ENCLOSURE 5

TENNESSEE VALLEY AUTHORITY

BROWNS FERRY NUCLEAR PLANT

TECHNICAL INSTRUCTION NO. 47

OFFSITE DOSE CALCULATION MANUAL (ODCM)

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1.0 Gaseous Effluents

1.1 Alarm/Trip Setpoints

Technical Specification 3.8.B.1 requires that the dose rate in unrestricted areas (see figure 1.1) due to gaseous effluents from the BFN 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 radioiodines and particulates.

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

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

1.1.1 Release Rate Limit Methodology - μCi/s

Step 1

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

Doses are determined for (1) noble gases and (2) iodines and particulates. Depending on the pathway involved, either air concentrations or ground concentrations are calculated. Figures 1.2

and 1.3 show the Offgas System, Standby Gas Treatment System, and normal building ventilation with effluent monitors located.

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 expected source term given in table 1.1.
4. Basic radionuclide data are given in table 1.2.
5. Releases are treated as ground level, split level, or elevated.
6. Meteorological data are expressed as joint frequency distributions (JFDs) of wind speed, wind direction, and atmospheric stability for the period January 1974 to December 1975 (table 1.3). Releases from the turbine building are treated as 100 percent ground level, whereas stack releases are considered 100 percent elevated. Releases from the reactor building and radwaste building are treated as split level, i.e., partly elevated and partly ground level.
7. Raw meteorological data for ground-level releases consist of wind speed and direction measurements at 10 m and temperature measurements of 10 m and 45 m. The ground-level portion of the split-level JFD was based on wind speeds and directions measured at the 10-m level and temperature measurements at 10 m and 45 m. The elevated portion of the split-level JFD was based on wind speeds and directions measured at 46 m and temperature measurements at 45 m and 90 m. Windspeeds and directions

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

8. Dose is to be evaluated at the nearest land site boundary point in each sector and at other locations expected to be maximum exposure points.

9. A semi-infinite cloud model is used. The use of a finite cloud model would result in calculated doses of less than 3 percent higher than those calculated using the semi-infinite cloud model for BFN.

10. No credit is taken for shielding by residence.

11. Plume depletion (figure 1.4) and radioactive decay are considered consistent with Regulatory Guide 1.111 methodology.

12. Building wake effects on effluent dispersion are considered.

13. A sector-average dispersion equation is used.

14. 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	2.80
6	3.4-5.5	4.45
7	5.6-8.2	6.91
9	>10.9	13.00

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

16. Terrain elevations are considered.

Equations

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

For determining the air concentration of any radionuclide:

$$\chi_i = \sum_{j=1}^{9} \sum_{k=1}^{7} \left(\frac{2}{\pi}\right)^{\frac{1}{2}} \frac{f_{jk}\ Q_i\ p}{\Sigma_{zK}\ u_j\ (2\pi x/n)} \quad \exp\left(-\lambda_i \frac{x}{u_j}\right) \exp\left(-h_e^2 / 2\sigma^2_{zk}\right) \tag{1.1}$$

where

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

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

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

p = fraction of radionuclide remaining in plume, figure 1.4, consistent with Regulatory Guide 1.111 methodology.

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

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

x = downwind distance, m.

n = number of sectors, 16.

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

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

h_e = effective release height, m.

For effluents exhausted from release points that are higher than twice the height of adjacent structures (elevated releases) the effective release height is determined by the following equation, consistent with Regulatory Guide 1.111

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

where

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

h_{pr} = plume rise above release point as determined by the Briggs equations given in Sagendorf (ERL ARL-42), m.

h_s = physical height of release point, m.

h_t = maximum terrain height between release point and receptor location, m.

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

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

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

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

Case 3 - split level if $1 < W_o/u < 5$.

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

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

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

For determining the total body dose rate

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

where

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

χ_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

$$D_s = \sum_i \chi_i\ [DFS_i + 1.11\ DF\Gamma_i] \qquad (1.3)$$

where

D_s = skin dose rate, mrem/yr.

χ_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).

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

1.11 = the average ratio of tissue to air energy absorption coefficient.

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

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

Assumptions, same as 1.1.1.A, except:

1. Dose is to be calculated for the critical organ, thyroid, and the critical age group, infant.
2. Exposure pathways from iodines and particulates are milk ingestion, ground contamination, and inhalation.
3. The radioiodine and particulate mix is based on the expected source term given in table 1.1.
4. Real cow and garden locations are not considered.
5. Deposition is calculated based on the curves given in figure 1.5.

Regulatory Guide 1.111

Equations

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

1. Inhalation

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

For determining the thyroid dose rate:

$$D_{THI} = 1 \times 10^{-6} \sum_{i} \chi_i \, DFI_i \qquad (1.4)$$

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 $\mu Ci/cm^3$, based on Regulatory Guide 1.109 dose commitment factors (mrem/pCi) and an assumed 1400 m^3/yr infant breathing rate.

$1x10^{-6}$ = m^3/cm^3 conversion factor.

2. Ground Contamination

For determining the ground concentration of any nuclide:

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

where

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

k = stability class.

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

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

DR = relative deposition rate, m^{-1} (figure 1.5). The choice of figure is governed by the effective release height calculated by equation 1.1a. A linear interpolation is used for effective release heights that fall in between the given curves.

x = downwind distance, m.

n = number of sectors, 16.

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

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

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

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

For determining the thyroid dose rate from ground contamination:

$$D_{THG} = (8,760)\ (1x10^6) \sum_i G_i\ DFG_i \qquad (1.6)$$

where

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

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

DFG_i = dose factor for standing on contaminated ground, mrem/h per pCi/m^2 (table 1.7).

8,760 = occupation time, h/yr.

$1x10^6$ = pCi/µCi conversion factor.

3. Milk Ingestion

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

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

where

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

k = stability class.

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

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

DR = relative deposition rate, m^{-1} (figure 1.5). The choice of figure is governed by the effective release height calculated by equation 1.1a. A linear interpolation is used for effective release heights that fall in between the given curves.

x = downwind distance, m.

n = number of sectors, 16.

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

r = fraction of deposited activity retained on vegetation, 0.47, consistent with NUREG/CR-1004.

λ_{Ei} = effective removal rate constant, $\lambda_{Ei} = \lambda_i + \lambda_w$, where λ_i is the radioactive decay coefficient, h^{-1}, and λ_w is a measure of physical loss by weathering ($\lambda_w = 0.0023\ h^{-1}$ for particulates and 0.0017 for iodines).

t_e = period over which deposition occurs, 720 h.

Y_v = agricultural yield, 1.18 kg/m^2.

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

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

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

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

3,600 = s/h conversion factor.

For determining the concentration of H-3 in vegetation:

$$CV_T = 1 \times 10^3\ \chi_T\ (0.75)(0.5/H) \qquad (1.8)$$

where

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

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

0.75 = fraction of total plant mass th t is water.

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

H = absolute humidity of the atmosphere, 9 g/m³.

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

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

$$CM_i = CV_i \; FM_i \; Q_f \exp^{(-\lambda_i \; t_f)} \quad (1.9)$$

where

CM_i = concentration of radionuclide i (including H-3) in cow's milk μCi/l.

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

FM_i = transfer factor from feed to milk for radionuclide i, table 1.6, d/l.

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

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

t_f = transport time of activity from milking to ingestion, 1 day.

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

$$D_{THM} = 1x10^6 \sum_i CM_i \; DFING_i \; UM \quad (1.10)$$

where

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

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

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

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

$1x10^6$ = pCi/μCi conversion factor.

4. Total Thyroid Dose Rate

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

$$D_{TH} = D_{THI} + D_{THG} + D_{THM} \quad (1.11)$$

where

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

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

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

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

The above dose calculations are repeated for each release point. Dose rates from building vents are summed. The calculated thyroid dose rates from the vents and stack will then be used in step 2.

Step 2

The dose rate limits of interest (10 CFR 20) are

Total Body = 500 mrem/yr.

Skin = 3,000 mrem/yr.

Maximum Organ = 1,500 mrem/yr.

Dividing the above limits by the appropriate dose rates calculated in step 1 yields the following ratios:

$$\frac{\text{Dose Rate Limit}}{\text{Vent Dose Rate step 1}} = R_1 \qquad \frac{\text{Dose Rate Limit}}{\text{Stack Dose Rate (Step 1)}} = R_2$$

These ratios, R_i, represent how far above or below the guidelines the step 1 calculation was. Multiplying the original source terms Q_i by the appropriate ratio R_i will give release rates, r_i, that will result in the dose rate limits given above.

Instantaneous release rates (q_i) for each nuclide type and release point are now limited by the following equations:

For noble gas releases:

$$\frac{q_1}{r_1} \quad \frac{q_2}{r_2} \leq 1$$

where

q_1 = instantaneous release rate from building exhaust vents (Ci/s).

q_2 = instantaneous release rate from main stack in Ci/s.

For iodines and particulates, half-lives > 8 days.

$$\frac{q_3}{r_3} \quad \frac{q_4}{r_4} \leq 1$$

where

q_3 = instantaneous release rate from building exhaust vents (μCi/s).

q_4 = instantaneous release rate from main stack (μCi/s).

To simplify the dynamic operation of the plant, the dose rate limits were transformed into conservative release rate limits based on historical source terms and meteorology. The values listed below were used as administrative guidelines for operation and development of alarm/trip setpoints (see Technical Instruction 15) to ensure that the instanteous dose rate limits are not exceeded.

Airborne	Noble Gas	Halogen and Particulate
Elevated	0.68 Ci/s	1.96 μCi/s
Ground Level	0.13 Ci/s	1.61 μCi/s

1.2 Monthly Dose Calculations

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

For noble gases,

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

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

For iodines and particulates,

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

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

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

1.2.1 Noble Gases

Step 1

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

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

Assumptions

1. Doses to be calculated are gamma and beta air doses.
2. The highest annual-average χ/Q based on licensing meteorology for any offsite location (not necessarily a site boundary location) will be used. Elevated meteorology is assumed for stack releases. All other vent releases assume ground-level meteorology.
3. No credit is taken for radioactive decay.
4. For gamma doses, releases of Ar-41, Xe-138, Kr-87, and Kr-88 are considered.
5. For beta doses, releases of Xe-133, Xe-138, Kr-85, Kr-87, and Kr-88 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.
8. A semi-infinite cloud model is used.
9. Building wake effects on effluent dispersion are considered.

Equations

For determining the gamma dose to air:

$$D_\gamma = \frac{(\chi/Q)}{0.9} \frac{10^6}{3.15\times10^7} \sum_i Q_i \, DF\gamma_i \qquad (1.12)$$

where

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

χ/Q = highest annual-average relative concentration, 2.26×10^{-6} s/m^3 (ground level), 1.8×10^{-8} s/m^3 (elevated).

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

Q_i = monthly release of radionuclide i, Ci.

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

Equation 1.12 reduces to:

$$D_\gamma = 7.97\times10^{-8} \sum_i Q_i \, DF\gamma_i \quad \text{(ground level)} \qquad (1.13)$$

$$D_\gamma = 6.34\times10^{-10} \sum_i Q_i \, DF\gamma_i \quad \text{(stack)} \qquad (1.14)$$

For determining the beta dose to air:

$$D_\beta = \frac{(\chi/Q)}{0.9} \frac{10^6}{3.15\times10^7} \sum_i Q_i \, DF\beta_i \qquad (1.15)$$

where

D_β = beta dose to air, mrad.

χ/Q = highest annual-average relative concentration, 2.26×10^{-6} s/m^3 (ground level), 1.8×10^{-8} s/m^3 (elevated).

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

Q_i = monthly release of radionuclide i, Ci.

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

Equation 1.15 then reduces to:

$$D_\beta = 7.97\times10^{-8} \sum_i Q_i \, DF\beta_i \quad \text{(ground level)} \qquad (1.16)$$

$$D_\beta = 6.34\times10^{-10} \sum_i Q_i \, DF\beta_i \quad \text{(stack)} \qquad (1.17)$$

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 land site boundary point in each sector and at other locations expected to be maximum exposure points.
3. Historical onsite meteorological data for the appropriate months from the period 1974-1975 will be used.

4. All measured radionuclide releases are considered.

5. A semi-infinite cloud model is used.

6. Radioactive decay is considered.

7. Building wake effects on effluent dispersion are considered.

8. Dose factors are calculated using data from TVA's radionuclide library.

Equations

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

For determining the gamma dose to air

$$D_{\gamma n} = t_m \sum_i \chi_{ni} \, DF\gamma_i \qquad (1.18)$$

where

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

χ_{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:

$$D_{\beta n} = t_m \sum_i \chi_{ni} \, DF\beta_i \qquad (1.19)$$

where

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

χ_{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 3.8.B.3.

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. Doses are to be calculated for the infant thyroid from milk ingestion and for the child bone 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/Qs for any location (not necessarily a site boundary location) are used based on licensing meteorology. Elevated meteorology is assumed for stack releases. All other vent releases assume ground-level meteorology.
4. No credit is taken for radioactive decay.
5. I-131 releases are considered for the milk pathway. Sr-90 releases are considered for the vegetable pathway.
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

$$DTH_{131} = \frac{Q_{131} \quad DF_{131} \quad D/Q}{(0.9) \quad (3.15x10^7)} \times 10^6 \qquad (1.20)$$

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, 7.24×10^{11} mrem/yr per $\mu Ci/m^2$-s based on Regulatory Guide 1.109 and NUREG/CR-1004 dose methodologies.

D/Q = relative deposition rate, $7.26x10^{-10}m^{-2}$ (ground level); $1.27x10^{-9}m^{-2}$ (stack).

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

$3.15x10^7$ = s/yr.

10^6 = $\mu Ci/Ci$ conversion factor

Equation 1.20 reduces to

$$DTH_{131} = 18.5 \; Q_{131} \text{ (ground level)} \qquad (1.21)$$

$$DTH_{131} = 32.4 \; Q_{131} \text{ (stack)} \qquad (1.22)$$

For determining the bone dose from vegetable ingestion:

$$DBC_s = \frac{10^6 \cdot \quad Q_s \cdot DF_s \cdot D/Q}{3.15x10^7 \; (0.9)} \qquad (1.23)$$

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 factor to child, $1.36x10^{13}$ mrem/yr per $\mu Ci/m^2$-s based on Regulatory Guide 1.109 amd NUREG/CR-1004 dose methodologies.

D/Q = relative deposition rate, $4.69 \times 10^{-9} m^{-2}$ (ground level); $1.27 \times 10^{-9} m^{-2}$ (stack)

3.15×10^{7} = s/yr conversion factor.

10^{6} = µCi/Ci conversion factor.

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

Equation 1.23 reduces to

$$DBC_s = 2250\ Q_s \text{ (ground level)} \quad (1.24)$$

$$DBC_s = 609\ Q_s \text{ (stack)} \quad (1.25)$$

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. Doses will be evaluated at real cow and home-use garden locations and will consider actual grazing information.

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

1.3 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 specification 6.7.5. Methodology for this analysis is the same as that described in section 1.1.1, except that real pathways and receptor locations (table 1.4A) are considered. In addition, meteorological data representative of each corresponding calendar quarter will be used. This analysis will replace the estimates in section 1.2.

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

1.4 Gaseous Radwaste Treatment System Operation

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

1.4.1 System Description

A flow diagram for the GRTS is given in figure 1.3. The system includes the subsystems that process and dispose of the gases from the main condenser air ejectors, the startup vacuum pumps, and the gland seal condensers. One gaseous radwaste treatment system is provided for each unit. The processed gases from each unit are routed to the plant stack for dilution and elevated release to the atmosphere. The air ejector off-gas line of each unit and the stack are continuously monitored by radiation monitors.

1.4.2 Dose Calculations

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

Table 1.1

Expected Annual Routine Atmospheric Releases
From One Unit at BFN

	Nuclear Plant (Ci/Yr/Unit)			Stack	
Isotope	Reactor Complex Vent	Radwaste Building Vent	Turbine Building Vent	Gland Seal and Offgas	MVP
Kr-85m	6	<1	2	1.66 E4	0
Kr-85	-	-	-	630	-
Kr-87	6	<1	95	747	0
Kr-88	9	<1	102	1.35 E4	0
Kr-89	1	34	503	4095	0
Xe-131m				309	
Xe-133m	0	60	0	851	0
Xe-133	103	294	581	9.47 E4	300
Xe-135m	111	667	464	917	0
Xe-135	173	328	672	599	200
Xe-137	78	113	386	5040	0
XE-138	12	2	1179	3150	0
I-131 I	0.0594	0.0050	0.0156	0.0041	0.0085
I-132 I	0.594	0.050	0.1786	0.0469	0.0973
I-133 I	0.297	0.025	0.1231	0.0323	0.0671
I-134 I	1.485	0.125	0.0267	0.0070	0.0145
I-135 I	0.594	0.050	0.1231	0.0323	0.0671
I-131 O	0.0316	0.029	0.0065	0.0332	0.2741
I-132 O	0.316	0.290	0.0744	0.3801	3.1384
I-133 O	0.158	0.145	0.0513	0.2619	2.1626
I-134 O	0.790	0.725	0.0111	0.0568	0.4687
I-135 O	0.316	0.290	0.0513	0.2619	2.1626
Cr-51	3 E-3	9 E-4	1 E-3	1 E-4	0
Mn-54	3 E-3	5 E-3	2 E-3	4 E-5	0
Co-58	2 E-3	4 E-4	9 E-5	2 E-5	0
Fe-59	1 E-4	8 E-4	4 E-4	2 E-4	0
Co-60	3 E-2	6 E-3	3 E-3	1 E-5	0
Zn-65	3 E-3	2 E-4	4 E-4	9 E-5	0
Sr-89	1 E-2	3 E-1	*	*	0
Sr-90	2 E-3	4 E-3	*	*	0
Nb-95	3 E-4	2 E-4	9 E-6	8 E-5	0
Sr-95	1 E-4	1 E-4	8 E-6	8 E-5	0
Ru-103	3 E-5	1 E-4	2 E-4	1 E-4	0
Ag-110m	7 E-6	*	*	*	0
Sb-124	3 E-5	3 E-4	6 E-5	8 E-5	0
Cs-134	5 E-3	3 E-4	5 E-4	2 E-5	0
Cs-136	2 E-3	5 E-5	1 E-4	9 E-8	0
Cs-137	7 E-3	4 E-4	2 E-3	7 E-4	0
Ba-140	4 E-3	5 E-4	2 E-2	8 E-3	0
Ce-141	4 E-4	2 E-4	2 E-3	2 E-5	0
Ce-144	5 E-6	*	*	4 E-6	0
Ar-41	25	0	0	0	0
C-14	0	0	0	9.5	0
H-3	0	9.5	0	0	0

*Not available.
I denotes nonorganic iodine (elemental, particulate, HIO)
O-denotes organic iodine.

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TABLE 1.2 - BASIC RADIONUCLIDE DATA

1	TRITIUM	101	4.44E 03	1.74E-09	2	1	5.68E-03	0.0	2.86E-07
2	C-14	604	2.09E 06	3.84E-12	2	1	5.17E-02	0.0	0.0
3	N-13	702	6.94E-03	1.16E-03	2	1	4.91E-01	1.02E 00	1.00E-02
4	O-19	804	3.36E-04	2.34E-02	2	1	1.02E 00	1.05E 00	1.00E-02
5	F-18	907	7.62E-02	1.05E-04	2	1	2.41E-01	9.88E-01	1.00E-04
6	NA-24	1104	6.33E-01	1.27E-05	5	1	5.55E-01	4.12E 00	1.00E-04
7	P-32	1504	1.43E 01	5.61E-07	5	1	6.94E-01	0.0	1.00E-04
8	AR-41	1805	7.63E-02	1.05E-04	2	1	3.63E-01	1.28E 00	0.0
9	CR-51	2405	2.78E 01	2.89E-07	5	1	3.75E-03	3.28E-02	1.00E-04
10	MN-54	2508	3.03E 02	2.65E-08	5	1	4.17E-03	8.36E-01	1.00E-04
11	MN-56	2509	1.07E-01	7.50E-05	5	1	7.97E-01	1.76E 00	1.00E-04
12	FE-59	2604	4.50E 01	1.78E-07	5	1	1.18E-01	1.19E 00	1.00E-04
13	CO-58	2706	7.13E 01	1.12E-07	5	1	2.05E-01	9.76E-01	1.00E-04
14	CO-60	2708	1.92E 03	4.18E-09	5	1	9.66E-02	2.50E 00	1.00E-04
15	ZN-69M	3007	5.75E-01	1.39E-05	5	1	0.0	4.15E 00	1.00E-04
16	ZN-69	3006	3.96E-02	2.03E-04	5	1	3.19E-01	0.0	1.00E-04
17	BR-84	3516	2.21E-02	3.63E-04	2	1	1.26E 00	1.64E 00	1.00E-04
18	BR-85	3518	2.08E-03	3.86E-03	2	2	1.04E 00	8.40E-01	1.00E-04
19	KR-85M	3611	1.83E-01	4.38E-05	1	2	2.53E-01	1.59E-01	1.00E-11
20	KR-85	3610	3.93E 03	2.04E-09	1	1	2.51E-01	2.21E-03	1.00E-11
21	KR-87	3612	5.28E-02	1.52E-04	1	1	1.32E 00	7.93E-01	1.00E-11
22	KR-88	3613	1.17E-01	6.86E-05	1	1	3.75E-01	1.96E 00	1.00E-11
23	KR-89	3614	2.21E-03	3.63E-03	1	1	1.23E 00	2.04E 00	1.00E-11
24	RB-88	3713	1.24E-02	6.47E-04	5	1	2.06E 00	6.88E-01	1.00E-04
25	RB-89	3714	1.07E-02	7.50E-04	5	1	0.0	2.40E 00	1.00E-04
26	SR-89	3808	5.20E 01	1.54E-07	5	1	5.73E-01	1.36E-04	2.67E-07
27	SR-90	3810	1.03E 04	7.79E-10	5	1	1.96E-01	0.0	2.67E-07
28	SR-91	3811	4.03E-01	1.99E-05	5	2	6.50E-01	6.95E-01	2.67E-07
29	SR-92	3812	1.13E-01	7.10E-05	5	1	1.95E-01	1.34E 00	2.67E-07
30	SR-93	3813	5.58E-03	1.44E-03	5	1	1.61E 00	6.28E-01	2.67E-07
31	Y-90	3916	2.67E 00	3.00E-06	5	1	9.36E-01	0.0	1.00E-04
32	Y-91M	3915	3.47E-02	2.31E-04	5	1	0.0	5.56E-01	1.00E-04
33	Y-91	3918	5.88E 01	1.36E-07	5	1	6.04E-01	3.61E-03	1.00E-04
34	Y-92	3920	1.47E-01	5.46E-05	5	1	1.44E 00	2.50E-01	1.00E-04
35	Y-93	3921	4.25E-01	1.87E-05	5	1	1.17E 00	8.94E-02	1.00E-04
36	ZR-95	4014	6.50E 01	1.23E-07	5	2	1.20E-01	7.35E-01	1.00E-04
37	NB-95M	4115	3.75E 00	2.14E-06	5	1	2.85E-01	5.67E-02	1.00E-04
38	NB-95	4114	3.50E 01	2.29E-07	5	1	4.50E-02	7.64E-01	1.00E-04
39	MO-99	4209	2.79E 00	2.87E-06	5	2	3.96E-01	1.62E-01	1.00E-04
40	TC-99M	4314	2.50E-01	3.21E-05	5	1	4.25E-03	1.43E-01	1.00E-04
41	TC-99	4313	7.74E 07	1.04E-13	5	1	8.38E-02	0.0	1.00E-04
42	TC-104	4320	1.25E-02	6.42E-04	5	1	0.0	0.0	1.00E-04
43	RU-106	4407	3.67E 02	2.19E-08	5	1	1.01E-02	0.0	1.00E-04
44	TE-132	5223	3.24E 00	2.48E-06	5	1	1.00E-01	2.05E-01	1.00E-04
45	I-129	5315	6.21E 09	1.29E-15	3	1	4.02E-02	3.77E-03	5.00E-06
46	I-131	5317	8.05E 00	9.96E-07	3	2	1.94E-01	3.81E-01	5.00E-06
47	MI-131	15317	8.05E 00	9.96E-07	4	2	1.94E-01	3.81E-01	5.00E-06
48	I-132	5318	9.58E-02	8.37E-05	3	1	5.14E-01	2.33E 00	5.00E-06
49	MI-132	15318	9.58E-02	8.37E-05	4	1	5.14E-01	2.33E 00	5.00E-06
50	I-133	5319	8.75E-01	9.17E-06	3	2	4.06E-01	6.10E-01	5.00E-06
51	MI-133	15319	8.75E-01	9.17E-06	4	2	4.06E-01	6.10E-01	5.00E-06
52	I-134	5320	3.61E-02	2.22E-04	3	1	6.10E-01	2.59E 00	5.00E-06
53	MI-134	15320	3.61E-02	2.22E-04	4	1	6.10E-01	2.59E 00	5.00E-06
54	I-135	5321	2.79E-01	2.87E-05	3	2	3.68E-01	1.58E 00	5.00E-06
55	MI-135	15321	2.79E-01	2.87E-05	4	2	3.68E-01	1.58E 00	5.00E-06
56	XE-131M	5412	1.18E 01	6.80E-07	1	1	1.43E-01	2.01E-02	1.00E-11
57	XE-133M	5414	2.26E 00	3.55E-06	1	1	1.90E-01	4.16E-02	1.00E-11
58	XE-133	5413	5.27E 00	1.52E-06	1	1	1.35E-01	4.54E-02	1.00E-11
59	XE-135M	5416	1.08E-02	7.43E-04	1	1	9.50E-02	4.32E-01	1.00E-11
60	XE-135	5415	3.82E-01	2.05E-05	1	1	3.17E-01	2.47E-01	1.00E-11
61	XE-137	5417	2.71E-03	2.96E-03	1	1	1.64E 00	1.59E-01	1.00E-11
62	XE-138	5418	1.18E-02	6.80E-04	1	1	6.06E-01	1.18E 00	1.00E-11
63	CS-134	5510	7.48E 02	1.07E-08	5	1	1.57E-01	1.04E 00	1.00E-04
64	CS-135	5512	1.10E 09	7.29E-15	5	1	5.74E-02	0.0	1.00E-04
65	CS-136	5514	1.30E 01	6.17E-07	5	1	1.01E-01	2.20E 00	1.00E-04
66	CS-137	5515	1.10E 04	7.29E-10	5	1	2.52E-01	5.47E-01	1.00E-04
67	CS-138	5516	2.24E-02	3.59E-04	5	1	1.23E 00	2.30E 00	1.00E-04
68	BA-139	5615	5.78E-02	1.39E-04	5	1	6.54E-01	5.05E-02	1.00E-04
69	BA-140	5616	1.28E 01	6.27E-07	5	1	3.15E-01	1.59E-01	1.00E-04
70	LA-140	5715	1.68E 00	4.77E-06	5	1	5.40E-01	2.31E 00	1.00E-04
71	CE-144	5819	2.84E 02	2.82E-08	5	1	4.13E-02	3.24E-02	1.00E-04
72	PR-143	5912	1.36E 01	5.90E-07	5	1	3.14E-01	0.0	1.00E-04
73	PR-144	5913	1.20E-02	6.68E-04	5	1	1.23E 00	3.10E-02	1.00E-04
74	NP-239	9310	2.36E 00	3.41E-06	5	1	[illegible]	[illegible]	[illegible]

Table .3

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

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

BROWNS FERRY NUCLEAR PLANT METEOROLOGICAL FACILITY*

JAN 1, 74 - DEC 31, 75

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

CALM * 0.01

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

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

ALL COLUMNS AND CALM TOTAL 100 PERCENT OF NET VALID READINGS

*METEOROLOGICAL FACILITY LOCATED 0.70 MILES ESE OF BROWNS FERRY NUCLEAR PLANT
TEMPERATURE INSTRUMENTS 33 AND 150 FEET ABOVE GROUND
RADWASTE BUILDING-GROUND LEVEL RELEASE 33 FEET WIND INFORMATION.

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Table 1.3 (Continued)

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

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

BROWNS FERRY NUCLEAR PLANT METEOROLOGICAL FACILITY*

JAN. 1, 74 - DEC 31, 75

WIND DIRECTION	WIND SPEED(MPH) 0.6-1.4	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	0.15	0.11	0.23	0.02	0.0	0.0	0.54
NNE	0.0	0.06	0.12	0.12	0.16	0.01	0.0	0.0	0.47
NE	0.0	0.03	0.07	0.06	0.01	0.0	0.0	0.0	0.17
ENE	0.0	0.02	0.04	0.01	0.01	0.0	0.0	0.0	0.08
E	0.0	0.03	0.02	0.03	0.0	0.0	0.0	0.0	0.08
ESE	0.0	0.07	0.06	0.04	0.01	0.0	0.0	0.0	0.18
SE	0.0	0.35	0.53	0.08	0.04	0.0	0.0	0.0	1.00
SSE	0.01	0.26	0.23	0.02	0.01	0.0	0.0	0.0	0.53
S	0.0	0.13	0.31	0.05	0.01	0.0	0.0	0.0	0.50
SSW	0.0	0.04	0.07	0.03	0.0	0.0	0.0	0.0	0.14
SW	0.0	0.07	0.11	0.01	0.01	0.0	0.0	0.0	0.20
WSW	0.0	0.04	0.24	0.07	0.09	0.01	0.0	0.0	0.45
W	0.0	0.01	0.12	0.12	0.09	0.02	0.01	0.0	0.37
WNW	0.0	0.02	0.13	0.20	0.33	0.09	0.02	0.0	0.77
NW	0.0	0.01	0.11	0.15	0.40	0.10	0.01	0.0	0.78
NNW	0.0	0.01	0.03	0.12	0.34	0.11	0.01	0.0	0.62
SUBTOTAL	0.01	1.18	2.34	1.22	1.74	0.36	0.05	0.0	6.90

CALM = 0.0

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

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

ALL COLUMNS AND CALM TOTAL 100 PERCENT OF NET VALID READINGS

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

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Table 1.3 (Continued)

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

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

BROWNS FERRY NUCLEAR PLANT METEOROLOGICAL FACILITY*

JAN 1, 74 - DEC 31, 75

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

CALM = 0.0

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

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

ALL COLUMNS AND CALM TOTAL 100 PERCENT OF NET VALID READINGS

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

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

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

BROWNS FERRY NUCLEAR PLANT METEOROLOGICAL FACILITY*

JAN 1, 74 - DEC 31, 75

WIND DIRECTION	WIND SPEED(MPH) 0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	>=24.5	TOTAL
N	0.04	0.31	0.41	0.53	0.09	0.12	0.0	0.0	2.30
NNE	0.01	0.42	0.48	0.38	0.35	0.02	0.0	0.0	1.66
NE	0.01	0.40	0.30	0.12	0.06	0.01	0.0	0.0	0.90
ENE	0.02	0.36	0.22	0.02	0.03	0.0	0.0	0.0	0.65
E	0.02	0.23	0.22	0.04	0.02	0.0	0.0	0.0	0.53
ESE	0.01	0.51	0.74	0.36	0.28	0.0	0.0	0.0	1.90
SE	0.05	1.44	1.45	0.58	0.15	0.03	0.0	0.0	3.70
SSE	0.01	0.97	0.54	0.13	0.04	0.0	0.0	0.0	1.69
S	0.01	1.06	0.75	0.18	0.02	0.0	0.0	0.0	2.02
SSW	0.01	0.33	0.23	0.07	0.01	0.0	0.0	0.0	0.65
SW	0.02	0.33	0.23	0.03	0.01	0.0	0.0	0.0	0.62
WSW	0.01	0.54	0.64	0.27	0.23	0.12	0.0	0.0	1.81
W	0.0	0.35	0.88	0.56	0.57	0.15	0.0	0.0	2.51
WNW	0.0	0.18	0.42	0.42	0.62	0.36	0.05	0.01	2.06
NW	0.01	0.10	0.24	0.40	0.85	0.40	0.03	0.01	2.04
NNW	0.01	0.26	0.36	0.36	1.26	0.50	0.01	0.0	2.76
SUBTOTAL	0.24	7.79	8.11	4.45	5.59	1.71	0.09	0.02	20.00

CALM = 0.01

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

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

ALL COLUMNS AND CALM TOTAL 100 PERCENT OF NET VALID READINGS

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

Table 1.3 (Continued)

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

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

BROWNS FERRY NUCLEAR PLANT METEOROLOGICAL FACILITY*

JAN 1, 74 - DEC 31, 75

WIND DIRECTION	WIND SPEED(MPH) 0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	>=24.5	TOTAL
N	0.06	0.55	0.52	0.37	0.26	0.01	0.0	0.0	1.77
NNE	0.10	0.77	0.50	0.26	0.13	0.01	0.0	0.0	1.77
NE	0.07	0.47	0.45	0.10	0.05	0.0	0.0	0.0	1.14
ENE	0.10	0.58	0.15	0.02	0.0	0.0	0.0	0.0	0.85
E	0.03	0.74	0.44	0.08	0.02	0.0	0.0	0.0	1.31
ESE	0.04	0.97	1.09	0.48	0.17	0.0	0.0	0.0	2.75
SE	0.23	2.31	1.87	1.01	0.53	0.0	0.0	0.0	5.95
SSE	0.22	1.09	0.56	0.21	0.09	0.0	0.0	0.0	2.16
S	0.14	0.94	0.84	0.63	0.23	0.0	0.0	0.0	2.78
SSW	0.17	0.59	0.28	0.18	0.08	0.01	0.0	0.0	1.30
SW	0.10	0.45	0.12	0.04	0.01	0.0	0.0	0.0	0.72
WSW	0.04	0.56	0.34	0.12	0.11	0.02	0.0	0.0	1.19
W	0.02	0.56	0.65	0.25	0.15	0.04	0.0	0.0	1.67
WNW	0.04	0.15	0.16	0.13	0.13	0.06	0.0	0.0	0.67
NW	0.05	0.15	0.21	0.09	0.26	0.09	0.0	0.0	0.85
NNW	0.08	0.50	0.56	0.39	0.31	0.04	0.0	0.0	1.88
SUBTOTAL	1.49	11.36	8.74	4.36	2.53	0.28	0.0	0.0	28.76

CALM = 0.06

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

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

ALL COLUMNS AND CALM TOTAL 100 PERCENT OF NET VALID READINGS

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

JAN 4 1983

Table 1.3 ([illegible]tinued)

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

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

BROWNS FERRY NUCLEAR PLANT METEOROLOGICAL FACILITY*

JAN 1, 74 - DEC 31, 75

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

CALM = 0.07

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

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

ALL COLUMNS AND CALM TOTAL 100 PERCENT OF NET VALID READINGS

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

Table 1.3 (Continued)

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

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

BROWNS FERRY NUCLEAR PLANT METEOROLOGICAL FACILITY*

JAN 1, 74 - DEC 31, 75

WIND DIRECTION	WIND SPEED(MPH) 0.6-1.4	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	0.29	0.93	0.17	0.04	0.0	0.0	0.0	0.0	1.41
NNE	0.20	1.28	0.10	0.02	0.0	0.0	0.0	0.0	1.60
NE	0.14	0.44	0.02	0.0	0.0	0.0	0.0	0.0	0.60
ENE	0.07	0.52	0.02	0.0	0.0	0.0	0.0	0.0	0.61
E	0.07	0.66	0.15	0.0	0.0	0.0	0.0	0.0	0.88
ESE	0.04	0.35	0.01	0.0	0.0	0.0	0.0	0.0	0.40
SE	0.15	0.74	0.09	0.03	0.01	0.0	0.0	0.0	1.02
SSE	0.19	0.61	0.13	0.04	0.02	0.0	0.0	0.0	0.99
S	0.14	0.54	0.14	0.06	0.0	0.0	0.0	0.0	0.88
SSW	0.07	0.06	0.0	0.0	0.0	0.0	0.0	0.0	0.13
SW	0.06	0.05	0.0	0.0	0.0	0.0	0.0	0.0	0.11
WSW	0.04	0.04	0.0	0.0	0.0	0.0	0.0	0.0	0.08
W	0.01	0.04	0.01	0.0	0.0	0.0	0.0	0.0	0.06
WNW	0.07	0.06	0.01	0.0	0.0	0.0	0.0	0.0	0.14
NW	0.07	0.09	0.01	0.0	0.0	0.0	0.0	0.0	0.17
NNW	0.18	0.36	0.10	0.04	0.0	0.0	0.0	0.0	0.68
SUBTOTAL	1.81	6.77	0.96	0.23	0.03	0.0	0.0	0.0	9.00

CALM = 0.09

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

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

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

*METEOROLOGICAL FACILITY LOCATED 0.70 MILES ESE OF BROWNS FERRY NUCLEAR PLANT
TEMPERATURE INSTRUMENTS 33 AND 150 FEET ABOVE GROUND
RADWASTE BUILDING-GROUND LEVEL RELEASE 33 FEET WIND INFORMATION.

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Table 1.3 (Continued)

PERCENT OCCURRENCE OF WIND SPEED
FOR ALL WIND DIRECTIONS

BROWNS FERRY NUCLEAR PLANT METEOROLOGICAL FACILITY*

JAN 1, 74 - DEC 31, 75

WIND DIRECTION	WIND SPEED (MPH) 0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	>24.5	TOTAL
N	0.02	0.23	0.29	0.46	1.71	1.96	0.51	0.02	5.20
NNE	0.03	0.24	0.38	0.55	2.04	2.36	0.60	0.07	6.30
NE	0.01	0.15	0.40	0.49	1.80	1.83	0.50	0.03	5.21
ENE	0.03	0.14	0.36	0.46	1.25	0.85	0.21	0.01	3.32
E	0.01	0.23	0.49	0.51	1.07	0.37	0.04	0.0	2.67
ESE	0.03	0.34	0.53	0.58	1.62	1.17	0.29	0.05	4.56
SE	0.04	0.56	1.19	1.53	3.63	2.74	1.39	0.56	11.64
SSE	0.08	0.64	0.99	1.22	3.11	2.66	1.24	0.67	10.61
S	0.03	0.48	0.83	1.04	2.74	2.49	1.08	0.74	9.43
SSW	0.03	0.40	0.63	0.56	2.17	2.71	1.42	0.50	8.42
SW	0.04	0.49	0.63	0.67	1.77	1.88	0.67	0.20	6.35
WSW	0.02	0.37	0.90	0.66	1.20	0.87	0.27	0.23	4.52
W	0.03	0.27	0.77	0.74	1.36	0.84	0.43	0.28	4.72
WNW	0.03	0.18	0.42	0.89	1.39	0.90	0.42	0.26	4.49
NW	0.02	0.31	0.70	0.84	2.08	1.50	0.85	0.27	6.57
NNW	0.03	0.23	0.47	0.53	1.54	2.27	0.71	0.09	5.87
SUBTOTAL	0.48	5.27	9.98	11.54	30.45	27.55	10.63	3.98	99.88

CALM = 0.11

6850 VALID WIND DIRECTION - WIND SPEED READINGS OUT OF 17520 TOTAL HOURS = 96.10 PERCENT

ALL COLUMNS AND CALM TOTAL 100 PERCENT OF NET VALID READINGS

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

JAN 4 1983

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TABLE 1.4

BROWNS FERRY NUCLEAR PLANT LAND SITE BOUNDARY DATA

Sector	Distance (m)	Elevated χ/Q[1]	Elevated D/Q[2]	Ground χ/Q[1]	Ground D/Q[2]
N	1,550	1.88(-10)[3]	9.55(-10)	2.26(-6)	5.66(-9)
NNE	1,400	4.06(-11)	7.71(-10)	1.02(-6)	2.05(-9)
NE	1,370	3.51(-11)	5.72(-10)	7.93(-7)	1.65(-9)
ENE	1,400	1.65(-11)	4.14(-10)	9.34(-7)	3.18(-9)
E	1,570	6.03(-11)	4.73(-10)	8.04(-7)	3.34(-9)
ESE	1,470	2.79(-11)	4.27(-10)	6.81(-7)	3.39(-9)
SE	5,460	9.33(-9)	3.18(-10)	1.11(-7)	3.83(-10)
SSE	2,740	1.82(-9)	5.99(-10)	7.03(-7)	1.90(-9)
S	2,380	8.43(-10)	5.47(-10)	1.19(-6)	2.51(-9)
SSW	2,410	1.03(-9)	6.61(-10)	1.32(-6)	2.40(-9)
SW	2,160	4.93(-10)	5.60(-10)	8.50(-7)	1.45(-9)
WSW	3,120	1.87(-9)	3.16(-10)	4.90(-7)	6.11(-10)
W	2,350	5.23(-10)	2.82(-10)	8.83(-7)	1.37(-9)
WNW	3,120	2.66(-9)	4.34(-10)	6.16(-7)	1.38(-9)
NW	3,440	7.97(-9)	9.76(-10)	1.29(-6)	2.84(-9)
NNW	1,620	1.73(-10)	1.09(-9)	2.20(-6)	4.84(-9)

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

Table 1.4A
Real Receptor Locations

Sector	Nearest Resident(m)	Home-Use Garden(m)[a]	Milch Animal(m)
N	1740	1740	7500
NNE	2960	2960	-
NE	3140	3140	10000
ENE	1920	1920	9688
E	4390	4390	-
ESE	4570	4570	-
SE	8050	8050	-
SSE	7130	7130	-
S	4330	4330	-
SSW	4050	4050	8001
SW	4880	4880	-
WSW	4050	4050	-
W	2440	2440	-
WNW	4180	4180	-
NW	3124	3581	-
NNW	1620	1620	11250

a. Home-use gardens are assumed to exist at nearest resident locations.

Table 1.5

Dose Factors for Submersion in Noble Gases

	DFB[a]	DFγ[b]	DFS[a]	DFβ[b]
Kr-85m	1.17(+3)[c]	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)	4.14(+3)	9.25(+3)
Ar-41	8.84(+3)	9.76(+3)	2.69(+3)	5.54(+3)

a. mrem/yr per $\mu Ci/m^3$.

b. mrad/yr per $\mu Ci/m^3$.

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

Table 1.6

Radionuclide Transfer Data

ID NUMBER		HALF-LIFE	RETENTION	B_{iv} (veg/soil)	FM_i (d/1)
TRITIUM	101	4.49E+03	4.70E-01	4.90E+00	1.30E-02
C-14	604	2.09E+06	4.70E-01	5.50E+00	1.20E-02
N-13	702	6.94E-03	4.70E-01	7.50E+00	2.20E-02
O-19	804	3.34E-04	4.70E-01	1.60E+00	2.00E-02
F-18	902	7.62E-02	4.70E-01	6.50E-04	1.40E-02
NA-24	1104	6.33E-01	4.70E-01	5.20E-02	4.00E-02
P-32	1504	1.43E+01	4.70E-01	1.10E+00	2.50E-02
AR-41	1805	7.63E-02	4.70E-01	6.00E-01	2.00E-02
CR-51	2405	2.78E+01	4.70E-01	2.50E-04	2.20E-03
MN-54	2506	3.03E+02	4.70E-01	2.90E-02	2.50E-04
MN-56	2509	1.07E-01	4.70E-01	2.90E-02	2.50E-04
FE-59	2604	4.50E+01	4.70E-01	6.60E-04	1.20E-03
CO-58	2706	7.13E+01	4.70E-01	9.40E-03	1.00E-03
CO-60	2708	1.92E+03	4.70E-01	9.40E-03	1.00E-03
ZN-69M	3007	5.75E-01	4.70E-01	4.00E-01	3.90E-02
ZN-69	3005	3.96E-02	4.70E-01	4.00E-01	3.90E-02
BR-84	3516	2.21E-02	4.70E-01	7.60E-01	5.00E-02
BR-85	3519	2.03E-03	4.70E-01	7.60E-01	5.00E-02
KR-85M	3611	1.83E-01	4.70E-01	3.00E+00	2.00E-02
KR-85	3610	3.93E+03	4.70E-01	3.00E+00	2.00E-02
KR-87	3612	5.28E-02	4.70E-01	3.00E+00	2.00E-02
KR-88	3613	1.17E-01	4.70E-01	3.00E+00	2.00E-02
KR-89	3614	2.21E-03	4.70E-01	3.00E+00	2.00E-02
RB-88	3713	1.24E-02	4.70E-01	1.30E-01	3.00E-02
RB-89	3714	1.07E-02	4.70E-01	1.30E-01	3.00E-02
SR-89	3809	5.20E+01	4.70E-01	1.70E-02	1.40E-03
SR-90	3810	1.03E+04	4.70E-01	1.70E-02	1.40E-03
SR-91	3811	4.03E-01	4.70E-01	1.70E-02	1.40E-03
SR-92	3812	1.13E-01	4.70E-01	1.70E-02	1.40E-03
SR-93	3813	5.56E-03	4.70E-01	1.70E-02	1.40E-03
Y-90	3916	2.67E+00	4.70E-01	2.60E-03	1.00E-05
Y-91M	3919	3.47E-02	4.70E-01	2.60E-03	1.00E-05
Y-91	3918	5.88E+01	4.70E-01	2.60E-03	1.00E-05
Y-92	3920	1.47E-01	4.70E-01	2.60E-03	1.00E-05
Y-93	3921	4.29E-01	4.70E-01	2.60E-03	1.00E-05
ZR-95	4014	6.50E+01	4.70E-01	1.70E-04	5.00E-06
NB-95M	4115	3.75E+00	4.70E-01	9.40E-03	2.50E-03
NB-95	4114	3.50E+01	4.70E-01	9.40E-03	2.50E-03
MO-99	4209	2.79E+00	4.70E-01	1.20E-01	7.50E-03
TC-99M	4314	2.50E-01	4.70E-01	2.50E-01	2.50E-02
TC-99	4313	7.74E+07	4.70E-01	2.50E-01	2.50E-02
TC-104	4320	1.25E-02	4.70E-01	2.50E-01	2.50E-02
RU-106	4407	3.67E+02	4.70E-01	5.00E-02	1.00E-06
TE-132	5223	3.24E+00	4.70E-01	1.30E+00	1.00E-03
I-129	5315	6.21E+09	4.70E-01	2.00E-02	1.20E-02
I-131	5317	8.05E+00	4.70E-01	2.00E-02	1.20E-02
MI-131	15317	8.05E+00	4.70E-01	2.00E-02	1.20E-02
I-132	5318	9.58E-02	4.70E-01	2.00E-02	1.20E-02
MI-132	15318	9.58E-02	4.70E-01	2.00E-02	1.20E-02
I-133	5319	8.75E-01	4.70E-01	2.00E-02	1.20E-02
MI-133	15319	8.75E-01	4.70E-01	2.00E-02	1.20E-02
I-134	5320	3.61E-02	4.70E-01	2.00E-02	1.20E-02
MI-134	15320	3.61E-02	4.70E-01	2.00E-02	1.20E-02
I-135	5321	2.79E-01	4.70E-01	2.00E-02	1.20E-02
MI-135	15321	2.79E-01	4.70E-01	2.00E-02	1.20E-02
XE-131M	5412	1.19E+01	4.70E-01	1.00E+01	2.00E-02
XE-133M	5414	2.26E+00	4.70E-01	1.00E+01	2.00E-02
XE-133	5413	5.27E+00	4.70E-01	1.00E+01	2.00E-02
XE-135M	5416	1.08E-02	4.70E-01	1.00E+01	2.00E-02
XE-135	5415	3.83E-01	4.70E-01	1.00E+01	2.00E-02
XE-137	5417	2.71E-03	4.70E-01	1.00E+01	2.00E-02
XE-138	5418	1.19E-02	4.70E-01	1.00E+01	2.00E-02
CS-134	5510	7.48E+02	4.70E-01	1.00E-02	8.00E-03
CS-135	5512	1.10E+09	4.70E-01	1.00E-02	8.00E-03
CS-136	5514	1.30E+01	4.70E-01	1.00E-02	8.00E-03
CS-137	5515	1.10E+04	4.70E-01	1.00E-02	8.00E-03
CS-138	5516	2.24E-02	4.70E-01	1.00E-02	8.00E-03
BA-139	5615	5.76E-02	4.70E-01	5.00E-03	4.00E-04
BA-140	5616	1.28E+01	4.70E-01	5.00E-03	4.00E-04
LA-140	5715	1.68E+00	4.70E-01	2.50E-03	5.00E-06
CE-144	5815	2.84E+02	4.70E-01	2.50E-03	1.00E-04
PR-143	5912	1.36E+01	4.70E-01	2.50E-03	5.00E-06
PR-144	5913	1.20E-02	4.70E-01	2.50E-03	5.00E-06
NP-239	9310	2.35E+00	4.70E-01	2.50E-03	5.00E-06

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Table 1.7

EXTERNAL DOSE FACTORS FOR STANDING ON CONTAMINATED GROUND

(mrem/h per pCi/m^2)

Element	DFG_i Total Body
H-3	0.0
C-14	0.0
NA-24	2.50E-08
P-32	0.0
Cr-51	2.20E-10
Mn-54	5.80E-09
Mn-56	1.10E-08
Fe-55	0.0
Fe-59	8.00E-09
Co-58	7.00E-09
Co-60	1.70E-08
Ni-63	0.0
Ni-65	3.70E-09
Cu-64	1.50E-09
Zn-65	4.00E-09
Zn-69	0.0
Br-83	6.40E-11
Br-84	1.20E-08
Br-85	0.0
Rb-86	6.30E-10
Rb-88	3.50E-09
Rb-89	1.50E-08
Sr-89	5.60E-13
Sr-91	7.10E-09
Sr-92	9.00E-09
Y-90	2.20E-12
Y-91M	3.80E-09
Y-91	2.40E-11
Y-92	1.60E-09
Y-93	5.70E-10
Zr-95	5.00E-09
Zr-97	5.50E-09
Nb-95	5.10E-09
Mo-99	1.90E-09
Tc-99M	9.60E-10
Tc-101	2.70E-09
Ru-103	3.60E-09
Ru-105	4.50E-09
Ru-106	1.50E-09
Ag-110M	1.80E-08
Te-125M	3.50E-11
Te-127M	1.10E-12
Te-127	1.00E-11
Te-129M	7.70E-10
Te-129	7.10E-10
Te-131M	8.40E-09
Te-131	2.20E-09
Te-132	1.70E-09
I-130	1.40E-08
I-131	2.80E-09
I-132	1.70E-08
I-133	3.70E-09
I-134	1.60E-08
I-135	1.20E-08
Cs-134	1.20E-08
Cs-136	1.50E-08
Cs-137	4.20E-09
Cs-138	2.10E-08
Ba-139	2.40E-09
Ba-140	2.10E-09
Ba-141	4.30E-09
Ba-142	7.90E-09
La-140	1.50E-08
La-142	1.50E-08
Ce-141	5.50E-10
Ce-143	2.20E-09
Ce-144	3.70E-10
Pr-143	0.0
Pr-144	2.00E-10
Nd-147	1.00E-09
W-187	3.10E-09
Np-239	9.50E-10

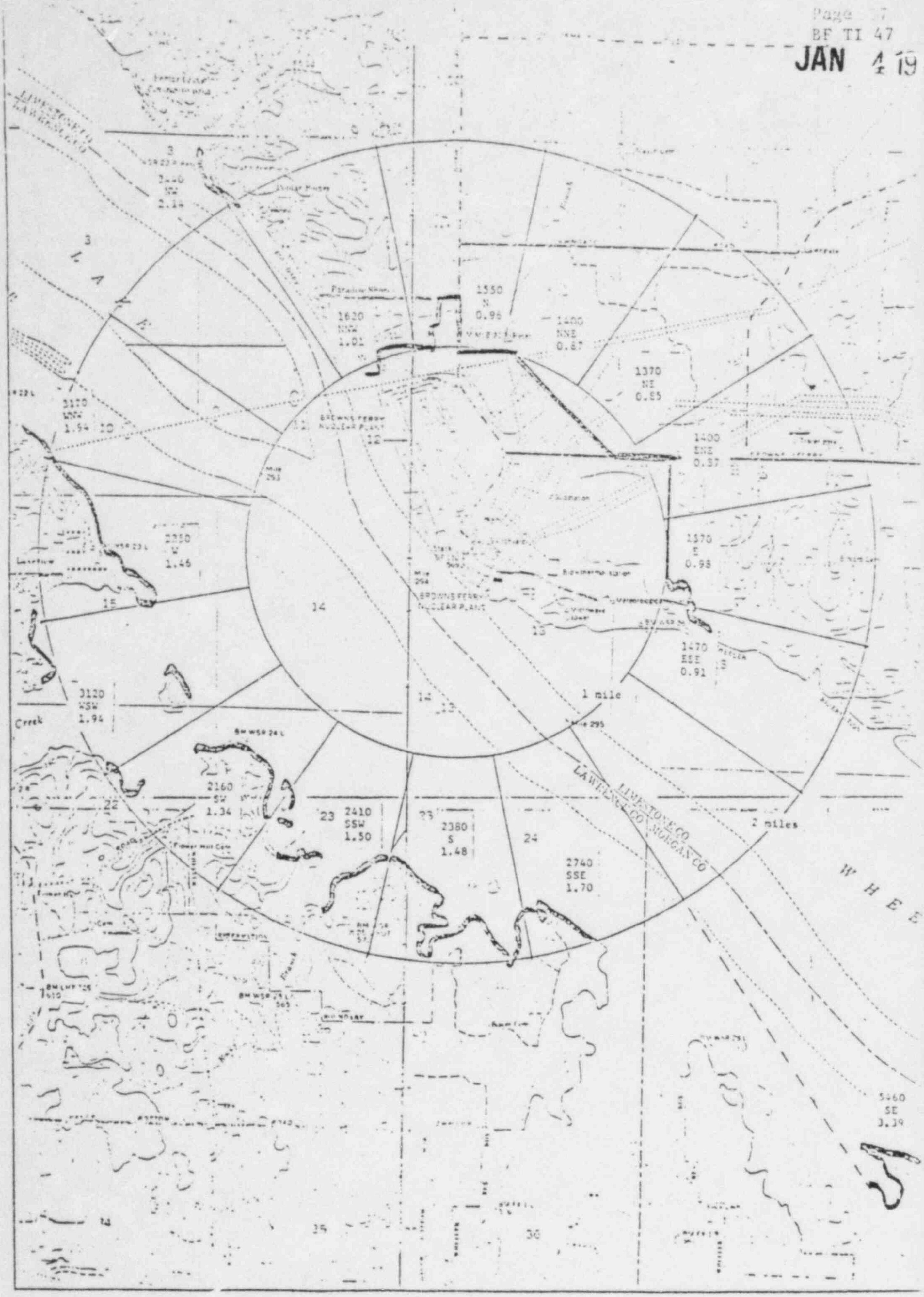

Figure 1.1
BFN - Land Site Boundary Locations

BFNP OFF GAS SYSTEM & SGTS EFFLUENT MONITORING

(TYPICAL UNIT & COMMON SGTS)

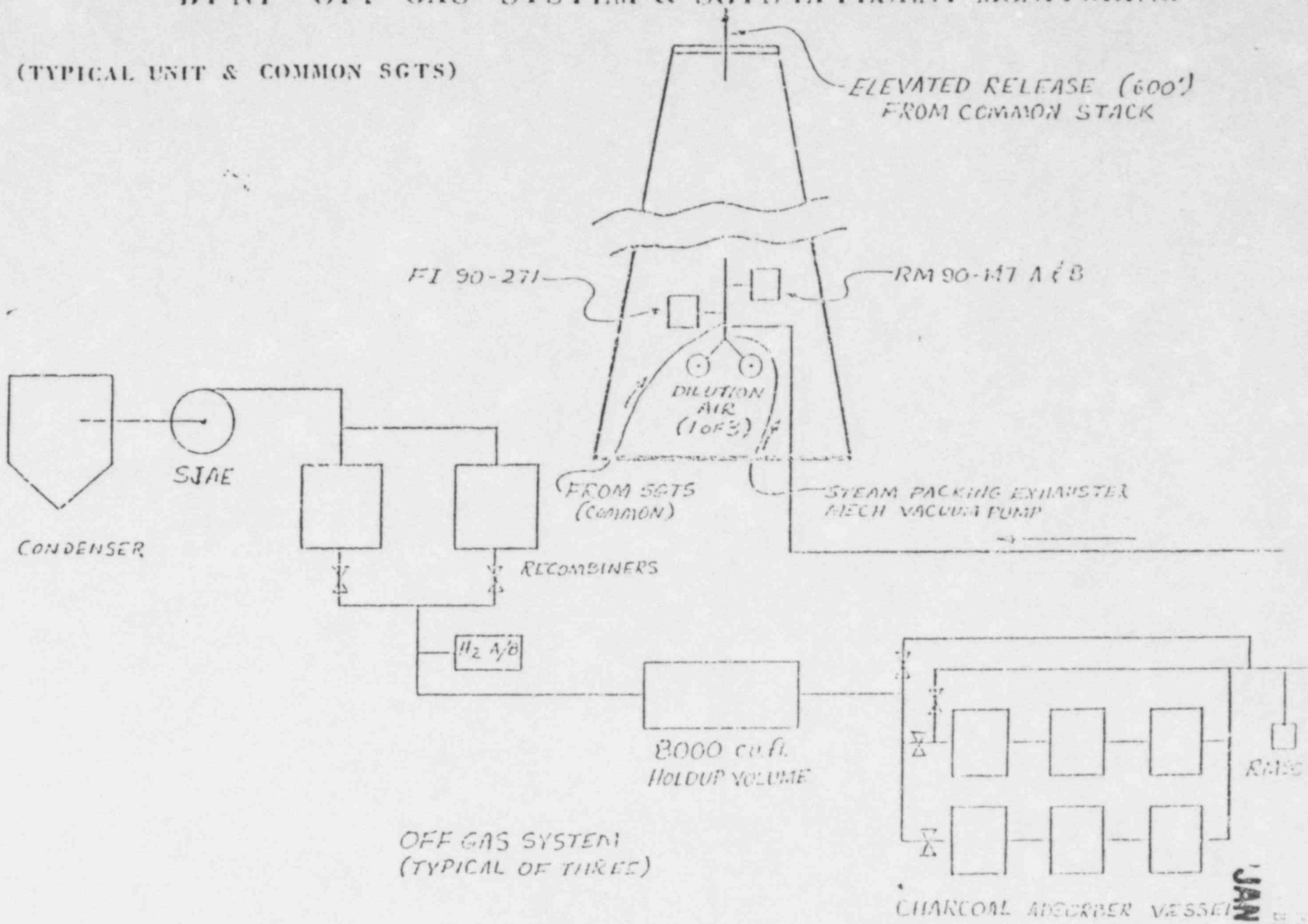

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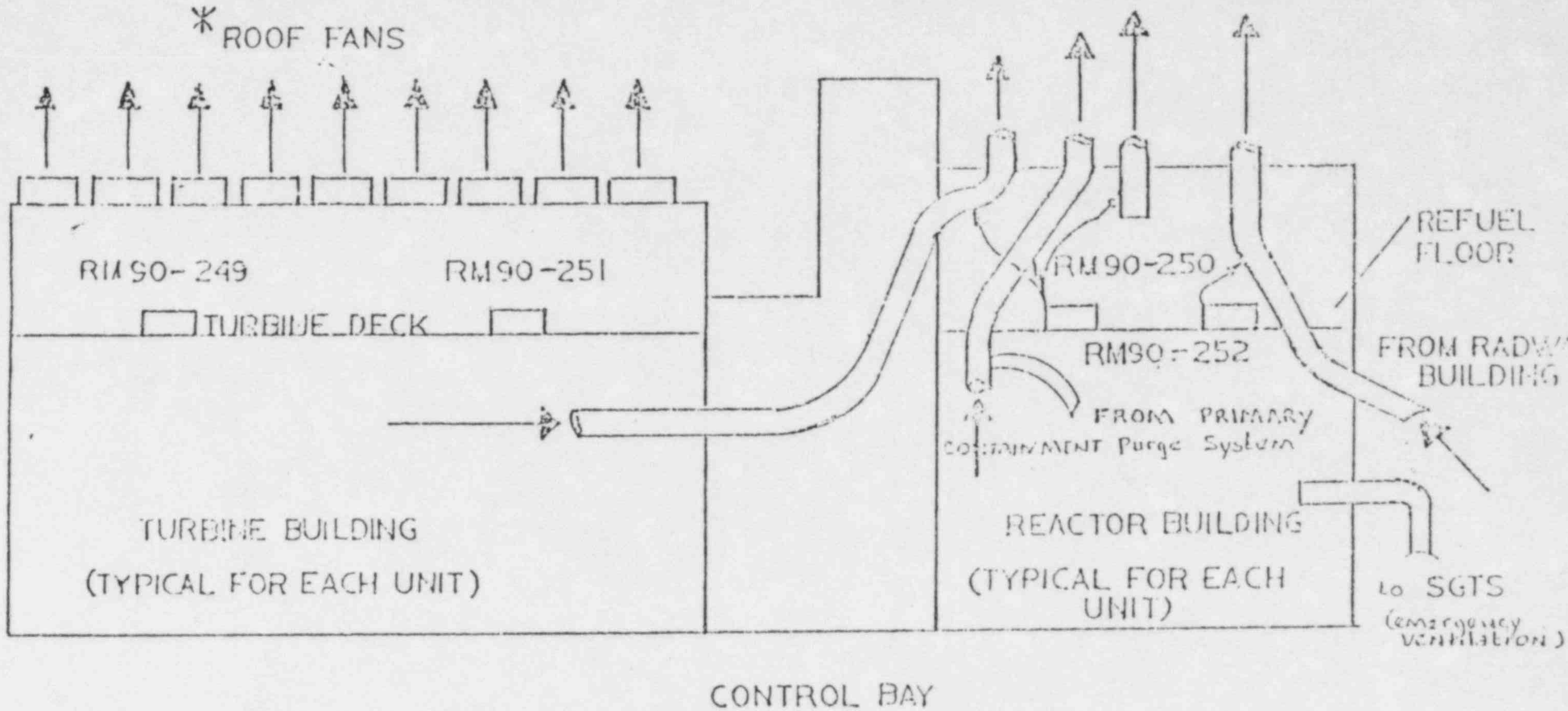
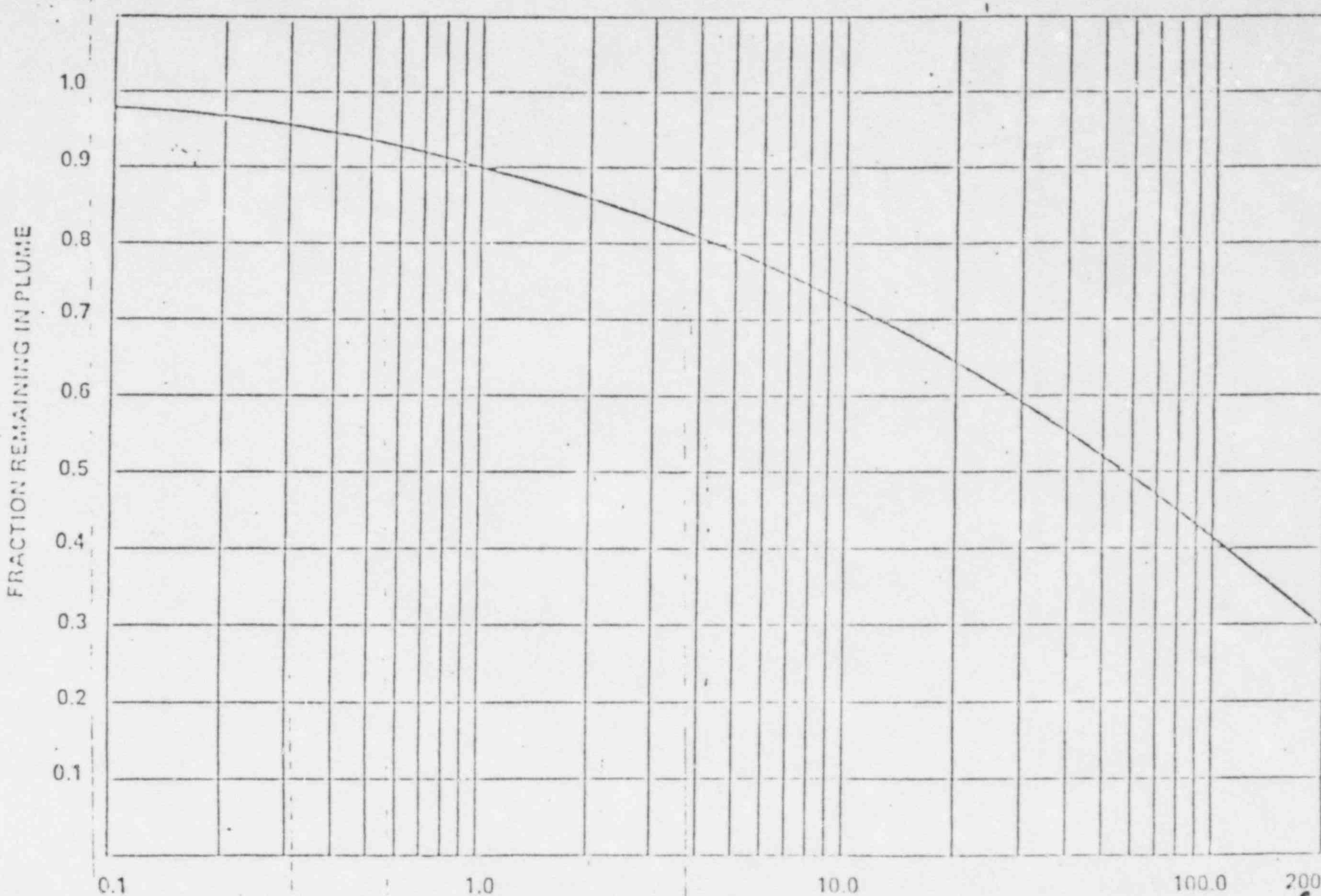
Figure 1.3

BFNP NORMAL BUILDING VENTILATION



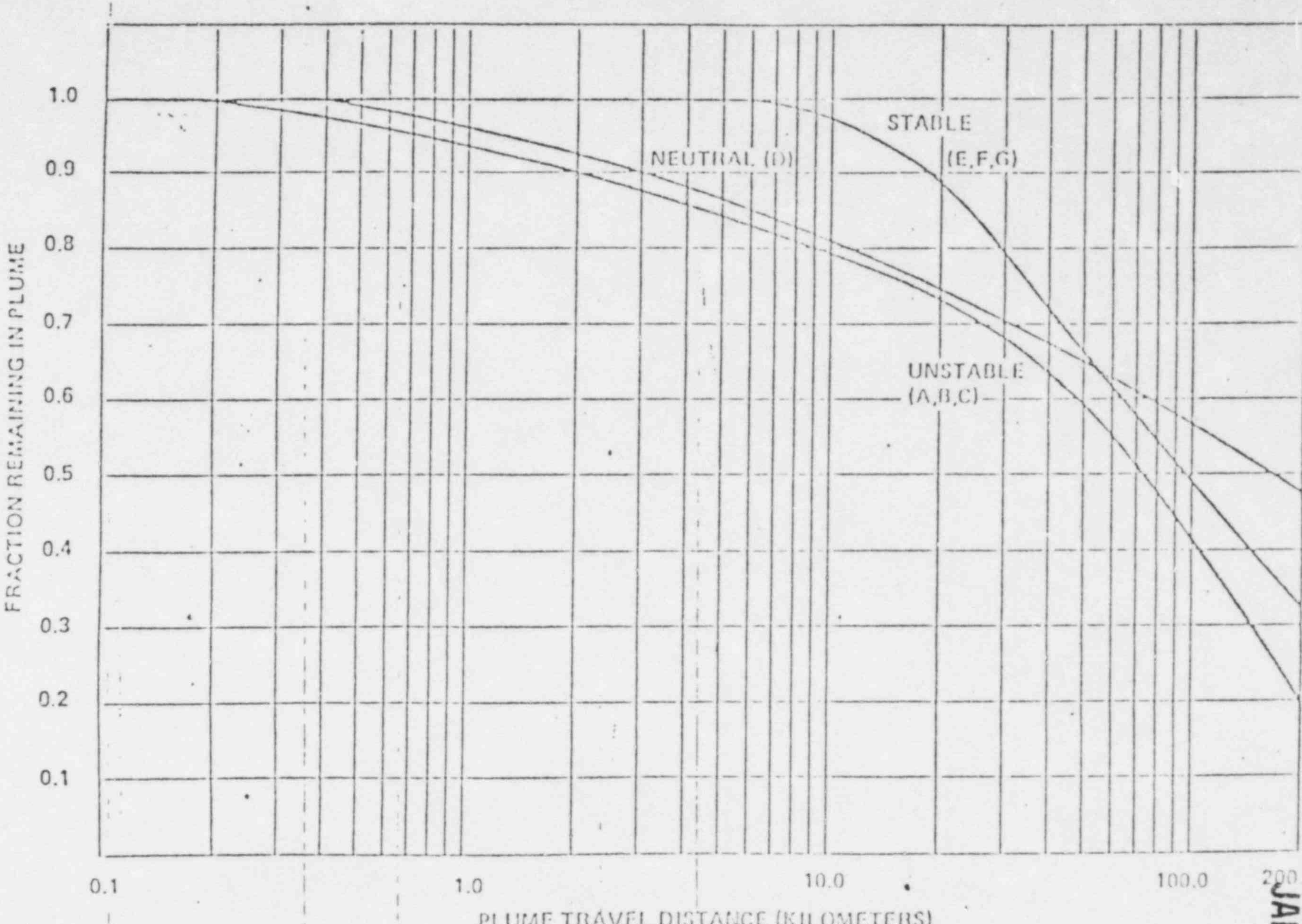
*ROOF FANS USED SEASONALLY TO CONTROL TEMPERATURE

FIGURE 1.4



Plume Depletion Effect for Ground Level Releases (All Atmospheric Stability Classes) (From Regulatory Guide 1.111, Revision 1, July 1977)

FIGURE 1.4 (CONTINUED)



Plume Depletion Effect for 30m Releases (Letters denote Pasquill Stability Class) (From Regulatory Guide 1.111, Revision 1,

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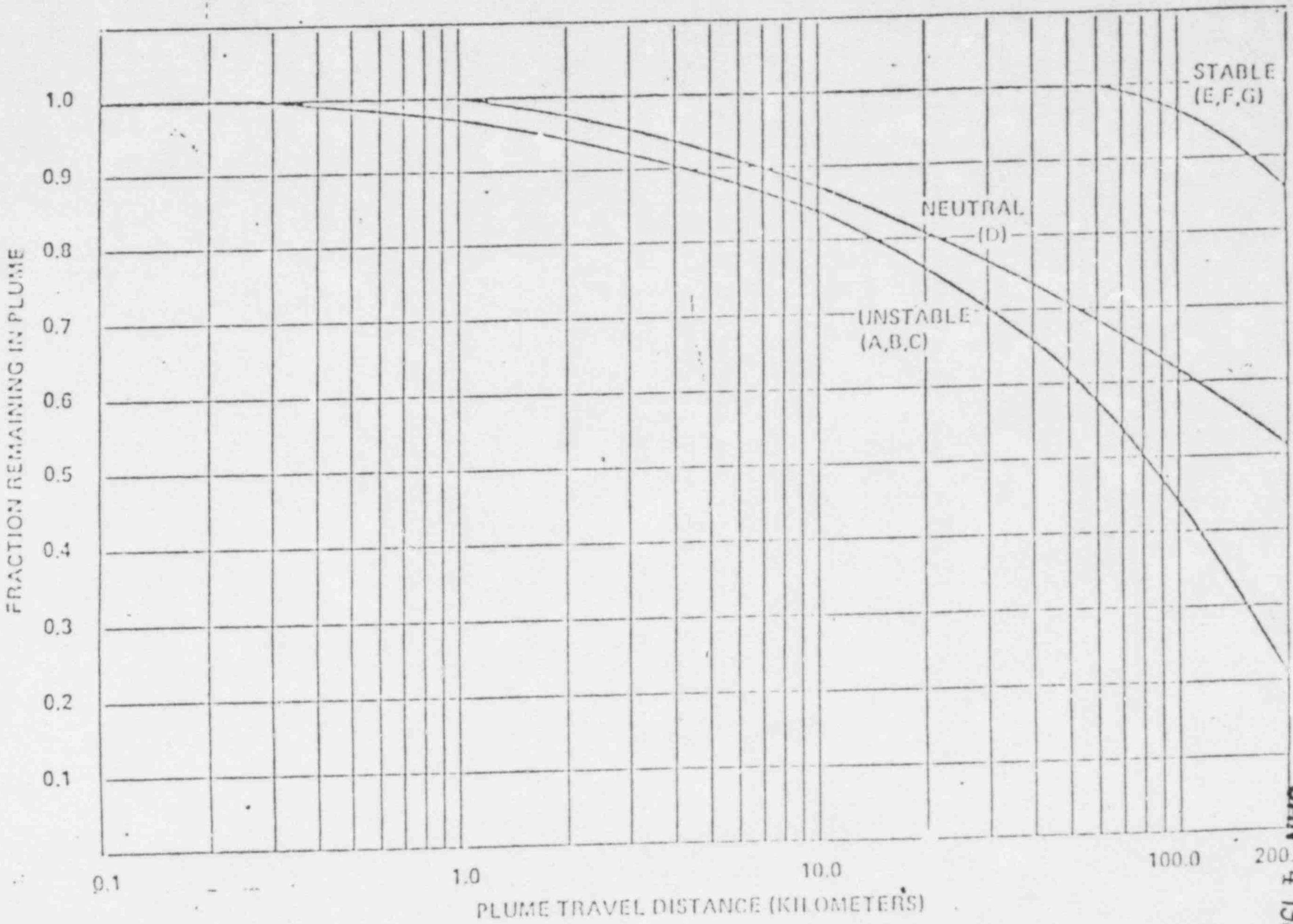
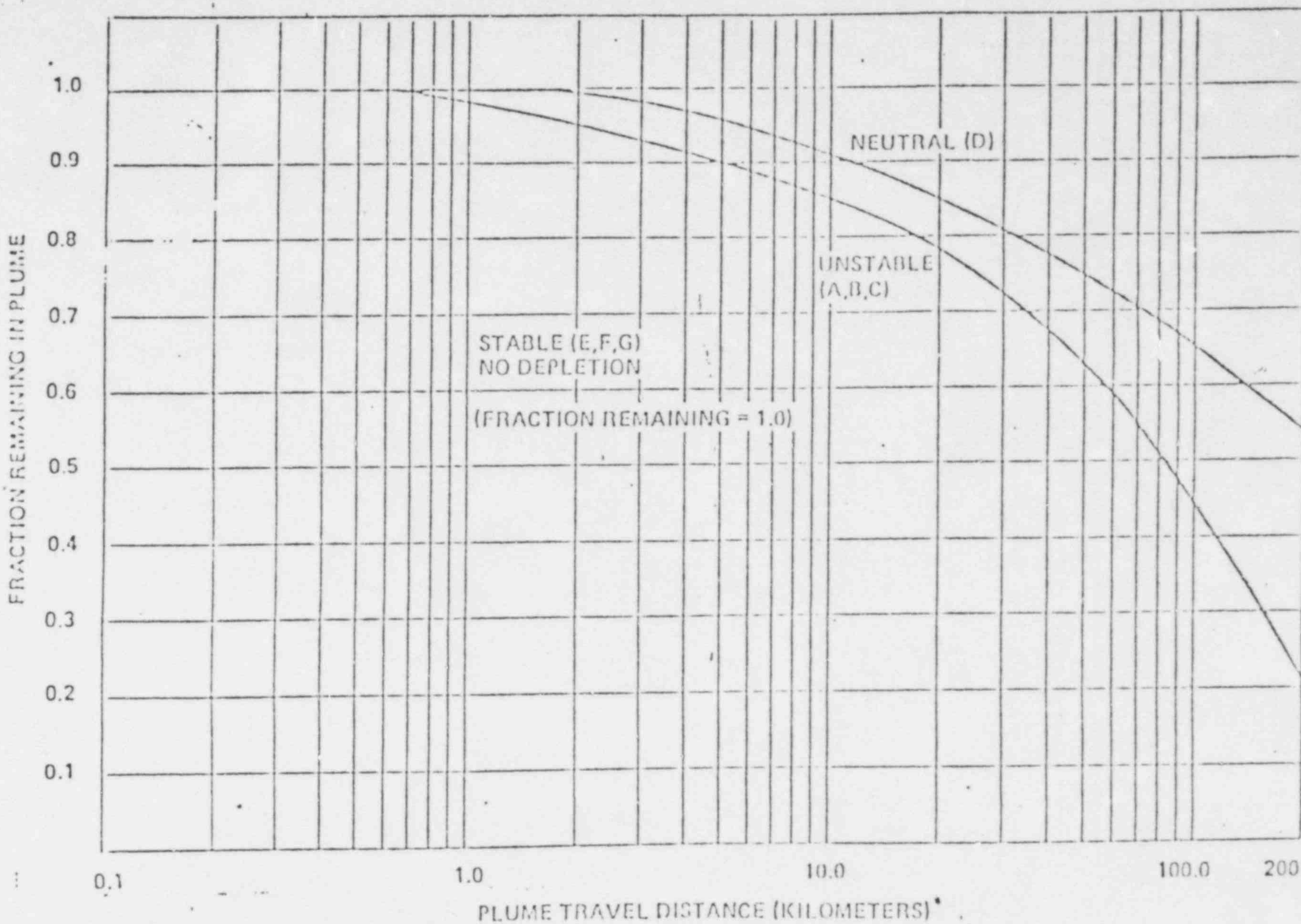
FIGURE 1.4 (CONTINUED)



Plume Depletion Effect for 60m Releases (Letters denote Pasquill Stability Class) (From Regulatory Guide 1.111,

JAN 4 1983

FIGURE 1.4 (CONTINUED)



Plume Depletion Effect for 100m Releases (Letters denote Pasquill Stability Class)
(From Regulatory Guide 1.111, Revision 1, July 1977)

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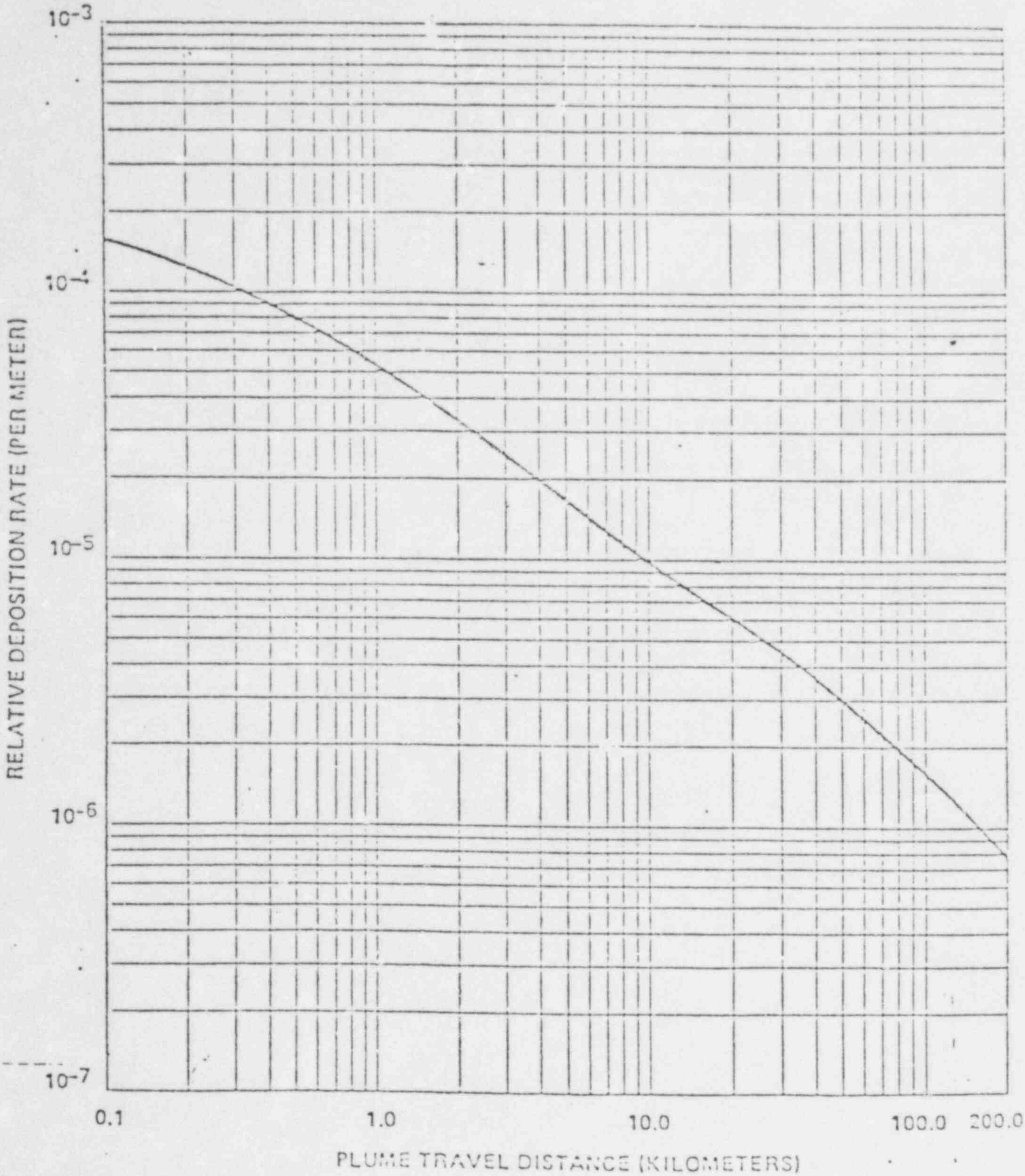
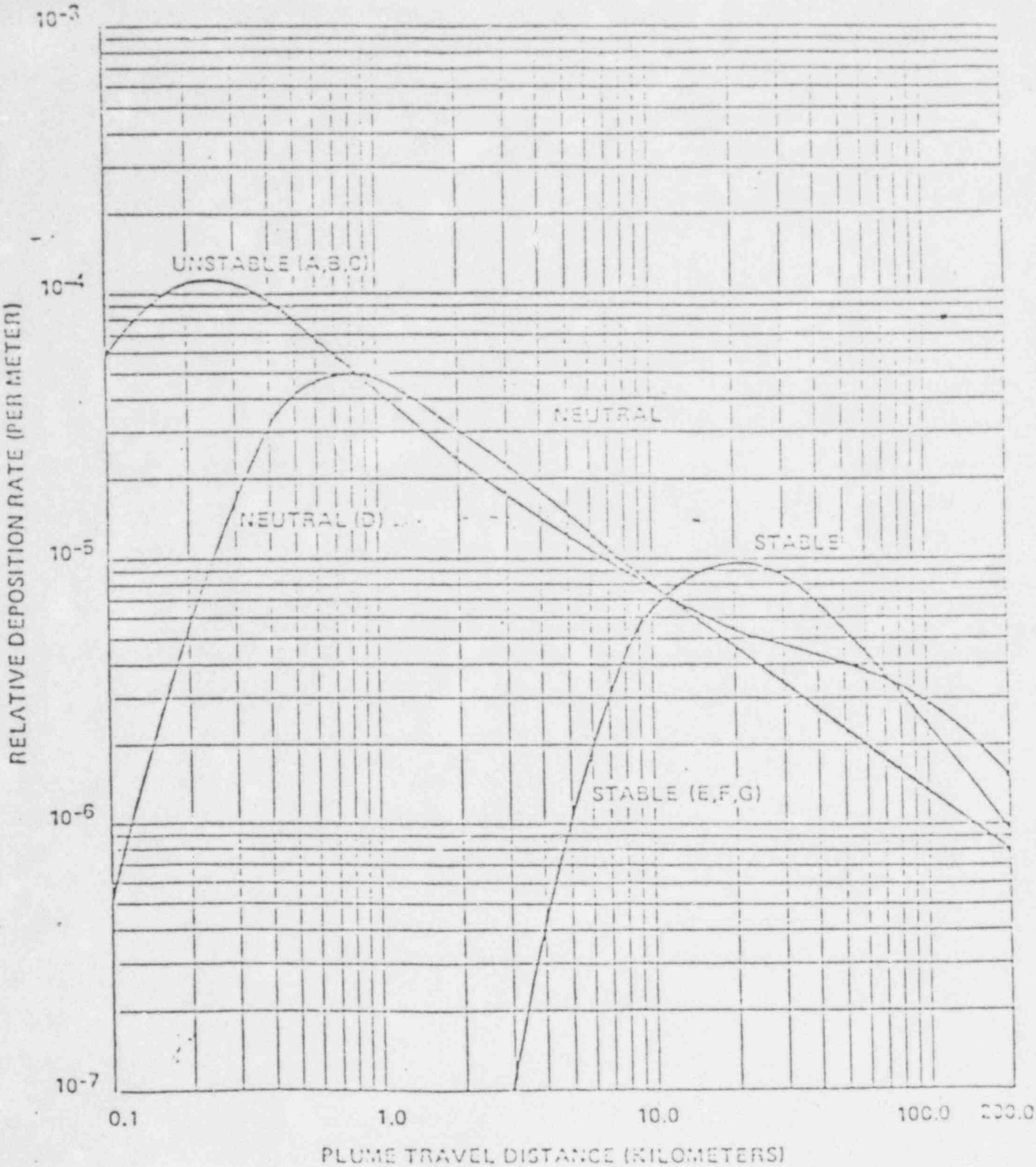
FIGURE 1.3

JAN 4 1983

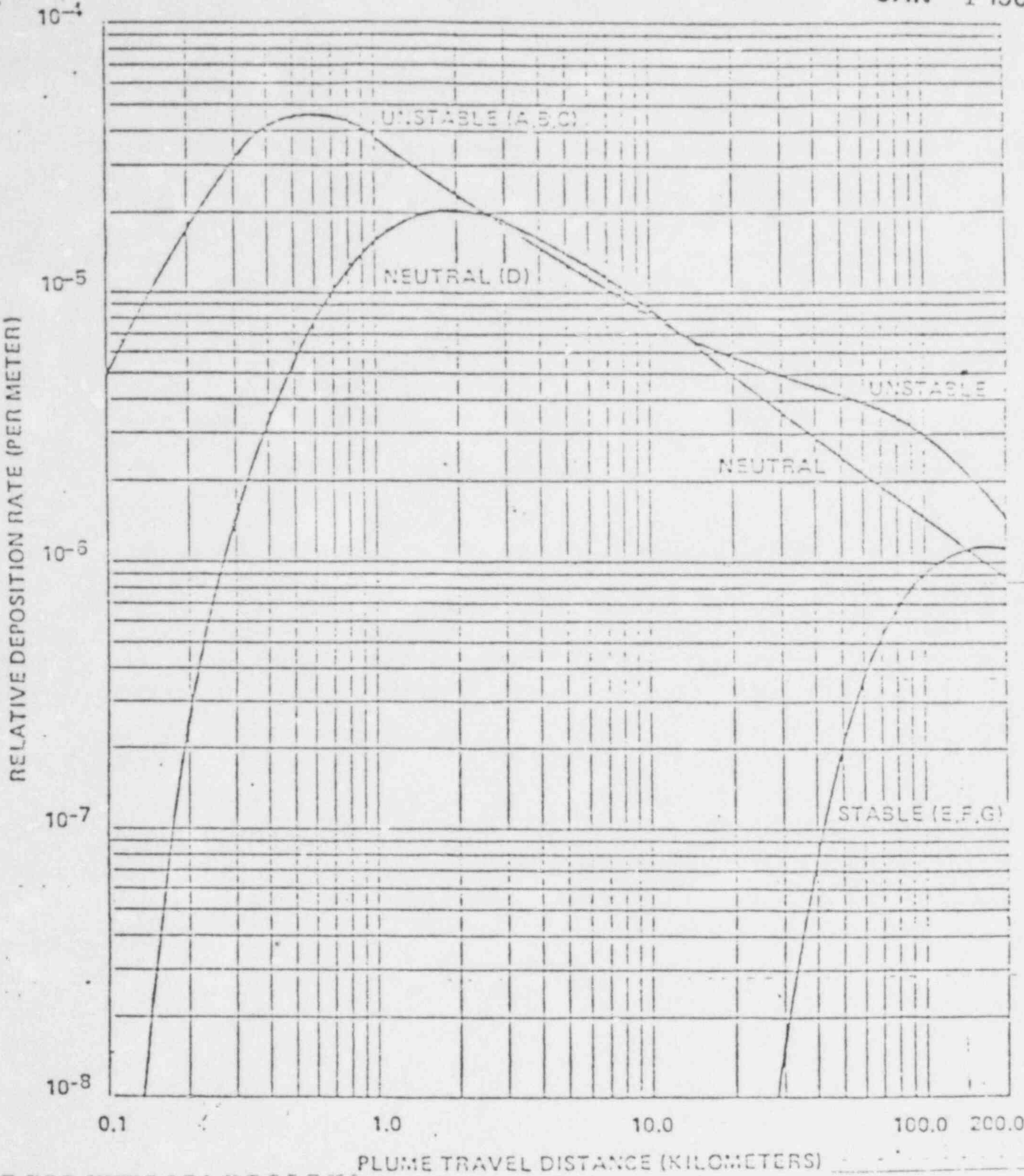


Relative Deposition for Ground Level Releases (All Atmospheric Stability Classes) (From Regulatory Guide 1.111, Revision 1, July 1977)

JAN 4 1983

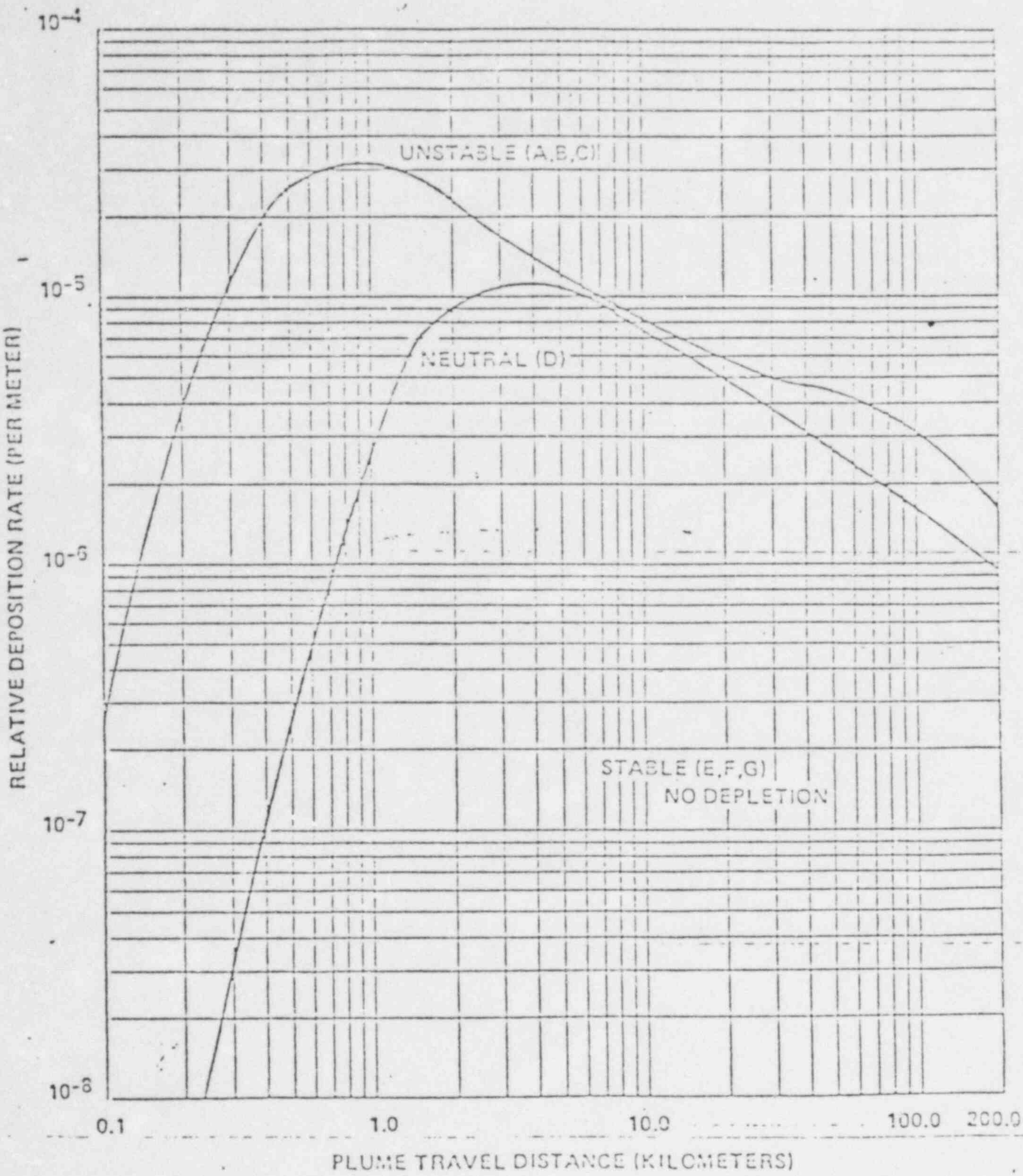


Relative Deposition for 30m Releases (Letters denote Pasquill Stability Class) (From Regulatory Guide 1.111, Revision 1, July 1977)



Relative Deposition for 60m Releases (Letters denote Pasquill Stability Class) (From Regulatory Guide 1.111, Revision 1, July 1977)

JAN 4 1983



Relative Deposition for 100m Releases (Letters denote Pasquill Stability Class) (From Regulatory Guide 1.111, Revision 1, July 1977)

2.0 Liquid Effluents

2.1 Concentration

2.1.1 RETS Requirement

Specification 3.8.A.1 of the Radiological Effluent Technical Specifications (RETS) requires that the concentration of radioactive material released at any time from the site to unrestricted areas (see figure 2.1) shall be limited to the Maximum Permissible Concentration 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

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

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

where

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

C_i = concentration of radionuclide i, μCi/ml.

2.1.3 MPC-Sum of the Ratios

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

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

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where

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

MPC_i = the MPC of radionuclide i, μCi/ml (10 CFR 20 - Appendix B, Table II, Col. 2)

R = the sum of the concentration ratios for the release.

For prerelease and post-release analysis the radionuclides present in the sample are first assumed to be unknown and the MPC after dilution at the site boundary is then $1x10^{-7}$ μCi/ml gross radioactivity. If the R calculated is too large for equation 2.3, then the appropriate MPC_i will be used with each C_i to determine the actual MPC fraction and compare to the 10 CFR 20 limit of 1. There is one liquid release point into the discharge canal by one of three possible modes.

```
           ┌------open - 3 pumps @ 200,000 gpm/pump------┐
Radwaste ──┼------helper - 3 pumps @ 150,000 gpm/pump----┼──→Discharge
           └------closed - 50,000 gpm -------------------┘   conduit
```

The following relationship will ensure concentrations are within allowable limits.

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

where

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

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

N = minimum dilution flow rate for prerelease analysis.

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 locations and identification numbers for each liquid effluent radiation detector are shown in figure 2.2 and figure 2.3. The respective alarm/trip setpoints at each release point will be conservatively set such that equation 2.2 is satisfied. The methodology describing the setpoint determination is contained in Technical Instruction 45.

2.2.2 Post-Release Analysis

A post-release analysis will be done using actual release data to ensure that the limits specified in section 2.1.1 were not exceeded. A composite list of concentrations (C_i), by isotope, will be used with the actual liquid radwaste (f) and dilution (F) flow rates (or volumes) during the release. The data will be substituted into equation 2.3 to demonstrate compliance with the limits in section 2.1.1. This data and setpoints will be recorded in auditable records by plant personnel.

2.3 Dose

2.3.1 RETS Requirement

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

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

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

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

2.3.2 Monthly Analysis

Principal radionuclides will be used to conservatively estimate the monthly contribution to the cumulative dose. If the projected dose exceeds section 2.3.1 limits, the methodology in section 2.3.3 will be implemented.

The following radionuclides based on operational source terms contribute more than 95 percent of the total estimated dose to the total body and maximum organ for both water and fish ingestion. The maximum organ for the ingestion pathway is the thyroid and for the fish pathway both the liver and gastrointestinal (GI) tract are considered.

H-3	Sr-90	Cs-134
Na-24	Nb-95	Cs-136
Co-60	I-131	Cs-137
Zn-65	I-133	

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

2.3.2.1 Water Ingestion

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

$$D_j = \frac{1}{0.95} \sum_{i=1}^{11} (DCF)_{ij} \times I_i \text{ rem} \qquad (2.4)$$

where

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

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

0.95 = conservative correction factor, considering only 11 radionuclides.

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

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

I_i is described by

$$I_i = \frac{365 A_i V}{12 \upsilon \delta} \qquad (2.5)$$

where

365 = days per year

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

V = average rate of water consumption (2000 ml/d, R.G. 1.109)

12 = months per year

υ = total dilution water flow during releases, ml.

δ = minimum diffuser pipe dilution (5)

The dose equation then becomes

$$D_j = \frac{1.3x10^7}{\upsilon} \sum_{i=1}^{11} (DCF)_{ij} \times A_i \text{ mrem} \qquad (2.6)$$

2.3.2.2 Fish Ingestion

The dose to an individual from the consumption of fish may be described by equation 2.4 where I_i is described by

$$I_i = \frac{A_i B_i M}{\upsilon \delta}, \ \mu Ci \qquad (2.7)$$

where

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

B_i = fish concentration factor of i^{th} radionuclide $\frac{\mu Ci/g}{\mu Ci/ml}$ (see attached table 2.1).

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

υ = total dilution water flow during releases, ml.

δ = minimum diffuser pipe dilution (5).

The dose equation 2.4 then becomes

$$D_j = \frac{4 \times 10^5}{\upsilon} \sum_{i=1}^{11} A_i \times B_i \times DCF_i \text{ mrem} \qquad (2.8)$$

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

To simplify the dynamic operation of the plant, the dose rate limits were transformed into conservative release rate limits based on historical source terms. The values per unit listed below are used as administrative guidelines for operations to ensure that the dose rate limits are not exceeded.

Liquid (Administrative Limits)

13 Ci/quarter/Reactor Unit

26 Ci/year/Reactor Unit

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. This analysis will replace previous estimates calculated in section 2.3.2 and consists of the following approach. The dose to the j^{th} organ from m radionuclides, D_j, is described by

$$D_j = \sum_{i=1}^{m} D_{ij}, \text{ rem} \quad (2.9)$$

$$= \sum_{i=1}^{m} (DCF)_{ij} \times I_i, \text{ rem} \quad (2.10)$$

where

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

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

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

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

I_i for water ingestion is described by

$$\frac{A_i \; V \; n}{F \quad d}, \ \mu\text{Ci} \quad (2.11)$$

and for fish ingestion I_i is described by

$$\frac{A_i \; B_i \; n}{F \quad d}, \ \mu\text{Ci} \quad (2.12)$$

where

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

V = average rate of water consumption:

2000 ml/d, max. individual (RG 1.109)

730 ml/d, avg. individual (ICRP23)

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

F = total river flow at location of interest for period (ml).

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

M = amount of fish eaten during period (fraction of year x 50 lb/yr. x 453.6g).

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

2.4 Operability of Liquid Radwaste Equipment

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

2.4.1 Release Limit Without Treatment

The liquid radwaste operability limit is an activity release limit based upon 4 years of operational releases excluding tritium. The curie limit is dependent upon the future operational mix being similar to past operational mix. The most restrictive pathway is to the total body by ingestion of fish. The individual dose from the .16 Ci operational source terms (excluding tritium) was calculated to be 0.02 mrem/mo. This dose is a factor of 3 below the operability limit of 0.06 mrem/mo.

per reactor unit to the total body. The allowable release without exceeding 0.06 mrem/mo. per reactor unit is 3 (.06 divided by .02) times 0.16 curie, or 0.5 curie/mo. per reactor unit (excluding tritium).

A_{limit} = 0.5 Ci/mo. per reactor unit (excluding tritium)

The value of 0.5 Ci/mo. per reactor unit will correspond to the limits specified in section 2.4 if the mixture of isotopes is similar to the operational mixture.

TABLE 2.1

DOSE COMMITMENT AND FISH CONCENTRATION FACTORS

NUCLIDE	RADIOLO. HALF-LIFE (DAYS)	BIOLOGICAL HALF-LIFE (DAYS)	EFFECTIVE HALF-LIFE (DAYS)	HUMAN DOSE COMMITMENT FACTORS (REM/CI) BONE	GI TRACT	THYROID	TOTAL BODY	LIVER	FISH CONCENTRATION FACT. STABLE	RADIOLO.	BIOLOGICAL HALF-LIFE DAYS
H-3	4.43E+03	1.00E+01	9.98E+00	9.77E-05	1.05E-04	1.05E-04	1.05E-04	1.05E-04	1.00E+00	1.00E+00	0.0
C-14	2.09E+06	1.00E+01	1.00E+01	2.84E-03	5.69E-04	5.88E-04	5.68E-04	5.68E-04	4.55E+03	4.55E+03	0.0
NA-24	6.33E-01	1.10E+01	5.99E-01	1.70E-03	1.70E-03	1.70E-03	1.70E-03	1.70E-03	1.00E+02	1.00E+02	0.0
P-32	1.43E+01	2.57E+02	1.35E+01	1.93E-01	2.17E-02	7.47E-03	7.46E-03	1.20E-02	1.00E+05	*2.50E+04	0.0
K-40	4.60E+11	5.80E+01	5.90E+01	3.45E-02	0.0	3.45E-02	3.45E-02	3.45E-02	2.50E+03	2.50E+03	0.0
CR-51	2.78E+01	6.16E+02	2.66E+01	3.21E-06	6.69E-04	1.59E-06	2.66E-06	2.66E-06	2.00E+02	2.00E+02	0.0
MN-54	3.03E+02	1.70E+01	1.61E+01	8.83E-04	1.40E-02	8.83E-04	8.72E-04	4.57E-03	4.00E+02	4.00E+02	0.0
MN-56	1.07E-01	1.70E+01	1.06E-01	2.04E-05	3.67E-03	2.01E-05	2.04E-05	1.15E-04	4.00E+02	4.00E+02	0.0
FE-55	9.50E+02	8.00E+02	4.34E+02	2.75E-03	1.03E-03	2.74E-04	4.43E-04	1.90E-03	1.00E+02	1.00E+02	0.0
FE-59	4.56E+01	8.00E+02	4.31E+01	4.34E-03	3.40E-02	3.01E-03	3.91E-03	1.02E-02	1.00E+02	1.00E+02	0.0
CO-58	7.13E+01	9.50E+00	8.38E+00	1.69E-03	1.51E-02	1.69E-03	1.67E-03	7.45E-04	5.00E+01	2.00E+01	1.00E+02
CO-60	1.92E+03	9.50E+00	9.45E+00	4.73E-03	4.02E-02	4.73E-03	4.72E-03	2.14E-03	5.00E+01	4.75E+01	1.00E+02
NI-65	1.07E-01	6.67E+02	1.07E-01	5.28E-04	1.74E-03	3.27E-05	3.13E-05	6.86E-05	1.00E+02	1.00E+02	0.0
CU-64	5.31E-01	8.00E+01	5.27E-01	3.91E-05	7.10E-03	3.91E-05	3.91E-05	8.33E-05	5.00E+01	5.00E+01	0.0
ZN-65	2.45E+02	9.33E+02	1.94E+02	4.84E-03	9.70E-03	7.13E-03	6.96E-03	1.54E-02	2.00E+03	1.42E+03	1.00E+02
ZN-69M	5.75E-01	9.33E+02	5.75E-01	1.55E-01	2.91E-03	3.64E-05	3.64E-05	4.09E-04	2.00E+03	1.14E+01	1.00E+02
ZN-69	3.96E-02	9.33E+02	3.96E-02	1.03E-05	2.96E-06	1.37E-06	1.37E-06	1.97E-05	2.00E+03	7.92E-01	1.00E+02
BR-82	1.48E+00	8.00E+00	1.25E+00	2.26E-03	2.59E-03	2.26E-03	2.26E-03	2.26E-03	4.20E+02	4.20E+02	0.0
BR-83	1.00E-01	8.00E+00	9.88E-02	3.55E-05	5.79E-05	3.55E-05	4.02E-05	4.02E-05	4.20E+02	4.20E+02	0.0
BR-84	2.21E-02	8.00E+00	2.20E-02	6.04E-05	4.09E-10	6.04E-05	5.21E-05	5.21E-05	4.20E+02	4.20E+02	0.0
BR-85	2.08E-03	8.00E+00	2.09E-03	5.17E-07	1.00E-21	5.17E-07	2.14E-06	2.14E-06	4.20E+02	4.20E+02	0.0
KR-83M	7.75E-02	1.00E+00	7.13E-02	0.0	1.46E-04	0.0	0.0	0.0	1.00E+00	1.00E+00	0.0
KR-85M	1.83E-01	1.00E+00	1.55E-01	0.0	3.30E-03	0.0	0.0	0.0	1.00E+00	1.00E+00	0.0
KR-85	3.93E+03	1.00E+00	1.00E+00	0.0	4.62E-02	0.0	0.0	0.0	1.00E+00	1.00E+00	0.0
RB-86	1.87E+01	4.50E+01	1.32E+01	9.83E-03	4.16E-03	9.83E-03	9.83E-03	2.11E-02	2.00E+03	2.00E+03	0.0
RB-88	1.21E-02	4.50E+01	1.21E-02	3.34E-05	8.36E-16	8.34E-05	3.21E-05	6.05E-05	2.00E+03	2.00E+03	0.0
RB-89	1.07E-02	4.50E+01	1.07E-02	2.86E-05	2.33E-18	2.86E-05	2.82E-05	4.01E-05	2.00E+03	2.00E+03	0.0
SR-89	5.27E+01	1.30E+04	5.25E+01	3.08E-01	4.94E-02	9.22E-03	8.84E-03	8.84E-03	3.00E+01	1.04E+01	1.00E+02
SR-90	1.01E+04	1.30E+04	5.68E+03	7.58E+00	2.19E-01	1.76E+00	1.86E+00	1.86E+00	3.00E+01	2.97E+01	1.00E+02
SR-91	4.03E-01	1.30E+04	4.03E-01	5.67E-03	2.70E-02	1.92E-04	2.29E-04	2.29E-04	3.00E+01	1.20E-01	1.00E+02
SR-92	1.13E-01	1.30E+04	1.13E-01	2.15E-03	4.26E-02	6.89E-05	9.30E-05	9.30E-05	3.00E+01	3.39E-02	1.00E+02
SR-93	5.56E-03	1.30E+04	5.56E-03	6.39E-05	1.89E-03	8.90E-06	8.90E-06	8.90E-06	3.00E+01	1.67E-03	1.00E+02
Y-90	2.67E+00	1.40E+04	2.67E+00	9.62E-06	1.02E-01	2.57E-07	2.58E-07	2.58E-07	2.50E+01	2.50E+01	0.0
Y-91M	3.47E-02	1.40E+04	3.47E-02	9.09E-08	2.67E-07	1.72E-09	3.52E-09	3.52E-09	2.50E+01	2.50E+01	0.0
Y-91	5.88E+01	1.40E+04	5.86E+01	1.41E-04	7.76E-02	3.66E-06	3.77E-06	3.77E-06	2.50E+01	2.50E+01	0.0
Y-92	1.47E-01	1.40E+04	1.47E-01	8.45E-07	1.48E-02	2.47E-08	2.47E-08	2.47E-08	2.50E+01	2.50E+01	0.0
Y-93	4.20E-01	1.40E+04	4.20E-01	2.68E-06	8.50E-02	5.51E-08	7.40E-08	7.40E-08	2.50E+01	2.50E+01	0.0
ZR-95	6.55E+01	4.50E+02	5.72E+01	3.04E-05	3.09E-02	6.39E-06	6.60E-06	9.79E-06	3.33E+00	3.33E+00	0.0
ZR-97	7.08E-01	4.50E+02	7.07E-01	1.68E-06	1.05E-01	1.55E-07	1.55E-07	3.39E-07	3.33E+00	3.33E+00	0.0
NB-95M	3.75E+00	7.60E+02	3.73E+00	5.86E-07	3.55E-02	2.88E-07	2.08E-07	4.63E-07	3.00E+01	3.00E+04	0.0
NB-95	3.50E+01	7.60E+02	3.35E+01	6.22E-06	2.10E-02	1.83E-06	1.86E-06	3.46E-06	3.00E+01	3.00E+04	0.0
NB-97	5.00E-02	7.60E+02	5.00E-02	4.90E-08	[illegible].10E-03	4.60E-09	4.60E-09	1.27E-08	3.00E+04	3.00E+04	0.0

*This effective concentration factor includes an adjustment of 0.25 for the fraction of the total phosphorus found in edible portions.

TABLE 2.1

DOSE COMMITMENT AND FISH CONCENTRATION FACTORS

NUCLIDE	RADIOL. HALF-LIFE (DAYS)	BIOLOGICAL HALF-LIFE (DAYS)	EFFECTIVE HALF-LIFE (DAYS)	HUMAN DOSE COMMITMENT FACTORS (REM/UCI): BONE	GI TRACT	THYROID	TOTAL BODY	LIVER	FISH: CONCENTRATION FACT. FRESH	MARINE	BIOLOGICAL HALF-LIFE DAYS
RU-103	3.96E+01	7.30E+00	6.16E+00	1.25E-04	2.16E-02	7.98E-05	7.95E-05	7.97E-05	1.00E+01	1.00E+01	0.0
RU-106	3.68E+02	7.30E+00	7.16E+00	2.75E-03	1.78E-01	3.50E-04	3.48E-04	3.43E-01	1.00E+01	1.00E+01	0.0
RH103M	3.96E-02	7.30E+00	3.94E-02	1.67E-07	1.21E-04	4.99E-08	4.99E-08	7.21E-07	1.00E+01	1.00E+01	0.0
AG110M	2.53E+02	5.00E+00	4.90E+00	1.60E-04	5.04E-02	8.78E-05	8.79E-05	1.48E-01	2.00E+00	2.00E+00	0.0
SB-124	6.02E+01	3.80E+01	2.33E+01	2.80E-03	7.95E-02	6.79E-06	1.11E-03	5.30E-05	1.00E+00	1.00E+00	0.0
SB-125	9.95E+02	3.80E+01	3.66E+01	1.79E-03	1.97E-02	1.82E-06	4.26E-04	2.40E-05	1.00E+00	1.00E+00	0.0
TE125M	5.80E+01	1.50E+01	1.19E+01	2.68E-03	1.07E-02	8.05E-04	3.59E-04	9.71E-04	4.00E+02	4.00E+02	0.0
TE127M	1.09E+02	1.50E+01	1.32E+01	6.77E-03	2.27E-02	1.73E-03	8.25E-04	2.42E-03	4.00E+02	4.00E+02	0.0
TE-127	3.92E-01	1.50E+01	3.82E-01	1.10E-04	9.68E-03	8.15E-05	2.38E-05	3.95E-05	4.00E+02	4.00E+02	0.0
TE129M	3.41E+01	1.50E+01	1.04E+01	1.15E-02	5.79E-02	3.95E-03	1.82E-03	4.29E-03	4.00E+02	4.00E+02	0.0
TE-129	4.77E-02	1.50E+01	4.75E-02	3.14E-05	2.37E-05	2.41E-05	7.65E-06	1.18E-05	4.00E+02	4.00E+02	0.0
TE131M	1.25E+00	1.50E+01	1.15E+00	1.73E-03	8.40E-02	1.34E-03	7.05E-04	8.46E-01	4.00E+02	4.00E+02	0.0
TE-131	1.72E-02	1.50E+01	1.72E-02	1.97E-05	2.79E-06	1.62E-05	6.22E-06	8.23E-06	4.00E+02	4.00E+02	0.0
TE-132	3.24E+00	1.50E+01	2.66E+00	2.52E-03	7.71E-02	1.80E-03	1.53E-03	1.63E-03	4.00E+02	4.00E+02	0.0
TE-134	2.92E-02	1.50E+01	2.91E-02	2.10E-05	8.93E-05	2.00E-05	1.57E-05	2.13E-05	4.00E+02	4.00E+02	0.0
I-129	6.21E+09	1.38E+02	1.38E+02	3.10E-03	0.0	9.61E+00	1.24E-02	2.81E-03	5.00E+01	5.00E+01	1.00E+00
I-130	5.17E-01	1.38E+02	5.17E-01	7.56E-04	1.92E-03	1.89E-01	8.80E-04	2.23E-03	5.00E+01	1.70E+01	1.00E+00
I-131	8.05E+00	1.38E+02	7.61E+00	4.15E-03	1.57E-03	1.95E+00	3.41E-03	5.95E-03	5.00E+01	4.45E+01	1.00E+00
I-132	9.42E-02	1.38E+02	9.41E-02	2.03E-04	1.02E-04	1.90E-02	1.90E-04	5.43E-04	5.00E+01	4.30E+00	1.00E+00
I-133	8.46E-01	1.38E+02	8.41E-01	1.42E-03	2.22E-03	3.63E-01	7.53E-04	2.47E-03	5.00E+01	2.29E+01	1.00E+00
I-134	3.61E-02	1.38E+02	3.61E-02	1.06E-04	2.51E-07	4.99E-03	1.03E-04	2.93E-04	5.00E+01	1.71E+00	1.00E+00
I-135	2.79E-01	1.38E+02	2.77E-01	4.43E-04	1.31E-03	7.65E-02	4.29E-04	1.16E-03	5.00E+01	1.09E+01	1.00E+00
XE 131M	2.26E+00	1.00E+00	6.93E-01	0.0	2.45E-02	0.0	0.0	0.0	1.00E+00	1.00E+00	0.0
XE-133	5.27E+00	1.00E+00	8.41E-01	0.0	2.53E-02	0.0	0.0	0.0	1.00E+00	1.00E+00	0.0
XE 133M	1.03E-02	1.00E+00	1.07E-02	0.0	3.29E-04	0.0	0.0	0.0	1.00E+00	1.00E+00	0.0
XE-135	3.83E-01	1.00E+00	2.77E-01	0.0	1.00E-02	0.0	0.0	0.0	1.00E+00	1.00E+00	0.0
CS-134	7.47E+02	7.00E+01	6.40E+01	6.22E-02	2.59E-03	1.20E-01	1.21E-01	1.48E-01	2.00E+03	2.00E+03	1.00E+00
CS-135	1.10E+03	7.00E+01	7.00E+01	1.96E-02	0.0	8.05E-03	8.05E-03	1.89E-02	2.00E+03	2.00E+03	1.00E+00
CS-136	1.37E+01	7.00E+01	1.15E+01	6.51E-03	2.92E-03	2.03E-02	1.85E-02	2.57E-02	2.00E+03	1.86E+03	1.00E+00
CS-137	1.10E+04	7.00E+01	6.96E+01	7.97E-02	2.11E-03	7.29E-02	7.14E-02	1.09E-01	2.00E+03	2.00E+03	1.00E+00
CS-138	2.24E-02	7.00E+01	2.24E-02	5.52E-05	4.65E-10	5.72E-05	5.40E-05	1.09E-04	2.00E+03	4.30E+01	1.00E+00
BA-139	5.76E-02	6.50E+01	5.75E-02	9.70E-05	1.72E-04	3.07E-06	2.94E-06	6.91E-08	4.00E+00	4.00E+00	0.0
BA-140	1.28E+01	6.50E+01	1.07E+01	2.03E-02	4.18E-02	1.23E-03	1.33E-03	2.55E-05	4.00E+00	4.00E+00	0.0
LA-140	1.68E+00	5.00E+02	1.67E+00	2.50E-06	9.25E-02	3.09E-07	3.33E-07	1.26E-06	2.50E+01	2.50E+01	0.0
LA-141	1.63E-01	5.00E+01	1.62E-01	3.90E-07	9.60E-03	2.03E-08	2.03E-08	9.91E-08	2.50E+01	2.50E+01	0.0
CE-141	3.25E+01	5.63E+02	3.07E+01	9.36E-06	2.42E-02	7.72E-07	7.18E-07	6.33E-06	2.50E+01	2.50E+01	0.0
CE-143	1.38E+00	5.63E+02	1.38E+00	1.65E-06	4.56E-02	3.56E-08	1.35E-07	1.22E-03	2.50E+01	2.50E+01	0.0
CE-144	2.84E+02	5.63E+02	1.89E+02	4.88E-04	1.65E-01	2.64E-05	2.62E-05	2.04E-04	2.50E+01	2.50E+01	0.0
PR-143	1.36E+01	7.50E+02	1.34E+01	9.20E-06	4.03E-02	4.60E-07	4.56E-07	3.69E-06	2.50E+01	2.50E+01	0.0
PR-144	1.20E-02	7.50E+02	1.20E-02	3.01E-08	4.33E-15	1.54E-09	1.53E-09	1.25E-08	2.50E+01	2.50E+01	0.0
ND-147	1.11E+01	6.56E+02	1.09E+01	6.29E-06	3.49E-02	4.55E-07	4.35E-07	7.27E-06	2.50E+01	2.50E+01	0.0
PM-147	9.57E+02	6.56E+02	3.89E+02	7.60E-05	1.33E-02	2.89E-06	2.89E-06	7.10E-06	2.50E+01	2.50E+01	0.0
PM-149	2.21E+00	6.56E+02	2.20E+00	1.54E-06	4.86E-02	8.87E-08	8.87E-08	2.15E-07	2.50E+01	2.50E+01	0.0
PM-151	1.16E+00	6.56E+02	1.16E+00	6.74E-07	3.17E-02	5.91E-08	5.91E-08	1.17E-07	2.50E+01	2.50E+01	0.0
SM-151	3.18E+04	6.56E+02	6.43E+02	6.09E-05	4.37E-03	1.56E-06	1.56E-06	1.19E-05	2.50E+01	2.50E+01	0.0
SM-153	1.95E+00	6.56E+02	1.94E+00	1.03E-05	3.58E-02	6.66E-08	6.66E-08	7.16E-07	2.50E+01	2.50E+01	0.0

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TABLE [illegible]

DOSE COMMITMENT AND FISH CONCENTRATION FACTORS

NUCLIDE	RADIOLO. HALF-LIFE (DAYS)	BIOLOGICAL HALF-LIFE (DAYS)	EFFECTIVE HALF-LIFE (DAYS)	HUMAN DOSE COMMITMENT FACTORS (REM/UCI) BONE	GI TRACT	THYROID	TOTAL BODY	LIVER	FISH: CONCENTRATION FACT. STABLE	RADIO.	BIOLOGICAL HALF-LIFE DAYS
Sm-156	3.92E-01	6.56E+02	3.92E-01	4.63E-07	5.86E-03	5.33E-08	5.33E-08	5.33E-05	2.50E+01	2.50E+01	0.0
Eu-155	6.61E+02	6.35E+02	3.24E+02	5.75E-05	1.35E-02	3.35E-06	3.35E-06	1.22E-05	2.50E+01	2.50E+01	0.0
Eu-156	1.54E+01	6.35E+02	1.50E+01	1.31E-05	1.02E-01	1.65E-06	1.65E-06	1.96E-05	2.50E+01	2.50E+01	0.0
W-187	9.96E-01	1.00E+00	4.99E-01	1.03E-04	2.82E-02	2.79E-05	3.01E-05	1.03E-01	1.20E+03	1.20E+03	0.0
Np-239	2.35E+00	3.90E+04	2.35E+00	1.19E-06	2.40E-02	7.74E-08	6.45E-08	1.19E-06	1.00E+01	1.00E+01	0.0

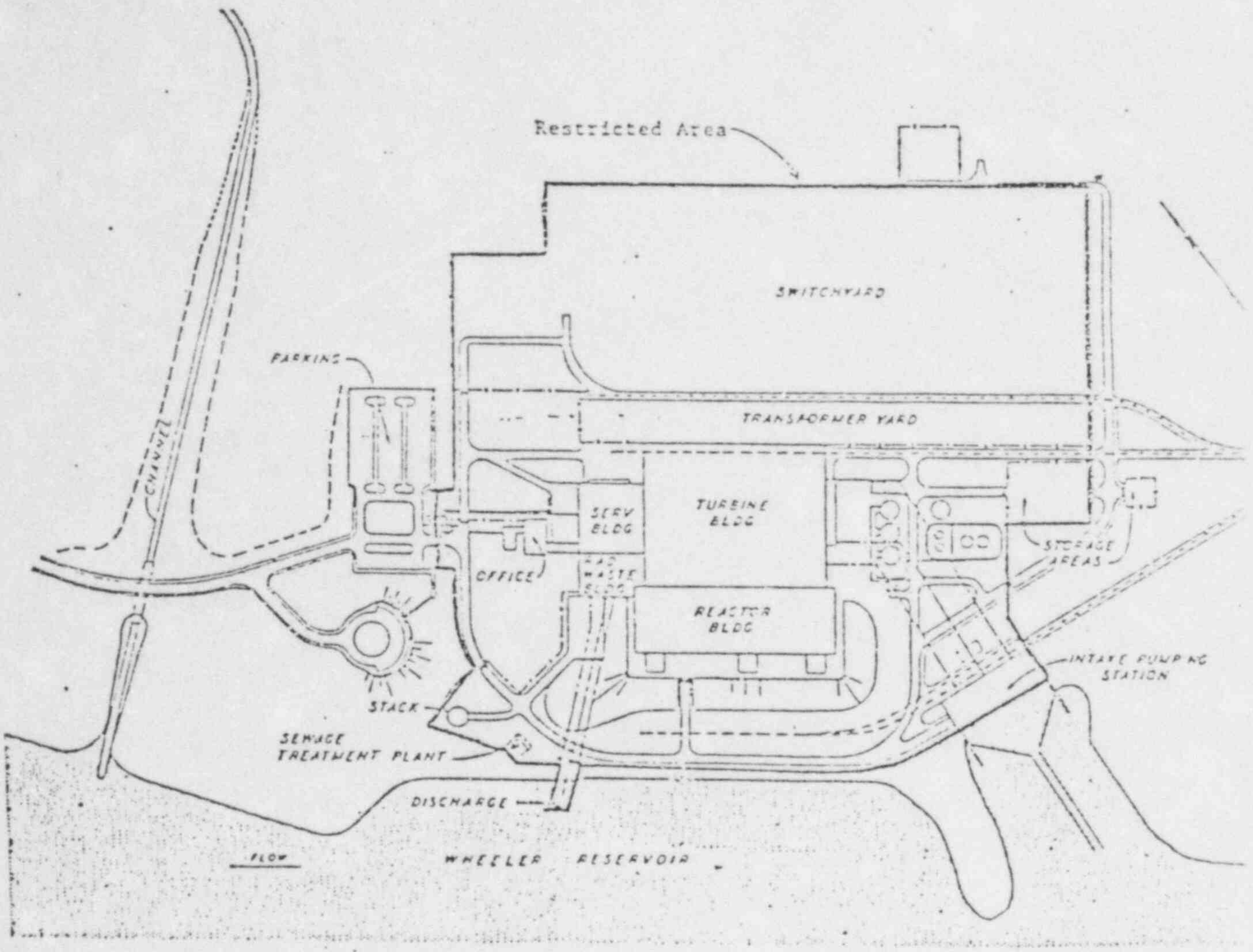


Figure 2.1--Assumed Liquid Effluent Restricted Area

Browns Ferry Nuclear Plant
RADWASTE TREATMENT SYSTEM

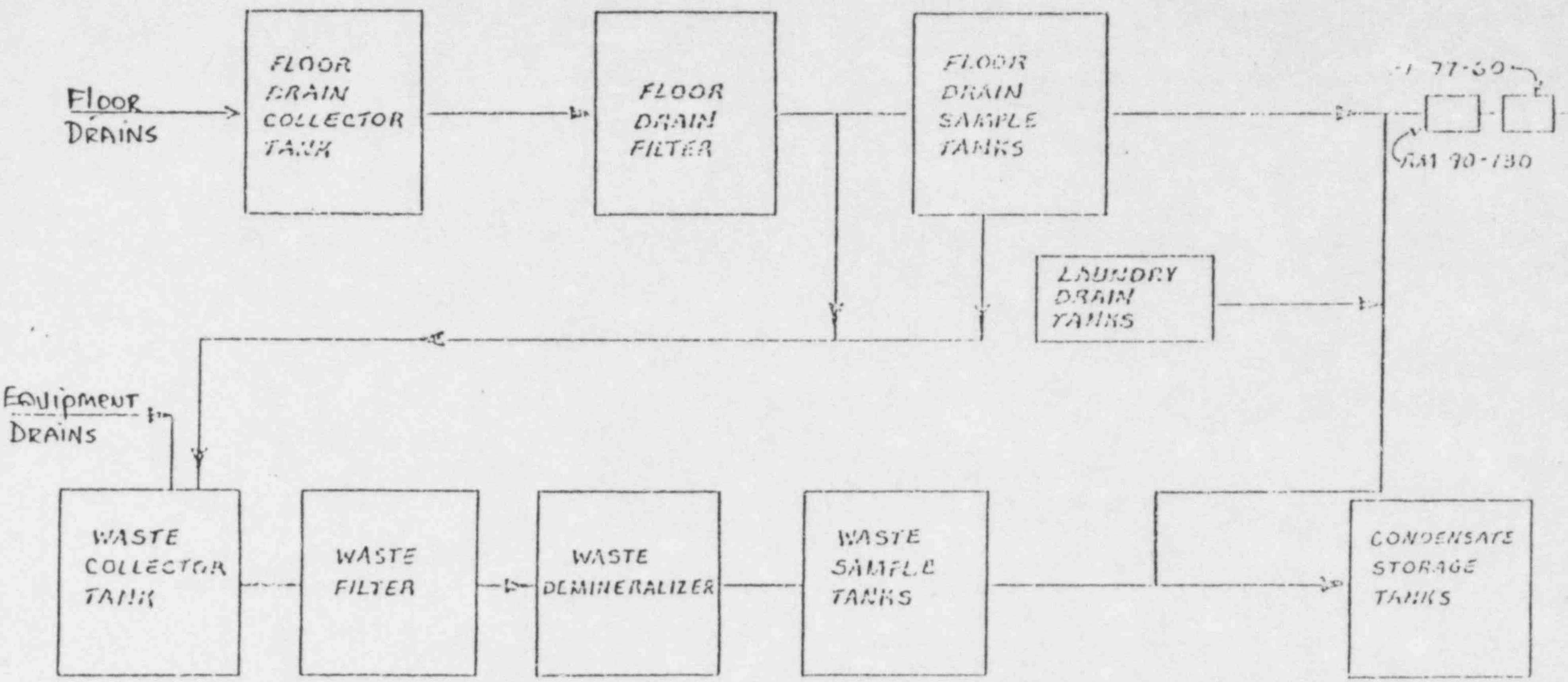
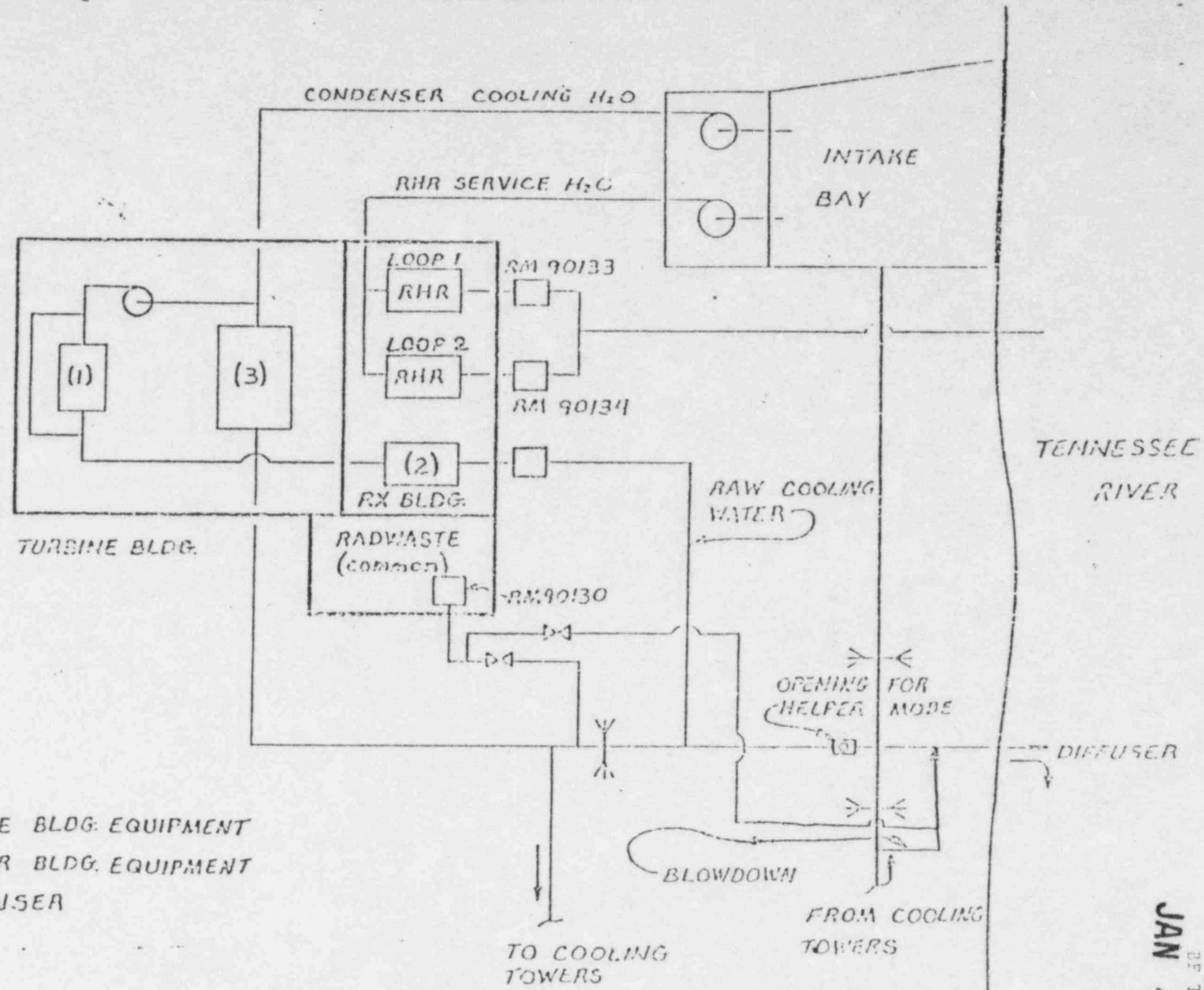


Figure 2.2 - Radwaste Treatment System

BFNP LIQUID EFFLUENT MONITORS (TYPICAL UNIT & COMMON RADWASTE)



(1) TURBINE BLDG. EQUIPMENT
(2) REACTOR BLDG. EQUIPMENT
(3) CONDENSER

Figure 2.3 - BFNP Liquid Effluent Monitors

3.0 Radiological Environmental Monitoring

3.1 Monitoring Program

An environmental radiological monitoring program, as described in tables 3.1-1, 3.1-2, and 3.1-3 and in figures 3.1-1, 3.1-2, 3.1-3, and 3.1-4 shall be conducted. Results of this program shall be reported in accordance with Technical Specification 3.13.

The atmospheric environmental radiological monitoring program shall consist of 10 monitoring stations from which samples of air particulates shall be collected.

The terrestrial monitoring program shall consist of the collection of vegetation, milk, soil, drinking water, and food crops. In addition, direct gamma radiation levels will be measured at 40 or more locations in the vicinity of the plant.

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

Deviations are permitted from the required sampling schedule if specimens are unobtainable due to hazardous conditions, sample unavailability, or 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 Technical Specification table 3.13-2 are achieved.

3.3 Nonroutine Reports

Nonroutine reports shall be submitted pursuant to Technical Specification 3.13.

Table 3.1-1

ENVIRONMENTAL RADIOLOGICAL MONITORING

Exposure Pathway and/or Sample	Number of Samples and Locations	Sampling and Collection Frequency	Type and Frequency of Analysis
AIRBORNE			
Particulates	5 samples from locations (in different sectors) at or near the site boundary	Continuous sampler operation with sample collection at least once per 7 days.	Particulate sampler. Analyze for gross beta radioactivity J 24 hours following filter change. Perform gamma isotopic analysis on each sample when gross beta activity is J 10 times the average of control samples. Perform gamma isotopic analysis on composite (by location) sample at least once per 92 days.
	2 samples from control locations greater than 10 miles from the plant		
	3 samples from locations in communities approximately 10 miles from the plant		Gross beta following filter change. Gamma scan at least once per year.
Radioiodine	3 samples from locations (in different sectors) at or near the site boundary 2 samples from control locations.	Continuous sampler operation with charcoal canister collection at least once per 7 days.	^{131}I every 7 days.
SOIL	Samples from same locations as air particulates	Once each 3 years	Gamma scan, ^{89}Sr, ^{90}Sr once each 3 years.
DIRECT	2 or more dosimeters placed at locations (in different sectors) at or near the site boundary in each of the 16 sectors	At least once per 92 days.	Gamma dose once per 92 days

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Table 3.1-1 (Continued)

ENVIRONMENTAL RADIOLOGICAL MONITORING

Exposure Pathway and/or Sample	Number of Samples and Locations	Sampling and Collection Frequency	Type and Frequency of Analysis
	2 or more dosimeters placed at stations located N5 miles from the plant in each of the 16 sectors	At least once per 92 days.	Gamma dose once per 92 days
	2 or more dosimeters in at least 8 additional locations of special interest		
WATERBORNE			
Surface	1 sample upstream 1 sample immediately downstream of discharge	Collected by automatic sequential-type sampler with composite sample taken at least once per 31 days[a].	Gamma scan on 4-week composite. Composite for tritium at least once per 92 days
Drinking	1 sample at the first potable surface water supply downstream from the plant 1 sample at control location[b]	Collected by automatic sequential-type sampler with composite sample taken at least once per 31 days[a,c]	Gross beta and gamma scan on 4-week composite. Composite for tritium at least once per 92 days
AQUATIC			
Sediment	1 sample upstream from discharge point	At least once per 184 days.	Gamma scan, 89Sr, and 90Sr analyses

a. Composite samples shall be collected by collecting an aliquot at intervals not exceeding 2 hours.
b. The surface water control sample shall be considered a control for the drinking water sample.
c. This assumes that the nearest drinking water intake is >3.0 mile downstream of the plant discharge. If a drinking water intake is constructed within 3.0 miles downstream of the plant discharge, sampling and analysis shall be every 2 weeks.

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Table 3.1-1 (Continued)

ENVIRONMENTAL RADIOLOGICAL MONITORING

Exposure Pathway and/or Sample	Number of Samples and Locations	Sampling and Collection Frequency	Type and Frequency of Analysis
	1 sample in immediate downstream area of discharge point	At least once per 184 days	Gamma scan, ^{89}Sr, and ^{90}Sr analyses
INGESTION			
Milk	At least 3 samples from dairy farms in the immediate vicinity of the plant	At least once per 15 days when animals are on pasture; at least once per 31 days at other times.	^{131}I on each sample. Gamma scan, ^{89}Sr and ^{90}Sr at least once per 31 days
	At least 1 sample from control locations (usually from 3 locations)		
Fish	3 samples representing commercial and game species in Guntersville Reservior above the plant	At least once per 184 days	Gamma scan at least once per 184 days on edible portions. $^{89,90}Sr$ on 2 whole fish samples
	3 samples representing commercial and game species in Wheeler Reservoir near the plant		
Fruits & Vegetables	Samples of food crops such as corn, green beans, tomatoes, and potatoes grown at private gardens and/or farms in the immediate vicinity of the plant	At least once per year at time of harvest	^{131}I, gamma scan on edible portion

Table 3.1-1 (Continued)

ENVIRONMENTAL RADIOLOGICAL MONITORING

Exposure Pathway and/or Sample	Number of Samples and Locations	Sampling and Collection Frequency	Type and Frequency of Analysis
	1 sample of each of the same foods grown at greater than 10 miles distance from the plant		
Vegetation (pasturage and grass)	Samples from the nearby dairy farms and from the atmospheric monitoring stations	Once per 31 days	^{131}I, gamma scan once per 31 days. ^{89}Sr and ^{90}Sr once per 92 days.
ANNUAL REVIEW			
Critical Pathway Verification-special studies as needed to verify critical pathways, such as the air-vegetation-milk pathway or the water-fish pathway, or to track radioactivity in the environment.	At least 24 samples	At least once per year	Dependent on pathway. Typically gamma scan, ^{131}I

Table 3.1-2

ATMOSPHERIC AND TERRESTRIAL MONITORING STATION LOCATIONS

Browns Ferry Nuclear Plant

	Location and Approximate Distance and Direction from Plant
LM-1 BF	1.0 mile N
LM-2 BF	0.9 mile NNE
LM-3 BF	1.0 mile NE
LM-4 BF	1.7 miles NNW
LM-6 BF	3 miles SSW
PM-1 BF (Rogersville, AL)	13.8 miles NW
PM-2 BF (Athens, AL)	10.9 miles NE
PM-3 BF (Decatur/Trinity, AL)	8.2 miles SSE
RM-1 BF (Muscle Shoals, AL)	32.0 miles W
RM-6 BF (Madison, AL, area)	~25 miles E
Farm B	7.0 miles NNW
Farm S	4.8 miles N
Farm L	5.8 miles ENE
Farm Ca (control)	32 miles W
Farm X-1 (control)	to be determined
Farm X-2 (control)	to be determined

Table 3.1-3

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

Supply	Source	Distance from plant (miles)
Courtland (Champion Paper Co.)[a]	Tennessee River (mile 282.6)	11.6
Control[b]	Tennessee River (mile 305.0)	11.0

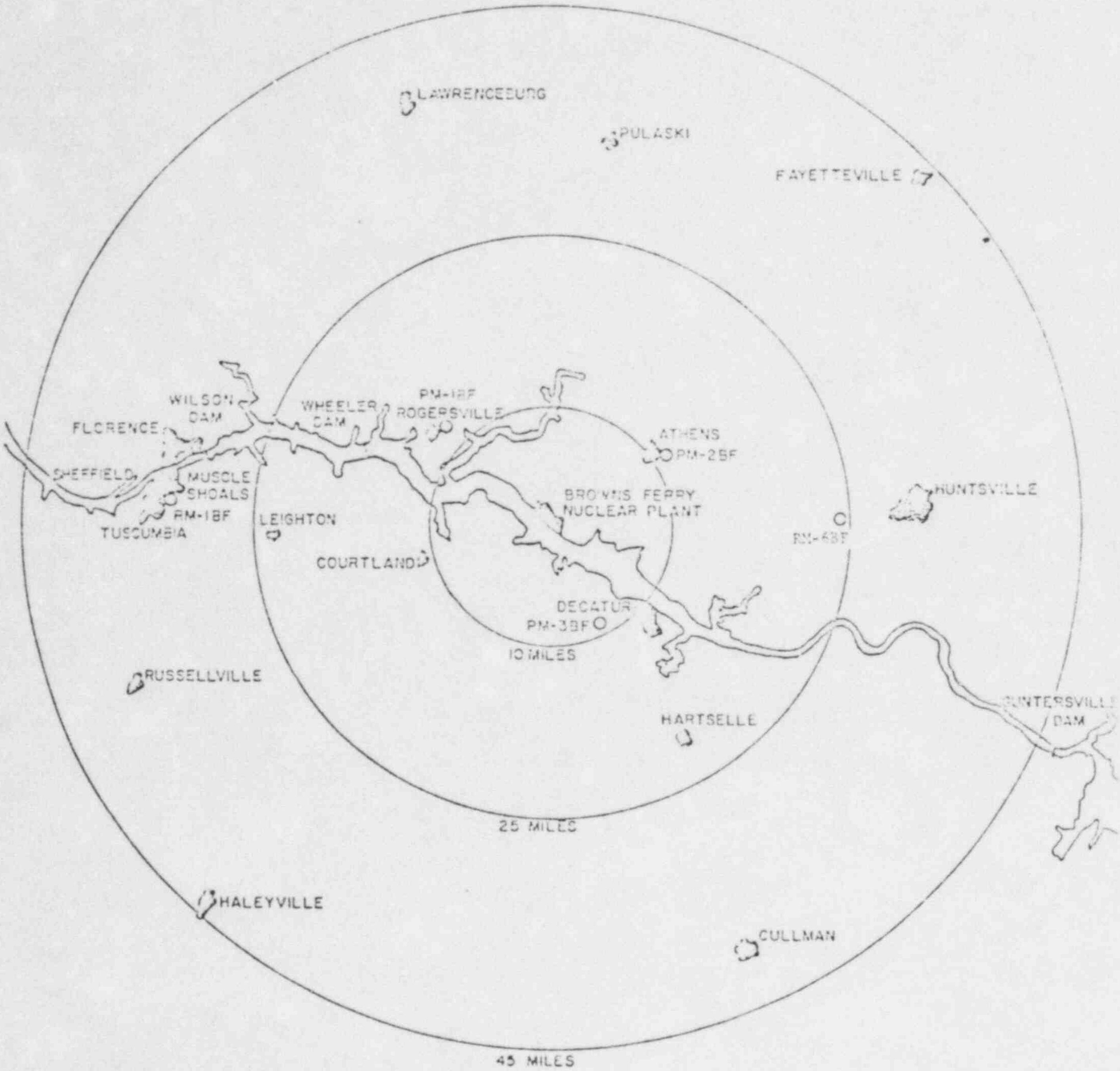
a. First potable water supply downstream of the plant. Sample collected automatically and analyzed monthly.

b. The sample collected at Champion Paper Company is a raw water sample taken at the intake area; therefore, the upstream surface water sample will be considered the control sample for drinking water.

Figure 3.1-1

Browns Ferry Nuclear Plant

ATMOSPHERIC AND TERRESTRIAL MONITORING NETWORK



O—ENVIRONMENTAL MONITORING STATION

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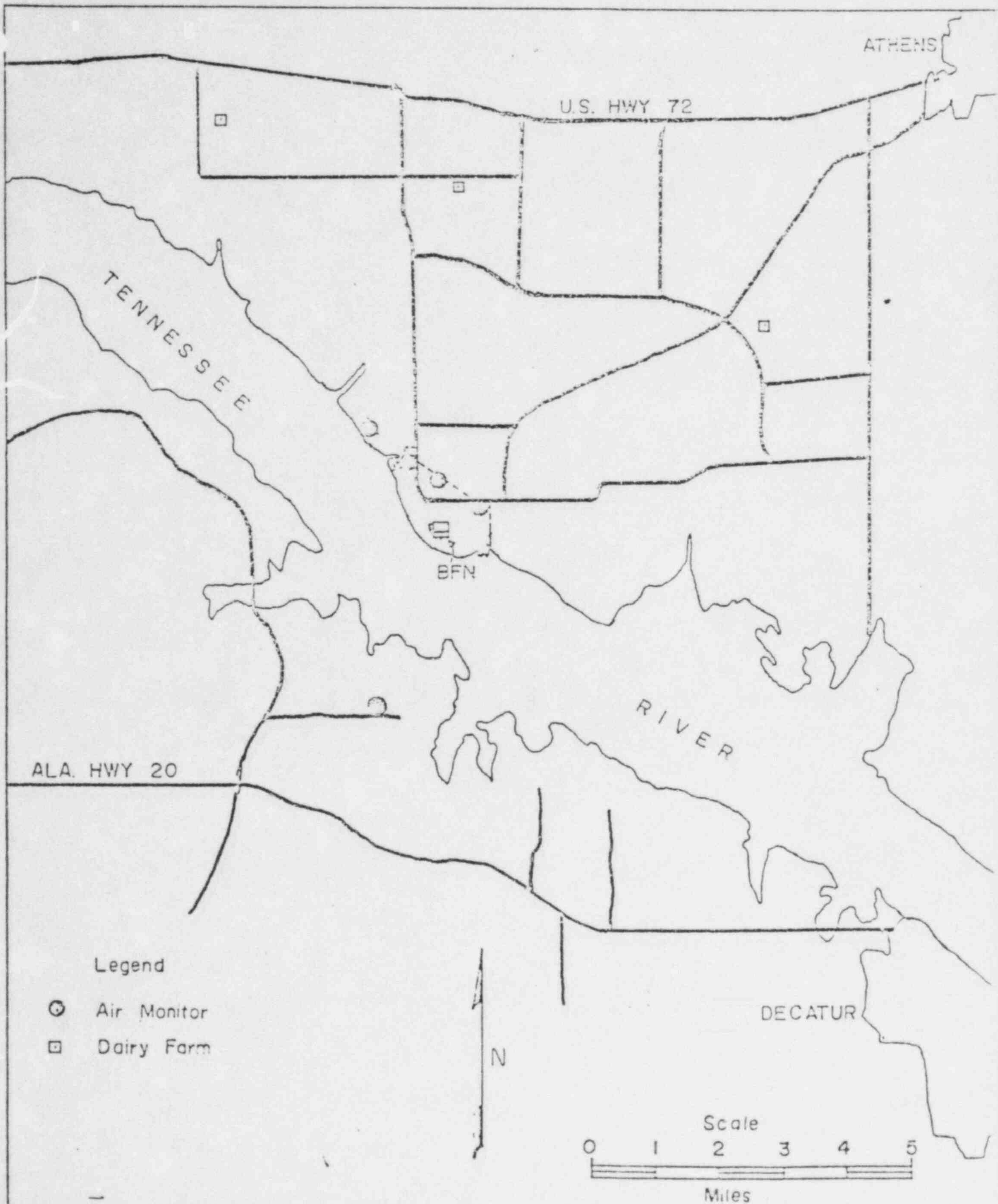
LOCAL MONITORING STATIONS
BROWNS FERRY NUCLEAR PLANT



JAN 4 198

Figure 3.1-3

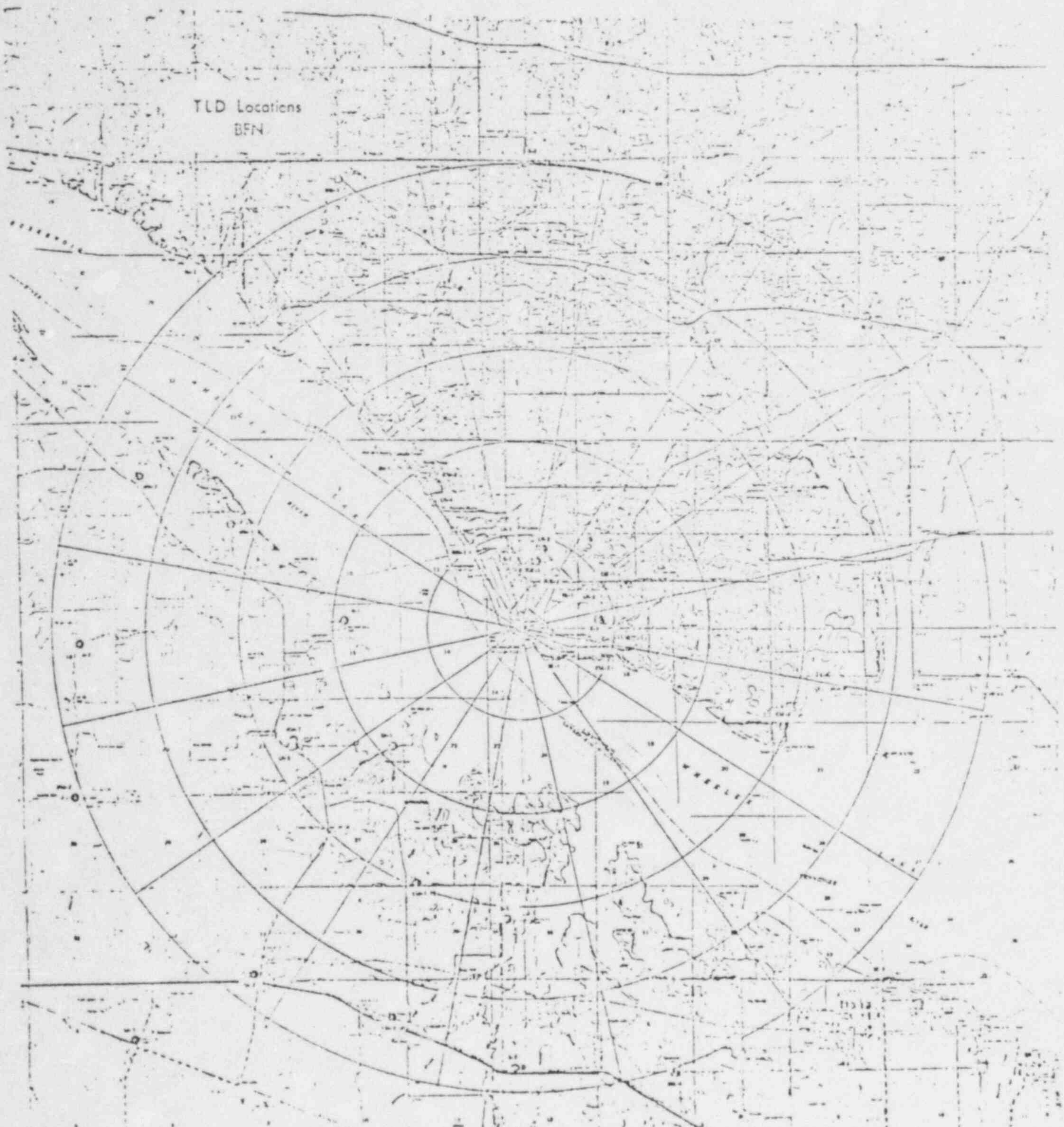
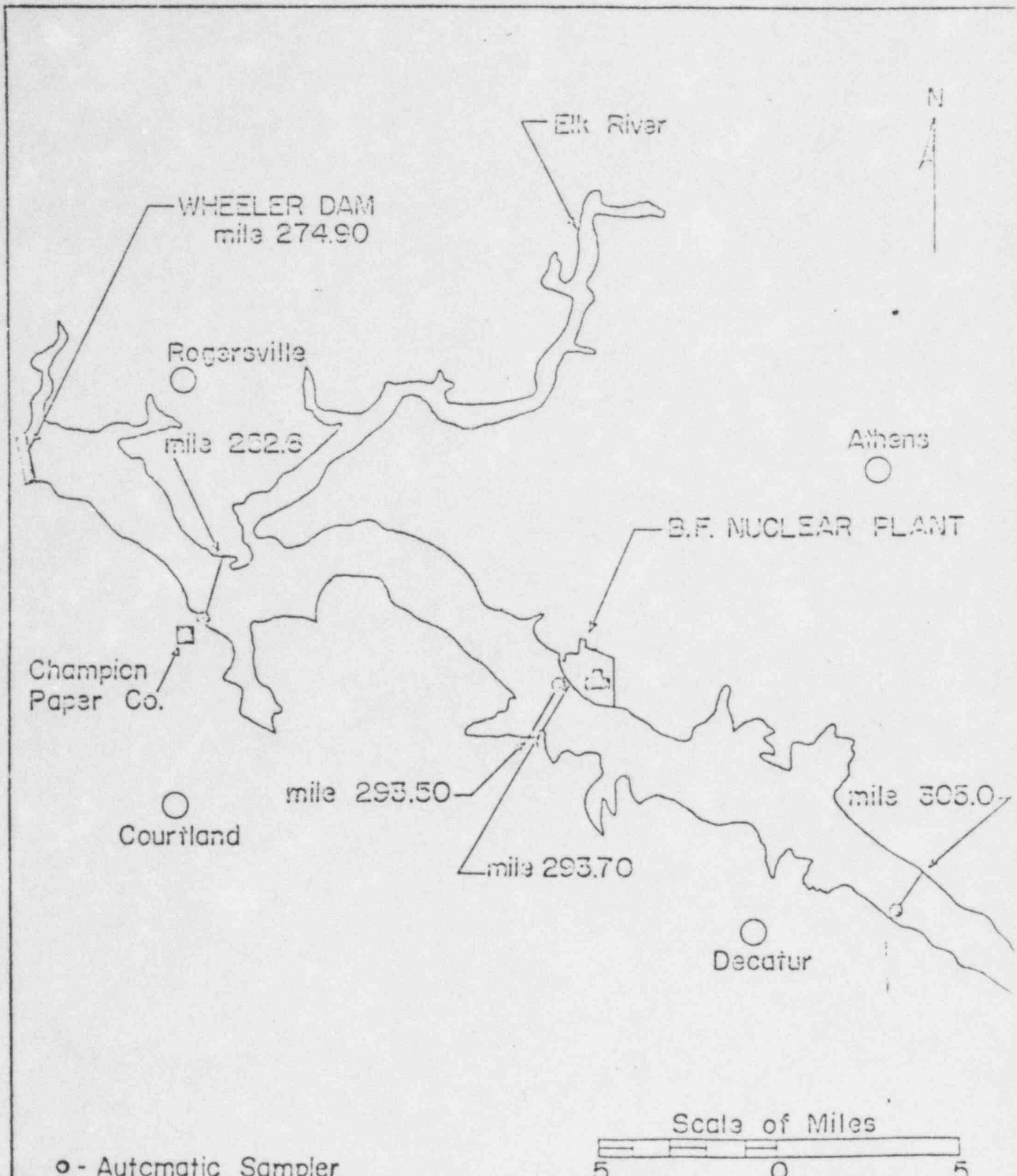
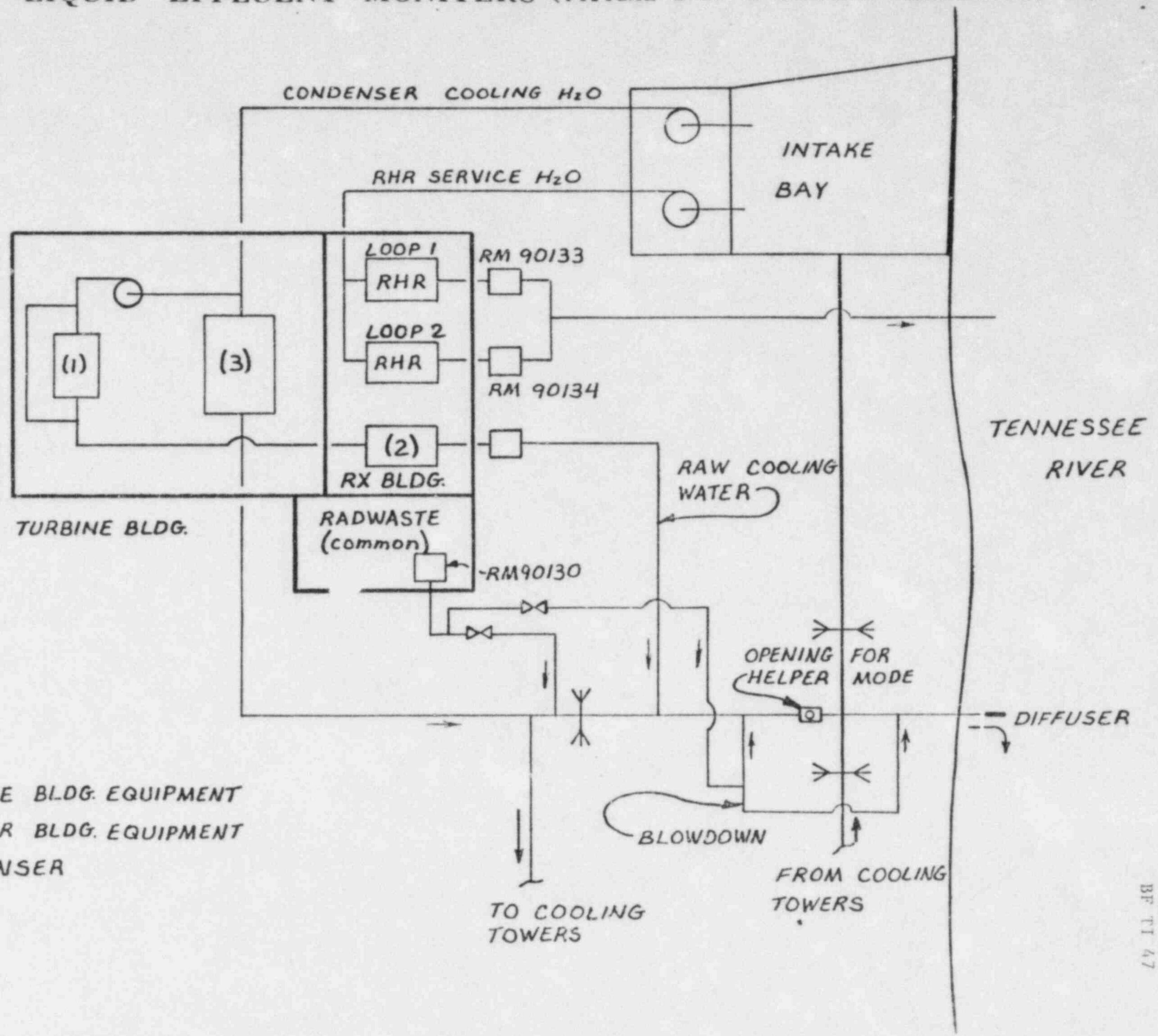


Figure 5.1-[illegible]
Browns Ferry Nuclear Plant

RESERVOIR MONITORING NETWORK



BFNP LIQUID EFFLUENT MONITERS (TYPICAL UNIT & COMMON RADWASTE)



(1) TURBINE BLDG. EQUIPMENT

(2) REACTOR BLDG. EQUIPMENT

(3) CONDENSER

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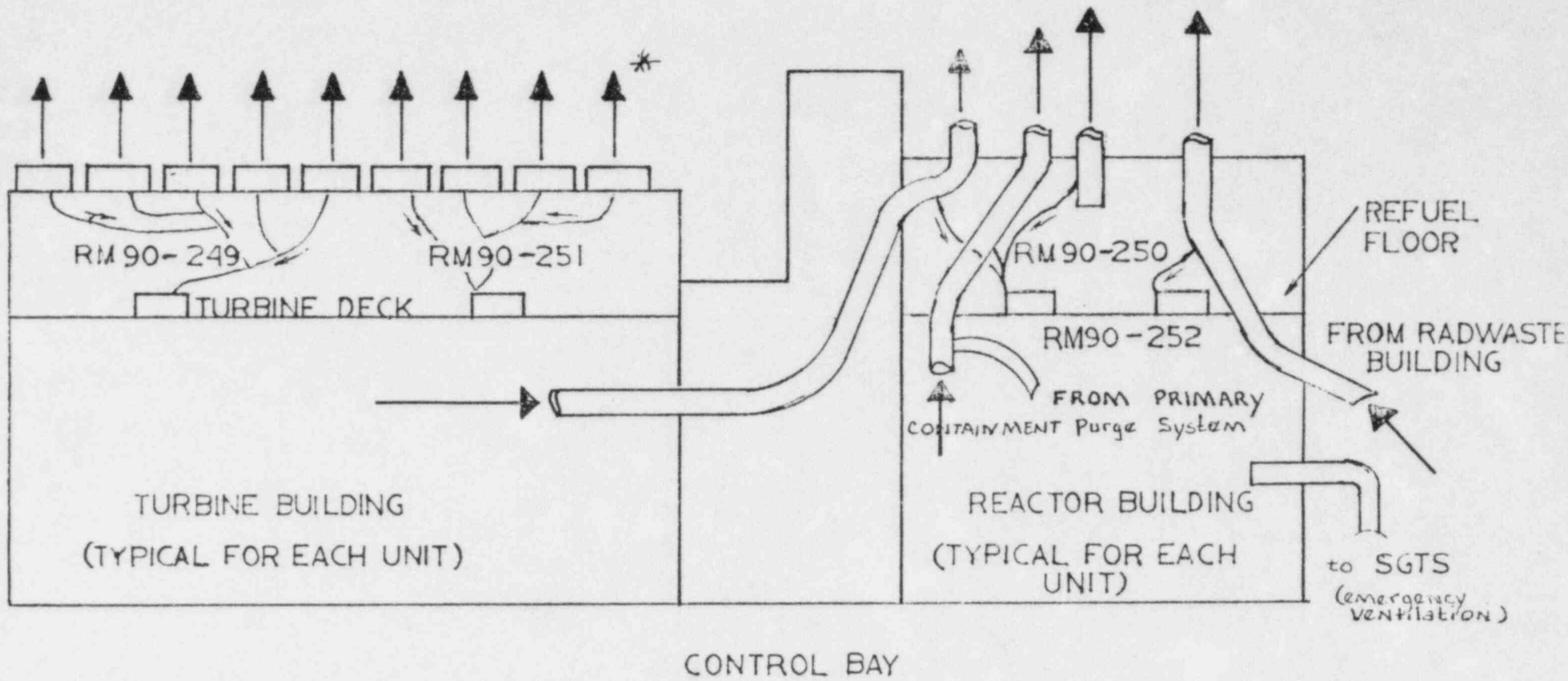
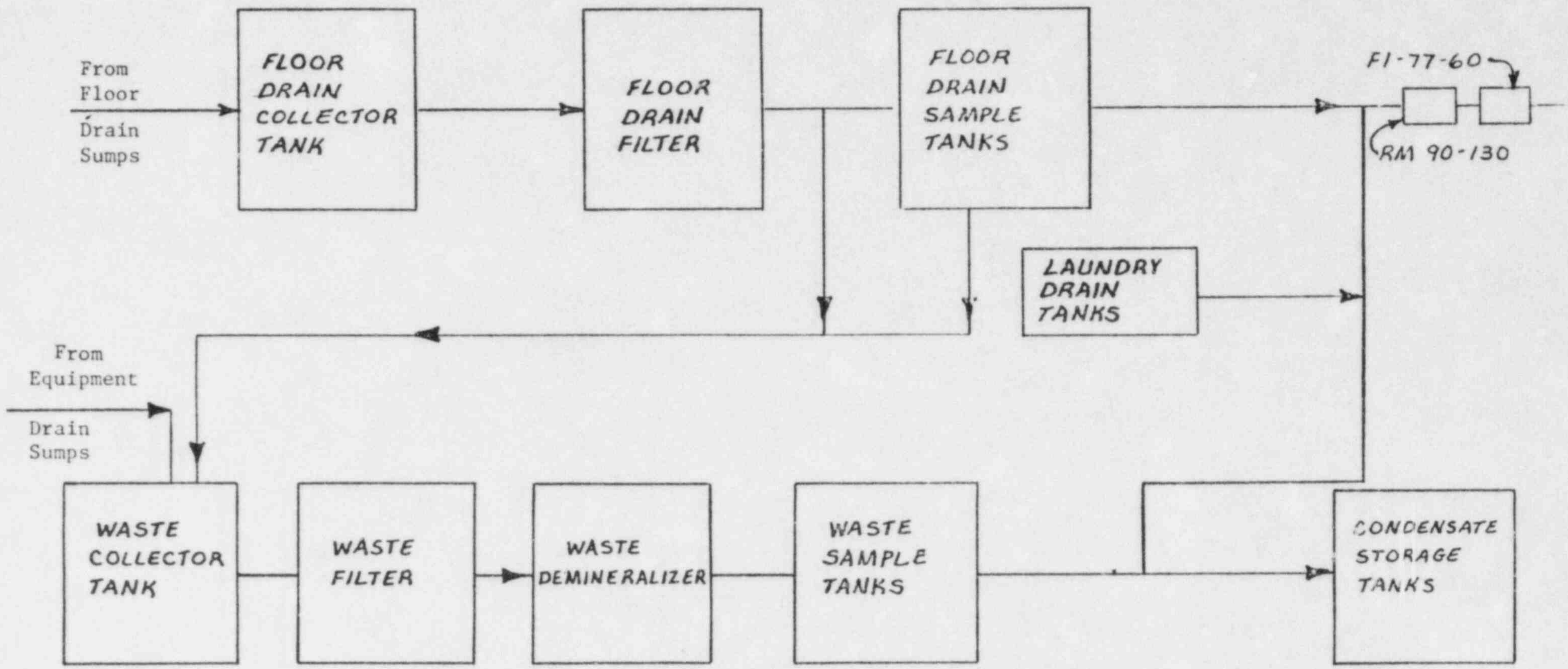
BFNP NORMAL BUILDING VENTILATION



*ROOF FANS USED SEASONALLY TO CONTROL TEMPERATURE

BROWNS FERRY NUCLEAR PLANT LIQUID

RADWASTE TREATMENT SYSTEM



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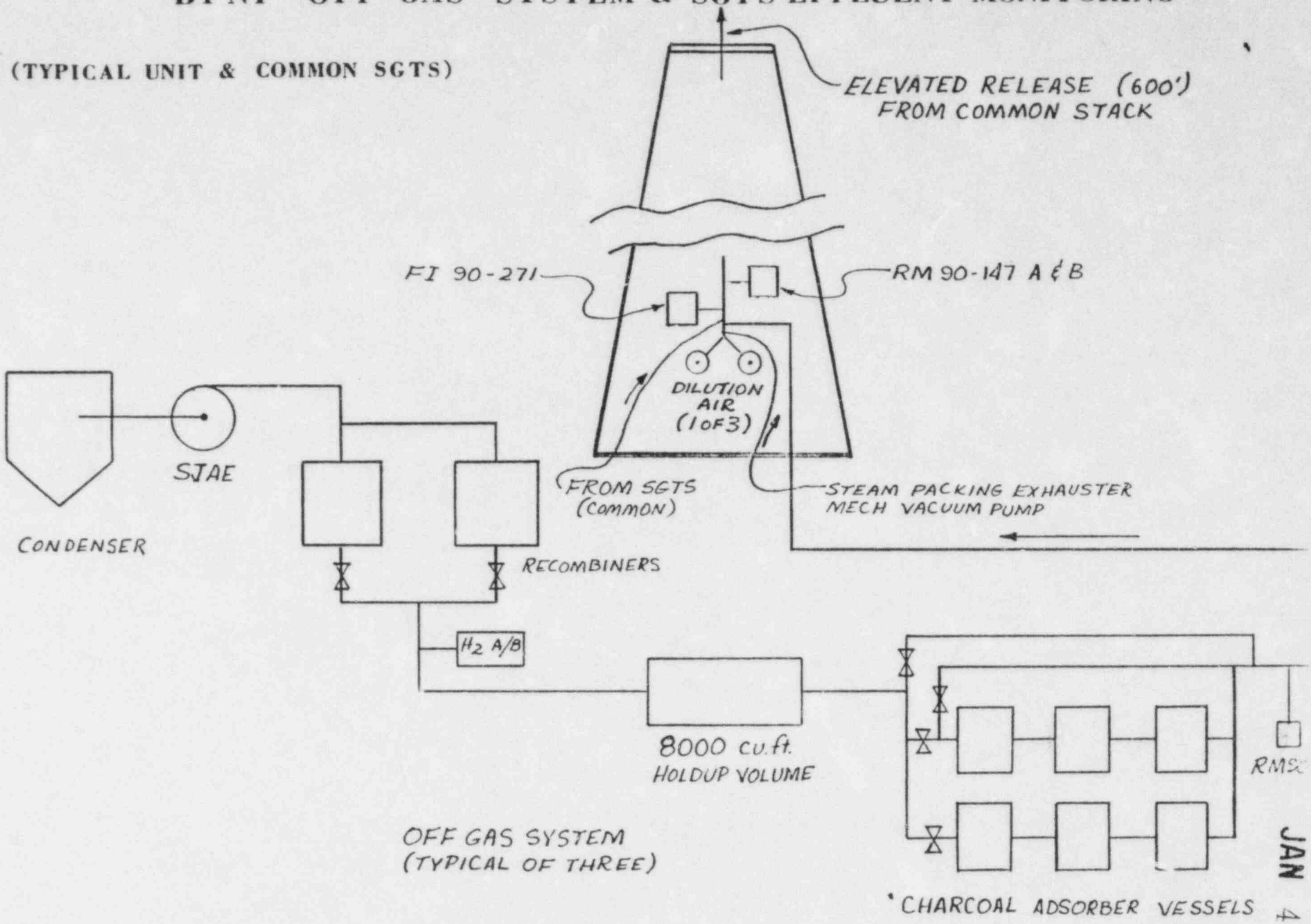
BFNP OFF GAS SYSTEM & SGTS EFFLUENT MONITORING

(TYPICAL UNIT & COMMON SGTS)



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