TENNESSEE VALLEY AUTHORITY
BROWNS FERRY NUCLEAR PLANT

TECHNICAL INSTRUCTION 47

OFFSITE DOSE CALCULATION MANUAL (ODCM)

Approved: [signature]
Plant Superintendent

Date: June 21, 1979

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1. Gaseous Effluents

1.1 Alarm/Trip Setpoints

Specification 3.8.B.1 requires that the dose rate in unrestricted areas due to gaseous effluents from the site shall be limited at all times to the following values:

1. 500 mrem/y to the total body and 3,000 mrem/y to the skin from noble gases.
2. 1,500 mrem/y to any organ from radioiodines and particulates.

Specification 3.2.K.1 requires gaseous effluent monitors to have alarm/trip setpoints to ensure that the above dose rates are not exceeded. This section of the ODCM describes the methodology that will be used to determine these setpoints.

The methodology for determining alarm/trip setpoints is divided into two major parts. The first consists of backcalculating from a dose rate to a release rate limit, in μCi/s, for each nuclide and release point. The second consists of using the release rate limits to determine the physical settings on the monitors. The methodology for the latter is contained in Technical Instruction 15.

1.1.1 Release Rate Limit Methodology - μCi/s

Step 1

The first step involves calculating a dose rate based on the design objective source term mix used in the licensing of the plant. Historical meteorological data used are in this calculation.

Doses are determined for (1) noble gases and (2) iodines and particulates. Depending on the pathway involved, either air concentrations or ground concentrations are calculated.

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

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Assumptions

1. Doses to be calculated are total body and skin.
2. Exposure pathway is submersion within a cloud of noble gases.
3. Noble gas radionuclide mix is based on the expected source term given in Table 1.1.
4. Basic radionuclide data are given in Table 1.2.
5. Releases are treated as ground-level, split-level, or elevated.
6. Meteorological data are expressed as joint frequency distributions (JFD's) of wind speed, wind direction, and atmospheric stability for the period January 1974 to December 1975 (Table 1.3). Releases from the turbine building are treated as 100 percent ground level, whereas stack releases are considered 100 percent elevated. Releases from the reactor building and radwaste building are treated as split-level; i.e., partly elevated and partly ground level.
7. Raw meteorological data for ground-level releases consist of wind speed and direction measurements at 10 m and temperature measurements at 10 m and 45 m. The ground-level portion of the split-level JFD was based on wind speeds and directions measured at the 10 m level and temperature measurements at 10 and 45 m. The elevated portion of the split-level JFD was based on wind speeds and directions measured at 46 m and temperature measurements at 45 and 90 m. Wind speeds and directions for elevated releases were measured at 93 m. Stability class D was assumed to persist during the entire period for elevated releases.
8. Dose is to be evaluated at the offsite exposure point where maximum concentrations are expected to exist.
9. Potential maximum-exposure (Table 1.4) considered are the nearest site boundary points in each sector.

10. A semi-infinite cloud model is used.

11. No credit is taken for shielding by residence.

12. Plume depletion and radioactive decay are considered.

13. Building wake effects on effluent dispersion are considered.

14. A sector-average dispersion equation is used.

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

Number	Range (m/s)	Midpoint (m/s)
1	<0.3	0
2	0.3-0.6	0.45
3	0.7-1.5	1.10
4	1.6-2.4	1.99
5	2.5-3.3	2.80
6	3.4-5.5	4.45
7	5.6-8.2	6.91
9	>10.9	13.00

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

17. Terrain elevations are considered.

Equations

To calculate the dose from radioactive effluents discharged from a given release point for any one of the 16 potential maximum-exposure points, the following equations are used.

For determining the air concentration of any radionuclide:

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

$$\exp\left(-h_e^{\,2}/2\sigma_{zk}^{\,2}\right) \qquad (1.1)$$

where

χ_i = air concentration of radionuclide i, $\mu Ci/m^3$.

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

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

p = fraction of radionuclide remaining in plume, Figure 1.[illegible].

Σ_{zk} = vertical dispersion coefficient for stability class k which includes a building wake adjustment, $\Sigma_{zk} = \left[\sigma_{zk}^{\,2} + 0.5A/\pi\right]^{1/2}$, where σ_{zk} is the vertical dispersion coefficient for stability class k (m), and A is the minimum building cross-sectional area (2,350 m^2), m.

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

x = downwind distance, m.

n = number of sectors, 16.

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

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

h_e = effective release height, m.

For effluents exhausted from release points that are higher than twice the height of adjacent structures (elevated releases) the effective release height is determined by

$$h_e = h_s + h_{pr} - h_t - c \qquad (1.1a)$$

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where

c = correction for low relative exit velocity, $c = 3(1.5-W_o/\bar{u})\,d$, where W_o = vertical plume exit velocity (m/s), $\bar{u}$ = mean windspeed (m/s), and d = inside diameter of the release point, m.

h_{pr} = plume rise above release point, m.

h_s = physical height of release point, m.

h_t = maximum terrain height between release point and receptor location (h_t can be any real number), m.

For effluents released from points less than the height of adjacent structures, a ground level release is assumed ($h_e = 0$).

For effluents released from points at the level of or above adjacent structures, but lower than elevated release points, releases are treated as follows:

Case 1 - elevated if $W_o/\bar{u} \geq 5$

Case 2 - ground-level ($h_e = 0$) if $W_o/\bar{u} \leq 1$.

Case 3 - split-level if $1 < W_o/\bar{u} < 5$.

Under Case 3 a split-level dispersion approach is implemented using a model that requires for each release point two JFD's, one for elevated releases and one for ground-level releases. The summation of the elevated and ground-level JFD's account for the total period of record. Releases are considered to be elevated 100 $(1-E_t)$ percent of the time and ground-level 100 E_t percent of the time where the entrainment coefficient, E_t, is defined by

$$E_t = 2.58 - 1.58\,(W_o/\bar{u}) \text{ for } 1 < W_o/\bar{u} \leq 1.5 \qquad (1.1b)$$

$$E_t = 0.3 - 0.06\,(W_o/\bar{u}) \text{ for } 1.5 < W_o/\bar{u} \leq 5 \qquad (1.1c)$$

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For determining the total body dose rate

$$D_{TB} = 1x10^6 \sum_i \chi_i \, DFB_i \quad (1.2)$$

where

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

χ_i = air concentration of radionuclide i, μCi

DFB_i = total body dose factor due to gamma radia... , mrem/y per pCi/m^3 (Table 1.5).

$1x10^6$ = pCi/μCi conversion factor.

For determining the skin dose rate

$$D_s = 1x10^6 \sum_i \chi_i \, [DFS_i + 1.11 \, DF\gamma_i] \quad (1.3)$$

where

D_s = skin dose rate, mrem/y.

χ_i = air concentration of radionuclide i, $\mu Ci/m^3$.

DFS_i = skin dose factor due to beta radiation, mrem/y per pCi/m^3 (Table 1.5).

$DF\gamma_i$ = gamma-to-air dose factor for radionuclide i, mrem/y per pCi/m^3 (Table 1.5).

$1x10^6$ = pCi/μCi conversion factor.

The above dose calculations are repeated for each release point (vent or stack) and then summed to obtain maximum total body and skin dose rates. The maximum total body and skin does rates will then be used in step 2.

IMAGE EVALUATION
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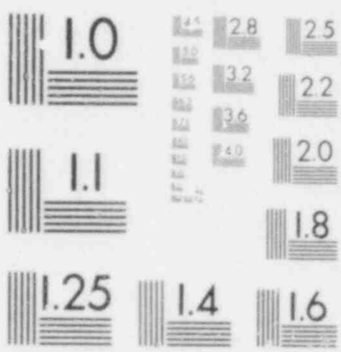

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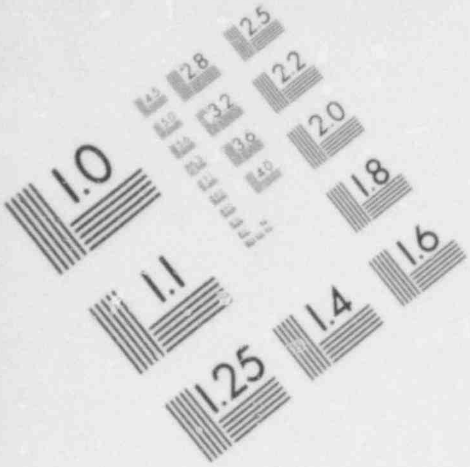

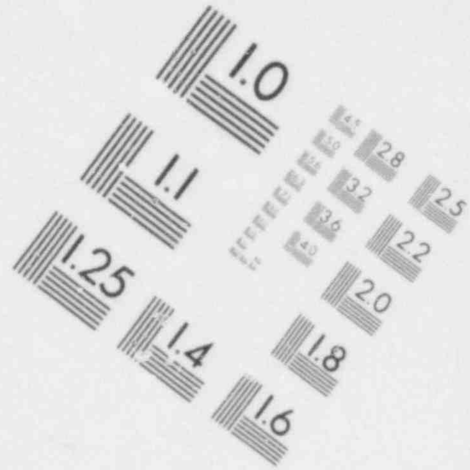

IMAGE EVALUATION
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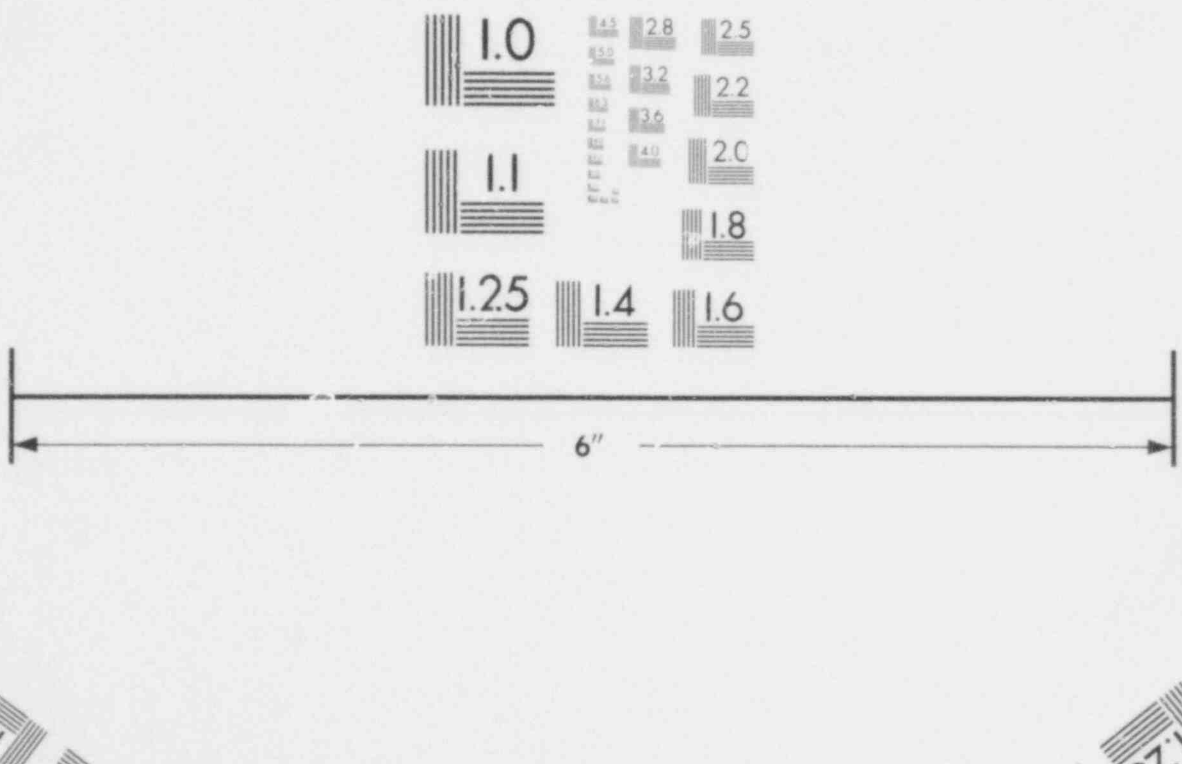

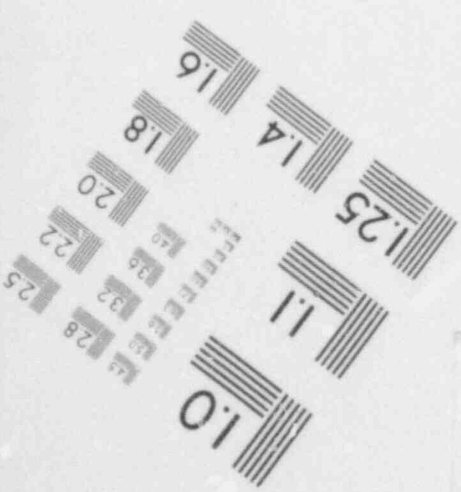

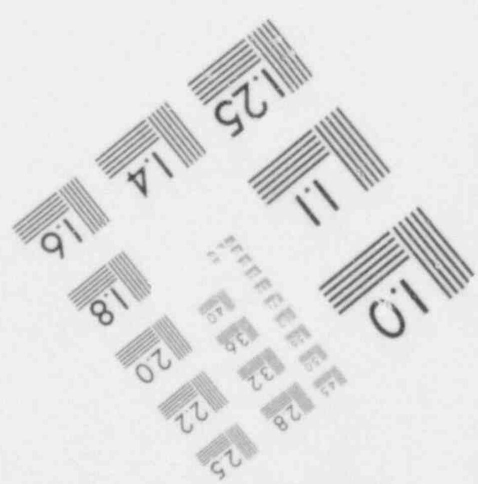

IMAGE EVALUATION
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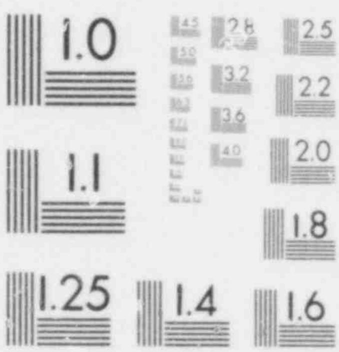

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IMAGE EVALUATION
TEST TARGET (MT-3)

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

Assumptions

1. Dose is to be calculated for the critical organ, thyroid, and the critical age group, infant.
2. Exposure pathways from iodines and particulates are milk ingestion, ground contamination, and inhalation.
3. The radioiodine and particulate mix is based on the expected source term given in Table 1.1.
4. Basic radionuclide data are given in Table 1.2.
5. Releases are treated as ground-level, split-level, or elevated.
6. Meteorological data are expressed as joint frequency distributions (JFD's) of wind speed, wind direction, and atmospheric stability for the period January 1974 to December 1975 (Table 1.3). Releases from the turbine building are treated as 100 percent ground level, whereas stack releases are considered 100 percent elevated. Releases from the reactor building and radwaste building are treated as split-level; i.e., partly elevated and partly ground level.
7. Raw meteorological data for ground-level releases consist of wind speed and direction measurements at 10 m and temperature measurements at 10 m and 45 m. The ground-level portion of the split-level JFD was based on wind speeds and directions measured at the 10 m level and temperature measurements at 10 and 45 m. The elevated portion of the split-level JFD was based on wind speeds and directions measured at 46 m and temperature measurements at 45 and 90 m. Wind speeds and directions for elevated releases

were measured at 93 m. Stability class D was assumed to persist during the entire period for elevated releases.

8. Dose is to be evaluated at the potential offsite exposure point where maximum concentrations are expected to exist.
9. Real cow and garden locations are not considered.
10. Potential maximum-exposure points (Table 1.4) considered are the nearest site boundary points in each sector.
11. Terrain elevations are considered.
12. Building wake effects on effluent dispersion are considered.
13. Plume depletion and radioactive decay are considered for air-concentration calculations.
14. Radioactive decay is considered for ground-concentration calculations.
15. Deposition is calculated based on the curves given in Figure 1.2.
16. A milk cow obtains 100 percent of her food from pasture grass.
17. No credit is taken for shielding by residence.

Equations

To calculate the dose from radioactive effluents discharged from a given release point for any one of the potential maximum-exposure points, the following equations are used.

1. Inhalation

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

For determining the thyroid dose rate:

$$D_{THI} = 1x10^6 \sum_{i} X_i \; DFI_i \; BR \qquad (1.4)$$

where:

D_{THI} = thyroid dose rate due to inhalation, mrem/y.

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

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

BR = infant breathing rate, 1,400 m^3/y.

$1x10^6$ = pCi/μCi conversion factor.

2. Ground Contamination

For determining the ground concentration of any nuclide:

$$G_i = 3.15x10^7 \sum_{k=1}^{7} \frac{f_k \; Q_i \; DR}{(2\pi x/n) \quad \lambda_i} \; [1-\exp^{-(\lambda_i \; t_b)}] \qquad (1.5)$$

where

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

k = stability class.

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

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

DR = relative deposition rate, m^{-1} (Figure 1.2). The choice of figure is governed by the effective release height calculated by equation 1.1a. A linear interpolation is used for effective release heights that fall in between the given curves.

x = downwind distance, m.

n = number of sectors, 16.

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

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

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

3.15×10^7 = s/y conversion factor.

For determining the thyroid dose rate from ground contamination:

$$D_{THG} = (8,760)(1 \times 10^6) \sum_i G_i \, DFG_i \qquad (1.6)$$

where:

D_{THG} = thyroid dose rate due to ground contamination, mrem/y.

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

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

8,760 = occupation time, h/y.

1×10^6 = pCi/μCi conversion factor

3. <u>Milk Ingestion</u>

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

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

where:

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

k = stability class.

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

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

DR = relative deposition rate, m^{-1} (Figure 1.2. The choice of figure is governed by the effective release height calculated by equation 1.1a. A linear interpolation is used for effective release heights that fall in between the given curves.

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^{-1}), h^{-1}.

t_e = period over which deposition occurs, 720 h.

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

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

λ_i = radioactive decay coefficient of ra[illegible]ide i, h^{-1}.

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

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

3,600 = s/h conversion factor.

For determining the concentration of C-14 in vegetation:

$$CV_{14} = 1x10^3 \; \chi_{14} \; (0.11/0.16) \qquad (1.8)$$

where

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

χ_{14} = air concentration of C-14, 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:

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

where

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

χ_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 milk:

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

where

CM_i = concentration of radionuclide i (including C-14 and H-3) in cow's mi[illegible] µCi/l.

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

FM_i = transfer factor from feed to milk for radionuclide i, d/l.

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

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

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

For determining the thyroid dose rate from ingestion of cow's milk:

$$D_{THM} = 1x10^6 \sum_i CM_i \, DFING_j \, UM \quad (1.11)$$

where

D_{THM} = thyroid dose rate due to milk ingestion, mrem/y.

CM_i = concentration of radionuclide i in cow's milk, µCi/l.

$DFING_i$ = infant ingestion dose factor from Reg. Guide 1.109 (Rev. 1), mrem/pCi (Table 1.7)

UM = infant ingestion rate for milk, 330 l/y.

$1x10^6$ = pCi/µCi conversion factor.

4. Total Thyroid Dose Rate

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

$$D_{TH} = D_{THI} + D_{THG} + D_{THM} \quad (1.12)$$

where

D_{TH} = total thyroid dose rate, mrem/y.

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D_{THI} = thyroid dose rate due to inhalation, mrem/y.

D_{THG} = thyroid dose rate due to ground contamination, mrem/y.

D_{THM} = thyroid dose rate due to milk ingestion, mrem/y.

The above dose calculations are repeated for each release point and then summed to obtain thyroid dose rates. The maximum thyroid dose rate will then be used in step 2.

Step 2

The dose rate limits of interest (10CFR20) are

Total Body = 500 mrem/y

Skin = 3,000 mrem/y

Maximum Organ = 1,500 mrem/y

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

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

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

Release rate limits in μCi/s for each nuclide and release point are now available.

1.2 Monthly Dose Calculations

Dose calculations will be performed monthly to determine compliance with specifications 3.8.B.3 and 3.8.B.5. These specifications require that the dose rate in unrestricted areas due to gaseous effluents from each reactor at the site shall be limited to the following values:

For noble gases,

1. During any calendar quarter, 5 mrad to air for gamma radiation and 10 mrad to air for beta radiation.
2. During any calendar year, 10 mrad to air for gamma radiation and 20 mrad to air for beta radiation.

For iodines and particulates,

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

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

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

1.2.1 Noble Gases

Step 1

Doses will be calculated using the methodology described in this step. If any limits are exceeded, step 2 will be performed.

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

Assumptions

1. Doses to be calculated are gamma and beta air doses.
2. The highest annual-average χ/Q based on licensing meteorology for ground-level releases for any offsite location will be used
3. No credit is taken for radioactive decay.
4. For gamma doses, releases of Xe-133, Xe-138, Kr-85m, and Kr-88 are considered.
5. For beta doses, releases of Xe-133, Xe-138, Kr-85m, and Kr-88 are considered.
6. Dose factors are calculated using data from TVA's nuclide library.
7. The nuclides considered are expected to contribute at least 90 percent of the total dose. However, the calculations extrapolate doses assuming that only 90 percent of total dose was contributed.
8. A semi-infinite cloud model is used.
9. Building wake effects on effluent dispersion are considered.

Equations

For determining the gamma dose to air:

$$D_\gamma = \frac{(\chi/Q)}{0.9} \sum_i Q_i \, DF\gamma_i \qquad (1.13)$$

where:

D_γ = gamma dose to air from continuous releases, mrad.

χ/Q = highest annual-average relative concentration, 2.26×10^{-6} s/m^3

0.9 = fraction of total gamma dose expected to be contributed by these nuclides (actually 0.94).

Q_i = monthly release of radionuclide i, Ci.

$DF\gamma_i$ = gamma-to-air dose factor for radionuclide i, mrad/s per Ci/m^3 (Table 1.5).

This equation then reduces to

$$D_\gamma = 2.51\times10^{-6} \sum_i Q_i \, DF\gamma_i \qquad (1.14)$$

For determining the beta dose to air:

$$D_\beta = \frac{(\chi/Q)}{0.9} \sum_i Q_i \, DF\beta_i \qquad (1.15)$$

where:

D_β = beta dose to air, mrad.

χ/Q = highest annual-average relative concentration, 2.26×10^{-6} s/m^3.

0.9 = fraction of total beta dose expected to be contributed by these nuclides (actually 0.90).

Q_i = monthly release of radionuclide i, Ci.

$DF\beta_i$ = beta-to-air dose factor for radionuclide i, mrad/s per Ci/m^3 (Table 1.5).

This equation then reduces to:

$$D_\beta = 2.51\times10^{-6} \sum_i Q_i \, DF\beta_i \qquad (1.16)$$

Step 2

This methodology is to be used if the calculations in Step 1 yield doses that exceed applicable limits.

Equations and assumptions for calculating doses to air from releases of noble gases are as follows:

Assumptions

1. Doses to be calculated are gamma and beta air doses.
2. Dose is to be evaluated at the nearest site boundary point in each sector.
3. Historical onsite meteorological data for the appropriate months from the period 1974-1975 will be used.
4. All measured radionuclide releases are considered.
5. A semi-infinite cloud model is used.
6. Radioactive decay is considered.
7. Building wake effects on effluent dispersion are considered.
8. Dose factors are calculated using data from TVA's radionuclide library.

Equations

Equation for calculating air concentration, χ, is the same as in Section 1.1.1, step 1, part A. Air concentrations are calculated for the site boundary in each sector.

For determining the gamma dose to air

$$D_{\gamma n} = t_m \sum_i \chi_{ni} DF_{\gamma i} \qquad (1.24)$$

where:

$D_{\gamma n}$ = gamma dose to air for sector n, mrad.

χ_{ni} = air concentration of radionuclide i in sector n, Ci/m^3.

$DF\gamma_i$ = gamma-to-air dose factor for radionuclide i, mrad/s per Ci/m^3 (Table 1.5).

t_m = time period considered (1 month, but number of s/mo is variable), s.

- For determining the beta dose to air:

$$D_{\beta n} = t_m \sum_i \chi_{ni} \, DF\beta_i \qquad (1.25)$$

where:

$D_{\beta n}$ = beta dose to air for sector n, mrad.

χ_{ni} = air concentration of radionuclide i in sector n, Ci/m^3.

$DF\beta_i$ = beta to air dose factor for radionuclide i, mrad/s per Ci/m^3.

t_m = time period considered (number of seconds in this month), s.

The sector having the highest total dose is then used to check compliance with specification 3.8.3.3.

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1.2.2 Iodines and Particulates

Step 1

Doses will be calculated using the methodology described in this step. If any limits are exceeded, step 2 will be performed.

Equations and assumptions for calculating doses from releases of iodines and particulates are as follows:

- Assumptions

1. Dose is to be calculated for the critical organ, thyroid, and the critical age group, infant.
2. Exposure pathway considered is milk ingestion.
3. The highest annual-average D/Q based on licensing meteorology for ground-level releases for any real cow location will be used for I-131 and I-133 doses.
4. The highest annual-average χ/Q based on licensing meteorology for ground-level releases for any cow location will be used for C-14 doses.
5. No credit is taken for radioactive decay.
6. Releases of I-131, I-133, and C-14 are considered.
7. The radionuclides considered are expected to contribute at least 99 percent of the total dose. However, the calculations

extrapolate doses assuming that only 90 percent of the total dose was contributed.

8. Releases of C-14 are based on the expected source term.

9. The cow is assumed to graze on pasture grass for the whole year.

Equations

For determining the thyroid dose from milk ingestion of I-131 or I-133:

$$DTH_{131(133)} = \frac{Q_{131(133)}\ DF_{131(133)}\ D/Q}{3.15\times10^{7}} \quad (1.26)$$

where:

$DTH_{131(133)}$ = thyroid dose from I-131(I-133), mrem.

$Q_{131(133)}$ = monthly release of I-131(133), Ci.

$DF_{131(133)}$ = I-131(133) milk ingestion dose factor to infant, mrem/y per Ci/m^2-s.

D/Q = relative deposition rate, $5.66\times10^{-9}m^{-2}$.

3.15×10^{7} = s/y.

For determining the thyroid dose from milk ingestion of C-14:

$$DTH_{14} = \frac{Q_{14}\ DF_{14}\ \chi/Q}{3.15\times10^{7}} \quad (1.27)$$

where:

DTH_{14} = thyroid dose from C-14, mrem.

Q_{14} = monthly release of radionuclide i, Ci.

DF_{14} = C-14 milk ingestion dose factor, mrem/y per Ci/m^3.

χ/Q = relative dispersion factor, 2.26×10^{-6} s/m^3.

3.15×10^{7} = s/y.

For determining the total thyroid dose from releases:

$$DTH = \frac{DTH_{131} + DTH_{133} + DTH_{14}}{0.9} \quad (1.28)$$

where:

DTH = thryoid dose, mrem.

DTH_{131} = thyroid dose from release of I-131, mrem.

DTH_{133} = thyroid dose from release of I-133, mrem.

DTH_{14} = thyroid dose from release of C-14, mrem.

0.9 = fraction of total thyroid dose expected to be contributed by these radionuclides (actually 0.99).

Step 2

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

Doses for releases of iodines and particulates shall be calculated using the methodology in Section 1.1.1, step 1, part B, with the following exceptions:

1. All measured radionuclide releases will be used.
2. Dose will be evaluated at real cow locations and will consider actual grazing information.

The receptor having the highest total dose is then used to check compliance with specification 3.8.B.5.

1.3 Gaseous Radwaste Treatment System Operation

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

1.3.1 System Description

A flow diagram for the GRTS is given in Figure 1. . The system includes the subsystems that process and dispose of the gases from the main condenser air ejectors, the startup vacuum pumps, and the gland seal condensers. One gaseous radwaste treatment system is provided for each unit. The processed gases from each unit are routed to the plant stack for dilution and elevated release to the atmosphere. The air ejector off-gas line of each unit and the stack are continuously monitored by radiation monitors.

1.3.2 Dose Calculations

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

TABLE 1.1

EXPECTED ANNUAL ROUTINE ATMOSPHERIC RELEASES FROM ONE UNIT AT BROWNS FERRY

	NUCLEAR PLANT (Ci/y/unit)			STACK	
ISOTOPE	REACTOR COMPLEX VENT	RADWASTE BUILDING VENT	TURBINE BUILDING VENTS	GLAND SEAL AND OFFGAS	MVP
Kr-85m	6	<1	2	1.10 E4	0
Kr-87	6	<1	95	873	0
Kr-88	9	<1	102	1.22 E4	0
Kr-89	1	34	503	0	0
Xe-133m	0	60	0	633	0
Xe-133	103	294	581	5.40 E4	300
Xe-135m	111	667	464	1212	0
Xe-135	173	328	672	868	200
Xe-137	78	113	386	.0	0
Xe-138	12	2	1179	1483	0
I-131 I	0.0594	0.0050	0.0156	0.0041	0.0055
I-132 I	0.594	0.050	0.1786	0.0469	0.0973
I-133 I	0.297	0.025	0.1231	0.0323	0.0671
I-134 I	1.485	0.125	0.0267	0.0070	0.0145
I-135 I	0.594	0.050	0.1231	0.0323	0.0671
I-131 O	0.0316	0.029	0.0065	0.0332	0.2741
I-132 O	0.316	0.290	0.0744	0.3801	3.1384
I-133 O	0.158	0.145	0.0513	0.2619	2.1626
I-134 O	0.790	0.725	0.0111	0.0568	0.4687
I-135 O	0.316	0.290	0.0513	0.2619	2.1626
Cr 51	3 E-3	9 E-4	1 E-3	1 E-4	0
Mn 54	3 E-3	5 E-3	2 E-3	4 E-5	0
Co 58	2 E-3	4 E-4	9 E-5	2 E-5	0
Fe 59	1 E-4	8 E-4	4 E-4	2 E-4	0
Co 60	3 E-2	6 E-3	3 E-3	1 E-5	0
Zn 65	3 E-3	2 E-4	4 E-4	9 E-5	0
Sr 89	1 E-2	3 E-1	*	*	0
Sr 90	2 E-3	4 E-3	*	*	0
Nb 95	3 E-4	2 E-4	9 E-6	8 E-[illegible]	0
Zr 95	1 E-4	1 E-4	8 E-6	8 E-5	0
Ru 103	3 E-5	1 E-4	2 E-4	1 E-4	0
Ag 110m	7 E-6	*	*	*	0
Sb 124	3 E-5	3 E-4	6 E-5	8 E-5	0
Cs 134	5 E-3	3 E-4	5 E-4	2 E-5	0
Cs 136	2 E-3	5 E-5	1 E-4	9 E-8	0
Cs 137	7 E-3	4 E-4	2 E-3	7 E-4	0
Ba 140	4 E-3	5 E-4	2 E-2	8 E-3	0
Ce 141	4 E-4	2 E-4	2 E-3	2 E-5	0
Ce 144	5 E-6	*	*	4 E-6	0
Ar-41	25	0	0	0	0
C-14	0	0	0	9.5	0
H-3	0	9.5	0	0	0

*Not available

I denotes nonorganic iodine (elemental, particulate, HIO)
O denotes organic iodine

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TABLE 1.2 BASIC RADIONUCLIDE DATA

NUCLIDE		HALF-LIFE (DAYS)	LAMDA (1/S)	T	C	BETA (MEV/DIS)	GAMMA (MEV/DIS)	WASH (1/S)
1 TRITIUM	101	4.49E 03	1.79E-09	2	1	5.68E-03	0.0	2.86E-07
2 C-14	614	2.09E 06	3.84E-12	2	1	5.17E-02	0.0	0.0
3 N-13	702	6.94E-03	1.16E-03	2	1	4.91E-01	1.02E 00	1.00E-02
4 O-19	804	3.36E-04	2.39E-02	2	1	1.02E 00	1.05E 00	1.00E-02
5 F-18	902	7.62E-02	1.05E-04	2	1	2.41E-01	9.88E-01	1.00E-04
6 NA-24	1104	6.33E-01	1.27E-05	5	1	5.55E-01	4.12E 00	1.00E-04
7 P-32	1504	1.43E 01	5.61E-07	5	1	6.95E-01	0.0	1.00E-04
8 AR-41	1805	7.63E-02	1.05E-04	2	1	3.63E-01	1.28E 00	0.0
9 CR-51	2405	2.78E 01	2.89E-07	5	1	3.75E-03	3.28E-02	1.00E-04
10 MN-54	2508	3.03E 02	2.65E-08	5	1	4.17E-03	8.36E-01	1.00E-04
11 MN-56	2509	1.07E-01	7.50E-05	5	1	7.93E-01	1.76E 00	1.00E-04
12 FE-59	2604	4.50E 01	1.78E-07	5	1	1.18E-01	1.19E 00	1.00E-04
13 CO-58	2706	7.13E 01	1.12E-07	5	1	2.05E-01	9.76E-01	1.00E-04
14 CO-60	2708	1.92E 03	4.18E-09	5	1	9.08E-02	2.50E 00	1.00E-04
15 ZN-69M	3007	5.75E-01	1.39E-05	5	1	0.0	4.15E 00	1.00E-04
16 ZN-69	3006	3.96E-02	2.03E-04	5	1	3.19E-01	0.0	1.00E-04
17 BR-84	3516	2.21E-02	3.63E-04	2	1	1.26E 00	1.68E 00	1.00E-04
18 BR-85	3518	2.08E-03	3.86E-03	2	2	1.04E 00	8.40E-01	1.00E-04
19 KR-85M	3611	1.83E-01	4.38E-05	1	2	2.53E-01	1.59E-01	1.00E-11
20 KR-85	3610	3.93E 03	2.04E-09	1	1	2.51E-01	2.21E-03	1.00E-11
21 KR-87	3612	5.28E-02	1.52E-04	1	1	1.32E 00	7.93E-01	1.00E-11
22 KR-88	3613	1.17E-01	6.86E-05	1	1	3.75E-01	1.96E 00	1.00E-11
23 KR-89	3614	2.21E-03	3.63E-03	1	1	1.23E 00	2.08E 00	1.00E-11
24 RB-88	3713	1.24E-02	6.47E-04	5	1	2.06E 00	6.86E-01	1.00E-04
25 RB-89	3714	1.07E-02	7.50E-04	5	1	0.0	2.40E 00	1.00E-04
26 SR-89	3808	5.20E 01	1.54E-07	5	1	5.73E-01	1.36E-04	2.67E-07
27 SR-90	3810	1.03E 04	7.79E-10	5	1	1.96E-01	0.0	2.67E-07
28 SR-91	3811	4.03E-01	1.99E-05	5	2	6.50E-01	6.95E-01	2.67E-07
29 SR-92	3812	1.13E-01	7.10E-05	5	1	1.95E-01	1.34E 00	2.67E-07
30 SR-93	3813	5.56E-02	1.44E-03	5	1	1.61E 00	6.28E-01	2.67E-07
31 Y-90	3916	2.67E 00	3.00E-06	5	1	9.36E-01	0.0	1.00E-04
32 Y-91M	3919	3.47E-02	2.31E-04	5	1	0.0	5.56E-01	1.00E-04
33 Y-91	3918	5.88E 01	1.36E-07	5	1	6.06E-01	3.61E-03	1.00E-04
34 Y-92	3920	1.47E-01	5.46E-05	5	1	1.44E 00	2.50E-01	1.00E-04
35 Y-93	3921	4.29E-01	1.87E-05	5	1	1.17E 00	8.94E-02	1.00E-04
36 ZR-95	4014	6.50E 01	1.23E-07	5	2	1.20E-01	7.35E-01	1.00E-04
37 NB-95M	4115	3.75E 00	2.14E-06	5	1	2.85E-01	5.47E-02	1.00E-04
38 NB-95	4114	3.50E 01	2.29E-07	5	1	4.50E-02	7.64E-01	1.00E-04
39 MO-99	4209	2.79E 00	2.87E-06	5	2	3.96E-01	1.62E-01	1.00E-04
40 TC-99M	4314	2.50E-01	3.21E-05	5	1	4.85E-03	1.43E-01	1.00E-04
41 TC-99	4313	7.74E 07	1.04E-13	5	1	8.38E-02	0.0	1.00E-04
42 TC-104	4320	1.25E-02	6.42E-04	5	1	0.0	0.0	1.00E-04
43 RU-106	4407	3.67E 02	2.19E-08	5	1	1.01E-02	0.0	1.00E-04
44 TE-132	5223	3.24E 00	2.48E-06	5	1	1.00E-01	2.05E-01	1.00E-04
45 I-129	5315	6.21E 09	1.29E-15	3	1	4.02E-02	3.77E-03	5.00E-06
46 I-131	5317	8.05E 00	9.96E-07	3	2	1.94E-01	3.81E-01	5.00E-06
47 MI-131	15317	8.05E 00	9.96E-07	4	2	1.94E-01	3.81E-01	5.00E-06
48 I-132	5318	9.58E-02	8.37E-05	3	1	5.14E-01	2.33E 00	5.00E-06
49 MI-132	15318	9.58E-02	8.37E-05	4	1	5.14E-01	2.33E 00	5.00E-06
50 I-133	5319	8.75E-01	9.17E-06	3	2	4.08E-01	6.10E-01	5.00E-06
51 MI-133	15319	8.75E-01	9.17E-06	4	2	4.08E-01	6.10E-01	5.00E-06
52 I-134	5320	3.61E-02	2.22E-04	3	1	6.10E-01	2.59E 00	5.00E-06
53 MI-134	15320	3.61E-02	2.22E-04	4	1	6.10E-01	2.59E 00	5.00E-06
54 I-135	5321	2.79E-01	2.87E-05	3	2	3.68E-01	1.58E 00	5.00E-06
55 MI-135	15321	2.79E-01	2.87E-05	4	2	3.68E-01	1.58E 00	5.00E-06
56 XE-131M	5412	1.18E 01	6.80E-07	1	1	1.43E-01	2.01E-02	1.00E-11
57 XE-133M	5414	2.26E 00	3.55E-06	1	1	1.90E-01	4.16E-02	1.00E-11
58 XE-133	5413	5.27E 00	1.52E-06	1	1	1.35E-01	4.54E-02	1.00E-11
59 XE-135M	5416	1.08E-02	7.43E-04	1	1	9.50E-02	4.32E-01	1.00E-11
60 XE-135	5415	3.82E-01	2.09E-05	1	1	3.17E-01	2.47E-01	1.00E-11
61 XE-137	5417	2.71E-03	2.96E-03	1	1	1.64E 00	1.94E-01	1.00E-11
62 XE-138	5418	1.18E-02	6.80E-04	1	1	6.06E-01	1.18E 00	1.00E-11
63 CS-134	5510	7.48E 02	1.07E-08	5	1	1.57E-01	1.04E 00	1.00E-04
64 CS-135	5512	1.10E 09	7.29E-15	5	1	5.74E-02	0.0	1.00E-04
65 CS-136	5514	1.30E 01	6.17E-07	5	1	1.01E-01	2.20E 00	1.00E-04
66 CS-137	5515	1.10E 04	7.29E-10	5	1	2.52E-01	5.97E-01	1.00E-04
67 CS-138	5516	2.24E-02	3.58E-04	5	1	1.23E 00	2.30E 00	1.00E-04
68 BA-139	5615	5.76E-02	1.39E-04	5	1	6.54E-01	5.05E-02	1.00E-04
69 BA-140	5616	1.28E 01	6.27E-07	5	1	3.15E-01	1.95E-01	1.00E-04
70 LA-140	5715	1.68E 00	4.77E-06	5	1	5.40E-01	2.31E 00	1.00E-04
71 CE-144	5815	2.84E 02	2.82E-08	5	1	9.13E-02	3.24E-02	1.00E-04
72 PR-143	5912	1.36E 01	5.90E-07	5	1	3.14E-01	0.0	1.00E-04
73 PR-144	5913	1.20E-02	6.68E-04	5	1	1.23E 00	3.10E-02	1.00E-04
74 NP-239	9310	2.35E 00	3.41E-06	5	1	1.24E-01	2.08E 00	1.00E-04

Table 1.3

JOINT PERCENTAGE FREQUENCIES OF WIND DIRECTION AND WIND SPEED
FOR DIFFERENT STABILITY CLASSES *

STABILITY CLASS A
DELTA T<=-1.9 DEG. C/100M

BROWNS FERRY NUCLEAR PLANT METEOROLOGICAL FACILITY*

JAN 1, 74 - DEC 31, 75

WIND DIRECTION	WIND SPEED(MPH) 0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	>=24.5	TOTAL
N	0.0	0.0	0.11	0.17	0.20	0.04	0.0	0.0	0.52
NNE	0.0	0.04	0.13	0.15	0.25	0.04	0.0	0.0	0.61
NE	0.0	0.04	0.10	0.07	0.02	0.0	0.0	0.0	0.23
ENE	0.0	0.01	0.04	0.02	0.0	0.0	0.0	0.0	0.07
E	0.0	0.01	0.03	0.02	0.0	0.0	0.0	0.0	0.06
ESE	0.0	0.05	0.19	0.14	0.05	0.0	0.0	0.0	0.43
SE	0.0	0.26	1.35	0.38	0.10	0.0	0.0	0.0	2.09
SSE	0.0	0.23	0.80	0.09	0.02	0.0	0.0	0.0	1.14
S	0.01	0.15	0.50	0.12	0.02	0.0	0.0	0.0	0.80
SSW	0.0	0.02	0.07	0.01	0.01	0.0	0.0	0.0	0.11
SW	0.0	0.02	0.10	0.01	0.01	0.0	0.0	0.0	0.14
WSW	0.0	0.02	0.13	0.09	0.05	0.0	0.0	0.0	0.29
W	0.0	0.01	0.06	0.06	0.04	0.0	0.01	0.0	0.18
WNW	0.0	0.02	0.06	0.12	0.18	0.07	0.01	0.0	0.46
NW	0.0	0.0	0.02	0.12	0.26	0.14	0.01	0.0	0.55
NNW	0.0	0.0	0.02	0.03	0.09	0.12	0.0	0.0	0.26
SUBTOTAL	0.01	0.88	3.71	1.60	1.30	0.41	0.03	0.0	7.94

CALM = 0.01

1337 STABILITY CLASS A OCCURRENCES OUT OF TOTAL 16559 VALID TEMPERATURE DIFFERENCE READINGS

1296 VALID WIND DIRECTION - WIND SPEED READINGS OUT OF TOTAL 1337 STABILITY CLASS A OCCURRENCES

ALL COLUMNS AND CALM TOTAL 100 PERCENT OF ALL VALID READINGS

*METEOROLOGICAL FACILITY LOCATED 0.78 MILES ESE OF BROWNS FERRY NUCLEAR PLANT
TEMPERATURE INSTRUMENTS 33 AND 150 FEET ABOVE GROUND
RADWASTE BUILDING-GROUND LEVEL RELEASE 33 FEET WIND INFORMATION.

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Table 1.3 (Continued)

JOINT PERCENTAGE FREQUENCIES OF WIND DIRECTION AND WIND SPEED
FOR DIFFERENT STABILITY CLASSES *

STABILITY CLASS B
-1.9< DELTA-T<=-1.7 DEG. C/100M

BROWNS FERRY NUCLEAR PLANT METEOROLOGICAL FACILITY*

JAN 1, 74 - DEC 31, 75

WIND DIRECTION	WIND SPEED(MPH) 0.5-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	>=24.5	TOTAL
N	0.0	0.03	0.15	0.11	0.23	0.02	0.0	0.0	0.54
NNE	0.0	0.06	0.12	0.12	0.16	0.01	0.0	0.0	0.47
NE	0.0	0.03	[illegible]	0.06	0.01	0.0	0.0	0.0	0.17
ENE	0.0	0.02	0.04	0.01	0.01	0.0	0.0	0.0	0.08
E	0.0	0.03	0.02	0.03	0.0	0.0	0.0	0.0	0.08
ESE	0.0	0.07	0.06	0.04	0.01	0.0	0.0	0.0	0.18
SE	0.0	0.35	0.53	0.08	0.04	0.0	0.0	0.0	1.00
SSE	0.01	0.26	0.23	0.02	0.01	0.0	0.0	0.0	0.53
S	0.0	0.13	0.31	0.05	0.01	0.0	0.0	0.0	0.50
SSW	0.0	0.04	0.07	0.03	0.0	0.0	0.0	0.0	0.14
SW	0.0	0.07	0.11	0.01	0.01	0.0	0.0	0.0	0.20
WSW	0.0	0.04	0.24	0.07	0.09	0.01	0.0	0.0	0.45
W	0.0	0.01	0.12	0.12	0.09	0.02	0.01	0.0	0.37
WNW	0.0	0.02	0.13	0.20	0.33	0.09	0.02	0.0	0.79
NW	0.0	0.01	0.11	0.15	0.40	0.10	0.01	0.0	0.78
NNW	0.0	0.01	0.03	0.12	0.34	0.11	0.01	0.0	0.62
SUBTOTAL	[illegible]	1.18	2.34	1.22	1.74	0.36	0.05	0.0	6.90

CALM = 0.0

1147 STABILITY CLASS B OCCURRENCES OUT OF TOTAL 16559 VALID TEMPERATURE DIFFERENCE READINGS

1119 VALID WIND DIRECTION - WIND SPEED READINGS OUT OF TOTAL 1147 STABILITY CLASS B OCCURRENCES

ALL COLUMNS AND CALM TOTAL 100 PERCENT OF NET VALID READINGS

*METEOROLOGICAL FACILITY LOCATED 0.78 MILES ESE OF BROWNS FERRY NUCLEAR PLANT
TEMPERATURE INSTRUMENTS 33 AND 150 FEET ABOVE GROUND
RADWASTE BUILDING-GROUND LEVEL RELEASE 33 FEET WIND INFORMATION.

Table 1.3 (Continued)

JOINT PERCENTAGE FREQUENCIES OF WIND DIRECTION AND WIND SPEED
FOR DIFFERENT STABILITY CLASSES *

STABILITY CLASS C
-1.7< DELTA-T<=-1.5 DEG. C/100M

BROWNS FERRY NUCLEAR PLANT METEOROLOGICAL FACILITY*

JAN 1, 74 - DEC 31, 75

WIND DIRECTION	WIND SPEED(MPH) 0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	>=24.5	TOTAL
N	0.0	0.02	0.08	0.09	0.17	0.04	0.0	0.0	0.40
NNE	0.0	0.04	0.07	0.06	0.07	0.02	0.0	0.0	0.26
NE	0.0	0.03	0.04	0.01	0.0	0.0	0.0	0.0	0.08
ENE	0.0	0.01	0.03	0.01	0.0	0.0	0.0	0.0	0.05
E	0.0	0.01	0.04	0.01	0.0	0.0	0.0	0.0	0.06
ESE	0.0	0.04	0.10	0.06	0.01	0.0	0.0	0.0	0.21
SE	0.0	0.28	0.21	0.05	0.02	0.0	0.0	0.0	0.56
SSE	0.0	0.21	0.12	0.01	0.0	0.0	0.0	0.0	0.34
S	0.0	0.15	0.12	0.01	0.0	0.0	0.0	0.0	0.28
SSW	0.0	0.02	0.04	0.01	0.0	0.0	0.0	0.0	0.07
SW	0.0	0.02	0.07	0.0	0.01	0.0	0.0	0.0	0.10
WSW	0.0	0.02	0.10	0.06	0.02	0.0	0.0	0.0	0.20
W	0.0	0.0	0.14	0.09	0.07	0.06	0.0	0.0	0.36
WNW	0.0	0.05	0.11	0.13	0.12	0.08	0.04	0.0	0.53
NW	0.0	0.01	0.09	0.07	0.23	0.08	0.01	0.0	0.49
NNW	0.0	0.02	0.06	0.10	0.27	0.15	0.01	0.0	0.61
SUBTOTAL	0.0	0.93	1.42	0.77	0.99	0.43	0.06	0.0	4.60

CALM = 0.0

757 STABILITY CLASS C OCCURRENCES OUT OF TOTAL 16559 VALID TEMPERATURE DIFFERENCE READINGS

739 VALID WIND DIRECTION - WIND SPEED READINGS OUT OF TOTAL 757 STABILITY CLASS C OCCURRENCES

ALL COLUMNS AND CALM TOTAL 1.0 PERCENT OF NET VALID READINGS

*METEOROLOGICAL FACILITY LOCATED 0.78 MILES ESE OF BROWNS FERRY NUCLEAR PLANT
TEMPERATURE INSTRUMENTS 33 AND 150 FEET ABOVE GROUND
RADWASTE BUILDING-GROUND LEVEL RELEASE 33 FEET WIND INFORMATION.

POOR ORIGINAL

302 022

Table 1.3 (Continued)

JOINT PERCENTAGE FREQUENCIES OF WIND DIRECTION AND WIND SPEED
FOR DIFFERENT STABILITY CLASSES *

STABILITY CLASS D
-1.5< DELTA-T<=-0.5 DEG. C/100M

BROWNS FERRY NUCLEAR PLANT METEOROLOGICAL FACILITY*

JAN 1, 74 - DEC 31, 75

WIND SPEED(MPH)

WIND DIRECTION	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	>=24.5	TOTAL
N	0.04	0.31	0.41	0.53	0.89	0.12	0.0	0.0	2.30
NNE	0.01	0.42	0.48	0.38	0.35	0.02	0.0	0.0	1.66
NE	0.01	0.40	0.30	0.12	0.06	0.01	0.0	0.0	0.90
ENE	0.02	0.36	0.22	0.02	0.03	0.0	0.0	0.0	0.65
E	0.02	0.23	0.22	0.04	0.02	0.0	0.0	0.0	0.53
ESE	0.01	0.51	0.74	0.36	0.28	0.0	0.0	0.0	1.90
SE	0.05	1.44	1.45	0.58	0.35	0.03	0.0	0.0	3.90
SSE	0.01	0.97	0.54	0.13	0.04	0.0	0.0	0.0	1.69
S	0.01	1.06	0.75	0.18	0.02	0.0	0.0	0.0	2.02
SSW	0.01	0.33	0.23	0.07	0.01	0.0	0.0	0.0	0.65
SW	0.02	0.33	0.23	0.03	0.01	0.0	0.0	0.0	0.62
WSW	0.01	0.54	0.64	0.27	0.23	0.12	0.0	0.0	1.81
W	0.0	0.35	0.88	0.56	0.57	0.15	0.0	0.0	2.51
WNW	0.0	0.18	0.42	0.42	0.62	0.36	0.05	0.01	2.06
NW	0.01	0.10	0.24	0.40	0.85	0.40	0.03	0.01	2.04
NNW	0.01	0.26	0.36	0.36	1.26	0.50	0.01	0.0	2.76
SUBTOTAL	0.24	7.79	8.11	4.45	5.59	1.71	0.09	0.02	28.00

CALM = 0.01

4648 STABILITY CLASS D OCCURRENCES OUT OF TOTAL 16559 VALID TEMPERATURE DIFFERENCE READINGS

4564 VALID WIND DIRECTION - WIND SPEED READINGS OUT OF TOTAL 4648 STABILITY CLASS D OCCURRENCES

ALL COLUMNS AND CALM TOTAL 100 PERCENT OF NET VALID READINGS

*METEOROLOGICAL FACILITY LOCATED 0.78 MILES ESE OF BROWNS FERRY NUCLEAR PLANT
TEMPERATURE INSTRUMENTS 33 AND 150 FEET ABOVE GROUND
RADWASTE BUILDING-GROUND LEVEL RELEASE 33 FEET WIND INFORMATION.

Table 1.3 (Continued)

JOINT PERCENTAGE FREQUENCIES OF WIND DIRECTION AND WIND SPEED
FOR DIFFERENT STABILITY CLASSES *

STABILITY CLASS E
-0.5< DELTA-T<= 1.5 DEG. C/100M

BROWNS FERRY NUCLEAR PLANT METEOROLOGICAL FACILITY*

JAN 1, 74 - DEC 31, 75

WIND DIRECTION	WIND SPEED(MPH) 0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	>=24.5	TOTAL
N	0.06	0.55	0.52	0.37	0.26	0.01	0.0	0.0	1.77
NNE	0.10	0.77	0.50	0.26	0.13	0.01	0.0	0.0	1.77
NE	0.07	0.47	0.45	0.10	0.05	0.0	0.0	0.0	1.14
ENE	0.10	0.58	0.15	0.02	0.0	0.0	0.0	0.0	0.85
E	0.03	0.74	0.44	0.08	0.02	0.0	0.0	0.0	1.31
ESE	0.04	0.97	1.09	0.48	0.17	0.0	0.0	0.0	2.75
SE	0.23	2.31	1.87	1.01	0.53	0.0	0.0	0.0	5.95
SSE	0.22	1.08	0.56	0.21	0.09	0.0	0.0	0.0	2.16
S	0.14	0.94	0.84	0.63	.23	0.0	0.0	0.0	2.78
SSW	0.17	0.58	0.28	0.18	0.08	0.01	0.0	0.0	1.30
SW	0.10	0.45	0.12	0.04	0.01	0.0	0.0	0.0	0.72
WSW	0.04	0.56	0.34	0.12	0.11	0.02	0.0	0.0	1.19
W	0.02	0.56	0.65	0.25	0.15	0.04	0.0	0.0	1.67
WNW	0.04	0.15	0.16	0.13	0.13	0.06	0.0	0.0	0.67
NW	0.05	0.15	0.21	0.09	0.26	0.09	0.0	0.0	0.85
NNW	0.08	0.50	0.56	0.39	0.31	0.04	0.0	0.0	1.88
SUBTOTAL	1.49	11.36	8.74	4.36	2.53	0.28	0.0	0.0	28.76

CALM = 0.06

4764 STABILITY CLASS E OCCURRENCES OUT OF TOTAL 16559 VALID TEMPERATURE DIFFERENCE READINGS

4700 VALID WIND DIRECTION - WIND SPEED READINGS OUT OF TOTAL 4764 STABILITY CLASS E OCCURRENCES

ALL COLUMNS AND CALM TOTAL 100 PERCENT OF NET VALID READINGS

*METEOROLOGICAL FACILITY LOCATED 0.78 MILES ESE OF BROWNS FERRY NUCLEAR PLANT
TEMPERATURE INSTRUMENTS 33 AND 150 FEET ABOVE GROUND
RADWASTE BUILDING-GROUND LEVEL RELEASE 3 FEET WIND INFORMATION.

Table 1.3 (Continued)

JOINT PERCENTAGE FREQUENCIES OF WIND DIRECTION AND WIND SPEED
FOR DIFFERENT STABILITY CLASSES *

STABILITY CLASS F
1.5< DELTA-T<= 4.0 DEG. C/100M

BROWNS FERRY NUCLEAR PLANT METEOROLOGICAL FACILITY*

JAN 1, 74 - DEC 31, 75

WIND DIRECTION	WIND SPEED(MPH) 0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	>=24.5	TOTAL
N	0.10	0.45	0.34	0.12	0.02	0.0	0.0	0.0	1.03
NNE	0.12	0.85	0.36	0.10	0.0	0.0	0.0	0.0	1.43
NE	0.10	0.51	0.15	0.02	0.0	0.0	0.0	0.0	0.78
ENE	0.09	0.60	0.06	0.0	0.0	0.0	0.0	0.0	0.75
E	0.06	0.93	0.36	0.0	0.0	0.0	0.0	0.0	1.35
ESE	0.07	0.72	0.28	0.04	0.0	0.0	0.0	0.0	1.11
SE	0.25	1.34	0.61	0.23	0.08	0.0	0.0	0.0	2.51
SSE	0.14	0.59	0.25	0.15	0.10	0.0	0.0	0.0	1.23
S	0.09	0.50	0.43	0.30	0.20	0.0	0.0	0.0	1.52
SSW	0.06	0.16	0.07	0.01	0.0	0.0	0.0	0.0	0.30
SW	0.04	0.15	0.01	0.0	0.0	0.0	0.0	0.0	0.20
WSW	0.05	0.10	0.0	0.01	0.01	0.0	0.0	0.0	0.17
W	0.04	0.09	0.02	0.01	0.0	0.0	0.0	0.0	0.16
WNW	0.02	0.13	0.03	0.01	0.0	0.0	0.0	0.0	0.19
NW	0.04	0.12	0.10	0.01	0.0	0.01	0.0	0.0	0.28
NNW	0.08	0.33	0.34	0.11	0.01	0.0	0.0	0.0	0.87
SUBTOTAL	1.35	7.57	3.41	1.12	0.42	0.01	0.0	0.0	13.88

CALM = 0.07

2286 STABILITY CLASS F OCCURRENCES OUT OF TOTAL 16559 VALID TEMPERATURE DIFFERENCE READINGS

2267 VALID WIND DIRECTION - WIND SPEED READINGS OUT OF TOTAL 2286 STABILITY CLASS F OCCURRENCES

ALL COLUMNS AND CALM TOTAL 100 PERCENT OF NET VALID RE' INGS

*METEOROLOGICAL FACILITY LOCATED 0.78 MILES ESE OF BROWNS FERRY NUCLEAR PLANT
TEMPERATURE INSTRUMENTS 33 AND 150 FEET ABOVE GROUND
RADWASTE BUILDING-GROUND LEVEL RELEASE 33 FEET WIND INFORMATION.

Table 1.3 (Continued)

JOINT PERCENTAGE FREQUENCIES OF WIND DIRECTION AND WIND SPEED
FOR DIFFERENT STABILITY CLASSES *

STABILITY CLASS G
DELTA T > 4.0 DEG. C/100M

BROWNS FERRY NUCLEAR PLANT METEOROLOGICAL FACILITY*

JAN 1, 74 - DEC 31, 75

WIND DIRECTION	WIND SPEED(MPH) 0.0-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	>=24.5	TOTAL
N	0.29	0.93	0.17	0.04	0.0	0.0	0.0	0.0	1.43
NNE	0.20	1.28	0.10	0.02	0.0	0.0	0.0	0.0	1.60
NE	0.14	0.44	0.02	0.0	0.0	0.0	0.0	0.0	0.60
ENE	0.09	0.52	0.02	0.0	0.0	0.0	0.0	0.0	0.63
E	0.07	0.66	0.15	0.0	0.0	0.0	0.0	0.0	0.88
ESE	0.04	0.35	0.01	0.0	0.0	0.0	0.0	0.0	0.40
SE	0.15	0.74	0.09	0.03	0.01	0.0	0.0	0.0	1.02
SSE	0.19	0.61	0.13	0.04	0.02	0.0	0.0	0.0	0.99
S	0.14	0.54	0.14	0.06	0.0	0.0	0.0	0.0	0.88
SSW	0.07	0.06	0.0	0.0	0.0	0.0	0.0	0.0	0.13
SW	0.06	0.05	0.0	0.0	0.0	0.0	0.0	0.0	0.11
WSW	0.04	0.04	0.0	0.0	0.0	0.0	0.0	0.0	0.08
W	0.01	0.04	0.01	0.0	0.0	0.0	0.0	0.0	0.06
WNW	0.07	0.06	0.01	0.0	0.0	0.0	0.0	0.0	0.14
NW	0.07	0.09	0.01	0.0	0.0	0.0	0.0	0.0	0.17
NNW	0.18	0.36	0.10	0.04	0.0	0.0	0.0	0.0	0.68
SUBTOTAL	1.81	6.77	0.96	0.23	0.03	0.0	0.0	0.0	9.80

CALM = 0.09

1620 STABILITY CLASS G OCCURRENCES OUT OF TOTAL 16559 VALID TEMPERATURE DIFFERENCE READINGS

1612 VALID WIND DIRECTION - WIND SPEED READINGS OUT OF TOTAL 1620 STABILITY CLASS G OCCURRENCES

ALL COLUMNS AND CALM TOTAL 100 PERCENT OF NET VALID READINGS .

*METEOROLOGICAL FACILITY LOCATED 0.78 MILES ESE OF BROWNS FERRY NUCLEAR PLANT
TEMPERATURE INSTRUMENTS 33 AND 150 FEET ABOVE GROUND
RADWASTE BUILDING-GROUND LEVEL RELEASE 33 FEET WIND INFORMATION.

Table 1.3 (Continued)

JOINT PERCENTAGE FREQUENCIES OF WIND DIRECTION AND WIND SPEED
FOR DIFFERENT STABILITY CLASSES *

STABILITY CLASS D
-1.5< DELTA-T<=-0.5 DEG. C/100M

BROWNS FERRY NUCLEAR PLANT METEOROLOGICAL FACILITY*

JAN 1, 74 - DEC 31, 75

WIND DIRECTION	WIND SPEED(MPH) 0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	>=24.5	TOTAL
N	0.0	0.02	0.12	0.23	0.79	0.92	0.31	0.01	2.40
NNE	0.01	0.10	0.21	0.34	1.04	0.86	0.13	0.0	2.69
NE	0.01	0.04	0.15	0.20	0.72	0.32	0.01	0.0	1.45
ENE	0.01	0.03	0.07	0.14	0.34	0.07	0.0	0.0	0.66
E	0.0	0.04	0.11	0.17	0.19	0.01	0.0	0.0	0.52
ESE	0.0	0.13	0.17	0.18	0.42	0.10	0.07	0.02	1.09
SE	0.0	0.22	0.55	0.54	1.25	0.81	0.48	0.19	4.04
SSE	0.01	0.32	0.40	0.41	0.84	0.72	0.39	0.11	3.20
S	0.0	0.18	0.26	0.31	0.78	0.59	0.28	0.15	2.55
SSW	0.0	0.11	0.20	0.12	0.56	.57	0.28	0.15	2.09
SW	0.01	0.24	0.33	0.20	0.58	.53	0.18	0.04	2.11
WSW	0.0	0.17	0.47	0.28	0.36	0.41	0.16	0.13	1.9[illegible]
W	0.01	0.10	0.39	0.40	0.56	0.48	0.28	0.21	2.43
WNW	0.0	0.09	0.22	0.40	0.75	0.55	0.30	0.21	2.52
NW	0.0	0.10	0.43	0.47	1.18	0.92	0.60	0.22	3.92
NNW	0.01	0.04	0.21	0.20	0.73	1.40	0.58	0.07	3.24
SUBTOTAL	0.07	1.93	4.29	4.59	11.09	9.36	4.05	1.51	36.89

CALM = 0.01

6114 STABILITY CLASS D OCCURRENCES OUT OF TOTAL 16481 VALID TEMPERATURE DIFFERENCE READINGS

6038 VALID WIND DIRECTION - WIND SPEED READINGS OUT OF TOTAL 6114 STABILITY CLASS D OCCURRENCES

ALL COLUMNS AND CALM TOTAL 100 PERCENT OF NET VALID READINGS

*METEOROLOGICAL FACILITY LOCATED 0.78 MILES ESE OF BROWNS FERRY NUCLEAR PLANT
TEMPERATURE INSTRUMENTS 300 AND 150 FEET ABOVE GROUND
WIND INSTRUMENTS AT 300 FEET ABOVE GROUND

Table 1.3 (Continued)

PERCENT OCCURRENCE OF WIND SPEED
FOR ALL WIND DIRECTIONS

BROWNS FERRY NUCLEAR PLANT METEOROLOGICAL FACILITY*

JAN 1, 74 - DEC 31, 75

WIND DIRECTION	WIND SPEED(MPH) 0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	>24.5	TOTAL
N	0.02	0.23	0.29	0.46	1.71	1.96	0.51	0.02	5.20
NNE	0.03	0.24	0.38	0.56	2.06	2.36	0.60	0.07	6.30
NE	0.01	0.15	0.40	0.49	1.80	1.83	0.50	0.03	5.21
ENE	0.03	0.15	0.36	0.46	1.25	0.85	0.21	0.01	3.32
E	0.01	0.23	0.49	0.51	1.02	0.37	0.04	0.0	2.67
ESE	0.03	0.34	0.53	0.58	1.62	1.12	0.29	0.05	4.56
SE	0.04	0.56	1.19	1.53	3.63	2.74	1.39	0.36	11.44
SSE	0.08	0.64	0.99	1.22	3.11	2.66	1.24	0.57	10.61
S	0.03	0.48	0.83	1.04	2.74	2.69	1.08	0.74	9.63
SSW	0.03	0.40	0.63	0.56	2.17	2.71	1.42	0.50	8.42
SW	0.04	0.49	0.63	0.67	1.77	1.88	0.67	0.20	6.35
WSW	0.02	0.37	0.90	0.66	1.20	0.87	0.27	0.23	4.52
W	0.03	0.27	0.77	0.74	1.36	0.84	0.43	0.28	4.72
WNW	0.03	0.18	0.42	0.89	1.39	0.90	0.42	0.26	4.49
NW	0.02	0.31	0.70	0.84	2.08	1.50	0.85	0.27	6.57
NNW	0.03	0.23	0.47	0.53	1.54	2.27	0.71	0.09	5.87
SUBTOTAL	0.48	5.27	9.98	11.54	30.45	27.55	10.63	3.98	99.88

CALM = 0.11

16850 VALID WIND DIRECTION - WIND SPEED READINGS OUT OF 17520 TOTAL HOURS = 96.18 PERCENT

ALL COLUMNS AND CALM TOTAL 100 PERCENT OF NET VALID READINGS

*METEOROLOGICAL FACILITY LOCATED 0.78 MILES ESE OF BROWNS FERRY NUCLEAR PLANT
WIND INSTRUMENTS AT 300 FEET ABOVE GROUND

302 028

TABLE 1.4

BROWNS FERRY NUCLEAR PLANT LAND SITE BOUNDARY DATA

Sector	Distance (m)	Elevated χ/Q^1	Elevated D/Q^2	Ground χ/Q^1	Ground D/Q^2
N	1,550	1.88(-10)[3]	9.55(-10)	2.26(-6)	5.66(-9)
NNE	1,400	4.06(-11)	7.71(-10)	1.02(-6)	2.05(-9)
NE	1,370	3.51(-11)	5.72(-10)	7.93(-7)	1.65(-9)
ENE	1,400	1.65(-11)	4.14(-10)	9.34(-7)	3.18(-9)
E	1,570	6.08(-11)	4.73(-10)	8.04(-7)	3.34(-9)
ESE	1,470	2.79(-11)	4.27(-10)	6.81(-7)	3.39(-9)
SE	5,460	9.33(-9)	3.18(-10)	1.11(-7)	3.83(-10)
SSE	2,740	1.82(-9)	5.99(-10)	7.03(-7)	1.90(-9)
S	2,380	8.43(-10)	5.47(-10)	1.19(-6)	2.51(-9)
SSW	2,410	1.08(-9)	6.61(-10)	1.32(-6)	2.40(-9)
SW	2,160	4.93(-10)	5.60(-10)	8.50(-7)	1.45(-9)
WSW	3,120	1.87(-9)	3.16(-10)	4.90(-7)	6.11(-10)
W	2,350	5.23(-10)	2.82(-10)	8.83(-7)	1.37(-9)
WNW	3,120	2.66(-9)	4.34(-10)	6.16(-7)	1.38(-9)
NW	3,440	7.97(-9)	9.76(-10)	1.29(-6)	2.84(-9)
NNW	1,620	1.73(-10)	1.09(-9)	2.20(-6)	4.84(-9)

1. s/m^3
2. m^{-2}
3. $1.88(-10) = 1.88\times10^{-10}$

TABLE 1.5

DOSE FACTORS FOR SUBMERSION IN NOBLE GASES

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

1. mrem/y per μCi/m³.
2. mrad/y per μCi/m³.
3. 1.17(+3) = 1.17×10^3.

302 030

TABLE 1.6

STABLE ELEMENT TRANSFER DATA

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

TABLE 1.7

INTERNAL DOSE FACTORS - INFANT THYROID

Radionuclide	Inhalation (mrem/pCi)	Ingestion (mrem/pCi)
H-3	4.62(-7)	3.08(-7)
C-14	3.79(-6)	5.06(-6)
Cr-51	4.11(-8)	9.20(-9)
Te-132	1.99(-7)	1.52(-5)
I-131	1.06(-2)	1.39(-2)
I-132	1.21(-4)	1.58(-4)
I-133	2.54(-3)	3.31(-3)
I-134	3.18(-5)	4.15(-5)
I-135	4.97(-4)	6.49(-4)

Table 1.8

EXTERNAL DOSE FACTORS FOR STANDING ON CONTAMINATED GROUND

(mrem/hr per pCi/m^2)

Element	Total Body	Skin
H-3	0.0	0.0
C-14	0.0	0.0
NA-24	2.50E-08	2.90E-08
P-32	0.0	0.0
Cr-51	2.20E-10	2.60E-10
Mn-54	5.80E-09	6.80E-09
Mn-56	1.10E-08	1.30E-08
Fe-55	0.0	0.0
Fe-59	8.00E-09	9.40E-09
Co-58	7.00E-09	8.20E-09
Co-60	1.70E-08	2.00E-08
Ni-63	0.0	0.0
Ni-65	3.70E-09	4.30E-09
Cu-64	1.50E-09	1.70E-09
Zn-65	4.00E-09	4.60E-09
Zn-69	0.0	0.0
Br-83	6.40E-11	9.30E-11
Br-84	1.20E-08	1.40E-08
Br-85	0.0	0.0
Rb-86	6.30E-10	7.20E-10
Rb-88	3.50E-09	4.00E-09
Rb-89	1.50E-08	1.80E-08
Sr-89	5.60E-13	6.50E-13
Sr-91	7.10E-09	8.30E-09
Sr-92	9.00E-09	1.00E-08
Y-90	2.20E-12	2.60E-12
Y-91M	3.80E-09	4.40E-09
Y-91	2.40E-11	2.70E-11
Y-92	1.60E-09	1.90E-09
Y-93	5.70E-10	7.80E-10
Zr-95	5.00E-09	5.80E-09
Zr-97	5.50E-09	6.40E-09
Nb-95	5.10E-09	6.00E-09
Mo-99	1.90E-09	2.20E-09
Tc-99M	9.60E-10	1.10E-09
Tc-101	2.70E-09	3.00E-09
Ru-103	3.60E-09	4.20E-09
Ru-105	4.50E-09	5.10E-09
Ru-106	1.50E-09	1.80E-09
Ag-110M	1.80E-08	2.10E-08
Te-125M	3.50E-11	4.00E-11
Te-127M	1.10E-12	1.30E-12
Te-127	1.00E-11	1.10E-11
Te-129M	7.70E-10	9.00E-10
Te-129	7.10E-10	8.40E-10
Te-131M	8.40E-09	9.90E-09
Te-131	2.20E-09	2.60E-06
Te-132	1.70E-09	2.00E-09
I-130	1.40E-08	1.7[illegible]E-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

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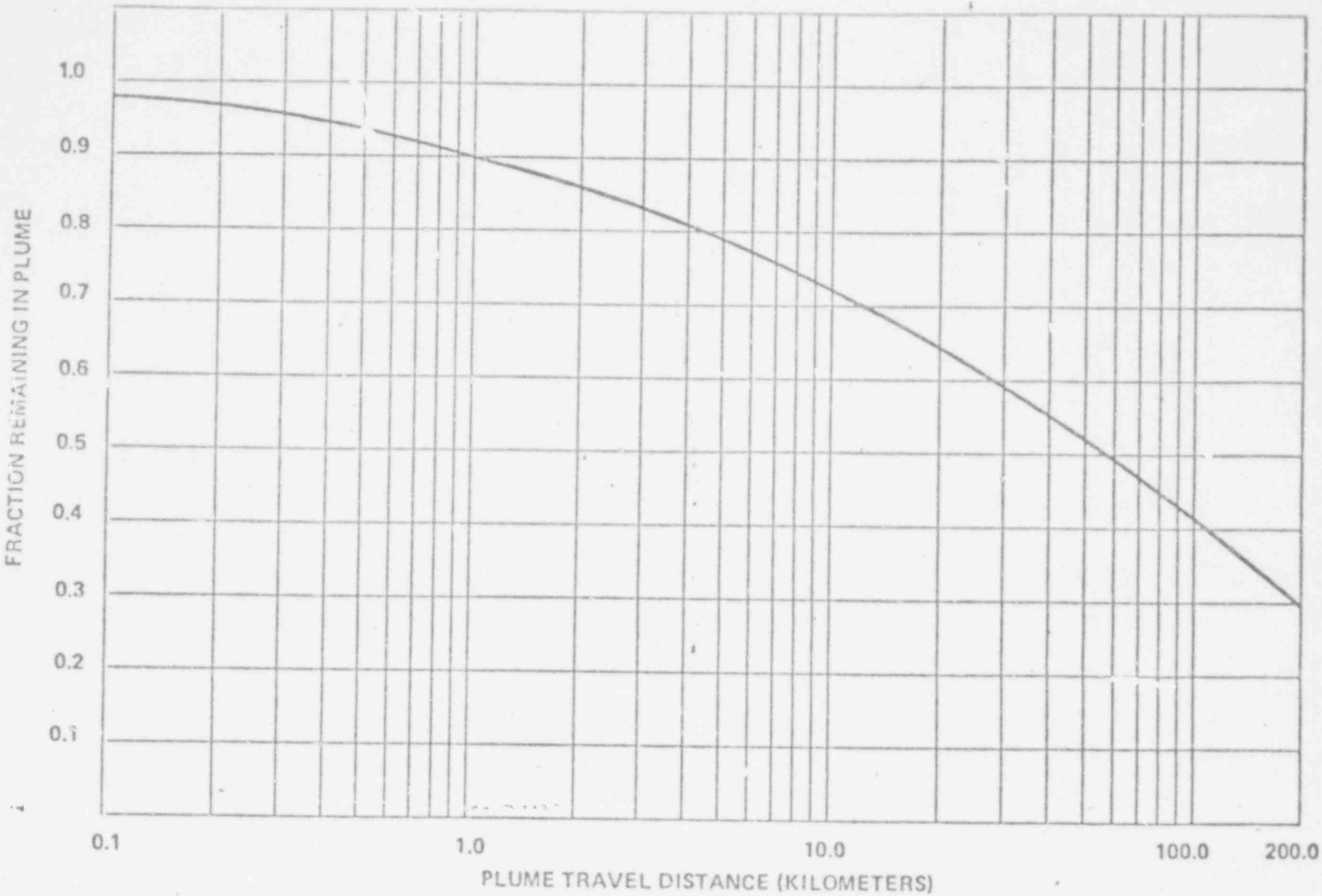
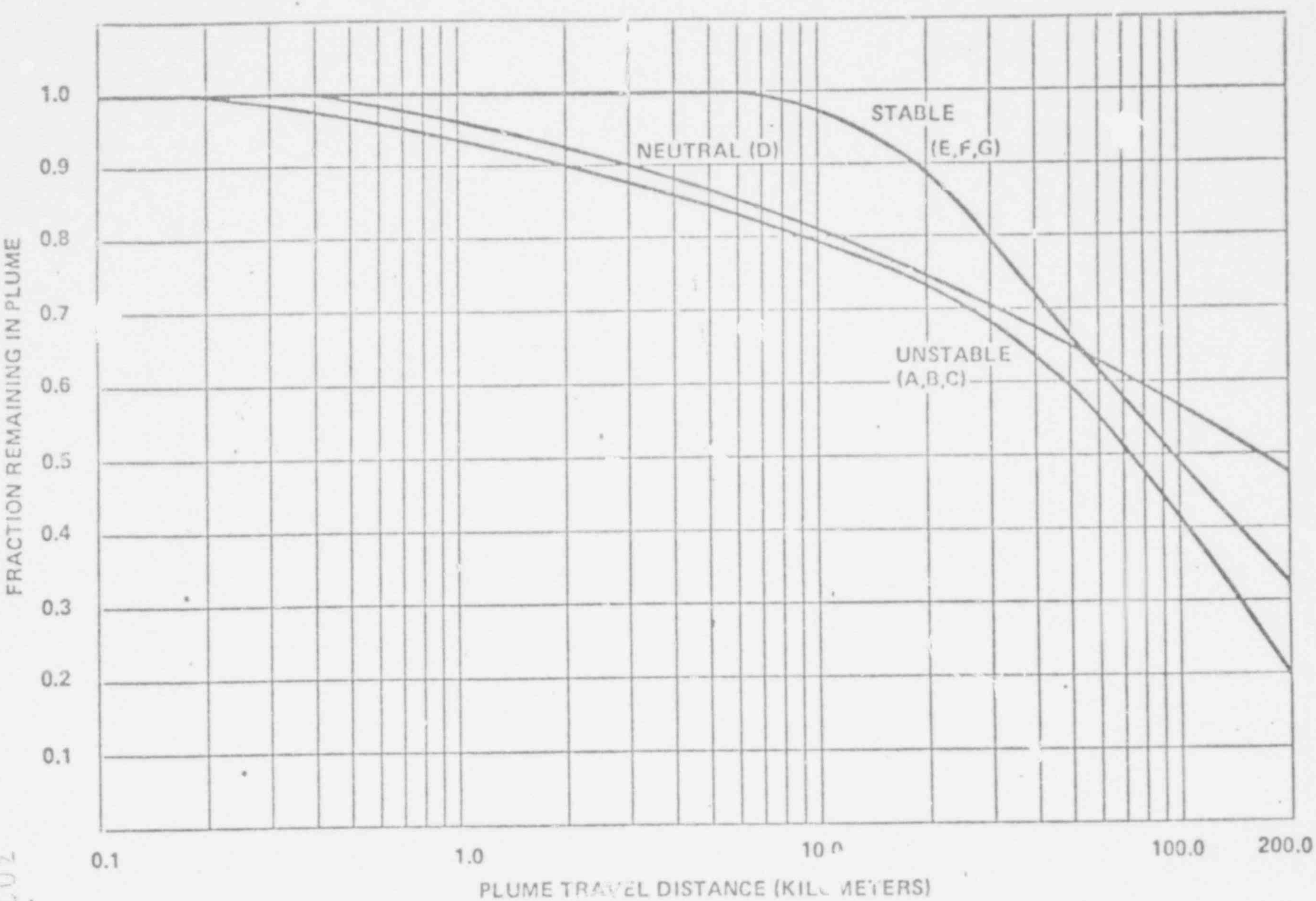
FIGURE 1.1



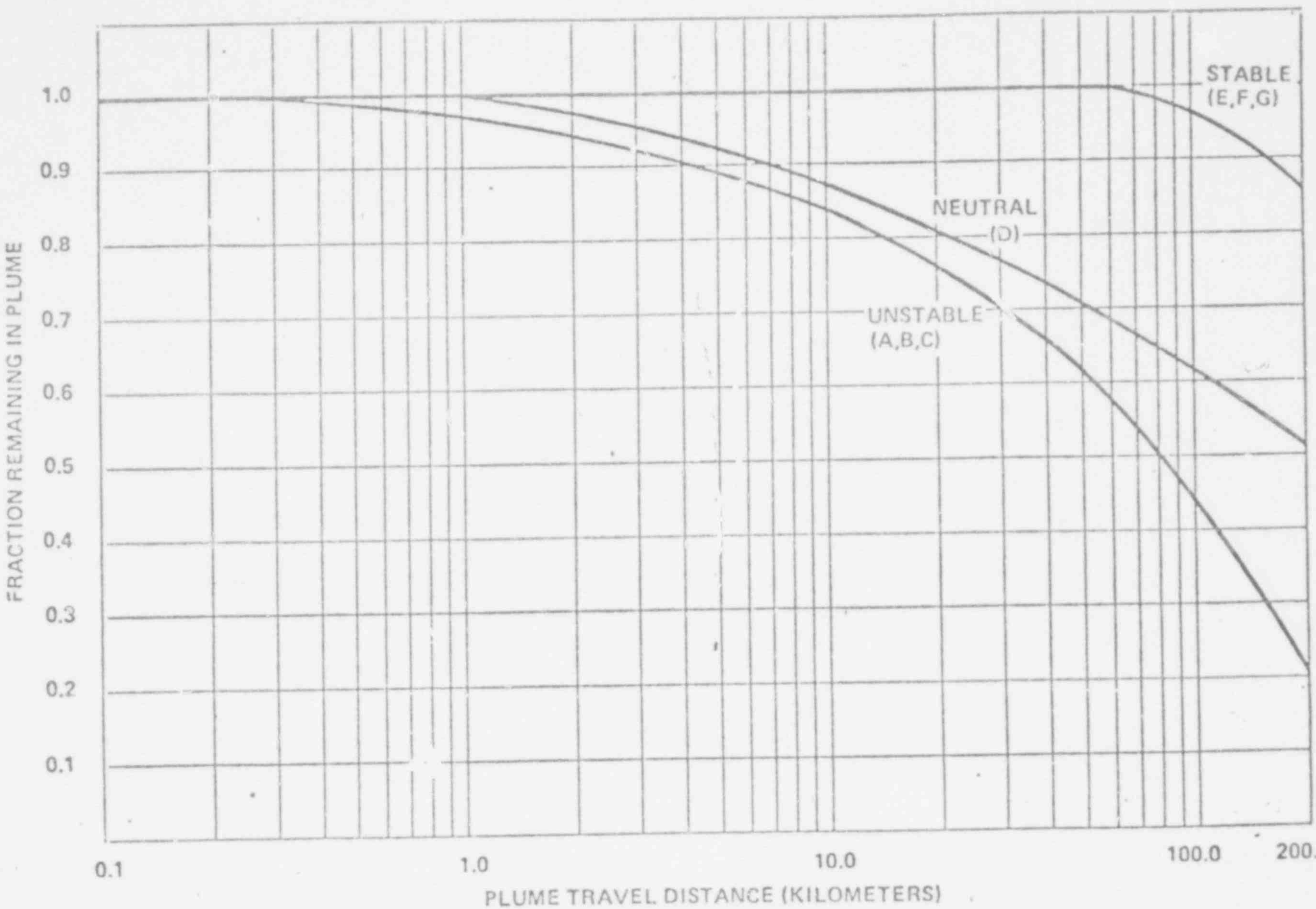
Plume Depletion Effect for Ground Level Releases (All Atmospheric Stability Classes)

FIGURE 1.1 (CONTINUED)



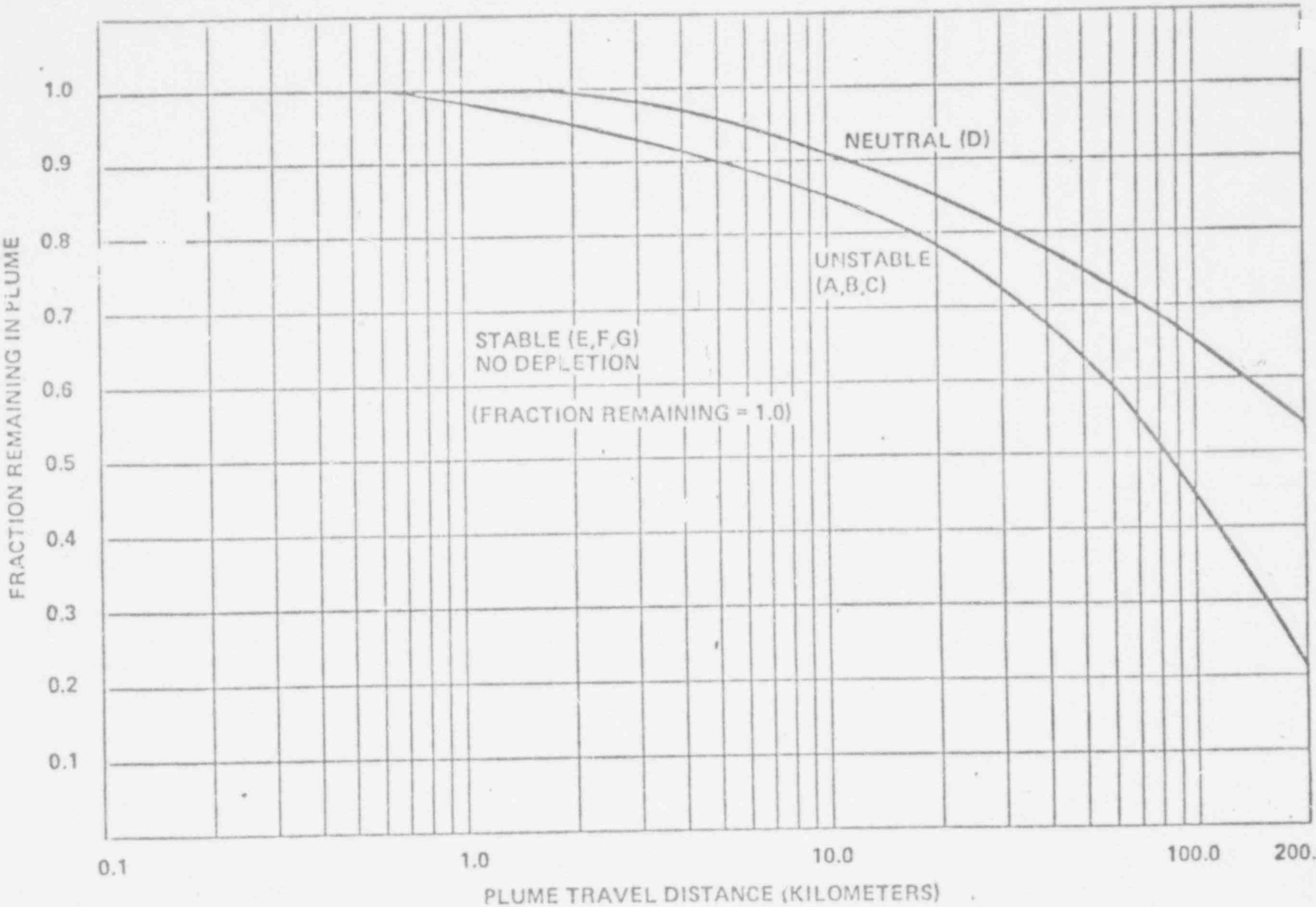
Plume Depletion Effect for 30m Releases (Letters denote Pasquill Stability Class)

FIGURE 1.1 (CONTINUED)



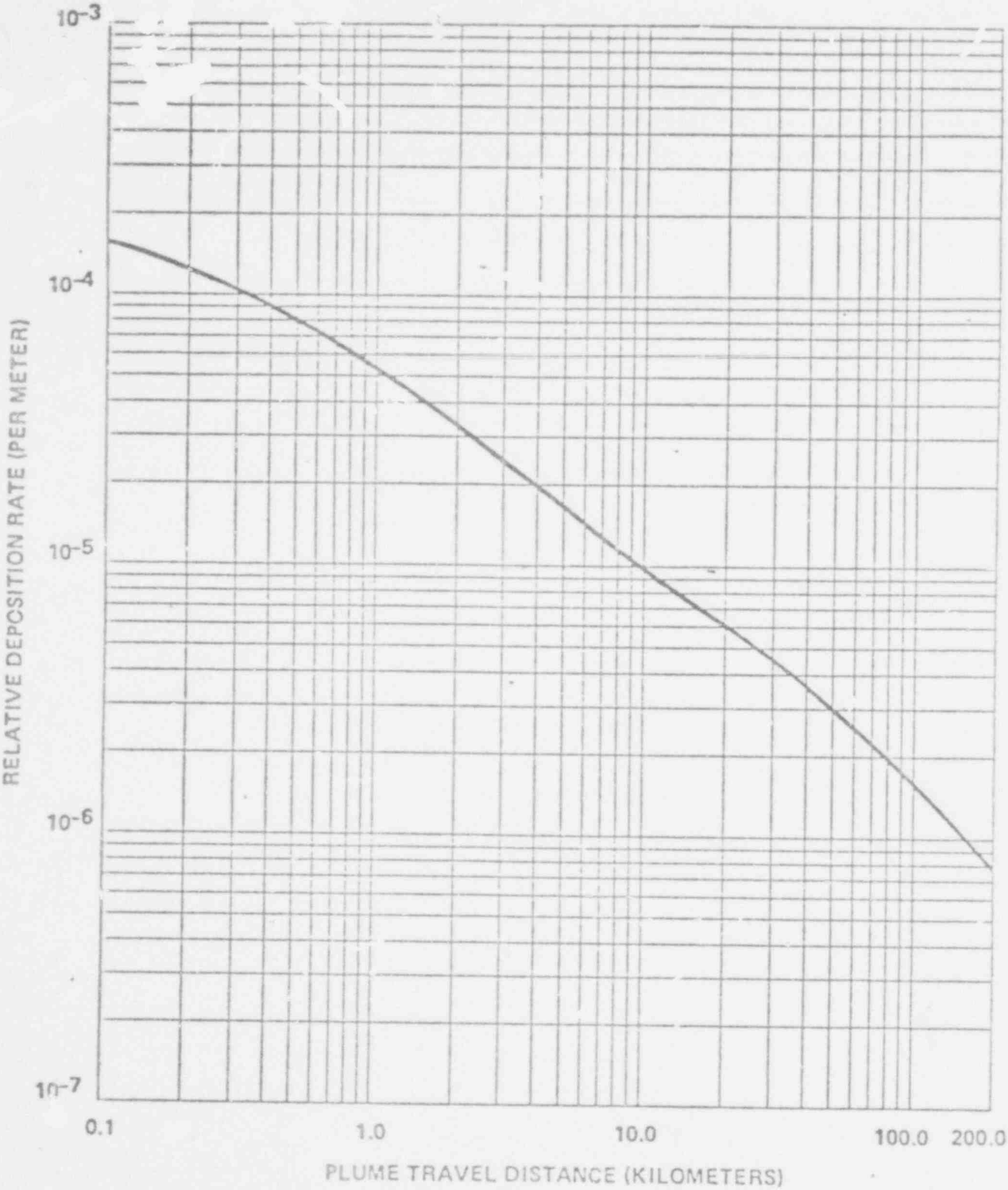
Plume Depletion Effect for 60m Releases (Letters denote Pasquill Stability Class)

FIGURE 1.1 (CONTINUED)



Plume Depletion Effect for 100m Releases (Letters denote Pasquill Stability Class)

FIGURE 1.2



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

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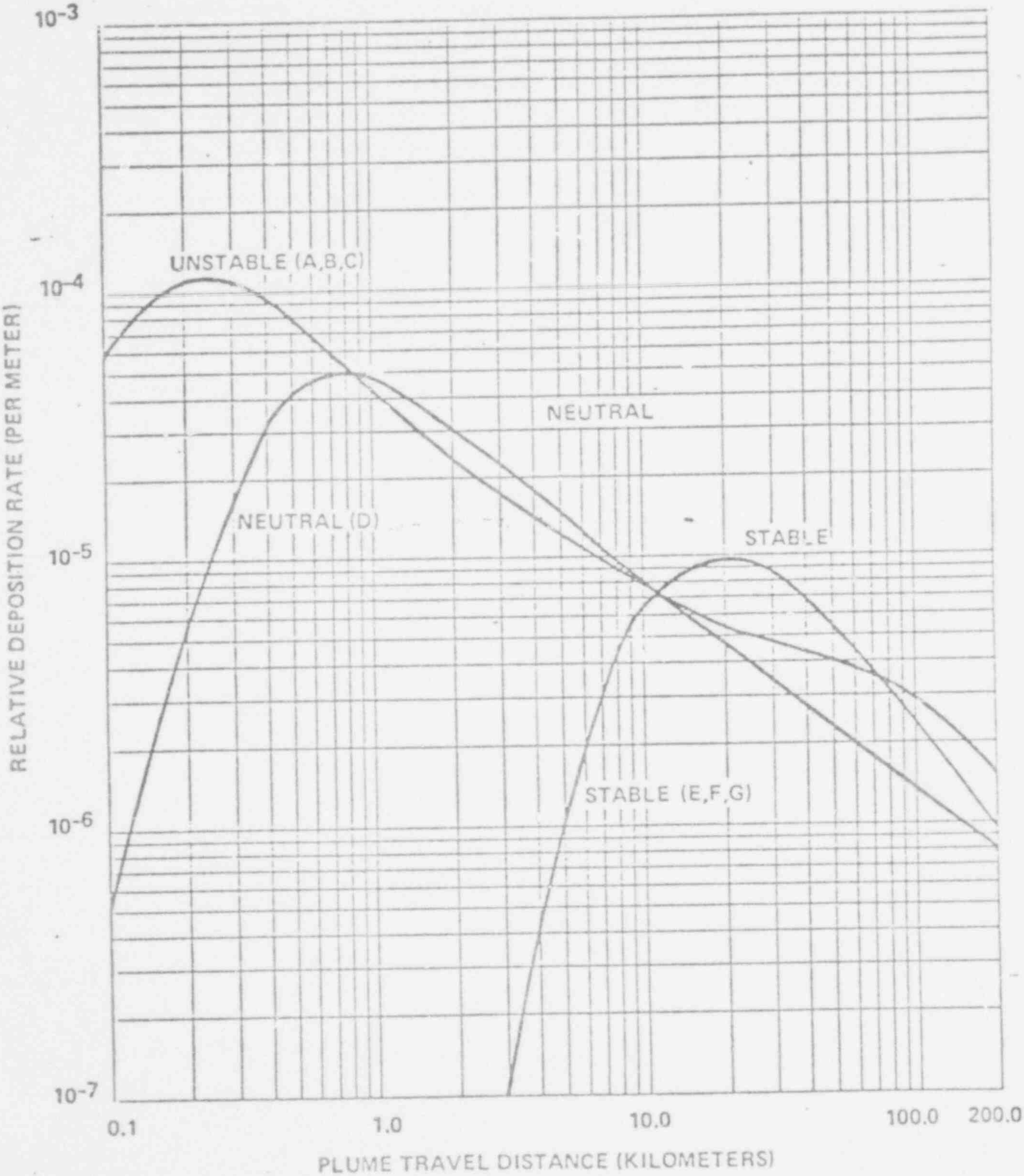

Relative Deposition for 30m Releases (Letters denote Pasquill Stability Class)

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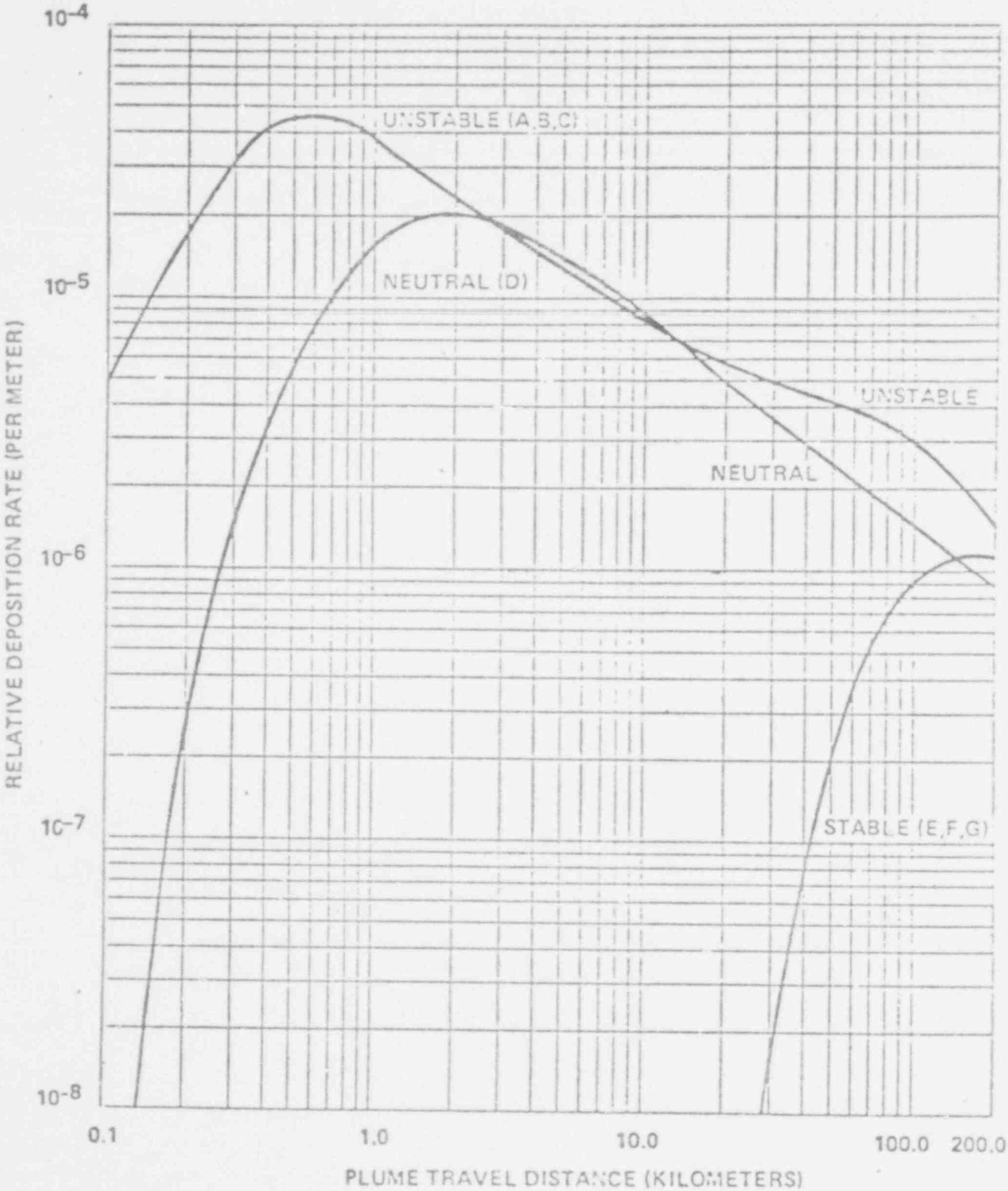

* Relative Deposition for 60m Releases (Letters denote Pasquill Stability Class)

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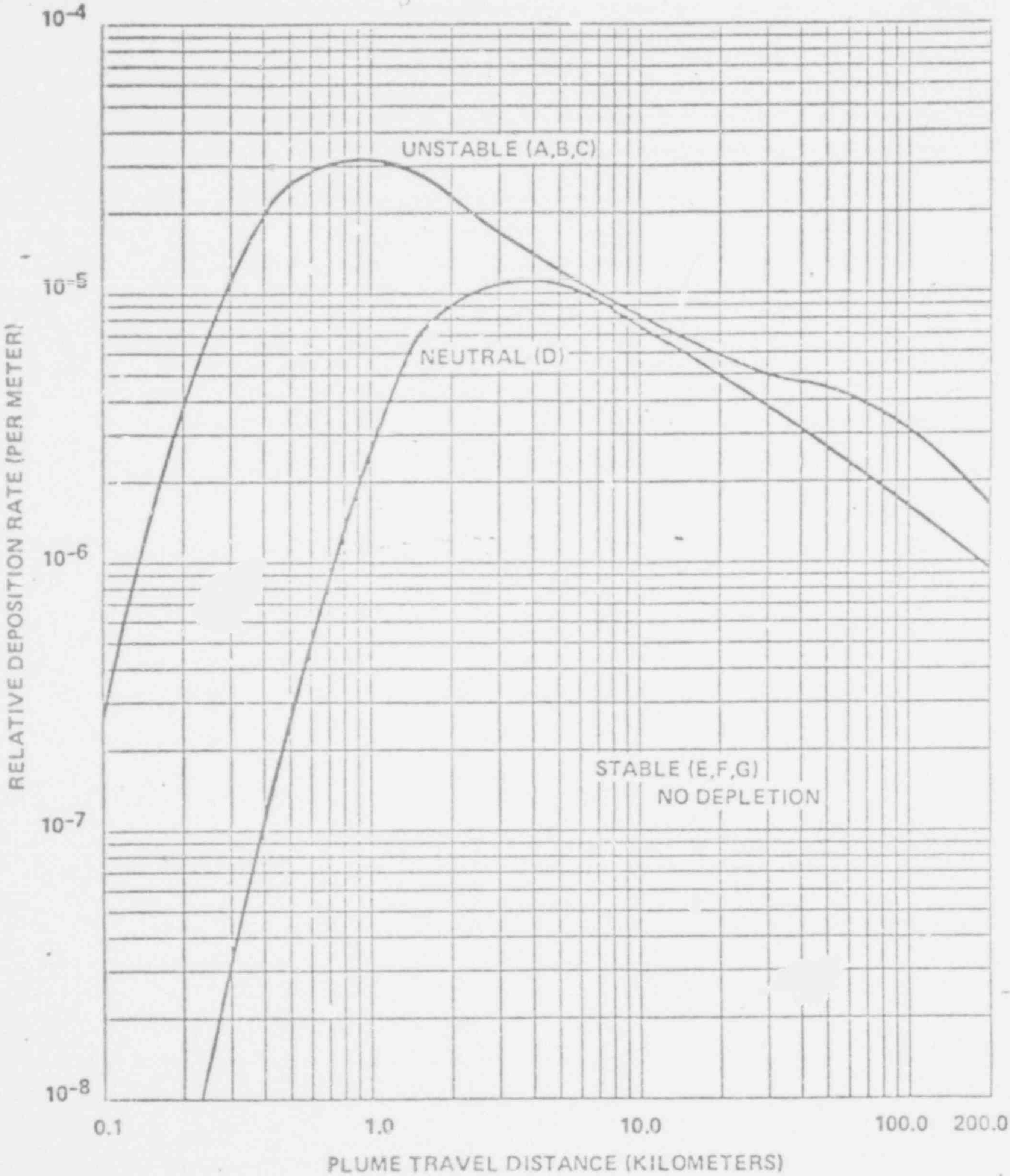

Relative Deposition for 100m Releases (Letters denote Pasquill Stability Class)

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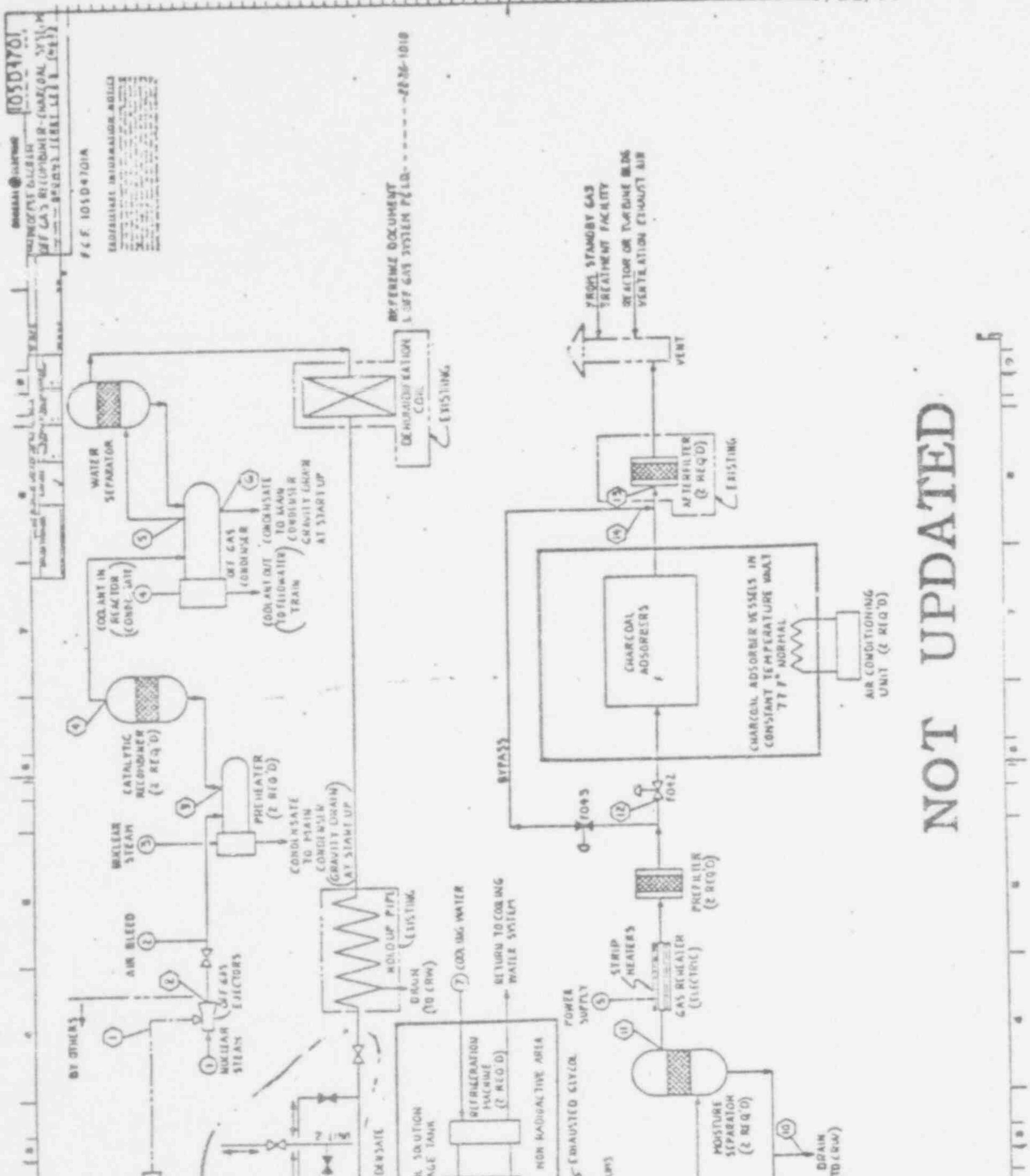
FIGURE 1.3

GASEOUS RADWASTE TREATMENT SYSTEM FLOW DIAGRAM



2. Liquid Effluents

2.1 Concentration

2.1.1 RETS Requirement

Specification 3.8.A.1 of the Radiological Effluent Technical Specifications (RETS) requires that the concentration of radioactive material released at any time from the site to unrestricted areas (see Figure 2.1) shall be limited to the Maximum Permissible Concentration (MPC, attached as Appendix I) specified in 10CFR20, Appendix B, Table II, Column 2 for nuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the concentration shall be limited to $2x10^{-4}$ µCi/ml total activity. To ensure compliance, the following approach will be used for each release.

2.1.2 Prerelease Analysis

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

$$C = \sum_{i=1}^{n} C_i \tag{2.1}$$

where:

C = total concentration in the liquid effluent, µCi/ml.

C_i = concentration of radionuclide i, µCi/ml.

2.1.3 MPC-Sum of the Ratios

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

$$R = \frac{C_A}{MPC_A} + \frac{C_B}{MPC_B} + \ldots + \frac{C_i}{MPC_i} \ldots + \frac{C_n}{MPC_n} \tag{2.2}$$

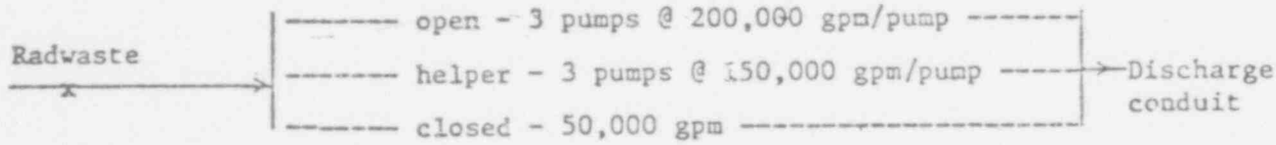
where:

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

MPC_i = the MPC of radionuclide i, μCi/ml.

R = the sum of the ratios for the release.

For prerelease and post-release analysis each C_i is first assumed to be unknown and the MPC is then 1×10^{-7} μCi/ml for each radionuclide i. If the R calculated is too large for equation 2.3 then the appropriate MPC_i will be used for each C_i. There is one liquid release point into the discharge canal by one of 3 possible modes.



The following relationship will assure concentrations are within allowable limits.

$$f(R-1) \leq F \qquad (2.3)$$

where:

f = the radwaste flow rate (gallons/minute) before dilution.

R = the sum of the ratios of the release as determined by Equation 2.2.

F = minimum dilution flow rate for prerelease analysis.

2.2 Instrument Setpoints

2.2.1 Setpoint Determination

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The respective alarm/trip setpoints at each release point will be set such that Equation 2.3 is satisfied. The methodology describing the setpoint determination is contained in Technical Instruction 45.

2.2.2 Post-Release Analysis

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

A composite list of concentrations (C_i), by isotope, will be used with the actual liquid radwaste (f) and dilution (F) flow rates (or volumes) during the release. The data will be substituted into Equation 2.3 to demonstrate compliance with the limits in Section 2.1.1. This data and setpoints will be recorded in auditable records by plant personnel.

2.3 Dose

2.3.1 RETS Requirement

Specification 3.8.A.2 of the Radiological Effluent Technical Specification (RETS) requires that the dose or dose commitment to an individual from radioactive materials in liquid effluents released to unrestricted areas from each reactor (see Figure 2.1) shall be limited:

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

b. During any calendar year to $\leq$ 3 mrem to the total body and to $\leq$ 10 mrem to any organ.

To ensure compliance, cumulative dose calculations will be performed at least once per month according to the following methodology.

2.3.2 Monthly Analysis

Principal radionuclides will be used to conservatively estimate the monthly contribution to the cumulative dose. If the projected dose exceeds the above limits, the methodology in Section 2.3.2 will be implemented.

The following radionuclides contribute at least 98 percent of the total estimated dose based on four years of operational source terms.

	Percent of Fish Dose		Percent of Ingestion Dose	
	Total Body	GI Tract	Total Body	Thyroid
H-3	-	-	8.5	1.0
Na-24	-	-	2.5	.3
Co-60	-	.5	1.8	.2
Zn-65	5.0	3.9	3.7	.4
Sr-90	.9	-	32.2	3.8
Nb-95	-	67.4	-	-
I-131	-	.1	1.2	81.1
I-133	-	-	-	5.9
Cs-134	40.4	8.3	20.7	2.4
Cs-136	2.4	3.3	1.7	.2
Cs-137	51.0	14.5	26.1	3.1
	99.7	98.0	98.4	98.4

A conservative calculation of the monthly dose will be done according to the following procedure. First, the monthly operating report containing the release data will be obtained and the activities released of each of the above 11 radionuclides will be noted. This information will then be used in the following calculations.

2.3.2.1 Water Ingestion

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

$$D_j = \frac{1}{.95} \sum_{i=1}^{11} (DCF)_{ij} \times I_i \text{ rem} \qquad (2.11)$$

where:

D_j = dose for the j^{th} organ from 11 radionuclides, rem.

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

..95 = conservative correction factor, considering only 11 radionuclides.

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

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

I_i is described by

$$I_i = \frac{365 A_i V}{12 \upsilon d}, \qquad (2.12)$$

where:

365 = days per year

A_i = activity released of i^{th} radionuclide during the month, μCi.

V = average rate of water consumption (730 ml/d ICRP 23, p. 358)

12 = months per year

υ = total cooling tower blowdown during releases, ml.

d = minimum diffuser pipe dilution (5)

The dose equation then becomes

$$D_j = \frac{4.6 \times 10^6}{\upsilon} \sum_{i=1}^{11} (DCF)_{ij} \times A_i \text{ mrem} \qquad (2.13)$$

2.3.2.2 Fish Ingestion

The dose to an individual from the consumption of fish may be described by Equation 2.11 where i is described by

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$$I_i = \frac{A_i \; B_i \; M}{U \; d}, \quad \mu Ci \tag{2.14}$$

where:

A_i = activity released of i^{th} radionuclide during the month, µCi

B_i = fish concentration factor of i^{th} radionuclide $\frac{\mu Ci/gm}{\mu Ci/ml}$, see attached Table 2.1.

M = amount of fish eaten monthly (1.9×10^3 gm)

U = total cooling tower blowdown during releases, ml.
d = minimum diffuser pipe dilution (5)

The dose equation then becomes

$$D_g = \frac{4 \times 10^5}{U} \sum_{i=1}^{11} A_i \times B_i \times DCF_i \quad \text{mrem} \tag{2.15}$$

If these calculated monthly doses exceed limits specified in Section 2.3.1, then a more accurate and complete calculation will be done as described in Section 2.3.3. An annual check will be made to ensure that the monthly dose estimates account for at least 95 percent of the dose calculated by the method described in Section 2.3.3. If less than 95 percent of the dose has been estimated, a new list of principal isotopes will be prepared.

2.3.3 Annual Analysis

A complete analysis utilizing the total source release will be done at least annually (monthly if necessary). This analysis will replace previous estimates calculated in Section 2.3.2 and consists of the following approach. The dose to the j^{th} organ from m radionuclides, D_j, is described by

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

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

where:

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

j = the organ of interest (bone, GI tract, thyroid, and total body).

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

I_i for water ingestion is described by

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

and for fish ingestion I_i is described by

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

where:

A_i = activity released of j^{th} radionuclide during the release period, μCi.

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

n = number of days during the release period (d).

υ = cooling tower blowdown during the release period, ml.

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

M = amount of fish eaten monthly (1.9×10^3 gm).

d = minimum diffuser pipe dilution (5).

2.4 Operability of Liquid Radwaste Equipment

Specification 3.8.A.5 of the Radiological Effluent Technical Specifications requires that the liquid radwaste system shall be used to reduce the radioactive materials in liquid wastes prior to their discharge when the projected dose per unit due to liquid effluent releases to unrestricted areas (see Figure 2.1.) when averaged over 31 days would exceed 0.06 mrem to the total body or 0.21 mrem to any organ. The following methodology will be implemented to assure compliance.

2.4.1 Release Limit

The liquid radwaste operability limit is an activity release limit based upon four years of operational releases excluding tritium. The curie limit is dependent upon the future operational mix being similar to past operational mix. The most restrictive pathway is to the GI tract by ingestion of fish. The individual dose from the operational source terms was calculated to be .04 mrem/mo. This dose is a factor of 5 below the operability limit of 0.21 mrem to any organ. The total activity released excluding tritium is 0.10 curies. The allowable release without exceeding 0.21 mrem/mo is 5 times 0.1 curies, or 0.50 curies/mo excluding tritium.

$$A_{limit} = 0.50 \text{ Ci/mo. excluding tritium}$$

The value of 0.50 Ci/mo will correspond to the limits specified in Section 2.4 if the mixture of isotopes is similar to the historical mixture.

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TABLE 2.1

DOSE CALCULATION DATA

NUCLIDE	RADIOLC. HALF-LIFE (DAYS)	BIOLOGICAL HALF-LIFE (DAYS)	EFFECTIVE HALF/LIFE (DAYS)	HUMAN DOSE COMMITMENT FACTORS (REM/UCI) BONE	GI TRACT	THYROID	TOTAL BODY	FISH CONCENTRATION FACT. STABLE	RADIOLO.	BIOLOG. HALF-LIFE (DAYS)
H-3	4.49E 03	1.00E 01	9.90E 00	9.77E-05	9.77E-05	9.77E-05	9.77E-05	1.00E 00	1.00E 00	0.0
C-14	2.09E 06	1.00E 01	1.00E 01	2.85E-03	5.70E-04	5.70E-04	5.70E-04	4.55E 03	4.55E 03	0.0
NA-24	6.33E-01	1.10E 01	5.99E-01	1.73E-03	5.32E-02	1.73E-03	1.73E-03	1.00E 02	1.00E 02	0.0
P-32	1.43E 01	2.57E 02	1.35E 01	1.99E-01	1.24E-01	7.47E-03	7.47E-03	1.00E 05	1.00E 05	0.0
K-40	4.60E 11	5.80E 01	5.80E 01	3.45E-02	0.0	3.45E-02	3.45E-02	2.50E 03	2.50E 03	0.0
CR-51	2.78E 01	6.16E 02	2.66E 01	3.21E-06	1.71E-03	3.39E-06	3.21E-06	2.00E 02	2.00E 02	0.0
MN-54	3.03E 02	1.70E 01	1.61E 01	8.03E-04	2.43E-02	8.03E-04	8.03E-04	4.00E 02	4.00E 02	0.0
MN-56	1.07E-01	1.70E 01	1.06E-01	2.04E-05	4.68E-03	2.04E-05	2.04E-05	4.00E 02	4.00E 02	0.0
FE-55	9.50E 02	8.00E 02	4.34E 02	3.83E-04	1.13E-03	2.74E-04	2.74E-04	1.00E 02	1.00E 02	0.0
FE-59	4.50E 01	8.00E 02	4.31E 01	3.32E-03	5.54E-02	3.01E-03	3.01E-03	1.00E 02	1.00E 02	0.0
CO-58	7.13E 01	9.50E 00	8.38E 00	1.69E-03	3.29E-02	1.69E-03	1.69E-03	5.00E 01	2.95E 01	1.00E 02
CO-60	1.92E 03	9.50E 00	9.45E 00	4.73E-03	8.58E-02	4.73E-03	4.73E-03	5.00E 01	4.75E 01	1.00E 02
NI-65	1.07E-01	6.67E 02	1.07E-01	5.30E-04	3.16E-03	3.27E-05	3.27E-05	1.00E 02	1.00E 02	0.0
ZN-65	2.45E 02	9.33E 02	1.94E 02	3.01E-03	1.69E-02	7.13E-03	7.13E-03	2.00E 03	1.42E 03	1.00E 02
ZN-69M	5.75E-01	9.33E 02	5.75E-01	1.55E-04	2.91E-03	3.64E-05	3.64E-05	2.00E 03	1.14E 01	1.00E 02
ZN-69	3.96E-02	9.33E 02	3.96E-02	1.03E-05	9.97E-04	1.37E-06	1.37E-06	2.00E 03	7.92E-01	1.00E 02
BR-83	1.00E-01	8.00E 00	9.88E-02	3.55E-05	1.30E-03	3.55E-05	3.55E-05	4.20E 02	4.20E 02	0.0
BR-84	2.21E-02	8.00E 00	2.20E-02	6.04E-05	4.53E-03	6.04E-05	6.04E-05	4.20E 02	4.20E 02	0.0
BR-85	2.08E-03	8.00E 00	2.08E-03	5.17E-07	7.24E-05	5.17E-07	5.17E-07	4.20E 02	4.20E 02	0.0
KR-83M	7.75E-02	1.00E 00	7.19E-02	0.0	1.46E-04	0.0	0.0	1.00E 00	1.00E 00	0.0
KR-85M	1.83E-01	1.00E 00	1.55E-01	0.0	3.30E-03	0.0	0.0	1.00E 00	1.00E 00	0.0
KR-85	3.93E 03	1.00E 00	1.00E 00	0.0	4.62E-02	0.0	0.0	1.00E 00	1.00E 00	0.0
RB-88	1.24E-02	4.50E 01	1.24E-02	3.34E-05	3.09E-03	3.34E-05	3.34E-05	2.00E 03	2.00E 03	0.0
RB-89	1.07E-02	4.50E 01	1.07E-02	2.86E-05	1.76E-03	2.86E-05	2.86E-05	2.00E 03	2.00E 03	0.0
SR-89	5.27E 01	1.30E 04	5.25E 01	1.39E-01	1.04E-01	9.22E-03	9.22E-03	3.00E 01	1.04E 01	1.00E 02
SR-90	1.01E 04	1.30E 04	5.66E 03	1.17E 01	3.56E-02	1.76E 00	1.76E 00	3.00E 01	2.97E 01	1.00E 02
SR-91	4.03E-01	1.30E 04	4.03E-01	1.72E-03	2.06E-02	1.92E-04	1.92E-04	3.00E 01	1.20E-01	1.00E 02
SR-92	1.13E-01	1.30E 04	1.13E-01	9.17E-04	1.35E-03	6.89E-05	6.89E-05	3.00E 01	3.39E-02	1.00E 02
SR-93	5.56E-03	1.30E 04	5.56E-03	6.39E-05	1.09E-03	9.90E-06	8.90E-06	3.00E 01	1.67E-03	1.00E 02
Y-90	2.67E 00	1.40E 04	2.67E 00	9.62E-06	1.25E-01	2.57E-07	2.57E-07	2.50E 01	2.50E 01	0.0
Y-91M	3.47E-02	1.40E 04	3.47E-02	2.12E-08	5.06E-04	1.72E-09	1.72E-09	2.50E 01	2.50E 01	0.0
Y-91	5.89E 01	1.40E 04	5.86E 01	1.37E-04	1.10E-01	3.66E-06	3.66E-06	2.50E 01	2.50E 01	0.0
Y-92	1.47E-01	1.40E 04	1.47E-01	8.49E-07	1.27E-02	2.47E-08	2.47E-08	2.50E 01	2.50E 01	0.0
Y-93	4.25E-01	1.40E 04	4.29E-01	1.97E-06	3.51E-02	5.51E-08	5.51E-08	2.50E 01	2.50E 01	0.0
ZR-95	6.55E 01	4.50E 02	5.72E 01	2.54E-05	4.20E-02	6.30E-06	6.30E-06	3.33E 00	3.33E 00	0.0
ZR-97	7.03E-01	4.50E 02	7.01E-01	1.64E-06	4.79E-02	1.55E-07	1.55E-07	3.33E 00	3.33E 00	0.0
NB-95M	3.75E 00	7.60E 02	3.73E 00	5.40E-07	3.55E-02	2.88E-07	2.88E-07	3.00E 04	3.00E 04	0.0
NB-95	3.50E 01	7.60E 02	3.35E 01	5.12E-06	3.01E-02	1.83E-06	1.83E-06	3.00E 04	3.00E 04	0.0
NB-97	5.00E-02	7.60E 02	5.00E-02	4.90E-08	2.10E-03	4.60E-09	4.60E-09	3.00E 04	3.00E 04	0.0
MO-99	2.79E 00	5.30E 00	1.79E 00	8.47E-04	5.93E-02	8.47E-04	8.47E-04	1.00E 01	1.00E 01	0.0
TC-99M	2.52E-01	1.00E 00	2.01E-01	2.44E-07	6.09E-04	9.37E-06	9.37E-06	1.50E 01	1.50E 01	0.0
TC-99	7.74E 07	1.00E 00	1.00E 00	1.27E-04	1.89E-02	5.06E-05	5.06E-05	1.50E 01	1.50E 01	0.0
TC-101	9.93E-03	1.00E 00	9.83E-03	2.57E-07	7.99E-04	3.60E-06	3.60E-06	1.50E 01	1.50E 01	0.0
RU-103	3.96E 01	7.30E 00	6.16E 00	1.04E-04	2.55E-02	7.98E-05	7.98E-05	1.00E 01	1.00E 01	0.0
RU-106	3.68E 02	7.30E 00	7.16E 00	2.86E-03	2.67E-01	3.50E-04	3.50E-04	1.00E 01	1.00E 01	0.0

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POOR ORIGINAL

TABLE 2.1 (CONTINUED)

NUCLIDE	RADIOLC. HALF-LIFE (DAYS)	BIOLOGICAL HALF-LIFE (DAYS)	EFFECTIVE HALF/LIFE (DAYS)	HUMAN DOSE COMMITMENT FACTORS (REM/UCI) BONE	GI TRACT	THYROID	TOTAL BODY	FISH CONCENTRATION FACT. STABLE	RADIOLO.	BIOLOG. HALF-LIFE (DAYS)
RH103M	3.46E-02	7.30E 00	3.94E-02	1.67E-07	1.21E-04	4.99E-08	4.99E-08	1.00E 01	1.00E 01	0.0
AG110M	2.53E 02	5.00E 00	4.90E 00	1.34E-04	9.27E-02	8.78E-05	8.73E-05	2.00E 00	2.00E 00	0.0
TE125M	5.80E 01	1.50E 01	1.19E 01	2.52E-03	2.25E-02	8.15E-04	4.55E-04	4.00E 02	4.00E 02	0.0
TE127M	1.09E 02	1.50E 01	1.32E 01	8.91E-03	1.56E-02	2.37E-03	1.12E-03	4.00E 02	4.00E 02	0.0
TE-127	3.92E-01	1.50E 01	3.82E-01	1.13E-04	6.76E-03	8.36E-05	2.44E-05	4.00E 02	4.00E 02	0.0
TE129M	3.41E 01	1.50E 01	1.04E 01	1.14E-02	4.96E-02	3.46E-03	1.84E-03	4.00E 02	4.00E 02	0.0
TE-129	4.77E-02	1.50E 01	4.75E-02	3.00E-05	1.77E-03	2.32E-05	7.37E-06	4.00E 02	4.00E 02	0.0
TE131M	1.25E 00	1.50E 01	1.15E 00	7.15E-04	3.61E-02	6.77E-04	4.89E-04	4.00E 02	4.00E 02	0.0
TE-131	1.74E-02	1.50E 01	1.72E-02	1.47E-05	1.79E-03	1.61E-05	6.44E-06	4.00E 02	4.00E 02	0.0
TE-132	3.24E 00	1.50E 01	2.66E 00	2.44E-03	2.21E-02	1.88E-03	1.50E-03	4.00E 02	4.00E 02	0.0
TE-134	2.92E-02	1.50E 01	2.91E-02	2.10E-05	8.93E-05	2.00E-05	1.57E-05	4.00E 02	4.00E 02	0.0
I-129	6.21E 09	1.30E 02	1.30E 02	3.10E-03	0.0	9.61E 00	1.24E-02	5.00E 01	5.00E 01	1.00E 00
I-131	8.05E 00	1.30E 02	7.61E 00	4.06E-03	4.44E-02	2.01E 00	3.52E-03	5.00E 01	4.45E 01	1.00E 00
I-132	9.42E-02	1.30E 02	9.41E-02	1.97E-04	4.25E-03	7.51E-02	1.57E-04	5.00E 01	4.30E 00	1.00E 00
I-133	8.46E-01	1.30E 02	8.41E-01	1.36E-03	3.78E-02	4.69E-01	7.51E-04	5.00E 01	2.29E 01	1.00E 00
I-134	3.61E-02	1.30E 02	3.61E-02	7.84E-05	3.40E-03	2.94E-02	7.47E-05	5.00E 01	1.74E 00	1.00E 00
I-135	2.78E-01	1.30E 02	2.77E-01	3.78E-04	1.17E-02	1.47E-01	3.98E-04	5.00E 01	1.09E 01	1.00E 00
XE133M	2.26E 00	1.00E 00	6.93E-01	0.0	2.45E-02	0.0	0.0	1.00E 00	1.00E 00	0.0
XE-133	5.27E 00	1.00E 00	8.41E-01	0.0	2.58E-02	0.0	0.0	1.00E 00	1.00E 00	0.0
XE135M	1.08E-02	1.00E 00	1.07E-02	0.0	3.29E-04	0.0	0.0	1.00E 00	1.00E 00	0.0
XE-135	3.83E-01	1.00E 00	2.77E-01	0.0	1.00E-02	0.0	0.0	1.00E 00	1.00E 00	0.0
CS-134	7.47E 02	7.00E 01	6.40E 01	5.49E-02	7.67E-02	1.20E-01	1.20E-01	2.00E 03	2.00E 03	1.00E 00
CS-135	1.10E 09	1.15E 02	1.15E 02	1.76E-02	0.0	8.06E-03	8.06E-03	2.00E 03	2.00E 03	1.00E 00
CS-136	1.37E 01	7.00E 01	1.15E 01	5.40E-03	8.77E-02	2.03E-02	2.03E-02	2.00E 03	1.86E 03	1.00E 00
CS-137	1.10E 04	7.00E 01	6.96E 01	7.07E-02	6.40E-02	7.28E-02	7.20E-02	2.00E 03	2.00E 03	1.00E 00
CS-138	2.24E-02	7.00E 01	2.24E-02	9.94E-06	2.61E-03	5.72E-05	5.72E-05	2.00E 03	4.30E 01	1.00E 00
BA-139	5.76E-02	6.50E 01	5.75E-02	1.05E-04	3.34E-03	3.07E-06	3.07E-06	4.00E 00	4.00E 00	0.0
BA-140	1.28E 01	6.50E 01	1.07E 01	1.41E-02	6.03E-02	1.23E-03	1.23E-03	4.00E 00	4.00E 00	0.0
LA-140	1.68E 00	5.00E 02	1.67E 00	1.90E-06	8.55E-02	3.09E-07	3.09E-07	2.50E 01	2.50E 01	0.0
LA-141	1.63E-01	5.00E 01	1.62E-01	3.90E-07	9.60E-03	2.03E-08	2.03E-08	2.50E 01	2.50E 01	0.0
CE-141	3.25E 01	5.63E 02	3.07E 01	9.32E-06	3.75E-02	7.72E-07	7.72E-07	2.50E 01	2.50E 01	0.0
CE-143	1.38E 00	5.63E 02	1.38E 00	5.53E-06	5.09E-02	3.56E-08	3.56E-08	2.50E 01	2.50E 01	0.0
CE-144	2.84E 02	5.63E 02	1.89E 02	4.90E-04	1.87E-02	2.64E-05	2.64E-05	2.50E 01	2.50E 01	0.0
PR-143	1.36E 01	7.50E 02	1.34E 01	9.24E-06	5.83E-02	4.60E-07	4.60E-07	2.50E 01	2.50E 01	0.0
PR-144	1.20E-02	7.50E 02	1.20E-02	3.04E-08	1.95E-03	1.54E-09	1.54E-09	2.50E 01	2.50E 01	0.0
ND-147	1.11E 01	6.56E 02	1.09E 01	6.37E-06	5.00E-02	4.55E-07	4.55E-07	2.50E 01	2.50E 01	0.0
PM-147	9.57E 02	6.56E 02	3.89E 02	7.60E-05	1.33E-02	2.89E-06	2.89E-06	2.50E 01	2.50E 01	0.0
PM-149	2.21E 00	6.56E 02	2.20E 00	1.54E-06	4.86E-02	8.87E-08	8.87E-08	2.50E 01	2.50E 01	0.0
PM-151	1.16E 00	6.56E 02	1.16E 00	6.74E-07	3.17E-02	5.91E-08	5.91E-08	2.50E 01	2.50E 01	0.0
SM-151	3.19E 04	6.56E 02	6.43E 02	6.07E-05	4.37E-03	1.56E-06	1.56E-06	2.50E 01	2.50E 01	0.0
SM-153	1.95E 00	6.56E 02	1.94E 00	1.03E-06	3.58E-02	6.66E-08	6.66E-08	2.50E 01	2.50E 01	0.0
SM-156	3.92E-01	6.56E 02	3.92E-01	4.63E-07	5.86E-03	5.33E-08	5.33E-08	2.50E 01	2.50E 01	0.0
EU-155	6.61E 02	6.35E 02	3.24E 02	5.75E-05	1.35E-02	3.35E-06	3.35E-06	2.50E 01	2.50E 01	0.0
EU-156	1.54E 01	6.35E 02	1.50E 01	1.31E-05	1.02E-01	1.65E-06	1.65E-06	2.50E 01	2.50E 01	0.0
W-187	9.96E-01	1.00E 00	4.99E-01	8.70E-05	2.54E-02	2.70E-05	2.70E-05	1.20E 03	1.20E 03	0.0
NP-239	2.35E 00	3.20E 04	2.35E 00	1.45E-06	3.10E-02	7.74E-08	7.74E-08	1.00E 01	1.00E 01	0.0

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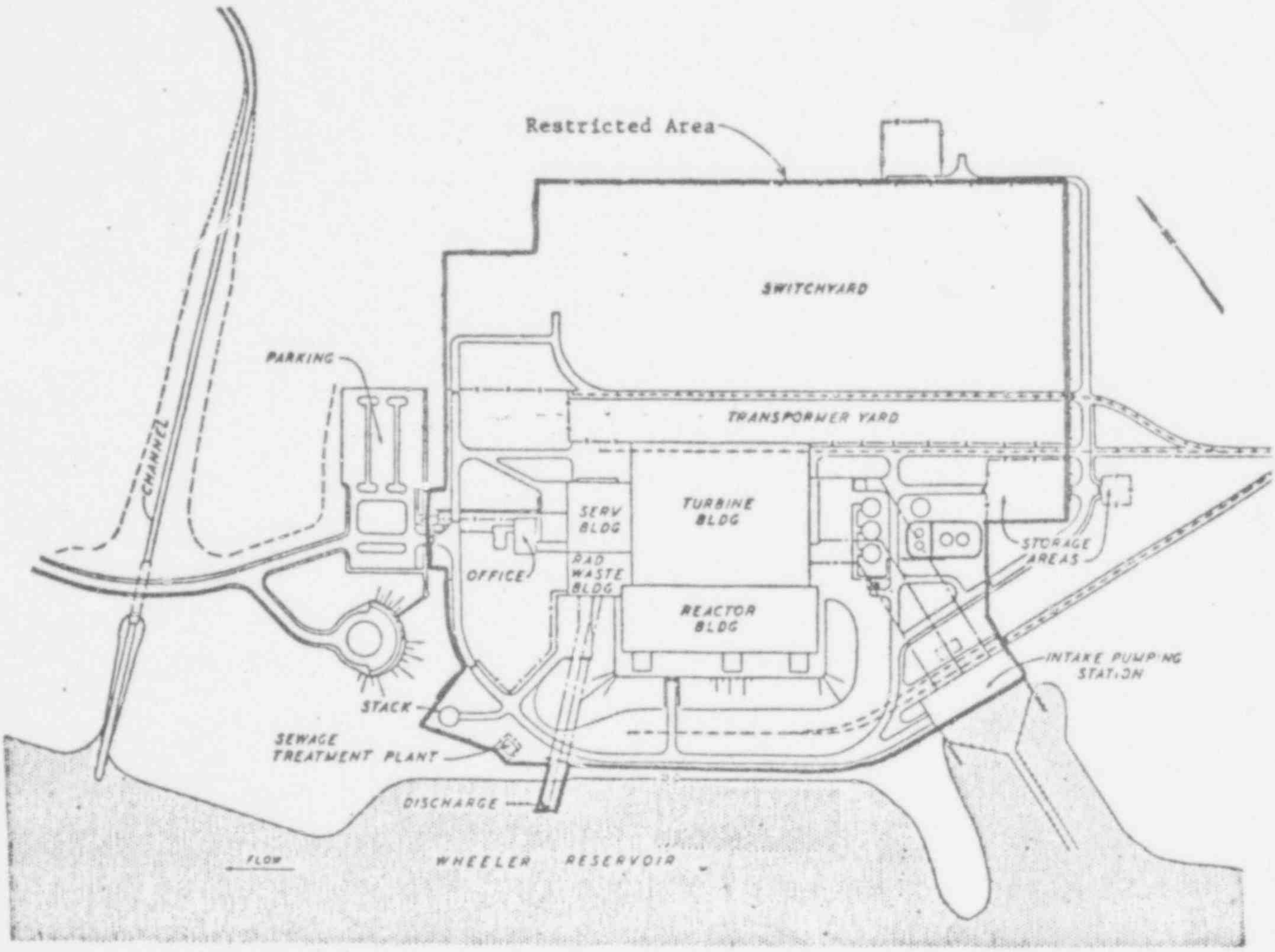

Figure 2.1--Assumed Liquid Effluent Restricted Area

3.0 Radiological Environmental Monitoring

3.1 Monitoring Program

An environmental radiological monitoring program shall be conducted

as described in Tables 3.1-1, 3.1-2 and 3.1-3, and in Figures 3.1-1, 3.1-2, 3.1-3, and 3.1-4. Results of this program shall be reported in accordance with Technical Specifications 6.7.1.d and 6.7.2.c.

The atmospheric environmental radiological monitoring program shall consist of 11 monitoring stations from which samples of air particulates, atmospheric radioiodine, rainwater, and heavy particle fallout shall be collected.

The terrestrial monitoring program shall consist of the collection of milk, soil, ground water, drinking water, and food crops. In addition, direct gamma radiation levels will be measured in the vicinity of the plant.

The reservoir sampling program shall consist of the collection of samples of surface water, sediment, and fish.

Deviations are permitted from the required sampling schedule if specimens are unobtainable due to hazardous conditions, sample unavailability, or to malfunction of sampling equipment. If the latter, every effort shall be made to complete corrective action prior to the end of the next sampling period.

3.2 Detection Capabilities

Analytical techniques shall be such that the detection capabilities listed in Table 3.2-1 are achieved.

TABLE 3.1-1

ENVIRONMENTAL RADIOLOGICAL MONITORING

Exposure Pathway and/or Sample	Sample Locations*	Sampling and Collection Frequency	Type of Frequency of Analysis
AIRBORNE			
Particulates	4 samples from locations (in different sectors) at or near the site boundary (LM 1, 2, 3, & 5)		
	1 sample from the residence having the highest X/Q (LM-4)	Continuous sampler operation with sample collection weekly	Gross beta following filter change composite (by location) monthly for gamma scan. Composite quarterly for ^{89}Sr, ^{90}Sr. If any filter indicates a gross beta concentration 1.0 pCi/m^3 greater than the average of the control stations, a gamma scan will be performed on the filter
	4 samples from communities approximately 10 miles distant from the plant (PM 1-4)		
	2 samples from control locations greater than 10 miles from the plant (RM 1&2)		
Radioiodine	Samples from same locations as air particulates	Continuous sampler operation with filter collection weekly	^{131}I weekly
Fallout	Samples from same locations as air particulates	Heavy particle fallout collected continuously on gummed acetate paper with paper collection monthly	Gross beta monthly
Rainwater	Samples from same locations as air particulates	Rainwater collected continuously with composite sample analyzed monthly	Gamma scan, monthly
Soil	Samples from same locations as air particulates	Once per 3 years	Gamma scan, ^{89}Sr, ^{90}Sr once each 3 years

*Sample locations are shown in Figures 3.1-1, 3.1-2, 3.1-3, and 3.1-4.

TABLE 3.1-1 (Continued)

Exposure Pathway and/or Sample	Sample Locations*	Sampling and Collection Frequency	Type and Frequency of Analysis
DIRECT	2 or more dosimeters placed at the air particulate sampling stations located greater than 5 miles from the plant (PM 1-4 and RM 1 & 2)	Quarterly	Gamma dose quarterly
	2 or more dosimeters placed at 8 locations (in different sectors) at or near the site boundary (Figure 3.1-2)		
WATERBORNE			
Surface (Figure 3.1-4)	TRM 305.0 TRM 293.5 TRM 285.2	Collected by automatic sequential-type sampler with composite sample taken monthly	Gamma scan monthly Composite for tritium, ^{89}Sr and ^{90}Sr quarterly
Ground (Figure 3.1-3)	. sample adjacent to plant	Collected by automatic sequential-type sampler with composite sample taken monthly	Gamma scan monthly. Composite quarterly for tritium.
	1 sample from ground water source upgradient	Monthly grab sample	Gamma scan monthly. Composite quarterly for tritium
Drinking (Table 3.1-3) (Figure 3.1-4)	1 sample at the first potable surface water supply downstream from the plant (TRM 282.6)	Collected by automatic sequential-type sampler with composite sample taken monthly	Gross beta and gamma scan monthly. Composite quarterly for ^{89}Sr, ^{90}Sr, and tritium.

*Sample locations are shown in Figures 3.1-1, 3.1-2, 3.1-3, and 3.1-4.

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TABLE 3.1-1 (Continued)

Exposure Pathway and/or Sample	Sample Location*	Sampling and Collection Frequency	Type and Frequency of Analysis
	1 sample at the next 2 downstream potable surface water supplies (greater than 10 miles downstream) (TRM's 274.9 and 254.3)	Monthly grab sample	Gross beta and gamma scan monthly. Composite quarterly for tritium, ^{89}Sr, and ^{90}Sr.
	1 sample at a control location (TRM 306.0)	Monthly grab sample	
Sediment (Figure 3.1-4)	TRM 307.5 TRM 393.7 TRM 288.8 TRM 278.0	Semiannually	Gamma scan, ^{89}Sr, and ^{90}Sr analyses semiannually
INGESTION			
Milk (Figure 3.1-3)	1 sample from milk producing animals in each of 1-3 areas indicated by the cow census where doses are calculated to be highest. If samples are not available from an area, doses to that area will be estimated by projecting the doses from concentrations detected in milk from other sectors or by sampling vegetation where milk is not available	Semimonthly when animals are on pasture. Monthly when animals are off pasture.	^{131}I analysis semimonthly or monthly on collection. Gamma scan, ^{89}Sr, and ^{90}Sr monthly.
	1 sample from a control location		

*Sample locations are shown in Figures 3.1-1, 3.1-2, 3.1-3, and 3.1-4.

TABLE 3.1-1 (Continued)

Exposure Pathway and/or Sample			
Fish	1 sample each of a commercial and a game species in Guntersville Reservoir above the plant		
	1 sample each of a commercial and a game species in Wheeler Reservoir near the plant	Semiannually	Gamma scan semiannually.
	1 sample each of a commercial and a game species in Wilson Reservoir below the plant		
Food Products	1 sample each of principal food products grown at private gardens and/or farms in the immediate vicinity of the plant. Selection of locations to be based on the land use census.	Annually, at time of harvest. The types of foods available for sampling will vary. Following is a list of typical foods which may be available: cabbage and/or lettuce, corn, green beans, potatoes, and tomatoes.	Gamma scan on edible portion
	1 sample each of the same good products grown at control locations.		

*Sample locations are shown in Figures 3.1-1, 3.1-2, 3.1-3, and 3.1-4.

TABLE 3.1-2

ATMOSPHERIC AND TERRESTRIAL MONITORING STATION LOCATIONS

BROWNS FERRY NUCLEAR PLANT

	Location and Approximate Distance and Direction from Plant
LM-1 BF	1.0 mile N
LM-2 BF	0.9 miles NNE
LM-3 BF	1.0 miles NE
LM-4 BF	1.7 miles NNW
LM-5 BF	2.5 miles WSW
PM-1 BF (Rogersville, AL)	13.8 miles NW
PM-2 BF (Athens, AL)	10.9 miles NE
PM-3 BF (Decatur/Trinity, AL)	8.2 miles SSE
PM-4 BF (Courtland, AL)	10.5 miles WSW
RM-1 BF (Muscle Shoals, AL)	32.0 miles W
RM-2 BF (Lawrenceburg, TN)	40.5 miles NNW
Farm B	7.0 miles NNW
Farm S	4.8 miles N
Farm Bi	4.5 miles ENE
Farm L	5.8 miles ENE
Farm T	7.0 miles ENE
Farm N (control)	27 miles NW
Farm J (control)	40 miles NNW
Farm C (control)	32 miles N
Farm Ca (control)	32 miles W

TABLE 3.1-3

LISTING OF TENNESSEE RIVER SURFACE WATER SUPPLIES TO BE SAMPLED IN ENVIRONMENTAL MONITORING PROGRAM

Supply	Source	Distance from Plant (miles)
Courtland (Champion Paper Co.)[a]	Tennessee River (mile 282.6)	11.6
Decatur[b]	Tennessee River (mile 306.0)	12.0
Wheeler Hydro Plant	Tennessee River (mile 274.9)	19.1
Sheffield	Tennessee River (mile 254.3)	39.7

a. First potable water supply downstream of the plant. Sample collected automatically and analyzed monthly.

b. Decatur is upstream of the Browns Ferry Nuclear Plant.

Table 3.2-1

DETECTION CAPABILITIES FOR ENVIRONMENTAL SAMPLE ANALYSIS

A. Specific Analyses

NOMINAL LOWER LIMIT OF DETECTION (LLD)*

	Air Particulates pCi/m³	Charcoal pCi/m³	Fallout mCi/Km²	Water pCi/l	Vegetation and grain pCi/g, dry	Soil and Sediment pCi/g, dry	Fish, clam flesh, plankton, pCi/g, dry	Clam shells pCi/g, dry	Foods, meat, poultry, pCi/Kgm, wet	Milk pCi/l
					0.01				1.5	
Total α			0.05	2.0	0.05	0.35	0.1	0.7		
Gross α	0.005			2.3	0.20	0.70	0.1	0.7	25	
Gross β	0.01									
^{3}H				330						0.5
^{131}I		0.01		10	0.25	1.5	0.5	5.0	40	10
^{89}Sr	0.005			2	0.05	0.3	0.1	1.0	8	2
^{90}Sr	0.001									

B. Gamma Analyses

NOMINAL LOWER LIMIT OF DETECTION (LLD)

	Air particulates pCi/m³ NaI*	Air particulates pCi/m³ Ge(Li)**	Water and milk pCi/l NaI	Water and milk pCi/l Ge(Li)	Vegetation and grain * pCi/g, dry NaI	Vegetation and grain * pCi/g, dry Ge(Li)	Soil and sediment pCi/g, dry NaI	Soil and sediment pCi/g, dry Ge(Li)	Fish pCi/g, dry NaI	Fish pCi/g, dry Ge(Li)	Clam flesh and plankton pCi/g, dry NaI	Clam flesh and plankton pCi/g, dry Ge(Li)	Clam shells pCi/g, dry NaI	Clam shells pCi/g, dry Ge(Li)	Foods, tomatoes potatoes, etc.) pCi/Kgm, wet NaI	Foods, tomatoes potatoes, etc.) pCi/Kgm, wet Ge(Li)	Meat and poultry pCi/Kgm, wet NaI	Meat and poultry pCi/Kgm, wet Ge(Li)
$^{141,144}Ce$	0.03		38		0.55		0.35		0.35				0.35		38		90	
^{144}Ce		0.02		33		0.22		0.06		0.06		0.35		0.06		33		40
^{51}Cr	0.07	0.03	60	44	1.10	0.47	0.60	0.10	0.60	0.10		0.56	0.60	0.10	60	44	200	90
^{131}I	0.01	0.01	15	8	0.35	0.09	0.20	0.02	0.20	0.02		0.07	0.20	0.02	15	8	50	20
$^{103,106}Ru$	0.04		40		0.65		0.45		0.45				0.45		40		150	
^{106}Ru		0.03		40		0.51		0.11		0.11		0.74		0.11		40		90
^{134}Cs	0.01	0.02	10	26	0.20	0.33	0.12	0.08	0.12	0.08		0.48	0.12	0.08	10	26	40	50
^{137}Cs	0.01	0.01	10	5	0.20	0.06	0.12	0.02	0.12	0.02		0.08	0.12	0.02	10	5	40	15
^{95}Zr-Nb	0.01		10		0.20		0.12		0.12				0.12		10		40	
^{95}Zr		0.01		10		0.11		0.03		0.03		0.15		0.03		10		20
^{95}Nb		0.01		5		0.05		0.01		0.01		0.07		0.01		5		15
^{58}Co	0.02	0.01	15	5	0.23	0.05	0.20	0.01	0.20	0.01		0.07	0.20	0.01	15	5	55	15
^{54}Mn	0.02	0.01	10	5	0.20	0.05	0.15	0.01	0.15	0.01		0.08	0.15	0.01	10	5	40	15
^{65}Zn	0.02	0.01	15	9	0.25	0.11	0.23	0.02	0.23	0.02		0.17	0.23	0.02	15	9	70	20
^{60}Co	0.01	0.01	10	5	0.17	0.06	0.11	0.01	0.11	0.01		0.08	0.11	0.01	10	5	30	15
^{40}K	0.10		150		2.50		0.90		0.90				0.90		150		400	
^{140}Ba-La	0.02		15		0.68		0.15		0.15				0.15		15		50	
^{140}Ba		0.02		25		0.34		0.07		0.07		0.30		0.07		25		50
^{140}La		0.01		7		0.08		0.02		0.02		0.10		0.02		7		15

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TABLE 3.2-1 (Continued)

TABLE NOTATIONS

* The NaI(Tl) LLD values are calculated by the method developed by Pasternak and Harley as described in HASL-300 and Nucl. Instr. Methods, 533-40 (1971). These LLD values are expected to vary depending on the activities of the components in the samples. These figures do not represent the LLD values achievable on a given sample. Water is counted in a 3.5-L Marinelli beaker. Vegetation, fish, soil, and sediment are counted in a 1-pint container as dry weight. The average dry weight is 120 grams for vegetation and 400-500 grams for soil sediment and fish. Meat and poultry are counted in a 1-pint container as dry weight, then corrected to wet weight using an average moisture content of 70%. Average dry weight is 250 grams. Air particulates are counted in a well crystal. The counting system consists of a multichannel analyzer and either a 4" x 5" well NaI(Tl) crystal. The counting time is 4000 seconds. All calculations are performed by the least-squares computer program ALPHA-M. The assumption is made that the samples are analyzed within one week of the collection date.

** The Ge(Li) LLD values are calculated by the methods developed by Pasternak and Harley as described in HASL-300. These LLD values are expected to vary depending on the activities of the components in the samples. These figures do not represent the LLD values achievable on given samples. Water is counted in either a 0.5-L or 3.5-L Marinelli beaker. Solid samples such as soil, sediment, and clam shells are counted in a 0.5-L Marinelli beaker as dry weight. The average dry weight is 400-500 grams. Air filters and very small volume samples are counted in petrie dishes centered in the detector endcap. The counting system consists of a ND-4420 multichannel analyzer and either a 8%, 14%, or 18% Ge(Li) detector. The counting time is normally 8 hours. All spectral analysis is performed using the softwater provided with the ND-4420. The assumption is made that all samples are analyzed within one week of the collection date.

a. All LLD values for isotopic separations are calculated by the method developed by Pasternak and Harley as described in HASL-300. Factors such as sample size, decay times, chemical yield, and counting efficiency may vary for a given sample; these variations may change the LLD value for the given sample. The assumption is made that all samples are analyzed within one week of the collection date.

The LLD is the smallest concentration of radioactive material in a sample that will be detected with 95% probability with 5% probability of fasely concluding that a blank observation represents a "real" signal.

TABLE 3.2-1 (Continued)

TABLE NOTATION

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

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

where

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

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

E is the counting efficiency (as counts per transformation)

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

2.22 is the number of transformation per minute per picocurie

Y is the fractional radiochemical yield (when applicable)

λ is the radioactive decay constant for the particular radionuclide

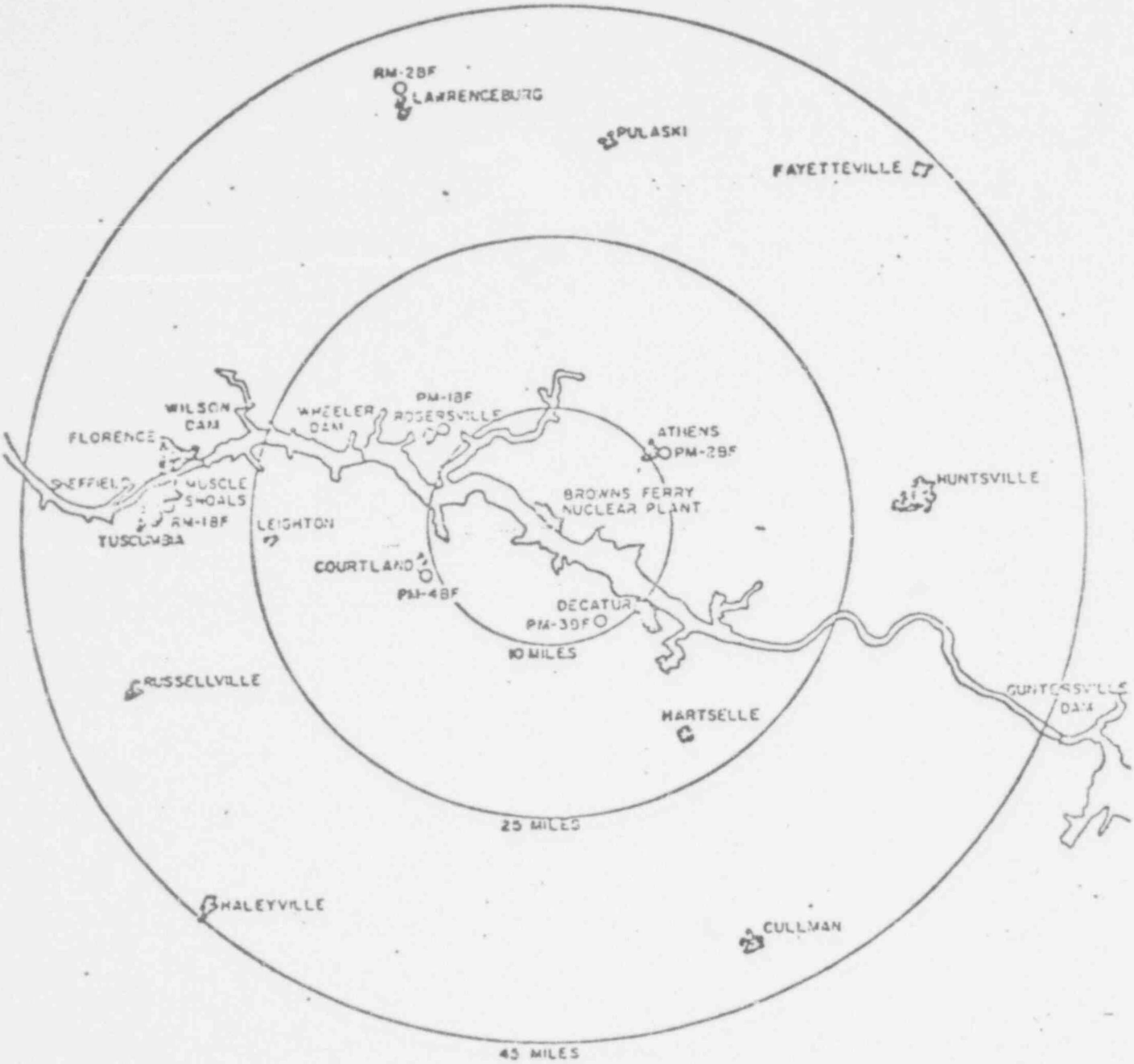
Δt is the elapsed time between sample collection (or end of the sample collection period) and time of counting

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

Figure 3.1-1

Browns Ferry Nuclear Plant

ATMOSPHERIC AND TERRESTRIAL MONITORING NETWORK



O - ENVIRONMENTAL MONITORING STATION

NOTE: THE FOLLOWING SAMPLES ARE COLLECTED FROM EACH STATION:

AIR PARTICULATES	RAINWATER
RADIOIODINE	SOIL
HEAVY PARTICLE FALLOUT	VEGETATION

POOR ORIGINAL

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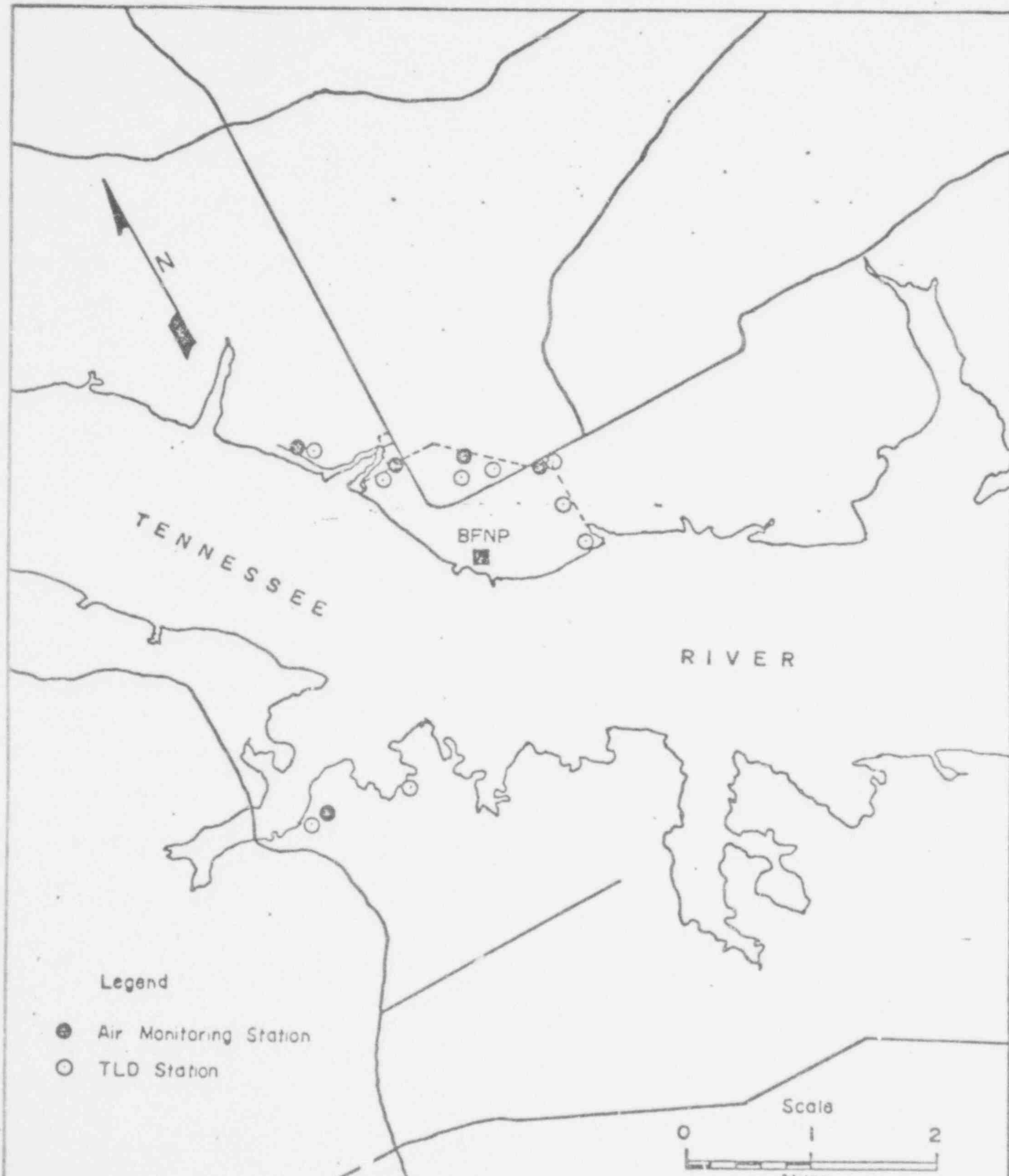
Figure 3.1-2

LOCAL MONITORING STATIONS

BROWNS FERRY NUCLEAR PLANT



302 066

Figure 3.1-3

LOCAL MONITORING STATIONS

BROWNS FERRY NUCLEAR PLANT

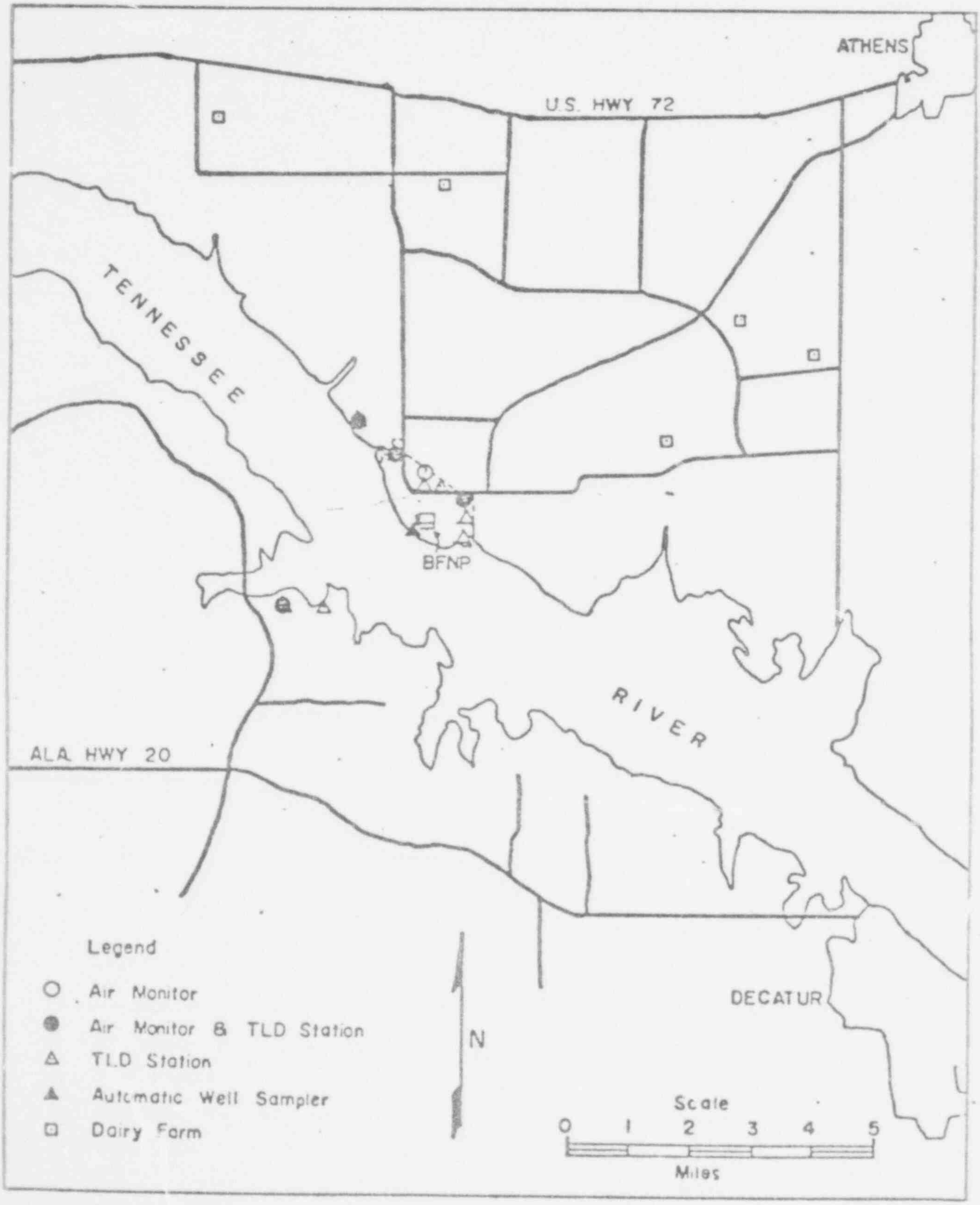
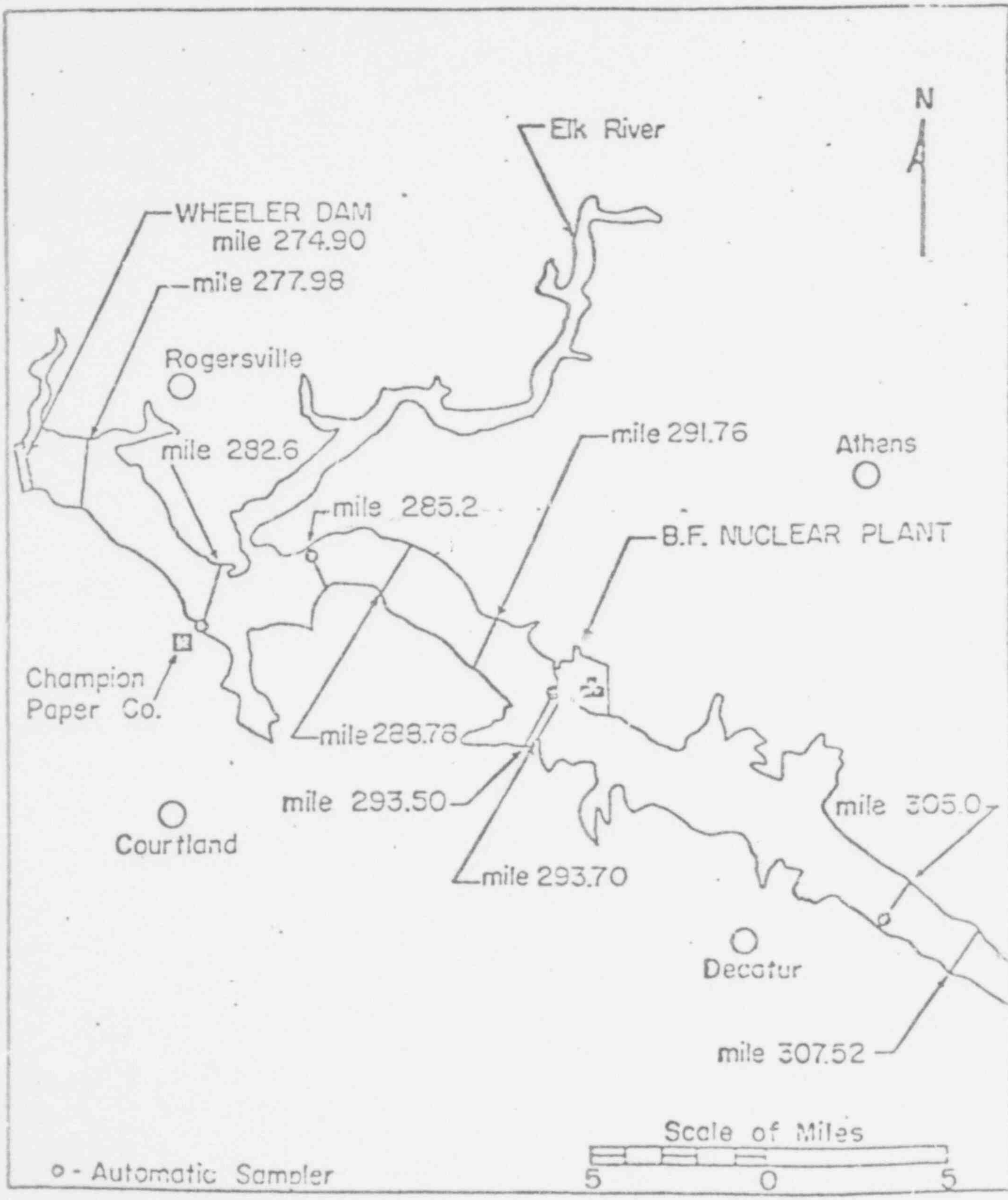


Figure 3.1-4

Browns Ferry Nuclear Plant

RESERVOIR MONITORING NETWORK



Appendix I

This appendix contains 10CFR20, Appendix B. The values in this appendix are the maximum permissible concentrations (MPC) in air and water above natural background.

APPENDIX B

Concentrations in Air and Water Above Natural Background

(See notes at end of appendix)

Element (atomic number)	Isotope[1]		Table I Column 1 Air (μc/ml)	Table I Column 2 Water (μc/ml)	Table II Column 1 Air (μc/ml)	Table II Column 2 Water (μc/ml)
Actinium (89)	Ac 227	S	2×10^{-12}	6×10^{-5}	8×10^{-14}	2×10^{-6}
		I	3×10^{-11}	9×10^{-3}	9×10^{-13}	3×10^{-4}
	Ac 228	S	8×10^{-8}	3×10^{-3}	3×10^{-9}	9×10^{-5}
		I	2×10^{-8}	3×10^{-3}	6×10^{-10}	9×10^{-5}
Americium (95)	Am 241	S	6×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		* I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}
	Am 242m	S	6×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		I	3×10^{-10}	3×10^{-3}	9×10^{-12}	9×10^{-5}
	Am 242	S	4×10^{-8}	4×10^{-3}	1×10^{-9}	1×10^{-4}
		I	5×10^{-8}	4×10^{-3}	2×10^{-9}	1×10^{-4}
	Am 243	S	6×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}
	Am 244	S	4×10^{-6}	1×10^{-1}	1×10^{-7}	5×10^{-3}
		I	2×10^{-5}	1×10^{-1}	8×10^{-7}	5×10^{-3}
Antimony (51)	Sb 122	S	2×10^{-7}	8×10^{-4}	6×10^{-9}	3×10^{-5}
		I	1×10^{-7}	8×10^{-4}	5×10^{-9}	3×10^{-5}
	Sb 124	S	2×10^{-7}	7×10^{-4}	5×10^{-9}	2×10^{-5}
		I	2×10^{-8}	7×10^{-4}	7×10^{-10}	2×10^{-5}
	Sb 125	S	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	3×10^{-8}	3×10^{-3}	9×10^{-10}	1×10^{-4}
Argon (18)	A 37	Sub[2]	6×10^{-3}	....	1×10^{-4}	....
	A 41	Sub	2×10^{-6}	....	4×10^{-8}	....
Arsenic (33)	As 73	S	2×10^{-6}	1×10^{-2}	7×10^{-8}	5×10^{-4}
		I	4×10^{-7}	1×10^{-2}	1×10^{-8}	5×10^{-4}
	As 74	S	3×10^{-7}	2×10^{-3}	1×10^{-8}	5×10^{-5}
		I	1×10^{-7}	2×10^{-3}	4×10^{-9}	5×10^{-5}
	As 76	S	1×10^{-7}	6×10^{-4}	4×10^{-9}	2×10^{-5}
		I	1×10^{-7}	6×10^{-4}	3×10^{-9}	2×10^{-5}
	As 77	S	5×10^{-7}	2×10^{-3}	3×10^{-8}	8×10^{-5}
		I	4×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-5}
Astatine (85)	At 211	S	7×10^{-9}	5×10^{-5}	2×10^{-10}	2×10^{-6}
		I	3×10^{-8}	2×10^{-3}	1×10^{-9}	7×10^{-5}
Barium (56)	Ba 131	S	1×10^{-6}	5×10^{-3}	4×10^{-8}	2×10^{-4}
		I	4×10^{-7}	5×10^{-3}	1×10^{-8}	2×10^{-4}
	Ba 140	S	1×10^{-7}	8×10^{-4}	4×10^{-9}	3×10^{-5}
		I	4×10^{-8}	7×10^{-4}	1×10^{-9}	2×10^{-5}
Berkelium (97)	Bk 249	S	9×10^{-10}	2×10^{-2}	3×10^{-11}	6×10^{-4}
		I	1×10^{-7}	2×10^{-2}	4×10^{-9}	6×10^{-4}
	Bk 250	S	1×10^{-7}	6×10^{-3}	5×10^{-9}	2×10^{-4}
		I	1×10^{-6}	6×10^{-3}	4×10^{-8}	2×10^{-4}
Beryllium (4)	Be 7	S	6×10^{-6}	5×10^{-2}	2×10^{-7}	2×10^{-3}
		I	1×10^{-6}	5×10^{-2}	4×10^{-8}	2×10^{-3}
Bismuth (83)	Bi 206	S	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
		I	1×10^{-7}	1×10^{-3}	5×10^{-9}	5×10^{-5}
	Bi 207	S	2×10^{-7}	2×10^{-3}	6×10^{-9}	6×10^{-5}
		I	1×10^{-8}	2×10^{-3}	5×10^{-10}	6×10^{-5}
	Bi 210	S	6×10^{-9}	1×10^{-3}	2×10^{-10}	4×10^{-5}
		I	6×10^{-9}	1×10^{-3}	2×10^{-10}	4×10^{-5}
			1×10^{-7}	1×10^{-2}	3×10^{-9}	4×10^{-4}

APPENDIX B

Concentrations in Air and Water Above Natural Background—Continued

(See notes at end of appendix)

Element (atomic number)	Isotope[1]		Table I Column 1 Air (μc/ml)	Table I Column 2 Water (μc/ml)	Table II Column 1 Air (μc/ml)	Table II Column 2 Water (μc/ml)
Bromine (35)	Br 82	S	1×10^{-6}	8×10^{-3}	4×10^{-8}	3×10^{-4}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
Cadmium (48)	Cd 109	S	5×10^{-8}	5×10^{-3}	2×10^{-9}	3×10^{-4}
		I	7×10^{-8}	5×10^{-3}	3×10^{-9}	2×10^{-4}
	Cd 115m	S	4×10^{-8}	7×10^{-4}	1×10^{-9}	1×10^{-5}
		I	4×10^{-8}	7×10^{-4}	1×10^{-9}	3×10^{-5}
	Cd 115	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	3×10^{-5}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	1×10^{-5}
Calcium (20)	Ca 45	S	3×10^{-8}	3×10^{-4}	1×10^{-9}	9×10^{-6}
		I	1×10^{-7}	5×10^{-3}	4×10^{-9}	2×10^{-4}
	Ca 47	S	2×10^{-7}	1×10^{-3}	6×10^{-9}	5×10^{-5}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	3×10^{-5}
Californium (98)	Cf 249	S	2×10^{-12}	1×10^{-4}	5×10^{-14}	4×10^{-6}
		I	1×10^{-10}	7×10^{-4}	3×10^{-12}	2×10^{-5}
	Cf 250	S	5×10^{-12}	4×10^{-4}	2×10^{-13}	1×10^{-5}
		I	1×10^{-10}	7×10^{-4}	3×10^{-12}	3×10^{-5}
	Cf 251	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	4×10^{-6}
		I	1×10^{-10}	8×10^{-4}	3×10^{-12}	3×10^{-5}
	Cf 252	* S	6×10^{-12}	7×10^{-4}	2×10^{-13}	7×10^{-6}
		* I	3×10^{-11}	7×10^{-4}	1×10^{-12}	7×10^{-6}
	Cf 253	S	8×10^{-10}	4×10^{-3}	3×10^{-11}	1×10^{-4}
		I	8×10^{-10}	4×10^{-3}	2×10^{-11}	1×10^{-4}
	Cf 254	S	5×10^{-12}	4×10^{-6}	2×10^{-13}	1×10^{-7}
		I	5×10^{-12}	4×10^{-6}	2×10^{-13}	1×10^{-7}
Carbon (6)	C 14	S	4×10^{-6}	2×10^{-2}	1×10^{-7}	8×10^{-4}
	(CO_2)	Sub	5×10^{-5}	....	1×10^{-6}	....
Cerium (58)	Ce 141	S	4×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
		I	2×10^{-7}	3×10^{-3}	5×10^{-9}	9×10^{-5}
	Ce 143	S	3×10^{-7}	1×10^{-3}	9×10^{-9}	4×10^{-5}
		I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}
	Ce 144	S	1×10^{-8}	3×10^{-4}	3×10^{-10}	1×10^{-5}
		I	6×10^{-9}	3×10^{-4}	2×10^{-10}	1×10^{-5}
Cesium (55)	Cs 131	S	1×10^{-5}	7×10^{-2}	4×10^{-7}	2×10^{-3}
		I	3×10^{-6}	3×10^{-2}	1×10^{-7}	9×10^{-4}
	Cs 134m	S	4×10^{-5}	2×10^{-1}	1×10^{-6}	6×10^{-3}
		I	6×10^{-6}	3×10^{-2}	2×10^{-7}	1×10^{-3}
	Cs 134	S	4×10^{-8}	3×10^{-4}	1×10^{-9}	9×10^{-6}
		I	1×10^{-8}	1×10^{-3}	4×10^{-10}	4×10^{-5}
	Cs 135	S	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	9×10^{-8}	7×10^{-3}	3×10^{-9}	2×10^{-4}
	Cs 136	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	9×10^{-5}
		I	2×10^{-7}	2×10^{-3}	6×10^{-9}	6×10^{-5}
	Cs 137	S	6×10^{-8}	4×10^{-4}	2×10^{-9}	2×10^{-5}
		I	1×10^{-8}	1×10^{-3}	5×10^{-10}	4×10^{-5}
Chlorine (17)	Cl 36	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-5}
		I	2×10^{-8}	2×10^{-3}	8×10^{-10}	6×10^{-5}
	Cl 38	S	3×10^{-6}	1×10^{-2}	9×10^{-8}	4×10^{-4}
		I	2×10^{-6}	1×10^{-2}	7×10^{-8}	4×10^{-4}
Chromium (24)	Cr 51	S	1×10^{-5}	5×10^{-2}	4×10^{-7}	2×10^{-3}

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APPENDIX B

Concentrations in Air and Water Above Natural Background—Continued

(See notes at end of appendix)

Element (atomic number)	Isotope [1]		Table I Column 1 Air (μc/ml)	Table I Column 2 Water (μc/ml)	Table II Column 1 Air (μc/ml)	Table II Column 2 Water (μc/ml)
Cobalt (27)	Co 57	S	3×10^{-6}	2×10^{-2}	1×10^{-7}	5×10^{-4}
		I	2×10^{-7}	1×10^{-2}	6×10^{-9}	4×10^{-4}
	Co 58m	S	2×10^{-5}	8×10^{-2}	6×10^{-7}	3×10^{-3}
		I	9×10^{-6}	6×10^{-2}	3×10^{-7}	2×10^{-3}
	Co 58	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	5×10^{-8}	3×10^{-3}	2×10^{-9}	9×10^{-5}
	Co 60	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	5×10^{-5}
		I	9×10^{-9}	1×10^{-3}	3×10^{-10}	3×10^{-5}
Copper (29)	Cu 64	S	2×10^{-6}	1×10^{-2}	7×10^{-8}	3×10^{-4}
		I	1×10^{-6}	6×10^{-3}	4×10^{-8}	2×10^{-4}
Curium (96)	Cm 242	S	1×10^{-10}	7×10^{-4}	4×10^{-12}	2×10^{-5}
		* I	2×10^{-10}	7×10^{-4}	6×10^{-12}	2×10^{-5}
	Cm 243	S	6×10^{-12}	1×10^{-4}	2×10^{-13}	5×10^{-6}
		I	1×10^{-10}	7×10^{-4}	3×10^{-12}	2×10^{-5}
	Cm 244	S	9×10^{-12}	2×10^{-4}	3×10^{-13}	7×10^{-6}
		I	1×10^{-10}	8×10^{-4}	3×10^{-12}	3×10^{-5}
	Cm 245	S	5×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}
	Cm 246	S	5×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}
	Cm 247	S	5×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		I	1×10^{-10}	6×10^{-4}	4×10^{-12}	2×10^{-5}
	Cm 248	S	6×10^{-13}	1×10^{-5}	2×10^{-14}	4×10^{-7}
		I	1×10^{-11}	4×10^{-5}	4×10^{-13}	1×10^{-6}
	Cm 249	S	1×10^{-5}	6×10^{-2}	4×10^{-7}	2×10^{-3}
		I	1×10^{-5}	6×10^{-2}	4×10^{-7}	2×10^{-3}
Dysprosium (66)	Dy 165	S	3×10^{-6}	1×10^{-2}	9×10^{-8}	4×10^{-4}
		I	2×10^{-6}	1×10^{-2}	7×10^{-8}	4×10^{-4}
	Dy 166	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
		I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}
Einsteinium (99)	Es 253	S	8×10^{-10}	7×10^{-4}	3×10^{-11}	2×10^{-5}
		I	6×10^{-10}	7×10^{-4}	2×10^{-11}	2×10^{-5}
	Es 254m	S	5×10^{-9}	5×10^{-4}	2×10^{-10}	2×10^{-5}
		I	6×10^{-9}	5×10^{-4}	2×10^{-10}	2×10^{-5}
	Es 254	S	2×10^{-11}	4×10^{-4}	6×10^{-13}	1×10^{-5}
		I	1×10^{-10}	4×10^{-4}	4×10^{-12}	1×10^{-5}
	Es 255	S	5×10^{-10}	8×10^{-4}	2×10^{-11}	3×10^{-5}
		I	4×10^{-10}	8×10^{-4}	1×10^{-11}	3×10^{-5}
Erbium (68)	Er 169	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
		I	4×10^{-7}	3×10^{-3}	1×10^{-8}	9×10^{-5}
	Er 171	S	7×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Europium (63)	Eu 152 (T/2 = 9.2 hrs)	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	Eu 152 (T/2 = 13 yrs)	S	1×10^{-8}	2×10^{-3}	4×10^{-10}	8×10^{-5}
		I	2×10^{-8}	2×10^{-3}	6×10^{-10}	8×10^{-5}
	Eu 154	S	4×10^{-9}	6×10^{-4}	1×10^{-10}	2×10^{-5}
		I	7×10^{-9}	6×10^{-4}	2×10^{-10}	2×10^{-5}
	Eu 155	S	9×10^{-8}	6×10^{-3}	3×10^{-9}	2×10^{-4}
		I	7×10^{-8}	6×10^{-3}	3×10^{-9}	2×10^{-4}

*Amended 37 FR 23319

APPENDIX B

Concentrations in Air and Water Above Natural Background—Continued

(See notes at end of appendix)

Element (atomic number)	Isotope [1]		Table I Column 1 Air (μc/ml)	Table I Column 2 Water (μc/ml)	Table II Column 1 Air (μc/ml)	Table II Column 2 Water (μc/ml)
Fermium (100)	Fm 254	S	6×10^{-8}	4×10^{-3}	2×10^{-9}	1×10^{-4}
		I	7×10^{-8}	4×10^{-3}	2×10^{-9}	1×10^{-4}
	Fm 255	S	2×10^{-8}	1×10^{-3}	6×10^{-10}	3×10^{-5}
		I	1×10^{-8}	1×10^{-3}	4×10^{-10}	3×10^{-5}
	Fm 256	S	3×10^{-9}	3×10^{-5}	1×10^{-10}	9×10^{-7}
		I	2×10^{-9}	3×10^{-5}	6×10^{-11}	9×10^{-7}
Fluorine (9)	F 18	S	5×10^{-6}	2×10^{-2}	2×10^{-7}	8×10^{-4}
		I	3×10^{-6}	1×10^{-2}	9×10^{-8}	5×10^{-4}
Gadolinium (64)	Gd 153	S	2×10^{-7}	6×10^{-3}	8×10^{-9}	2×10^{-4}
		I	9×10^{-8}	6×10^{-3}	3×10^{-9}	2×10^{-4}
	Gd 159	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	8×10^{-5}
		I	4×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-5}
Gallium (31)	Ga 72	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
Germanium (32)	Ge 71	S	1×10^{-5}	5×10^{-2}	4×10^{-7}	2×10^{-3}
		I	6×10^{-6}	5×10^{-2}	2×10^{-7}	2×10^{-3}
Gold (79)	Au 196	S	1×10^{-6}	5×10^{-3}	4×10^{-8}	2×10^{-4}
		I	6×10^{-7}	4×10^{-3}	2×10^{-8}	1×10^{-4}
	Au 198	S	3×10^{-7}	2×10^{-3}	1×10^{-8}	5×10^{-5}
		I	2×10^{-7}	1×10^{-3}	8×10^{-9}	5×10^{-5}
	Au 199	S	1×10^{-6}	5×10^{-3}	4×10^{-8}	2×10^{-4}
		I	8×10^{-7}	4×10^{-3}	3×10^{-8}	2×10^{-4}
Hafnium (72)	Hf 181	S	4×10^{-8}	2×10^{-3}	1×10^{-9}	7×10^{-5}
		I	7×10^{-8}	2×10^{-3}	3×10^{-9}	7×10^{-5}
Holmium (67)	Ho 166	S	2×10^{-7}	9×10^{-4}	7×10^{-9}	3×10^{-5}
		I	2×10^{-7}	9×10^{-4}	6×10^{-9}	3×10^{-5}
Hydrogen (1)	H3	S	5×10^{-6}	1×10^{-1}	2×10^{-7}	3×10^{-3}
		I	5×10^{-6}	1×10^{-1}	2×10^{-7}	3×10^{-3}
		Sub	2×10^{-3}	....	4×10^{-5}	....
Indium (49)	In 113m	S	8×10^{-6}	4×10^{-2}	3×10^{-7}	1×10^{-3}
		I	7×10^{-6}	4×10^{-2}	2×10^{-7}	1×10^{-3}
	In 114m	S	1×10^{-7}	5×10^{-4}	4×10^{-9}	2×10^{-5}
		I	2×10^{-8}	5×10^{-4}	7×10^{-10}	2×10^{-5}
	In 115m	S	2×10^{-6}	1×10^{-2}	8×10^{-8}	4×10^{-4}
		I	2×10^{-6}	1×10^{-2}	6×10^{-8}	4×10^{-4}
	In 115	S	2×10^{-7}	3×10^{-3}	9×10^{-9}	9×10^{-5}
		I	3×10^{-8}	3×10^{-3}	1×10^{-9}	9×10^{-5}
Iodine (53)	I 125	S	5×10^{-9}	4×10^{-5}	8×10^{-11}	2×10^{-7}
		I	2×10^{-7}	6×10^{-3}	6×10^{-9}	2×10^{-4}
	I 126	S	8×10^{-9}	5×10^{-5}	9×10^{-11}	3×10^{-7}
		I	3×10^{-7}	3×10^{-3}	1×10^{-8}	9×10^{-5}
	I 129	S	2×10^{-9}	1×10^{-5}	2×10^{-11}	6×10^{-8}
		I	7×10^{-8}	6×10^{-3}	2×10^{-9}	2×10^{-4}
	I 131	S	9×10^{-9}	6×10^{-5}	1×10^{-10}	3×10^{-7}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	I 132	S	2×10^{-7}	2×10^{-3}	3×10^{-9}	8×10^{-6}
		I	9×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
	I 133	S	3×10^{-8}	2×10^{-4}	4×10^{-10}	1×10^{-6}
		I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}
	I 134	S	5×10^{-7}	4×10^{-3}	6×10^{-9}	2×10^{-5}

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APPENDIX B

Concentrations in Air and Water Above Natural Background—Continued

(See notes at end of appendix)

Element (atomic number)	Isotope [1]		Table I Column 1 Air (μc/ml)	Table I Column 2 Water (μc/ml)	Table II Column 1 Air (μc/ml)	Table II Column 2 Water (μc/ml)
Iodine (53)	I 134	I	3×10^{-6}	2×10^{-2}	1×10^{-7}	6×10^{-4}
	I 135	S	1×10^{-7}	7×10^{-4}	1×10^{-8}	4×10^{-6}
		I	4×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-6}
Iridium (77)	Ir 190	S	1×10^{-6}	6×10^{-3}	4×10^{-8}	2×10^{-5}
		I	4×10^{-7}	5×10^{-3}	1×10^{-8}	2×10^{-4}
	Ir 192	S	1×10^{-7}	1×10^{-3}	4×10^{-9}	4×10^{-4}
		I	3×10^{-8}	1×10^{-3}	9×10^{-10}	4×10^{-5}
	Ir 194	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	3×10^{-5}
		I	2×10^{-7}	9×10^{-4}	5×10^{-9}	3×10^{-5}
Iron (26)	Fe 55	S	9×10^{-7}	2×10^{-2}	3×10^{-8}	8×10^{-4}
		I	1×10^{-6}	7×10^{-2}	3×10^{-8}	2×10^{-3}
	Fe 59	S	1×10^{-7}	2×10^{-3}	5×10^{-9}	6×10^{-5}
		I	5×10^{-8}	2×10^{-3}	2×10^{-9}	5×10^{-5}
Krypton (36)	Kr 85m	Sub	6×10^{-6}	....	1×10^{-7}	....
	Kr 85	Sub	1×10^{-5}	....	3×10^{-7}	....
	Kr 87	Sub	1×10^{-6}	....	2×10^{-8}	....
	Kr 88	Sub	1×10^{-6}	....	2×10^{-8}	....
Lanthanum (57)	La 140	S	2×10^{-7}	7×10^{-4}	5×10^{-9}	2×10^{-5}
		I	1×10^{-7}	7×10^{-4}	4×10^{-9}	2×10^{-5}
Lead (82)	Pb 203	S	3×10^{-6}	1×10^{-2}	9×10^{-8}	4×10^{-4}
		I	2×10^{-6}	1×10^{-2}	6×10^{-8}	4×10^{-4}
	Pb 210	S	1×10^{-10}	4×10^{-6}	4×10^{-12}	1×10^{-7}
		I	2×10^{-10}	5×10^{-3}	8×10^{-12}	2×10^{-4}
	Pb 212	S	2×10^{-8}	6×10^{-4}	6×10^{-10}	2×10^{-5}
		I	2×10^{-8}	5×10^{-4}	7×10^{-10}	2×10^{-5}
Lutetium (71)	Lu 177	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Manganese (25)	Mn 52	S	2×10^{-7}	1×10^{-3}	7×10^{-9}	3×10^{-5}
		I	1×10^{-7}	9×10^{-4}	5×10^{-9}	3×10^{-5}
	Mn 54 *	S	4×10^{-7}	4×10^{-3}	1×10^{-8}	1×10^{-4}
		I	4×10^{-8}	3×10^{-3}	1×10^{-9}	1×10^{-4}
	Mn 56	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Mercury (80)	Hg 197m	S	7×10^{-7}	6×10^{-3}	3×10^{-8}	2×10^{-4}
		I	8×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
	Hg 197	S	1×10^{-6}	9×10^{-3}	4×10^{-8}	3×10^{-4}
		I	3×10^{-6}	1×10^{-2}	9×10^{-8}	5×10^{-4}
	Hg 203	S	7×10^{-8}	5×10^{-4}	2×10^{-9}	2×10^{-5}
		I	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-4}
Molybdenum (42)	Mo 99	S	7×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
		I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}
Neodymium (60)	Nd 144	S	8×10^{-11}	2×10^{-3}	3×10^{-12}	7×10^{-5}
		I	3×10^{-10}	2×10^{-3}	1×10^{-11}	8×10^{-5}
	Nd 147	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	2×10^{-7}	2×10^{-3}	8×10^{-9}	6×10^{-5}
	Nd 149	S	2×10^{-6}	8×10^{-3}	6×10^{-8}	3×10^{-4}
		I	1×10^{-6}	8×10^{-3}	5×10^{-8}	3×10^{-4}

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APPENDIX B

Concentrations in Air and Water Above Natural Background—Continued

(See notes at end of appendix)

Element (atomic number)	Isotope [1]		Table I Column 1 Air (μc/ml)	Table I Column 2 Water (μc/ml)	Table II Column 1 Air (μc/ml)	Table II Column 2 Water (μc/ml)
Neptunium (93)	Np 237	S	4×10^{-12}	9×10^{-5}	1×10^{-13}	3×10^{-6}
		I	1×10^{-10}	9×10^{-3}	4×10^{-12}	3×10^{-4}
	Np 239	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	7×10^{-7}	4×10^{-3}	2×10^{-8}	1×10^{-4}
Nickel (28)	Ni 59	S	5×10^{-7}	6×10^{-3}	2×10^{-8}	2×10^{-4}
		I	8×10^{-7}	6×10^{-2}	3×10^{-8}	2×10^{-3}
	Ni 63	S	6×10^{-8}	8×10^{-4}	2×10^{-9}	3×10^{-5}
		I	3×10^{-7}	2×10^{-2}	1×10^{-8}	7×10^{-4}
	Ni 65	S	9×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Niobium (Columbium) (41)	Nb 93m	S	1×10^{-7}	1×10^{-2}	4×10^{-9}	4×10^{-4}
		I	2×10^{-7}	1×10^{-2}	5×10^{-9}	4×10^{-4}
	Nb 95	S	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	1×10^{-7}	3×10^{-3}	3×10^{-9}	1×10^{-4}
	Nb 97	S	6×10^{-6}	3×10^{-2}	2×10^{-7}	9×10^{-4}
		I	5×10^{-6}	3×10^{-2}	2×10^{-7}	9×10^{-4}
Osmium (76)	Os 185	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	7×10^{-5}
		I	5×10^{-8}	2×10^{-3}	2×10^{-9}	7×10^{-5}
	Os 191m	S	2×10^{-5}	7×10^{-2}	6×10^{-7}	3×10^{-3}
		I	9×10^{-6}	7×10^{-2}	3×10^{-7}	2×10^{-3}
	Os 191	S	1×10^{-6}	5×10^{-3}	4×10^{-8}	2×10^{-4}
		I	4×10^{-7}	5×10^{-3}	1×10^{-8}	2×10^{-4}
	Os 193	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	3×10^{-7}	2×10^{-3}	9×10^{-9}	5×10^{-5}
Palladium (46)	Pd 103	S	1×10^{-6}	1×10^{-2}	5×10^{-8}	3×10^{-4}
		I	7×10^{-7}	8×10^{-3}	3×10^{-8}	3×10^{-4}
	Pd 109	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
		I	4×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-5}
Phosphorus (15)	P 32	S	7×10^{-8}	5×10^{-4}	2×10^{-9}	2×10^{-5}
		I	8×10^{-8}	7×10^{-4}	3×10^{-9}	2×10^{-5}
Platinum (78)	Pt 191	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
	Pt 193m	S	7×10^{-6}	3×10^{-2}	2×10^{-7}	1×10^{-3}
		I	5×10^{-6}	3×10^{-2}	2×10^{-7}	1×10^{-3}
**	Pt 193	S	1×10^{-6}	3×10^{-3}	4×10^{-8}	9×10^{-5}
		I	3×10^{-7}	5×10^{-3}	1×10^{-8}	2×10^{-4}
	Pt 197m	S	6×10^{-6}	3×10^{-2}	2×10^{-7}	1×10^{-3}
		I	5×10^{-6}	3×10^{-2}	2×10^{-7}	9×10^{-4}
	Pt 197	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Plutonium (94)	Pu 238	S	2×10^{-12}	1×10^{-4}	7×10^{-14}	5×10^{-6}
		I	3×10^{-11}	8×10^{-4}	1×10^{-12}	3×10^{-5}
	Pu 239	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	5×10^{-6}
		I	4×10^{-11}	8×10^{-4}	1×10^{-12}	3×10^{-5}
	Pu 240	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	5×10^{-6}
		I	4×10^{-11}	8×10^{-4}	1×10^{-12}	3×10^{-5}
	Pu 241	S	9×10^{-11}	7×10^{-3}	3×10^{-12}	2×10^{-4}
		I	4×10^{-8}	4×10^{-2}	1×10^{-9}	1×10^{-3}

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Concentrations in Air and Water Above Natural Background—Continued

(See notes at end of appendix)

Element (atomic number)	Isotope[1]		Table I Column 1 Air (μc/ml)	Table I Column 2 Water (μc/ml)	Table II Column 1 Air (μc/ml)	Table II Column 2 Water (μc/ml)
Plutonium (94)	Pu 242	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	5×10^{-6}
		I	4×10^{-11}	9×10^{-4}	1×10^{-12}	3×10^{-5}
	Pu 243	S	2×10^{-6}	1×10^{-2}	6×10^{-8}	3×10^{-4}
		I	2×10^{-6}	1×10^{-2}	8×10^{-8}	3×10^{-4}
	Pu 244	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	4×10^{-6}
		I	3×10^{-11}	3×10^{-4}	1×10^{-12}	1×10^{-5}
Polonium (84)	Po 210	S	5×10^{-10}	2×10^{-5}	2×10^{-11}	7×10^{-7}
		I	2×10^{-10}	8×10^{-4}	7×10^{-12}	3×10^{-5}
Potassium (19)	K 42	S	2×10^{-6}	9×10^{-4}	7×10^{-8}	3×10^{-5}
		I	1×10^{-7}	6×10^{-4}	4×10^{-9}	2×10^{-5}
Praseodymium (59)	Pr 142	S	2×10^{-7}	9×10^{-4}	7×10^{-9}	3×10^{-5}
		I	2×10^{-7}	9×10^{-4}	5×10^{-9}	3×10^{-5}
	Pr 143	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	5×10^{-5}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	5×10^{-5}
Promethium (61)	Pm 147	S	6×10^{-8}	6×10^{-3}	2×10^{-9}	2×10^{-4}
		I	1×10^{-7}	6×10^{-3}	3×10^{-9}	2×10^{-4}
	Pm 149	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	4×10^{-5}
		I	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
Protoactinium (91)	Pa 230	S	2×10^{-9}	7×10^{-3}	6×10^{-11}	2×10^{-4}
		I	8×10^{-10}	7×10^{-3}	3×10^{-11}	2×10^{-4}
	Pa 231	S	1×10^{-12}	3×10^{-5}	4×10^{-14}	9×10^{-7}
		I	1×10^{-10}	8×10^{-4}	4×10^{-12}	2×10^{-5}
	Pa 233	S	6×10^{-7}	4×10^{-3}	2×10^{-8}	1×10^{-4}
		I	2×10^{-7}	3×10^{-3}	6×10^{-9}	1×10^{-4}
Radium (88)	Ra 223	S	2×10^{-9}	2×10^{-5}	6×10^{-11}	7×10^{-7}
		I	2×10^{-10}	1×10^{-4}	8×10^{-12}	4×10^{-6}
	Ra 224	S	5×10^{-9}	7×10^{-5}	2×10^{-10}	2×10^{-6}
		I	7×10^{-10}	2×10^{-4}	2×10^{-11}	5×10^{-6}
	Ra 226	S	3×10^{-11}	4×10^{-7}	3×10^{-12}	3×10^{-8}
		I	5×10^{-11}	9×10^{-4}	2×10^{-12}	3×10^{-5}
	Ra 228	S	7×10^{-11}	8×10^{-7}	2×10^{-12}	3×10^{-8}
		I	4×10^{-11}	7×10^{-4}	1×10^{-12}	3×10^{-5}
Radon (86)	Rn 220	S	3×10^{-7}	....	1×10^{-8}	....
	Rn 222	S	1×10^{-7}	....	3×10^{-9}	....
Rhenium (75)	Re 183	S	3×10^{-6}	2×10^{-2}	9×10^{-8}	6×10^{-4}
		I	2×10^{-7}	8×10^{-3}	5×10^{-9}	3×10^{-4}
	Re 186	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
		I	2×10^{-7}	1×10^{-3}	8×10^{-9}	5×10^{-5}
	Re 187	S	9×10^{-6}	7×10^{-2}	3×10^{-7}	3×10^{-3}
		I	5×10^{-7}	4×10^{-2}	2×10^{-8}	2×10^{-3}
	Re 188	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	2×10^{-7}	9×10^{-4}	6×10^{-9}	3×10^{-5}
Rhodium (45)	Rh 103m	S	8×10^{-5}	4×10^{-1}	3×10^{-6}	1×10^{-2}
		I	6×10^{-5}	3×10^{-1}	2×10^{-6}	1×10^{-2}
	Rh 105	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Rubidium (37)	Rb 86	S	3×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-5}
		I	7×10^{-8}	7×10^{-4}	2×10^{-9}	2×10^{-5}
	Rb 87	S	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	7×10^{-8}	5×10^{-3}	2×10^{-9}	2×10^{-4}

APPENDIX B

Concentrations in Air and Water Above Natural Background—Continued

(See notes at end of appendix)

Element (atomic number)	Isotope[1]		Table I Column 1 Air (μc/ml)	Table I Column 2 Water (μc/ml)	Table II Column 1 Air (μc/ml)	Table II Column 2 Water (μc/ml)
Ruthenium (44)	Ru 97	S	2×10^{-6}	1×10^{-2}	8×10^{-8}	4×10^{-4}
		I	2×10^{-6}	1×10^{-2}	6×10^{-8}	3×10^{-4}
	Ru 103	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	8×10^{-5}
		I	8×10^{-8}	2×10^{-3}	3×10^{-9}	8×10^{-5}
	Ru 105	S	7×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
	Ru 106	S	8×10^{-8}	4×10^{-4}	3×10^{-9}	1×10^{-5}
		I	6×10^{-9}	3×10^{-4}	2×10^{-10}	1×10^{-5}
Samarium (62)	Sm 147	S	7×10^{-11}	2×10^{-3}	2×10^{-12}	6×10^{-5}
		I	3×10^{-10}	2×10^{-3}	9×10^{-12}	7×10^{-5}
	Sm 151	S	6×10^{-8}	1×10^{-2}	2×10^{-9}	4×10^{-4}
		I	1×10^{-7}	1×10^{-2}	5×10^{-9}	4×10^{-4}
	Sm 153	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	8×10^{-5}
		I	4×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-5}
Scandium (21)	Sc 46	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
		I	2×10^{-8}	1×10^{-3}	8×10^{-10}	4×10^{-5}
	Sc 47	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
	Sc 48	S	2×10^{-7}	8×10^{-4}	6×10^{-9}	3×10^{-5}
		I	1×10^{-7}	8×10^{-4}	5×10^{-9}	3×10^{-5}
Selenium (34)	Se 75	S	1×10^{-6}	9×10^{-3}	4×10^{-8}	3×10^{-4}
		I	1×10^{-7}	8×10^{-3}	4×10^{-9}	3×10^{-4}
Silicon (14)	Si 31	S	6×10^{-6}	3×10^{-2}	2×10^{-7}	9×10^{-4}
		I	1×10^{-6}	6×10^{-3}	3×10^{-8}	2×10^{-4}
Silver (47)	Ag 105	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	8×10^{-8}	3×10^{-3}	3×10^{-9}	1×10^{-4}
	Ag 110m	S	2×10^{-7}	9×10^{-4}	7×10^{-9}	3×10^{-5}
		I	1×10^{-8}	9×10^{-4}	3×10^{-10}	3×10^{-5}
	Ag 111	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	4×10^{-5}
		I	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
Sodium (11)	Na 22	S	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
		I	9×10^{-9}	9×10^{-4}	3×10^{-10}	3×10^{-5}
	Na 24	S	1×10^{-6}	6×10^{-3}	4×10^{-8}	2×10^{-4}
		I	1×10^{-7}	8×10^{-4}	5×10^{-9}	3×10^{-5}
Strontium (38)	Sr 85m	S	4×10^{-5}	2×10^{-1}	1×10^{-6}	7×10^{-3}
		I	3×10^{-5}	2×10^{-1}	1×10^{-6}	7×10^{-3}
	Sr 85	S	2×10^{-7}	3×10^{-3}	8×10^{-9}	1×10^{-4}
		I	1×10^{-7}	5×10^{-3}	4×10^{-9}	2×10^{-4}
	Sr 89	S	3×10^{-8}	3×10^{-4}	3×10^{-10}	3×10^{-6}
		I	4×10^{-8}	8×10^{-4}	1×10^{-9}	3×10^{-5}
	Sr 90	S	1×10^{-9}	1×10^{-5}	3×10^{-11}	3×10^{-7}
		I	5×10^{-9}	1×10^{-3}	2×10^{-10}	4×10^{-5}
	Sr 91	S	4×10^{-7}	2×10^{-3}	2×10^{-8}	7×10^{-5}
		I	3×10^{-7}	1×10^{-3}	9×10^{-9}	5×10^{-5}
	Sr 92	S	4×10^{-7}	2×10^{-3}	2×10^{-8}	7×10^{-5}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
Sulfur (16)	S 35	S	3×10^{-7}	2×10^{-3}	9×10^{-9}	6×10^{-5}
		I	3×10^{-7}	8×10^{-3}	9×10^{-9}	3×10^{-4}
Tantalum (73)	Ta 182	S	4×10^{-8}	1×10^{-3}	1×10^{-9}	4×10^{-5}
		I	2×10^{-8}	1×10^{-3}	7×10^{-10}	4×10^{-5}

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Concentrations in Air and Water Above Natural Background—Continued

(See notes at end of appendix)

Element (atomic number)	Isotope[1]		Table I Column 1 Air (μc/ml)	Table I Column 2 Water (μc/ml)	Table II Column 1 Air (μc/ml)	Table II Column 2 Water (μc/ml)
Technetium (43)	Tc 96m	S	8×10^{-5}	4×10^{-1}	3×10^{-6}	1×10^{-2}
		I	3×10^{-5}	3×10^{-1}	1×10^{-6}	1×10^{-2}
	Tc 96	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	2×10^{-7}	1×10^{-3}	8×10^{-9}	5×10^{-5}
	Tc 97m	S	2×10^{-6}	1×10^{-2}	8×10^{-8}	4×10^{-4}
		I	2×10^{-7}	5×10^{-3}	5×10^{-9}	2×10^{-4}
	Tc 97	S	1×10^{-5}	5×10^{-2}	4×10^{-7}	2×10^{-3}
		I	3×10^{-7}	2×10^{-2}	1×10^{-8}	8×10^{-4}
	Tc 99m	S	4×10^{-5}	2×10^{-1}	1×10^{-6}	6×10^{-3}
		I	1×10^{-5}	8×10^{-2}	5×10^{-7}	3×10^{-3}
	Tc 99	S	2×10^{-6}	1×10^{-2}	7×10^{-8}	3×10^{-4}
		I	6×10^{-8}	5×10^{-3}	2×10^{-9}	2×10^{-4}
Tellurium (52)	Te 125m	S	4×10^{-7}	5×10^{-3}	1×10^{-8}	2×10^{-4}
		I	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-4}
	Te 127m	S	1×10^{-7}	2×10^{-3}	5×10^{-9}	6×10^{-5}
		I	4×10^{-8}	2×10^{-3}	1×10^{-9}	5×10^{-5}
	Te 127	S	2×10^{-6}	8×10^{-3}	6×10^{-8}	3×10^{-4}
		I	9×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
	Te 129m	S	8×10^{-8}	1×10^{-3}	3×10^{-9}	3×10^{-5}
		I	3×10^{-8}	6×10^{-4}	1×10^{-9}	2×10^{-5}
	Te 129	S	5×10^{-6}	2×10^{-2}	2×10^{-7}	8×10^{-4}
		I	4×10^{-6}	2×10^{-2}	1×10^{-7}	8×10^{-4}
	Te 131m	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
	Te 132	S	2×10^{-7}	9×10^{-4}	7×10^{-9}	3×10^{-5}
		I	1×10^{-7}	6×10^{-4}	4×10^{-9}	2×10^{-5}
Terbium (65)	Tb 160	S	1×10^{-7}	1×10^{-3}	3×10^{-9}	4×10^{-5}
		I	3×10^{-8}	1×10^{-3}	1×10^{-9}	4×10^{-5}
Thallium (81)	Tl 200	S	3×10^{-6}	1×10^{-2}	9×10^{-8}	4×10^{-4}
		I	1×10^{-6}	7×10^{-3}	4×10^{-8}	2×10^{-4}
	Tl 201	S	2×10^{-6}	9×10^{-3}	7×10^{-8}	3×10^{-4}
		I	9×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
	Tl 202	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	2×10^{-7}	2×10^{-3}	8×10^{-9}	7×10^{-5}
	Tl 204	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	3×10^{-8}	2×10^{-3}	9×10^{-10}	6×10^{-5}
Thorium (90)	Th 227	S	3×10^{-10}	5×10^{-4}	1×10^{-11}	2×10^{-5}
		I	2×10^{-10}	5×10^{-4}	6×10^{-12}	2×10^{-5}
	Th 228	S	9×10^{-12}	2×10^{-4}	3×10^{-13}	7×10^{-6}
		I	6×10^{-12}	4×10^{-4}	2×10^{-13}	1×10^{-5}
	Th 230	S	2×10^{-12}	5×10^{-5}	8×10^{-14}	2×10^{-6}
		I	1×10^{-11}	9×10^{-4}	3×10^{-13}	3×10^{-5}
	Th 231	S	1×10^{-6}	7×10^{-3}	5×10^{-8}	2×10^{-4}
		I	1×10^{-6}	7×10^{-3}	4×10^{-8}	2×10^{-4}
	Th 232	S	3×10^{-11}	5×10^{-5}	1×10^{-12}	2×10^{-6}
		I	3×10^{-11}	1×10^{-3}	1×10^{-12}	4×10^{-5}
	Th natural	S	3×10^{-11}	3×10^{-5}	1×10^{-12}	1×10^{-6}
		I	3×10^{-11}	3×10^{-4}	1×10^{-12}	1×10^{-5}

APPENDIX B

Concentrations in Air and Water Above Natural Background—Continued

(See notes at end of appendix)

Element (atomic number)	Isotope[1]		Table I Column 1 Air (μc/ml)	Table I Column 2 Water (μc/ml)	Table II Column 1 Air (μc/ml)	Table II Column 2 Water (μc/ml)
Thorium (90)	Th 234	S	6×10^{-8}	5×10^{-4}	2×10^{-9}	2×10^{-5}
		I	3×10^{-8}	5×10^{-4}	1×10^{-9}	2×10^{-5}
Thulium (69)	Tm 170	S	4×10^{-8}	1×10^{-3}	1×10^{-9}	5×10^{-5}
		I	3×10^{-8}	1×10^{-3}	1×10^{-9}	5×10^{-5}
	Tm 171	S	1×10^{-7}	1×10^{-2}	4×10^{-9}	5×10^{-4}
		I	2×10^{-7}	1×10^{-2}	8×10^{-9}	5×10^{-4}
Tin (50)	Sn 113	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	9×10^{-5}
		I	5×10^{-8}	2×10^{-3}	2×10^{-9}	8×10^{-5}
	Sn 125	S	1×10^{-7}	5×10^{-4}	4×10^{-9}	2×10^{-5}
		I	8×10^{-8}	5×10^{-4}	3×10^{-9}	2×10^{-5}
Tungsten (Wolfram) (74)	W 181	S	2×10^{-6}	1×10^{-2}	8×10^{-8}	4×10^{-4}
		I	1×10^{-7}	1×10^{-2}	4×10^{-9}	3×10^{-4}
	W 185	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-4}
	W 187	S	4×10^{-7}	2×10^{-3}	2×10^{-8}	7×10^{-5}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
Uranium (92)	U 230	S	3×10^{-10}	1×10^{-4}	1×10^{-11}	5×10^{-6}
		I	1×10^{-10}	1×10^{-4}	4×10^{-12}	5×10^{-6}
	U 232	S	1×10^{-10}	8×10^{-4}	3×10^{-12}	3×10^{-5}
		I	3×10^{-11}	8×10^{-4}	9×10^{-13}	3×10^{-5}
	U 233	S	5×10^{-10}	9×10^{-4}	2×10^{-11}	3×10^{-5}
		I	1×10^{-10}	9×10^{-4}	4×10^{-12}	3×10^{-5}
	U 234	S	6×10^{-10}	9×10^{-4}	2×10^{-11}	3×10^{-5}
		I	1×10^{-10}	9×10^{-4}	4×10^{-12}	3×10^{-5}
	U 235	S	5×10^{-10}	8×10^{-4}	2×10^{-11}	3×10^{-5}
		I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}
	U 236	S	6×10^{-10}	1×10^{-3}	2×10^{-11}	3×10^{-5}
		I	1×10^{-10}	1×10^{-3}	4×10^{-12}	3×10^{-5}
	U 238	S	7×10^{-11}	1×10^{-3}	3×10^{-12}	4×10^{-5}
		I	1×10^{-10}	1×10^{-3}	5×10^{-12}	4×10^{-5}
	U 240	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	3×10^{-5}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	3×10^{-5}
	U-natural	S	7×10^{-11}	5×10^{-4}	3×10^{-12}	2×10^{-5}
		I	6×10^{-11}	5×10^{-4}	2×10^{-12}	2×10^{-5}
Vanadium (23)	V 48	S	2×10^{-7}	9×10^{-4}	6×10^{-9}	3×10^{-5}
		I	6×10^{-8}	8×10^{-4}	2×10^{-9}	3×10^{-5}
Xenon (54)	Xe 131m	Sub	2×10^{-5}	....	4×10^{-7}	....
	Xe 133	Sub	1×10^{-5}	....	3×10^{-7}	....
	Xe 133m	Sub	1×10^{-5}	....	3×10^{-7}	....
	Xe 135	Sub	4×10^{-6}	....	1×10^{-7}	....
Ytterbium (70)	Yb 175	S	7×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Yttrium (39)	Y 90	S	1×10^{-7}	6×10^{-4}	4×10^{-9}	2×10^{-5}
		I	1×10^{-7}	6×10^{-4}	3×10^{-9}	2×10^{-5}
	Y 91m	S	2×10^{-5}	1×10^{-1}	8×10^{-7}	3×10^{-3}
		I	2×10^{-5}	1×10^{-1}	6×10^{-7}	3×10^{-3}
	Y 91	S	4×10^{-8}	8×10^{-4}	1×10^{-9}	3×10^{-5}
		I	3×10^{-8}	8×10^{-4}	1×10^{-9}	3×10^{-5}
	Y 92	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}

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APPENDIX B

Concentrations in Air and Water Above Natural Background—Continued

(See notes at end of appendix)

Element (atomic number)	Isotope[1]		Table I Column 1 Air (μc/ml)	Table I Column 2 Water (μc/ml)	Table II Column 1 Air (μc/ml)	Table II Column 2 Water (μc/ml)
Zinc (30)	Zn 65	S	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-4}
		I	6×10^{-8}	5×10^{-3}	2×10^{-9}	2×10^{-4}
	Zn 69m	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-5}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	Zn 69	S	7×10^{-6}	5×10^{-2}	2×10^{-7}	2×10^{-3}
		I	9×10^{-6}	5×10^{-2}	3×10^{-7}	2×10^{-3}
Zirconium (40)	Zr 93	S	1×10^{-7}	2×10^{-2}	4×10^{-9}	8×10^{-4}
		I	3×10^{-7}	2×10^{-2}	1×10^{-8}	8×10^{-4}
	Zr 95	S	1×10^{-7}	2×10^{-3}	4×10^{-9}	6×10^{-5}
		I	3×10^{-8}	2×10^{-3}	1×10^{-9}	6×10^{-5}
	Zr 97	S	1×10^{-7}	5×10^{-4}	4×10^{-9}	2×10^{-5}
		I	9×10^{-8}	5×10^{-4}	3×10^{-9}	2×10^{-5}
Any single radionuclide not listed above with decay mode other than alpha emission or spontaneous fission and with radioactive half-life less than 2 hours.	....	Sub	1×10^{-6}	....	3×10^{-8}	....
Any single radionuclide not listed above with decay mode other than alpha emission or spontaneous fission and with radioactive half-life greater than 2 hours.	....		3×10^{-9}	9×10^{-5}	1×10^{-10}	3×10^{-6}
Any single radionuclide not listed above, which decays by alpha emission or spontaneous fission.	....		6×10^{-13}	4×10^{-7}	2×10^{-14}	3×10^{-8} (3X10[-8])

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* [1] Soluble (S); Insoluble (I).

[2] "Sub" means that values given are for submersion in a semispherical infinite cloud of airborne material.

NOTE. In any case where there is a mixture in air or water of more than one radionuclide, the limiting values for purposes of this Appendix should be determined as follows:

1. If the identity and concentration of each radionuclide in the mixture are known, the limiting values should be derived as follows: Determine, for each radionuclide in the mixture, the ratio between the quantity present in the mixture and the limit otherwise established in Appendix B for the specific radionuclide when not in a mixture. The sum of such ratios for all the radionuclides in the mixture may not exceed "1" (i.e., "unity").

EXAMPLE: If radionuclides A, B, and C are present in concentrations C_A, C_B, and C_C, and if the applicable MPC's are MPC_A, and MPC_B, and MPC_C respectively, then the concentrations shall be limited so that the following relationship exists:

$$\frac{C_A}{MPC_A}+\frac{C_B}{MPC_B}+\frac{C_C}{MPC_C} \leq 1$$

* 2. If either the identity or the concentration of any radionuclide in the mixture is not known, the limiting values for purposes of Appendix B shall be:

a. For purposes of Table I, Col. 1—6×10^{-13}
b. For purposes of Table I, Col. 2—4×10^{-7}
c. For purposes of Table II, Col. 1—2×10^{-14}
d. For purposes of Table II, Col. 2—3×10^{-8}

— 26 FR 11042 —

3. If any of the conditions specified below are met, the corresponding values specified below may be used in lieu of those specified in paragraph 2 above.

a. If the identity of each radionuclide in the mixture is known but the concentration of one or more of the radionuclides in the mixture is not known, the concentration limit for the mixture is the limit specified in Appendix "B" for the radionuclide in the mixture having the lowest concentration limit; or

b. If the identity of each radionuclide in the mixture is not known, but it is known that certain radionuclides specified in Appendix "B" are not present in the mixture, the concentration limit for the mixture is the lowest concentration limit specified in Appendix "B" for any radionuclide which is not known to be absent from the mixture; or

— 30 FR 15801 —

a. Element (atomic number) and isotope	Table I Column 1 Air (μc/ml)	Table I Column 2 Water (μc/ml)	Table II Column 1 Air (μc/ml)	Table II Column 2 Water (μc/ml)
If it is known that Sr 90, I 125, I 126, I 129, I 131, (I 133, table II only), Pb 210, Po 210, At 211, Ra 223, Ra 224, Ra 226, Ac 227, Ra 228, Th 230, Pa 231, Th 232, Th-nat, Cm 248, Cf 254, and Fm 256 are not present	....	9×10^{-5}	....	3×10^{-6}
If it is known that Sr 90, I 125, I 126, I 129, (I 131, I 133, table II only), Pb 210, Po 210, Ra 223, Ra 226, Ra 228, Pa 231, Th-nat, Cm 248, Cf 254, and Fm 256 are not present	....	6×10^{-5}	....	2×10^{-6}
If it is known that Sr 90, I 129, (I 125, I 126, I 131, table II only), Pb 210, Ra 226, Ra 228, Cm 248, and Cf 254 are not present	....	2×10^{-5}	....	6×10^{-7}
If it is known that (I 129, table II only), Ra 226, and Ra 228 are not present	....	3×10^{-5}	....	1×10^{-6}
** If it is known that alpha emitters and Sr 90, I 129, Pb 210, Ac 227, Ra 228, Pa 230, Pu 241, and Bk 249 are not present	3×10^{-9}	....	1×10^{-10}	....
If it is known that alpha emitters and Pb 210, Ac 227, Ra 228, and Pu 241 are not present	3×10^{-10}	....	1×10^{-11}	....
If it is known that alpha emitters and Ac 227 are not present	3×10^{-11}	....	1×10^{-12}	....
If it is known that Ac 227, Th 230, Pa 231, Pu 238, Pu 239, Pu 240, Pu 242, Pu 244, Cm 248, Cf 249 and Cf 251 are not present	3×10^{-12}	....	1×10^{-13}	....

— 27 FR 13542 —

4. If the mixture of radionuclides consists of uranium and its daughter products in ore dust prior to chemical processing of the uranium ore, the values specified below may be used in lieu of those determined in accordance with paragraph 1 above or those specified in paragraphs 2 and 3 above.

a. For purposes of Table I, Col. 1—1×10^{-10} μc/ml gross alpha activity; or 2.5×10^{-11} μc/ml natural uranium; or 75 micrograms per cubic meter of air natural uranium.

b. For purposes of Table II, Col. 1—3×10^{-12} μc/ml gross alpha activity; or 8×10^{-12} μc/ml natural uranium; or 3 micrograms per cubic meter of air natural uranium.

5. For purposes of this note, a radionuclide may be considered as not present in a mixture if (a) the ratio of the concentration of that radionuclide in the mixture (C_A) to the concentration limit for that radionuclide specified in Table II of Appendix "B" (MPC_A) does not exceed 1/10, (i.e. $\frac{C_A}{MPC_A} \leq \frac{1}{10}$) and (b) the sum of such ratios for all the radionuclides considered as not present in the mixture does not exceed 1/4, i.e.

$$\frac{C_A}{MPC_A}+\frac{C_B}{MPC_B}+\ldots \leq \frac{1}{4}.$$

*Revised 30 FR 15801

**ERRATUM: This line should read: "210, Ac 227, Ra 228, Pa 230, Pu 241, and Bk 249 are not"

Appendix B from 25 FR 10914 except as otherwise noted.

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