ATTACHMENT 2

Consumers Power Company
Palisades Plant
Docket 50-255

SEMI ANNUAL RADIOACTIVE EFFLUENT RELEASE
AND WASTE DISPOSAL REPORT

OFFSITE DOSE CALCULATION MANUAL

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PALISADES NUCLEAR POWER PLANT

OFFSITE DOSE CALCULATION MANUAL

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I. GASEOUS EFFLUENTS

A. ALARM/TRIP SETPOINT METHOD

Specification 3.24.5.1 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:

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

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

Specification 3.24.2.1 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. Allowable Concentration

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

$$R_{(k)} = \left(\frac{X}{Q}\right)(F) \sum_i \frac{C_i}{MPC_i} = \leq 1.0 \qquad (1.1)$$

where:

C_i = Actual or measured concentration, at ambient temperature and pressure of nuclide i (uCi/cc)

MPCi = 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 1.40E-06 sec/m^3).

F = Release flow rate (83,000 cfm = 39.2 m^3/sec) for stack monitor considerations; variable for other monitors.

NOTE: If a batch release is made while a continuous release or another batch release is in progress, the sum of all values of R_k must be less than 1.0.

2. Monitor Response

Normal radioactivity releases consist mainly of well-decayed fission gasses. Therefore, monitor response calibrations are performed to fission gas typical of normal releases (maily Xe-133). Response of monitors used to define fission product release rates under accident conditions may vary from that of Xe-133, however. Monitor response for the two categories of monitor is determined as follows:

a. Normal Releases (aged fission gasses)

Total gas concentration (uCi/cc) at the monitor is calculated. The calibration curve or constant for cpm/(uCi/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 measured concentration (c):

$$s = b \times c \qquad (1.2)$$

b. 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.

Setpoints of accident monitors (if set to monitor normal releases) are reset to the accident alarm settings at the end of normal release. Setpoints of other release monitors are maintained at the level used at the latest release (well below the level which would allow MPC to be exceeded at the site boundary), or are reset to approximately three times background in order to detect leakage or inadvertent releases of low level gases.

B. **DOSE RATE CALCULATION**

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

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

1) Assumptions

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

b) Exposure pathway is submersion within a cloud of noble gases.

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

d) Basic radionuclide data are given in Table 1.2.

e) All releases are treated as ground-level.

f) Meteorological data expressed as joint-frequency distribution of wind speed, wind direction, and atmospheric stability for the period resulting in X/Q's and D/Q's shown in Table 1.3.

g) Raw meteorological data consists of wind speed and direction measurements at 10m and temperature measurements at 10m and 60m.

h) Dose is to be evaluated at the offsite exposure points where maximum concentrations are expected to exist (overland sector site boundaries), and nearest residents.

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

j) A semi-infinite cloud model is used.

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

l) Radioactive decay is considered for the plume.

m) Building wake effects on effluent dispersion are considered.

n) A sector-average dispersion equation is used.

o) 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	0.2
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	--

p) 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.

q) Terrain effects are not considered.

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:

$$X_i = \sum_{j=1}^{9} \sum_{k=1}^{7} \left(\frac{2}{\pi}\right)^{1/2} \frac{f_{jk} Q_i p}{\Sigma_{zk} u_j (2\pi x/n)} \left[\exp^- \left(\lambda_i \frac{x}{u_j}\right)\right] \quad (1/3)$$

where:

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

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

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

p = Fraction of radionuclide remaining in plume.

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

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

x = Downwind distance, m.

n = Number of sectors, 16.

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

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

For determining the total body dose rate:

$$D_{TB} = \sum_i X_i \; DFB_i \quad (1.4)$$

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:

$$D_s = \sum_i X_i \, (DFS_i + 1.11 \, DFY_i) \qquad (1.5)$$

where:

D_s = Skin dose rate, mrem/y.

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

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

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

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

For determining dose rate to a point in air:

$$D_a = \sum_i X_i \, (DFY_i \text{ or } DFB_i) \qquad (1.6)$$

where:

D_a = Air dose rate, mrad/yr

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

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

1) Assumptions

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

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

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

d) Basic radionuclide data are given in Table 1.2.

e) All releases are treated as ground-level.

f) Mean annual average X/Q's for the period January 1, 1978 - December 31, 1982 are given in Table 1.3.

g) Raw meteorological data for ground-level releases consist of wind speed and direction measurements at 10m and temperature measurements at 10m and 60m.

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

i) Real cow, goat and garden locations are considered.

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

k) Terrain effects and open terrain recirculation factors are not considered.

l) Building wake effects on effluent dispersion are considered.

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

n) Radioactive decay is considered for ground-concentration calculations.

o) Deposition is calculated based on the curves given in Figure 1.2.

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

q) Credit is taken for shieldin residence (factor of 0.7).

2) Equations

To calculate the dose for any one of the potential maximum-exposure points, the following equations in Section 1.2.2 are used.

a) Inhalation

Equation for calculating air concentration, X_i is the same as in the Noble Gas Section (Equation 1.3).

For determining the organ dose rate:

$$D_i = 1x10^6 \sum_i X_i \, DFI_i \, BR \qquad (1.7)$$

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

$1x10^6$ = pCi/µCi conversion factor.

b) Ground Contamination

For determining the ground concentration of any nuclide:

$$G_i = 3.15x10^7 \sum_{k=1}^{7} \frac{f_k \, Q_i \, DR}{(2\pi x/n)\lambda_i} \, [1-\exp-(\lambda_i \, t_b)] \qquad (1.8)$$

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^{-1} (Fig 1.2).

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, 15 y.

3.15×10^7 = s/y conversion factor.

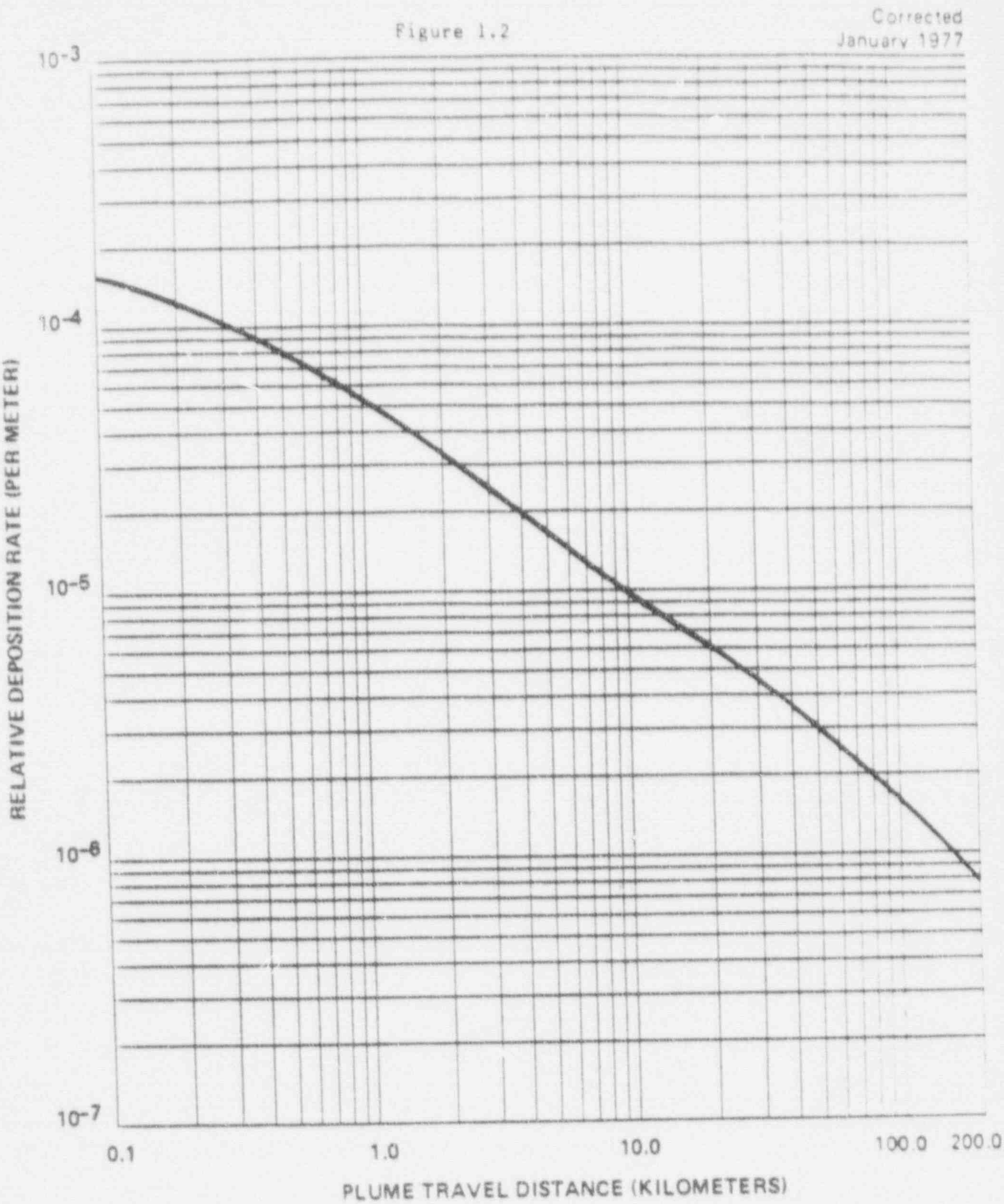


Figure 7. Relative Deposition for Ground Level Releases (All Atmospheric Stability Classes)

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

$$D_G = (8,760)(1x10^6)(0.7) \sum_i G_i \; DFG_i \qquad (1.9)$$

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.

$1x10^6$ = pCi/μCi conversion factor.

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

c) Milk and Vegetation Ingestion

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

$$CV_i = 3,600 \sum_{k=1}^{7} \frac{f_k \, Q_i \, DR}{(2\pi x/n)} \left(\frac{r[1-\exp(-\lambda_{Ei} t_e)]}{Y_v \, \lambda_{Ei}} + \frac{B_{iv} [1-\exp(-\lambda_i t_b)]}{P \, \lambda_i} \right) \left[[\exp^{-}(\lambda_i t_h)] \right] \qquad (1.10)$$

where:

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

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 rage, m^{-1} (Figure 1.2).

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 (λ_w = .0021 h^{-}).

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, 1.31×10^5 h (15y).

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

3,600 = s/h conversion factor.

t_h = Holdup time between harvest and consumption of food (2,160 hours for stored food)

For determining the concentration of C-14 in vegetation:

$$CV_{14} = 1x10^3 X_{14} (0.11/0.16) \quad (1.11)$$

where:

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

X_{14} = Air concentration of C-14, µCi/m³.

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

0.16 = Concentration of natural carbon in the atmosphere, g/m³.

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

For determining the concentration of H-3 in vegetation:

$$CV_T = 1x10^3 X_T (0.75)(0.5/H) \quad (1.12)$$

where:

CV_T = Concentration of H-3 in vegetation, µCi/m³.

X_T = Air concentration of H-3, µCi/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:

$$CM_i = CV_i \; FM_i \; Q_f \exp(-\lambda_i t_f) \quad (1.13)$$

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 , d/l (Table 1.6).

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

λi = 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:

$$D = 1x10^6 \sum_i CM_i \; DF_i \; UM \qquad (1.14)$$

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/yr (child), no ingestion by infant.

$1x10^6$ = pCi/µCi conversion factor.

d) Meat Ingestion (Beef)

To calculate the concentration of a nuclide in animal flesh:

$$C_{fi} = F_{fi} \ CV_i \ Q_{fi} \ \exp(\lambda_i t_s) \qquad (1.15)$$

where:

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

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

CV_i = Concentration of radionuclide i in the animal's feed (Equation 1.10).

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

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

To determine the organ dose from ingestion of beef:

$$D_f = \sum_i C_{fi} \, D_{fi} \, U_f \qquad (1.16)$$

where:

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

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

e) Organ Dose Rates

For determining the total body and organ dose rate from iodines and particulates:

$$D = D_I + D_G + D_M + D_V + D_F \qquad (1.17)$$

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 du;e to vegetable ingestion, mrem/y.

D_F = Dose rate due to beef ingestion, mrem/y.

3) The maximum organ dose rate, maximum total body dose rate, and maximum skin dose rate calculated in the previous section (Sec 1.2.2) are used to calculate design basis quantities as described in Section 1.3.

c. Design Basis Quantities

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

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

2) 15 millirem to skin of an individual from noble gas.

3) 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 from the amount of radionuclide (Ci) used to conservatively estimate the doses of Section D, as listed in Table 1.1 (or a hypothetical 1 Ci/year):

the result is then multiplied by the amount of radionuclide used.

$$DBQ = \frac{D_{AI}}{D_c} (C_c) \qquad (1.18)$$

where:

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

D_c = Calculated dose (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 (ie, 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.

d. <u>Land Use Census and DBQ Changes</u>

Specifications 4.11.3 and 4.11.4 describe 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), Table 1.4a (Critical Receptors), 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.

e. Gaseous Releases From the Steam Generator Blowdown Vent and Atmosphere Release Valves

Releases from the steam generator blowdown vent and atmospheric relief valves are difficult to quantify as there are no sampling capabilities on these steam release systems. However, neither system is a normal release path. The steam generator blowdown vent is normally routed to the main condenser and recirculated. Radioactive releases will be calculated by analyzing steam generator blowdown liquid and assuming that 100 percent of Noble Gases, 10 percent of the Iodines and 1 percent of the Particulates will be released to the environment in the steam phase. Volumes will be released to the environment in the steam phase. Volumes will be calculated using water balances or alternate means as available.

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

1. Batch Releases

Prior to each batch release (waste decay tank release or containment purge), 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 then is divided by the design objective quantity 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:

$$\sum_i \frac{Ai}{(DBQ)_i} < 1.0 \qquad (1.19)$$

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. Continuous Releases

Low level continuous releases from the vent gas collection header and other low level sources are totaled on a weekly basis and summed with any batch releases for the week in order to establish the cumulative DBQ fraction from batch plus continuous released for the year-to-date. Calculations are performed in the same manner as for batch releases described in C.1.0.

3. 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 Palisades Plant to date (based on review of semiannual effluent data) has never exceeded the annual or quarterly DBQ fraction, despite its conservatism. 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. 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 Palisades. From time to time, however, other nuclides may be detected.

If the unlisted nuclide constitutes less than 10% of the MPC-fration 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. 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 1.19. 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, teen and adult), since Table 1.9 indicates these parameters.

a. <u>Simplified Conservative Approach</u>

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 over-estimates dose. If limits appear to be exceeded by this method, Section D.1.2 (a concise method, but requi[illegible]omputer support) will be utilized.

1. <u>Assumptions</u>

   a) All assumptions of Section 1.1 are utilized.

   b) Limiting doses for each gaseous nuclide are summed, regardless of limiting decay mode (gamma or beta).

   c) Limiting doses for each particulate and iodine nuclide are summed, regardless of dose point location, exposure pathway or organ affected.

   d) 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.

2. <u>Equations</u>

   For determining gaseous effluent dose:

$$D_G = \sum_{0}^{i} A_{iG}(D_c/C_c)_{iG} < 5 \text{ millirad/quarter, } 10 \text{ mrad/yr} \quad (1.20)$$

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 tritium, particulate and iodine dose to organs:

$$D_{TPI} = \sum^{i} A_{TPIi} (D_c/C_c)_{TPIi} < 7.5 \text{ mrem/q, } 15 \text{ mrem/y} \quad (1.21)$$

where:

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

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

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

b. Realistic Calculation

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.

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

E. GASEOUS RADWASTE TREATMENT SYSTEM OPERATION

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

1. System Description

A flow diagram for the GRTS is given in Figure 1-1. 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.

Design of the system precludes hydrogen explosion by means of ignition source elimination (diaphragm valves, low flow diaphragm compressors and system electrical grounding), and minimization of leakage outside the system. Explosive mixtures of hydrogen and oxygen have been demonstrated compatible with the system by operational experience over the past 13 years.

2. Determination of S tisfactory Operation

Design basis quantity fraction will be calculated for batch and contir ious releases as described in Section I.C. These calculations will 'e used to ensure that the GRTS is operating as designed. Beca se the plant was designed to collect and hold for decay a vast maj rity of the high level gasses generated within the primary sy tem, and because the 13-year operating history (to date of writing 'ne initial ODCM) of the plant has demonstrated the system's consistent performance well below Appendix I limits, no additional operability requirements are specified.

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 1-1.) Concentrations at this level if present for one year will result in a dose of 500 mrem wholebody or 1500 mrem organ or 3000 mrem skin 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 even under unusual operating conditions, to release quantities of material higher than a small percentage of 10 CFR 20.106 limits but still within those limits. 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 CASPAR 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 assume to be residing at the site boundary with highest X/Q, is 2.15E-02 mrem (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 500/2.15E-02 or 1.11 Ci/sec.

C. **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 a gas batch (waste gas decay tank or containment purge, for example), or a series of samples are obtained to follow the course of a release. In any event, sample intervals are weekly, at minimum.

Because HEPA filters are present between most source inputs to the stack and the sample point, releases of particulates normally are significantly less than pre-release calculations indicate. This provides for conservatism in establishing setpoints and in estimation of pre-release design basis quantity fraction. However, for the sake of maintaining accurate release totals, monitor results (for gasses) and sample results (for particulates and iodines) utilized rather than the pre-release estimates, for cumulative records.

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.

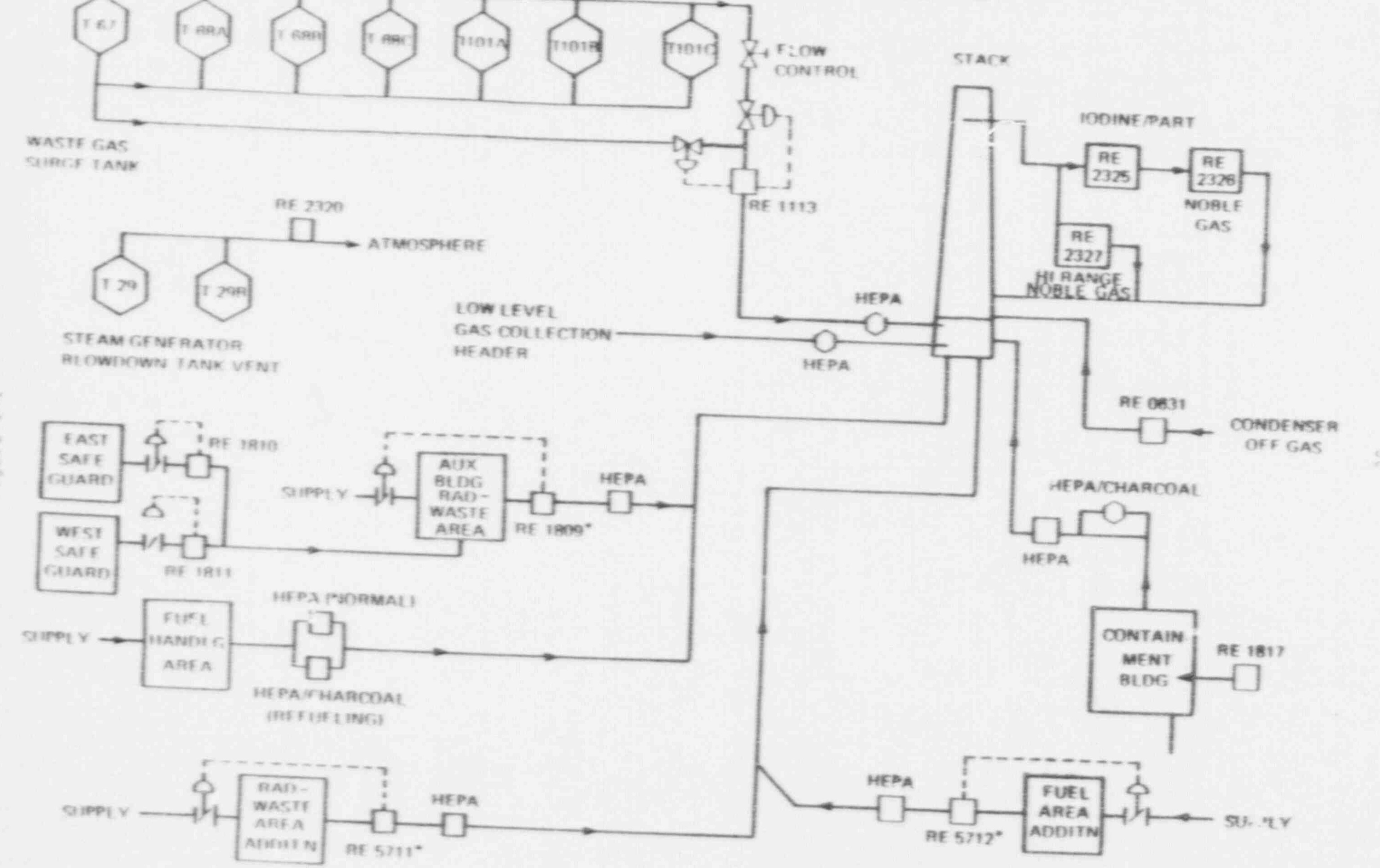
H. **NOBLE GAS SAMPLING**

Noble gasses will be sampled from Waste Gas Decay Tanks prior to release and the Containment prior to purging. Analysis of these samples will be used for accountability of noble gasses. Off gas will be sampled at least weekly and used to calculate monthly noble gas releases. Nonroutine releases will be quantified from the stack noble gas monitor (RE 2326) which has a LLD of 1E-06 μCi/cc (if RE 1815 is used because RE 2326 is out of service, the LLD will be 5E-05 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.

PALISADES GASEOUS EFFLUENTS



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

PALISADES EFFLUENT FLOW PATHS (GASEOUS

Figure 1-1

TABLE 1.1
PALISADES GASEOUS AND LIQUID SOURCE TERMS, CURIES/YEAR (1)

Nuclide	Gaseous(2)	Liquid(2)
H-3	5.5	159
Kr-85	4.1	NA
Kr-85m	0.12	NA
Kr-87	8.4E-02	NA
Kr-88	2.1E-01	NA
Ar-41	3.1E-02	NA
Xe-131m	2.2	NA
Xe-133	1493	NA
Xe-133m	0.43	NA
Xe-135	1.11	NA
Xe-135m	0.3	NA
I-131	0.025	3.21E-03
I-132	2.91E-03	NA
I-133	6.5E-03	4.7E-05
I-134	4.8E-04	NA
I-135	1.84E-02	NA
Na-24	1.5E-06	NA
Cr-51	2.5E-04	3.9E-03
Mn-54	4.1E-04	7.8E-03
Co-57	2.1E-06	3.2E-05
Co-58	8.6E-04	2.9E-02
Fe-59	6.6E-06	4.1E-04
Co-60	1.1E-03	1.24E-02
Se-75	3.7E-06	NA
Nb-95	2.4E-05	4.53E-04
Zr-95	4.7E-06	1.79E-04
Mo-99	1.5E-07	NA
Ru-103	.3E-07	.1E-05
Sb-127	NA	3.5E-05
Cs-134	4.5E-05	0.7
Cs-136	NA	1.8E-06
Cs-137	2.6E-04	1.36E-02
Ba-140	2.8E-07	NA
La-140	7.5E-07	1.1E-04
Unidentified beta	3.9E-04	3.3E-03

(1) Data derived from taking the effluents released during July-December 1978 through January-June 1982 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	0.0
4	O-19	3.36E-04	2.39E-02	1.02E 00	1.02E 00
5	F-18	7.62E-02	1.05E-04	2.50E-01	1.05E 00
6	NA-24	6.33E-01	1.27E-05	5.55E-01	1.02E 00
7	P-32	1.43E 01	5.61E-07	6.95E-01	4.12E 00
8	AR-41	7.63E-02	1.05E-04	4.64E-01	0.0
9	CR-51	2.78E 01	2.89E-07	3.86E-03	1.28E 00
10	MN-54	3.03E 02	2.65E-08	3.80E-03	3.28E-02
11	MN-56	1.07E-01	7.50E-05	8.29E-01	8.36E-01
12	FE-59	4.50E 01	1.78E-07	1.18E-01	1.69E 00
13	CO-58	7.13E 01	1.12E-07	2.41E-02	1.19E 00
14	CO-60	1.92E 03	4.18E-09	9.68E-02	9.78E-01
15	ZN-69m	5.75E-01	1.39E-05	2.21E-02	2.50E 00
16	ZN-69	3.96E-02	2.03E-04	3.19E-01	4.16E-01
17	BR-84	2.21E-02	3.63E-04	1.28E 00	0.0
18	BR-85	2.08E-03	3.86E-03	1.04E 00	1.77E 00
19	KR-85m	1.83E-01	4.38E-05	2.53E-01	6.60E-02
20	KR-85	3.93E 03	2.04E-09	2.51E-01	1.59E-01
21	KR-87	5.28E-02	1.52E-04	1.32E 00	2.21E-03
22	KR-88	1.17E-01	6.86E-05	3.61E-01	7.93E-01
23	KR-89	2.21E-03	3.63E-03	1.36E 00	1.96E 00
24	RB-88	1.24E-02	6.47E-04	2.06E 00	1.83E 00
25	RB-89	1.07E-02	7.50E-04	1.01E 00	6.26E-01
26	SR-89	5.20E 01	1.54E-07	5.83E-01	2.05E-00
27	SR-90	1.03E 04	7.79E-10	1.96E-01	8.45E-05
28	SR-91	4.03E-01	1.99E-05	6.50E-01	0.0
29	SR-92	1.13E-01	7.10E-05	1.95E-01	6.95E-01
30	SR-93	5.56E-03	1.44E-03	9.20E-01	1.34E 00
31	Y-90	2.67E 00	3.00E-06	9.36E-01	2.24E 00
32	Y-91m	3.47E-02	2.31E-04	2.73E-02	0.0
33	Y-91	5.88E 01	1.36E-07	6.06E-01	5.30E-01
34	Y-92	1.47E-01	5.46E-05	1.44E 00	3.61E-03
35	Y-93	4.29E-01	1.87E-05	1.17E 00	2.50E-01
36	ZR-95	6.50E 01	1.23E-07	1.16E-01	8.94E-02
37	NB-95m	3.75E 00	2.14E-06	1.81E-01	7.35E-01
38	NB-95	3.50E 01	2.29E-07	4.44E-02	6.06E-02
39	MO-99	2.79E 00	2.87E-06	3.96E-01	7.64E-01
40	TC-99m	2.50E-01	3.21E-05	1.56E-02	1.50E-01
41	TC-99	7.74E 07	1.04E-13	8.46E-02	1.26E-01
42	TC-104	1.25E-02	6.42E-04	1.60E 00	0.0
					1.95E 00

TABLE 1.2 (CONTD)

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	1.94E-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 00

[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.

USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 02-[illegible]-90

***** PALISADES XOQDOQ82 ***** USING 01/01/83 - 12/31/87 MET DATA *****

GROUND LEVEL RELEASE - TOP OF CONTAINMENT BUILDING
NO DECAY, UNDEPLETED

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

SECTOR	0.250	0.500	0.750	1.000	1.500	2.000	2.500	3.000	3.500	4.000	4.500
S	3.120E-06	1.032E-06	5.627E-07	3.707E-07	2.057E-07	1.359E-07	9.861E-08	7.535E-08	6.091E-08	5.334E-08	[illegible]
SSW	2.301E-06	9.129E-07	4.917E-07	3.244E-07	1.808E-07	1.201E-07	8.761E-08	6.773E-08	5.452E-08	4.520E-08	3.832E-08
SW	2.944E-06	9.492E-07	5.065E-07	3.344E-07	1.868E-07	1.246E-07	9.112E-08	7.062E-08	5.695E-08	4.729E-08	[illegible]
WSW	3.502E-06	1.112E-06	5.838E-07	3.830E-07	2.131E-07	1.428E-07	1.050E-07	8.173E-08	6.616E-08	5.512E-08	4.693E-08
W	5.234E-06	1.607E-06	8.435E-07	5.517E-07	3.058E-07	2.047E-07	1.504E-07	1.170E-07	9.471E-08	7.889E-08	[illegible]
WNW	6.695E-06	2.136E-06	1.122E-06	7.319E-07	4.044E-07	2.706E-07	1.989E-07	1.544E-07	1.252E-07	1.043E-07	8.853E-08
NW	7.600E-06	2.407E-06	1.257E-06	8.211E-07	4.555E-07	3.064E-07	2.262E-07	1.767E-07	1.434E-07	1.198E-07	[illegible]
NNW	9.334E-06	2.888E-06	1.498E-06	9.789E-07	5.446E-07	3.680E-07	2.727E-07	2.136E-07	1.738E-07	1.456E-07	[illegible]
N	1.067E-05	3.298E-06	1.711E-06	1.116E-06	6.191E-07	4.187E-07	3.106E-07	2.435E-07	1.983E-07	1.661E-07	[illegible]
NNE	4.404E-06	1.402E-06	7.463E-07	4.903E-07	2.728E-07	1.824E-07	1.334E-07	1.039E-07	8.401E-08	6.990E-08	5.944E-08
NE	5.112E-06	1.695E-06	9.240E-07	6.067E-07	3.325E-07	2.181E-07	1.574E-07	1.206E-07	9.641E-08	7.944E-08	6.730E-08
ENE	4.205E-06	1.374E-06	7.413E-07	4.834E-07	2.655E-07	1.743E-07	1.259E-07	9.662E-08	7.729E-08	6.375E-08	5.381E-08
E	3.970E-06	1.322E-06	7.150E-07	4.649E-07	2.540E-07	1.660E-07	1.195E-07	9.146E-08	7.298E-08	6.005E-08	5.059E-08
ESE	3.179E-06	1.123E-06	6.067E-07	3.930E-07	2.147E-07	1.398E-07	1.004E-07	7.659E-08	6.099E-08	5.009E-08	4.211E-08
SE	3.919E-06	1.296E-06	6.972E-07	4.529E-07	2.475E-07	1.614E-07	1.160E-07	8.864E-08	7.065E-08	5.827E-08	4.888E-08
SSE	3.997E-06	1.317E-06	7.115E-07	4.622E-07	2.524E-07	1.651E-07	1.189E-07	9.103E-08	7.266E-08	5.984E-08	5.044E-08

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

SECTOR	5.000	7.500	10.000	15.000	20.000	25.000	30.000	35.000	40.000	45.000	50.000
S	3.666E-08	2.070E-08	1.384E-08	7.886E-09	1.312E-09	3.917E-09	3.057E-09	2.482E-09	2.072E-09	1.769E-09	1.535E-09
SSW	3.308E-08	1.884E-08	1.268E-08	7.247E-09	4.939E-09	3.659E-09	2.867E-09	2.335E-09	1.955E-09	1.673E-09	1.456E-09
SW	3.471E-08	1.987E-08	1.342E-08	7.732E-09	5.272E-09	3.916E-09	3.075E-09	2.509E-09	2.104E-09	1.803E-09	1.571E-09
WSW	4.068E-08	2.352E-08	1.600E-08	9.341E-09	6.402E-09	4.784E-09	3.776E-09	3.093E-09	2.604E-09	2.239E-09	1.956E-09
W	5.820E-08	3.364E-08	2.288E-08	1.336E-08	9.154E-09	6.841E-09	5.399E-09	4.423E-09	3.724E-09	3.202E-09	2.797E-09
WNW	7.699E-08	4.434E-08	3.031E-08	1.771E-08	1.215E-08	9.083E-09	7.172E-09	5.879E-09	4.952E-09	4.259E-09	3.722E-09
NW	8.877E-08	5.174E-08	3.539E-08	2.062E-08	1.434E-08	1.076E-08	8.523E-09	7.002E-09	5.909E-09	5.090E-09	4.456E-09
NNW	1.081E-07	6.337E-08	4.350E-08	2.572E-08	1.778E-08	1.337E-08	1.061E-08	8.730E-09	7.378E-09	6.362E-09	5.573E-09
N	1.236E-07	7.259E-08	4.990E-08	2.956E-08	2.046E-08	1.540E-08	1.223E-08	1.007E-08	8.515E-09	7.347E-09	6.441E-09
NNE	5.147E-08	2.945E-08	2.011E-08	1.170E-08	7.996E-09	5.964E-09	4.699E-09	3.844E-09	3.232E-09	2.775E-09	2.422E-09
NE	5.757E-08	3.226E-08	2.147E-08	1.216E-08	8.167E-09	6.009E-09	4.683E-09	3.796E-09	3.166E-09	2.700E-09	2.342E-09
ENE	4.628E-08	2.604E-08	1.738E-08	9.890E-09	6.668E-09	4.921E-09	3.845E-09	3.123E-09	2.611E-09	2.230E-09	1.938E-09
E	4.345E-08	2.425E-08	1.609E-08	9.086E-09	6.092E-09	4.477E-09	3.485E-09	2.823E-09	2.354E-09	2.006E-09	1.740E-09
ESE	3.611E-08	2.006E-08	1.327E-08	7.456E-09	4.985E-09	3.656E-09	2.842E-09	2.299E-09	1.915E-09	1.630E-09	1.412E-09
SE	4.193E-08	2.335E-08	1.548E-08	8.723E-09	5.844E-09	4.292E-09	3.340E-09	2.705E-09	2.255E-09	1.922E-09	1.666E-09
SSE	4.333E-08	2.426E-08	1.614E-08	9.165E-09	6.150E-09	4.530E-09	3.534E-09	2.867E-09	2.394E-09	2.043E-09	1.774E-09

VENT AND BUILDING PARAMETERS:

RELEASE HEIGHT	(METERS)	58.10
DIAMETER	(METERS)	0.00
EXIT VELOCITY	(METERS)	0.00
REP. WIND HEIGHT	(METERS)	10.0
BUILDING HEIGHT	(METERS)	58.1
BLDG.MIN.CRS.SEC.AREA	(SQ.METERS)	2000.0
HEAT EMISSION RATE	(CAL/SEC)	0.0

ALL GROUND LEVEL RELEASES.

USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 02-[illegible]-90

***** PALISADES XOQDO[illegible] ***** USING 01/01/83 - 12/31/87 MET DATA *****

GROUND LEVEL RELEASE - TOP OF CONTAINMENT BUILDING
NO DECAY, UNDEPLETED

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

SEGMENT BOUNDARIES IN MILES FROM THE SITE

DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	5.817E-07	2.113E-07	9.947E-08	6.118E-08	4.269E-08	2.120E-08	8.065E-09	3.945E-09	2.490E-09	1.772E-09
SSW	5.105E-07	1.857E-07	8.433E-08	5.475E-08	3.842E-08	1.926E-08	7.441E-09	3.684E-09	2.342E-09	1.676E-09
SW	5.284E-07	1.920E-07	9.184E-08	5.718E-08	4.026E-08	2.030E-08	7.909E-09	3.941E-09	2.516E-09	1.806E-09
WSW	6.120E-07	2.196E-07	1.054E-07	6.641E-08	4.705E-08	2.399E-08	9.514E-09	4.812E-09	3.102E-09	2.242E-09
W	8.835E-07	3.155E-07	1.513E-07	9.506E-08	6.732E-08	3.432E-08	1.341E-08	6.441E-09	4.436E-09	3.207E-09
WNW	1.174E-06	4.177E-07	2.004E-07	1.257E-07	8.905E-08	4.542E-08	1.804E-08	9.135E-09	5.895E-09	4.266E-09
NW	1.319E-06	4.705E-07	2.278E-07	1.439E-07	1.024E-07	5.270E-08	2.116E-08	1.082E-08	7.020E-09	5.098E-09
NNW	1.576E-06	5.626E-07	2.744E-07	1.743E-07	1.246E-07	6.449E-08	2.614E-08	1.344E-08	8.752E-09	6.371E-09
N	1.799E-06	6.404E-07	3.126E-07	1.990E-07	1.424E-07	7.386E-08	3.003E-08	1.548E-08	1.010E-08	7.358E-09
NNE	7.783E-07	2.809E-07	1.346E-07	8.432E-08	5.959E-08	3.026E-08	1.192E-08	6.000E-09	3.855E-09	2.780E-09
NE	9.535E-07	3.421E-07	1.589E-07	9.687E-08	6.720E-08	3.309E-08	1.245E-08	6.056E-09	3.809E-09	2.705E-09
ENE	7.672E-07	2.734E-07	1.271E-07	7.769E-08	5.397E-08	2.669E-08	1.012E-08	4.956E-09	3.134E-09	2.234E-09
E	7.368E-07	2.618E-07	1.207E-07	7.334E-08	5.074E-08	2.506E-08	9.312E-09	4.511E-09	2.836E-09	2.011E-09
ESE	6.257E-07	2.210E-07	1.014E-07	6.130E-08	4.226E-08	2.061E-08	7.649E-09	3.665E-09	2.308E-09	1.634E-09
SE	7.216E-07	2.549E-07	1.172E-07	7.100E-08	4.903E-08	2.398E-08	8.944E-09	4.325E-09	2.715E-09	1.926E-09
SSE	7.353E-07	2.602E-07	1.201E-07	7.304E-08	5.039E-08	2.469E-08	9.368E-09	4.563E-09	2.877E-09	2.047E-09

USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 02-05-90

***** PALISADES XOQDOQ82 ***** USING 01/01/83 - 12/31/87 MET DATA *****

GROUND LEVEL RELEASE - TOP OF CONTAINMENT BUILDING
2.260 DAY DECAY, UNDEPLETED

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

SECTOR	0.250	0.500	0.750	1.000	1.500	2.000	2.500	3.000	3.500	4.000	4.500
S	3.117E-06	1.030E-06	5.613E-07	3.695E-07	2.046E-07	1.349E-07	9.776E-08	7.516E-08	6.017E-08	4.965E-08	4.191E-08
SSW	2.799E-06	9.092E-07	4.906E-07	3.232E-07	1.798E-07	1.192E-07	8.678E-08	6.697E-08	5.380E-08	4.452E-08	3.768E-08
SW	2.942E-06	9.476E-07	5.052E-07	3.333E-07	1.859E-07	1.237E-07	9.034E-08	6.989E-08	5.627E-08	4.663E-08	3.955E-08
WSW	3.499E-06	1.110E-06	5.822E-07	3.816E-07	2.119E-07	1.418E-07	1.041E-07	8.086E-08	6.534E-08	5.436E-08	4.622E-08
W	5.029E-06	1.604E-06	8.412E-07	5.496E-07	3.040E-07	2.031E-07	1.490E-07	1.157E-07	9.344E-08	7.768E-08	6.602E-08
WNW	6.690E-06	2.132E-06	1.120E-06	7.297E-07	4.026E-07	2.690E-07	1.974E-07	1.533E-07	1.239E-07	1.031E-07	8.763E-08
NW	7.674E-06	2.403E-06	1.255E-06	8.186E-07	4.534E-07	3.065E-07	2.265E-07	1.750E-07	1.419E-07	1.183E-07	1.008E-07
NNW	9.328E-06	2.884E-06	1.495E-06	9.761E-07	5.423E-07	3.639E-07	2.707E-07	2.117E-07	1.720E-07	1.438E-07	1.227E-07
N	1.066E-05	3.293E-06	1.708E-06	1.112E-06	6.164E-07	4.163E-07	3.086E-07	2.414E-07	1.963E-07	1.642E-07	1.403E-07
NNE	4.400E-06	1.400E-06	7.465E-07	4.887E-07	2.713E-07	1.812E-07	1.327E-07	1.029E-07	8.306E-08	6.900E-08	5.860E-08
NE	5.108E-06	1.693E-06	9.221E-07	6.030E-07	3.312E-07	2.169E-07	1.563E-07	1.196E-07	9.566E-08	7.836E-08	6.613E-08
ENE	4.201E-06	1.371E-06	7.393E-07	4.817E-07	2.661E-07	1.730E-07	1.248E-07	9.555E-08	7.629E-08	6.280E-08	5.291E-08
E	3.967E-06	1.320E-06	7.133E-07	4.635E-07	2.528E-07	1.650E-07	1.186E-07	9.057E-08	7.218E-08	5.927E-08	4.984E-08
ESE	3.376E-06	1.121E-06	6.033E-07	3.917E-07	2.136E-07	1.389E-07	9.953E-08	7.583E-08	6.027E-08	4.962E-08	4.149E-08
SE	3.915E-06	1.296E-06	6.956E-07	4.515E-07	2.463E-07	1.606E-07	1.151E-07	8.779E-08	6.985E-08	5.733E-08	4.817E-08
SSE	3.994E-06	1.315E-06	7.101E-07	4.609E-07	2.516E-07	1.661E-07	1.181E-07	9.027E-08	7.197E-08	5.917E-08	4.980E-08

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

SECTOR	5.000	7.500	10.000	15.000	20.000	25.000	30.000	35.000	40.000	45.000	50.000
S	3.603E-08	2.017E-08	1.337E-08	7.492E-09	4.966E-09	3.605E-09	2.771E-09	2.216E-09	1.824E-09	1.534E-09	1.313E-09
SSW	3.246E-08	1.832E-08	1.221E-08	6.897E-09	4.395E-09	3.348E-09	2.581E-09	2.068E-09	1.706E-09	1.437E-09	1.232E-09
SW	3.412E-08	1.937E-08	1.297E-08	7.375E-09	4.937E-09	3.612E-09	2.794E-09	2.247E-09	1.858E-09	1.569E-09	1.348E-09
WSW	3.996E-08	2.291E-08	1.545E-08	8.877E-09	5.989E-09	4.404E-09	3.427E-09	2.767E-09	2.297E-09	1.947E-09	1.678E-09
W	5.709E-08	3.269E-08	2.202E-08	1.262E-08	8.497E-09	6.242E-09	4.845E-09	3.905E-09	3.237E-09	2.740E-09	2.358E-09
WNW	7.582E-08	4.352E-08	2.939E-08	1.692E-08	1.143E-08	8.429E-09	6.563E-09	5.307E-09	4.410E-09	3.743E-09	3.229E-09
NW	8.742E-08	5.056E-08	3.433E-08	1.990E-08	1.352E-08	1.001E-08	7.815E-09	6.335E-09	5.277E-09	4.488E-09	3.879E-09
NNW	1.066E-07	6.202E-08	4.229E-08	2.466E-08	1.682E-08	1.249E-08	9.784E-09	7.951E-09	6.637E-09	5.654E-09	4.896E-09
N	1.219E-07	7.104E-08	4.850E-08	2.834E-08	1.936E-08	1.439E-08	1.128E-08	9.169E-09	7.657E-09	6.526E-09	5.652E-09
NNE	5.065E-08	2.895E-08	1.949E-08	1.117E-08	7.522E-09	5.531E-09	4.297E-09	3.468E-09	2.877E-09	2.438E-09	2.100E-09
NE	5.676E-08	3.158E-08	2.084E-08	1.165E-08	7.721E-09	5.606E-09	4.311E-09	3.450E-09	2.842E-09	2.393E-09	2.050E-09
ENE	4.542E-08	2.531E-08	1.673E-08	9.343E-09	6.155E-09	4.465E-09	3.444E-09	2.752E-09	2.263E-09	1.903E-09	1.628E-09
E	4.271E-08	2.364E-08	1.555E-08	8.635E-09	5.693E-09	4.116E-09	3.156E-09	2.516E-09	2.066E-09	1.735E-09	1.483E-09
ESE	3.550E-08	1.955E-08	1.282E-08	7.088E-09	4.663E-09	3.367E-09	2.578E-09	2.055E-09	1.687E-09	1.416E-09	1.210E-09
SE	4.125E-08	2.279E-08	1.498E-08	8.310E-09	5.481E-09	3.964E-09	3.041E-09	2.428E-09	1.996E-09	1.677E-09	1.435E-09
SSE	4.272E-08	2.373E-08	1.569E-08	8.771E-09	5.819E-09	4.231E-09	3.256E-09	2.610E-09	2.153E-09	1.813E-09	1.557E-09

VENT AND BUILDING PARAMETERS:

RELEASE HEIGHT	(METERS)	58.10
DIAMETER	(METERS)	0.00
EXIT VELOCITY	(METERS)	0.00
REP. WIND HEIGHT	(METERS)	10.0
BUILDING HEIGHT	(METERS)	58.1
BLDG.MIN.CRS.SEC.AREA	(SQ.METERS)	2000.0
HEAT EMISSION RATE	(CAL/SEC)	0.0

ALL GROUND LEVEL RELEASES.

USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 02-05-90

***** PALISADES XOQDOQ82 ***** USING 01/01/83 - 12/31/87 MET DATA *****

GROUND LEVEL RELEASE - TOP OF CONTAINMENT BUILDING
2.260 DAY DECAY, UNDEPLETED

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

SEGMENT BOUNDARIES IN MILES FROM THE SITE

DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	5.002E-07	2.103E-07	9.863E-08	6.044E-08	4.203E-08	2.067E-08	7.675E-09	3.634E-09	2.225E-09	1.535E-
SSW	5.091E-07	1.867E-07	8.751E-08	5.403E-08	3.777E-08	1.873E-08	7.055E-09	3.373E-09	2.077E-09	1.441E-
SW	5.271E-07	1.910E-07	9.106E-08	5.650E-08	3.964E-08	1.980E-08	7.535E-09	3.638E-09	2.255E-09	1.573E-
WSW	6.104E-07	2.183E-07	1.048E-07	6.558E-08	4.630E-08	2.339E-08	9.035E-09	4.637E-09	2.777E-09	1.951E-
W	8.811E-07	3.138E-07	1.501E-07	9.379E-08	6.617E-08	3.337E-08	1.288E-08	6.283E-09	3.919E-09	2.746E-
WNW	1.171E-06	4.159E-07	1.989E-07	1.244E-07	8.783E-08	4.442E-08	1.725E-08	8.464E-09	5.324E-09	3.750E-
NW	1.316E-06	4.684E-07	2.261E-07	1.424E-07	1.010E-07	5.154E-08	2.027E-08	1.007E-08	6.355E-09	4.496E-
NNW	1.573E-06	5.603E-07	2.728E-07	1.726E-07	1.230E-07	6.316E-08	2.510E-08	1.256E-08	7.974E-09	5.664E-
N	1.792E-06	6.377E-07	3.104E-07	1.970E-07	1.403E-07	7.232E-08	2.883E-08	1.447E-08	9.195E-09	6.537E-
NNE	7.763E-07	2.796E-07	1.337E-07	8.338E-08	5.874E-08	2.957E-08	1.140E-08	5.566E-09	3.479E-09	2.443E-
NE	9.316E-07	3.408E-07	1.578E-07	9.392E-08	6.634E-08	3.241E-08	1.195E-08	5.632E-09	3.464E-09	2.399E-
ENE	7.632E-07	2.720E-07	1.259E-07	7.665E-08	5.306E-08	2.596E-08	9.581E-09	4.522E-09	2.763E-09	1.908E-
E	7.371E-07	2.606E-07	1.198E-07	7.251E-08	4.999E-08	2.428E-08	8.865E-09	4.132E-09	2.527E-09	1.740E-
ESE	6.243E-07	2.200E-07	1.006E-07	6.056E-08	4.162E-08	2.011E-08	7.284E-09	3.397E-09	2.066E-09	1.420E-
SE	7.200E-07	2.537E-07	1.163E-07	7.021E-08	4.832E-08	2.342E-08	8.535E-09	4.000E-09	2.438E-09	1.682E-
SSE	7.339E-07	2.592E-07	1.192E-07	7.232E-08	4.993E-08	2.438E-08	8.997E-09	4.263E-09	2.621E-09	1.819E-

USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 02-05-90

***** PALISADES XOQDOQ82 ***** USING 01/01/83 - 12/31/87 MET DATA *****

GROUND LEVEL RELEASE - TOP OF CONTAINMENT BUILDING
8.000 DAY DECAY, DEPLETED

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

SECTOR	0.250	0.500	0.750	1.000	1.500	2.000	2.500	3.000	3.500	4.000	4.500
S	2.952E-06	9.420E-07	5.011E-07	3.242E-07	1.744E-07	1.123E-07	7.968E-08	6.013E-08	4.736E-08	3.840E-08	3.225E-08
SSW	2.630E-06	8.214E-07	4.378E-07	2.837E-07	1.533E-07	9.925E-08	7.078E-08	5.363E-08	4.238E-08	3.455E-08	2.884E-08
SW	2.786E-06	8.664E-07	4.511E-07	2.924E-07	1.584E-07	1.030E-07	7.363E-08	5.595E-08	4.429E-08	3.616E-08	3.022E-08
WSW	3.313E-06	1.015E-06	5.198E-07	3.349E-07	1.607E-07	1.160E-07	8.484E-08	6.472E-08	5.144E-08	4.214E-08	3.532E-08
W	4.763E-06	1.467E-06	7.511E-07	4.824E-07	2.593E-07	1.691E-07	1.215E-07	9.263E-08	7.362E-08	6.029E-08	5.053E-08
WNW	6.135E-06	1.949E-06	9.992E-07	6.402E-07	3.430E-07	2.237E-07	1.608E-07	1.226E-07	9.743E-08	7.981E-08	6.691E-08
NW	7.267E-06	2.197E-06	1.120E-06	7.182E-07	3.843E-07	2.533E-07	1.828E-07	1.400E-07	1.116E-07	9.163E-08	7.698E-08
NNW	8.832E-06	2.636E-06	1.334E-06	8.562E-07	4.620E-07	3.042E-07	2.204E-07	1.692E-07	1.352E-07	1.113E-07	9.367E-08
N	1.010E-05	3.010E-06	1.524E-06	9.757E-07	5.232E-07	3.462E-07	2.511E-07	1.929E-07	1.543E-07	1.271E-07	1.070E-07
NNE	4.167E-06	1.250E-06	6.446E-07	4.268E-07	2.314E-07	1.507E-07	1.081E-07	8.233E-08	6.534E-08	5.346E-08	4.477E-08
NE	4.837E-06	1.547E-06	8.230E-07	5.289E-07	2.821E-07	1.803E-07	1.272E-07	9.559E-08	7.502E-08	6.079E-08	5.067E-08
ENE	3.979E-06	1.254E-06	6.601E-07	4.227E-07	2.251E-07	1.460E-07	1.017E-07	7.650E-08	6.009E-08	4.873E-08	4.049E-08
E	3.756E-06	1.207E-06	6.348E-07	4.066E-07	2.155E-07	1.372E-07	9.661E-08	7.245E-08	5.676E-08	4.593E-08	3.829E-08
ESE	3.197E-06	1.025E-06	5.365E-07	3.437E-07	1.821E-07	1.156E-07	8.111E-08	6.067E-08	4.743E-08	3.830E-08	3.171E-08
SE	3.708E-06	1.183E-06	6.209E-07	3.961E-07	2.099E-07	1.334E-07	9.377E-08	7.022E-08	5.493E-08	4.442E-08	3.680E-08
SSE	3.782E-06	1.202E-06	6.337E-07	4.063E-07	2.141E-07	1.365E-07	9.613E-08	7.214E-08	5.656E-08	4.579E-08	3.800E-08

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

SECTOR	5.000	7.500	10.000	15.000	[illegible].000	25.000	30.000	35.000	40.000	45.000	50.000
S	2.719E-08	1.468E-08	9.203E-09	4.830E-09	[illegible].041E-09	2.114E-09	1.565E-09	1.210E-09	9.659E-10	7.900E-10	6.587E-10
SSW	2.453E-08	1.317E-08	8.424E-09	4.459E-09	2.823E-09	1.971E-09	1.463E-09	1.136E-09	9.090E-10	7.451E-10	6.225E-10
SW	2.575E-08	1.391E-08	8.927E-09	4.751E-09	3.020E-09	2.115E-09	1.574E-09	1.225E-09	9.825E-10	8.069E-10	6.753E-10
WSW	3.017E-08	1.646E-08	1.064E-08	5.723E-09	3.666E-09	2.584E-09	1.934E-09	1.510E-09	1.215E-09	1.002E-09	8.407E-10
W	4.314E-08	2.352E-08	1.520E-08	8.169E-09	5.228E-09	3.682E-09	2.755E-09	2.149E-09	1.729E-09	1.423E-09	1.194E-09
WNW	5.714E-08	3.119E-08	2.018E-08	1.087E-08	6.968E-09	4.913E-09	3.683E-09	2.878E-09	2.318E-09	1.911E-09	1.605E-09
NW	6.588E-08	3.623E-08	2.357E-08	1.278E-08	8.232E-09	5.828E-09	4.380E-09	3.430E-09	2.769E-09	2.287E-09	1.924E-09
NNW	8.027E-08	4.460E-08	2.899E-08	1.580E-08	1.022E-08	7.252E-09	5.462E-09	4.286E-09	3.465E-09	2.867E-09	2.415E-09
N	9.178E-08	5.086E-08	3.325E-08	1.816E-08	1.176E-08	8.356E-09	6.298E-09	4.945E-09	4.000E-09	3.311E-09	2.790E-09
NNE	3.819E-08	2.074E-08	1.339E-08	7.177E-09	4.587E-09	3.227E-09	2.413E-09	1.882E-09	1.513E-09	1.246E-09	1.045E-09
NE	4.274E-08	2.261E-08	1.430E-08	7.467E-09	4.691E-09	3.257E-09	2.409E-09	1.862E-09	1.486E-09	1.215E-09	1.013E-09
ENE	3.431E-08	1.821E-08	1.155E-08	6.047E-09	3.807E-09	2.647E-09	1.960E-09	1.516E-09	1.210E-09	9.898E-10	8.256E-10
E	3.222E-08	1.697E-08	1.070E-08	5.566E-09	3.466E-09	2.415E-09	1.743E-09	1.375E-09	1.096E-09	8.947E-10	7.449E-10
ESE	2.679E-08	1.404E-08	8.824E-09	4.567E-09	2.854E-09	1.973E-09	1.455E-09	1.121E-09	8.926E-10	7.282E-10	6.059E-10
SE	3.111E-08	1.635E-08	1.030E-08	5.347E-09	3.348E-09	2.319E-09	1.712E-09	1.321E-09	1.053E-09	8.601E-10	7.164E-10
SSE	3.217E-08	1.700E-08	1.075E-08	5.618E-09	3.534E-09	2.457E-09	1.819E-09	1.408E-09	1.123E-09	9.206E-10	7.683E-10

VENT AND BUILDING PARAMETERS:

RELEASE HEIGHT	(METERS)	58.10
DIAMETER	(METERS)	0.00
EXIT VELOCITY	(METERS)	0.00
REP. WIND HEIGHT	(METERS)	10.0
BUILDING HEIGHT	(METERS)	58.1
BLDG.MIN.CRS.SEC.AREA	(SQ.METERS)	2000.0
HEAT EMISSION RATE	(CAL/SEC)	0.0

ALL GROUND LEVEL RELEASES.

USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 02-05-90

***** PALISADES XOQDOQ82 ***** USING 01/01/83 - 12/31/87 MET DATA *****

GROUND LEVEL RELEASE - TOP OF CONTAINMENT BUILDING
8.000 DAY DECAY, DEPLETED

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

SEGMENT BOUNDARIES IN MILES FROM THE SITE

DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	5.204E-07	1.801E-07	8.056E-08	4.743E-08	3.216E-08	1.496E-08	5.007E-09	2.142E-09	1.218E-09	7.935E-10
SSW	4.368E-07	1.562E-07	7.151E-08	4.261E-08	2.893E-08	1.359E-08	4.613E-09	1.996E-09	1.143E-09	7.483E-10
SW	4.729E-07	1.634E-07	7.437E-08	4.452E-08	3.033E-08	1.432E-08	4.909E-09	2.141E-09	1.233E-09	8.102E-10
WSW	5.478E-07	1.871E-07	8.564E-08	5.169E-08	3.544E-08	1.692E-08	5.902E-09	2.612E-09	1.519E-09	1.005E-09
W	7.907E-07	2.688E-07	1.227E-07	7.398E-08	5.069E-08	2.418E-08	8.425E-09	3.723E-09	2.162E-09	1.429E-09
WNW	1.031E-06	3.560E-07	1.623E-07	9.791E-08	6.712E-08	3.206E-08	1.120E-08	4.970E-09	2.895E-09	1.918E-09
NW	1.181E-06	4.009E-07	1.845E-07	1.121E-07	7.721E-08	3.719E-08	1.315E-08	5.890E-09	3.449E-09	2.295E-09
NNW	1.411E-06	4.795E-07	2.223E-07	1.358E-07	9.393E-08	4.552E-08	1.625E-08	7.327E-09	4.309E-09	2.877E-09
N	1.611E-06	5.457E-07	2.532E-07	1.550E-07	1.073E-07	5.212E-08	1.867E-08	8.439E-09	4.972E-09	3.322E-09
NNE	6.965E-07	2.394E-07	1.092E-07	6.567E-08	4.491E-08	2.136E-08	7.404E-09	3.264E-09	1.893E-09	1.251E-09
NE	8.333E-07	2.917E-07	1.287E-07	7.547E-08	5.067E-08	2.339E-08	7.753E-09	3.308E-09	1.875E-09	1.220E-09
ENE	6.865E-07	2.330E-07	1.029E-07	6.045E-08	4.064E-08	1.882E-08	6.273E-09	2.682E-09	1.526E-09	9.942E-10
E	6.612E-07	2.232E-07	9.776E-08	5.712E-08	3.824E-08	1.757E-08	5.783E-09	2.444E-09	1.385E-09	8.987E-10
ESE	5.600E-07	1.884E-07	8.212E-08	4.773E-08	3.184E-08	1.455E-08	4.752E-09	2.001E-09	1.129E-09	7.315E-10
SE	6.458E-07	2.173E-07	9.493E-08	5.536E-08	3.695E-08	1.694E-08	5.359E-09	2.331E-09	1.331E-09	8.640E-10
SSE	6.581E-07	2.219E-07	9.728E-08	5.691E-08	3.615E-08	1.759E-08	5.833E-09	2.469E-09	1.417E-09	9.246E-10

USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 02-05-40

***** PALISADES XOQDOQ82 ***** USING 01/01/83 - 12/31/87 MET DATA *****

GROUND LEVEL RELEASE - TOP OF CONTAINMENT BUILDING

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

DISTANCES IN MILES

DIRECTION FROM SITE	0.25	0.50	0.75	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50
S	2.394E-08	8.394E-09	4.137E-09	2.552E-09	1.273E-09	7.718E-10	5.218E-10	3.781E-10	2.875E-10	2.265E-10	1.834E-10
SSW	1.736E-08	5.871E-09	3.014E-09	1.851E-09	9.228E-10	5.596E-10	3.784E-10	2.742E-10	2.085E-10	1.643E-10	1.330E-10
SW	1.668E-08	5.640E-09	2.896E-09	1.778E-09	8.865E-10	5.377E-10	3.635E-10	2.634E-10	2.003E-10	1.578E-10	1.278E-10
WSW	1.128E-08	6.183E-09	3.175E-09	1.949E-09	9.718E-10	5.896E-10	3.985E-10	2.888E-10	2.196E-10	1.730E-10	1.400E-10
W	2.941E-08	9.946E-09	5.107E-09	3.136E-09	1.563E-09	9.481E-10	6.410E-10	4.645E-10	3.532E-10	2.783E-10	2.253E-10
WNW	4.353E-08	1.342E-08	7.905E-09	4.854E-09	2.420E-09	1.468E-09	9.923E-10	7.191E-10	5.468E-10	4.308E-10	3.487E-10
NW	4.377E-08	1.368E-08	7.947E-09	4.880E-09	2.433E-09	1.475E-09	9.976E-10	7.229E-10	5.497E-10	4.330E-10	3.506E-10
NNW	5.346E-08	1.808E-08	9.282E-09	5.700E-09	2.841E-09	1.723E-09	1.165E-09	8.443E-10	6.420E-10	5.058E-10	4.095E-10
N	5.246E-08	1.774E-08	9.108E-09	5.593E-09	2.788E-09	1.691E-09	1.143E-09	8.285E-10	6.300E-10	4.963E-10	4.018E-10
NNE	2.523E-08	8.530E-09	4.380E-09	2.689E-09	1.341E-09	8.132E-10	5.498E-10	3.984E-10	3.029E-10	2.387E-10	1.932E-10
NE	4.823E-08	1.631E-08	8.374E-09	5.142E-09	2.564E-09	1.555E-09	1.051E-09	7.617E-10	5.792E-10	4.563E-10	3.694E-10
ENE	3.710E-08	1.255E-08	6.442E-09	3.956E-09	1.972E-09	1.196E-09	8.087E-10	5.860E-10	4.456E-10	3.510E-10	2.842E-10
E	4.075E-08	1.378E-08	7.076E-09	4.345E-09	2.166E-09	1.314E-09	8.882E-10	6.437E-10	4.894E-10	3.856E-10	3.122E-10
ESE	3.630E-08	1.228E-08	6.303E-09	3.870E-09	1.929E-09	1.170E-09	7.912E-10	5.733E-10	4.359E-10	3.434E-10	2.781E-10
SE	4.434E-08	1.499E-08	7.698E-09	4.727E-09	2.357E-09	1.429E-09	9.664E-10	7.003E-10	5.325E-10	4.195E-10	3.396E-10
SSE	4.416E-08	1.493E-08	7.668E-09	4.709E-09	2.347E-09	1.424E-09	9.626E-10	6.975E-10	5.304E-10	4.179E-10	3.383E-10

DISTANCES IN MILES

DIRECTION FROM SITE	5.00	7.50	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00
S	1.317E-10	7.434E-11	4.666E-11	2.337E-11	1.427E-11	9.567E-12	6.855E-12	5.147E-12	4.002E-12	3.197E-12	2.610E-12
SSW	1.100E-10	5.390E-11	3.382E-11	1.710E-11	1.035E-11	6.937E-12	4.971E-12	3.733E-12	2.902E-12	2.318E-12	1.892E-12
SW	1.057E-10	5.179E-11	3.249E-11	1.642E-11	9.940E-12	6.665E-12	4.776E-12	3.586E-12	2.788E-12	2.227E-12	1.818E-12
WSW	1.158E-10	5.677E-11	3.562E-11	1.800E-11	1.090E-11	7.306E-12	5.235E-12	3.931E-12	3.056E-12	2.442E-12	1.993E-12
W	1.863E-10	9.132E-11	5.730E-11	2.896E-11	1.753E-11	1.175E-11	8.421E-12	6.324E-12	4.917E-12	3.928E-12	3.206E-12
WNW	2.885E-10	1.414E-10	8.870E-11	4.483E-11	2.713E-11	1.819E-11	1.304E-11	9.789E-12	7.611E-12	6.080E-12	4.962E-12
NW	2.900E-10	1.421E-10	8.917E-11	4.507E-11	2.728E-11	1.829E-11	1.311E-11	9.841E-12	7.651E-12	6.112E-12	4.989E-12
NNW	3.387E-10	1.660E-10	1.041E-10	5.264E-11	3.186E-11	2.136E-11	1.531E-11	1.149E-11	8.937E-12	7.139E-12	5.827E-12
N	3.324E-10	1.629E-10	1.022E-10	5.165E-11	3.126E-11	2.096E-11	1.502E-11	1.128E-11	8.769E-12	7.005E-12	5.718E-12
NNE	1.598E-10	7.832E-11	4.914E-11	2.484E-11	1.503E-11	1.008E-11	7.223E-12	5.424E-12	4.217E-12	3.369E-12	2.749E-12
NE	3.056E-10	1.498E-10	9.396E-11	4.749E-11	2.874E-11	1.927E-11	1.381E-11	1.037E-11	8.063E-12	6.441E-12	5.257E-12
ENE	2.351E-10	1.152E-10	7.228E-11	3.653E-11	2.211E-11	1.483E-11	1.062E-11	7.977E-12	6.202E-12	4.955E-12	4.044E-12
E	2.582E-10	1.265E-10	7.939E-11	4.013E-11	2.429E-11	1.628E-11	1.167E-11	8.762E-12	6.813E-12	5.442E-12	4.442E-12
ESE	2.300E-10	1.127E-10	7.072E-11	3.574E-11	2.163E-11	1.451E-11	1.039E-11	7.805E-12	6.068E-12	4.847E-12	3.957E-12
SE	2.809E-10	1.377E-10	8.638E-11	4.366E-11	2.642E-11	1.772E-11	1.270E-11	9.533E-12	7.412E-12	5.921E-12	4.833E-12
SSE	2.798E-10	1.371E-10	8.604E-11	4.349E-11	2.632E-11	1.765E-11	1.265E-11	9.495E-12	7.383E-12	5.898E-12	4.814E-12

USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 02-05-90

***** PALISADES XOQDOQ82 ***** USING 01/01/83 - 12/31/87 MET DATA *****

GROUND LEVEL RELEASE - TOP OF CONTAINMENT BUILDING

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

SEGMENT BOUNDARIES IN MILES

DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	6.319E-09	1.334E-09	5.310E-10	2.902E-10	1.866E-10	7.922E-11	2.456E-11	9.736E-12	5.199E-12	3.210E-12
SSW	5.132E-09	9.676E-10	3.850E-10	2.104E-10	1.337E-10	5.744E-11	1.781E-11	7.060E-12	3.770E-12	2.356E-12
SW	5.009E-09	9.296E-10	3.699E-10	2.021E-10	1.285E-10	5.519E-11	1.711E-11	6.783E-12	3.622E-12	2.262E-12
WSW	5.298E-09	1.019E-09	4.055E-10	2.216E-10	1.408E-10	6.050E-11	1.876E-11	7.435E-12	3.970E-12	2.480E-12
W	5.306E-09	1.639E-09	6.523E-10	3.565E-10	2.266E-10	9.732E-11	3.018E-11	1.196E-11	6.387E-12	3.989E-12
WNW	8.214E-09	2.538E-09	1.010E-09	5.518E-10	3.507E-10	1.506E-10	4.671E-11	1.851E-11	9.887E-12	6.120E-12
NW	8.257E-09	2.551E-09	1.015E-09	5.547E-10	3.526E-10	1.514E-10	4.696E-11	1.861E-11	9.939E-12	6.152E-12
NNW	9.644E-09	2.980E-09	1.186E-09	6.479E-10	4.118E-10	1.769E-10	5.485E-11	2.174E-11	1.161E-11	7.186E-12
N	9.464E-09	2.924E-09	1.163E-09	6.358E-10	4.041E-10	1.736E-10	5.382E-11	2.133E-11	1.139E-11	7.051E-12
NNE	4.551E-09	1.406E-09	5.595E-10	3.057E-10	1.943E-10	8.347E-11	2.588E-11	1.026E-11	5.478E-12	3.391E-12
NE	8.701E-09	2.688E-09	1.070E-09	5.845E-10	3.715E-10	1.596E-10	4.949E-11	1.961E-11	1.047E-11	6.483E-12
ENE	6.693E-09	2.068E-09	8.229E-10	4.497E-10	2.858E-10	1.228E-10	3.807E-11	1.509E-11	8.057E-12	4.987E-12
E	7.352E-09	2.271E-09	9.039E-10	4.939E-10	3.139E-10	1.348E-10	4.181E-11	1.657E-11	8.850E-12	5.478E-12
ESE	6.549E-09	2.023E-09	8.051E-10	4.399E-10	2.796E-10	1.201E-10	3.724E-11	1.476E-11	7.883E-12	4.879E-12
SE	7.999E-09	2.471E-09	9.834E-10	5.374E-10	3.415E-10	1.467E-10	4.549E-11	1.803E-11	9.629E-12	5.960E-12
SSE	7.967E-09	2.462E-09	9.795E-10	5.353E-10	3.402E-10	1.461E-10	4.531E-11	1.796E-11	9.591E-12	5.936E-12

VENT AND BUILDING PARAMETERS:

RELEASE HEIGHT	(METERS)	58.10	REP. WIND HEIGHT	(METERS)	10.0
DIAMETER	(METERS)	0.00	BUILDING HEIGHT	(METERS)	58.1
EXIT VELOCITY	(METERS)	0.00	BLDG.MIN.CRS.SEC.AREA	(SQ.METERS)	2000.0
			HEAT EMISSION RATE	(CAL/SEC)	0.0

ALL GROUND LEVEL RELEASES.

TABLE 1.4

1990 PALISADES LAND USE CENSUS

TABLE 10.11-1

Distance to the nearest residence, garden, dairy/beef cattle and goat in each sector.

SECTOR	RESIDENCE	GARDEN	BEEF CATTLE	DAIRY COW	GOAT
N	>5 mi	>5 mi	>5 mi	>5 mi	>5 mi
NNE	1.6 mi	3.8 mi	>5 mi	>5 mi	>5 mi
NE	1.8 mi	1.8 mi	>5 mi	>5 mi	>5 mi
ENE	1.3 mi	2.9 mi	2.5 mi	4.0 mi	3.8 mi
E	1.0 mi	1.1 mi	3.5 mi	>5 mi	>5 mi
ESE	1.0 mi	1.0 mi	>5 mi	>5 mi	>5 mi
SE	.9 mi	1.1 mi	3.8 mi	4.3 mi	>5 mi
SSE	.75 mi	1.5 mi	>5 mi	>5 mi	>5 mi
S	.5	1.5 mi	>5 mi	>5 mi	>5 mi
SSW	.75 mi	1.5 mi	>5 mi	>5 mi	>5 mi

TABLE 1.4a

1990 PALISADES LAND USE CENSUS

TABLE 10.11-3

Critical Receptor I'ems

Sector	Distance (Miles)	Location/Description	Item	*X/Q (sec/m³)
SSE	0.48	Site Boundary	N/A	1.40E-06
S	0.50	Residence, Palisades Park; 3/4 mile West of 29th Avenue and Blue Star intersection.	Residence/ Garden	1.00E-06
ENE	2.50	Robinson, 18800 M-140 Covert (West side of road)	Beef Cattle	1.30E-07
ENE	4.00	Cecil Hodge, 16971 72nd Street, 3/8 mile South of 16th Avenue and 72nd Street intersection (West side of 72nd Street).	Dairy	6.40E-08
ENE	3.80	Harlett, 19487 72nd Street ½ mile South of 72nd Street CR 380 intersection.	Goat	6.90E-08

NOTE:

*Ba. d on Palisades 5-year composite meteorological data, 1983-1987.

TABLE 1.5

DOSE FACTORS FOR SUBMERSION IN NOBLE GASES*

	DFR[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 USNRC Regulatory Guide 1.109, Revision 1 (October 19[illegible]

TABLE 1.6

STABLE ELEMENT TRANSFER DATA

ELEMENT	F_m - MILK (COW) (DAYS/L)	F_m - MILK (GOAT) (DAYS/L)	F_f - MEAT (DAYS/KG)	B_{iv} (VEG/SOIL)
H	1.0E-02	1.7E-01	1.2E-02	4.8E-00
C	1.2E-02	1.0E-01	3.1E-02	5.5E-00
Na	4.0E-02	4.0E-02	3.0E-02	5.2E-02
P	2.5E-02	2.5E-01	4.6E-02	1.1E-00
Cr	2.2E-03	2.2E-03	2.4E-03	2.5E-04
Mn	2.5E-04	2.5E-04	8.0E-04	2.9E-02
Fe	1.2E-03	1.3E-04	4.0E-02	6.6E-04
Co	1.0E-03	1.0E-03	1.3E-02	9.4E-03
Ni	6.7E-03	6.7E-03	5.3E-02	1.9E-02
Cu	1.4E-02	1.3E-02	8.0E-03	1.2E-01
Zn	3.9E-02	3.9E-02	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

INFANT INHALATION DOSE COMMITMENT FACTORS (MREM/50Y PER PCI INHALED IN FIRST YR)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
H3*	0.	4.62E-07	4.62E-07	4.62E-07	4.62E-07	4.62E-07	4.62E-07
BE10	2.44E-04	1.25E-04	2.65E-05	0.	0.	1.49E-03	1.73E-05
C14	1.89E-05	3.79E-06	3.79E-06	3.79E-06	3.79E-06	3.79E-06	3.79E-06
N13	4.39E-08	4.39E-08	4.39E-08	4.39E-08	4.39E-08	4.39E-08	4.39E-08
F18	3.92E-06	0.	3.33E-07	0.	0.	0.	8.10E-07
NA22	7.37E-05	7.37E-05	7.37E-05	7.37E-05	7.37E-05	7.37E-05	7.37E-05
NA24	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06
P32	1.45E-03	8.03E-05	5.53E-05	0.	0.	0.	1.15E-05
AR39	0.	0.	0.	0.	0.	1.00E-08	0.
AR41	0.	0.	0.	0.	0.	3.14E-08	0.
CA41	7.48E-05	0.	8.16E-06	0.	0.	6.94E-02	2.96E-07
SC46	3.75E-04	5.41E-04	1.69E-04	0.	3.56E-04	0.	2.19E-05
CR51	0.	0.	6.39E-08	4.11E-08	9.45E-09	9.17E-06	2.55E-07
MN54	0.	1.81E-05	3.56E-06	0.	3.56E-06	7.14E-04	5.04E-06
MN56	0.	1.10E-09	1.58E-10	0.	7.86E-10	8.45E-06	5.12E-05
FE55	1.41E-05	8.39E-06	2.38E-06	0.	0.	6.21E-05	7.82E-07
FE59	9.69E-06	1.68E-05	6.77E-06	0.	0.	7.25E-04	1.77E-05
CO57	0.	4.65E-07	4.58E-07	0.	0.	2.71E-04	3.47E-06
CO58	0.	8.71E-07	1.30E-06	0.	0.	5.55E-04	7.95E-06
CO60	0.	5.73E-06	8.41E-06	0.	0.	3.22E-03	2.28E-05
NI59	1.81E-05	5.44E-06	3.10E-06	0.	0.	5.48E-05	6.34E-07
NI63	2.42E-04	1.46E-05	8.29E-06	0.	0.	1.49E-04	1.73E-06
NI65	1.71E-09	2.03E-10	8.79E-11	0.	0.	5.80E-06	3.58E-05
CU64	0.	1.34E-09	5.53E-10	0.	2.84E-09	6.64E-06	1.07E-05
ZN65	1.38E-05	4.47E-05	2.22E-05	0.	2.32E-05	4.62E-04	3.67E-05
ZN69M+D	8.98E-09	1.84E-08	1.67E-09	0.	7.45E-09	1.91E-05	2.92E-05
ZN69	3.85E-11	6.91E-11	5.13E-12	0.	2.87E-11	1.05E-06	9.44E-06
SE79	0.	2.25E-06	4.20E-07	0.	2.47E-06	2.99E-04	3.46E-06
BR82	0.	0.	9.49E-06	0.	0.	0.	0.
BR83+D	0.	0.	2.72E-07	0.	0.	0.	0.
BR84	0.	0.	2.86E-07	0.	0.	0.	0.
BR85	0.	0.	1.46E-08	0.	0.	0.	0.
KR83M	0.	0.	0.	0.	0.	2.50E-09	0.
KR85M	0.	0.	0.	0.	0.	1.31E-08	0.
KR85	0.	0.	0.	0.	0.	1.16E-08	0.
KR87	0.	0.	0.	0.	0.	6.59E-08	0.
KR88+D	0.	0.	0.	0.	0.	1.38E-07	0.
KR89	0.	0.	0.	0.	0.	8.67E-08	0.
RB86	0.	1.36E-04	6.30E-05	0.	0.	0.	2.17E-06
RB87	0.	7.11E-05	2.64E-05	0.	0.	0.	2.99E-07
RB88	0.	3.98E-07	2.05E-07	0.	0.	0.	2.42E-07
RB89+D	0.	2.29E-07	1.47E-07	0.	0.	0.	4.87E-08
SR89+D	2.84E-04	0.	8.15E-06	0.	0.	1.45E-03	4.57E-05
SR90+D	2.92E-02	0.	1.85E-03	0.	0.	8.03E-03	9.36E-05
SR91+D	6.83E-08	0.	2.47E-09	0.	0.	3.76E-05	5.24E-05
SR92+D	7.50E-09	0.	2.79E-10	0.	0.	1.70E-05	1.00E-04

*Includes a 50% increase to account for percutaneous transpiration.

INFANT INHALATION DOSE COMMITMENT FACTORS(MREM/50Y PER PCI INHALED IN FIRST YR)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
Y90	2.35E-06	0.	6.30E-08	0.	0.	1.92E-04	7.43E-05
Y91M+D	2.91E-10	0.	9.90E-12	0.	0.	1.99E-06	1.68E-06
Y91	4.20E-04	0.	1.12E-05	0.	0.	1.75E-03	5.02E-05
Y92	1.17E-08	0.	3.29E-10	0.	0.	1.75E-05	9.04E-05
Y93	1.07E-07	0.	2.91E-09	0.	0.	5.46E-05	1.19E-04
ZR93+D	2.24E-04	9.51E-05	6.18E-05	0.	3.19E-04	1.37E-03	1.48E-05
ZR95+D	8.24E-05	1.99E-05	1.45E-05	0.	2.22E-05	1.25E-03	1.55E-05
ZR97+D	1.07E-07	1.83E-08	8.36E-09	0.	1.85E-08	7.88E-05	1.00E-04
NB93M	1.38E-04	3.59E-05	1.15E-05	0.	3.68E-05	2.09E-04	2.47E-06
NB95	1.12E-05	4.59E-06	2.70E-06	0.	3.37E-06	3.42E-04	9.05E-06
NB97	2.44E-10	5.21E-11	1.88E-11	0.	4.07E-11	2.37E-06	1.92E-05
MO93	0.	6.46E-06	2.22E-07	0.	1.54E-06	3.40E-04	3.76E-06
MO99+D	0.	1.18E-07	2.31E-08	0.	1.89E-07	9.63E-05	3.48E-05
TC99M	9.98E-13	2.06E-12	2.66E-11	0.	2.22E-11	5.79E-07	1.45E-06
TC99	2.09E-07	2.68E-07	8.85E-08	0.	2.49E-06	6.77E-04	7.82E-06
TC101	4.65E-14	5.88E-14	5.80E-13	0.	6.95E-13	4.17E-07	6.03E-07
RU103+D	1.44E-06	0.	4.85E-07	0.	3.03E-06	3.94E-04	1.15E-05
RU105+D	8.74E-10	0.	2.93E-10	0.	6.42E-10	1.12E-05	3.46E-05
RU106+D	6.20E-05	0.	7.77E-06	0.	7.61E-05	8.26E-03	1.17E-04
RH105	8.26E-09	5.41E-09	3.63E-09	0.	1.50E-08	2.08E-05	1.37E-05
PD107	0.	4.92E-07	4.11E-08	0.	2.75E-06	6.34E-05	7.33E-07
PD109	0.	3.92E-09	1.05E-09	0.	1.28E-08	1.68E-05	2.85E-05
AG110M+D	7.13E-06	5.16E-06	3.57E-06	0.	7.80E-06	2.62E-03	2.36E-05
AG111	3.75E-07	1.45E-07	7.75E-08	0.	3.05E-07	2.06E-04	3.02E-05
CD113M	0.	6.67E-04	2.64E-05	0.	5.80E-04	1.40E-03	1.65E-05
CD115M	0.	1.73E-04	6.19E-06	0.	9.41E-05	1.47E-03	5.02E-05
SN123	2.09E-04	4.21E-06	7.28E-06	4.27E-06	0.	2.22E-03	4.08E-05
SN125+D	1.01E-05	2.51E-07	6.00E-07	2.47E-07	0.	6.43E-04	7.26E-05
SN126+D	8.30E-04	1.44E-05	3.52E-05	3.84E-06	0.	4.93E-03	1.65E-05
SB124	2.71E-05	3.97E-07	8.56E-06	7.18E-08	0.	1.89E-03	4.22E-05
SB125+D	3.69E-05	3.41E-07	7.78E-06	4.45E-08	0.	1.17E-03	1.05E-05
SB126	3.08E-06	6.01E-08	1.11E-06	2.35E-08	0.	6.88E-04	5.33E-05
SB127	2.82E-07	5.04E-09	8.76E-08	3.60E-09	0.	1.54E-04	3.78E-05
TE125M	3.40E-06	1.42E-06	4.70E-07	1.16E-06	0.	3.19E-04	9.22E-06
TE127M+D	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+D	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+D	7.62E-08	3.93E-08	2.59E-08	6.38E-08	1.89E-07	1.42E-04	8.51E-05
TE131+D	1.24E-11	5.87E-12	3.57E-12	1.13E-11	2.85E-11	1.47E-06	5.87E-06
TE132+D	2.66E-07	1.69E-07	1.26E-07	1.99E-07	7.39E-07	2.43E-04	3.15E-05
TE133M+D	5.13E-11	3.59E-11	2.74E-11	5.52E-11	1.72E-10	3.92E-06	1.59E-05
TE134+D	3.18E-11	2.04E-11	1.68E-11	2.91E-11	9.59E-11	2.93E-06	2.53E-06
I129	2.16E-05	1.59E-05	1.16E-05	1.04E-02	1.88E-05	0.	2.12E-07
I130	4.54E-06	9.91E-06	3.98E-06	1.14E-03	1.09E-05	0.	1.42E-06
I131+D	2.71E-05	3.17E-05	1.40E-05	1.06E-02	3.70E-05	0.	7.56E-07

NFANT INHALATION DOSE COMMITMENT FACTORS(MREM/50Y PER PCI INHALED IN FIRST YR)

SOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
I132	1.21E-06	2.53E-06	8.99E-07	1.21E-04	2.82E-06	0.	1.36E-06
I133+D	9.46E-06	1.37E-05	4.00E-06	2.54E-03	1.60E-05	0.	1.54E-06
I134	6.58E-07	1.34E-06	4.75E-07	3.18E-05	1.49E-06	0.	9.[illegible]E-07
I135+D	2.76E-06	5.43E-06	1.98E-06	4.97E-04	6.05E-06	0.	1.31E-06
XE131M	0.	0.	0.	0.	0.	6.77E-09	0.
XE133M	0.	0.	0.	0.	0.	8.89E-09	0.
XE133	0.	0.	0.	0.	0.	7.41E-09	0.
XE135M	0.	0.	0.	0.	0.	8.05E-09	0.
XE135	0.	0.	0.	0.	0.	1.80E-08	0.
XE137	0.	0.	0.	0.	0.	8.30E-08	0.
XE138+D	0.	0.	0.	0.	0.	9.78E-0[illegible]	0.
CS134M+D	1.32E-07	2.10E-07	1.11E-07	0.	8.50E-0[illegible]	2.00E-08	1.16E-07
CS134	2.83E-04	5.02E-04	5.32E-05	0.	1.36E-04	5.69E-05	9.53E-07
CS135	1.00E-04	8.66E-05	4.73E-06	0.	2.58E-05	1.01E-05	2.18E-07
CS136	3.45E-05	9.61E-05	3.78E-05	0.	4.03E-05	8.40E-06	1.02E-06
CS137+D	3.92E-04	4.37E-04	3.25E-05	0.	1.23E-04	5.09E-05	9.53E-07
CS138	3.61E-07	5.58E-07	2.84E-07	0.	2.93E-07	4.67E-08	6.26E-07
CS139+D	2.32E-07	3.03E-07	1.22E-07	0.	1.65E-07	2.53E-08	1.33E-08
BA139	1.06E-09	7.03E-13	3.07E-11	0.	4.23E-13	4.25E-06	3.64E-05
BA140+D	4.00E-05	4.00E-08	2.07E-06	0.	9.59E-09	1.14E-03	2.74E-05
BA141+D	1.12E-10	7.70E-14	3.55E-12	0	4.64E-14	2.12E-06	3.39E-06
BA142+D	2.84E-11	2.36E-14	1.40E-12	0.	1.36E-14	1.11E-06	4.95E-07
LA140	3.61E-07	1.43E-07	3.68E-08	0.	0.	1.20E-04	6.06E-05
LA141	4.85E-09	1.40E-09	2.45E-10	0.	0.	1.22E-05	5.96E-05
LA142	7.36E-10	2.69E-10	6.46E-11	0.	0.	5.87E-06	4.25E-05
CE141	1.98E-05	1.19E-05	1.42E-06	0.	3.75E-06	3.69E-04	1.54E-05
CE143+D	2.09E-07	1.38E-07	1.58E-08	0.	4.03E-08	8.30E-05	3.55E-05
CE144+D	2.28E-03	8.65E-04	1.26E-04	0.	3.84E-04	7.03E-03	1.06E-04
PR143	1.00E-05	3.74E-06	4.99E-07	0.	1.41E-06	3.09E-04	2.66E-05
PR144	3.42E-11	1.32E-11	1.72E-12	0.	4.80E-12	1.15E-06	3.06E-06
ND147+D	5.67E-06	5.81E-06	3.57E-07	0.	2.25E-06	2.30E-04	2.23E-05
PM147	3.91E-04	3.07E-05	1.56E-05	0.	4.93E-05	4.55E-04	5.75E-06
PM148M+D	5.00E-05	1.24E-05	9.94E-06	0.	1.45E-05	1.22E-03	3.37E-05
PM148	3.34E-06	4.82E-07	2.44E-07	0.	5.76E-07	3.20E-04	6.04E-05
PM149	3.10E-07	4.08E-08	1.78E-08	0.	4.96E-08	6.50E-05	3.01E-05
PM151	7.52E-08	1.10E-08	5.55E-09	0.	1.30E-08	3.25E-05	2.58E-05
SM151	3.38E-04	6.45E-05	1.63E-05	0.	5.24E-05	2.98E-04	3.46E-06
SM153	1.53E-07	1.18E-07	9.06E-09	0.	2.47E-08	3.70E-05	1.93E-05
EU152	7.83E-04	1.77E-04	1.72E-04	0.	5.94E-04	1.48E-03	9.88E-06
EU154	2.96E-03	3.46E-04	2.45E-04	0.	1.14E-03	3.05E-03	2.84E-05
EU155	5.97E-04	5.72E-05	3.46E-05	0.	1.58E-04	5.20E-04	5.19E-05
EU156	1.56E-05	9.59E-06	1.54E-06	0.	4.48E-06	6.12E-04	4.14E-05
TB160	1.12E-04	0.	1.40E-05	0.	3.20E-05	1.11E-03	2.14E-05
HO166M	1.45E-03	3.07E-04	2.51E-04	0.	4.22E-04	2.05E-03	1.65E-05
W181	4.86E-08	1.46E-08	1.67E-09	0.	0.	1.33E-05	2.63E-07
W185	1.57E-06	4.83E-07	5.58E-08	0.	0.	4.48E-04	1.12E-05
W187	9.26E-09	6.44E-09	2.23E-09	0.	0.	2.83E-05	2.54E-05

INFANT INHALATION DOSE COMMITMENT FACTORS(MREM/50Y PER PCI INHALED IN FIRST YR)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
PB210+D	4.62E-02	2.02E-02	3.43E-03	0.	6.85E-02	1.78E-01	3.79E-05
BI210+D	0.	1.33E-05	1.18E-06	0.	1.03E-04	9.96E-03	3.27E-05
PO210	2.98E-03	5.63E-03	7.12E-04	0.	1.30E-02	2.40E-01	4.36E-05
RN222+D	0.	0.	0.	0.	0.	9.88E-06	0.
RA223+D	1.56E-03	2.26E-06	3.12E-04	0.	4.16E-05	2.25E-01	3.04E-04
RA224+D	1.77E-04	4.00E-07	3.54E-05	0.	7.30E-06	7.91E-02	3.42E-04
RA225+D	2.57E-03	2.88E-06	5.13E-04	0.	5.31E-05	2.57E-01	2.87E-04
RA226+D	2.48E-01	1.46E-05	2.04E-01	0.	2.94E-04	7.83E-01	3.05E-04
RA228+D	1.60E-01	7.61E-06	1.40E-01	0.	1.53E-04	1.04E+00	5.19E-05
AC225	3.69E-03	4.72E-03	2.48E-04	0.	3.49E-04	1.96E-01	2.71E-04
AC227+D	5.29E+00	8.76E-01	3.28E-01	0.	1.86E-01	1.62E+00	5.27E-05
TH227+D	1.82E-03	3.03E-05	5.24E-05	0.	1.13E-04	3.27E-01	3.53E-04
TH228+D	8.46E-01	1.10E-02	2.86E-02	0.	5.61E-02	4.65E+00	3.62E-04
TH229	1.34E+01	1.82E-01	6.62E-01	0.	8.99E-01	1.22E+01	3.29E-04
TH230	3.46E+00	1.79E-01	9.65E-02	0.	8.82E-01	2.18E+00	3.87E-05
TH232+D	3.86E+00	1.53E-01	2.24E-01	0.	7.54E-01	2.04E+00	3.29E-05
TH234	1.33E-05	7.17E-07	3.86E-07	0.	2.70E-06	1.62E-03	7.40E-05
PA231+D	9.10E+00	3.00E-01	3.62E-01	0.	1.62E+00	3.85E-01	4.61E-05
PA233	6.84E-06	1.32E-06	1.19E-06	0.	3.68E-06	2.19E-04	9.04E-06
U232+D	2.57E-01	0.	2.13E-02	0.	2.40E-02	1.49E+00	4.36E-05
U233+D	5.44E-02	0.	3.83E-03	0.	1.09E-02	3.56E-01	4.03E-05
U234	5.22E-02	0.	3.75E-03	0.	1.07E-02	3.49E-01	3.95E-05
U235+D	5.01E-02	0.	3.52E-03	0.	1.01E-02	3.28E-01	5.02E-05
U236	5.01E-02	0.	3.60E-03	0.	1.03E-02	3.35E-01	3.71E-05
U237	3.25E-07	0.	8.65E-08	0.	8.08E-07	9.13E-05	1.31E-05
U238+D	4.79E-02	0.	3.29E-03	0.	9.40E-03	3.06E-01	3.54E-05
NP237+D	3.03E+00	2.32E-01	1.26E-01	0.	7.69E-01	3.49E-01	5.10E-05
NP238	2.57E-06	6.73E-08	4.16E-08	0.	1.47E-07	9.19E-05	2.58E-05
NP239	2.65E-07	2.37E-08	1.34E-08	0.	4.73E-08	4.25E-05	1.78E-05
PU238	5.02E+00	6.33E-01	1.27E-01	0.	4.64E-01	9.03E-01	4.69E-05
PU239	5.50E+00	6.72E-01	1.34E-01	0.	4.95E-01	8.47E-01	4.28E-05
PU240	5.49E+00	6.71E-01	1.34E-01	0.	4.94E-01	8.47E-01	4.36E-05
PU241+D	1.55E-01	6.69E-03	3.11E-03	0.	1.15E-02	7.62E-04	8.97E-07
PU242	5.09E+00	6.47E-01	1.29E-01	0.	4.77E-01	8.15E-01	4.20E-05
PU244	5.95E+00	7.40E-01	1.48E-01	0.	5.46E-01	9.33E-01	6.26E-05
AM241	1.84E+00	8.44E-01	1.31E-01	0.	7.94E-01	4.06E-01	4.78E-05
AM242M	1.90E+00	8.24E-01	1.35E-01	0.	8.03E-01	1.64E-01	6.01E-05
AM243	1.82E+00	8.10E-01	1.27E-01	0.	7.72E-01	3.85E-01	5.60E-05
CM242	8.58E-02	7.44E-02	5.70E-03	0.	1.69E-02	2.97E-01	5.10E-05
CM243	1.71E+00	7.96E-01	1.06E-01	0.	3.91E-01	4.24E-01	5.02E-05
CM244	1.43E+00	7.04E-01	8.89E-02	0.	3.21E-01	4.08E-01	4.86E-05
CM245	2.26E+00	8.80E-01	1.36E-01	0.	5.23E-01	3.92E-01	4.53E-05
CM246	2.24E+00	8.79E-01	1.36E-01	0.	5.23E-01	3.99E-01	4.45E-05
CM247+D	2.18E+00	8.64E-01	1.33E-01	0.	5.15E-01	3.92E-01	5.85E-05
CM248	1.82E+01	7.12E+00	1.10E+00	0.	4.24E+00	3.23E+00	9.43E-04
CF252	4.26E+00	0.	1.01E-01	0.	0.	1.37E+00	1.85E-04

CHILD INHALATION DOSE COMMITMENT FACTORS(MREM/50Y PER PCI INHALED IN FIRST YR)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
H3*	0.	3.04E-07	3.04E-07	3.04E-07	3.04E-07	3.04E-07	3.04E-07
BE10	8.43E-04	9.83E-05	2.12E-05	0.	0.	7.41E-04	1.72E-05
C14	9.70E-06	1.82E-06	1.82E-06	1.82E-06	1.82E-06	1.82E-06	1.82E-06
N13	2.33E-08	2.33E-08	2.33E-08	2.33E-08	2.33E-08	2.33E-08	2.33E-08
F18	1.88E-06	0.	1.65E-07	0.	0.	0.	3.27E-07
NA22	4.41E-05	4.41E-05	4.41E-05	4.41E-05	4.41E-05	4.41E-05	4.41E-05
NA24	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06
P32	7.04E-04	3.09E-05	2.67E-05	0.	0.	0.	1.14E-05
AR39	0.	0.	0.	0.	0.	4.89E-04	0.
AR41	0.	0.	0.	0.	0.	1.68E-08	0.
CA41	7.06E-05	0.	7.70E-06	0.	0.	7.21E-02	2.94E-07
SC46	1.97E-04	2.70E-04	1.04E-04	0.	2.39E-04	0.	2.45E-05
CR51	0.	0.	4.17E-08	2.31E-08	6.57E-09	4.59E-06	2.93E-07
MN54	0.	1.16E-05	2.57E-06	0.	2.71E-06	4.26E-04	6.19E-06
MN56	0.	4.48E-10	8.43E-11	0.	4.52E-10	3.55E-06	3.33E-05
FE55	1.28E-05	6.80E-06	2.10E-06	0.	0.	3.00E-05	7.75E-07
FE59	5.54E-06	9.04E-06	4.51E-06	0.	0.	3.43E-04	1.91E-05
CO57	0.	2.44E-07	2.88E-07	0.	0.	1.37E-04	3.58E-06
CO58	0.	4.79E-07	8.55E-07	0.	0.	2.99E-04	9.29E-06
CO60	0.	3.55E-06	6.12E-06	0.	0.	1.91E-03	2.60E-05
NI59	1.66E-05	4.67E-06	2.83E-06	0.	0.	2.73E-05	6.29E-07
NI63	2.22E-04	1.25E-05	7.56E-06	0.	0.	7.43E-05	1.71E-06
NI65	8.08E-10	7.99E-11	4.44E-11	0.	0.	2.21E-06	2.27E-05
CU64	0.	5.39E-10	2.90E-10	0.	1.63E-09	2.59E-06	9.92E-06
ZN65	1.15E-05	3.06E-05	1.90E-05	0.	1.93E-05	2.69E-04	4.41E-06
ZN69M+D	4.26E-09	7.28E-09	8.59E-10	0.	4.22E-09	7.36E-06	2.71E-05
ZN69	1.81E-11	2.61E-11	2.41E-12	0.	1.58E-11	3.84E-07	2.75E-06
SE79	0.	1.23E-06	2.60E-07	0.	1.71E-06	1.49E-04	3.43E-06
BR82	0.	0.	5.66E-06	0.	0.	0.	0.
BR83+D	0.	0.	1.28E-07	0.	0.	0.	0.
BR84	0.	0.	1.48E-07	0.	0.	0.	0.
BR85	0.	0.	6.84E-09	0.	0.	0.	0.
KR83M	0.	0.	0.	0.	0.	1.22E-09	0.
KR85M	0.	0.	0.	0.	0.	6.58E-09	0.
KR85	0.	0.	0.	0.	0.	5.66E-09	0.
KR87	0.	0.	0.	0.	0.	3.38E-08	0.
KR88+D	0.	0.	0.	0.	0.	6.99E-08	0.
KR89	0.	0.	0.	0.	0.	4.55E-08	0.
RB86	0.	5.36E-05	3.09E-05	0.	0.	0.	2.16E-06
RB87	0.	3.16E-05	1.37E-05	0.	0.	0.	2.96E-07
RB88	0.	1.52E-07	9.90E-08	0.	0.	0.	4.66E-09
RB89+D	0.	9.33E-08	7.83E-08	0.	0.	0.	5.11E-10
SR89+D	1.62E-04	0.	4.66E-06	0.	0.	5.83E-04	4.52E-05
SR90+D	2.73E-02	0.	1.74E-03	0.	0.	3.99E-03	9.28E-05
SR91+D	3.28E-08	0.	1.24E-09	0.	0.	1.44E-05	4.70E-05
SR92+D	3.54E-09	0.	1.42E-10	0.	0.	6.49E-06	6.55E-05

*Includes a 50% increase to account for percutaneous transpiration.

CHILD INHALATION DOSE COMMITMENT FACTORS(MREM/50Y PER PCI INHALED IN FIRST YR)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
Y90	1.11E-06	0.	2.99E-08	0.	0.	7.07E-05	7.24E-05
Y91M+D	1.37E-10	0.	4.98E-12	0.	0.	7.60E-07	4.64E-07
Y91	2.47E-04	0.	6.59E-06	0.	0.	7.10E-04	4.97E-05
Y92	5.50E-09	0.	1.57E-10	0.	0.	6.46E-06	6.46E-05
Y93	5.04E-08	0.	1.38E-09	0.	0.	2.01E-05	1.05E-04
ZR93+D	2.07E-04	7.80E-05	5.55E-05	0.	3.00E-04	7.10E-04	1.47E-05
ZR95+D	5.13E-05	1.13E-05	1.00E-05	0.	1.61E-05	6.03E-04	1.65E-05
ZR97+D	5.07E-08	7.34E-09	4.32E-09	0.	1.05E-08	3.06E-05	9.49E-05
NB93M	1.27E-04	3.17E-05	1.04E-05	0.	3.44E-05	1.04E-04	2.45E-06
NB95	6.35E-06	2.48E-06	1.77E-06	0.	2.33E-06	1.66E-04	1.00E-05
NB97	1.16E-10	2.08E-11	9.74E-12	0.	2.31E-11	9.23E-07	7.52E-06
MO93	0.	3.76E-06	1.35E-07	0.	1.06E-06	1.70E-04	3.78E-06
MO99+D	0.	4.66E-08	1.15E-08	0.	1.06E-07	3.66E-05	3.42E-05
TC99M	4.81E-13	9.41E-13	1.56E-11	0.	1.37E-11	2.57E-07	1.30E-06
TC99	1.34E-07	1.49E-07	5.35E-08	0.	1.75E-06	3.37E-04	7.75E-06
TC101	2.19E-14	2.30E-14	2.91E-13	0.	3.92E-13	1.58E-07	4.41E-09
RU103+D	7.55E-07	0.	2.90E-07	0.	1.90E-06	1.79E-04	1.21E-05
RU105+D	4.13E-10	0.	1.50E-10	0.	3.63E-10	4.30E-06	2.69E-05
RU106+D	3.68E-05	0.	4.57E-06	0.	4.97E-05	3.87E-03	1.16E-04
RH105	3.91E-09	2.10E-09	1.79E-09	0.	8.39E-09	7.82E-06	1.33E-05
PD107	0.	2.65E-07	2.51E-08	0.	1.97E-06	3.16E-05	7.26E-07
PD109	0.	1.48E-09	4.95E-10	0.	7.06E-09	6.16E-06	2.59E-05
AG110M+D	4.56E-06	3.08E-06	2.47E-06	0.	5.74E-06	1.48E-03	2.71E-05
AG111	1.81E-07	5.68E-08	3.75E-08	0.	1.71E-07	7.73E-05	2.98E-05
CD113M	0.	4.93E-04	2.12E-05	0.	5.13E-04	6.94E-04	1.63E-05
CD115M	0.	7.88E-05	3.39E-06	0.	5.93E-05	5.86E-04	4.97E-05
SN123	1.29E-04	2.14E-06	4.19E-06	2.27E-06	0.	9.59E-04	4.05E-05
SN125+D	4.95E-06	9.94E-08	2.95E-07	1.03E-07	0.	2.43E-04	7.17E-05
SN126+D	5.23E-04	1.04E-05	2.36E-05	2.84E-06	0.	3.02E-03	1.63E-05
SB124	1.55E-05	2.00E-07	5.41E-06	3.41E-08	0.	8.76E-04	4.43E-05
SB125+D	2.66E-05	2.05E-07	5.59E-06	2.46E-08	0.	6.27E-04	1.09E-05
SB126	1.72E-06	2.62E-08	6.16E-07	1.00E-08	0.	2.86E-04	5.67E-05
SB127	1.36E-07	2.09E-09	4.70E-08	1.51E-09	0.	6.17E-05	3.82E-05
TE125M	1.82E-06	6.29E-07	2.47E-07	5.20E-07	0.	1.29E-04	9.13E-06
TE127M+D	5.72E-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+D	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+D	3.63E-08	1.60E-08	1.37E-08	2.64E-08	1.08E-07	5.56E-05	8.32E-05
TE131+D	5.87E-12	2.28E-12	1.78E-12	4.59E-12	1.59E-11	5.55E-07	3.60E-07
TE132+D	1.30E-07	7.36E-08	7.12E-08	8.58E-08	4.79E-07	1.02E-04	3.72E-05
TE133M+D	2.93E-11	1.51E-11	1.50E-11	2.32E-11	1.01E-10	1.60E-06	4.77E-06
TE134+D	1.53E-11	8.81E-12	9.40E-12	1.24E-11	5.71E-11	1.23E-06	4.87E-07
I129	1.05E-05	6.40E-06	5.71E-06	4.28E-03	1.08E-05	0.	2.15E-07
I130	2.21E-06	4.43E-06	2.28E-06	4.99E-04	6.61E-06	0.	1.38E-06
I131+D	1.30E-05	1.30E-05	7.37E-06	4.39E-03	2.13E-05	0.	7.68E-07

ILD INHALATION DOSE COMMITMENT FACTORS(MREM/50Y PER PCI INHALED IN FIRST YR)

SOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
I132	5.72E-07	1.10E-06	5.07E-07	5.23E-05	1.69E-06	0.	8.65E-07
I133+D	4.48E-06	5.49E-06	2.08E-06	1.04E-03	9.13E-06	0.	1.48E-06
I134	3.17E-07	5.84E-07	2.69E-07	1.37E-05	8.92E-07	0.	2.58E-07
I135+D	1.33E-06	2.36E-06	1.12E-06	2.14E-04	3.62E-06	0.	1.20E-06
E131M	0.	0.	0.	0.	0.	3.30E-09	0.
E133M	0.	0.	0.	0.	0.	4.36E-09	0.
E133	0.	0.	0.	0.	0.	3.66E-09	0.
E135M	0.	0.	0.	0.	0.	4.48E-09	0.
E135	0.	0.	0.	0.	0.	9.09E-09	0.
E137	0.	0.	0.	0.	0.	4.07E-08	0.
E138+D	0.	0.	0.	0.	0.	5.17E-08	0.
S134M+D	5.33E-08	8.92E-08	6.12E-08	0.	4.94E-08	8.35E-09	7.92E-08
S134	1.76E-04	2.74E-04	6.07E-05	0.	8.93E-05	3.27E-05	1.04E-06
S135	5.23E-05	4.13E-05	4.45E-06	0.	1.53E-05	5.22E-06	2.17E-07
S136	1.76E-05	4.62E-05	3.14E-05	0.	2.58E-05	3.93E-06	1.13E-06
S137+D	2.45E-04	2.23E-04	3.47E-05	0.	7.63E-05	2.81E-05	9.78E-07
S138	1.71E-07	2.27E-07	1.50E-07	0.	1.68E-07	1.84E-08	7.29E-08
S139+D	1.09E-07	1.15E-07	5.80E-08	0.	9.08E-08	9.36E-09	7.23E-12
A139	4.98E-10	2.66E-13	1.45E-11	0.	2.33E-13	1.56E-06	1.56E-05
A140+D	2.00E-05	1.75E-08	1.17E-06	0.	5.7[illegible]E-09	4.71E-04	2.75E-05
A141+D	5.29E-11	2.95E-14	1.72E-12	0.	2.56E-14	7.89E-07	7.44E-08
A142+D	1.35E-11	9.73E-15	7.54E-13	0.	7.87E-15	4.44E-07	7.41E-10
A140	1.74E-07	6.08E-08	2.04E-08	0.	0.	4.94E-05	6.10E-05
A141	2.28E-09	5.31E-10	1.15E-10	0.	0.	4.48E-06	4.37E-05
A142	3.50E-10	1.11E-10	3.49E-11	0.	0.	2.35E-06	2.05E-05
E141	1.06E-05	5.28E-06	7.83E-07	0.	2.31E-06	1.47E-04	1.53E-05
E143+D	9.89E-08	5.37E-08	7.77E-09	0.	2.26E-08	3.12E-05	3.44E-05
E144+D	1.83E-0[illegible]	5.72E-04	9.77E-05	0.	3.17E-04	3.23E-03	1.05E-04
R143	4.99E-06	1.50E-06	2.47E-07	0.	8.11E-07	1.17E-04	2.63E-05
R144	1.61E-11	4.99E-12	8.10E-13	0.	2.64E-12	4.23E-07	5.32E-08
D147+D	2.92E-06	2.36E-06	1.84E-07	0.	1.30E-06	8.87E-05	2.22E-05
M147	3.52E-04	2.52E-05	1.36E-05	0.	4.45E-05	2.20E-04	5.70E-06
M148M+D	3.31E-05	6.55E-06	6.55E-06	0.	9.74E-06	5.72E-04	3.58E-05
M148	1.61E-06	1.94E-07	1.25E-07	0.	3.30E-07	1.24E-04	6.01E-05
M149	1.47E-07	1.56E-08	8.45E-09	0.	2.75E-08	2.40E-05	2.92E-05
M151	3.57E-08	[illegible]	2.92E-09	0.	7.35E-09	1.24E-05	2.50E-05
M151	3.14E-04	[illegible]	1.49E-05	0.	4.89E-05	1.48E-04	3.43E-06
M153	7.24E-08	[illegible]	4.35E-09	0.	1.37E-08	1.37E-05	1.87E-05
U152	7.42E-04	1.37E-04	1.61E-04	0.	5.73E-04	9.00E-04	1.14E-05
U154	2.74E-03	2.49E-04	2.27E-04	0.	1.09E-03	1.66E-03	2.98E-05
U155	5.60E-04	4.05E-05	3.18E-05	0.	1.51E-04	2.79E-04	5.39E-05
U156	7.89E-06	4.23E-06	8.75E-07	0.	2.72E-06	2.54E-04	4.24E-05
B160	7.79E-05	0.	9.67E-06	0.	2.32E-05	5.34E-04	2.28E-05
O166M	1.34E-03	2.81E-04	2.37E-04	0.	4.01E-04	1.13E-03	1.63E-05
181	2.66E-08	6.52E-09	8.99E-10	0.	0.	5.71E-06	2.61E-07
185	9.31E-07	2.08E-07	2.91E-08	0.	0.	1.86E-04	1.11E-05
187	4.41E-09	2.61E-09	1.17E-09	0.	0.	1.11E-05	2.46E-05

CHILD INHALATION DOSE COMMITMENT FACTORS(MREM/50Y PER PCI INHALED IN FIRST YR)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
PB210+D	8.03E-02	1.65E-02	3.18E-03	0.	6.31E-02	8.74E-02	3.75E-0
BI210+D	0.	5.11E-06	5.65E-07	0.	5.76E-05	3.70E-03	3.21E-0
PO210	1.70E-03	2.75E-03	4.09E-04	0.	8.85E-03	1.05E-01	4.32E-0
RN222+D	0.	0.	0.	0.	0.	4.82E-06	0.
RA223+D	7.69E-04	8.89E-07	1.54E-04	0.	2.36E-05	8.48E-02	3.00E-0
RA224+D	3.44E-05	1.53E-07	1.69E-05	0.	4.06E-06	2.92E-02	3.34E-0
RA225+D	1.28E-03	1.14E-06	2.56E-04	0.	3.02E-05	9.74E-02	2.84E-0
RA226+D	2.34E-01	7.65E-06	1.92E-01	0.	2.03E-04	3.90E-01	3.02E-0
RA228+D	1.49E-01	3.94E-06	1.68E-01	0.	1.04E-04	5.37E-01	5.14E-0
AC225	1.81E-03	1.87E-03	1.21E-04	0.	1.99E-04	7.37E-02	2.67E-0
AC227+D	4.96E+00	8.05E-01	3.07E-01	0.	1.77E-01	8.04E-01	5.22E-0
TH227+D	9.24E-04	1.26E-05	2.67E-05	0.	6.67E-05	1.26E-01	3.49E-0
TH228+D	8.06E-01	1.04E-02	2.72E-02	0.	5.41E-02	3.34E+00	3.59E+0
TH229	1.28E+01	1.76E-01	6.31E-01	0.	8.68E-01	1.04E+01	3.27E-0
TH230	3.30E+00	1.73E-01	9.20E-02	0.	8.52E-01	1.85E+00	3.84E-0
TH232+D	3.68E+00	1.47E-01	1.26E-01	0.	7.28E-01	1.77E+00	3.27E-0
TH234	6.94E-06	3.07E-07	2.00E-07	0.	1.62E-06	6.31E-04	7.32E-0
PA231+D	8.62E+00	2.86E-01	3.43E-01	0.	1.56E+00	1.92E-01	4.57E-0
PA233	4.14E-06	6.48E-07	7.25E-07	0.	2.38E-06	9.77E-05	8.95E-0
U232+D	2.14E-01	0.	1.50E-02	0.	1.67E-02	7.42E-01	4.33E-0
U233+D	4.64E-02	0.	2.82E-03	0.	7.62E-03	1.77E-01	4.00E-0
U234	4.46E-02	0.	2.76E-03	0.	7.47E-03	1.74E-01	3.92E-0
U235+D	4.27E-02	0.	2.59E-03	0.	7.01E-03	1.63E-01	4.98E-0
U236	4.27E-02	0.	2.55E-03	0.	7.16E-03	1.67E-01	3.67E-0
U237	1.57E-07	0.	4.17E-06	0.	4.53E-07	3.40E-05	1.29E-0
U238+D	4.09E-02	0.	2.42E-03	0.	6.55E-03	1.53E-01	3.51E-0
NP237+D	2.88E+00	2.21E-01	1.19E-01	0.	7.41E-01	1.74E-01	5.06E-0
NP238	1.25E-0[illegible]	2.56E-08	1.97E-08	0.	8.16E-08	3.39E-05	2.50E-0
NP239	1.26E-07	9.04E-09	6.35E-09	0.	2.63E-08	1.57E-05	1.73E-0
PU238	4.77E+00	6.05E-01	1.21E-01	0.	4.47E-01	6.08E-01	4.65E-0
PU239	5.24E+00	6.44E-01	1.28E-01	0.	4.78E-01	5.72E-01	4.24E-0
PU240	5.23E+00	6.43E-01	1.27E-01	0.	4.77E-01	5.71E-01	4.33E-0
PU241+D	1.46E-01	6.33E-03	2.93E-03	0.	1.10E-02	5.06E-04	8.90E-0
PU242	4.85E+00	6.20E-01	1.23E-01	0.	4.60E-01	5.50E-01	4.16E-0
PU244	5.67E+00	7.10E-01	1.41E-01	0.	5.27E-01	6.30E-01	6.20E-0
AM241	1.74E+00	7.85E-01	1.24E-01	0.	7.63E-01	2.02E-01	4.73E-0
AM242M	1.79E+00	7.65E-01	1.27E-01	0.	7.71E-01	8.14E-02	5.96E-0
AM243	1.72E+00	7.53E-01	1.20E-01	0.	7.42E-01	1.92E-01	5.55E-0
CM242	5.33E-02	4.84E-02	4.20E-03	0.	1.34E-02	1.31E-01	5.06E-0
CM243	1.61E+00	7.33E-01	9.95E-02	0.	3.74E-01	2.10E-01	4.98E-0
CM244	1.33E+00	6.[illegible]8E-01	8.31E-02	0.	3.06E-01	2.02E-01	4.82E-0
CM245	2.14E+00	8.16E-01	1.28E-01	0.	5.03E-01	1.95E-01	4.49E-0
CM246	2.13E+00	8.15E-01	1.28E-01	0.	5.03E-01	1.99E-01	4.41E-0
CM247+D	2.07E+00	8.02E-01	1.26E-01	0.	4.95E-01	1.95E-01	5.80E-0
CM248	1.72E+01	6.61E+00	1.04E+00	0.	4.08E+00	1.61E+00	9.35E-0
CF252	3.92E+00	0.	9.33E-02	0.	0.	6.62E-01	1.84E-0

TEEN INHALATION DOSE COMMITMENT FACTORS(MREM/50Y PER PCI INHALED IN FIRST YR)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
H3*	0.	1.59E-07	1.59E-07	1.59E-07	1.59E-07	1.59E-07	1.59E-07
BE10	2.78E-04	4.33E-05	7.09E-06	0.	0.	3.84E-04	1.77E-05
C14	3.25E-06	6.09E-07	6.09E-07	6.09E-07	6.09E-07	6.09E-07	6.09E-07
N13	8.65E-09	8.65E-09	8.65E-09	8.65E-09	8.65E-09	8.65E-09	8.65E-09
F18	6.52E-07	0.	7.10E-08	0.	0.	0.	3.89E-06
NA22	1.76E-05	1.76E-05	1.76E-05	1.76E-05	1.76E-05	1.76E-05	1.76E-05
NA24	1.72E-06	1.72E-06	1.72E-06	1.72E-06	1.72E-06	1.72E-06	1.72E-06
P32	2.36E-04	1.37E-05	8.95E-06	0.	0.	0.	1.16E-05
AR39	0.	0.	0.	0.	0.	4.00E-09	0.
AR41	0.	0.	0.	0.	0.	1.44E-06	0.
CA41	4.05E-05	0.	4.38E-06	0.	0.	1.01E-01	3.03E-07
SC46	7.24E-05	1.41E-04	4.18E-05	0.	1.35E-04	0.	2.98E-05
CR51	0.	0.	1.64E-08	9.37E-09	3.84E-09	2.62E-06	3.75E-07
MN54	0.	6.39E-06	1.05E-06	0.	1.59E-06	2.48E-04	8.35E-06
MN56	0.	2.12E-10	3.15E-11	0.	2.24E-10	1.90E-06	7.18E-06
FE55	4.18E-06	2.98E-06	6.93E-07	0.	0.	1.55E-05	7.99E-07
FE59	1.99E-06	4.62E-06	1.79E-06	0.	0.	1.91E-04	2.23E-05
CO57	0.	1.18E-07	1.15E-07	0.	0.	7.33E-05	3.93E-06
CO58	0.	2.59E-07	3.47E-07	0.	0.	1.68E-04	1.19E-05
CO60	0.	1.89E-06	2.48E-06	0.	0.	1.09E-03	3.24E-05
NI59	5.44E-06	2.02E-06	9.24E-07	0.	0.	1.41E-05	6.48E-07
NI63	7.25E-05	5.43E-06	2.47E-06	0.	0.	3.84E-05	1.77E-06
NI65	2.73E-10	3.66E-11	1.59E-11	0.	0.	1.17E-06	4.59E-06
CU64	0.	2.54E-10	1.06E-10	0.	8.01E-10	1.39E-06	7.68E-06
ZN65	4.82E-06	1.67E-05	7.80E-06	0.	1.08E-05	1.55E-04	5.83E-06
ZN69M+D	1.44E-09	3.39E-09	3.11E-10	0.	2.06E-09	3.92E-06	2.14E-05
ZN69	6.04E-12	1.15E-11	8.07E-13	0.	7.53E-12	1.98E-07	3.56E-08
SE79	0.	5.43E-07	8.71E-08	0.	8.13E-07	7.71E-05	3.53E-06
BR82	0.	0.	2.28E-06	0.	0.	0.	0.
BR83+D	0.	0.	4.30E-08	0.	0.	0.	0.
BR84	0.	0.	5.41E-08	0.	0.	0.	0.
BR85	0.	0.	2.29E-09	0.	0.	0.	0.
KR83M	0.	0.	0.	0.	0.	9.97E-10	0.
KR85M	0.	0.	0.	0.	0.	5.40E-09	0.
KR85	0.	0.	0.	0.	0.	4.63E-09	0.
KR87	0.	0.	0.	0.	0.	2.82E-08	0.
KR88+D	0.	0.	0.	0.	0.	5.81E-08	0.
KR89	0.	0.	0.	0.	0.	3.85E-08	0.
RB86	0.	2.38E-05	1.05E-05	0.	0.	0.	2.21E-06
RB87	0.	1.40E-05	4.58E-06	0.	0.	0.	3.05E-07
RB88	0.	6.82E-08	3.40E-08	0.	0.	0.	3.65E-15
RB89+D	0.	4.40E-08	2.91E-08	0.	0.	0.	4.22E-17
SR89+D	3.43E-05	0.	1.56E-06	0.	0.	3.02E-04	4.64E-05
SR90+D	1.35E-02	0.	8.35E-04	0.	0.	2.06E-03	9.56E-05
SR91+D	1.10E-08	0.	4.39E-10	0.	0.	7.59E-06	3.24E-05
SR92+D	1.19E-09	0.	5.08E-11	0.	0.	3.43E-06	1.49E-05

*Includes a 50% increase to account for percutaneous transpiration.

TEEN INHALATION DOSE COMMITMENT FACTORS(MREM/50Y PER PCI INHALED IN FIRST YR)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
Y90	3.73E-07	0.	1.00E-08	0.	0.	3.66E-05	6.99E-0
Y91M+D	4.63E-11	0.	1.77E-12	0.	0.	4.00E-07	3.77E-0
Y91	8.26E-05	0.	2.21E-06	0.	0.	3.67E-04	5.11E-0
Y92	1.84E-09	0.	5.36E-11	0.	0.	3.35E-06	2.06E-0
Y93	1.69E-08	0.	4.65E-10	0.	0.	1.04E-05	7.24E-0
ZR93+D	6.83E-05	3.38E-05	1.84E-05	0.	1.16E-04	3.67E-04	1.60E-0
ZR95+D	1.82E-05	5.73E-06	3.94E-06	0.	8.42E-06	3.36E-04	1.86E-0
ZR97+D	1.72E-08	3.40E-09	1.57E-09	0.	5.15E-09	1.62E-05	7.88E-0
NB93M	4.14E-05	1.36E-05	3.41E-06	0.	1.59E-05	5.36E-05	2.52E-0
NB95	2.32E-06	1.29E-06	7.08E-07	0.	1.25E-06	9.39E-05	1.[illegible]1E-0
NB97	3.92E-11	9.72E-12	3.55E-12	0.	1.14E-11	4.91E-07	2.7[illegible]E-[illegible]
MO93	0.	1.66E-06	4.52E-08	0.	5.06E-07	8.81E-05	3.99E-0
MO99+D	0.	2.11E-08	4.03E-09	0.	5.14E-08	1.92E-05	3.36E-0
TC99M	1.73E-13	4.83E-13	6.24E-12	0.	7.20E-12	1.44E-07	7.66E-0
TC99	4.48E-08	6.58E-08	1.79E-08	0.	8.35E-07	1.74E-04	7.99E-0
TC101	7.40E-15	1.05E-14	1.03E-13	0.	1.90E-13	8.34E-08	1.09E-1
RU103+D	2.63E-07	0.	1.12E-07	0.	9.29E-07	9.79E-05	1.36E-0
RU105+D	1.40E-10	0.	5.42E-11	0.	1.76E-10	2.27E-06	1.13E-0
RU106+D	1.23E-05	0.	1.55E-06	0.	2.38E-05	2.01E-03	1.20E-0
RH105	1.32E-09	9.48E-10	6.24E-10	0.	4.04E-09	4.09E-06	1.23E-0
PD107	0.	1.17E-07	8.39E-09	0.	9.39E-07	1.63E-05	7.49E-0
PD109	0.	6.[illegible]6E-10	1.66E-10	0.	3.36E-09	3.19E-06	1.96E-0
AG110M+D	1.73E-06	1.64E-06	9.99E-07	0.	3.13E-06	8.44E-04	3.41E-0
AG111	6.07E-08	2.52E-08	1.26E-08	0.	8.17E-08	4.00E-05	3.00E-0
CD113M	0.	2.17E-04	7.10E-06	0.	2.43E-04	3.59E-04	1.68E-0
CD115M	0.	3.48E-05	1.14E-06	0.	2.82E-05	3.03E-04	5.10E-0
SN123	4.31E-05	9.44E-07	1.40E-06	7.55E-07	0.	4.96E-04	4.16E-0
SN125+D	1.66E-06	4.42E-08	9.99E-08	3.45E-08	0.	1.26E-04	7.29E-0
SN126+D	2.18E-04	5.39E-06	8.24E-06	1.42E-06	0.	1.72E-03	1.68E-0
SB124	5.38E-06	9.92E-08	2.10E-06	1.22E-08	0.	4.81E-04	4.98E-0
SB125+D	9.23E-06	1.01E-07	2.15E-06	8.80E-09	0.	3.42E-04	1.24E-0
SB126	6.19E-07	1.27E-08	2.23E-07	3.50E-09	0.	1.55E-04	6.01E-0
SB127	4.64E-08	9.92E-10	1.75E-08	5.21E-10	0.	3.31E-05	3.94E-0
TE125M	6.10E-07	2.80E-07	8.34E-08	1.75E-07	0.	6.70E-05	9.38E-0
TE127M+D	2.25E-06	1.02E-06	2.73E-07	5.48E-07	8.17E-06	2.07E-04	1.99E-0
TE127	2.51E-10	1.14E-10	5.52E-11	1.77E-10	9.10E-10	1.40E-06	1.01E-0
TE129M+D	1.74E-06	8.23E-07	2.81E-07	5.72E-07	6.49E-06	2.47E-04	5.06E-0
TE129	8.87E-12	4.22E-12	2.20E-12	6.48E-12	3.32E-11	4.12E-07	2.02E-0
TE131M+D	1.23E-08	7.51E-09	5.03E-09	9.06E-09	5.49E-08	2.97E-05	7.76E-0
TE131+D	1.97E-12	1.04E-12	6.30E-13	1.55E-12	7.72E-12	2.92E-07	1.89E-0
TE132+D	4.50E-08	3.63E-08	2.74E-08	3.07E-08	2.44E-07	5.61E-05	5.79E-0
TE133M+D	1.01E-11	7.33E-12	5.71E-12	8.18E-12	5.07E-11	8.71E-07	1.23E-0
TE134+D	5.31E-12	4.35E-12	3.64E-12	4.46E-12	2.91E-11	6.75E-07	1.37E-0
I129	3.53E-06	2.94E-06	4.90E-06	3.66E-03	5.26E-06	0.	2.29E-0
I130	7.80E-07	2.24E-06	8.96E-07	1.86E-04	3.44E-06	0.	1.14E-0
I131+D	4.43E-06	6.14E-06	3.30E-06	1.83E-03	1.05E-05	0.	8.11E-0

TEEN INHALATION DOSE COMMITMENT FACTORS(MREM/50Y PER PCI INHALED IN FIRST YR)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
I132	1.9[illegible]E-07	5.47E-07	1.97E-07	1.89E-05	8.65E-07	0.	1.59E-07
I133+D	1.52E-06	2.56E-06	7.78E-07	3.65E-04	4.49E-06	0.	1.29E-06
I134	1.11E-07	2.90E-07	1.05E-07	4.94E-06	4.58E-07	0.	2.55E-09
I135+D	4.62E-07	1.18E-06	4.36E-07	7.76E-05	1.86E-06	0.	8.69E-07
XE131M	0.	0.	0.	0.	0.	2.70E-09	0.
XE133M	0.	0.	0.	0.	0.	3.59E-09	0.
XE133	0.	0.	0.	0.	0.	2.99E-09	0.
XE135M	0.	0.	0.	0.	0.	3.88E-09	0.
XE135	0.	0.	0.	0.	0.	7.55E-09	0.
XE137	0.	0.	0.	0.	0.	3.33E-08	0.
XE138+D	0.	0.	0.	0.	0.	4.38E-08	0.
CS134M+D	2.20E-08	4.35E-08	2.35E-08	0.	2.54E-08	4.56E-09	2.02E-08
CS134	6.28E-05	1.41E-04	6.86E-05	0.	4.69E-05	1.83E-05	1.22E-06
CS135	2.08E-05	1.62E-05	4.47E-06	0.	7.30E-06	2.70E-06	2.23E-07
CS136	6.44E-06	2.42E-05	1.71E-05	0.	1.38E-05	2.22E-06	1.36E-06
CS137+D	8.38E-05	1.06E-04	3.89E-05	0.	3.80E-05	1.51E-05	1.06E-06
CS138	5.82E-08	1.07E-07	5.58E-08	0.	8.28E-08	9.84E-09	3.38E-11
CS139+D	3.65E-08	5.12E-08	1.97E-08	0.	4.34E-08	4.86E-09	1.66E-23
BA139	1.67E-10	1.18E-13	4.87E-12	0.	1.11E-13	8.08E-07	8.06E-07
BA140+D	5.84E-06	8.38E-09	4.40E-07	0.	2.85E-09	2.54E-04	2.86E-05
BA141+D	1.78E-11	1.32E-14	5.93E-13	0.	1.23E-14	4.11E-07	9.33E-14
BA142+D	4.62E-12	4.63E-15	2.84E-13	0.	3.92E-15	2.39E-07	5.99E-20
LA140	5.99E-08	2.95E-08	7.82E-09	0.	0.	2.68E-05	6.09E-05
LA141	7.63E-10	2.35E-10	3.87E-11	0.	0.	2.31E-06	1.54E-05
LA142	1.20E-10	5.31E-11	1.32E-11	0.	0.	1.27E-06	1.50E-06
CE141	3.55E-06	2.37E-06	2.71E-07	0.	1.11E-06	7.67E-05	1.58E-05
CE143+D	3.32E-08	2.42E-08	2.70E-09	0.	1.08E-08	1.63E-05	3.19E-05
CE144+D	6.11E-04	2.53E-04	3.28E-05	0.	1.51E-04	1.67E-03	1.08E-04
PR143	1.67E-06	6.64E-07	8.28E-08	0.	3.86E-07	6.04E-05	2.67E-05
PR144	5.37E-12	2.20E-12	2.72E-13	0.	1.26E-12	2.19E-07	2.94E-17
ND147+D	9.83E-07	1.07E-06	6.41E-08	0.	6.28E-07	4.65E-05	2.28E-05
PM147	1.15E-04	1.10E-05	4.50E-06	0.	2.10E-05	1.14E-04	5.87E-06
PM148M+D	1.32E-05	3.35E-06	2.62E-06	0.	5.07E-06	3.20E-04	4.10E-05
PM148	5.44E-07	8.88E-08	4.48E-08	0.	1.60E-07	6.52E-05	6.14E-05
PM149	4.91E-08	6.89E-09	2.84E-09	0.	1.31E-08	1.24E-05	2.79E-05
PM151	1.20E-08	1.99E-09	1.01E-09	0.	3.57E-09	6.56E-06	2.27E-05
SM151	1.07E-04	2.10E-05	4.86E-06	0.	2.27E-05	7.68E-05	3.53E-06
SM153	2.43E-08	2.01E-08	1.47E-09	0.	6.56E-09	7.11E-06	1.77E-05
EU152	2.96E-04	7.19E-05	6.30E-05	0.	3.34E-04	5.01E-04	1.35E-05
EU154	9.43E-04	1.23E-04	8.60E-05	0.	5.44E-04	9.12E-04	3.34E-05
EU155	2.00E-04	1.96E-05	1.21E-05	0.	7.65E-05	1.51E-03	5.97E-05
EU156	2.70E-06	2.03E-06	3.30E-07	0.	1.36E-06	1.37E-04	4.56E-05
TB160	3.04E-05	0.	3.79E-06	0.	1.20E-05	2.97E-04	2.60E-05
HO166M	4.40E-04	1.36E-04	9.87E-05	0.	2.00E-04	6.24E-04	1.68E-05
W181	8.90E-09	2.88E-09	3.01E-10	0.	0.	2.95E-06	2.69E-07
W185	2.78E-07	9.17E-08	9.73E-09	0.	0.	9.60E-05	1.14E-05
W187	1.50E-09	1.22E-09	4.29E-10	0.	0.	5.92E-06	2.21E-05

TABLE 1.7 (Contd)

TEEN INHALATION DOSE COMMITMENT FACTORS(MREM/50Y PER PCI INHALED IN FIRST YR)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
PB210+D	3.09E-02	8.28E-03	1.07E-03	0.	2.95E-02	4.52E-02	3.87E-05
BI210+D	0.	2.26E-06	1.89E-07	0.	2.74E-05	1.91E-03	3.19E-05
PO210	5.68E-04	1.22E-03	1.37E-04	0.	4.21E-03	5.41E-02	4.45E-05
RN222+D	0.	0.	0.	0.	0.	3.94E-06	0.
RA223+D	2.57E-04	3.93E-07	5.14E-05	0.	1.12E-05	4.39E-02	3.04E-04
RA224+D	2.83E-05	6.77E-08	5.65E-06	0.	1.93E-06	1.51E-02	3.29E-04
RA225+D	4.28E-04	5.04E-07	8.56E-05	0.	1.44E-05	5.04E-02	2.89E-04
RA226+D	1.33E-01	3.38E-06	9.67E-02	0.	9.67E-05	2.02E-01	3.11E-04
RA228+D	5.34E-02	1.74E-06	5.88E-02	0.	4.97E-05	2.78E-01	5.30E-05
AC225	6.04E-04	8.25E-04	4.06E-05	0.	9.47E-05	3.81E-02	2.70E-04
AC227+D	2.49E+00	3.64E-01	1.48E-01	0.	1.07E-01	4.16E-01	5.38E-05
TH227+D	3.09E-04	5.56E-06	8.93E-06	0.	3.18E-05	6.50E-02	3.57E-04
TH228+D	2.60E-01	4.37E-03	8.78E-03	0.	2.45E-02	1.69E+00	3.70E-04
TH229	9.06E+00	1.36E-01	4.45E-01	0.	6.67E-01	5.05E+00	3.36E-04
TH230	2.34E+00	1.34E-01	6.49E-02	0.	6.55E-01	8.98E-01	3.95E-05
TH232+D	2.61E+00	1.14E-01	9.21E-02	0.	5.60E-01	8.60E-01	3.36E-05
TH234	2.32E-05	1.35E-07	6.71E-08	0.	7.73E-07	3.26E-04	7.49E-05
PA231+D	5.32E+00	2.00E-01	2.07E-01	0.	1.12E+00	9.91E-02	4.71E-05
PA233	1.68E-06	3.24E-07	2.89E-07	0.	1.22E-06	5.39E-05	1.00E-05
U232+D	7.31E-02	0.	5.23E-03	0.	7.94E-03	3.84E-01	4.46E-05
U233+D	1.55E-02	0.	9.42E-04	0.	3.63E-03	9.18E-02	4.12E-05
U234	1.48E-02	0.	9.23E-04	0.	3.55E-03	8.99E-02	4.04E-05
U235+D	1.42E-02	0.	8.67E-04	0.	3.34E-03	8.44E-02	5.13E-05
U236	1.42E-02	0.	8.86E-04	0.	3.41E-03	8.62E-02	3.79E-05
U237	5.25E-08	0.	1.40E-08	0.	2.16E-07	1.76E-05	1.29E-05
U238+D	1.36E-02	0.	8.10E-04	0.	3.12E-03	7.89E-02	3.62E-05
NP237+D	1.77E+00	1.54E-01	7.21E-02	0.	5.35E-01	8.99E-02	5.22E-05
NP238	4.23E-07	1.13E-08	6.59E-09	0.	3.88E-08	1.75E-05	2.38E-05
NP239	4.23E-08	3.99E-09	2.21E-09	0.	1.25E-08	8.11E-06	1.65E-05
PU238	2.86E+00	4.06E-01	7.22E-02	0.	3.10E-01	3.12E-01	4.79E-05
PU239	3.31E+00	4.50E-01	8.05E-02	0.	3.44E-01	2.93E-01	4.37E-05
PU240	3.31E+00	4.49E-01	8.04E-02	0.	3.43E-01	2.93E-01	4.46E-05
PU241+D	6.97E-02	3.57E-03	1.40E-03	0.	6.47E-03	2.60E-04	9.17E-07
PU242	3.07E+00	4.33E-01	7.75E-02	0.	3.31E-01	2.82E-01	4.29E-05
PU244	3.59E+00	4.96E-01	8.88E-02	0.	3.79E-01	3.23E-01	6.39E-05
AM241	1.06E+00	4.07E-01	7.10E-02	0.	5.32E-01	1.05E-01	4.88E-05
AM242M	1.07E+00	3.93E-01	7.15E-02	0.	5.30E-01	4.21E-02	6.14E-05
AM243	1.06E+00	3.92E-01	6.95E-02	0.	5.21E-01	9.91E-02	5.72E-05
CM242	2.12E-02	2.14E-02	1.41E-03	0.	6.40E-03	6.76E-02	5.21E-05
CM243	8.45E-01	3.50E-01	5.00E-02	0.	2.34E-01	1.09E-01	5.13E-05
CM244	6.46E-01	3.03E-01	3.88E-02	0.	1.81E-01	1.05E-01	4.96E-05
CM245	1.32E+00	4.11E-01	7.53E-02	0.	3.52E-01	1.01E-01	4.63E-05
CM246	1.31E+00	4.11E-01	7.52E-02	0.	3.51E-01	1.03E-01	4.54E-05
CM247+D	1.28E+00	4.04E-01	7.41E-02	0.	3.46E-01	1.01E-01	5.97E-05
CM248	1.06E+01	3.33E+00	6.11E-01	0.	2.85E+00	8.32E-01	9.63E-04
CF252	1.29E+00	0.	3.07E-02	0.	0.	3.43E-01	1.89E-04

ADULT INHALATION DOSE COMMITMENT FACTORS(MREM/50Y PER PCI INHALED IN FIRST YR)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
H3*	0.	1.58E-07	1.58E-07	1.58E-07	1.58E-07	1.58E-07	1.58E-07
BE10	1.94E-04	3.06E-05	4.96E-06	0.	0.	2.22E-04	1.67E-05
C14	2.27E-06	4.26E-07	4.26E-07	4.26E-07	4.26E-07	4.26E-07	4.26E-07
N13	6.27E-09	6.27E-09	6.27E-09	6.27E-09	6.27E-09	6.27E-09	6.27E-09
F18	4.71E-07	0.	5.19E-08	0.	0.	0.	9.24E-09
NA22	1.30E-05	1.30E-05	1.30E-05	1.30E-05	1.30E-05	1.30E-05	1.30E-05
NA24	1.28E-06	1.28E-06	1.28E-06	1.28E-06	1.28E-06	1.28E-06	1.28E-06
P32	1.65E-04	9.64E-06	6.26E-06	0.	0.	0.	1.08E-05
AR39	0.	0.	0.	0.	0.	2.08E-09	0.
AR41	0.	0.	0.	0.	0.	8.06E-09	0.
CA41	3.83E-05	0.	4.13E-06	0.	0.	3.83E-06	2.86E-07
SC46	5.51E-05	1.07E-04	3.11E-05	0.	4.99E-05	0.	3.23E-05
CR51	0.	0.	1.25E-08	7.44E-09	2.85E-09	1.80E-06	4.15E-07
MN54	0.	4.95E-06	7.87E-07	0.	1.23E-06	1.75E-04	9.67E-06
MN56	0.	1.55E-10	2.29E-11	0.	1.63E-10	1.18E-06	2.53E-06
FE55	3.07E-06	2.12E-06	4.93E-07	0.	0.	9.01E-06	7.54E-07
FE59	1.47E-06	3.47E-06	1.32E-06	0.	0.	1.27E-04	2.35E-05
CO57	0.	8.65E-08	8.39E-08	0.	0.	4.62E-05	3.93E-06
CO58	0.	1.98E-07	2.59E-07	0.	0.	1.16E-04	1.33E-05
CO60	0.	1.44E-06	1.85E-06	0.	0.	7.46E-04	3.56E-05
NI59	4.06E-06	1.46E-06	6.77E-07	0.	0.	8.20E-06	6.11E-07
NI63	5.40E-05	3.93E-06	1.81E-06	0.	0.	2.23E-05	1.67E-06
NI65	1.92E-10	2.62E-11	1.14E-11	0.	0.	7.00E-07	1.54E-06
CU64	0.	1.83E-10	7.69E-11	0.	5.78E-10	8.48E-07	6.12E-06
ZN65	4.05E-06	1.29E-05	5.82E-06	0.	8.62E-06	1.08E-04	6.68E-06
ZN69M+D	1.02E-09	2.45E-09	2.24E-10	0.	1.48E-09	2.38E-06	1.71E-05
ZN69	4.23E-12	8.14E-12	5.65E-13	0.	5.27E-12	1.15E-07	2.04E-09
SE79	0.	3.83E-07	6.09E-08	0.	5.69E-07	4.47E-05	3.33E-06
BR82	0.	0.	1.69E-06	0.	0.	0.	1.30E-06
BR83+D	0.	0.	3.01E-08	0.	0.	0.	2.90E-08
BR84	0.	0.	3.91E-08	0.	0.	0.	2.05E-13
BR85	0.	0.	1.60E-09	0.	0.	0.	0.
KR83M	0.	0.	0.	0.	0.	5.19E-10	0.
KR85M	0.	0.	0.	0.	0.	2.91E-09	0.
KR85	0.	0.	0.	0.	0.	2.41E-09	0.
KR87	0.	0.	0.	0.	0.	1.53E-08	0.
KR88+D	0.	0.	0.	0.	0.	3.13E-08	0.
KR89	0.	0.	0.	0.	0.	2.13E-08	0.
RB86	0.	1.69E-05	7.37E-06	0.	0.	0.	2.08E-06
RB87	0.	9.86E-06	3.21E-06	0.	0.	0.	2.88E-07
RB88	0.	4.84E-08	2.41E-08	0.	0.	0.	4.18E-19
RB89+D	0.	3.20E-08	2.12E-08	0.	0.	0.	1.16E-21
SR89+D	3.80E-05	0.	1.09E-06	0.	0.	1.75E-04	4.37E-05
SR90+D	1.24E-02	0.	7.62E-04	0.	0.	1.20E-03	9.02E-05
SR91+D	7.74E-09	0.	3.13E-10	0.	0.	4.56E-06	2.39E-05
SR92+D	8.43E-10	0.	3.64E-11	0.	0.	2.06E-06	5.38E-06

Includes a 50% increase to account for percutaneous transpiration.

ADULT INHALATION DOSE COMMITMENT FACTORS(MREM/50Y PER PCI INHALED IN FIRST YR)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
Y90	2.61E-07	0.	7.01E-09	0.	0.	2.12E-05	6.32E-05
Y91M+D	3.26E-11	0.	1.27E-12	0.	0.	2.40E-07	1.66E-10
Y91	5.78E-05	0.	1.55E-06	0.	0.	2.13E-04	4.81E-05
Y92	1.29E-09	0.	3.77E-11	0.	0.	1.96E-06	9.19E-06
Y93	1.18E-08	0.	3.26E-10	0.	0.	6.06E-06	5.27E-05
ZR93+D	5.22E-05	2.92E-06	1.37E-06	0.	1.11E-05	2.13E-05	1.51E-06
ZR95+D	1.34E-05	4.30E-06	2.91E-06	0.	6.77E-06	2.21E-04	1.88E-05
ZR97+D	1.21E-08	2.45E-09	1.13E-09	0.	3.71E-09	9.84E-06	6.54E-05
NB93M	3.10E-05	1.01E-05	2.49E-06	0.	1.16E-05	3.11E-05	2.38E-06
NB95	1.76E-06	9.77E-07	5.26E-07	0.	9.67E-07	6.31E-05	1.30E-05
NB97	2.78E-11	7.03E-12	2.56E-12	0.	8.18E-12	3.00E-07	3.02E-08
MO93	0.	1.17E-06	3.17E-08	0.	3.55E-07	5.11E-05	3.79E-06
MO99+D	0.	1.51E-06	2.87E-09	0.	3.64E-08	1.14E-05	3.10E-05
TC99M	1.29E-13	3.64E-13	4.63E-12	0.	5.52E-12	9.55E-08	5.20E-07
TC99	3.13E-08	4.64E-08	1.25E-08	0.	5.85E-07	1.01E-04	7.54E-06
TC101	5.22E-15	7.52E-15	7.38E-14	0.	1.35E-13	4.99E-08	1.36E-21
RU103+D	1.91E-07	0.	8.23E-08	0.	7.29E-07	6.31E-05	1.38E-05
RU105+D	9.88E-11	0.	3.89E-11	0.	1.27E-10	1.37E-06	6.02E-06
RU106+D	8.64E-06	0.	1.09E-06	0.	1.67E-05	1.17E-03	1.14E-04
RH105	9.24E-10	6.73E-10	4.43E-10	0.	2.86E-09	2.41E-06	1.09E-05
PD107	0.	8.27E-08	5.87E-09	0.	6.57E-07	9.47E-06	7.06E-07
PD109	0.	4.63E-10	1.16E-10	0.	2.35E-09	1.85E-06	1.52E-05
AG110M+D	1.35E-06	1.25E-06	7.43E-07	0.	2.46E-06	5.79E-04	3.78E-05
AG111	4.25E-08	1.78E-08	8.87E-09	0.	5.74E-08	2.33E-05	2.79E-05
CD113M	0.	1.54E-04	4.97E-06	0.	1.71E-04	2.08E-04	1.59E-05
CD115M	0.	2.46E-05	7.95E-07	0.	1.98E-05	1.76E-04	4.80E-05
SN123	3.02E-05	6.67E-07	9.82E-07	5.67E-07	0.	2.88E-04	3.92E-05
SN125+D	1.16E-06	3.12E-08	7.03E-08	2.59E-08	0.	7.37E-05	6.81E-05
SN126+D	1.58E-04	4.18E-06	6.00E-06	1.23E-06	0.	1.17E-03	1.59E-05
SB124	3.90E-06	7.36E-08	1.55E-06	9.44E-09	0.	3.10E-04	5.08E-05
SB125+D	6.67E-06	7.44E-08	1.58E-06	6.75E-09	0.	2.18E-04	1.26E-05
SB126	4.50E-07	9.13E-09	1.62E-07	2.75E-09	0.	9.57E-05	6.01E-05
SB127	3.30E-08	7.22E-10	1.27E-08	3.97E-10	0.	2.05E-05	3.77E-05
TE125M	4.27E-07	1.98E-07	5.84E-08	1.31E-07	1.55E-06	3.92E-05	8.83E-06
TE127M+D	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+D	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+D	8.74E-09	5.45E-09	3.63E-09	6.88E-09	3.86E-08	1.82E-05	6.95E-05
TE131+D	1.39E-12	7.44E-13	4.49E-13	1.17E-12	5.46E-12	1.74E-07	2.30E-09
TE132+D	3.25E-08	2.69E-08	2.02E-08	2.37E-08	1.82E-07	3.60E-05	6.37E-05
TE133M+D	7.24E-12	5.40E-12	4.17E-12	6.27E-12	3.74E-11	5.51E-07	5.49E-08
TE134+D	3.84E-12	3.22E-12	1.57E-12	3.44E-12	2.18E-11	4.34E-07	2.97E-11
I129	2.48E-06	2.11E-06	6.91E-06	5.54E-03	4.53E-06	0.	2.22E-07
I130	5.72E-07	1.68E-06	6.60E-07	1.42E-04	2.61E-06	0.	9.61E-07
I131+D	3.15E-06	4.47E-06	2.56E-06	1.49E-03	7.66E-06	0.	7.85E-07

ADULT INHALATION DOSE COMMITMENT FACTORS(MREM/50Y PER PCI INHALED IN FIRST YR)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
I132	1.45E-07	4.07E-07	1.45E-07	1.43E-05	6.48E-07	0.	5.08E-08
I133+D	1.08E-06	1.85E-06	5.65E-07	2.69E-04	3.23E-06	0.	1.11E-06
I134	8.05E-08	2.16E-07	7.69E-08	3.73E-06	3.44E-07	0.	1.26E-10
I135+D	3.35E-07	8.73E-07	3.21E-07	5.60E-05	1.39E-06	0.	6.56E-07
XE131M	0.	0.	0.	0.	0.	1.40E-09	0.
XE133M	0.	0.	0.	0.	0.	1.89E-09	0.
XE133	0.	0.	0.	0.	0.	1.57E-09	0.
XE135M	0.	0.	0.	0.	0.	2.22E-09	0.
XE135	0.	0.	0.	0.	0.	4.05E-09	0.
XE137	0.	0.	0.	0.	0.	1.74E-08	0.
XE138+D	0.	0.	0.	0.	0.	2.44E-08	0.
CS134M+D	1.59E-08	3.20E-08	1.72E-08	0.	1.83E-08	2.93E-09	7.92E-09
CS134	4.66E-05	1.06E-04	9.10E-05	0.	3.59E-05	1.22E-05	1.30E-06
CS135	1.46E-05	1.29E-05	5.94E-06	0.	5.11E-06	1.57E-06	2.11E-07
CS136	4.88E-06	1.83E-05	1.38E-05	0.	1.07E-05	1.50E-06	1.46E-06
CS137+D	5.98E-05	7.76E-05	5.35E-05	0.	2.78E-05	9.40E-06	1.05E-06
CS138	4.14E-08	7.76E-08	4.05E-08	0.	6.00E-08	6.07E-09	2.33E-13
CS139+D	2.56E-08	3.63E-08	1.39E-08	0.	3.05E-08	2.84E-09	5.49E-31
BA139	1.17E-10	8.32E-14	3.42E-12	0.	7.78E-14	4.70E-07	1.12E-07
BA140+D	4.88E-06	6.13E-09	3.21E-07	0.	2.09E-09	1.59E-04	2.73E-05
BA141+D	1.25E-11	9.41E-15	4.20E-13	0.	8.75E-15	2.42E-07	1.45E-17
BA142+D	3.29E-12	3.38E-15	2.07E-13	0.	2.86E-15	1.49E-07	1.96E-26
LA140	4.30E-08	2.17E-08	5.73E-09	0.	0.	1.70E-05	5.73E-05
LA141	5.34E-10	1.66E-10	2.71E-11	0.	0.	1.35E-06	7.31E-06
LA142	8.54E-11	3.88E-11	9.65E-12	0.	0.	7.91E-07	2.64E-07
CE141	2.49E-06	1.69E-06	1.91E-07	0.	7.83E-07	4.52E-05	1.50E-05
CE143+D	2.33E-08	1.72E-08	1.91E-09	0.	7.60E-09	9.97E-06	2.83E-05
CE144+D	4.29E-04	1.79E-04	2.30E-05	0.	1.06E-04	9.72E-04	1.02E-04
PR143	1.17E-06	4.69E-07	5.80E-08	0.	2.70E-07	3.51E-05	2.50E-05
PR144	3.76E-12	1.56E-12	1.91E-13	0.	8.81E-13	1.27E-07	2.69E-18
ND147+D	6.59E-07	7.62E-07	4.56E-08	0.	4.45E-07	2.76E-05	2.16E-05
PM147	8.37E-05	7.87E-06	3.19E-06	0.	1.49E-05	6.60E-05	5.54E-06
PM148M+D	9.82E-06	2.54E-06	1.94E-06	0.	3.85E-06	2.14E-04	4.18E-05
PM148	3.84E-07	6.37E-08	3.20E-08	0.	1.20E-07	3.91E-05	5.80E-05
PM149	3.44E-08	4.87E-09	1.99E-09	0.	9.19E-09	7.21E-06	2.50E-05
PM151	8.50E-09	1.42E-09	7.21E-10	0.	2.55E-09	3.94E-06	2.00E-05
SM151	8.59E-05	1.48E-05	3.55E-06	0.	1.66E-05	4.45E-05	3.25E-06
SM153	1.70E-08	1.42E-08	1.04E-09	0.	4.59E-09	4.14E-06	1.58E-05
EU152	2.38E-04	5.41E-05	4.76E-05	0.	3.35E-04	3.43E-04	1.59E-05
EU154	7.40E-04	9.10E-05	6.48E-05	0.	4.36E-04	5.84E-04	3.40E-05
EU155	1.01E-04	1.43E-05	9.21E-06	0.	6.59E-05	9.46E-05	5.95E-06
EU156	1.93E-06	1.48E-06	2.40E-07	0.	9.95E-07	8.56E-05	4.50E-05
TB160	2.21E-05	0.	2.75E-06	0.	9.10E-06	1.92E-04	2.68E-05
HO166M	3.37E-04	1.05E-04	8.00E-05	0.	1.57E-04	3.94E-04	1.59E-05
W181	5.23E-09	2.03E-09	2.17E-10	0.	0.	1.71E-06	2.53E-07
W185	1.75E-07	6.47E-08	6.81E-09	0.	0.	5.57E-05	1.07E-05
W187	1.06E-09	8.85E-10	3.10E-10	0.	0.	3.63E-06	1.94E-05

TABLE 1.7 (Contd)

ADULT INHALATION DOSE COMMITMENT FACTORS(MREM/50Y PER PCI INHALED IN FIRST YR)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
PB210+D	2.64E-02	6.73E-03	8.37E-04	0.	2.12E-02	2.62E-02	3.65E-05
BI210+D	0.	1.59E-06	1.32E-07	0.	1.92E-05	1.11E-03	2.95E-05
PO210	3.97E-04	8.60E-04	9.58E-05	0.	2.95E-03	3.14E-02	4.19E-05
RN222+D	0.	0.	0.	0.	0.	2.05E-06	0.
RA223+D	1.80E-04	2.77E-07	3.60E-05	0.	7.85E-06	2.55E-02	2.84E-04
RA224+D	1.98E-05	4.78E-08	3.96E-06	0.	1.35E-06	8.77E-03	3.01E-04
RA225+D	3.00E-04	3.56E-07	5.99E-05	0.	1.01E-05	2.92E-02	2.71E-04
RA226+D	1.25E-01	2.39E-06	9.14E-02	0.	6.77E-05	1.17E-01	2.94E-04
RA228+D	4.41E-02	1.23E-06	4.78E-02	0.	3.48E-05	1.61E-01	5.00E-05
AC225	4.23E-04	5.82E-04	2.84E-05	0.	6.63E-05	2.21E-02	2.52E-04
AC227+D	2.30E+00	3.05E-01	1.36E-01	0.	9.82E-02	2.41E-01	5.08E-05
TH227+D	2.17E-04	3.92E-06	6.25E-06	0.	2.22E-05	3.77E-02	3.34E-04
TH228+D	2.00E-01	3.39E-03	6.77E-03	0.	1.89E-02	1.01E+00	3.49E-04
TH229	9.88E+00	1.33E-01	4.36E-01	0.	6.52E-01	3.49E+00	3.17E-04
TH230	2.29E+00	1.31E-01	6.36E-02	0.	6.40E-01	6.21E-01	3.73E-05
TH232+D	2.56E+00	1.12E-01	9.04E-02	0.	5.47E-01	5.96E-01	3.17E-05
TH234	1.63E-06	9.56E-08	4.70E-08	0.	5.41E-07	1.89E-04	7.03E-05
PA231+D	5.08E+00	1.91E-01	1.98E-01	0.	1.07E+00	5.75E-02	4.44E-05
PA233	1.21E-06	2.42E-07	2.09E-07	0.	9.15E-07	3.52E-05	1.02E-05
U232+D	5.14E-02	0.	3.66E-03	0.	5.56E-03	2.22E-01	4.21E-05
U233+D	1.09E-02	0.	6.60E-04	0.	2.54E-03	5.32E-02	3.89E-05
U234	1.04E-02	0.	6.46E-04	0.	2.49E-03	5.22E-02	3.81E-05
U235+D	1.00E-02	0.	6.07E-04	0.	2.34E-03	4.90E-02	4.84E-05
U236	1.00E-02	0.	6.20E-04	0.	2.39E-03	5.00E-02	3.57E-05
U237	3.67E-08	0.	9.77E-09	0.	1.51E-07	1.02E-05	1.20E-05
U238+D	9.58E-03	0.	5.67E-04	0.	2.18E-03	4.58E-02	3.41E-05
NP237+D	1.69E+00	1.47E-01	6.87E-02	0.	5.10E-01	5.22E-02	4.92E-05
NP238	2.96E-07	8.00E-09	4.61E-09	0.	2.72E-08	1.02E-05	2.13E-05
NP239	2.87E-08	2.82E-09	1.55E-09	0.	8.75E-09	4.70E-06	1.49E-05
PU238	2.74E+00	3.87E-01	6.90E-02	0.	2.96E-01	1.82E-01	4.52E-05
PU239	3.19E+00	4.31E-01	7.75E-02	0.	3.30E-01	1.72E-01	4.13E-05
PU240	3.18E+00	4.30E-01	7.73E-02	0.	3.29E-01	1.72E-01	4.21E-05
PU241+D	6.41E-02	3.28E-03	1.29E-03	0.	5.93E-03	1.52E-04	8.65E-07
PU242	2.95E+00	4.15E-01	7.46E-02	0.	3.17E-01	1.65E-01	4.05E-05
PU244	3.45E+00	4.76E-01	8.54E-02	0.	3.64E-01	1.89E-01	6.03E-05
AM241	1.01E+00	3.59E-01	6.71E-02	0.	5.04E-01	6.06E-02	4.60E-05
AM242M	1.02E+00	3.46E-01	6.73E-02	0.	5.01E-01	2.44E-02	5.79E-05
AM243	1.01E+00	3.47E-01	6.57E-02	0.	4.95E-01	5.75E-02	5.40E-05
CM242	1.48E-02	1.51E-02	9.84E-04	0.	4.48E-03	3.92E-02	4.91E-05
CM243	7.86E-01	2.97E-01	4.61E-02	0.	2.15E-01	6.31E-02	4.84E-05
CM244	5.90E-01	2.54E-01	3.51E-02	0.	1.64E-01	6.06E-02	4.68E-05
CM245	1.26E+00	3.59E-01	7.14E-02	0.	3.33E-01	5.85E-02	4.36E-05
CM246	1.25E+00	3.59E-01	7.13E-02	0.	3.33E-01	5.96E-02	4.29E-05
CM247+D	1.22E+00	3.53E-01	7.03E-02	0.	3.28E-01	5.85E-02	5.63E-05
CM248	1.01E+01	2.91E+00	5.79E-01	0.	2.70E+00	4.82E-01	9.09E-04
CF252	9.78E-01	0.	2.33E-02	0.	0.	1.99E-01	1.78E-04

TABLE 1.8

EXTERNAL DOSE FACTORS FOR STANDING ON CONTAMINATED GROUND (DFG_i)

(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	4.2[illegible]-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	6.80E-11
Te-127m	1.10E-12	1.30E-12
Te-127	1.00E-11	1.10E-11

TABLE 1.8 (Contd)

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

1991 PALISADES GASEOUS DESIGN

OBJECTIVE ANNUAL QUANTITIES

Nuclide	Organ	Dose Factor mrem/Ci	Design Objective Annual Quantity (Ci)
Ag-110m	GI Tract-T	1.05E+00	1.43E+01
Ar-41	Total Body	2.75E-04	1.82E+04
Ba-139	GI Tract-C	2.38E-03	6.30E+03
Ba-140	Lung-C	7.18E-02	2.09E+02
Br-82	Total Body-I	1.16E-03	4.31E+03
C-14	Bone-C	1.07E-01	1.40E+02
Ce-141	GI Tract-T	1.15E-01	1.30E+02
Ce-144	GI Tract-T	3.06E+00	4.90E+00
Co-57	GI Tract-T	7.74E-02	1.94E+02
Co-58	GI Tract-T	1.37E-01	1.09E+02
Co-60	GI Tract-T	7.83E-01	1.92E+01
Cr-51	GI Tract-A,T	2.14E-03	7.01E+03
Cs-134	Liver-C	6.29E+00	2.38E+00
Cs-136	Total Body-I	4.68E-02	1.07E+02
Cs-137	Bone-C	6.15E+00	2.44E+00
Cs-138	Total Body-I	1.64E-05	3.05E+05
Fe-55	Bone-C	1.88E-01	7.98E+01
Fe-59	GI Tract-T	2.19E-01	6.85E+01
H-3	Total Body-C	1.23E-04	4.07E+04
I-131	Thyroid-I	4.68E+00	3.21E+00
I-132	Thyroid-C	8.28E-03	1.81E+03
I-133	Thyroid-C	1.65E-01	9.09E+01
I-134	Thyroid-C	2.17E-03	6.91E+03
I-135	Thyroid-C	3.39E-02	4.42E+02
Kr-83m	Skin	6.66E-07	2.25E+07
Kr-85	Skin	6.01E-05	2.50E+05
Kr-85m	Total Body	1.09E-04	4.59E+04
Kr-87	Skin	6.45E-04	2.33E+04
Kr-88	Total Body	4.57E-04	1.09E+04
Kr-89	Total Body	5.16E-04	9.69E+03
La-140	GI Tract-T	2.01E-02	7.46E+02
Mn-54	GI Tract-T	2.21E-01	6.79E+01
Mn-56	GI Tract-C	5.08E-03	2.95E+03
Mo-99	GI Tract-T	1.11E-02	1.35E+03
N-13	Total Body-C	2.67E-50	1.87E+50
Na-24	Total Body-C	6.63E-04	7.54E+03
Nb-95	GI Tract-A	1.01E-01	1.49E+02
Ni-65	GI Tract-C	3.46E-03	4.34E+03
Np-239	GI Tract-T	[illegible].44E-03	2.76E+03
Rb-88	Total Body-C	1.51E-05	3.31E+05
Ru-103	GI Tract-A	1.61E-01	9.32E+01
Sb-124	GI Tract-T	7.04E-01	2.13F+01
Sb-125	GI Tract-T	3.97E-01	3.78E+01

TABLE 1.9 (Cont'd)

1991 PALISADES CASEOUS DESICN

OBJECTIVE ANNUAL QUANTITIES (Contd)

Nuclide	Organ	Dose Factor Mrem/Ci	Design Objective Annual Quantity (Ci)
Sr-89	Bone-C	8.26E+00	1.82E+00
Sr-90	Bone-C	3.40E+02	4.41E-02
Sr-91	Bone-I	1.68E+00	8.93E+00
Sr-92	GI Tract-C	9.99E-03	1.50E+03
Tc-99m	GI Tract-T	2.53E-04	5.93E+04
Tc-101	GI Tract-I	3.48E-05	4.31E+05
Te-127	GI Tract-T	3.33E-03	4.50E+03
Xe-131m	Skin	2.65E-05	5.66E+05
Xe-133	Total Body	9.13E-06	5.48E+05
Xe-133m	Skin	5.54E-05	2.71E+05
Xe-135	Total Body	5.62E-05	8.90E+04
Xe-135m	Total Body	9.69E-05	5.16E+04
Xe-137	Skin	5.94E-04	2.53E+04
Xe-138	Total Body	2.74E-04	1.82E+04
Zn-65	Total Body-C	4.16E-01	1.20E+01
Zr-95	GI Tract-T	2.89E-01	5.19E+01

II. LIQUID EFFLUENTS

A. CONCENTRATION

1. Rets Requirements

Specification 3.24.3.2 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 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 2E-04 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. Maximum Permissible Concentration (MPC) - Sum of the Ratios

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:

$$R_j = \sum_i \frac{C_i}{MPC_i} \qquad (2.2)$$

where:

C_i = Effluent concentration of radionuclide i, µCi/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 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. Composite Samplers

Effluent pathways, Turbine Sump and Service Water, are equipped with continuous compositors to meet the requirements of Technical Specification Table 4.24-3. These compositors are adjustable and normally set in a time mode and collect a 30 mL sample directly from the effluent every 10 minutes, 24 hours a day. A representative sample

is collected daily from the compositor and saved for the weekly, monthly analysis requirements of Technical Specification Table 4.24-3. In the event that a compositor is not operational, effluent releases via this pathway may continue provided that grab samples are collected and analyzed for gross radioactivity at least once per 24 hours per Technical Specification Table 3.24-1, action 30.

3. 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.

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 3.24.4.1 the Radiological Effluent Technical Specification (RETS) requires that the quantity of radionuclides released by limited such that the dose or dose commitment to an individual from radioactive materials in liquid effluents released to unrestricted areas from the 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 foll.ws in Section 2.

2. Release Analysis

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

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

where:

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

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 3.24.4.1 has been met.

Values for the design basis quantities (C_i), and the dose per Curie (Dc/Cc)i for each nuclide i shown in Table 2.2, were calculated as follows in Sections 2.1 and 2.2.

a. Water Ingestion

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

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

where:

D_j = Dose for the jth organ from radionuclides releases, mrem.

j = The organ of interest.

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

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

I_i is described by:

$$I_i = \frac{(A_i)(V)(365)}{(1000)(d)} (1E06) \qquad (2.7)$$

where:

365 = Days per year.

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

V = Average rate of water consumption (2000 ml/d - adult, 1400 ml/d - teen and child. 900 ml/d - infant, ICRP 23, p. 358).

d = Dilution water flow for year, ml

1000 = Dispersion factor from discharge to nearest drinking water supply

1E06 = Conversion µCi to pCi

The dose equation then becomes:

$$D_j = \frac{(3.65E05)(V)}{d} \sum_{i=1}^{i} (DCF)_{ij} \times A_i \text{ mrem} \qquad (2.8)$$

b. Fish Ingestion

The dose to an individual from the consumption of fish is described by Equation 2.10. In this case the activity ingested of the i^{th} radionuclide (I_i) is described by:

$$I_i = \frac{A_i B_i F (1E09)}{15 d} = \text{pCi} \qquad (2.9)$$

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 adult, 16 kg teen, 6.9 kg child, none infant)

15 = Dispersion factor from discharge to fish exposure point.

d = Dilution water flow for year, ml

1E09 = Conversion of μCi and Kgm to gross

Substitution of Equation 2.9 into Equation 2.6 gives:

$$D_j = \frac{(6.7E07)F}{d} \sum_{i=1}^{i} A_i \times B_i \times DCF_i \text{ mrem} \qquad (2.10)$$

c. 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 on LADTAP. The dose to the j^{th} organ from m radionuclides, D_j, is described by:

$$D_j = \sum_{i=1}^{m} D_{ij} \text{ mrem} \qquad (2.11)$$

$$= \sum_{i=1}^{m} (DCF)_{ij} \times I_j \text{ mrem} \qquad (2.12)$$

where:

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

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, mrem/pCi, see Table 2.1.

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

I_i for water ingestion is described by:

$$I_i = \frac{A_i V_T}{vd} \quad \mu Ci \qquad (2.13)$$

and for fish ingestion I_i is described by:

$$I_i = \frac{A_i B_i F_T}{v d} \quad \mu Ci$$

where:

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

V = Average rate of water consumption (2000 ml/d).

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

v = 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 Palisades 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 3.24.4.1. Maintaining the cumulative fraction if 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. 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 3.88E-03 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 (162) times 500/3.88E-03 or 2.1E07 Ci/yr = 0.661 Ci/sec.

III. URANIUM FUEL CYCLE DOSE

A. SPECIFICATION

In accordance with Specification 3.24.8.1, if either liquid or gaseous quarterly releases exceed the quantity which would cause offsite doses more than twice the limit of Specifications 3.24.4.1, 3.24.5.2 or 3.24.5.3, 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 protected to be the most highly exposed to these combined sources.

B. ASSUMPTIONS

1. The full time resident determined to be 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 shore line 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 16 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 CASPAR 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 present curing the quarter in question, times the assumed fishing time.

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

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 questions (hours).

IV. RADWASTE SYSTEM MODIFICATIONS

A. DEFINITION OF MAJOR RADWASTE SYSTEM MODIFICATION

1. Purpose

The purpose of this definition is to assure that Technical Specification 6.20 will be satisfied under clearly identifiable circumstances, and with the objective that current radwaste system capabilities are not jeopardized.

2. Definition

A major radwaste system modification is a modification which would remove (either by bypassing or physical removal) or replace with less efficient equipment, any components of the radwaste system:

a. Letdown filters or demineralizers

b. Vacuum degassifier

c. Miscellaneous or clean waste evaporators

d. The present waste gas compressor/decay tank system

e. Fuel pool filters/demineralizers

f. Radwaste polishing demineralizers

g. Radwaste solidification system

Improvements or additions to improve efficiency will not be considered major modifications unless a complete substitution of equipment or systems is made with equipment of unrelated design. Examples would be, 1) replacement of mechanical degassifier with steam, jet degassifier, 2) replacement of waste gas system with cryogenic system, 3) replacement of asphalt solidification with cement system, and 4) change from deep bed resins to Powdex, etc.

Figure 2-1

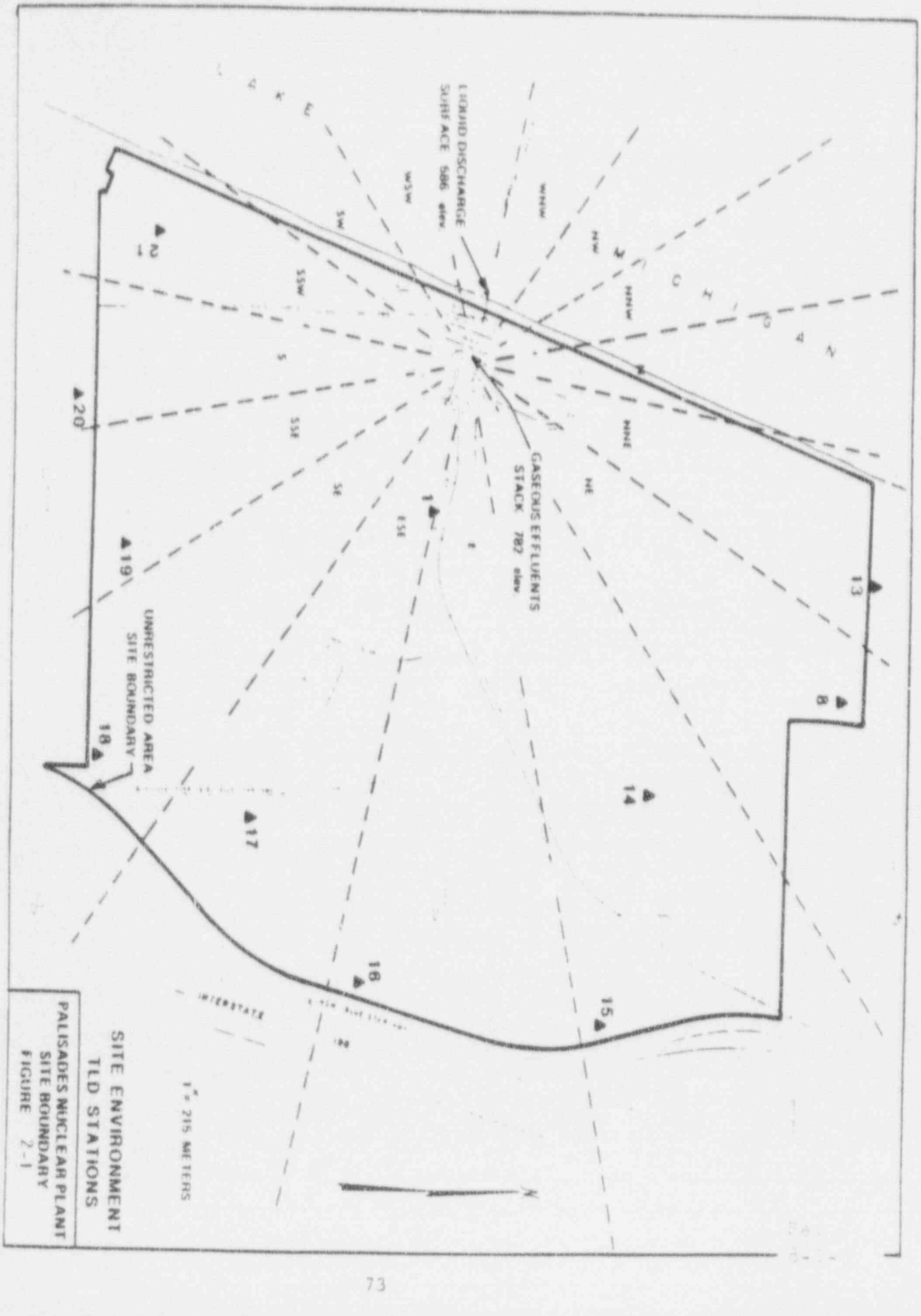

LAKE MICHIGAN
LIQUID DISCHARGE
SURFACE 586 elev.
GASEOUS EFFLUENTS
STACK 782 elev.
UNRESTRICTED AREA
SITE BOUNDARY
NNW
NW
WNW
WSW
SW
SSW
S
SSE
SE
ESE
E
NE
NNE
1
2
8
13
14
15
16
17
18
19
20
INTERSTATE
196
1" = 215 METERS
N
SITE ENVIRONMENT
TLD STATIONS
PALISADES NUCLEAR PLANT
SITE BOUNDARY
FIGURE 2-1

Figure 2-2

PALISADES RADWASTE EFFLUENTS - LIQUID

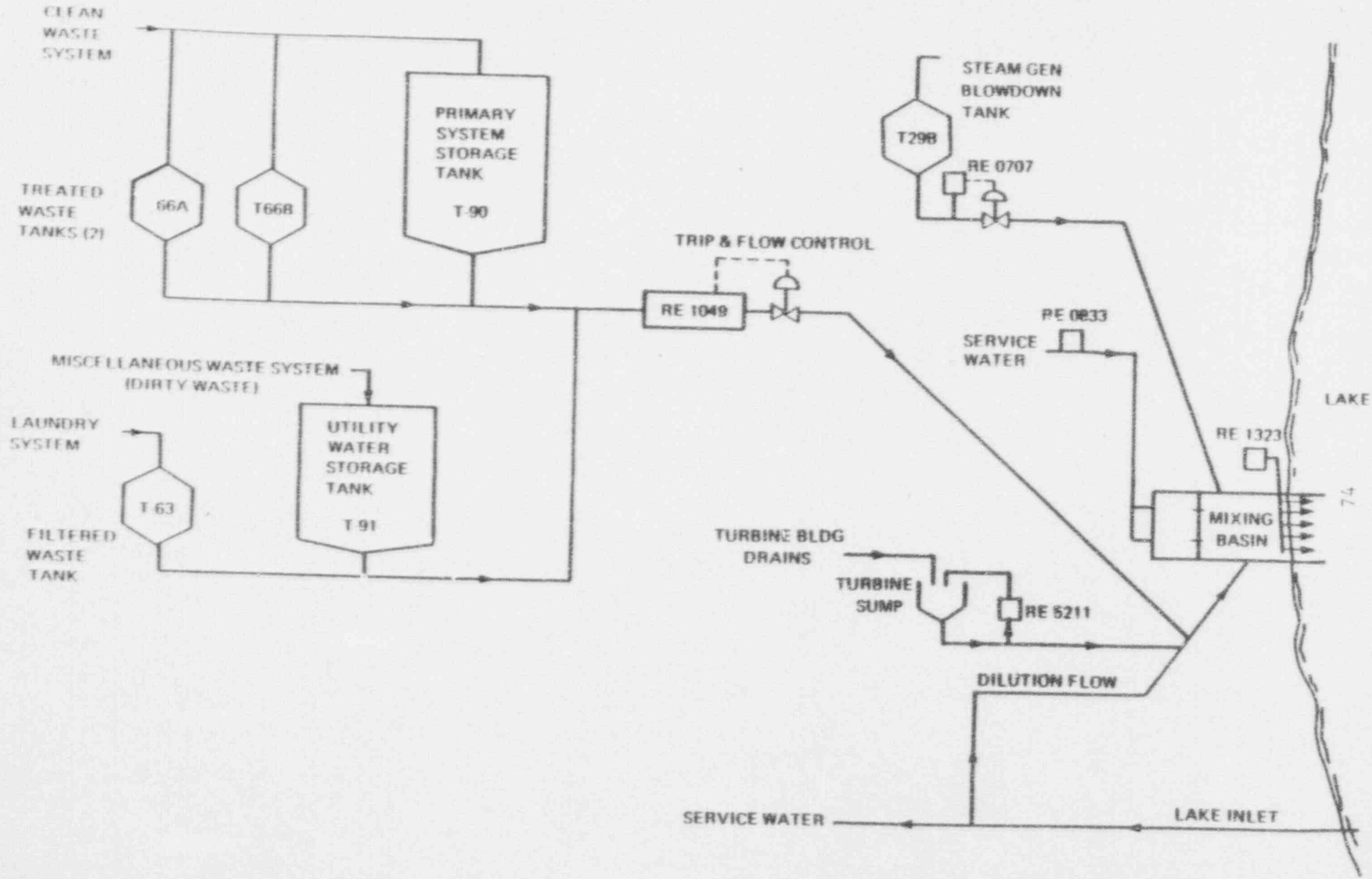


TABLE 2.0

BIOACCUMULATION FACTORS
μCi/gm per μCi/ml

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

INFANT INGESTION DOSE COMMITMENT FACTORS(MREM/50Y PER PCI INGESTED IN FIRST YR)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
H3	0.	3.08E-07	3.08E-07	3.08E-07	3.08E-07	3.08E-07	3.08E-07
BE10	1.71E-05	2.64E-06	5.16E-07	0.	1.64E-06	0.	2.78E-05
C14	2.37E-05	5.06E-06	5.06E-06	5.06E-06	5.06E-06	5.06E-06	5.06E-06
N13	5.85E-08	5.85E-08	5.85E-08	5.85E-08	5.85E-08	5.85E-08	5.85E-08
F18	5.19E-06	0.	4.43E-07	0.	0.	0.	1.22E-06
NA22	9.83E-05	9.83E-05	9.83E-05	9.83E-05	9.83E-05	9.83E-05	9.83E-05
NA24	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05
P32	1.70E-03	1.00E-04	6.59E-05	0.	0.	0.	2.30E-05
AR39	0.	0.	0.	0.	0.	0.	0.
AR41	0.	0.	0.	0.	0.	0.	0.
CA41	3.74E-04	0.	4.08E-05	0.	0.	0.	1.91E-07
SC46	3.75E-08	5.41E-08	1.69E-08	0.	3.56E-08	0.	3.53E-05
CR51	0.	0.	1.41E-08	9.20E-09	2.01E-09	1.79E-08	4.11E-07
MN54	0.	1.99E-05	4.51E-06	0.	4.41E-06	0.	7.31E-06
MN56	0.	8.18E-07	1.41E-07	0.	7.03E-07	0.	7.43E-05
FE55	1.39E-05	8.98E-06	2.40E-06	0.	0.	4.39E-06	1.14E-06
FE59	3.08E-05	5.38E-05	2.12E-05	0.	0.	1.59E-05	2.57E-05
CO57	0.	1.15E-06	1.87E-06	0.	0.	0.	3.92E-06
CO58	0.	3.60E-06	8.98E-06	0.	0.	0.	8.97E-06
CO60	0.	1.08E-05	2.55E-05	0.	0.	0.	2.57E-05
NI59	4.71E-05	1.45E-05	8.17E-06	0.	0.	0.	7.16E-07
NI63	6.34E-04	3.92E-05	2.20E-05	0.	0.	0.	1.95E-06
NI65	4.70E-06	5.32E-07	2.42E-07	0.	0.	0.	4.05E-05
CU64	0.	6.09E-07	2.82E-07	0.	1.03E-06	0.	1.25E-05
ZN65	1.84E-05	6.31E-05	2.91E-05	0.	3.06E-05	0.	5.33E-05
ZN69M+D	1.50E-06	3.06E-06	2.79E-07	0.	1.24E-06	0.	4.24E-05
ZN69	9.33E-08	1.68E-07	1.25E-08	0.	6.98E-08	0.	1.37E-05
SE79	0.	2.10E-05	3.90E-06	0.	2.43E-05	0.	5.58E-07
BR82	0.	0.	1.27E-05	0.	0.	0.	0.
BR83+D	0.	0.	3.63E-07	0.	0.	0.	0.
BR84	0.	0.	3.82E-07	0.	0.	0.	0.
BR85	0.	0.	1.94E-08	0.	0.	0.	0.
KR83M	0.	0.	0.	0.	0.	0.	0.
KR85M	0.	0.	0.	0.	0.	0.	0.
KR85	0.	0.	0.	0.	0.	0.	0.
KR87	0.	0.	0.	0.	0.	0.	0.
KR88+D	0.	0.	0.	0.	0.	0.	0.
KR89	0.	0.	0.	0.	0.	0.	0.
RB86	0.	1.70E-04	8.40E-05	0.	0.	0.	4.35E-06
RB87	0.	8.88E-05	3.52E-05	0.	0.	0.	5.98E-07
RB88	0.	4.98E-07	2.73E-07	0.	0.	0.	4.85E-07
RB89+D	0.	2.86E-07	1.97E-07	0.	0.	0.	9.74E-08
SR89+D	2.51E-03	0.	7.20E-05	0.	0.	0.	5.16E-05
SR90+D	1.85E-02	0.	4.71E-03	0.	0.	0.	2.31E-04
SR91+D	5.00E-05	0.	1.81E-06	0.	0.	0.	5.92E-05
SR92+D	1.92E-05	0.	7.13E-07	0.	0.	0.	2.07E-04

INFANT INGESTION DOSE COMMITMENT FACTORS(MREM/SUY PER PCI INJESTED IN FIRST YR)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
Y90	8.69E-08	0.	2.33E-09	0.	0.	0.	1.20E-04
Y91M+D	8.10E-10	0.	2.76E-11	0.	0.	0.	2.70E-06
Y91	1.13E-06	0.	3.01E-08	0.	0.	0.	8.10E-05
Y92	7.65E-09	0.	2.15E-10	0.	0.	0.	1.46E-04
Y93	2.43E-08	0.	6.62E-10	0.	0.	0.	1.92E-04
ZR93+D	1.93E-07	9.18E-08	5.54E-08	0.	2.71E-07	0.	2.39E-05
ZR95+D	2.06E-07	5.02E-08	3.56E-08	0.	5.41E-08	0.	2.50E-05
ZR97+D	1.48E-08	2.54E-09	1.16E-09	0.	2.56E-09	0.	1.62E-04
NB93M	1.23E-07	3.33E-08	1.04E-08	0.	3.25E-08	0.	3.98E-06
NB95	4.20E-08	1.73E-08	1.00E-08	0.	1.24E-08	0.	1.46E-05
NB97	4.59E-10	9.79E-11	3.53E-11	0.	7.65E-11	0.	3.09E-05
MO93	0.	5.65E-05	1.82E-06	0.	1.13E-05	0.	1.21E-06
MO99+D	0.	3.40E-05	6.63E-06	0.	5.08E-05	0.	1.12E-05
TC99M	1.92E-09	3.96E-09	5.10E-08	0.	4.26E-08	2.07E-09	1.15E-06
TC99	1.08E-06	1.46E-06	4.55E-07	0.	1.23E-05	1.42E-07	6.31E-06
TC101	2.27E-09	2.86E-09	2.83E-08	0.	3.40E-08	1.56E-09	4.86E-07
RU103+D	1.48E-06	0.	4.95E-07	0.	3.08E-06	0.	1.80E-05
RU105+D	1.36E-07	0.	4.58E-08	0.	1.00E-06	0.	5.41E-05
RU106+D	2.41E-05	0.	3.01E-06	0.	2.85E-05	0.	1.83E-04
RH105	1.09E-06	7.13E-07	4.79E-07	0.	1.98E-06	0.	1.77E-05
PD107	0.	1.19E-06	8.45E-08	0.	6.79E-06	0.	9.46E-07
PD109	0.	1.50E-06	3.62E-07	0.	5.51E-06	0.	3.68E-05
AG110M+D	9.96E-07	7.27E-07	4.81E-07	0.	1.04E-06	0.	3.77E-05
AG111	5.20E-07	2.02E-07	1.07E-07	0.	4.22E-07	0.	4.82E-05
CD113M	0.	1.77E-05	6.52E-07	0.	1.34E-05	0.	2.66E-05
CD115M	0.	1.42E-05	4.93E-07	0.	7.41E-06	0.	8.09E-05
SN123	2.49E-04	3.89E-06	6.50E-06	3.91E-06	0.	0.	6.58E-05
SN125+D	7.41E-05	1.38E-06	3.29E-06	1.36E-06	0.	0.	1.11E-04
SN126+D	5.53E-04	7.26E-06	1.80E-05	1.91E-06	0.	0.	2.52E-05
SB124	2.14E-05	3.15E-07	6.63E-06	5.68E-08	0.	1.34E-05	6.60E-05
SB125+D	1.23E-05	1.19E-07	2.53E-06	1.54E-08	0.	7.72E-06	1.66E-05
SB126	8.06E-06	1.58E-07	2.91E-06	6.19E-08	0.	5.07E-06	8.[illegible]E-05
SB127	2.23E-06	3.98E-08	6.90E-07	2.84E-08	0.	1.15E-06	5.91E-05
TE125M	2.33E-05	7.79E-06	3.15E-06	7.84E-06	0.	0.	1.11E-05
TE127M+D	5.85E-05	1.94E-05	7.08E-06	1.69E-05	1.44E-04	0.	2.36E-05
TE127	1.00E-06	3.35E-07	2.15E-07	8.14E-07	2.44E-06	0.	2.10E-05
TE129M+D	1.00E-04	3.43E-05	1.54E-05	3.84E-05	2.50E-04	0.	5.97E-05
TE129	2.84E-07	9.79E-08	6.63E-08	2.38E-07	7.07E-07	0.	2.27E-05
TE131M+D	1.52E-05	6.12E-06	5.05E-06	1.24E-05	4.21E-05	0.	1.03E-04
TE131+D	1.76E-07	6.50E-08	4.94E-08	1.57E-07	4.50E-07	0.	7.[illegible]E-06
TE132+D	2.08E-05	1.03E-05	9.61E-06	1.52E-05	6.44E-05	0.	3.81E-05
TE133M+D	3.91E-07	1.79E-07	1.71E-07	3.45E-07	1.22E-06	0.	1.93E-05
TE134+D	2.67E-07	1.34E-07	1.38E-07	2.39E-07	9.03E-07	0.	3.06E-06
I129	2.86E-05	2.12E-05	1.55E-05	1.36E-02	2.51E-05	0.	4.24E-07
I130	6.00E-06	1.32E-05	5.30E-06	1.48E-03	1.45E-05	0.	2.83E-06
I131+D	3.59E-05	4.23E-05	1.86E-05	1.39E-02	4.94E-05	0.	1.51E-06

INFANT INGESTION DOSE COMMITMENT FACTORS(MREM/50Y PER PCI INGESTED IN FIRST YR)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
I132	1.66E-06	3.37E-06	1.20E-06	1.58E-04	3.76E-06	0.	2.73E-06
I133+D	1.25E-05	1.82E-05	5.33E-06	3.31E-03	2.14E-05	0.	3.08E-06
I134	8.69E-07	1.78E-06	6.33E-07	4.15E-05	1.99E-06	0.	1.84E-06
I135+D	3.64E-06	7.24E-06	2.64E-06	6.49E-04	8.07E-06	0.	2.62E-06
XE131M	0.	0.	0.	0.	0.	0.	0.
XE133M	0.	0.	0.	0.	0.	0.	0.
XE133	0.	0.	0.	0.	0.	0.	0.
XE135M	0.	0.	0.	0.	0.	0.	0.
XE135	0.	0.	0.	0.	0.	0.	0.
XE137	0.	0.	0.	0.	0.	0.	0.
XE138+D	0.	0.	0.	0.	0.	0.	0.
CS134M+D	1.76E-07	2.93E-07	1.48E-07	0.	1.13E-07	2.60E-08	2.32E-07
CS134	3.77E-04	7.03E-04	7.10E-05	0.	1.81E-04	7.42E-05	1.91E-06
CS135	1.33E-04	1.21E-04	6.30E-06	0.	3.44E-05	1.31E-05	4.37E-07
CS136	4.59E-05	1.35E-04	5.04E-05	0.	5.38E-05	1.10E-05	2.05E-06
CS137+D	5.22E-04	6.11E-04	4.33E-05	0.	1.64E-04	6.64E-05	1.91E-06
CS138	4.81E-07	7.82E-07	3.79E-07	0.	3.90E-07	6.09E-08	[illegible]
CS139+D	3.10E-07	4.24E-07	1.62E-07	0.	2.19E-07	3.30E-08	2.66E-08
BA139	9.81E-07	5.84E-10	2.55E-08	0.	3.51E-10	3.54E-10	5.58E-05
BA140+D	1.71E-04	1.71E-07	8.81E-06	0.	4.06E-08	1.05E-07	4.20E-05
BA141+D	4.25E-07	2.91E-10	1.34E-08	0.	1.75E-10	1.77E-10	5.19E-06
BA142+D	1.84E-07	1.53E-10	9.06E-09	0.	8.81E-11	9.26E-11	7.59E-07
LA140	2.11E-08	[illegible].32E-09	2.14E-09	0.	0.	0.	9.77E-05
LA141	2.89E-09	8.38E-10	1.46E-10	0.	0.	0.	9.61E-05
LA142	1.10E-09	4.04E-10	9.67E-11	0.	0.	0.	6.86E-05
CE141	7.87E-08	4.80E-08	5.65E-09	0.	1.48E-08	0.	2.48E-05
CE143+D	1.48E-08	9.82E-06	1.12E-09	0.	2.86E-09	0.	5.73E-05
CE144+D	2.98E-06	1.22E-06	1.67E-07	0.	4.93E-07	0.	1.71E-04
PR143	8.13E-08	3.04E-08	4.03E-09	0.	1.13E-08	0.	4.29E-05
PR144	2.74E-10	1.06E-10	1.38E-11	0.	3.84E-11	0.	4.93E-06
ND147+D	5.53E-08	5.68E-08	3.48E-09	0.	2.19E-08	0.	3.60E-05
PM147	3.88E-07	3.27E-08	1.59E-08	0.	4.88E-08	0.	9.27E-06
PM148M+D	1.65E-07	4.18E-08	3.28E-08	0.	4.80E-08	0.	5.44E-05
PM148	6.32E-08	9.13E-09	4.60E-09	0.	1.04E-08	0.	9.74E-05
PM149	1.38E-08	1.81E-09	7.90E-10	0.	2.20E-09	0.	4.86E-05
PM151	6.18E-09	9.01E-10	4.56E-10	0.	1.07E-09	0.	4.17E-05
SM151	2.90E-07	6.67E-08	1.44E-08	0.	4.53E-08	0.	5.58E-06
SM153	7.72E-09	5.97E-09	4.58E-10	0.	1.25E-09	0.	3.12E-05
EU152	6.74E-07	1.79E-07	1.51E-07	0.	5.02E-07	0.	1.59E-05
EU154	2.64E-06	3.67E-07	2.20E-07	0.	9.95E-07	0.	4.58E-05
EU155	5.42E-07	6.25E-08	3.23E-08	0.	1.40E-07	0.	8.37E-05
EU156	1.14E-07	7.06E-08	1.12E-08	0.	3.26E-08	0.	6.67E-05
TB160	2.59E-07	0.	3.24E-08	0.	7.37E-08	0.	3.45E-05
HO166M	1.25E-06	2.69E-07	2.13E-07	0.	3.57E-07	0.	0.
W181	6.85E-08	2.72E-08	3.04E-09	0.	0.	0.	3.82E-07
W185	3.62E-06	1.13E-06	1.29E-07	0.	0.	0.	1.62E-05
W187	9.03E-07	6.28E-07	2.17E-07	0.	0.	0.	3.69E-05

INFANT INGESTION DOSE COMMITMENT FACTORS(MREM/50Y PER PCI INGESTED IN FIRST YR)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
PB210+D	5.28E-02	1.42E-02	2.38E-03	0.	4.33E-02	0.	5.62E-05
BI210+D	4.16E-06	2.68E-05	3.58E-07	0.	2.08E-04	0.	5.27E-05
PO210	3.10E-03	5.93E-03	7.41E-04	0.	1.26E-02	0.	6.61E-05
RN222+D	0.	0.	0.	0.	0.	0.	0.
RA223+D	4.41E-02	6.42E-05	8.82E-03	0.	1.17E-03	0.	3.43E-06
RA224+D	1.46E-02	3.29E-05	2.91E-03	0.	6.00E-04	0.	3.86E-06
RA225+D	5.78E-02	6.52E-05	1.15E-02	0.	1.19E-03	0.	3.24E-06
RA226+D	5.20E-01	4.78E-05	5.14E-01	0.	8.71E-04	0.	3.44E-06
RA228+D	4.32E-01	2.58E-05	4.86E-01	0.	4.73E-04	0.	5.86E-0
AC225	3.92E-05	5.03E-05	2.63E-06	0.	3.69E-06	0.	4.36E-0
AC227+D	4.49E-03	7.67E-04	2.79E-04	0.	1.56E-04	0.	8.50E-0
TH227+D	1.20E-06	2.01E-06	3.45E-06	0.	7.41E-06	0.	5.70E-0
TH228+D	2.47E-03	3.38E-05	8.36E-05	0.	1.58E-04	0.	5.84E-0
TH229	1.48E-02	1.94E-04	7.24E-04	0.	9.24E-04	0.	5.31E-0
TH230	3.80E-03	1.90E-04	1.06E-04	0.	9.12E-04	0.	6.24E-0
TH232+D	4.24E-03	1.63E-04	1.64E-04	0.	7.79E-04	0.	5.31E-0
TH234	5.92E-07	3.77E-08	2.00E-08	0.	1.39E-07	0.	1.19E-0
PA231+D	7.57E-03	2.50E-04	3.02E-04	0.	1.34E-03	0.	7.44E-0
PA233	3.11E-06	6.09E-09	5.43E-09	0.	1.67E-08	0.	1.46E-0
U232+D	2.42E-02	0.	2.16E-03	0.	2.37E-03	0.	7.04E-0
U233+D	5.08E-03	0.	3.87E-04	0.	1.08E-03	0.	6.51E-0
U234	4.88E-03	0.	3.80E-04	0.	1.06E-03	0.	6.37E-0
U235+D	4.67E-03	0.	3.56E-04	0.	9.93E-04	0.	8.10E-0
U236	4.67E-03	0.	3.64E-04	0.	1.01E-03	0.	5.98E-0
U237	4.95E-07	0.	1.32E-07	0.	1.23E-06	0.	2.11E-0
U238+D	4.47E-03	0.	3.33E-04	0.	9.28E-04	0.	5.71E-0
NP237+D	2.53E-03	1.93E-04	1.05E-04	0.	6.34E-04	0.	8.23E-0
NP238	1.24E-07	3.12E-09	1.92E-09	0.	6.81E-09	0.	4.17E-0
NP239	1.11E-08	9.93E-10	5.61E-10	0.	1.98E-09	0.	2.87E-0
PU238	1.34E-03	1.69E-04	3.40E-05	0.	1.21E-04	0.	7.57E-0
PU239	1.45E-03	1.77E-04	3.54E-05	0.	1.28E-04	0.	6.91E-0
PU240	1.45E-03	1.77E-04	3.54E-05	0.	1.28E-04	0.	7.04E-0
PU241+D	4.38E-05	1.90E-06	8.82E-07	0.	3.17E-06	0.	1.45E-0
PU242	1.35E-03	1.70E-04	3.41E-05	0.	1.23E-04	0.	6.77E-0
PU244	1.57E-03	1.95E-04	3.91E-05	0.	1.41E-04	0.	1.01E-0
AM241	1.53E-03	7.18E-04	1.09E-04	0.	6.55E-04	0.	7.70E-0
AM242M	1.58E-03	7.02E-04	1.13E-04	0.	6.64E-04	0.	9.69E-0
AM243	1.51E-03	6.68E-04	1.06E-04	0.	6.36E-04	0.	9.03E-0
CM242	1.37E-04	1.24E-04	9.10E-06	0.	7.62E-05	0.	8.23E-0
CM243	1.45E-03	6.88E-04	8.98E-05	0.	3.27E-04	0.	8.10E-0
CM244	1.22E-03	6.16E-04	7.59E-05	0.	2.71E-04	0.	7.84E-0
CM245	1.89E-03	7.49E-04	1.13E-04	0.	4.32E-04	0.	7.30E-0
CM246	1.87E-03	7.49E-04	1.13E-04	0.	4.31E-04	0.	7.17E-0
CM247+D	1.82E-03	7.36E-04	1.11E-04	0.	4.24E-04	0.	9.43E-0
CM248	1.51E-02	6.07E-03	4.16E-04	0.	3.50E-03	0.	1.52E-0
CF252	1.24E-03	0.	2.95E-05	0.	0.	0.	2.99E-0

CHILD INGESTION DOSE COMMITMENT FACTORS(MREM/50Y PER P.I INGESTED IN FIRST YR)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
H3	0.	2.03E-07	2.03E-07	2.03E-07	2.03E-07	2.03E-07	2.03E-07
BE10	1.35E-05	1.57E-06	3.34E-07	0.	1.11E-06	0.	2.75E-05
C14	1.21E-05	2.42E-06	2.42E-06	2.42E-06	2.42E-06	2.42E-06	2.42E-06
N13	3.10E-08	3.10E-08	3.10E-08	3.10E-08	3.10E-08	3.10E-08	3.10E-08
F18	2.44E-06	0.	2.47E-07	0.	0.	0.	6.74E-07
NA22	5.88E-05	5.88E-05	5.88E-05	5.88E-05	5.88E-05	5.88E-05	5.88E-05
NA24	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06
P32	8.25E-04	3.86E-05	3.18E-05	0.	0.	0.	2.28E-05
AR39	0.	0.	0.	0.	0.	0.	0.
AR41	0.	0.	0.	0.	0.	0.	0.
CA41	3.47E-04	0.	3.74E-05	0.	0.	0.	1.96E-07
SC46	1.97E-08	2.70E-0[illegible]	[illegible]94E-08	0.	2.37E-08	0.	3.95E-05
CR51	0.	0.	[illegible]	[illegible]94E-09	1.35E-09	9.02E-09	4.72E-07
MN54	0.	1.07E-0[illegible]	2.8[illegible]	[illegible]	3.00E-06	0.	8.98E-06
MN56	0.	3.34E-0[illegible]	7.54E[illegible]	[illegible]	4.04E-07	0.	4.84E-05
FE55	1.15E-05	6.10E-06	[illegible]	0.	0.	3.45E-06	1.13E-06
FE59	1.65E-05	2.67E-05	1.33E-05	0.	0.	7.74E-06	2.78E-05
CO57	0.	4.93E-07	9.98E-07	0.	0.	0.	4.04E-06
CO58	0.	1.80E-06	5.51E-06	0.	0.	0.	1.05E-05
CO60	0.	5.29E-06	1.56E-05	0.	0.	0.	2.93E-05
NI59	4.02E-05	1.07E-05	6.82E-06	0.	0.	0.	7.10E-07
NI63	5.38E-04	2.88E-05	1.83E-05	0.	0.	0.	1.94E-06
NI65	2.22E-06	2.09E-07	1.22E-07	0.	0.	0.	2.56E-05
CU64	0.	2.45E-07	1.48E-07	0.	5.92E-07	0.	1.15E-05
ZN65	1.37E-05	3.65E-05	2.27E-05	0.	2.30E-05	0.	6.41E-06
ZN69M+D	7.10E-07	1.21E-06	1.43E-07	0.	7.03E-07	0.	3.94E-05
ZN69	4.38E-06	6.33E-08	5.85E-09	0.	3.84E-08	0.	3.99E-06
SE79	0.	8.43E-06	1.87E-06	0.	1.37E-05	0.	5.53E-07
BR82	0.	0.	7.55E-06	0.	0.	0.	0.
BR83+D	0.	0.	1.71E-07	0.	0.	0.	0.
BR84	0.	0.	1.98E-07	0.	0.	0.	0.
BR85	0.	0.	9.12E-09	0.	0.	0.	0.
KR83M	0.	0.	0.	0.	0.	0.	0.
KR85M	0.	0.	0.	0.	0.	0.	0.
KR85	0.	0.	0.	0.	0.	0.	0.
KR87	0.	0.	0.	0.	0.	0.	0.
KR88+D	0.	0.	0.	0.	0.	0.	0.
KR89	0.	0.	0.	0.	0.	0.	0.
RB86	0.	6.70E-05	4.12E-05	0.	0.	0.	4.31E-06
RB87	0.	3.95E-05	1.83E-05	0.	0.	0.	5.92E-07
RB88	0.	1.90E-07	1.32E-07	0.	0.	0.	9.32E-09
RB89+D	0.	1.17E-07	1.04E-07	0.	0.	0.	1.02E-09
SR89+D	1.32E-03	0.	3.77E-05	0.	0.	0.	5.11E-05
SR90+D	1.70E-02	0.	4.31E-03	0.	0.	0.	2.29E-04
SR91+D	2.40E-05	0.	9.06E-07	0.	0.	0.	5.30E-05
SR92+D	9.03E-06	0.	3.62E-07	0.	0.	0.	1.71E-06

CHILD INGESTION DOSE COMMITMENT FACTORS(MREM/50Y PER PCI INGESTED IN FIRST YR)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
Y90	4.11E-08	0.	1.10E-09	0.	0.	0.	1.17E-04
Y91M+D	3.82E-10	0.	1.39E-11	0.	0.	0.	7.48E-07
Y91	6.02E-07	0.	1.61E-08	0.	0.	0.	8.02E-05
Y92	3.60E-09	0.	1.03E-10	0.	0.	0.	1.04E-04
Y93	1.14E-08	0.	3.13E-10	0.	0.	0.	1.70E-04
ZR93+D	1.67E-07	6.25E-08	4.45E-08	0.	2.42E-07	0.	2.37E-05
ZR95+D	1.16E-07	2.55E-08	2.27E-08	0.	3.65E-08	0.	2.66E-05
ZR97+D	6.99E-09	1.01E-09	5.96E-10	0.	1.45E-09	0.	1.53E-04
NB93M	1.05E-07	2.62E-08	8.61E-09	0.	2.83E-08	0.	3.95E-06
NB95	2.25E-08	8.76E-09	6.26E-09	0.	8.23E-09	0.	1.62E-05
NB97	2.17E-10	3.92E-11	1.83E-11	0.	4.35E-11	0.	1.21E-05
MO93	0.	2.41E-05	8.65E-07	0.	6.35E-06	0.	1.22E-06
MO99+D	0.	1.33E-05	3.29E-06	0.	2.84E-05	0.	1.10E-05
TC99M	9.23E-10	1.61E-09	3.00E-08	0.	2.63E-08	9.19E-10	1.03E-06
TC99	5.35E-07	5.96E-07	2.14E-07	0.	7.02E-06	5.27E-08	6.25E-06
TC101	1.07E-09	1.12E-09	1.42E-08	0.	1.91E-08	5.92E-10	3.56E-09
RU103+D	7.31E-07	0.	2.81E-07	0.	1.84E-06	0.	1.89E-05
RU105+D	6.45E-08	0.	2.34E-08	0.	5.67E-07	0.	4.21E-05
RU106+D	1.17E-05	0.	1.46E-06	0.	1.58E-05	0.	1.82E-04
RH105	5.14E-07	2.76E-07	2.36E-07	0.	1.10E-06	0.	1.71E-05
PD107	0.	4.72E-07	4.01E-08	0.	3.95E-06	0.	9.37E-07
PD109	0.	5.67E-07	1.70E-07	0.	3.04E-06	0.	3.35E-05
AG110M+D	5.39E-07	3.64E-07	2.91E-07	0.	6.78E-07	0.	4.33E-05
AG111	2.48E-07	7.76E-08	5.12E-08	0.	2.34E-07	0.	4.75E-05
CD113M	0.	1.02E-05	4.34E-07	0.	1.05E-05	0.	2.63E-05
CD115M	0.	5.89E-06	2.51E-07	0.	4.38E-06	0.	8.01E-05
SN123	1.33E-04	1.65E-06	3.24E-06	1.75E-06	0.	0.	6.52E-05
SN125+D	3.55E-05	5.35E-07	1.59E-06	5.55E-07	0.	0.	1.10E-04
SN126+D	3.33E-04	4.15E-06	9.46E-06	1.14E-06	0.	0.	2.50E-05
SB124	1.11E-05	1.44E-07	3.89E-06	2.45E-08	0.	6.16E-06	6.94E-05
SB125+D	7.16E-06	5.52E-08	1.50E-06	6.63E-09	0.	3.99E-06	1.71E-05
SB126	4.40E-06	6.73E-08	1.58E-06	2.58E-08	0.	2.10E-06	8.87E-05
SB127	1.06E-06	1.64E-08	3.68E-07	1.18E-08	0.	4.60E-07	5.97E-05
TE125M	1.14E-05	3.09E-06	1.52E-06	3.20E-06	0.	0.	1.10E-05
TE127M+D	2.89E-05	7.78E-06	3.43E-06	6.91E-06	8.24E-05	0.	2.34E-05
TE127	4.71E-07	1.27E-07	1.01E-07	3.26E-07	1.34E-06	0.	1.84E-05
TE129M+D	4.87E-05	1.36E-05	7.56E-06	1.57E-05	1.43E-04	0.	5.94E-05
TE129	1.34E-07	3.74E-08	3.18E-08	9.56E-08	3.92E-07	0.	8.34E-06
TE131M+D	7.20E-06	2.49E-06	2.65E-06	5.12E-06	2.41E-05	0.	1.01E-04
TE131+D	8.30E-08	2.53E-08	2.47E-08	6.35E-08	2.51E-07	0.	4.36E-07
TE132+D	1.01E-05	4.47E-06	5.40E-06	6.51E-06	4.15E-05	0.	4.50E-05
TE133M+D	1.87E-07	7.56E-08	9.37E-08	1.45E-07	7.18E-07	0.	5.77E-06
TE134+D	1.29E-07	5.80E-08	7.74E-08	1.02E-07	5.37E-07	0.	5.89E-07
I129	1.39E-05	8.53E-06	7.62E-06	5.58E-03	1.44E-05	0.	4.29E-07
I130	2.92E-06	5.90E-06	3.04E-06	6.50E-04	8.82E-06	0.	2.76E-06
I131+D	1.72E-05	1.73E-05	9.83E-06	5.72E-03	2.84E-05	0.	1.54E-06

CHILD INGESTION DOSE COMMITMENT FACTORS(MREM/50Y PER PCI INGESTED IN FIRST YR)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
I132	8.00E-07	1.47E-06	6.76E-07	6.82E-05	2.25E-06	0.	1.73E-06
I133+D	5.92E-06	7.32E-06	2.77E-06	1.36E-03	1.22E-05	0.	2.95E-06
I134	4.19E-07	7.78E-07	3.58E-07	1.79E-05	1.19E-06	0.	5.16E-07
I135+D	1.75E-06	3.15E-06	1.49E-06	2.79E-04	4.83E-06	0.	2.40E-06
XE131M	0.	0.	0.	0.	0.	0.	0.
XE133M	0.	0.	0.	0.	0.	0.	0.
XE133	0.	0.	0.	0.	0.	0.	0.
XE135M	0.	0.	0.	0.	0.	0.	0.
XE135	0.	0.	0.	0.	0.	0.	0.
XE137	0.	0.	0.	0.	0.	0.	0.
XE138+D	0.	0.	0.	0.	0.	0.	0.
CS134M+D	8.44E-08	1.25E-07	8.16E-08	0.	6.59E-08	1.09E-08	1.58E-07
CS134	2.34E-04	3.84E-04	8.10E-05	0.	1.19E-04	4.27E-05	2.07E-06
CS135	8.30E-05	5.78E-05	5.93E-06	0.	2.04E-05	6.81E-06	4.33E-07
CS136	2.35E-05	6.46E-05	4.18E-05	0.	3.44E-05	5.13E-06	2.27E-06
CS137+D	3.27E-04	3.13E-04	4.62E-05	0.	1.02E-04	3.67E-05	1.96E-06
CS138	2.28E-07	3.17E-07	2.01E-07	0.	2.23E-07	2.40E-08	1.46E-07
CS139+D	1.45E-07	1.61E-07	7.74E-08	0.	1.21E-07	1.22E-08	1.45E-11
BA139	4.14E-07	2.21E-10	1.20E-08	0.	1.93E-10	1.30E-10	2.39E-05
BA140+D	8.31E-05	7.28E-08	4.85E-06	0.	2.37E-08	4.34E-08	4.21E-05
BA141+D	2.00E-07	1.12E-10	6.51E-09	0.	9.69E-11	6.58E-10	1.14E-07
BA142+D	8.74E-08	6.29E-11	4.88E-09	0.	5.09E-11	3.70E-11	1.14E-09
LA140	1.01E-08	3.53E-09	1.19E-09	0.	0.	0.	9.84E-05
LA141	1.35E-09	3.17E-10	6.86E-11	0.	0.	0.	7.05E-05
LA142	5.24E-10	1.67E-10	5.23E-11	0.	0.	0.	3.31E-05
CE141	3.97E-08	1.98E-08	2.94E-09	0.	8.68E-09	0.	2.47E-05
CE143+D	6.99E-09	3.79E-06	5.49E-10	0.	1.59E-09	0.	5.55E-05
CE144+D	2.08E-06	6.52E-07	1.11E-07	0.	3.61E-07	0.	1.70E-04
PR143	3.93E-08	1.18E-08	1.95E-09	0.	6.39E-09	0.	4.24E-05
PR144	1.29E-10	3.99E-11	6.49E-12	0.	2.11E-11	0.	8.59E-08
ND147+D	2.79E-08	2.26E-08	1.75E-09	0.	1.24E-08	0.	3.58E-05
PM147	3.18E-07	2.27E-08	1.22E-08	0.	4.01E-08	0.	9.19E-06
PM148M+D	1.03E-07	2.05E-08	2.05E-08	0.	3.04E-08	0.	5.76E-05
PM148	3.02E-08	3.63E-09	2.35E-09	0.	6.17E-09	0.	9.70E-05
PM149	5.49E-09	6.90E-10	3.74E-10	0.	1.22E-09	0.	4.71E-05
PM151	2.92E-09	3.55E-10	2.31E-10	0.	6.02E-10	0.	4.03E-05
SM151	2.56E-07	3.81E-08	1.20E-08	0.	3.94E-08	0.	5.53E-06
SM153	3.65E-09	2.27E-09	2.19E-10	0.	[illegible]1E-10	0.	3.02E-05
EU152	5.15E-07	1.12E-07	1.33E-07	0.	4.73E-07	0.	1.84E-05
EU154	2.30E-06	2.07E-07	1.89E-07	0.	9.09E-07	0.	4.81E-05
EU155	4.82E-07	3.47E-08	2.72E-08	0.	1.30E-07	0.	8.69E-05
EU156	5.62E-08	3.01E-08	6.23E-09	0.	1.94E-08	0.	6.83E-05
TB160	1.66E-07	0.	2.06E-08	0.	4.94E-08	0.	3.68E-05
HO166M	1.08E-06	2.26E-07	1.91E-07	0.	3.22E-07	0.	0.
W181	4.23E-06	1.04E-08	1.43E-09	0.	0.	0.	3.79E-07
W185	1.73E-06	4.32E-07	6.05E-08	0.	0.	0.	1.61E-05
W187	4.29E-07	2.54E-07	1.14E-07	0.	0.	0.	3.57E-05

CHILD INGESTION DOSE COMMITMENT FACTORS(MREM/PCI PER PCI INGESTED IN FIRST YR)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
PB210+D	4.75E-02	1.22E-02	2.04E-03	0.	3.67E-02	0.	6.67E-05
BI210+D	1.97E-06	1.02E-05	1.64E-07	0.	1.15E-04	0.	5.17E-05
PO210	1.52E-03	2.43E-03	3.67E-04	0.	7.56E-03	0.	6.55E-05
RN222+D	0.	0.	0.	0.	0.	0.	0.
RA223+D	2.12E-02	2.45E-05	4.24E-03	0.	6.50E-04	0.	3.38E-06
RA224+D	5.89E-03	1.25E-05	1.38E-03	0.	3.31E-04	0.	3.78E-06
RA225+D	2.80E-02	2.60E-05	5.59E-03	0.	6.62E-04	0.	3.21E-06
RA226+D	5.75E-01	1.84E-05	4.72E-01	0.	4.88E-04	0.	3.41E-06
RA228+D	3.46E-01	4.94E-06	4.32E-01	0.	2.65E-04	0.	5.81E-05
AC225	1.48E-05	1.94E-05	1.26E-06	0.	2.07E-06	0.	4.31E-06
AC227+D	4.12E-[illegible]	6.63E-04	2.55E-04	0.	1.46E-04	0.	8.43E-05
TH227+D	5.85E-05	7.96E-07	1.64E-06	0.	4.22E-06	0.	5.63E-06
TH228+D	2.07E-03	2.65E-05	7.00E-05	0.	1.38E-04	0.	5.79E-06
TH229	1.34E-02	1.81E-04	6.60E-04	0.	8.84E-04	0.	5.27E-06
TH230	3.55E-03	1.78E-04	9.41E-05	0.	8.67E-04	0.	6.19E-05
TH232+D	3.96E-03	1.52E-04	3.01E-04	0.	7.41E-04	0.	5.27E-05
TH234	3.42E-07	1.51E-08	9.88E-09	0.	8.01E-08	0.	1.18E-04
PA231+D	7.07E-03	2.34E-04	2.61E-04	0.	1.28E-03	0.	7.37E-05
PA233	1.81E-08	2.82E-09	3.16E-09	0.	1.04E-08	0.	1.44E-05
U232+D	1.76E-02	0.	1.26E-03	0.	1.34E-03	0.	6.98E-05
U233+D	3.72E-03	0.	2.25E-04	0.	6.10E-04	0.	6.45E-05
U234	3.57E-03	0.	2.21E-04	0.	5.98E-04	0.	6.32E-05
U235+D	3.42E-03	0.	2.07E-04	0.	5.61E-04	0.	8.03E-05
U236	3.42E-03	0.	2.12E-04	0.	5.73E-04	0.	5.92E-05
U237	2.36E-07	0.	6.27E-08	0.	6.81E-07	0.	2.08E-05
U238+D	3.27E-03	0.	1.94E-04	0.	5.24E-04	0.	5.66E-05
NP237+D	2.36E-[illegible]	1.81E-04	9.79E-05	0.	6.05E-04	0.	8.16E-05
NP238	5.83E-06	1.18E-09	9.08E-10	0.	3.76E-09	0.	4.04E-05
NP239	5.25E-09	3.77E-10	2.65E-10	0.	1.09E-04	0.	2.79E-05
PU238	1.25E-03	1.56E-04	3.16E-05	0.	1.15E-04	0.	7.50E-05
PU239	1.36E-03	1.65E-04	3.31E-05	0.	1.22E-04	0.	6.85E-05
PU240	1.36E-03	1.65E-04	3.31E-05	0.	1.22E-04	0.	6.98E-05
PU241+D	4.00E-05	1.72E-06	8.04E-07	0.	2.96E-06	0.	1.44E-06
PU242	1.26E-03	1.54E-04	3.14E-05	0.	1.17E-04	0.	6.71E-[illegible]
PU244	1.47E-03	1.82E-04	3.65E-05	0.	1.35E-04	0.	1.00E-04
AM241	1.43E-03	6.40E-04	1.02E-04	0.	6.23E-04	0.	7.64E-05
AM242M	1.47E-03	6.25E-04	1.04E-04	0.	6.30E-04	0.	9.61E-05
AM243	1.41E-03	6.14E-04	9.83E-05	0.	6.06E-04	0.	8.95E-05
CM242	8.80E-05	6.73E-05	5.84E-06	0.	1.[illegible]7E-05	0.	8.16E-05
CM243	1.33E-03	6.03E-04	8.24E-05	0.	[illegible].08E-04	0.	8.03E-05
CM244	1.11E-03	5.36E-04	6.93E-05	0.	[illegible].54E-04	0.	7.77E-05
CM245	1.76E-03	6.64E-04	1.05E-04	0.	4.11E-04	0.	7.24E-05
CM246	1.74E-03	6.64E-04	1.05E-04	0.	4.10E-04	0.	7.11E-05
CM247+D	1.70E-03	6.53E-04	1.03E-04	0.	4.04E-04	0.	9.35E-05
CM248	1.41E-02	5.36E-03	8.62E-04	0.	3.33E-03	0.	1.51E-03
CF252	1.07E-03	0.	2.54E-05	0.	0.	0.	2.96E-06

TEEN INGESTION DOSE COMMITMENT FACTORS(MREM/PCI PER PCI INGESTED IN FIRST YR)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
H3	0.	1.06E-07	1.06E-07	1.06E-07	1.06E-07	1.06E-07	1.06E-07
BE10	4.48E-06	6.94E-07	1.13E-07	0.	5.30E-07	0.	2.84E-05
C14	4.06E-06	8.12E-07	8.12E-07	8.12E-07	8.12E-07	8.12E-07	8.12E-07
N13	1.15E-08	1.15E-08	1.15E-08	1.15E-08	1.15E-08	1.15E-08	1.15E-08
F18	8.64E-07	0.	9.47E-08	0.	0.	0.	7.78E-08
NA22	2.34E-05	2.34E-05	2.34E-05	2.34E-05	2.34E-05	2.34E-05	2.34E-05
NA24	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06
P32	2.76E-04	1.71E-05	1.07E-05	0.	0.	0.	2.32E-05
AR39	0.	0.	0.	0.	0.	0.	0.
AR41	0.	0.	0.	0.	0.	0.	0.
CA41	1.97E-04	0.	2.13E-05	0.	0.	0.	1.95E-07
SC46	7.24E-09	1.41E-08	4.18E-09	0.	1.35E-08	0.	4.80E-05
CR51	0.	0.	3.60E-09	2.00E-09	7.89E-10	5.14E-09	6.05E-07
MN54	0.	5.90E-06	1.17E-06	0.	1.76E-06	0.	1.21E-05
MN56	0.	1.58E-07	2.81E-08	0.	2.00E-07	0.	1.04E-05
FE55	3.78E-06	2.68E-06	6.25E-07	0.	0.	1.70E-06	1.16E-06
FE59	5.87E-06	1.37E-05	5.29E-06	0.	0.	4.32E-06	3.24E-05
CO57	0.	2.38E-07	3.99E-07	0.	0.	0.	4.44E-06
CO58	0.	9.72E-07	2.24E-06	0.	0.	0.	1.34E-05
CO60	0.	2.81E-06	6.33E-06	0.	0.	0.	3.66E-05
NI59	1.32E-05	4.66E-06	2.24E-06	0.	0.	0.	7.31E-07
NI63	1.77E-04	1.25E-05	6.00E-06	0.	0.	0.	1.99E-06
NI65	7.49E-07	9.57E-08	4.30E-08	0.	0.	0.	5.14E-06
CU64	0.	1.15E-07	5.41E-08	0.	2.91E-07	0.	8.92E-06
ZN65	5.76E-06	2.00E-05	9.33E-06	0.	1.28E-05	0.	8.47E-06
ZN69M+D	2.40E-07	5.60E-07	5.19E-08	0.	3.44E-07	0.	3.11E-05
ZN69	1.47E-08	2.80E-08	1.96E-09	0.	1.83E-08	0.	5.16E-06
SE79	0.	3.73E-06	6.27E-07	0.	6.50E-06	0.	5.70E-07
BR82	0.	0.	3.04E-06	0.	0.	0.	0.
BR83+D	0.	0.	5.74E-08	0.	0.	0.	0.
BR84	0.	0.	7.22E-08	0.	0.	0.	0.
BR85	0.	0.	3.05E-09	0.	0.	0.	0.
KR83M	0.	0.	0.	0.	0.	0.	0.
KR85M	0.	0.	0.	0.	0.	0.	0.
KR85	0.	0.	0.	0.	0.	0.	0.
KR87	0.	0.	0.	0.	0.	0.	0.
KR88+D	0.	0.	0.	0.	0.	0.	0.
KR89	0.	0.	0.	0.	0.	0.	0.
RB86	0.	2.98E-05	1.40E-05	0.	0.	0.	4.41E-06
RB87	0.	1.75E-05	6.11E-06	0.	0.	0.	6.11E-07
RB88	0.	8.52E-08	4.54E-08	0.	0.	0.	7.30E-15
RB89+D	0.	5.50E-06	3.84E-08	0.	0.	0.	8.43E-17
SR89+D	4.40E-04	0.	1.26E-05	0.	0.	0.	5.24E-05
SR90+D	8.30E-03	0.	2.05E-03	0.	0.	0.	2.33E-04
SR91+D	8.07E-06	0.	3.21E-07	0.	0.	0.	3.66E-05
SR92+D	3.05E-06	0.	1.30E-07	0.	0.	0.	7.77E-05

TEEN INGESTION DOSE COMMITMENT FACTORS(MREM/50Y PER PCI INGESTED IN FIRST YR)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
Y90	1.37E-08	0.	3.64E-10	0.	0.	0.	1.13E-04
Y91M+D	1.29E-10	0.	4.93E-12	0.	0.	0.	6.09E-09
Y91	2.01E-07	0.	5.39E-09	0.	0.	0.	8.24E-05
Y92	1.21E-09	0.	3.50E-11	0.	0.	0.	3.32E-05
Y93	3.83E-09	0.	1.05E-10	0.	0.	0.	1.17E-04
ZR93+D	5.53E-08	2.73E-08	1.49E-08	0.	9.65E-08	0.	2.58E-05
ZR95+D	4.12E-08	1.30E-08	8.94E-09	0.	1.91E-08	0.	3.00E-05
ZR97+D	2.37E-09	4.69E-10	2.16E-10	0.	7.11E-10	0.	1.27E-04
NB93M	3.44E-08	1.13E-08	2.83E-09	0.	1.32E-08	0.	4.07E-06
NB95	8.22E-09	4.56E-09	2.51E-09	0.	4.42E-09	0.	1.95E-05
NB97	7.37E-11	1.83E-11	6.68E-12	0.	2.14E-11	0.	4.37E-07
MO93	0.	1.06E-05	2.90E-07	0.	3.04E-06	0.	1.29E-06
MO99+D	0.	6.03E-06	1.15E-06	0.	1.38E-05	0.	1.08E-05
TC99M	3.32E-10	9.26E-10	1.20E-08	0.	1.38E-08	5.14E-10	6.08E-07
TC99	1.79E-07	2.63E-07	7.17E-08	0.	3.34E-06	2.72E-08	6.44E-06
TC101	3.60E-10	5.12E-10	5.03E-09	0.	9.26E-09	3.12E-10	8.75E-17
RU103+D	2.55E-07	0.	1.09E-07	0.	8.99E-07	0.	2.13E-05
RU105+D	2.18E-08	0.	8.46E-09	0.	2.75E-07	0.	1.76E-05
RU106+D	3.92E-06	0.	4.94E-07	0.	7.56E-06	0.	1.88E-04
RH105	1.73E-07	1.25E-07	8.20E-08	0.	5.31E-07	0.	1.59E-05
PD107	0.	2.08E-07	1.34E-08	0.	1.88E-06	0.	9.66E-07
PD109	0.	2.51E-07	5.70E-08	0.	1.45E-06	0.	2.53E-05
AG110M+D	2.05E-07	1.94E-07	1.18E-07	0.	3.70E-07	0.	5.45E-05
AG111	8.29E-08	3.44E-08	1.73E-08	0.	1.12E-07	0.	4.80E-05
CD113M	0.	4.51E-06	1.45E-07	0.	4.99E-06	0.	2.71E-05
CD115M	0.	2.60E-06	8.39E-08	0.	2.08E-06	0.	8.23E-05
SN123	4.44E-05	7.29E-07	1.08E-06	5.84E-07	0.	0.	6.71E-05
SN125+D	1.19E-05	2.37E-07	5.37E-07	1.86E-07	0.	0.	1.12E-04
SN126+D	1.16E-04	2.16E-06	3.30E-06	5.69E-07	0.	0.	2.58E-05
SB124	3.87E-06	7.13E-08	1.51E-06	8.78E-09	0.	3.38E-06	7.80E-05
SB125+D	2.48E-06	2.71E-08	5.80E-07	2.37E-09	0.	2.18E-06	1.93E-05
SB126	1.59E-06	3.25E-08	5.71E-07	8.99E-09	0.	1.14E-06	9.41E-05
SB127	3.63E-07	7.76E-09	1.37E-07	4.08E-09	0.	2.47E-07	6.16E-05
TE125M	3.83E-06	1.38E-06	5.12E-07	1.07E-06	0.	0.	1.13E-05
TE127M+D	9.67E-06	3.43E-06	1.15E-06	2.30E-06	3.92E-05	0.	2.41E-05
TE127	1.58E-07	5.60E-08	3.40E-08	1.09E-07	6.40E-07	0.	1.22E-05
TE129M+D	1.63E-05	6.05E-06	2.58E-06	5.26E-06	6.82E-05	0.	6.12E-05
TE129	4.48E-08	1.67E-08	1.09E-08	3.20E-08	1.88E-07	0.	2.45E-07
TE131M+D	2.44E-06	1.17E-06	9.76E-07	1.76E-06	1.22E-05	0.	9.39E-05
TE131+D	2.79E-08	1.15E-08	8.72E-09	2.15E-08	1.22E-07	0.	2.29E-09
TE132+D	3.49E-06	2.21E-06	2.08E-06	2.33E-06	2.12E-05	0.	7.00E-05
TE133M+D	6.44E-08	3.66E-08	3.56E-08	5.11E-08	3.62E-07	0.	1.48E-07
TE134+D	4.47E-08	2.87E-08	3.00E-08	3.67E-08	2.74E-07	0.	1.66E-09
I129	4.66E-06	3.92E-06	6.54E-06	4.77E-03	7.01E-06	0.	4.57E-07
I130	1.03E-06	2.98E-06	1.19E-06	2.43E-04	4.59E-06	0.	2.29E-06
I131+D	5.85E-06	8.19E-06	4.40E-06	2.39E-03	1.41E-05	0.	1.62E-06

TEEN INGESTION DOSE COMMITMENT FACTORS(MREM/50Y PER PCI INGESTED IN FIRST YR)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
I132	2.79E-07	7.30E-07	2.62E-07	2.46E-05	1.15E-06	0.	3.18E-07
I133+D	2.01E-06	3.41E-06	1.04E-06	4.76E-04	5.98E-06	0.	2.58E-06
I134	1.46E-07	3.87E-07	1.39E-07	6.45E-06	6.10E-07	0.	5.10E-09
I135+D	6.10E-07	1.57E-06	5.82E-07	1.01E-04	2.48E-06	0.	1.74E-06
XE131M	0.	0.	0.	0.	0.	0.	0.
XE133M	0.	0.	0.	0.	0.	0.	0.
XE133	0.	0.	0.	0.	0.	0.	0.
XE135M	0.	0.	0.	0.	0.	0.	0.
XE135	0.	0.	0.	0.	0.	0.	0.
XE137	0.	0.	0.	0.	0.	0.	0.
XE138+D	0.	0.	0.	0.	0.	0.	0.
CS134M+D	2.94E-08	6.09E-08	3.13E-08	0.	3.39E-08	5.95E-09	4.05E-08
CS134	8.37E-05	1.97E-04	9.14E-05	0.	6.26E-05	2.39E-05	2.45E-06
CS135	2.78E-05	2.55E-05	5.96E-06	0.	9.73E-06	3.52E-06	4.46E-07
CS136	8.54E-06	3.38E-05	2.27E-05	0.	1.84E-05	2.90E-06	2.72E-06
CS137+D	1.12E-04	1.49E-04	5.19E-05	0.	5.07E-05	1.97E-05	2.12E-06
CS138	7.76E-08	1.49E-07	7.45E-08	0.	1.10E-07	1.28E-08	6.76E-11
CS139+D	4.87E-08	7.17E-08	2.63E-08	0.	5.79E-08	6.34E-09	3.33E-23
BA139	1.39E-07	9.78E-11	4.05E-09	0.	9.22E-11	6.74E-11	1.24E-06
BA140+D	2.84E-05	3.48E-08	1.83E-06	0.	1.18E-08	2.34E-08	4.38E-05
BA141+D	6.71E-08	5.01E-11	2.24E-09	0.	4.65E-11	3.43E-11	1.43E-13
BA142+D	2.99E-08	2.99E-11	1.84E-09	0.	2.53E-11	1.99E-11	9.18E-20
LA140	3.48E-09	1.71E-09	4.55E-10	0.	0.	0.	9.82E-05
LA141	4.55E-10	1.40E-10	2.31E-11	0.	0.	0.	2.48E-05
LA142	1.79E-10	7.95E-11	1.98E-11	0.	0.	0.	2.42E-06
CE141	1.33E-08	8.88E-09	1.02E-09	0.	4.18E-09	0.	2.54E-05
CE143+D	2.35E-09	1.71E-06	1.91E-10	0.	7.67E-10	0.	5.14E-05
CE144+D	6.96E-07	2.88E-07	3.74E-08	0.	1.72E-07	0.	1.75E-04
PR143	1.31E-08	5.23E-09	6.52E-10	0.	3.04E-09	0.	4.31E-05
PR144	4.30E-11	1.76E-11	2.18E-12	0.	1.01E-11	0.	4.74E-14
ND147+D	9.38E-09	1.02E-08	6.11E-10	0.	5.99E-09	0.	3.68E-05
PM147	1.05E-07	9.96E-09	4.06E-09	0.	1.90E-08	0.	9.47E-06
PM148M+D	4.14E-08	1.05E-08	8.21E-09	0.	1.59E-08	0.	6.61E-05
PM148	1.02E-08	1.66E-09	8.36E-10	0.	3.00E-09	0.	9.90E-05
PM149	2.17E-09	3.05E-10	1.25E-10	0.	5.81E-10	0.	4.49E-05
PM151	9.87E-10	1.63E-10	8.25E-11	0.	2.93E-10	0.	3.66E-05
SM151	8.73E-08	1.68E-08	3.94E-09	0.	1.84E-08	0.	5.70E-06
SM153	1.22E-09	1.01E-09	7.43E-11	0.	3.30E-10	0.	2.85E-05
EU152	2.45E-07	5.90E-08	5.20E-08	0.	2.74E-07	0.	2.17E-05
EU154	7.91E-07	1.02E-07	7.19E-08	0.	4.56E-07	0.	5.39E-05
EU155	1.74E-07	1.68E-08	1.04E-08	0.	6.57E-08	0.	9.63E-05
EU156	1.92E-08	1.44E-08	2.35E-09	0.	9.69E-09	0.	7.36E-05
TB160	5.47E-08	0.	8.07E-09	0.	2.56E-08	0.	4.19E-05
HO166M	3.57E-07	1.10E-07	7.96E-08	0.	1.61E-07	0.	0.
W181	1.42E-08	4.58E-09	4.79E-10	0.	0.	0.	3.90E-07
W185	5.79E-07	1.91E-07	2.02E-08	0.	0.	0.	1.65E-05
W187	1.46E-07	1.19E-07	4.17E-08	0.	0.	0.	3.22E-05

Table 2.1 (Contd)

TEEN INGESTION DOSE COMMITMENT FACTORS(MREM/50Y PER PCI INGESTED IN FIRST YR)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
PB210+D	1.81E-02	5.44E-03	7.01E-04	0.	1.72E-02	0.	5.74E-05
BI210+D	5.54E-07	4.51E-06	5.66E-08	0.	5.48E-05	0.	5.15E-05
PO210	5.09E-04	1.07E-03	1.23E-04	0.	3.60E-03	0.	6.78E-05
RN222+D	0.	0.	0.	0.	0.	0.	0.
RA223+D	7.11E-03	1.08E-05	1.42E-03	0.	3.10E-04	0.	3.43E-04
RA224+D	2.31E-03	5.52E-06	4.61E-04	0.	1.58E-04	0.	3.71E-04
RA225+D	3.37E-03	1.10E-05	1.67E-03	0.	3.15E-04	0.	3.27E-04
RA226+D	3.22E-01	8.13E-06	2.34E-01	0.	2.32E-04	0.	3.51E-04
RA228+D	1.37E-01	4.41E-06	1.51E-01	0.	1.26E-04	0.	5.98E-05
AC225	6.24E-06	8.59E-06	4.22E-07	0.	9.85E-07	0.	4.36E-04
AC227+D	2.05E-03	3.03E-04	1.22E-04	0.	8.81E-05	0.	8.68E-05
TH227+D	1.96E-05	3.52E-07	5.65E-07	0.	2.01E-06	0.	5.75E-04
TH228+D	5.80E-04	1.14E-05	2.30E-05	0.	6.41E-05	0.	5.97E-04
TH229	8.39E-03	1.26E-04	4.11E-04	0.	6.10E-04	0.	5.43E-04
TH230	2.16E-03	1.23E-04	6.00E-05	0.	5.49E-04	0.	6.38E-05
TH232+D	2.42E-03	1.05E-04	1.63E-04	0.	5.11E-04	0.	5.43E-05
TH234	1.14E-07	6.68E-09	3.31E-09	0.	3.81E-08	0.	1.21E-04
PA231+D	4.31E-03	1.62E-04	1.68E-04	0.	9.10E-04	0.	7.60E-05
PA233	7.33E-09	1.41E-09	1.26E-09	0.	5.32E-09	0.	1.61E-05
U232+D	5.89E-03	0.	4.21E-04	0.	6.38E-04	0.	7.19E-05
U233+D	1.24E-03	0.	7.54E-05	0.	2.90E-04	0.	6.65E-05
U234	1.19E-03	0.	7.39E-05	0.	2.85E-04	0.	6.51E-05
U235+D	1.14E-03	0.	6.94E-05	0.	2.67E-04	0.	8.28E-05
U236	1.14E-03	0.	7.09E-05	0.	2.73E-04	0.	6.11E-05
U237	7.89E-08	0.	2.10E-08	0.	3.24E-07	0.	2.09E-05
U238+D	1.09E-03	0.	6.49E-05	0.	2.50E-04	0.	5.83E-05
NP237+D	1.44E-03	1.25E-04	5.85E-05	0.	4.33E-04	0.	8.41E-05
NP238	1.95E-09	5.22E-10	3.04E-10	0.	1.79E-09	0.	3.83E-05
NP239	1.76E-09	1.66E-10	9.22E-11	0.	5.21E-10	0.	2.67E-05
PU238	7.21E-04	1.02E-04	1.82E-05	0.	7.80E-05	0.	7.73E-05
PU239	8.27E-04	1.12E-04	2.01E-05	0.	8.57E-05	0.	7.06E-05
PU240	8.26E-04	1.12E-04	2.01E-05	0.	8.56E-05	0.	7.19E-05
PU241+D	1.84E-05	9.42E-07	3.69E-07	0.	1.71E-06	0.	1.48E-06
PU242	7.66E-04	1.08E-04	1.94E-05	0.	8.25E-05	0.	6.92E-05
PU244	8.95E-04	1.23E-04	2.22E-05	0.	9.45E-05	0.	1.03E-04
AM241	8.62E-04	3.29E-04	5.75E-05	0.	4.31E-04	0.	7.87E-05
AM242M	9.70E-04	3.19E-04	5.80E-05	0.	4.30E-04	0.	9.90E-05
AM243	8.60E-04	3.17E-04	5.62E-05	0.	4.22E-04	0.	9.23E-05
CM242	2.94E-05	2.97E-05	1.95E-06	0.	8.89E-06	0.	8.40E-05
CM243	6.91E-04	2.86E-04	4.09E-05	0.	1.91E-04	0.	8.28E-05
CM244	5.32E-04	2.49E-04	3.19E-05	0.	1.49E-04	0.	8.00E-05
CM245	1.07E-03	3.33E-04	6.10E-05	0.	2.85E-04	0.	7.46E-05
CM246	1.06E-03	3.32E-04	6.09E-05	0.	2.84E-04	0.	7.33E-05
CM247+D	1.03E-03	3.27E-04	6.00E-05	0.	2.80E-04	0.	9.63E-05
CM248	8.60E-03	2.69E-03	4.95E-04	0.	2.31E-03	0.	1.55E-03
CF252	3.51E-04	0.	8.37E-06	0.	0.	0.	3.05E-04

ADULT INGESTION DOSE COMMITMENT FACTORS(MREM/50Y PER PCI INGESTED IN FIRST YR)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
H3	0.	1.05E-07	1.05E-07	1.05E-07	1.05E-07	1.05E-07	1.05E-07
BE10	3.18E-06	4.91E-07	7.94E-08	0.	3.71E-07	0.	2.68E-05
C14	2.84E-06	5.68E-07	5.68E-07	5.68E-07	5.68E-07	5.68E-07	5.68E-07
N13	8.36E-09	8.36E-09	8.36E-09	8.36E-09	8.36E-09	8.36E-09	8.36E-09
F18	6.24E-07	0.	6.92E-08	0.	0.	0.	1.85E-08
NA22	1.74E-05	1.74E-05	1.74E-05	1.74E-05	1.74E-05	1.74E-05	1.74E-05
NA24	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06
P32	1.93E-04	1.20E-05	7.46E-06	0.	0.	0.	2.17E-05
AR39	0.	0.	0.	0.	0.	0.	0.
AR41	0.	0.	0.	0.	0.	0.	0.
CA41	1.83E-05	0.	2.00E-05	0.	0.	0.	1.84E-07
SC46	5.51E-09	1.07E-08	3.11E-09	0.	9.99E-09	0.	5.21E-05
CR51	0.	0.	2.66E-09	1.59E-09	5.86E-10	3.53E-09	6.69E-07
MN54	0.	4.57E-06	8.72E-07	0.	1.36E-06	0.	1.40E-05
MN56	0.	1.15E-07	2.04E-08	0.	1.46E-07	0.	3.67E-06
FE55	2.75E-06	1.90E-06	4.43E-07	0.	0.	1.06E-06	1.09E-06
FE59	4.34E-06	1.02E-05	3.91E-06	0.	0.	2.85E-06	3.40E-05
CO57	0.	1.75E-07	2.91E-07	0.	0.	0.	4.44E-06
CO58	0.	7.45E-07	1.67E-06	0.	0.	0.	1.51E-05
CO60	0.	2.14E-06	4.72E-06	0.	0.	0.	4.02E-05
NI59	9.76E-05	3.35E-05	1.63E-06	0.	0.	0.	6.90E-07
NI63	1.30E-04	9.01E-06	4.36E-06	0.	0.	0.	1.88E-06
NI65	5.26E-07	6.86E-08	3.13E-08	0.	0.	0.	1.74E-06
CU64	0.	8.33E-08	3.91E-08	0.	2.10E-07	0.	7.10E-06
ZN65	4.84E-06	1.54E-05	6.96E-06	0.	1.03E-05	0.	9.70E-06
ZN69M+D	1.70E-07	4.08E-07	3.73E-08	0.	2.47E-07	0.	2.49E-05
ZN69	1.03E-08	1.97E-08	1.37E-09	0.	1.28E-08	0.	2.96E-09
SE79	0.	2.63E-06	4.39E-07	0.	4.55E-06	0.	5.38E-07
BR82	0.	0.	2.26E-06	0.	0.	0.	2.59E-06
BR83+D	0.	0.	4.02E-08	0.	0.	0.	5.79E-08
BR84	0.	0.	5.21E-08	0.	0.	0.	4.09E-13
BR85	0.	0.	2.14E-09	0.	0.	0.	0.
KR83M	0.	0.	0.	0.	0.	0.	0.
KR85M	0.	0.	0.	0.	0.	0.	0.
KR85	0.	0.	0.	0.	0.	0.	0.
KR87	0.	0.	0.	0.	0.	0.	0.
KR88+D	0.	0.	0.	0.	0.	0.	0.
KR89	0.	0.	0.	0.	0.	0.	0.
RB86	0.	2.11E-05	9.83E-06	0.	0.	0.	4.16E-06
RB87	0.	1.23E-05	4.28E-06	0.	0.	0.	5.76E-07
RB88	0.	6.05E-08	3.21E-08	0.	0.	0.	8.36E-19
RB89+D	0.	4.01E-08	2.82E-08	0.	0.	0.	2.33E-21
SR89+D	3.08E-04	0.	8.84E-06	0.	0.	0.	4.94E-05
SR90+D	7.58E-03	0.	1.86E-03	0.	0.	0.	2.19E-04
SR91+D	5.67E-06	0.	2.29E-07	0.	0.	0.	2.70E-05
SR92+D	2.15E-06	0.	9.30E-08	0.	0.	0.	4.26E-05

Table 2.1 (Contd)

ADULT INGESTION DOSE COMMITMENT FACTORS(MREM/50Y PER PCI INGESTED IN FIRST YR)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
Y90	9.62E-09	0.	2.58E-10	0.	0.	0.	1.02E-04
Y91M+D	9.09E-11	0.	3.52E-12	0.	0.	0.	2.67E-10
Y91	1.41E-07	0.	3.77E-09	0.	0.	0.	7.76E-05
Y92	8.45E-10	0.	2.47E-11	0.	0.	0.	1.48E-05
Y93	2.68E-09	0.	7.40E-11	0.	0.	0.	8.50E-05
ZR93+D	4.18E-08	2.34E-09	1.09E-09	0.	8.87E-09	0.	2.43E-06
ZR95+D	3.04E-08	9.75E-09	6.60E-09	0.	1.53E-08	0.	3.09E-05
ZR97+D	1.68E-09	3.39E-10	1.55E-10	0.	5.12E-10	0.	1.05E-04
NB93M	2.55E-08	8.32E-09	2.05E-09	0.	9.57E-09	0.	3.84E-06
NB95	6.22E-09	3.46E-09	1.86E-09	0.	3.42E-09	0.	2.10E-05
NB97	5.22E-11	1.32E-11	4.82E-12	0.	1.54E-11	0.	4.87E-08
MO93	0.	7.51E-06	2.03E-07	0.	2.13E-06	0.	1.22E-06
MO99+D	0.	4.31E-06	8.20E-07	0.	9.76E-06	0.	9.99E-06
TC99M	2.47E-10	6.98E-10	8.89E-09	0.	1.06E-08	3.42E-10	4.13E-07
TC99	1.25E-07	1.86E-07	5.02E-08	0.	2.34E-06	1.58E-08	6.08E-06
TC101	2.54E-10	3.66E-10	3.59E-09	0.	6.59E-09	1.67E-10	1.10E-21
RU103+D	1.85E-07	0.	7.97E-08	0.	7.06E-07	0.	2.16E-05
RU105+D	1.54E-08	0.	6.08E-09	0.	1.99E-07	0.	9.42E-06
RU106+D	2.75E-06	0.	3.48E-07	0.	5.31E-06	0.	1.78E-04
RH105	1.21E-07	8.85E-08	5.83E-08	0.	3.76E-07	0.	1.41E-05
PD107	0.	1.47E-07	9.40E-09	0.	1.32E-06	0.	9.11E-07
PD109	0.	1.77E-07	3.99E-08	0.	1.01E-06	0.	1.96E-05
AG110M+D	1.60E-07	1.48E-07	8.79E-08	0.	2.91E-07	0.	6.04E-05
AG111	5.81E-08	2.43E-08	1.21E-08	0.	7.84E-08	0.	4.46E-05
CD113M	0.	3.18E-06	1.02E-07	0.	3.50E-06	0.	2.56E-05
CD115M	0.	1.84E-06	5.87E-08	0.	1.46E-06	0.	7.74E-05
SN123	3.11E-05	5.15E-07	7.59E-07	4.38E-07	0.	0.	6.33E-05
SN125+D	8.33E-06	1.68E-07	3.70E-07	1.39E-07	0.	0.	1.04E-04
SN126+D	8.45E-05	1.67E-06	2.40E-06	4.92E-07	0.	0.	2.43E-05
SB124	2.80E-06	5.29E-08	1.11E-06	6.79E-09	0.	2.18E-06	7.95E-05
SB125+D	1.79E-06	2.00E-08	4.26E-07	1.82E-09	0.	1.38E-06	1.97E-05
SB126	1.15E-06	2.34E-08	4.15E-07	7.04E-09	0.	7.05E-07	9.40E-05
SB127	2.58E-07	5.65E-09	9.90E-08	3.10E-09	0.	1.53E-07	5.90E-05
TE125M	2.68E-06	9.71E-07	3.59E-07	8.06E-07	1.09E-05	0.	1.07E-05
TE127M+D	6.77E-06	2.42E-06	8.25E-07	1.73E-06	2.75E-05	0.	2.27E-05
TE127	1.10E-07	3.95E-08	2.38E-08	8.15E-08	4.48E-07	0.	8.68E-06
TE129M+D	1.15E-05	4.29E-06	1.82E-06	3.95E-06	4.80E-05	0.	5.79E-05
TE129	3.14E-08	1.18E-08	7.65E-09	2.41E-08	1.32E-07	0.	2.37E-08
TE131M+D	1.73E-06	8.46E-07	7.05E-07	1.34E-06	8.57E-06	0.	8.40E-05
TE131+D	1.97E-08	8.23E-09	6.22E-09	1.62E-08	8.63E-08	0.	2.79E-09
TE132+D	2.52E-06	1.63E-06	1.53E-06	1.80E-06	1.57E-05	0.	7.71E-05
TE133M+D	4.62E-08	2.70E-08	2.60E-08	3.91E-08	2.67E-07	0.	6.64E-08
TE134+D	3.24E-08	2.12E-08	1.30E-08	2.83E-08	2.05E-07	0.	3.59E-11
I129	3.27E-06	2.81E-06	9.21E-06	7.23E-03	6.04E-06	0.	4.44E-07
I130	7.56E-07	2.23E-06	8.80E-07	1.89E-04	3.48E-06	0.	1.92E-06
I131+D	4.16E-06	5.95E-06	3.41E-06	1.95E-03	1.02E-05	0.	1.57E-06

DULT INGESTION DOSE COMMITMENT FACTORS(MREM/50Y PER PCI INGESTED IN FIRST YR)

SOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
I132	2.03E-07	5.43E-07	1.90E-07	1.90E-05	8.65E-07	0.	1.02E-07
I133+D	1.42E-06	2.47E-06	7.53E-07	3.63E-04	4.31E-06	0.	2.22E-06
I134	1.06E-07	2.88E-07	1.03E-07	4.99E-06	4.58E-07	0.	2.51E-10
I135+D	4.43E-07	1.16E-06	4.28E-07	7.65E-05	1.86E-06	0.	1.31E-06
XE131M	0.	0.	0.	0.	0.	0.	0.
XE133M	0.	0.	0.	0.	0.	0.	0.
XE133	0.	0.	0.	0.	0.	0.	0.
XE135M	0.	0.	0.	0.	0.	0.	0.
XE135	0.	0.	0.	0.	0.	0.	0.
XE137	0.	0.	0.	0.	0.	0.	0.
XE138+D	0.	0.	0.	0.	0.	0.	0.
CS134M+D	2.13E-08	4.48E-08	2.29E-08	0.	2.43E-08	3.83E-09	1.58E-08
CS134	6.22E-05	1.48E-04	1.21E-04	0.	4.79E-05	1.59E-05	2.59E-06
CS135	1.95E-05	1.80E-05	7.99E-06	0.	6.81E-06	2.04E-06	4.21E-07
CS136	6.51E-06	2.57E-05	1.85E-05	0.	1.43E-05	1.96E-06	2.92E-06
CS137+D	7.97E-05	1.09E-04	7.14E-05	0.	3.70E-05	1.23E-05	2.11E-06
CS138	5.52E-08	1.09E-07	5.40E-08	0.	8.01E-08	7.91E-09	4.65E-13
CS139+D	3.41E-08	5.08E-08	1.85E-08	0.	4.07E-08	3.70E-09	1.10E-30
BA139	9.70E-08	6.91E-11	2.84E-09	0.	6.46E-11	3.92E-11	1.72E-07
BA140+D	2.03E-05	2.55E-08	1.33E-06	0.	8.67E-09	1.46E-08	4.18E-05
BA141+D	4.71E-08	3.56E-11	1.59E-09	0.	3.31E-11	2.02E-11	2.22E-17
BA142+D	2.13E-08	2.19E-11	1.34E-09	0.	1.85E-11	1.24E-11	3.00E-26
LA140	2.50E-09	1.26E-09	3.33E-10	0.	0.	0.	9.25E-05
LA141	3.19E-10	9.90E-11	1.62E-11	0.	0.	0.	1.18E-05
LA142	1.28E-10	5.82E-11	1.45E-11	0.	0.	0.	4.25E-07
CE141	9.36E-09	6.33E-09	7.18E-10	0.	2.94E-09	0.	2.42E-05
CE143+D	1.65E-09	1.22E-06	1.35E-10	0.	5.37E-10	0.	4.56E-05
CE144+D	4.88E-07	2.04E-07	2.62E-08	0.	1.21E-07	0.	1.65E-04
PR143	9.20E-09	3.69E-09	4.56E-10	0.	2.13E-09	0.	4.03E-05
PR144	3.01E-11	1.25E-11	1.53E-12	0.	7.05E-12	0.	4.33E-18
ND147+D	6.29E-09	7.27E-09	4.35E-10	0.	4.25E-09	0.	3.49E-05
PM147	7.54E-08	7.09E-09	2.67E-09	0.	1.34E-08	0.	8.93E-06
PM148M+D	3.07E-08	7.95E-09	6.08E-09	0.	1.20E-08	0.	6.74E-05
PM148	7.17E-09	1.19E-09	5.99E-10	0.	2.25E-09	0.	9.35E-05
PM149	1.52E-09	2.15E-10	8.78E-11	0.	4.06E-10	0.	4.03E-05
PM151	6.97E-10	1.17E-10	5.91E-11	0.	2.09E-10	0.	3.22E-05
SM151	6.90E-08	1.19E-08	2.85E-09	0.	1.33E-08	0.	5.25E-06
SM153	8.57E-10	7.15E-10	5.22E-11	0.	2.31E-10	0.	2.55E-05
EU152	1.95E-07	4.44E-08	3.90E-08	0.	2.75E-07	0.	2.56E-05
EU154	6.15E-07	7.56E-08	5.38E-08	0.	3.62E-07	0.	5.48E-05
EU155	8.60E-08	1.22E-08	7.87E-09	0.	5.63E-08	0.	9.60E-06
EU156	1.37E-08	1.06E-08	1.71E-09	0.	7.08E-09	0.	7.26E-05
TB160	4.70E-08	0.	5.86E-09	0.	1.94E-08	0.	4.33E-05
HO166M	2.70E-07	8.43E-08	6.40E-08	0.	1.26E-07	0.	0.
W181	9.91E-09	3.23E-09	3.46E-10	0.	0.	0.	3.68E-07
W185	4.05E-07	1.35E-07	1.42E-08	0.	0.	0.	1.56E-05
W187	1.03E-07	8.61E-08	3.01E-08	0.	0.	0.	2.82E-05

ADULT INGESTION DOSE COMMITMENT FACTORS(MREM/50Y PER PCI INGESTED IN FIRST YR)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
PB210+D	1.53E-02	4.37E-03	5.44E-04	0.	1.23E-02	0.	5.42E-05
BI210+D	4.61E-07	3.18E-06	3.96E-08	0.	3.83E-05	0.	4.75E-05
PO210	3.56E-04	7.56E-04	8.59E-05	0.	2.52E-03	0.	6.36E-05
RN222+D	0.	0.	0.	0.	0.	0.	0.
RA223+D	4.97E-03	7.65E-06	9.94E-04	0.	2.17E-04	0.	3.21E-04
RA224+D	1.61E-03	3.90E-06	3.23E-04	0.	1.10E-04	0.	3.40E-04
RA225+D	5.56E-03	7.78E-06	1.31E-03	0.	2.21E-04	0.	3.06E-04
RA226+D	3.02E-01	5.74E-06	2.20E-01	0.	1.63E-04	0.	3.32E-04
RA228+D	1.12E-01	3.12E-06	1.21E-01	0.	8.83E-05	0.	5.64E-05
AC225	4.40E-06	6.06E-06	2.96E-07	0.	6.90E-07	0.	4.07E-04
AC227+D	1.87E-03	2.48E-04	1.11E-04	0.	8.00E-05	0.	8.19E-05
TH227+D	1.37E-05	2.48E-07	3.95E-07	0.	1.41E-06	0.	5.40E-04
TH228+D	4.96E-04	8.40E-06	1.68E-05	0.	4.67E-05	0.	5.63E-04
TH229	7.98E-03	1.19E-04	3.91E-04	0.	5.75E-04	0.	5.12E-04
TH230	2.06E-03	1.17E-04	5.70E-05	0.	5.65E-04	0.	6.02E-05
TH232+D	2.30E-03	1.00E-04	1.50E-04	0.	4.82E-04	0.	5.12E-05
TH234	8.01E-08	4.71E-09	2.31E-09	0.	2.67E-08	0.	1.13E-04
PA231+D	4.10E-03	1.54E-04	1.59E-04	0.	8.64E-04	0.	7.17E-05
PA233	5.26E-09	1.06E-09	9.12E-10	0.	3.94E-09	0.	1.64E-05
U232+D	4.13E-03	0.	2.95E-04	0.	4.47E-04	0.	6.78E-05
U233+D	8.71E-04	0.	5.28E-05	0.	2.03E-04	0.	6.27E-05
U234	8.36E-04	0.	5.17E-05	0.	1.99E-04	0.	6.14E-05
U235+D	8.01E-04	0.	4.86E-05	0.	1.87E-04	0.	7.81E-05
U236	8.01E-04	0.	4.96E-05	0.	1.91E-04	0.	5.76E-05
U237	5.52E-08	0.	1.47E-08	0.	2.27E-07	0.	1.94E-05
U238+D	7.67E-04	0.	4.54E-05	0.	1.75E-04	0.	5.50E-05
NP237+D	1.37E-03	1.19E-04	5.54E-05	0.	4.12E-04	0.	7.94E-05
NP238	1.37E-08	3.69E-10	2.13E-10	0.	1.25E-09	0.	3.43E-05
NP239	1.19E-09	1.17E-10	6.45E-11	0.	3.65E-10	0.	2.40E-05
PU238	6.80E-04	9.58E-05	1.71E-05	0.	7.32E-05	0.	7.30E-05
PU239	7.87E-04	1.06E-04	1.91E-05	0.	8.11E-05	0.	6.66E-05
PU240	7.85E-04	1.06E-04	1.91E-05	0.	8.10E-05	0.	6.78E-05
PU241+D	1.65E-05	8.44E-07	3.32E-07	0.	1.53E-06	0.	1.40E-06
PU242	7.29E-04	1.02E-04	1.84E-05	0.	7.81E-05	0.	6.53E-05
PU244	8.52E-04	1.17E-04	2.11E-05	0.	8.95E-05	0.	9.73E-05
AM241	8.19E-04	2.88E-04	5.41E-05	0.	4.07E-04	0.	7.42E-05
AM242M	8.24E-04	2.78E-04	5.43E-05	0.	4.05E-04	0.	9.34E-05
AM243	8.18E-04	2.78E-04	5.30E-05	0.	3.99E-04	0.	8.70E-05
CM242	2.06E-05	2.10E-05	1.37E-06	0.	6.22E-06	0.	7.92E-05
CM243	6.39E-04	2.41E-04	3.75E-05	0.	1.75E-04	0.	7.81E-05
CM244	4.83E-04	2.07E-04	2.87E-05	0.	1.34E-04	0.	7.55E-05
CM245	1.02E-03	2.87E-04	5.76E-05	0.	2.69E-04	0.	7.04E-05
CM246	1.01E-03	2.87E-04	5.75E-05	0.	2.68E-04	0.	6.91E-05
CM247+D	9.84E-04	2.83E-04	5.67E-05	0.	2.64E-04	0.	9.09E-05
CM248	8.18E-03	2.33E-03	4.67E-04	0.	2.18E-03	0.	1.47E-03
CF252	2.64E-04	0.	6.29E-06	0.	0.	0.	2.88E-06

TABLE 2.2

PALISADES
Liquid Effluent

Design Objective Annual Quantity

Nuclide	Half-Life	Dose Conversion Factors (mrem/Ci)	Individual/Organ	Design Objective Annual Quantity (Curies)
H-3	12.3 yr	1.75E-06	Adult/TB	1.71E+06
Na-24	15 h	5.44E-03	Teen/TB	551.5
Sc-46	83.9 d	2.02E-02	Teen/TB	148.5
Cr-51	27.8 d	1.56E-03	Adult/GI (LLI)	6,410.0
Mn-54	303 d	3.50E-02	Teen/TB	85.7
Fe-55	2.6 yr	4.48E-03	Child/Bone	2,232.0
Mn-56	2.576 h	1.86E-03	Teen/TB	1,612.0
Co-57	270 d	4.39E-03	Teen/TB	683.4
Co-58	71.3 d	1.03E-02	Teen/TB	291.3
Fe-59	45.6 d	4.08E-02	Adult/GI (LLI)	245.1
Co-60	5.26 yr	4.71E-01	Teen/TB	6.37
Cu-64	12.8 h	1.32E-03	Teen/GI (LLI)	7,575.0
Ni-65	2.56 h	5.82E-04	Teen/TB	5,154.0
Zn-65	245 d	1.83E-01	Teen/TB	16.4
Br-84	31.8 mo	2.02E-03	Teen/TB	1,485.2
Rb-86	1.02 mo	3.06E-01	Child/TB	9.80
Rb-88	17.8 mo	6.92E-04	Teen/TB	4,335.3
Sr-89	52.7 d	1.56E-01	Child/Bone	64.1
Sr-90	27.7 yr	2.71E00	Adult/Bone	3.69
Sr-91	9.67 h	1.16E-03	Teen/TB	2,586.0
Sr-92	2.71 h	1.51E-03	Teen/TB	1,986.8
Y-92	3.53 h	2.69E-04	Teen/TB	11,150.0
Nb-95	35 d	7.24E+00	Adult/GI (LLI)	1.38
Zr-95	65.5 d	6.17E-03	Teen/TB	486.2
Nb-97	72 mo	6.95E-04	Teen/TB	4,316.6
Zr-97	17 h	9.28E-04	Teen/TB	3,232.8
Mo-99	66.7 h	1.11E-03	Teen/Kidney	9,009.0
Tc-99m	6.05 h	1.42E-04	Teen/TB	21,126.8
Ru-103	39.5 d	2.74E-03	Teen/TB	1,094.9
Ag-110m	255 d	7.75E-02	Teen/TB	38.7

Table 2.2 (Contd)

Nuclide	Half-Life	Dose Conversion Factors (mrem/Ci)	Individual/Organ	Design Objective Annual Quantity (Curies)
Cd-113m	13.6 yr	6.02E-02	Adult/GI (LLI)	166.1
Sb-124	60 d	1.51E-02	Teen/TB	198.7
Sb-125	2.7 yr	5.11E-02	Teen/TB	58.7
Te-127	9.4 h	7.38E-03	Teen/GI (LLI)	1,355.0
Te-127m	109 d	1.39E-01	Teen/Kidney	71.9
Te-129m	34.1 d	2.66E-01	Adult/GI (LLI)	37.6
I-130	12.3 h	1.17E-02	Child/Thyroid	854.7
I-131	8.05 d	3.27E-01	Child/Thyroid	30.6
Te-131m	30 h	2.27E-01	Adult/GI (LLI)	44.0
I-132	2.26 h	3.18E-05	Teen/TB	94,339.0
Te-132	77.7 h	2.93E-01	Adult/GI (LLI)	34.1
I-133	20.3 h	3.94E-02	Child/Thyroid	253.8
Cs-134	2 yr	2.86E+00	Adult/TB	1.04
I-134	52 mo	2.43E-03	Teen/TB	1,234.0
I-135	6.68 h	1.64E-03	Child/Thyroid	6,097.0
Cs-136	13.7 d	4.13E-01	Adult/TB	7.26
Cs-137	30 yr	1.71E+00	Adult/TB	1.75
Cs-138	32.2 mo	2.31E-03	Teen/TB	1,298.0
Ba-139	82.9 mo	4.66E-05	Teen/TB	64,377.0
Ba-140	12.8 d	7.96E-04	Teen/TB	3,768.0
La-140	40.22 h	1.85E-02	Adult/GI (LLI)	540.5
Ce-141	32.5 d	3.70E-04	Teen/TB	8,108.0
Ce-144	284 d	1.56E-03	Teen/TB	1,923.0
Eu-152	12.7 yr	3.24E-01	Teen/TB	9.25
W-187	23.9 h	1.98E-01	Adult/GI (LLI)	50.5
Np-239	2.346 d	2.26E-03	Adult/GI (LLI)	4,424.0

ODCM

Appendix B

DOCKET 50-255 - LICENSE DPR-20 - PALISADES PLANT

REQUEST TO RETAIN SOIL IN ACCORDANCE WITH 10CFR 20.302

Revision 0

August 1, 1991

Approved [signature] 8/20/91 — MRN
Manager - Radiological Services — Date

[signature] 8-1-91
RMC Administrator — Date

[signature] 8-1-91
Tech Review — Date

Paul F. Bruce 91-082a 8-14-91
PRC — Date

Request to Retain Soil .. Accordance with 10CFR 20.302

Consumers Power Company correspondence dated November 12, 1987 and January 25, 1988 requested authorization to dispose of contaminated soil in place as specified by 10CFR 20.302. The area known as the South Radwaste Area has been contaminated by numerous cooling tower overflows and contamination was redistributed by heavy rain showers. Although the majority of the radioactive material has been packed for waste shipment, a large volume of very low activity radioactive material remains. This volume of material would be very expensive to ship as waste.

The specific area contaminated is noted as Area B on the attached survey grid map in reference 1. The entire area is fenced and is about 12,000 sq ft of soil exposed with the remainder buildings and asphalt. The inhalation pathway is for breathing suspended soil from this area. The radworker could receive 8.03E-04 mRem/50-year maximum organ (liver) dose and the infant could receive 3.16E-05 mRem/50-year maximum organ (liver) dose, both of which are insignificant. Direct dose to a radworker is less than 2E-03 mRem/hr. Occupancy in this area should not average more than 2 hours/week or 100 hours/year, which would result in a dose of <1 mRem/year.

The radwaste activities which caused the contamination of the soil were completely relocated to a new east radwaste area. The South Building has been deconned and is being used for non-radwaste activities. Some fixed contamination is present in floor cracks and vaults. This has been documented for plant decommissioning. No further contamination will be added to the south area from the South Radwaste Building. In spite of this commitment, revocation of Michigan shipping privileges in November 1990 require the use of this area to store packaged low level radioactive waste (LLW). Use of this building is addressed in CPCo's letter to NRC Document Control Desk, April 24, 1991 which is entered as reference 6.

This LLW, in the form of dry active waste (DAW) will be packaged in metal boxes and labeled, ready for future shipment to burial sites. The DAW metal shipping boxes will be stored off the floor to prevent water damage. The metal shipping boxes are strong, tight containers designed to prevent any leakage of radioactive material during transportation. Incidental water contact will not result in the spread of contamination. Radioactive waste will not be processed in the South Radwaste Building and the building will be maintained as a normally clean (radiologically) area.

References

(1) CPCo's letters, T.C. Bordine to NRC Document Control Desk, November 12, 1987 and January 25, 1988.

(2) Memorandum from L.J. Cunningham, DREP to T.R. Quay, T.V. Wambach, "Request for Additional Information (RAI)", March 15, 1988, April 7, 1989, and January 12, 1990.

(3) CPCo's supplement to Reference (1), J.L. Kuemin to NRC Document Control Desk, June 27, 1988.

(4) CPCo's supplement to References (1, 2), G.B. Slade to NRC Document Control Desk, August 31, 1990.

(5) CPCo's letter, T.P. Neal to B. Holian, October 23, 1990. (Typo of 10/13/90 in original reference).

(6) CPCo's letter, G.B. Slade to NRC Document Control Desk, April 24, 1991. "Use of South Storage Building as an Interim Radioactive Waste Storage Building".

(7) NRC Letter, Brian Holian to G.B. Slade, CPCo, June 7, 1991, "Approval and Conditions to Retain Soil in Place".

Consumers
Power

**POWERING
MICHIGAN'S PROGRESS**

General Offices: 1945 West Parnall Road, Jackson, MI 49201 • (517) 788-0550

November 12, 1987

Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

DOCKET 50- 15 - LICENSE DPR-20 - PALISADES PLANT -
REQUEST TC RETAIN SOIL IN ACCORDANCE WITH 10CFR20.302

3745 1252

The Code of Federal Regulations, Title 10, section 20.302 allows for approval of proposed procedures to dispose of licensed material in a manner not otherwise authorized in the regulations. Flooding of the South Radwaste Building has caused contamination of 4,173 cubic feet of soil with 2,992.6 µCi of Cs-137 and 79.3 µCi of Co-60. The area is approximately 30 meters from Lake Michigan. Site hydrology (Attachment 2, FSAR 2.2) indicates most of the activity will migrate to Lake Michigan in a few years. In July, 1986 a two-fold evaluation began to identify and map the extent of the ground contamination in the flood plain. The initial findings and evaluation were provided to NRC and the Michigan Department of Public Health by internal letter dated September 26, 1986, to LHueter, NRC, Region III.

Consumers Power Company requests authorization to dispose of this soil inplace as the costs of disposal at a burial ground is estimated at $270,000 while radiological consequences to the general public and site employees is very low. The activities in the contaminated soil were input as a single radioactive liquid release to Lake Michigan into the NRC LADTAP Code. The output indicated an estimated wholebody dose to the general public (50 mile radius population 1.05E06) of 1.69E-02 manRem or 1.6E-05 millirem per person. The maximum estimated wholebody dose to an individual would be 5.13E-03 millirem and maximum organ dose (teenage liver) would be 8.67E-03 millirem. The maximum whole body dose rate was assumed to be at 18 inches from contaminated soil. The maximum whole body dose rate calculated using the Microshield Code was 1.02E-02 mR/hr. Occupancy of this area is controlled by the Radiological Safety Department and secured by a locked fence. Average yearly occupancy is approximately 8 hours per week per individual for 4 to 5 individuals. A radiation worker should not exceed an additional wholebody dose of 4.08 millirem/year.

Flooding of the South Radwaste Building as a result of the cooling tower overflows is being addressed in two stages. For the short term the cooling tower bypass valve is now electrically isolated during cooling tower operation. Most previous flooding has been due to instrument failures that cause the valve to open during normal operation. In addition the South Radwaste Building has been decontaminated to eliminate or minimize contamination that

could be transported to the environment. A long term solution to remove radwaste activities from this area is being included in the Five-Year Plan.

The activity released to the environment from a flooding release prior to 1986 was estimated and added to the liquid section of the Semi-Annual Radiological Effluent Release Report dated February 28, 1986. Following approval of this application, it is proposed to account for current activity as an abnormal liquid release included in the semi-annual effluent report. A background, evaluation and survey results discussion follows in Attachment A. Attachment 1 is the Microshield Code output and Attachment 2 is FSAR section 2.2 (including referenced tables and figures) on site hydrology.

Pursuant to 10CFR170.12(c) a check in the amount of $150 is attached.

Thomas C Bordine (Signed)

Thomas C Bordine
Administrator, Nuclear Licensing

CC Administrator, Region III, NRC
NRC Resident Inspector - Palisades

Attachment

ATTACHMENT A

Consumers Power Company
Palisades Plant
Docket 50-255

EVALUATION AND SURVEY RESULTS

November 12, 1987

10 Pages

Background

In 1986, a soil survey was conducted south of the Turbine Building which included the South Radwaste area. The survey was conducted due to the South Radwaste Building being in the main flowpath of 'A' Cooling Tower, which has overflowed on three separate occasions in 8 years. The survey found that radioactive material was deposited in the soil due to the flooding of contamination and radioactive material areas inside the South Radwaste Building. Other areas sampled that were not in the flood plain were; liquid radwaste storage tanks, T-90, T-91, storm drains, the beach and the sand dunes. The survey included a survey grid, surface sample results and core sample results. All contaminated areas found in Area A (Figure 1) were packaged as radwaste. In addition, the highest activity areas adjoining the South Radwaste Building were also packaged. A total of 16-98 cubic foot boxes were packaged containing over 85 percent of the estimated activity.

Evaluation

In August of 1987, the survey was conducted again to prepare this report and to verify the location of the ground contamination and if any contamination migrated further into the ground since the 1986 survey. The survey was a two phase evaluation with the first phase being a mapped area consisting of 25' x 25' squares south of the Turbine Building. Once mapped out, surface samples were taken in this area. The intent of this phase was to accurately map the location and determine the activity in µCi/gram of all ground surface contamination. Each surface sample consisted of approximately 20 grams of soil taken

from the top 1/2" of ground and placed in a petri dish for analysis on the Multi-Channel Analyzer (MCA). Over 275 samples were collected and analyzed with two surface samples being taken in each sector. All samples were counted on MCA, Intrinsic Detector #1. Figure 2 shows the sector where activity was detected and their highest levels in µCi/gram.

Phase II was initiated after completion of the "surface" sample analysis. This consisted of taking core samples in 6" increments where activity was detected. Core samples were taken until two consecutive core samples reflected no activity. Core samples were also taken below the activity levels found in the 1986 soil survey until two consecutive core samples revealed no activity.

Figure 3 indicates the depth level where activity was no longer detectable. For example, 6 inches is indicated in H-10 on Figure 3. This indicates that activity was only detected on the surface. H-9 and I-10 indicate 18" which means activity was detected only at 12". Table 1 shows the results summary in µCi/gram of the highest activity at all sample locations. The sector numbers respond to grid coordinates shown on Figures 1, 2 and 3.

In addition to the sample sectors shown on Figure 1, 25 samples were collected at various locations on site. These include surface and core samples around T-90, and T-91 on the Northwest side of the Turbine Building (location not shown on figures). Surface samples were taken under the asphalt around the South Radwaste Building. These are indicated by a hexagon on Figure 1 in F-11, I-12 and K-10 sectors. Core samples taken under the South Radwaste Building are indicated by circles on Figure 1. Of the areas sampled above activity was

found only under the East side of the South Radwaste Building in sector I-9 (Table 1).

In the 1986 soil survey other areas were sampled that were not in the flood plain of the South Radwaste Building. Those included Feedwater Purity Building, North Storage Building, beach areas North and South of Plant, North and Northeast sand dunes and various storm drains. In all of these areas no activity was detected. Therefore, they were not sampled in the 1987 soil survey as they were not in the flood plain.

Since the 1986 soil survey, asphalt has been placed over various locations in the protected area. Asphalt was placed around all storm drains and approximately 50% of the South end of the Turbine Building. Before asphalt was laid down, about 3-6" of the top soil was removed and taken offsite. The soil before leaving site was sampled and counted with no activity detected.

Results

To quantify activity and determine impact, the areas of ground contamination were separated into two areas. Area A which contains all the sectors (A-L, 1-8) North of the "black top" to the Turbine Building. Area B contains all sectors (C-L, 9-14) South of "black top" in the vicinity of the South Radwaste Building. In Area A no activity was detected, therefore it was not used in determining activity or impact.

In Area B activity was detected in almost all sectors to the East of the South Radwaste Building (Figure 2). Activities ranged from 2.07E-6 µCi/gram (E-11) to 3.75E-5 µCi/gram (H-11). Cs-137 was the primary radionuclide present in all samples with two other samples containing Co-60 1.12E-5 µCi/gram at 6" and 5.80E-6 µCi/gram at 12" (I-9 East Figure 2). The greatest depth where activity was detected was in sector H-11 at 18" and when compared to the 1986 soil survey the activity has migrated down into the soil 6" inches further. Activity was detected at the surface in sectors E-11, E-13, J-12 and L-9 and at 6" in L-9. This was a result of moving the sand deposited on the asphalt during the flood to these sectors and the movement of soil during the grading and dumping during the asphalting of the South Radwaste area.

Activity in µCi was calculated for each sector (Table 2) by the following formula: sector ft^2 x depth of activity ft x *48144 grams/ft^3 x activity (µCi/gram) = µCi. *Average liter of soil weighed 1700 grams x 28.32 L/ft^3 = 48144 grams/ft^3. The first level at which no activity was detected was used to determine depth of activity. In a few sectors, activity was only detected on the first 1/2" of soil, but for determining cubic feet and activity a depth of 6" was used. For example, activity for H-10 was calculated as follows: 625 ft^2 x .5 ft. depth x 48144 grams/ft^3 x 2.6E-6 µCi/gram activity of surface sample equals 39.12 µCi.

Total volume in cubic feet and total activity in µCi were calculated for each sector of Area B. For sectors with activity, the highest activity detected per sector was used in the µCi calculation. Total contaminated area in Area B is

4173 ft^3, total activity is 3071.9 µCi. Sector H-11 contains 73.0% of the total activity which comprises 14.5% of the total contaminated area of Area B.

To quantify the dose to the population projections, 2992.6 µCi of Cs-137 and 79.3 µCi of Co-60 was entered into the LADTAP computer program. Assuming that the total 3071.9 µCi was eventually released to Lake Michigan thru the water table, and the uptake pathways which included fish, drinking, swimming, boating and shoreline the 50 mile population estimated at 1.05E6 would receive a total body dose of 1.69E-2 manRem, or 1.61E-5 millirem per person. The maximum wholebody dose to an individual would be 5.13E-3 millirem and maximum organ dose (teenage liver) would be 8.67E-03 millirem.

Direct dose to an individual working in the affected areas was calculated using the MICROSHIELD code. The activities from sectors H-11 and I-9 were used for a dose 18 inches above the surface. The dose rates from H-11 and I-9 are 8.75E-06 R/hr and 1.02E-05 R/hr respectively (Attachment 1). Therefore, a 50 hour occupancy in one week could result in a maximum exposure of 0.51 millirem. Normal occupancy of this area is on an as needed bases and averages less than 8 hours/week per individual in contact with contaminated soil.

3745 0257

<u>Table 1</u>

<u>Soil Sample Core Results (uCi/gram)</u>

Sector #	Surface	6"	12"	18"	24	30"	36"	42"	48"
E-11	2.07E-6	<MDA	<MDA	<MDA					
E-13	4.39E-6	<MDA	<MDA	<MDA					
H-9	4.19E-6	<MDA	4.79E-6	<MDA	<MDA	<MDA			
H-10	2.60E-6	<MDA	<MDA						
H-11	3.75E-5	<MDA	<MDA	8.45E-6	<MDA	<MDA	<MDA		
I-9	1.24E-5	<MDA	<MDA						
I-10	<MDA	<MDA	5.39E-6	<MDA	<MDA	<MDA	<MDA	<MDA	
J-9	5.39E-6	<MDA	<MDA						
J-12	6.39E-6	<MDA	<MDA						
L-9	<MDA	6.77E-6	<MDA	<MDA					
T-90	<MDA	<MDA							
T-91	<MDA	<MDA							
**I-9 #1	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA		
**I-9 #2	<MDA	1.40E-5*	5.80E-6+	<MDA	<MDA	<MDA	<MDA		
**I-10 #3	<MDA	<MDA							
**I-11 #4	<MDA	<MDA							
***K-10	<MDA								
***I-12	<MDA								
***F-11	<MDA								

+ Activity is all Co-60

* Includes 1.12E-5 μCi/gram of Co-60. All other activities listed were identified as Cs-137.

** Core samples under foundation of the South Radwaste Building.

*** Surface samples under asphalt in South Radwaste area.

Table 2

Activity Calculations per Sector

Area B

Sector #	Sq.ft. X	Depth =	ft^3 X	g/ft^3 X	uCi/g =	Total uCi
E-11	375	0.5	187.5	48144	2.07E-6	18.7
E-13	375	0.5	187.5	48144	4.39E-6	39.6
H-9	625	1.5	937.5	48144	4.79E-6	216.2
H-10	625	0.5	312.5	48144	2.60E-6	39.1
H-11	625	2.0	1250.0*	48144	3.75E-5	2256.8*
I-9	527	0.5	263.5	48144	1.24E-5	157.3
I-10	275	1.5	412.5	48144	5.39E-6	107.0
J-9	450	0.5	225	48144	5.39E-6	58.4
J-12	200	0.5	100	48144	6.39E-6	30.8
L-9	150	1.0	150	48144	6.77E-6	48.9
I-9 east	98	1.5	147	48144	1.40E-5	99.1
	4325		4173			3071.9

*1250 =

*2256.8 = 73.5% of total activity

MI0986-0062A-HP01

FIGURE 1

SURVEY GRID

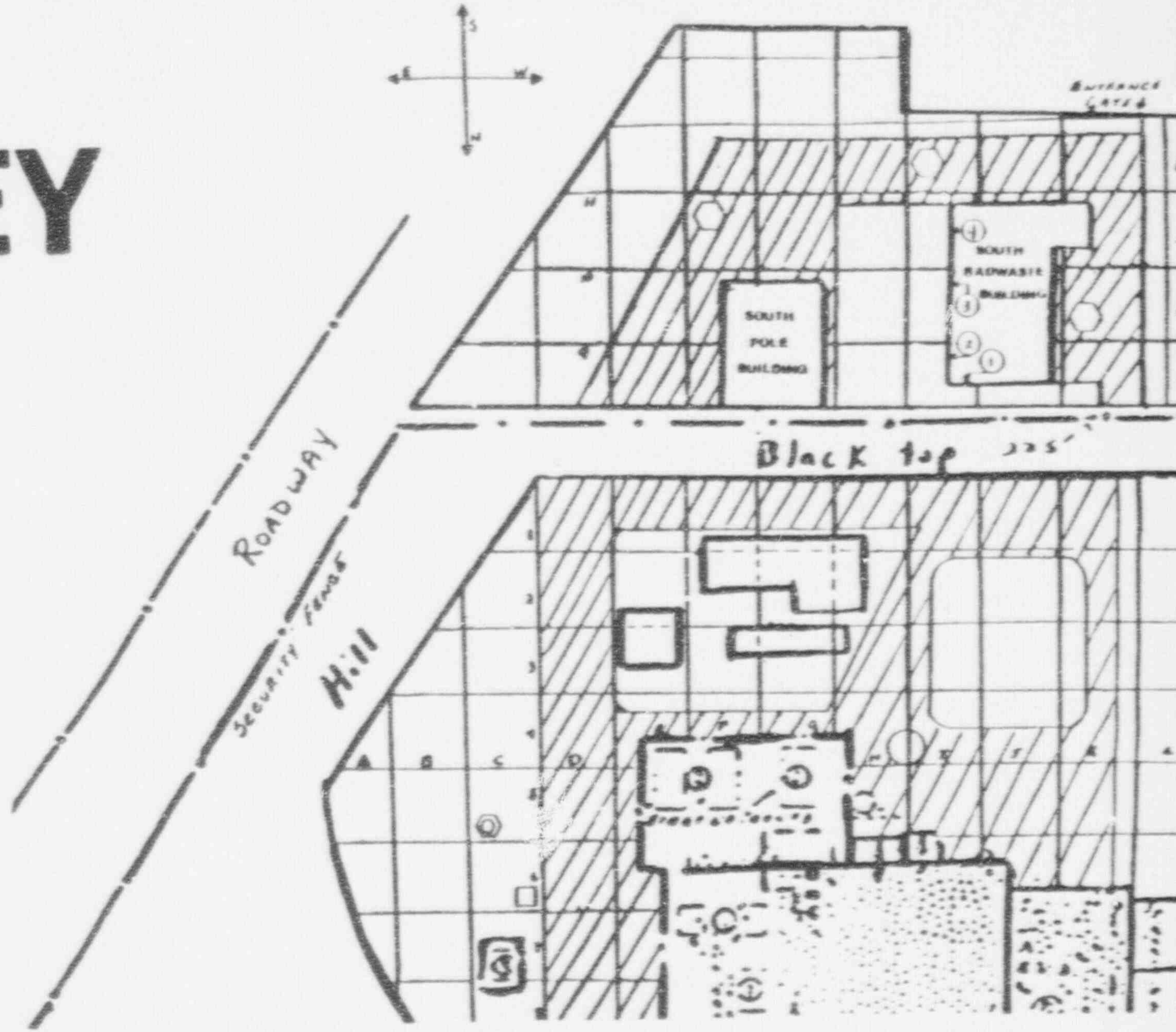
LEGEND

ASPHALT AREAS

25' x 25' SECTORS

AREA "B"

AREA "A"

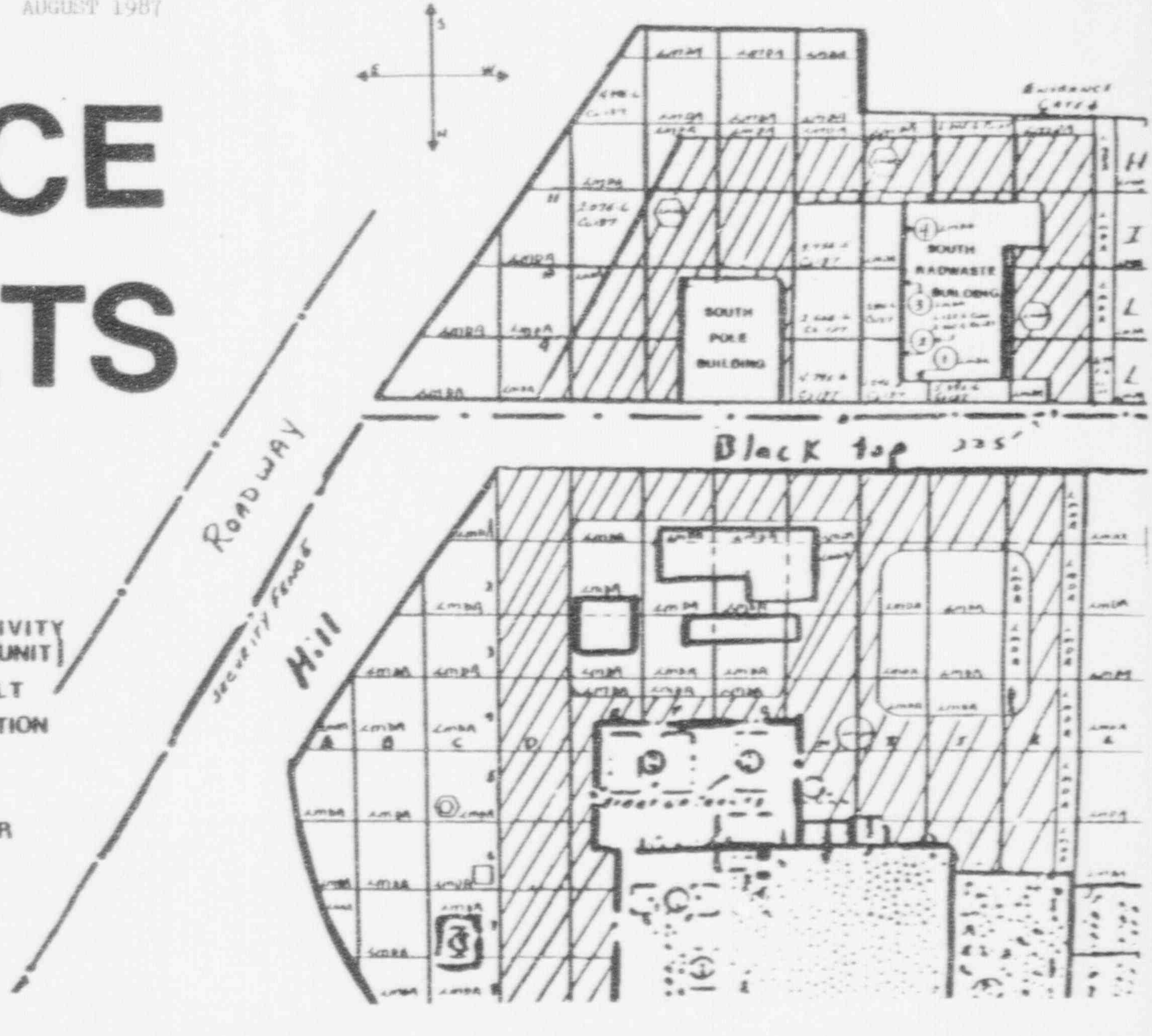


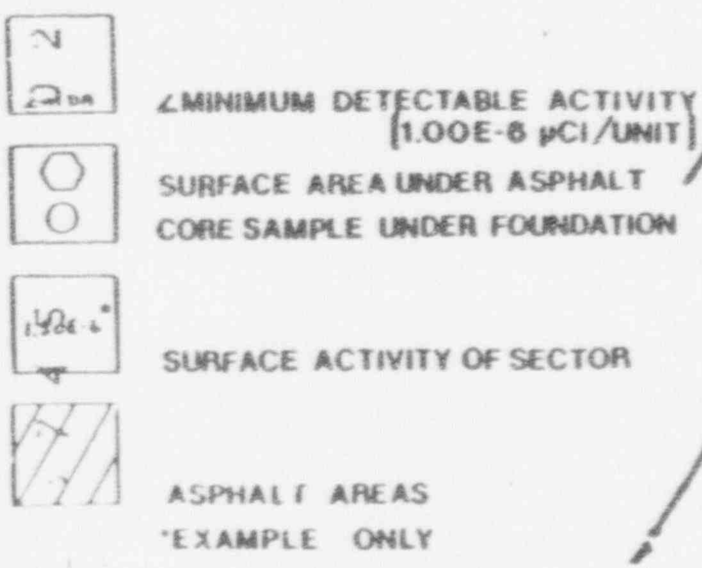
AUGUST 1987

FIGURE 2

SURFACE RESULTS

LEGEND

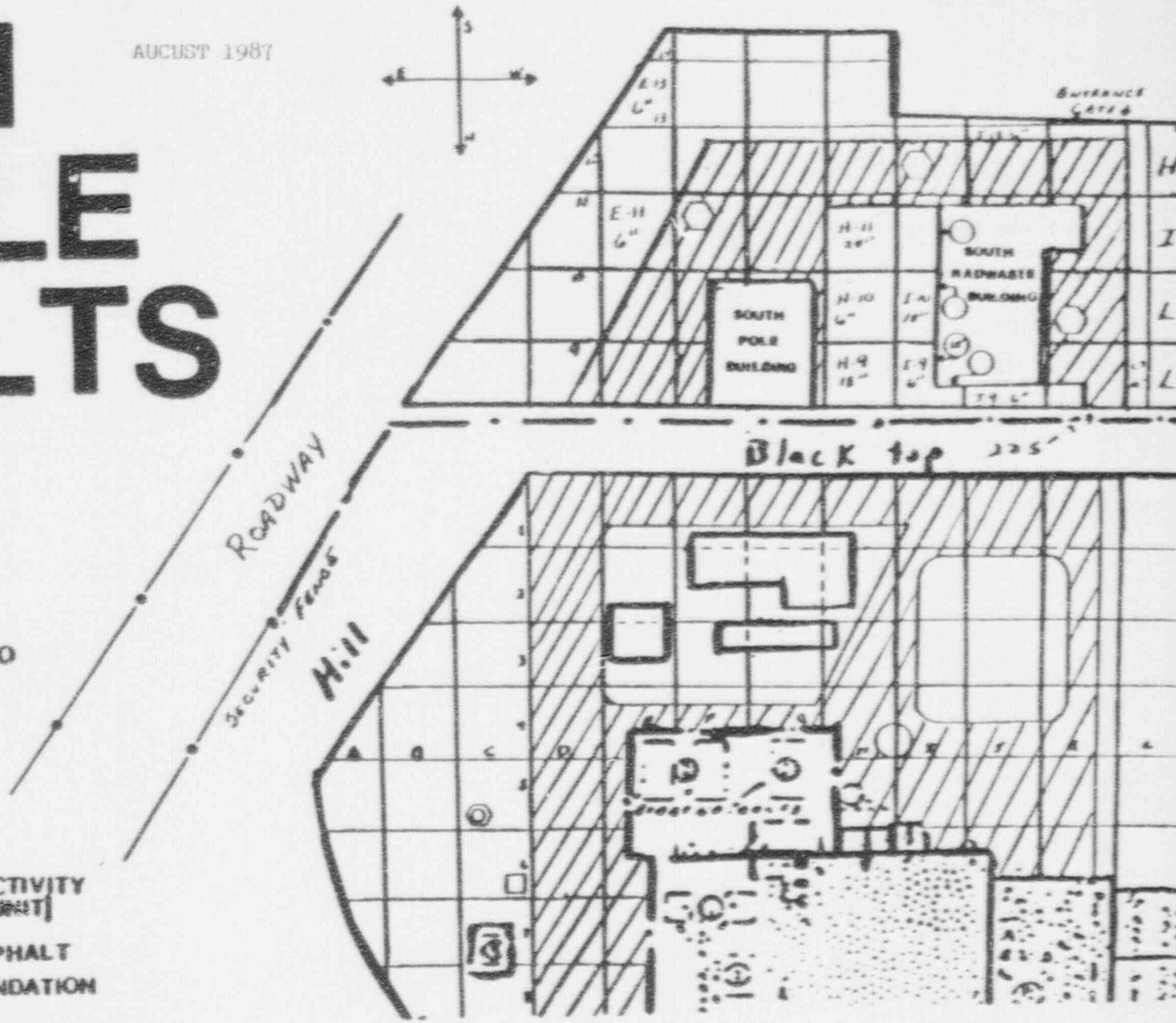




FIGU E 3

DEPTH SAMPLE RESULTS

AUGUST 1987



LEGEND

D-4 — LETTE (D)=COLUMN NUMB (4)=ROW

6" — DEPTH LEVEL AT WHICH NO ACTIVITY WAS DETECTED

ASPHALT AREAS

<MINIMUM DETECTABLE ACTIVITY [1.00 E-6 µCi/UNIT]

SURFACE AREA UNDER ASPHALT

CORE SAMPLE UNDER FOUNDATION

ATTACHMENT 1

Consumers Power Company
Palisades Plant
Docket 50-255

MICROSHIELD CODE OUTPUT

November 12, 1987

8 Pages

3745 1266

****** [illegible] ******

[illegible]
[illegible]
[illegible]: 08:22:03
[illegible]: 09-29-1997

[illegible]: ____________
Date: ____________
[illegible]: ____________
[illegible]: ____________

****** CASE TITLE ******
CONTAMINATED SOIL [illegible] LOCATION [illegible] INCHES DEEP

****** GEOMETRY [illegible] centimeters ******

RECTANGULAR VOLUME..........................[illegible]

Dosepoint dimensions   Source dimensions   Shields
X = 60.96   thickness = 15.24   T 1 = 45.72
height = 228.[illegible]
width = 762
Integration parameters
radial increment = [illegible]
horiz. intervals = 5
vert. intervals = 5

Source volume (cubic centimeters) = [illegible].334E+06

****** SHIELD MATERIAL DENSITIES (g/cc) ******
(Buildup is based on the properties of shield 1.)

Material	Source	Shield 1
Water	1.000	
Air	0.00129	0.00129
Carbon	1.700	

Rev 0
8-1-91

****** MICROSHIELD 3.02 ******

Page : 2 of 2 [illegible]   File Ref: ____________
File : [illegible]
Dated: 09:22:09
: 08-28-1987

****** CASE TITLE ******

CONTAMINATED SOIL ? [illegible] LOCATION 6 INCHES DEEP

****** SOURCE STRENGTH ******

Isotope	Activity, microCuries cc
Ba 137m	2.750E-05

****** RESULTS ******

Photon group energy, MEV	Activity, photons/sec	Dose point flux MEV sq cm sec	Dose rate R hr
0.10 - 0.20			
0.20 - 0.30			
0.30 - 0.40			
0.40 - 0.55			
0.55 - 0.75	4.308E-06	4.208E+00	8.750E-06
0.75 - 0.90			
0.90 - 1.10			
1.10 - 1.35			
1.35 - 1.60			
1.60 - 1.80			
1.80 - 2.00			
2.00 - 2.20			
2.20 - 2.40			
2.40 - 2.60			
2.60 - 2.80			
2.80 - 3.20			
3.20 - 4.00			
4.00 - 5.00			
5.00 - 6.00			
6.00 - 7.20			
7.20 - 10.00			
Totals:	4.808E-06	4.208E+00	8.750E-06

+ 9.446E-11 (page 4)

= 8.75 E-06 Total

3745 1267

Rev 0
8-1-91

****** [illegible] ******

Page : [illegible]	File Ref: ________
File : [illegible]	Date: ___ ___ ___
[illegible] : 08:02:28	By: ________
: 08-08-1987	Checked: ________

****** CASE TITLE ******

CONTAMINATED SOIL [illegible] LOCATION [illegible] DEEP

****** GEOMETRY (centimeters) ******

RECTANGULAR VOLUME.......................SLAB

Locating dimensions	Source dimensions	Shields
X = 105.88	thickness = 15.24	t 1 = 45.72
	height = 228.23	t 2 = 45.72
	width = 762	

Integration parameters
radial increment = 2
horiz. intervals = 5
vert. intervals = 5

Source volume (cubic centimeters) = 2.884E+06

****** SHIELD MATERIAL DENSITIES (g/cc) ******
(Buildup is based on the properties of shield 1.)

Material	Source	Shield 1	Shield 2
Water	1.000	1.000	
Air	0.00129	0.00129	0.00129
Carbon	1.700	1.700	

3745 9263

Rev 0
8-1-91

****** MICROSHIELD [illegible] ******

Page [illegible]   File name: ____________
File [illegible]
[illegible] 09:02:03
[illegible] : 09-23-1987

****** CASE TITLE ******
CONTAMINATED SOIL @ [illegible] LOCATION, [illegible] DEEP

****** SOURCE STRENGTH ******

Nuclide	Activity, microcuries cc
Ba 137m	[illegible]E-05

****** RESULTS ******

Photon group energy, MeV	Activity, photons sec	Dose point flux MeV sq cm sec	Dose rate R hr
0.10 - 0.20			
0.20 - 0.30			
0.30 - 0.40			
0.40 - 0.55			
0.55 - 0.75	1.083E+06	4.541E-05	9.446E-1
0.75 - 0.90			
0.90 - 1.10			
1.10 - 1.25			
1.25 - 1.50			
1.50 - 1.80			
1.80 - 2.00			
2.00 - 2.20			
2.20 - 2.40			
2.40 - 2.60			
2.60 - 2.80			
2.80 - 3.20			
3.20 - 4.00			
4.00 - 5.00			
5.00 - 6.20			
6.20 - 7.20			
7.20 - 10.00			
Totals:	1.083E+06	4.541E-05	9.446E-11

3745 0269

Rev 0
8-1-91

****** MICROSHIELD 3.13 ******

Page : 1 of 2
File : SOIL8 .OUT
Run at: 09:09:15
on 08-08-1991

File Ref: ____________
Date: ___ ___ ___
By: ____________
Checked: ____________

****** CASE TITLE ******

CONTAMINATED SOIL @ THA LOCATION 4 ACRES USED

****** GEOMETRY (centimeters) ******

RECTANGULAR VOLUME........................8

Dose point dimensions	Source dimensions	Shields
x = 50.56	thickness = 15.24	t 2 = 45.72
	height = 228.19	
	width = 750	

Integration parameters:
radial increment = 1
horiz. intervals = 9
vert. intervals =

Source volume (cubic centimeters) = 2.64E+06

****** SHIELD MATERIAL DENSITIES (g/cc) ******
(Buildup is based on the properties of shield 1.)

Material	Source	Shield 2
Water	1.000	
Air	0.00123	0.00123
Carbon	1.700	

3745 1270

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8-1-91

****** MICROSHIELD 3.01 ******

Page : 2 of 2 File Ref: ____________
File : [illegible]
Saved: 09:28:15
: 09-03-1987

****** CASE TITLE ******
CONTAMINATED SOIL @ I-8 LOCATION 6 INCHES DEEP

****** SOURCE STRENGTH ******

Isotope	Activity (microCuries cc)
Ba 137m	2.800E-06
Co 60	1.120E-05

****** RESULTS ******

Photon group energy (MEV)	Activity (photons/sec)	Dose point flux (MEV/sq cm/sec)	Dose rate (R/hr)
0.10 - 0.20			
0.20 - 0.30			
0.30 - 0.40			
0.40 - 0.65			
0.65 - 0.75	2.530E+05	3.142E-01	6.503E-07
0.75 - 0.90	1.813E+02	1.598E-04	2.296E-10
0.90 - 1.10			
1.10 - 1.25	3.316E+06	4.988E+00	8.173E-08
1.25 - 1.50			
1.50 - 1.80			
1.80 - 2.00			
2.00 - 2.20			
2.20 - 2.40			
2.40 - 2.60			
2.60 - 2.80			
2.80 - 3.20			
3.20 - 4.00			
4.00 - 5.00			
5.00 - 6.00			
6.00 - 7.00			
7.00 - 10.00			
Totals:	3.584E+06	5.302E+00	9.832E-06

+ 3.280E-07 (page 8)

= 1.02 E-05 (Total)

3745 0271

Rev 0
8-1-91

Attachment 1

****** [illegible] ******

Page [illegible]
File [illegible]
Date: 09:04:35 [illegible]
09-28-1987

File ref: ______
Date: ______
By: ______
Checked: ______

****** CASE TITLE ******
CONTAMINATED SOIL @ [illegible] LOCATION [illegible] DEEP

****** GEOMETRY (centimeters) ******

RECTANGULAR VOLUME..........................[illegible]

Locating dimensions	Source dimensions	Shields
X = 76.2	thickness = 15.24	[illegible] = [illegible]
	height = [illegible]	[illegible] = [illegible]
	width = [illegible]	

Integration parameters
radial increment = [illegible]
horiz. intervals = 5
vert. intervals = 5

Source volume (cubic centimeters) = [illegible]

****** SHIELD MATERIAL DENSITIES (g/cc) ******
(Buildup is based on the properties of shield [illegible].)

Material	+Source	Shield [illegible]	Shield [illegible]
Water	1.000	1.000	
Air	0.00129	0.00129	0.00129
Carbon	1.700	1.700	

3745 1272

Rev 0
8-1-91

****** [illegible] ******

Page : [illegible] File Ref: ____________
File : [illegible]
Saved: 08:04:28
 : 03-23-1987

****** CASE TITLE ******
CONTAMINATED SOIL @ I-8 LOCATION [illegible] INCHES DEEP

****** SOURCE STRENGTH ******

Isotope	Activity, microCuries [illegible]
Co 60	5.300E-05

****** RESULTS ******

Photon group energy (MeV)	Activity (photons/sec)	Dose point flux (MeV/sq cm/sec)	Dose rate (R/hr)
0.10 - 0.20			
0.20 - 0.30			
0.30 - 0.40			
0.40 - 0.55			
0.55 - 0.75			
0.75 - 0.90	3.255E+01	4.299E-05	[illegible]
0.90 - 1.10			
1.10 - 1.35	1.570E+06	1.732E-01	3.230E-07
1.35 - 1.60			
1.60 - 1.80			
1.80 - 2.00			
2.00 - 2.20			
2.20 - 2.40			
2.40 - 2.60			
2.60 - 2.80			
2.80 - 3.20			
3.20 - 4.00			
4.00 - 5.00			
5.00 - 6.00			
6.00 - 7.20			
7.20 - 10.00			
Totals:	1.570E+06	1.732E-01	3.230E-07

Rev 0
8-1-91

ATTACHMENT 2

Consumers Power Company
Palisades Plant
Docket 50-255

FSAR SECTION 2.2 - SITE HYDROLOGY

November 12, 1987

10 Pages

TPN-HP01-NL01

2.2 HYDROLOGY

The Palisades Plant site is surrounded on the north, east and south sides by sand dunes. The west side of the site is the Lake Michigan shoreline. As a result of this local topography, the site drainage is independent of the Brandywine Creek drainage basin which drains the hinterland. All surface water runoff drains directly to the lake and the percolating runoff also discharges to the lake (see Reference 3). There are no data available to verify the amount of surface runoff from the site; however, the flow from the Brandywine Creek drainage basin should be useful for the purpose of comparison.

Data obtained to establish base flow figures for Van Buren County streams indicate that the Brandywine Creek drainage basin is about 17 square miles (see Reference 4). The average annual rainfall for the area is 34 inches. During the period September 1962 to October 1963, the base flow measurements varied from a minimum of 0.90 cubic feet per second (ft^3/s) to a maximum of 11.4 ft^3/s. This resulted in a mean annual 7-day minimum flow of 1.6 ft^3/s or 0.094 $ft^3/s/sq$ mi (cubic feet per second per square mile). The period of stream measurements was representative of drought conditions.

The deposits of Brandywine Creek drainage basin are of low permeability which results in a nearly total runoff to Lake Michigan. This runoff probably occurs soon after precipitation. Minor groundwater storage in the old beach and reworked older sandy lake deposits observed on the surface to the east of the site area probably maintain Brandywine Creek during periods of low rainfall.

2.2.1 GROUNDWATER

Almost all the water used in Van Buren County is obtained from wells. Exceptions are the City of South Haven that obtains its municipal supply from Lake Michigan and some irrigation supplies that are obtained from streams, lakes and local ditches (see Reference 4).

The glacial drift is the only known source of fresh groundwater in the county. All the glacial deposits are capable of yielding some water to wells, but the sand and gravel outwash deposits yield the largest quantities (see Reference 4).

The area of sand dunes along Lake Michigan is not generally favorable for obtaining large supplies of groundwater. Probably most of the dune sand is above the water table and most wells must be drilled into the underlying lake deposits (see Reference 4).

1. General

Groundwater levels were established by the 1966 Geology and Groundwater Investigation conducted by Bechtel Company for Consumers Power Company (see Reference 3). The results of the investigation are shown on Figure 2-4. It is readily apparent that subsurface drainage is generally westward

toward the lake (see Profile A-A). Minor variations; ie, flow toward surface streams, may exist but are not considered significant.

An average hydraulic gradient toward the lake of about 13 feet per mile was obtained along Profile A-A as shown on Figure 2-9. This gradient represents only the upper surface of unconfined groundwater. Water released on the surface would move toward the lake at an estimated rate of 650 feet per year (see Reference 3).

The nearest domestic wells to the site are located one-half mile to the east and south. The data indicates that groundwater in the vicinity of the eastern wells is flowing west toward the site. Local groundwater in the area of the southern wells is also flowing west toward the lake, perpendicular to the shoreline.

There are no major sources of groundwater withdrawal, eg, large-scale industrial or agricultural pumping, that might reverse the direction of groundwater flow and cause groundwater to flow from the Plant area toward any existing domestic wells. Without such pumping, it is difficult to envision a condition which would cause sufficient groundwater lowering at any of the domestic wells such that the direction of flow might be reversed.

2. Plant Site

Groundwater levels in the vicinity of the site are shown on Figure 2-9. The water table generally slopes toward the lake. During the site investigations, groundwater elevations averaged 580 feet MSL beneath the building site. This elevation corresponds to the approximate mean level of Lake Michigan. As shown by water levels measured during drilling, groundwater levels rise to the east to approximately 604 feet MSL beneath the switchyard and 601 feet MSL near the eastern site boundary (see Reference 3).

Field permeability tests performed during the 1965 exploratory drilling yielded values ranging from 30 to 1,720 feet per year in the site area, Table 2-11. In Drill Hole 5, located approximately 500 feet northwest of the containment building, the permeability values ranged from 30.4 feet per year to 143 feet per year. In Drill Hole 7, located approximately 650 feet south of the containment building, the permeability values ranged from 156 feet per year to 1,720 feet per year.

3. Groundwater Movement

An unconfined aquifer is present in the dune area with groundwater levels controlled by the level of Lake Michigan. The rate of movement of groundwater downward into material underlying the dunes appears to be very slow. Nine samples from Drill Hole 22 in the site area were tested for sodium absorption ratio (SAR), Table 2-12. A high SAR indicates poor downward percolation of water due to sodium deposition on and between soil particles. At the Plant site, the SAR is considered to be high between elevations [illegible] and 566 feet MSL and low between 566 and 555 feet MSL (see Reference [illegible]

3/45 0276

Groundwater levels and permeability data from the sandy lake deposits underlying the dunes indicate a slow rate of discharge into Lake Michigan.

4. Conclusions

   a. Groundwater in the unconfined aquifer moves westerly from the Brandywine Creek basin to Lake Michigan.

   b. The hydraulic gradient is approximately 13 feet per mile and flow is essentially perpendicular to the shoreline.

   c. Water discharged on the ground surface at the Plant site will percolate downward at a slow rate and mix with groundwater moving toward Lake Michigan.

   d. Infiltration of surface water from the site to domestic wells offsite does not appear to be possible under present groundwater conditions.

2.2.2 GENERAL LAKE HYDROLOGY

1. Lake Levels

The level of Lake Michigan is cyclic and is expected to fluctuate with time and is dependent on long-term above-normal or below-normal amounts of precipitation. The highest monthly mean stage of Lake Michigan was 583.68 feet MSL in 1886. Subsequent modifications in the St Clair River and the opening of the diversion out of the basin at Chicago have tended to reduce the maximum level attainable. During the recent period of record (1900 to present), the highest recorded monthly mean stage was 582.6 feet MSL in July 1974, and the lowest monthly mean stage was 576.91 feet MSL in March and April 1964 (see Reference 5). Great Lakes levels are reported using International Great Lakes Datum which is converted to MSL at the Palisades site by adding 1.558 feet. The 1.558-foot correction factor is taken from the reference point at St Joseph, Michigan.

Short-time variations in lake levels (seiches), caused by meteorological factors and measured in hours rather than days, occur occasionally. The greatest level change of this type on record over a 105-year period involved a sudden rise of 6 feet at Michigan City, Indiana (8:10 AM, June 26, 1954) and a rise of 8 feet at Montrose Harbor, Chicago (9:30 AM on the same date) (see Reference 6). These seiches were reported in the "Science" article by Ewing, Press and Donn (Vol 120, Page 684). On passing into the shallow water at Michigan City, the wave was reflected and refracted to reach the Chicago shore of the lake. The US Lake Survey gauge at Holland, Michigan, which is 30 miles north of the Palisades site and has similar lake geometry to the site, indicated no surge on June 26, 1954.

As part of the Systematic Evaluation Program (SEP Topic II-3.B), the maximum probable surge elevation was reevaluated. The offshore surge value was reevaluated to produce an onshore surge height of 10.9 feet. The maximum monthly mean level was also reduced from 583.6 feet MSL to 582.6 feet MSL

This resulted in a probable maximum flood protection level for the Palisades Plant of 593.5 feet MSL.

The service water pump motors at 594.7 feet MSL provide the basis for determining the minimum flood protection requirements for the Plant. Therefore, the resultant wave surges from Lake Michigan do not present a problem at Palisades.

2. Water Movements

Conclusions from a study of lake hydrology in the Palisades Park, Michigan area by Dr J L Hough (see Reference 6) indicate that surface currents generated by wind conditions and modified by the earth's rotation and lake configuration will provide adequate mixing of Plant liquid effluents into the lake. The study included actual measurements of lake water movement in the area near the Plant site, and water mixing where the Black River enters Lake Michigan at South Haven.

A summary of the study is as follows:

> Lake water is almost constantly moving past the Palisades site, with an appreciable velocity of flow, under the influence of winds. It is estimated, on the basis of wind records, that an alongshore current flows northward about 33% of the time and an alongshore current flows southward about 23% of the time. Offshore drift of surface water should occur about 38% of the time, according to frequency of offshore winds, but these would have a minimal effect close to shore, which is bordered by a high dune ridge. It is likely, therefore, that the alongshore currents would tend to persist, once set up, while offshore winds were blowing. Thus, the frequency of alongshore current flow is probably greater than the 33% and 23% based on wind directions.
>
> Under the procedure of taking water from a depth of about 20 feet, 3,500 feet offshore, raising its temperature as it is used for service water and dilution of cooling tower blowdown, and returning the effluent to the lake near shore, the effluent water will almost always be warmer than the lake water into which it is discharged. This is because a single Lake Michigan water mass is involved during most of the year. When the effluent is warmer, it will tend to float at the surface, to drift with the surface current, and to be mixed by surface turbulence due to wave action. On rare occasions, during the spring warming period when the upper layer of lake water is less than 20 feet deep, and during the summer when strong offshore winds cause a thinning of the normally deep surface mass to less than 20 feet, the intake water coming from a colder layer may not be warmed in the Plant sufficiently to have a temperature higher than that of the surface lake water. At such times, the effluent water will tend to sink to the thermocline and it will not be subject to vigorous turbulence caused by surface wave action. It will tend to mix more slowly.
>
> Surveys of the performance of Black River water, entering Lake Michigan at South Haven under various weather conditions, have indicated that

5/45 127d

the river water is diluted rapidly, reaching a concentration of about only 1% in the lake within a mile of the river mouth.

The discharge of the Black River was evaluated because the rate was determined to be nearly the same as the discharge rate from the Palisades Plant with once-through cooling. Since the Plant is now operated with cooling towers, the discharge to the lake has been reduced to approximately 60,000 gpm or about 1/7 the original rate. The mixing and dilution factors are considered to be as great as during the higher discharge periods and the discharge concentrations should be diluted at least 1,000 times by the time the discharge could reach the public water intake at South Haven, Michigan.

3. Conclusions

a. The level of Lake Michigan is cyclic; however, the recorded high of 1886 is unlikely to be exceeded. High lake levels are not expected to present a problem at the Plant site.

b. There is no recorded evidence of short-time variations in lake levels (seiches) along the eastern shore of Lake Michigan which would be expected to affect the Plant site.

c. Surface currents generated by wind conditions and modified by the earth's rotation and lake configuration will provide adequate mixing of Plant liquid effluents into the lake.

TABLE 2-11

FIELD PERMEABILITY TEST RESULTS

Drill Hole Number	Elevation of Test	Flow "Q" (Gpm)	Head "H" (Feet)		Permeability, "K" (ft/Yr)	Permeability, "K" (cm/s)
5	576	0.0029	12.3		30.4	0.3×10^{-4}
	570	0.0101	12.3		106.0	1.1×10^{-4}
	565	0.0088	12.3		92.0	0.89×10^{-4}
	560	0.0035	12.3		36.8	0.36×10^{-4}
	555	0.0136	12.3		143.0	1.4×10^{-4}
	550	0.0064	12.3		67.0	0.65×10^{-4}
	545	0.0033	12.3		34.6	0.34×10^{-4}
				Average	72.8	0.72×10^{-4}
7	580	0.0303	25		156	1.5×10^{-4}
	575	0.0477	25		246	2.4×10^{-4}
	570	0.0588	25		303	2.9×10^{-4}
	565	0.0588	25		303	2.9×10^{-4}
	560	0.0834	25		430	4.2×10^{-4}
	550	0.3333	25		1,720	16.7×10^{-4}
	545	0.0677	25		350	3.4×10^{-4}
	540	0.2500	25		1,290	12.5×10^{-4}
	535	0.2000	25		1,035	10.1×10^{-4}
				Average	648	6.3×10^{-4}

5745 1280

TABLE 2-12

ANALYSES OF SOIL SAMPLES

Sample No	pH	ECe	Saturation Extract Values, Milliequivalents per Liter: Calcium	Magnesium	Sodium	SAR	Sample Description
1	8.25	1.2	0.5	Trace	11.7	23.5	DH 22 E1 596
2	8.4	1.4	0.5	Trace	13.0	26	DH 22 E1 591
3	8.3	1.3	0.5	Trace	12.3	24.5	DH 22 E1 586
4	8.45	1.4	0.5	Trace	14.4	29	DH 22 E1 581
5	8.5	1.5	0.5	0.1	14.8	27	DH 22 E1 576
6	8.3	1.5	0.5	Trace	14.8	29.5	DH 22 E1 571
7	8.5	1.3	0.5	0.05	12.7	24	DH 22 E1 566
8	8.2	0.5	3.0	0.4	1.1	1	DH 22 E1 561
9	8.1	0.6	3.4	0.7	2.4	1.5	DH 22 E1 555

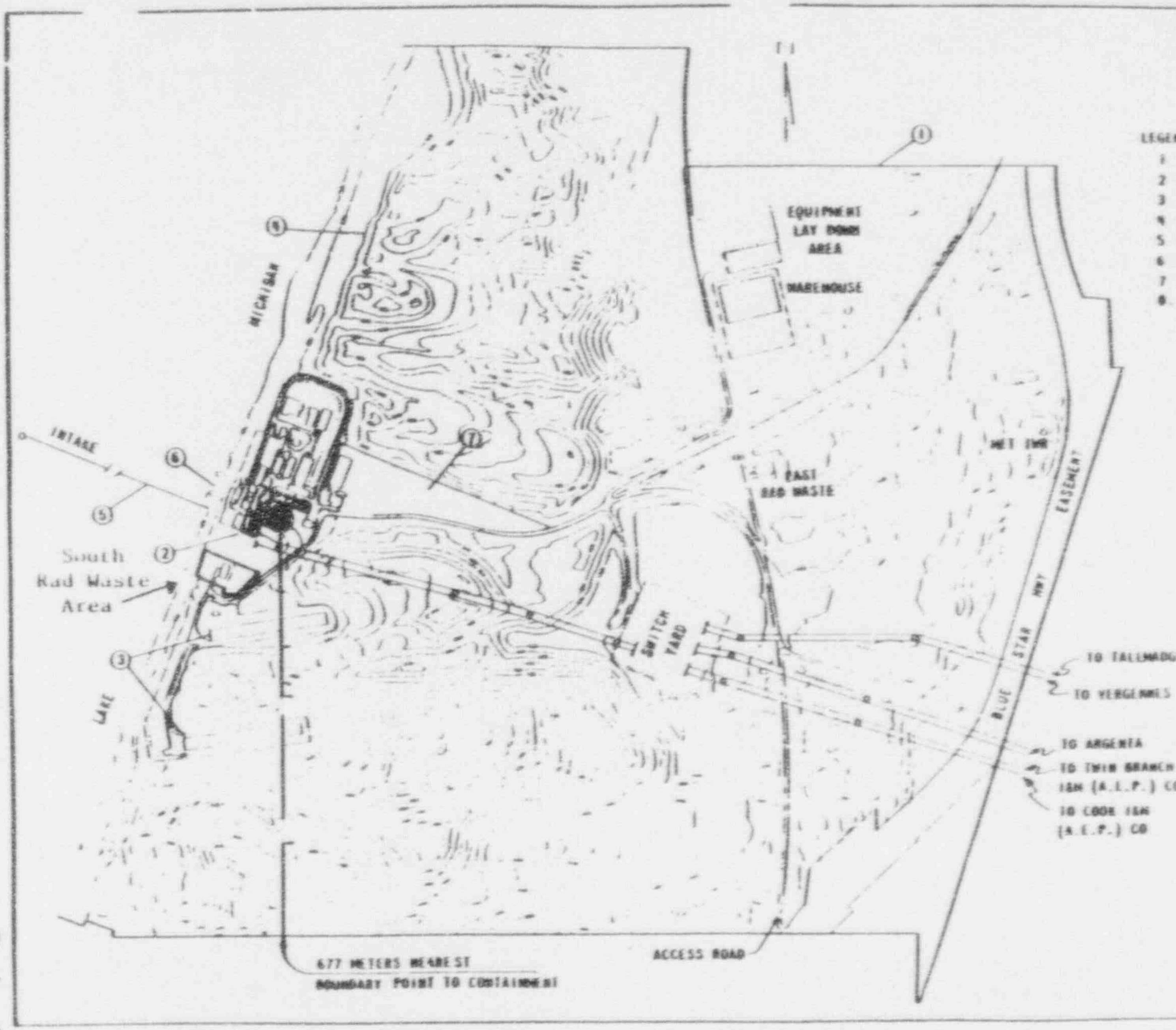
ECe = Millimhos per centimeter
SAR = Sodium adsorption ratio on saturation extract

TABLE 2-12

ANALYSES OF SOIL SAMPLES

Sample No	pH	ECe	Saturation Extract Values Milliequivalents per Liter: Calcium	Magnesium	Sodium	SAR	Sample Description
1	8.25	1.2	0.5	Trace	11.7	23.5	DH 22 E1 596
2	8.4	1.4	0.5	Trace	13.0	26	DH 22 E1 591
3	8.3	1.3	0.5	Trace	12.3	24.5	DH 22 E1 586
4	8.45	1.4	0.5	Trace	14.4	29	DH 22 E1 581
5	8.5	1.5	0.5	0.1	14.8	27	DH 22 E1 576
6	8.3	1.5	0.5	Trace	14.8	29.5	DH 22 E1 571
7	8.5	1.3	0.5	0.05	12.7	24	DH 22 E1 566
8	8.2	0.5	3.0	0.4	1.1	1	DH 22 E1 561
9	8.1	0.6	3.4	0.7	2.4	1.5	DH 22 E1 555

ECe = Millimhos per centimeter
SAR = Sodium adsorption ratio on saturation extract



LEGEND

1. SITE PROPERTY BOUNDARY & EXCLUSION AREA
2. POWER BLOCK PLAN
3. CIRCULATING WATER COOLING TOWERS
4. SITE CONTOUR INTERVALS OF 20' INCREMENTS
5. 3300 FOOT INTAKE PIPE TO CRIB
6. DISCHARGE STRUCTURE
7. PARKING
8. TOPOGRAPHIC ELEVATIONS IN FEET ABOVE MEAN SEA LEVEL

CONSUMERS POWER COMPANY
PALISADES PLANT
FSAR UPDATE

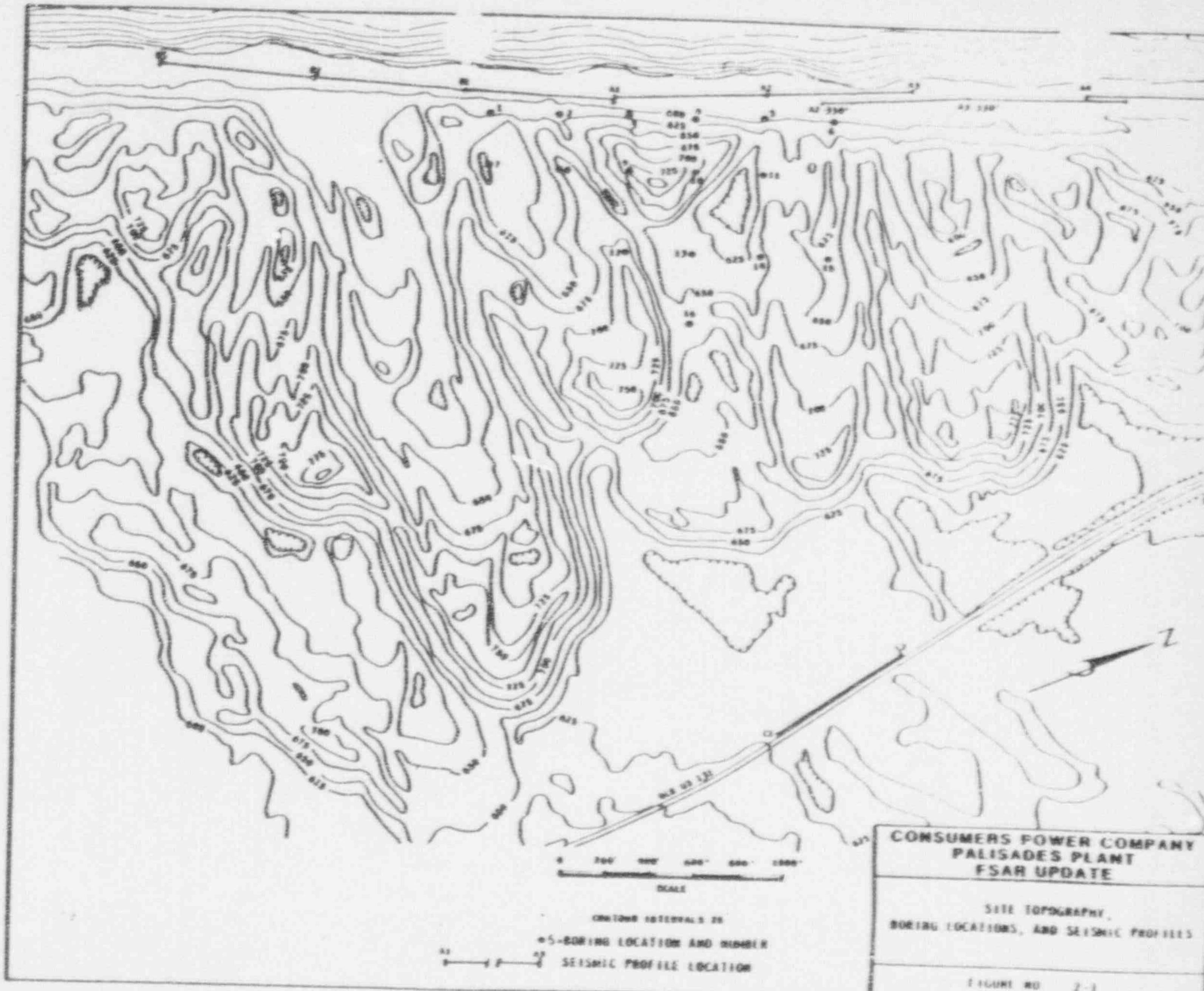
SITE LAYOUT

FIGURE NO 2-2

REVISION NO 6

7450282

ATTACHMENT 2



CONSUMERS POWER COMPANY
PALISADES PLANT
FSAR UPDATE

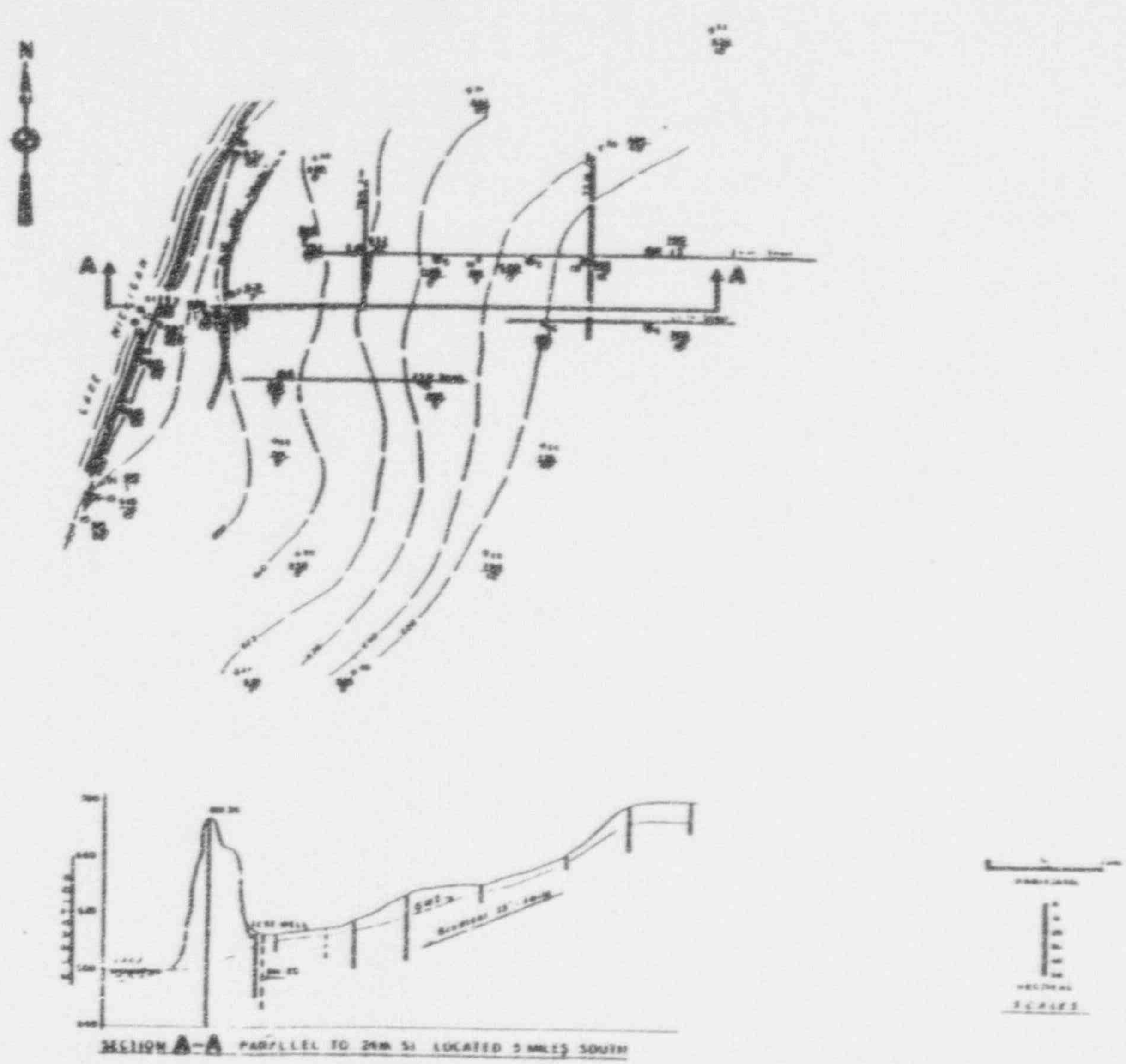
SITE TOPOGRAPHY,
BORING LOCATIONS, AND SEISMIC PROFILES

FIGURE NO 2-3

REVISION NO 0

7745 0283

ATTACHMENT 2



EXPLANATION

CONSUMERS POWER COMPANY PALISADES PLANT FSAR UPDATE
GROUNDWATER ELEVATIONS AND AREA GRADIENTS
FIGURE NO. 2-9

REVISION NO. 0

Consumers Power

POWERING MICHIGAN'S PROGRESS

General Offices: 1945 West Parnall Road, Jackson, MI 49201 • (517) 788-0550

January 25, 1988

Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

DOCKET 50-255 - LICENSE DPR-20 - PALISADES PLANT -
SUPPLEMENT - REQUEST TO RETAIN SOIL IN ACCORDANCE WITH 10CFR20.302

Consumers Power Company letter dated November 12, 1987, requested authorization to dispose of soil in place as specified by 10CFR20.302. The letter included the results of a survey and evaluation performed in August, 1987. Following submittal of that letter, a cooling tower overflow on November 13, 1987 again flooded the South Radwaste Building. The flooding caused additional activity that necessitated Consumers Power Company to request placing our November 12, 1987 request on hold until further evaluation and surveys could be completed. This letter includes the results of our evaluation and survey of the November 13, 1987 flooding incident and is intended to supplement our original November 12, 1987 request.

Following the cooling tower overflow, a survey indicated additional activity had been released from the building. The building was being maintained in a non-contaminated condition to prevent this type of occurrence; however, during this period a destructive testing program on waste packages was being conducted in a small area of the building. The survey clearly showed the release of activity from the building adjoining the testing area. The top six inches of soil from the sectors adjoining the building were removed and packaged (588 cubic feet) to prevent additional dispersion of radioactivity. The area was then completely resurveyed.

An evaluation of the August 1987 and November 1987 (post packaging) activities is attached. The survey indicates a drop of 49% in activities between the August and November surveys. We propose the activities specified in the November 12, 1987 submittal be used as justification for the request because they are conservative. In addition since the November 13, 1987 flooding and following the most recent survey the area was subject to heavy rains which could have diluted some activities to below minimum detectable activity (MDA is nominally 1E-06 µCi/g).

OC0188-0018-NL02

The one non-conservative value from our August survey and evaluation is the maximum dose rate at 18 inches above the surface. The November survey value from MICROSHIELD is 1.17 mR/hr as opposed to 1.02 mR/hr. This small increase only slightly changes the radiation workers' conservative dose estimate from 4.08 mR/year to 4.7 mR/year.

Following approval of this application, it is proposed to account for the most conservative values of activity, which was stated in the November 12, 1987 submittal, as an abnormal release in the semi-annual report. In order to prevent recurrence of these releases to the environment, Consumers Power Company is also committing to transfer radwaste activities from this area, except for high level vault use which is not a potential flooding release problem.

Relocation of these activities to a new radwaste facility is currently scheduled to be completed in 1988.

A check in the amount of $150.00 was attached to our November 12, 1987 submittal pursuant to 10CFR170.12(c).

Thomas C Bordine (Signed)

Thomas C Bordine
Administrator, Nuclear Licensing

CC Administrator, Region III, NRC
NRC Resident Inspector - Palisades

Attachment

Attachment A

Consumers Power Company
Palisades Nuclear Plant
Docket 50-255

Evaluation and Survey Results Comparison Post November
Flood and Packaging Versus the November 12, 1987 Submittal

<u>'A' Cooling Tower - South Radwaste Flood</u>

In August of [illegible] a resurvey was conducted of the soil at the South Radwaste Building and adjacent areas. The resurvey was conducted to verify the location of ground contamination and if any contamination migrated further into the ground since the 1986 survey.

After submittal of the 1987 soil results and request to retain, in accordance with 10CFR20.302, 'A' Cooling Tower Basin overflowed again flooding the South Radwaste Building and outlying areas. Immediately following the occurrence, one liter sample was taken with no activity detected on the Multi-Channel Analyzer (MCA). Then, another complete survey was conducted which included at least two surface samples and core samples in every sector (Figures 1 and 2).

Surface sample results showed that activities have increased as well as new sectors contaminated. The most heavily affected sectors were I-10, I-11, J-9 and K-9 (Figure 1A). To keep these areas from spreading, the top 6" of each of these sectors was removed and placed in 6 LSA boxes (approx. 588 cu.ft) and stored for disposition at a later date.

After removal of soil, the sectors were resurveyed (Figure 1B) and core samples were taken in each sector in 6-inch increments. Core samples were taken as far down as in the 1986 and August 1987 surveys, and in some instances even further in this survey. Results showed that no activity was detected below 6 inches as shown in Figure 2.

Table 1 and Table 2 show comparisons between the August and November 1987 soil surveys. Table 1 compares the depths, the activities, the total cu.ft. and total µCi per sector. After the removal of soil, the November 1987 soil survey results showed approximately a 49.3% drop in total contaminated soil (cu.ft.) and a 51.1% drop in total µCi in comparison to the August 1987 survey results. In Table 2 the comparison is between sectors affected in each survey and the depth at which each of these sectors were sampled. No activity was detected past 6 inches in the November 1987 soil survey, in comparison to that of 18 inches detected in August 1987.

Direct dose to an individual working in the affected areas was calculated using the MICROSHIELD code. The activities from sectors H-9 and J-9 were used for a dose at 18" inches above the surface. The dose rates from H-9 and J-9 are 9.97E-6 R/hr and 1.17E-5 R/hr, respectively. Therefore, a 50-hour occupancy in one week could result in a maximum exposure of .59 millirem. Normal occupancy of this area is on an "as needed basis" and averages less than 8 hours/week per individual in contact with the contaminated soil.

In reviewing the soil results between August and November 1987, the August 1987 soil survey remains more conservative based on the information shown on Tables 1 and 2. Therefore, the August 1987 soil survey is still valid in support of our request to retain the soil in accordance with 10CFR20.302.

Table 1

Comparison Table Between Total Cu. Ft. and Total µCi

August 1987

Sector #	Sq.ft.	X	Depth	=	ft³	X	g/ft³	X	µCi/g	=	Total µCi
E-11	375		0.5		187.5		48144		2.07E-6		18.7
E-13	375		0.5		187.5		48144		4.39E-6		39.6
H-9	625		1.5		937.5		48144		4.79E-6		216.2
H-10	625		0.5		312.5		48144		2.60E-6		39.1
H-11	625		2.0		1250*		48144		3.75E-5		2256.8
I-9	527		0.5		263.5		48144		1.24E-5		157.3
I-10	275		1.5		412.5		48144		5.39E-6		107.0
J-9	450		0.5		225		48144		5.39E-6		58.4
J-12	200		0.5		100		48144		6.39E-6		30.8
L-9	150		1.0		150		48144		6.77E-6		48.9
I-9 East	98		1.5		147		48144		1.40E-5		99.1
	4325				4173						3071.9

*1250 = *2256.8 = 73.5% of total activity

November 1987

Sector #	Sq.ft.	Depth	ft³	g/ft³	µCi/g	Total µCi
E-11	375	0.5	187.5	48144	1.80E-6	16.25
H-9	625	0.5	312.5	48144	4.35E-5	654.46
H-10	625	0.5	312.5	48144	3.20E-6	48.14
H-11	625	0.5	312.5	48144	3.22E-5	484.45
H-12	250	0.5	125	48144	2.20E-6	13.24
I-9	527	0.5	263.5	48144	6.79E-6	86.14
I-12	220	0.5	110	48144	3.0E-6	15.89
J-9	450	0.5	225	48144	2.05E-5	222.06
J-12	200	0.5	100	48144	2.60E-6	12.52
K-9	216	0.5	108	48144	3.39E-6	17.63
	4113		2056.5			1570.78

Table 2

Survey Comparison Between August and November 1987 Soil Surveys

Sector	August 1987 / November 1987 Surface	6"	12"	18"	24"	30"	36"	42"
E-11	2.07E-6	<MDA	<MDA	<MDA				
	1.80E-6	<MDA	<MDA	<MDA				
E-13	4.39E-6	<MDA	<MDA	<MDA				
	<MDA	N/A	<MDA	<MDA				
H-9	4.19E-6	<MDA	4.79E-6	<MDA	<MDA	<MDA		
	4.35E-5	<MDA	<MDA	<MDA	<MDA	<MDA		
H-10	2.60E-6	<MDA	<MDA					
	3.20E-6	<MDA	<MDA					
H-11	3.75E-5	<MDA	<MDA	8.45E-6	<MDA	<MDA	<MDA	
	3.22E-5	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	
H-12	<MDA	N/A						
	2.20E-6	N/A						
I-9	1.24E-5	<MDA	<MDA					
	6.79E-6	<MDA	<MDA					
I-10	<MDA	<MDA	5.39E-6	<MDA	<MDA	<MDA	<MDA	<MDA
	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
I-11	<MDA	N/A						
	<MDA	<MDA	<MDA	<MDA				
I-12	<MDA	N/A						
	3.00E-6	N/A						
J-9	5.39E-6	<MDA	<MDA					
	2.05E-5	<MDA	<MDA					
J-12	6.39E-6	<MDA	<MDA					
	2.60E-6	N/A	<MDA					
K-9	<MDA	N/A						
	3.39E-6	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	
L-9	<MDA	6.77E-6	<MDA	<MDA				
	<MDA	N/A	<MDA	<MDA				

Microshield 3.02
****
(Consumer's Power Company - #037)

Page : 1
File : SOIL1.MSH
Run date: January 18, 1988
Run time: 4.17 p.m.

CASE: CONTAMINATED SOIL @ H-9 LOCATION (6 INCHES DEEP)

GEOMETRY 11: Rectangular solid source - slab shields

Distance to detector........................	X	60.960	cm.
Source width.................................	W	762.	"
Source length................................	L	762.	"
Rectangular solid, thickness toward dose pt..	T1	15.240	"
Thickness of second shield...................	T2	45.720	"

Source Volume: 8.84901e+6 cubic centimeters

MATERIAL DENSITIES (g/cc):

Material	Source	Shield 2
Air	.001220	.001220
Aluminum		
Carbon	1.70	
Concrete		
Hydrogen		
Iron		
Lead		
Lithium		
Nickel		
Tin		
Titanium		
Tungsten		
Urania		
Uraniun		
Water	1.0	
Zirconium		

Rev 0
8-1-91

CASE: CONTAMINATED SOIL @ H-9 LOCATION (6 INCHES DEEP)

BUILDUP FACTOR: based on TAYLOR method.
Using the characteristics of the materials in shield 1.

INTEGRATION PARAMETERS:

Number of lateral angle segments (Ntheta)..... 5
Number of azimuthal angle segments (Npsi)..... 5
Number of radial segments (Nradius)........... 5

SOURCE NUCLIDES:

Ba-137m: 3.8493e-04 curies

RESULTS:

Group #	Energy (MeV)	Activity (photons/sec)	Dose point flux MeV/(sq cm)/sec	Dose rate (mr/hr)
1	.664	1.282e+07	4.808e+00	9.969e-03
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
	TOTALS:	1.282e+07	4.808e+00	9.969e-03

Microshield 3.02
****
(Consumer's Power Company - #037)

Page : 1
File : SOIL2.MSH
Run date: January 18, 1988
Run time: 4:26 p.m.

CASE: CONTAMINATED SOIL @ J-9 LOCATION (6 INCHES DEEP)

GEOMETRY 11: Rectangular solid source - slab shields

Distance to detector..........................	X	60.960	cm.
Source width..................................	W	762.	"
Source length.................................	L	548.640	"
Rectangular solid, thickness toward dose pt..	T1	15.240	"
Thickness of second shield....................	T2	45.720	"

Source Volume: 6.37129e+6 cubic centimeters

MATERIAL DENSITIES (g/cc):

Material	Source	Shield 2
Air	.001220	.001220
Aluminum		
Carbon	1.70	
Concrete		
Hydrogen		
Iron		
Lead		
Lithium		
Nickel		
Tin		
Titanium		
Tungsten		
Urania		
Uranium		
Water	1.0	
Zirconium		

Rev 0
8-1-91

CASE: CONTAMINATED SOIL @ J-9 LOCATION (6 INCHES DEEP)

BUILDUP FACTOR: based on TAYLOR method.
Using the characteristics of the materials in shield 1.

INTEGRATION PARAMETERS:

Number of lateral angle segments (Ntheta)..... 5
Number of azimuthal angle segments (Npsi)..... 5
Number of radial segments (Nradius)........... 5

SOURCE NUCLIDES:

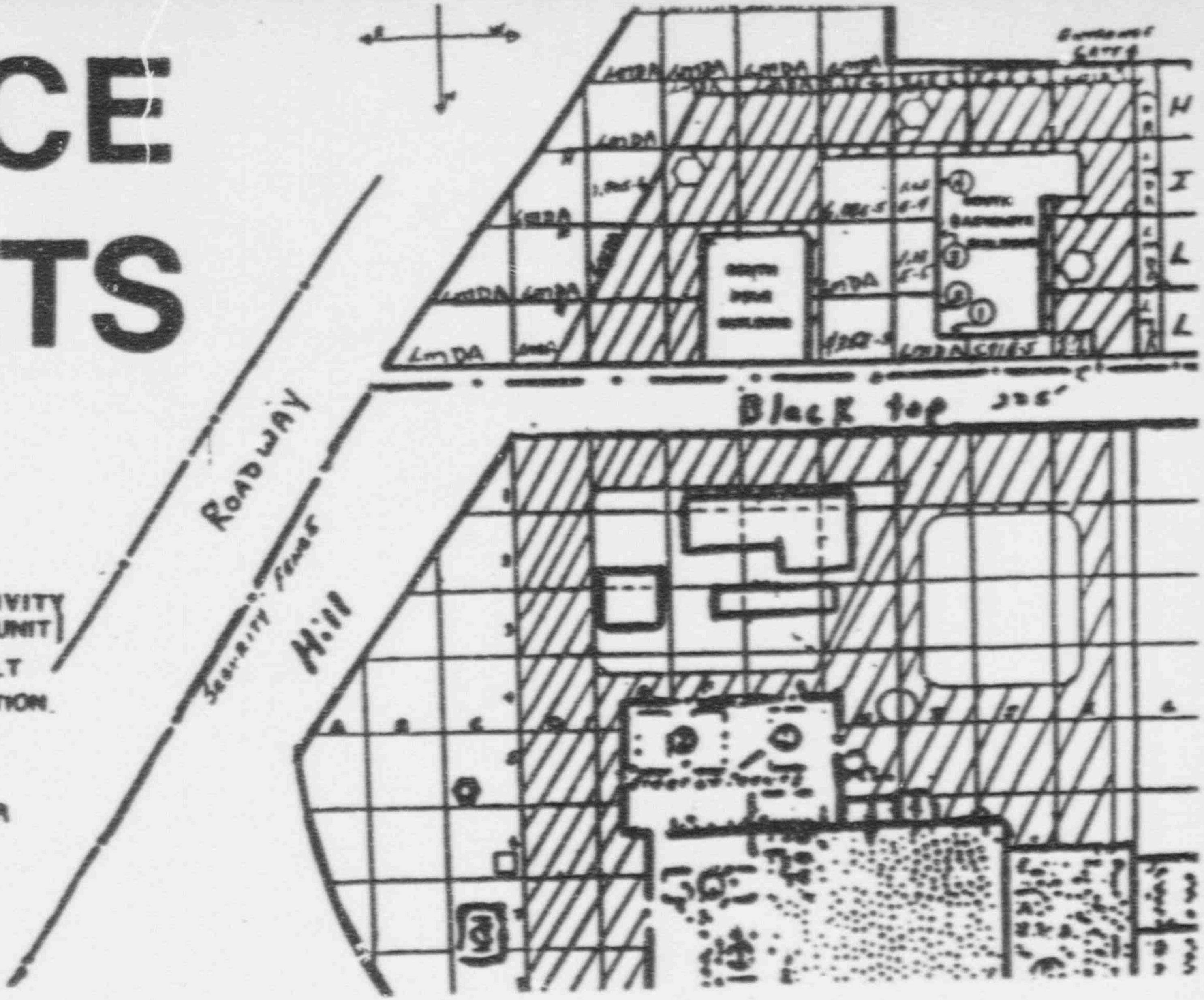
Co-60: 8.9198e-05 curies

RESULTS:

Group #	Energy (MeV)	Activity (photons/sec)	Dose point flux MeV/(sq cm)/sec	Dose rate (mr/hr)
1	1.336	3.300e+06	3.411e+00	6.155e-03
2	1.180	3.300e+06	2.958e+00	5.497e-03
3	.695	5.383e+02	2.888e-04	5.950e-07
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
TOTALS:		6.601e+06	6.370e+00	1.165e-02

Rev 0
8-1-91

SURFACE RESULTS



LEGEND

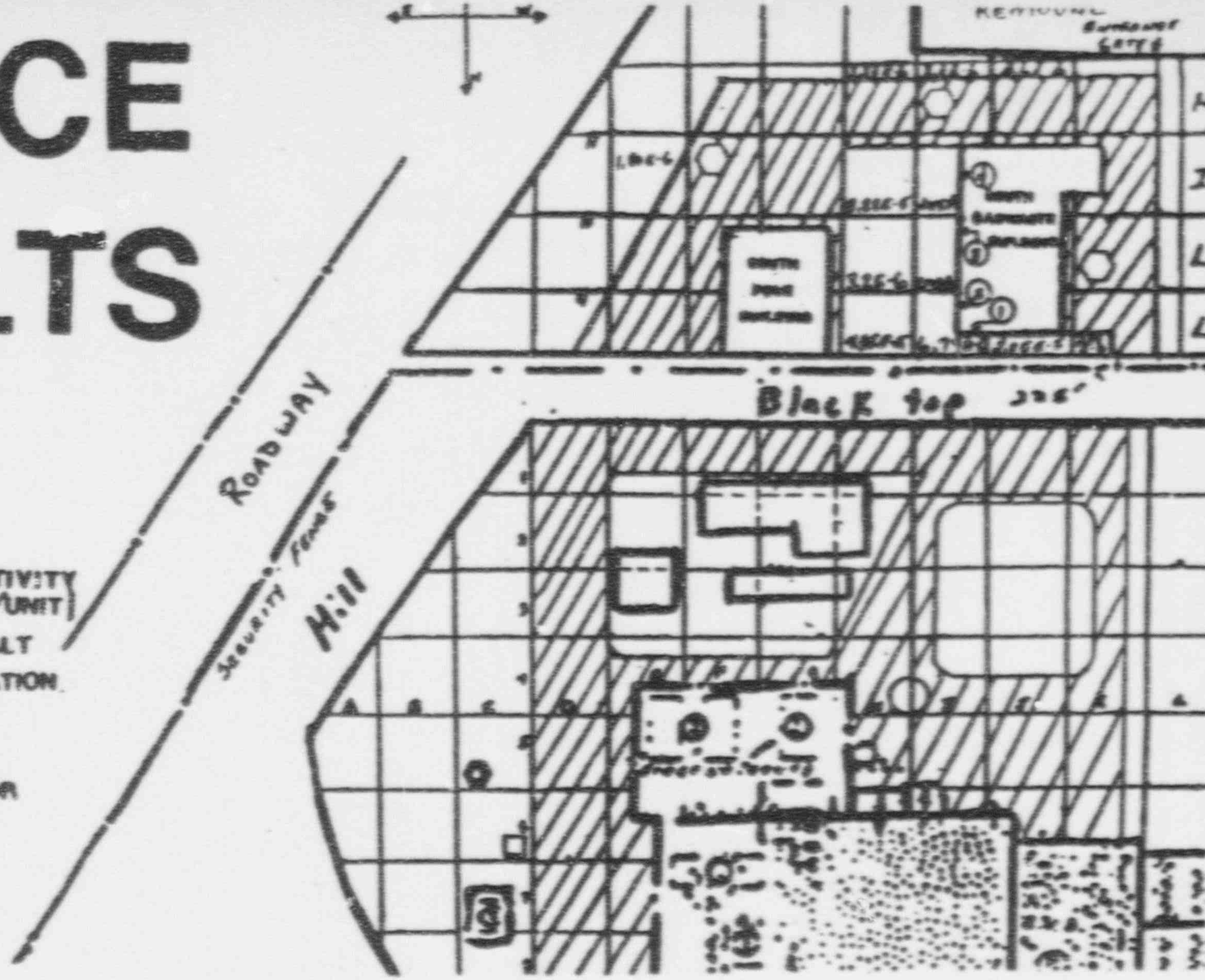
- LMDA: < MINIMUM DETECTABLE ACTIVITY (1.00E-6 μCi/UNIT)
- SURFACE AREA UNDER ASPHALT
- CORE SAMPLE UNDER FOUNDATION
- SURFACE ACTIVITY OF SECTOR*
- ASPHALT AREAS

*EXAMPLE ONLY

Rev 0
8-1-91

SURFACE RESULTS

LEGEND



≤MINIMUM DETECTABLE ACTIVITY (1.00E-6 µCi/UNIT)

SURFACE AREA UNDER ASPHALT

CORE SAMPLE UNDER FOUNDATION

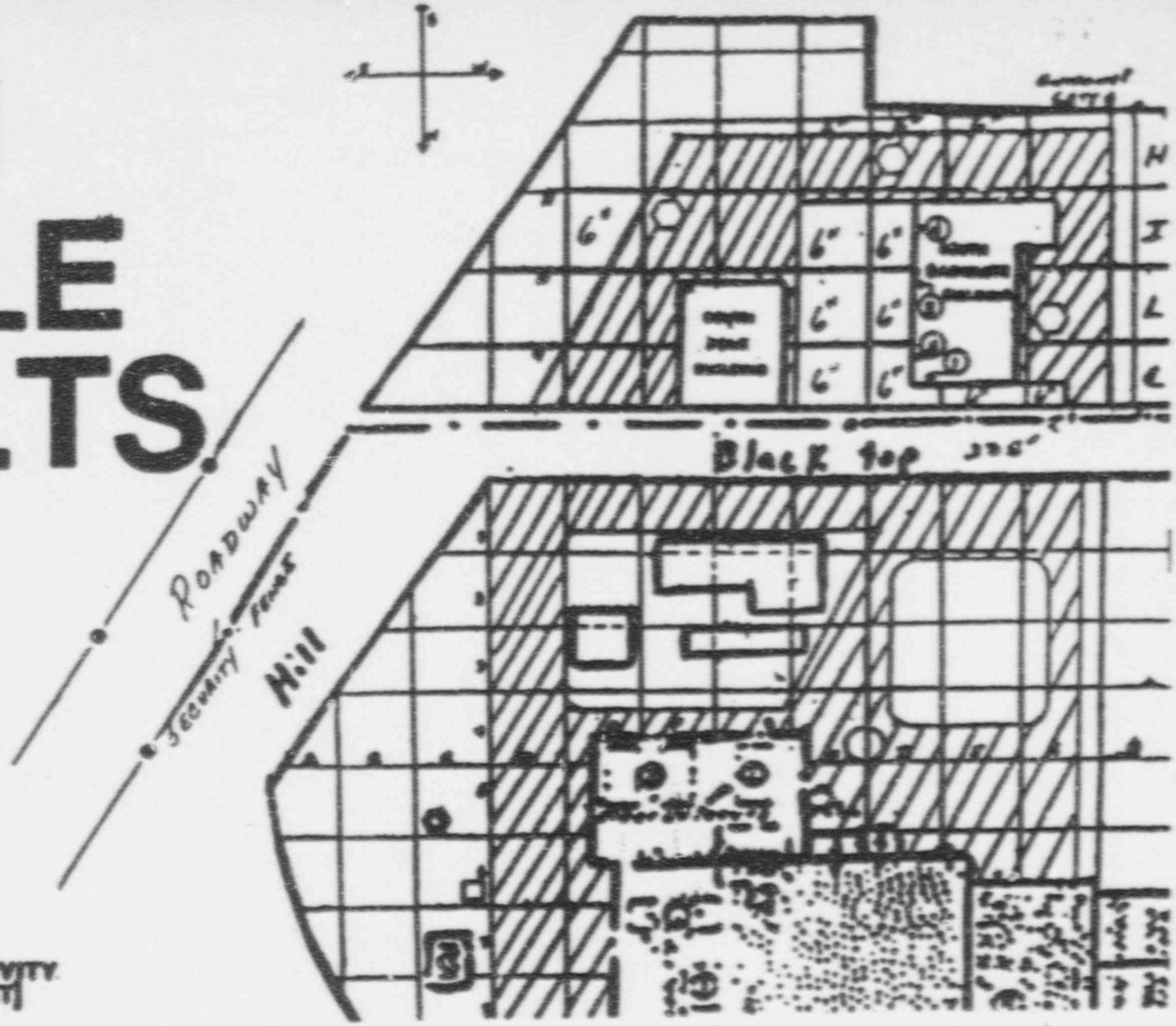
SURFACE ACTIVITY OF SECTOR

ASPHALT AREAS

*EXAMPLE ONLY

FIGURE 2

DEPTH SAMPLE RESULTS



LEGEND

LETTER (D)=COLUMN
NUMBER (4)=ROW

DEPTH LEVEL AT WHICH NO ACTIVITY WAS DETECTED

ASPHALT AREAS

< MINIMUM DETECTABLE ACTIVITY [1.00 E-6 µCi/UNIT]

SURFACE AREA UNDER ASPHALT

CORE SAMPLE UNDER FOUNDATION

ODCM - APPENDIX B
REFERENCE 2

PW031588B

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

RECEIVED
MAR 1 9 1988
NUCLEAR LICENSING

March 15, 1988

Docket No. 50-255

Mr. Kenneth W. Berry
Director, Nuclear Licensing
Consumers Power Company
1945 West Parnall Road
Jackson, Michigan 49201

Dear Mr. Berry:

SUBJECT: PALISADES PLANT - REQUEST TO RETAIN CONTAMINATED SOIL IN ACCORDANCE WITH 10 CFR 20.302 (TAC NO. 67408)

The subject request submitted by Consumers Power Company by letter dated November 12, 1987 and supplemented by information forwarded by letter dated January 25, 1988 contains detailed information evaluating the radiation doses via the liquid pathways for very low levels of contamination presently in areas of soil near the Palisades Plant South Radwaste Building. Detailed evaluations are also presented of potential occupational doses from this contaminated soil.

One additional dose pathway should, however, be evaluated to complete the analysis of the impact viz., the inhalation pathway. In your submittals, you have presented diagrams showing areas in which contamination has been detected. It appears that for some of these areas 6" of soil has been removed, others are now covered by black top, and still others have not been disturbed. In order for the staff to complete the evaluation under 10 CFR 20.302, we ask that you submit a diagram indicating all contaminated soil surface areas included in this request, the condition of this soil surface, and an evaluation of the radiation doses via the inhalation pathway associated with these soil surfaces. The request in this letter affects fewer than ten respondents; therefore, OMB clearance is not required under PL 96-511.

Sincerely,

Thomas V. Wambach

Thomas V. Wambach, Project Manager
Project Directorate III-1
Division of Reactor Projects - III, IV, V
& Special Projects

cc: See Next Page

DCC: 42+40+50
24+34

Mr. Kenneth W. Berry
Consumers Power Company

Palisades Plant

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Covert, Michigan 49043

Resident Inspector
c/o U.S. Nuclear Regulatory Commission
Palisades Plant
27782 Blue Star Memorial Hwy.
Covert, Michigan 49043

Nuclear Facilities and
Environmental Monitoring
Section Office
Division of Radiological
Health
P.O. Box 30035
Lansing, Michigan 48909

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

RECEIVED
JAN 1 1990
NUCLEAR LICENSING

January 12, 1990

Docket No. 50-255
Serial No. PAL 90-002

Mr. Kenneth W. Berry
Director, Nuclear Licensing
Consumers Power Company
1945 West Parnall Road
Jackson, Michigan 49201

Dear Mr. Berry:

SUBJECT: PALISADES PLANT - REQUEST TO RETAIN SOIL IN ACCORDANCE WITH 10 CFR 20.302 (TAC NO. 67408)

By letters dated November 12, 1987 and January 25, 1988, Consumers Power Company requested authorization under the provisions of 10 CFR 20.302 to dispose contaminated soil in place. The NRC staff replied with a request for additional information which was forwarded to you on March 15, 1988.

By letter dated June 27, 1988, Consumers Power Company provided additional information in response to our request. However, in that response, CPCo expanded the original request to include the entire South Radwaste area as a contingency against future spread of contamination and to obviate the need for additional requests under 10 CFR 20.302. For the staff to complete its review of this request, additional specific information is required. This is because NRC approval under 10 CFR 20.302 is for the disposal of specifically identified and characterized slightly contaminated material by the applicant.

We request that you provide a revised submittal describing the licensed material for disposal and the analysis and evaluation called for under 10 CFR 20.302. The attached request for additional information provides additional detail for the content of the revised submittal.

The reporting and/or recordkeeping requirements of this letter affect fewer than ten respondents; therefore, OMB clearance under PL 96-511 is not required.

Sincerely,

Albert W. De Agazio

Albert W. De Agazio, Sr. Project Manager
Project Directorate III-1
Division of Reactor Projects - III, IV, V & Special Projects
Office of Nuclear Reactor Regulation

cc: See next page

42*40*50
24*32

Mr. Kenneth W. Berry
Consumers Power Company

Palisades Plant

cc:

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Room 1 - Capitol Building
Lansing, Michigan 48913

Mr. Gerald B. Slade
Plant General Manager
Palisades Plant
27780 Blue Star Memorial Hwy.
Covert, Michigan 49043

Resident Inspector
c/o U.S. Nuclear Regulatory Commission
Palisades Plant
27782 Blue Star Memorial Hwy.
Covert, Michigan 49043

Nuclear Facilities and
Environmental Monitoring
Section Office
Division of Radiological
Health
P.O. Box 30035
Lansing, Michigan 48909

ENCLOSURE

SECOND REQUEST FOR ADDITIONAL INFORMATION (RAI)

ON THE CONSUMERS POWER COMPANY

PALISADES PLANT REQUEST

TO RETAIN SOIL IN ACCORDANCE

WITH 10 CFR 20.302

The subject request submitted by Consumers Power Company (licensee) by letter dated November 12, 1987 and supplemented by information forwarded by letter dated January 25, 1988 contained detailed information evaluating the radiation doses via the liquid pathways for very low levels of contamination presently in areas of soil near the Palisades Plant South Radwaste Building. Detailed evaluations were also presented of potential occupational doses from this contaminated soil.

Three significant questions arose during the staff evaluation of this request:

1. The inhalation pathway for doses from the contaminated soil was not addressed.

2. The proposals contain no delineation of the specific contaminated areas covered by the disposal request.

3. The licensee's Technical Specifications for radiological environmental monitoring require an LLD of 2×10^{-7} μCi/gm for ^{137}Cs determinations in sediment - yet all of the measurements reported in the request were made with equipment 5 to 10 times less sensitive for these gamma radiations

By letter dated June 27, 1988 the licensee submitted additional information in response to the staff's RAI of March 15, 1988. This submittal was unacceptable in that it addressed potentially contaminated areas and hypothetical maximum contamination parameters rather than measured licensed material to be disposed of under the regulations.

It is requested that the licensee submit a complete, revised 20.302 request incorporating the dose evaluation information of the measured contamination considered in the November 12, 1987 and January 25, 1988 submissions and updated if appropriate with dose evaluations of the inhalation pathway based on the same measured contamination. As part of the proposal the licensee should record exactly what areas of measured contamination are covered by the request for which disposal under 10 CFR 20.302 is proposed.

Consumers Power

POWERING MICHIGAN'S PROGRESS

General Offices: 1945 West Parnall Road, Jackson, MI 49201 • (517) 788-0550

June 27, 1988

Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

DOCKET 50-255 - LICENSE DPR-20 - PALISADES PLANT -
SUPPLEMENT - REQUEST TO RETAIN SOIL IN ACCORDANCE WITH 10CFR20.302

Consumers Power Company correspondence dated November 12, 1987 and January 25, 1988 requested authorization to dispose contaminated soil inplace as specified by 10 CFR 20.302. The area, known as the South Radwaste Area, has been contaminated by numerous cooling tower overflows and redistributed by heavy rain showers. Although the majority of the radioactive material has been packaged for waste shipment, a large volume of very low activity radioactive material remains. This volume of material would be very expensive to ship as waste. The NRC, by letter of March 15, 1988 to Consumers Power Company, requested additional inhalation dose information and clarification of the contaminated area.

A generic inhalation dose evaluation is described in Attachment A. Conservative assumptions have been made to get the maximum organ dose possible from inhalation of contaminated soil. The inhalation doses are not significant.

Consumers Power Company requests to expand this 10 CFR 20.302 request to include the entire South Radwaste Area. Periodic cooling tower overflows and occasional heavy rains have caused redistribution of radioactive material to areas which were below Lower Limits of Detection (LLD) during previous evaluations. Expanding the area would eliminate the need for a new 10 CFR 20.302 submittal if radioactive material is redistributed within the South Radwaste Area. The South Radwaste Area is completely fenced and located directly South of the Plant South Security fence. Area fence is shown in dark outline on Figure 1.

As described in our January 25, 1988, letter we intend to transfer the radwaste activities which caused the contamination of soil from the South Radwaste Area, except for the high level vault use which is not a potential flooding release problem.

Consumers Power Company requests approval to dispose of inplace low level radioactive materials which meet the following conditions without further 10 CFR 20.302 submittals.

1. Material contained in the fenced area described as South Radwaste Area.

2. Direct dose to a radiation worker would not exceed 5E-02 mRem/hour from contaminated soil.

3. Average gross beta/gamma concentration not to exceed 5E-05 μCi/gm so inhalation doses to a radiation worker or at the site boundary would not exceed the values contained in Attachment 1.

4. Additional radioactive material releases shall be identified in liquid Semi-Annu Effluents Reports as an 'Abnormal Release'.

Sampling, analyses and Semiannual Effluent Report inclusions of 'Abnormal Release' will be performed only when further flooding of the area occurs.

James L Kuemin (Signed)

James L Kuemin
Staff Licensing Engineer

CC Administrator, Region III, NRC
NRC Resident Inspector - Palisades

Attachment

OC0688-0049-NL02

Attachment 1

The inhalation doses have been calculated on a generic worst case basis. A generic basis has been selected to compensate for the elevated Lower Limit of Detection (LLD) in analysis and also to address movement of radioactivity within the South Radwaste Area. The assumptions made are the worst case Dose Conversion Factor (DCF) used (see Table 3), a total average activity concentratiou of 5E-05 μCi/gram and the entire area (500 m^2) used instead of the indicated contaminated area (117 m^2).

Increasing the area is self-explanatory. The total average activity concentration is being used instead of actual to account for dose important isotopes which may be present near the analysis LLD of 1E-06 μCi/gm, but not detected. The worst case DCF is used to demonstrate a <u>maximum</u> organ dose. A variation in isotope mixes could shift the maximum dose to a different organ but could not exceed the dose indicated.

Radworker and site boundary inhalation dose calculations are attached.

OC0688-0049-NL02

Table 1

Inhalation Dose From Contaminated Soil - Adult Radiation Worker

$DW = C_S \cdot f_{18} \cdot f_{14} \cdot f_{15} \cdot E_f \cdot DCF_i$

Where: C_S = concentration of waste: 5.0E04 pCi/Kg.

E_f = occupancy factor: 2080 worker hours ÷ 8760 hrs/yr = 0.237

f_{18} = areal mass available for resuspension (top 1 cm of soil): 16 Kg/m^2

f_{14} = resuspension factor: 8.5E-9/m

f_{15} = adult annual inhalation rate: 7300 m^3 (RG 1.109)

DCF_i = 7.46E-04 mRem/(50 yr . pCi): adult lung (RG 1.109)

Substituting:

D_W = 8.78E-03 mRem/50 yr: maximum organ dose

Reference: AIF/NESP-035 Evaluation of the Potential for De-Regulated Disposal of Very Low Level Wastes From Nuclear Power Plants

OC0688-0049-NL02

Table 2

Inhalation Dose At Site Boundary - Infant Most Limiting

$$D_{SB} = C_S \cdot f_{18} \cdot f_{14} \cdot f_{16} \cdot X/Q \cdot \mu \cdot A \cdot DCF_i$$

Where: Terms are identified in Table 1 and

F_{16} = 2045 m^3: infant annual breathing rate (RG 1.109)

X/Q = 1.4 E-6 sec/m^3: actual 5 year site average

μ = 3.8 m/sec average wind speed: actual 1986

A = 500 m^2: contaminated area

DCF_i = 3.22E-03 mR/(50 yr . pCi): infant lung (RG 1.109)

Substituting

D_{SB} = 1.19E-04 mRem/50 yr: maximum organ dose

Table 3

Dose Conversion Factors for Inhalation: Committed dose (mRem) over 50 years per pCi inhaled, per Regulatory Guide 1.109.

Onsite - Radiation Worker

	Bone	Liver	Kidney	Lung	GI
Cs-134	4.66E-05	1.06E-04	3.59E-05	1.22E-05	1.30E-06
Cs-137	5.98E-05	7.76E-05	2.78E-05	9.40E-06	1.05E-06
Ba-140+D	4.88E-06	6.13E-09	2.09E-09	1.59E-04	2.73E-05
Sr-90*	1.24E-02	0.0	0.0	1.20E-03	9.02E-05
Co-60**	0.0	1.44E-06	0.0	7.46E-04	3.56E-05

* Sr-90 is a factor of 5E-03 lower than Cs-137 based upon 10 CFR 61 sampling analysis and cannot be limiting. Cs-137 was present in all samples where activity was identified.

** Given the concentration restriction on Sr-90 noted above, Co-60 lung dose is most limiting.

Offsite - Infant Most Limiting for Inhalation

Cs-134	2.83E-04	5.02E-04	1.36E-04	5.69E-05	9.53E-07
Cs-137	3.92E-04	4.37E-04	1.23E-04	5.09E-05	9.53E-07
Ba-140	4.00E-05	4.00E-08	9.59E-09	1.14E-03	2.74E-05
Sr-90*	2.92E-02	0.0	0.0	8.03E-03	9.36E-05
Co-60**	0.0	5.73E-06	0.0	3.22E-03	2.28E-5

* Sr-90 is a factor of 5E-03 lower than Cs-137 based upon 10 CFR 61 sampling analysis and cannot be limiting. Cs-137 was present in all samples where activity was identified.

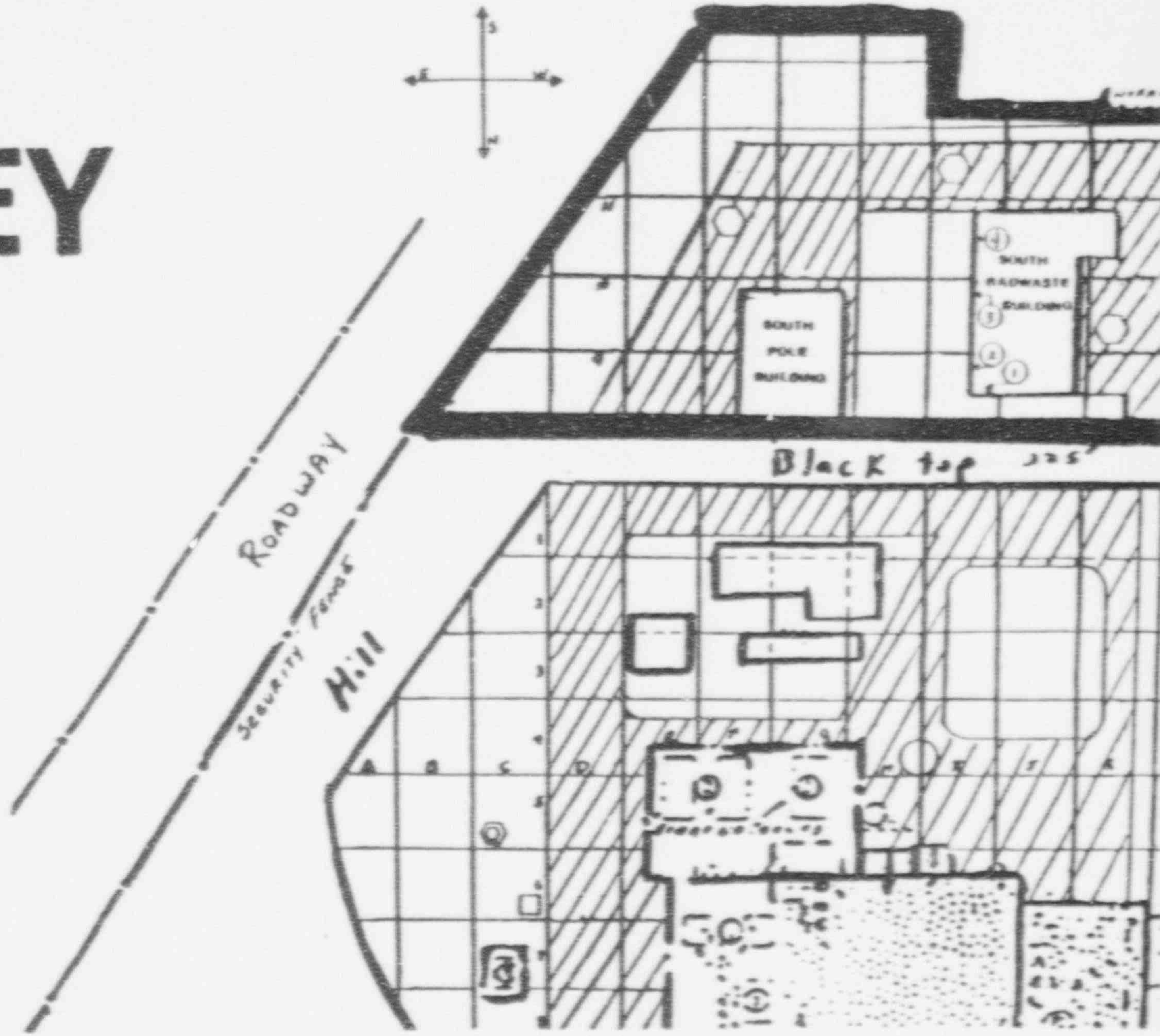
** Given the concentration restriction on Sr-90 noted above, Co-60 lung dose is most limiting.

FIGURE 1

SURVEY GRID

LEGEND

- ASPHALT AREAS
- 25' x 25' SECTORS
- AREA "B"
- AREA "A"



Consumers Power
POWERING MICHIGAN'S PROGRESS
Palisades Nuclear Plant 27780 Blue Star Memorial Highway Covert, MI 49043

G B Slade
General Manager

August 31, 1990

Nuclear Regulatory Commission
Document Control Desk
Washington, D C 20555

DOCKET 50-255 - LICENSE DPR-20 - PALISADES PLANT
SUPPLEMENT - REQUEST TO RETAIN SOIL IN ACCORDANCE WITH 10CFR 20.302

Consumers Power Company correspondence dated November 12, 1987 and January 25, 1988 requested authorization to dispose of contaminated soil in place as specified by 10CFR 20.302. The area known as the South Radwaste Area has been contaminated by numerous cooling tower overflows and contamination was redistributed by heavy rain showers. Although the majority of the radioactive material has been packed for waste shipment, a large volume of very low activity radioactive material remains. This volume of material would be very expensive to ship as waste. The NRC, by letter of March 15, 1988 to Consumers Power Company, requested additional inhalation dose information and clarification of the contaminated area.

After discussions with the NRC reviewer, a supplement was submitted on June 27, 1988 which was based on generic approval. It proposed that further submittals would not be required if flooding moved activity from an identified to an unidentified sector. Subsequently, on January 12, 1990, the NRC Staff requested additional information. The information request required the licensee to submit a revised proposal incorporating the dose evaluation information of the measured contamination considered in the November 12, 1987 and January 25, 1988 submittals and updated, if appropriate, with dose evaluations of the inhalation pathway based on the same measured contamination. As part of the proposal, the licensee was asked to record exactly what areas of measured contamination are covered by the request for which disposal under 10CFR 20.302 is proposed.

The attached material supplies the requested information. The specific area contaminated is noted as Area B on the attached survey grid map. The entire area is fenced and is about 12,000 sq ft of soil exposed with the remainder buildings and asphalt. The inhalation pathway is for breathing suspended soil from this area. Table 2 addresses a radworker in Area B, and Table 3 addresses an infant on the site boundary. The radworker could receive 8.03E-04 mRem/50-year maximum organ (liver) dose and the infant could receive 3.16E-05 mRem/50-year maximum organ (liver) dose, both of which are insignificant.

When the flooding problem was discovered and planning for a formal survey was done, the environmental sediment LLD was not considered, as this was a nuclear plant site. We attempted to get the best LLD we could using our equipment and the number of samples we were going to have to run. With the hundreds of samples run, we felt 1E-06 uCi/gm was adequate. To be conservative, we expanded the August and November 1987 surveys to use 1.0E-06 uci/gm Cs-137 in any sector which showed LLD. This will increase the radioactivity to 5,006 uCi from 4,643 uCi, an increase of 8%. The activities are on Table 1 and 1A. If this submittal is approved, we will add the released activity to the Liquid Semi-annual Effluent Report as an abnormal release, and the approval to retain the soil in place will be documented in the FSAR.

In summation, Consumers Power Company requests approval to dispose of in place the low-level radioactive materials which are contaminated soil contained in the fenced area described as South Radwaste Area (Area B). Direct dose to a radiation worker would not exceed 1.7E-02 mRem/hour from this contaminated soil. Inhalation doses to a radiation worker or at the site boundary would not exceed 8.03E-04 mRem/50-year. Tables 1 and 1A radioactive material release shall be identified in liquid Semi-annual Effluent Reports as an 'abnormal release'. The disposal in place would be documented in the FSAR.

The radwaste activities which caused the contamination of the soil have been completely relocated to a new east radwaste area. The South Building has been deconned and is being used for non-radwaste activities. Some fixed contamination is present in floor cracks and vaults. This has been documented for plant decommissioning. No further contamination will be added to the south area from the South Radwaste Building.

Gerald B Slade (Signed)

Gerald B Slade
General Manager

pc: Administrator, Region III, USNRC
NRC Resident Inspector, Palisades

Attachment A

Consumers Power Company
Palisades Nuclear Plant
Docket 50-255

Tables 1 and 1A, Survey Results
Microshield Direct Dose Calculation
Table 2 - Radworker Inhalation Dose
Table 3 - Site Boundary Inhalation Dose
Figure 1 - Survey Grid
Figure 2 - Survey Results

Table 1

August 1987 Survey

Sector #	Sq.ft.	X	Depth	=	ft³	X	g/ft³	X	µCi/g	=	Total µCi
E-11	375		0.5		187.5		48144		2.07E-6		18.7
E-13	375		0.5		187.5		48144		4.39E-6		39.6
H-9	625		1.5		937.5		48144		4.79E-6		216.2
H-10	625		0.5		312.5		48144		2.60E-6		39.1
H-11	625		2.0		1250*		48144		3.75E-5		2256.8
I-9	527		0.5		263.5		48144		1.24E-5		157.3
I-10	275		1.5		412.5		48144		5.39E-6		107.0
J-9	450		0.5		225		48144		5.39E-6		58.4
J-12	200		0.5		100		48144		6.39E-6		30.8
L-9	150		1.0		150		48144		6.77E-6		48.9
I-9 East	98		1.5		147		48144		1.40E-5		99.1
Subtotals	4325				4173						3071.9
Remainder of Section	7613		0.5		3807		48144		1.0E-06		183
TOTAL	11,938										3,255.

MI0890-0074A-HP01

Table 1A

November 1987 Survey

Sector #	Sq.ft.	X	Depth	=	ft³	X	g/ft³	X	uCi/g	=	Total uCi
B-9	125		0.5		62.5		48144		1E-06		3
C-9	625		0.5		312.5		48144		1E-06		15
C-10	500		0.5		250		48144		1E-06		12
D-9	500		0.5		250		48144		1E-06		12
D-10	625		0.5		312.5		48144		1E-06		15
D-11	550		0.5		275		48144		1E-06		13
D-12	75		0.5		37.5		48144		1E-06		2
E-10	125		0.5		62.5		48144		1E-06		3
E-11	375		0.5		187.5		48144		1.8E-06		16
E-12	625		0.5		312.5		48144		1.E-06		15
E-13	550		0.5		275		48144		1E-06		13
F-12	300		0.5		150		48144		1E-06		7
F-13	625		0.5		312.5		48144		1E-06		15
G-12	750		0.5		125		48144		1E-06		6
G-13	625		0.5		312.5		48144		1E-06		15
H-9	625		0.5		312.5		48144		4.4E-05		662
H-10	625		0.5		312.5		48144		3.2E-06		48
H-11	600		0.5		300		48144		3.2E-05		462
H-12	250		0.5		125		48144		2.2E-06		13
H-13	625		0.5		312.5		48144		1.0E-06		15
I-9	527		0.5		263.5		48144		6.8E-06		86
I-10	275		0.5		137.5		48144		1.0E-06		7
I-11	250		0.5		125		48144		1.0E-06		6
I-12	220		0.5		110		48144		3.0E-06		16
J-9	450		0.5		225		48144		2.1E-05		227
J-12	200		0.5		100		48144		2.6E-06		13
K-9	216		0.5		108		48144		3.4E-06		18
L-9	150		0.5		75		48144		1.0E-06		4
L-10	150		0.5		75		48144		1.0E-06		4
L-11	150		0.5		75		48144		1.0E-06		4
L-12	150		0.5		75		48144		1.0E-06		4
Subtotals	11,938 ft²				5,969 ft³		Maximum		4.4E-05		1751
							Average		6.1E-06		

Microshield 3.02
****
(Consumer's Power Company - #037)

Page : [illegible]
File : SOIL1.MSH
Run date: January 18, 1989
Run time: 4:17 p.m.

CASE: CONTAMINATED SOIL @ H-8 LOCATION (6 INCHES DEEP)

GEOMETRY 11: Rectangular solid source - slab shields

Distance to detector..........................	X	60.960	cm.
Source width..................................	W	762.	
Source length.................................	L	762.	
Rectangular solid, thickness toward dose pt..	T1	15.240	
Thickness of second shield....................	T2	45.720	

Source Volume: 8.84901e+6 cubic centimeters

MATERIAL DENSITIES (g/cc):

Material	Source	Shield 2
Air	.001220	.001220
Aluminum		
Carbon	1.70	
Concrete		
Hydrogen		
Iron		
Lead		
Lithium		
Nickel		
Tin		
Titanium		
Tungsten		
Urania		
Uranium		
Water	1.0	
Zirconium		

[illegible] CONTAMINATED [illegible]

BUILDUP FACTOR: based on TAYLOR method,
using the characteristics of the materials in shield

INTEGRATION PARAMETERS:

Number of lateral angle segments (Ntheta)..... [illegible]
Number of azimuthal angle segments (Npsi)...... [illegible]
Number of radial segments (Nradius)............ [illegible]

SOURCE NUCLIDES:

Ba-137m: 3.8493e-04 curies

Actual
6.51E-04 Ci
(4.4E-05 uCi/gm)

RESULTS:

Group #	Energy (MeV)	Activity (photons/sec)	Dose point flux MeV/(sq cm)/sec	Dose rate (mr/hr)
1	.664	1.282e+07	4.808e+00	9.969e-03
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
TOTALS:		1.282e+07	4.808e+00	9.969e-03

Ratio of $\frac{6.51 \text{ Ci}}{3.85 \text{ Ci}}$ = 1.69 x 9.969E-03 = 1.7E-02 mR/hr

Table 2

Inhalation Dose From Contaminated Soil - Adult Radiation Worker

$D_W = C_S \cdot f_{18} \cdot f_{14} \cdot f_{15} \cdot E_f \cdot DCF_i$

where: C_S = concentration of waste - 4.4E04 pCi/Kg Cs-137 (actual max concentration)

E_f = occupancy factor - 2080 worker hours ÷ 8760 hrs/yr = 0.237

f_{18} = a real/mass available for resuspension (top 1 cm of soil) - 16 Kg/m^2

f_{14} = resuspension factor - 8.5E-9/m

f_{15} = adult annual inhalation rate - 7300 m^3 (RG 1.109)

DCF_i = 7.76E-05 mRem/50 yr · pCi - Cs-137 adult liver (RG 1.109)

Substituting:

D_W = 8.03E-04 mRem/50 yr - maximum organ dose

Reference: AIF/NESP-035 Evaluation of the Potential for De-regulated Disposal of Very Low Level Wastes From Nuclear Power Plants

Table 3

Inhalation Dose At Site Boundary -
Infant Most Limiting

$D_{SB} = C_S \cdot f_{18} \cdot f_{14} \cdot f_{16} \cdot X/Q \cdot u \cdot A \cdot DCF_i$

Where: Terms are identified in Table 1 and

F_{16} = 2045 m³ - infant annual breathing rate (RG 1.109)

X/Q = 1.4 E-6 sec/m³ - actual 5 year site average

u = 3.8 m/sec average wind speed - actual 1986

A - 1110 m² - contaminated area

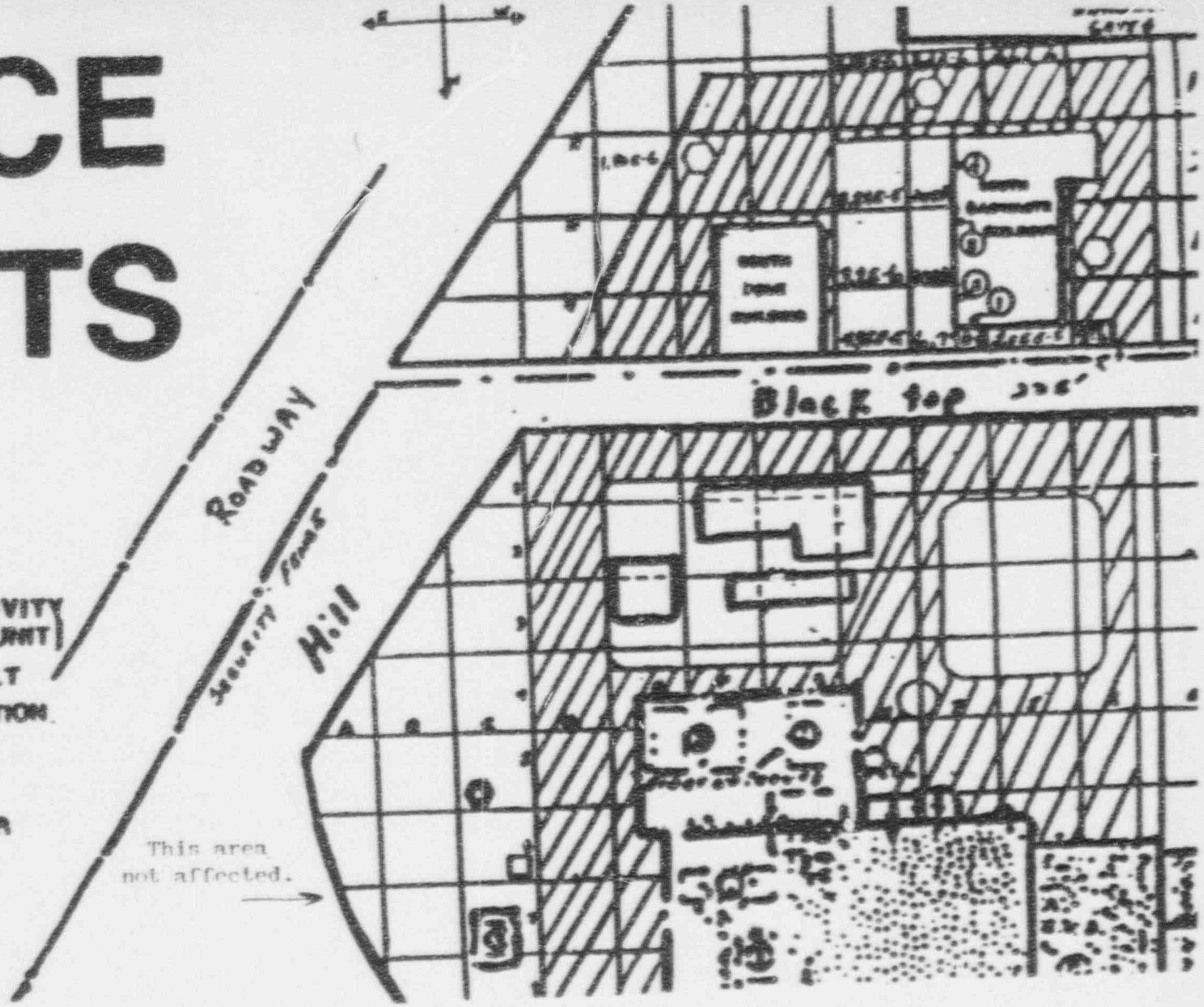
DCF_i - 4.37E-04 mR/50 yr · pCi - Cs-137 infant liver (RG 1.109)

ostituting:

D_{SB} = 3.16E-05 mRem/50 yr - maximum organ dose

-IGURE 1D

SURFACE RESULTS



LEGEND

All these sectors
Assigned 1E-06 uCi/gm
∠MINIMUM DETECTABLE ACTIVITY (1.00E-6 µCi/UNIT)

SURFACE AREA UNDER ASPHALT

CORE SAMPLE UNDER FOUNDATION

SURFACE ACTIVITY OF SECTOR

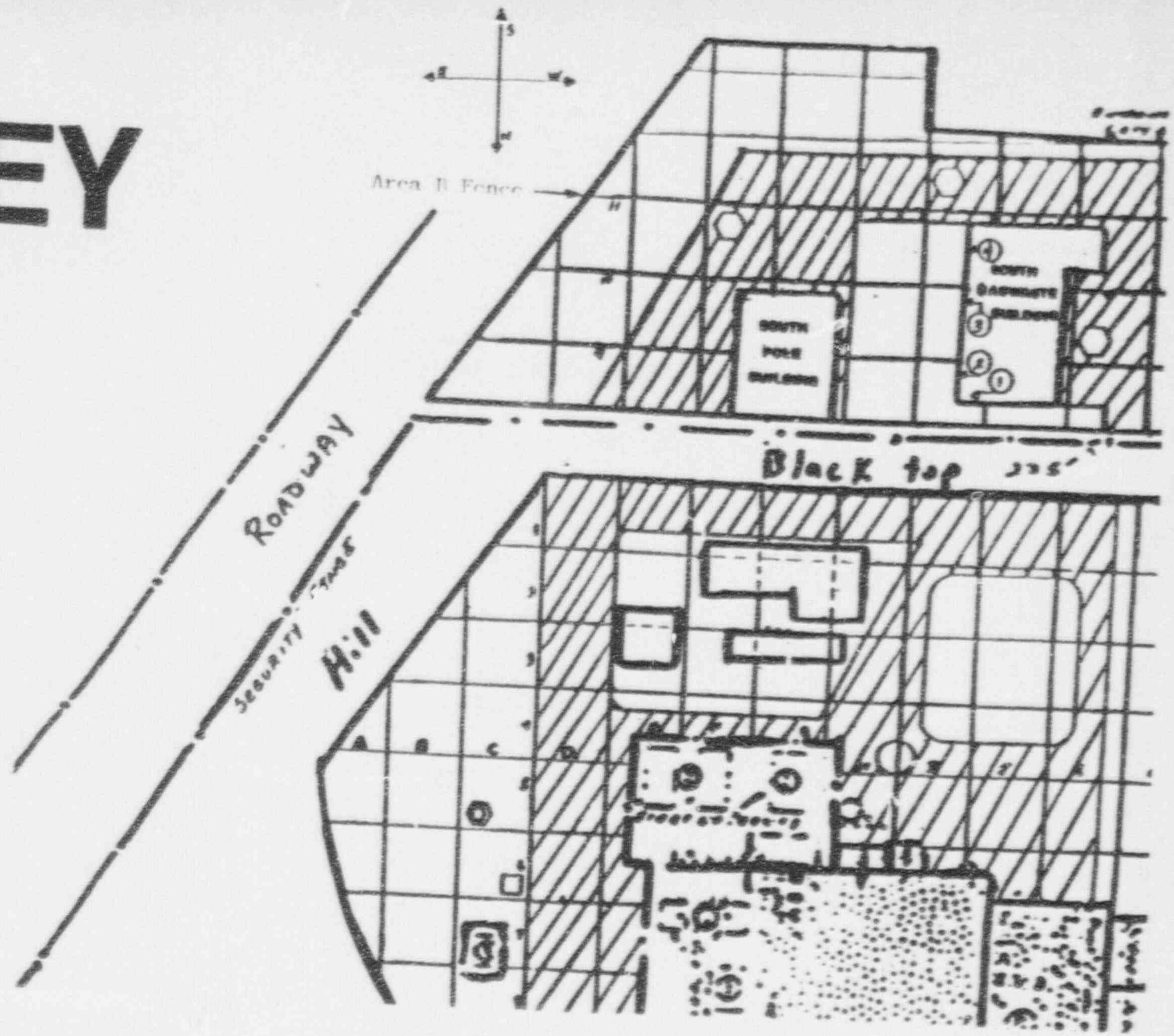
ASPHALT AREAS

*EXAMPLE ONLY

Rev 0
8-1-91

FIGURE 1

SURVEY GRID



LEGEND

ASPHALT AREAS

25' x 25' SECTORS

Contaminated AREA "B"

AREA "A"

To	BHolian	
From	TPNeal *TPN*	CONSUMERS POWER COMPANY
Date	October 23, 1990	
Subject	PALISADES PLANT- 10CFR20.302 SOIL SUBMITTAL	
CC	RLSmedley KMHaas	TPN90*028

The following samples were obtained from sectors H-9 and J-9 on October 23, 1990.

Sample Location	uCi/gm
H9-1	3.92E-6
H9-2	3.70E-6
H9-3	1.26E-6
H9-4	<MDA
H9-5	<MDA
J9-1	1.90E-6
J9-2	<MDA
J9-3	<MDA
J9-4	2.28E-6
J9-5	5.86E-6

Sector H-9 was the highest reading in 1988 at 4.4E-05 uCi/gm and J-9, 2.1E-05. Both areas are now showing a factor of 10 drop in activity. Sector H-11 could not be resampled because of equipment stored in this location. The data indicates direct dose would be less than 2E-03 mR/hr. Occupancy in this area should not exceed 2 hours/week or 100 weeks/year, which is less than 1 mR/year. Sample and analysis by MAWillers and GStama, review by TPNeal.

Consumers Power
POWERING MICHIGAN'S PROGRESS
Palisades Nuclear Plant 27780 Blue Star Memorial Highway Covert MI 49043

G B Slade
General Manager

April 24, 1991

Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

DOCKET 50-255 - LICENSE DPR-20 - PALISADES PLANT -
USE OF SOUTH STORAGE BUILDING AS AN INTERIM RADIOACTIVE WASTE STORAGE BUILDING

On November 10, 1990, radioactive waste generators in the State of Michigan were banned from the three currently active burial sites. As a result of this ban action must be taken to ensure that Palisades maintains the capability to store radioactive waste until such time as we are again able to gain access to the burial sites. We believe our actions are consistent with NRC guidance received in Generic Letter 90-09. Therefore, the South Storage Building will be utilized as an interim storage facility for low level radioactive waste (LLW).

The South Storage Building (then referred to as the South Radwaste Building) had been previously used for all processing and storing of radioactive waste produced at Palisades from 1976 to 1989. During that period several cooling tower overflows occurred which resulted in flooding this building and spreading contamination from the processing area to the surrounding soil. This spread in contamination resulted in NRC Open Items (85019-01 and 89025-01) which required implementation of actions to prevent future flooding. In 1988 it was decided to relocate the radwaste processing functions performed in the South Radwaste Building to a new addition at the East Radwaste Building to prevent the spread of contamination in the event of future cooling tower overflows. All radwaste processing equipment was relocated to the East Radwaste Building and the South Radwaste Building was decontaminated. The South Radwaste Building (then re-named the South Storage Building) has since been used for non-radiological material storage.

As a result of increases in radioactive waste, the South Storage Building is now needed to store low level radioactive waste (LLW). This LLW, in the form of dry active waste (DAW) will be packaged in metal boxes and labelled, ready for future shipment to burial sites. The DAW metal shipping boxes will be stored off the floor to prevent water damage. The metal shipping boxes are strong, tight containers designed to prevent any leakage of radioactive material during transportation. Incidental water contact will not result in the spread of contamination. Radioactive waste will not be processed in the

South Radwaste Building and the building will be maintained as a normally clean (radiologically) area.

The current Palisades Radwaste Storage Plan requires low dose-rate DAW boxes to be placed adjacent to the walls of the South Radwaste Building to limit dose rates outside the building. All DAW boxes and the storage building will be inspected quarterly in accordance with Palisades Health Physics Procedure HP 6.27. This procedure incorporates the storage and inventory guidelines contained in NRC Information Notice No. 90-09, "Extended Interim Storage of Low Level Radioactive Waste by Fuel Cycle and Material Licensee".

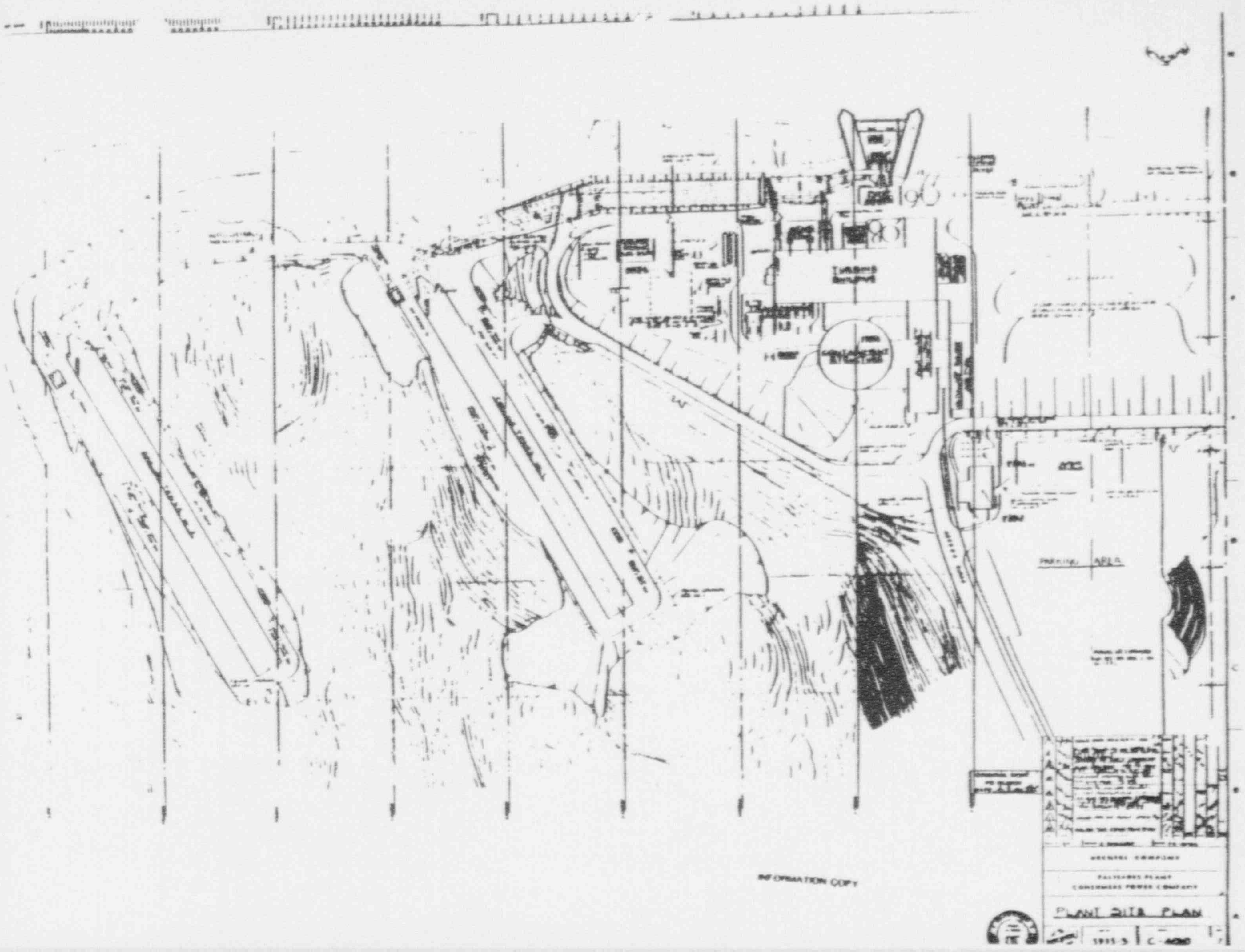
The same radiological and security controls currently in force at the East Radwaste Building will apply at the South Radwaste Building. The South Radwaste Building is surrounded by a locked fence and all building access doors will normally be locked, with keys controlled by Radiation Safety Department. All access to the building will be controlled through the Radiation Safety Office and the Palisades RWP/Dosimetry System. Building status sheets will be updated on a monthly basis or whenever radiological conditions change. Any areas outside the building reaching 5mr/hr or greater shall be posted in accordance with current HP Procedures.

Since the South Radwaste Building will be used for the storage of low level radioactive waste and not for radioactive waste processing, it is believed that the public health and safety will not be adversely affected.

It is Palisades' intent to continue to use the South Radwaste Building to store low level radioactive waste (LLW) until such time when radwaste generators in Michigan are again allowed to ship radioactive waste to the burial sites. Upon resumption of shipping to the burial sites the South Radwaste Building will be emptied, surveyed and returned to the plant for non-radiological material storage.

Gerald B Slade
General Manager

CC Administrator, Region III, USNRC
Resident Inspector, Palisades


PARKING AREA
PALISADES PLANT
CONSUMERS POWER COMPANY
PLANT SITE PLAN
INFORMATION COPY

UNITED STATES
NUCLEAR REGULATORY COM
WASHINGTON, D.C. 20555

TPNeal, Pal

June 7, 1991

Docket No. 50-255

JUN 12 1991

Mr. Gerald B. Slade
Plant General Manager
Palisades Plant
Consumers Power Company
27780 Blue Star Memorial Highway
Covert, Michigan 49043

Dear Mr. Slade:

SUBJECT: REQUEST UNDER 10 CFR 20.302 TO RETAIN CONTAMINATED SOIL ONSITE AT PALISADES PLANT (TAC NO. 67408)

By letters dated November 12, 1987, and January 25, 1988, (Reference 1 of the enclosed Safety Evaluation (SE)), Consumers Power Company submitted a request pursuant to 10 CFR 20.302(a) for the disposal of contaminated soil onsite at the Palisades Plant. We have completed our review of the request and find your procedures (with commitments as documented in Reference 1) to be acceptable. **This approval is granted provided that References 1-5 of the enclosed Safety Evaluation are permanently incorporated into your Offsite Dose Calculation Manual (ODCM) as an Appendix.** Also, future modifications of these commitments shall be reported to the NRC in accordance with the applicable ODCM change protocol. We further find that the radiological environmental impact of the proposed action meets the staff criteria as reflected in Reference 6 of the enclosed Safety Evaluation.

Sincerely,

Brian Holian, Project Manager
Project Directorate III-1
Division of Reactor Projects III/IV/V
Office of Nuclear Reactor Regulation

Enclosure:
As stated

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Consumers Power Company

Palisades Plant

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

SAFETY EVALUATION RELATED TO

THE PALISADES NUCLEAR PLANT

RETENTION OF CONTAMINATED SOIL ONSITE

INTRODUCTION

In reference (1), Consumers Power Company (CPCo) requested approval pursuant to Section 20.302 of Title 10 of the Code of Federal Regulations (CFR) for the disposal of licensed material not previously considered by the NRC in the Palisades Final Environmental Statement (FES), dated June 1972. The petition submitted contains a detailed description of the licensed material (i.e., contaminated soil) subject to this 10 CFR 20.302 request. The 6,000 cubic feet of onsite contaminated soil contains a total radionuclide inventory of 5.1 mCi, based on radioactive material that was deposited in the soil due to the flooding of the South Radwaste Building. The contaminated area is located inside the security fences, and is on company controlled land. This area (South Radwaste Area) is fenced in, within the plant's south security fences. Thus it is inaccessible to the public (see Figures 1 and 2).

In the submittals (References 1-5), the licensee addressed specific information requested in accordance with 10 CFR 20.302(a), provided a detailed description of the licensed material, thoroughly analyzed and evaluated the environmental effects relative to retention of the contaminated soil onsite, and committed to follow specific procedures to minimize the risk of unexpected exposures. Although the environmental impact of the proposed action is well within the dose criteria contained in the Commission's Below Regulatory Concern (BRC) Policy Statement, dated July 3, 1990, the licensee has not requested, and the staff has not considered, the actions described herein to be exempt from NRC regulation.

CPCo plans to dispose of the 6,000 cubic feet of contaminated soil onsite pursuant to 10 CFR 20.302. The area, known as the South Radwaste Area, has been contaminated by several cooling tower overflows (three times in an eight-year period), and has subsequently been redistributed by heavy rain showers. The cooling tower overflows were caused by instrument failures that opened the cooling tower bypass valve during normal operation. This valve is now electrically isolated during cooling tower operation. The licensee conducted a soil survey because the South Radwaste Building was in the main path of the water overflows from the cooling tower. Survey results indicated that radioactive material was deposited in the soil. Although the majority of the radioactive material has been packaged as radwaste and will be subsequently shipped offsite (16 boxes each having a volume of 98 cubic feet, containing 85% of the estimated activity), a large volume of low level contaminated soil is contained in the fenced area described as the South Radwaste Area.

The specific area contaminated is noted as Area B on the survey grid map (see Figure 2). The total activity of this area (5.1 mCi) is based on 6,000 cubic feet of soil contaminated with the spoils from the South Radwaste Building. Table 1 lists the principal nuclides identified in the contaminated soil. The activity in this table is based on measurements in 1987; see data from a recent submittal (Reference 5) shows that activity concentrations in the contaminated area have decreased by approximately 10 percent. The radionuclide half-lives, which are dominated by 30-year Cs-137, meet the staff's 10 CFR 20.302 guidelines (Reference 6, which applies to radionuclides with half-lives less than 35 years).

Table 1

Nuclide	Average Concentration (pCi/g)	Total Activity (mCi)
Co-60	0.05	0.079
Cs-137	30	5.0
	Total	5.079

RADIOLOGICAL IMPACTS

The licensee has evaluated the following potential exposure pathways to members of the general public from the radionuclides in the contaminated soil: (1) external exposure caused by direct radiation from radionuclides in the soil; and (2) internal exposure from inhalation of resuspended radionuclides. The staff has reviewed the licensee's calculational methods and assumptions and finds that they are consistent with NRC Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1, October 1977. The staff finds the assessment methodology acceptable. The dose assessments are based on the following:

1. 5.1 mCi of contaminated soil distributed over 12,000 square foot planar source having a thickness of 0.5 feet (6000 cubic feet source volume).

2. Direct radiation exposure of 2000 hours per year.

3. Inhalation exposure based on 2000 hours per year is minimized due to six-inch layer of gravel (which inhibits wind erosion.)

4. Groundwater not considered because there are no domestic wells in the area down-gradient from the plant.

Doses calculated from these pathways are shown in Table 2. The total dose of 0.85 mrem per year is within the staff's guideline of 1 mrem per year (Reference 6).

Table 2

Pathway	Whole Body Dose Received by Maximally Exposed Individual (mrem/year)
Groundshine	0.85
Inhalation	0.00081
Groundwater Ingestion	0.0
TOTAL	0.85

The above doses are a small fraction of the 300 mrem received annually by members of the general public in the United States and Canada from sources of natural background radiation (Reference 7).

Based on our review of the proposed disposal of contaminated soil onsite, we conclude that:

(1) The radioactive material will be disposed in a manner such that it is unlikely that the material will be recycled;

(2) Doses to the total whole body and any body organ of a maximally exposed individual (a member of the general public or a non-occupationally exposed member) from the probable pathways of exposure to the disposed material will be less than 1 mrem per year;

(3) Doses to the total whole body and any body organ of an inadvertent intruder from the probable pathways of exposure will be less than 5 mrem per year since the burial location is on company-controlled land;

(4) The radiation exposures to the nuclear station workers are small compared to the routine occupational exposures at the Palisades Plant;

(5) The possible radiation risks to members of the general public as a result of such disposal are well below regulatory limits and small in comparison to the doses they receive each year from natural background radiation.

The licensee's procedures and commitments as documented in the submittal are acceptable, provided that they are permanently incorporated into the licensee Offsite Dose Calculation Manual (ODCM) as an Appendix, and that future modifications be reported to NRC in accordance with the applicable ODCM change protocol.

REFERENCES

(1) CPCo's letters, T. C. Bordine to NRC Document Control Desk, November 12, 1987 and January 25, 1988.

(2) Memorandum from L. J. Cunningham, DREP to T. R. Quay, T. V. Wambach, "Request for Additional Information (RAI)," March 15, 1988, April 7, 1989, and January 12, 1990.

(3) CPCo's supplement to Reference (1), J. L. Kuemin to NRC Document Control Desk, June 27, 1988.

(4) CPCo's supplement to References (1, 2), G. B. Slade to NRC Document Control Desk, August 31, 1990.

(5) CPCo's letter, T. P. Neal to B. Holian, October 13, 1990.

(6) E. F. Branagan, Jr. and F. J. Congel, "Disposal of Slightly Contaminated Radioactive Wastes from Nuclear Power Plants," presented at CONF-860203, Health Physics Considerations Decontamination Decommissioning, Knoxville, TN, February, 1986.

(7) National Council on Radiation Protection and Measurements, "Exposure of the Population in the United States and Canada from Natural Background Radiation," NCRP Report No. 94, Bethesda, MD. December 30, 1987.

Principal Contributor: J. L. Minns

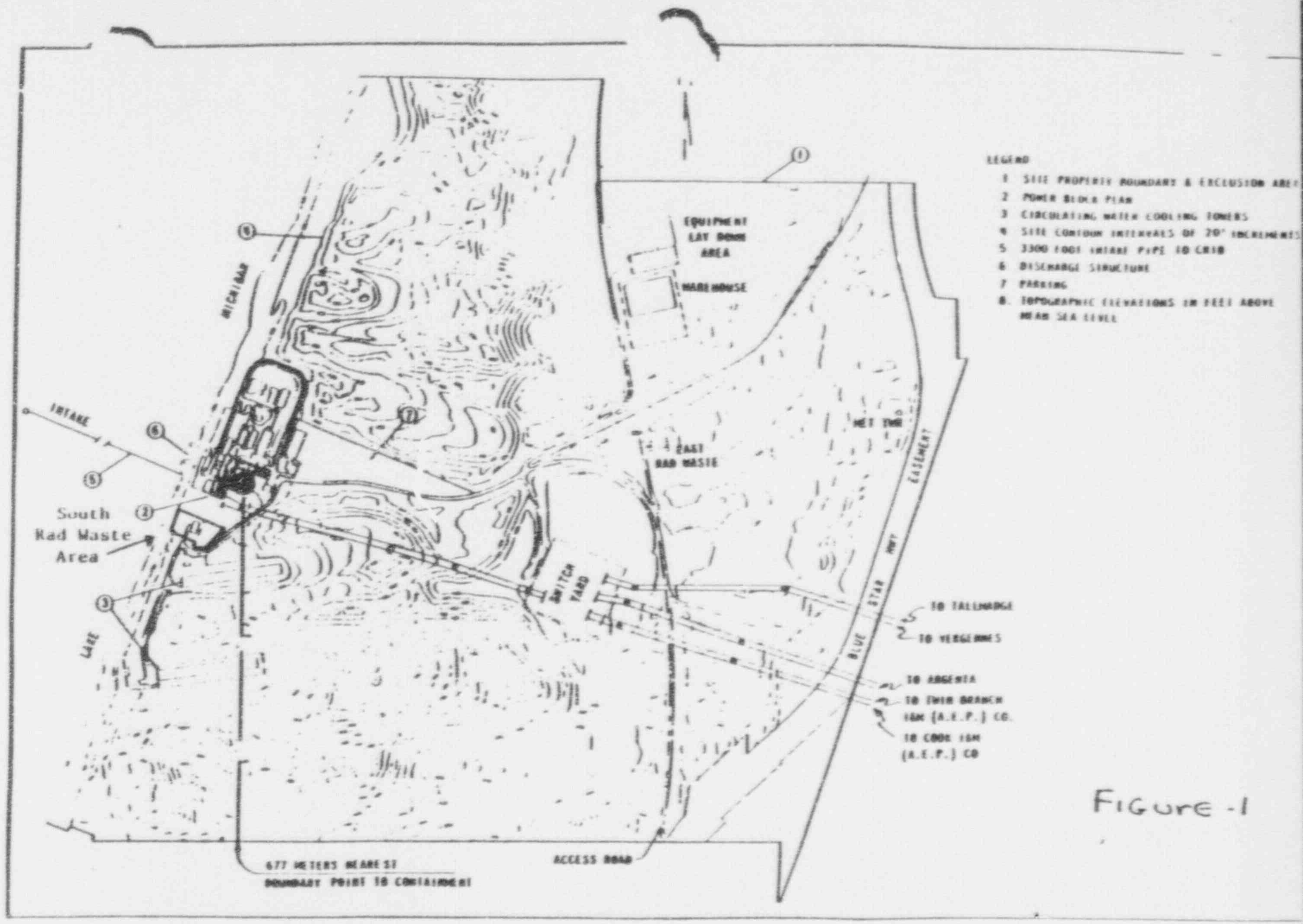
LEGEND
1 SITE PROPERTY BOUNDARY & EXCLUSION AREA
2 POWER BLOCK PLAN
3 CIRCULATING WATER COOLING TOWERS
4 SITE CONTOUR INTERVALS OF 20' INCREMENTS
5 3300 FOOT INTAKE PIPE TO CRIB
6 DISCHARGE STRUCTURE
7 PARKING
8. TOPOGRAPHIC ELEVATIONS IN FEET ABOVE MEAN SEA LEVEL
EQUIPMENT LAY DOWN AREA
WAREHOUSE
EAST RAD WASTE
MET TWR
EASEMENT
BLUE STAR HWY
SWITCH YARD
TO TALLMADGE
TO VERGENNES
TO ARGENTA
TO TWIN BRANCH I&M (A.E.P.) CO.
TO COOK I&M (A.E.P.) CO
ACCESS ROAD
677 METERS NEAREST BOUNDARY POINT TO CONTAINMENT
MICHIGAN
LAKE
INTAKE
South Rad Waste Area

Figure -1

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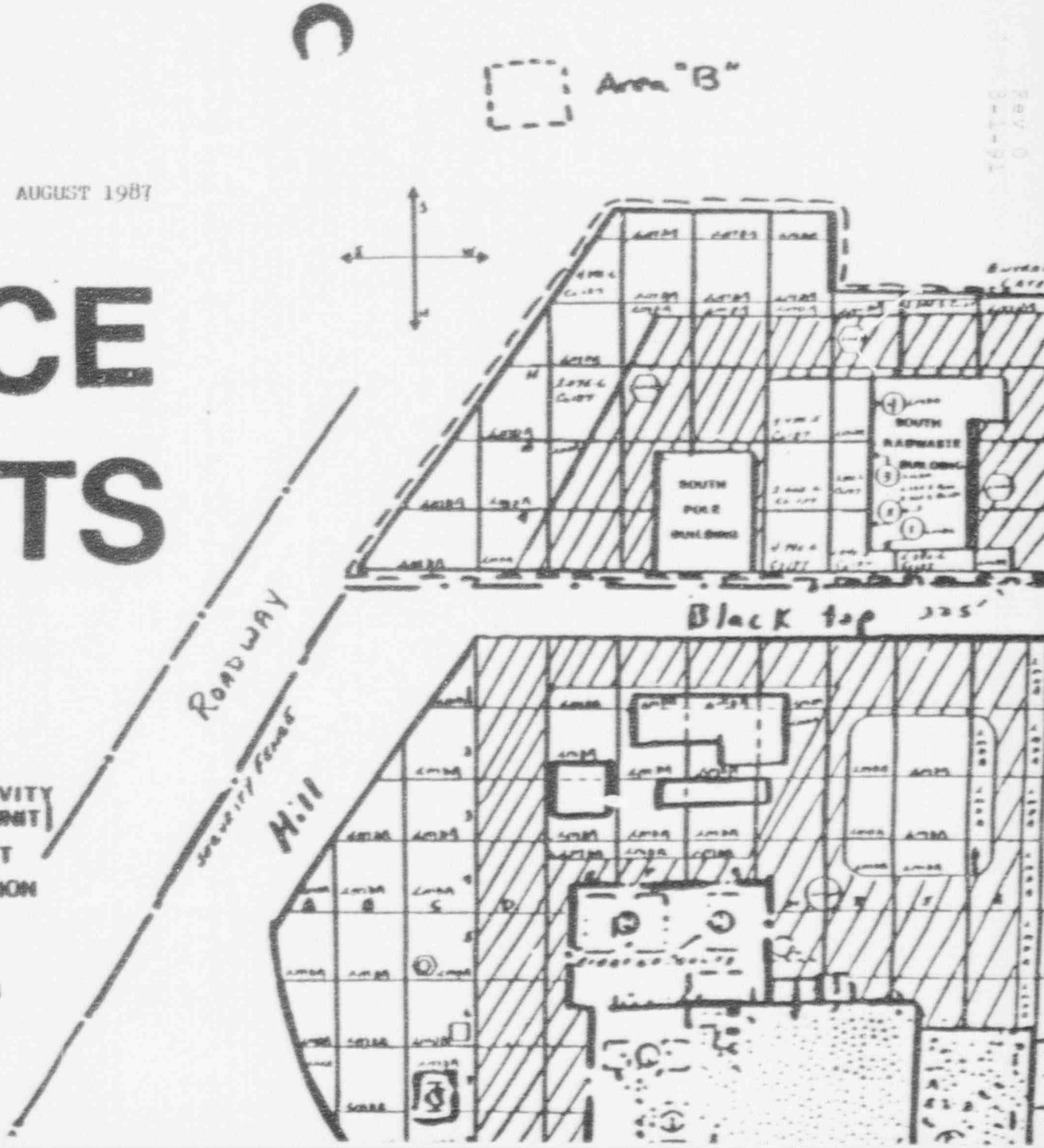
FIGURE 2
SURFACE RESULTS



LEGEND

- <MINIMUM DETECTABLE ACTIVITY [1.00E-6 µCi/UNIT]
- SURFACE AREA UNDER ASPHALT
- CORE SAMPLE UNDER FOUNDATION
- SURFACE ACTIVITY OF SECTOR
- ASPHALT AREAS

*EXAMPLE ONLY