OFFSITE DOSE CALCULATION MANUAL

FOR

GEORGIA POWER COMPANY

VOGTLE ELECTRIC GENERATING PLANT

REVISION 3

MARCH 1987

A009
1/1

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont.)

TABLE OF CONTENTS (Cont.)

TABLE OF CONTENTS (Cont.)

LIST OF TABLES

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES

REFERENCES

1. J. S. Boegli, R. R. Bellamy, W. L. Britz, and R. L. Waterfield, "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants", NUREG-0133 (October 1978).

2. Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR 50, Appendix I, U. S. NRC Regulatory Guide 1.109 (March 1976).

3. Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR 50, Appendix I, U. S. NRC Regulatory Guide 1.109 Rev. 1 (October 1977).

4. Vogtle Electric Generating Plant, Unit 1 and Unit 2, Environmental Report - Operating License Stage, Georgia Power Company.

5. Vogtle Electric Generating Plant, Unit 1 and Unit 2, "Final Safety Analysis Report", Georgia Power Company.

6. Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors, U.S. NRC Regulatory Guide 1.111 (March 1976).

7. Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors, U.S. NRC Regulatory Guide 1.111, Rev. 1 (July 1977).

8. Estimating Acquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I, U. S. NRC Regulatory Guide 1.113, Rev. 1 (April 1977).

9. Vogtle Nuclear Plant, Units 1 and 2, Waste Water Effluent Discharge Structure Plume Analysis; Georgia Power Company; April 1981.

10. Direct communications with Water Resources Division; U.S. Geological Survey; U. S. Department of Interior; February 1985.

11. Water Resources Data, Georgia, Water Year 1983; U. S. Geological Survey, Water - Data Report GA-83-1; W. R. Stokes, III, T. W. Hale, J. L. Pearman, and G. R. Buell; June 1984.

12. Vogtle Electric Generating Plant Land Use Survey - 1986; 2
Georgia Power Company; April 1986.

13. Letter to Georgia Power Company from Pickard Lowe, and 2,3
Garrick, Inc.; Washington, D.C.; December 16, 1986.

14. Kahn, Bernd, et. al; "Bioaccumulation of P-32 in Bluegill 2
and Catfish"; NUREG/CR-3981 (February 1985).

15. Sagendorf, et.al; "XOQDOQ: Computer Program for the 3
Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations"; NUREG/CR-2919 (September 1982).

INTRODUCTION

The OFFSITE DOSE CALCULATION manual is a supporting document of the RADIOLOGICAL EFFLUENT TECHNICAL SPECIFICATIONS. As such the ODCM describes the methodology and parameters to be used in the calculation of offsite doses due to radioactive liquid and gaseous effluents and in the calculation of liquid and gaseous effluent monitoring instrumentation alarm/trip setpoints. The ODCM contains schematics of liquid and gaseous radwaste effluent treatment systems, which include release points to unrestricted areas. Also included in the ODCM are a list and maps indicating specific sample locations for the radiological environmental monitoring program.

The ODCM will be maintained at the plant for use as a reference guide and training document of accepted methodologies and calculations. Changes in the calculational methods or parameters will be incorporated into the ODCM in order to assure that the ODCM represents current methodology in all applicable areas. Computer software to perform the described calculations will be maintained current with the ODCM.

SECTION 1

LIQUID EFFLUENTS

The Vogtle Electric Generating Plant is located on the west bank of the Savannah River approximately 151 river miles from the Atlantic Ocean. There are two pressurized water reactors on the site. Each unit is served by a separate liquid waste processing system; however, certain components are shared between the two systems. All liquid radwastes treated by the liquid waste processing system are collected in waste monitor tanks for sampling and analysis prior to release. Releases from the waste monitor tanks are to the discharge line from the blowdown sump to the Savannah River. The blowdown sump receives input from the waste water retention basins, turbine plant cooling tower blowdown, and nuclear service cooling tower blowdown. Additional dilution water is available from the cooling tower make-up water bypass line.

Although no significant quantities of radioactivity are expected in the nuclear service cooling water, the steam generator blowdown processing system, the turbine building drain system, or the control building sump, these effluent pathways are monitored as a precautionary measure. The monitors serving the latter three effluent pathways provide for automatic termination of release from these systems in the event radioactivity is detected above predetermined levels. These three systems discharge to the waste water retention basin. Sampling and analysis of releases via these effluent pathways must be sufficient to assure that the dose limits specified in Technical Specification 3.11.1.2 are not exceeded. 2

The Liquid Effluent Section of the ODCM describes the methodology for calculating monitor setpoints and for calculating individual doses due to liquid effluents released from Plant Vogtle to the Savannah River. Schematics of the liquid waste processing systems are presented in Figures 1.5-1 and 1.5-2. Liquid discharge pathways are shown in Figure 1.5-3.

1.1. LIQUID EFFLUENT MONITOR SETPOINTS

Liquid monitor setpoint values calculated in accordance with the methodology presented in this Subsection will be regarded as upper bounds for the actual monitor setpoints for high alarms. However, a lower setpoint may be established on the monitor if desired. Intermediate level setpoints should be established at an appropriate level to give sufficient warning prior to reaching the high alarm setpoint. The basic calculated monitor setpoint value is in terms of concentration, uCi/ml. The actual monitor setpoint established on the monitor is the calculated monitor setpoint value adjusted by appropriate calibration data, and monitor background. Monitor calibration data may include operational data obtained from monitor response to concentrations determined by liquid sample analyses. In addition, monitor background must be controlled so that the monitor is capable of responding to concentrations in the range of the setpoint value.

For planned releases from the liquid waste processing systems' monitor tanks, monitor setpoints are determined to assure that the limits of 10 CFR 20 are not exceeded. For the steam generator processing system effluent line, the turbine building drain effluent line and the control building sump effluent line, the purpose of the monitor setpoints is to minimize releases of radioactivity from these systems by terminating releases upon detection of low levels of radioactivity. Therefore, setpoints for these monitors should be established as close to background as practical to prevent spurious alarms and yet alarm should an inadvertent release occur. This approach should also be used for establishing monitor setpoints when no release is planned for a particular pathway, or if there is no detectable activity in the planned release.

1.1.1. Liquid Waste Processing System Effluent Monitor (RE0018) (One monitor per unit)

The liquid waste processing system effluent line radioactivity monitors provide alarm and automatic termination of release prior to exceeding the concentration limits specified in 10 CFR 20, Appendix B, Table II, Column 2 at the release point to the unrestricted area. Concentration limits are specified in Technical Specification 3/4.11.1.1; setpoint requirements are specified in Technical Specification 3.3.3.10. To meet these specifications, the alarm/trip setpoint for this liquid effluent monitor is set to assure that the following equation is satisfied:

$$\frac{cf}{F + f} \leq C_{MPC} \qquad (1)$$

where:

C_{MPC} = the effluent concentration limit corresponding to the specific mix of radionuclides in the waste monitor tank being considered for discharge, in uCi/ml.

c = the setpoint, in uCi/ml, of the radioactivity monitor measuring the concentration of radioactivity in the effluent line prior to dilution and subsequent release. (Note that the monitor setpoint is inversely propor-
tional to the effluent flow rate, f, and 1
directly proportional to the dilution stream flow rate, F + f.) The setpoint represents a concentration value which, if exceeded, could result in concentrations exceeding the limits of 10 CFR 20 in the unrestricted area.

f = the effluent flow rate at the location of the radioactivity monitor, in volume per unit time, and in the same units as F, below.

F = the dilution stream flow rate which can be assured prior to the release point to the 1
river, in volume per unit time.

At Plant Vogtle, the liquid waste processing system collects liquid wastes in monitor tanks prior to release. There are two waste monitor tanks for each unit. The discharge lines from the two tanks join to form a common line, on which the radioactivity monitor is installed. The lines from each unit then join to form a common line which releases to the blowdown sump discharge line to the Savannah River. (See Figure 1.5-3)

Dilution flow comes from the blowdown sump which receives water from nuclear service cooling tower blowdown, turbine plant cooling tower blowdown, waste water retention basin discharge, and the cooling tower make-up line. The two major sources for dilution are the turbine plant cooling tower blowdown and the cooling tower make-up bypass line. A predetermined 1
dilution flow rate must be assured for use in the calculation of the radioactivity monitor setpoint.

While equation (1) shows the relationships between the limiting concentration, C_{MPC}, the effluent flow rate, f, the dilution flow rate, F, and the radioactivity monitor setpoint, it cannot practically be applied to a mixture of radionuclides with different limiting concentrations, i.e. different MPC values.

For a mixture of radionuclides, equation (1) is satisfied in a practicable manner, based on measured radionuclide concentrations and a dilution stream flow rate which can be assured for the duration of the release, designated as F_d, by calculating the MPC fraction for the radionuclide mixture, the maximum permissible effluent flow rate, f_m, and the radioactivity monitor setpoint, c.

In order to facilitate effluent release control and accountability, liquid releases normally should be controlled administatively such that only one waste monitor tank per unit is released at a time. Subsection 1.1.1.1 presents the methodology for calculating the monitor setpoint for this situation. In the event it becomes necessary to release both waste monitor tanks, of the same unit, at the same time, the methodology for calculating the monitor setpoint is more complex. This increased complexity is due to the fact that the two waste monitor tanks discharge through a common line served by a single monitor. Therefore, the radioactivity concentration at the monitor is a function of the concentrations measured in each tank and the flow rates at which the tanks are released. The setpoint methodology for this situation is presented in Subsection 1.1.1.2.

1.1.1.1. <u>Monitor Setpoint Calculation Methodology When One Waste Monitor Tank per Unit Is to Be Released at a Time</u>

Step 1) The radionuclide concentrations for the waste monitor tank planned for release are determined in accordance with Technical Specification Table 4.11-1. The relationship of the various required sample analyses is shown as follows:

$$\sum_i C_i = \sum_g C_g + (C_a + C_s + C_f + C_t) \quad (2)$$

where

C_g = the concentration of each measured gamma emitter observed by gamma-ray spectroscopy of the particular waste sample.

C_a = the concentration of alpha emitters in liquid waste as measured in the MONTHLY composite sample. (NOTE: Sample is analyzed for gross alpha.)

C_s = the measured concentrations of Sr-89 and Sr-90 in liquid waste as observed in the QUARTERLY composite sample.

C_f = The measured concentrations of Fe-55 in liquid waste as observed in the QUARTERLY composite sample.

C_t = the measured concentration of H-3 in liquid waste as determined from analysis of the MONTHLY composite sample.

The C_g term will include the analysis of each batch; terms for alpha, strontiums, iron, and tritium will be included in accordance with Technical Specification Table 4.11-1 as appropriate.

In order to assure that sample analyses are based on samples which are representative of the volume from which the samples are taken, liquid volumes must be thoroughly mixed prior to sampling. Mixing may be
accomplished by any method of mixing which has been 1
demonstrated to achieve mixing sufficient to allow representative sampling.

Step 2) Measured radionuclide concentrations are used to calculate MPC fractions. The MPC fractions are used along with a safety factor to calculate a required dilution factor, which is the ratio of dilution flow rate to monitor tank discharge flow rate which would be required to assure that the limiting concentrations of 10 CFR 20, Appendix B, Table II, Column 2 are not exceeded at the point of release to the river. The required dilution factor, RDF, is calculated as follows:

$$RDF = \sum_i \frac{C_i}{MPC_i} \div SF$$

$$RDF = \left[\sum_g \frac{C_g}{MPC_g} + \frac{C_a}{MPC_a} + \frac{C_s}{MPC_s} + \frac{C_f}{MPC_f} + \frac{C_t}{MPC_t}\right] \div SF \quad (3)$$

where

C_i = measured concentrations of C_g, C_a, C_s, C_f and C_t as defined in Step 1. Terms C_a, C_s, C_f, and C_t will be included in the calculation as appropriate.

MPC_i = MPC_g, MPC_a, MPC_s, MPC_f, and MPC_t are limiting concentrations of the appropriate radionuclide from 10 CFR 20, Appendix B, Table II, Column 2. For dissolved or entrained noble gases, the concentration shall be limited to 2×10^{-4} uCi/ml total activity. For gross alpha the maximum permissible concentration shall be 3×10^{-8} uCi/ml. If specific alpha-emitting radionuclides are measured, the MPC for the specific radionuclide(s) shall be used. 2

SF = the safety factor, which is a conservative factor selected to compensate for statistical fluctuations and errors of measurements. The value for the safety factor must be between 0 and 1; a value of 0.5 is a reasonable value for liquid releases. A more precise value may be developed if desired.

Step 3) Determine the dilution stream flow rate which will be assured during the period of the release, which is designated as F_d. For Plant Vogtle the flow rate which can be assured is the value selected as the setpoint for the dilution stream flow rate measurement device. Since the value selected as the setpoint for the dilution stream flow rate measurement device is the dilution stream flow rate which can be assured during the release, this value must be used as the basis for calculating the maximum permissible effluent release rate, f_m, and the radioactivity monitor setpoint, c.

If simultaneous releases are planned from the liquid waste processing systems of Unit 1 and Unit 2, the dilution stream must be allocated between the two units. This is accomplished by multiplying the assured dilution stream flow rate, F_d, by an allocation factor, AF, to obtain a unit-specific assured dilution stream flow rate, F_{du}:

$$F_{du} = F_d \, (AF) \tag{4}$$

where

AF = An allocation factor selected to apportion the diluting capacity of the dilution stream between the two units when simultaneous releases from the liquid waste processing systems are planned. AF may be assigned any value between 0 and 1 for each unit under the condition that the sum of the allocation factors does not exceed 1. For convenience AF may be assigned the value of 0.5 for each unit. Also, if it is desired to make liquid waste processing system releases from each unit without regard to releases from the other unit, AF should be assigned the value of 0.5 for each unit.

If more precise allocation values are desired, they may be determined based on the relative radiological impact of each unit's liquid waste processing system effluent stream on the dilution stream, which may be approximated by multiplying the MPC fraction of each effluent stream by its associated planned release flow rate and comparing these values for the two units.

If no simultaneous liquid waste processing system releases are being made, AF may be assigned the value of 1 and then F_{du} is equal to F_d.

For the case RDF $<$ 1, the waste monitor tank meets the limits of 10 CFR 20 without dilution and could be released at any desired flow rate. However, in order to maintain

individual doses due to radioactivity in liquids released to unrestricted areas ALARA, no releases from the liquid waste processing system should be made if assured dilution 1
stream flow rate, F_d, is less than 5000 gpm.

Step 4) For the case RDF>1, calculate the maximum permissible waste monitor tank discharge flow rate, f_m, as follows:

$$f_m = \frac{F_{du}}{RDF-1} \qquad (5)$$

For the case RDF ≤ 1, equation (5) is not valid. However, as discussed above, for the case RDF ≤ 1 the release may be made at full pump discharge capacity and the monitor setpoint calculated in accordance with Step 5.

NOTE 1: Waste monitor tank discharge flow rate is actually limited by pump design discharge capacity which is 100 gpm (maximum). When calculated maximum permissible release flow rates are ≥100 gpm, the release may be made at full pump capacity. Release rates < 100 gpm may be achieved by throttling.

Note 2: If radioactivity due to plant operations is detected in any of the effluent streams discharging to the blowdown sump (waste water retention basin, nuclear service water cooling tower blowdown, or turbine plant cooling tower blowdown), the diluting capacity of the dilution stream would be diminished. (Further, sampling and analysis of these effluent streams must be sufficient to assure that the dose limits specified in Technical Specification 3.11.1.2 are not exceeded.) Under these conditions, equation (5) must be modified to include a term to account for radioactivity present in the dilution stream prior to the introduction of the liquid waste processing system effluent: 2

$$f_m = \frac{F_{du}}{RDF-1}\left[1 - \sum_r \sum_i \left(\frac{C_i}{MPC_i}\right)_r \frac{f_r}{F_d}\right] \qquad (6)$$ 2

where

$\sum_i (C_i/MPC_i)_r$ is the MPC fraction of the effluent stream(s) containing the detectable radioactivity.

f_r is the flow rate of the effluent stream(s) containing the radioactivity.

If RDF ≤ 1, NOTE 2 does not apply.

Step 5) Based on the values determined in the previous steps, a liquid waste processing system effluent radioactivity monitor base setpoint is calculated to provide assurance that the limits of 10 CFR 20, Appendix B, Table II, Column 2 will not be exceeded. The radioactivity monitor response is to gamma radiation primarily; therefore, the monitor setpoint calculation is based on $\sum_g C_g$, in units of uCi/ml, as follows: 1

$$c = A \sum_g C_g \quad (7)$$

where

A = Adjustment factor which will allow the setpoint to be established in a practical manner to prevent spurious alarms and to allow for the margin between measured concentrations and concentrations which would approach 10 CFR 20 limits:

$$A = \frac{ADF}{RDF} \quad (8)$$

NOTE: ADF is the assured dilution factor: 1

$$ADF = \frac{F_{du} + f_a}{f_a} \quad (8a)$$

and f_a is the anticipated release flow rate from the waste monitor tank to be discharged.

If $A \geq 1$, calculate the monitor setpoint, c. However, if the calculated setpoint value is within 10 percent of the actual concentration planned for release, it may be impractical to set the monitor setpoint based on this value. If this situation should arise, it indicates that measured concentrations are approaching values which could cause 10 CFR 20 limits to be exceeded. Therefore, steps should be taken to reduce potential release concentrations. These steps may include decreasing the planned waste monitor tank release rate, increasing the dilution stream flow rate, postponing simultaneous releases, and/or by decreasing concentrations by further processing of the liquid waste planned for release. Following these actions, repeat the previous steps and calculate a new monitor setpoint.

If $A < 1$, no release may be made under planned conditions. Consider the alternatives discussed above to reduce potential release concentrations, and calculate a new monitor setpoint based on the results of the alternatives selected.

The calculated setpoint establishes the base value for the radioacitvity monitor setpoint. However, in establishing the actual setpoint for a particular monitor, adjustments must be taken into account for background radiation levels and monitor calibration information. Background radiation levels must be controlled such that radioactivity levels in the effluent stream being monitored can accurately be assessed at levels below the setpoint value.

Calibration of the monitors by the manufacturer utilized NBS traceable liquid solutions in the exact geometry of the production monitors over a gamma-ray emergy range of 0.08 to 1.33 MeV. The calibration factor is a function of the radionuclide mix in the liquid to be released and will be calculated for the monitor based on the results of the pre discharge sample results from the laboratory gamma-ray spectrometer system. The actual monitor setpoint is determined as follows: 2

$$C_{ms} = \left[A \sum_g C_g (CF)_g\right] + BG \qquad (8b)$$

Where 1,2

CF = the calibration factor for the particular radionuclide g for the monitor. 2

BG = background level for the particular monitor

The monitor setpoints determined in accordance with the methodology described above establishes the upper bound for a particular monitor setpoint. Monitor setpoints may be established at lower values if desired. If no release is planned for the discharge line served by a particular monitor or if the planned release contains no measurable radioactivity, the monitor setpoint should be established as close to background as practical to prevent spurious alarms and yet alarm should an inadvertent release occur.

1.1.1.2 Monitor Setpoint Calculation Methodology When Two Waste Monitor Tanks per Unit Are to Be Released at a Time

Step 1) Determine radionuclide concentrations for each waste monitor tank as described in Step 1 of Subsection 1.1.1.1.

From the $\sum_g C_g$ terms determined for each tank, determine an effective $(\sum_g C_g)_e$ for the two tanks considered together as follows:

$$(\sum_g C_g)_e = \frac{V_1(\sum_g C_g)_1 + V_2(\sum_g C_g)_2}{V_1 + V_2} \quad (9)$$

where

V_1 = Volume of liquid in tank containing greater quantity (referred to throughout this Subsection as first tank.)

V_2 = Volume of liquid in tank containing lesser quantity (referred to throughout this Subsection as second tank).

$(\sum_g C_g)_1$ = measured concentrations of gamma emitting radionuclides in first tank

$(\sum_g C_g)_2$ = measured concentration of gamma emitting radionuclides in second tank

Step 2) Determine a required dilution factor, RDF, for each tank in accordance with Step 2 of Subsection 1.1.1.1. Using these values calculate an effective required dilution factor, $(RDF)_e$, for the two tanks considered together as follows:

$$(RDF)_e = \frac{V_1\ (RDF)_1 + V_2\ (RDF)_2}{V_1 + V_2} \quad (10)$$

where

V_1 = volume of first tank

V_2 = volume of second tank

$(RDF)_1$ = required dilution factor for first tank

$(RDF)_2$ = required dilution factor for second tank

Step 3) Determine the dilution stream flow rate in accordance with step 3 of Subsection 1.1.1.1.

Step 4) To facilitate calculation of the monitor setpoint, determine release flow rates for each tank so that the durations of the releases from the two tanks are equal. First select a release flow rate for the first tank, f_1. Then determine the release flow rate for the second rank, f_2, as follows:

$$f_2 = \frac{f_1 V_2}{V_1} \quad (11)$$

Next, determine a combined flow rate, f_c, for releases from both tanks, as follows:

$$f_c = f_1 + f_2 \quad (12)$$

Next, calculate a maximum permissible flow rate, f_m, for the combined release in accordance with Step 4 of Subsection 1.1.1.1 using the effective $(RDF)_e$ determined in Step 2 above.

Then compare the combined release flow rate, f_c, with the maximum permissible combined release flow rate, f_m. If $f_m > f_c$, the release may be made under the assumed conditions. If $f_m < f_c$, the two release flow rates may be throttled, maintaining the same ratio of f_2 to f_1, as determined earlier. If it is impractical to throttle the release flow rates to the necessary degree to achieve $f_c < f_m$, steps must be taken to reduce potential release concentrations prior to making the release, and a new f_c determined following the necessary actions. (Steps which may be undertaken to reduce potential release concentrations were discussed in Step 5 of Subsection 1.1.1.1.)

Step 5) Calculate the monitor setpoint in accordance with Step 5 of Subsection 1.1.1.1 with the following substitutions:

$$\text{Let} \sum_g C_g = \left(\sum_g C_g \right)_e;$$

$$RDF = (RDF)_e;$$

$$\text{and } f_a = f_c$$

Observe the same limiting conditions discussed in Step 5 of Subsection 1.1.1.1.

1.1.2. Steam Generator Blowdown Effluent Radioactivity Monitor (RE-0021); Turbine Building Drain Effluent Radioactivity Monitor (RE-0848); and Control Building Sump Effluent Radioactivity Monitor (RE-17646). (One of each monitor per unit)

According to Plant Vogtle design and operating philosophy, the purpose of these radioactivity monitors is to minimize release of radioactivity via these effluent streams by automatically isolating or diverting effluent flow upon radioactivity in either of the effluent streams reaching certain low levels. In order to achieve the desired objective, setpoints for these monitors should be established as close to background radiation levels as practical to prevent spurious alarms and yet alarm should an inadvertent release occur. The actual setpoint for each monitor should be established under operating conditions and within the stated objective of preventing releases of
radioactivity via these pathways to the extent practicable. All 1
three of these effluent streams discharge to the waste water retention basin, which in turn releases to the blowdown sump; the blowdown sump discharges to the Savannah River.

Should it become necessary to make releases from any of these three sources containing levels of radioactivity above that which would normally be isolated or diverted, radioactivity monitor setpoints should be determined in the same manner as described in Subsection 1.1.1. However, special consideration must be given to Step 3. An allocation factor must be assigned to the release pathway under consideration here and allocation factors for other pathways, which may be releasing simultaneously, adjusted if necessary so that for simultaneous liquid releases from the site, the sum of the allocation factors does not exceed 1.

As stated earlier, all three of these effluent streams
discharge to the waste water retention basin. Composite samples
are collected from the discharge line from the waste water
retention basin to the blowdown sump. Sample collection and 2
analysis must be sufficient to assure that the dose limits
specified in Technical Specification 3.11.1.2 are not exceeded.

1.1.3. Nuclear Service Cooling Water System Effluent Radioactivity Monitor (RE-0020 A and B) (Two monitors per unit)

Radioactivity in these effluent streams normally is expected to be below detectable levels. Therefore, the radioactivity monitor setpoints should be established as close to background as practical to prevent spurious alarms and yet alarm should an inadvertent release occur. If any one of these effluent streams should become contaminated with radioactivity, radionuclide concentrations must be determined and a radioactivity monitor setpoint determined in the same manner as described in Subsection 1.1.1. However, special consideration must be given to Step 3. An allocation factor must be assigned to the release pathway under consideration here and allocation factors for other pathways, which may be releasing simultaneously, adjusted if necessary so that for simultaneous liquid releases from the site the sum of the allocation factors does not exceed 1. Determination of concentrations of
radioactivity in these streams must be adequate to assure that 2
the dose limits specified in Technical Specification 3.11.1.2 are not exceeded.

1.2. DOSE CALCULATION FOR LIQUID EFFLUENTS 1

For liquid releases from Plant Vogtle to the Savannah River, two human exposure pathways exist: consumption of drinking water and fish taken from the river. Fish are considered to be taken from the vicinity of the plant discharge; drinking water is taken from the river for potable use at Beaufort, South Carolina, which is approximately 112 river miles downstream from the plant site. The methodology for calculating doses to an individual due to exposure to these two pathways is presented in this Subsection.

The dose limits specified in Technical Specification 3.11.1.2 are on a per reactor basis. Therefore the doses calculated in accordance with this Subsection must be determined and recorded on a per reactor basis.

The dose to the maximum exposed individual due to radionuclides identified in liquid effluents released from each unit to unrestricted areas will be calculated for the purpose of implementation of Technical Specification 3.11.1.2, as follows:

$$D_\tau = \sum_i A_{i\tau} \sum_{l=1}^{m} \Delta t_l \, C_{il} \, F_l \qquad (13)$$

where

D_τ = The cumulative dose commitment to the total body or any organ, τ, due to radioactivity in liquid effluents for the total time period $\sum_{l=1}^{m} \Delta t_l$ in mrem (Reference 1).

Δt_l = The length of the lth time period over which C_{il} and F_l are averaged for any liquid release, in hours.

C_{il} = The average concentration of radionuclide i, in undiluted liquid effluent during time period Δt_l from any liquid release, in uCi/ml.

F_l = The near field average dilution factor in the Savannah River during any liquid effluent release, defined as the ratio of the undiluted liquid waste flow during release to the product of the average dilution stream flow rate into the river times Z.

NOTE: If simultaneous releases from both units occur, the dilution stream flow rate must be apportioned between the two units as discussed in Subsection 1.1.1, Step 3. In such cases, F_l is unit-specific).

$$F_l = \frac{\text{(average undiluted liquid waste flow)}}{\text{(average dilution stream flow during the period of release of radioactivity)} \times Z} \quad (14)$$

NOTE: The denominator of equation (14) is limited to 1000 cfs (448,800 gpm) or less. (Reference 1, Section 4.3).

Z = Applicable dilution factor for the Savannah River. For the months May through December, Z=10; for the months January through April, Z=20. (Reference 5, Section 11.2.3.4; Reference 11)

$A_{i\tau}$ = The site-related adult ingestion dose commitment factor to the total body or any organ for each identified radionuclide. Site-related $A_{i\tau}$ values for Plant Vogtle are listed in Table 1.2-3 in mrem-ml per hr-uCi.

$$A_{i\tau} = K_o((U_w/D_w)\ e^{-\lambda_i t_w} + U_F\ BF_i\ e^{-\lambda_i t_f})\ DF_{i\tau} \quad (15)$$

K_o = Units conversion factor 1.14×10^5, determined by:

$$10^6 \frac{pCi}{uCi} \times 10^3 \frac{ml}{l} \div 8760 \frac{hr}{yr}$$

U_w = Adult drinking water consumption (730 liters/yr; Reference 3, Table E-5)

D_w = Dilution factor from the vicinity of the liquid release point for the plant site to the potable water intake location (8; Reference 11)

λ_i = The decay constant for radionuclide i. (hr^{-1})

t_w = Transit time from release to receptor for water consumption (48 hours; Reference 3, Section A.2; Reference 10)

U_F = Adult fish consumption (21 kg/yr; Reference 3, Table E-5)

BF_i = Bioaccumulation factor for radionuclide i, in fresh water fish, in pCi/kg per pCi/l (See Table 1.2-1; Reference 3, Table A-1; Reference 2 for Ag)

t_f = Transit time from release to receptor for fish consumption (24 hours; Reference 3, Section A.2)

$DF_{i\tau}$ = Dose conversion factor for radionuclide i, for adults in organ, τ, in mrem/pCi, from Table 1.2-2 (Reference 3, Table E-11).

TABLE 1.2-1

BIOACCUMULATION FACTORS

(pCi/kg per pCi/liter)*

Element	Freshwater Fish	
H	9.0E-01	
C	4.6E 03	
Na	1.0E 02	
P	3.0E 03	2
Cr	2.0E 02	
Mn	4.0E 02	
Fe	1.0E 02	
Co	5.0E 01	
Ni	1.0E 02	
Cu	5.0E 01	
Zn	2.0E 03	
Br	4.2E 02	
Rb	2.0E 03	
Sr	3.0E 01	
Y	2.5E 01	
Zr	3.3E 00	
Nb	3.0E 04	
Mo	1.0E 01	
Tc	1.5E 01	
Ru	1.0E 01	
Rh	1.0E 01	
Ag	2.3E 00	
Te	4.0E 02	
I	1.5E 01	
Cs	2.0E 03	
Ba	4.0E 00	
La	2.5E 01	

*Reference 3, Table A-1; Reference 2 for Ag; Reference 14 for P 2

TABLE 1.2-1 (Continued)
BIOACCUMULATION FACTORS
(pCi/kg per pCi/liter)*

Element	Freshwater Fish
Ce	1.0E 00
Pr	2.5E 01
Nd	2.5E 01
W	1.2E 03
Np	1.0E 01

* Reference 3, Table A-1; Reference 2 for Ag; Reference 14 for P | 2

Table 1.2-2
Page 1 of 3

Adult Ingestion Dose Factors*
(mrem per pCi ingested)

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	No Data	1.05E-07	1.05E-07	1.05E-07	1.05E-07	1.05E-07	1.05E-07
C-14	2.84E-06	5.68E-07	5.68E-07	5.68E-07	5.68E-07	5.68E-07	5.68E-07
Na-24	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06
P-32	1.93E-04	1.20E-05	7.46E-06	No Data	No Data	No Data	2.17E-05
Cr-51	No Data	No Data	2.66E-09	1.59E-09	5.86E-10	3.53E-09	6.69E-07
Mn-54	No Data	4.57E-06	8.72E-07	No Data	1.36E-06	No Data	1.40E-05
Mn-56	No Data	1.15E-07	2.04E-08	No Data	1.46E-07	No Data	3.67E-06
Fe-55	2.75E-06	1.90E-06	4.43E-07	No Data	No Data	1.06E-06	1.09E-06
Fe-59	4.34E-06	1.02E-05	3.91E-06	No Data	No Data	2.85E-06	3.40E-05
Co-58	No Data	7.45E-07	1.67E-06	No Data	No Data	No Data	1.51E-05
Co-60	No Data	2.14E-06	4.72E-06	No Data	No Data	No Data	4.02E-05
Ni-63	1.30E-04	9.01E-06	4.36E-06	No Data	No Data	No Data	1.88E-06
Ni-65	5.28E-07	6.86E-08	3.13E-08	No Data	No Data	No Data	1.74E-06
Cu-64	No Data	8.33E-08	3.91E-08	No Data	2.10E-07	No Data	7.10E-06
Zn-65	4.84E-06	1.54E-05	6.96E-06	No Data	1.03E-05	No Data	9.70E-06
Zn-69	1.03E-08	1.97E-08	1.37E-09	No Data	1.28E-08	No Data	2.96E-09
Br-83	No Data	No Data	4.02E-08	No Data	No Data	No Data	5.79E-08
Br-84	No Data	No Data	5.21E-08	No Data	No Data	No Data	4.09E-13
Br-85	No Data	No Data	2.14E-09	No Data	No Data	No Data	LT E-24
Rb-86	No Data	2.11E-05	9.83E-06	No Data	No Data	No Data	4.16E-06
Rb-88	No Data	6.05E-08	3.21E-08	No Data	No Data	No Data	8.36E-19
Rb-89	No Data	4.01E-08	2.82E-08	No Data	No Data	No Data	2.33E-21
Sr-89	3.08E-04	No Data	8.84E-06	No Data	No Data	No Data	4.94E-05
Sr-90	7.58E-03	No Data	1.86E-03	No Data	No Data	No Data	2.19E-04
Sr-91	5.67E-06	No Data	2.29E-07	No Data	No Data	No Data	2.70E-05
Sr-92	2.15E-06	No Data	9.30E-08	No Data	No Data	No Data	4.26E-05
Y-90	9.62E-09	No Data	2.58E-10	No Data	No Data	No Data	1.02E-04
Y-91m	9.09E-11	No Data	3.52E-12	No Data	No Data	No Data	2.67E-10
Y-91	1.41E-07	No Data	3.77E-09	No Data	No Data	No Data	7.76E-05
Y-92	8.45E-10	No Data	2.47E-11	No Data	No Data	No Data	1.48E-05

*Reference 3, Table E-11

Adult Ingestion Dose Factors*
(mrem per pCi ingested)

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Y-93	2.68E-09	No Data	7.40E-11	No Data	No Data	No Data	8.50E-05
Zr-95	3.04E-08	9.75E-09	6.60E-09	No Data	1.53E-08	No Data	3.09E-05
Zr-97	1.68E-09	3.39E-10	1.55E-10	No Data	5.12E-10	No Data	1.05E-04
Nb-95	6.22E-09	3.46E-09	1.86E-09	No Data	3.42E-09	No Data	2.10E-05
Mo-99	No Data	4.31E-06	8.20E-07	No Data	9.76E-06	No Data	9.99E-06
Tc-99m	2.47E-10	6.98E-10	8.89E-09	No Data	1.06E-08	3.42E-10	4.13E-07
Tc-101	2.54E-10	3.66E-10	3.59E-09	No Data	6.59E-09	1.87E-10	1.10E-21
Ru-103	1.85E-07	No Data	7.97E-08	No Data	7.06E-07	No Data	2.16E-05
Ru-105	1.54E-08	No Data	6.08E-09	No Data	1.99E-07	No Data	9.42E-06
Ru-106	2.75E-06	No Data	3.48E-07	No Data	5.31E-06	No Data	1.78E-04
Ag-110m	1.60E-07	1.48E-07	8.79E-08	No Data	2.91E-07	No Data	6.04E-05
Te-125m	2.68E-06	9.71E-07	3.59E-07	8.06E-07	1.09E-05	No Data	1.07E-05
Te-127m	6.77E-06	2.42E-06	8.25E-07	1.73E-06	2.75E-05	No Data	2.27E-05
Te-127	1.10E-07	3.95E-08	2.38E-08	8.15E-08	4.48E-07	No Data	8.68E-06
Te-129m	1.15E-05	4.29E-06	1.82E-06	3.95E-06	4.80E-05	No Data	5.79E-05
Te-129	3.14E-08	1.18E-08	7.65E-09	2.41E-08	1.32E-07	No Data	2.37E-08
-131m	1.73E-06	8.46E-07	7.05E-07	1.34E-06	8.57E-06	No Data	8.40E-05
e-131	1.97E-08	8.23E-09	6.22E-09	1.62E-08	8.63E-08	No Data	2.79E-09
Te-132	2.52E-06	1.63E-06	1.53E-06	1.80E-06	1.57E-05	No Data	7.71E-05
I-130	7.56E-07	2.23E-06	8.80E-07	1.89E-04	3.48E-06	No Data	1.92E-06
I-131	4.16E-06	5.95E-06	3.41E-06	1.95E-03	1.02E-05	No Data	1.57E-06
I-132	2.03E-07	5.43E-07	1.90E-07	1.90E-05	8.65E-07	No Data	1.02E-07
I-133	1.42E-06	2.47E-06	7.53E-07	3.63E-04	4.31E-06	No Data	2.22E-06
I-134	1.06E-07	2.88E-07	1.03E-07	4.99E-06	4.58E-07	No Data	2.51E-10
I-135	4.43E-07	1.16E-06	4.28E-07	7.65E-05	1.86E-06	No Data	1.31E-06
Cs-134	6.22E-05	1.48E-04	1.21E-04	No Data	4.79E-05	1.59E-05	2.59E-06
Cs-136	6.51E-06	2.57E-05	1.85E-05	No Data	1.43E-05	1.96E-06	2.92E-06
Cs-137	7.97E-05	1.09E-04	7.14E-05	No Data	3.70E-05	1.23E-05	2.11E-06
Cs-138	5.52E-08	1.09E-07	5.40E-08	No Data	8.01E-08	7.91E-09	4.65E-13
Ba-139	9.70E-08	6.91E-11	2.84E-09	No Data	6.46E-11	3.92E-11	1.72E-07
Ba-140	2.03E-05	2.55E-08	1.33E-06	No Data	8.67E-09	1.46E-08	4.18E-05
Ba-141	4.71E-08	3.56E-11	1.59E-09	No Data	3.31E-11	2.02E-11	2.22E-17
Ba-142	2.13E-08	2.19E-11	1.34E-09	No Data	1.85E-11	1.24E-11	3.00E-26

*Reference 3, Table E-11

Table 1.2-2 (Continued)

Adult Ingestion Dose Factors*
(mrem per pCi ingested)

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
La-140	2.50E-09	1.26E-09	3.33E-10	No Data	No Data	No Data	9.25E-05
La-142	1.28E-10	5.82E-11	1.45E-11	No Data	No Data	No Data	4.25E-07
Ce-141	9.36E-09	6.33E-09	7.18E-10	No Data	2.94E-09	No Data	2.42E-05
Ce-143	1.65E-09	1.22E-06	1.35E-10	No Data	5.37E-10	No Data	4.56E-05
Ce-144	4.88E-07	2.04E-07	2.62E-08	No Data	1.21E-07	No Data	1.65E-04
Pr-143	9.20E-09	3.69E-09	4.56E-10	No Data	2.13E-09	No Data	4.03E-05
Pr-144	3.01E-11	1.25E-11	1.53E-12	No Data	7.05E-12	No Data	4.33E-18
Nd-147	6.29E-09	7.27E-09	4.35E-10	No Data	4.25E-09	No Data	3.49E-05
W-187	1.03E-07	8.61E-08	3.01E-08	No Data	No Data	No Data	2.82E-05
Np-239	1.19E-09	1.17E-10	6.45E-11	No Data	3.65E-10	No Data	2.40E-05

*Reference 3, Table E-11

Table 1.2-3
Page 1 of 2

.te Related Ingestion Dose Factors, $A_{i\tau}$, For Freshwater Fish and Drinking Water Consumption*

(mrem/hr per uCi/ml)

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	1.32E+00	1.32E+00	1.32E+00	1.32E+00	1.32E+00	1.32E+00
C-14	3.13E+04	6.26E+03	6.26E+03	6.26E+03	6.26E+03	6.26E+03	6.26E+03
Na-24	1.36E+02	1.36E+02	1.36E+02	1.36E+02	1.36E+02	1.36E+02	1.36E+02
P-32	4.40E+07	2.74E+06	1.70E+06	0.00E+00	0.00E+00	0.00E+00	4.95E+06
Cr-51	0.00E+00	0.00E+00	1.27E+00	7.58E-01	2.79E-01	1.68E+00	3.19E+02
Mn-54	0.00E+00	4.41E+03	8.42E+02	0.00E+00	1.31E+03	0.00E+00	1.35E+04
Mn-56	0.00E+00	1.73E-01	3.07E-02	0.00E+00	2.20E-01	0.00E+00	5.52E+00
Fe-55	6.86E+02	4.74E+02	1.11E+02	0.00E+00	0.00E+00	2.65E+02	2.72E+02
Fe-59	1.07E+03	2.51E+03	9.61E+02	0.00E+00	0.00E+00	7.01E+02	8.36E+03
Co-58	0.00E+00	9.59E+01	2.15E+02	0.00E+00	0.00E+00	0.00E+00	1.94E+03
Co-60	0.00E+00	2.78E+02	6.14E+02	0.00E+00	0.00E+00	0.00E+00	5.23E+03
Ni-63	3.25E+04	2.25E+03	1.09E+03	0.00E+00	0.00E+00	0.00E+00	4.70E+02
Ni-65	1.94E-01	2.52E-02	1.15E-02	0.00E+00	0.00E+00	0.00E+00	6.39E-01
Cu-64	0.00E+00	2.79E+00	1.31E+00	0.00E+00	7.02E+00	0.00E+00	2.37E+02
Zn-65	2.32E+04	7.37E+04	3.33E+04	0.00E+00	4.93E+04	0.00E+00	4.64E+04
Zn-69	1.24E-06	2.38E-06	1.65E-07	0.00E+00	1.55E-06	0.00E+00	3.57E-07
Br-83	0.00E+00	0.00E+00	4.02E-02	0.00E+00	0.00E+00	0.00E+00	5.80E-02
Br-84	0.00E+00	0.00E+00	1.16E-12	0.00E+00	0.00E+00	0.00E+00	9.12E-18
[illegible]-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
[illegible]-86	0.00E+00	9.75E+04	4.54E+04	0.00E+00	0.00E+00	0.00E+00	1.92E+04
Rb-88	0.00E+00	1.18E-22	6.26E-23	0.00E+00	0.00E+00	0.00E+00	1.63E-33
Rb-89	0.00E+00	1.38E-26	9.73E-27	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	2.50E+04	0.00E+00	7.16E+02	0.00E+00	0.00E+00	0.00E+00	4.00E+03
Sr-90	6.23E+05	0.00E+00	1.53E+05	0.00E+00	0.00E+00	0.00E+00	1.80E+04
Sr-91	7.47E+01	0.00E+00	3.02E+00	0.00E+00	0.00E+00	0.00E+00	3.56E+02
Sr-92	3.32E-01	0.00E+00	1.43E-02	0.00E+00	0.00E+00	0.00E+00	6.57E+00
Y-90	5.04E-01	0.00E+00	1.35E-02	0.00E+00	0.00E+00	0.00E+00	5.34E+03
Y-91M	1.31E-11	0.00E+00	5.06E-13	0.00E+00	0.00E+00	0.00E+00	3.83E-11
Y-91	9.77E+00	0.00E+00	2.61E-01	0.00E+00	0.00E+00	0.00E+00	5.38E+03
Y-92	4.59E-04	0.00E+00	1.34E-05	0.00E+00	0.00E+00	0.00E+00	8.04E+00
Y-93	3.30E-02	0.00E+00	9.11E-04	0.00E+00	0.00E+00	0.00E+00	1.05E+03
Zr-95	5.47E-01	1.76E-01	1.19E-01	0.00E+00	2.75E-01	0.00E+00	5.56E+02
Zr-97	7.45E-03	1.50E-03	6.87E-04	0.00E+00	2.27E-03	0.00E+00	4.66E+02
Nb-95	4.38E+02	2.44E+02	1.31E+02	0.00E+00	2.41E+02	0.00E+00	1.48E+06
Mo-99	0.00E+00	1.08E+02	2.05E+01	0.00E+00	2.44E+02	0.00E+00	2.50E+02
Tc-99M	5.72E-04	1.62E-03	2.06E-02	0.00E+00	2.45E-02	7.92E-04	9.56E-01
Tc-101	1.01E-33	1.45E-33	1.42E-32	0.00E+00	2.62E-32	7.42E-34	0.00E+00

*Calculated using Equation (15). Site related dose factors are presented as zero in this table when "not data" is reported for dose factors for specific radionuclide-organ combinations in Reference 3.

Table 1.2-3 (Continued)
Page 2 of 2

Site Related Ingestion Dose Factors, $A_{i\tau}$, For Freshwater Fish and Drinking Water Consumption*
(mrem/hr per uCi/ml)

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Ru-103	6.21E+00	0.00E+00	2.68E+00	0.00E+00	2.37E+01	0.00E+00	7.25E+02
Ru-105	8.81E-03	0.00E+00	3.48E-03	0.00E+00	1.14E-01	0.00E+00	5.39E+00
Ru-106	9.42E+01	0.00E+00	1.19E+01	0.00E+00	1.82E+02	0.00E+00	6.10E+03
Ag-110M	2.53E+00	2.34E+00	1.39E+00	0.00E+00	4.61E+00	0.00E+00	9.57E+02
Te-125M	2.56E+03	9.29E+02	3.43E+02	7.71E+02	1.04E+04	0.00E+00	1.02E+04
Te-127M	6.51E+03	2.33E+03	7.93E+02	1.66E+03	2.64E+04	0.00E+00	2.18E+04
Te-127	1.80E+01	6.46E+00	3.89E+00	1.33E+01	7.33E+01	0.00E+00	1.42E+03
Te-129M	1.09E+04	4.07E+03	1.73E+03	3.75E+03	4.55E+04	0.00E+00	5.49E+04
Te-129	1.49E-05	5.59E-06	3.62E-06	1.14E-05	6.25E-05	0.00E+00	1.12E-05
Te-131M	9.58E+02	4.68E+02	3.90E+02	7.42E+02	4.74E+03	0.00E+00	4.65E+04
Te-131	5.82E-17	2.43E-17	1.84E-17	4.79E-17	2.55E-16	0.00E+00	8.24E-18
Te-132	1.97E+03	1.27E+03	1.19E+03	1.40E+03	1.22E+04	0.00E+00	6.01E+04
I-130	7.56E+00	2.23E+01	8.80E+00	1.89E+03	3.48E+01	0.00E+00	1.92E+01
I-131	1.73E+02	2.48E+02	1.42E+02	8.13E+04	4.25E+02	0.00E+00	6.55E+01
I-132	4.60E-03	1.23E-02	4.31E-03	4.31E-01	1.96E-02	0.00E+00	2.31E-03
I-133	2.54E+01	4.41E+01	1.35E+01	6.49E+03	7.70E+01	0.00E+00	3.97E+01
I-134	1.75E-08	4.74E-08	1.70E-08	8.22E-07	7.54E-08	0.00E+00	4.13E-11
I-135	1.34E+00	3.51E+00	1.30E+00	2.32E+02	5.64E+00	0.00E+00	3.97E+00
-134	2.98E+05	7.10E+05	5.80E+05	0.00E+00	2.30E+05	7.62E+04	1.24E+04
-136	2.97E+04	1.17E+05	8.44E+04	0.00E+00	6.52E+04	8.94E+03	1.33E+04
Cs-137	3.82E+05	5.23E+05	3.43E+05	0.00E+00	1.78E+05	5.90E+04	1.01E+04
Cs-138	9.47E-12	1.87E-11	9.26E-12	0.00E+00	1.37E-11	1.36E-12	7.98E-17
Ba-139	5.44E-06	3.88E-09	1.59E-07	0.00E+00	3.62E-09	2.20E-09	9.65E-06
Ba-140	3.74E+02	4.69E-01	2.45E+01	0.00E+00	1.60E-01	2.69E-01	7.69E+02
Ba-141	3.78E-25	2.85E-28	1.27E-26	0.00E+00	2.65E-28	1.62E-28	1.78E-34
Ba-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La-140	1.10E-01	5.56E-02	1.47E-02	0.00E+00	0.00E+00	0.00E+00	4.09E+03
La-142	1.56E-07	7.11E-08	1.77E-08	0.00E+00	0.00E+00	0.00E+00	5.19E-04
Ce-141	1.15E-01	7.79E-02	8.84E-03	0.00E+00	3.62E-02	0.00E+00	2.98E+02
Ce-143	8.65E-03	6.40E+00	7.08E-04	0.00E+00	2.82E-03	0.00E+00	2.39E+02
Ce-144	6.22E+00	2.60E+00	3.34E-01	0.00E+00	1.54E+00	0.00E+00	2.10E+03
Pr-143	6.10E-01	2.45E-01	3.02E-02	0.00E+00	1.41E-01	0.00E+00	2.67E+03
Pr-144	1.37E-28	5.68E-29	6.95E-30	0.00E+00	3.20E-29	0.00E+00	1.97E-35
Nd-147	4.11E-01	4.75E-01	2.84E-02	0.00E+00	2.78E-01	0.00E+00	2.28E+03
W-187	1.48E+02	1.24E+02	4.32E+01	0.00E+00	0.00E+00	0.00E+00	4.05E+04
Np-239	2.81E-02	2.76E-03	1.52E-03	0.00E+00	8.61E-03	0.00E+00	5.66E+02

*Calculated Using Equation (15). Site related dose factors are presented as zero in this table when "no data" is reported for dose factors for specific radionuclide-organ combinations in Reference 3. 2

1.3. DOSE PROJECTIONS FOR LIQUID EFFLUENTS

1.3.1. Thirty-One Day Dose Projections

In order to meet the requirements of Technical Specification 3.11.1.3, which pertains to operation of the liquid radwaste treatment systems, dose projections must be made at least once per thirty-one days, during periods in which discharge of liquid effluents containing radioactive materials to unrestricted areas occurs or is expected.

Projected 31-day doses to individuals due to liquid effluents may be determined as follows:

$$D_{tb(prj)} = \frac{D_{tb(c)}}{t} \times 31 \qquad (16)$$ 1

$$D_{o(prj)} = \frac{D_{o(c)}}{t} \times 31 \qquad (17)$$ 1

where

$D_{tb(c)}$ = the cumulative total body dose for the elapsed portion of the current quarter plus the release under consideration.

t = the number of days into the current quarter, including the period of the release under consideration. 1

$D_{o(c)}$ = the cumulative organ doses for specific organs, for the elapsed portion of the current quarter plus the release under consideration.

If operational activities planned during the ensuing 31-day period are expected to result in liquid releases which will contribute a dose in addition to the dose due to routine liquid effluents, this additional dose contribution should be included in the equations as follows:

$$D_{tb(prj)} = \frac{D_{tb(c)}}{t} \times 31 + D_{PA} \qquad (18)$$ 1

$$D_{o(prj)} = \frac{D_{o(c)}}{t} \times 31 + D_{PA} \qquad (19)$$ 1

where D_{PA} is the expected dose due to the particular planned activity.

1.3.2. Dose Projections for Specific Releases

Dose projections may be performed for a particular release by performing a pre-release dose calculation assuming that the planned release will proceed as anticipated. For individual dose projections due to liquid releases, follow the methodology presented in Subsection 1.2 using sample analyses values for the source to be released and parametric values expected to exist for the release period.

1.4 DEFINITIONS OF LIQUID EFFLUENT TERMS

Term		Definition	Section Of Initial Use
A	=	adjustment factor used in calculating monitor setpoints, which is the ratio of the assured dilution factor to the required dilution factor (unitless).	1.1.1
$A_{i\tau}$	=	the site related ingestion dose commitment factor for the total body or any organ for each identified principal radionuclide listed in Table 1.2-3 in mrem-ml per hr-uCi.	1.2
ADF	=	the assured dilution factor, which is the ratio of unit-specific assured dilution flow rate to anticipated effluent release rate (unitless).	1.1.1.1
BF_i	=	Bioaccumulation Factor for nuclide i, in fresh water fish, pCi/kg per pCi/l, from table 1.2-1.	1.2
BG	=	the background level for the radioactivity monitor of interest.	1.1.1
c	=	the base setpoint of the radioactivity monitor which measures the radioactivity concentration in the effluent line prior to dilution and subsequent release.	1.1.1
c_{ms}	=	the actual setpoint for a radioactivity monitor, including adjustments for calibration factor and background.	1.1.1

1

Term		Definition	Section Of Initial Use
C_a	=	the effluent concentration of alpha emitting nuclides observed by gross alpha analysis of the MONTHLY composite sample, in uCi/ml.	1.1.1
C_f	=	the concentration of Fe-55 in liquid wastes as observed in the QUARTERLY composite sample, in uCi/ml.	1.1.1
C_g	=	the effluent concentration of a gamma emitting nuclide, g, observed by gamma-ray spectroscopy of the waste sample, in uCi/ml.	1.1.1
C_i	=	the concentration of nuclide i as determined by the analysis of the waste sample, in uCi/ml.	1.1.1
C_{il}	=	the average concentration of radionuclide i, in undiluted liquid effluent during time period Δt_l, for a release in uCi/ml.	1.2
C_{MPC}	=	the effluent concentration limit (Technical Specification 3.11.1.1) implementing 10 CFR 20 for the site, in uCi/ml.	1.1.1
C_s	=	the concentration of Sr-89 and Sr-90 in liquid wastes as determined by analysis of the QUARTERLY composite sample, in uCi/ml.	1.1.1
C_t	=	the measured concentration of H-3 in liquid waste as determined by analysis of the MONTHLY composite sample, in uCi/ml.	1.1.1

Term		Definition	Section Of Initial Use
CF	=	the calibration factor for a particular radioactivity monitor.	1.1.1
D_τ	=	the cumulative dose commitment to the total body or any organ, τ, from the liquid effluents for the total time period, in mrem.	1.2
D_w	=	Additional dilution factor between vicinity of release point and drinking water location (unitless).	1.2
$DF_{i\tau}$	=	a dose conversion factor for nuclide, i, for adults in organ, τ, in mrem/pCi found in Table 1.2-2.	1.2
f	=	the flow as determined for the radiation monitor location in gpm. (General expression for equation 1).	1.1.1
F	=	the dilution water flow rate as determined prior to the point at which the dilution stream discharges to the river, in gpm. (General expression for equation 1).	1.1.1
F_d	=	the flow rate of the dilution stream which can be assured during the time of release in gpm. This is also the setpoint for the dilution stream flow rate measurement device.	1.1.1
F_{du}	=	the unit-specific assured flow rate of the dilution stream used as the basis for setpoint calculations, in gpm.	1.1.1

1

Term		Definition	Section Of Initial Use	
F_1	=	the near field average dilution factor for C_{i1} during any liquid effluent release (unitless).	1.2	
f_a	=	anticipated effluent flow rate in gpm.	1.1.1	
f_m	=	maximum permissible effluent flow rate in gpm.	1.1.1	1
K_o	=	1.14×10^5, units conversion factor, which converts uCi to pCi, liters to ml, and hours to year.	1.2	
m	=	number of liquid releases.	1.2	
MPC_i	=	MPC_g, MPC_a, MPC_s, MPC_f, and MPC_t which are the limiting concentrations of the appropriate gamma emmitting radionuclides, alpha emitting radionuclides, strontium, iron and tritium, respectively, from 10 CFR, Part 20, Appendix B, Table II, Column 2.	1.1.1	
RDF	=	The required dilution factor, which is the ratio of the dilution flow rate to the effluent stream flow rate(s) which would be required to assure that the limiting concentration of 10 CFR, Part 20, Appendix B, Table II, Column 2 are met at the point of discharge to the Unrestricted Area (unitless).	1.1.1	1

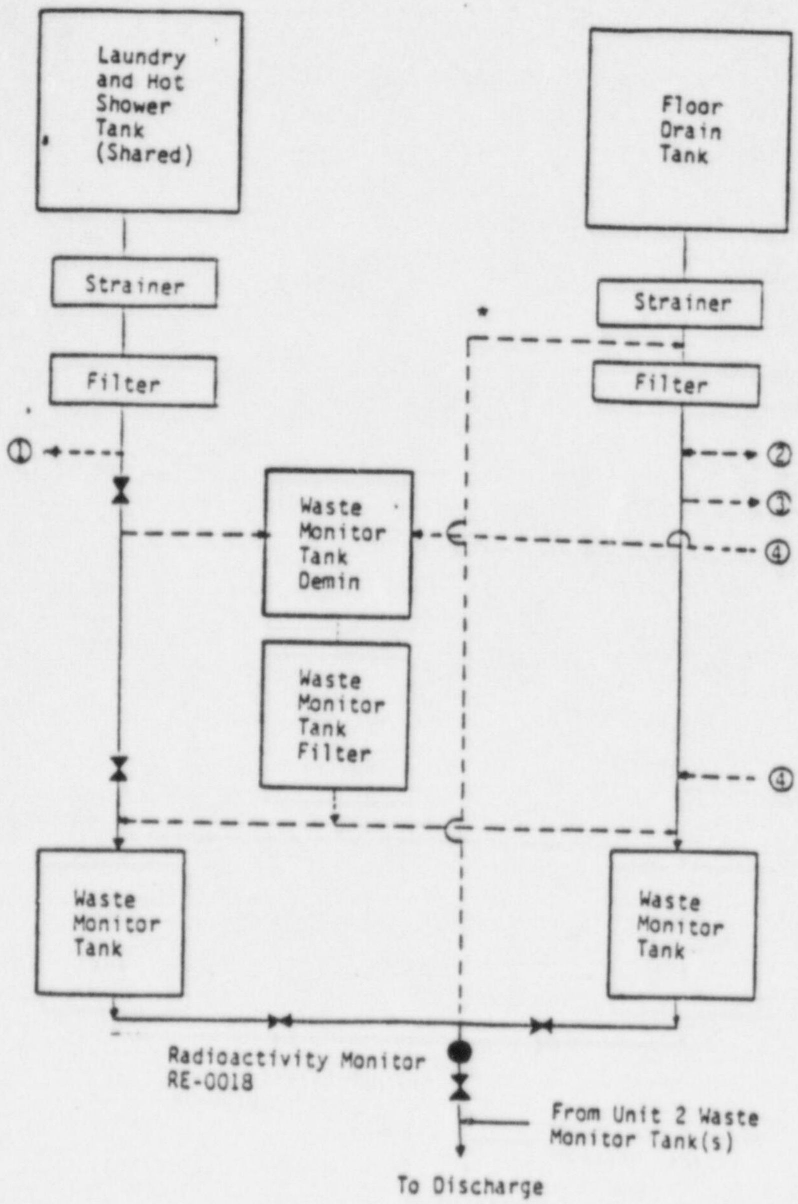
Term		Definition	Section Of Initial Use
SF	=	the safety factor, which is a conservative factor used to compensate for statistical fluctuations and errors of measurement. The value for the safety factor must be between 0 and 1.	1.1.1
t_f	=	the transit time from release to receptor (fish consumption), in hours.	1.2
t_w	=	the transit time from release to receptor (drinking water consumption), in hours.	1.2
Δt_1	=	duration of release under consideration, in hours.	1.2 1
U_F	=	21 kg/yr, fish consumption (adult).	1.2
U_w	=	730 liters/yr, water consumption (adult)	1.2
Z	=	Applicable factor when additional receiving water body dilution is considered (unitless).	1.2
λ_i	=	The decay constant for radionuclide i. (hr^{-1})	1.2

1.5 LIQUID WASTE PROCESSING SYSTEM AND LIQUID DISCHARGE PATHWAYS

Figures 1.5-1 and 1.5-2 are schematics of the Liquid Waste Processing Systems for Unit 1 and Unit 2 respectively. The dotted lines indicate alternate pathways through which liquid wastes may be routed as appropriate. These alternate routes increase the operational flexibility of the liquid waste processing systems.

FIGURE 1.5-3 is a schematic of plant discharge pathways for liquids.

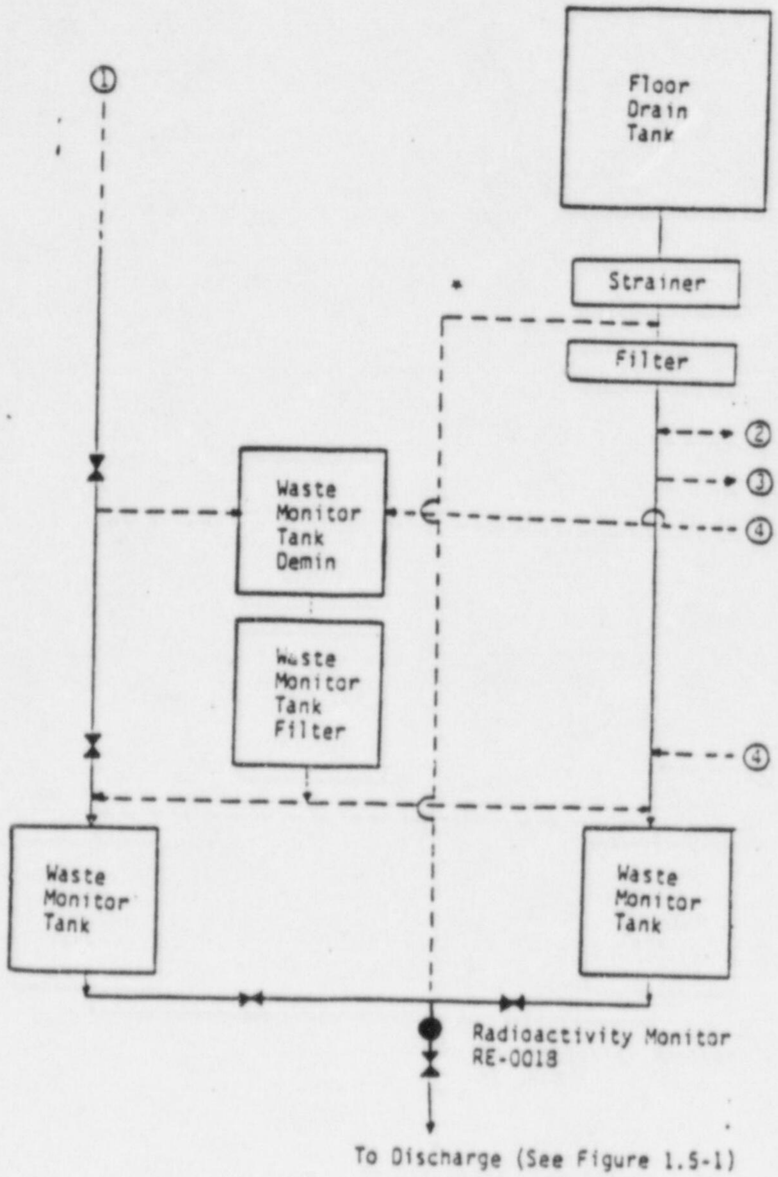
Figure 1.5-1 LIQUID WASTE PROCESSING SYSTEM (Unit 1)



*Dotted lines indicate alternate routes for increased operational flexibility and/or additional processing.

① To Unit 2
② From/To Unit 2
③ To Drain Channel A
④ From Drain Channel A

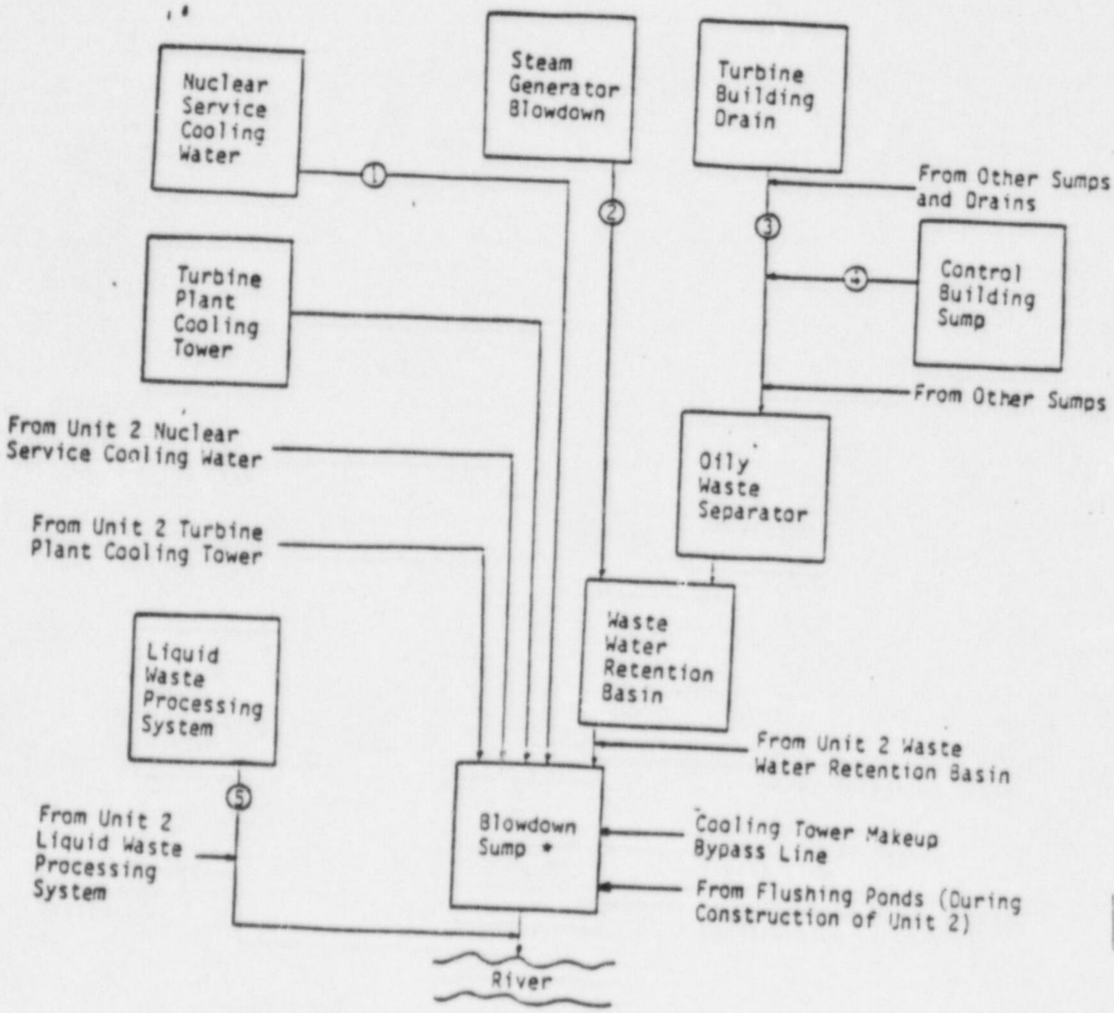
Figure 1.5-2 LIQUID WASTE PROCESSING SYSTEM (Unit 2)



*Dotted lines indicate alternate routes for increased operational flexibility and/or additional processing.

① From Unit 1
② From/To Unit 1
③ To Drain Channel A
④ From Drain Channel A

Figure 1.5-3 LIQUID DISCHARGE PATHWAYS



Radioactivity Monitors:
(1) RE0020
(2) RE0021
(3) RE0848
(4) RE17646
(5) RE0018

*The Blowdown Sump is common to both units.

SECTION 2
GASEOUS EFFLUENTS

At Plant Vogtle there are five potential points where
radioactivity is released to the atmosphere in gaseous
discharges. These five potential release points are: Unit 1
plant vent; Unit 2 plant vent; Unit 1 and Unit 2 turbine building
vents, which are not normal release pathways until a primary to 2
secondary leak exists; and the radwaste solidification building
vent.

The turbine building vent serves as the discharge point for the condenser air ejector and steam packing exhauster system. The fuel handling building is common to both units; however ventilation from this area is through the Unit 1 plant vent. Certain components of the Gaseous Waste Processing System are shared between the two units and releases from this system are through the Unit 1 plant vent. Containment building releases are through the respective plant vents.

Gaseous releases from the turbine building vents and
the radwaste solidification building vent are considered to be
ground-level releases. Gaseous releases from the plant vents are
considered to be mixed-mode releases as determined by the wake-
split model. (See NOTE in Subsection 2.1.1). All five release 3
points are considered to be continuous releases. In the absence
of confirmed primary to secondary leak(s), the turbine building
vents are not release points.

Gaseous effluent monitor setpoints are required only for noble gas monitors serving the five release points. Methodology for calculating noble gas monitor setpoints is presented in Subsection 2.1. Although setpoint calculations are not required for radioiodine and particulate monitors, the methodology for assuring the potential organ dose rates due to radioiodines, tritium, and particulates in gaseous releases from the site do not exceed the limits of Technical Specification 3.11.2.1(b) is presented in the NOTE in Subsection 2.2.1.2.

2.1 GASEOUS EFFLUENT MONITOR SETPOINTS

Gaseous monitor setpoints are determined by calculating a basic setpoint value, c_s, for a particular monitor, and then adding this basic setpoint value to monitor background to obtain 1
the actual setpoint for the monitor.

Subsections 2.1.1, 2.1.2 and 2.1.3 present the methodology for calculating the basic setpoint value, c_s, and the actual monitor setpoint, c_{sp}. Throughout these subsections the 1
term C_m is used to designate monitor response to a measured concentration. Monitor response and background considerations are discussed further in Subsection 2.1.4.

Monitor setpoints determined in accordance with this Subsection will be regarded as upper bounds for the high alarm setpoint. However, a lower setpoint may be established on the monitor if desired. Also, intermediate alarm setpoints should be established at a level below the high alarm setpoint to give appropriate warning prior to reaching the high alarm setpoint.

If no release is planned for a particular pathway, or if there is no detectable activity in the planned release, the monitor setpoint should be established as close to background as practical to prevent spurious alarms and yet alarm should an inadvertent release occur. The monitor setpoint determined in this manner must be less than the setpoint value calculated in accordance with Subsection 2.1.1 or 2.1.2 assuming Kr-88 as the radionuclide being released.

If a calculated setpoint is less than the monitor reading associated with the particular release pathway, no release may be made under current conditions. Steps must be taken to reduce contributing source terms and/or reassign allocation factors (discussed in Subsection 2.1.5) and the setpoint recalculated, if releases via the pathway under consideration are to continue. 1

2.1.1 <u>Unit 1 Turbine Building Vent, Unit 2 Turbine Building Vent and Radwaste Solidification Building Vent</u>
Monitors: RE-12839C (Unit 1), 2RE-12839C (Unit 2) and ARE-0026C

NOTE: Turbine Building Vent serves as the release point for the Condenser Air Ejector and the Steam Packing Exhauster.

For the purpose of implementation of Technical Specification 3.3.3.11, the setpoint for these noble gas monitors will be calculated as follows:

c_s = calculated basic setpoint value

$$c_s = \text{the lesser of} \begin{cases} (AG)\ (SF)\ (R_t)\ (D_{TB}) & (1) \\ \text{or} & \\ (AG)\ (SF)\ (R_s)\ (D_{ss}) & (1a) \end{cases}$$ 1

$$c_{sp} = c_s + BG \qquad (2)$$

SF = safety factor, which is a conservative factor applied to each noble gas monitor to compensate for statistical fluctuations and errors of measurement. The value of the safety factor must be between 0 and 1; a value of 0.4 to 0.6 is a reasonable range of values for gaseous releases. A more precise value may be developed if desired. 1

BG = background level for the particular monitor 1

AG = an administrative allocation factor applied to apportion the release setpoints among all gaseous release discharge pathways to assure that release limits will not be exceeded by simultaneous releases. The allocation factor for a particular discharge pathway may be assigned any desired value between 0 and 1 under the condition that the sum of the allocation factors for all simultaneous release pathways does not exceed 1. For ease of implementation, AG may be set equal to 1/n, where n is the number of simultaneous final gaseous release points. For a more exact determination of allocation factors, see Subsection 2.1.5.

D_{TB} = dose rate limit to the total body of an individual which is 500 mrem/year.

R_t = relationship between monitor response and the dose rate to the total body for the conditions of the release under consideration. 1

$$R_t = C_m \div ((\overline{X/Q})_G \sum_i K_i Q_{ig}) \qquad (3)$$

where

C_m = monitor response of a noble gas monitor corresponding to the grab sample radionuclide concentrations taken in accordance with Technical Specification Table 4.11-2. (See Subsection 2.1.4 for further discussion of monitor response). 1

$(\overline{X/Q})_G$ = the highest annual average relative concentration at the site boundary. (If desired, the annual average relative concentration at the site boundary for the particular release point may be used.) The release points addressed in this Subsection are ground-level releases.

$(\overline{X/Q})_G$ = 6.83×10^{-5} sec/m^3 in the ENE sector. 2,3

K_i = total body dose factor due to gamma emissions from radionuclide i (mrem/yr per uCi/m^3) from Table 2.1-1.

Q_{ig} = rate of release of noble gas radionuclide i (uCi/sec) from the vent release pathway under consideration (ground-level), which is the product of X_{iv} and F_v, where X_{iv} is the concentration of radionuclide i for the particular release and F_v is the maximum expected release flow rate for this release point. (X_{iv} in uCi/ml and F_v in ml/sec.)

D_{ss} = dose rate limit to the skin of the body of an individual in an unrestricted area which is 3000 mrem/year.

R_s = relationship between monitor response and the dose rate to the skin for the conditions of the release under consideration. 1

$$R_s = C_m \div \left((\overline{X/Q})_G \sum_i (L_i + 1.1\, M_i)\; Q_{ig} \right) \quad (4)$$

where

L_i = skin dose factor due to beta emissions from radionuclide i (mrem/yr per uCi/m^3) from Table 2.1-1.

1.1 = mrem skin dose per mrad air dose.

M_i = air dose factor due to gamma emissions from radionuclide i (mrad/yr per uCi/m^3) from Table 2.1-1.

2.1.2 <u>Unit 1 Plant Vent and Unit 2 Plant Vent</u>

Monitors: RE12442C (Unit 1) and 2RE12442C (Unit 2)

Gaseous releases from the plant vent(s) are regarded as mixed-mode releases in that under certain conditions of vent exit velocity and meteorological conditions, the plume will behave as an elevated release. Under other conditions of vent exit velocity and meteorological conditions, the plume will behave as a ground-level release. Using the wake-split model, dispersion values have been calculated utilizing expected annual average conditions. (See NOTE below). 3

However, since setpoints for plant vent monitors must 2
be established to ensure that the limits of Technical Specification 3.11.2.1.a will not be exceeded at any point in time, the ground level dispersion value used in Subsection 2.1.1 is also used in the calculation of setpoints for plant vent monitors.

NOTE: Default recirculation values are utilized for 3
determination of dispersion and deposition factors for calculation of the offsite effect of gaseous effluents.

Ground-level release parameters are used for plant vent releases in the east and east-northeast sectors (sectors in which the cooling towers are located) to account for any potential cooling tower wake effects.

The setpoint calculation methodology presented in Subsection 2.1.1 applies to these monitors with the exception that Q_{ig} must be replaced with Q_{im} where Q_{im} is defined as follows: 2

Q_{im} = rate of release of noble gas radionuclide i (uCi/sec) from the plant vent release pathway under consideration (mixed-mode), which is the product of X_{iv} and F_v, where X_{iv} is the concentration of radionuclide i for the particular release and F_v is the maximum expected release flow rate for this release point. (X_{iv} in uCi/ml and F_v in ml/sec.)

2.1.3 Gaseous Waste Processing System Discharge and Reactor Containment Purge

Monitors: ARE0014, RE-2565C (Unit 1) and 2RE-2565C (Unit 2)

The Gaseous Waste Processing System discharges to the Unit 1 plant vent, Unit 1 containment purge discharges to the Unit 1 plant vent, and Unit 2 containment purge discharges to the Unit 2 plant vent. The plant vents are equipped with continuous final effluent monitors as discussed in Subsection 2.1.2. However, due to the potential significance of releases from these sources, the setpoint methodology is presented for the system effluent monitors also. The system monitors have the control logic to terminate the release at alarm trip point. The final monitors have no trip logic. 3

Sampling and analyses are completed and monitor setpoints determined prior to release. These setpoints must take into account simultaneous release pathways; the combined allocation factors for contributing pathway monitors must not exceed the allocation factor for the final release pathway monitor to which they contribute.

Downstream monitors must also take into consideration the combinations of source terms for the particular release pathway.

2.1.3.1 Gaseous Waste Processing System

Monitor: ARE-0014

The Gaseous Waste Processing System discharges through the Unit 1 plant vent; therefore, the Gaseous Waste Processing System effluent monitor is not the final monitor for releases from this system. However, because of the significance of this release pathway and because the Unit 1 plant vent monitor setpoint has to accommodate releases from the Gaseous Waste Processing System, and the trip logic is associated with this monitor, the setpoint methodology for this monitor is presented. 3

The methodology presented in subsection 2.1.2 applies to this monitor with the following five exceptions:

Exception 1:

$$R_t = r_t = C_m \div \left((\overline{X/Q})_M \sum_i K_i \, q_i \right) \qquad (5)$$

Exception 2:

C_m = monitor response of the Gaseous Waste Processing System monitor for radionuclide concentrations to be discharged (sample taken and analyzed prior to discharge). (See Subsection 2.1.4 for further discussion of monitor response). 1

Exception 3:

q_i = rate of release of noble gas radionuclide i (uCi/sec) from the Gaseous Waste Processing

System, determined by multiplying the expected release rate by the concentration of radionuclide i.

Exception 4:

$$R_s = r_s = C_m \div ((\overline{X/Q})_M \sum_i (L_i + 1.1M_i)\, q_i) \qquad (6)$$

Exception 5:

AG = A selected allocation factor value which must be less than the allocation factor for the monitor serving the final release point, Unit 1 plant vent.

When releases are to be made from the Gaseous Waste Processing System, it will be necessary to redetermine the setpoint for the Unit 1 plant vent monitor (RE-12442C) which is downstream from the Gaseous Waste Processing System effluent monitor (ARE-0014).

Redetermination of this setpoint is accomplished by applying the methodology of Subsection 2.1.2 with the following two exceptions:

Exception 1:

A new source term, $(Q_{im})_{GP}$, is determined which includes the routine Unit 1 plant vent source term Q_{im} (based on sample results from Technical Specification Table 4.11-2) combined with the Gaseous Waste Processing System source term for the tank planned for release, q_i, as follows:

$$(Q_{im})_{GP} = Q_{im} + q_i \qquad (7)$$

Exception 2:

C_m = monitor response corresponding to the concentration resulting from the combined release; this concentration value is obtained by dividing $\sum_i (Q_{im})_{GP}$ by the combined flow rate (ml/sec) through the plant vent. (See 1
Subsection 2.1.4 for further discussion of monitor response.)

2.1.3.2 <u>Reactor Containment Purge</u>

Monitors: RE-2565C (One for each unit)

Unit 1 containment purge discharges through the Unit 1 plant vent; Unit 2 containment purge discharges through the Unit 2 plant vent. Therefore, the containment purge monitor is not the final monitor for containment purge releases. However, because of the significance of these releases and because the respective plant vent monitor setpoint has to accommodate containment purge releases, the setpoint methodology for these monitors is presented.

The methodology presented in Subsection 2.1.2 applies to this monitor with the following five exceptions:

Exception 1:

$$R_t = r_t = C_m \div ((\overline{X/Q})_M \sum_i K_i \, q_i) \qquad (8)$$

Exception 2:

C_m = monitor response of the containment purge monitor for radionuclide concentrations to be discharged (sample taken and analyzed prior to discharge). (See Subsection 2.1.4 for 1
further discussion of monitor response.)

Exception 3:

q_i = rate of release of noble gas radionuclide i (uCi/sec) from containment purge, determined by multiplying the expected release rate by the concentration of radionuclide i.

Exception 4:

$$R_s = r_s = C_m \div ((\overline{X/Q})_M \sum_i (L_i + 1.1M_i)\, q_i) \quad (9)$$

Exception 5:

AG = a selected allocation factor value which must be less than the allocation factor for the monitor serving the final release point, the respective plant vent.

When containment purge releases are to be made, it will be necessary to redetermine the setpoint for the respective plant vent monitor (RE-12442C) which is downstream from the containment purge monitor (RE-2565C).

Redetermination of this setpoint is accomplished by applying the methodology of Subsection 2.1.2 with the following two exceptions:

Exception 1:

A new source term, $(Q_{im})_{CP}$, is determined which includes the routine respective plant vent source term Q_{im} (based on sample results from Technical Specification Table 4.11-2) combined with the containment purge source term for the unit containment planned for release, q_i, as follows:

$$(Q_{im})_{CP} = Q_{im} + q_i \quad (10)$$

Exception 2:

C_m = monitor response corresponding to the concentration resulting from the combined release; this concentration value is obtained by dividing $\sum_i (Q_{im})_{CP}$ by the combined flow rate (ml/sec) through the plant vent. (See Subsection 2.1.4 for further discussion of monitor response.) 1

2.1.4 Consideration of Monitor Response and Background in Establishing Gaseous Effluent Monitor Setpoints

The calculated monitor setpoint, c_s, establishes the base value for the monitor setpoint. The monitor setpoint calculation includes the monitor response term, C_m. The monitor response is the net monitor reading corresponding to the measured concentration of the particular noble gas sample. The monitor response may be obtained by observing the net monitor reading at the time the noble gas sample is taken. The monitor response may also be determined by multiplying the measured noble gas concentration by the calibration factor for the particular monitor. It is important to note that the monitor response 1 corresponds to the release rate and/or dose rate only for the specific conditions of release flow rate and radionuclide-specific concentrations determined for the release under consideration.

If any monitor adjustments are to be made which affect monitor response to radionuclide concentrations, such as gain factor adjustments, these adjustments must be made prior to determining the monitor response, C_m, which is to be used in the setpoint calculation for a particular monitor.

The actual monitor setpoint, c_{sp}, must include the
calculated basic setpoint, c_s, plus monitor background, BG.
Contributions to background radiation levels may include ambient
background, plant environmental background at monitor locations
when plant is in shutdown status, plant environmental background 1
at monitor location when plant is at power, and internal
background of monitor due to contamination of sample chamber.
Background levels must be controlled such that radioactivity
levels in the effluent stream being monitored can be accurately
assessed at or below the calculated setpoint value.

2.1.5 Determination of Allocation Factor, AG

When simultaneous gaseous releases are made to the environment, an (administrative) allocation factor must be applied to each discharge pathway. This is to ensure that simultaneous gaseous releases from the site to unrestricted areas will not exceed the dose rate limits specified in Technical Specification 3.11.2.1. For Plant Vogtle, final discharge pathways which may be released simultaneously are the Unit 1 plant vent, Unit 2 plant vent, Unit 1 turbine building vent, Unit 2 turbine building vent, and the radwaste solidification building vent. The allocation factor for each gaseous discharge pathway must be between 0 and 1 and the sum of the allocation factors for the simultaneous releases must not exceed 1.

There are three methods by which allocation factors may be determined:

1. The allocation factor for a particular release pathway may be administratively selected based on an estimate of the fraction of the total dose rate (from all simultaneous releases) which is contributed by the particular release pathway.

2. The allocation factor may be calculated using the expression

$$AG = 1/n \tag{11}$$

where n = the number of release pathways to be released simultaneously.

3. The allocation factor may be determined for a particular discharge pathway by calculating the ratio of the total body dose rate due to noble gases released from the particular discharge pathway under consideration to the total body dose rate due to noble gases in all simultaneous releases, as follows:

For Unit 1 turbine building vent, Unit 2 turbine building vent, and radwaste solidification building vent (ground-level releases):

$$AG = \frac{(\overline{X/Q})_G \sum_i K_i Q_{ig(r)}}{(\overline{X/Q})_G \sum_{ng} \sum_i K_i (Q_{ig})_{ng} + (\overline{X/Q})_M \sum_{nm} \sum_i K_i (Q_{im})_{nm}} \tag{12}$$ 2

For Unit 1 plant vent and Unit 2 plant vent (mixed-mode releases):

$$AG = \frac{(\overline{X/Q})_M \sum_i K_i Q_{im(r)}}{(\overline{X/Q})_G \sum_{ng} \sum_i K_i (Q_{ig})_{ng} + (\overline{X/Q})_M \sum_{nm} \sum_i K_i (Q_{im})_{nm}} \tag{13}$$ 2

Where ng is the number of simultaneous vent releases (ground level); nm is the number of simultaneous vent releases (mixed-mode); and (r) is the particular discharge pathway for which an allocation factor is being determined.

TABLE 2.1-1

DOSE FACTORS FOR EXPOSURE TO A SEMI-INFINITE CLOUD OF NOBLE GASES*

Nuclidè	Gamma -Body***(K)	Beta -Skin ***(L)	Gamma -Air**(M)	Beta -Air**(N)
Kr-83m	7.56E-02	———	1.93E+01	2.88E+02
Kr-85m	1.17E+03	1.46E+03	1.23E+03	1.97E+03
Kr-85	1.61E+01	1.34E+03	1.72E+01	1.95E+03
Kr-87	5.92E+03	9.73E+03	6.17E+03	1.03E+04
Kr-88	1.47E+04	2.37E+03	1.52E+04	2.93E+03
Kr-89	1.66E+04	1.01E+04	1.73E+04	1.06E+04
Kr-90	1.56E+04	7.29E+03	1.63E+04	7.83E+03
Xe-131m	9.15E+01	4.76E+02	1.56E+02	1.11E+03
Xe-133m	2.51E+02	9.94E+02	3.27E+02	1.48E+03
Xe-133	2.94E+02	3.06E+02	3.53E+02	1.05E+03
Xe-135m	3.12E+03	7.11E+02	3.36E+03	7.39E+02
Xe-135	1.81E+03	1.86E+03	1.92E+03	2.46E+03
Xe-137	1.42E+03	1.22E+04	1.51E+03	1.27E+04
Xe-138	8.83E+03	4.13E+03	9.21E+03	4.75E+03
Ar-41	8.84E+03	2.69E+03	9.30E+03	3.28E+03

*Values taken from Reference 3, Table B-1

** $\frac{mrad\text{-}m^3}{uCi\text{-}yr}$

*** $\frac{mrem\text{-}m^3}{uCi\text{-}yr}$

TABLE 2.1-2

GASEOUS RELEASE POINTS FLOW RATES

Release Point	Flow Rates	
	ft^3/min	ml/sec
Plant Vent (Unit 1)	1.5E05	7.08E07
Plant Vent (Unit 2)	9.0E04	4.25E07
Radwaste Solidification Building Vent	3.4E04	1.60E07
Turbine Building Vent (Unit 1; Condenser Air Ejector and Steam Packing Exhaust)	9.0E02	4.25E05
Turbine Building Vent (Unit 2; Condenser Air Ejector and Steam Packing Exhaust)	9.0E02	4.25E05

Reference 5, Tables 11.5.2-1 and 11.5.5-1

2.2 GASEOUS EFFLUENT DOSE RATE AND DOSE CALCULATIONS

2.2.1 Dose Rates at or beyond Site Boundary

2.2.1.1 Dose Rates Due to Noble Gases

For the purpose of implementing Technical Specification 3.11.2.1(a), the dose rate in areas at or beyond the site boundary due to noble gases shall be calculated as follows:

D_t = total body dose rate at time of release (mrem/yr)

$$= \left[(\overline{X/Q})_G \sum_{ng} \sum_i K_i \, (Q_{ig})_{ng}\right] + \left[(\overline{X/Q})_M \sum_{nm} \sum_i K_i \, (Q_{im})_{nm}\right] \quad (14)$$ 2

D_s = skin dose rate at time of release (mrem/yr)

$$= \left[(\overline{X/Q})_G \sum_{ng} \sum_i (L_i + 1.1M_i)(Q_{ig})_{ng}\right] + \left[(\overline{X/Q})_M \sum_{nm} \sum_i (L_i + 1.1M_i)(Q_{im})_{nm}\right] \quad (15)$$ 2

Where ng is the number of simultaneous ground-level vent releases and nm is the number of simultaneous mixed-mode vent releases. Other terms were defined previously in Subsection 2.1. 2

The dose rate limits are site limits at any point in time; therefore, dose rates are summed over all gaseous releases occurring simultaneously. For Plant Vogtle, Unit 1 turbine building vent, Unit 2 turbine building vent, and radwaste solidification building vent are ground-level releases. Unit 1 plant vent and Unit 2 plant vent are mixed-mode releases. However, since the limits of Technical Specification 3.11.2.1 apply at any point in time, ground-level dispersion values are used in lieu of mixed-mode values as discussed in Subsection 2.1.2. 2 (See NOTE in Subsection 2.1.2). 3

2.2.1.2 Dose Rates Due to I-131, I-133, Tritium, and Particulates

For the purpose of implementing Technical Specification 3.11.2.1(b), organ dose rates due to I-131, I-133, tritium and all radioactive materials in particulate form with half lives greater than eight days, are required to be calculated for the inhalation pathway for the child age group. The child age group would experience the highest potential dose rate via the inhalation pathway. These dose rates are calculated as follows:

D_o = organ dose rate at time of release (mrem/yr)

$$= \left[(\overline{X/Q})_G \sum_{ng} \sum_{i} P_{io} \; (Q'_{ig})_{ng}\right] + \left[(\overline{X/Q})_M \sum_{nm} \sum_{i} P_{io} \; (Q'_{im})_{nm}\right] \qquad (16)$$ 2

where

nm and ng = defined previously in subsection 2.2.1.1 2

$(\overline{X/Q})_G$ = defined previously in subsection 2.1.1

$(\overline{X/Q})_M$ = defined previously in subsection 2.1.2

Q'_{ig} = release rate (uCi/sec) of I-131, I-133, tritium and particulates from Unit 1 turbine building vent; Unit 2 turbine building vent; and radwaste solidification building vent, which are ground-level releases.

Q'_{im} = release rate (uCi/sec) of I-131, I-133, tritium and particulates from Unit 1 plant vent and Unit 2 plant vent, which are mixed-mode releases.

P_{io} = organ dose parameter for organ o and radionuclide i, (mrem/yr per uCi/m^3) for inhalation determined as follows:

$$P_{io} = K'(BR)\ DF_{io} \quad (17)$$

and where

K' = constant of unit conversion, 10^6pCi/uCi

BR = breathing rate for child age group; 3700 m^3/yr from Table 2.2-10

DF_{io} = inhalation pathway dose factor for child age group for organ o and radionuclide i, from Table 2.2-2)

NOTE: In order to assure that potential dose rates (pre-release) to an organ due to I-131, I-133, tritium, and particulates in simultaneous gaseous releases from the site do not exceed 1500 mrem/yr as specified in Technical Specification 3.11.2.1(b), the potential organ dose rate D_o must be limited as follows:

$$D_o \leq (AG)(SF)\ 1500\ \text{mrem/yr} \quad (18)$$

where AG and SF are assigned the same values as were used in Subsection 2.1 for the gaseous discharge pathway under consideration. To further ensure that dose rate limits were not exceeded (post-release), dose rates from simultaneous releases should be summed, as shown in equation (16) above.

2.2.2 Air Doses and Doses to a Member of the Public at or beyond the Site Boundary

(See NOTE in Subsection 2.1.2). 3

2.2.2.1 Air Doses at or beyond the Site Boundary

For the purpose of implementing Technical Specification 3.11.2.2, air doses in areas at or beyond the site boundary shall be determined as follows:

D_{gamma} = air dose due to gamma emissions from noble gas radionuclides (mrad)

$$= 3.17 \times 10^{-8}\left[\left[(\overline{X/Q})_G \sum_i M_i \tilde{Q}_{ig}\right] + \left[(\overline{X/Q})_M \sum_i M_i \tilde{Q}_{im}\right]\right] \quad (19)$$ 2

where

3.17×10^{-8} = the fraction of one year per one second

$\tilde{Q}_{ig}$ = cumulative release of noble gas radionuclide i over the period of interest (uCi) from the vent release (ground-level) under consideration.

$\tilde{Q}_{im}$ = cumulative release of noble gas radionuclide i over the period of interest (uCi) from the vent release (mixed-mode) under consideration.

M_i = defined previously in Subsection 2.1.1

$(\overline{X/Q})_G$ = defined previously in Subsection 2.1.1

$(\overline{X/Q})_M$ = 6.83×10^{-5} sec/m^3 in the ENE sector 2,3

D_{beta} = air dose due to beta emissions from noble gas radionuclides (mrad).

$$= 3.17 \times 10^{-8}\left[\left[(\overline{X/Q})_G \sum_i N_i \tilde{Q}_{ig}\right] + \left[(\overline{X/Q})_M \sum_i N_i \tilde{Q}_{im}\right]\right] \quad (20)$$ 2

where

N_i = air dose factor due to beta emissions from noble gas radionuclide i (mrad/yr per uCi/m^3), from Table 2.1-1.

2.2.2.2 Dose to a Member of the Public at or beyond the Site Boundary

Doses to a member of the public due to I-131, I-133, tritium, and radioactive materials in particulate form, in gaseous releases, will be calculated for the purpose of implementing Technical Specification 3.11.2.3 as follows:

(NOTE: The member of the public expected to receive the highest dose in the plant vicinity is referred to as the controlling (or critical) receptor. The dose received depends on the location, age-group, and exposure pathways present. For Plant Vogtle, the controlling receptor(s) for which doses must be calculated, and the applicable exposure pathways, are presented in Table 2.2-12.)

D_j = dose to an organ j of an individual in age-group a from radioiodines, tritium, and radionuclides in particulate form with half-lives greater than eight days (mrem).

$$= 3.17 \times 10^{-8} \sum_{pi} R_{aipj} \left(W'_{GP} \tilde{Q}'_{ig} + W'_{MP} \tilde{Q}'_{im}\right) \quad (21)$$

where

3.17×10^{-8} = fraction of one year per one second.

pi = for all pathways and all isotopes 3

W'_{GP} = pathway-dependent relative dispersion or deposition at the location of the controlling receptor, associated with ground-level plant releases as follows:

$(\overline{X/Q'})_{GP}$ = annual average relative dispersion parameter for location of controlling (critical) receptor for ground-level plant releases. $(\overline{X/Q'})_{GP}$ applies only to inhalation and all tritium pathways. (For all tritium pathways the Q_i' source term is limited to tritium.) See Table 2.2-12 for value.

$(\overline{D/Q'})_{GP}$ = annual average deposition parameter for the location of controlling (critical) receptor for ground-level vent releases. $(\overline{D/Q'})_{GP}$ applies to all other pathways. See Table 2.2-12 for value.

W'_{MP} = pathway-dependent relative dispersion or deposition at the location of the controlling receptor, associated with plant vent releases, which are mixed-mode as follows:

$(\overline{X/Q'})_{MP}$ = annual average relative dispersion parameter for location of controlling (critical) receptor for mixed mode releases. $(\overline{X/Q'})_{MP}$ applies only to inhalation and all tritium pathways. (For all tritium pathways, the Q_i' source term is limited to tritium.) See Table 2.2-12 for values.

$(\overline{D/Q'})_{MP}$ = annual average deposition parameter for the location of controlling (critical) receptor for mixed mode releases. $(\overline{D/Q'})_{MP}$ applies to all other pathways. See Table 2.2-12 for values.

The selection of the dispersion or deposition parameter, X/Q or D/Q, is dependent upon the pathway being considered. The dispersion parameter, X/Q, is required for the inhalation pathway and the tritium contribution to ingestion pathways since tritium is taken up by vegetation directly from the surrounding air. The deposition parameter, D/Q, is required for the ground-plane pathway and I-131, I-133 and particulate contributions to ingestion pathways.

$\tilde{Q}'_{ig}$ = cumulative release (uCi), from ground-level plant releases, of radionuclide i as required by Technical Specification 3.11.2.3 over the period of interest. Dose determinations required by Technical Specification 3.11.2.3 are on a per reactor basis; therefore, cumulative release quantities must also be unit-specific. Since the radwaste solidification building serves both units, release quantities must be apportioned between the two units. In absence of evidence that one unit contributes a greater quantity of radioactivity than the other over the period of interest release quantities may be apportioned equally between the two units. (For dose contributions due to tritium from the ingestion pathways, the $\tilde{Q}'_{ig}$ term is limited to tritium.)

$\tilde{Q}'_{im}$ = cumulative release (uCi), from the mixed-mode plant vent releases, of radionuclide i as required by Technical Specification 3.11.2.3 over the period of interest. Dose determinations required by Technical Specification 3.11.2.3 are on a per reactor basis; therefore, cumulative release quantities must also be unit-specific. (For dose contributions due to tritium from the ingestion pathways, the term $\widetilde{Q}'_{1m}$ is limited to tritium.)

R_{aipj} = pathway-specific, individual age-specific, organ dose factor for radionuclide i, pathway p, organ j, and individual age group, a. Routine individual dose calculations address the inhalation, ground-plane, grass-cow-milk, grass-goat-milk, grass-cow-meat, and garden vegetation pathways. However, the dose pathways actually present at the controlling location, as well as the controlling individual age group, are determined through the Land Use Census for the site vicinity and are presented in Table 2.2-12. Pathway factors R_{aipj} are determined as shown in the following Subsections.

Plant Vogtle site-specific values, or appropriate default values, required in the pathway factor determinations are presented in Table 2.2-13.

<u>Inhalation Pathway Factor</u>

$$R_{aipj} = K'(BR)_a\ (DFA_{ij})_a \text{ mrem/yr per uCi/m}^3 \qquad (22)$$

where

K' = constant of unit conversion 10^6 pCi/uCi

$(BR)_a$ = the breathing rate for a particular age group in m^3/year from Table 2.2-10.

DFA_{ija} = the inhalation dose factor for receptor age group a, organ j, and for radionuclide i, in mrem/pCi from Tables 2.2-1 through 2.2-4.

Ground-Plane Pathway Factor

$$R_{aipj} = K'K'' (SHF)(DFG_{ij}) ((1-e^{-\lambda_i t})/\lambda_i)$$
$$(m^2 mrem/year\ per\ uCi/sec) \quad (23)$$

K' = constant of unit conversion, 10^6 pCi/uCi.

K'' = constant of unit conversion, 8760 hr/yr.

SHF = shielding factor, 0.7 (dimensionless) | 1

DFG_{ij} = ground plane dose conversion factor for radionuclide i (same for all age groups and specific organs are assumed to receive the same dose as the total body) (mrem/hr per pCi/m^2) Table 2.2-9.

λ_i = decay constant for radionuclide i, in sec^{-1}.

t = exposure time, 4.73×10^8 sec (15 years).

Vegetation Pathway Factor

$$R_{aipj} = K' \frac{r}{Y_v(\lambda_i + \lambda_w)} (DFL_{ij})_a \left(U_{al}\, f_l\, e^{-\lambda_i t_l} + U_{as}\, f_g\, e^{-\lambda_i t_{hv}}\right) \quad (24)$$

(m^2mrem/year per uCi/sec)

where

K' = a constant of unit conversion, 10^6 pCi/uCi.

r = fraction of deposited activity retained on vegetation. (1.0 for radioiodines; 0.2 for particulates.)

U_{al} = the consumption rate of fresh leafy vegetation by the receptor in age group a, in kg/year. (See Table 2.2-10)

U_{as} = the consumption rate of stored vegetation by the receptor in age group a, in kg/year. (See Table 2.2-10)

f_l = the fraction of the annual intake of fresh leafy vegetation grown locally.

f_g = the fraction of the annual intake of stored vegetation grown locally.

t_l = the average time between harvest of leafy vegetation and its consumption in seconds. (8.6×10^4)

t_{hv} = the average time between harvest of stored vegetation and its consumption in seconds. (5.18×10^6)

Y_v = the vegetation areal density, in kg/m^2.

$(DFL_{ij})_a$ = the organ ingestion dose factor for the ith radionuclide for the receptor in age group a, in mrem/pCi from Tables 2.2-5 through 2.2-8.

λ_i = the decay constant for the ith radionuclide, in sec^{-1}.

λ_w = the decay constant for removal of activity on leaf and plant surfaces by weathering, 5.73×10^{-7} sec^{-1} (corresponding to a 14 day half-life).

For tritium in vegetation, the vegetation pathway factor is a special case due to the fact that the concentration of tritium in vegetation is based on airborne concentration rather than deposition:

$$R_{aipj} = K'K'''(U_{al}f_l + U_{as}f_g)(DFL_{ij})_a (0.75(0.5/H)) \quad \text{(mrem/yr per uCi/m}^3\text{)} \qquad (25)$$

where

K''' = a constant of unit conversion, 10^3 gm/kg.

H = absolute humidity of the atmosphere, in gm/m^3.

0.75 = the fraction of total vegetation that is water.

0.5 = the ratio of the specific activity of the vegetation water to the atmospheric water.

and other parameters and values are given above.

Grass-Cow-Milk Pathway Factor

$$R_{aipj} = K'\frac{Q_F(U_{ap})}{\lambda_i + \lambda_w}F_m(r)(DFL_{ij})_a \left[\frac{f_p f_s}{Y_p} + \frac{(1-f_p f_s)e^{-\lambda_i t_{hm}}}{Y_s}\right] e^{-\lambda_i t_f} \qquad (26)$$

(m^2mrem/yr per uCi/sec)

where

K' = a constant of unit conversion, 10^6 pCi/uCi.

Q_F = the cow's consumption rate, in kg/day (wet weight).

U_{ap} = the receptor's milk consumption rate for age group a, in liters/yr from Table 2.2-10.

Y_p = the agricultural productivity by unit area of pasture feed grass, in kg/m^2.

Y_s = the agricultural productivity by unit area of stored feed, in kg/m^2.

F_m = the stable element transfer coefficients, in days/liter. (See Table 2.2-11.)

r = fraction of deposited activity retained on feed grass. (1.0 for radioiodines; 0.2 for particulates)

$(DFL_{ij})_a$ = the organ ingestion dose factor for the ith radionuclide for the receptor in age group a, in mrem/pCi from Tables 2.2-5 through 2.2-8.

λ_i = the decay constant for the ith radionuclide, in sec^{-1}.

λ_w = the decay constant for removal of activity on leaf and plant surfaces by weathering, 5.73×10^{-7} sec^{-1} (corresponding to a 14 day half-life).

t_f = the transport time from pasture to cow, to milk, to receptor, in sec. (1.73×10^5).

t_{hm} = the transport time from pasture, to harvest, to cow, to milk, to receptor, in sec. (7.78×10^6).

f_p = fraction of the year that the cow is on pasture (dimensionless).

f_s = fraction of the cow feed that is pasture grass while the cow is on pasture (dimensionless).

For tritium in milk, the grass-cow-milk pathway factor is a special case due to the fact that the concentration of tritium in milk is based on airborne concentration rather than deposition:

$$R_{aipj} = K'K'''F_m Q_F U_{ap} (DFL_{ij})_a (0.75(0.5/H)) \quad (\text{mrem/yr per uCi/m}^3) \tag{27}$$

where

K''' = a constant of unit conversion, 10^3 gm/kg.

H = absolute humidity of the atmosphere, in gm/m^3.

0.75 = the fraction of total feed that is water.

0.5 = the ratio of the specific activity of the feed grass water to the atmospheric water.

and other parameters and values as previously defined.

Grass-Goat-Milk Pathway Factor

$$R_{aipj} = K'\frac{Q_F(U_{ap})}{\lambda_i + \lambda_w}F_m(r)(DFL_{ij})_a \left[\frac{f_p f_s}{Y_p} + \frac{(1-f_p f_s)e^{-\lambda_i t_{hm}}}{Y_s}\right] e^{-\lambda_i t_f} \tag{28}$$

(m^2mrem/yr per uCi/sec)

where

K' = a constant of unit conversion, 10^6 pCi/uCi.

Q_F = the goat's consumption rate, in kg/day (wet weight).

U_{ap} = the receptor's milk consumption rate for age group a, in liters/yr from Table 2.2-10.

Y_p = the agricultural productivity by unit area of pasture feed grass, in kg/m^2.

Y_s = the agricultural productivity by unit area of stored feed, in kg/m^2.

F_m = the stable element transfer coefficients, in days/liter. (See Table 2.2-11.)

r = fraction of deposited activity retained on feed grass. (1.0 for radioiodines; 0.2 for particulates)

$(DFL_{ij})_a$ = the organ ingestion dose factor for the ith radionuclide for the receptor in age group a, in mrem/pCi from Tables 2.2-5 through 2.2-8.

λ_i = the decay constant for the ith radionuclide, in sec^{-1}.

λ_w = the decay constant for removal of activity on leaf and plant surfaces by weathering, 5.73 x 10^{-7} sec^{-1} (corresponding to a 14 day half-life).

t_f = the transport time from pasture to goat, to milk, to receptor, in sec. (1.73×10^5)

t_{hm} = the transport time from pasture, to harvest, to goat, to milk, to receptor, in sec. (7.78×10^6)

f_p = fraction of the year that the goat is on pasture (dimensionless).

f_s = fraction of the goat feed that is pasture grass while the goat is on pasture (dimensionless).

For tritium in milk, the grass-goat-milk pathway factor is a special case due to the fact that the concentration of tritium in milk is based on airborne concentration rather than desposition:

$$R_{aipj} = K'K'''F_m Q_F U_{ap} (DFL_{ij})_a (0.75(0.5/H)) \quad \text{(mrem/yr per uCi/m}^3\text{)} \qquad (29)$$

where:

K''' = a constant of unit conversion, 10^3 gm/kg.

H = absolute humidity of the atmosphere, in gm/m^3.

0.75 = the fraction of total feed that is water.

0.5 = the ratio of the specific activity of the feed grass water to the atmospheric water.

and other parameters and values are given above.

Grass-Cow-Meat-Pathway-Factor

$$R_{aipj} = K'\frac{Q_F(U_{ap})}{\lambda_i + \lambda_w}F_f(r)(DFL_{ij})_a \left[\frac{f_p f_s}{Y_p} + \frac{(1-f_p f_s)e^{-\lambda_i t_{hm}}}{Y_s}\right]e^{-\lambda_i t_f} \quad (30)$$

(m^2mrem/yr per uCi/sec)

where

K' = a constant of unit conversion, 10^6 pCi/uCi.

Q_F = the cow's consumption rate, in kg/day (wet weight).

U_{ap} = the receptor's meat consumption rate for age group a, in kg/yr from Table 2.2-10.

Y_p = the agricultural productivity by unit area of pasture feed grass, in kg/m^2.

Y_s = the agricultural productivity by unit area of stored feed, in kg/m^2.

F_f = The stable element transfer coefficients, in days/kg. (see Table 2.2-11.)

r = fraction of deposited activity retained on feed grass. (1.0 for radioiodines; 0.2 for particulates)

$(DFL_{ij})_a$ = the organ ingestion dose factor for the ith radionuclide for the receptor in age group a, in mrem/pCi from Tables 2.2-5 through 2.2-8.

λ_i = the decay constant for the ith radionuclide, in sec^{-1}.

λ_w = the decay constant for removal of activity on leaf and plant surfaces by weathering, 5.73×10^{-7} sec^{-1} (corresponding to a 14 day half-life).

t_f = the transport time from pasture to cow, to meat, to receptor, in sec. (1.73×10^6)

t_{hm} = the transport time from pasture, to harvest, to cow, to meat, to receptor, in sec. (7.78×10^6)

f_p = fraction of the year that the cow is on pasture (dimensionless).

f_s = fraction of the cow feed that is pasture grass while the cow is on pasture (dimensionless).

For tritium in meat, the grass-cow-meat pathway factor is a special case due to the fact that the concentration of tritium in meat is based on airborne concentration rather than deposition:

$$R_{aipj} = K'K'''F_f Q_F U_{ap} (DFL_{ij})_a (0.75(0.5/H)) \quad \text{(mrem/yr per uCi/m}^3\text{)} \qquad (31)$$

where:

K'" = a constant of unit conversion, 10^3 gm/kg.

H = absolute humidity of the atmosphere, in gm/m^3.

0.75 = the fraction of total feed that is water.

0.5 = the ratio of the specific activity of the feed grass water to the atmospheric water.

and other parameters and values are given above.

2.2.2.3 Dose Calculations to Support Other Technical Specifications

In the event radiological impact assessment becomes necessary to support Technical Specification 6.6.1, which pertains to reportable events, dose calculations may be performed using the equations in Subsection 2.2.2.2 with the substitution of average meteorological (dispersion and deposition) parameters for the period covered by the report, and the appropriate pathway dose factors (R_{aipj}) for the receptor of interest.

For the purpose of supporting Technical Specification 3.12.2, which pertains to the Annual Land Use Survey, it may become necessary to perform dose calculations in addition to those required by Technical Specifications 3.11.2.3. In the event that the Land use Survey reveals that exposure pathways have changed at previously identified locations, or if new locations are identified, it may become necessary to perform dose calculations at two or more locations to either confirm the previously identified controlling receptor or identify the new receptor which should be designated as the controlling receptor. The necessary dose calculations may be performed using the equations presented in Subsection 2.2.2.2 substituting the appropriate pathway dose factors (R_{aipj}) and the appropriate meteorological (dispersion and deposition) parameters for the receptor(s) and location(s) of interest. Annual average meteorological paramaters may be used for these calculations.

Potential receptors are presented in Table 2.2-14; the associated dispersion and deposition parameters are shown in Table 2.2-15. Information contained in these two tables may be useful in performing dose calculations to support Technical Specifications 6.6.1 or 3.12.2.

TABLE 2.2-1

INHALATION DOSE FACTORS FOR INFANT*

(MREM PER PCI INHALED)

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	No Data	4.62E-07	4.62E-07	4.62E-07	4.62E-07	4.62E-07	4.62E-07
C-14	1.89E-05	3.79E-06	3.79E-06	3.79E-06	3.79E-06	3.79E-06	3.79E-06
Na-24	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06
P-32	1.45E-03	8.03E-05	5.53E-05	No Data	No Data	No Data	1.15E-05
Cr-51	No Data	No Data	6.39E-08	4.11E-08	9.45E-09	9.17E-06	2.55E-07
Mn-54	No Data	1.81E-05	3.56E-06	No Data	3.56E-06	7.14E-04	5.04E-06
Mn-56	No Data	1.10E-09	1.58E-10	No Data	7.86E-10	8.95E-06	5.12E-05
Fe-55	1.41E-05	8.39E-06	2.38E-06	No Data	No Data	6.21E-05	7.82E-07
Fe-59	9.69E-06	1.68E-05	6.77E-06	No Data	No Data	7.25E-04	1.77E-05
Co-58	No Data	8.71E-07	1.30E-06	No Data	No Data	5.55E-04	7.95E-06
Co-60	No Data	5.73E-06	8.41E-06	No Data	No Data	3.22E-03	2.28E-05
Ni-63	2.42E-04	1.46E-05	8.29E-06	No Data	No Data	1.49E-04	1.73E-06
Ni-65	1.71E-09	2.03E-10	8.79E-11	No Data	No Data	5.80E-06	3.58E-05
Cu-64	No Data	1.34E-09	5.53E-10	No Data	2.84E-09	6.64E-06	1.07E-05
[illegible]-65	1.38E-05	4.47E-05	2.22E-05	No Data	2.32E-05	4.62E-04	3.67E-05
Zn-69	3.85E-11	6.91E-11	5.13E-12	No Data	2.87E-11	1.05E-06	9.44E-06
Br-83	No Data	No Data	2.72E-07	No Data	No Data	No Data	LT E-24
Br-84	No Data	No Data	2.86E-07	No Data	No Data	No Data	LT E-24
Br-85	No Data	No Data	1.46E-08	No Data	No Data	No Data	LT E-24
Rb-86	No Data	1.36E-04	6.30E-05	No Data	No Data	No Data	2.17E-06
Rb-88	No Data	3.98E-07	2.05E-07	No Data	No Data	No Data	2.42E-07
Rb-89	No Data	2.29E-07	1.47E-07	No Data	No Data	No Data	4.87E-08
Sr-89	2.84E-04	No Data	8.15E-06	No Data	No Data	1.45E-03	4.57E-05
Sr-90	2.92E-02	No Data	1.85E-03	No Data	No Data	8.03E-03	9.36E-05
Sr-91	6.83E-08	No Data	2.47E-09	No Data	No Data	3.76E-05	5.24E-05
Sr-92	7.50E-09	No Data	2.79E-10	No Data	No Data	1.70E-05	1.00E-04
Y-90	2.35E-06	No Data	6.30E-08	No Data	No Data	1.92E-04	7.43E-05
Y-91M	2.91E-10	No Data	9.90E-12	No Data	No Data	1.99E-06	1.68E-06
Y-91	4.20E-04	No Data	1.12E-05	No Data	No Data	1.75E-03	5.02E-05
Y-92	1.17E-08	No Data	3.29E-10	No Data	No Data	1.75E-05	9.04E-05

Reference 3, Table E-10.

TABLE 2.2-1 CONT'D

INHALATION DOSE FACTORS FOR INFANT*

(MREM PER PCI INHALED)

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Y-93	1.07E-07	No Data	2.91E-09	No Data	No Data	5.46E-05	1.19E-04
Zr-95	8.24E-05	1.99E-05	1.45E-05	No Data	2.22E-05	1.25E-03	1.55E-05
Zr-97	1.07E-07	1.83E-08	8.36E-09	No Data	1.85E-08	7.88E-05	1.00E-04
Nb-95	1.12E-05	4.59E-06	2.70E-06	No Data	3.37E-06	3.42E-04	9.05E-06
Mo-99	No Data	1.18E-07	2.31E-08	No Data	1.89E-07	9.63E-05	3.48E-05
Tc-99M	9.98E-13	2.06E-12	2.66E-11	No Data	2.22E-11	5.79E-07	1.45E-06
Tc-101	4.65E-14	5.88E-14	5.80E-13	No Data	6.99E-13	4.17E-07	6.03E-07
Ru-103	1.44E-06	No Data	4.85E-07	No Data	3.03E-06	3.94E-04	1.15E-05
Ru-105	8.74E-10	No Data	2.93E-10	No Data	6.42E-10	1.12E-05	3.46E-05
Ru-106	6.20E-05	No Data	7.77E-06	No Data	7.61E-05	8.26E-03	1.17E-04
Ag-110M	7.13E-06	5.16E-06	3.57E-06	No Data	7.80E-06	2.62E-03	2.36E-05
Te-125M	3.40E-06	1.42E-06	4.70E-07	1.16E-06	No Data	3.19E-04	9.22E-06
Te-127M	1.19E-05	4.93E-06	1.48E-06	3.48E-06	2.68E-05	9.37E-04	1.95E-05
Te-127	1.59E-09	6.81E-10	3.49E-10	1.32E-09	3.47E-09	7.39E-06	1.74E-05
Te-129M	1.01E-05	4.35E-06	1.59E-06	3.91E-06	2.27E-05	1.20E-03	4.93E-05
Te-129	5.63E-11	2.48E-11	1.34E-11	4.82E-11	1.25E-10	2.14E-06	1.88E-05
Te-131M	7.62E-08	3.93E-08	2.59E-08	6.38E-08	1.89E-07	1.42E-04	8.51E-05
Te-131	1.24E-11	5.87E-12	3.57E-12	1.13E-11	2.85E-11	1.47E-06	5.87E-06
Te-132	2.66E-07	1.69E-07	1.26E-07	1.99E-07	7.39E-07	2.43E-04	3.15E-05
I-130	4.54E-06	9.91E-06	3.98E-06	1.14E-03	1.09E-05	No Data	1.42E-06
I-131	2.71E-05	3.17E-05	1.40E-05	1.06E-02	3.70E-05	No Data	7.56E-07
I-132	1.21E-06	2.53E-06	8.99E-07	1.21E-04	2.82E-06	No Data	1.36E-06
I-133	9.46E-06	1.37E-05	4.00E-06	2.54E-03	1.60E-05	No Data	1.54E-06
I-134	6.58E-07	1.34E-06	4.75E-07	3.18E-05	1.49E-06	No Data	9.21E-07
I-135	2.76E-06	5.43E-06	1.98E-06	4.97E-04	6.05E-06	No Data	1.31E-06
Cs-134	2.83E-04	5.02E-04	5.32E-05	No Data	1.36E-04	5.69E-05	9.53E-07
Cs-136	3.45E-05	9.61E-05	3.78E-05	No Data	4.03E-05	8.40E-06	1.02E-06
Cs-137	3.92E-04	4.37E-04	3.25E-05	No Data	1.23E-04	5.09E-05	9.53E-07
Cs-138	3.61E-07	5.58E-07	2.84E-07	No Data	2.93E-07	4.67E-08	6.26E-07
Ba-139	1.06E-09	7.03E-13	3.07E-11	No Data	4.23E-13	4.25E-06	3.64E-05
Ba-140	4.00E-05	4.00E-08	2.07E-06	No Data	9.59E-09	1.14E-03	2.74E-05
Ba-141	1.12E-10	7.70E-14	3.55E-12	No Data	4.64E-14	2.12E-06	3.39E-06
Ba-142	2.84E-11	2.36E-14	1.40E-12	No Data	1.36E-14	1.11E-06	4.95E-07
140	3.61E-07	1.43E-07	3.68E-08	No Data	No Data	1.20E-04	6.06E-05

TABLE 2.2-1 CONT'D

INHALATION DOSE FACTORS FOR INFANT*

(MREM PE PCI INHALED)

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
La-142	7.36E-10	2.69E-10	6.46E-11	No Data	No Data	5.87E-06	4.25E-05
Ce-141	1.98E-05	1.19E-05	1.42E-06	No Data	3.75E-06	3.69E-04	1.54E-05
Ce-143	2.09E-07	1.38E-07	1.58E-08	No Data	4.03E-08	8.30E-05	3.55E-05
Ce-144	2.28E-03	8.65E-04	1.26E-04	No Data	3.84E-04	7.03E-03	1.06E-04
Pr-143	1.00E-05	3.74E-06	4.99E-07	No Data	1.41E-06	3.09E-04	2.66E-05
Pr-144	3.42E-11	1.32E-11	1.72E-12	No Data	4.80E-12	1.15E-06	3.06E-06
Nd-147	5.67E-06	5.81E-06	3.57E-07	No Data	2.25E-06	2.30E-04	2.23E-05
W-187	9.26E-09	6.44E-09	2.23E-09	No Data	No Data	2.83E-05	2.54E-05
Np-239	2.65E-07	2.37E-08	1.34E-08	No Data	4.73E-08	4.25E-05	1.78E-05

TABLE 2.2-2

INHALATION DOSE FACTORS FOR CHILD*

(MREM PER PCI INHALED)

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	No Data	3.04E-07	3.04E-07	3.04E-07	3.04E-07	3.04E-07	3.04E-07
C-14	9.70E-06	1.82E-06	1.82E-06	1.82E-06	1.82E-06	1.82E-06	1.82E-06
Na-24	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06
P-32	7.04E-04	3.09E-05	2.67E-05	No Data	No Data	No Data	1.14E-05
Cr-51	No Data	No Data	4.17E-08	2.31E-08	6.57E-09	4.59E-06	2.93E-07
Mn-54	No Data	1.16E-05	2.57E-06	No Data	2.71E-06	4.26E-04	6.19E-06
Mn-56	No Data	4.48E-10	8.43E-11	No Data	4.52E-10	3.55E-06	3.33E-05
Fe-55	1.28E-05	6.80E-06	2.10E-06	No Data	No Data	3.00E-05	7.75E-07
Fe-59	5.59E-06	9.04E-06	4.51E-06	No Data	No Data	3.43E-04	1.91E-05
Co-58	No Data	4.79E-07	8.55E-07	No Data	No Data	2.99E-04	9.29E-06
Co-60	No Data	3.55E-06	6.12E-06	No Data	No Data	1.91E-03	2.60E-05
Ni-63	2.22E-04	1.25E-05	7.56E-06	No Data	No Data	7.43E-05	1.71E-06
Ni-65	8.08E-10	7.99E-11	4.44E-11	No Data	No Data	2.21E-06	2.27E-05
Cu-64	No Data	5.39E-10	2.90E-10	No Data	1.63E-09	2.59E-06	9.92E-06
Zn-65	1.15E-05	3.06E-05	1.90E-05	No Data	1.93E-05	2.69E-04	4.41E-06
Zn-69	1.81E-11	2.61E-11	2.41E-12	No Data	1.58E-11	3.84E-07	2.75E-06
Br-83	No Data	No Data	1.28E-07	No Data	No Data	No Data	LT E-24
Br-84	No Data	No Data	1.48E-07	No Data	No Data	No Data	LT E-24
Br-85	No Data	No Data	6.84E-09	No Data	No Data	No Data	LT E-24
Rb-86	No Data	5.36E-05	3.09E-05	No Data	No Data	No Data	2.16E-06
Rb-88	No Data	1.52E-07	9.90E-08	No Data	No Data	No Data	4.66E-09
Rb-89	No Data	9.33E-08	7.83E-08	No Data	No Data	No Data	5.11E-10
Sr-89	1.62E-04	No Data	4.66E-06	No Data	No Data	5.83E-04	4.52E-05
Sr-90	2.73E-02	No Data	1.74E-03	No Data	No Data	3.99E-03	9.28E-05
Sr-91	3.28E-08	No Data	1.24E-09	No Data	No Data	1.44E-05	4.70E-05
Sr-92	3.54E-09	No Data	1.42E-10	No Data	No Data	6.49E-06	6.55E-05
Y-90	1.11E-06	No Data	2.99E-08	No Data	No Data	7.07E-05	7.24E-05
Y-91M	1.37E-10	No Data	4.98E-12	No Data	No Data	7.60E-07	4.64E-07
Y-91	2.47E-04	No Data	6.59E-06	No Data	No Data	7.10E-04	4.97E-05
Y-92	5.50E-09	No Data	1.57E-10	No Data	No Data	6.46E-06	6.46E-05

Reference 3, Table E-9.

TABLE 2.2-2 CONT'D

INHALATION DOSE FACTORS FOR CHILD*

(MREM PER PCI INHALED)

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Y-93	5.04E-08	No Data	1.38E-09	No Data	No Data	2.01E-05	1.05E-04
Zr-95	5.13E-05	1.13E-05	1.00E-05	No Data	1.61E-05	6.03E-04	1.65E-05
Zr-97	5.07E-08	7.34E-09	4.32E-09	No Data	1.05E-08	3.06E-05	9.49E-05
Nb-95	6.35E-06	2.48E-06	1.77E-06	No Data	2.33E-06	1.66E-04	1.00E-05
Mo-99	No Data	4.66E-08	1.15E-08	No Data	1.06E-07	3.66E-05	3.42E-05
Tc-99M	4.81E-13	9.41E-13	1.56E-11	No Data	1.37E-11	2.57E-07	1.30E-06
Tc-101	2.19E-14	2.30E-14	2.91E-13	No Data	3.92E-13	1.58E-07	4.41E-09
Ru-103	7.55E-07	No Data	2.90E-07	No Data	1.90E-06	1.79E-04	1.21E-05
Ru-105	4.13E-10	No Data	1.50E-10	No Data	3.63E-10	4.30E-06	2.69E-05
Ru-106	3.68E-05	No Data	4.57E-06	No Data	4.97E-05	3.87E-03	1.16E-04
Ag-110M	4.56E-06	3.08E-06	2.47E-06	No Data	5.74E-06	1.48E-03	2.71E-05
Te-125M	1.82E-06	6.29E-07	2.47E-07	5.20E-07	No Data	1.29E-04	9.13E-06
Te-127M	6.72E-06	2.31E-06	8.16E-07	1.64E-06	1.72E-05	4.00E-04	1.93E-05
Te-127	7.49E-10	2.57E-10	1.65E-10	5.30E-10	1.91E-09	2.71E-06	1.52E-05
Te-129M	5.19E-06	1.85E-06	8.22E-07	1.71E-06	1.36E-05	4.76E-04	4.91E-05
Te-129	2.64E-11	9.45E-12	6.44E-12	1.93E-11	6.94E-11	7.93E-07	6.89E-06
Te-131M	3.63E-08	1.60E-08	1.37E-08	2.64E-08	1.08E-07	5.56E-05	8.32E-05
Te-131	5.87E-12	2.28E-12	1.78E-12	4.59E-12	1.59E-11	5.55E-07	3.60E-07
Te-132	1.30E-07	7.36E-08	7.12E-08	8.58E-08	4.79E-07	1.02E-04	3.72E-05
I-130	2.21E-06	4.43E-06	2.28E-06	4.99E-04	6.61E-06	No Data	1.38E-06
I-131	1.30E-05	1.30E-05	7.37E-06	4.39E-03	2.13E-05	No Data	7.68E-07
I-132	5.72E-07	1.10E-06	5.07E-07	5.23E-05	1.69E-06	No Data	8.65E-07
I-133	4.48E-06	5.49E-06	2.08E-06	1.04E-03	9.13E-06	No Data	1.48E-06
I-134	3.17E-07	5.84E-07	2.69E-07	1.37E-05	8.92E-07	No Data	2.58E-07
I-135	1.33E-06	2.36E-06	1.12E-06	2.14E-04	3.62E-06	No Data	1.20E-06
Cs-134	1.76E-04	2.74E-04	6.07E-05	No Data	8.93E-05	3.27E-05	1.04E-06
Cs-136	1.76E-05	4.62E-05	3.14E-05	No Data	2.58E-05	3.93E-06	1.13E-06
Cs-137	2.45E-04	2.23E-04	3.47E-05	No Data	7.63E-05	2.81E-05	9.78E-07
Cs-138	1.71E-07	2.27E-07	1.50E-07	No Data	1.68E-07	1.84E-08	7.29E-08
Ba-139	4.98E-10	2.66E-13	1.45E-11	No Data	2.33E-13	1.56E-06	1.56E-05
Ba-140	2.00E-05	1.75E-08	1.17E-06	No Data	5.71E-09	4.71E-04	2.75E-05
Ba-141	5.29E-11	2.95E-14	1.72E-12	No Data	2.56E-14	7.89E-07	7.44E-08
Ba-142	1.35E-11	9.73E-15	7.54E-13	No Data	7.87E-15	4.44E-07	7.41E-10
140	1.74E-07	6.08E-08	2.04E-08	No Data	No Data	4.94E-05	6.10E-05

TABLE 2.2-2 CONT'D

INHALATION DOSE FACTORS FOR CHILD*

(MREM PER PCI INHALED)

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
La-142	3.50E-10	1.11E-10	3.49E-11	No Data	No Data	2.35E-06	2.05E-05
Ce-141	1.06E-05	5.28E-06	7.83E-07	No Data	2.31E-06	1.47E-04	1.53E-05
Ce-143	9.89E-08	5.37E-08	7.77E-09	No Data	2.26E-08	3.12E-05	3.44E-05
Ce-144	1.83E-03	5.72E-04	9.77E-05	No Data	3.17E-04	3.23E-03	1.05E-04
Pr-143	4.99E-06	1.50E-06	2.47E-07	No Data	8.11E-07	1.17E-04	2.63E-05
Pr-144	1.61E-11	4.99E-12	8.10E-13	No Data	2.64E-12	4.23E-07	5.32E-08
Nd-147	2.92E-06	2.36E-06	1.84E-07	No Data	1.30E-06	8.87E-05	2.22E-05
W-187	4.41E-09	2.61E-09	1.17E-09	No Data	No Data	1.11E-05	2.46E-05
Np-239	1.26E-07	9.04E-09	6.35E-09	No Data	2.63E-08	1.57E-05	1.73E-05

TABLE 2.2-3

INHALATION DOSE FACTORS FOR TEENAGER*

(MREM PER PCI INHALED)

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	No Data	1.59E-07	1.59E-07	1.59E-07	1.59E-07	1.59E-07	1.59E-07
C-14	3.25E-06	6.09E-06	6.09E-07	6.09E-07	6.09E-07	6.09E-07	6.09E-07
Na-24	1.72E-06	1.72E-06	1.72E-06	1.72E-06	1.72E-06	1.72E-06	1.72E-06
P-32	2.36E-04	1.37E-05	8.95E-06	No Data	No Data	No Data	1.16E-05
Cr-51	No Data	No Data	1.69E-08	9.37E-09	3.84E-09	2.62E-06	3.75E-07
Mn-54	No Data	6.39E-06	1.05E-06	No Data	1.59E-06	2.48E-04	8.35E-06
Mn-56	No Data	2.12E-10	3.15E-11	No Data	2.24E-10	1.90E-06	7.18E-06
Fe-55	4.18E-06	2.98E-06	6.93E-07	No Data	No Data	1.55E-05	7.99E-07
Fe-59	1.99E-06	4.62E-06	1.79E-06	No Data	No Data	1.91E-04	2.23E-05
Co-58	No Data	2.59E-07	3.47E-07	No Data	No Data	1.68E-04	1.19E-05
Co-60	No Data	1.89E-06	2.48E-06	No Data	No Data	1.09E-03	3.24E-05
Ni-63	7.25E-05	5.43E-06	2.47E-06	No Data	No Data	3.84E-05	1.77E-06
Ni-65	2.73E-10	3.66E-11	1.59E-11	No Data	No Data	1.17E-06	4.59E-06
Cu-64	No Data	2.54E-10	1.06E-10	No Data	8.01E-10	1.39E-06	7.68E-06
Zn-65	4.82E-06	1.67E-05	7.80E-06	No Data	1.08E-05	1.55E-04	5.83E-06
Zn-69	6.04E-12	1.15E-11	8.07E-13	No Data	7.53E-12	1.98E-07	3.56E-08
Br-83	No Data	No Data	4.30E-08	No Data	No Data	No Data	LT E-24
Br-84	No Data	No Data	5.41E-08	No Data	No Data	No Data	LT E-24
Br-85	No Data	No Data	2.29E-09	No Data	No Data	No Data	LT E-24
Rb-86	No Data	2.38E-05	1.05E-05	No Data	No Data	No Data	2.21E-06
Rb-88	No Data	6.82E-08	3.40E-08	No Data	No Data	No Data	3.65E-15
Rb-89	No Data	4.40E-08	2.91E-08	No Data	No Data	No Data	4.22E-17
Sr-89	5.43E-05	No Data	1.56E-06	No Data	No Data	3.02E-04	4.64E-05
Sr-90	1.35E-02	No Data	8.35E-04	No Data	No Data	2.06E-03	9.56E-05
Sr-91	1.10E-08	No Data	4.39E-10	No Data	No Data	7.59E-06	3.24E-05
Sr-92	1.19E-09	No Data	5.08E-11	No Data	No Data	3.43E-06	1.49E-05
Y-90	3.73E-07	No Data	1.00E-08	No Data	No Data	3.66E-05	6.99E-05
Y-91M	4.63E-11	No Data	1.77E-12	No Data	No Data	4.00E-07	3.77E-09
Y-91	8.26E-05	No Data	2.21E-06	No Data	No Data	3.67E-04	5.11E-05
Y-92	1.84E-09	No Data	5.36E-11	No Data	No Data	3.35E-06	2.06E-05

Reference 3, Table E-8

TABLE 2.2-3 CONT'D

INHALATION DOSE FACTORS FOR TEENAGER*

(MREM PER PCI INHALED)

Page 2 of 3

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Y-93	1.69E-08	No Data	4.65E-10	No Data	No Data	1.04E-05	7.24E-05
Zr-95	1.82E-05	5.73E-06	3.94E-06	No Data	8.42E-06	3.36E-04	1.86E-05
Zr-97	1.72E-08	3.40E-09	1.57E-09	No Data	5.15E-09	1.62E-05	7.88E-05
Nb-95	2.32E-06	1.29E-06	7.08E-07	No Data	1.25E-06	9.39E-05	1.21E-05
Mo-99	No Data	2.11E-08	4.03E-09	No Data	5.14E-08	1.92E-05	3.36E-05
Tc-99M	1.73E-13	4.83E-13	6.24E-12	No Data	7.20E-12	1.44E-07	7.66E-07
Tc-101	7.40E-15	1.05E-14	1.03E-13	No Data	1.90E-13	8.34E-08	1.09E-16
Ru-103	2.63E-07	No Data	1.12E-07	No Data	9.29E-07	9.79E-05	1.36E-05
Ru-105	1.40E-10	No Data	5.42E-11	No Data	1.76E-10	2.27E-06	1.13E-05
Ru-106	1.23E-05	No Data	1.55E-06	No Data	2.38E-05	2.01E-03	1.20E-04
Ag-110M	1.73E-06	1.64E-06	9.99E-07	No Data	3.13E-06	8.44E-04	3.41E-05
Te-125M	6.10E-07	2.80E-07	8.34E-08	1.75E-07	No Data	6.70E-05	9.38E-06
Te-127M	2.25E-06	1.02E-06	2.73E-07	5.48E-07	8.17E-06	2.07E-04	1.99E-05
Te-127	2.51E-10	1.14E-10	5.52E-11	1.77E-10	9.10E-10	1.40E-06	1.01E-05
Te-129M	1.74E-06	8.23E-07	2.81E-07	5.72E-07	6.49E-06	2.47E-04	5.06E-05
Te-129	8.87E-12	4.22E-12	2.20E-12	6.48E-12	3.32E-11	4.12E-07	2.02E-07
Te-131M	1.23E-08	7.51E-09	5.03E-09	9.06E-09	5.49E-08	2.97E-05	7.76E-05
Te-131	1.97E-12	1.04E-12	6.30E-13	1.55E-12	7.72E-12	2.92E-07	1.89E-09
Te-132	4.50E-08	3.63E-08	2.74E-08	3.07E-08	2.44E-07	5.61E-05	5.79E-05
I-130	7.80E-07	2.24E-06	8.96E-07	1.86E-04	3.44E-06	No Data	1.14E-06
I-131	4.43E-06	6.14E-06	3.30E-06	1.83E-03	1.05E-05	No Data	8.11E-07
I-132	1.99E-07	5.47E-07	1.97E-07	1.89E-05	8.65E-07	No Data	1.59E-07
I-133	1.52E-06	2.56E-06	7.78E-07	3.65E-04	4.49E-06	No Data	1.29E-06
I-134	1.11E-07	2.90E-07	1.05E-07	4.94E-06	4.58E-07	No Data	2.55E-09
I-135	4.62E-07	1.18E-06	4.36E-07	7.76E-05	1.86E-06	No Data	8.69E-07
Cs-134	6.28E-05	1.41E-04	6.86E-05	No Data	4.69E-05	1.83E-05	1.22E-06
Cs-136	6.44E-06	2.42E-05	1.71E-05	No Data	1.38E-05	2.22E-06	1.36E-06
Cs-137	8.38E-05	1.06E-04	3.89E-05	No Data	3.80E-05	1.51E-05	1.06E-06
Cs-138	5.82E-08	1.07E-07	5.58E-08	No Data	8.28E-08	9.84E-09	3.38E-11
Ba-139	1.67E-10	1.18E-13	4.87E-12	No Data	1.11E-13	8.08E-07	8.06E-07
Ba-140	6.84E-06	8.38E-09	4.40E-07	No Data	2.85E-09	2.54E-04	2.86E-05
Ba-141	1.78E-11	1.32E-14	5.93E-13	No Data	1.23E-14	4.11E-07	9.33E-14
Ba-142	4.62E-12	4.63E-15	2.84E-13	No Data	3.92E-15	2.39E-07	5.99E-20
140	5.99E-08	2.95E-08	7.82E-09	No Data	No Data	2.68E-05	6.09E-05

TABLE 2.2-3 CONT'D

INHALATION DOSE FACTORS FOR TEENAGER*

(MREM PER PCI INHALED)

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
La-142	1.20E-10	5.31E-11	1.32E-11	No Data	No Data	1.27E-06	1.50E-06
Ce-141	3.55E-06	2.37E-06	2.71E-07	No Data	1.11E-06	7.67E-05	1.58E-05
Ce-143	3.32E-08	2.42E-08	2.70E-09	No Data	1.08E-08	1.63E-05	3.19E-05
Ce-144	6.11E-04	2.53E-04	3.28E-05	No Data	1.51E-04	1.67E-03	1.08E-04
Pr-143	1.67E-06	6.64E-07	8.28E-08	No Data	3.86E-07	6.04E-05	2.67E-05
Pr-144	5.37E-12	2.20E-12	2.72E-13	No Data	1.26E-12	2.19E-07	2.94E-14
Nd-147	9.83E-07	1.07E-06	6.41E-08	No Data	6.28E-07	4.65E-05	2.28E-05
W-187	1.50E-09	1.22E-09	4.29E-10	No Data	No Data	5.92E-06	2.21E-05
Np-239	4.23E-08	3.99E-09	2.21E-09	No Data	1.25E-08	8.11E-06	1.65E-05

TABLE 2.2-4

INHALATION DOSE FACTORS FOR ADULTS*

(MREM PER PCI INHALED)

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	No Data	1.58E-07	1.58E-07	1.58E-07	1.58E-07	1.58E-07	1.58E-07
C-14	2.27E-06	4.26E-07	4.26E-07	4.26E-07	4.26E-07	4.26E-07	4.26E-07
Na-24	1.28E-06	1.28E-06	1.28E-06	1.28E-06	1.28E-06	1.28E-06	1.28E-06
P-32	1.65E-04	9.64E-06	6.26E-06	No Data	No Data	No Data	1.08E-05
Cr-51	No Data	No Data	1.25E-08	7.44E-09	2.85E-09	1.80E-06	4.15E-07
Mn-54	No Data	4.95E-06	7.87E-07	No Data	1.23E-06	1.75E-04	9.67E-06
Mn-56	No Data	1.55E-10	2.29E-11	No Data	1.63E-10	1.18E-06	2.53E-06
Fe-55	3.07E-06	2.12E-06	4.93E-07	No Data	No Data	9.01E-06	7.54E-07
Fe-59	1.47E-06	3.47E-06	1.32E-06	No Data	No Data	1.27E-04	2.35E-05
Co-58	No Data	1.98E-07	2.59E-07	No Data	No Data	1.16E-04	1.33E-05
Co-60	No Data	1.44E-06	1.85E-06	No Data	No Data	7.46E-04	3.56E-05
Ni-63	5.40E-05	3.93E-06	1.81E-06	No Data	No Data	2.23E-05	1.67E-06
Ni-65	1.92E-10	2.62E-11	1.14E-11	No Data	No Data	7.00E-07	1.54E-06
Cu-64	No Data	1.83E-10	7.69E-11	No Data	5.78E-10	8.48E-07	6.12E-06
Zn-65	4.05E-06	1.29E-05	5.82E-06	No Data	8.62E-06	1.08E-04	6.68E-06
Zn-69	4.23E-12	8.14E-12	5.65E-13	No Data	5.27E-12	1.15E-07	2.04E-09
Br-83	No Data	No Data	3.01E-08	No Data	No Data	No Data	2.90E-08
Br-84	No Data	No Data	3.91E-08	No Data	No Data	No Data	2.05E-13
Br-85	No Data	No Data	1.60E-09	No Data	No Data	No Data	LT E-24
Rb-86	No Data	1.69E-05	7.37E-06	No Data	No Data	No Data	2.08E-06
Rb-88	No Data	4.84E-08	2.41E-08	No Data	No Data	No Data	4.18E-19
Rb-89	No Data	3.20E-08	2.12E-08	No Data	No Data	No Data	1.16E-21
Sr-89	3.80E-05	No Data	1.09E-06	No Data	No Data	1.75E-04	4.37E-05
Sr-90	1.24E-02	No Data	7.62E-04	No Data	No Data	1.20E-03	9.02E-05
Sr-91	7.74E-09	No Data	3.13E-10	No Data	No Data	4.56E-06	2.39E-05
Sr-92	8.43E-10	No Data	3.64E-11	No Data	No Data	2.06E-06	5.38E-06
Y-90	2.61E-07	No Data	7.01E-09	No Data	No Data	2.12E-05	6.32E-05
Y-91M	3.26E-11	No Data	1.27E-12	No Data	No Data	2.40E-07	1.66E-10
Y-91	5.78E-05	No Data	1.55E-06	No Data	No Data	2.13E-04	4.81E-05
Y-92	1.29E-09	No Data	3.77E-11	No Data	No Data	1.96E-06	9.19E-06

Reference 3, Table E-7.

INHALATION DOSE FACTORS FOR ADULTS*

(MREM PER PCI INHALED)

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Y-93	1.18E-08	No Data	3.26E-10	No Data	No Data	6.06E-06	5.27E-05
Zr-95	1.34E-05	4.30E-06	2.91E-06	No Data	6.77E-06	2.21E-04	1.88E-05
Zr-97	1.21E-08	2.45E-09	1.13E-09	No Data	3.71E-09	9.84E-06	6.54E-05
Nb-95	1.76E-06	9.77E-07	5.26E-07	No Data	9.67E-07	6.31E-05	1.30E-05
Mo-99	No Data	1.51E-08	2.87E-09	No Data	3.64E-08	1.14E-05	3.10E-05
Tc-99M	1.29E-13	3.64E-13	4.63E-12	No Data	5.52E-12	9.55E-08	5.20E-07
Tc-101	5.22E-15	7.52E-15	7.38E-14	No Data	1.35E-13	4.99E-08	1.36E-21
Ru-103	1.91E-07	No Data	8.23E-08	No Data	7.29E-07	6.31E-05	1.38E-05
Ru-105	9.88E-11	No Data	3.89E-11	No Data	1.27E-10	1.37E-06	6.02E-06
Ru-106	8.64E-06	No Data	1.09E-06	No Data	1.67E-05	1.17E-03	1.14E-04
Ag-110M	1.35E-06	1.25E-06	7.43E-07	No Data	2.46E-06	5.79E-04	3.78E-05
Te-125M	4.27E-07	1.98E-07	5.84E-08	1.31E-07	1.55E-06	3.92E-05	8.83E-06
Te-127M	1.58E-06	7.21E-07	1.96E-07	4.11E-07	5.72E-06	1.20E-04	1.87E-05
Te-127	1.75E-10	8.03E-11	3.87E-11	1.32E-10	6.37E-10	8.14E-07	7.17E-06
Te-129M	1.22E-06	5.84E-07	1.98E-07	4.30E-07	4.57E-06	1.45E-04	4.79E-05
Te-129	6.22E-12	2.99E-12	1.55E-12	4.87E-12	2.34E-11	2.42E-07	1.96E-08
Te-131M	8.74E-09	5.45E-09	3.63E-09	6.88E-09	3.86E-08	1.82E-05	6.95E-05
Te-131	1.39E-12	7.44E-13	4.49E-13	1.17E-12	5.46E-12	1.74E-07	2.30E-09
Te-132	3.25E-08	2.69E-08	2.02E-08	2.37E-08	1.82E-07	3.60E-05	6.37E-05
I-130	5.72E-07	1.68E-06	6.60E-07	1.42E-04	2.61E-06	No Data	9.61E-07
I-131	3.15E-06	4.47E-06	2.56E-06	1.49E-03	7.66E-06	No Data	7.85E-07
I-132	1.45E-07	4.07E-07	1.45E-07	1.43E-05	6.48E-07	No Data	5.08E-08
I-133	1.08E-06	1.85E-06	5.65E-07	2.69E-04	3.23E-06	No Data	1.11E-06
I-134	8.05E-08	2.16E-07	7.69E-08	3.73E-06	3.44E-07	No Data	1.26E-10
I-135	3.35E-07	8.73E-07	3.21E-07	5.60E-05	1.39E-06	No Data	6.56E-07
Cs-134	4.66E-05	1.06E-04	9.10E-05	No Data	3.59E-05	1.22E-05	1.30E-06
Cs-136	4.88E-06	1.83E-05	1.38E-05	No Data	1.07E-05	1.50E-06	1.46E-06
Cs-137	5.98E-05	7.76E-05	5.35E-05	No Data	2.78E-05	9.40E-06	1.05E-06
Cs-138	4.14E-08	7.76E-08	4.05E-08	No Data	6.00E-08	6.07E-09	2.33E-13
Ba-139	1.17E-10	8.32E-14	3.42E-12	No Data	7.78E-14	4.70E-07	1.12E-07
Ba-140	4.88E-06	6.13E-09	3.21E-07	No Data	2.09E-09	1.59E-04	2.73E-05
Ba-141	1.25E-11	9.41E-15	4.20E-13	No Data	8.75E-15	2.42E-07	1.45E-17
Ba-142	3.29E-12	3.38E-15	2.07E-13	No Data	2.86E-15	1.49E-07	1.96E-26
140	4.30E-08	2.17E-08	5.73E-09	No Data	No Data	1.70E-05	5.73E-05

TABLE 2.2-4 CONT'D

INHALATION DOSE FACTORS FOR ADULTS*

(MREM PER PCI INHALED)

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
La-142	8.54E-11	3.88E-11	9.65E-12	No Data	No Data	7.91E-07	2.64E-07
Ce-141	2.49E-06	1.69E-06	1.91E-07	No Data	7.83E-07	4.52E-05	1.50E-05
Ce-143	2.33E-08	1.72E-08	1.91E-09	No Data	7.60E-09	9.97E-06	2.83E-05
Ce-144	4.29E-04	1.79E-04	2.30E-05	No Data	1.06E-04	9.72E-04	1.02E-04
Pr-143	1.17E-06	4.69E-07	5.80E-08	No Data	2.70E-07	3.51E-05	2.50E-05
Pr-144	3.76E-12	1.56E-12	1.91E-13	No Data	8.81E-13	1.27E-07	2.69E-18
Nd-147	6.59E-07	7.62E-07	4.56E-08	No Data	4.45E-07	2.76E-05	2.16E-05
W-187	1.06E-09	8.85E-10	3.10E-10	No Data	No Data	3.63E-06	1.94E-05
Np-239	2.87E-08	2.82E-09	1.55E-09	No Data	8.75E-09	4.70E-06	1.49E-05

TABLE 2.2-5

INGESTION DOSE FACTORS FOR INFANT*

(MREM PER PCI INGESTED)

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	No Data	3.08E-07	3.08E-07	3.08E-07	3.08E-07	3.08E-07	3.08E-07
C-14	2.37E-05	5.06E-06	5.06E-06	5.06E-06	5.06E-06	5.06E-06	5.06E-06
Na-24	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05
P-32	1.70E-03	1.00E-04	6.59E-05	No Data	No Data	No Data	2.30E-05
Cr-51	No Data	No Data	1.41E-08	9.20E-09	2.01E-09	1.79E-08	4.11E-07
Mn-54	No Data	1.99E-05	4.51E-06	No Data	4.41E-06	No Data	7.31E-06
Mn-56	No Data	8.18E-07	1.41E-07	No Data	7.03E-07	No Data	7.43E-05
Fe-55	1.39E-05	8.98E-06	2.40E-06	No Data	No Data	4.39E-06	1.14E-06
Fe-59	3.08E-05	5.38E-05	2.12E-05	No Data	No Data	1.59E-05	2.57E-05
Co-58	No Data	3.60E-06	8.98E-06	No Data	No Data	No Data	8.97E-06
Co-60	No Data	1.08E-05	2.55E-05	No Data	No Data	No Data	2.57E-05
Ni-63	6.34E-04	3.92E-05	2.20E-05	No Data	No Data	No Data	1.95E-06
Ni-65	4.70E-06	5.32E-07	2.42E-07	No Data	No Data	No Data	4.05E-05
Cu-64	No Data	6.09E-07	2.82E-07	No Data	1.03E-06	No Data	1.25E-05
Zn-65	1.84E-05	6.31E-05	2.91E-05	No Data	3.06E-05	No Data	5.33E-05
Zn-69	9.33E-08	1.68E-07	1.25E-08	No Data	6.98E-08	No Data	1.37E-05
Br-83	No Data	No Data	3.63E-07	No Data	No Data	No Data	LT E-24
Br-84	No Data	No Data	3.82E-07	No Data	No Data	No Data	LT E-24
Br-85	No Data	No Data	1.94E-08	No Data	No Data	No Data	LT E-24
Rb-86	No Data	1.70E-04	8.40E-05	No Data	No Data	No Data	4.35E-06
Rb-88	No Data	4.98E-07	2.73E-07	No Data	No Data	No Data	4.85E-07
Rb-89	No Data	2.86E-07	1.97E-07	No Data	No Data	No Data	9.74E-08
Sr-89	2.51E-03	No Data	7.20E-05	No Data	No Data	No Data	5.16E-05
Sr-90	1.85E-02	No Data	4.71E-03	No Data	No Data	No Data	2.31E-04
Sr-91	5.00E-05	No Data	1.81E-06	No Data	No Data	No Data	5.92E-05
Sr-92	1.92E-05	No Data	7.13E-07	No Data	No Data	No Data	2.07E-04
Y-90	8.69E-08	No Data	2.33E-09	No Data	No Data	No Data	1.20E-04
Y-91M	8.10E-10	No Data	2.76E-11	No Data	No Data	No Data	2.70E-06
Y-91	1.13E-06	No Data	3.01E-08	No Data	No Data	No Data	8.10E-05
Y-92	7.65E-09	No Data	2.15E-10	No Data	No Data	No Data	1.46E-04

Reference 3, Table E-14.

TABLE 2.2-5 CONT'D

INGESTION DOSE FACTORS FOR INFANT*

(MREM PER PCI INGESTED)

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Y-93	2.43E-08	No Data	6.62E-10	No Data	No Data	No Data	1.92E-04
Zr-95	2.06E-07	5.02E-08	3.56E-08	No Data	5.41E-08	No Data	2.50E-05
Zr-97	1.48E-08	2.54E-09	1.16E-09	No Data	2.56E-09	No Data	1.62E-04
Nb-95	4.20E-08	1.73E-08	1.00E-08	No Data	1.24E-08	No Data	1.46E-05
Mo-99	No Data	3.40E-05	6.63E-06	No Data	5.08E-05	No Data	1.12E-05
Tc-99M	1.92E-09	3.96E-09	5.10E-08	No Data	4.26E-08	2.07E-09	1.15E-06
Tc-101	2.27E-09	2.86E-09	2.83E-08	No Data	3.40E-08	1.56E-09	4.86E-07
Ru-103	1.48E-06	No Data	4.95E-07	No Data	3.08E-06	No Data	1.80E-05
Ru-105	1.36E-07	No Data	4.58E-08	No Data	1.00E-06	No Data	5.41E-05
Ru-106	2.41E-05	No Data	3.01E-06	No Data	2.85E-05	No Data	1.83E-04
Ag-110M	9.96E-07	7.27E-07	4.81E-07	No Data	1.04E-06	No Data	3.77E-05
Te-125M	2.33E-05	7.79E-06	3.15E-06	7.84E-06	No Data	No Data	1.11E-05
Te-127M	5.85E-05	1.94E-05	7.08E-06	1.69E-05	1.44E-04	No Data	2.36E-05
Te-127	1.00E-06	3.35E-07	2.15E-07	8.14E-07	2.44E-06	No Data	2.10E-05
Te-129M	1.00E-04	3.43E-05	1.54E-05	3.84E-05	2.50E-04	No Data	5.97E-05
Te-129	2.84E-07	9.79E-08	6.63E-08	2.38E-07	7.07E-07	No Data	2.27E-05
Te-131M	1.52E-05	6.12E-06	5.05E-06	1.24E-05	4.21E-05	No Data	1.03E-04
Te-131	1.76E-07	6.50E-08	4.94E-08	1.57E-07	4.50E-07	No Data	7.11E-06
Te-132	2.08E-05	1.03E-05	9.61E-06	1.52E-05	6.44E-05	No Data	3.81E-05
I-130	6.00E-06	1.32E-05	5.30E-06	1.48E-03	1.45E-05	No Data	2.83E-06
I-131	3.59E-05	4.23E-05	1.86E-05	1.39E-02	4.94E-05	No Data	1.51E-06
I-132	1.66E-06	3.37E-06	1.20E-06	1.58E-04	3.76E-06	No Data	2.73E-06
I-133	1.25E-05	1.82E-05	5.33E-06	3.31E-03	2.14E-05	No Data	3.08E-06
I-134	8.69E-07	1.78E-06	6.33E-07	4.15E-05	1.99E-06	No Data	1.84E-06
I-135	3.64E-06	7.24E-06	2.64E-06	6.49E-04	8.07E-06	No Data	2.62E-06
Cs-134	3.77E-04	7.03E-04	7.10E-05	No Data	1.81E-04	7.42E-05	1.91E-06
Cs-136	4.59E-05	1.35E-04	5.04E-05	No Data	5.38E-05	1.10E-05	2.05E-06
Cs-137	5.22E-04	6.11E-04	4.33E-05	No Data	1.64E-04	6.64E-05	1.91E-06
Cs-138	4.81E-07	7.82E-07	3.79E-07	No Data	3.90E-07	6.09E-08	1.25E-06
Ba-139	8.81E-07	5.84E-10	2.55E-08	No Data	3.51E-10	3.54E-10	5.58E-05

TABLE 2.2-5 CONT'D

INGESTION DOSE FACTORS FOR INFANT*

(MREM PER PCI INGESTED)

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Ba-140	1.71E-04	1.71E-07	8.81E-06	No Data	4.06E-08	1.05E-07	4.20E-05
Ba-141	4.25E-07	2.91E-10	1.34E-08	No Data	1.75E-10	1.77E-10	5.19E-06
Ba-142	1.84E-07	1.53E-10	9.06E-09	No Data	8.81E-11	9.26E-11	7.59E-07
La-140	2.11E-08	8.32E-09	2.14E-09	No Data	No Data	No Data	9.77E-05
La-142	1.10E-09	4.04E-10	9.67E-11	No Data	No Data	No Data	6.86E-05
Ce-141	7.87E-08	4.80E-08	5.65E-09	No Data	1.48E-08	No Data	2.48E-05
Ce-143	1.48E-08	9.82E-06	1.12E-09	No Data	2.86E-09	No Data	5.73E-05
Ce-144	2.98E-06	1.22E-06	1.67E-07	No Data	4.93E-07	No Data	1.71E-04
Pr-143	8.13E-08	3.04E-08	4.03E-09	No Data	1.13E-08	No Data	4.29E-05
Pr-144	2.74E-10	1.06E-10	1.38E-11	No Data	3.84E-11	No Data	4.93E-06
Nd-147	5.53E-08	5.68E-08	3.48E-09	No Data	2.19E-08	No Data	3.60E-05
W-187	9.03E-07	6.28E-07	2.17E-07	No Data	No Data	No Data	3.69E-05
Np-239	1.11E-08	9.93E-10	5.61E-10	No Data	1.98E-09	No Data	2.87E-05

TABLE 2.2-6

INGESTION DOSE FACTORS FOR CHILD*

(MREM PER PCI INGESTED)

Page 1 of 3

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	No Data	2.03E-07	2.03E-07	2.03E-07	2.03E-07	2.03E-07	2.03E-07
C-14	1.21E-05	2.42E-06	2.42E-06	2.42E-06	2.42E-06	2.42E-06	2.42E-06
Na-24	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06
P-32	8.25E-04	3.86E-05	3.18E-05	No Data	No Data	No Data	2.28E-05
Cr-51	No Data	No Data	8.90E-09	4.94E-09	1.35E-09	9.02E-09	4.72E-07
Mn-54	No Data	1.07E-05	2.85E-06	No Data	3.00E-06	No Data	8.98E-06
Mn-56	No Data	3.34E-07	7.54E-08	No Data	4.04E-07	No Data	4.84E-05
Fe-55	1.15E-05	6.10E-06	1.89E-06	No Data	No Data	3.45E-06	1.13E-06
Fe-59	1.65E-05	2.67E-05	1.33E-05	No Data	No Data	7.74E-06	2.78E-05
Co-58	No Data	1.80E-06	5.51E-06	No Data	No Data	No Data	1.05E-05
Co-60	No Data	5.29E-06	1.56E-05	No Data	No Data	No Data	2.93E-05
Ni-63	5.38E-04	2.88E-05	1.83E-05	No Data	No Data	No Data	1.94E-06
Ni-65	2.22E-06	2.09E-07	1.22E-07	No Data	No Data	No Data	2.56E-05
Cu-64	No Data	2.45E-07	1.48E-07	No Data	5.92E-07	No Data	1.15E-05
Zn-65	1.37E-05	3.65E-05	2.27E-05	No Data	2.30E-05	No Data	6.41E-06
Zn-69	4.38E-08	6.33E-08	5.85E-09	No Data	3.84E-08	No Data	3.99E-06
Br-83	No Data	No Data	1.71E-07	No Data	No Data	No Data	LT E-24
Br-84	No Data	No Data	1.98E-07	No Data	No Data	No Data	LT E-24
Br-85	No Data	No Data	9.12E-09	No Data	No Data	No Data	LT E-24
Rb-86	No Data	6.70E-05	4.12E-05	No Data	No Data	No Data	4.31E-06
Rb-88	No Data	1.90E-07	1.32E-07	No Data	No Data	No Data	9.32E-09
Rb-89	No Data	1.17E-07	1.04E-07	No Data	No Data	No Data	1.02E-09
Sr-89	1.32E-03	No Data	3.77E-05	No Data	No Data	No Data	5.11E-05
Sr-90	1.70E-02	No Data	4.31E-03	No Data	No Data	No Data	2.29E-04
Sr-91	2.40E-05	No Data	9.06E-07	No Data	No Data	No Data	5.30E-05
Sr-92	9.03E-06	No Data	3.62E-07	No Data	No Data	No Data	1.71E-04
Y-90	4.11E-08	No Data	1.10E-09	No Data	No Data	No Data	1.17E-04
Y-91M	3.82E-10	No Data	1.39E-11	No Data	No Data	No Data	7.48E-07
Y-91	6.02E-07	No Data	1.61E-08	No Data	No Data	No Data	8.02E-05
Y-92	3.60E-09	No Data	1.03E-10	No Data	No Data	No Data	1.04E-04

Reference 3, Table E-13.

TABLE 2.2-6 CONT'D

INGESTION DOSE FACTORS FOR CHILD*

(MREM PER PCI INGESTED)

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Y-93	1.14E-08	No Data	3.13E-10	No Data	No Data	No Data	1.70E-04
Zr-95	1.16E-07	2.55E-08	2.27E-08	No Data	3.65E-08	No Data	2.66E-05
Zr-97	6.99E-09	1.01E-09	5.96E-10	No Data	1.45E-09	No Data	1.53E-04
Nb-95	2.25E-08	8.76E-09	6.26E-09	No Data	8.23E-09	No Data	1.62E-05
Mo-99	No Data	1.33E-05	3.29E-06	No Data	2.84E-05	No Data	1.10E-05
Tc-99M	9.23E-10	1.81E-09	3.00E-08	No Data	2.63E-08	9.19E-10	1.03E-06
Tc-101	1.07E-09	1.12E-09	1.42E-08	No Data	1.91E-08	5.92E-10	3.56E-09
Ru-103	7.31E-07	No Data	2.81E-07	No Data	1.84E-06	No Data	1.89E-05
Ru-105	6.45E-08	No Data	2.34E-08	No Data	5.67E-07	No Data	4.21E-05
Ru-106	1.17E-05	No Data	1.46E-06	No Data	1.58E-05	No Data	1.82E-04
Ag-110M	5.39E-07	3.64E-07	2.91E-07	No Data	6.78E-07	No Data	4.33E-05
Te-125M	1.14E-05	3.09E-06	1.52E-06	3.20E-06	No Data	No Data	1.10E-05
Te-127M	2.89E-05	7.78E-06	3.43E-06	6.91E-06	8.24E-05	No Data	2.34E-05
Te-127	4.71E-07	1.27E-07	1.01E-07	3.26E-07	1.34E-06	No Data	1.84E-05
Te-129M	4.87E-05	1.36E-05	7.56E-06	1.57E-05	1.43E-04	No Data	5.94E-05
Te-129	1.34E-07	3.74E-08	3.18E-08	9.56E-08	3.92E-07	No Data	8.34E-06
Te-131M	7.20E-06	2.49E-06	2.65E-06	5.12E-06	2.41E-05	No Data	1.01E-04
Te-131	8.30E-08	2.53E-08	2.47E-08	6.35E-08	2.51E-07	No Data	4.36E-07
Te-132	1.01E-05	4.47E-06	5.40E-06	6.51E-06	4.15E-05	No Data	4.50E-05
I-130	2.92E-06	5.90E-06	3.04E-06	6.50E-04	8.82E-06	No Data	2.76E-06
I-131	1.72E-05	1.73E-05	9.83E-06	5.72E-03	2.84E-05	No Data	1.54E-06
I-132	8.00E-07	1.47E-06	6.76E-07	6.82E-05	2.25E-06	No Data	1.73E-06
I-133	5.92E-06	7.32E-06	2.77E-06	1.36E-03	1.22E-05	No Data	2.95E-06
I-134	4.19E-07	7.78E-07	3.58E-07	1.79E-05	1.19E-06	No Data	5.16E-07
I-135	1.75E-06	3.15E-06	1.49E-06	2.79E-04	4.83E-06	No Data	2.40E-06
Cs-134	2.34E-04	3.84E-04	8.10E-05	No Data	1.19E-04	4.27E-05	2.07E-06
Cs-136	2.35E-05	6.46E-05	4.18E-05	No Data	3.44E-05	5.13E-06	2.27E-06
Cs-137	3.27E-04	3.13E-04	4.62E-05	No Data	1.02E-04	3.67E-05	1.96E-06
Cs-138	2.28E-07	3.17E-07	2.01E-07	No Data	2.23E-07	2.40E-08	1.46E-07
Ba-139	4.14E-07	2.21E-10	1.20E-08	No Data	1.93E-10	1.30E-10	2.39E-05
Ba-140	8.31E-05	7.28E-08	4.85E-06	No Data	2.37E-08	4.34E-08	4.21E-05
Ba-141	2.00E-07	1.12E-10	6.51E-09	No Data	9.69E-11	6.58E-10	1.14E-07
Ba-142	8.74E-08	6.29E-11	4.88E-09	No Data	5.09E-11	3.70E-11	1.14E-09

TABLE 2.2-6 CONT'D

INGESTION DOSE FACTORS FOR CHILD*

(MREM PER PCI INGESTED)

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
La-140	1.01E-08	3.53E-09	1.19E-09	No Data	No Data	No Data	9.84E-05
La-142	5.24E-10	1.67E-10	5.23E-11	No Data	No Data	No Data	3.31E-05
Ce-141	3.97E-08	1.98E-08	2.94E-09	No Data	8.68E-09	No Data	2.47E-05
Ce-143	6.99E-09	3.79E-06	5.49E-10	No Data	1.59E-09	No Data	5.55E-05
Ce-144	2.08E-06	6.52E-07	1.11E-07	No Data	3.61E-07	No Data	1.70E-04
Pr-143	3.93E-08	1.18E-08	1.95E-09	No Data	6.39E-09	No Data	4.24E-05
Pr-144	1.29E-10	3.99E-11	6.49E-12	No Data	2.11E-11	No Data	8.59E-08
Nd-147	2.79E-08	2.26E-08	1.75E-09	No Data	1.24E-08	No Data	3.58E-05
W-187	4.29E-07	2.54E-07	1.14E-07	No Data	No Data	No Data	3.57E-05
Np-239	5.25E-09	3.77E-10	2.65E-10	No Data	1.09E-09	No Data	2.79E-05

TABLE 2.2-7

INGESTION DOSE FACTORS FOR TEENAGER*

(MREM PER PCI INGESTED)

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	No Data	1.06E-07	1.06E-07	1.06E-07	1.06E-07	1.06E-07	1.06E-07
C-14	4.06E-06	8.12E-07	8.12E-07	8.12E-07	8.12E-07	8.12E-07	8.12E-07
Na-24	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06
P-32	2.76E-04	1.71E-05	1.07E-05	No Data	No Data	No Data	2.32E-05
Cr-51	No Data	No Data	3.60E-09	2.00E-09	7.89E-10	5.14E-09	6.05E-07
Mn-54	No Data	5.90E-06	1.17E-06	No Data	1.76E-06	No Data	1.21E-05
Mn-56	No Data	1.58E-07	2.81E-08	No Data	2.00E-07	No Data	1.04E-05
Fe-55	3.78E-06	2.68E-06	6.25E-07	No Data	No Data	1.70E-06	1.16E-06
Fe-59	5.87E-06	1.37E-05	5.29E-06	No Data	No Data	4.32E-06	3.24E-05
Co-58	No Data	9.72E-07	2.24E-06	No Data	No Data	No Data	1.34E-05
Co-60	No Data	2.81E-06	6.33E-06	No Data	No Data	No Data	3.66E-05
Ni-63	1.77E-04	1.25E-05	6.00E-06	No Data	No Data	No Data	1.99E-06
Ni-65	7.49E-07	9.57E-08	4.36E-08	No Data	No Data	No Data	5.19E-06
Cu-64	No Data	1.15E-07	5.41E-08	No Data	2.91E-07	No Data	8.92E-06
Zn-65	5.76E-06	2.00E-05	9.33E-06	No Data	1.28E-05	No Data	8.47E-06
Zn-69	1.47E-08	2.80E-08	1.96E-09	No Data	1.83E-08	No Data	5.16E-08
Br-83	No Data	No Data	5.74E-08	No Data	No Data	No Data	LT E-24
Br-84	No Data	No Data	7.22E-08	No Data	No Data	No Data	LT E-24
Br-85	No Data	No Data	3.05E-09	No Data	No Data	No Data	LT E-24
Rb-86	No Data	2.98E-05	1.40E-05	No Data	No Data	No Data	4.41E-06
Rb-88	No Data	8.52E-08	4.54E-08	No Data	No Data	No Data	7.30E-15
Rb-89	No Data	5.50E-08	3.89E-08	No Data	No Data	No Data	8.43E-17
Sr-89	4.40E-04	No Data	1.26E-05	No Data	No Data	No Data	5.24E-05
Sr-90	8.30E-03	No Data	2.05E-03	No Data	No Data	No Data	2.33E-04
Sr-91	8.07E-06	No Data	3.21E-07	No Data	No Data	No Data	3.66E-05
Sr-92	3.05E-06	No Data	1.30E-07	No Data	No Data	No Data	7.77E-05
Y-90	1.37E-08	No Data	3.69E-10	No Data	No Data	No Data	1.13E-04
Y-91M	1.29E-10	No Data	4.93E-12	No Data	No Data	No Data	6.09E-09
Y-91	2.01E-07	No Data	5.39E-09	No Data	No Data	No Data	8.24E-05
Y-92	1.21E-09	No Data	3.50E-11	No Data	No Data	No Data	3.32E-05

* Reference 3, Table E-12.

TABLE 2.2-7 CONT'D

INGÉSTION DOSE FACTORS FOR TEENAGER*

(MREM PER PCI INGESTED)

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Y-93	3.83E-09	No Data	1.05E-10	No Data	No Data	No Data	1.17E-04
Zr-95	4.12E-08	1.30E-08	8.94E-09	No Data	1.91E-08	No Data	3.00E-05
Zr-97	2.37E-09	4.69E-10	2.16E-10	No Data	7.11E-10	No Data	1.27E-04
Nb-95	8.22E-09	4.56E-09	2.51E-09	No Data	4.42E-09	No Data	1.95E-05
Mo-99	No Data	6.03E-06	1.15E-06	No Data	1.38E-05	No Data	1.08E-05
Tc-99M	3.32E-10	9.26E-10	1.20E-08	No Data	1.38E-08	5.14E-10	6.08E-07
Tc-101	3.60E-10	5.12E-10	5.03E-09	No Data	9.26E-09	3.12E-10	8.75E-17
Ru-103	2.55E-07	No Data	1.09E-07	No Data	8.99E-07	No Data	2.13E-05
Ru-105	2.18E-08	No Data	8.46E-09	No Data	2.75E-07	No Data	1.76E-05
Ru-106	3.92E-06	No Data	4.94E-07	No Data	7.56E-06	No Data	1.88E-04
Ag-110M	2.05E-07	1.94E-07	1.18E-07	No Data	3.70E-07	No Data	5.45E-05
Te-125M	3.83E-06	1.38E-06	5.12E-07	1.07E-06	No Data	No Data	1.13E-05
Te-127M	9.67E-06	3.43E-06	1.15E-06	2.30E-06	3.92E-05	No Data	2.41E-05
Te-127	1.58E-07	5.60E-08	3.40E-08	1.09E-07	6.40E-07	No Data	1.22E-05
Te-129M	1.63E-05	6.05E-06	2.58E-06	5.26E-06	6.82E-05	No Data	6.12E-05
Te-129	4.48E-08	1.67E-08	1.09E-08	3.20E-08	1.88E-07	No Data	2.45E-07
Te-131M	2.44E-06	1.17E-06	9.76E-07	1.76E-06	1.22E-05	No Data	9.39E-05
Te-131	2.79E-08	1.15E-08	8.72E-09	2.15E-08	1.22E-07	No Data	2.29E-09
Te-132	3.49E-06	2.21E-06	2.08E-06	2.33E-06	2.12E-05	No Data	7.00E-05
I-130	1.03E-06	2.98E-06	1.19E-06	2.43E-04	4.59E-06	No Data	2.29E-06
I-131	5.85E-06	8.19E-06	4.40E-06	2.39E-03	1.41E-05	No Data	1.62E-06
I-132	2.79E-07	7.30E-07	2.62E-07	2.46E-05	1.15E-06	No Data	3.18E-07
I-133	2.01E-06	3.41E-06	1.04E-06	4.76E-04	5.98E-06	No Data	2.58E-06
I-134	1.46E-07	3.87E-07	1.39E-07	6.45E-06	6.10E-07	No Data	5.10E-09
I-135	6.10E-07	1.57E-06	5.82E-07	1.01E-04	2.48E-06	No Data	1.74E-06
Cs-134	8.37E-05	1.97E-04	9.14E-05	No Data	6.26E-05	2.39E-05	2.45E-06
Cs-136	8.59E-06	3.38E-05	2.27E-05	No Data	1.84E-05	2.90E-06	2.72E-06
Cs-137	1.12E-04	1.49E-04	5.19E-05	No Data	5.07E-05	1.97E-05	2.12E-06
Cs-138	7.76E-08	1.49E-07	7.45E-08	No Data	1.10E-07	1.28E-08	6.76E-11
Ba-139	1.39E-07	9.78E-11	4.05E-09	No Data	9.22E-11	6.74E-11	1.24E-06

TABLE 2.2-7 CONT'D

INGESTION DOSE FACTORS FOR TEENAGER*

(MREM PER PCI INGESTED)

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Ba-140	2.84E-05	3.48E-08	1.83E-06	No Data	1.18E-08	2.34E-08	4.38E-05
Ba-141	6.71E-08	5.01E-11	2.24E-09	No Data	4.65E-11	3.43E-11	1.43E-13
Ba-142	2.99E-08	2.99E-11	1.84E-09	No Data	2.53E-11	1.99E-11	9.18E-20
La-140	3.48E-09	1.71E-09	4.55E-10	No Data	No Data	No Data	9.82E-05
La-142	1.79E-10	7.95E-11	1.98E-11	No Data	No Data	No Data	2.42E-06
Ce-141	1.33E-08	8.88E-09	1.02E-09	No Data	4.18E-09	No Data	2.54E-05
Ce-143	2.35E-09	1.71E-06	1.91E-10	No Data	7.67E-10	No Data	5.14E-05
Ce-144	6.96E-07	2.88E-07	3.74E-08	No Data	1.72E-07	No Data	1.75E-04
Pr-143	1.31E-08	5.23E-09	6.52E-10	No Data	3.04E-09	No Data	4.31E-05
Pr-144	4.30E-11	1.76E-11	2.18E-12	No Data	1.01E-11	No Data	4.74E-14
Nd-147	9.38E-09	1.02E-08	6.11E-10	No Data	5.99E-09	No Data	3.68E-05
W-187	1.46E-07	1.19E-07	4.17E-08	No Data	No Data	No Data	3.22E-05
Np-239	1.76E-09	1.66E-10	9.22E-11	No Data	5.21E-10	No Data	2.67E-05

TABLE 2.2-8

INGESTION DOSE FACTORS FOR ADULTS*

(MREM PER PCI INGESTED)

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	No Data	1.05E-07	1.05E-07	1.05E-07	1.05E-07	1.05E-07	1.05E-07
C-14	2.84E-06	5.68E-07	5.68E-07	5.68E-07	5.68E-07	5.68E-07	5.68E-07
Na-24	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06
P-32	1.93E-04	1.20E-05	7.46E-06	No Data	No Data	No Data	2.17E-05
Cr-51	No Data	No Data	2.66E-09	1.59E-09	5.86E-10	3.53E-09	6.69E-07
Mn-54	No Data	4.57E-06	8.72E-07	No Data	1.36E-06	No Data	1.40E-05
Mn-56	No Data	1.15E-07	2.04E-08	No Data	1.46E-07	No Data	3.67E-06
Fe-55	2.75E-06	1.90E-06	4.43E-07	No Data	No Data	1.06E-06	1.09E-06
Fe-59	4.34E-06	1.02E-05	3.91E-06	No Data	No Data	2.85E-06	3.40E-05
Co-58	No Data	7.45E-07	1.67E-06	No Data	No Data	No Data	1.51E-05
Co-60	No Data	2.14E-06	4.72E-06	No Data	No Data	No Data	4.02E-05
Ni-63	1.30E-04	9.01E-06	4.36E-06	No Data	No Data	No Data	1.88E-06
Ni-65	5.28E-07	6.86E-08	3.13E-08	No Data	No Data	No Data	1.74E-06
Cu-64	No Data	8.33E-08	3.91E-08	No Data	2.10E-07	No Data	7.10E-06
Zn-65	4.84E-06	1.54E-05	6.96E-06	No Data	1.03E-05	No Data	9.70E-06
Zn-69	1.03E-08	1.97E-08	1.37E-09	No Data	1.28E-08	No Data	2.96E-09
Br-83	No Data	No Data	4.02E-08	No Data	No Data	No Data	5.79E-08
Br-84	No Data	No Data	5.21E-08	No Data	No Data	No Data	4.09E-13
Br-85	No Data	No Data	2.14E-09	No Data	No Data	No Data	LT E-24
Rb-86	No Data	2.11E-05	9.83E-06	No Data	No Data	No Data	4.16E-06
Rb-88	No Data	6.05E-08	3.21E-08	No Data	No Data	No Data	8.36E-19
Rb-89	No Data	4.01E-08	2.82E-08	No Data	No Data	No Data	2.33E-21
Sr-89	3.08E-04	No Data	8.84E-06	No Data	No Data	No Data	4.94E-05
Sr-90	7.58E-03	No Data	1.86E-03	No Data	No Data	No Data	2.19E-04
Sr-91	5.67E-06	No Data	2.29E-07	No Data	No Data	No Data	2.70E-05
Sr-92	2.15E-06	No Data	9.30E-08	No Data	No Data	No Data	4.26E-05
Y-90	9.62E-09	No Data	2.58E-10	No Data	No Data	No Data	1.02E-04
Y-91M	9.09E-11	No Data	3.52E-12	No Data	No Data	No Data	2.67E-10
Y-91	1.41E-07	No Data	3.77E-09	No Data	No Data	No Data	7.76E-05
Y-92	8.45E-10	No Data	2.47E-11	No Data	No Data	No Data	1.48E-05

* Reference 3, Table E-11.

TABLE 2.2-8 CONT'D

INGESTION DOSE FACTORS FOR ADULTS*

(MREM PER PCI INGESTED)

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Y-93	2.68E-09	No Data	7.40E-11	No Data	No Data	No Data	8.50E-05
Zr-95	3.04E-08	9.75E-09	6.60E-09	No Data	1.53E-08	No Data	3.09E-05
Zr-97	1.68E-09	3.39E-10	1.55E-10	No Data	5.12E-10	No Data	1.05E-04
Nb-95	6.22E-09	3.46E-09	1.86E-09	No Data	3.42E-09	No Data	2.10E-05
Mo-99	No Data	4.31E-06	8.20E-07	No Data	9.76E-06	No Data	9.99E-06
Tc-99M	2.47E-10	6.98E-10	8.89E-09	No Data	1.06E-08	3.42E-10	4.13E-07
Tc-101	2.54E-10	3.66E-10	3.59E-09	No Data	6.59E-09	1.87E-10	1.10E-21
Ru-103	1.85E-07	No Data	7.97E-08	No Data	7.06E-07	No Data	2.16E-05
Ru-105	1.54E-08	No Data	6.08E-09	No Data	1.99E-07	No Data	9.42E-06
Ru-106	2.75E-06	No Data	3.48E-07	No Data	5.31E-06	No Data	1.78E-04
Ag-110M	1.60E-07	1.48E-07	8.79E-08	No Data	2.91E-07	No Data	6.04E-05
Te-125M	2.68E-06	9.71E-07	3.59E-07	8.06E-07	1.09E-05	No Data	1.07E-05
Te-127M	6.77E-06	2.42E-06	8.25E-07	1.73E-06	2.75E-05	No Data	2.27E-05
Te-127	1.10E-07	3.95E-08	2.38E-08	8.15E-08	4.48E-07	No Data	8.68E-06
Te-129M	1.15E-05	4.29E-06	1.82E-06	3.95E-06	4.80E-05	No Data	5.79E-05
Te-129	3.14E-08	1.18E-08	7.65E-09	2.41E-08	1.32E-07	No Data	2.37E-08
Te-131M	1.73E-06	8.46E-07	7.05E-07	1.34E-06	8.57E-06	No Data	8.40E-05
Te-131	1.97E-08	8.23E-09	6.22E-09	1.62E-08	8.63E-08	No Data	2.79E-09
Te-132	2.52E-06	1.63E-06	1.53E-06	1.80E-06	1.57E-05	No Data	7.71E-05
I-130	7.56E-07	2.23E-06	8.80E-07	1.89E-04	3.48E-06	No Data	1.92E-06
I-131	4.16E-06	5.95E-06	3.41E-06	1.95E-03	1.02E-05	No Data	1.57E-06
I-132	2.03E-07	5.43E-07	1.90E-07	1.90E-05	8.65E-07	No Data	1.02E-07
I-133	1.42E-06	2.47E-06	7.53E-07	3.63E-04	4.31E-06	No Data	2.22E-06
I-134	1.06E-07	2.88E-07	1.03E-07	4.99E-06	4.58E-07	No Data	2.51E-10
I-135	4.43E-07	1.16E-06	4.28E-07	7.65E-05	1.86E-06	No Data	1.31E-06
Cs-134	6.22E-05	1.48E-04	1.21E-04	No Data	4.79E-05	1.59E-05	2.59E-06
Cs-136	6.51E-06	2.57E-05	1.85E-05	No Data	1.43E-05	1.96E-06	2.92E-06
Cs-137	7.97E-05	1.09E-04	7.14E-05	No Data	3.70E-05	1.23E-05	2.11E-06
Cs-138	5.52E-08	1.09E-07	5.40E-08	No Data	8.01E-08	7.91E-09	4.65E-13
Ba-139	9.70E-08	6.91E-11	2.84E-09	No Data	6.46E-11	3.92E-11	1.72E-07
Ba-140	2.03E-05	2.55E-08	1.33E-06	No Data	8.67E-09	1.46E-08	4.18E-05
Ba-141	4.71E-08	3.56E-11	1.59E-09	No Data	3.31E-11	2.02E-11	2.22E-17
Ba-142	2.13E-08	2.19E-11	1.34E-09	No Data	1.85E-11	1.24E-11	3.00E-26

TABLE 2.2-8 CONT'D

INGESTION DOSE FACTORS FOR ADULTS*

(MREM PER PCI INGESTED)

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
La-140	2.50E-09	1.26E-09	3.33E-10	No Data	No Data	No Data	9.25E-05
La-142	1.28E-10	5.82E-11	1.45E-11	No Data	No Data	No Data	4.25E-07
Ce-141	9.36E-09	6.33E-09	7.18E-10	No Data	2.94E-09	No Data	2.42E-05
Ce-143	1.65E-09	1.22E-06	1.35E-10	No Data	5.37E-10	No Data	4.56E-05
Ce-144	4.88E-07	2.04E-07	2.62E-08	No Data	1.21E-07	No Data	1.65E-04
Pr-143	9.20E-09	3.69E-09	4.56E-10	No Data	2.13E-09	No Data	4.03E-05
Pr-144	3.01E-11	1.25E-11	1.53E-12	No Data	7.05E-12	No Data	4.33E-18
Nd-147	6.29E-09	7.27E-09	4.35E-10	No Data	4.25E-09	No Data	3.49E-05
W-187	1.03E-07	8.61E-08	3.01E-08	No Data	No Data	No Data	2.82E-05
Np-239	1.19E-09	1.17E-10	6.45E-11	No Data	3.65E-10	No Data	2.40E-05

TABLE 2.2-9

EXTERNAL DOSE FACTORS FOR STANDING ON CONTAMINATED GROUND*

(mrem/hr per pCi/m^2)

RADIONUCLIDE	TOTAL BODY	SKIN
H-3	0.0	0.0
C-14	0.0	0.0
Na-24	2.50E-08	2.90E-08
P-32	0.0	0.0
Cr-51	2.20E-10	2.60E-10
Mn-54	5.80E-09	6.80E-09
Mn-56	1.10E-08	1.30E-08
Fe-55	0.0	0.0
Fe-59	8.00E-09	9.40E-09
Co-58	7.00E-09	8.20E-09
Co-60	1.70E-08	2.00E-08
Ni-63	0.0	0.0
Ni-65	3.70E-09	4.30E-09
Cu-64	1.50E-09	1.70E-09
Zn-65	4.00E-09	4.60E-09
Zn-69	0.0	0.0
Br-83	6.40E-11	9.30E-11
Br-84	1.20E-08	1.40E-08
Br-85	0.0	0.0
Rb-86	6.30E-10	7.20E-10
Rb-88	3.50E-09	4.00E-09
Rb-89	1.50E-08	1.80E-08
Sr-89	5.60E-13	6.50E-13
Sr-91	7.10E-09	8.30E-09
Sr-92	9.00E-09	1.00E-08
Y-90	2.20E-12	2.60E-12

* Reference 3, Table E-6

TABLE 2.2-9 (Continued)

EXTERNAL DOSE FACTORS FOR STANDING ON CONTAMINATED GROUND*

RADIONUCLIDE	TOTAL BODY	SKIN
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
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

TABLE 2.2-9 (Continued)

EXTERNAL DOSE FACTORS FOR STANDING ON CONTAMINATED GROUND*

RADIONUCLIDE	TOTAL BODY	SKIN
Ba-140	2.10E-09	2.40E-09
Ba-141	4.30E-09	4.90E-09
Ba-142	7.90-09	9.00E-09
La-140	1.50E-08	1.70E-08
La-142	1.50E-08	1.80E-08
Ce-141	5.50E-10	6.20E-10
Ce-143	2.20E-09	2.50E-09
Ce-144	3.20E-10	3.70E-10
Pr-143	0.0	0.0
Pr-144	2.00E-10	2.30E-10
Nd-147	1.00E-09	1.20E-09
W-187	3.10E-09	3.60E-09
Np-239	9.50E-10	1.10E-09

TABLE 2.2-10

INDIVIDUAL USAGE FACTORS*

	INFANT	CHILD	TEENAGER	ADULT
Milk Consumption Rate, U_{ap} (liters/year)	330	330	400	310
Meat Consumption Rate, U_{ap} (kg/year)	0	41	65	110
Fresh Leafy Vegetation Consumption Rate, U_{al} (kg/year)	0	26	42	64
Stored Vegetation Consumption Rate, U_{as} (kg/year)	0	520	630	520
Breathing Rate (m^3/year)	1400	3700	8000	8000

* Reference 3, Table E-5.

TABLE 2.2-11

STABLE ELEMENT TRANSFER DATA*

(Milk - days/liter; Meat-days/kg)

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

* References 3, Table E-1; Reference 3, Table E-2 for H, C, P, Fe, Cu, Sr, I and Cs in goat's milk; the remainder of elements in goat's milk are taken from Table E-1 as presented for cow's milk. 2

TABLE 2.2-12

CONTROLLING RECEPTOR

(To Support Subsection 2.2.2.2)

The location and exposure pathways associated with the controlling receptors are determined during the annual land use census. Dispersion and deposition values were calculated based ib VEGP site meteorological data collected for the period February 1, 1984 through January 31, 1986. 2

Sector: WSW Distance: 1.3 miles Age Group: Child

Dispersion: $(\overline{X/Q'})_{GP} = 9.49E-6\ sec/m^3$ $(\overline{X/Q'})_{MP} = 1.07E-6\ sec/m^3$

Deposition: $(\overline{D/Q'})_{GP} = 6.73E-9\ m^{-2}$ $(\overline{D/Q'})_{MP} = 2.53E-9\ m^{-2}$ 3

Exposure pathways: Inhalation, ground plane, and vegetation

NOTE: A milk cow was observed during the 1985 Land Use Survey. The owner indicated that the cow was on an irregular milking cycle, and is dry for long periods of time. However, because of the potentially significant dose associated with this pathway, dose calculations must be performed during periods in which the cow is being milked for human consumption. A garden is also present at this location. Under certain conditions, the individual exposed to these pathways could become the controlling receptor. The determining factor is likely to be the number of months the cow is milked in a year. Calculated dose results should be compared to the receptor presented above to determine which is the controlling receptor.

Sector: WNW Distance: 2.8 miles Age group: Child

Dispersion: $(\overline{X/Q'})_{GP} = 1.36E-6\ sec/m^3$ $(\overline{X/Q'})_{MP} = 1.55E-7\ sec/m^3$ 2,3

Deposition: $(\overline{D/Q'})_{GP} = 8.40E-10\ m^{-2}$ $(\overline{D/Q'})_{MP} = 2.64E-10\ m^{-2}$

Exposure pathways: Inhalation, ground plane, vegetation, and milk cow

*Reference 12; Reference 13

TABLE 2.2-13

SITE-SPECIFIC (OR DEFAULT) VALUES TO BE USED IN PATHWAY FACTOR CALCULATIONS

(Supports Subsections 2.2.2.2 and 2.2.2.3)

Parameter	Description	Value
Inhalation		
$(BR)_a$	Breathing rate for age group	Table 2.2-10
$(DFA)_{ija}$	Inhalation dose factor for age group	Tables 2.2-1 2.2-4
Ground plane		
SHF	Shielding factor due to structure	0.7 (Reference 3, Table E-15)
$(DFG)_{ij}$	Ground plane dose factor (Same for all age groups)	Table 2.2-9
Garden Vegetation		
Y_v	Garden vegetation areal density	2.0 kg/m^2 (Reference 3, Table E-15)
U_{al}	Leafy vegetation consumption rate for age group	Table 2.2-10
U_{as}	Stored vegetation consumption rate for age group	Table 2.2-10

TABLE 2.2-13 (Continued)

SITE-SPECIFIC (OR DEFAULT) VALUES TO

BE USED IN PATHWAY FACTOR CALCULATIONS

Parameter	Description	Value	
f_l	Fraction of annual intake of leafy vegetation grown locally	1.0 (Reference 1, page 36)	2
f_g	Fraction of annual intake of stored vegetation grown locally	0.76 (Reference 1, page 36)	2
H	Absolute humidity of the atmosphere	8.0 gm/m^3 (Reference 1, page 34)	2

TABLE 2.2-13 (Continued)

SITE-SPECIFIC (OR DEFAULT) VALUES TO

BE USED IN PATHWAY FACTOR CALCULATIONS

Parameter	Description	Value	
Grass-Cow-Meat			
Q_F	Feed consumption rate for cow	50 kg/day (Reference 3, Table E-3)	2
U_{ap}	Meat consumption rate for age group	Table 2.2-10	
$(DFL)_{ija}$	Ingestion dose factor for age group	Tables 2.2-5 - 2.2-8	
Y_p	Pasture grass areal density	0.7 kg/m^2 (Reference 3, Table E-15)	2
Y_s	Stored feed areal density	2.0 kg/m^2 (Reference 3, Table E-15)	2
f_p	Fraction of year that cow grazes on pasture	1.0 (Reference 1, page 33)	2
f_s	Fraction of total feed that is pasture grass while cow is on pasture	1.0 (Reference 1, page 33)	2
H	Absolute humidity of the atmosphere	8.0 gm/m^3 (Reference 1, page 34)	2
Grass-Cow-Milk			
Q_F	Feed consumption rate for cow	50 kg/day (Reference 3, Table E-3)	2

TABLE 2.2-13 (Continued)

SITE-SPECIFIC (OR DEFAULT) VALUES TO

BE USED IN PATHWAY FACTOR CALCULATIONS

Parameter	Description	Value
U_{ap}	Milk consumption rate for age group	Table 2.2-10
$(DFL)_{ija}$	Ingestion dose factor for age group	Tables 2.2-5 - 2.2-8
Y_p	Pasture grass areal density	0.7 kg/m^2 (Reference 3, Table E-15)
Y_s	Stored feed areal density	2.0 kg/m^2 (Reference 3, Table E-15)
f_p	Fraction of year that cow grazes on pasture	1.0 (Reference 1, page 33) 2
f_s	Fraction of total feed that is pasture grass while cow is on pasture	1.0 (Reference 1, page 33) 2
H	Absolute humidity of the atmosphere	8.0 gm/m^3 (Reference 1, page 34) 2
Grass-Goat-Milk		
Q_F	Feed consumption rate for goat	6.0 kg/day (References 3, Table E-3)
U_{ap}	Milk consumption rate for age group	Table 2.2-10

TABLE 2.2-13 (Continued)

SITE-SPECIFIC (OR DEFAULT) VALUES TO

BE USED IN PATHWAY FACTOR CALCULATIONS

Parameter	Description	Value
$(DFL)_{ija}$	Ingestion dose factor for age group	Tables 2.2-5 - 2.2-8
Y_p	Pasture grass areal density	0.7 kg/m^2 (Reference 3, Table E-15)
Y_s	Stored feed areal density	2.0 kg/m^2 (Reference 3, Table E-15)
f_p	Fraction of year that goat grazes on pasture	1.0 (Reference 1, page 33) 2
f_s	Fraction of total feed that is pasture grass while goat is on pasture	1.0 (Reference 1, page 33) 2
H	Absolute humidity of the atmosphere	8.0 gm/m^3 (Reference 1, page 34) 2

TABLE 2.2-14

POTENTIAL RECEPTOR LOCATIONS AND PATHWAYS

(To Support Subsection 2.2.2.3)

Sector	Distance (Miles)	Km	Pathway***	Age Group	3
N	*				
NNE	*				
NE	*				
ENE	*				
E	*				
ESE	*				
SE	3.3	5.3	Vegetation	Child	
SSE	4.6	7.4	Vegetation	Child	
S	4.5	7.2	Vegetation/Meat Animal	Child	
SSW	4.7	7.6	Meat Animal	Child	2,3
SW	3.1	5.0	Meat Animal	Child	
WSW	1.3	2.1	Vegetation	Child	
W	4.2	6.8	Vegetation	Child	
WNW	2.3	3.7	Vegetation	Child	
	2.8****	4.5	Vegetation/Milk Cow	Child	
NW	3.9	6.3	Vegetation	Child	
NNW	**				

* Savannah River Plant Property (closed to public)

** No receptor identified within five miles

*** Inhalation and ground plane pathways are assumed at all locations where ingestion pathways exist.

**** A milk cow has been observed at this location. However, discussions with the owner revealed that she is on an irregular milking cycle. The pathway will exist during periods when the cow is being milked. 2

Reference 12

TABLE 2.2-15

DISPERSION AND DEPOSITON PARAMETERS

(To Support Subsection 2.2.2.3)

Sector	Distance (Miles)	Km	Ground-Level Release X/Q sec/m^3	Ground-Level Release D/Q m^{-2}	Mixed-Mode Release X/Q sec/m^3	Mixed-Mode Release D/Q m^{-2}	
							3
N	*						
NNE	*						
NE	*						
ENE	*						
E	*						
ESE	*						
SE	3.3	5.3	6.80E-7	6.15E-9	7.05E-8	1.58E-10	
SSE	4.6	7.4	4.37E-7	2.15E-10	4.49E-8	8.26E-11	
S	4.5	7.2	4.48E-7	2.88E-10	5.35E-8	1.12E-10	
SSW	4.7	7.6	3.70E-7	2.32E-10	5.30E-8	1.56E-10	
SW	3.1	5.0	1.53E-6	1.02E-9	2.19E-7	4.53E-10	2,
WSW	1.3	2.1	9.49E-6	6.73E-9	1.07E-6	2.53E-9	3
W	4.2	6.8	6.20E-7	3.36E-10	7.41E-8	1.38E-10	
WNW	2.3	3.7	2.03E-6	1.27E-9	2.16E-7	3.80E-10	
	2.8	4.5	1.36E-6	8.40E-10	1.55E-7	2.64E-10	
NW	3.9	6.3	7.25E-7	3.72E-10	7.99E-8	1.25E-10	
NNW	**						

* Savannah River Plant property (closed to public)
** No receptor identified within five miles

Reference 12; Reference 13. 2

2.2.3 Dose Projections for Gaseous Effluents

2.2.3.1 Thirty-One Day Dose Projections

In order to meet the requirements of Technical Specification 3.11.2.4, which pertains to operation of the Ventilation Exhaust Treatment System and the Gaseous Waste Processing System, dose projections must be made at least once per 31 days, during periods in which discharge of gaseous effluents containing radioactive materials to unrestricted areas occurs or is expected.

Projected 31-day air doses and doses to individuals due to gaseous effluents may be determined as follows:

Air Doses:

$$D_{beta(prj)} = \frac{D_{beta(c)}}{t} \times 31 \qquad (32)$$

$$D_{gamma(prj)} = \frac{D_{gamma(c)}}{t} \times 31 \qquad (33)$$

Individual:

$$D_{o(prj)} = \frac{D_{o(c)}}{t} \times 31 \qquad (34)$$

1

where

$D_{beta(c)}$ = the cumulative air dose, due to beta emissions from noble gases, for the elapsed portion of the current quarter plus the release under consideration.

$D_{gamma(c)}$ = the cumulative air dose, due to gamma emissions from noble gases, for the elapsed portion of the current quarter plus the release under consideration.

$D_{o(c)}$ = the cumulative organ dose, to an individual due to I-131, I-133, tritium and particulates, for the elapsed portion of the current quarter plus the release under consideration.

t = the number of days into the current quarter, including the period of the release under consideration. 1

If operational activities planned during the ensuing 31 day period are expected to result in gaseous releases which will contribute a dose in addition to the dose due to routine gaseous effluents, this additional dose contribution should be included in the projected dose as follows:

Air Doses:

$$D_{beta(prj)} = \left[\frac{D_{beta(c)}}{t} \times 31\right] + D_{PA} \quad (35)$$

$$D_{gamma(prj)} = \left[\frac{D_{gamma(c)}}{t} \times 31\right] + D_{PA} \quad (36)$$ 1

$$D_{o(prj)} = \left[\frac{D_{o(c)}}{t} \times 31\right] + D_{PA} \quad (37)$$

Where D_{PA} is the expected dose due to the particular planned activity.

2.2.3.2 Dose Projections for Specific Releases

Dose projections may be performed for a particular release by performing a pre-release dose calculation assuming that the planned release will proceed as anticipated. For air dose projections due to noble gases, follow the methodology presented in Subsection 2.2.2.1 using sample analyses results for the particular release point and parametric values expected to exist for the release period. For individual organ dose projections, due to I-131, I-133, tritium and particulates, follow the methodology presented in Subsection 2.2.2.2 using sample analyses results for the particular release point and parametric values expected to exist for the release period.

2.3 METEOROLOGICAL MODEL

(Reference 7, 13, 15 and Section 2.3.5 of Reference 5) 3

2.3.1 Atmospheric Dispersion

Atmospheric dispersion (long-term) may be calculated using the appropriate form of the sector-averaged straight line flow Gaussian model. Gaseous releases are considered to be either ground-level or mixed-mode. Considered as ground-level are releases from the turbine building(s) vents and the radwaste solidification building vent. Releases from reactor building(s) (plant) vent(s) are considered to be mixed-mode. (See NOTE in Subsection 2.1.2). 3

2.3.1.1 Ground-Level Releases

$(X/Q)_G$ = the ground-level sector-averaged relative concentration for a given wind direction (sector) and distance. (sec/m^3)

$$= (RCF)\, 2.032\, d_p \sum_{jk} \frac{n_{jk}}{N\, u_{jk}\, x \quad {}_{zk}} \qquad (38)$$ 3

where

2.032 = $(2/\pi)^{1/2}$ divided by the number of radians in a 22.5^{o} sector (0.3927 radians).

d_p = plume depletion factor for all radionuclides other than noble gases at a distance x shown in Figure 2.3-2 for ground-level releases; for noble gases the depletion factor is unity. If an undepleted relative concentration is desired, the depletion factor is unity. Only depletion by deposition is considered since depletion by decay would be of little significance at the distances considered.

RCF = open terrain recirculation factor. Values for specific distances are obtained from Figure 3
3.2 of Reference 15.

n_{jk} = number of hours meteorological conditions are observed to be in a given wind direction, windspeed class j, and stability class k. NOTE: If periodic data (hourly) are used instead of the joint frequency data, the summation over j and k is deleted and the summation is accomplished for all hours at all distances for each direction.

N = total hours of valid meteorological data throughout the period of interest.

u_{jk} = wind speed (mid-point of windspeed class j) at ground level (m/sec), during stability class k.

x = distance from release point to location of interest (meters).

Σ_{zk} = the vertical standard deviation of the plume concentration distribution considering the initial dispersion within the building wake.

= the lesser of $(\sigma_z^2 + (b^2/2\pi))^{1/2}$ or $\sqrt{3}(\sigma_z)$

σ_{zk} = the vertical standard deviation of the plume concentration distribution (meters) for a given distance and stability category k as shown in Figure 2.3-1. The stability category is determined by the vertical temperature gradient $\Delta T/\Delta z$ ($^{o}C/100m$).

π = 3.1416

b = maximum height of adjacent plant structure (55 meters).

2.3.1.2 Mixed-Mode Releases

$(X/Q)_M$ = the mixed-mode sector-averaged relative concentration for a given wind direction (sector) and distance (sec/m^3)

$$= 2.032(RCF)d_p \sum_{jk} \frac{n_{jk}}{Nx} \left[\frac{E}{u_{jk}\,zk} + \frac{(1-E)}{U_{jk}\sigma_{zk}} \exp(-h^2/2\sigma_{zk}^2) \right] \qquad (39)$$ 3

where

d_p = plume depletion factor for all radionuclides other than noble gases at a distance x shown in Figures 2.3-3 through 2.3-5 for elevated releases; for noble gases the depletion factor is unity. If an undepleted relative concentration is desired, the depletion factor is unity. Only depletion by deposition is considered since depletion by decay would be of little significance at the distances considered.

U_{jk} = wind speed extrapolated to the effective release height; extrapolation is accomplished by raising the ratio of the two heights to the n power where n = 0.25, 0.33, and 0.5 for unstable, neutral, and stable conditions, respectively. (Reference 5, Section 2.3.5).

E = fraction considered as ground level releases

$$1.0 \quad \text{for} \quad \frac{W_o}{u} \leq 1.0$$

$$2.58 - 1.58 \left(\frac{W_o}{u}\right) \quad \text{for } 1.0 < \frac{W_o}{u} \leq 1.5$$

$$0.3 - 0.06 \left(\frac{W_o}{u}\right) \quad \text{for } 1.5 < \frac{W_o}{u} \leq 5.0$$

$$0 \quad \text{for} \quad \frac{W_o}{u} > 5.0$$

W_o = vent exit velocity (m/sec)

h = effective release height (m)

$$= h_v + h_{pr} - h_t - c_v \qquad (40)$$

h_v = height of release point (m)

h_t = maximum terrain height between the release point and the point of interest (m) (See Table 2.3-1)

h_{pr} = additional height due to plume rise (m)

$$= 1.44d\ (W_o/u)^{2/3}(x/d)^{1/3} \qquad (41)$$

limited by the lesser of the following two equations:

$$h_{pr(max)} = 3(W_o/u)d \text{ or } h_{pr(max)} = 1.5(F_m'/u)^{1/3}S^{-1/6}$$

d = inside diameter of vent

c_v = correction for low vent exit velocity (m)

$$c_v = \begin{cases} 3\left(1.5 - \frac{W_o}{u}\right) d & \text{for } \frac{W_o}{u} \le 1.5 \\ 0 & \text{for } \frac{W_o}{u} > 1.5 \end{cases}$$

F'_m = momentum flux parameter (m^4/sec^2)

$$= (W_o)^2 \, (d/2)^2$$

S = stability parameter

$$S = \begin{cases} 8.75 \times 10^{-4} \text{ sec}^{-2} & \text{for } -0.5 < \Delta T \le 1.5 \\ 1.75 \times 10^{-3} \text{ sec}^{-2} & \text{for } 1.5 < \Delta T \le 4.0 \\ 2.45 \times 10^{-3} \text{ sec}^{-2} & \text{for } \Delta T > 4.0 \end{cases}$$

All other terms were defined in Subsection 2.3.1.1.

2.3.2 Relative Deposition

(See NOTE in Subsection 2.1.2). 3

2.3.2.1 Ground-Level Releases

$(D/Q)_G$ = the ground-level sector-averaged relative deposition at a given distance and for a given sector ($1/m^2$).

$$= (RCF) \sum_k \frac{2.55\ D_g\ n_k}{N\ x} \qquad (42)$$ 3

where

2.55 = the inverse of the number of radians in a 22.5° sector $(2\pi/16)^{-1}$.

D_g = deposition rate at a given distance, taken from Figure 2.3-6 for ground-level releases.

n_k = the number of hours the wind is directed into the sector of interest, during which time stability category k exists.

N = the total number of hours of valid meteorological data.

RCF = open terrain recirculation factor. Values for specific distances are obtained from Figure 3.2 of Reference 15. 3

2.3.2.2 Mixed-Mode Releases

$(D/Q)_M$ = the mixed-mode sector-averaged relative deposition at a given distance and for a given sector ($1/m^2$).

$$= \frac{2.55}{x} (RCF) ((E)(D_g) + (1 - E) D_e) \qquad (43)$$ 3

where

D_g = relative deposition rate for the ground-level portion of mixed-mode releases from Figure 2.3-6.

D_e = relative deposition rate for the elevated portion of mixed-mode releases from Figures 2.3-7 through 2.3-9.

E = fraction of releases considered as ground-level.

Other terms were defined in previous Subsections.

TABLE 2.3-1

Terrain Elevation Above Plant Grade

(Page 1 of 2)

Wind Direction from Plant to Receptor

Distance (m)	N	NNE	NE	ENE	E	ESE	SE	SSE
500	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1500	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2500	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3500	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4000	0.0	0.0	0.0	0.0	0.0	0.0	4.5	0.0
5000	0.0	0.0	0.0	0.0	0.0	0.0	11.1	0.0
6000	0.0	0.0	0.0	0.0	0.0	0.0	11.1	0.0
7000	0.0	0.0	0.0	7.8	0.0	0.0	11.1	0.0
8000	0.0	0.0	21.1	13.9	0.0	0.0	11.8	0.0
9000	0.0	0.0	24.4	14.6	0.0	0.0	12.7	7.1
10,000	0.0	10.2	24.4	20.2	0.0	0.0	17.1	17.0
12,000	0.0	15.9	26.8	20.2	0.0	0.0	17.1	19.5
14,000	0.0	15.9	26.8	20.2	0.0	0.0	17.1	19.5
16,000	0.0	15.9	26.8	21.7	13.2	0.0	17.1	19.5

Reference 5

TABLE 2.3-1

Terrain Elevation Above Plant Grade

(Page 2 of 2)

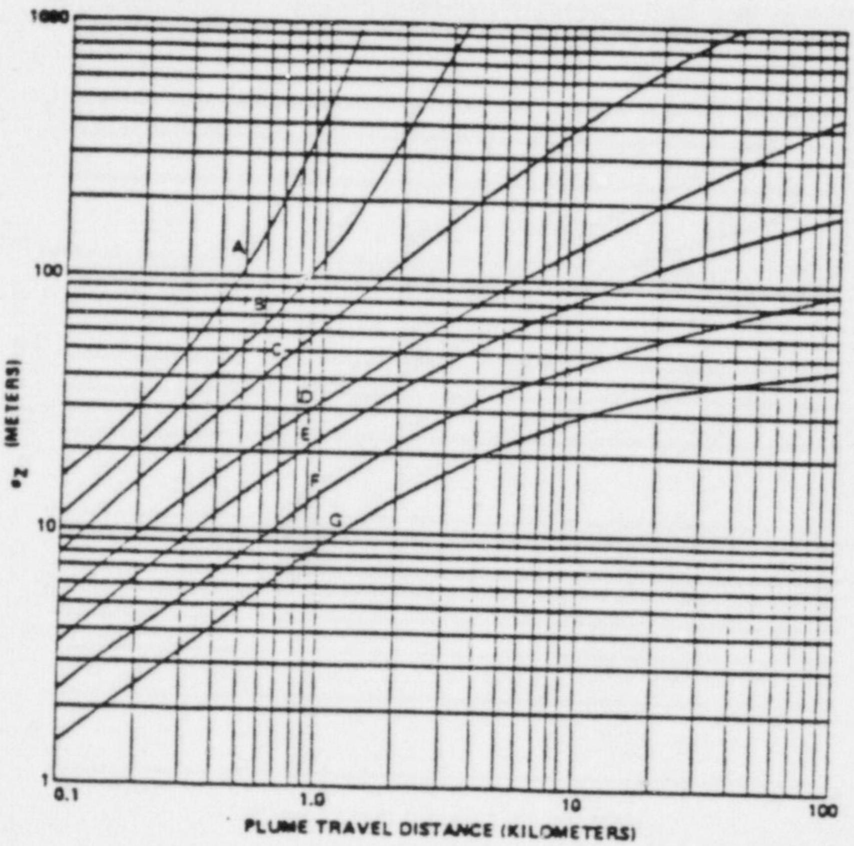
Wind Direction from Plant to Receptor

Distance (m)	S	SSW	SW	WSW	W	WNW	NW	NNW
500	0.0	4.7	8.7	5.7	1.4	5.8	5.7	3.5
1000	0.0	4.7	16.7	13.4	3.3	10.4	11.8	6.8
1500	0.0	4.7	21.7	18.6	7.3	12.2	14.3	7.3
2000	0.0	4.7	21.7	18.6	7.3	12.2	14.3	7.3
2500	0.0	4.7	21.7	18.6	7.3	12.2	14.3	7.3
3000	0.0	4.7	23.7	18.6	7.3	12.2	14.3	7.3
3500	0.0	4.7	24.4	18.6	7.3	12.2	16.9	7.3
4000	0.0	4.7	24.4	18.6	7.3	12.2	16.9	7.3
5000	0.0	4.7	24.7	18.6	7.3	12.2	16.9	7.3
6000	0.0	4.7	26.8	18.6	7.3	12.2	16.9	7.3
7000	3.6	4.7	26.8	18.6	7.3	12.2	16.9	7.3
8000	14.6	4.7	26.8	18.6	7.3	12.2	16.9	7.3
9000	14.6	5.1	26.8	18.6	7.3	12.2	16.9	7.3
10,000	14.6	6.8	26.8	18.6	7.3	12.2	16.9	7.3
12,000	14.6	6.8	34.1	28.9	13.4	12.2	16.9	7.3
14,000	14.6	6.8	34.1	28.9	13.4	16.5	19.7	7.3
16,000	14.6	6.8	34.1	28.9	13.4	16.5	25.7	7.3

FIGURE 2.3-1

Vertical Standard Deviation of Material in a Plume (σ_z)

(Letters Denote Pasquill Stability Class)



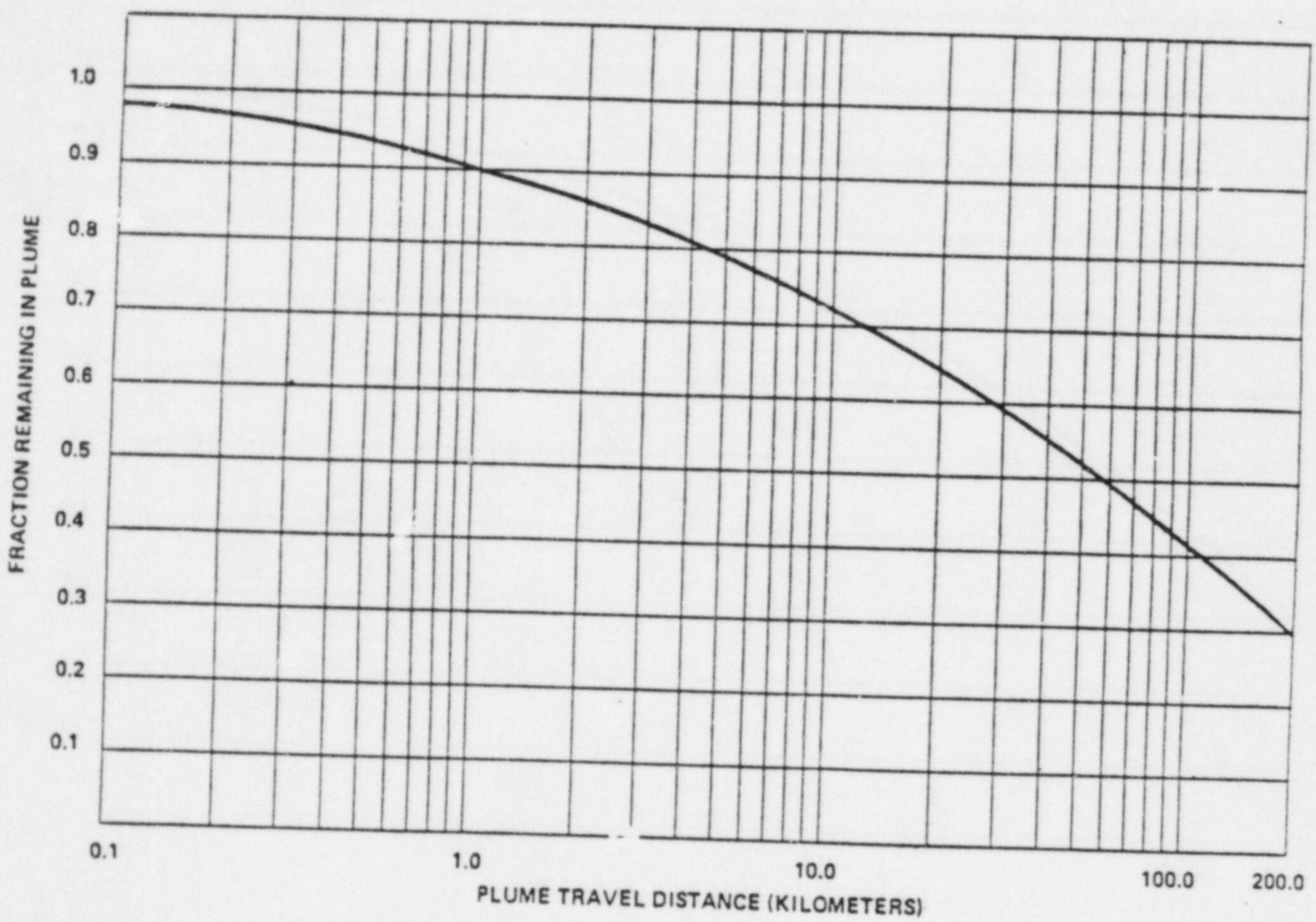
Category	Range of Vertical Temperature Gradient (°C/100m)	Range of Vertical Temperature Gradient (°F/100ft)
A	$\Delta T/\Delta Z < -1.9$	$\Delta T < -1.0$
B	$-1.9 \leq \Delta T/\Delta Z < -1.7$	$-1.0 \leq \Delta T < -0.9$
C	$-1.7 \leq \Delta T/\Delta Z < -1.5$	$-0.9 \leq \Delta T < -0.8$
D	$-1.5 \leq \Delta T/\Delta Z < -0.5$	$-0.8 \leq \Delta T < -0.3$
E	$-0.5 \leq \Delta T/\Delta Z < 1.5$	$-0.3 \leq \Delta T < 0.8$
F	$1.5 \leq \Delta T/\Delta Z < 4.0$	$0.8 \leq \Delta T < 2.2$
G	$4.0 \leq \Delta T/\Delta Z$	$2.2 \leq \Delta T$

Reference 7

FIGURE 2.3-2

Plume Depletion Effect for Ground-Level Releases

(All Atmospheric Stability Classes)

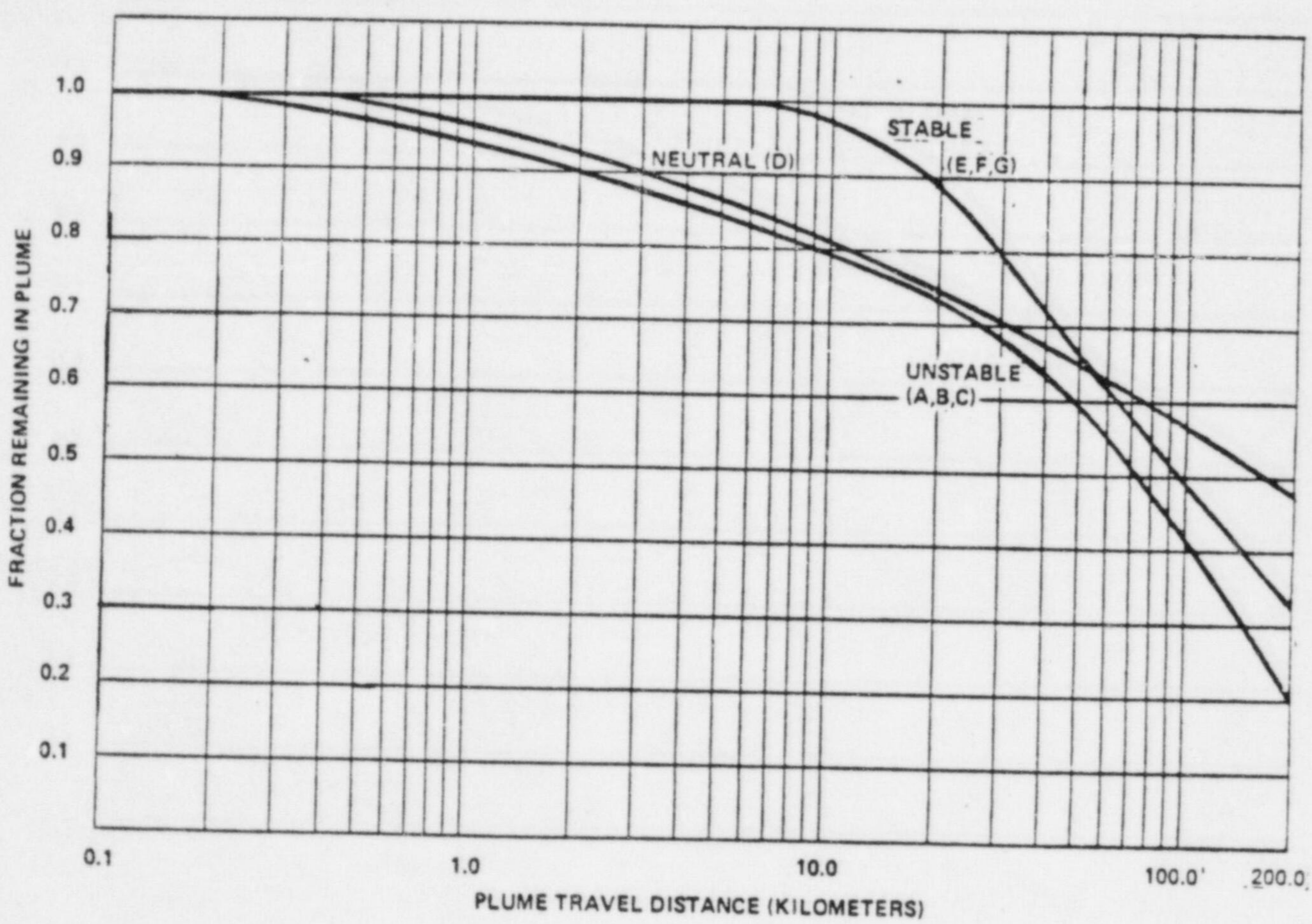


Reference 7

FIGURE 2.3-3

Plume Depletion Effect for 30-Meter Releases

(Letters Denote Pasquill Stability Class)

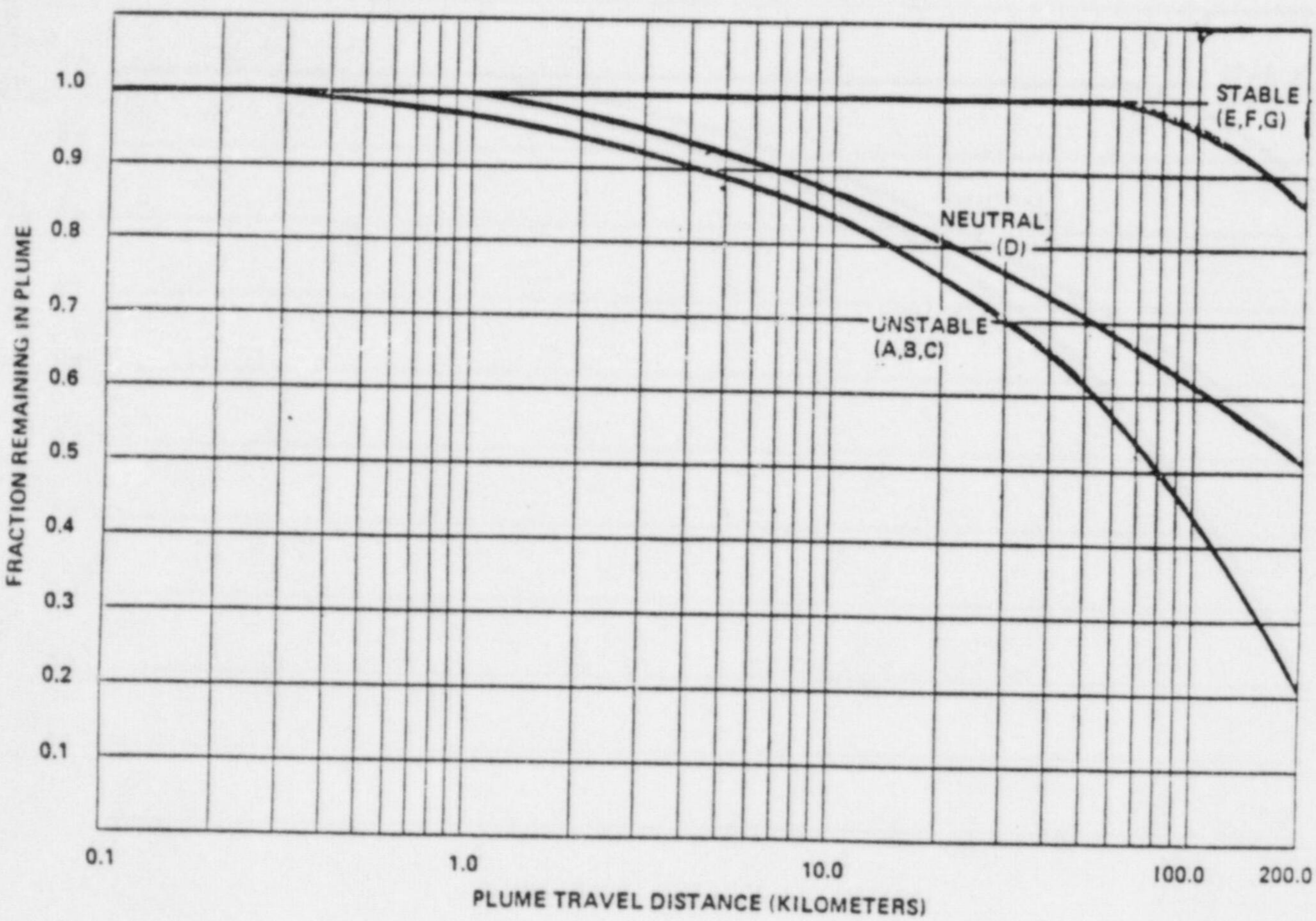


Reference 7

FIGURE 2.3-4

Plume Depletion Effect for 60-Meter Releases

(Letters Denote Pasquill Stability Class)

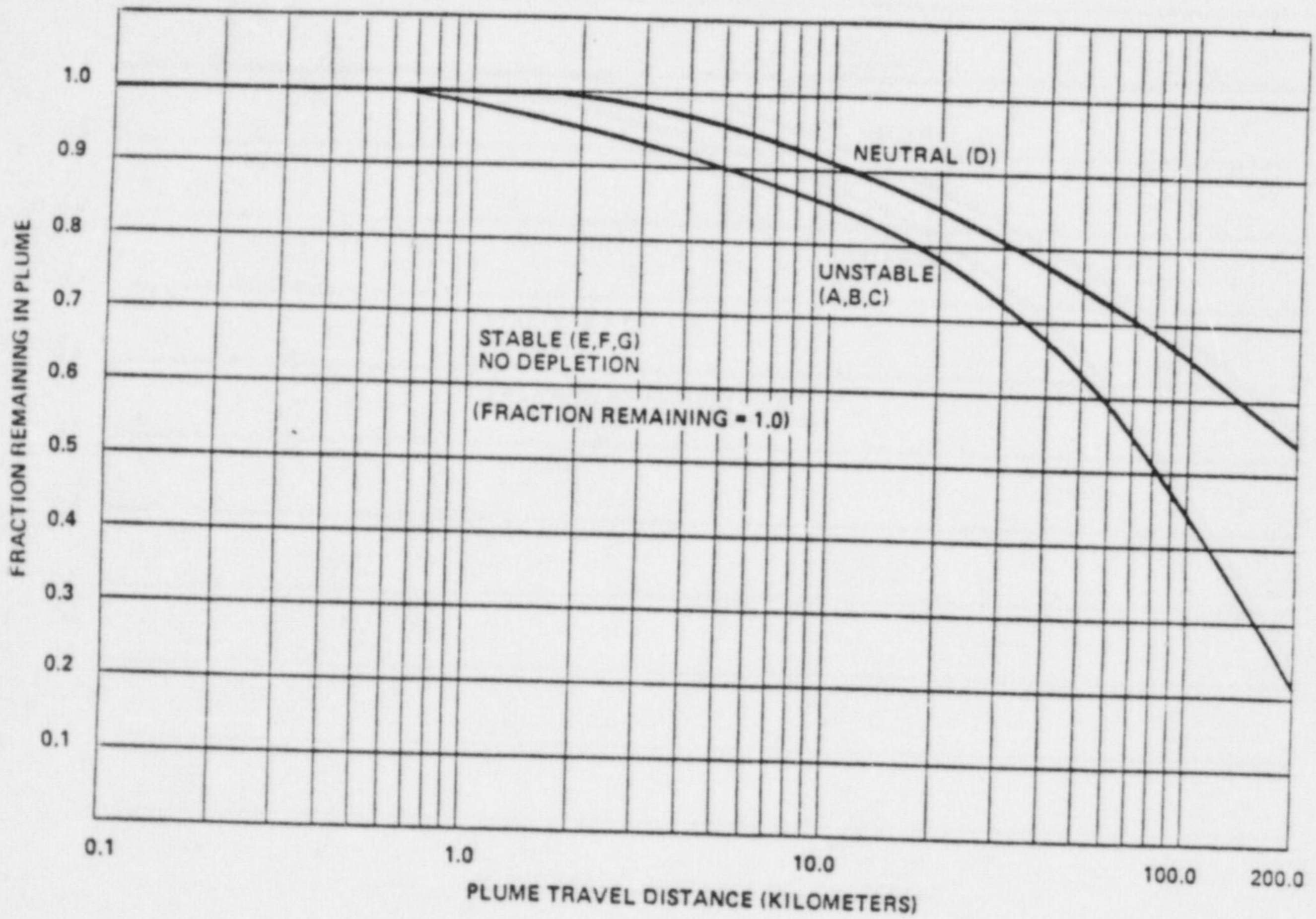


Reference 7

FIGURE 2.3-5

Plume Depletion Effect for 100-Meter Releases

(Letters Denote Pasquill Stability Class)

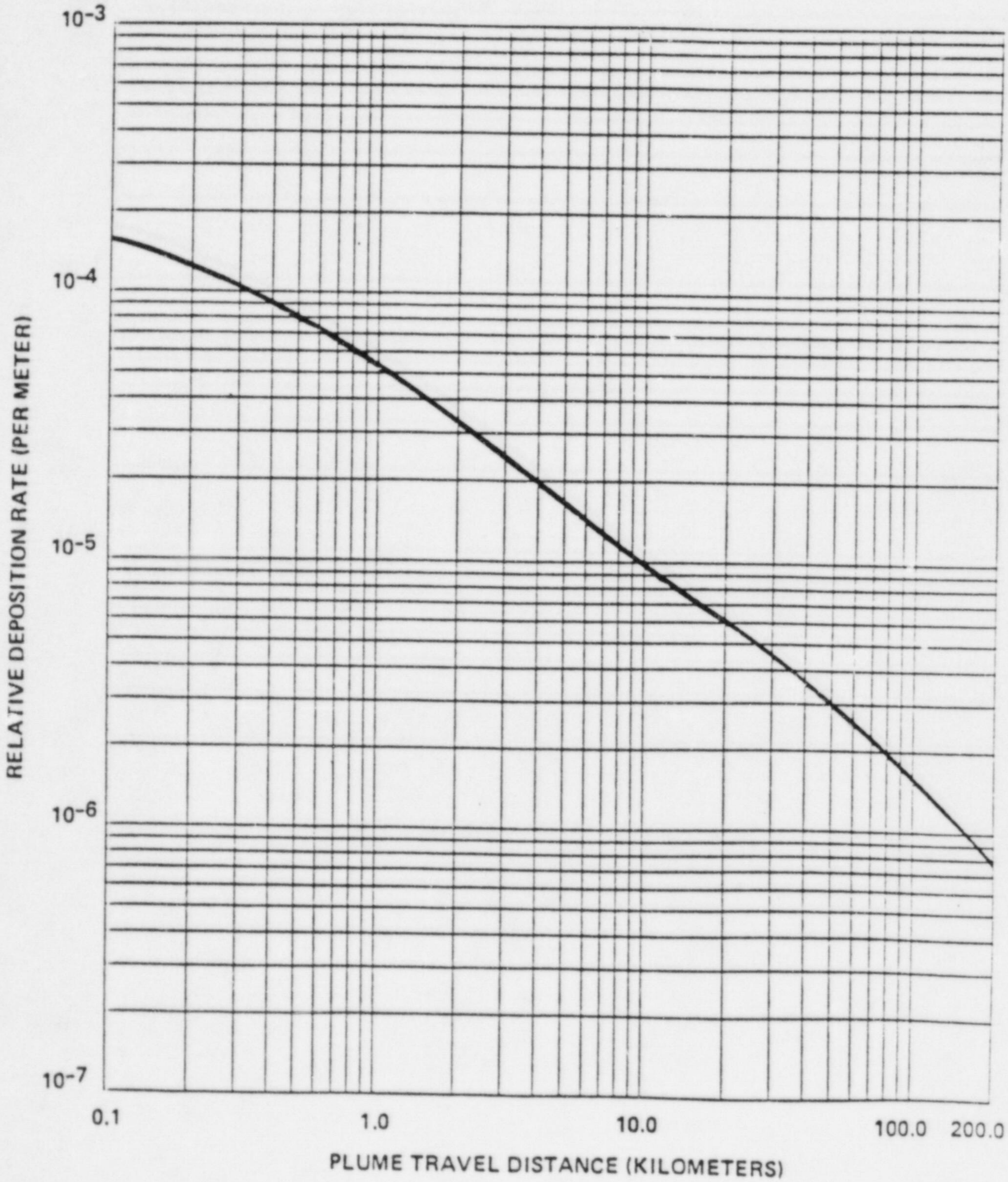


Reference 7

FIGURE 2.3-6

Relative Deposition for Ground-Level Releases

(All Atmospheric Stability Classes)

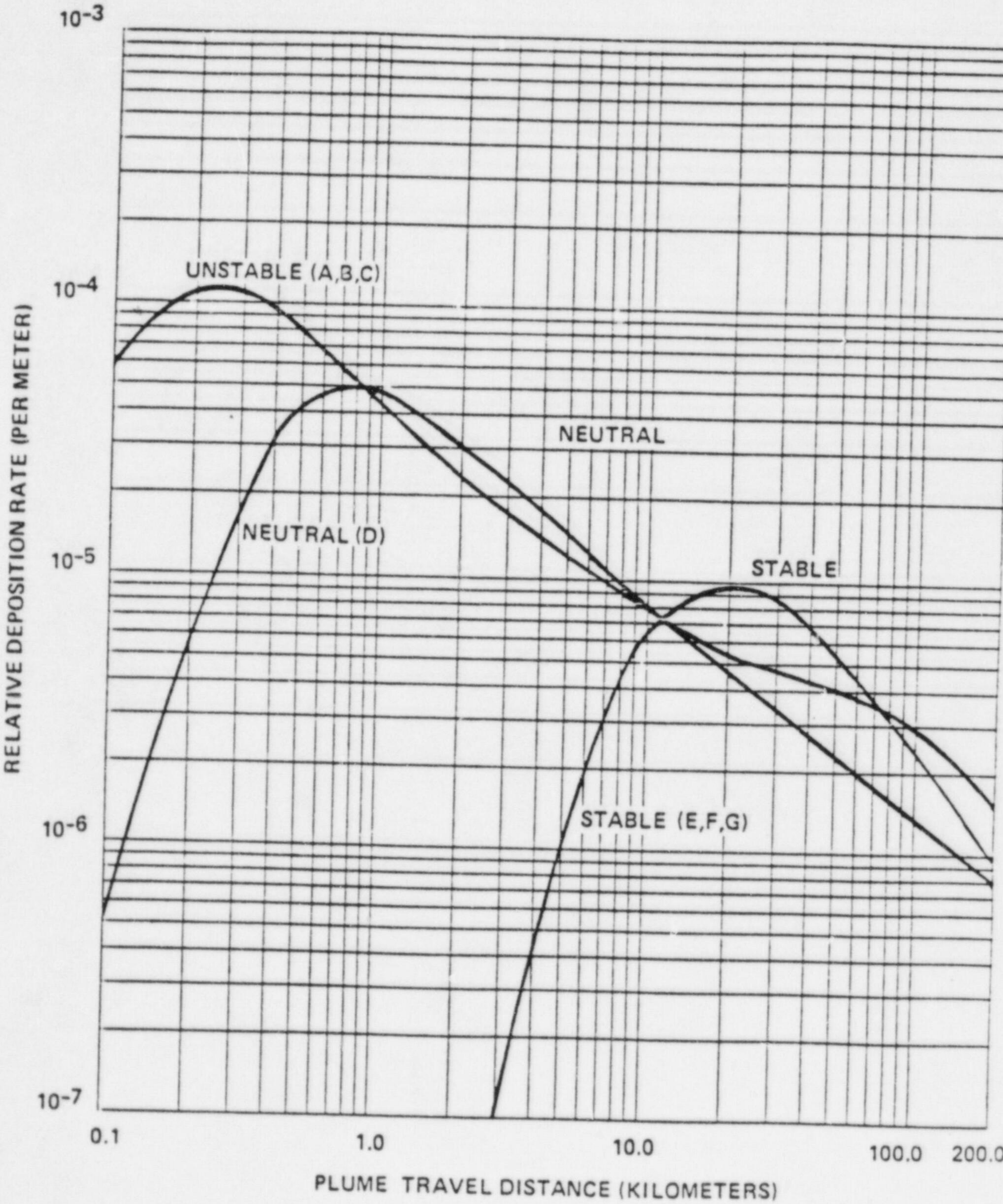


Reference 7

FIGURE 2.3-7

Relative Deposition for 30-Meter Releases

(Letters Denote Pasquill Stability Class)

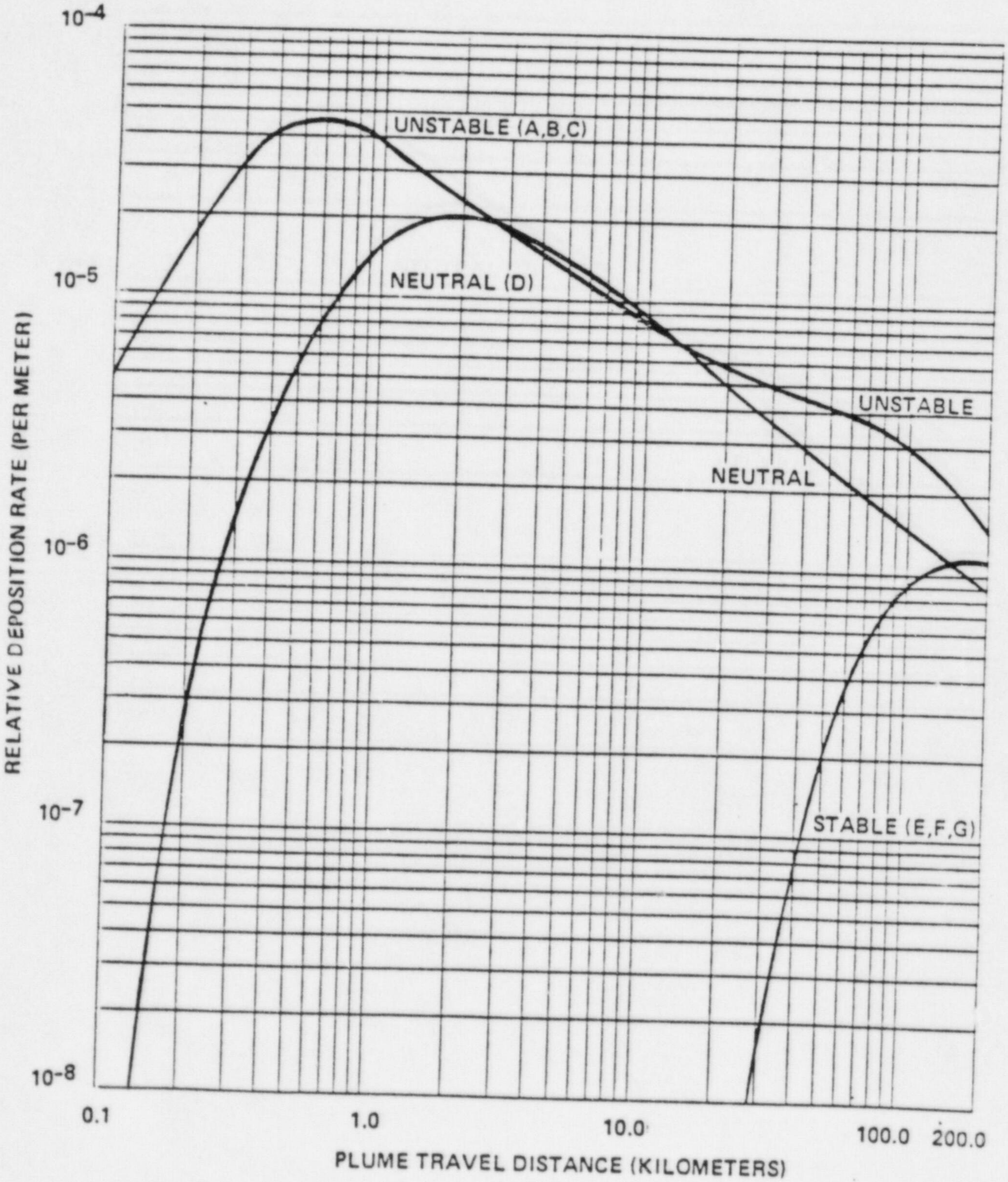


Reference 7

FIGURE 2.3-8

Relative Deposition for 60-Meter Releases

(Letters Denote Pasquill Stability Class)

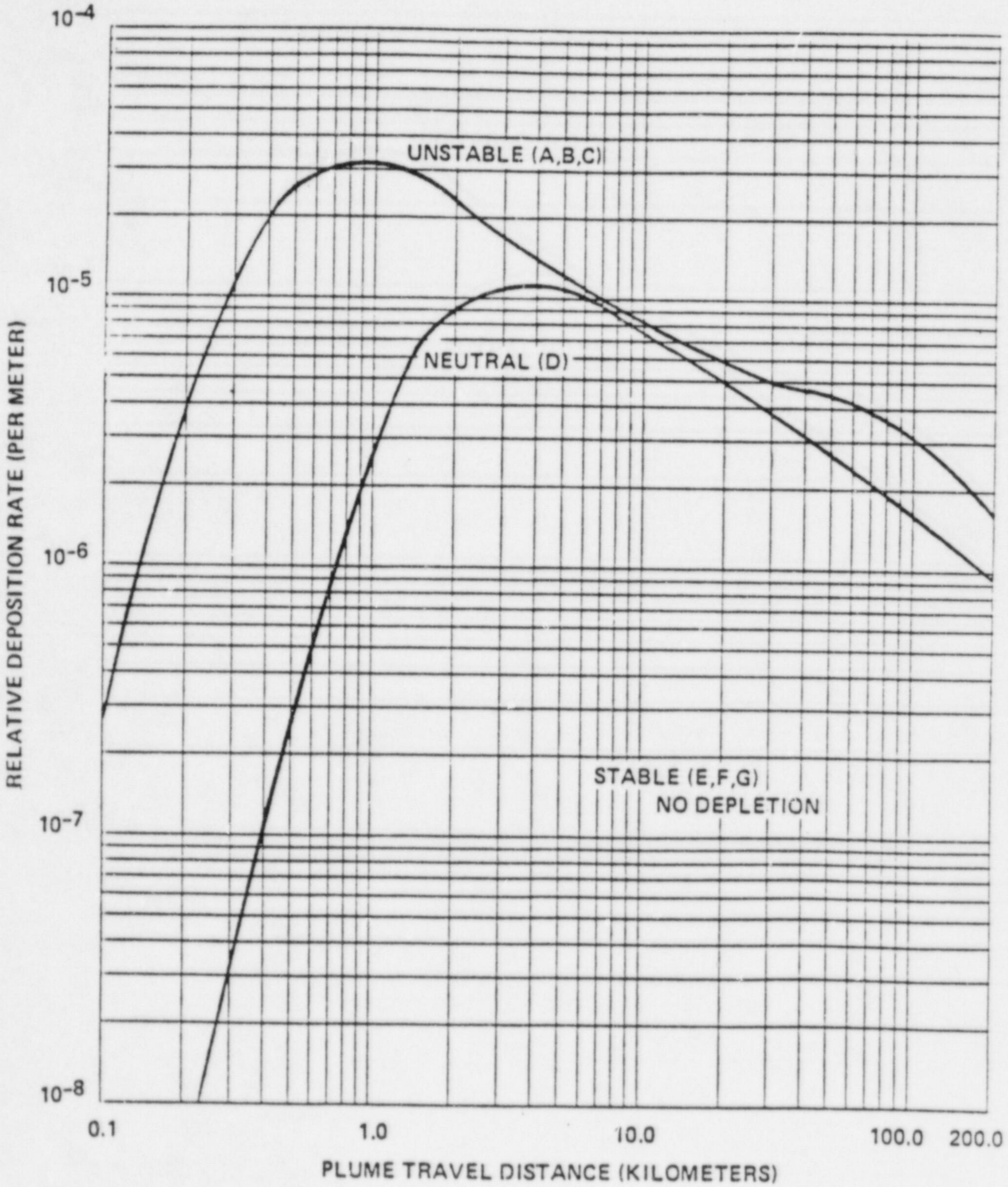


Reference 7

FIGURE 2.3-9

Relative Deposition for 100-Meter Releases

(Letters Denote Pasquill Stability Class)



Reference 7

2.4 DEFINITIONS OF GASEOUS EFFLUENT TERMS

Term		Definition	Subsection of Initial Use	
AG	=	administrative allocation factor for gaseous effluent pathways (unitless).	2.1.1	
BR	=	breathing rate for individual from Table 2.2-10 (m^3/year).	2.2.1.2	1
b	=	maximum height of the adjacent building (meters).	2.3.1.1	
C_m	=	monitor response of a noble gas monitor corresponding to associated grab sample radionuclide concentrations.	2.1.1	
c_s	=	calculated basic monitor setpoint value	2.1.1	
c_{sp}	=	actual monitor setpoint which includes the calculated basic monitor setpoint value plus background.	2.1.1	1
c_v	=	correction to effective release height due to low vent exit velocity (meters).	2.3.1.2	
D_{TB}	=	limiting dose rate to the total body of an individual in an unrestricted area which is 500 mrem/year.	2.1.1	
D_t	=	total body dose rate at time of release (mrem/yr).	2.2.1.1	
D_{ss}	=	limiting dose rate to the skin of an individual in an unrestricted area which is 3000 mrem/year.	2.1.1	

Term		Definition	Subsection of Initial Use
D_s	=	skin dose rate at time of release (mrem/yr).	2.2.1.1
D_o	=	organ dose rate at time of release (mrem/yr).	2.2.1.2
DF_{io}	=	inhalation pathway dose factor for child age group for organ o and radionuclide i (mrem/pCi inhaled) from Table 2.2-2.	2.2.1.2
D_{beta}	=	air dose due to beta emissions from noble gases (mrad).	2.2.2.1
D_{gamma}	=	air dose due to gamma emissions from noble gases (mrad).	2.2.2.1
D_j	=	dose to an organ of individual from radioiodines, tritium, and radionuclides in particulate form with half-lives greater than eight days (mrem).	2.2.2.2
$(DFA_{ij})_a$	=	the inhalation dose factor for the ith radionuclide for the receptor in age group a (mrem/pCi) from Tables 2.2-1 through 2.2-4.	2.2.2.2
DFG_{ij}	=	ground-plane dose conversion factor for radionuclide i (same for all age groups) (mrem/hr per pCi/m^2) from Table. 2.2-9.	2.2.2.2

2.4 DEFINITIONS OF GASEOUS EFFLUENT TERMS (Continued)

Term		Definition	Subsection of Initial Use
$(DFL_{ij})_a$	=	the organ ingestion dose factor for the ith radionuclide for the receptor in age group a (mrem/pCi) from Tables 2.2-5 through 2.2-8.	2.2.2.2
d_p	=	plume depletion factor for all radionuclides other than noble gases at distance x (unitless).	2.3.1.1
d	=	inside diameter of plant vent (meters).	2.3.1.2
D_g	=	deposition rate for ground-level releases (m^{-1}).	2.3.2.1
D_e	=	deposition rate for elevated releases (m^{-1}).	2.3.2.1
E	=	fraction of release considered to be ground-level (unitless).	2.3.2.1
f_l	=	fraction of the annual intake of fresh leafy vegetation grown locally (dimensionless).	2.2.2.2
f_g	=	fraction of annual intake of stored vegetation grown locally (dimensionless).	2.2.2.2
f_p	=	fraction of the year that the cow (or goat) is on pasture (dimensionless).	2.2.2.3

Term		Definition	Subsection of Initial Use
f_s	=	fraction of the cow (or goat) feed that is pasture grass while the cow or goat is on pasture (dimensionless).	2.2.2.3
F_f	=	the stable element transfer coefficient for meat (days/kg) from Table 2.2-11.	2.2.2.3
F_m	=	the stable element transfer coefficient for milk (days/liter) from Table 2.2-11.	2.2.2.3
F'_m	=	momentum flux parameter (m^4/sec^2)	2.3.1.2
F_v	=	maximum expected release flow rate through a particular release point (ml/sec) from Table 2.1-2	2.1.1
H	=	absolute humidity of the atmosphere (gm/m^3).	2.2.2.2
h	=	effective release height (meters).	2.3.1.2
h_v	=	height of release point (meters).	2.3.1.2
h_t	=	maximum terrain height between the release point and the point of interest (meters).	2.3.1.2
h_{pr}	=	additional height due to plume rise (meters).	2.3.1.2

Term		Definition	Subsection of Initial Use
K_i	=	total body dose factor due to gamma emissions from radionuclide i (mrem/year per uCi/m^3) from Table 2.1-1.	2.1.1
K'	=	constant of unit conversion (10^6pCi/uCi).	2.2.1.2
K"	=	constant of unit conversion (8760 hr/year).	2.2.2.2
K'"	=	constant of unit conversion (10^3 gm/kg).	2.2.2.2
L_i	=	skin dose factor due to beta emissions from radionuclide i (mrem/year per uCi/m^3) from Table 2.1-1.	2.1.1
M_i	=	air dose factor due to gamma emissions from radionuclide i (mrad/year per uCi/m^3) from Table 2.1-1.	2.1.1
N_i	=	air dose factor due to beta emissions from noble gas radionuclide i (mrad/year per uCi/m^3) from Table 2.1-1.	2.2.2.1
n	=	the number of simultaneous gaseous release pathways.	2.1.5
n_{jk}	=	number of hours meteorological conditions are observed to be in a given wind direction, wind-speed class j, and atmospheric stability class k.	2.3.1.1

Term	Definition	Subsection of Initial Use
N	= total hours of valid meteorological data.	2.3.1.1
P_{io}	= dose parameter for radionuclide i, (mrem/yr per uCi/m^3) for the inhalation pathway.	2.2.1.2
Q_{ig}	= Source term for ground-level release noble gas radionuclide i (uCi/sec)	2.1.1
Q_{im}	= Source term for mixed-mode release noble gas radionuclide i (uCi/sec)	2.1.1
$Q_{ig(r)}$	= source term for ground-level release noble gas radionuclide i from a specific release point (uCi/sec)	2.1.5
$Q_{im(r)}$	= source term for mixed-mode release noble gas radionuclide i from a specific release point (uCi/sec)	2.1.5
Q'_{ig}	= source term for ground-level release radioiodine, tritium and particulate radionuclide i (uCi/sec)	2.2.1.2
Q'_{im}	= source term for mixed-mode release radioiodine, tritium and particulate radionuclide i (uCi/sec)	2.2.1.2
$\tilde{Q}_{ig}$	= cumulative ground-level release of noble gas radionuclide i (uCi)	2.2.2.1
$\tilde{Q}_{im}$	= cumulative mixed-mode release of noble gas radionuclide i (uCi)	2.2.2.1

Term		Definition	Subsection of Initial Use
$\tilde{Q}'_{ig}$	=	cumulative ground-level release of radioiodines, tritium and particulate radionuclide i (uCi)	2.2.2.2
$\tilde{Q}'_{im}$	=	cumulative mixed-mode release of radioiodines, tritium and particulate radionuclide i (uCi)	2.2.2.2
Q_F	=	Feed consumption rate for cow or goat (kg/day)	2.2.2.3
q_i	=	noble gas source term for the Gaseous Waste Processing System or Containment purge (uCi/sec)	2.1.3.1 and 2.1.3.2
R_t	=	relationship between monitor response and the dose rate to the total body for the conditions of the release under consideration.	2.1.1
R_s	=	relationship between monitor response and the dose rate to the skin for the conditions of the release under consideration.	2.1.1
r_t	=	relationship between monitor response and the dose rate to the total body for Gaseous Waste Processing System or Containment purge release for the conditions of the release under consideration.	2.1.3.1

Term		Definition	Subsection of Initial Use
r_s	=	relationship between monitor response and the dose rate to the skin for Gaseous Waste Processing System or Containment purge release for the conditions of the release under consideration.	2.1.3.1
R_{aipj}	=	pathway-specific, individual age-specific, organ dose factor for radionuclide i, pathway p, organ j, and age group a, (mrem/yr per uCi/m^3) or (m^2-mrem/yr per uCi/sec).	2.2.2.2
r	=	fraction of deposited radionuclide retained on vegetation (unitless).	2.2.2.2
SF	=	safety factor used to introduce a margin of conservatism into setpoint calculations.	2.1.1
SHF	=	shielding factor afforded by structure (unitless).	2.2.2.2
S	=	stability parameter (sec^{-2})	2.3.1.2
t	=	exposure time for radioactivity deposited on ground (seconds)	2.2.2.2
t_l	=	time between harvest of leafy vegetation and consumption (seconds)	2.2.2.2
t_{hv}	=	time between harvest of stored vegetation and consumption (seconds)	2.2.2.2

Term		Definition	Subsection of Initial Use
t_{hm}	=	transport time from feed to receptor for stored feed (seconds)	2.2.2.3
t_f	=	transport time from feed to receptor for pasture grass (seconds)	2.2.2.3
U_{ap}	=	receptor's milk (liters/year) or meat (kg/year) consumption rate for age group a from Table 2.2-10.	2.2.2.3
U_{as}	=	consumption rate of stored vegetation by the receptor in age group a (kg/year) from Table 2.2-10.	2.2.2.2
U_{al}	=	consumption rate of fresh leafy vegetation by the receptor in age group a (kg/year) from Table 2.2-10.	2.2.2.2
u_{jk}	=	wind speed (midpoint of windspeed class j) at ground level during atmospheric stability class k (m/sec).	2.3.1.1
U_{jk}	=	wind speed (midpoint of wind speed class j) at the height of release, h, of an elevated release during atmospheric stability class k (m/sec).	2.3.1.2
W'_{GP}	=	pathway-dependent relative dispersion or deposition for ground-level releases at the location of the critical receptor.	2.2.2.2

1

2.4 DEFINITIONS OF GASEOUS EFFLUENT TERMS (Continued)

Term		Definition	Subsection of Initial Use	
W'_{MP}	=	pathway-dependent relative dispersion or deposition for mixed-mode releases at the location of the critical receptor.	2.2.2.2	
x	=	distance from release point to point of interest (meters).	2.3.1.1	1
Y_v	=	vegetation areal density (kg/m^2).	2.2.2.2	
Y_p	=	agricultural productivity by unit area of pasture feed grass (kg/m^2).	2.2.2.3	
Y_s	=	agricultural productivity by unit area of stored feed (kg/m^2).	2.2.2.3	
$(\overline{X/Q})_G$	=	highest annual average relative concentration for a ground-level release type (sec/m^3).	2.1.1	
$(\overline{X/Q})_M$	=	highest annual average relative concentration for a mixed-mode release type (sec/m^3).	2.1.2	
$(\overline{X/Q'})_G$	=	annual average relative concentration for location of controlling (critical) receptor for inhalation and all tritium pathways for a ground-level release type (sec/m^3).	2.2.2.2	
$(\overline{X/Q'})_M$	=	annual average relative concentration for location of controlling (critical) receptor for inhalation and all tritium pathways for a mixed-mode release type (sec/m^3).	2.2.2.2	

Term		Definition	Subsection of Initial Use	
λ_i	=	decay constant for the ith radionuclide (sec^{-1}).	2.2.2.2	
λ_w	=	decay constant for removal of activity on leaf and plant surfaces by weathering (sec^{-1}).	2.2.2.2	1
Σ_{zk}	=	the vertical standard deviation of the plume concentration distribution considering the initial dispersion within the building wake (meters).	2.3.1.1	1
σ_{zk}	=	vertical standard deviation of the plume (in meters), for a given distance under the stability category k indicated by $\Delta T/\Delta Z$ from Figure 2.3-1.	2.3.1.1	
$\Delta T/\Delta Z$	=	vertical temperature gradient used to determine the atmospheric stability category (^{o}C/100m or ^{o}F/100 ft.)	2.3.1.1	
X_{iv}	=	concentration of radionuclide i for the particular vent release pathway under consideration (uCi/ml).	2.1.1	

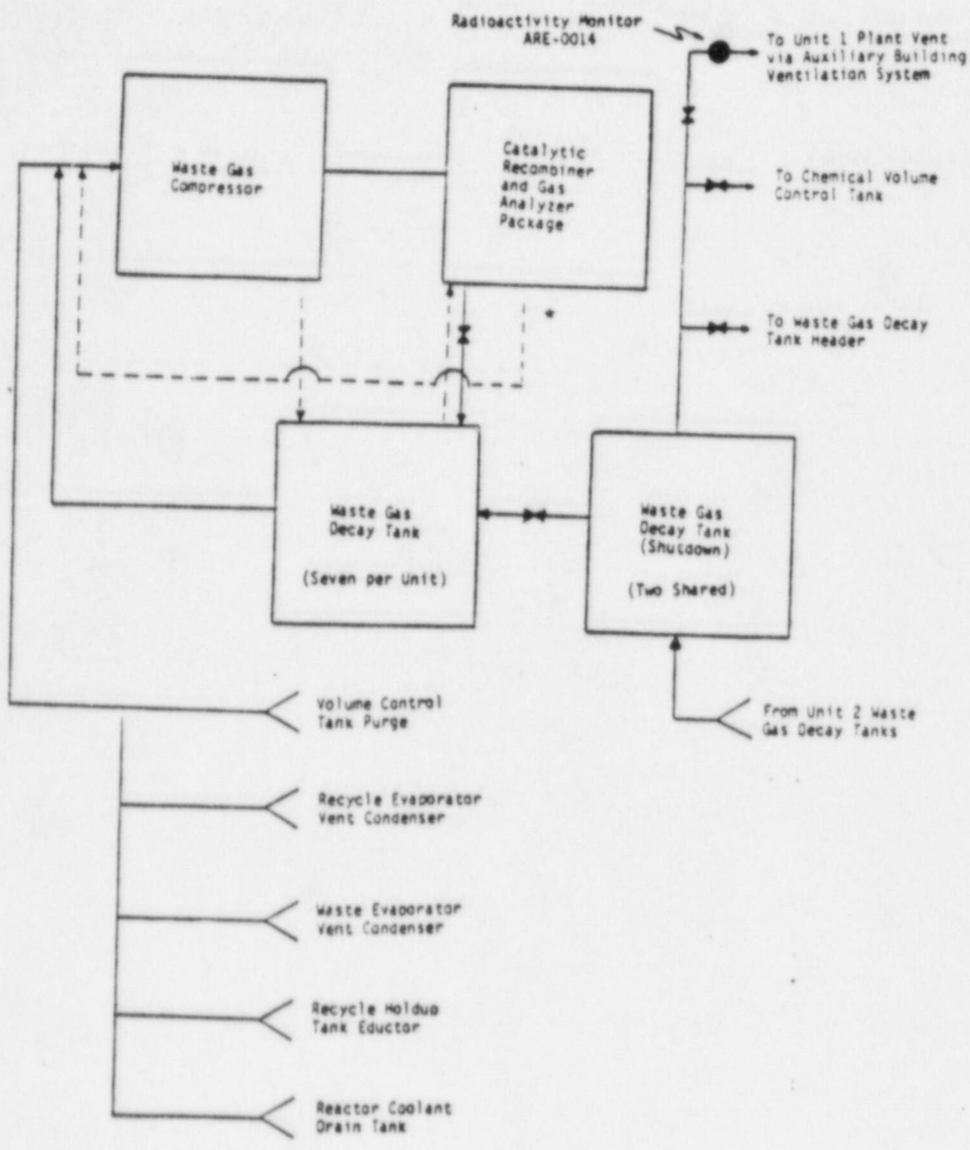
2.5 GASEOUS RADWASTE TREATMENT SYSTEMS

Figures 2.5-1, 2.5-2, 2.5-3, and 2.5-4 present schematics of the Gaseous Waste Processing System and Ventilation Exhaust Treatment Systems. (Reference 5)

FIGURE 2.5-1

Gaseous Waste Processing System

(Typical of both units. However, Unit 2 GWPS releases via Unit 1 plant vent.)

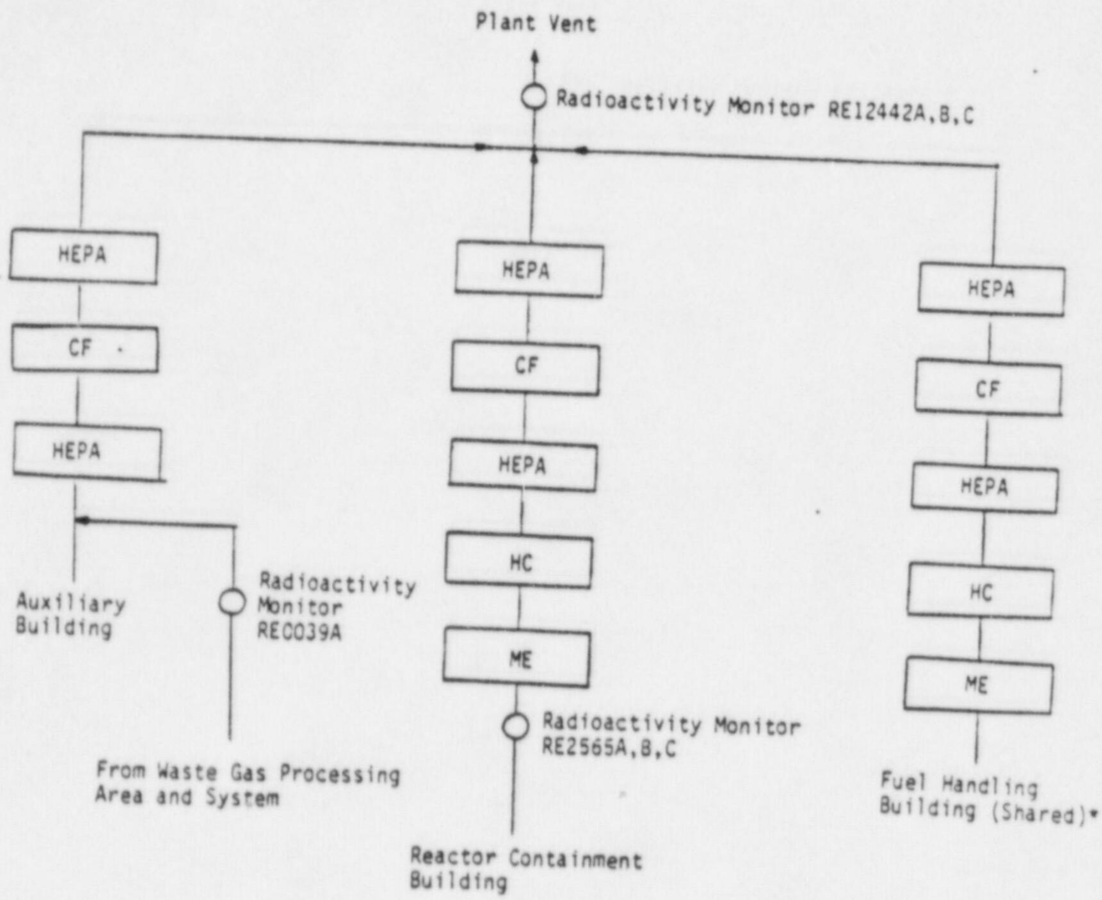


*Dotted line operational between 20 and 100 psig

FIGURE 2.5-2

Ventilation Exhaust Treatment System
(Plant Vent)

(Typical of both units. However, all Gaseous Waste Processing System and Fuel Handling Building releases are via Unit 1 plant vent.)



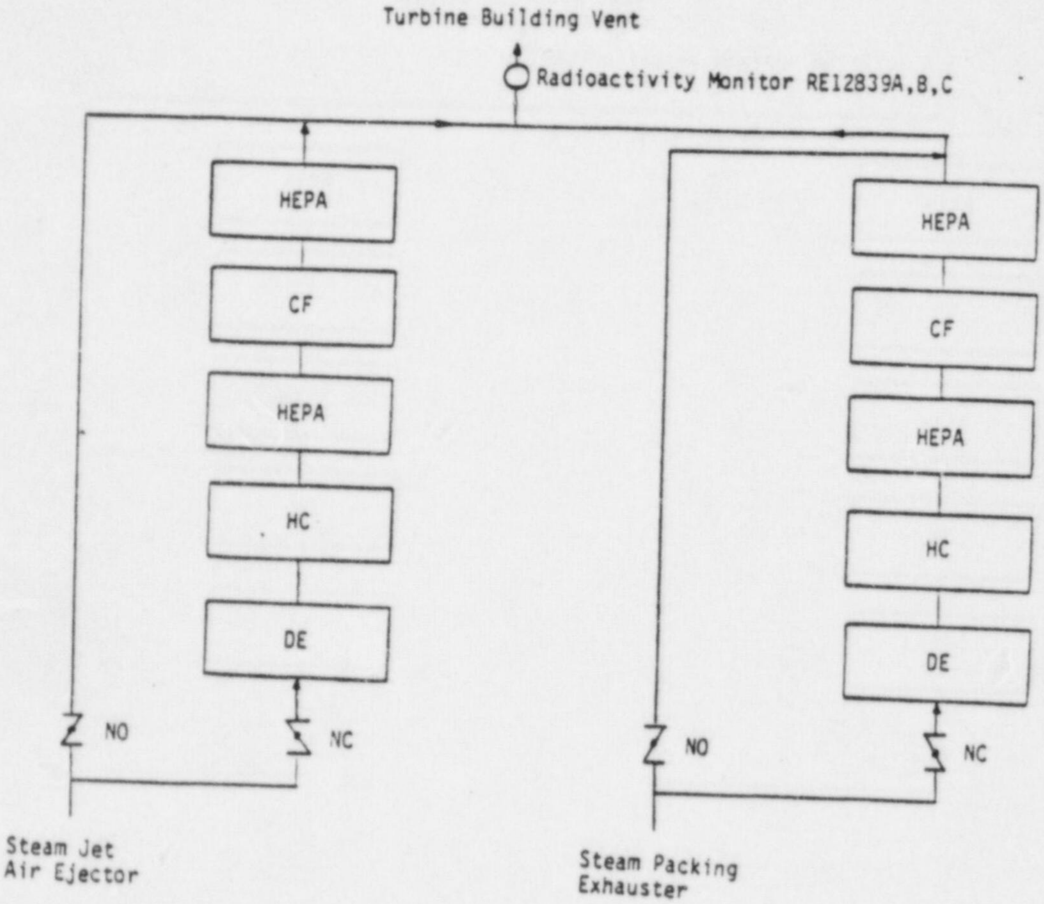
HEPA -High Efficiency Particulate Air Filter
CF -Activated Charcoal Filter
HC -Heating Coil
ME -Moisture Eliminator

*Prior to treatment by the Fuel Handling Building Ventilation Exhaust Treatment System, exhaust from Unit 1 Spent Fuel Pool Area is monitored by ARE2532B and ARE2533B; exhaust from Unit 2 Spent Fuel Pool Area is monitored by ARE2532A and ARE2533A.

FIGURE 2.5-3

Ventilation Exhaust Treatment System
(Turbine Building)

(Typical of both units)

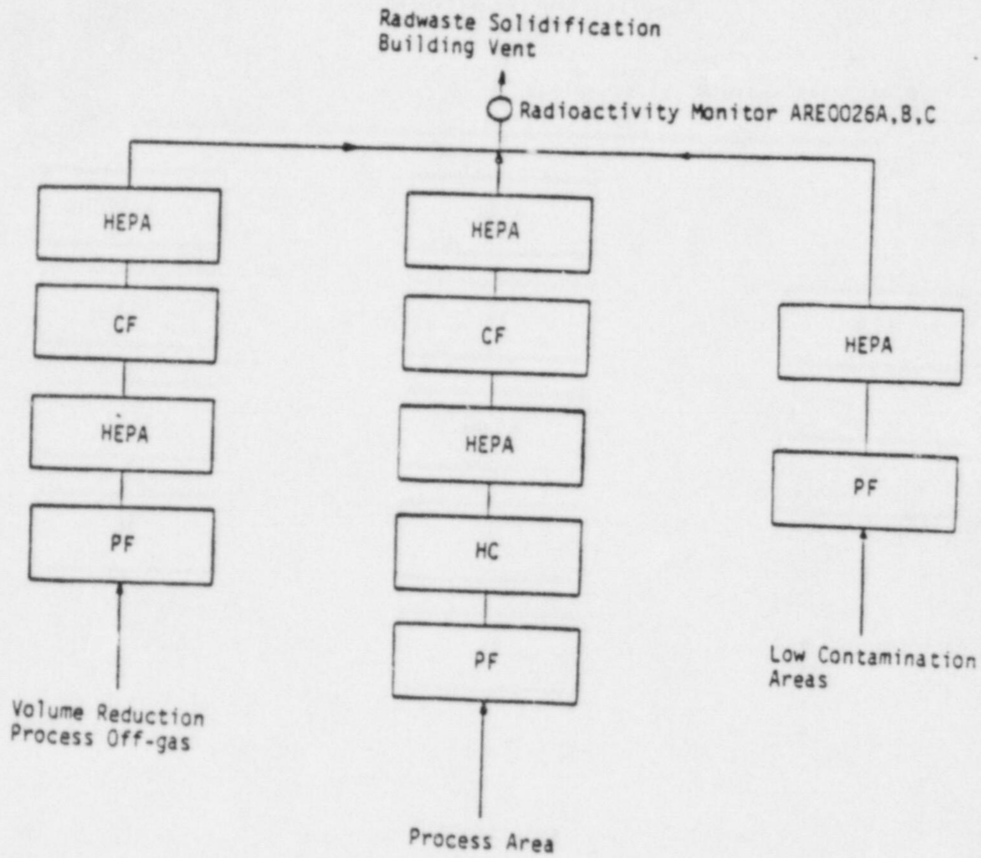


HEPA -High Efficiency Particulate Air Filter
CF -Activated Charcoal Filter
HC -Heating Coil
DE -Demister
NO -Normally Open
NC -Normally Closed

FIGURE 2.5-4

Ventilation Exhaust Treatment System
(Radwaste Solidification Building)

(Common to both units)



HEPA -High Efficiency Particulate Air Filter
CF -Activated Charcoal Filter
PF -Prefilter
HC -Heating Coil

SECTION 3.0

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Radiological environmental sampling and monitoring locations are described in Table 3.0-1 and shown on maps in Figures 3.0-1, 3.0-2, 3.0-3, and 3.0-4 as required by Technical Specifications 3.12.1 and 4.12.1.

TABLE 3.0-1

RADIOLOGICAL ENVIRONMENTAL SAMPLING LOCATIONS

LOCATION NUMBER	DESCRIPTIVE LOCATION	DIRECTION	DISTANCE (MILES)	SAMPLE TYPE	
1	Hancock Landing Road	N	1.1	D	
2	River Bank	NNE	0.8	D	
3	Discharge Area	NE	0.6	A	2
3	River Bank	NE	0.7	D	
4	River Bank	ENE	0.8	D	
5	River Bank	E	1.0	D	
6	Plant Wilson	ESE	1.1	D	
7	Simulator Building	SE	1.5	D,V,A	
8	River Road	SSE	1.1	D	
9	River Road	S	1.1	D	
10	Met Tower	SSW	0.8	A	
10	River Road	SSW	1.1	D	
11	River Road	SW	1.2	D	
12	River Road	WSW	1.1	D,A	2
13	River Road	W	1.3	D	
14	River Road	WNW	1.8	D	
15	Hancock Landing Road	NW	1.5	D,V	
16	Hancock Landing Road	NNW	1.4	D,A	
17	Savannah River Plant River Road	N	5.4	D	
18	Savannah River Plant D Area	NNE	5.0	D	
19	Savannah River Plant Road A.13	NE	4.6	D	
20	Savannah River Plant Road A.13.1	ENE	4.8	D	
21	Savannah River Plant Road A.17	E	5.3	D	
22	River Bank Downstream of Buxton Landing	ESE	5.2	D	
23	River Road	SE	4.7	D	
24	Chance Road	SSE	4.9	D	

TABLE 3.0-1 (Continued)

RADIOLOGICAL ENVIRONMENTAL SAMPLING LOCATIONS

LOCATION NUMBER	DESCRIPTIVE LOCATION	DIRECTION	DISTANCE (MILES)	SAMPLE TYPE	
25	Chance Road and Highway 23	S	5.2	D	
26	Highway 23, mile 15.5	SSW	4.6	D	
27	Highway 23, mile 17	SW	4.8	D	
28	Claybon Road	WSW	5.0	D	
29	Claxton-Lively Road	W	5.0	D	
30	Ben Hatcher Road	WNW	4.7	D	
31	River Road at Allen's Church Fork	NW	5.0	D	
32	River Bank	NNW	4.8	D	
33	Nearby Residence	SE	3.3	D	
34	Girard Elementary School	SSE	6.3	D	
35	Girard	SSE	6.6	D,A	
36	Waynesboro	WSW	15.0	D,A	
37	Substation (Waynesboro) (North Side of Road)	WSW	17.5	D,V	
38	Substation (Waynesboro) (South Side of Road)	WSW	17.5	D	
43	Employees Recreation Area	SW	2.2	D	
80	North Augusta Water Treatment Plant	NNW	23.6	W	
81	Savannah River (mile 153.1)	N	2.2	R,S,F(2,3)	
82	Savannah River (mile 151.2)	NNE	0.8	R,S(3)	
83	Savannah River (mile 150.4)	ENE	0.8	R	
84	Savannah River (mile 149.5)	ESE	1.6	R,S(3)	
85	Savannah River (mile 146.7)	ESE	5.0	R,F(2)	
87	Beaufort-Jasper Water Treatment Plant; Beaufort, S.C.	SE	84	W	
88	Cherokee Hill Water Treatment Plant; Port Wentworth, Ga.	SSE	82	W	
91	Colemans	WNW	2.8	M	2
98	W. C. Dixon Dairy	SE	9.8	M	
99	Boyceland Dairy	W	24.5	M	2

RADIOLOGICAL ENVIRONMENTAL SAMPLING LOCATIONS

TABLE NOTATION:

(1) Sample Types

- A - Airborne Radioactivity
- D - Direct Radiation
- F - Fish
- M - Milk
- R - River Water
- S - River Shoreline Sediment
- W - Drinking Water (at water treatment plant)
- V - Vegetation

(2) These are approximate locations for fish sampling. It is generally necessary to cover a stretch of river up to five miles to obtain an adequate fish sample.

(3) These are approximate locations for sediment sampling. High water may sometimes cause an otherwise suitable location for sediment sampling to be unavailable.

FIGURE 3.0-1

Terrestrial Stations Near Site Boundary

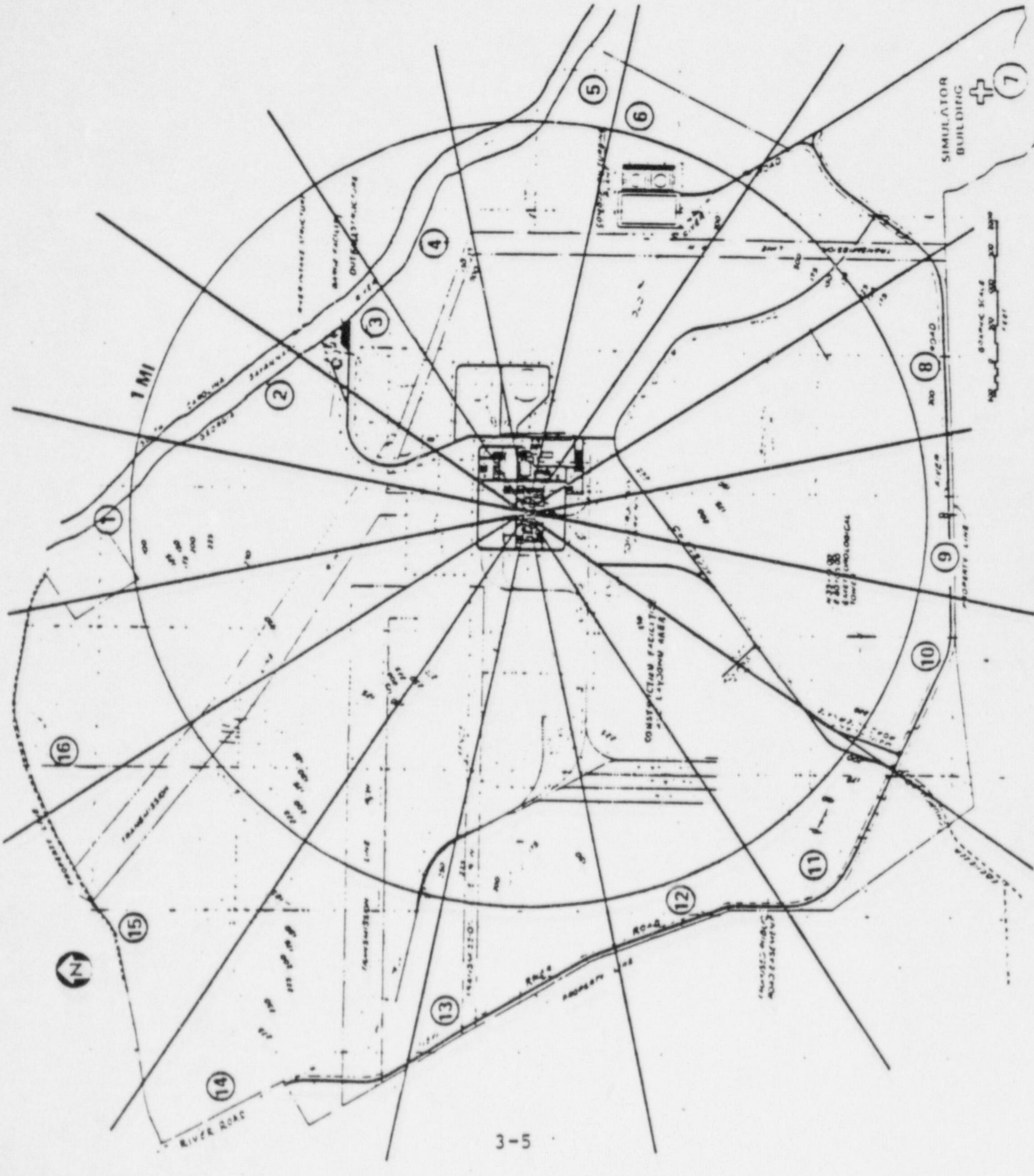
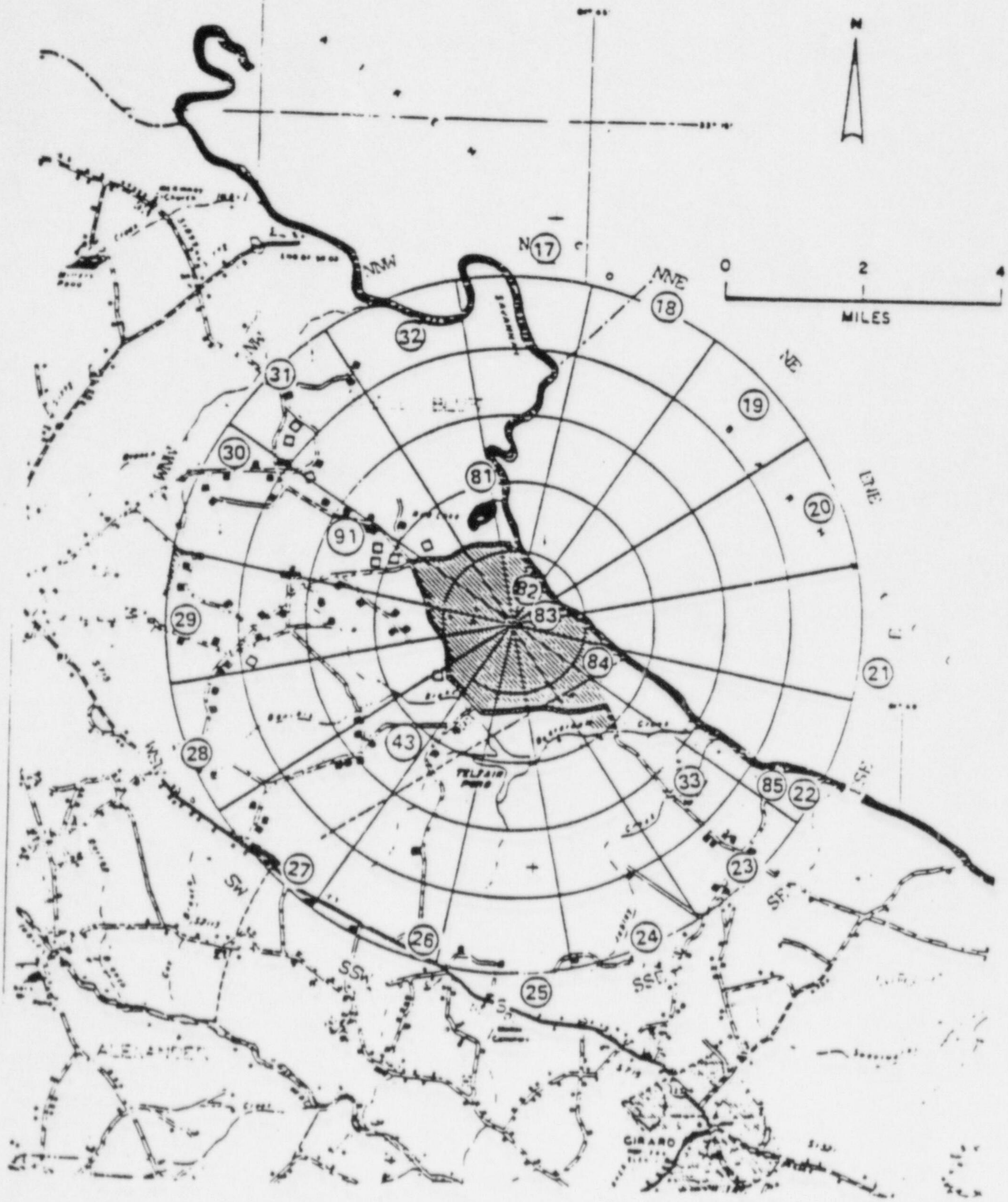


FIGURE 3.0-2

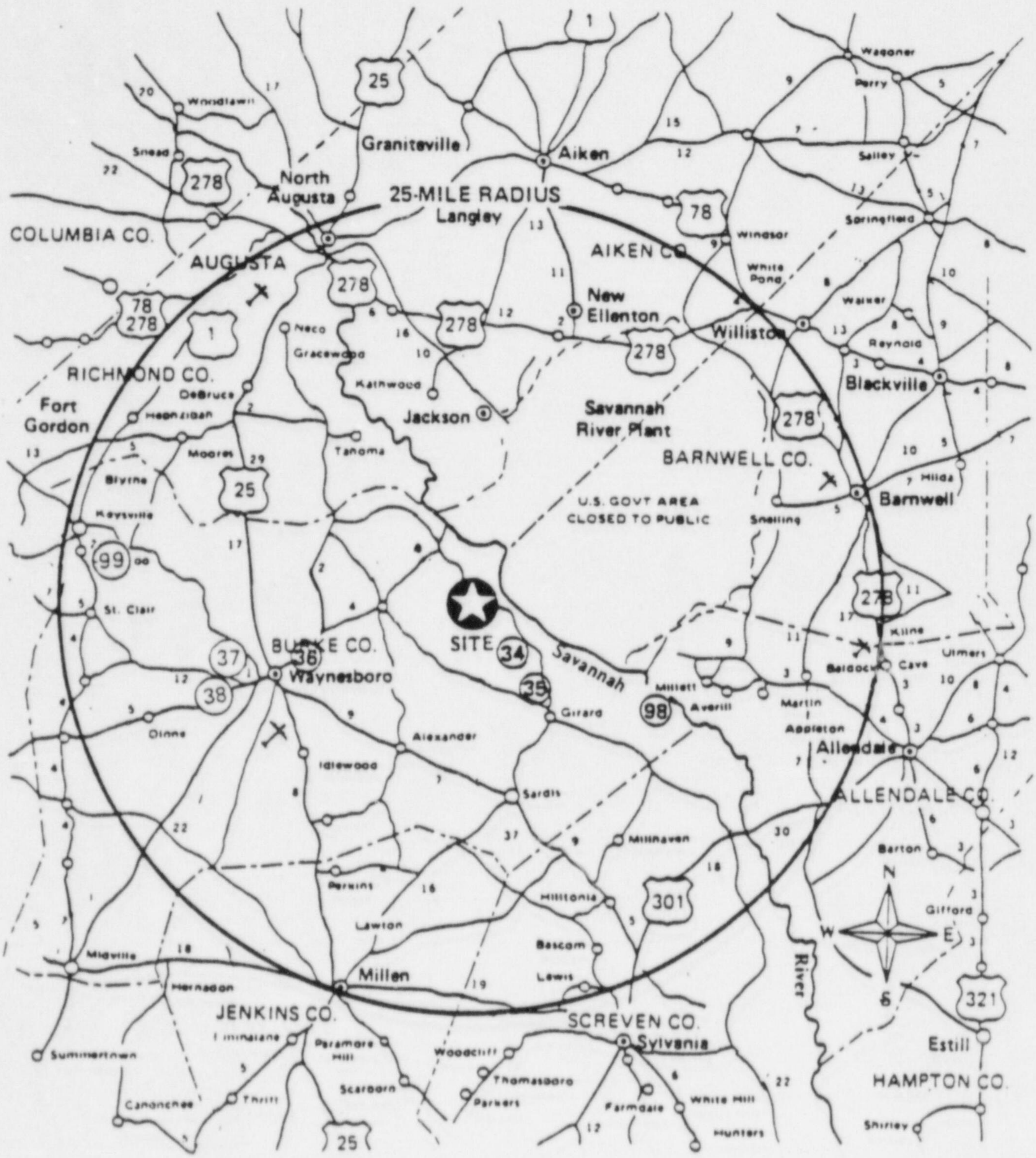
Terrestrial Stations beyond Site Boundary out to Approximately Five Miles and Aquatic Stations



2

FIGURE 3.0-3

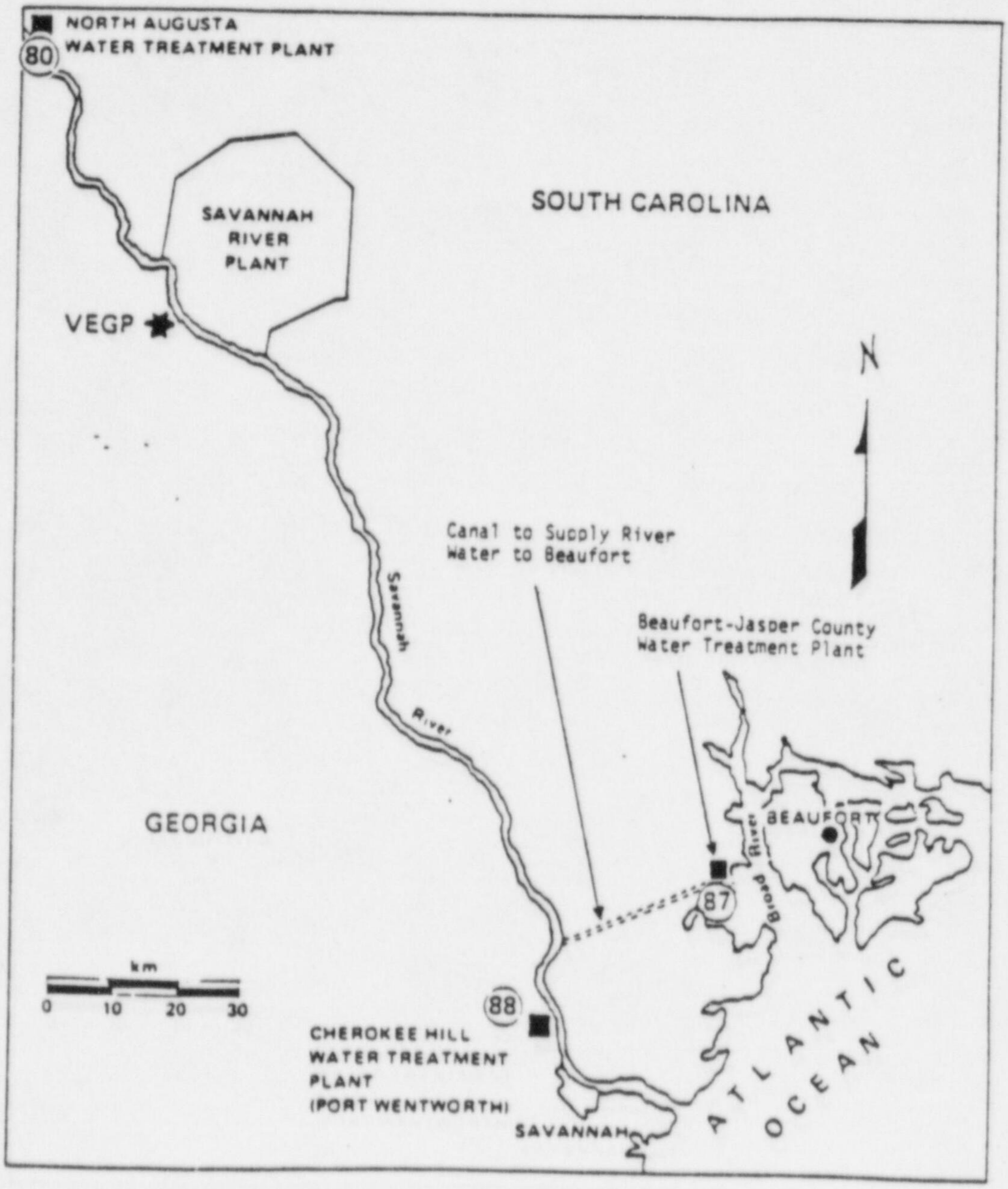
Terrestrial Stations beyond Five Miles



2

FIGURE 3.0-4

Drinking Water Stations



SECTION 4.0

TOTAL DOSE DETERMINATIONS

Technical Specification 3.11.4 addresses the requirements of 40 CFR 190 and 10 CFR 20.105(c), which pertain to limitation of annual doses to a member of the public from nuclear fuel cycle facilities. No other nuclear fuel cycle facility is located within five miles of Plant Vogtle. Therefore, it is only necessary to include doses from the two Plant Vogtle units in the total dose determinations.

For the purpose of implementing Technical Specification 3.11.4, total dose determinations will be made by calculating doses due to liquid effluents in accordance with Technical Specification 3.11.1.2; by calculating doses due to gaseous effluents in accordance with 3.11.2.3; and by combining direct radiation doses based on direct radiation measurements, or calculations, with these effluent doses to determine total dose to a real individual. Methodology for calculating individual doses due to liquid effluents was presented in Subsection 1.2. Methodology for calculating individual doses due to gaseous effluents was presented in Subsection 2.2.2.2.

SECTION 5.0

POTENTIAL DOSES TO MEMBERS OF THE PUBLIC DUE TO THEIR ACTIVITIES INSIDE THE SITE BOUNDARY

For the purpose of implementing Technical Specification 6.8.1.4, an assessment of potential doses to MEMBERS OF THE PUBLIC due to their activities within the SITE BOUNDARY will be performed if circumstances have changed such that any of the limits of Technical Specifications 3.11.2.2 or 3.11.2.3 are exceeded. The locations of interest within the SITE BOUNDARY at Plant Vogtle are the Visitors Center and Plant Wilson. (Plant Wilson is owned and operated by Georgia Power Company, but individuals working at Plant Wilson are not directly associated with Plant Vogtle. Therefore, those individuals are considered in this dose determination as a precautionary measure.) 2

The annual average atmospheric dispersion and deposition values for these two locations and the expected occupancy factors, by an individual during the year, are as follows:

Location	X/Q(sec/m^3)	D/Q(m^{-2})	Estimated Occupancy Factor (by an individual during a year)
Visitors Center	2.53E-5	1.76E-8	0.00046 (4 hours)
Plant Wilson	5.37E-6	3.90E-9	0.228 (2000 hours) 2

In the event that any limit of Technical Specification 3.11.2.2 is exceeded, an assessment will be performed considering direct radiation dose to an individual resulting from submersion in the plume. This assessment will take into consideration the annual average dispersion parameters and the estimated occupancy factor stated above, or a more precise value if available, for the locations of interest.

In the event that any limit of Technical Specification 3.11.2.3 is exceeded, an assessment will be performed considering the dose to an individual due to inhalation of airborne radioactive materials suspended in the plume and due to direct radiation from radioactive materials deposited on the ground. This assessment will take into consideration the annual average dispersion and deposition parameters and the estimated occupancy factors stated above, or a more precise value if available for the location of interest.

If none of the limits discussed above is exceeded,
potential annual doses to an individual at the Visitors Center
are not expected to exceed 0.05 mrem to an organ due to
inhalation and ground-plane or 0.004 mrem to the total body due 2
to direct radiation from the plume. Likewise, potential doses to
an individual at Plant Wilson are not expected to exceed 5.20
mrem to an organ due to inhalation and ground-plane or 0.42 mrem 2
to the total body due to direct radiation from the plume.

These values are based on annual average dispersion and deposition parameters and the estimated occupancy factors stated above. The occupancy factor for the Visitors Center is based on anticipated usage; the occupancy factor for Plant Wilson is based on a standard forty hour work week, assuming that an individual is assigned to the facility for the entire year.

SECTION 6.0

INTERLABORATORY COMPARISON PROGRAM

For the purpose of implementing Technical Specification 3.12.3, Plant Vogtle will participate in the Environmental Protection Agency's Environmental Radioactivity Laboratory Intercomparison Studies (Crosscheck) Program conducted by the Environmental Monitoring and Support Laboratory in Las Vegas, Nevada or in an equivalent program which has been approved by the Nuclear Regulatory Commission.

Those sample media and analyses specified in Technical Specification Table 3.12-1 and available in the EPA Intercomparison Studies Program will be included in the crosscheck program for Plant Vogtle. For analyses performed by a contract vendor, the crosscheck analyses will be performed by that vendor. Participation in the crosscheck program is as follows:

Sample Medium	Analyses Performed
Air filters	Gross beta; gamma isotopics
Water	H-3; gross beta; gamma isotopics
Milk	I-131; gamma isotopics

A summary showing the results obtained from Plant Vogtle's participation in the crosscheck program will be included in the Annual Radiological Environmental Surveillance Report as required by Technical Specification 4.12.3.

Georgia Power Company
333 Piedmont Avenue
Atlanta, Georgia 30308
Telephone 404 526-6526

Mailing Address:
Post Office Box 4545
Atlanta, Georgia 30302

Georgia Power
the southern electric system

L. T. Gucwa
Manager Nuclear Safety
and Licensing

SL-2423
0259m

April 28, 1987

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

NRC DOCKETS 50-424, 50-425
OPERATING LICENSE NPF-68, CONSTRUCTION PERMIT CPPR-109
VOGTLE ELECTRIC GENERATING PLANT UNITS 1 AND 2
OFF-SITE DOSE CALCULATION MANUAL

Gentlemen:

Enclosed for your information and use is Revision 3 of the Vogtle Off-Site Dose Calculation Manual (ODCM). This revision incorporates the changes submitted by letters dated December 16, 1986, January 5, 1987, and January 8, 1987, thus satisfying the conditions of the NRC staff's approval of the ODCM.

Please contact this office if you have any questions.

Sincerely,

for L. T. Gucwa

JH/lm

Enclosure

A009
1/1

Georgia Power

U. S. Nuclear Regulatory Commission
April 28, 1987
Page Two

c: Georgia Power Company
Mr. R. E. Conway (w/o)
Mr. J. P. O'Reilly (w/o)
Mr. G. Bockhold, Jr. (w/o)
Mr. J. F. D'Amico (w/o)
Mr. C. W. Hayes (w/o)
GO-NORMS (w/o)

Southern Company Services
Mr. R. A. Thomas (w/o)
Mr. J. A. Bailey (w/o)

Shaw, Pittman, Potts & Trowbridge
Mr. B. W. Churchill, Attorney-at-Law (w/o)

Troutman, Sanders, Lockerman & Ashmore
Mr. A. H. Domby, Attorney-at-Law (w/o)

U. S. Nuclear Regulatory Commission
Dr. J. N. Grace, Regional Administrator (w)
Ms. M. A. Miller, Licensing Project Manager, NRR (2 copies, w)
Mr. J. F. Rogge, Senior Resident Inspector-Operations, Vogtle (w)

Georgians Against Nuclear Energy
Mr. D. Feig (w/o)
Ms. C. Stangler (w/o)

0259m

700775