00E-04
44 TE-132	5223	3.24E 00	2.48E-06	5	1	1.00E-01	2.05E-01	1.00E-04
45 I-129	5315	6.21E 09	1.29E-15	3	1	4.02E-02	3.77E-03	5.00E-06
46 I-131	5317	8.05E 00	9.96E-07	3	2	1.94E-01	3.81E-01	5.00E-06
47 MI-131	15317	8.05E 00	9.96E-07	4	2	1.94E-01	3.81E-01	5.00E-06
48 I-132	5318	9.58E-02	8.37E-05	3	1	5.14E-01	2.33E 00	5.00E-06
49 MI-132	15318	9.58E-02	8.37E-05	4	1	5.14E-01	2.33E 00	5.00E-06
50 I-133	5319	8.75E-01	9.17E-06	3	2	4.08E-01	6.10E-01	5.00E-06
51 MI-133	15319	8.75E-01	9.17E-06	4	2	4.08E-01	6.1[illegible]E-01	5.00E-06
52 I-134	5320	3.61E-02	2.22E-04	3	1	6.10E-01	2.59E 00	5.00E-06
53 MI-134	15320	3.61E-02	2.22E-04	4	1	6.10E-01	2.59E 00	5.00E-06
54 I-135	5321	2.79E-01	2.87E-05	3	2	3.68E-01	1.58E 00	5.00E-06
55 MI-135	15321	2.79E-01	2.87E-05	4	2	3.68E-01	1.58E 00	5.00E-06
56 XE-131M	5412	1.18E 01	6.80E-07	1	1	1.43E-01	2.01E-02	1.00E-11
57 XE-133M	5414	2.26E 00	3.55E-06	1	1	1.90E-01	4.16E-02	1.00E-11
58 XE-133	5413	5.27E 00	1.52E-06	1	1	1.35E-01	4.54E-02	1.00E-11
59 XE-135M	5416	1.08E-02	7.43E-04	1	1	9.50E-02	4.32E-01	1.00E-11
60 XE-135	5415	3.82E-01	2.09E-05	1	1	3.17E-01	2.47E-01	1.00E-11
61 XE-137	5417	2.71E-03	2.96E-03	1	1	1.64E 00	1.94E-01	1.00E-11
62 XE-138	5418	1.18E-02	6.80E-04	1	1	6.04E-01	1.18E 00	1.00E-11
63 CS-134	5510	7.48E 02	1.07E-08	5	1	1.57E-01	1.04E 00	1.00E-04
64 CS-135	5512	1.10E 09	7.29E-15	5	1	5.74E-02	0.0	1.00E-04
65 CS-136	5514	1.30E 01	6.17E-07	5	1	1.01E-01	2.20E 00	1.00E-04
66 CS-137	5515	1.10E 04	7.29E-10	5	1	2.52E-01	5.47E-01	1.00E-04
67 CS-138	5516	2.24E-02	3.58E-04	5	1	1.23E 00	2.30E 00	1.00E-04
68 BA-139	5615	5.78E-02	1.39E-04	5	1	6.54E-01	5.05E-02	1.00E-04
69 BA-140	5616	1.28E 01	6.27E-07	5	1	3.15E-01	1.59E-01	1.00E-04
70 LA-140	5715	1.68E 00	4.77E-06	5	1	5.40E-01	2.31E 00	1.00E-04
71 CE-144	5815	2.84E 02	2.82E-08	5	1	9.13E-02	3.24E-02	1.00E-04
72 PR-143	5912	1.38E 01	5.80E-07	5	1	3.14E-01	0.0	1.00E-04
73 PR-144	5913	1.20E-02	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table 1.3

PALISADES SITE
ANNUAL AVERAGE X/Q VALUES (sec/m^3)*
(9/1/73-8/31/74)

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WIND DIRECTION

Distance (m)	NNE	NE	ENE	E	ESE	SE	SSE	S
805	1.0-05	1.6-05	8.0-05	1.4-05	1.2-05	1.4-05	9.8-06	9.3-06
2414	1.2-06	1.8-06	9.9-07	1.5-06	1.4-06	1.6-06	1.1-06	1.0-06
4023	4.0-07	5.8-07	3.2-07	4.8-07	4.6-07	5.6-07	3.8-07	3.3-07
5633	2.0-07	2.8-07	1.6-07	2.4-07	2.3-07	2.9-07	1.9-07	1.7-07
7242	1.3-07	1.8-07	1.0-07	1.5-07	1.5-07	1.9-07	1.2-07	1.1-07
12070	5.2-08	7.2-08	4.1-08	5.9-08	6.1-08	7.9-08	5.0-08	4.4-08

*Wind direction is defined as the direction from which the wind flows. The sector affected will be offset 180°. X/Q values are abbreviated (e.g., 2.00 x 10^{-6} is written 2.00-06). X/Q values as presented are based on a straight-line airflow model with open terrain adjustment factors; plume depletion was not included.

Table 1.3 (Cont'd)

Distance (m)	SSW	SW	WSW	W	WNW	NW	NNW	N
805	3.9-06	7.1-06	6.6-06	1.2-05	8.3-06	1.1-05	9.9-06	8.8-06
2414	4.0-07	7.9-07	6.9-07	1.3-06	9.6-07	1.3-06	1.2-06	9.9-07
4023	1.3-07	2.6-07	2.2-07	4.4-07	3.3-07	4.6-07	4.0-07	3.2-07
5633	6.2-08	1.3-07	1.1-07	2.2-07	1.7-07	2.0-07	2.1-07	1.6-07
7242	3.9-08	8.3-08	7.1-08	1.5-07	1.1-07	1.6-07	1.4-07	1.0-07
12070	1.5-08	3.3-08	2.8-08	5.9-08	4.7-08	6.7-08	5.7-08	4.2-08

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MAXIMUM DOSE POINTS*

TABLE 1.4

Miles to the Nearest:

Sector	Residence	Meat Animal	Garden ≥ 500 Sq Ft	Milk Cows	Goats
NNE	1.2	None	1.70	None	2.60
NE	1.65	2.90	1.80	4.30	None
ENE	1.6	3.10	1.80	None	None
E	1.2	5.00	2.10	None	4.85
ESE	1.00	1.00	1.25	4.20	3.25
SE	1.2	2.10	1.40	4.20	None
SSE	0.9	5.3	1.80	5.30	None
S	0.63	5.10	1.40	None	3.20
SSW	0.7	None	4.90	None	None
SW	None	None	None	None	None
WSW	None	None	None	None	None
W	None	None	None	None	None
WNW	None	None	None	None	None
NW	None	None	None	None	None
N	None	None	None	None	None

Current Locations of Maximum Dose

No	Distance (Miles)	Location (Sector)	Description	Normal X/Q (s/m³)	Deposition D/Q (1/m²)
1	0.63	S	Residence	5.56(-6)	3.08(-8)
2	1.25	ESE	Garden	1.4 (-6)	9.6 (-9)
3	1.00	ESE	Meat Animal	2.13(-6)	1.49(-8)
4	2.6	NNE	Goat Milk	1.17(-7)	1.1 (-9)
5	4.2	SE	Milk Cow	1.78(-7)	7.2(-10)

* Example based on 3-12-79 submittal.

TABLE 1.5

DOSE FACTORS FOR SUBMERSION IN NOBLE GASES

	DFB[1]	DFγ[2]	DFS[1]	DFβ[2]
Kr-85m	1.17(+3)[3]	1.21(+3)	1.46(+3)	3.86(+3)
Kr-85	1.61(+1)	1.69(+1)	1.34(+3)	3.83(+3)
Kr-87	5.92(+3)	6.05(+3)	9.73(+3)	2.01(+4)
Kr-88	1.47(+4)	1.50(+4)	2.37(+3)	5.72(+3)
Kr-89	1.66(+4)	1.59(+4)	1.01(+4)	1.88(+4)
Xe-131m	9.15(+1)	1.53(+2)	4.76(+2)	2.18(+3)
Xe-133m	2.51(+2)	3.17(+2)	9.94(+2)	2.90(+3)
Xe-133	2.94(+2)	3.46(+2)	3.06(+2)	2.06(+3)
Xe-135m	3.12(+3)	3.30(+3)	7.11(+2)	1.45(+3)
Xe-135	1.81(+3)	1.88(+3)	1.86(+3)	4.84(+3)
Xe-137	1.42(+3)	1.48(+3)	1.22(+4)	2.50(+4)
Xe-138	8.83(+3)	9.00(+3)	4.13(+3)	9.25(+3)
Ar-41	8.84(+3)	9.76(+3)	2.69(+3)	5.54(+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.

TABLE 1.6

STABLE ELEMENT TRANSFER DATA

ELEMENT	F_m - MILK (COW)	F_m - MILK (GOAT)	F_f - MEAT
H	1.0E-02	1.7E-01	1.2E-02
C	1.2E-02	1.0E-01	3.1E-02
Na	4.0E-02	4.0E-02	3.0E-02
P	2.5E-02	2.5E-01	4.6E-02
Cr	2.2E-03	2.2E-03	2.4E-03
Mn	2.5E-04	2.5E-04	8.0E-04
Fe	1.2E-03	1.3E-04	4.0E-02
Co	1.0E-03	1.0E-03	1.3E-02
Ni	6.7E-03	6.7E-03	5.3E-02
Cu	1.4E-02	1.3E-02	8.0E-03
Zn	3.9E-02	3.9E-02	3.0E-02
	3.0E-02	3.0E-02	3.1E-02
	8.0E-04	1.4E-02	6.0E-04
Y	1.0E-05	1.0E-05	4.6E-03
Zr	5.0E-06	5.0E-06	3.4E-02
Nb	2.5E-03	2.5E-03	2.8E-01
Mo	7.5E-03	7.5E-03	8.0E-03
Tc	2.5E-02	2.5E-02	4.0E-01
Ru	1.0E-06	1.0E-06	4.0E-01
Rh	1.0E-02	1.0E-02	1.5E-03
Ag	5.0E-02	5.0E-02	1.7E-02
Te	1.0E-03	1.0E-03	7.7E-02
I	6.0E-03	6.0E-02	2.9E-03
Cs	1.2E-02	3.0E-02	4.0E-03
Ba	4.0E-04	4.0E-04	3.2E-03
La	5.0E-06	5.0E-06	2.0E-04
Ce	1.0E-04	1.0E-04	1.2E-03
Pr	5.0E-06	5.0E-06	4.7E-03
Nd	5.0E-06	5.0E-06	3.3E-03
W	5.0E-04	5.0E-04	1.3E-03
Np	5.0E-06	5.0E-06	2.0E-04

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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
NA 24	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06
P 32	1.45E-03	8.03E-05	5.53E-05	NO DATA	NO DATA	NO DATA	1.15E-05
CR 51	NO DATA	NO DATA	6.37E-08	4.11E-08	9.45E-09	9.17E-06	2.55E-07
MN 54	NO DATA	1.81E-05	3.56E-06	NO DATA	3.56E-06	7.14E-04	5.04E-06
MN 56	NO DATA	1.10E-09	1.58E-10	NO DATA	7.86E-10	8.95E-06	5.12E-05
FE 55	1.41E-05	8.39E-06	2.38E-06	NO DATA	NO DATA	6.21E-05	7.82E-07
FE 59	9.69E-06	1.68E-05	6.77E-06	NO DATA	NO DATA	7.25E-04	1.77E-05
CO 58	NO DATA	8.71E-07	1.30E-06	NO DATA	NO DATA	5.55E-04	7.95E-06
CO 60	NO DATA	5.73E-06	8.41E-06	NO DATA	NO DATA	3.22E-03	2.28E-05
NI 63	2.42E-04	1.46E-05	8.29E-06	NO DATA	NO DATA	1.49E-04	1.73E-06
NI 65	1.71E-09	2.03E-10	8.79E-11	NO DATA	NO DATA	5.80E-06	3.58E-05
CU 64	NO DATA	1.34E-09	5.53E-10	NO DATA	2.84E-09	6.64E-06	1.07E-05
ZN 65	1.38E-05	4.47E-05	2.22E-05	NO DATA	2.32E-05	4.62E-04	3.67E-05
ZN 69	3.85E-11	6.91E-11	5.13E-12	NO DATA	2.87E-11	1.05E-06	9.44E-06
BR 83	NO DATA	NO DATA	2.72E-07	NO DATA	NO DATA	NO DATA	LT E-24
BR 84	NO DATA	NO DATA	2.86E-07	NO DATA	NO DATA	NO DATA	LT E-24
BR 85	NO DATA	NO DATA	1.46E-08	NO DATA	NO DATA	NO DATA	LT E-24
RB 86	NO DATA	1.36E-04	6.30E-05	NO DATA	NO DATA	NO DATA	2.17E-06
RB 88	NO DATA	3.98E-07	2.05E-07	NO DATA	NO DATA	NO DATA	2.42E-07
RB 89	NO DATA	2.29E-07	1.47E-07	NO DATA	NO DATA	NO DATA	4.87E-08
SR 89	2.84E-04	NO DATA	8.15E-06	NO DATA	NO DATA	1.45E-03	4.57E-05
SR 90	2.92E-02	NO DATA	1.85E-03	NO DATA	NO DATA	8.03E-03	9.36E-05
SR 91	6.83E-08	NO DATA	2.47E-09	NO DATA	NO DATA	3.76E-05	5.24E-05
SR 92	7.50E-09	NO DATA	2.79E-10	NO DATA	NO DATA	1.70E-05	1.00E-04
Y 90	2.35E-06	NO DATA	6.30E-08	NO DATA	NO DATA	1.92E-04	7.43E-05
Y 91M	2.91E-10	NO DATA	9.90E-12	NO DATA	NO DATA	1.99E-06	1.68E-06
Y 91	4.20E-04	NO DATA	1.12E-05	NO DATA	NO DATA	1.75E-03	5.02E-05
Y 92	1.17E-08	NO DATA	3.29E-10	NO DATA	NO DATA	1.75E-05	9.04E-05

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TABLE 1.7 CONT'D

INHALATION DOSE FACTORS FOR INFANT

(MREM PER PCI INHALED)

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	1.79E-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	5.98E-14	5.80E-13	NO DATA	6.99E-13	4.17E-07	6.03E-07
RU103	1.44E-06	NO DATA	4.85E-07	NO DATA	3.03E-06	3.94E-04	1.15E-05
RU105	8.74E-10	NO DATA	2.93E-10	NO DATA	6.42E-10	1.12E-05	3.46E-05
RU106	6.20E-05	NO DATA	7.77E-06	NO DATA	7.61E-05	8.26E-03	1.17E-04
AG110M	7.13E-06	5.16E-06	3.57E-06	NO DATA	7.80E-06	2.62E-03	2.36E-05
TE125M	3.40E-06	1.42E-06	4.70E-07	1.16E-06	NO DATA	3.19E-04	9.22E-06
TE127M	1.19E-05	4.93E-06	1.48E-06	3.48E-06	2.68E-05	9.37E-04	1.95E-05
TE127	1.59E-09	6.81E-10	3.47E-10	1.32E-09	3.47E-09	7.39E-06	1.74E-05
TE129M	1.01E-05	4.35E-06	1.59E-06	3.91E-06	2.27E-05	1.20E-03	4.93E-05
TE129	5.63E-11	2.48E-11	1.34E-11	4.82E-11	1.25E-10	2.14E-06	1.88E-05
TE131M	7.62E-08	3.93E-08	2.59E-08	6.38E-08	1.89E-07	1.42E-04	8.51E-05
TE131	1.24E-11	5.87E-12	3.57E-12	1.13E-11	2.85E-11	1.47E-06	5.87E-06
TE132	2.66E-07	1.69E-07	1.26E-07	1.99E-07	7.39E-07	2.43E-04	3.15E-05
I 130	4.54E-06	9.91E-06	3.98E-06	1.14E-03	1.09E-05	NO DATA	1.42E-06
I 131	2.71E-05	3.17E-05	1.40E-05	1.06E-02	3.70E-05	NO DATA	7.56E-07
I 132	1.21E-06	2.53E-06	8.99E-07	1.21E-04	2.82E-06	NO DATA	1.36E-06
I 133	9.46E-06	1.37E-05	4.00E-06	2.54E-03	1.60E-05	NO DATA	1.54E-06
I 134	6.58E-07	1.34E-06	4.75E-07	3.18E-05	1.49E-06	NO DATA	9.21E-07
I 135	2.76E-06	5.43E-06	1.98E-06	4.97E-04	6.05E-06	NO DATA	1.31E-06
CS134	2.83E-04	5.02E-04	5.32E-05	NO DATA	1.36E-04	5.69E-05	9.53E-07
CS136	3.45E-05	9.61E-05	3.78E-05	NO DATA	4.03E-05	8.40E-06	1.02E-06
CS137	3.92E-04	4.37E-04	3.25E-05	NO DATA	1.23E-04	5.09E-05	9.53E-07
CS138	3.61E-07	5.58E-07	2.84E-07	NO DATA	2.93E-07	4.67E-08	6.26E-07
BA139	1.06E-09	7.03E-13	3.07E-11	NO DATA	4.73E-13	4.25E-06	3.64E-05

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TABLE 1.7 CONT'D

INHALATION DOSE FACTORS FOR INFANT

(MREM PER PCI INHALED)

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	4.97E-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

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TABLE 1.7

INHALATION DOSE FACTORS FOR ADULTS

(MREM PER PCI INHALED)

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

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TABLE 1.7 CONT'D

INHALATION DOSE FACTORS FOR ADULTS

(MREM PER PCI INHALED)

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	5.64E-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	6.80E-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

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TABLE 1.7, CONT'D

INHALATION DOSE FACTORS FOR ADULTS

(MREM PER PCI INHALED)

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

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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-08	6.57E-09	4.59E-06	2.93E-07
MN 54	NO DATA	1.16E-05	2.57E-06	NO DATA	2.71E-06	4.26E-04	6.19E-06
MN 56	NO DATA	4.48E-10	8.43E-11	NO DATA	4.52E-10	3.55E-06	3.33E-05
FE 55	1.28E-05	6.80E-06	2.10E-06	NO DATA	NO DATA	3.00E-05	7.75E-07
FE 59	5.59E-06	9.04E-06	4.51E-06	NO DATA	NO DATA	3.43E-04	1.91E-05
CO 58	NO DATA	4.79E-07	8.55E-07	NO DATA	NO DATA	2.99E-04	9.29E-06
CO 60	NO DATA	3.55E-06	6.12E-06	NO DATA	NO DATA	1.91E-03	2.60E-05
NI 63	2.22E-04	1.25E-05	7.56E-06	NO DATA	NO DATA	7.43E-05	1.71E-06
NI 65	8.08E-10	7.99E-11	4.44E-11	NO DATA	NO DATA	2.21E-06	2.27E-05
CU 64	NO DATA	5.39E-10	2.90E-10	NO DATA	1.63E-09	2.59E-06	9.92E-06
ZN 65	1.15E-05	3.06E-05	1.90E-05	NO DATA	1.93E-05	2.69E-04	4.41E-06
ZN 69	1.81E-11	2.61E-11	2.41E-12	NO DATA	1.58E-11	3.84E-07	2.75E-06
BR 83	NO DATA	NO DATA	1.28E-07	NO DATA	NO DATA	NO DATA	LT E-24
BR 84	NO DATA	NO DATA	1.48E-07	NO DATA	NO DATA	NO DATA	LT E-24
BR 85	NO DATA	NO DATA	6.84E-09	NO DATA	NO DATA	NO DATA	LT E-24
RB 86	NO DATA	5.36E-05	3.09E-05	NO DATA	NO DATA	NO DATA	2.16E-06
RB 88	NO DATA	1.52E-07	9.90E-08	NO DATA	NO DATA	NO DATA	4.66E-09
RB 89	NO DATA	9.33E-08	7.83E-08	NO DATA	NO DATA	NO DATA	5.11E-10
SR 89	1.62E-04	NO DATA	4.66E-06	NO DATA	NO DATA	5.83E-04	4.52E-05
SR 90	2.73E-02	NO DATA	1.74E-03	NO DATA	NO DATA	3.99E-03	9.28E-05
SR 91	3.28E-08	NO DATA	1.24E-09	NO DATA	NO DATA	1.44E-05	4.70E-05
SR 92	3.54E-09	NO DATA	1.42E-10	NO DATA	NO DATA	6.49E-06	6.55E-05
Y 90	1.11E-06	NO DATA	2.99E-08	NO DATA	NO DATA	7.07E-05	7.24E-05
Y 91M	1.37E-10	NO DATA	4.98E-12	NO DATA	NO DATA	7.60E-07	4.64E-07
Y 91	2.47E-04	NO DATA	6.59E-06	NO DATA	NO DATA	7.10E-04	4.97E-05
Y 92	5.50E-09	NO DATA	1.57E-10	NO DATA	NO DATA	6.46E-06	6.46E-05

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TABLE 1.7 CONT'D

INHALATION DOSE FACTORS FOR CHILD

(MREM PER PCI INHALED)

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

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TABLE 1.7 CONT'D

INHALATION DOSE FACTORS FOR CHILD

(MREM PER PCI INHALED)

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

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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
Te-129M	7.70E-10	9.00E-10
Te-129	7.10E-10	8.40E-10

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TABLE 1.8 (Continued)

ELEMENT	TOTAL BODY	SKIN
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

Gaseous and Particulate
Design Objective Annual Quantities

Nuclide	Organ	Dose Factor (mrem/Curie)	Design Objective Annual Quantity (Curies)
H-3	Soft Tissue	1.12E-04	133,929
C-14	Soft Tissue	1.83E-02	820
Ar-41	Air Dose (γ)	3.53E-03	2,830
Mn-54	GI	2.44E-01	61.5
Co-58	GI	1.11E-01	135
Co-60	GI	5.82E-01	25.8
Fe-59	GI	2.30E-01	65.2
Kr-85m	Air Dose (β)	1.20E-03	16,600
Kr-85	Air Dose (β)	1.01E-03	19,800
Kr-87	Air Dose (β)	7.80E-03	2,560
Kr-88	Air Dose (γ)	5.88E-03	1,700
Sr-89	Bone	1.06E+01	1.42
Sr-90	Bone	4.03E+02	0.037
I-131	Thyroid	9.45E+00	1.59
I-133	Thyroid	1.60E-01	93.8
Xe-131m	Air Dose (β)	4.02E-04	49,700
Xe-133m	Air Dose (β)	8.08E-04	24,800
Xe-133	Air Dose (β)	2.82E-04	70,900
Xe-135	Air Dose (β)	1.57E-03	12,800
Cs-134	Liver	7.17E+00	2.09
Cs-137	Liver	4.5 E+00	3.33

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)

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

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
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	9.63E-08	NO DATA	2.79E-09
TE132	2.52E-06	1.63E-06	1.53E-06	1.80E-06	1.57E-05	NO DATA	7.71E-05
I 130	7.56E-07	2.23E-06	8.80E-07	1.89E-04	3.48E-06	NO DATA	1.92E-06
I 131	4.16E-06	5.95E-06	3.41E-06	1.95E-03	1.02E-05	NO DATA	1.57E-06
I 132	2.03E-07	5.43E-07	1.90E-07	1.90E-05	8.65E-07	NO DATA	1.02E-07
I 133	1.42E-06	2.47E-06	7.53E-07	3.63E-04	4.31E-06	NO DATA	2.22E-06
I 134	1.06E-07	2.88E-07	1.03E-07	4.99E-06	4.58E-07	NO DATA	2.51E-10
I 135	4.43E-07	1.16E-06	4.29E-07	7.65E-05	1.86E-06	NO DATA	1.31E-06
CS134	6.22E-05	1.48E-04	1.21E-04	NO DATA	4.79E-05	1.59E-05	2.59E-06
CS136	6.51E-06	2.57E-05	1.85E-05	NO DATA	1.43E-05	1.96E-06	2.92E-06
CS137	7.97E-05	1.09E-04	7.14E-05	NO DATA	3.70E-05	1.23E-05	2.11E-06
CS138	5.52E-08	1.09E-07	5.40E-08	NO DATA	8.01E-08	7.91E-09	4.65E-13
BA139	9.70E-08	6.91E-11	2.84E-09	NO DATA	6.46E-11	3.92E-11	1.72E-07
BA140	2.03E-05	2.55E-08	1.33E-06	NO DATA	8.67E-09	1.46E-08	4.18E-05
BA141	4.71E-08	3.56E-11	1.59E-09	NO DATA	3.31E-11	2.02E-11	2.22E-17
BA142	2.13E-08	2.19E-11	1.34E-09	NO DATA	1.85E-11	1.24E-11	3.00E-26
LA140	2.50E-09	1.26E-09	3.33E-10	NO DATA	NO DATA	NO DATA	9.25E-05
LA142	1.28E-10	5.82E-11	1.45E-11	NO DATA	NO DATA	NO DATA	4.25E-07
CE141	9.36E-09	6.33E-09	7.18E-10	NO DATA	2.94E-09	NO DATA	2.42E-05
CE143	1.65E-09	1.22E-06	1.35E-10	NO DATA	5.37E-10	NO DATA	4.56E-05
CE144	4.88E-07	2.04E-07	2.62E-08	NO DATA	1.21E-07	NO DATA	1.65E-04
PR143	9.20E-09	3.69E-09	4.56E-10	NO DATA	2.13E-09	NO DATA	4.03E-05
PR144	3.01E-11	1.25E-11	1.53E-12	NO DATA	7.05E-12	NO DATA	4.33E-18
ND147	6.29E-09	7.27E-09	4.35E-10	NO DATA	4.25E-09	NO DATA	3.49E-05
W 197	.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

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TABLE 2.2

Liquid Effluent
Design Objective Annual Quantities

Nuclide	Organ	Dose Factor (mRem/Curie)	Design Objective Annual Quantity (Curies)
H-3	Tot Body	1.31E-06	2.29E+06
Cr-51	GI	1.49E-03	6,730
Mn-54	GI	6.22E-02	161
Fe-55	GI	1.21E-02	827
Fe-59	GI	3.77E-02	265
Co-58	GI	8.38E-03	1,190
Co-60	Tot Body	4.50E-01	6.67
Rb-86	Tot Body	2.28E-01	13.2
Sr-89	Bone	1.07E-02	935
Sr-90	Bone	1.64E-01	61.0
Mo-99	GI	1.11E-03	9,020
Te-99m	GI	6.88E-05	145,000
Te-127m	GI	1.01E-01	99.2
Te-127	GI	2.85E-02	259
Te-129m	GI	2.57E-01	38.9
Te-131m	GI	3.73E-01	26.8
Te-132	GI	3.42E-01	29.2
I-130	Thyroid	5.28E-02	190
I-131	Thyroid	3.24E-01	30.9
I-132	Thyroid	1.32E-02	755
I-133	Thyroid	4.05E-02	254
I-135	Thyroid	2.83E-02	353
Cs-134	Tot Body	2.83E+00	1.06
Cs-136	Tot Body	3.94E-01	7.61
Cs-137	Tot Body	1.67E+00	1.80
Ba-140	GI	1.86E-03	5,390
La-140	GI	2.57E-02	390
Np-239	GI	2.66E-03	3,750

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TABLE 3.2
NUS-1729
APPENDIX I ANALYSIS

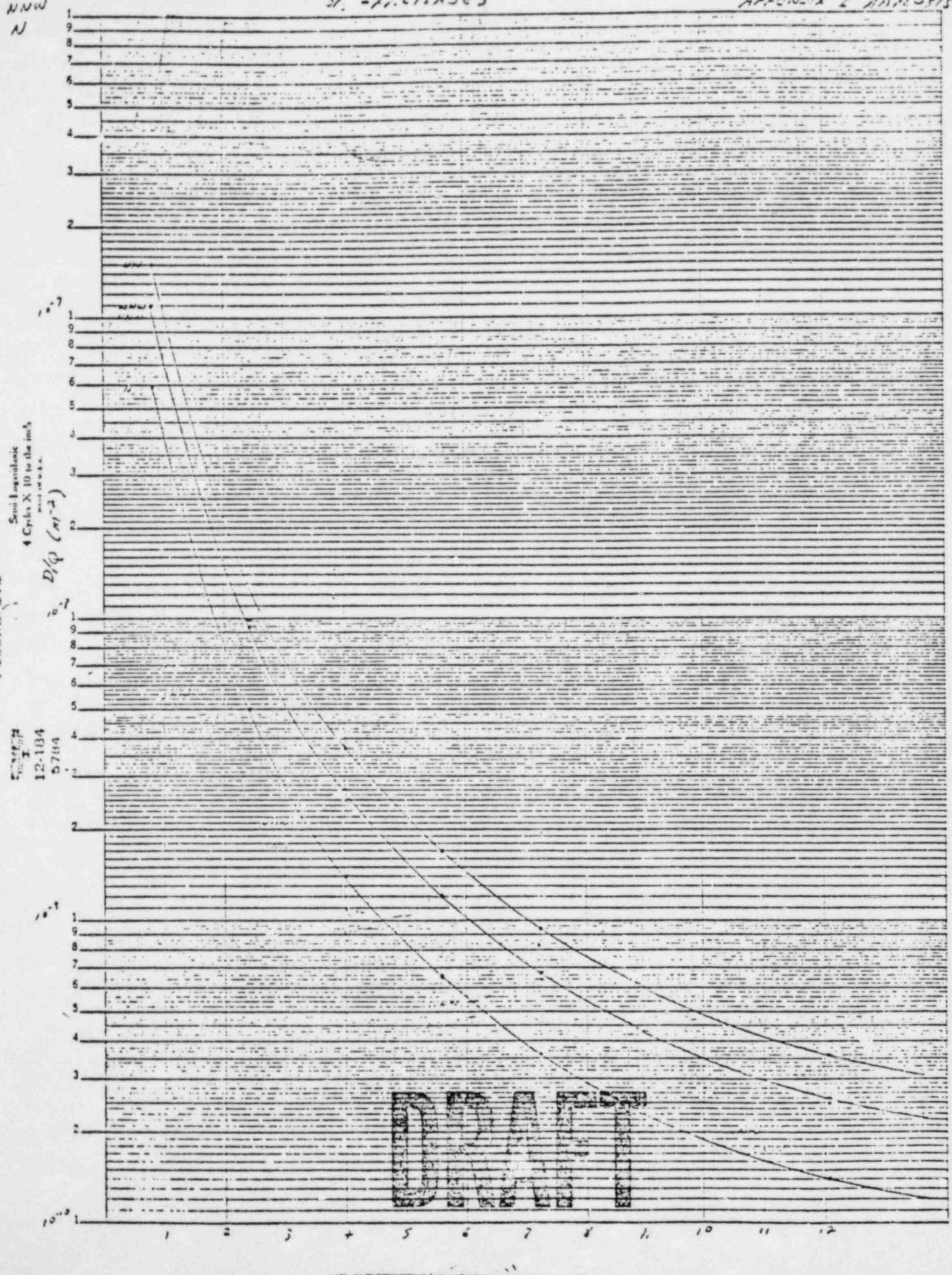


FIGURE 1.1

TABLE 3.7
NUS-1729
APPENDIX I ANALYSIS

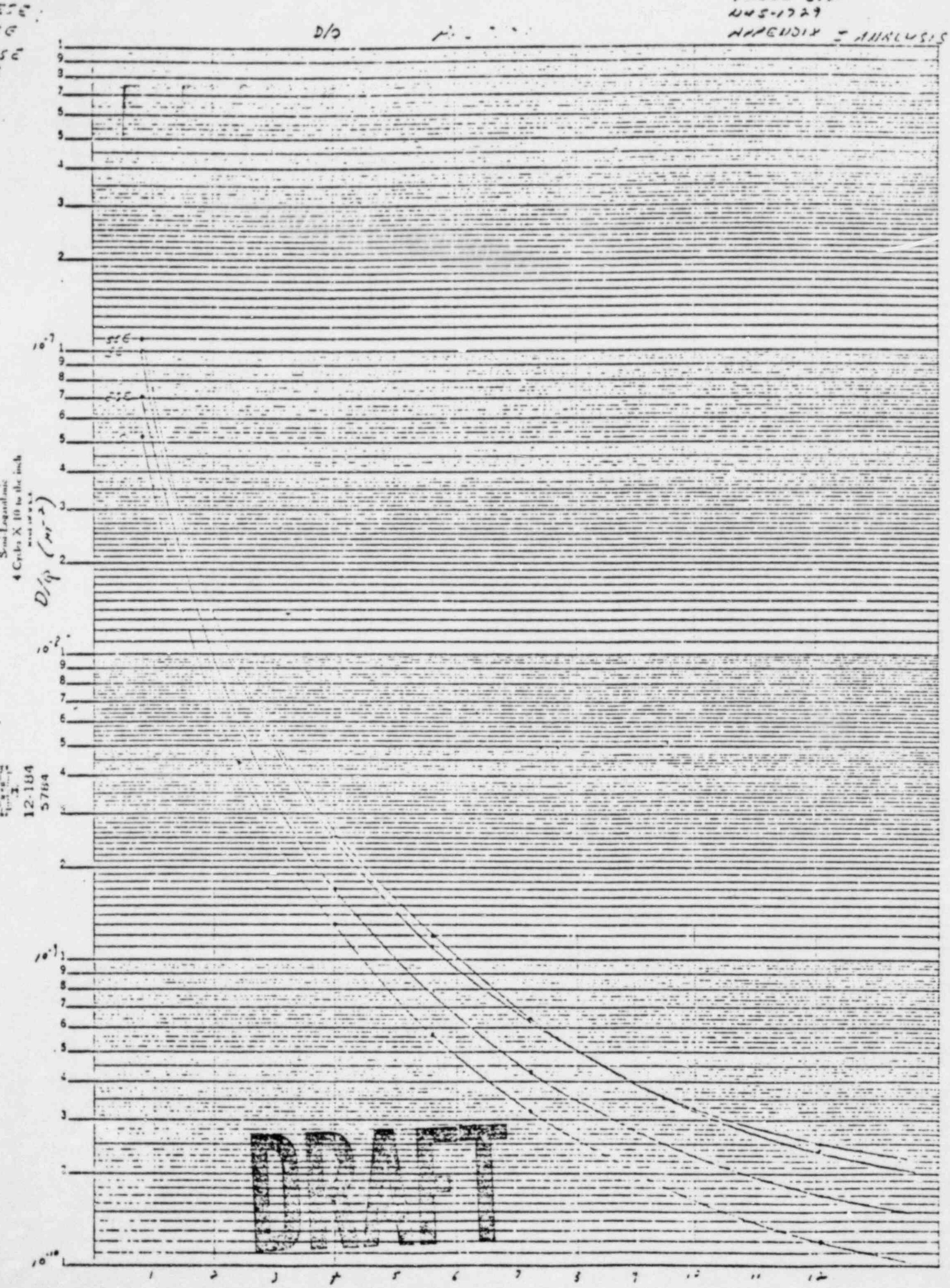


FIGURE 1.1

TABLE 3.2

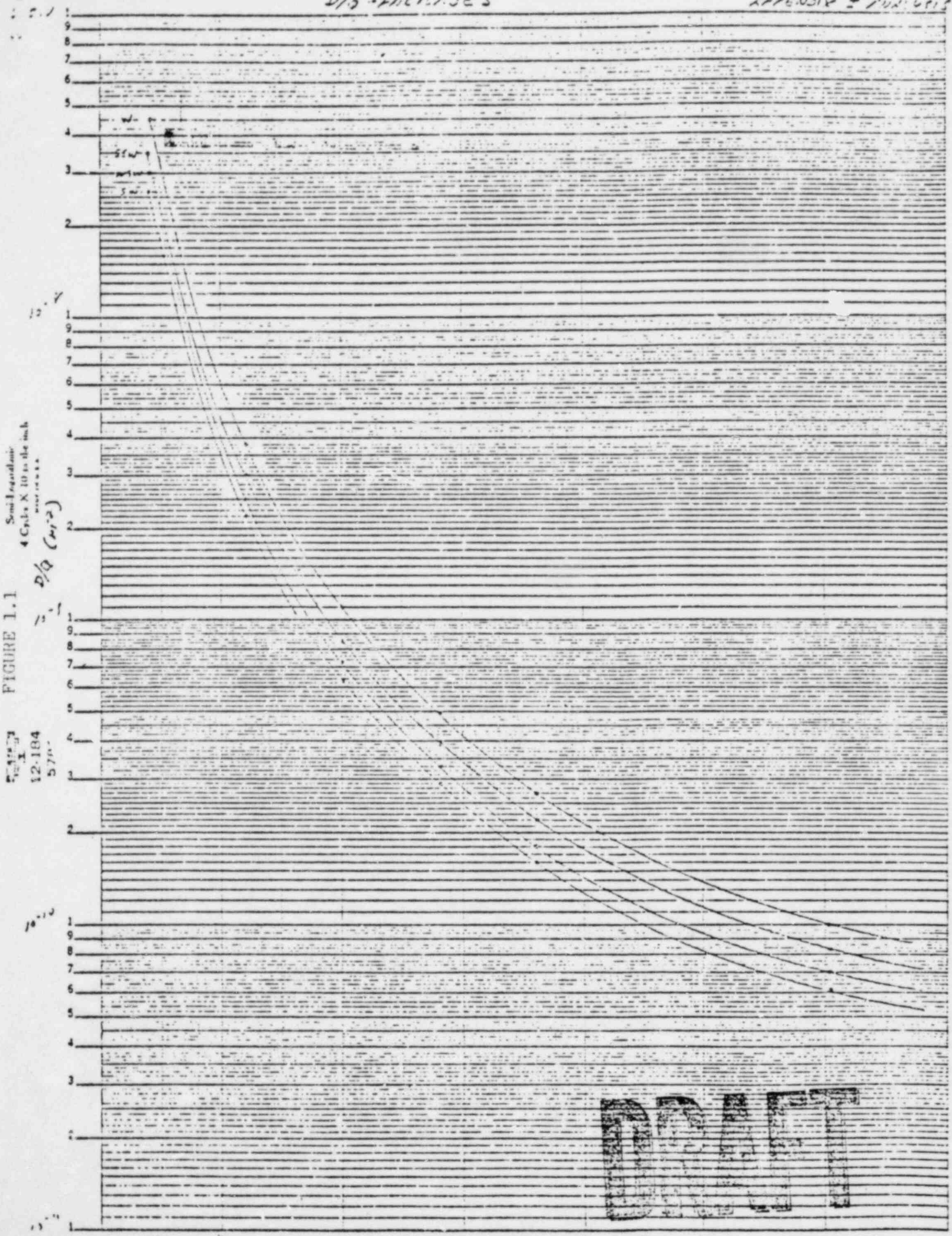
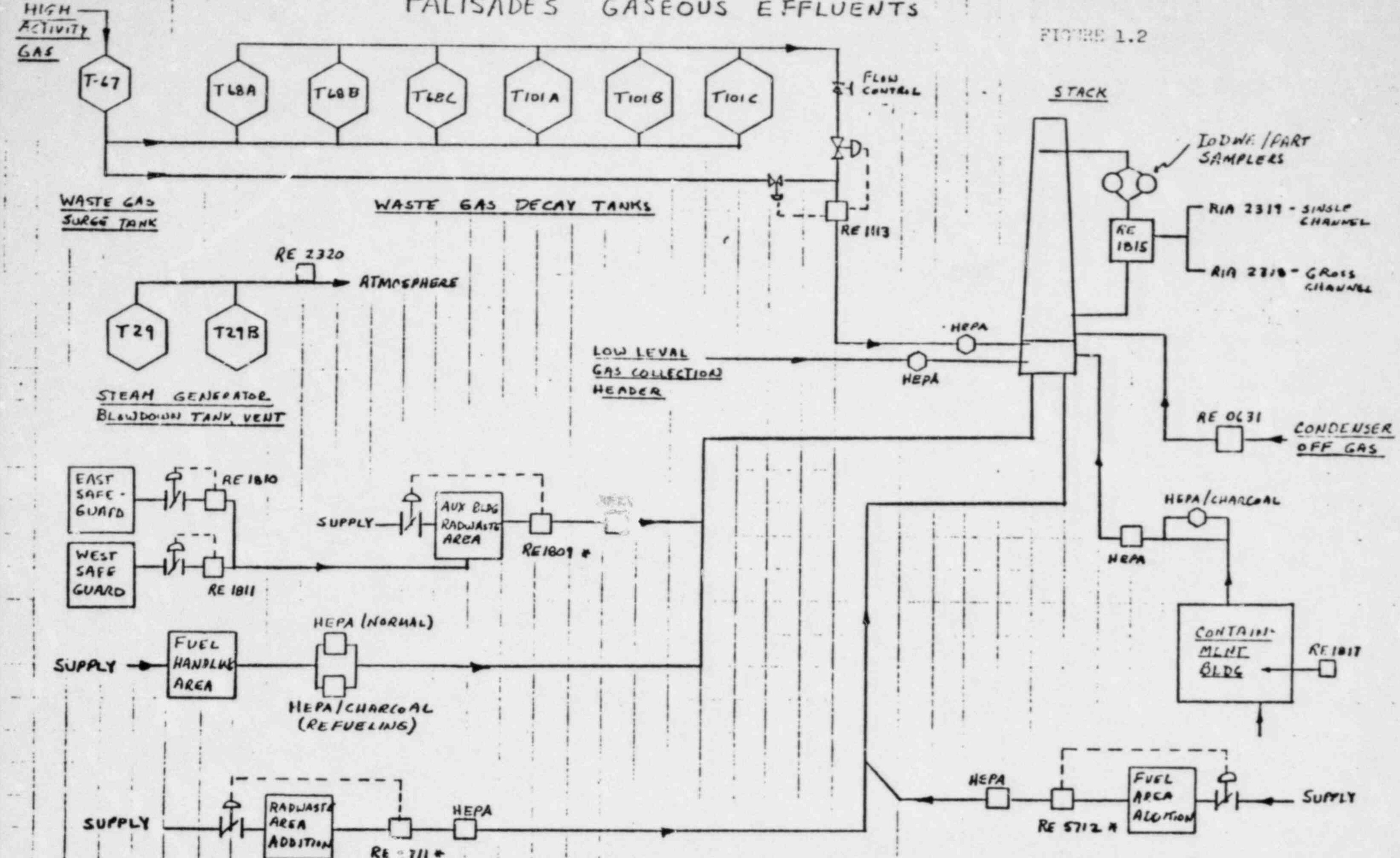


FIGURE 1.1

PALISADES GASEOUS EFFLUENTS

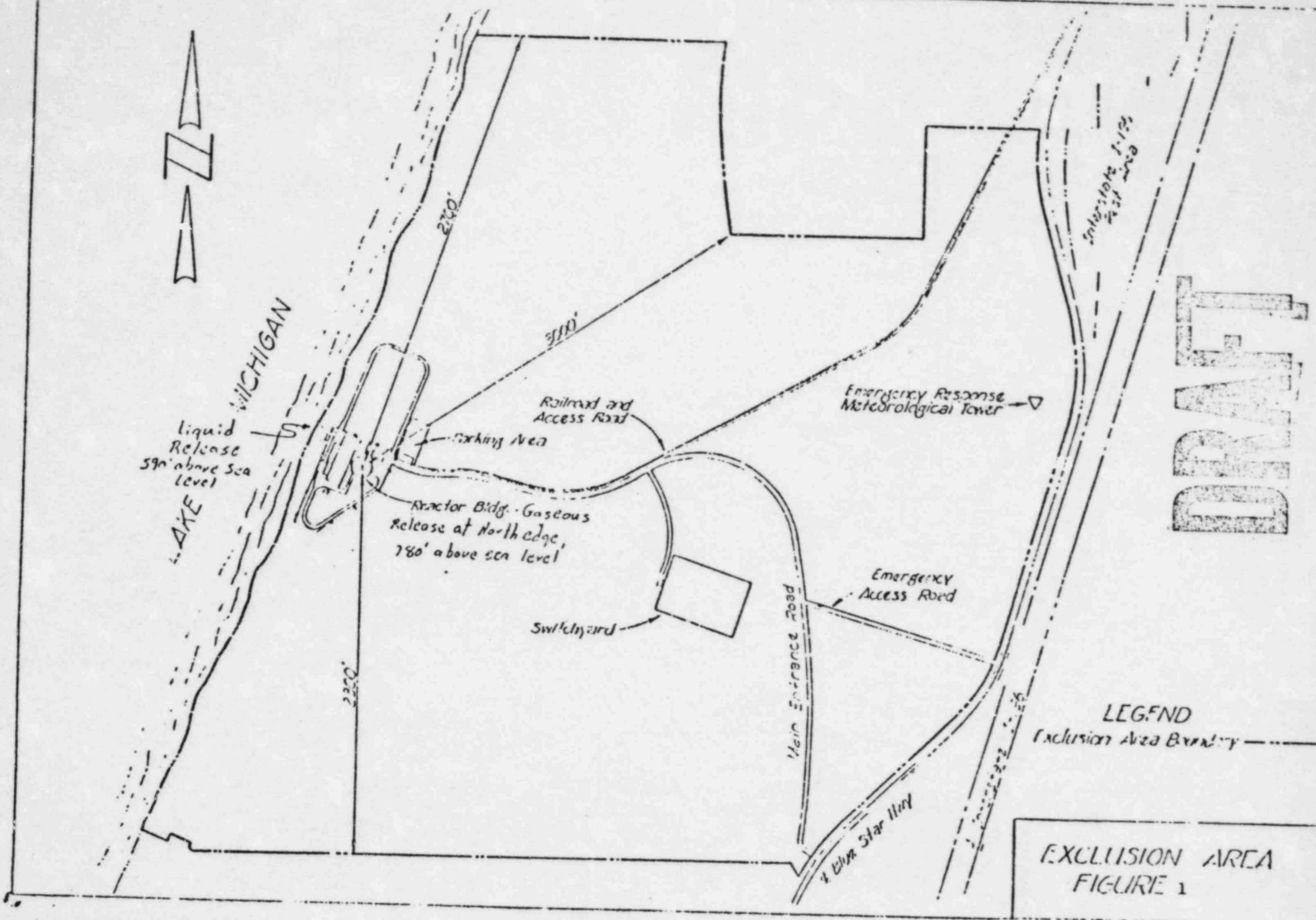
FIGURE 1.2



* RE 1809, 5711 AND 5712 TRIP SUPPLY AND ONE OF TWO EXHAUSTERS. FLOW IS NOT TERMINATED

PALISADES EFFLUENT FLOW PATHS GASEOUS

PALISADES - FIGURE 2.1



PALISADES RADWASTE EFFLUENTS - LIQUID

FIGURE 2.2