WATTS BAR NUCLEAR PLANT

OFFSITE DOSE CALCULATION MANUAL

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1. Gaseous Effluents

1.1 Alarm/Trip Setpoints

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/yr to the total body and 3,000 mrem/yr to the skin from noble gases.

2. 1,500 mrem/yr to any organ from I-131, I-133, H3, and radionuclides in particulate form with half lives greater than 8 days.

Noble gas effluent monitors will have alarm/trip setpoints to ensure that the above dose rates are not exceeded. This section of the ODCM which describes the methodology that will be used to determine these setpoints is consistent with Reg Guides 1.109 and 1.111.

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

1.1.1 Release Rate Limit Methodology - µCi/s

Step 1

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

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

Assumptions:

1. Doses to be calculated are total body and skin.

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

3. Noble gas radionuclide mix is based on the design objective source term given in Table 1.1.

4. Basic radionuclide data are given in Table 1.2.

5. All releases are treated as ground level.

6. Meteorological data are expressed as a joint-frequency distribution of wind speed and wind direction by atmospheric stability for the period January 1975 to December 1978 (Table 1.3).

7. Raw meteorological data consist of wind speed and direction measurements at 10m and temperature measurements at 10m and 46m.

8. Dose is to be evaluated at the offsite exposure point where maximum concentrations are expected to exist.

9. Potential maximum-exposure points (Table 1.4) considered are the 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	0.13
2	0.3-0.6	0.45
3	0.7-1.5	1.10
4	1.6-2.4	1.99
5	2.5-3.3	2.88
6	3.4-5.5	4.45
7	5.6-8.2	6.91
8	8.3-10.8	9.59
9	> 10.9	10.95

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

17. Terrain effects are not considered.

Equations

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

For determining the air concentration of any radionuclide:

$$X_i = \sum_{j=1}^{9} \sum_{k=1}^{7} (2/\pi)^{1/2} \frac{f_{jk} Q_i P}{\sum_{zk} u_j (2\pi x/n)} \exp(-\lambda_i x/u_j) \quad (1.1)$$

where

X_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 1.1.

$\sum_{zk}$ = vertical dispersion coefficient for stability class k which includes a building wake adjustment,

$\sum_{zk} = (\sigma_{zk}^2 + cA/\pi)^{1/2}$, where σ_{zk} is the vertical dispersion coefficient for stability class k (m), c is a building shape factor (c=0.5), and A is the minimum building cross-sectional area (1630 m^2), m.

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

x = downwind distance, m.

n = number of sectors, 16.

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

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

For determining the total body dose rate

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

where

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

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

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

For determining the skin dose rate

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

where

D_s = skin dose rate, mrem/yr.

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

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

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

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

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

Assumptions

1. Dose is to be calculated for the critical organ, thyroid, and the critical age 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 design objective source term given in Table 1.1.

4. Basic radionuclide data are given in Table 1.2.

5. All releases are treated as ground-level.

6. Meteorological data are expressed as joint-frequency distributions (JFD's) of wind speed and wind direction by atmospheric stability for the period January 1975 to December 1978 (Table 1.3).

7. Raw meteorological data for ground-level releases consist of wind speed and direction measurements at 10m and temperature measurements at 10m and 46m.

8. Dose is to be evaluated at the potential offsite exposure point where maximum concentrations are expected to exist.

9. Real cow locations are not considered.

10. Potential maximum exposure points (Table 1.4) considered are the site boundary points in each sector.

11. Terrain effects are not considered.

12. Building wake effects on effluent dispersion are considered.

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

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

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

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 for any one of the potential maximum-exposure points, the following equations are used:

1. Inhalation

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

For determining the thyroid dose rate:

$$D_{THI} = 1 \times 10^{-6} \sum_i X_i \, DFI_i \qquad (1.4)$$

where:

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

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

DFI_i = infant inhalation dose factor, mrem/yr per $\mu Ci/cm^3$, (Table 1.7).

1×10^{-6} = m^3/cm^3 conversion factor.

2. Ground Contamination

For determining the ground concentration of any nuclide:

$$G_i = 3.15 \times 10^7 \sum_{k=1}^{7} \frac{f_k \; Q_i \; DR}{(2\pi x/n)\,\lambda_i} \left(1-\exp\left(-\lambda_i \, t_b\right)\right) \quad (1.5)$$

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).

x = downwind distance, m.

n = number of sectors, 16.

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

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

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

3.15×10^7 = s/yr conversion factor.

For determining the critical organ dose rate from ground contamination:

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

where:

D_{THG} = critical organ dose rate due to ground contamination, mrem/yr.

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

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

8,760 = occupation time, h/yr.

1×10^6 = pCi/μCi conversion factor.

3. Milk Ingestion

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

(1.7)

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

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).

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, 0.47.

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 = .0023 h^{-1}) for particulates and 0.0017 for iodines.

t_e = period over which deposition occurs, 720 h.

Y_v = agricultural yield, 1.18 kg/m².

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

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

t_b = time for buildup of radionuclides on the ground, 3.07×10^8 h (35yr).

P = effective surface density of soil, 240 kg/m².

3,600 = s/h conversion factor.

For determining the concentration of H-3 in vegetation:

$$CV_T = 1 \times 10^3 \, X_T \, (0.75)(0.5/H) \qquad (1.9)$$

where:

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

X_T = air concentration of H-3, μCi/m³.

0.75 = fraction of total plant mass that is water.

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

H = absolute humidity of the atmosphere, g/m³.

1×10^3 = g/kg conversion factor.

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

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

where:

CM_i = concentration of radionuclide i (including ~~C-14 and~~ H-3) in cow's milk, μCi/1.

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

FM_i = transfer factor from feed to milk for radionuclide i, d/1 (Table 1.6).

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, 1 day.

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

$$D_{THM} = 1 \times 10^6 \sum_i CM_i \, DFING_i \, UM \qquad (1.11)$$

where:

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

CM_i = concentration of radionuclide i in cow's milk, μCi/1.

$DFING_i$ = infant ingestion dose factor, mrem/pCi, (Regulatory Guide 1.109, Table E-14)

UM = infant ingestion rate for milk, 330 1/yr.

1×10^6 = pCi/μCi conversion factor.

4. Total Thyroid Dose Rate

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

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

where:

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

D_{TH1} = thyroid dose rate due to inhalation, mrem/yr.

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

D_{THK} = thyroid dose rate due to mild ingestion, mrem/yr.

The maximum dose rate calculated in this step will be used in step 2 with the following dose rate limits (10 CFR 20):

Total body = 500 mrem/yr

Skin = 3,000 mrem/yr

Maximum organ = 1,500 mrem/yr

Step 2a (Initial Setpoints)

For the determination of initial setpoints, the above limits are divided by the appropriate dose calculated in step 1 yielding,

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

This ratio, R, represents how far above or below the guidelines this step 1 calculation was. Multiplying the original source term by R will give release rates that should correspond to the dose limits given above. Step 1 is redone using the adjusted source terms to ensure that this is the case.

Appropriate release rate limits in μCi/sec for each nuclide and release point will be provided to plant personnel for use in establishing monitor setpoints. The setpoint for each gaseous effluent monitor will be established using plant instructions. Release rate limit, principal beta emitter, geometry, detector efficiency, and a safety factor are combined to give an equivalent setpoint in counts per minute (cpm). The safety factor ranges from 0.2 for systems without automatic isolation features and 0.5 for systems with automatic isolation features. The physical and technical description, location, and identification number for each gaseous radiation detector is contained in plant documentation.

Step 2b (Release Mix Specific Setpoints)

When release mixes are known, setpoints are based on the dose methodology given in Step 1, disregarding the design source term mix. Using a normalized source term for each nuclide (r_i), each nuclide specific dose rates (D_i) are determined independently for each nuclide using Step 1 methodology. Dividing the appropriate dose rate limit above by the nuclide specific dose rate, D_i, yields,

$$\frac{\text{Dose Rate Limit}}{D_i} = R_i$$

This ratio, R_i, represents how far above or below the guidelines the nuclide specific dose rate (D_i) is. Multiplying the nuclide specific source term (r_i) by R_i will give the maximum normalized allowable release rate for nuclide i, RR_i.

For a known mixture of nuclides the release rates, rr_i, must be such that:

$$\sum \left(\frac{rr_i}{RR_i} + \cdots \frac{rr_n}{RR_n} \right) < 1$$

Appropriate release rate limits in μCi/s for each nuclide and the release point will be provided to plant personnel for use in establishing monitor setpoints. The setpoint for each gaseous effluent monitor will be established using plant instructions. Release rate limit, principal beta emitter, geometry, detector, effeciency, and a safety factor are combined to give an equivalent setpoint in counts per minute (cpm). The safety factor ranges from 0.2 for systems without automatic isolation features and 0.5 for systems with automatic isolation features. The physical and technical description, location, and identification number for each gaseous radiation detector is contained in plant documentation.

1.2 Monthly Dose Calculations

Dose calculations will be performed monthly to ensure that the dose rate is unrestricted areas due to gaseous effluents from the reactor at the site will 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 these 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 X/Q based on historical 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-131m, Xe-133, Xe-135, Ar-41, and Kr-88 are considered.

5. For beta doses, releases of Xe-131m, Xe-133, Xe-135, Kr-85, and Ar-41 are considered.

6. Dose factors are calculated using data from TVA's nuclide library.

7. The calculations extrapolate doses assuming that only 90 percent of total dose was contributed by those nuclides.

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:

$$D\gamma = \frac{(X/Q)}{0.9} \left(\frac{10^6}{3.15 \times 10^7} \right) \sum_i QM_i \; DF_{\gamma i} \qquad (1.13)$$

where:

$D\gamma$ = gamma dose to air, mrad.

X/Q = highest annual-average relative concentration, 6.59×10^{-6} s/m³.

0.9 = fraction of total gamma dose expected to be contributed by these nuclides.

10^6 = μCi/Ci conversion factor

3.15×10^7 = s/yr conversion factor

QM_i = monthly release of radionuclide i, Ci.

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

This equation then reduces to

$$D\gamma = 2.32 \times 10^{-7} \sum_i QM_i \; DF\gamma_i \qquad (1.14)$$

For determining the beta dose to air:

$$D_\beta = \frac{(X/Q)}{0.9} \left(\frac{10^6}{3.15 \times 10^7} \right) \sum_i QM_i \; DF_{\beta i} \qquad (1.15)$$

where:

D_β = beta dose to air, mrad.

X/Q = highest annual-average relative concentration, 6.59×10^{-6} s/m³. (Table 1.4)

0.9 = fraction of total beta dose expected to be contributed by these nuclides.

10^6 = µCi/Ci conversion factor

3.15×10^7 = s/yr conversion factor

QM_i = monthly release of radionuclide i, Ci.

$DF_{\beta i}$ = Beta-to-air dose factor for radionuclide i, mrad/yr per µCi/m³ (Table 1.5).

This equation then reduces to:

$$D_\beta = 2.32 \times 10^{-7} \sum_i QM_i \, DF_{\beta i} \qquad (1.16)$$

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 1975-1978 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

Equations for calculating air concentration, X, 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

$$D_{\gamma n} = t_m \sum_i X_{ni} \, DF_{\gamma i} \qquad (1.17)$$

where:

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

X_{ni} = air concentration of radionuclide i in sector n, $\mu Ci/m^3$.

$DF_{\gamma i}$ = gamma-to-air dose factor for radionuclide i, mrad/yr per $\mu Ci/m^3$ (Table 1.5).

t_m = time period considered, yr

For determining the beta dose to air:

$$D_{\beta n} = t_m \sum_i X_{ni} \, DF_{\beta i} \qquad (1.18)$$

where:

$D\beta_n$ = beta dose to air for sector n, mrad.

X_{ni} = air concentration of radionuclide i in sector n, $\mu Ci/m^3$

$DF_{\beta i}$ = beta to air dose factor for radionuclide i, mrad/yr per $\mu Ci/m^3$ (Table 1.5)

t_m = time period considered, yr

The sector having the highest total dose is then used to check compliance with specification 3.11.2.2.

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 infant thyroid from milk ingestion and for the child bone and teen g.i. tract from vegetable ingestion.

2. Real cow locations are considered for the milk pathway and nearest resident-locations with home-use gardens are considered for the vegetable pathway.

3. The highest annual-average D/Q based on 1975 to 1978 meteorological data for ground level releases will be used for (Table 1.4) ingestion pathway doses.

4. No credit is taken for radioactive decay.

5. Releases of I-131 are considered for the milk pathway. Sr-90 releases are considered for the vegetable pathway to the child bone.

   Co-58 releases are considered for the vegetable pathway to the teen g.i. tract.

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

7. 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:

$$DTH_{131} = \frac{Q_{131} \quad DF_{131} \quad D/Q}{0.9 \quad 3.15 \times 10^{7}} \times 10^{6} \qquad (1.19)$$

where:

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

Q_{131} = monthly release of I-131, Ci.

DF_{131} = I-131 milk ingestion dose factor to infant, mrem/yr per $\mu Ci/m^2$-s (Table 1.7)

D/Q = relative deposition rate, $2.78 \times 10^{-9} m^{-2}$ (Table 1.4)

0.9 = fraction of dose expected to be contributed by I-131

3.15×10^7 = s/yr.

10^6 = μCi/Ci

Equation 1.19 then reduces to: $DTH_{131} = 71.0 \quad Q_{131}$

For determining the bone dose from vegetable ingestion:

$$DBC_s = \frac{Q_s \quad DF_s \quad D/Q}{3.15 \times 10^7 \ (0.9)} \times 10^6 \qquad (1.20)$$

where:

DBC_s = bone dose to child from Sr-90, mrem.

Q_s = monthly release of Sr-90, Ci.

DF_s = Sr-90 vegetable ingestion dose fractor to child, 1.36×10^{13} mrem/yr per μCi/m^2-s. (Regulatory Guide 1.109 and NUREG/CR-1004 methodologies)

D/Q = relative deposition rate, $5.68 \times 10^{-9} m^{-2}$ (Table 1.4)

3.15×10^7 = s/yr.

10^6 = μCi/Ci.

0.9 = fraction of total bone dose expected to be contributed by Sr-90.

Equation 1.20 then reduces to $DBC_s = 2724.8 \ Q_s$

For determining the gastrointestinal (g.i.) tract dose from vegetable ingestion:

$$DGI_T = \frac{Q_c \ DF_c \ D/Q \times 10^6}{(0.9)(3.15 \times 10^7)} \qquad (1.21)$$

Where:

DGI_T = teen g.i. tract dose from Co-58, mrem

Q_c = monthly release of Co-58, Ci

DF_c = Co-58 vegetable ingestion dose factor for the teen g.i. tract, 3.87 x 10^9 mrem/yr per µCi/m^2-s. (Regulatory Guide 1.109 and NUREG/CR-1004 methodologies.)

D/Q = relative deposition rate, 5.68 x 10^{-9} m^{-2}

3.15 x 10^7 = s/yr

10^6 = µCi/Ci

0.9 = fraction of total g.i. tract dose expected to be contributed by Co-58

Equation 1.21 then reduces to $DGI_T = 0.78\ Q_c$

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 3.11.2.3. Calendar quarter doses are first estimated by summing the doses calculated for each month in the current quarter. Calendar year doses are first estimated by summing the doses calculated for each month in that year. However, if the annual doses determined in this manner exceed or approach the specification limits, doses calculated for the previous quarters with the methodology of Section 1.4 will be used instead of those quarterly doses estimated by summing monthly results.

1.3 Dose Projections

In accordance with specification 3.11.2.4, dose projections will be performed. This will be done by averaging the calculated dose for the most recent month and the calculated dose for the previous month and assigning that average dose as the projection for the current month.

1.4 Quarterly and Annual Dose Calculations

A complete dose analysis utilizing the total estimated gaseous releases for each calendar quarter will be performed and reported as required in the Technical Specifications. Methodology for this analysis is the same as that described in Section 1.1.1, except that real pathways and receptor locations (Table 1.4) are considered. In addition, meteorological data representative of a ground level release for each corresponding calendar quarter will be used. This analysis will replace the estimates in Section 1.2.

At the end of the year an annual dose analysis will be performed by calculating the sum of the quarterly doses to the critical receptors.

1.5 Gaseous Radwaste Treatment System Operation

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

1.5.1 System Description

A flow diagram for the GRTS is given in Figure 1.3. The system consists of two waste-gas compressor packages, nine gas decay tanks, and the associated piping, valves, and instrumentation. Gaseous wastes are received from the following: degassing of the reactor coolant and purging of the volume control tank prior to a cold shutdown, displacing of cover gases caused by liquid accumulation in the tanks connected to the vent header, and boron recycle process operation.

1.5.2 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 GASEOUS RELEASES FROM ONE UNIT AT WATTS BAR NUCLEAR PLANT
CURIES/YEAR

NUCLIDE	AUXILIARY BUILDING	CONTAINMENT	TURBINE BUILDING	SERVICE BUILDING
Kr-83m	4.4(-1)	3.3(-1)	3.0(-1)	1.1(-2)
Kr-85m	2.2(0)	2.3(0)	1.5(0)	6.0(-2)
Kr-85	2.0(0)	5.1(2)	1.2(0)	5.1(+0)
Kr-87	1.2(0)	8.1(-1)	8.2(-1)	2.8(-2)
Kr-88	4.1(0)	3.6(0)	2.7(0)	1.0(-1)
Kr-89	2.7(-2)	8.3(-3)	6.4(-2)	9.0(-4)
Xe-131m	1.7(0)	2.6(1)	1.1(0)	2.9(-1)
Xe-133m	3.7(0)	1.6(1)	2.4(0)	2.2(-1)
Xe-133	2.9(2)	2.4(3)	1.8(2)	2.9(+1)
Xe-135m	1.8(+1)	7.8(-2)	2.0(-1)	1.8(-1)
Xe-135	6.8(0)	9.9(0)	4.4(0)	2.1(-1)
Xe-137	5.6(-2)	1.8(-2)	1.2(-1)	1.9(-3)
Xe-138	5.9 (-1)	2.4(-1)	6.2(-1)	1.5(-2)
Br-83	8.0(-4)	1.5(-5)	9.5(-5)	9.1(-6)
Br-84	3.5(-4)	4.9(-6)	1.7(-5)	3.7(-6)
Br-85	1.2(-5)	1.3(-7)	2.4(-7)	1.2(-7)
I-130	3.6(-4)	1.3(-5)	6.9(-5)	4.4(-6)
I-131	4.5(-2)	1.2(-2)	9.2(-3)	6.6(-4)
I-132	1.7(-2)	3.7(-4)	2.6(-3)	2.0(-4)
I-133	6.5(-2)	3.3(-3)	1.4(-2)	8.2(-4)
I-134	7.1(-3)	1.1(-4)	5.0(-4)	7.7(-5)
I-135	3.3(-2)	9.0(-4)	5.4(-3)	3.9(-4)
Rb-86	1.9(-7)	2.1(-8)	2.4(-7)	4.5(-9)
Rb-88	1.6(0)	2.1(-2)	1.0(-4)	1.6(-2)
Cs-134	5.5(-5)	1.1(-5)	6.4(-5)	1.3(-6)
Cs-136	2.9(-5)	2.6(-6)	3.6(-5)	6.8(-7)
Cs-137	4.0(-5)	7.8(-6)	5.3(-5)	1.0(-6)
Cr-51	2.0(-6)	2.6(-7)	3.6(-7)	2.6(-8)
Mn-54	1.6(-6)	3.1(-7)	4.5(-7)	2.4(-8)
Fe-59	2.1(-6)	3.2(-7)	5.4(-7)	3.0(-8)
Co-58	5.3(-7)	8.8(-8)	9.0(-6)	9.6(-8)
Co-60	1.6(-6)	3.1(-7)	2.7(-7)	2.2(-8)

TABLE 1.1
EXPECTED ANNUAL ROUTINE GASEOUS RELEASES FROM ONE UNIT AT WATTS BAR NUCLEAR PLANT
CURIES/YEAR

NUCLIDE	AUXILIARY BUILDING	CONTAINMENT	TURBINE BUILDING	SERVICE BUILDING
Sr-89	7.6(-7)	1.2(-7)	1.6(-7)	1.0(-8)
Sr-90	2.2(-8)	4.3(-9)	8.4(-9)	3.5(-10)
Sr-91	1.5(-6)	1.2(-8)	8.9(-8)	1.6(-8)
Y-90	3.8(-8)	4.7(-9)	8.2(-9)	5.1(-10)
Y-91m	9.1(-7)	7.4(-9)	4.1(-8)	9.6(-9)
Y-91	4.4(-6)	7.0(-7)	1.9(-6)	7.0(-8)
Y-93	3.0(-7)	2.4(-9)	3.6(-8)	3.4(-9)
Zr-95	1.3(-7)	2.1(-8)	8.4(-8)	2.4(-9)
Nb-95	1.1(-7)	2.2(-8)	8.4(-8)	2.2(-9)
Mo-99	9.9(-4)	3.0(-5)	1.4(-4)	1.2(-5)
Tc-99m	8.9(-4)	2.8(-5)	1.0(-4)	1.0(-5)
Ru-103	9.8(-8)	1.4(-8)	4.2(-8)	1.5(-9)
Ru-106	2.2(-8)	4.1(-9)	8.4(-9)	3.5(-10)
Rh-103m	1.1(-7)	1.4(-8)	2.8(-8)	1.5(-9)
Rh-106	2.2(-8)	4.1(-9)	2.7(-7)	3.0(-9)
Te-125m	6.3(-8)	1.0(-8)	1.3(-8)	8.6(10)
Te-127m	6.1(-7)	1.1(-7)	2.1(-7)	9.3(-9)
Te-129m	3.1(-6)	4.3(-7)	1.3(-6)	4.8(-8)
Te-129	3.6(-6)	2.8(-7)	8.3(-7)	4.7(-8)
Te-131m	5.6(-6)	9.1(-8)	2.0(-6)	7.7(-8)
Te-131	2.2(-6)	2.0(-8)	2.7(-7)	2.5(-8)
Te-132	6.0(-5)	2.0(-6)	2.1(-5)	8.3(-7)
Ba-137m	3.8(-5)	7.3(-6)	1.5(-5)	6.0(-7)
Ba-140	4.8(-7)	4.4(-8)	2.1(-7)	7.3(-9)
La-140	3.4(-7)	4.6(-8)	1.4(-7)	5.3(-9)
Ce-141	1.5(-7)	2.1(-8)	8.4(-8)	2.6(-9)
Ce-143	8.9(-8)	1.6(-9)	2.0(-8)	1.1(-9)
Ce-144	7.2(-8)	1.4(-8)	4.2(-8)	1.3(-9)
Pr-143	1.1(-7)	1.1(-8)	4.2(-8)	1.6(-9)
Pr-144	7.7(-8)	1.4(-8)	2.8(-8)	1.2(-9)
Np-239	2.7(-6)	7.0(-8)	1.2(-6)	4.0(-8)

TABLE 1.2

BASIC RADIONUCLIDE DATA
(Sheet 1)

Nuclide	Half-Life (Days)	LAMBDA (1/S)	BETA (MEV/DIS)	GAMMA (MEV/DIS)
1 TRITIUM	4.49E 03	1.79E-09	5.68E-03	0.0
2 C-14	2.09E 06	3.84E-12	5.17E-02	0.0
3 N-13	6.94E-03	1.16E-03	4.91E-01	1.02E 00
4 O-19	3.36E-04	2.39E-02	1.02E 00	1.05E 00
5 F-18	7.62E-02	1.05E-04	2.41E-01	9.88E-01
6 NA-24	6.33E-01	1.27E-05	5.55E-01	4.12E 00
7 P-32	1.43E 01	5.61E-07	6.95E-01	0.0
8 AR-41	7.63E-02	1.05E-04	3.63E-01	1.28E 00
9 CR-51	2.78E 01	2.89E-07	3.75E-03	3.28E-02
10 MN-54	3.03E 02	2.65E-08	4.17E-03	8.36E-01
11 MN-56	1.07E-01	7.50E-05	7.93E-01	1.76E 00
12 FE-59	4.50E 01	1.78E-07	1.18E-01	1.19E 00
13 CO-58	7.13E 01	1.12E-07	2.05E-01	9.76E-01
14 CO-60	1.92E 03	4.18E-09	9.68E-02	2.50E 00
15 ZN-69M	5.75E-01	1.39E-05	0.0	4.15E 00
16 ZN-69	3.96E-02	2.03E-04	3.19E-01	0.0
17 BR-84	2.21E-02	3.63E-04	1.28E 00	1.68E 00
18 BR-85	2.08E-03	3.86E-03	1.04E 00	8.40E-01
19 KR-85M	1.83E-01	4.38E-05	2.53E-01	1.59E-01
20 KR-85	3.93E 03	2.04E-09	2.51E-01	2.21E-03
21 KR-87	5.28E-02	1.52E-04	1.32E 00	7.93E-01
22 KR-88	1.17E-01	6.86E-05	3.75E-01	1.96E 00
23 KR-89	2.21E-03	3.63E-01	1.23E 00	2.08E 00
24 RB-88	1.24E-02	6.47E-04	2.06E 00	6.86E-01
25 RB-89	1.07E-02	7.50E-04	0.0	2.40E 00
26 SR-89	5.20E 01	1.54E-07	5.73E-01	1.36E-04
27 SR-90	1.03E 04	7.79E-10	1.96E-01	0.0
28 SR-91	4.03E-01	1.99E-05	6.50E-01	6.95E-01
29 SR-92	1.13E-01	7.10E-05	1.95E-01	1.34E 00
30 SR-93	5.56E-03	1.44E-03	1.61E 00	6.28E-01
31 Y-90	2.67E 00	3.00E-06	9.36E-01	0.0
32 Y-91M	3.47E-02	2.31E-04	0.0	5.56E-01
33 Y-91	5.88E 01	1.36E-07	6.06E-01	3.61E-03
34 Y-92	1.47E-01	5.46E-05	1.44E 00	2.50E-01
35 Y-93	4.29E-01	1.87E-05	1.17E 00	8.94E-02
36 ZR-95	6.50E 01	1.23E-07	1.20E-01	7.35E-01
37 NB-95M	3.75E 00	2.14E-06	2.85E-01	5.87E-02
38 NB-95	3.50E 01	2.29E-07	4.50E-02	7.64E-01
39 MO-99	2.79E 00	2.87E-06	3.96E-01	1.62E-01
40 TC-99M	2.50E-01	3.21E-05	4.85E-03	1.43E-01
41 TC-99	7.74E 07	1.04E-13	8.38E-02	0.0
42 TC-104	1.25E-02	6.42E-04	0.0	0.0
43 RU-106	3.67E 02	2.19E-08	1.01E-02	0.0
44 TE-132	3.24E 00	2.48E-06	1.00E-01	2.05E-01
45 I-129	6.21E 09	1.29E-15	4.02E-02	3.77E-03
46 I-131	8.05E 00	9.96E-07	1.94E-01	3.81E-01
47 MI-131	8.05E 00	9.96E-07	1.94E-01	3.81E-01
48 I-132	9.58E-02	8.37E-05	5.14E-01	2.33E 00
49 MI-132	9.58E-02	8.37E-05	5.14E-01	2.33E 00
50 I-133	8.75E-01	9.17E-06	4.08E-01	6.10E-01

TABLE 1.2

BASIC RADIONUCLIDE DATA
(Sheet 2)

Nuclide	Half-Life (Days)	LAMBDA (1/S)	BETA (MEV/DIS)	GAMMA (MEV/DIS)
51 MI-133	8.75E-01	9.17E-06	4.08E-01	6.10E-01
52 I-134	3.61E-02	2.22E-04	6.10E-01	2.59E 00
53 MI-134	3.61E-02	2.22E-04	6.10E-01	2.59E 00
54 I-135	2.79E-01	2.87E-05	3.68E-01	1.58E 00
55 MI-135	2.79E-01	2.87E-05	3.68E-01	1.58E 00
56 XE-131M	1.18E 01	6.80E-07	1.43E-01	2.01E-02
57 XE-133M	2.26E 00	3.55E-06	1.90E-01	4.16E-02
58 XE-133	5.27E 00	1.52E-06	1.35E-01	4.54E-02
59 XE-135M	1.08E-02	7.43E-04	9.50E-02	4.32E-01
60 XE-135	3.83E-01	2.09E-05	3.17E-01	2.47E-01
61 XE-137	2.71E-03	2.96E-03	1.64E 00	1.94E-01
62 XE-138	1.18E-02	6.80E-04	6.06E-01	1.18E 00
63 CS-134	7.48E 02	1.07E-08	1.57E-01	1.04E 00
64 CS-135	1.10E 09	7.29E-15	5.74E-02	0.0
65 CS-136	1.30E 01	6.17E-07	1.01E-01	2.20E 00
66 CS-137	1.10E 04	7.29E-10	2.52E-01	5.97E-01
67 CS-138	2.24E-02	3.58E-04	1.23E 00	2.30E 00
68 BA-139	5.76E-02	1.39E-04	6.54E-02	5.05E-02
69 BA-140	1.28E 01	6.27E-07	3.15E-01	1.95E-01
70 LA-140	1.68E 00	4.77E-06	5.40E-01	2.31E 00
71 CE-144	2.84E 02	2.82E-08	9.13E-02	3.29E-02
72 PR-143	1.36E 01	5.90E-07	3.14E-01	0.0
73 PR-144	1.20E-02	6.68E-04	1.23E 00	3.10E-01
74 NP-239	2.35E 00	3.41E-06	1.24E-01	2.08E 00

TABLE 1.3

JOINT PERCENTAGE FREQUENCIES OF WIND SPEED AND WIND DIRECTION FOR
STABILITY CLASS A (DELTA T<=-1.9 C/100 M)

WATTS BAR NUCLEAR PLANT

JAN 1, 75 - DEC 31, 78

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	0.01	0.02	0.05	0.08	0.0	0.0	0.0	0.16
NNE	0.0	0.0	0.05	0.07	0.17	0.0	0.0	0.0	0.29
NE	0.0	0.01	0.04	0.07	0.08	0.0	0.0	0.0	0.20
ENE	0.0	0.02	0.04	0.07	0.05	0.0	0.0	0.0	0.18
E	0.0	0.03	0.06	0.03	0.01	0.0	0.0	0.0	0.13
ESE	0.0	0.01	0.0	0.0	0.0	0.0	0.0	0.0	0.01
SE	0.0	0.0	0.01	0.0	0.0	0.0	0.0	0.0	0.01
SSE	0.0	0.01	0.03	0.01	0.03	0.0	0.0	0.0	0.08
S	0.0	0.01	0.04	0.06	0.10	0.0	0.0	0.0	0.21
SSW	0.0	0.0	0.05	0.22	0.56	0.18	0.01	0.0	1.02
SW	0.0	0.0	0.04	0.13	0.16	0.03	0.0	0.0	0.36
WSW	0.0	0.0	0.01	0.0	0.07	0.06	0.0	0.0	0.14
W	0.0	0.01	0.01	0.01	0.06	0.03	0.0	0.0	0.12
WNW	0.0	0.0	0.0	0.01	0.02	0.01	0.0	0.0	0.04
NW	0.0	0.0	0.01	0.02	0.04	0.02	0.0	0.0	0.09
NNW	0.0	0.01	0.03	0.06	0.11	0.02	0.0	0.0	0.23
SUBTOTAL	0.0	0.12	0.44	0.81	1.54	0.35	0.01	0.0	3.27

TOTAL HOURS OF VALID STABILITY OBSERVATIONS	32550
TOTAL HOURS OF STABILITY CLASS A	1053
TOTAL HOURS OF VALID WIND DIRECTION-WIND SPEED-STABILITY CLASS A	1037
TOTAL HOURS CALM	0

ALL COLUMNS AND CALM TOTAL 100 PERCENT OF JOINT VALID OBSERVATIONS

METEOROLOGICAL FACILITY: LOCATED ABOUT 0.8 KM SW OF THE REACTOR BUILDING
STABILITY BASED ON LAPSE RATE MEASURED BETWEEN 9.51 AND 45.63 METERS
WIND SPEED AND DIRECTION MEASURED AT THE 10.00 METER LEVEL

MEAN WIND SPEED = 8.3 MPH

TABLE 1.3

JOINT PERCENTAGE FREQUENCIES OF WIND SPEED [illegible]IND DIRECTION FOR
STABILITY CLASS B (-1.9< DELTA-T<=-1.7 C/100 M)

WATTS BAR NUCLEAR PLANT

JAN 1, 75 - DEC 31, 78

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	0.01	0.04	0.06	0.06	0.0	0.0	0.0	0.17
NNE	0.0	0.0	0.06	0.13	0.16	0.01	0.0	0.0	0.36
NE	0.0	0.02	0.07	0.08	0.09	0.0	0.0	0.0	0.26
ENE	0.0	0.02	0.05	0.07	0.04	0.0	0.0	0.0	0.18
E	0.0	0.07	0.08	0.03	0.0	0.0	0.0	0.0	0.18
ESE	0.0	0.01	0.03	0.0	0.0	0.0	0.0	0.0	0.04
SE	0.0	0.0	0.02	0.0	0.0	0.0	0.0	0.0	0.02
SSE	0.0	0.01	0.04	0.01	0.01	0.0	0.0	0.0	0.07
S	0.0	0.01	0.05	0.03	0.05	0.01	0.0	0.0	0.15
SSW	0.0	0.01	0.07	0.17	0.25	0.07	0.01	0.0	0.58
SW	0.0	0.0	0.05	0.14	0.06	0.01	0.0	0.0	0.26
WSW	0.0	0.0	0.01	0.03	0.02	0.01	0.0	0.0	0.07
W	0.0	0.0	0.01	0.02	0.03	0.02	0.0	0.0	0.08
WNW	0.0	0.0	0.0	0.01	0.04	0.01	0.0	0.0	0.06
NW	0.0	0.0	0.01	0.0	0.05	0.0	0.0	0.0	0.06
NNW	0.0	0.0	0.03	0.03	0.07	0.0	0.0	0.0	0.13
SUBTOTAL	0.0	0.16	0.62	0.81	0.93	0.14	0.01	0.0	2.67

TOTAL HOURS OF VALID STABILITY OBSERVATIONS	32550
TOTAL HOURS OF STABILITY CLASS B	867
TOTAL HOURS OF VALID WIND DIRECTION-WIND SPEED-STABILITY CLASS B	854
TOTAL HOURS CALM	0

ALL COLUMNS AND CALM TOTAL 100 PERCENT OF JOINT VALID OBSERVATIONS

METEOROLOGICAL FACILITY: LOCATED ABOUT 0.8 KM SW OF THE REACTOR BUILDING
STABILITY BASED ON LAPSE RATE MEASURED BETWEEN 9.51 AND 45.63 METERS
WIND SPEED AND DIRECTION MEASURED AT THE 10.00 METER LEVEL

MEAN WIND SPEED = 7.2 MPH

TABLE 1.3

JOINT PERCENTAGE FREQUENCIES OF WIND SPEED AND DIRECTION FOR
STABILITY CLASS C (-1.7< DELTA-T<=-1.5 C/100 M)

WATTS BAR NUCLEAR PLANT

JAN 1, 75 - DEC 31, 78

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	0.03	0.09	0.19	0.21	0.01	0.0	0.0	0.53
NNE	0.0	0.08	0.27	0.26	0.35	0.02	0.0	0.0	0.98
NE	0.0	0.11	0.29	0.26	0.21	0.0	0.0	0.0	0.87
ENE	0.0	0.09	0.27	0.16	0.05	0.0	0.0	0.0	0.57
E	0.0	0.18	0.33	0.07	0.01	0.0	0.0	0.0	0.59
ESE	0.0	0.06	0.09	0.0	0.0	0.0	0.0	0.0	0.15
SE	0.0	0.04	0.11	0.02	0.0	0.0	0.0	0.0	0.17
SSE	0.0	0.10	0.19	0.07	0.02	0.01	0.0	0.0	0.39
S	0.0	0.09	0.31	0.14	0.11	0.02	0.0	0.0	0.67
SSW	0.0	0.05	0.48	0.62	0.48	0.11	0.0	0.0	1.74
SW	0.0	0.03	0.28	0.22	0.09	0.01	0.0	0.0	0.63
WSW	0.0	0.03	0.08	0.06	0.04	0.02	0.0	0.0	0.23
W	0.0	0.02	0.05	0.07	0.12	0.02	0.0	0.0	0.28
WNW	0.0	0.01	0.02	0.05	0.16	0.03	0.0	0.0	0.27
NW	0.0	0.01	0.03	0.10	0.22	0.02	0.0	0.0	0.38
NNW	0.0	0.01	0.08	0.14	0.19	0.01	0.0	0.0	0.43
SUBTOTAL	0.0	0.94	2.97	2.43	2.26	0.28	0.0	0.0	8.88

TOTAL HOURS OF VALID STABILITY OBSERVATIONS	32550
TOTAL HOURS OF STABILITY CLASS C	2899
TOTAL HOURS OF VALID WIND DIRECTION-WIND SPEED-STABILITY CLASS C	2844
TOTAL HOURS CALM	0

ALL COLUMNS AND CALM TOTAL 100 PERCENT OF JOINT VALID OBSERVATIONS

METEOROLOGICAL FACILITY: LOCATED ABOUT 0.8 KM SW OF THE REACTOR BUILDING
STABILITY BASED ON LAPSE RATE MEASURED BETWEEN 9.51 AND 45.63 METERS
WIND SPEED AND DIRECTION MEASURED AT THE 10.00 METER LEVEL

MEAN WIND SPEED = 6.4 MPH

TABLE 1.3

JOINT PERCENTAGE FREQUENCIES OF WIND SPEED AND WIND DIRECTION FOR
STABILITY CLASS D (-1.5< DELTA-T<=-0.5 C/100 M)

WATTS BAR NUCLEAR PLANT

JAN 1, 75 - DEC 31, 78

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	0.03	0.32	0.83	0.91	1.09	0.03	0.0	0.0	3.21
NNE	0.03	0.38	1.05	1.05	1.12	0.03	0.0	0.0	3.66
NE	0.03	0.53	0.91	0.51	0.28	0.01	0.0	0.0	2.27
ENE	0.05	0.68	0.67	0.19	0.06	0.01	0.0	0.0	1.66
E	0.07	0.80	0.43	0.08	0.03	0.0	0.0	0.0	1.41
ESE	0.04	0.21	0.15	0.01	0.0	0.0	0.0	0.0	0.41
SE	0.03	0.44	0.28	0.04	0.04	0.0	0.0	0.0	0.83
SSE	0.06	0.63	0.39	0.05	0.04	0.01	0.01	0.0	1.19
S	0.04	0.85	0.98	0.37	0.32	0.06	0.02	0.0	2.64
SSW	0.02	0.91	1.99	1.27	1.34	0.44	0.05	0.0	6.02
SW	0.03	0.59	0.99	0.26	0.22	0.02	0.0	0.0	2.11
WSW	0.02	0.45	0.37	0.12	0.12	0.06	0.0	0.0	1.14
W	0.05	0.44	0.38	0.43	0.51	0.08	0.01	0.0	1.90
WNW	0.07	0.34	0.42	0.45	0.54	0.08	0.0	0.0	1.90
NW	0.06	0.32	0.42	0.66	0.79	0.08	0.0	0.0	2.33
NNW	0.06	0.32	0.47	0.52	0.83	0.04	0.0	0.0	2.24
SUBTOTAL	0.69	8.21	10.73	6.92	7.33	0.95	0.09	0.0	34.92

TOTAL HOURS OF VALID STABILITY OBSERVATIONS	32550
TOTAL HOURS OF STABILITY CLASS D	11312
TOTAL HOURS OF VALID WIND DIRECTION-WIND SPEED-STABILITY CLASS D	11118
TOTAL HOURS CALM	0

ALL COLUMNS AND CALM TOTAL 100 PERCENT OF JOINT VALID OBSERVATIONS

METEOROLOGICAL FACILITY: LOCATED ABOUT 0.8 KM SW OF THE REACTOR BUILDING
STABILITY BASED ON LAPSE RATE MEASURED BETWEEN 9.51 AND 45.63 METERS
WIND SPEED AND DIRECTION MEASURED AT THE 10.00 METER LEVEL

MEAN WIND SPEED = 5.6 MPH

TABLE 1.3

JOINT PERCENTAGE FREQUENCIES OF WIND SPEED [redacted]ND DIRECTION FOR
STABILITY CLASS E (-0.5< DELTA-T<=1.[redacted]C/100 M)

WATTS BAR NUCLEAR PLANT

JAN 1, 75 - DEC 31, 78

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	0.15	0.64	0.78	0.46	0.11	0.0	0.0	0.0	2.14
NNE	0.14	0.51	0.53	0.28	0.11	0.01	0.0	0.0	1.58
NE	0.14	0.65	0.32	0.11	0.03	0.0	0.0	0.0	1.25
ENE	0.24	1.04	0.33	0.04	0.01	0.0	0.0	0.0	1.66
E	0.22	0.62	0.15	0.02	0.0	0.0	0.0	0.0	1.01
ESE	0.08	0.16	0.03	0.01	0.0	0.0	0.0	0.0	0.28
SE	0.10	0.23	0.05	0.03	0.03	0.0	0.0	0.0	0.44
SSE	0.15	0.65	0.15	0.06	0.07	0.02	0.0	0.0	1.10
S	0.20	1.00	0.49	0.20	0.14	0.06	0.01	0.0	2.10
SSW	0.22	1.32	1.09	0.84	1.00	0.20	0.05	0.0	4.72
SW	0.24	0.96	0.34	0.19	0.18	0.03	0.0	0.0	1.94
WSW	0.27	0.91	0.15	0.10	0.08	0.03	0.0	0.0	1.54
W	0.48	0.89	0.27	0.13	0.06	0.03	0.0	0.0	1.86
WNW	0.41	0.75	0.21	0.11	0.04	0.0	0.0	0.0	1.52
NW	0.58	1.06	0.28	0.16	0.07	0.01	0.0	0.0	2.16
NNW	0.36	0.73	0.34	0.10	0.09	0.0	0.0	0.0	1.62
SUBTOTAL	3.98	12.12	5.51	2.84	2.02	0.39	0.06	0.0	26.92

TOTAL HOURS OF VALID STABILITY OBSERVATIONS	32550
TOTAL HOURS OF STABILITY CLASS E	8815
TOTAL HOURS OF VALID WIND DIRECTION-WIND SPEED-STABILITY CLASS E	8640
TOTAL HOURS CALM	27

ALL COLUMNS AND CALM TOTAL 100 PERCENT OF JOINT VALID OBSERVATIONS

METEOROLOGICAL FACILITY: LOCATED ABOUT 0.8 KM SW OF THE REACTOR BUILDING
STABILITY BASED ON LAPSE RATE MEASURED BETWEEN 9.51 AND 45.63 METERS
WIND SPEED AND DIRECTION MEASURED AT THE 10.00 METER LEVEL

MEAN WIND SPEED = 3.7 MPH

TABLE 1.3

JOINT PERCENTAGE FREQUENCIES OF WIND SPEED [redacted] ND DIRECTION FOR
STABILITY CLASS F (1.5< DELTA-T<= [redacted] C/100 M)

WATTS BAR NUCLEAR PLANT

JAN 1, 75 - DEC 31, 78

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	0.37	0.39	0.03	0.01	0.0	0.0	0.0	0.0	0.80
NNE	0.29	0.38	0.03	0.0	0.0	0.0	0.0	0.0	0.70
NE	0.27	0.48	0.02	0.0	0.0	0.0	0.0	0.0	0.77
ENE	0.37	0.70	0.08	0.0	0.0	0.0	0.0	0.0	1.15
E	0.23	0.36	0.02	0.0	0.0	0.0	0.0	0.0	0.61
ESE	0.07	0.08	0.0	0.0	0.0	0.0	0.0	0.0	0.15
SE	0.17	0.14	0.01	0.0	0.0	0.0	0.0	0.0	0.32
SSE	0.22	0.34	0.02	0.01	0.0	0.0	0.0	0.0	0.59
S	0.24	0.48	0.05	0.01	0.01	0.0	0.0	0.0	0.79
SSW	0.27	0.59	0.16	0.12	0.02	0.0	0.0	0.0	1.16
SW	0.32	0.57	0.08	0.02	0.02	0.0	0.0	0.0	1.01
WSW	0.54	0.63	0.06	0.0	0.0	0.0	0.0	0.0	1.23
W	0.63	0.78	0.04	0.0	0.0	0.0	0.0	0.0	1.45
WNW	0.69	0.63	0.02	0.0	0.0	0.0	0.0	0.0	1.34
NW	0.89	1.20	0.07	0.01	0.0	0.0	0.0	0.0	2.17
NNW	0.59	0.76	0.03	0.0	0.0	0.0	0.0	0.0	1.38
SUBTOTAL	6.16	8.51	0.72	0.18	0.05	0.0	0.0	0.0	15.62

TOTAL HOURS OF VALID STABILITY OBSERVATIONS	32550
TOTAL HOURS OF STABILITY CLASS F	5218
TOTAL HOURS OF VALID WIND DIRECTION-WIND SPEED-STABILITY CLASS F	5064
TOTAL HOURS CALM	79

ALL COLUMNS AND CALM TOTAL 100 PERCENT OF JOINT VALID OBSERVATIONS

METEOROLOGICAL FACILITY: LOCATED ABOUT 0.8 KM SW OF THE REACTOR BUILDING
STABILITY BASED ON LAPSE RATE MEASURED BETWEEN 9.51 AND 45.63 METERS
WIND SPEED AND DIRECTION MEASURED AT THE 10.00 METER LEVEL

MEAN WIND SPEED = 1.8 MPH

TABLE 1.3

JOINT PERCENTAGE FREQUENCIES OF WIND SPEED [redacted]IND DIRECTION FOR
STABILITY CLASS G (DELTA T > 4.0 C/100 M)

WATTS BAR NUCLEAR PLANT

JAN 1, 75 - DEC 31, 78

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	0.16	0.10	0.0	0.0	0.0	0.0	0.0	0.0	0.26
NNE	0.17	0.14	0.0	0.0	0.0	0.0	0.0	0.0	0.31
NE	0.21	0.20	0.0	0.0	0.0	0.0	0.0	0.0	0.41
ENE	0.41	0.45	0.01	0.0	0.0	0.0	0.0	0.0	0.87
E	0.28	0.18	0.0	0.0	0.0	0.0	0.0	0.0	0.46
ESE	0.09	0.04	0.0	0.0	0.0	0.0	0.0	0.0	0.13
SE	0.16	0.09	0.0	0.0	0.0	0.0	0.0	0.0	0.25
SSE	0.16	0.13	0.01	0.0	0.0	0.0	0.0	0.0	0.30
S	0.19	0.15	0.01	0.0	0.0	0.0	0.0	0.0	0.35
SSW	0.14	0.14	0.02	0.0	0.0	0.0	0.0	0.0	0.30
SW	0.17	0.15	0.01	0.0	0.0	0.0	0.0	0.0	0.33
WSW	0.23	0.30	0.0	0.0	0.0	0.0	0.0	0.0	0.53
W	0.34	0.44	0.01	0.0	0.0	0.0	0.0	0.0	0.79
WNW	0.28	0.24	0.0	0.0	0.0	0.0	0.0	0.0	0.52
NW	0.41	0.34	0.03	0.0	0.0	0.0	0.0	0.0	0.78
NNW	0.31	0.18	0.0	0.0	0.0	0.0	0.0	0.0	0.49
SUBTOTAL	3.71	3.27	0.10	0.0	0.0	0.0	0.0	0.0	7.08

TOTAL HOURS OF VALID STABILITY OBSERVATIONS	32550
TOTAL HOURS OF STABILITY CLASS G	2386
TOTAL HOURS OF VALID WIND DIRECTION-WIND SPEED-STABILITY CLASS G	2306
TOTAL HOURS CALM	51

ALL COLUMNS AND CALM TOTAL 100 PERCENT OF JOINT VALID OBSERVATIONS

METEOROLOGICAL FACILITY: LOCATED ABOUT 0.8 KM SW OF THE REACTOR BUILDING
STABILITY BASED ON LAPSE RATE MEASURED BETWEEN 9.51 AND 45.63 METERS
WIND SPEED AND DIRECTION MEASURED AT THE 10.00 METER LEVEL

MEAN WIND SPEED = 1.5 MPH

TABLE 1.4

WATTS BAR NUCLEAR PLANT - POINTS OF INTEREST

	POINT	SECTOR	DISTANCE (M)	ELEVATION (M)	CHI-OVER-Q (S/M**3)	D-OVER-Q (1/M**2)
1	SITE BOUNDARY	N	1100.	71.	3.56E-06	7.77E-09
2	SITE BOUNDARY	NNE	1100.	22.	4.94E-06	1.75E-08
3	SITE BOUNDARY	NE	1100.	4.	3.58E-06	7.47E-09
4	SITE BOUNDARY	ENE	1100.	-9.	4.04E-06	5.52E-09
5	SITE BOUNDARY	E	1100.	-9.	5.29E-06	7.32E-09
6	SITE BOUNDARY	ESE	1100.	-9.	4.67E-06	6.39E-09
7	SITE BOUNDARY	SE	1100.	-9.	6.59E-06	9.01E-09
8	SITE BOUNDARY	SSE	1100.	-9.	4.60E-06	7.36E-09
9	SITE BOUNDARY	S	1100.	-9.	3.33E-06	8.18E-09
10	SITE BOUNDARY	SSW	1100.	-9.	3.18E-06	8.86E-09
11	SITE BOUNDARY	SW	1100.	-9.	3.21E-06	6.79E-09
12	SITE BOUNDARY	WSW	1100.	-2.	4.77E-06	7.07E-09
13	SITE BOUNDARY	W	1100.	10.	3.18E-06	4.95E-09
14	SITE BOUNDARY	WNW	1100.	46.	9.47E-07	1.32E-09
15	SITE BOUNDARY	NW	1100.	46.	1.68E-06	2.31E-09
16	SITE BOUNDARY	NNW	1100.	28.	2.53E-06	4.19E-09
17	NEAREST RESIDENT	N	6584.	7.	2.72E-07	3.68E-10
18	NEAREST RESIDENT	NNE	3292.	16.	9.66E-07	2.81E-09
19	NEAREST RESIDENT	NE	2438.	-9.	1.12E-06	2.01E-09
20	NEAREST RESIDENT	ENE	2316.	-5.	1.39E-06	1.62E-09
21	NEAREST RESIDENT	E	2012.	-9.	2.21E-06	2.73E-09
22	NEAREST RESIDENT	ESE	1859.	-9.	2.18E-06	2.73E-09
23	NEAREST RESIDENT	SE	1463.	-9.	4.34E-06	5.68E-09
24	NEAREST RESIDENT	SSE	1585.	-2.	2.68E-06	4.07E-09
25	NEAREST RESIDENT	S	1676.	-2.	1.78E-06	4.14E-09
26	NEAREST RESIDENT	SSW	2225.	-12.	1.12E-06	2.78E-09
27	NEAREST RESIDENT	SW	2103.	-12.	1.23E-06	2.35E-09
28	NEAREST RESIDENT	WSW	2682.	22.	1.32E-06	1.62E-09
29	NEAREST RESIDENT	W	1768.	-2.	1.56E-06	2.30E-09
30	NEAREST RESIDENT	WNW	1585.	16.	5.41E-07	7.32E-10
31	NEAREST RESIDENT	NW	1753.	16.	8.39E-07	1.08E-09
32	NEAREST RESIDENT	NNW	5243.	22.	2.70E-07	2.99E-10
33	MILK GOAT ADULT	NE	3322.	-2.	7.19E-07	1.18E-09
34	MILK COW CHILD	NE	6218.	22.	3.01E-07	3.92E-10
35	MILK COW ADULT	E	4846.	65.	6.54E-07	6.01E-10
36	MILK COW INFANT	ESE	5700.	10.	4.63E-07	3.92E-10
37	MILK COW CHILD	ESE	5974.	4.	4.35E-07	3.60E-10
38	MILK COW INFANT	SE	5578.	10.	6.78E-07	5.74E-10
39	MILK COW CHILD	S	2499.	4.	1.00E-06	2.11E-09
40	MILK COW TEEN	S	4755.	83.	4.03E-07	6.94E-10
41	MILK COW INFANT	S	5243.	83.	3.52E-07	5.83E-10
42	MILK COW CHILD	SSW	2225.	-9.	1.12E-06	2.78E-09
43	MILK COW CHILD	SSW	2560.	4.	9.15E-07	2.19E-09
44	MILK COW CHILD	SW	2408.	-9.	1.02E-06	1.86E-09
45	MILK COW CHILD	SW	2560.	-9.	9.32E-07	1.68E-09
46	MILK COW ADULT	WSW	8412.	-2.	2.80E-07	2.16E-10
47	MILK COW TEEN	WNW	5486.	65.	9.54E-08	8.68E-11
48	MILK COW TEEN	WNW	7376.	77.	6.39E-08	5.10E-11
49	MILK COW TEEN	WNW	7529.	52.	6.22E-08	4.91E-11
50	MILK COW ADULT	NW	7376.	22.	1.16E-07	8.89E-11
51	MILK COW TEEN	NW	7529.	22.	1.13E-07	8.57E-11
52	MILK COW CHILD	NW	7620.	10.	1.11E-07	8.38E-11

TABLE 1.5

DOSE FACTORS FOR SUBMERSION IN NOBLE GASES

	DFB[1]	DF_γ [2]	DFS[1]	DF_β [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/yr per $\mu Ci/m^3$
2. mrad/yr per $\mu Ci/m^3$
3. 1.17(+3) = 1.17×10^3

TABLE 1.6

NUCLIDE SPECIFIC TRANSFER DATA*

	NUCLIDE	HALF-LIFE	RETENTION*	$B_{iv}(\frac{veg.}{soil})$ **	FM_i $(\frac{d}{L})$ ***
1	TRITIUM	4.49E+03	4.70E-01	4.80E+00	1.30E-02
2	C-14	2.09E+06	4.70E-01	5.50E+00	1.20E-02
3	N-13	6.94E-03	4.70E-01	7.50E+00	2.20E-02
4	O-19	3.36E-04	4.70E-01	1.60E+00	2.00E-02
5	F-18	7.62E-02	4.70E-01	6.50E-04	1.40E-02
6	NA-24	6.33E-01	4.70E-01	5.20E-02	4.00E-02
7	P-32	1.43E+01	4.70E-01	1.10E+00	2.50E-02
8	AR-41	7.63E-02	4.70E-01	6.00E-01	2.00E-02
9	CR-51	2.78E+01	4.70E-01	2.50E-04	2.20E-03
10	MN-54	3.03E+02	4.70E-01	2.90E-02	2.50E-04
11	MN-56	1.07E-01	4.70E-01	2.90E-02	2.50E-04
12	FE-59	4.50E+01	4.70E-01	6.60E-04	1.20E-03
13	CO-58	7.13E+01	4.70E-01	9.40E-03	1.00E-03
14	CO-60	1.92E+03	4.70E-01	9.40E-03	1.00E-03
15	ZN-69M	5.75E-01	4.70E-01	4.00E-01	3.90E-02
16	ZN-69	3.96E-02	4.70E-01	4.00E-01	3.90E-02
17	BR-84	2.21E-02	4.70E-01	7.60E-01	5.00E-02
18	BR-85	2.08E-03	4.70E-01	7.60E-01	5.00E-02
19	KR-85M	1.83E-01	4.70E-01	3.00E+00	2.00E-02
20	KR-85	3.93E+03	4.70E-01	3.00E+00	2.00E-02
21	KR-87	5.28E-02	4.70E-01	3.00E+00	2.00E-02
22	KR-88	1.17E-01	4.70E-01	3.00E+00	2.00E-02
23	KR-89	2.21E-03	4.70E-01	3.00E+00	2.00E-02
24	RB-88	1.24E-02	4.70E-01	1.30E-01	3.00E-02
25	RB-89	1.07E-02	4.70E-01	1.30E-01	3.00E-02
26	SR-89	5.20E+01	4.70E-01	1.70E-02	1.40E-03
27	SR-90	1.03E+04	4.70E-01	1.70E-02	1.40E-03
28	SR-91	4.03E-01	4.70E-01	1.70E-02	1.40E-03
29	SR-92	1.13E-01	4.70E-01	1.70E-02	1.40E-03
30	SR-93	5.56E-03	4.70E-01	1.70E-02	1.40E-03
31	Y-90	2.67E+00	4.70E-01	2.60E-03	1.00E-05
32	Y-91M	3.47E-02	4.70E-01	2.60E-03	1.00E-05
33	Y-91	5.88E+01	4.70E-01	2.60E-03	1.00E-05
34	Y-92	1.47E-01	4.70E-01	2.60E-03	1.00E-05
35	Y-93	4.29E-01	4.70E-01	2.60E-03	1.00E-05
36	ZR-95	6.50E+01	4.70E-01	1.70E-04	5.00E-06
37	NB-95M	3.75E+00	4.70E-01	9.40E-03	2.50E-03
38	NB-95	3.50E+01	4.70E-01	9.40E-03	2.50E-03
39	MO-99	2.79E+00	4.70E-01	1.20E-01	7.50E-03
40	TC-99M	2.50E-01	4.70E-01	2.50E-01	2.50E-02
41	TC-99	7.74E+07	4.70E-01	2.50E-01	2.50E-02
42	TC-104	1.25E-02	4.70E-01	2.50E-01	2.50E-02
43	RU-106	3.67E+02	4.70E-01	5.00E-02	1.00E-06
44	TE-132	3.24E+00	4.70E-01	1.30E+00	1.00E-03
45	I-129	6.21E+09	4.70E-01	2.00E-02	1.20E-02
46	I-131	8.05E+00	4.70E-01	2.00E-02	1.20E-02
47	MI-131	8.05E+00	4.70E-01	2.00E-02	1.20E-02
48	I-132	9.58E-02	4.70E-01	2.00E-02	1.20E-02
49	MI-132	9.58E-02	4.70E-01	2.00E-02	1.20E-02
50	I-133	8.75E-01	4.70E-01	2.00E-02	1.20E-02
51	MI-133	8.75E-01	4.70E-01	2.00E-02	1.20E-02
52	I-134	3.61E-02	4.70E-01	2.00E-02	1.20E-02
53	MI-134	3.61E-02	4.70E-01	2.00E-02	1.20E-02
54	I-135	2.79E-01	4.70E-01	2.00E-02	1.20E-02
55	MI-135	2.79E-01	4.70E-01	2.00E-02	1.20E-02
56	XE-131M	1.18E+01	4.70E-01	1.00E+01	2.00E-02
57	XE-133M	2.26E+00	4.70E-01	1.00E+01	2.00E-02
58	XE-133	5.27E+00	4.70E-01	1.00E+01	2.00E-02
59	XE-135M	1.08E-02	4.70E-01	1.00E+01	2.00E-02
60	XE-135	3.83E-01	4.70E-01	1.00E+01	2.00E-02
61	XE-137	2.71E-03	4.70E-01	1.00E+01	2.00E-02
62	XE-138	1.18E-02	4.70E-01	1.00E+01	2.00E-02
63	CS-134	7.48E+02	4.70E-01	1.00E-02	8.00E-03
64	CS-135	1.10E+09	4.70E-01	1.00E-02	8.00E-03
65	CS-136	1.30E+01	4.70E-01	1.00E-02	8.00E-03
66	CS-137	1.10E+04	4.70E-01	1.00E-02	8.00E-03
67	CS-138	2.24E-02	4.70E-01	1.00E-02	8.00E-03
68	BA-139	5.76E-02	4.70E-01	5.00E-03	4.00E-04
69	BA-140	1.28E+01	4.70E-01	5.00E-03	4.00E-04
70	LA-140	1.68E+00	4.70E-01	2.50E-03	5.00E-06
71	CE-144	2.84E+02	4.70E-01	2.50E-03	1.00E-04
72	PR-143	1.36E+01	4.70E-01	2.50E-03	5.00E-06
73	PR-144	1.20E-02	4.70E-01	2.50E-03	5.00E-06
74	NP-239	2.35E+00	4.70E-01	2.50E-03	5.00E-06

*Reference: NUREG/CR-1004

**Reference: Regulatory Guide 1.109

***Reference: NUREG/CR-1004 for Iodine, Strontium, and Cesium; R.G. 1.109 for all other nuclides.

TABLE 1.7

INTERNAL DOSE FACTORS[1] - INFANT THYROID

Radionuclide	(DFI_i) Inhalation[1] $\left(\frac{\text{mrem}}{\text{yr}} - \frac{\text{cm}^3}{\mu\text{Ci}}\right)$	(DF_i) Cow Milk Ingestion[2] $\left(\frac{\text{mrem}}{\text{yr}} - \frac{\text{m}^2\text{-s}}{\mu\text{Ci}}\right)$
H-3	6.47(+8)	3.53(+9)*
Te-132	2.79(+8)	3.50(+7)
I-131	1.48(+13)	7.24(+11)
I-133	3.56(+12)	1.52(+10)

*Unit for H-3 is mrem/yr per $\mu Ci/cm^3$.

1. Based on Regulatory Guide 1.109 methodology with an infant breathing rate of 1400 m^3/yr.
2. Based on Regulatory Guide 1.109 and NUREG/CR-1004 dose methodologies

TABLE 1.8
(Sheet 1)

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

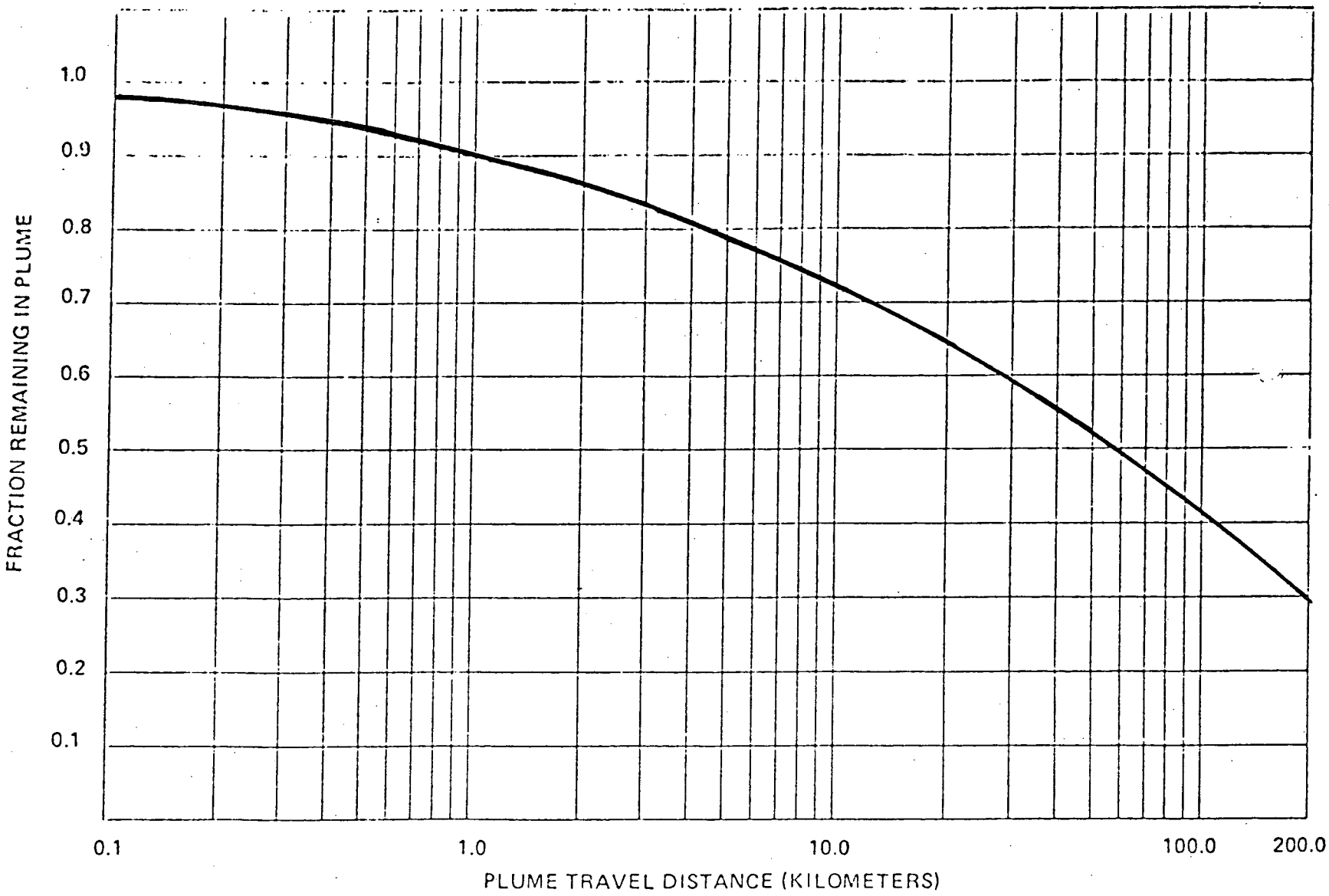
Element	Total Body (DFG_i)	Skin
H-3	0.0	0.0
C-14	0.0	0.0
Na-24	2.50E-08	2.90E-08
P-32	0.0	0.0
Cr-51	2.20E-10	2.60E-10
Mn-54	5.80E-09	6.80E-09
Mn-56	1.10E-08	1.30E-08
Fe-55	0.0	0.0
Fe-59	8.00E-09	9.40E-09
Co-58	7.00E-09	8.20E-09
Co-60	1.70E-08	2.00E-08
Ni-63	0.0	0.0
Ni-65	3.70E-09	4.30E-09
Cu-64	1.50E-09	1.70E-09
Zn-65	4.00E-09	4.60E-09
Zn-69	0.0	0.0
Br-83	6.40E-11	9.30E-11
Br-84	1.20E-08	1.40E-08
Br-85	0.0	0.0
Rb-86	6.30E-10	7.20E-10
Rb-88	3.50E-09	4.00E-09
Rb-89	1.50E-08	1.80E-08
Sr-89	5.60E-13	6.50E-13
Sr-91	7.10E-09	8.30E-09
Sr-92	9.00E-09	1.00E-08
Y-90	2.20E-12	2.60E-12
Y-91M	3.80E-09	4.40E-09
Y-91	2.40E-11	2.70E-11
Y-92	1.60E-09	1.90E-09
Y-93	5.70E-10	7.80E-10
Zr-95	5.00E-09	5.80E-09
Zr-97	5.50E-09	6.40E-09
Nb-95	5.10E-09	6.00E-09
Mo-99	1.90E-09	2.20E-09
Tc-99M	9.60E-10	1.10E-09
Tc-101	2.70E-09	3.00E-09
Ru-103	3.60E-09	4.20E-09
Ru-105	4.50E-09	5.10E-09
Ru-106	1.50E-09	1.80E-09
Ag-110M	1.80E-08	2.10E-08
Te-125M	3.50E-11	4.80E-11
Te-127M	1.10E-12	1.30E-12
Te-127	1.00E-11	1.10E-11
Te-129M	7.70E-10	9.00E-10
Te-129	7.10E-10	8.40E-10
Te-131M	8.40E-09	9.90E-09
Te-131	2.20E-09	2.60E-06
Te-132	1.70E-09	2.00E-09
I-130	1.40E-08	1.70E-08
I-131	2.80E-09	3.40E-09

TABLE 1.8
(Sheet 2)

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

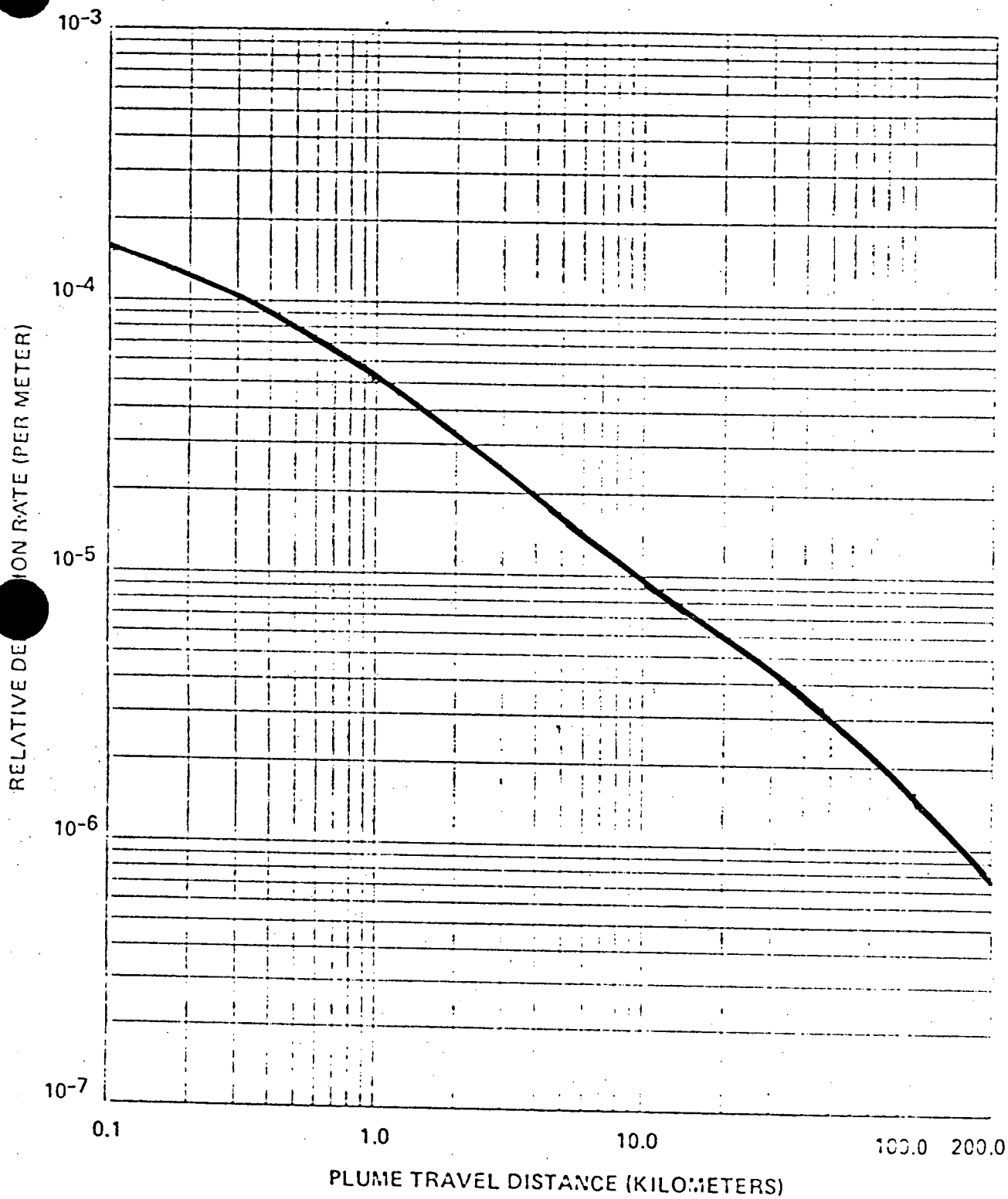
Element	Total Body (DFG_i)	Skin
I-132	1.70E-08	2.00E-08
I-133	3.70E-09	4.50E-09
I-134	1.60E-08	1.90E-08
I-135	1.20E-08	1.40E-08
Cs-134	1.20E-08	1.40E-08
Cs-136	1.50E-08	1.70E-08
Cs-137	4.20E-09	4.90E-09
Cs-138	2.10E-08	2.40E-08
Ba-139	2.40E-09	2.70E-09
Ba-140	2.10E-09	2.40E-09
Ba-141	4.30E-09	4.90E-09
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

FIG 2.1



Plume Depletion Effect for Ground Level Releases (All Atmospheric Stability Classes) (R.G. 1.111- USNRC-July 1977)

FIGURE 1.2



Relative Deposition for Ground Level Releases (All Atmospheric Stability Classes)(R.G. 1.111-USNRC-July 1977)

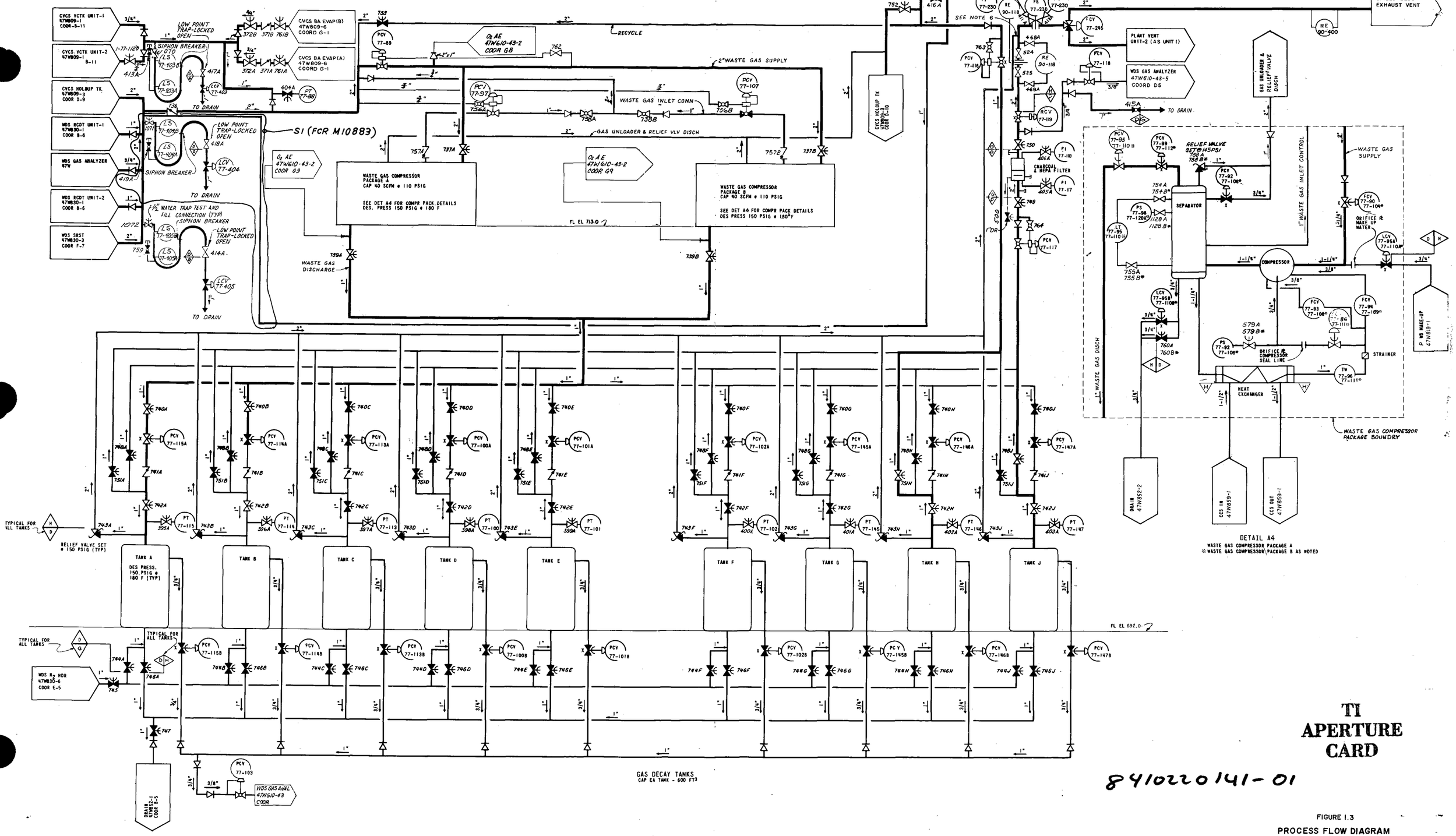


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FIGURE 1.3

PROCESS FLOW DIAGRAM

2. Liquid Effluents

2.1 Concentration

2.1.1 RETS Requirement

The concentration of radioactive material released at any time from the site to unrestricted areas shall be limited to the Maximum Permissible Concentration (MPC, attached as Appendix I) specified in 10 CFR 20, Appendix B, Table II, Column 2 for nuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the concentration shall be limited to 2×10^{-4} µCi/ml total activity. To ensure compliance, the following approach will be used for each release.

2.1.2 Prerelease Analysis

Tanks will be recirculated through two volume changes prior to sampling before release to ensure that a representative sample is obtained. Because of the size, the cask decontamination tank will not necessarily be recirculated through two volumes. An appropriate recirculation time for these tanks will be determined by a one time test. The tank will be recirculated and periodically sampled for suspended particulates during the test. The appropriate recirculation time will be the time that the suspended particulate concentration reaches steady state. The condensate demineralizer waste evaporator blowdown tank cannot be recirculated. However the contents of the tank will be under administrative control and could be transferred to the distillate tanks prior to release.

Prior to release a grab sample will be analyzed for each batch release point (j) to determine the concentration (Cij) of each radionuclide (i). For continuous release, Cij is based on the most recent isotopic analysis for that release point. The following equation is then used to calculate MPC fractions (Mij).

$$M_{ij} = \frac{C_{ij}}{MPC_i} \qquad (2.1)$$

where:

M_{ij} = MPC fraction of radionuclide i for release point j.

C_i = concentration of radionuclide i for release point j, µCi/mL.

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

2.1.3 MPC-Sum of the Ratios

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

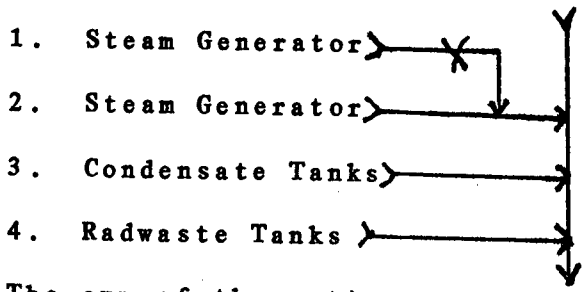
$$R_j = \sum_i M_{ij} \qquad (2.2)$$

where:

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

M_{ij} = MPC fraction from equation 2.1.

There are 4 possible liquid release points into cooling tower blowdown.



The sum of the ratios at the diffuser pipes must be ≤ 1 due to the releases from any or all of the above sources. The following relationship will assure this criterion is met:

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

where:

f_1, f_2, f_3, f_4 = the effluent flow rate (gallons/minute) at the respective release point determined by plant personnel.

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

F = minimum dilution flow rate for prerelease analysis (cooling tower blowdown, gallons/minute) = 20,000 gal/min.

2.2 Instrument Setpoints

2.2.1 Setpoint Determination

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

The respective alarm/trip setpoints at each release point will be set such that the sum of the ratios (R_j) for all points, as calculated by Equation 2.3 will not be exceeded.[J] The minimum alarm/trip setpoint value P is calculated based on release concentration, but for ease of operation it may be desired that the setpoint(S) be set above the minimum alarm/trip setpoint.

That is,

$$S_j = b_j \times P_j \qquad (2.4)$$

or

$$b_j = \frac{S_j}{P_j}$$

where:

S_j = desired alarm/trip setpoint at release point j, cpm.

b_j = scaling factor to prevent alarms/trips due to variations in the effluent concentrations at release point j.

P_j = minimum setpoint calculated based on release concentration, cpm.

The R_j used in Equation 2.3 must also be scaled by the corresponding scale[J] factor. Equation 2.3 and the corresponding alarm/trip setpoints become

$$f_1(b_1R_1-1) + (b_2R_2-1) + f_3(b_3R_3-1) + f_4(b_4R_4-1) \leq F \quad (2.5)$$

$$b_1 = \frac{S_1}{P_1} \quad (2.6)$$

$$b_2 = \frac{S_2}{P_2} \quad (2.7)$$

$$b_3 = \frac{S_3}{P_3} \quad (2.8)$$

$$b_4 = \frac{S_4}{P_4} \quad (2.9)$$

For example, for 2 release points and minimum dilution flow this becomes,

$$f_1\left(\frac{S_1}{P_1} \times R1\right) - 1 + f2\left(\frac{S_2}{P_2} \times R2\right) - 1 < 20{,}000 \quad (2.10)$$

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 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 Requirements

Specification 3.11.1.2 of the Radiological Effluent Technical Specifications (RETS) requires that does or dose commitment to an individual from radioactive materisl in liquid effluents released to unrestricted areas from each reactor shall be limited:

a. During any calender 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 2.3.3 will be implemented.

The 22 nuclides (listed below), based on Sequoyah Nuclear Plant historical release data, contribute more than 95 percent of the dose to the total body and the most cricital organs for both the water and fish ingestion pathways. The critical organs considered for fish ingestion are the gastrointestinal tract (GIT), bone, thyroid, and liver. Critical organs considered for water ingestion are the GIT, bone, and thyroid.

H-3	Co-58	SR-90	Cs-134
Na-24	Co-60	Zr-95	Cs-136
Cr-51	Z_n-65	Nb-95	Cs-137
Mn-54	Sr-89	Mo-99	I-133
Fe-55		Tc-99m	I-131
Fe-59		Ag-110m	
		Sb-124	

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 bove 22 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.

$$D_j = \frac{1}{.95} \sum_{i=1}^{22} (DCF)_{ij} \times I_{ij}, \text{ rem} \quad (2.11)$$

where:

D_j = dose for the jth organ from 22 radionuclides, rem

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

.95 = conservative correction factor, considering only 22 radionuclides.

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

I_{ij} = monthly activity ingested of the i^{th} radionuclide by the critical age group for the jth organ, μCi.

I_{ij} is described by

$$I_{ij} = \frac{A_i \; V_{ij} \; (30)}{Fd \; (7.34 \times 1010)} \quad \mu Ci \qquad (2.12)$$

where:

A_i = activity released of ith radionuclide during the month, μCi.

V_{ij} = maximum individual water consumption rate corresponding to the age group selected for the critical DCF_{ij} above (Adult: 2000 mL/d, Child: 1400 mL/dμ Regulatory Guide 1.109)

30 = days per month

F = average river flow rate at Watts Bar Dam for the month (cubic feet per second)

d = fraction of river flow available for dilution (0.06)

7.34×10^{10} = conversion from cubic feet per seond to milliliters per month.

Considering the conversion factor from rem to mrem (x103), the dose equation then becomes

$$D_j = \frac{7.17 \times 10^{-6}}{F} \sum_{i=1}^{22} (V \cdot DCF)_{ij} \cdot A_i \text{, mrem} \qquad (2.13)$$

2.3.2.2 Fish Ingestion

The dose to an individual from the consumption of fish is described by Equation 2.11. In this case the activity ingested of the i^{th} radionuclide (I_i) is described by

$$I_i = \frac{A_i \; B_i \; M_{ij}}{Fd \; (7.34 \times 10^{10})}, \; \mu Ci \qquad (2.14)$$

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

B_i = effective fish concentration factor of i^{th} radionuclide $\frac{\mu Ci/g}{\mu Ci/mL}$, see attached as Table 2.2.

M_{ij} = amount of fish eaten monthly by maximum individual corresponding to age group selected for the critical DCF_{ij} above (adult: 1750 gμ child: 575 gμ Regulatory Guide 1.109).

F = average river flow rate at Watts Bar Dam for month (cubic feet per second)

d = fraction river flow available for dilution (0.06)

7.34×10^{10} = conversion from cubic feet per second to milliliters per month.

Considering the conversion factor from rem to mrem (x103), the dose equation then becomes

$$D_j = \frac{2.39 \times 10^{-7}}{F} \sum_{i=1}^{22} A_i \cdot B_i \cdot (M \cdot DCF)_{ij}, \; mrem \qquad (2.15)$$

2.3.2.3 Recreation

The total body dose to an individual via the shoreline recreation pathway is described by the following equation. For this calculation, the total dose is estimated based on a calculation for Co-58, Co-60, C_s-134, and C_s-137. These four nuclides are expected to contribute over 95 percent of the recreation dose.

$$D = \frac{1}{0.95} \sum_{i=1}^{4} \frac{[(RDCF)_i \xi_i \ 67]}{8760}, \text{ mrem} \quad (2.16)$$

D = dose to the total body from plant releases, mrem

$\frac{1}{0.95}$ = conservative correction factor for considering only 4 radionuclides

$RDCF_i$ = shoreline recreation dose commitment factor for the i^{th} radionuclide (mrem/yr per $\mu Ci/cm^2$). See attached table 2.3. (Note: For Cs-137, the dose commitment factor for its daughter, Ba-137m, is assumed.)

ξ_i = concentration of i^{th} radionuclide in shoreline sediment ($\mu Ci/cm^2$), as described by the following equation (based on equation A-5 in Regulatory Guide 1.109).

$$\xi_i = 100 \cdot RHL_i \cdot C_i \cdot W [1 - \exp(-\lambda_i \cdot t)] \quad (2.17)$$

where:

100 = transfer constant defined in Regulatory Guide 1.109

RHL_i = radiological half-life of the i^{th} radioisotope, days from Table 2.1

C_i = concentration of i^{th} radionuclide in the Tennessee River, $\mu Ci/mL$. $\mu C_i = A_i/(F \cdot d \cdot 7.34 \times 10^{10})$

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

F = average river flow at Watts Bar Dam for the month cubic feet per second

d = fraction of river flow available for dilution (0.06)

7.34×10^{10} = conversion from cubic feet per seond to milliliters per month.

W = shoreline width factor (0.3 for a lake shore, per table A-2 Regulatory Guide 1.109)

λ_i = decay constant of the i^{th} radionuclide

t = buildup time in sediment, assumed 15 years, per Regulatory Guide 1.109

67 = assumed monthly exposure time for maximum individual, h

$= 500 \frac{h}{yr}$ (~10 h/week) •0.4 (fractional exposure for quarter) ÷ 3 (months/quarter)

8760 = conversion from year to hours.

0.1 = conversion factor, $m^2 \cdot ml/cm^2 \cdot 1$

The dose equation then becomes:

$$D = \frac{1}{F} (0.0231 A_{Co-60} + 0.0004 A_{Co-58} + 0.0069 A_{Cs-134} + 0.0114 A_{Cs-137}) \quad (2.18)$$

2.3.2.4 Monthly Summary

Calendar quarter doses are first estimated by summing the doses calculated for each month in that quarter. Calendar year doses are first estimated by summing the doses calculated for each month in that year. However, if the annual doses determined in this manner exceed or approach the specification limits, doses calculated for previous quarters with the methodology of Section 2.3.3 will be used instead of those quarterly doses estimated by summing monthly results. 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, either a new list if principal isotopes will be prepared or a new correction factor will be used. The latter option will not be used if less than 90 percent of the total dose is predicted.

2.3.2.5 Dose Projections

In accordance with specification 3.11.1.3, dose projections will be performed. This will be done by averaging the calculatd dose for the most recent month and the calculated dose for the previous month and assigning that average dose as the projection for the current month.

2.3.3 Quarterly and Annual Analysis

A complete analysis utilizing the total estimated liquid releases for each calendar quarter will be performed and reported as required in Section 6.9 of the Technical Specificaitons. This analysis will replace previous estimates calculated using Section 2.3.2 methodology and will also include an approximation population doses.

2.3.3.1 Individual Doses

The dose to the j^{th} organ of the maximum individual from m nuclides, D_j, is described by

$$D_j = \sum_{k=1}^{5} \sum_{i=1}^{m} D_{ijk}, \text{ rem} \qquad (2.19)$$

$$= \sum_{i=1}^{m} \sum_{k=1}^{2} [(DCF)_{ij} \cdot I_{ik}] \qquad (2.20)$$

$$+ \sum_{k=3}^{5} [(RDCF)_{ijk} \cdot \xi_{ik} \cdot T_k \cdot \phi], \text{ rem}$$

where:

D_{ijk} = dose to the j^{th} organ from the i^{th} radionuclide via the k^{th} exposure path

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

k = exposure pathway of interest:
1. water ingestion,
2. fish ingestion,
3. shoreline recreation,
4. above water recreation, and
5. in-water recreation

$(IDCF)_{ij}$ = ingestion dose commitment factor for the j^{th} organ from the ith radionuclide, rem/μCi. For the combination of pathways considered and the nuclide mix expected, the maximum exposed individual will be an adult or child. Table 2.1 is a list of ingestion dose factors for the two age groups.

I_{ik} = the activity ingested of the i^{th} radionuclide, via the kth exposure pathway, μCi.

$$I_{il} = C_i V_n \qquad (2.21)$$

For the fish pathway

$$I_{i2} = C_i B_i M \qquad (2.22)$$

C_i = concentration of the i^{th} radionuclide in the Tennessee River, μCi/mL

$$C_i = A_i/(F_1 d) \qquad (2.23)$$

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

F_1 = total river flow at location 1 during period, mL.

1 = location of interest (for dose to the maximum individual the first down-river exposure point is used. For the population dose, various down-river locations are used to account for the total exposed population. Table 2.4a gives the river location of public water supplies; Tables 2.4b and 2.4c give the boundaries of the various reaches in which concentrations are calculated for the fish and recreation pathways).

d = fraction of river flow available for dilution (1/5 above Chickamauga Dam, 1 below the dam).

V = average rate of water consumption per Regulatory Guide 1.109

For maximum individual:

Adult - 2000 mL/d
Child - 1400 mL/d

For average individual (population):

Adult - 1010 mL/d
Child - 710 mL/d

n = number of days during the release period, day.

B_i = bioaccumulation factor for the i^{th} radionuclide in fish, μCi/g per μCi/mL, from Table 2.2

M = amount of fish consumed during the period (fraction of year times the annual consumption rate per Regulatory Guide 1.109).

For maximum individual:

Adult - 21 kg/yr
Child - 6.9 kg/yr

For average individual (population):

Adult - 6.9 kg/yr
Child - 2.2 kg/yr

$(RDCF)_{ijk}$ = recreation dose commitment factor for the j^{th} organ from the i^{th} radionuclide via the k^{th} pathway; mrem/yr per concentration (ξ_{ik}) in medium; from Table 2.3.

ξ_{ik} = the concentration of the i^{th} radionuclide in the environmental medium pertaining to the k^{th} pathway.

For above-water and in-water pathways

$$\xi_{ik} = \xi_{i5} = C_i \qquad (2.24)$$

For the shoreline pathway, a 15-year buildup in the sediment of the lake is assumed (per Regulatory Guide 1.109 equation A-5).

$$\xi_{i3} = 100 \cdot RHL_i \cdot C_i \cdot W\,[1-\exp(-\lambda_i \quad t)] \qquad (2.25)$$

where:

100 = transfer constant as defined in Regulatory Guide 1.109.

RHL_i = radiological half-life of the i^{th} isotope, days, from Table 2.1.

W = shoreline width factor (0.3 for a lake shore, per Table A-2 of Regulatory Guide 1.109).

λ_i = decay constant of the i^{th} radionuclide = $0.693/RHL_i$.

t = buildup time in sediment, assumed 15 years, per Regulatory Guide 1.109.

T_k = assumed exposure time of maximum individual for the k^{th} pathway

(3) shoreline	500 h/yr	(~10 h/week)
(4) above-water	1800 h/yr	(6 h/d, 300 d/yr)
(5) in-water	920 h/yr	(6 h/d, for five summer months)

ϕ = fraction of annual exposure for each quarter

1st Quarter	January-March	0.1
2nd Quarter	April-June	0.3
3rd Quarter	July-September	0.4
4th Quarter	October-December	0.2

2.3.3.2 Population Doses

The total dose from all 5 pathways to the j^{th} organ of the population, A_j, from m nuclides at n locations is described by:

$$\Delta_j = \sum_{l=1}^{n} \sum_{k=1}^{5} \sum_{i=1}^{m} \Delta_{ijkl} \qquad (2.26)$$

$$= \sum_{l=1}^{n} \sum_{k=1}^{5} \sum_{i=1}^{m} D_{ijkl} \; P_{kl} \qquad (2.27)$$

where:

Δ_{ijkl} = dose to the j^{th} organ of the total population from the i^{th} radionuclide via the k^{th} pathway at location L.

D_{ijkl} = dose to individual as described in Section 2.3.3.1 at location L.

P_{kl} = number of people exposed via the k^{th} pathway at location 1, from Table 2.4.a-c. The population is assumed to consist of 71-percent adults and 29-percent children (from Appendix D, Regulatory Guide 1.109 - the value for children includes teenagers).

2.4 Operability of Liquid Radwaste Equipment

Specification 3.11.1.3 of the Radiological Effluent Technical Specification (RETS) 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 due to liquid effluent releases* to unrestricted areas (see Figure 2.1.1-1) when averaged over 31 days would exceed 0.06 mrem to the total body or 0.21 mrem to any organ. Doses will be projected monthly to assure compliance.

*Per operating reactor unit.

Table 2.1

Sheet 1 of 8

DOSE [illegible]TMENT FACTORS --- (REM/UCI)

NUCLIDE	HALF-LIFE (DAYS)	ADULT					CHILD				
		BONE	GI TRACT	THYROID	TOTAL BODY	LIVER	BONE	GI TRACT	THYROID	TOTAL BODY	LIVER
H-3	4.50E+03	1.05E-04	1.05E-04	1.05E-04	1.05E-04	1.05E-04	2.03E-04	2.03E-04	2.03E-04	2.03E-04	2.03E-04
C-14	2.09E+06	2.84E-03	5.68E-04	5.68E-04	5.68E-04	5.68E-04	1.21E-02	2.42E-03	2.42E-03	2.42E-03	2.42E-03
NA-22	9.49E+02	2.50E-02	1.35E-02	1.21E-02	1.36E-02	1.40E-02	2.50E-02	1.35E-02	1.21E-02	1.36E-02	1.40E-02
NA-24	6.26E-01	1.70E-03	1.70E-03	1.70E-03	1.70E-03	1.70E-03	5.80E-03	5.80E-03	5.80E-03	5.80E-03	5.80E-03
P-32	1.43E+01	1.93E-01	2.17E-02	7.46E-03	7.46E-03	1.20E-02	8.25E-01	2.28E-02	3.18E-02	3.18E-02	3.86E-02
CR-51	2.77E+01	2.66E-06	6.69E-04	1.59E-06	2.66E-06	2.66E-06	8.90E-06	4.72E-04	4.94E-06	8.90E-06	8.90E-06
MN-54	3.12E+02	8.72E-04	1.40E-02	8.72E-04	8.72E-04	4.57E-03	2.85E-03	8.98E-03	2.85E-03	2.85E-03	1.07E-02
MN-56	1.08E-01	2.04E-05	3.67E-03	2.04E-05	2.04E-05	1.15E-04	7.54E-05	4.84E-02	7.54E-05	7.54E-05	3.34E-04
FE-55	9.86E+02	2.75E-03	1.09E-03	4.43E-04	4.43E-04	1.90E-03	1.15E-02	1.13E-03	1.89E-03	1.89E-03	6.10E-03
FE-59	4.46E+01	4.34E-03	3.40E-02	3.91E-03	3.91E-03	1.02E-02	1.65E-02	2.78E-02	1.33E-02	1.33E-02	2.67E-02
CO-57	2.71E+02	3.57E-04	4.56E-03	1.10E-04	1.84E-04	2.53E-04	3.57E-04	4.56E-03	1.10E-04	1.84E-04	2.53E-04
CO-58	7.09E+01	1.67E-03	1.51E-02	1.67E-03	1.67E-03	7.45E-04	5.51E-03	1.05E-02	5.51E-03	5.51E-03	1.80E-03
CO-60	1.92E+03	4.72E-03	4.02E-02	4.72E-03	4.72E-03	2.14E-03	1.56E-02	2.93E-02	1.56E-02	1.56E-02	5.29E-03
NI-63	3.65E+04	1.30E-01	1.89E-03	4.36E-03	4.36E-03	9.01E-03	5.39E-01	1.94E-03	1.83E-02	1.83E-02	2.88E-02
NI-65	1.05E-01	5.28E-04	1.74E-03	3.13E-05	3.13E-05	6.86E-05	2.22E-03	2.56E-02	1.22E-04	1.22E-04	2.09E-04
CU-64	5.30E-01	3.91E-05	7.10E-03	3.91E-05	3.91E-05	5.33E-05	1.48E-04	1.15E-02	1.48E-04	1.48E-04	2.45E-04
ZN-65	2.44E+02	4.84E-03	9.70E-03	6.96E-03	6.96E-03	1.54E-02	1.37E-02	6.41E-03	2.27E-03	2.27E-03	3.65E-02
ZN-69	3.96E-02	1.03E-05	2.96E-06	1.37E-06	1.37E-06	1.97E-05	4.39E-05	3.99E-03	5.85E-06	5.85E-06	6.33E-05
AS-74	1.78E+01	2.90E-04	3.88E-02	2.90E-04	2.90E-04	2.51E-04	2.90E-04	3.88E-02	2.90E-04	2.90E-04	2.51E-04
AS-76	1.10E+00	4.49E-05	9.70E-02	4.49E-05	4.49E-05	4.70E-05	4.49E-05	9.70E-02	4.49E-05	4.49E-05	4.70E-05
BR-83	1.00E-01	4.02E-05	5.79E-05	4.02E-05	4.02E-05	4.02E-05	1.71E-04	0.00E+00	1.71E-04	1.71E-04	1.71E-04
BR-84	2.21E-02	5.21E-05	4.09E-10	5.21E-05	5.21E-05	5.21E-05	1.98E-04	0.00E+00	1.98E-04	1.98E-04	1.98E-04
BR-85	1.99E-03	2.14E-06	1.00E-21	2.14E-06	2.14E-06	2.14E-06	9.12E-06	0.00E+00	9.12E-06	9.12E-06	9.12E-06
KR-83M	7.75E-02	0.00E+00	1.46E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.46E-04	0.00E+00	0.00E+00	0.00E+00
KR-85M	1.87E-01	0.00E+00	3.39E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.30E-03	0.00E+00	0.00E+00	0.00E+00
KR-85	3.91E+03	0.00E+00	4.62E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.62E-02	0.00E+00	0.00E+00	0.00E+00
RB-86	1.87E+01	9.83E-03	4.16E-03	9.83E-03	9.83E-03	2.11E-02	4.12E-02	4.31E-03	4.12E-02	4.12E-02	6.70E-02
RB-88	1.23E-02	3.21E-05	8.36E-16	3.21E-05	3.21E-05	6.05E-05	1.32E-04	9.32E-06	1.32E-04	1.32E-04	1.90E-04
RB-89	1.07E-02	2.82E-05	2.33E-18	2.82E-05	2.82E-05	4.01E-05	1.04E-04	1.02E-06	1.04E-04	1.04E-04	1.17E-04
SR-89	5.05E+01	3.02E-01	4.94E-02	8.84E-03	8.84E-03	8.84E-03	1.32E+00	5.11E-02	3.77E-02	3.77E-02	3.77E-02
SR-90	1.06E+04	7.59E+00	2.19E-01	1.86E+00	1.86E+00	1.86E+00	1.70E+01	2.29E-01	4.31E+00	4.31E+00	4.31E+00
SR-91	3.97E-01	5.67E-03	2.70E-02	2.29E-04	2.29E-04	2.29E-04	2.40E-02	5.30E-02	9.06E-04	9.06E-04	9.06E-04
SR-92	1.13E-01	2.15E-03	4.26E-02	9.30E-05	9.30E-05	4.30E-05	9.03E-03	1.71E-01	3.62E-04	3.62E-04	3.62E-04
Y-90	2.67E+00	9.62E-06	1.02E-01	2.58E-07	2.58E-07	2.58E-07	4.11E-05	1.17E-01	1.10E-06	1.10E-06	1.10E-06
Y-91	5.86E+01	1.41E-04	7.76E-02	3.77E-06	3.77E-06	3.77E-06	6.02E-04	8.02E-02	1.61E-05	1.61E-05	1.61E-05
Y-91M	3.45E-02	9.09E-08	2.67E-07	3.52E-09	3.52E-09	3.52E-09	3.82E-07	7.48E-04	1.39E-08	1.39E-08	1.39E-08
Y-92	1.48E-01	1.48E-02	2.47E-03	2.47E-08	2.47E-08	2.47E-08	3.60E-06	1.04E-01	1.03E-07	1.03E-07	1.03E-07
Y-93	4.21E-01	2.69E-06	8.50E-02	7.40E-08	7.40E-08	7.40E-08	1.14E-05	1.70E-01	3.13E-07	3.13E-07	3.13E-07
ZR-95	6.40E+01	3.04E-05	3.09E-02	6.60E-06	6.60E-06	9.75E-06	1.16E-04	2.66E-02	2.27E-05	2.27E-05	2.55E-05
ZR-97	7.00E-01	1.68E-06	1.05E-01	1.55E-07	1.55E-07	3.39E-07	6.99E-06	1.53E-01	5.96E-07	5.96E-07	1.01E-06
NB-95	3.50E+00	6.22E-06	2.10E-02	1.86E-06	1.86E-06	3.46E-06	2.25E-05	1.62E-02	6.26E-06	6.26E-06	8.76E-06
NB-95M	3.61E+00	5.95E-07	2.43E-02	2.54E-07	2.54E-07	4.63E-07	5.95E-07	2.43E-02	2.54E-07	2.54E-07	4.63E-07
NB-97	5.11E-02	1.56E-05	1.43E-03	7.85E-07	2.90E-05	1.62E-05	1.56E-05	1.43E-03	7.85E-07	2.90E-05	1.62E-05
NB-97M	6.25E-04	3.48E-07	2.71E-05	3.12E-08	6.28E-07	4.73E-07	3.48E-07	2.71E-05	3.12E-08	6.28E-07	4.73E-07
MO-99	2.75E+00	8.20E-04	9.99E-03	8.20E-04	8.20E-04	4.31E-03	3.29E-03	1.10E-02	3.29E-03	3.29E-03	1.33E-02
TC-99	7.77E+07	4.10E-04	3.20E-03	1.41E-02	2.14E-04	6.28E-04	4.10E-04	3.20E-03	1.41E-02	2.14E-04	6.28E-04
TC-99M	2.51E-01	2.47E-07	4.13E-04	8.89E-06	8.89E-06	6.98E-07	9.23E-07	1.03E-03	3.00E-05	3.00E-05	1.81E-06
RU-103	3.94E+01	1.89E-04	2.16E-02	7.97E-05	7.97E-05	7.97E-05	7.31E-04	1.89E-02	2.81E-04	2.81E-04	2.81E-04
RU-105	1.85E-01	1.54E-05	9.42E-03	6.08E-06	6.08E-06	6.08E-06	6.45E-05	4.21E-02	2.34E-05	2.34E-05	2.34E-05
RU-106	3.6E 02	2.75E-03	1.79E-01	3.48E-04	3.48E-04	3.48E-04	1.17E-02	1.82E-01	1.46E-03	1.46E-03	1.46E-03
RH103M	3.89E 2	4.05E-08	9.27E-05	1.58E-08	8.96E-07	2.21E-08	4.05E-08	9.27E-05	1.58E-08	8.96E-07	2.21E-08
RH-105	1.48E+00	5.68E-05	1.41E-02	1.30E-05	1.02E-04	3.35E-05	5.68E-05	1.41E-02	1.30E-05	1.02E-04	3.35E-05
RH105M	1.40E-04	2.72E-08	7.78E-06	4.91E-09	6.34E-08	2.00E-08	2.72E-08	7.78E-06	4.91E-09	6.34E-08	2.00E-08
RH-106	3.46E-04	1.86E-08	7.20E-05	2.80E-09	1.89E-07	3.57E-08	1.86E-08	7.20E-05	2.80E-09	1.89E-07	3.57E-08
AG110M	2.52E+02	1.60E-04	6.04E-02	8.79E-05	8.79E-05	1.48E-04	5.39E-04	4.33E-02	2.91E-04	2.91E-04	3.64E-04
AG-111	7.47E+00	5.65E-05	4.85E-02	1.26E-05	1.26E-05	2.46E-05	5.65E-05	4.85E-02	1.26E-05	1.26E-05	2.46E-05

NUCLIDE	HALF-LIFE (DAYS)	DOSE COMMITMENT FACTORS --- (REM/UCI)									
		ADULT					CHILD				
		BONE	GI TRACT	THYROID	TOTAL BODY	LIVER	BONE	GI TRACT	THYROID	TOTAL BODY	LIVER
SB-122	2.72E+00	2.29E-04	6.47E-02	3.11E-06	6.70E-05	4.51E-06	2.29E-04	6.47E-02	3.11E-06	6.70E-05	4.51E-06
SB-124	6.02E+01	2.75E-03	9.70E-02	7.14E-06	1.16E-03	5.47E-07	2.75E-03	9.70E-02	7.14E-06	1.16E-03	5.47E-07
SB-127	3.80E+00	5.45E-04	7.00E-02	1.19E-04	6.13E-04	2.95E-04	5.45E-04	7.00E-02	1.19E-04	6.13E-04	2.95E-04
TE125M	5.80E+01	2.69E-03	1.07E-02	8.06E-04	3.59E-04	9.71E-04	1.14E-02	1.10E-02	3.20E-03	1.52E-03	3.09E-03
TE-127	3.92E-01	1.10E-04	8.68E-03	6.15E-05	2.38E-05	3.95E-05	4.71E-04	1.84E-02	3.26E-04	1.01E-04	1.27E-04
TE127M	1.09E+02	6.77E-03	2.27E-02	1.73E-03	8.25E-04	2.42E-03	2.89E-02	2.34E-02	6.91E-03	3.43E-03	7.78E-03
TE-129	4.86E-02	3.14E-05	2.37E-05	2.41E-05	7.65E-06	1.18E-05	1.34E-04	8.34E-03	9.56E-05	3.18E-05	3.74E-05
TE129M	3.34E+01	1.15E-02	5.79E-02	3.95E-03	1.82E-03	4.29E-03	4.87E-02	5.94E-02	1.57E-02	7.56E-03	1.36E-02
TE-131	1.74E-02	1.97E-05	2.79E-06	1.62E-05	6.22E-06	8.23E-06	8.30E-05	4.36E-04	6.35E-05	2.47E-05	2.53E-05
TE131M	1.25E+00	1.73E-03	8.40E-02	1.34E-03	7.05E-04	8.46E-04	7.20E-03	1.01E-01	5.12E-03	2.65E-03	2.49E-03
TE-132	3.25E+00	2.52E-03	7.71E-02	1.80E-03	1.53E-03	1.63E-03	1.01E-02	4.50E-02	6.51E-03	5.40E-03	4.47E-03
I-129	5.80E+09	9.42E-04	7.84E-05	7.80E+00	3.18E-03	7.24E-04	9.42E-04	7.84E-05	7.80E+00	3.18E-03	7.24E-04
I-130	5.15E-01	7.56E-04	1.92E-03	1.89E-01	8.80E-04	2.23E-03	2.92E-03	2.76E-03	6.50E-01	3.04E-03	5.90E-03
I-131	8.04E+00	4.16E-03	1.57E-03	1.95E+00	3.41E-03	5.95E-03	1.72E-02	1.54E-03	5.72E+00	9.83E-03	1.73E-02
I-132	9.54E-02	2.03E-04	1.02E-04	1.90E-02	1.90E-04	5.43E-04	8.00E-04	1.73E-03	6.82E-02	6.76E-04	1.47E-03
I-133	8.67E-01	1.42E-03	2.22E-03	3.63E-01	7.53E-04	2.47E-03	5.92E-03	2.95E-03	1.36E+00	2.77E-03	7.32E-03
I-134	3.65E-02	1.06E-04	2.51E-07	4.99E-03	1.03E-04	2.88E-04	4.19E-04	5.16E-04	1.79E-02	3.58E-04	7.78E-04
I-135	2.74E-01	4.43E-04	1.31E-03	7.65E-02	4.28E-04	1.16E-03	1.75E-03	2.40E-03	2.79E-01	1.49E-03	3.15E-03
XE133M	2.19E+00	0.00E+00	2.45E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.45E-02	0.00E+00	0.00E+00	0.00E+00
XE-133	5.25E+00	0.00E+00	2.58E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.58E-02	0.00E+00	0.00E+00	0.00E+00
XE135M	1.06E-02	0.00E+00	3.29E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.29E-04	0.00E+00	0.00E+00	0.00E+00
XE-135	3.79E-01	0.00E+00	1.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E-02	0.00E+00	0.00E+00	0.00E+00
CS-134	7.53E+02	6.22E-02	2.59E-03	1.21E-01	1.21E-01	1.48E-01	2.34E-01	2.07E-03	8.10E-02	8.10E-02	3.84E-01
CS-135	8.40E+08	1.30E-02	5.35E-04	1.13E-02	6.61E-03	1.12E-02	1.30E-02	5.35E-04	1.13E-02	6.61E-03	1.12E-02
CS-136	1.31E+01	6.51E-03	2.92E-03	1.85E-02	1.85E-02	2.57E-02	2.35E-02	2.27E-03	4.18E-02	4.18E-02	6.46E-02
CS-137	1.10E+04	7.97E-02	2.11E-03	7.14E-02	7.14E-02	1.09E-01	3.27E-01	1.96E-03	4.62E-02	4.62E-02	3.13E-01
CS-138	2.24E-02	5.52E-02	4.65E-10	5.40E-05	5.40E-05	1.09E-04	2.28E-04	1.46E-04	2.01E-04	2.01E-04	3.17E-04
BA137M	1.77E-03	2.93E-07	2.87E-05	4.07E-08	5.12E-07	5.29E-07	2.93E-07	2.87E-05	4.07E-08	5.12E-07	5.29E-07
BA-139	5.78E-02	9.70E-05	1.72E-04	2.84E-06	2.84E-06	6.91E-08	4.14E-04	2.39E-02	1.20E-05	1.20E-05	2.21E-07
BA-140	1.28E+01	2.03E-02	4.18E-02	1.33E-03	1.33E-03	2.55E-05	8.31E-02	4.21E-02	4.85E-03	4.85E-03	7.28E-05
BA-141	1.26E-02	4.71E-05	2.22E-14	1.59E-06	1.59E-06	3.56E-08	2.00E-04	1.14E-04	6.51E-06	6.51E-06	1.12E-07
BA-142	7.43E-03	2.13E-05	3.00E-23	1.34E-06	1.34E-06	2.19E-08	8.74E-05	1.14E-06	4.88E-06	4.88E-06	6.29E-08
LA-140	1.68E+00	2.50E-06	9.25E-02	3.33E-07	3.33E-07	1.26E-06	1.01E-05	9.84E-02	1.19E-06	1.19E-06	3.53E-06
LA-142	6.42E-02	1.28E-07	4.25E-04	1.45E-08	1.45E-08	5.82E-08	5.24E-07	3.31E-02	5.23E-08	5.23E-08	1.67E-07
CE-141	3.25E+01	9.36E-06	2.42E-02	7.18E-07	7.18E-07	6.33E-06	3.97E-05	2.47E-02	2.94E-06	2.94E-06	1.98E-05
CE-143	1.38E+00	1.65E-06	4.56E-02	1.35E-07	1.35E-07	1.22E-03	6.99E-06	5.55E-02	5.49E-07	5.49E-07	3.79E-03
CE-144	2.84E+02	4.88E-04	1.65E-01	2.62E-05	2.62E-05	2.04E-04	2.08E-03	1.70E-01	1.11E-04	1.11E-04	6.52E-04
PR-143	1.36E+01	9.20E-06	4.03E-02	4.56E-07	4.56E-07	3.69E-06	3.93E-05	4.24E-02	1.95E-06	1.95E-06	1.18E-05
PR-144	1.20E-02	3.01E-08	4.33E-15	1.53E-09	1.53E-09	1.25E-08	1.29E-07	8.59E-05	6.49E-09	6.49E-09	3.99E-08
PR144M	5.00E-03	8.86E-08	5.69E-04	5.14E-09	3.29E-06	9.58E-08	8.86E-08	5.69E-04	5.14E-09	3.29E-06	9.58E-08
ND-147	1.10E+01	6.29E-06	3.49E-02	4.35E-07	4.35E-07	7.27E-06	2.79E-05	3.58E-02	1.75E-06	1.75E-06	2.26E-05
PM-147	9.57E+02	2.87E-05	1.17E-02	5.33E-07	5.02E-05	1.02E-04	2.87E-05	1.17E-02	5.38E-07	5.02E-05	1.02E-04
PM-149	2.21E+00	1.53E-06	4.85E-02	1.24E-07	1.24E-07	2.50E-07	1.53E-06	4.85E-02	1.24E-07	1.24E-07	2.50E-07
SM-147	3.94E+13	3.20E-01	4.26E-02	1.18E-03	2.98E-02	2.20E-01	3.20E-01	4.26E-02	1.18E-03	2.98E-02	2.20E-01
SM-151	3.33E+04	6.87E-05	4.85E-03	2.84E-06	2.84E-06	1.18E-05	6.87E-05	4.85E-03	2.84E-06	2.84E-06	1.18E-05
SM-153	1.95E+00	7.90E-07	2.43E-02	6.13E-08	6.13E-08	7.61E-07	7.90E-07	2.43E-02	6.13E-08	6.13E-08	7.61E-07
EU-155	1.74E+03	4.63E-05	9.70E-03	5.26E-06	5.26E-06	1.08E-05	4.63E-05	9.70E-03	5.26E-06	5.26E-06	1.08E-05
TA-182	1.15E+02	1.72E-05	4.85E-02	8.75E-06	8.75E-06	6.37E-05	1.72E-05	4.85E-02	8.75E-06	8.75E-06	6.37E-05
W-187	9.96E-01	1.03E-04	2.82E-02	3.01E-05	3.01E-05	8.61E-05	4.29E-04	3.57E-02	1.14E-04	1.14E-04	2.54E-04

NUCLIDE	HALF-LIFE (DAYS)	DOSE COMMITMENT FACTORS --- (REM/UCI)									
		ADULT					CHILD				
		BONE	GI TRACT	THYROID	TOTAL BODY	LIVER	BONE	GI TRACT	THYROID	TOTAL BODY	LIVER
PB-210	8.14E+03	2.10E+01	2.03E-02	3.00E-01	1.70E+00	1.40E+00	2.10E+01	2.03E-02	3.00E-01	1.70E+00	1.40E+00
PB-212	4.43E-01	1.20E-01	7.57E-02	5.22E-04	2.57E-03	5.85E-03	1.20E-01	7.57E-02	5.22E-04	2.57E-03	5.85E-03
PB-214	1.86E-02	3.03E-04	3.14E-03	1.18E-05	5.64E-05	2.97E-05	3.03E-04	3.14E-03	1.18E-05	5.64E-05	2.97E-05
BI-212	4.21E-02	3.03E-04	5.90E-03	4.97E-05	1.26E-04	7.24E-05	3.03E-04	5.90E-03	4.97E-05	1.26E-04	7.24E-05
BI-214	1.38E-02	4.16E-05	3.18E-03	5.11E-06	2.97E-05	1.58E-05	4.16E-05	3.18E-03	5.11E-06	2.97E-05	1.58E-05
PO-212	3.50E-12	1.50E-33	9.17E-13	3.48E-34	1.96E-15	1.08E-33	1.50E-33	9.17E-13	3.48E-34	1.96E-15	1.08E-33
PO-214	1.89E-09	4.80E-12	4.28E-10	7.01E-14	1.30E-12	3.35E-13	4.80E-12	4.28E-10	7.01E-14	1.30E-12	3.35E-13
PO-216	1.74E-06	9.35E-07	3.68E-07	3.11E-09	1.85E-08	7.39E-08	9.35E-07	3.68E-07	3.11E-09	1.85E-08	7.39E-08
PO-218	2.12E-03	9.60E-05	6.84E-04	1.64E-06	8.62E-06	1.11E-05	9.60E-05	6.84E-04	1.64E-06	8.62E-06	1.11E-05
RA-224	3.66E+00	3.30E+00	6.60E-01	8.32E-02	7.47E-02	8.90E-02	3.30E+00	6.60E-01	8.32E-02	7.47E-02	8.90E-02
RA-226	5.84E+05	4.30E+01	3.30E-01	5.90E-01	3.40E+00	5.90E-01	4.30E+01	3.30E-01	5.90E-01	3.40E+00	5.90E-01
RA-228	2.10E+03	2.10E+01	7.14E-02	4.00E-01	1.70E+00	4.00E-01	2.10E+01	7.14E-02	4.00E-01	1.70E+00	4.00E-01
AC-228	2.55E-01	3.48E-03	8.07E-03	6.13E-06	1.99E-04	3.54E-04	3.48E-03	8.07E-03	6.13E-06	1.99E-04	3.54E-04
TH-228	6.98E+02	4.10E+00	4.70E-01	7.42E-03	3.80E-02	2.34E-02	4.10E+00	4.70E-01	7.42E-03	3.80E-02	2.34E-02
TH-230	2.81E+07	1.60E+01	1.80E-01	4.56E-03	9.24E-02	2.18E-02	1.60E+01	1.80E-01	4.56E-03	9.24E-02	2.18E-02
TH-232	5.11E+12	1.80E+01	1.50E-01	3.94E-03	9.63E-02	1.88E-02	1.80E+01	1.50E-01	3.94E-03	9.63E-02	1.88E-02
TH-234	2.41E+01	4.91E-05	1.60E-01	1.60E-06	6.39E-04	1.46E-05	4.91E-05	1.60E-01	1.60E-06	6.39E-04	1.46E-05
PA-234	2.79E-01	3.00E-04	1.11E-02	7.20E-06	3.12E-04	2.28E-04	3.00E-04	1.11E-02	7.20E-06	3.12E-04	2.28E-04
U-234	8.91E+07	3.10E+01	1.90E-01	6.32E-02	2.30E+00	6.32E-02	3.10E+01	1.90E-01	6.32E-02	2.30E+00	6.32E-02
U-238	1.63E+12	2.80E+01	1.70E-01	5.63E-02	2.00E+00	5.35E-02	2.80E+01	1.70E-01	5.63E-02	2.00E+00	5.35E-02
NP-238	2.12E+00	4.42E-03	3.21E-02	1.22E-05	4.03E-04	1.08E-03	4.42E-03	3.21E-02	1.22E-05	4.03E-04	1.08E-03
NP-239	2.35E+00	1.19E-06	2.40E-02	6.45E-08	6.45E-08	1.17E-07	5.25E-06	2.79E-02	2.65E-07	2.65E-07	3.77E-07
PU-238	3.20E+04	2.10E+00	2.10E-01	3.23E-03	2.83E-02	4.40E-01	2.10E+00	2.10E-01	3.23E-03	2.83E-02	4.40E-01
PU-239	8.80E+06	2.60E+00	2.00E-01	3.63E-03	3.13E-02	4.90E-01	2.60E+00	2.00E-01	3.63E-03	3.13E-02	4.90E-01
PU-240	2.39E+06	2.60E+00	2.00E-01	3.62E-03	3.13E-02	4.90E-01	2.60E+00	2.00E-01	3.62E-03	3.13E-02	4.90E-01
PU-241	5.37E+03	4.83E-02	9.92E-04	7.49E-05	6.19E-04	9.50E-03	4.83E-02	9.92E-04	7.49E-05	6.19E-04	9.50E-03
PU-242	1.37E+08	2.60E+00	1.90E-01	3.45E-03	2.98E-02	4.70E-01	2.60E+00	1.90E-01	3.45E-03	2.98E-02	4.70E-01
AM-241	1.58E+05	8.00E+01	2.10E-01	1.20E-01	1.00E+00	1.70E+01	8.00E+01	2.10E-01	1.20E-01	1.00E+00	1.70E+01
AM-242	6.68E-01	5.19E-03	9.26E-03	1.06E-05	1.44E-04	1.51E-03	5.19E-03	9.26E-03	1.06E-05	1.44E-04	1.51E-03
AM-243	2.69E+06	8.50E+01	2.20E-01	1.30E-01	1.00E+00	1.70E+01	8.50E+01	2.20E-01	1.30E-01	1.00E+00	1.70E+01
CM-242	1.63E+02	1.50E+00	2.30E-01	2.72E-03	2.58E-02	4.40E-01	1.50E+00	2.30E-01	2.72E-03	2.58E-02	4.40E-01
CM-243	1.04E+04	4.80E+01	2.50E-01	8.22E-02	7.10E-01	1.20E+01	6.00E+03	1.00E+03	1.01E+03	2.01E+03	1.00E+03
CM-244	6.61E+03	3.80E+01	2.20E-01	6.40E-02	5.60E-01	9.50E+00	3.80E+01	2.20E-01	6.40E-02	5.60E-01	9.50E+00

*Dose factors were taken from the following references in order of preference:

1. Regulatory Guide 1.109, USNRC, October 1977
2. NUREG/CR-0150, D. E. Dunning, ORNL, October 1981
3. ORNL-4992, G. G. Killough and L. R. McKay, March 1976

Table 2.2

FISH CONCENTRATION FACTORS *

NUCLIDE		NUCLIDE		NUCLIDE	
[redacted]-3	9.00E-01	TC-99M	1.50E+01	CE-144	1.00E+00
[redacted]C-14	4.60E+03	RU-103	1.00E+01	PR-143	2.50E+01
NA-22	1.00E+02	RU-105	1.00E+01	PR-144	2.50E+01
NA-24	1.00E+02	RU-106	1.00E+01	PR144M	2.50E+01
P-32	3.00E+03	RH103M	1.00E+01	ND-147	2.50E+01
CR-51	2.00E+02	RH-105	1.00E+01	PM-147	2.50E+01
MN-54	4.00E+02	RH105M	1.00E+01	PM-149	2.50E+01
MN-56	4.00E+02	RH-106	1.00E+01	SM-147	2.50E+01
FE-55	1.00E+02	AG110M	2.31E+00	SM-151	2.50E+01
FE-59	1.00E+02	AG-111	2.31E+00	SM-153	2.50E+01
CO-57	5.00E+01	SB-122	1.00E+00	EU-155	2.50E+01
CO-58	5.00E+01	SB-124	1.00E+00	TA-182	3.00E+04
CO-60	5.00E+01	SB-127	1.00E+00	W-187	1.20E+03
NI-63	1.00E+02	TE125M	4.00E+02	PB-210	3.00E+02
NI-65	1.00E+02	TE-127	4.00E+02	PB-212	3.00E+02
CU-64	5.00E+01	TE127M	4.00E+02	PB-214	3.00E+02
ZN-65	2.00E+03	TE-129	4.00E+02	BI-212	1.50E+01
ZN-69	2.00E+03	TE129M	4.00E+02	BI-214	1.50E+01
AS-74	1.00E+02	TE-131	4.00E+02	PO-212	5.00E+01
AS-76	1.00E+02	TE131M	4.00E+02	PO-214	5.00E+01
BR-83	4.20E+02	TE-132	4.00E+02	PO-216	5.00E+01
BR-84	4.20E+02	I-129	1.50E+01	PO-218	5.00E+01
BR-85	4.20E+02	I-130	1.50E+01	RA-224	5.00E+01
KR-83M	1.00E+00	I-131	1.50E+01	RA-226	5.00E+01
KR-85M	1.00E+00	I-132	1.50E+01	RA-228	5.00E+01
KR-85	1.00E+00	I-133	1.50E+01	AC-228	2.50E+01
RB-86	2.00E+03	I-134	1.50E+01	TH-228	3.00E+01
RB-88	2.00E+03	I-135	1.50E+01	TH-230	3.00E+01
RB-89	2.00E+03	XE133M	1.00E+00	TH-232	3.00E+01
SR-89	3.00E+01	XE-133	1.00E+00	TH-234	3.00E+01
SR-90	3.00E+01	XE135M	1.00E+00	PA-234	1.13E+01
SR-91	3.00E+01	XE-135	1.00E+00	U-234	1.00E+01
SR-92	3.00E+01	CS-134	2.00E+03	U-238	1.00E+01
Y-90	2.50E+01	CS-135	2.00E+03	NP-238	1.00E+01
Y-91	2.50E+01	CS-136	2.00E+03	NP-239	1.00E+01
Y-91M	2.50E+01	CS-137	2.00E+03	PU-238	3.50E+02
Y-92	2.50E+01	CS-138	2.00E+03	PU-239	3.50E+02
Y-93	2.50E+01	BA137M	4.00E+00	PU-240	3.50E+02
ZR-95	3.33E+00	BA-139	4.00E+00	PU-241	3.50E+02
ZR-97	3.33E+00	BA-140	4.00E+00	PU-242	3.50E+02
NB-95	3.00E+04	BA-141	4.00E+00	AM-241	2.50E+01
NB-95M	3.00E+04	BA-142	4.00E+00	AM-242	2.50E+01
NB-97	3.00E+04	LA-140	2.50E+01	AM-243	2.50E+01
NB-97M	3.00E+04	LA-142	2.50E+01	CM-242	2.50E+01
MO-99	1.00E+01	CE-141	1.00E+00	CM-243	2.50E+01
TC-99	1.50E+01	CE-143	1.00E+00	CM-244	2.50E+01

* The source for the fish concentration factors, given in order of preference is:

NUREG/CR-1336, "The Bioaccumulation Factor for Phosphorus-32 in Edible Fish Tissue," B. Kahn and K. S. Turgeon, Georgia Institute of Technology, March 1980.

Regulatory Guide 1.109, October 1977.

UCRL-50564, "Concentration Factors of Chemical Elements in Edible Aquatic Organisms," S. E. Thompson, et al.; Lawrence Livermore Laboratory, October 1972.

UCRL-50163, "Prediction of the Maximum Dosage to Man from the Fallout of Nuclear Devices: IV. Handbook for Estimating the Maximum Internal Dose from Radionuclides Released to the Biosphere," Y.C. Ng et al.; Lawrence Livermore Laboratory, May 1968.

Regulatory Guide 1.109, Draft, March 1976.

TVA generated numbers for noble gases.

NUCLIDE	SWIMMING (MREM/YEAR PER UCI/ML) BONE	GI	THYROID	TB	LIVER	SKIN	SHORELINE (MREM/YEAR PER UCI/SQUARE CENTIMETER) BONE	GI	THYROID	TB	LIVER	SKIN
H-3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C-14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NA-22	3.14E+07	2.49E+07	2.30E+07	2.67E+07	2.27E+07	3.16E+07	2.76E+06	2.19E+06	2.01E+06	2.33E+06	1.99E+06	2.76E+06
NA-24	5.66E+07	5.92E+07	6.22E+07	5.39E+07	4.80E+07	6.16E+07	3.96E+06	4.10E+06	4.28E+06	3.76E+06	3.33E+06	4.29E+06
P-32	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CR-51	5.43E+05	3.07E+05	3.30E+05	3.79E+05	3.09E+05	4.56E+05	5.45E+04	3.08E+04	3.39E+04	3.81E+04	3.10E+04	4.69E+04
MN-54	1.16E+07	8.57E+06	7.35E+06	9.66E+06	8.26E+06	1.24E+07	1.04E+06	7.69E+05	6.60E+05	8.69E+05	7.42E+05	1.11E+06
MN-56	2.33E+07	2.14E+07	1.82E+07	2.07E+07	1.81E+07	2.54E+07	1.88E+06	1.69E+06	1.44E+06	1.66E+06	1.45E+06	2.05E+06
FE-55	3.16E+01	3.47E+01	6.94E+00	1.68E+02	1.47E-01	3.16E+03	2.71E+01	2.98E+01	5.96E+00	1.44E+02	1.26E-01	2.71E+03
FE-59	1.64E+07	1.38E+07	1.23E+07	1.45E+07	1.23E+07	1.76E+07	1.36E+06	1.15E+06	1.02E+06	1.20E+06	1.02E+06	1.46E+06
CO-57	2.71E+06	9.80E+05	1.69E+06	1.48E+06	1.13E+06	1.75E+06	2.32E+05	1.02E+05	1.76E+05	1.55E+05	1.17E+05	1.94E+05
CO-58	1.38E+07	1.03E+07	8.78E+06	1.13E+07	9.68E+06	1.43E+07	1.25E+06	9.36E+05	8.00E+05	1.03E+06	8.82E+05	1.30E+06
CO-60	3.46E+07	3.02E+07	2.73E+07	3.11E+07	2.62E+07	3.67E+07	2.83E+06	2.46E+06	2.23E+06	2.54E+06	2.14E+06	3.00E+06
NI-63	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NI-65	7.65E+06	6.36E+06	6.50E+06	6.94E+06	5.84E+06	7.93E+06	6.18E+05	5.52E+05	5.22E+05	5.60E+05	4.71E+05	6.41E+05
CU-64	2.83E+06	2.20E+06	1.85E+06	2.23E+06	1.92E+06	2.67E+06	2.71E+05	2.11E+05	1.78E+05	2.14E+05	1.84E+05	2.59E+05
ZN-65	7.99E+06	6.49E+06	5.58E+06	6.96E+06	5.90E+06	8.67E+06	6.75E+05	5.48E+05	4.71E+05	5.88E+05	4.98E+05	7.40E+05
ZN-69	9.55E+01	6.49E+01	6.09E+01	7.12E+01	6.00E+01	8.51E+01	9.40E+00	6.39E+00	6.00E+00	7.01E+00	5.90E+00	8.38E+00
AS-74	1.70E+05	1.30E+05	1.40E+05	1.40E+05	1.10E+05	1.60E+05	1.36E+06	1.10E+06	1.16E+06	1.12E+06	9.40E+05	1.33E+06
AS-76	8.31E+04	6.68E+04	7.04E+04	6.83E+04	5.73E+04	8.12E+04	6.82E+05	5.48E+05	5.78E+05	5.60E+05	4.70E+05	6.66E+05
BR-83	1.12E+05	8.64E+04	7.24E+04	8.81E+04	7.59E+04	1.06E+05	1.07E+04	8.29E+03	6.95E+03	8.45E+03	7.28E+03	1.02E+04
BR-84	2.46E+07	2.42E+07	2.59E+07	2.28E+07	2.03E+07	2.69E+07	1.80E+06	1.73E+06	1.79E+06	1.65E+06	1.46E+06	1.96E+06
BR-85	2.86E+05	2.11E+05	1.81E+05	2.39E+05	2.04E+05	3.07E+05	2.55E+04	1.88E+04	1.61E+04	2.13E+04	1.82E+04	2.74E+04
KR-83M	5.24E+02	1.22E+02	1.22E+02	9.46E+02	3.71E+01	1.13E+04	4.33E+02	1.18E+02	5.97E+01	9.66E+02	1.12E+01	1.23E+04
KR-85M	3.21E+06	1.36E+06	1.97E+06	1.93E+06	1.50E+06	2.30E+06	3.30E+05	1.39E+05	2.02E+05	1.99E+05	1.54E+05	2.39E+05
KR-85	3.34E+04	2.59E+04	2.17E+04	2.62E+04	2.26E+04	3.14E+04	3.22E+03	2.49E+03	2.09E+03	2.53E+03	2.18E+03	3.03E+03
RB-86	1.29E+06	1.04E+06	8.73E+05	1.12E+06	9.50E+05	1.42E+06	1.10E+05	8.79E+04	7.40E+04	9.50E+04	8.06E+04	1.20E+05
RB-88	8.99E+06	9.16E+06	8.10E+06	8.32E+06	7.33E+06	9.90E+06	6.77E+05	6.82E+05	5.97E+05	6.24E+05	5.49E+05	7.46E+05
RB-89	2.69E+07	2.67E+07	2.41E+07	2.61E+07	2.27E+07	3.17E+07	2.27E+06	2.06E+06	1.85E+06	2.04E+06	1.77E+06	2.49E+06
SR-89	1.88E+03	1.41E+03	1.18E+03	1.58E+03	1.35E+03	2.05E+03	1.66E+02	1.24E+02	1.04E+02	1.40E+02	1.19E+02	1.31E+02
SR-90	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-91	9.71E+06	7.32E+06	6.32E+06	8.17E+06	6.96E+06	1.04E+07	8.56E+05	6.43E+05	5.56E+05	7.19E+05	6.13E+05	9.13E+05
SR-92	1.86E+07	1.68E+07	1.59E+07	1.70E+07	1.43E+07	1.93E+07	1.50E+06	1.35E+06	1.28E+06	1.37E+06	1.15E+06	1.55E+06
Y-90	1.10E+00	2.90E-01	1.11E-01	1.32E+00	2.77E-02	1.06E+01	7.97E-01	2.17E-01	7.68E-02	9.65E-01	1.91E-02	7.87E+00
Y-91	4.99E+04	4.25E+04	3.77E+04	4.43E+04	3.75E+04	5.33E+04	4.12E+03	3.51E+03	3.11E+03	3.66E+03	3.10E+03	4.41E+03
Y-91M	7.83E+06	6.02E+06	5.06E+06	6.21E+06	5.34E+06	7.53E+06	7.48E+05	5.74E+05	4.83E+05	5.93E+05	5.10E+05	7.20E+05
Y-92	3.51E+06	2.30E+06	2.49E+06	3.02E+06	2.57E+06	3.72E+06	3.02E+05	2.39E+05	2.12E+05	2.59E+05	2.20E+05	3.19E+05
Y-93	1.30E+06	1.10E+06	9.91E+05	1.10E+06	9.42E+05	1.33E+06	1.10E+05	8.91E+04	8.17E+04	9.13E+04	7.77E+04	1.10E+05
ZR-95	1.04E+07	7.78E+06	6.64E+06	8.56E+06	7.32E+06	1.06E+07	9.56E+05	7.13E+05	6.08E+05	7.84E+05	6.71E+05	9.88E+05
ZR-97	2.57E+06	2.04E+06	1.87E+06	2.18E+06	1.86E+06	2.62E+06	2.23E+05	1.74E+05	1.60E+05	1.88E+05	1.60E+05	2.27E+05
NB-95	1.08E+07	8.01E+06	6.84E+06	8.87E+06	7.59E+06	1.12E+07	9.82E+05	7.31E+05	6.24E+05	8.09E+05	6.92E+05	1.02E+06
NB-95M	1.17E+06	5.59E+05	7.04E+05	7.59E+05	5.90E+05	9.51E+05	1.22E+05	5.66E+04	7.17E+04	8.05E+04	5.98E+04	1.23E+05
NB-97	9.40E+06	7.11E+06	6.03E+06	7.61E+06	6.52E+06	9.43E+06	8.77E+05	6.63E+05	5.62E+05	7.10E+05	6.08E+05	8.79E+05
NB-97M	1.03E+07	7.67E+06	6.54E+06	8.44E+06	7.22E+06	1.06E+07	9.42E+05	7.03E+05	5.99E+05	7.73E+05	6.61E+05	9.74E+05
MO-99	2.41E+06	1.63E+06	1.52E+06	1.87E+06	1.57E+06	2.34E+06	2.27E+05	1.51E+05	1.43E+05	1.75E+05	1.47E+05	2.21E+05
TC-99	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TC-99M	2.74E+06	1.03E+06	1.69E+06	1.55E+06	1.18E+06	1.83E+06	2.83E+05	1.07E+05	1.74E+05	1.60E+05	1.21E+05	1.93E+05
RU-103	7.05E+06	5.44E+06	4.57E+06	5.51E+06	4.75E+06	6.60E+06	6.81E+05	5.25E+05	4.41E+05	5.32E+05	4.58E+05	6.37E+05
RU-105	1.15E+07	8.32E+06	7.34E+06	9.16E+06	7.79E+06	1.14E+07	1.08E+06	7.78E+05	6.88E+05	8.57E+05	7.29E+05	1.06E+06
RU-106	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RH103M	3.73E+03	4.88E+02	1.27E+03	2.82E+03	3.92E+02	1.27E+04	1.74E+03	2.10E+02	5.66E+02	1.36E+03	1.63E+02	6.42E+03
RH-105	1.35E+06	7.56E+05	8.38E+05	9.39E+05	7.64E+05	1.12E+06	1.36E+05	7.59E+04	8.41E+04	9.43E+04	7.67E+04	1.13E+05
RH105M	6.12E+05	2.18E+05	3.75E+05	3.42E+05	2.51E+05	4.51E+05	7.05E+04	2.30E+04	4.10E+04	4.11E+04	2.66E+04	7.39E+04
RH-106	2.99E+06	2.30E+06	1.96E+06	2.41E+06	2.07E+06	2.93E+06	2.31E+05	2.16E+05	1.84E+05	2.25E+05	1.94E+05	2.74E+05

NUCLIDE	SWIMMING (MREM/YEAR PER UCI/ML) BONE	GI	THYROID	TB	LIVER	SKIN	SHORELINE (MREM/YEAR PER UCI/SQUARE CENTIMETER) BONE	GI	THYROID	TB	LIVER	SKIN
AG110M	3.87E+07	2.97E+07	2.68E+07	3.28E+07	2.79E+07	4.03E+07	3.41E+06	2.61E+06	2.35E+06	2.88E+06	2.45E+06	3.55E+06
AG-111	4.03E+05	2.32E+05	2.51E+05	2.83E+05	2.31E+05	3.39E+05	4.03E+04	2.32E+04	2.51E+04	2.83E+04	2.31E+04	3.39E+04
SB-122	8.06E+04	6.27E+04	6.58E+04	6.31E+04	5.26E+04	7.73E+04	6.83E+05	5.31E+05	5.57E+05	5.35E+05	4.46E+05	6.54E+05
SB-124	2.61E+07	2.28E+07	2.07E+07	2.29E+07	1.98E+07	2.71E+07	2.18E+06	1.86E+06	1.69E+06	1.90E+06	1.64E+06	2.25E+06
SB-127	1.01E+07	7.39E+06	6.47E+06	8.03E+06	6.65E+06	9.91E+06	9.52E+05	6.94E+05	6.09E+05	7.55E+05	6.43E+05	9.31E+05
TE125M	2.47E+05	2.93E+04	1.24E+05	1.35E+05	4.71E+04	3.39E+05	4.60E+04	9.08E+03	2.32E+04	2.50E+04	8.75E+03	6.29E+04
TE-127	7.84E+04	5.17E+04	4.90E+04	5.77E+04	4.83E+04	6.89E+04	7.74E+03	5.10E+03	4.92E+03	5.69E+03	4.77E+03	6.80E+03
TE127M	6.91E+04	1.33E+04	3.45E+04	3.82E+04	1.28E+04	9.89E+04	1.31E+04	2.54E+03	6.60E+03	7.21E+03	2.44E+03	1.86E+04
TE-129	8.68E+05	6.12E+05	5.58E+05	6.69E+05	5.60E+05	8.33E+05	8.52E+04	5.87E+04	5.43E+04	6.50E+04	5.37E+04	8.28E+04
TE129M	4.72E+05	3.23E+05	2.94E+05	3.71E+05	3.02E+05	5.03E+05	4.89E+04	3.09E+04	2.98E+04	3.71E+04	2.88E+04	5.38E+04
TE-131	6.79E+06	4.21E+06	4.37E+06	4.99E+06	4.13E+06	6.11E+06	6.49E+05	3.94E+05	4.16E+05	4.71E+05	3.88E+05	5.78E+05
TE131M	2.06E+07	1.53E+07	1.39E+07	1.70E+07	1.45E+07	2.12E+07	1.84E+06	1.35E+06	1.23E+06	1.51E+06	1.28E+06	1.89E+06
TE-132	4.27E+06	1.92E+06	2.54E+06	2.68E+06	2.04E+06	3.32E+06	4.55E+05	1.98E+05	2.68E+05	2.83E+05	2.12E+05	3.60E+05
I-129	2.25E+05	4.84E+04	1.19E+05	1.15E+05	4.75E+04	2.49E+05	5.02E+04	1.07E+04	2.67E+04	2.57E+04	1.05E+04	5.70E+04
I-130	3.09E+07	2.33E+07	2.00E+07	2.50E+07	2.14E+07	3.08E+07	2.88E+06	2.17E+06	1.86E+06	2.32E+06	1.99E+06	2.86E+06
I-131	6.22E+06	3.93E+06	3.92E+06	4.54E+06	3.77E+06	5.47E+06	6.16E+05	3.87E+05	3.38E+05	4.49E+05	3.72E+05	5.41E+05
I-132	3.23E+07	2.45E+07	2.16E+07	2.68E+07	2.29E+07	3.32E+07	2.91E+06	2.20E+06	1.93E+06	2.41E+06	2.06E+06	2.99E+06
I-133	8.96E+06	6.90E+06	5.89E+06	7.18E+06	6.16E+06	8.69E+06	8.44E+05	6.49E+05	5.54E+05	6.75E+05	5.79E+05	8.17E+05
I-134	3.67E+07	2.84E+07	2.49E+07	3.11E+07	2.65E+07	3.89E+07	3.22E+06	2.46E+06	2.16E+06	2.71E+06	2.32E+06	3.40E+06
I-135	2.19E+07	1.95E+07	1.75E+07	1.96E+07	1.67E+07	2.33E+07	1.78E+06	1.57E+06	1.41E+06	1.58E+06	1.35E+06	1.89E+06
XE133M	6.05E+05	2.38E+05	3.55E+05	3.71E+05	2.61E+05	5.27E+05	8.09E+04	2.81E+04	4.65E+04	4.77E+04	3.05E+04	7.71E+04
XE-133	8.52E+05	2.53E+05	4.84E+05	4.24E+05	2.74E+05	5.73E+05	1.11E+05	3.17E+04	6.28E+04	5.57E+04	3.39E+04	8.27E+04
XE135M	6.41E+06	4.94E+06	4.15E+06	5.04E+06	4.33E+06	6.08E+06	6.21E+05	4.75E+05	4.01E+05	4.87E+05	4.17E+05	5.90E+05
XE-135	4.54E+06	2.28E+06	2.76E+06	3.02E+06	2.40E+06	3.63E+06	4.59E+05	2.29E+05	2.79E+05	3.04E+05	2.41E+05	3.67E+05
CS-134	2.22E+07	1.67E+07	1.43E+07	1.81E+07	1.55E+07	2.26E+07	2.04E+06	1.54E+06	1.32E+06	1.67E+06	1.43E+06	2.08E+06
CS-135	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CS-136	3.10E+07	2.26E+07	2.03E+07	2.55E+07	2.15E+07	3.21E+07	2.77E+06	2.00E+06	1.81E+06	2.26E+06	1.91E+06	2.85E+06
CS-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CS-138	3.29E+07	3.03E+07	2.86E+07	2.98E+07	2.56E+07	3.46E+07	2.62E+06	2.37E+06	2.23E+06	2.35E+06	2.02E+06	2.74E+06
BA137M	8.56E+06	6.45E+06	5.48E+06	6.92E+06	5.93E+06	8.59E+06	8.01E+05	6.02E+05	5.12E+05	6.47E+05	5.54E+05	8.04E+05
BA-139	7.49E+05	3.44E+05	4.73E+05	4.66E+05	3.60E+05	5.55E+05	7.61E+04	3.38E+04	4.75E+04	4.67E+04	3.57E+04	5.62E+04
BA-140	2.29E+06	1.60E+06	1.46E+06	1.73E+06	1.46E+06	2.10E+06	2.29E+05	1.56E+05	1.46E+05	1.71E+05	1.42E+05	2.13E+05
BA-141	1.31E+07	8.90E+06	8.96E+06	1.02E+07	8.49E+06	1.22E+07	1.21E+06	7.97E+05	8.15E+05	9.26E+05	7.70E+05	1.12E+06
BA-142	1.51E+07	1.11E+07	1.02E+07	1.24E+07	1.04E+07	1.54E+07	1.34E+06	9.38E+05	9.03E+05	1.10E+06	9.17E+05	1.36E+06
LA-140	3.20E+07	2.91E+07	2.73E+07	2.88E+07	2.46E+07	3.31E+07	2.60E+06	2.32E+06	2.18E+06	2.32E+06	1.98E+06	2.67E+06
LA-142	3.74E+07	3.80E+07	3.72E+07	3.47E+07	3.10E+07	4.10E+07	2.75E+06	2.73E+06	2.64E+06	2.53E+06	2.52E+06	3.00E+06
CE-141	1.59E+06	5.94E+05	9.70E+05	9.01E+05	6.75E+05	1.09E+06	1.69E+05	6.20E+04	1.02E+05	9.52E+04	7.07E+04	1.16E+05
CE-143	4.54E+06	2.64E+06	2.79E+06	3.22E+06	2.60E+06	4.00E+06	4.66E+05	2.61E+05	2.83E+05	3.24E+05	2.57E+05	4.07E+05
CE-144	4.18E+05	1.42E+05	2.51E+05	2.26E+05	1.63E+05	2.81E+05	4.64E+04	1.55E+04	2.76E+04	2.50E+04	1.76E+04	3.18E+04
PR-143	1.26E-01	9.38E-02	8.00E-02	1.03E-01	8.83E-02	1.30E-01	1.15E-02	8.60E-03	7.33E-03	9.45E-03	8.09E-03	1.19E-02
PR-144	4.40E+05	4.24E+05	3.74E+05	3.97E+05	3.50E+05	4.75E+05	3.46E+04	3.24E+04	2.87E+04	3.10E+04	2.72E+04	3.71E+04
PR144M	1.42E+05	3.32E+04	7.19E+04	6.95E+04	3.23E+04	1.25E+05	2.28E+04	5.33E+03	1.15E+04	1.12E+04	5.17E+03	2.06E+04
ND-147	2.33E+06	1.34E+06	1.44E+06	1.57E+06	1.25E+06	1.93E+06	2.47E+05	1.35E+05	1.50E+05	1.62E+05	1.27E+05	2.03E+05
PM-147	7.86E+01	2.76E+01	4.92E+01	4.26E+01	3.23E+01	4.93E+01	8.17E+00	2.92E+00	5.11E+00	4.43E+00	3.36E+00	5.17E+00
PM-149	1.98E+05	1.12E+05	1.23E+05	1.39E+05	1.13E+05	1.69E+05	1.98E+04	1.11E+04	1.22E+04	1.38E+04	1.12E+04	1.67E+04
SM-147	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SM-151	1.69E+01	2.20E+00	5.68E+00	1.33E+01	1.61E+00	6.78E+01	7.60E+00	1.04E+00	2.56E+00	6.24E+00	7.22E-01	3.55E+01
SM-153	1.25E+06	3.89E+05	7.21E+05	6.33E+05	4.25E+05	8.08E+05	1.57E+05	4.71E+04	8.79E+04	7.83E+04	5.07E+04	1.04E+05

NUCLIDE	SWIMMING (MREM/YEAR PER UCI/ML) BONE	GI	THYROID	TB	LIVER	SKIN	SHORELINE (MREM/YEAR PER UCI/SQUARE CENTIMETER) BONE	GI	THYROID	TB	LIVER	SKIN
EU-155	1.35E+06	4.28E+05	7.98E+05	6.81E+05	4.78E+05	8.21E+05	1.54E+05	4.82E+04	8.98E+04	7.73E+04	5.35E+04	9.49E+04
TA-182	2.42E+05	1.90E+05	1.80E+05	2.04E+06	1.68E+05	2.44E+05	1.94E+06	1.41E+06	1.45E+06	1.63E+06	1.35E+06	1.96E+06
W-187	7.25E+06	5.09E+06	4.57E+06	5.55E+06	4.68E+06	6.81E+06	6.99E+05	4.84E+05	4.39E+05	5.30E+05	4.45E+05	6.52E+05
PB-210	3.69E+04	9.75E+03	1.71E+04	1.76E+04	9.16E+03	3.27E+04	5.31E+03	1.46E+03	2.42E+03	3.05E+03	1.28E+03	1.43E+04
PB-212	2.89E+06	1.26E+06	1.72E+06	1.78E+06	1.36E+06	2.13E+06	2.99E+05	1.29E+05	1.78E+05	1.83E+05	1.40E+05	2.25E+05
PB-214	4.29E+06	2.39E+06	2.65E+06	2.95E+06	2.39E+06	3.55E+06	4.32E+05	2.39E+05	2.66E+05	2.96E+05	2.39E+05	3.61E+05
BI-212	2.59E+06	2.08E+06	1.89E+06	2.22E+06	1.90E+06	2.69E+06	2.25E+05	1.78E+05	1.61E+05	1.92E+05	1.63E+05	2.36E+05
BI-214	2.10E+07	1.89E+07	1.69E+07	1.87E+07	1.62E+07	2.23E+07	1.71E+06	1.51E+06	1.35E+06	1.51E+06	1.31E+06	1.81E+06
PO-212	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PO-214	1.54E+03	1.14E+03	9.75E+02	1.27E+03	1.09E+03	1.62E+03	1.39E+02	1.03E+02	8.84E+01	1.15E+02	9.85E+01	1.46E+02
PO-216	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PO-218	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RA-224	1.87E+05	8.92E+04	1.13E+05	1.21E+05	9.45E+04	1.45E+05	1.90E+04	9.04E+03	1.15E+04	1.22E+04	9.58E+03	1.49E+04
RA-226	1.37E+05	5.79E+04	8.19E+04	8.21E+04	6.26E+04	9.83E+04	1.41E+04	5.94E+03	8.41E+03	8.45E+03	6.41E+03	1.05E+04
RA-228	8.53E-05	9.39E-05	1.88E-05	4.53E-04	3.96E-07	8.53E-03	7.89E-05	8.68E-05	1.74E-05	4.19E-04	3.68E-07	7.89E-03
AC-228	1.32E+07	9.95E+06	8.99E+06	1.10E+07	9.30E+06	1.37E+07	1.17E+06	8.65E+05	7.86E+05	9.64E+05	8.14E+05	1.23E+06
TH-228	4.33E+04	1.54E+04	2.56E+04	2.41E+04	1.74E+04	3.33E+04	4.75E+03	1.67E+03	2.74E+03	2.95E+03	1.84E+03	8.88E+03
TH-230	8.79E+03	2.86E+03	4.78E+03	4.83E+03	3.07E+03	1.00E+04	1.11E+03	3.53E+02	5.44E+02	6.92E+02	3.39E+02	5.86E+03
TH-232	3.91E+03	1.20E+03	2.03E+03	2.21E+03	1.23E+03	6.81E+03	5.93E+02	1.78E+02	2.53E+02	6.10E+02	1.45E+02	5.44E+03
TH-234	1.90E+05	6.00E+04	1.10E+05	9.53E+04	6.63E+04	1.18E+05	2.14E+04	6.70E+03	1.23E+04	1.11E+04	7.33E+03	1.94E+04
PA-234	2.89E+07	2.07E+07	1.92E+07	2.34E+07	1.98E+07	2.93E+07	2.61E+06	1.83E+06	1.72E+06	2.10E+06	1.77E+06	2.69E+06
U-234	2.77E+03	8.30E+02	1.38E+03	1.80E+03	8.36E+02	8.05E+03	5.71E+02	1.46E+02	1.85E+02	7.43E+02	1.00E+02	7.34E+03
U-238	9.69E+02	2.47E+02	3.66E+02	8.02E+02	1.97E+02	5.91E+03	3.32E+02	8.41E+01	7.05E+01	5.46E+02	2.97E+01	6.06E+03
NP-238	7.50E+06	5.78E+06	4.77E+06	6.38E+06	5.43E+06	8.32E+06	6.50E+05	4.99E+05	4.12E+05	5.54E+05	4.69E+05	7.45E+05
NP-239	3.44E+06	1.40E+06	2.14E+06	2.02E+06	1.57E+06	2.43E+06	3.59E+05	1.45E+05	2.22E+05	2.13E+05	1.62E+05	2.90E+05
PU-238	9.79E+02	2.32E+02	3.16E+02	1.00E+03	1.67E+02	8.46E+03	4.77E+02	1.42E+02	7.02E+01	7.97E+02	2.54E+01	8.55E+03
PU-239	1.39E+03	4.51E+02	7.98E+02	9.42E+02	5.05E+02	3.87E+03	2.33E+02	8.55E+01	9.52E+01	3.60E+02	5.44E+01	3.32E+03
PU-240	1.01E+03	2.33E+02	3.34E+02	9.90E+02	1.78E+02	8.10E+03	4.65E+02	1.36E+02	7.17E+01	7.64E+02	2.69E+01	8.14E+03
PU-241	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PU-242	8.25E+02	1.93E+02	2.83E+02	7.96E+02	1.52E+02	6.40E+03	3.68E+02	6.23E+01	5.81E+01	6.03E+02	2.22E+01	6.41E+03
AM-241	5.01E+05	1.43E+05	2.47E+05	2.37E+05	1.42E+05	3.12E+05	6.40E+04	1.81E+04	3.11E+04	3.16E+04	1.79E+04	5.77E+04
AM-242	3.08E+05	1.04E+05	1.95E+05	1.62E+05	1.21E+05	1.96E+05	3.32E+04	1.11E+04	2.07E+04	1.80E+04	1.29E+04	2.97E+04
AM-243	1.22E+06	3.71E+05	6.70E+05	5.97E+05	3.96E+05	7.28E+05	1.37E+05	4.16E+04	7.49E+04	6.79E+04	4.42E+04	9.30E+04
CM-242	1.08E+03	2.95E+02	2.97E+02	1.14E+03	1.56E+02	9.49E+03	6.08E+02	2.02E+02	7.14E+01	9.05E+02	2.57E+01	9.00E+03
CM-243	2.57E+06	1.06E+06	1.59E+06	1.53E+06	1.18E+06	1.85E+06	2.68E+05	1.09E+05	1.64E+05	1.62E+05	1.22E+05	2.33E+05
CM-244	6.91E+02	2.00E+02	1.25E+02	9.01E+02	5.13E+01	8.47E+03	5.22E+02	1.76E+02	4.96E+01	8.07E+02	1.34E+01	8.15E+03

Table 2.4.a

Public Water Supply Information*

TRM	2020 POPULATION	WATER SUPPLY
528.0		Watts Bar Nuclear Plant
503.8	12,300	Dayton
484.5		SEQUOYAH NUCLEAR PLANT
473.0	2000	ICI AMERICA, INC. (VAAP)
473.0	900	C. F. INDUSTRIES, INC.
470.5	4000	E. I. DUPONT, COMPANY
465.3	610700	CHATTANOOGA
418.0	4400	SOUTH PITTSBURG
413.6	3400	BRIDGEPORT
407.6	500	WIDOWS CREEK STEAM PLANT
405.2	500	MEAD PAPER BOARD
392.0		BELLEFONTE NUCLEAR PLANT
385.8	38700	SCOTTSBORO
382.1	18600	SAND MOUNTAIN WATER AUTHORITY
368.2	125	CHRISTIAN YOUTH CAMP
358.0	14900	GUNTERSVILLE
334.5	4500	N.E.MORGAN CO., WATER AND FIRE
334.2	168600	HUNTSVILLE
330.2	10000	REDSTONE ARSENAL
324.2		REDSTONE ARSENAL
306.0	84600	DECATUR
294.0		BROWNS FERRY NUCLEAR PLANT
283.0	500	U.S. PLYWOOD-CHAMPION PAPER
274.9	50	WHEELER DAM
259.6	14100	MUSCLE SHOALS
259.5	2700	TVA-NFDC
254.3	21100	SHEFFIELD
245.0	520	COLBERT STEAM PLANT
239.3	3900	CHEROKEE
238.7	350	U.S. STEEL AGRI-CHEMICALS, INC.
217.4	1	YELLOW CREEK NUCLEAR PLANT
206.8	2400	HARDIN CO. WATER DISTRICT
193.5	1900	TRI-COUNTY UTILITY DISTRICT
158.0	1100	CLIFTON
101.9	170	FOOTE MINERAL CO.
100.5	6100	NEW JOHNSONVILLE
100.4	13300	CAMDEN
100.0	375	JOHNSONVILLE STEAM PLANT
98.5	900	E. I. DUPONT COMPANY
95.5	700	CONSOLIDATED ALUMINUM CORPORATION
94.5	250	INLAND CONTAINER CORPORATION
79.5	120	BASS BAY RESORT
39.3	4300	JONATHAN CREEK WATER DISTRICT
28.5	9100	NORTH MARSHALL WATER DISTRICT
23.6	650	GRAND RIVERS
17.8	600	B. F. GOODRICH CHEMICAL CO.
17.4	106	AIRCO CARBIDE
16.8	592	AIRCO ALLOYS
16.7	510	AIR PRODUCTS AND CHEMICALS
1.1	69800	PADUCAH

*From TVA Water Quality Branch, updated December 1979

Table 2.4.b

Fish Harvest Data

RIVER SPAN (TRM)	NAME OF REACH	FISH HARVEST (LBS/YR) SPORT*	COMMERCIAL**
52[illegible].0 - 499.0	Chickamauga Lake below WBN	1.3×10^5	1.2×10^5
499.0 - 484.5	Chickamauga Lake above SQN	1.9×10^5	1.7×10^5
484.5 - 471.0	Chickamauga Lake below SQN	5.4×10^5	2.0×10^5
471.0 - 452.0	Nickajack Lake (Part 1 of 2)	1.2×10^5	4.6×10^4
452.0 - 424.7	Nickajack Lake (Part 2 of 2)	2.9×10^5	1.1×10^5
424.7 - 417.5	Guntersville Lake (Part 1 of 4)	2.6×10^5	9.5×10^4
417.5 - 392.0	Guntersville Lake above BLN	5.2×10^5	1.9×10^5
392.0 - 373.0	Guntersville Lake below BLN	7.8×10^5	2.9×10^5
373.0 - 349.0	Guntersville Lake (Part 4 of 4)	1.0×10^6	3.8×10^5
349.0 - 294.0	Wheeler Lake above BFN	1.0×10^6	3.8×10^5
294.0 - 274.9	Wheeler Lake below BFN	1.5×10^6	5.7×10^5
274.9 - 259.4	Wilson Lake	5.9×10^5	2.2×10^5
259.4 - 217.4	Pickwick Lake above YCN	1.3×10^6	4.9×10^5
[illegible]4 - 206.7	Pickwick Lake below YCN	3.3×10^5	1.2×10^5
[illegible].7 - 165.0	Kentucky Lake (Part 1 of 4)	6.1×10^5	2.3×10^5
165.0 - 121.0	Kentucky Lake (Part 2 of 4)	6.1×10^5	2.3×10^5
121.0 - 76.0	Kentucky Lake (Part 3 of 4)	1.8×10^6	6.8×10^5
76.0 - 22.4	Kentucky Lake (Part 4 of 4)	3.1×10^6	1.1×10^6

*Derived from "Situation Assessment and Planning Assumptions," Division of Forestry, Fisheries, and Wildlife, TVA, December 1978.

**Derived from "Estimated Commercial Fish and Mussel Harvest from the Tennessee Valley," Fisheries and Aquatic Ecology Branch, TVA, 1980.

Table 2.4.c

Recreation Usage Data*

RIVER SPAN (TRM)	NAME OF REACH	HOURS OF USAGE PER YEAR		
		SHORELINE	ABOVE-WATER	IN-WATER
528.0 - 499.0	Chickamauga Lake below WBN	5.4×10^5	5.9×10^5	1.2×10^5
499.0 - 484.5	Chickamauga Lake above SQN	2.4×10^6	2.7×10^6	5.2×10^5
484.5 - 471.0	Chickamauga Lake below SQN	5.5×10^6	1.0×10^6	4.9×10^6
471.0 - 452.0	Nickajack Lake (Part 1 of 2)	1.2×10^5	2.5×10^4	1.1×10^5
452.0 - 424.7	Nickajack Lake (Part 2 of 2)	2.0×10^5	4.0×10^4	1.8×10^5
424.7 - 417.5	Guntersville Lake (Part 1 of 4)	7.0×10^4	1.5×10^4	6.0×10^4
417.5 - 392.0	Guntersville Lake above BLN	5.2×10^5	1.0×10^5	4.7×10^5
392.0 - 373.0	Guntersville Lake below BLN	4.7×10^6	8.9×10^5	4.2×10^6
373.0 - 349.0	Guntersville Lake (Part 4 of 4)	1.1×10^7	2.1×10^6	9.8×10^6
349.0 - 294.0	Wheeler Lake above BFN	4.0×10^6	7.6×10^5	3.6×10^6
294.0 - 274.9	Wheeler Lake below BFN	5.2×10^6	1.0×10^6	4.7×10^4
274.9 - 259.4	Wilson Lake	3.9×10^6	7.4×10^5	3.5×10^6
259.4 - 217.4	Pickwick Lake above YCN	2.0×10^6	3.5×10^5	2.0×10^6
7.4 - 206.7	Pickwick Lake below YCN	2.0×10^6	4.0×10^5	1.8×10^6
206.7 - 165.0	Kentucky Lake (Part 1 of 4)	6.0×10^5	1.2×10^5	5.4×10^5
165.0 - 121.0	Kentucky Lake (Part 2 of 4)	1.2×10^6	2.3×10^5	1.1×10^6
121.0 - 76.0	Kentucky Lake (Part 3 of 4)	2.4×10^6	4.7×10^5	2.2×10^6
76.0 - 22.4	Kentucky Lake (Part 4 of 4)	2.6×10^7	4.9×10^6	2.3×10^7

*Based on "Extent of Recreation Development and Use of TVA Lake Frontage Property;" (unpublished data from 1974 Annual Recreation Survey); and Observations of Recreation Use of TVA Reservoirs, Division of Reservoir Properties, Recreation Resources Branch, TVA, 1975.

3.0 Radiological Environmental Monitoring

3.1 Monitoring Program

An environmental radiological monitoring program shall be conducted as described in Tables 3.1 and 3.2 and in Figures 3.1, 3.2, 3.3, and 3.4 shall be conducted. Results of this program shall be reported in accordance with Technical Specifications.

The atmospheric environmental radiological monitoring program shall consist of 10 monitoring stations from which samples of air particulats, 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 (for example: because of 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 3.3 are achieved.

4.0 Annual Maximum Individual Doses - Total

To determine compliance with 40 CFR 190, the annual dose contributions to the maximum individual from WBN radioactive effluents and all other nearby uranium fuel cycle sources will be considered. The annual dose to the maximum individual will be conservatively estimated by: first, summing the total body air submersion dose, and the critical organ dose from gaseous effluents; the total body dose, and critical organ dose from liquid effluents for each quarter in accordance with sections 1.4 and 2.3.3. Then to this sum for each quarter is added any identifiable increase in direct radiation dose levels attributable to the plant as determined by the environmental monitoring program outlined in section 3.0. These quarterly sums are then conservatively summed for the four calendar quarters to estimate the maximum individual dose for the year.

TABLE 3.1

RADIOLOGICAL ENVIRONMENTAL MONITO[illegible]PROGRAM

Exposure Pathway and/or Sample	Sample Locations*	Sampling and Collection Frequency	Type and Frequency of Analysis
1. AIRBORNE			
a. Particulates	4 samples from locations (in different sectors) at or near the site boundary (Table 3.2 and Figure 3.3, Stations LM-1WB, LM-2WB, LM-3WB, and LM-4WB)		
	4 samples from communities approximately 3 to 10 miles distant from the plant (Table 3.2 and Figure 3.1, Stations PM-2WB, PM-3WB, PM-4WB, PM-5WB)	Continuous sampler operation with sample collection at least once per 7 days	Gross beta, following filter change. Composite by location for gamma scan at least once per 31 days and for ^{89}Sr, and ^{90}Sr at least once per 92 days
	2 samples from control locations greater than 10 miles from the plant (Table 3.2 and Figure 3.1, Stations RM-2WB and RM-3WB)		
b. Radioiodine	Samples from same locations as air particulates	Continuous sampler operation with filter collection at least once per 7 days	^{131}I at least once per 7 day

*Sample locations are shown on Figures 3.1, 3.2, 3.3, and 3.4.
**Samples shall be collected by collecting an aliquot at intervals not exceeding 2 hours.

TABLE 3.1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Sample Locations*	Sampling and Collection Frequency	Type and Frequency of Analysis
c. Fallout	Samples from same locations as air particulates	Heavy particulate fallout collected continuously on gummed acetate paper with paper collection at least once per 31 days	Gross beta following collection
d. Rainwater	Samples from same locations as air particualtes	Rainwater collected continuously with composite samples analyzed at least once per 31 days	Gamma scan, 89Sr, 90Sr at least once per 31 days
e. Soil	Samples from same locations as air particulates	Once per 3 years	Gamma scan, 89Sr, 90Sr once each 3 years
2. DIRECT	(Figures 3.2 and 3.3) 35-40 locations with at least 2 dosimeters for continuously measuring and recording dose rate at each location	At least once per 92 days	Gamma dose at least once per 92 days
3. WATERBORNE			
a. Surface	TRM 529.3 TRM 523.1 TRM 517.9 (Figure 3.4)	Collected by automatic sequential-type sampler** with composite sample collected over a period of $\leq$ 31 days	Gamma scan of each composite. Composite for tritium, 89Sr and 90Sr at least once once per 92 days
b. Ground	1 sample adjacent to plant (Table 3.2 and Figure 3.3g, Station W-1)	Collected by automatic sequential-type sampler with composite sample collected over a period at $\leq$ 31 days	Gamma scan of each composite. Composite for tritium at least once per 92 days
	1 sample from ground water source upgradient (Table 3.2 and Figure 3.3, Station M-1)	Grab sample once per 31 days	Gamma scan once per 31 days. Composite for tritium at least once per 92 days.

[a]The sample collected at TRM 503.8 is taken from the raw water supply; therefore, the upstream surface water sample will be considered the control sample for drinking water.

TABLE 3.1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Sample Locations*	Sampling and Collection Frequency	Type and Frequency of Analysis
c. Drinking (Table 3.3) (Figure 3.4)	1 sample at the first potable surface water supply downstream from the plant (TRM 503.8, Figure 3.4)	Collected by automatic sequential-type sampler** with composite sample collected over a period of ≤ 31 days.	
	1 sample at a control location (TRM 529.3,[a] Figure 3.4)		Gross beta and gamma scan of each composite. Composite for tritium, ^{89}Sr, and ^{90}Sr at least once per 92 days
4. AQUATIC			
a. Sediment	TRM 527.4, Figure 3.4 TRM 532.1, Figure 3.4	At lease once per 184 days	Gamma scan ^{89}Sr, and ^{90}Sr analyses of each sample
b. Sediment from shoreline	TRM 513, Figure 3.4 TRM 530, Figure 3.4	At least once per 184 days	Gamma scan on each sample
5. INGESTION			
a. Milk	1 sample from milk producing animals in each of 1-3 areas indicated by the cow census where doses are calculated ≤ 0.5 m rem/year. If samples are unavailable from an area, doses to that area will be estimated by projecting the doses from concentrations detected in milk from other areas or by sampling vegetation where milk samples are not available.	At least once per 15 days (Table 3.2 and Figure 3.1)	^{131}I analysis of each sample Gamma scan, ^{89}Sr, and ^{90}Sr at least once per 31 days

TABLE 3.1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Sample Locations*	Sampling and Collection Frequency	Type and Frequency of Analysis
b. Fish	1 sample each of a commercially and a recreationally important species from Nickajack. Chickamauga, and Watts Bar Reservoirs (Figure 3.4)	At least once per 184 days. At least two of the following species shall be sampled: Channel Catfish, White Crappie Small Mouth Buffalo	Gamma scan on edible portions. ^{89}Sr, ^{90}Sr
c. Vegetation (Pasturage and grass)	Samples from atompsheric monitoring stations and the dairy farms from which milk is obtained (Table 3.2 and Figure 3.1)	At least once per 92 days	Gamma scan on edible portions, ^{89}Sr, ^{90}Sr
d. Food Products	1 sample each of principal food products grown at private gardens and/or farms in the immediate vicinity of the plant. 1 sample of each of the same foods grown at distances of greater than 10 miles from the plant	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 Tomatoes	Gamma scan on edible portion

TABLE 3.1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Sample Locations*	Sampling and Collection Frequency	Type and Frequency of Analysis
	Samples of three different kinds of available broad leaf vegetation grown nearest each of two different offsite locations of highest predicted annual average ground-level D/Q if milk sampling is not performed as outlined in Section 5.a above.	Monthly when available.	Gamma isotopic (5) and I-131 analysis.
	One sample of each of the similar broad leaf vegetation grown 15-30 km distant in the least prevalent wind direction if milk sampling is not performed as outlined in Section 5.a. above.	Monthly when available.	Gamma isotopic(5) and I-131 analysis.

TABLE 3.2

ENVIRONMENTAL MONITORING STATION LOCATIONS

WATTS NUCLEAR PLANT

Sample Station	Approximate Distance and Direction from Plant		
LM-1 WB	1/2 mile	(3/4 kilometers)	SSW
LM-2 WB	1/2 mile	(3/4 kilometers)	N
LM-3 WB	2.1 miles	(3-1/4 kilometers)	NNE
LM-4 WB	1 mile	(1-3/5 kilometers)	SE
PM-2 WB, Spring City, TN	7 miles	(11-4/4 kilometers)	NW
PM-3 WB, Cedine Camp	11-1/2 miles	(18-1/2 kilometers)	NNE
PM-4 WB, Ten Mile, TN	7-3/4 miles	(12-1/2 kilometers)	NE
PM-5 WB, Decatur, TN	6-1/4 miles	(10 kilometers	S
Farm L[a] (M-1)	1-1/2 miles	(2 kilometers)	SSW
Farm Mo[a](M-2)	4-1/2 miles	(7-1/4 killometers)	NW
Farm H[a] (M-3)	4-3/4 miles	(7-2/3 kilometers)	W
Well (W-1)	7/10 mile	(1 kilometer)	SSW
Control Stations			
RM-2 WB, Dayton, TN (Identical with RM-2S, Sequoyah Nuclear Plant)	15 miles	(24-1/4 kilometers)	SW
RM-3 WB, Alloway, TN	~ 15 miles	(24-1/4 kilometers)	NNW
Farm B (M-4)	15 miles	(24-1/4 kilometers)	E
Farm C (M-5)	16 miles	(25-3/4 kilometers)	SSW
Farm S (M-6)	19-1/2 miles	(31-1/3 kilometers)	SW

[a]Considered as controls for well water.

TABLE 3.3
(Sheet 1)

DETECTION CAPABILITIES FOR ENVIRONMENTAL SAMPLE ANALYSIS [a]

LOWER LIMIT OF DETECTION (LLD)[b,c]

Analysis	Water (pCi/ℓ)	Airborne Particulate or Gases (pCi/m³)	Fish (pCi/kg, wet)	Milk (pCi/ℓ)	Food Products (pCi/kg, wet)	Sediment (pCi/kg, dry)
gross beta	4	0.01				
H-3	2000*					
Mn-54	15		130			
Fe-59	30		260			
Co-58, 60	15		130			
Zn-65	30		260			
Zr-Nb-95	15					
I-131	1[d]	0.07		1	60	
Cs-134	15	0.05	130	15	60	150
Cs-137	18	0.06	150	18	80	180
Ba-La-140	15			15		

*If no drinking water pathway exists, a value of 3000 pCi/ℓ may be used.

TABLE 3.3
(Sheet 2)

TABLE NOTATION

[a]This list does not mean that only these nuclides are to be considered. Other peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Annual Radiological Environmental Operating Report.

[b]Required detection capabilities for thermoluminescent dosimeters used for environmental measurements are given in Regulatory Guide 4.13.

[c]The LLD is defined, for purposes of these specifications, as the smallest concentration of radioactive material in a sample that will yield a net count, above system background, that will be detected with 95 percent probability with only 5 percent probability of falsely concluding that a blank observation represents a 'real' signal.

For a particular measurement system, which may include radiochemical separation:

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

Where:

LLD is the 'a priori' lower limit of detection as defined above, as picocuries 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 disintegration,

V is the sample size in units of mass or volume,

2.22 is the number of disintegrations per minute per picocurie,

Y is the fractional radiochemical yield, when applicable,

λ is the radioactive decay constant for the particular radionuclide, and

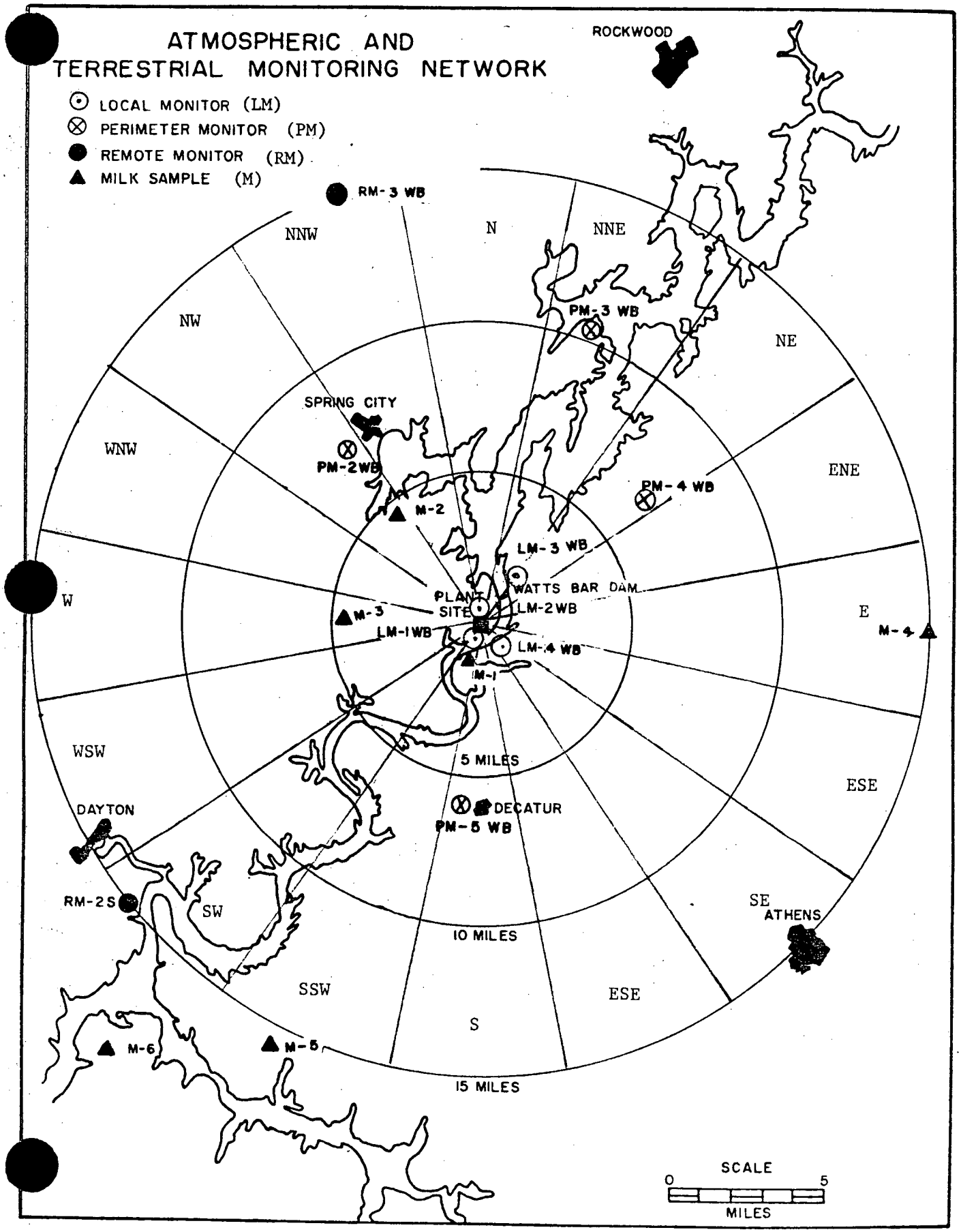
Δt for environmental samples is the elapsed time between sample collection, or end of the sample collection period, and time of counting

Typical values of E, V, Y, and Δt should be used in the calculation.

It should be recognized that the LLD is defined as an a priori (before the fact) limit representing the capability of a measurement system and not as an a posteriori (after the fact) limit for a particular measurement. Analyses shall be performed in such a manner that the stated LLDs will be achieved under routine conditions. Occasionally background fluctuations, unavoidable small sample sizes, the presence of interfering nuclides, or other uncontrollable circumstances may render these LLDs unachievable. In such cases the contributing factors shall be identified and described in the Annual Radiological Environmental Operating Report.

[d]LLD for drinking water samples within 3 miles downstream from the plant. If no drinking water pathway exists within 3 miles downstream from the plant, the LLD of gamma isotopic analysis may be used.

Figure 3.1



(1 mile - 1.6 kilometers)

FIGURE 3.2

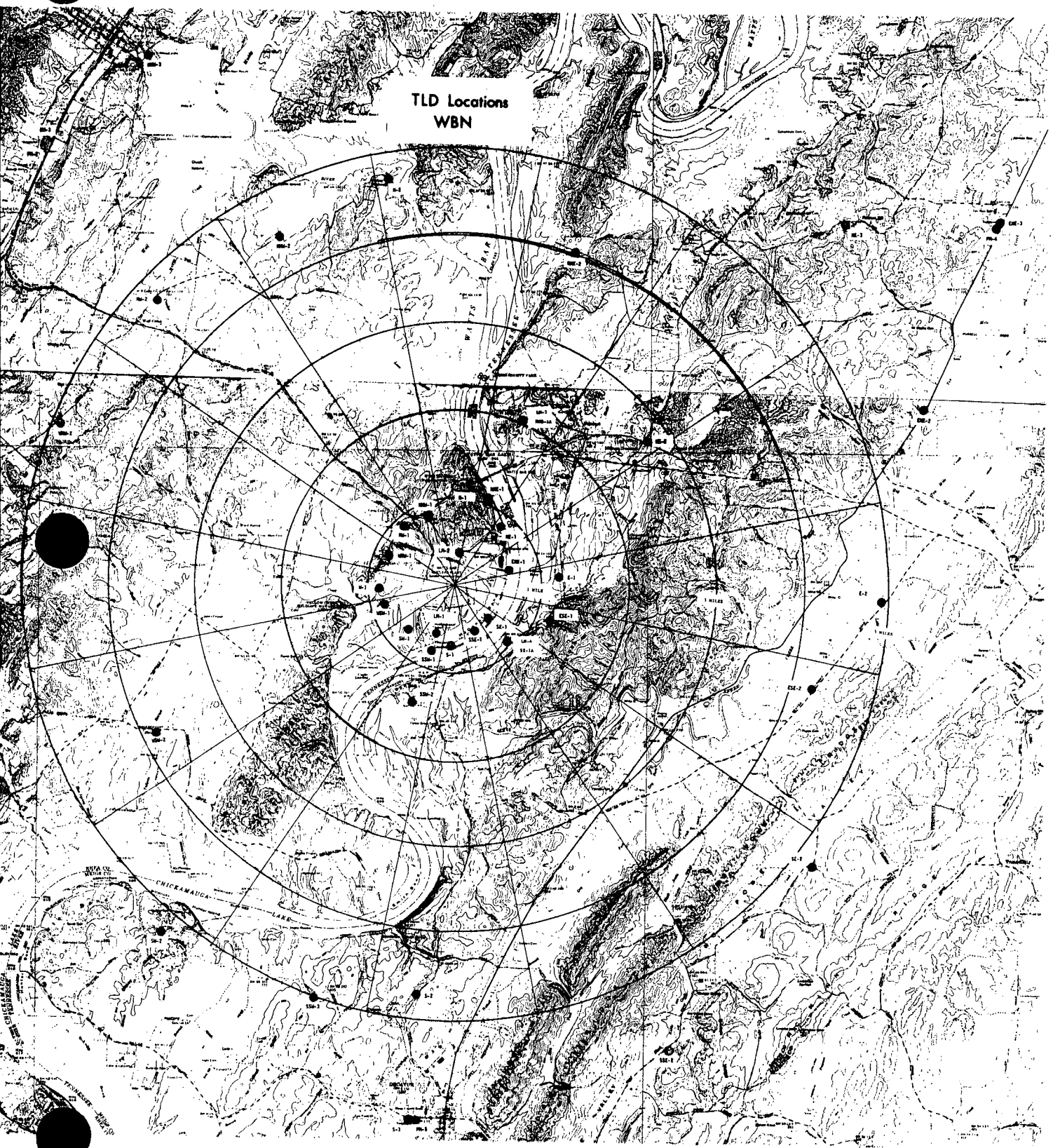


Figure 3.3
WBN
Site/Near Site Monitoring Stations

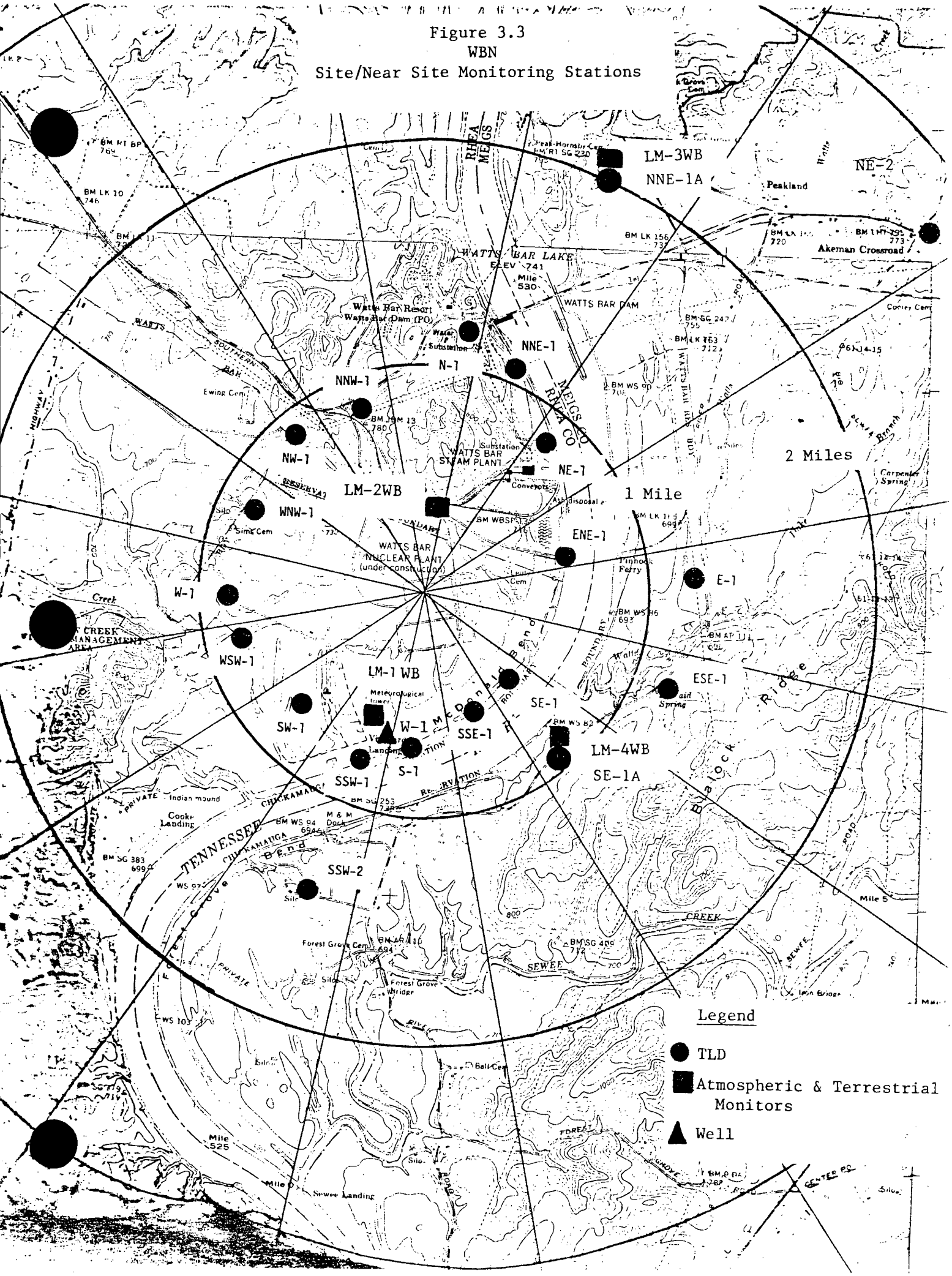
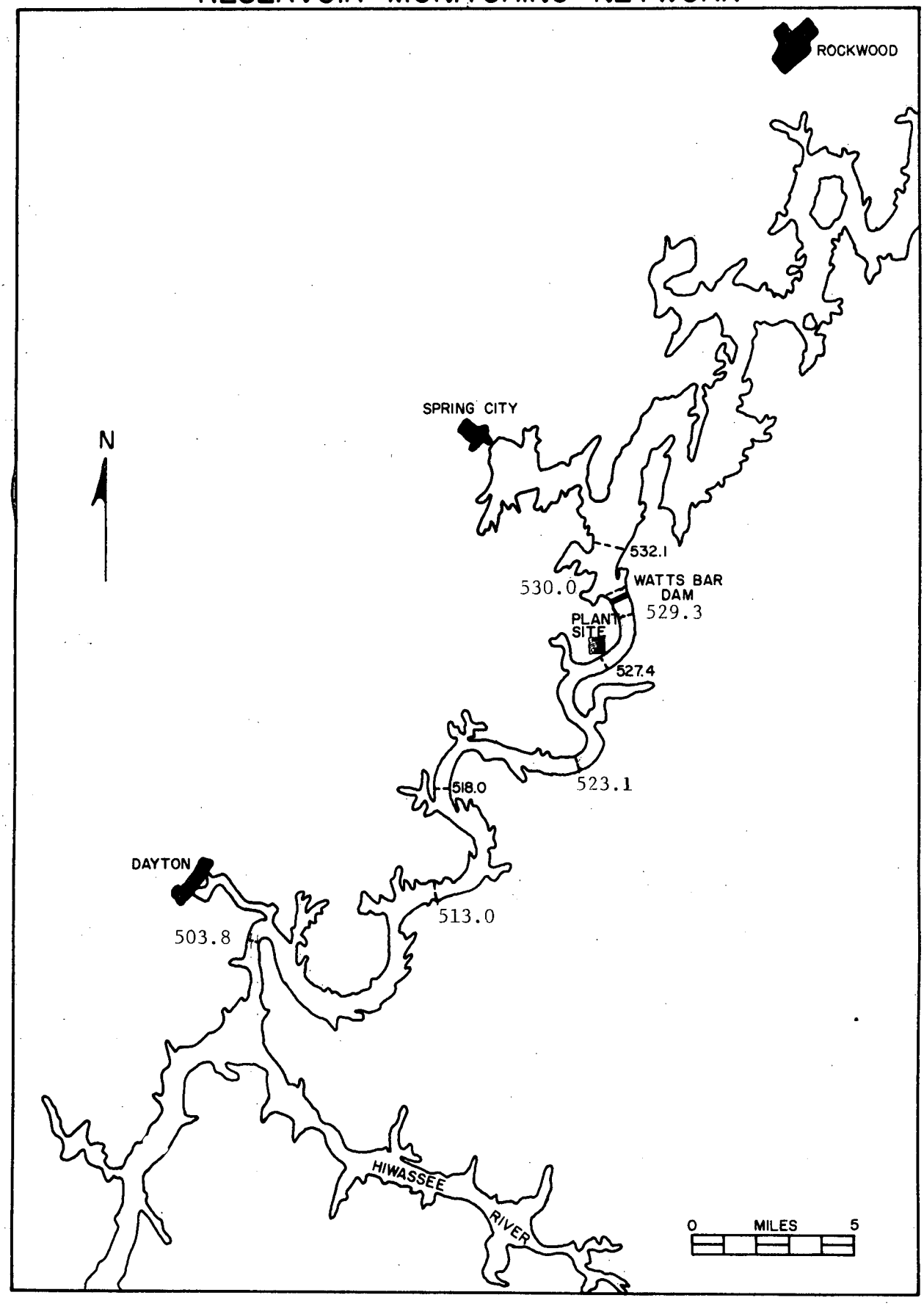


Figure 3.4

RESERVOIR MONITORING NETWORK