ENCLOSURE 4

VOGTLE ELECTRIC GENERATING PLANT
REQUEST FOR TECHNICAL SPECIFICATION CHANGES
RESPONSE TO GENERIC LETTER 89-01
RADIOLOGICAL EFFLUENT TECHNICAL SPECIFICATION CHANGES

<u>OFFSITE DOSE CALCULATION MANUAL</u>

OFFSITE DOSE CALCULATION MANUAL

FOR

GEORGIA POWER COMPANY

VOGTLE ELECTRIC GENERATING PLANT

DRAFT 1991

INTRODUCTION

The Offsite Dose Calculation Manual is a supporting document of the 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. It includes a list and maps indicating specific sample locations for the radiological environmental monitoring program. It also includes the radioactive effluent controls and radiological environmental monitoring programs required by section 6.7.4 of the Technical Specifications and descriptions of the information that should be included in the Annual Radiological Environmental Surveillance and Semiannual Radioactive Effluent Release Reports required by specifications 6.8.1.3 and 6.8.1.4.

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.

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VOGTLE ELECTRIC GENERATING PLANT
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1.0 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. The 5000-gallon waste monitor tanks are recirculated for a minimum of 30 minutes, and the 20,000-gallon waste monitor tanks are recirculated for a minimum of 45 minutes. This mixing method assures that a representative sample can be taken from the tank. 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 makeup water bypass line.

Although no significant quantities of radioactivity are expected in the nuclear service cooling water, the steam generator blowdown processing system or the turbine building drain system, these effluent pathways are monitored as a precautionary measure. The monitors serving the latter two effluent pathways provide for automatic termination of release from these systems in the event radioactivity is detected above predetermined levels. These two systems discharge to the waste water-retention basin. Sampling and analysis of releases via these effluent pathways must be sufficient to assure the dose limits specified in subsection 1.5.2 are not exceeded.

Section 1.0 of the ODCM describes the methodology for calculating monitor setpoints and 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 1.6-1 and 1.6-2. Liquid discharge pathways are shown in figure 1.6-3.

1.1 LIQUID EFFLUENT MONITOR SETPOINTS

Liquid monitor setpoint values calculated in accordance with the methodology presented in this section 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, μCi/ml. 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 system's 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, and the turbine building drain 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.

1.1.1 Liquid Waste Processing System Effluent Monitor (1(2)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 subsection 1.5.1; setpoint requirements are specified in subsection 1.5.4. To meet these specifications, the alarm/trip setpoint for this liquid effluent monitor is set to assure that the following equation is satisfied:

$$\frac{cf}{F + f} \leq C_{MPC} \tag{1}$$

where:

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

c = the setpoint, in μCi/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 proportional to the effluent flowrate, f, and directly proportional to the dilution stream flowrate, 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 flowrate at the location of the radioactivity monitor, in volume per unit time, and in the same units as F, below.

F = the dilution stream flowrate which can be assured prior to the release point to the 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 1.6-3.)

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 makeup line. The two major sources for dilution are the turbine plant cooling tower blowdown and the cooling tower makeup bypass line. A predetermined dilution flowrate 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 flowrate, f, the dilution flowrate, 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 flowrate which can be assured for the duration of the release, designated as F_a, by calculating the MPC fraction for the radionuclide mixture, the maximum permissible effluent flowrate, f_m, and the radioactivity monitor setpoint, c.

In order to facilitate effluent release control and accountability, liquid releases normally should be controlled administratively such that only one waste monitor tank per unit is released at a time. Paragraph 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 flowrates at which the tanks are released. The setpoint methodology for this situation is presented in paragraph 1.1.1.2.

1.1.1.1 Monitor Setpoint Calculation Methodology When One Waste Monitor Tank per Unit Is To Be Released at a Time

Step 1

The radionuclide concentrations for the waste monitor tank planned for release are determined in accordance with subsection 1.5.1. 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 subsection 1.5.1 as appropriate.

To assure sample analyses are based on samples that 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 demonstrated to achieve mixing sufficient to allow representative sampling.

Step 2

Measured radionuclide concentrations are used to calculate maximum permissible concentration (MPC) fractions. The MPC fractions are used along with a safety factor to calculate a required dilution factor, which is the ratio of dilution flowrate to monitor tank discharge flowrate which are required to assure the limiting concentrations given in 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 = the 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} μCi/ml total activity. For gross alpha the maximum permissible concentration shall be 3×10^{-8} μCi/ml. If specific alpha-emitting radionuclides are measured, the MPC for the specific radionuclide(s) shall be used.

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 flowrate which will be assured during the period of the release, which is designated as F_d. For Plant Vogtle the flowrate which can be assured is the value selected as the setpoint for the dilution stream flowrate measurement device. Since the value selected as the setpoint for the dilution stream flowrate measurement device is the dilution stream flowrate 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 flowrate, F_d, by an allocation factor, AF, to obtain a unit-specific assured dilution stream flowrate, 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 flowrate 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 flowrate. However, in order to maintain individual doses due to radioactivity in liquids released to unrestricted areas as low as reasonably achievable (ALARA), no releases from the liquid waste processing system should be made if assured dilution stream flowrate, F_d, is less than 5000 gpm.

Step 4

For the case RDF > 1, calculate the maximum permissible waste monitor tank discharge flowrate, 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 flowrate is actually limited by pump design discharge capacity which is 100 gpm (maximum). When calculated maximum permissible release flowrates 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 subsection 1.5.2 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:

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

where:

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

f_r = the flowrate of the effluent stream(s) containing the radioactivity.

If RDF $\leq$ 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 μCi/ml, as follows:

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

where:

A = the 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:

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

NOTE: ADF is the assured dilution factor:

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

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

If A ≥ 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 flowrate, 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 setpoint thus calculated is in the units μCi/ml. The monitor actually measures counts per minute, subtracts a predetermined background count rate, and then multiplies by a calibration factor to convert the counts per minute to μCi/ml.

Calibration of the monitors by the manufacturer and Georgia Power Company utilized NBS traceable liquid solutions in the exact geometry of each production monitor over a gamma-ray energy 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 predischarge sample results from the laboratory gamma-ray spectrometer system.

The mix-dependent calibration factor will be used as the gain factor in the PERMS monitor or used to modify the calculated base monitor setpoint so that the default calibration factor can be left in the PERMS monitor.

The monitor setpoints determined in accordance with the methodology described above establish the upper bound for a particular monitor setpoint. Monitor setpoints may be established at lower values, if desired.

1.1.1 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 paragraph 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:

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

where:

V_1 = the volume of liquid in tank containing greater quantity (referred to throughout this subsection as first tank.)

V_2 = the volume of liquid in tank containing lesser quantity (referred to throughout this subsection as second tank).

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

$(\sum_g C_g)_2$ = the 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 paragraph 1.1.1.1. Using these values calculate an effective required dilution factor, (RDF)e, for the two tanks considered together as follows:

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

where:

V_1 = the volume of first tank.

V_2 = the volume of second tank.

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

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

Step 3

Determine the dilution stream flowrate in accordance with step 3 of paragraph 1.1.1.1.

Step 4

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

$$f_2 = \frac{f_1 V_2}{V_1} \tag{11}$$

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

$$f_c = f_1 + f_2 \tag{12}$$

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

Then, compare the combined release flowrate, f_c, with the maximum permissible combined release flowrate, f_m. If $f_m > f_c$, the release may be made under the assumed conditions. If $f_m < f_c$, the two release flowrates may be throttled, maintaining the same ratio of f_2 to f_1, as determined earlier. If it is impractical to throttle the release flowrates 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 paragraph 1.1.1.1.)

Step 5

Calculate the monitor setpoint in accordance with step 5 of paragraph 1.1.1.1 with the following substitutions:

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

$$RDF = (RDF)_e;$$

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

Observe the same limiting conditions discussed in step 5 of paragraph 1.1.1.1.

1.1.2 Steam Generator Blowdown Effluent Radioactivity Monitor (1(2)RE-0021); Turbine Building Drain Effluent Radioactivity Monitor (1(2)RE-0848); (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. 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 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 two 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, both 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 analysis must be sufficient to assure that the dose limits specified in subsection 1.5.2 are not exceeded.

1.1.3 Nuclear Service Cooling Water System Effluent Radioactivity Monitor (1(2)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 the dose limits specified in subsection 1.5.2 are not exceeded.

1.2 DOSE CALCULATION FOR LIQUID EFFLUENTS

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 subsection 1.5.2 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 subsection 1.5.2 as follows:

$$D_\tau = \sum_i A_{i\tau} \sum_{\ell=1}^{m} \Delta t_\ell \, C_{i\ell} \, F_\ell \qquad (13)$$

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:

$\sum_{\ell=1}^{m} \Delta t_\ell$ in mrem (Reference 1).

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

$C_{i\ell}$ = the average concentration of radionuclide i, in undiluted liquid effluent during time period Δt_ℓ from any liquid release, in μCi/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 flowrate into the river times Z.

NOTE: If simultaneous releases from both units occur, the dilution stream flowrate 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 = (average undiluted liquid waste flow) ÷ ((average dilution stream flow during the period of release of radioactivity) x Z) (14)

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

Z = the 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, paragraph 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/h-μCi.

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

K_o = the units conversion factor 1.14 x 10^5, determined by:

$$10^6 \frac{pCi}{\mu Ci} \times 10^3 \frac{ml}{l} \div 8760 \frac{h}{year}$$

U_w = the adult drinking-water consumption (730 liters/year; Reference 3, table E-5).

D_w = the 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 (h^{-1}).

t_w = the transit time from release to receptor for water consumption (48 h; Reference 3, section A.2; Reference 10).

U_f = the adult fish consumption (21 kg/year; Reference 3, table E-5).

BF_i = the bioaccumulation factor for radionuclide i, in fresh water fish, in pCi/kg/pCi/l. (See table 1.2-1; Reference 3, table A-1; Reference 2 for Ag; Reference 14 for P.)

t_f = the transit time from release to receptor for fish consumption (24 h; Reference 3, section A.2).

$DF_{i\tau}$ = the 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
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	5.5E 02
Mo	1.0E 01
Tc	1.5E 01
Ru	1.0E 01
Rh	1.0E 01
Ag	2.3E 00
Sb	2.0E 02
Te	4.0E 02
I	1.5E 01
Cs	2.0E 03
Ba	4.0E 00
La	2.5E 01
Ce	1.0E 00
Pr	2.5E 01
Nd	2.5E 01
W	1.2E 03
Np	1.0E 01

*Reference 3, Table A-1; Reference 2 for Ag; Reference 14 for P; and Reference 17 for Nb and Sb.

Table 1.2-2 (SHEET 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.

Table 1.2-2 (SHEET 2 OF 3)

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
Sb-124	2.81E-06	5.3E-08	1.11E-06	6.79E-09	No Data	2.18E-06	7.95E-05**
Sb-125	2.23E-06	2.4E-08	4.48E-07	1.98E-09	No Data	2.33E-04	1.97E-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-[illegible]	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	0.00E+00	8.67E-09	1.46E-08	4.18E-05
Ba-141	4.71E-08	3.56E-11	1.59E-09	0.00E+00	3.31E-11	2.02E-11	2.22E-17
Ba-142	2.13E-08	2.19E-11	1.34E-09	0.00E+00	1.85E-11	1.24E-11	3.00E-26

* Reference 3, Table E-11.
**Reference 17.

Table 1.2-2 (SHEET 3 OF 3)

ADULT INGESTION DOSE FACTORS*
(mrem per pCi ingested)

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
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
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 (SHEET 1 OF 2)

SITE-RELATED INGESTION DOSE FACTORS, A_{io}
(FOR FRESHWATER FISH AND DRINKING WATER CONSUMPTION)*
(mrem/h per μCi/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	1.32E+06	8.22E+04	5.11E+04	0.00E+00	0.00E+00	0.00E+00	1.49E+05
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	1.74E-01	3.09E-02	0.00E+00	2.21E-01	0.00E+00	5.55E+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	1.72E-01	2.23E-02	1.02E-02	0.00E+00	0.00E+00	0.00E+00	5.67E-01
Cu-64	0.00E+00	2.76E+00	1.29E+00	0.00E+00	6.95E+00	0.00E+00	2.35E+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	7.91E-07	1.51E-06	1.05E-07	0.00E+00	9.83E-07	0.00E+00	2.27E-07
Br-83	0.00E+00	0.00E+00	3.84E-02	0.00E+00	0.00E+00	0.00E+00	5.53E-02
Br-84	0.00E+00	0.00E+00	1.23E-12	0.00E+00	0.00E+00	0.00E+00	9.67E-18
Br-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-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	1.30E-22	6.90E-23	0.00E+00	0.00E+00	0.00E+00	1.80E-33
Rb-89	0.00E+00	1.64E-26	1.38E-26	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	2.49E+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	7.25E+01	0.00E+00	2.93E+00	0.00E+00	0.00E+00	0.00E+00	3.45E+02
Sr-92	3.34E-01	0.00E+00	1.44E-02	0.00E+00	0.00E+00	0.00E+00	6.61E+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	1.04E-11	0.00E+00	4.03E-13	0.00E+00	0.00E+00	0.00E+00	3.06E-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	4.61E-04	0.00E+00	1.35E-05	0.00E+00	0.00E+00	0.00E+00	8.08E+00
Y-93	3.19E-02	0.00E+00	8.82E-04	0.00E+00	0.00E+00	0.00E+00	1.01E+03
Zr-95	5.47E-01	1.75E-01	1.19E-01	0.00E+00	2.75E-01	0.00E+00	5.56E+02
Zr-97	7.40E-03	1.49E-03	6.83E-04	0.00E+00	2.26E-03	0.00E+00	4.63E+02
Nb-95	8.16E+00	4.54E+00	2.44E+00	0.00E+00	4.48E+00	0.00E+00	2.76E+04
Sb-124	1.36E+03	2.56E+01	5.43E+02	3.28E+00	0.00E+00	1.05E+03	3.88E+04
Sb-125	1.09E+03	1.16E+01	2.19E+02	9.57E-01	0.00E+00	1.13E+05	9.63E+03
Mo-99	0.00E+00	1.07E+02	2.04E+01	0.00E+00	2.43E+02	0.00E+00	2.49E+02
Tc-99M	5.70E-04	1.61E-03	2.05E-02	0.00E+00	2.45E-02	7.89E-04	9.53E-01
Tc-101	2.75E-33	3.96E-33	3.89E-32	0.00E+00	7.14E-32	2.03E-33	0.00E+00

*Calculated using Equation (15). When "no data" is reported for dose factors for specific radionuclide-organ combinations in Reference 3, site-related dose factors are presented as zero in this table.

Table 1.2-? (SHEET 2 OF 2)

SITE-RELATED INGESTION DOSE FACTORS, A
(FOR FRESHWATER FISH AND DRINKING WATER CONSUMPTION)*
(mrem/h per μCi/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	8.79E-03	0.00E+00	3.47E-03	0.00E+00	1.14E-01	0.00E+00	5.38E+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	9.56E+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	1.78E+01	6.40E+00	3.85E+00	1.32E+01	7.26E+01	0.00E+00	1.41E+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	1.78E-05	6.70E-06	4.34E-06	1.37E-05	7.50E-05	0.00E+00	1.35E-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	8.71E-17	3.64E-17	2.75E-17	7.16E-17	3.82E-16	0.00E+00	1.23E-17
Te-132	1.97E+03	1.27E+03	1.19E+03	1.41E+03	1.23E+04	0.00E+00	6.02E+04
I-130	7.60E+00	2.24E+01	8.85E+00	1.90E+03	3.50E+01	0.00E+00	1.93E+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	5.28E-03	1.41E-02	4.94E-03	4.94E-01	2.25E-02	0.00E+00	2.65E-03
I-133	2.59E+01	4.51E+01	1.37E+01	6.62E+03	7.86E+01	0.00E+00	4.05E+01
I-134	2.19E-08	5.96E-08	2.13E-08	1.03E-06	9.48E-08	0.00E+00	5.19E-11
I-135	1.31E+00	3.44E+00	1.27E+00	2.27E+02	5.52E+00	0.00E+00	3.89E+00
Cs-134	2.98E+05	7.10E+05	5.80E+05	0.00E+00	2.30E+05	7.62E+04	1.24E+04
Cs-136	2.96E+04	1.17E+05	8.42E+04	0.00E+00	6.51E+04	8.92E+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	9.18E-12	1.81E-11	8.98E-1[illegible]	0.00E+00	1.33E-11	1.32E-12	7.73E-17
Ba-139	5.66E-06	4.03E-09	1.66E-[illegible]	0.00E+00	3.77E-09	2.29E-09	1.00E-05
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	8.57E-25	6.47E-28	2.89E-26	0.00E+00	6.02E-28	3.67E-28	4.04E-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	4.08E+03
La-142	2.19E-07	9.98E-08	2.49E-08	0.00E+00	0.00E+00	0.00E+00	7.29E-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	1.50E-28	6.22E-29	7.61E-30	0.00E+00	3.51E-29	0.00E+00	2.15E-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	1.23E+02	4.31E+01	0.00E+00	0.00E+00	0.00E+00	4.04E+04
Np-239	2.81E-02	2.76E-03	1.52E-03	0.00E+00	8.61E-03	0.00E+00	5.67E+02

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

1.3 DOSE PROJECTIONS FOR LIQUID EFFLUENTS

1.3.1 Thirty-One-Day Dose Projections

In order to meet the requirements of subsection 1.5.3, which pertains to operation of the liquid radwaste treatment systems, dose projections must be made at least once per 31 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:

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

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

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.

$D_{o(c)}$ = 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:

$$D_{tb(prj)} = \left[\frac{D_{tb(c)}}{t} \times 31 \right] + D_{PA} \quad (18)$$

$$D_{o(prj)} = \left[\frac{D_{o(c)}}{t} \times 31 \right] + D_{PA} \quad (19)$$

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 section 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	=	the 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 h-μCi.	1.2
ANALOG CHANNEL OPERATIONAL TEST(ACOT)		An Analog Channel Operational Test shall be the injection of a simulated signal into the channel as close to the sensor as practicable to verify operability of alarm, interlock, and/or trip functions. The Analog Channel Operational Test shall include adjustments, as necessary, of the alarm, interlock, and/or trip setpoints, such that the setpoints are within the required range and accuracy.	1.5
ADF	=	the assured dilution factor, which is the ratio of unit-specific assured dilution flowrate to anticipated effluent release rate (unitless).	1.1.1.1
BF_i	=	the bioaccumulation factor for nuclide i, in freshwater fish, pCi/kg per pCi/l, from table 1.2-1.	1.2

Term	Definition	Section of Initial Use
BATCH RELEASE	A batch release is the discharge of liquid wastes of a discrete volume. Prior to sampling for analyses, each batch shall be isolated and then thoroughly mixed by a method described in the ODCM to assure representative sampling.	1.5
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_{α}	= the effluent concentration of alpha-emitting nuclides observed by gross alpha analysis of the monthly composite sample, in μCi/ml.	1.1.1
C_f	= the concentration of Fe-55 in liquid wastes as observed in the quarterly composite sample, in μCi/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 μCi/ml.	1.1.1
C_i	= the concentration of nuclide i as determined by the analysis of the waste sample, in μCi/ml.	1.1.1
$C_{i\ell}$	= the average concentration of radionuclide i, in undiluted liquid effluent during time period Δt_i, for a release, in μCi/ml.	1.2
C_{MPC}	= the effluent concentration limit (Technical Specification 3.11.1.1) implementing 10 CFR 20 for the site, in μCi/ml.	1.1.1

Term		Definition	Section of Initial Use
C_s	=	the concentration of Sr-89 and Sr-90 in liquid wastes as determined by analysis of the QUARTERLY composite sample, in μCi/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 μCi/ml.	1.1.1

CHANNEL CALIBRATION

A channel calibration shall be the adjustment, as necessary, of the channel, such that it responds within the required range and accuracy to known values of input. The channel calibration shall encompass the entire channel including the sensors and alarm, interlock, and/or trip functions and may be performed by any series of sequential, overlapping, or total channel steps, such that the entire channel is calibrated. 1.5

CHANNEL CHECK

A channel check shall be the qualitative assessment of channel behavior during operation by observation. This determination shall include, where possible, comparison of the channel indication and/or status with other indications and/or status derived from independent instrument channels measuring the same parameter. 1.5

COMPOSITE SAMPLE

A composite sample is one in which the quantity of liquid sampled is proportional to the quantity of liquid waste discharged and in which the method of sampling employed results in a specimen that is representative of the liquids released. 1.5

Term	Definition	Section of Initial Use
CONTINUOUS RELEASE	A continuous release is the discharge of liquid wastes of a nondiscrete volume, e.g., from a volume of a system that has an input flow during the continuous release.	1.5
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	= the 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 flowrate 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

Term	Definition	Section of Initial Use

FREQUENCY NOTATION

The f· quency notation specified for the performance of surveillance requirements shall correspond to the intervals defined below. 1.5

NOTATION	FREQUENCY
S	At least once per 12 hours.
D	At least once ɩer 24 hours.
W	At least once per 7 days.
M	At least once per 31 days.
Q	At least once per 92 days.
SA	At least once per 184 days.
R	At least once per 18 months.
S/U	Prior to each reactor startup.
N.A.	Not applicable.
P	Completed prior to each release.

F_d = the flowrate of the dilution stream which can be assured during the time of release in gpm. This is also the setpoint for the dilution stream flowrate measurement device. 1.1.1

F_{du} = the unit-specific assured flowrate of the dilution stream used as the basis for setpoint calculations, in gpm. 1.1.1

F_ℓ = the near-field average dilution factor for $C_{i\ell}$ during any liquid effluent release (unitless). 1.2

f_a = the anticipated effluent flowrate in gpm. 1.1.1

Term		Definition	Section Of Initial Use
f_m	=	the maximum permissible effluent flowrate in gpm.	1.1.1
K_c	=	1.14×10^5, units conversion factor, which converts μCi to pCi, liters to ml, and hours to year.	1.2

LOWER LIMIT OF DETECTION

The principal gamma emitters for which the lower limit of detection (LLD) specification applies include the following radionuclides: Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, and Ce-141. Ce-144 shall also be measured, but with an LLD of 5×10^{-6}. This list does not mean that only these nuclides are to be considered. Other gamma peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the semiannual Radioactive Effluent Release Report pursuant to Technical Specification 6.8.1.4.

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

Term	Definition	Section Of Initial Use

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

$$LLD = \frac{4.66\ s_b}{E \bullet V \bullet 2.22 \times 10^6 \bullet Y \bullet \exp(-\lambda \Delta t)}$$

where:

LLD = the *a priori* lower limit of detection (microCurie per unit mass or volume).

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

E = the counting efficiency (counts per disintegration).

V = the sample size (units of mass or volume).

2.22×10^6 = the number of disintegrations per minute per microCurie.

Y = the fractional radiochemical yield, when applicable.

λ = the radioactive decay constant for the particular radionuclide (sec^{-1}).

Δt = the elapsed time between the midpoint of sample collection and the time of counting (sec).

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

It should be recognized that the LLD is defined as an *a priori* (before the fact) limit representing the capability of a measurement system and not as an *a posteriori* (after the fact) limit for a particular measurement.

m = the 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-emitting radionuclides, alpha-emitting radionuclides, strontium, iron, and tritium, respectively, from 10 CFR 20, Appendix B, table II, column 2. 1.1.1

Term	Definition	Section Of Initial Use
RDF	= the required dilution factor, which is the ratio of the dilution flowrate to the effluent stream flowrate(s) which would be required to assure that the limiting concentration of 10 CFR 20, Appendix B, table II, column 2 are met at the point of discharge to the unrestricted area (unitless).	1.1.1

REPRESENTATIVE SAMPLE FOR CONTINUOUS RELEASES

To be representative of the quantities and concentrations of radioactive materials in liquid effluents, samples shall be collected continuously in proportion to the rate of flow of the effluent stream. Prior to analyses, all samples taken for the composite shall be thoroughly mixed in order for the composite sample to be representative of the effluent release. 1.5

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

SOURCE CHECK

A source check shall be the qualitative assessment of channel response when the channel sensor is exposed to a source of increased radioactivity. 1.5

t_r = the transit time from release to receptor (fish consumption), in hours. 1.2

Term		Definition	Section Of Initial Use
t_w	=	the transit time from release to receptor (drinking-water consumption), in hours.	1.2
Δt_ℓ	=	the duration of release under consideration, in hours.	1.2
U_f	=	21 kg/year, fish consumption (adult).	1.2
U_w	=	730 liters/year, water consumption (adult).	1.2
Z	=	the applicable factor when additional receiving water body dilution is considered (unitless).	1.2
λ_i	=	the decay constant for radionuclide i (h^{-1}).	1.2

1.5 LIMITS OF OPERATION

1.5.1 Concentration in Liquid Effluents

The concentration of radioactive material released in liquid effluents to unrestricted areas (see figures 3.0-1 and 3.0-2) shall be limited to the concentrations specified in 10 CFR 20, Appendix B, table II, column 2, for radionuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the concentration shall be limited to 2.00E-4 microCurie/ml total activity. This limit applies at all times for all modes of operation.

1.5.1.1 Exceeding the Limits

If the concentration of radioactive material released in liquid effluents to unrestricted areas exceeds the above limits, immediately restore the concentration to within the above limits. These limits do not affect mode changes.

1.5.1.2 Sampling and Analysis

To assure these limits are not exceeded, the following sampling and analysis program must be implemented:

1.5.1.2.1 Batch Releases. For batch waste releases from any of the six waste monitor tanks or from the drainage of a system, each batch must be sampled prior to its release and analyzed for (1) principal gamma emitters to an LLD of 5.00E-7 microCurie/ml and (2) I-131 to an LLD of 1.00E-6 microCurie/ml. These results shall be used to calculate setpoints and flowrates, per section 1.1, to assure that the concentrations at the point of release are maintained within the limits specified above. In addition, this same sample taken prior to release, shall be used to measure for dissolved and entrained gases (gamma

emitters) at least monthly. This analysis must meet an LLD of 1.00E-5 microCurie/ml. Normally, this can be combined into the same analysis for principal gamma emitters.

Also included in this sample taken prior to release, enough of the composite sample shall be set aside to prepare a monthly composite for monthly tritium analysis to an LLD of 1.00E-5 μCi/ml and monthly gross alpha analysis to an LLD of 1.00E-7 microCurie/ml. Finally, a quarterly composite shall be analyzed quarterly for Sr-89 and Sr-90 to an LLD of 5.00E-8 microCurie/ml and for Fe-55 to an LLD of 1.00E-6 microCurie/ml. These composites are prepared for each unit.

1.5.1.2.2 Continuous Releases. All liquid effluents that do not normally contain contamination but could become contaminated in the event of steam generator tube leak are discharged from the site through the waste water retention basins (WWRB). Because of the potential for contamination, a representative sample of each WWRB is collected continuously with the composite sample container being changed weekly. The WWRB will not be considered to be a release point until there is a confirmed primary to secondary release. Once a primary to secondary leak has been confirmed to occur, this composite shall be analyzed weekly for (1) principal gamma emitters to an LLD of 5.00E-7 μCi/ml and (2) I-131 to an LLD of 1.00E-6 μCi/ml. These results can be used to calculate setpoints and flowrates, per section 1.1, to assure that the concentrations at the point of release are maintained within the limits specified above. In addition, a monthly grab sample shall be taken and analyzed monthly for dissolved and entrained gases (gamma emitters) to an LLD of 1.00E-5 μCi/ml. Normally, this can be combined into the same analysis for principal gamma emitters.

Also included in this sample taken continuously, a monthly composite shall be analyzed monthly for tritium to an LLD of 1.00E-5 μCi/ml and for gross alpha to an LLD of 1.00E-7 μCi/ml. Finally, a quarterly composite shall be analyzed

quarterly for Sr-89 and Sr-90 to an LLD of 5.00E-8 μCi/ml and for Fe-55 to an LLD of 1.00E-6 μCi/ml. These composites are prepared for each unit. Once these composites begin, they shall continue until three consecutive weekly composite samples show no activity above LLD.

1.5.1.2.3 The low levels specified in 10 CFR 20 provide additional assurance that the levels of radioactive materials in bodies of water in unrestricted areas will result in exposures within (1) the section II.A, design objectives, Appendix I, 10 CFR 50, to a member of the public and (2) the limits of 10 CFR 20.106(e) to the population. The concentration limit for dissolved or entrained noble gases is based upon the assumption that Xe-135 is the controlling radioisotope, and its MPC in air (submersion) was converted to an equivalent concentration in water using the methods described in International Commission on Radiological Protection (ICRP) Publication 2.

The specification applies to the release of radioactive materials in liquid effluents from all units at the site.

The required detection capabilities for radioactive materials in liquid waste samples are tabulated in terms of the LLD's. Detailed discussion of the LLD and other detection limits can be found in HASL Procedures Manual, HASL-300 (revised annually), L. A. Currie, "Limits for Qualitative Detection and Quantitative Determination - Application to Radiochemistry," Anal. Chem. 40, 586-93, 1968, and J. K. Hartwell, "Detection Limits for Radioanalytical Counting Techniques," Atlantic Richfield Hanford Company Report ARH-SA-215, June 1975.

Composite samples are sent to off-site labs at the plant's discretion; in this case, the date the sample is mailed via the warehouse is the date used to sign off the surveillance.

1.5.2 Dose Due to Liquid Effluents

The dose or dose commitment to a member of the public from radioactive materials in liquid effluents released from each unit to unrestricted areas (see figure 3.0-1 and 3.0-2) shall be limited (1) during any calendar quarter

to less than or equal to 1.5 mrems to the whole body and to less than or equal to 5 mrems to any organ and (2) during any calendar year to less than or equal to 3 mrems to the whole body and to less than or equal to 10 mrems to any organ. This limit applies at all times for all modes of operation.

1.5.2.1 Calculated Dose That Exceeds Limits

If the calculated dose from the release of radioactive materials in liquid effluents exceeds any of the above limits, prepare and submit to the NRC within 30 days, pursuant to Technical Specification 6.8.2, a special report that (1) identifies the cause(s) for exceeding the limit(s) and (2) defines the corrective action(s) that have been taken to reduce the releases and the proposed corrective actions to be taken to assure that subsequent releases will be in compliance with the above limits. These limits do not affect mode changes.

1.5.2.2 Requirements for Calculations

To assure that these limits are not exceeded, the cumulative dose contributions from liquid effluents for the current calendar quarter and the current calendar year shall be determined in accordance with subsection 1.3.1 at least once per 31 days.

1.5.2.3 Bases for The Limits

These limits are provided to implement the requirements of sections II.A, III.A, and IV.A, Appendix I, 10 CFR 50. Also for fresh water sites with drinking water supplies that can be potentially affected by plant operations, these is reasonable assurance that the operation of the facility will not result in radionuclide concentrations that are in excess of the requirements of 40 CFR 141, in the finished drinking water. The dose calculation methodology and parameters in this ODCM implement the Appendix I, section III.A requirements that conformance with the Appendix I guides be shown by

calculational procedures based on models and data, such that the actual exposure to a member of the public through appropriate pathways is unlikely to be substantially underestimated. The equations specified in this ODCM for calculating the doses that are due to the actual release rates of radioactive materials in liquid effluents are consistent with the methodology provided in Regulatory Guide 1.109 and 1.113.

This specification applies to the release of radioactive materials in liquid effluents from each unit at the site. When shared radwaste treatment systems are used by more than one unit at the site, the wastes from all units are mixed for shared treatment. By such mixing, the effluent releases cannot accurately be ascribed to a specific unit. An estimate should be made of the contributions from each unit based on input conditions, e.g., flowrates and radioactivity concentrations, or, if not practicable, the treated effluent releases may be allocated equally to each of the radioactive waste-producing units sharing the radwaste treatment system.

The laundry and hot shower tank liquids are common to both units. The recycle holdup tanks receive liquids from both the units. During normal operations the volume is proportioned equally between each processing unit. Whenever these is an outage, consideration is given to allocating more of the waste to the unit that is in the outage. The chemical drain tank liquid is charged to Unit 1 only.

1.5.3 Liquid Radwaste Treatment System

1.5.3.1 Dose Limits for Operation of the Liquid Radwaste Treatment System

The liquid radwaste treatment system shall be operable, and appropriate portions of the system shall be used to reduce radioactivity releases when the projected doses that are due to the liquid effluent, from each unit to unrestricted areas (see figure 3.0-1 and 3.0-2), would exceed 0.06 mrem to the whole body or 0.2 mrem to any organ in a 31-day period. This limit applies at all times for all modes of operation.

1.5.3.2 Projected Doses That Exceed Limits

If radioactive liquid waste is being discharged in excess of the above limits without treatment and if any portion of the liquid radwaste treatment system is not in operation, prepare and submit to the NRC within 30 days, pursuant to Technical Specification 6.8.2, a special report that includes the following information:

1) An explanation of why liquid radwaste was being discharged without treatment. Identification of any inoperable equipment or subsystems and the reason for inoperability.
2) What actions will be taken to restore the inoperable equipment to operable status.
3) A summary description of action(s) that will be taken to prevent a recurrence.

These limits do not affect mode changes.

1.5.3.3 Bases for Projecting Doses

To assure these limits are not exceeded, doses that are due to liquid releases, from each unit to unrestricted areas, shall be projected at least once per 31 days, in accordance with the methodology and parameters in this ODCM, when liquid radwaste treatment systems are not being fully utilized.

The operability of the liquid radwaste treatment system ensures that this system will be available for use whenever liquid effluents require treatment prior to release to the environment. The requirement that the appropriate portions of this system be used when specified provides assurance that the releases of radioactive materials in liquid effluents will be kept "as low as is reasonably achievable." This specification implements the requirements of 10 CFR 50.36a, General Design Criterion 60, Appendix A, 10 CFR 50 and the design objective given in section II.D, Appendix I, 10 CFR 50. The specified limits governing the use of appropriate portions of the liquid radwaste treatment system were specified as a suitable fraction of the dose design objectives that are set forth in section II.A, Appendix I, 10 CFR 50, for liquid effluents.

1.5.4 Liquid Effluent Monitoring Instrumentation

The radioactive liquid effluent monitoring instrumentation channels specified below shall be operable with their alarm/trip setpoints set to ensure that the limits in subsection 1.5.1 of this ODCM are not exceeded. This limit applies at all times for all modes of operation.

1.5.4.1 Nonconservative Liquid Monitor Setpoint and ACTIONS

If a radioactive liquid effluent monitoring instrumentation channel alarm/trip setpoint is less conservative than required, immediately suspend the release of radioactive liquid effluents monitored by the affected channel or declare the channel inoperable.

If less than the minimum number of radioactive liquid effluent monitoring instrumentation channels are operable, take the ACTION shown in table 1.5-1. Restore the inoperable instrumentation to operable status within 30 days or, if unsuccessful, explain in the next Semiannual Radioactive Effluent Release Report, per Technical Specification 6.8.1.4, why this inoperability was not corrected in a timely manner. These limits do not affect modes changes.

1.5.4.2 Liquid Monitor Operability

Each radioactive liquid effluent monitoring instrumentation channel shall be demonstrated operable by performance of the channel check, source check, channel calibration, and analog channel operational test at the frequencies shown in table 1.5-1. Specific instrument numbers are provided in parentheses for information only. The numbers apply to each unit. These numbers will help to identify associated channels or loops and are not intended to limit the requirements to the specific instruments associated with the number.

TABLE 1.5-1 (SHEET 1 OF 4)

LIQUID EFFLUENT MONITORING INSTRUMENTATION

	Minimum Channels Operable	ACTION	Channel Check	Source Check	Channel Calibration	Analog Channel Operational Test
1. Radwaste monitors providing alarm and auto termination of release						
a) Liquid radwaste effluent (RE-0018)	1	37	D	P	R(3)	Q(1)
b) SG blowdown effluent (RE-0021)	1	38	D	M	R(3)	Q(1)
c) Turbine building effluent (RE-0848)	1	38	D	M	R(3)	Q(1)
2. Radwaste monitors providing alarm but not providing auto termination of release						
a) NSCW effluent line (RE-0020 A&B)	1	39	D	M	R(3)	Q(2)
3. Flowrate measurement devices						
a) Liquid radwaste effluent line (FT-0018) or (FT-1035) or (FT-1036)	1	40	D(4)	NA	R	NA
b) Steam generator blowdown effluent (FT-0021)	1	40	D(4)	NA	R	NA
c) Flow to blowdown sump (AFQI-7620, FR7620 pen 1)	1	40	D(4)	NA	R	Q

TABLE 1.5-1 (SHEET 2 OF 4)

TABLE NOTATIONS

(1) The analog channel operational test shall also demonstrate that automatic isolation of this pathway (for item a. below only) and control room alarm annunciation occur if any of the following conditions exists:

   a. Instrument indicates measured levels above the alarm/trip setpoint.
   b. Circuit failure.
   c. Instrument indicates a downscale failure.
   d. Instrument controls not set in operate mode. (Annunciation via computer printout.)

(2) The analog channel operational test shall also demonstrate that control room alarm annunciation occurs if any of the following conditions exists:

   a. Instrument indicates measured levels above the alarm setpoint.
   b. Circuit failure.
   c. Instrument indicates a downscale failure.
   d. Instrument controls not set in operate mode. (Annunciation via computer printout).

(3) The initial channel calibration shall be performed using one or more of the reference standards certified by the National Bureau of Standards (NBS) or using standards that have been obtained from suppliers that participate in measurement assurance activities with NBS. These standards shall permit calibrating the system over its intended range of energy and measurement range. For subsequent channel calibration, sources that have been related to the initial calibration shall be used.

(4) Channel check shall consist of verifying indication of flow during periods of release. Channel check shall be made at least once per 24 hours on days during which continuous, periodic, or batch releases are made.

ACTION STATEMENTS

ACTION 37 - With the number of channels operable less than required by the minimum channels operable requirement, effluent releases via this pathway may continue provided that prior to initiating a release:

a. at least two independent samples are analyzed in accordance with subsection 1.5.1 of this ODCM
b. at least two technically qualified members of the facility staff independently verify the release-rate calculations and discharge line valving.

Otherwise, suspend release of radioactive effluents via this pathway.

ACTION 38 - With the number of channels operable less than required by the minimum channels operable requirement, effluent releases via this pathway may continue provided grab samples are analyzed for radioactivity at a lower limit of detection no more than 1×10^{-7} μCi/ml:

a. at least once per 12 hours when the specific activity of the secondary coolant is greater than 0.01 μCi/gram dose equivalent I-131
b. at least once per 24 hours when the specific activity of the secondary coolant is less than or equal to 0.01 μCi/gram dose equivalent I-131.

ACTION 39 - With the number of channels operable less than required by the minimum channels operable requirement, effluent releases via this pathway may continue provided that, at least once per 12 hours, grab samples are collected and analyzed for radioactivity at a lower level of detection no more than 1×10^{-7} μCi/ml.

TABLE 1.5-1 (SHEET 4 OF 4)

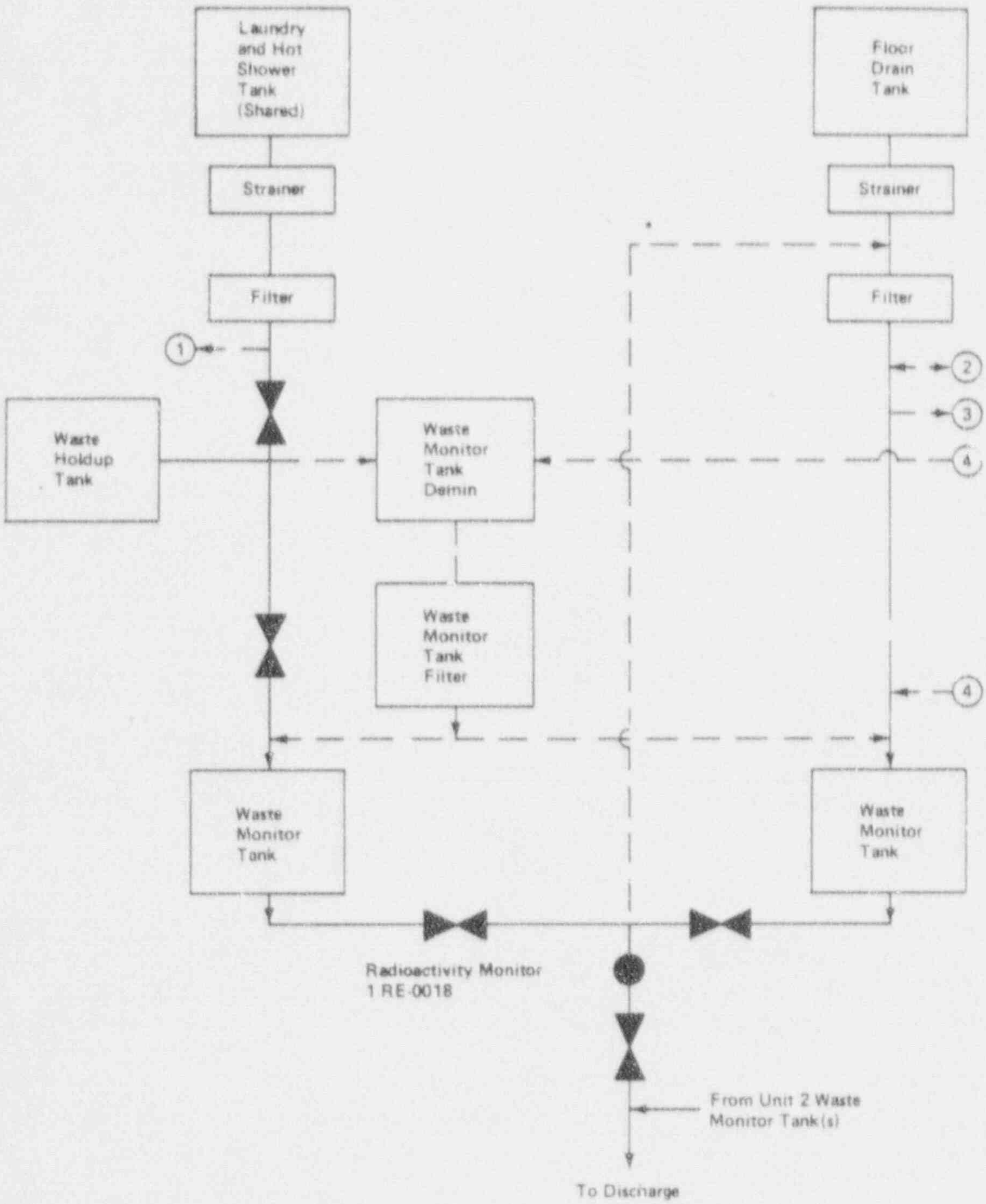
ACTION STATEMENTS

ACTION 40 - With the number of channels operable less than required by the minimum channels operable requirement, effluent releases via this pathway may continue provided the flowrate is estimated at least once per 4 hours during actual releases. Pump performance curves generated in place may be used to estimate flow.

1.6 LIQUID WASTE PROCESSING SYSTEM AND LIQUID DISCHARGE PATHWAYS

Figures 1.6-1 and 1.6-2 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 1.6-3 is a schematic of plant discharge pathways for liquids.



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

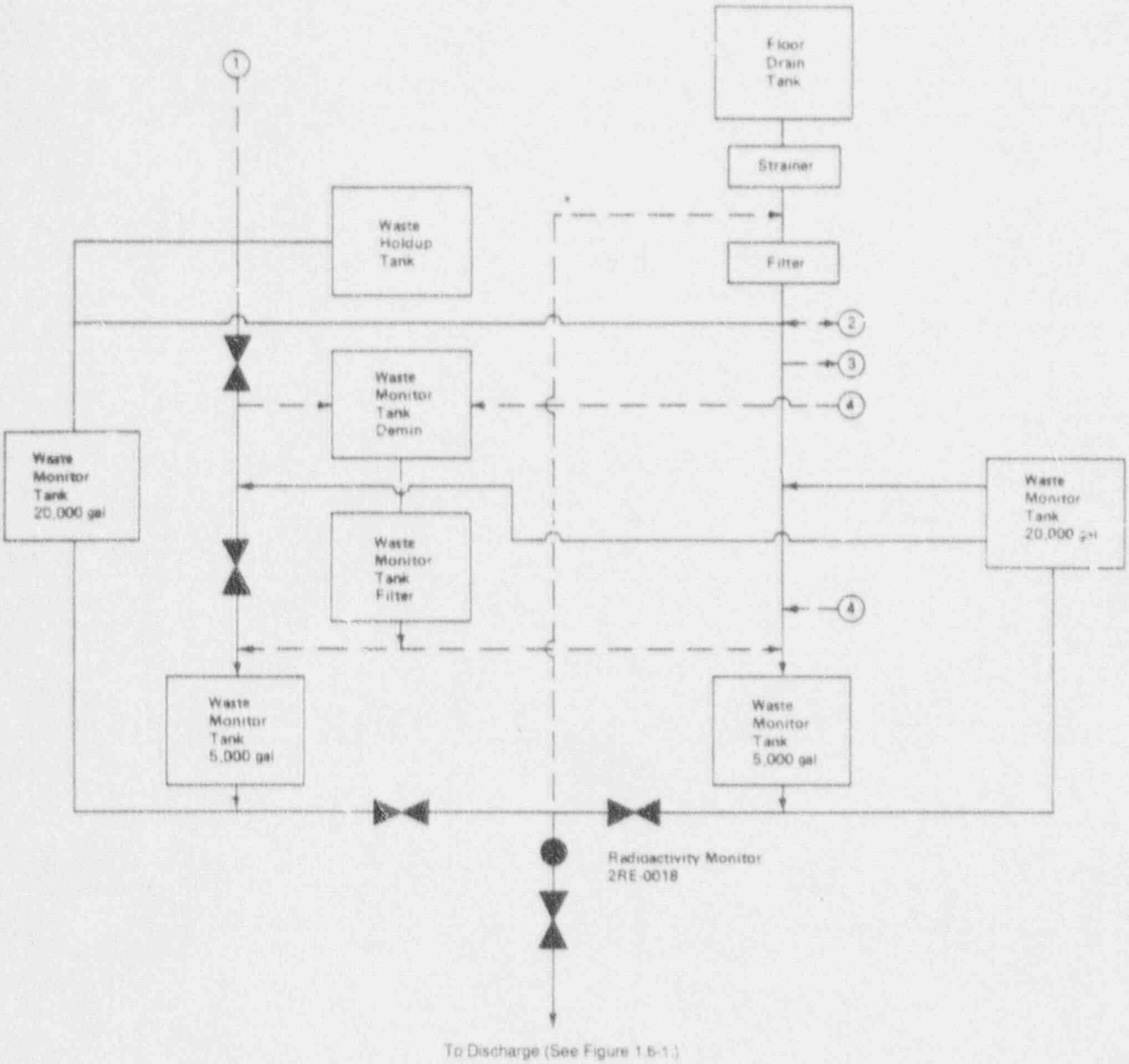
1. To Unit 2
2. From/To Unit 2
3. To Drain Channel A
4. From Drain Channel A

Georgia Power

VOGTLE
ELECTRIC GENERATING PLANT
UNIT 1 AND UNIT 2

LIQUID WASTE PROCESSING SYSTEM
(Unit 1)

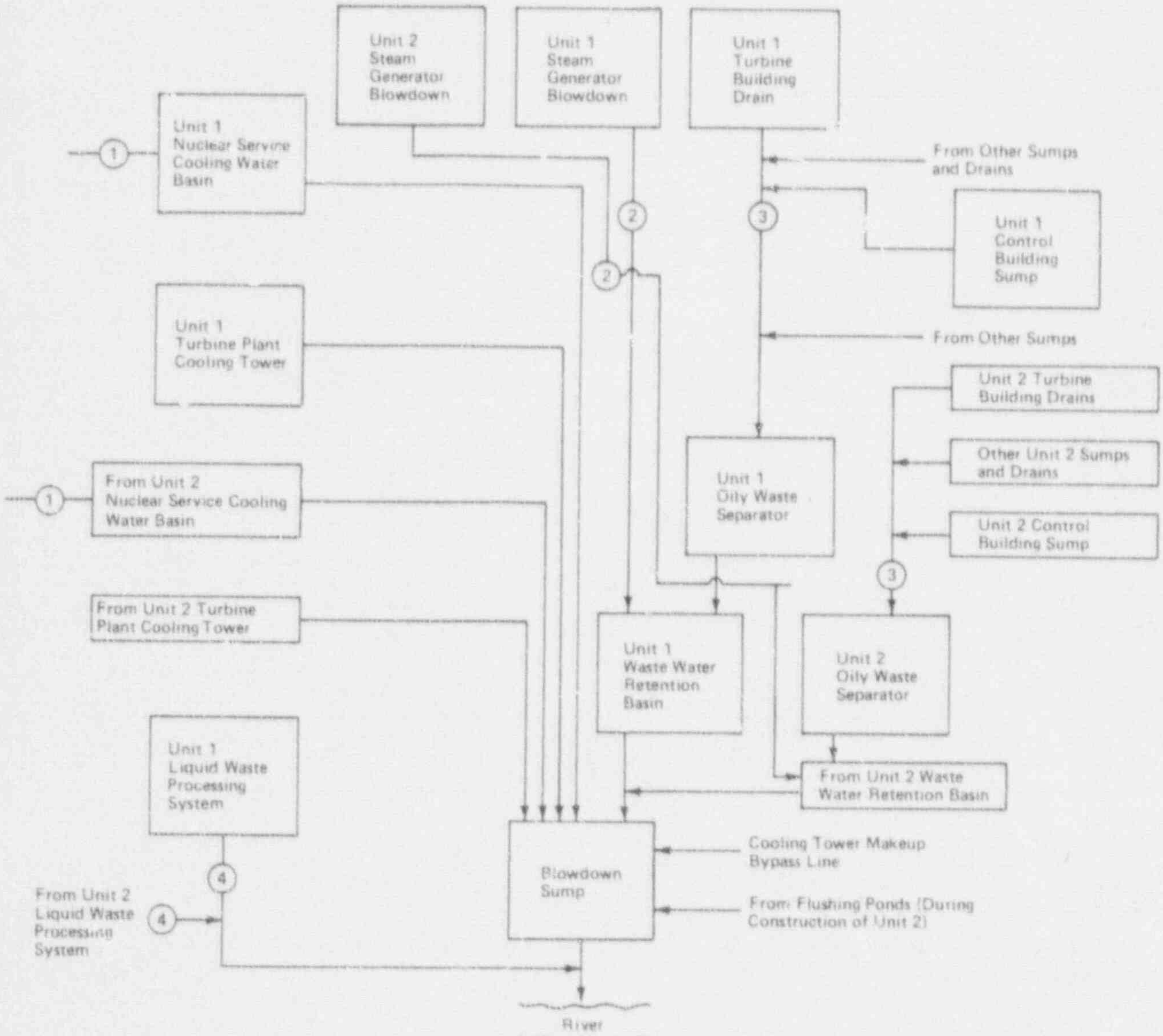
FIGURE 1.6-1



*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

Georgia Power	VOGTLE ELECTRIC GENERATING PLANT UNIT 1 AND UNIT 2	LIQUID WASTE PROCESSING SYSTEM (Unit 2)
		FIGURE 1.6-2



Radioactivity Monitors:

① 1(2) RE0020
② 1(2) RE0021
③ 1(2) RE0848
④ 1(2) RE0018

*The blowdown sump is common to both units.

Georgia Power

VOGTLE ELECTRIC GENERATING PLANT UNIT 1 AND UNIT 2

LIQUID DISCHARGE PATHWAYS

FIGURE 1.6-3

433-9

2.0 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 secondary leak exists; and the dry active waste processing 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, the radwaste solidification building vent, and the dry active waste processing 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 2.1.2.) All six release points are considered to be continuous releases. In the absence of 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 excluding the dry active waste processing building. Methodology for calculating noble gas monitor setpoints is presented in section 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 subsection 2.5.1 is presented in the NOTE in paragraph 2.2.1.2.

2.1 GASEOUS EFFLUENT MONITOR SETPOINTS

The setpoint for a particular noble gas monitor is determined by calculating a basic setpoint value, c_s, which will assure the limits of subsection 2.5.1 are not exceeded.

Subsections 2.1.1, 2.1.2, and 2.1.3 present the methodology for calculating the basic setpoint value, c_s, for the respective noble gas monitors. Monitor response and background considerations are discussed 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 setpoint must be 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 current 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.

2.1.1 Unit 1 Turbine Building Vent and Unit 2 Turbine Building Vent

Monitors: 1RE-12839C (Unit 1) and 2RE-12839C (Unit 2)

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 subsection 2.5.4, the setpoint for these noble gas monitors will be calculated as follows:

c_g = the calculated basic setpoint value.

c_s = the lesser of

$$(AG)\ (SF)\ (R_t)\ (D_{TB}) \quad (1)$$

or

$$(AG)\ (SF)\ (R_s)\ (D_{ss}) \quad (2)$$

SF = the 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.

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

R_t = the relationship between the noble gas concentration and the dose rate to the total body for the conditions of the release under consideration.

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

where:

C_m = the noble gas grab sample radionuclide concentration taken in accordance with subsection 2.5.2, the release point under consideration.

$(\overline{X/Q})_G$ = the highest annual average relative concentration at the site boundary. The release points addressed in this subsection are ground-level releases.

$(\overline{X/Q})_G$ = 2.55 x 10-6 s/m³ in the NE sector.

K_i = the total-body dose factor due to gamma emissions from radionuclide i (mrem/year/μCi/m³) from table 2.1-1.

Q_{ig} = the rate of release of noble gas radionuclide i (μCi/s) 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 flowrate for this release point (X_{iv} in $\mu Ci/ml$ and F_v in ml/s).

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

R_s = the relationship between the noble gas concentration and the dose rate to the skin for the conditions of the release under consideration.

$$R_s = C_m \div ((\overline{X/Q})_G \sum_i (L + 1.1\ M_i)\ Q_{ig}) \qquad (4)$$

where:

L_i = the skin dose factor due to beta emissions from radionuclide i (mrem/year/$\mu Ci/m^3$) from table 2.1-1.

1.1 = the mrem skin dose per mrad air dose.

M_i = the air dose factor due to gamma emissions from radionuclide i (mrad/year/$\mu Ci/m^3$) from table 2.1-1.

2.1.2 Unit 1 Plant Vent and Unit 2 Plant Vent

Monitors: 1RE-12442C (Unit 1), 2RE-12442C (Unit 2)
1RE-12444C (Unit 1), 2RE-12444C (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.

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} and $(\overline{X/Q})_{G}$ must be replaced with $(\overline{X/Q})_{M}$, where Q_{im} and $(\overline{X/Q})_{M}$ are defined as follows:

Q_{im} = the rate of release of noble gas radionuclide i (μCi/s) 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 flowrate for this release point (X_{iv} in μi/ml and F_v in ml/s.).

$(\overline{X/Q})_{M}$ = the highest annual average relative concentration for a mixed-mode release release type (s/m^3). Currently 4.62×10^{-7} s/m^3 in the NE sector.

2.1.3 Gaseous Waste Processing System Discharge and Reactor Containment Purge

Monitors: ARE0014, 1RE-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 also presented for the system effluent monitors. The system monitors have the control logic to terminate the release at alarm trip point. The final monitors have no trip logic.

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.

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

Exception 1:

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

Exception 2:

C_m = the Gaseous Waste Processing System noble gas concentration to be discharged (sample taken and analyzed prior to discharge).

Exception 3:

q_i = the rate of release of noble gas radionuclide i (μCi/s) from the Gaseous Waste Processing System, determined by multiplying the expected release rate by the concentration of radionuclide i.

Exception 4:

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

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 (1RE-12442C or 1RE-12444C), 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, $(Q_{im})_{GP}$, which includes the routine Unit 1 plant vent source term Q_{im} (based on sample results from subsection 2.5.2) combined with the Gaseous Waste Processing System source term for the tank planned for release, q_i, as follows:

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

Exception 2:

C_m = the noble gas concentration determined for the combined release; this concentration value is obtained by dividing $\sum_i (Q_{im})_{GP}$ by the combined flowrate (ml/s) through the plant vent.

2.1.3.2 Reactor Containment Purge

Monitors: 1(2)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 = the containment purge noble gas concentration to be discharged (sample taken and analyzed prior to discharge).

Exception 3:

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

Exception 4:

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

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 (1(2)RE-12442C) which is downstream from the containment purge monitor (1(2)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 subsection 2.5.2) combined with the containment purge source term for the unit containment planned for release, q_i, as follows:

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

Exception 2:

C_m = the noble gas concentration determined for the combined release; this concentration value is obtained by dividing $\sum_i (Q_{im})_{CP}$ by the flowrate (ml/s) through the plant vent.

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 thus calculated is in the units

μCi/ml. The monitor actually measures counts per minute, subtracts a predetermined background count rate, and then multiplies by a calibration factor to convert the counts per minute to μCi/ml.

Calibration of the gas monitors by the manufacturer and Georgia Power Company utilized at least one NBS traceable gaseous radionuclide source, except for the main steam lines in the exact geometry of each production monitor and point sources covering the Beta end point energy range for 0.293 to at least 1.488 MeV. The calibration factor is a function of the radionuclide mix in the gas to be released and will be calculated for the monitor based on the results of the predischarge sample results from the laboratory gamma-ray spectrometer system.

The mix-dependent calibration factor will be used as the gain factor in the PERMS monitor or used to modify the calculated base monitor setpoint so the default calibration factor can be left in the PERMS monitor.

Contributions to background radiation levels may include ambient background, plant environmental background at monitor locations when plant is in shutdown status, plant environmental background 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 DAW processing 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. If the building is not in service for its intended function an allocation factor of zero can be used for that building.

2. The allocation factor may be calculated using the expression

$$AG = 1/n \quad (11)$$

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 and Unit 2 turbine building vent (ground-level releases):

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

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

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

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. When using equations 12 and 13, be sure to include the DAW processing building vent for the particulate releases.

2.1.6 Particulate Effluent Monitor Setpoints

Particulate effluent monitor setpoints for RE-12442A, RE-2565A, and ARE-13256 are determined using the method outlined for gaseous effluent monitor setpoints. Co-60 and lung organ were used as the main isotope and organ. Reference 18 details the way the initial setpoint calculations were made for certain monitors.

TABLE 2.1-1

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

Nuclide	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.

** $\frac{\text{mrad-m}^3}{\mu\text{Ci-year}}$

*** $\frac{\text{mrem-m}^3}{\mu\text{Ci-year}}$

TABLE 2.1-2

GASEOUS RELEASE POINTS FLOWRATES

Release Point	Flowrates ft^3/min	Flowrates ml/s
Plant Vent (Unit 1)	1.5E05	7.08E07
Plant Vent (Unit 2)	9.0E04	4.25E07
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
Dry Active Waste Processing Building Vent	2.20E3	1.04E6

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 subsection 2.5.1, the dose rate in areas at or beyond the site boundary due to noble gases shall be calculated as follows:

D_t = the total-body dose rate at time of release (mrem/year).

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

D_s = the skin dose rate at time of release (mrem/year).

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

Where: ng = the number of simultaneous ground-level vent releases, and nm = the number of simultaneous mixed-mode vent releases. Other terms were defined previously in subsection 2.1.

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 and Unit 2 turbine building vent are ground-level releases. Unit 1 plant vent and Unit 2 plant vent are mixed-mode releases.

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

For the purpose of implementing subsection 2.5.1, 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 = the organ dose rate at time of release (mrem/year).

$$= (\overline{X/Q})_G \sum_{ng} \sum_i P_{io} (Q'_{ig})_{ng} + (\overline{X/Q})_M \sum_{nm} \sum_i P_{io} (Q'_{im})_{nm} \quad (16)$$

where:

nm and ng = defined previously in paragraph 2.2.1.1.

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

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

Q'_{ig} = the release rate (μCi/s) of I-131, I-133, tritium, and particulates from Unit 1 turbine building vent; Unit 2 turbine building vent; and dry active waste processing building vent which are ground-level releases. NOTE: DAW is particulates only.

Q'_{im} = the release rate (μCi/s) 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} = the organ dose parameter for organ o and radionuclide i, (mrem/year per $\mu Ci/m^3$) for inhalation determined as follows:

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

where:

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

BR = the breathing rate for child age group; 3700 m^3/year from table 2.2-10.

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

NOTE: To ensure 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/year as specified in subsection 2.5.1, the potential organ dose rate D_o must be limited as follows:

$$D_o + (AG)(SF) \leq 1500 \text{ mrem/year} \qquad (18)$$

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 Dose to a Member of the Public at or Beyond the Site Boundary

2.2.2.1 Air Doses at or Beyond the Site Boundary

For the purpose of implementing subsection 2.5.2, air doses in areas at or beyond the site boundary shall be determined as follows:

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

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

where:

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

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

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

M_i = defined previously in subsection 2.1.1.

$(\overline{X/Q})_G$ = 2.55×10^{-6} s/m^3 in the NE sector.

$(\overline{X/Q})_M$ = 4.62×10^{-7} s/m^3 in the NE sector.

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

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

where:

N_i = the air dose factor due to beta emissions from noble gas radionuclide i (mrad/year/μCi/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 subsection 2.5.3 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 = the 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 8 days (mrem).

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

where:

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

pi = for all pathways and all isotopes.

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

$(\overline{X/Q'})_{GP}$ = the 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.

$(\overline{D/Q'})_{GP}$ = the 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} = the pathway-dependent relative dispersion or deposition at the location of the controlling receptor, associated with plant vent releases, which are mixed mode as follows:

$(\overline{X/Q'})_{MP}$ = the 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.

$(\overline{D/Q'})_{MP}$ = the 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.

$\bar{Q}'_{ig}$ = the cumulative release (μCi), from ground-level plant releases, of radionuclide i, as required by subsection 2.5.3 over the period of interest. Dose determinations required by

subsection 2.5.3 are on a per reactor basis; therefore, cumulative release quantities must also be unit-specific. Since the dry active waste processing 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.)

Q'_{im} = the cumulative release (μCi), from the mixed-mode plant vent releases, of radionuclide i as required by subsection 2.5.3 over the period of interest. Dose determinations required by subsection 2.5.3 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 $\tilde{Q}_{im}$ is limited to tritium.)

R_{aipj} = the 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.

Inhalation Pathway Factor

$$R_{aipj} = K'(BR)_a\ (DFA_{ij})_a \text{ mrem/year/}\mu\text{Ci/m3} \tag{22}$$

where:

K' = the constant of unit conversion 10^6 pCi/μCi.

$(BR)_a$ = 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

$$R_{aipj} = K'K''\ (SHF)(DFG_{ij})\ ((1-e^{-\lambda_i t})/\lambda_i) \tag{23}$$

$(m^2 mrem/year/\mu Ci/s)$.

where:

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

K" = the constant of unit conversion, 8760 h/year.

SHF = the shielding factor, 0.7 (dimensionless).

DFG_{ij} = the 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/h/ pCi/m^2) table 2.2-9.

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

t = the exposure time, 4.73 x 10^8 s (15 years).

Vegetation Pathway Factor

$$R_{aipj} = K' \frac{r}{Y_v(\lambda_i + \lambda_w)} (DFL_{ij})_a (U_{a\ell} \; f_\ell \; e^{-\lambda_i t_\ell} + U_{as} \; f_g \; e^{-\lambda_i t_{hv}}) \qquad (24)$$

(m^2mrem/year per μCi/s)

where:

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

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

$U_{a\ell}$ = 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 s, (8.6×10^4).

t_{hv} = the average time between harvest of stored vegetation and its consumption in s, (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 s^{-1}.

λ_w = the decay constant for removal of activity on leaf and plant surfaces by weathering, $5.73 \times 10^{-7}\ s^{-1}$ (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:

$$R_{aipj} = K'K'''(U_{aL} f_L + U_{aS} f_g)\ (DFL_{ij})_a\ (0.75(0.5/H)) \qquad (25)$$

(mrem/year/μCi/m^3)

where:

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

H = the 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.

Other parameters and values are given above.

<u>Grass-Cow-Milk Pathway Factor</u>

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

(m^2mrem/year/μCi/s)

where:

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

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/year 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 = the 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 s^{-1}.

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

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

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

2.3 METEOROLOGICAL MODEL

(References 7 and 13, and subsection 2.3.5 of Reference 5)

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 dry active waste processing building vent. Releases from reactor building(s) (plant) vent(s) are considered to be mixed mode. (See NOTE in subsection 2.1.2).

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 (s/m^3).

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

where:

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

d_p = the 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 = the open terrain recirculation factor. Values for specific distances are obtained from Appendix A of Reference 13.

n_{jk} = the 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 = the total hours of valid meteorological data throughout the period of interest.

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

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

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

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

σ_{zk} = the vertical standard deviation of the plume concentration distribution (m) 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 $\Delta T/\Delta Z$ (°C/100 m).

π = 3.1416

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

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 (s/m^3).

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

where:

d_p = the 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} = the 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, subsection 2.3.5.)

E = the fraction considered as ground-level releases.

1.0 for $\frac{W_0}{u} \leq 1.0$

$2.58 - 1.58 \left(\frac{W_0}{u}\right)$ for $1.0 < \frac{W_0}{u} \leq 1.5$

$0.3 - 0.06 \left(\frac{W_0}{u}\right)$ for $1.5 < \frac{W_0}{u} \leq 5.0$

0 for $\frac{W_0}{u} > 5.0$

W_o = the vent exit velocity (m/s).

h = the effective release height (m).

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

h_v = the height of release point (m).

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

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

$= 1.44d\ (W_0/u)^{2/3}(x/d)^{1/3}$ (41)

= limited by the lesser of the following two equations:

$h_{pr(max)}$ = $3(W_0\ /u)d$ or $h_{pr(max)} = 1.5(F_m'/u)^{1/3}S^{-1/6}$

d = the inside diameter of vent.

c_v = the correction for low vent exit velocity (m).

$$= \begin{cases} 3(1.5 - \frac{W_0}{u})\ d & \text{for } \frac{W_0}{u} \le 1.5 \\ 0 & \text{for } \frac{W_0}{u} > 1.5 \end{cases}$$

F_m' = the momentum flux parameter (m^4/s^2).

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

S = the stability parameter.

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

Other terms were defined in subsection 2.3.1.1.

2.3.2 Relative Deposition

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 ($1/m^2$).

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

where:

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

D_g = the 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 = the open terrain recirculation factor. Values for specific distances are obtained from Appendix A of Reference 13.

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 ($1/m^2$).

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

where:

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

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

E = the fraction of releases considered as ground level.

Other terms were defined in previous subsections.

TABLE 2.3-1 (SHEET 1 OF 2)

TERRAIN ELEVATION ABOVE PLANT GRADE
WIND DIRECTION FROM PLANT TO RECEPTOR

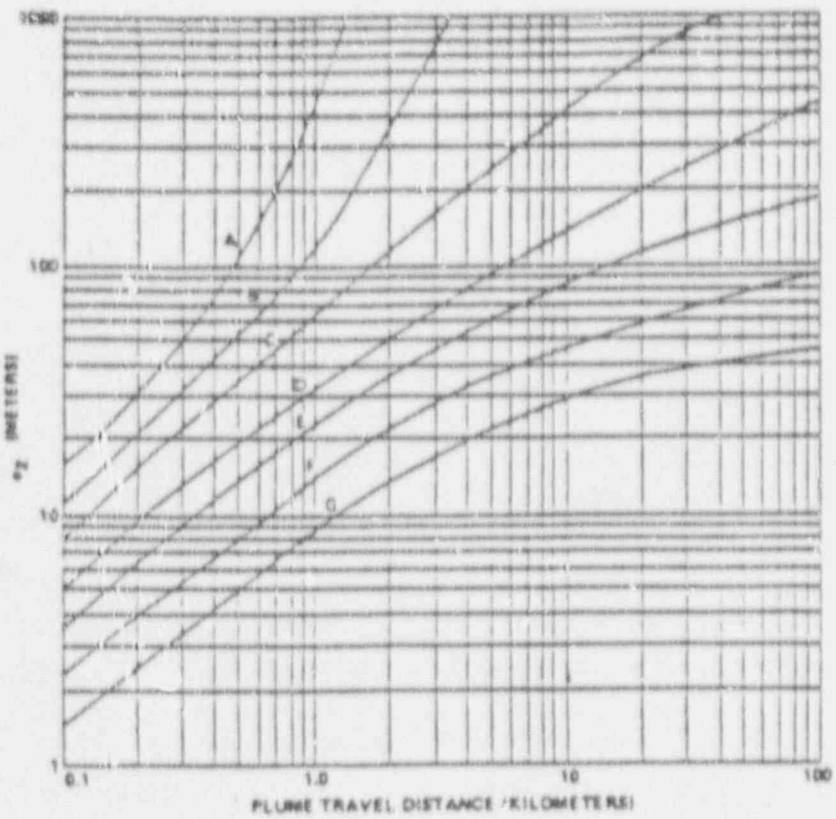
Distance (m)	N	NNE	NE	ENE	E	ESE	SE	SSE
500	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1,000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1,500	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2,000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2,500	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3,000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3,500	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4,000	0.0	0.0	0.0	0.0	0.0	0.0	4.5	0.0
5,000	0.0	0.0	0.0	0.0	0.0	0.0	11.1	0.0
6,000	0.0	0.0	0.0	0.0	0.0	0.0	11.1	0.0
7,000	0.0	0.0	0.0	7.8	0.0	0.0	11.1	0.0
8,000	0.0	0.0	21.1	13.9	0.0	0.0	11.8	0.0
9,000	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 (SHEET 2 OF 2)

TERRAIN ELEVATION ABOVE PLANT GRADE
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
1,000	0.0	4.7	16.7	13.4	3.3	10.4	11.8	6.8
1,500	0.0	4.7	21.7	18.6	7.3	12.2	14.3	7.3
2,000	0.0	4.7	21.7	18.6	7.3	12.2	14.3	7.3
2,500	0.0	4.7	21.7	18.6	7.3	12.2	14.3	7.3
3,000	0.0	4.7	23.7	18.6	7.3	12.2	14.3	7.3
3,500	0.0	4.7	24.4	18.6	7.3	12.2	16.9	7.3
4,000	0.0	4.7	24.4	18.6	7.3	12.2	16.9	7.3
5,000	0.0	4.7	24.7	18.6	7.3	12.2	16.9	7.3
6,000	0.0	4.7	26.8	18.6	7.3	12.2	16.9	7.3
7,000	3.6	4.7	26.8	18.6	7.3	12.2	16.9	7.3
8,000	14.6	4.7	26.8	18.6	7.3	12.2	16.9	7.3
9,000	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



Category	Range of Vertical Temperature Gradient (°C/100m)	Range of Vertical Temperature Gradient (°F/100ft)
A	ΔT/ΔZ < -1.9	ΔT < -1.0
B	-1.9 ≤ ΔT/ΔZ < -1.7	-1.0 ≤ ΔT < -0.9
C	-1.7 ≤ ΔT/ΔZ < -1.5	-0.9 ≤ ΔT < -0.8
D	-1.5 ≤ ΔT/ΔZ < -0.5	-0.8 ≤ ΔT < -0.3
E	-0.5 ≤ ΔT/ΔZ < 1.5	-0.3 ≤ ΔT < 0.8
F	1.5 ≤ ΔT/ΔZ < 4.0	0.8 ≤ ΔT < 2.2
G	4.0 ≤ ΔT/ΔZ	2.2 ≤ ΔT

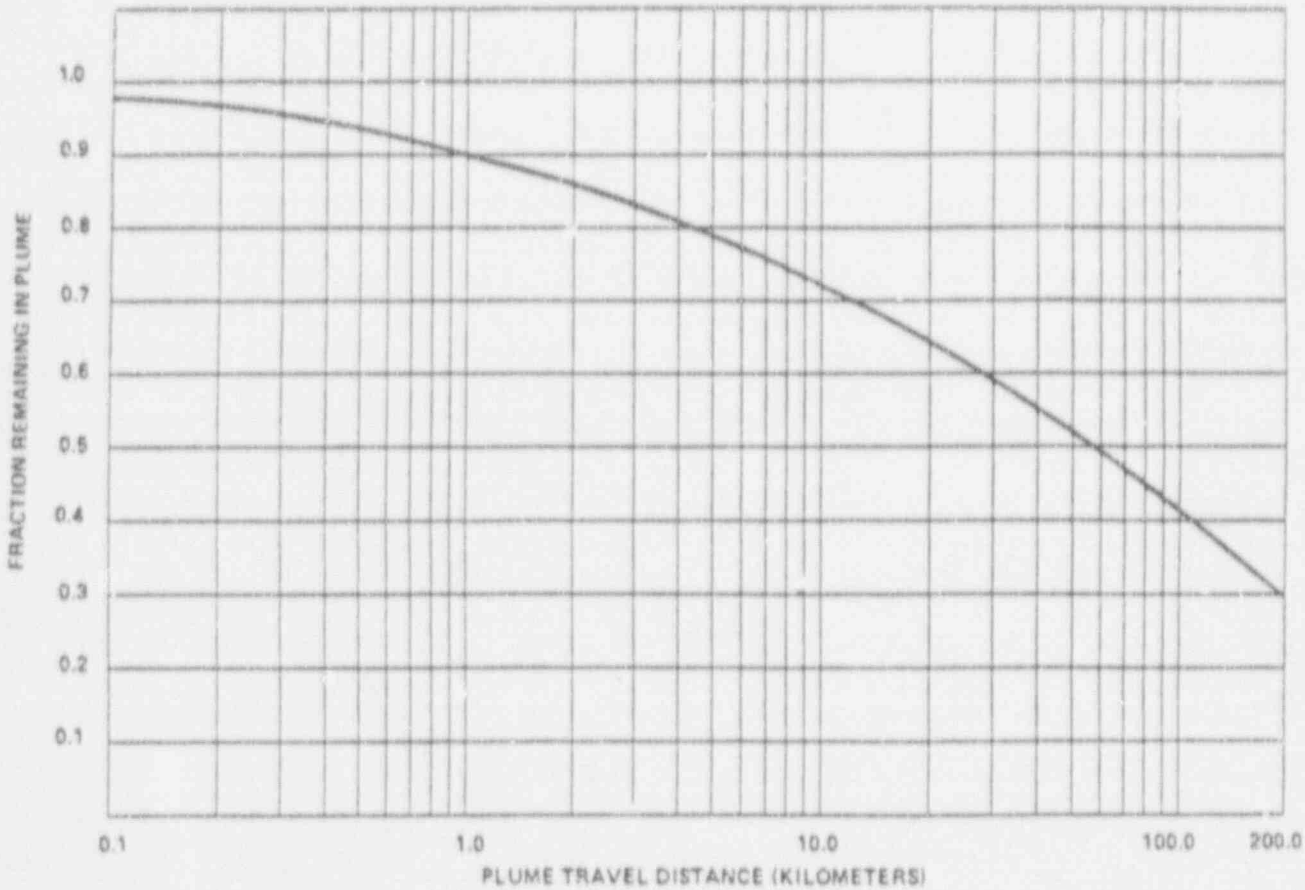
*Reference 7.

Georgia Power

VOGTLE
ELECTRIC GENERATING PLANT
UNIT 1 AND UNIT 2

VERTICAL STANDARD DEVIATION OF MATERIAL IN A PLUME (σ_z)*
(Letters Denote Pasquill Stability Class)

FIGURE 2.3-1



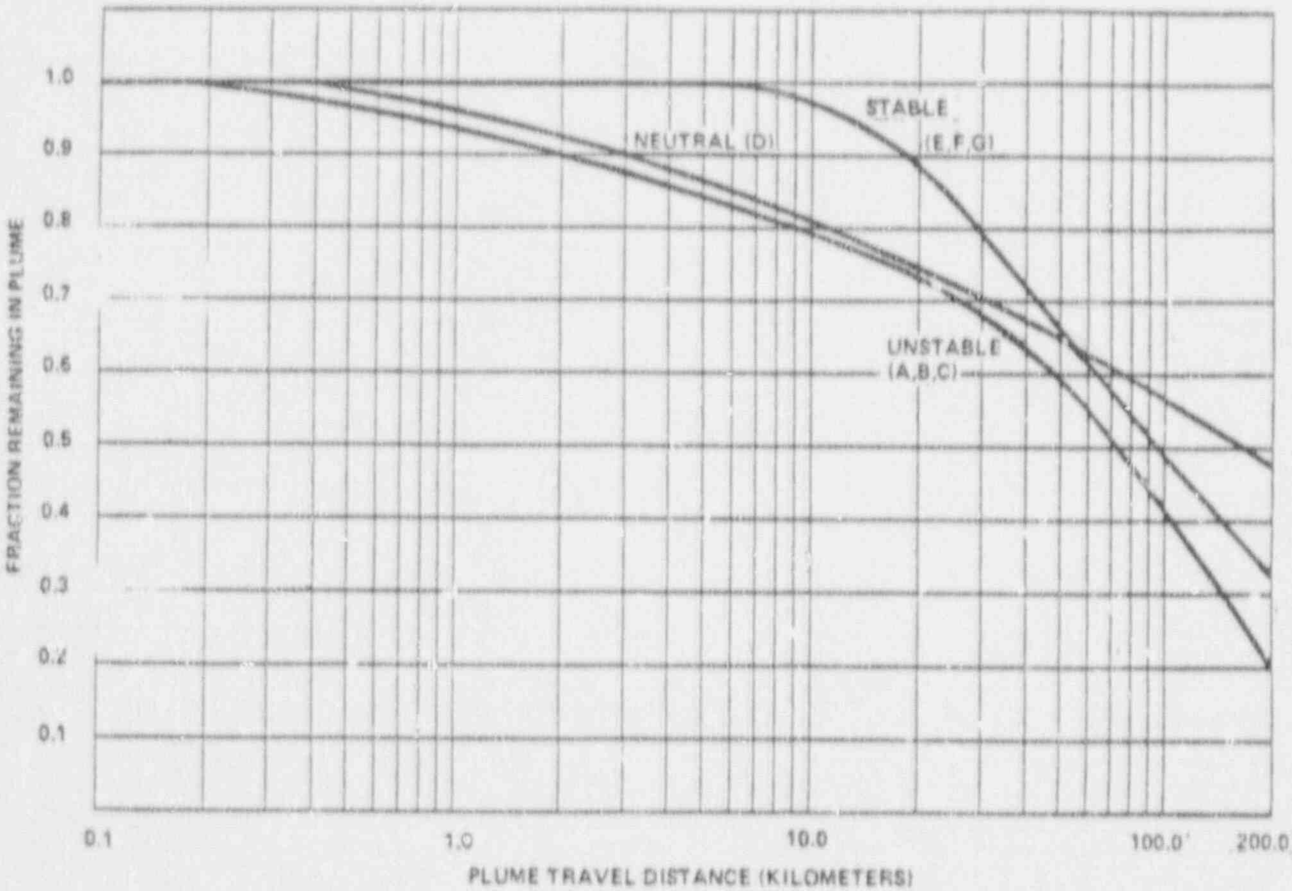
*Reference 7.

Georgia Power

VOGTLE
ELECTRIC GENERATING PLANT
UNIT 1 AND UNIT 2

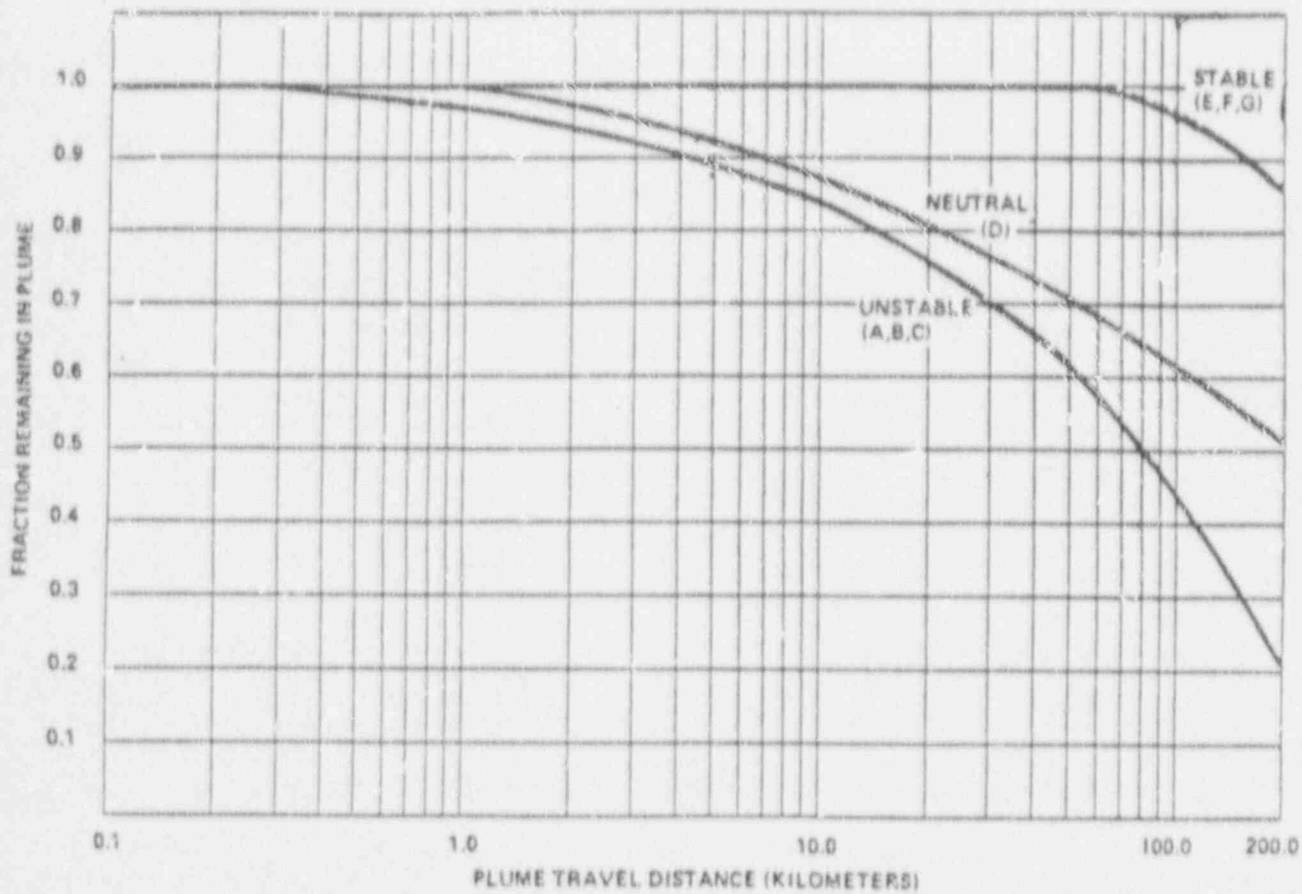
PLUME DEPLETION EFFECT FOR GROUND-LEVEL RELEASES
(All Atmospheric Stability Classes)

FIGURE 2.3-2



Reference 7.

Georgia Power VOGTLE ELECTRIC GENERATING PLANT UNIT 1 AND UNIT 2	PLUME DEPLETION EFFECT FOR 30-METER RELEASES* (Letters Denote Pasquill Stability Class)
	FIGURE 2.3-3



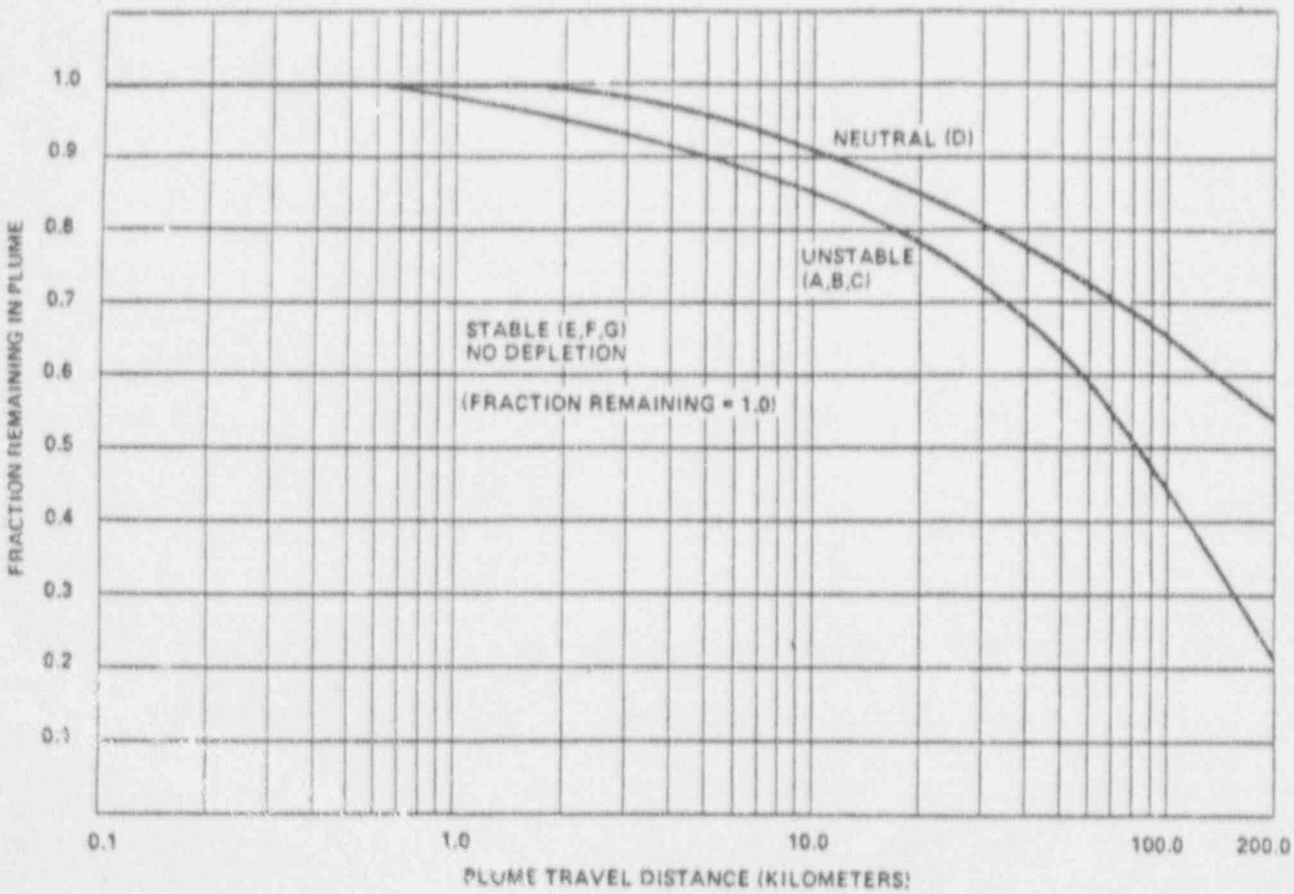
*Reference 7.

Georgia Power

VOGTLE
ELECTRIC GENERATING PLANT
UNIT 1 AND UNIT 2

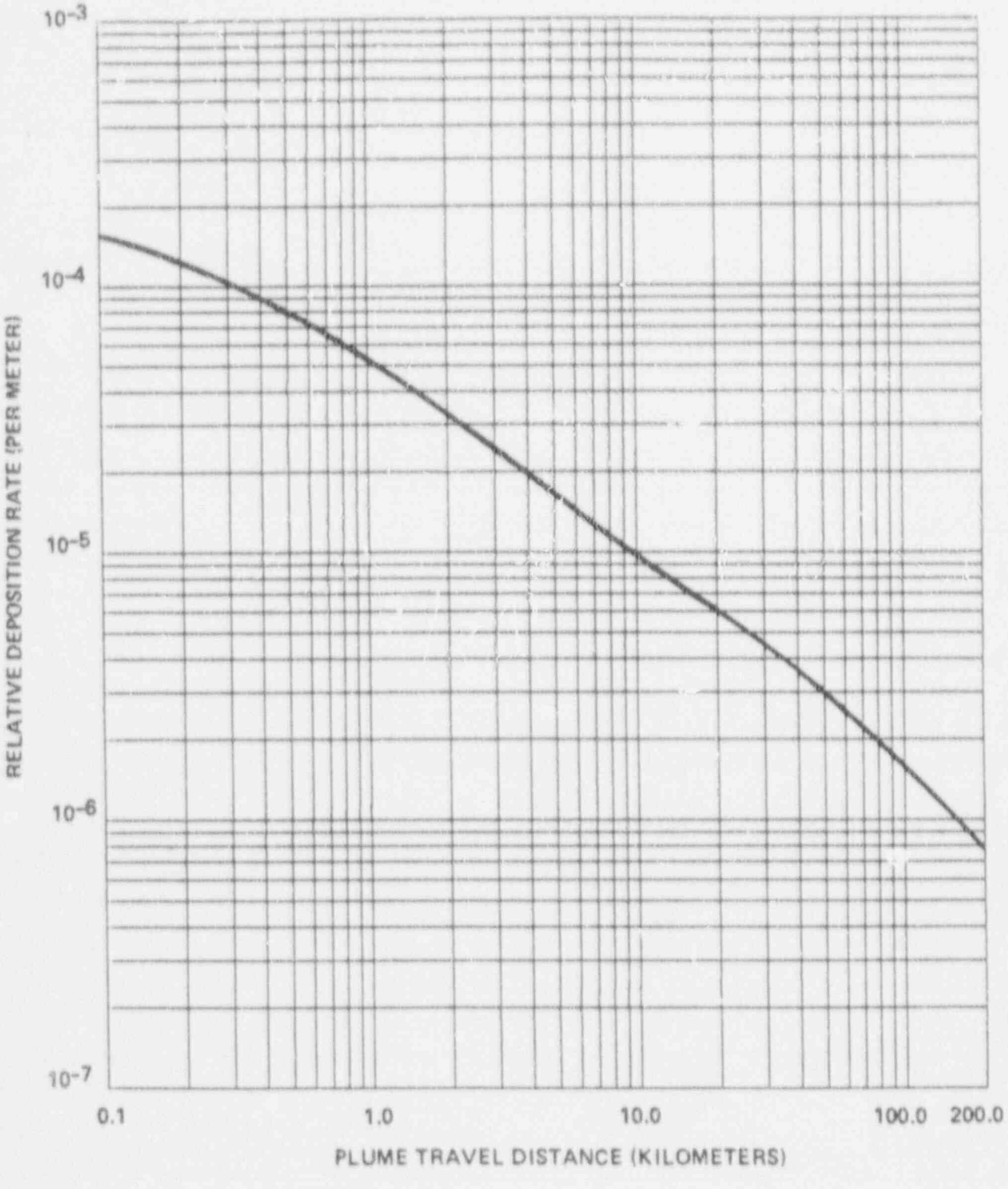
PLUME DEPLETION EFFECT FOR 60-METER RELEASES*
(Letters Denote Pasquill Stability Class)

FIGURE 2.3-4



*Reference 7.

Georgia Power	VOGTLE ELECTRIC GENERATING PLANT UNIT 1 AND UNIT 2	PLUME DEPLETION EFFECT FOR 100-METER RELEASES* (Letters Denote Pasquill Stability Class)
		FIGURE 2.3-5

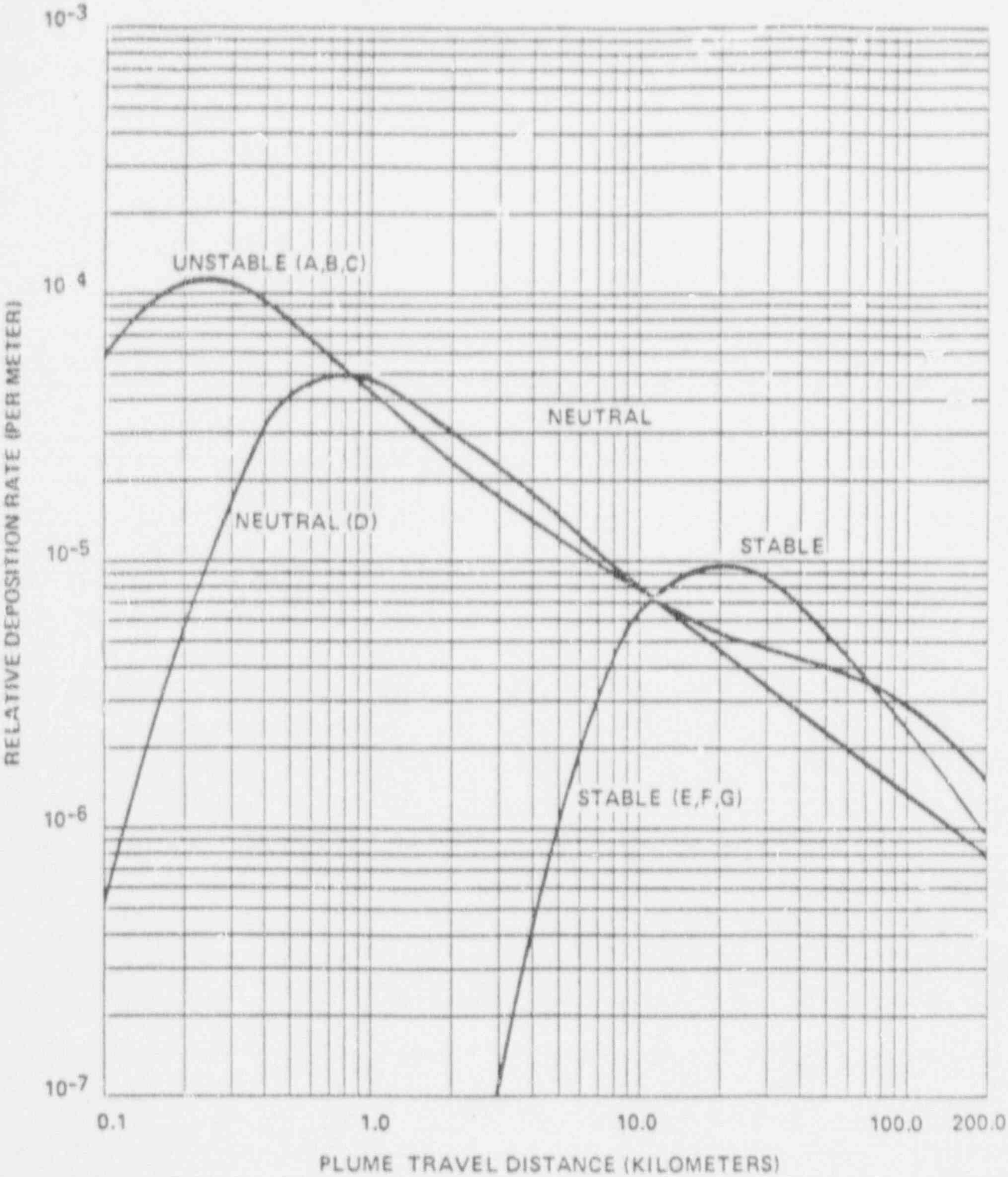


Georgia Power

VOGTLE
ELECTRIC GENERATING PLANT
UNIT 1 AND UNIT 2

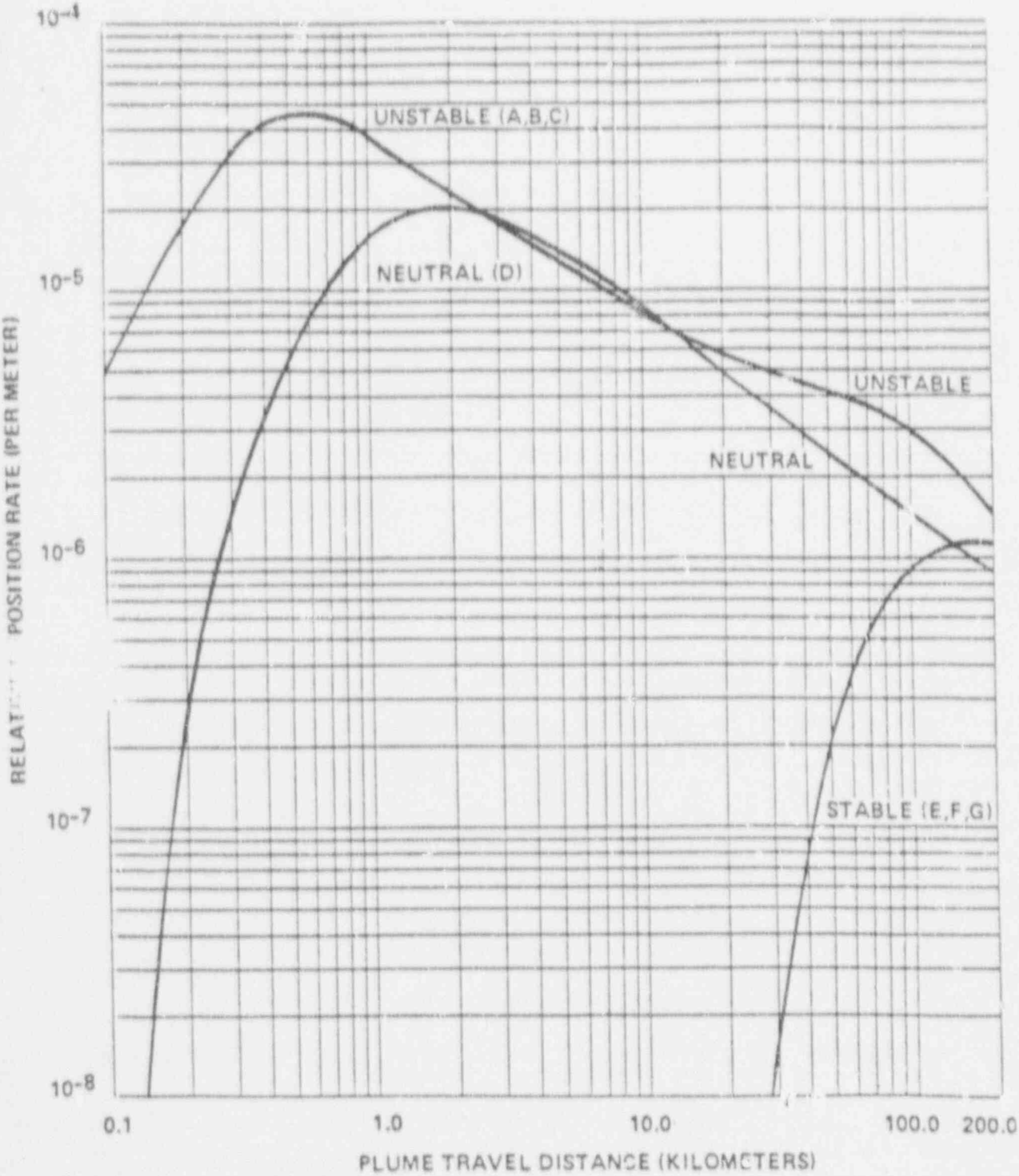
RELATIVE DEPOSITION FOR GROUND-LEVEL RELEASES
(All Atmospheric Stability Classes)

FIGURE 2.3-6



*Reference 7.

Georgia Power	VOGTLE ELECTRIC GENERATING PLANT UNIT 1 AND UNIT 2	RELATIVE DEP`SITION FOR 30-METER RELEASES* (Letters Denote Pasquill Stability Class)
		FIGURE 2.3-7



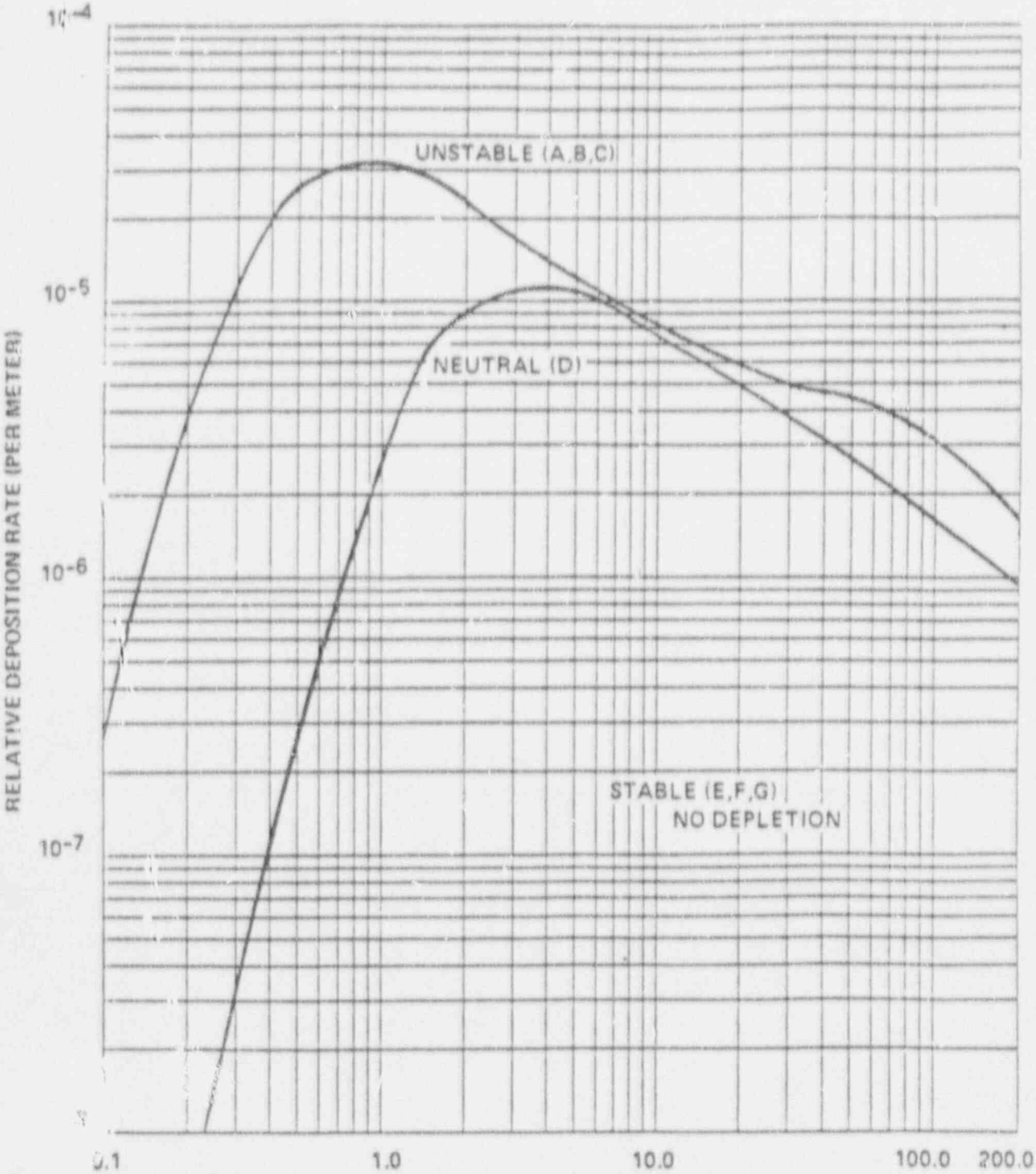
*Reference 7.

Georgia Power

VOGTLE
ELECTRIC GENERATING PLANT
UNIT 1 AND UNIT 2

RELATIVE DEPOSITION FOR 60-METER RELEASES*
(Letters Denote Pasquill Stability Class)

FIGURE 2.3-8



*Reference 7.

Georgia Power VOGTLE ELECTRIC GENERATING PLANT UNIT 1 AND UNIT 2	RELATIVE DEPOSITION FOR 100-METER RELEASES* (Letters Denote Pasquill Stability Class)
	FIGURE 2.3-9

2.4 DEFINITIONS OF GASEOUS EFFLUENT TERMS

Term		Definition	Subsection of Initial Use
AG	=	the administrative allocation factor for gaseous effluent pathways (unitless).	2.1.1
BR	=	the breathing rate for individual from table 2.2-10 (m^3/year).	2.2.1.2
b	=	the maximum height of the adjacent building (m).	2.3.1.1
C_m	=	Noble gas grab sample concentrations, taken in accordance with subsection 2.5.2, for the release under consideration.	2.1.1
c_s	=	the calculated basic monitor setpoint value. (μCi/cc)	2.1.1
c_v	=	the correction to effective release height due to low vent exit velocity (m).	2.3.1.2
D_{TB}	=	the limiting dose rate to the total body of an individual in an unrestricted area which is 500 mrem/year.	2.1.1
D_t	=	the total body dose rate at time of release (mrem/year).	2.2.1.1
D_{SS}	=	the 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	=	the skin dose rate at time of release (mrem/year).	2.2.1.1
D_o	=	the organ dose rate at time of release (mrem/year).	2.2.1.2
DF_{io}	=	the 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}	=	the air dose due to beta emissions from noble gases (mrad).	2.2.2.1
D_{gamma}	=	the air dose due to gamma emissions from noble gases (mrad).	2.2.2.1
D_j	=	the 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}	=	the ground plane dose conversion factor for radionuclide i (same for all age groups) (mrem/h per pCi/m^2) from table 2.2-9.	2.2.2.2
$(DFL_{ij})_a$	=	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

Term	Definition	Subsection of Initial Use
d_x	= the plume depletion factor for all radionuclides other than noble gases at distance x (unitless).	2.3.1.1
d	= the inside diameter of plant vent (m).	2.3.1.2
D_v	= the deposition rate for ground-level releases (m^{-1}).	2.3.2.1
D_e	= the deposition rate for elevated releases (m^{-1}).	2.3.2.1
E	= the fraction of release considered to be ground level (unitless).	2.3.2.1
f_ℓ	= the fraction of the annual intake of fresh leafy vegetation grown locally (dimensionless).	2.2.2.2
f_g	= the fraction of annual intake of stored vegetation grown locally (dimensionless).	2.2.2.2
f_p	= the fraction of the year that the cow (or goat) is on pasture (dimensionless).	2.2.2.2
f_s	= the fraction of the cow (or goat) feed that is pasture grass while the cow or goat is on pasture (dimensionless).	2.2.2.2
F_f	= the stable element transfer coefficient for meat (days/kg) from table 2.2-11.	2.2.2.2
F_m	= the stable element transfer coefficient for milk (days/liter) from table 2.2-11.	2.2.2.2

Term		Definition	Subsection of Initial Use
F_m'	=	the momentum flux parameter (m^4/s^2).	2.3.1.2
F_v	=	the maximum expected release flowrate through a particular release point (ml/s) from table 2.1-2.	2.1.1
H	=	the absolute humidity of the atmosphere (gm/m^3).	2.2.2.2
h	=	the effective release height (m).	2.3.1.2
h_v	=	the height of release point (m).	2.3.1.2
h_t	=	the maximum terrain height between the release point and the point of interest (m).	2.3.1.2
h_{pr}	=	the additional height due to plume rise (m).	2.3.1.2
K_i	=	the total body dose factor due to gamma emissions from radionuclide i (mrem/year per $\mu Ci/m^3$) from table 2.1-1.	2.1.1
K'	=	the constant of unit conversion (10^6pCi/mCi).	2.2.1.2
K"	=	the constant of unit conversion (8760 h/year)	2.2.2.2
K'"	=	the constant of unit conversion (10^3 gm/kg).	2.2.2.2
L_i	=	the skin dose factor due to beta emissions from radionuclide i (mrem/year per $\mu Ci/m^3$) from table 2.1-1.	2.1.1
M_i	=	the air dose factor due to gamma emissions from radionuclide i (mrad/year per $\mu Ci/m^3$) from table 2.1-1.	2.1.1

Term		Definition	Subsection of Initial Use
N_i	=	the air dose factor due to beta emissions from noble gas radionuclide i (mrad/year per $\mu Ci/m^3$) from table 2.1-1.	2.2.2.1
n	=	the number of simultaneous gaseous release pathways.	2.1.5
n_{jk}	=	the number of hour ateorological conditions are observed to be in a given wind direction, windspeed class j, and atmospheric stability class k.	2.3.1.1
N	=	the total hours of valid meteorological data.	2.3.1.1
P_{ie}	=	the dose parameter for radionuclide i, (mrem/year per $\mu Ci/m^3$) for the inhalation pathway.	2.2.1.2
Q_{ig}	=	the source term for ground-level release noble gas radionuclide i ($\mu Ci/s$).	2.1.1
Q_{im}	=	the source term for mixed mode release noble gas radionuclide i ($\mu Ci/s$).	2.1.1
$Q_{ig(r)}$	=	the source term for ground-level release noble gas radionuclide i from a specific release point ($\mu Ci/s$).	2.1.5
$Q_{im(r)}$	=	the source term for mixed-mode release noble gas radionuclide i from a specific release point ($\mu Ci/s$).	2.1.5

Term	Definition	Subsection of Initial Use
Q'_{ig}	= the source term for ground-level release radioiodine, tritium, and particulate radionuclide i ($\mu Ci/s$).	2.2.1.2
Q'_{im}	= the source term for mixed-mode release radioiodine, tritium, and particulate radionuclide i ($\mu Ci/s$).	2.2.1.2
$\tilde{Q}_{ig}$	= the cumulative ground-level release of noble gas radionuclide i (μCi).	2.2.2.1
$\tilde{Q}_{im}$	= the cumulative mixed-mode release of noble gas radionuclide i (μCi).	2.2.2.1
$\tilde{Q}'_{ig}$	= the cumulative ground-level release of radioiodines, tritium, and particulate radionuclide i (μCi).	2.2.2.2
$\tilde{Q}'_{im}$	= the cumulative mixed-mode release of radioiodines, tritium, and particulate radionuclide i (μCi).	2.2.2.2
Q_F	= the feed consumption rate for cow or goat (kg/day).	2.2.2.3
q_i	= the noble gas source term for the Gaseous Waste Processing System or Containment purge ($\mu Ci/s$).	2.1.3.1 and 2.1.3.2
R_t	= the relationship between noble gas concentration and the dose rate to the total body for the conditions of the release under consideration (mrem/year/μCi/cc).	2.1.1

Term		Definition	Subsection of Initial Use
R_s	=	the relationship between noble gas concentration and the dose rate to the skin for the conditions of the release under consideration (mrem/year/μCi/cc).	2.1.1
r_t	=	the relationship between noble gas concentration 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 (mrem/year/μCi/cc).	2.1.3.1
r_s	=	the relationship between noble gas concentration 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}	=	the pathway-specific, individual age-specific, organ dose factor for radionuclide i, pathway p, organ j, and age group a, (mrem/year per $\mu Ci/m^3$) or (m^2-mrem/year/μCi/s).	2.2.2.2
r	=	the fraction of deposited radionuclide retained on vegetation (unitless).	2.2.2.2
SF	=	the safety factor used to introduce a margin of conservatism into setpoint calculations.	2.1.1
SHF	=	the shielding factor afforded by structure (unitless).	2.2.2.2
S	=	the stability parameter (s^{-2}).	2.3.1.2

Term		Definition	Subsection of Initial Use
t	=	the exposure time for radioactivity deposited on ground (s).	2.2.2.2
t_ℓ	=	the time between harvest of leafy vegetation and consumption (s).	2.2.2.2
t_{hv}	=	the time between harvest of stored vegetation and consumption (s).	2.2.2.2
t_{hm}	=	the transport time from feed to receptor for stored feed (s).	2.2.2.3
t_f	=	the transport time from feed to receptor for pasture grass (s).	2.2.2.3
U_{ap}	=	the 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}	=	the consumption rate of stored vegetation by the receptor in age group a (kg/year) from table 2.2-10.	2.2.2.2
$U_{a\ell}$	=	the 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}	=	the wind speed (midpoint of wind speed class j) at ground level during atmospheric stability class k (m/s).	2.3.1.1
U_{jk}	=	the wind speed (midpoint of wind speed class j) at the height of release, h, of an elevated release during atmospheric stability class k (m/s).	2.3.1.2

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

Term	Definition	Subsection of Initial Use
$(\overline{X/Q'})_{MP}$	= the annual average relative concentration for location of controlling (critical) receptor for inhalation and all tritium pathways for a mixed-mode release type (s/m^3).	2.2.2.2
λ_i	= the decay constant for the ith radionuclide (s^{-1}).	2.2.2.2
λ_w	= the decay constant for removal of activity on leaf and plant surfaces by weathering (s^{-1}).	2.2.2.2
Σ_{zk}	= the vertical standard deviation of the plume concentration distribution considering the initial dispersion within the building wake (m).	2.3.1.1
σ_{zk}	= the vertical standard deviation of the plume (m), for a given distance under the stability category k, indicated by $\Delta T/\Delta Z$ from figure 2.3-1.	2.3.1.1
$\Delta T/\Delta Z$	= the vertical temperature gradient used to determine the atmospheric stability category (°C/100 m or °F/100 ft).	2.3.1.1
X_{iv}	= the concentration of radionuclide i for the particular vent release pathway under consideration (μCi/ml	2.1.1

2.5 LIMITS OF OPERATION

2.5.1 Gaseous Effluents Dose Rate

The dose rate due to radioactive materials released in gaseous effluents, from the site to areas at and beyond the site boundary (see figures 3.0-1 and 3.0-2) shall be limited to less than or equal to 500 mrems/yr to the whole body for noble gases and less than or equal to 3000 mrems/yr to the skin for noble gases. The dose rate shall also be limited to 1500 mrems/yr to any organ for Iodine-131, for Iodine-133, for tritium, and for all radionuclides in particulate form with half-lives greater than 8 days. This limit applies at all times for all modes of operation.

2.5.1.1 Exceeding Gaseous Effluent Dose Rate Limits

If the dose rates exceed the above limits, immediately restore the release rate to within the above limits. These limits do not affect mode changes.

2.5.1.2 Sampling and Analysis of Gaseous Effluents

The dose rate due to Iodine-131, Iodine-133, tritium, noble gases, and all radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents shall be determined to be within the above limits by obtaining representative samples and performing analyses in accordance with the following sampling and analysis program.

2.5.1.2.1 Waste Gas Decay Tank Releases

For waste gas decay tanks, each tank must be sampled prior to its release and analyzed for noble gas principal gamma emitters to a LLD of 1.00E-4 μCi/ml.

2.5.1.2.2 Containment Purge (Venting)

For containment purges (14 in. mini or 24 in. maxi) the containment atmosphere must be sampled prior to each purge and analyzed for noble gas principal gamma emitters to a LLD of 1.00E-4 μCi/ml. In addition, a monthly tritium from a containment purge must be sampled and analyzed to an LLD of 1.00E-6 μCi/ml.

If a purge is in progress and a shutdown, startup, or a thermal power change exceeding 15 percent of rated thermal power within a one-hour period occurs, then a grab sample of the containment atmosphere must be taken and analyzed for noble gas principal gamma emitters to an LLD of 1.00E-4 μCi/ml. However, this requirement does not apply if (1) analysis shows that the dose equivalent I-131 concentration in the primary coolant has not increased more than a factor of 3 and (2) the noble gas monitor shows that effluent activity has not increased more than a factor of 3.

2.5.1.2.3 Plant Vent Continuous Release

For the plant vent a grab sample must be taken monthly and analyzed monthly for (1) noble gas principal gamma emitters to an LLD of 1.00E-4 μCi/ml and (2) tritium to an LLD of 1.00E-6 μCi/ml. Tritium samples are also required at least once per 24 hours for the Unit 1 plant vent, when the refueling canal is flooded. This does not apply to the Unit 2 plant vent, because the refueling floor ventilation exits the Unit 1 plant vent only. Also for Unit 1 plant vent only, tritium samples are required at least once per 7 days whenever spent fuel is in the spent fuel pool.

If a shutdown, startup, or a thermal power change exceeding 15 percent of rated thermal power within a 1-hour period occurs, then a grab sample of the plant vent for the affected unit must be taken and analyzed for noble gas principal gamma emitters to an LLD of 1.00E-4 μCi/ml and for tritium to an LLD of 1.00E-6 μCi/ml. However, this requirement does not apply if (1) analysis shows that the dose equivalent I-131 concentration in the primary coolant has not increased more than a factor of 3 and (2) the plant vent noble gas monitor shows that effluent activity has not increased more than a factor of 3.

In addition to the monthly sampling, a continuous composite charcoal sample must be taken and analyzed weekly for I-131 to an LLD of 1.00E-12 μCi/ml. A continuous composite particulate sample must be taken and analyzed (1) weekly for principal gamma emitters to an LLD of 1.00E-11 μCi/ml, (2) monthly for gross alpha contamination to an LLD of 1.00E-11 μCi/ml, and (3) quarterly for Sr-89 and SR-90 to an LLD of 1.00E-11 μCi/ml.

For both the charcoal and the particulate composite, the ratio of the sample flowrate to the sampled stream flowrate shall be known for the time period covered by each dose or dose rate calculation made in accordance with subsections 2.5.1, 2.5.2, and 2.5.3 of this ODCM. In addition, the charcoal and particulate samples shall be changed at least once per 7 days, and analyses shall be completed within 48 hours after removal from sampler. Sampling shall also be performed at least once per 24 hours for at least 7 days following each shutdown, startup, or thermal power change exceeding 15 percent of rated thermal power within a 1-hour period, and analyses shall be completed within 48 hours of changing. When samples collected for 24 hours are analyzed, the corresponding LLDs may be increased by a factor of 10. The requirement does not apply if (1) analysis shows that the dose equivalent I-131 concentration in the reactor coolant has not increased more than a factor of 3 and (2) the plant vent noble gas monitor shows that effluent activity has not increased more than a factor of 3.

2.5.1.2.4 Turbine Building Vent Exhaust

The turbine building vent is the release point for the condenser air ejector and steam packing exhaust. All sampling and analyses may be omitted for this vent, provided the absence of a primary to secondary leak has been demonstrated, that is, the gamma activity in the secondary water does not exceed background by more than 20 percent.

If required, a grab sample must be taken monthly and analyzed monthly for (1) noble gas principal gamma emitters to an LLD of 1.00E-4 μCi/ml and (2) tritium to an LLD of 1.00E-6 μCi/ml.

In addition to the monthly sampling, a continuous composite charcoal sample must be taken and analyzed weekly for I-131 to an LLD of 1.00E-12 μCi/ml. A continuous composite particulate sample must be taken and analyzed (1) weekly for principal gamma emitters to an LLD of 1.00E-11 μCi/ml, (2) monthly for gross alpha contamination to an LLD of 1.00E-11 μCi/ml, and (3) quarterly for Sr-89 and Sr-90 to an LLD of 1.00E-11 μCi/ml.

For both the charcoal and the particulate composite, the ratio of the sample flowrate to the sampled stream flowrate shall be known for the time period covered by each dose or dose rate calculation made in accordance with subsections 2.5.1, 2.5.2, and 2.5.3 of this ODCM. In addition, the charcoal and particulate samples shall be changed at least once per 7 days, and analyses shall be completed within 48 hours after changing. Sampling shall also be performed at least once per 24 hours for at least 7 days following each shutdown, startup, or thermal power change exceeding 15 percent of rated thermal power within a 1-hour period and analyses shall be completed within 48 hours of changing. When samples collected for 24 hours are analyzed, the corresponding LLD's may be increased by a factor of 10. This requirement does not apply if (1) analysis shows that the dose equivalent I-131 concentration in the reactor coolant has not increased more than a factor of 3 and (2) the turbine building vent noble gas monitor shows that effluent activity has not increased more than a factor of 3.

2.5.1.2.5 Basis for the Gaseous Effluent Dose Rate

This specification is provided to ensure that the dose at any time at and beyond the site boundary from gaseous effluents from all units on the site will be within the annual dose limits of 10 CFR 20 to unrestricted areas. The annual dose limits are the doses associated with the concentrations of 10 CFR 20, Appendix B, table II, column I. These limits provide reasonable assurance that radioactive material discharged in gaseous effluents will not result in the exposure of a member of the public in an unrestricted area, either within or outside the site boundary, to annual average concentrations exceeding the limits specified in Appendix B, table II, of 10 CFR 20 (10 CFR 20.106(b)). For members of the public who may at times be within the site boundary, the

occupancy of that member of the public will usually be sufficiently low to compensate for any increase in the atmospheric diffusion factor above that for the site boundary. Examples of calculations for such members of the public, with the appropriate occupancy factors, shall be given in the ODCM. The specified release rate limits restrict, at all times, the corresponding gamma and beta dose rates above background to a member of the public at or beyond the site boundary to less than or equal to 500 mrem/yr to the whole body or to less than or equal to 3000 mrem/yr to the skin. These release-rate limits also restrict, at all times, the corresponding thyroid dose rate above background to a child, via the inhalation pathway, to less than or equal to 1500 mrem/yr.

This specification applies to the release of radioactive materials in gaseous effluents from all units at the site.

The required detection capabilities for radioactive materials in gaseous waste samples are tabulated in terms of the LLDs. Detailed discussion of the LLD and other detection limits can be found in HASL Procedures Manual, HASL-300 (revised annually), L. A., Currie, "Limits for Qualitative Detection and Quantitative Determination - Application to Radio-chemistry," Anal. Chem. 40, 586-93, 1968, and J. K. Hartwell, "Detection Limits for Radioanalytical Counting Techniques," Atlantic Richfield Hanford Company Report ARH-SA-215, June 1975.

2.5.2 Noble Gas Air Dose

The air dose due to noble gases released in gaseous effluents, from each unit to areas at and beyond the site boundary (figures 3.0-1 and 3.0-2), shall be limited, during any calendar quarter, to less than or equal to 5 mrad for gamma radiation and to less than or equal to 10 mrad for beta radiation. In addition, during any calendar year, it shall be limited to less than or equal to 10 mrad for gamma radiation and to less than or equal to 20 mrad for beta radiation. This limit applies at all times for all modes of operation.

2.5.2.1 Exceeding the Noble Gas Air Doses

If the calculated air dose from radioactive noble gases in gaseous effluents exceeds any of the above limits, prepare and submit to the NRC within 30 days, pursuant to Technical Specification 6.8.2, a special report that identifies the cause(s) for exceeding the limit(s) and defines the corrective action(s) that have been taken to reduce the releases and the proposed corrective actions to be taken to assure that subsequent releases will be in compliance with the above limits. These limits do not affect mode changes.

2.5.2.2 Cumulative Dose Calculation Requirements

To assure these limits are not exceeded, the cumulative dose contributions for the current calendar quarter and current calendar year for noble gases shall be determined in accordance with the methodology and parameters of subsection 2.2.2 at least once per 31 days.

2.5.2.3 Basis for Noble Gas Air Doses

This specification is provided to implement the requirements of sections II.B, III.A, and IV.A of Appendix I, 10 CFR 50. The limiting condition for operation implements the guides set forth in section I.B of Appendix I. The action statements provide the required operating flexibility and at the same time implement the guides set forth in section IV.A of Appendix I to assure that the releases of radioactive material in gaseous effluents to unrestricted areas will be kept "as low as is reasonably achievable." The surveillance requirements implement the requirements in section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data such that the actual exposure of a member of the public through appropriate pathways is unlikely to be substantially underestimated. The dose calculation methodology and parameters established in the ODCM for calculating the doses due to the actual release rates of radioactive noble gases in gaseous effluents are consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses

to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR 50, Appendix I," Revision 1, October 1977 and Regulatory Guide 1.111, "Methods for ' 'imating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water Cooled Reactors," Revision 1, July 1977. The ODCM equations provided for determining the air doses at and beyond the site boundary are based upon the historical average atmospheric conditions.

2.5.3 Dose to A Member of the Public from Tritium, Radioiodines, and Particulates

The dose to a member of the public frcm I-131, I-133, tritium, and all radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents released, from each unit to areas at and beyond the site boundary (figures 3.0-1 and 3.0-2), shall be limited during any calendar quarter to less than or equal to 7.5 mrem to any organ and during any calendar year to less than or equal to 15 mrem to any organ. This limit applies at all times for all modes of operation.

2.5.3.1 Exceeding the Dose Limits

If the calculated dose from the release of I-131, I-133, tritium, and radionuclides in particulate form with half-lives greater than 8 days, in gaseous effluents exceeding any of the above limits, prepare and submit to the NRC within 30 days, pursuant to Technical Specification 6.8.2, a special report that identifies the cause(s) for exceeding the limit(s) and defines the corrective action(s) that have to be taken to assure that subseouent releases will be in compliance with the above limits. These limits do not affect modes changes.

2.5.3.2 Cumulative Dose Calculation Requirements

To assure these limits are not exceeded, the cumulative dose contributions for the current calendar quarter and current calendar year for I-131, I-133, tritium, and radionuclides in particulate form with half-lives greater than 8 days shall be determined in accordance with the methodology and parameters in subsection 2.2.2 at least once per 31 days.

2.5.3.3 Basis for Tritium, Radioiodine, and Particulate Organ Dose Limits

This specification is provided to implement the requirements of sections II.C, III.A, and IV.A of Appendix I, 10 CFR 50. The limiting conditions for operation are the guides set forth in section II.C of Appendix I. The action statements provide the required operating flexibility and at the same time implement the guides set forth in section IV.A of Appendix I to assure that the releases of radioactive materials in gaseous effluents to unrestricted areas will be kept "as low as is reasonably achievable." The ODCM calculational methods specified in the surveillance requirements implement the requirements in section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data, such that the actual exposure of a member of the public through appropriate pathways is unlikely to be substantially underestimated. The ODCM calculational methodology and parameters for calculating the doses due to the actual release rates of the subject materials are consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR 50, Appendix I," Revision 1, October 1977 and Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," Revision 1, July 1977. These equations also provide for determining the actual doses based upon the historical average atmospheric conditions. The release rate specifications for Iodine-131 Iodine-133, tritium, and radionuclides in particulate form with half-lives greater than 8 days are dependent upon the existing radionuclide pathways to man in the areas

at and beyond the site boundary. The pathways that were examined in the development of the calculations were (1) individual inhalation of airborne radionuclides, (2) deposition of radionuclides onto green leafy vegetation with subsequent consumption by man, (3) deposition onto grassy areas where milk animals and meat-producing animals graze, with consumption of the milk and meat by man, and (4) deposition on the ground with subsequent exposure of man.

2.5.4 Gaseous Radwaste Treatment System Operation

The ventilation exhaust treatment system and the gaseous waste processing system shall be operable, and appropriate portions of these systems shall be used to reduce releases of radioactivity when the projected doses in 31 days due to gaseous effluent releases, from each unit to areas at and beyond the site boundary (figures 3.0-1 and 3.0-2), would exceed 2.00E-1 mrad to air from gamma radiation, 4.00E-1 mrad to air from beta radiation, or 3.00E-1 mrem to any organ of a member of the public. This limit applies at all times for all modes of operation.

2.5.4.1 Exceeding the Dose Limits for Operation of the Gaseous Waste Processing System

If radioactive gaseous waste is being discharged without treatment and is in excess of the above limits, prepare and submit to the NRC within 30 days, pursuant to Technical Specification 6.8.2, a special report that includes the following information (1) identification of any inoperable equipment or subsystems and the reason for the inoperability, (2) action(s) taken to restore the inoperable equipment to operable status, and (3) summary description of action(s) taken to prevent a recurrence. These limits do not affect mode changes.

2.5.4.2 Requirement for Projecting Doses Due to Gaseous Releases

To assure these limits are not exceeded, doses due to gaseous releases, from each unit to areas at and beyond the site boundary, shall be projected at least once per 31 days in accordance with the methodology and parameters in subsection 2.2.2, when gaseous radwaste treatment systems are not being fully utilized.

2.5.4.3 Basis for the Operability of the Gaseous Waste Processing System

The operability of the gaseous waste processing system and the ventilation exhaust treatment system ensures that the systems will be available for use whenever gaseous effluents require treatment prior to release to the environment. The requirement that the appropriate portions of these systems be used, when specified, provides reasonable assurance that the releases of radioactive materials in gaseous effluents will be kept "as low as is reasonably achievable." This specification implements the requirements of 10 CFR 50.36a, General Design Criterion 60, Appendix A, 10 CFR 50, and the design objectives given in section II.D, Appendix I, 10 CFR 50. The specified limits governing the use of appropriate portions of the systems were specified as a suitable fraction of the dose design objectives set forth in sections II.B and II.C, Appendix I, 10 CFR 50, for gaseous effluents.

2.5.5 <u>Dose to the Public from the Uranium Fuel Cycle</u>

The annual (calendar year) dose or dose commitment to any member of the public due to releases of radioactivity and to radiation from uranium fuel cycle sources shall be limited to less than or equal to 25 mrem to the whole body or any organ, except the thyroid, which shall be limited to less than or equal to 75 mrem. This limit applies at all times for all modes of operation.

2.5.5.1 Cumulative Dose Calculation Requirements

To assure these limits are not exceeded, cumulative dose contributions from direct radiation from each unit (including outside storage tanks, etc.) shall be determined in accordance with the methodology and parameters in section 4.0. This requirement is applicable only if the conditions in paragraph 2.5.5.2 are met.

2.5.5.2 Conditions Required for Cumulative Dose Calculations

If the calculated doses from the release of radioactive materials in liquid or gaseous effluents exceeds twice the limits of subsections 1.5.2, 2.5.2, or 2.5.3, calculations shall be made including direct radiation contributions from the unit (including outside storage tanks etc.) to determine whether the above limits have been exceeded. If such is the case, prepare and submit to the NRC within 30 days, pursuant to Technical Specification 6.8.2, a special report that (1) defines the corrective action(s) to be taken to reduce subsequent releases to prevent recurrence of exceeding the above limits and (2) includes the schedule for achieving conformance with the above limits. This special report, as defined in 10 CFR 20.405(c), shall include an analysis that estimates the radiation exposure (dose) to a member of the public from uranium fuel cycle sources, including all effluent pathways and direct radiation, for the calendar year that includes the release(s) covered by this report. It shall also describe levels of radiation and concentrations of radioactive material involved, and the cause of the exposure levels or concentrations. If the estimated dose(s) exceeds the above limits and if the release condition resulting in violation of 40 CFR 190 has not already been corrected, the special report shall include a request for a variance in accordance with the provisions of 40 CFR 190. Submittal of the report is considered a timely request, and a variance is granted until staff action on the request is complete. These limits do not affect mode changes.

2.5.5.3 Exceeding the Dose Limitations

This specification is provided to meet the dose limitations of 40 CFR 190 that have been incorporated into 10 CFR 20 by 46 FR 18525. The specification requires the preparation and submittal of a special report whenever the calculated doses due to releases of radioactivity and to radiation from uranium fuel cycle sources that directly support the production of electrical power for public use exceed 25 mrem to the whole body or any organ, except the thyroid, which shall be limited to less than or equal to 75 mrem. For sites containing up to four reactors, it is highly unlikely that the resultant dose to a member of the public will exceed the dose limits of 40 CFR 190 if the individual reactors remain within twice the dose design objectives of Appendix I and if direct radiation doses from the units including outside storage tanks, etc. are kept small. The special report will describe a course of action that should result in the limitation of the annual dose to a member of the public to within the 40 CFR 190 limits. For the purposes of the special report, it may be assumed that the dose commitment to the member of the public from other uranium fuel cycle sources is negligible, with the exception that dose contributions from other nuclear fuel cycle facilities at the same site or within a radius of 8 km must be considered. If the dose to any member of the public is estimated to exceed the requirements of 40 CFR 190, the special report with a request for a variance (provided the release conditions resulting in violation of 40 CFR 190 have not already been corrected), in accordance with the provisions of 40 CFR 190.11 and 10 CFR 20.405c, is considered to be a timely request and fulfills the requirements of 40 CFR 190 until NRC staff action is completed. The variance only relates to the limits of 40 CFR 190 and does not apply in any way to the other requirements of dose limitation of 10 CFR 20, as addressed in subsections 1.5.1 and 2.5.1. An individual is not considered a member of the public during any period in which he/she is engaged in carrying out any operation that is part of the nuclear fuel cycle.

2.5.6 Gaseous Effluent Monitoring Instrumentation

The radioactive gaseous effluent monitoring instrumentation channels specified below shall be operable with their alarm/trip setpoints set to ensure that the limits of subsection 2.5.1 of this ODCM are not exceeded. This limit applies at all times for all modes of operation.

2.5.6.1 Nonconservative Gaseous Effluent Monitor Setpoint and ACTIONS

If a radioactive gaseous effluent monitoring instrumentation channel alarm/trip setpoint is less conservative than required by the above specification, immediately suspend the release of radioactive gaseous effluents monitored by the affected channel, or declare the channel inoperable.

If less than the minimum number of radioactive gaseous effluent monitoring instrumentation channels are operable, take the ACTION shown in table 2.5-1. Restore the inoperable instrumentation to operable status within 30 days, or, if unsuccessful, explain in the next Semiannual Radioactive Effluent Release Report, pursuant to Technical Specification 6.8.1.4, why this inoperability was not corrected in a timely manner. These limits do not affect mode changes.

2.5.6.2 Gaseous Effluent Monitor Operability

Each radioactive gaseous effluent monitoring instrumentation channel shall be demonstrated operable by performance of the channel check, source check, channel calibration, and analog channel operational test at the frequencies shown in table 2.5-1. Specific instrument numbers are provided in parentheses for information only. The numbers apply to each unit. These numbers will help to identify associated channels or loops and are not intended to limit the requirements to the specific instruments associated with the number.

TABLE 2.5-1 (SHEET 1 OF 4)

GASEOUS EFFLUENT MONITORING INSTRUMENTATION

	Minimum Channels Operable	ACTION	Channel Check	Source Check	Channel Calibration	Analog Channel Operational Test	Modes Required
1. Gas waste processing system							
a) Noble gas activity monitor - providing alarm and automatic termination of release (ARE-0014) (common)	1	45	P	P	R(3)	Q(1)	*
b) Effluent system flowrate measuring Device (AFT-0014) (common)	1	45	P	NA	R	NA	*
2. Turbine building vent							
a) Noble gas activity monitor (RE-12839C)	1	47	D	M	R(3)	Q(2)	*
b) Iodine and particulate samplers (RE-12839A&B)	1	51	W(6)	NA	NA	NA	*
c) Flowrate monitor (FT-12839 or FIS-12862)**	1	46	D	NA	R	NA	*
d) Sampler flowrate monitor (FI-13211)	1	46	D	NA	R	Q	*
3. Plant vent							
a) Noble gas activity monitor (RE-12442C or RE-12444C)	1	47,48	D	M	R(3)	Q(2)	at all times
b) Iodine sampler/monitor (RE-12442B or RE-12444B)	1	51	W(6)	NA	NA/R	NA	at all times
c) Particulate sampler/monitor (RE-12442A or RE-12444A)	1	51	D	NA	NA/R	Q	at all times
d) Flowrate monitor (FT-12442 or 12835)	1	46	D	NA	R	NA	at all times
e) Sampler flowrate monitor (FI-12442 or FI-12444)	1	46	D	NA	R	Q	at all times

TABLE NOTATIONS

1) The analog channel operational test shall also demonstrate that automatic isolation of this pathway (for item a. below only) and control room alarm annunciation occurs if any of the following conditions exists:

a. Instrument indicates measured levels above the alarm/trip setpoint.
b. Circuit failure.
c. Instrument indicates a downscale failure.
d. Instrument controls not set in operate mode. (Annunciation via computer printout.)

(2) The analog channel operational test shall also demonstrate that control room alarm annunciation occurs if any of the following conditions exists:

a. Instrument indicates measured levels above the alarm setpoint.
b. Circuit failure.
c. Instrument indicates a downscale failure.
d. Instrument controls not set in operate mode. (Annunciation via computer printout.)

(3) The initial channel calibration shall be pe ormed using one or more of the reference standards certified by the National Bureau of Standards (NBS) or using standards that have been obtained from suppliers that participate in measurement assurance activities with NBS. These standards shall permit calibrating the system over its intended range of energy and measurement range. For subsequent channel calibration, sources that have been related to the initial calibration shall be used.

(4) Not used.

(5) Not used.

(6) The channel check shall consist of visually verifying that the collection device (i.e., particulate filter or charcoal cartridge, etc.) is in place for sampling.

TABLE 2.5-1 (SHEET 3 OF 4)

ACTION STATEMENTS

ACTION 41-44 (Not Used)

ACTION 45 - With the number of channels operable less than required by the minimum channels operable requirement, the contents of the tank(s) may be released to the environment provided that prior to initiating the release

a. at least two independent samples of the tank's contents are analyzed
b. at least two technically qualified members of the facility staff independently verify the release rate calculations and discharge valve lineup.

Otherwise, suspend release of radioactive effluents via this pathway.

ACTION 46 - With the number of channels operable less than required by the minimum channels operable requirement, effluent releases via this pathway may continue provided the flowrate is estimated at least once per 4 hours.

ACTION 47 - With the number of channels operable less than required by the minimum channels operable requirement, effluent releases via this pathway may continue provided grab samples are taken at least once per 12 hours and these samples are analyzed for radioactivity within 24 hours.

ACTION 48 - With the number of channels operable less than required by the minimum channels operable requirement, immediately suspend containment purging of radioactive effluents via this pathway.

ACTION 49 - Not Used.

TABLE 2.5-1 (SHEET 4 OF 4)

ACTION 50 - Not Used.

ACTION 51 - With the number of channels operable less than required by the minimum channels operable requirement, effluent releases via the affected pathway may continue provided samples are continuously collected with auxiliary sampling equipment.

*During radioactive releases via this pathway.
**During emergency filtration.

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

f_s = the 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:

$$R_{aipj} = K'K'''F_m Q_F U_{ap} (DFL_{ij})_a (0.75(0.5/H)) \quad (27)$$

(mrem/year/μCi/m^3)

where:

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

H = the 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.

Other parameters and values as previously defined.

<u>Grass-Goat-Milk Pathway Factor</u>

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

(m^{2}mrem/year/μCi/s)

where:

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

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/year 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 = the 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 s^{-1}.

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

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

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

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

f_s = the 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:

$$R_{aipj} = K'K'''F_m Q_F U_{ap} (DFL_{ij})_a (0.75(0.5/H)) \qquad (29)$$

$$(\text{mrem/year}/\mu\text{Ci/m}^3)$$

where:

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

H = the absolute humidity of the atmosphere, in gm/m³.

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.

Other parameters and values are given above.

Grass-Cow-Meat-Pathway-Factor

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

$$(\text{m}^2\text{mrem/year}/\mu\text{Ci/s})$$

where:

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

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/year 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 = the 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 s^{-1}.

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

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

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

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

f_s = the 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:

$$R_{aipj} = K'K'''F_fQ_fU_{ap}(DFL_{ij})_a(0.75(0.5/H)) \qquad (31)$$

$$(\text{mrem/year}/\mu\text{Ci/m}^3)$$

where:

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

H = the 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.

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 subsection 3.1.2, which pertains to the Annual Land Use Survey, it may become necessary to perform dose calculations in addition to those required by subsection 2.5.3. 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 paragraph 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.

TABLE 2.2-1 (SHEET 1 OF 3)

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
Zn-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 (SHEET 2 OF 3)

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	5.86E-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

* Reference 3, Table E-10.

TABLE 2.2-1 (SHEET 3 OF 3)

INHALATION DOSE FACTORS FOR INFANT*
(mrem per pci inhaled)

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
La-140	3.61E-07	1.43E-07	3.68E-08	No Data	No Data	1.20E-04	6.06E-05
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	2.23E-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

* Reference 3, Table E-10.

TABLE 2.2-2 (SHEET 1 OF 3)

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-05	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 (SHEET 2 OF 3)

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	[illegible].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	[illegible].79E-04	1.21E-05
Ru-105	4.13E-10	No Data	1.30E-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.[illegible]E-10	[illegible].65E-10	5.30E-10	1.91E-09	2.71E-06	1.52E-05
Te-129M	5.19E-06	1.8[illegible]-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-05	No Data	[illegible].38E-06
I-131	1.30E-05	1.30E-05	7.37E-06	4.39E-03	2.13E-05	No Data	[illegible].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

* Reference 3, Table E-9.

TABLE 2.2-2 (SHEET 3 OF 3)

INHALATION DOSE FACTORS FOR CHILD*
(mrem per pci inhaled)

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
La-140	1.74E-07	6.08E-08	2.04E-08	No Data	No Data	4.94E-05	6.10E-05
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	7.7[illegible]E-09	No Data	2.26E-08	3.12E-05	3.44E-05
Ce-144	1.83E-03	5.72E-04	9.7[illegible]E-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

* Reference 3, Table E-9.

TABLE 2.2-3 (SHEET 1 OF 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-1[illegible]	No [illegible]	2.[illegible]4E-10	1.90E-06	7.18E-06
Fe-55	4.18E-06	2.98E-06	6.93E-0[illegible]	No Data	[illegible]	1.55E-05	7.99E-07
Fe-59	1.99E-06	4.62E-06	1.79E-06	[illegible]	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-05
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 (SHEET 2 OF 3)

INHALATION DOSE FACTORS FOR TEENAGER*
(mrem per pci inhaled)

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

* Reference 3, Table E-8.

TABLE 2.2-3 (SHEET 3 OF 3)

INHALATION DOSE FACTORS FOR TEENAGER*
(mrem per pci inhaled)

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
La-140	5.99E-08	2.95E-08	7.82E-09	No Data	No Data	2.68E-05	6.09E-05
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

* Reference 3, Table E-8.

TABLE 2.2-4 (SHEET 1 OF 3)

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.

TABLE 2.2-4 (SHEET 2 OF 3)

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	1.56E-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

* Reference 3, Table E-7.

TABLE 2.2-4 (SHEET 3 OF 3)

INHALATION DOSE FACTORS FOR ADULTS*
(mrem per pci inhaled)

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
La-140	4.30E-08	2.17E-08	5.73E-09	No Data	No Data	1.70E-05	5.73E-05
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	3.75E-09	4.70E-06	1.49E-05

* Reference 3, Table E-7.

TABLE 2.2-5 (SHEET 1 OF 3)

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 (SHEET 2 OF 3)

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

* Reference 3, Table E-14.

TABLE 2.2-5 (SHEET 3 OF 3)

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

* Reference 3, Table E-14.

TABLE 2.2-6 (SHEET 1 OF 3)

INGESTION DOSE FACTORS FOR CHILD*
(mrem per pci ingested)

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	5.80F-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 (SHEET 2 OF 3)

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-03	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

* Reference 3, Table E-13.

TABLE 2.2-6 (SHEET 3 OF 3)

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

* Reference 3, Table E-13.

TABLE 2.2-7 (SHEET 1 OF 3)

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.[illegible]E-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 (SHEET 2 OF 3)

INGESTION 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

* Reference 3, Table E-12.

TABLE 2.2-7 (SHEET 3 OF 3)

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

* Reference 3, Table E-12.

TABLE 2.2-8 (SHEET 1 OF 3)

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	1.0[illegible]E-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 (SHEET 2 OF 3)

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
Sb-124	2.81E-06	5.3E-08	1.11E-06	6.79E-09	No Data	2.18E-06	7.95E-05
Sb-125	2.23E-06	2.4E-08	4.48E-07	1.98E-09	No Data	2.33E-04	1.97E-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

* Reference 3, Table E-11.

TABLE 2.2-B (SHEET 3 OF 3)

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-[illegible]	No Data	2.40E-05

* Reference 3, Table E-11.

TABLE 2.2-9 (SHEET 1 OF 2)

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

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
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

* Reference 3, Table E-6.

TABLE 2.2-9 (SHEET 2 OF 2)

EXTERNAL DOSE FACTORS FOR STANDING ON CONTAMINATED GROUND*
(mrem/h per pCi/m^2)

RADIONUCLIDE	TOTAL BODY	SKIN
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
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

* Reference 3, Table E-6.

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, $U_{a\ell}$ (kg/year)	0	26	4[illegible]	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.

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 on VEGP site meteorological data collected for the period January 1, 1985, through December 31, 1987 (Reference 13).

Sector: WSW Distance: 1.2 miles Age Group: Child

Dispersion: $(\overline{X/Q'})_{GP} = 6.2E-7\ s/m^3$ $(\overline{X/Q'})_{MP} = 1.27E-7\ s/m^3$

Deposition: $(\overline{D/Q'})_{GP} = 2.8E-9\ m^{-2}$ $(\overline{D/Q'})_{MP} = 9.9E-10\ m^{-2}$

Exposure pathways: Inhalation and ground plane.

* References 12, 13, 15 and 16.

TABLE 2.2-13 (SHEET 1 OF 4)

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	table 2.2-9 (Same for all age groups)
Garden Vegetation		
Y_v	Garden vegetation areal density	2.0 kg/m^2 (Reference 3, table E-15)
$U_{a\ell}$	Leafy vegetation consumption rate for age group	table 2.2-10
U_{as}	Stored vegetation consumption rate for age group	table 2.2-10
f_ℓ	Fraction of annual intake of leafy vegetation grown locally	1.0 (Reference 1, page 36)
f_g	Fraction of annual intake of stored vegetation grown locally	0.76 (Reference 1, page 36)
H	Absolute humidity of the atmosphere	8.0 gm/m^3 (Reference 1, page 34)

TABLE 2.2-13 (SHEET 2 OF 4)

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)
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)
Y_s	Stored feed areal density	2.0 kg/m^{2}2 (Reference 3, table E-15)
f_p	Fraction of year that cow grazes on pasture	1.0 (Reference 1, page 33)
f_s	Fraction of total feed that is pasture grass while cow is on pasture	1.0 (Reference 1, page 33)
H	Absolute humidity of the atmosphere	8.0 gm/m^3 (Reference 1, page 34)
Grass-Cow-Milk		
Q_F	Feed consumption rate for cow	50 kg/day (Reference 3, table E-3)
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

TABLE 2.2-13 (SHEET 3 OF 4)

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

Parameter	Description	Value
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	1.0 (Reference 1, page 33)
f_s	Fraction of total feed that is pasture grass while cow is on pasture	1.0 (Reference 1, page 33)
H	Absolute humidity of the atmosphere	8.0 gm/m^3 (Reference 1, page 34)
Grass-Goat-Milk		
Q_F	Feed consumption rate for goat	6.0 kg/day (Reference 3, table E-3)
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 goat is on pasture	1.0 (Reference 1, page 33)

TABLE 2.2-13 (SHEET 4 OF 4)

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

Parameter	Description	Value
f_s	Fraction of total feed that is pasture grass while goat is on pasture	1.0 (Reference 1, page 33)
H	Absolute humidity of the atmosphere	8.0 gm/m^3 (Reference 1, page 34)

TABLE 2.2-14

POTENTIAL RECEPTOR LOCATIONS AND PATHWAYS
(To support subsection 2.2.2.3)

(This table has bee- 'eleted.)

TABLE 2.2-15

DISPERSION AND DEPOSITION PARAMETERS
(To Support Subsection 2.2.2.3)

(This table has been deleted.)

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:

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

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

Individual:

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

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.

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:

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

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

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

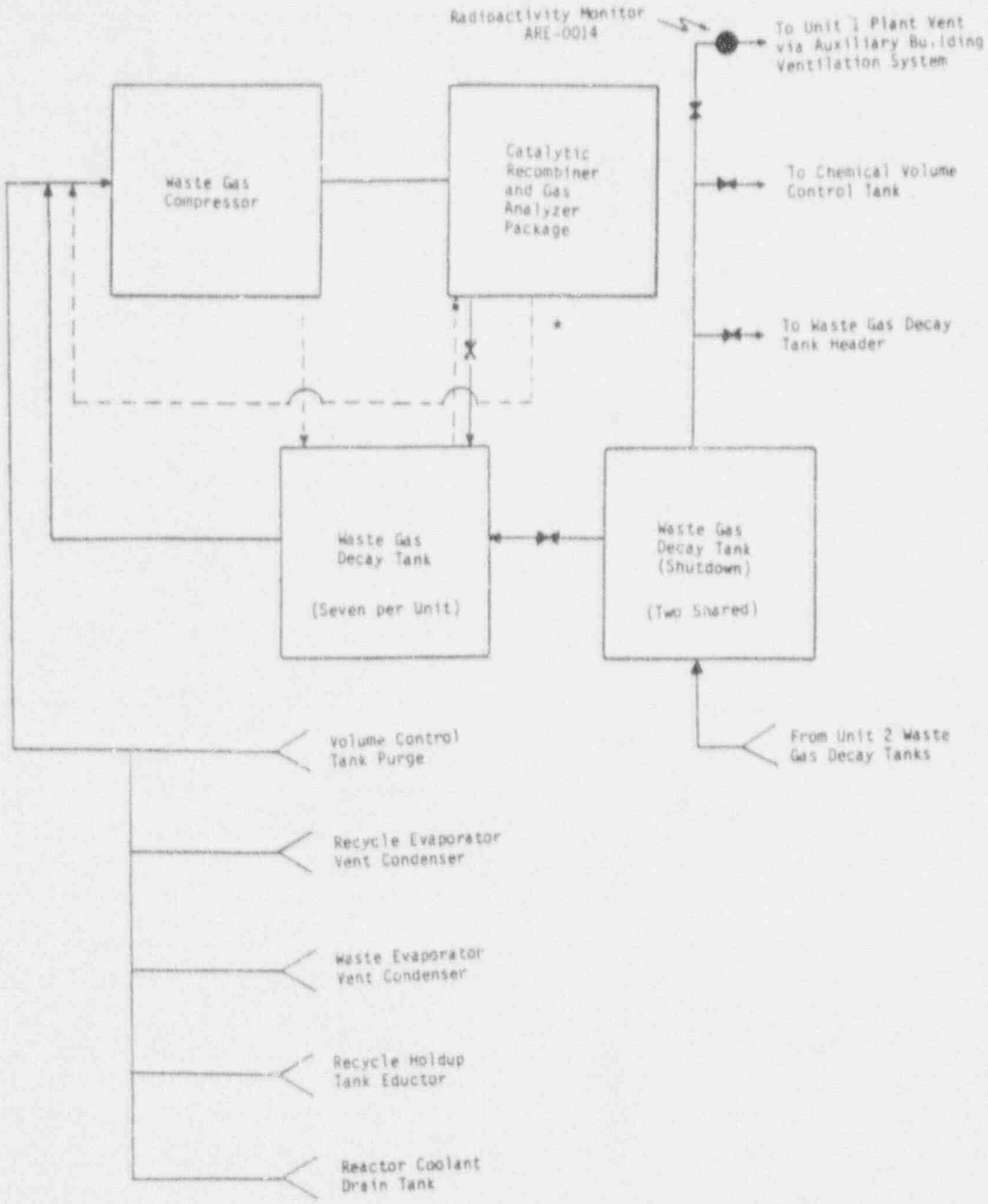
Where D_{PA} is the expected dose due to the particular planned activity.

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 paragraph 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 paragraph 2.2.2.2 using sample analyses results for the particular release point and parametric values expected to exist for the release period.

2.6 GASEOUS RADWASTE TREATMENT SYSTEMS

Figures 2.6-1, 2.6-2, 2.6-3, and 2.6-4 present schematics of the Gaseous Waste Processing System and Ventilation Exhaust Treatment Systems (Reference 5).



*Dotted line operational between 20 and 100 psig

NOTE: This is typical of both units. However, Unit 2 GWPS releases via Unit 1 plant vent.

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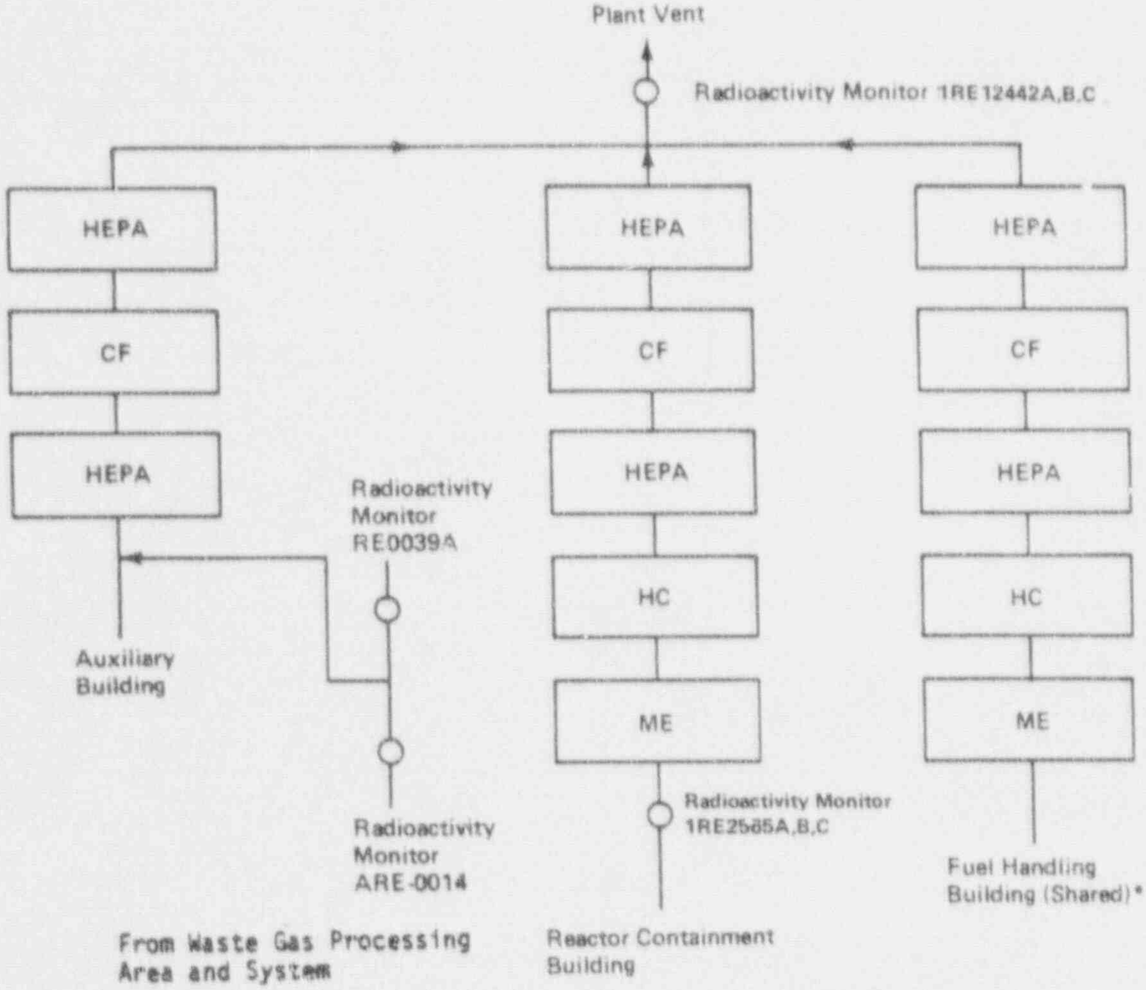
VOGTLE
ELECTRIC GENERATING PLANT
UNIT 1 AND UNIT 2

GASEOUS WASTE PROCESSING SYSTEM

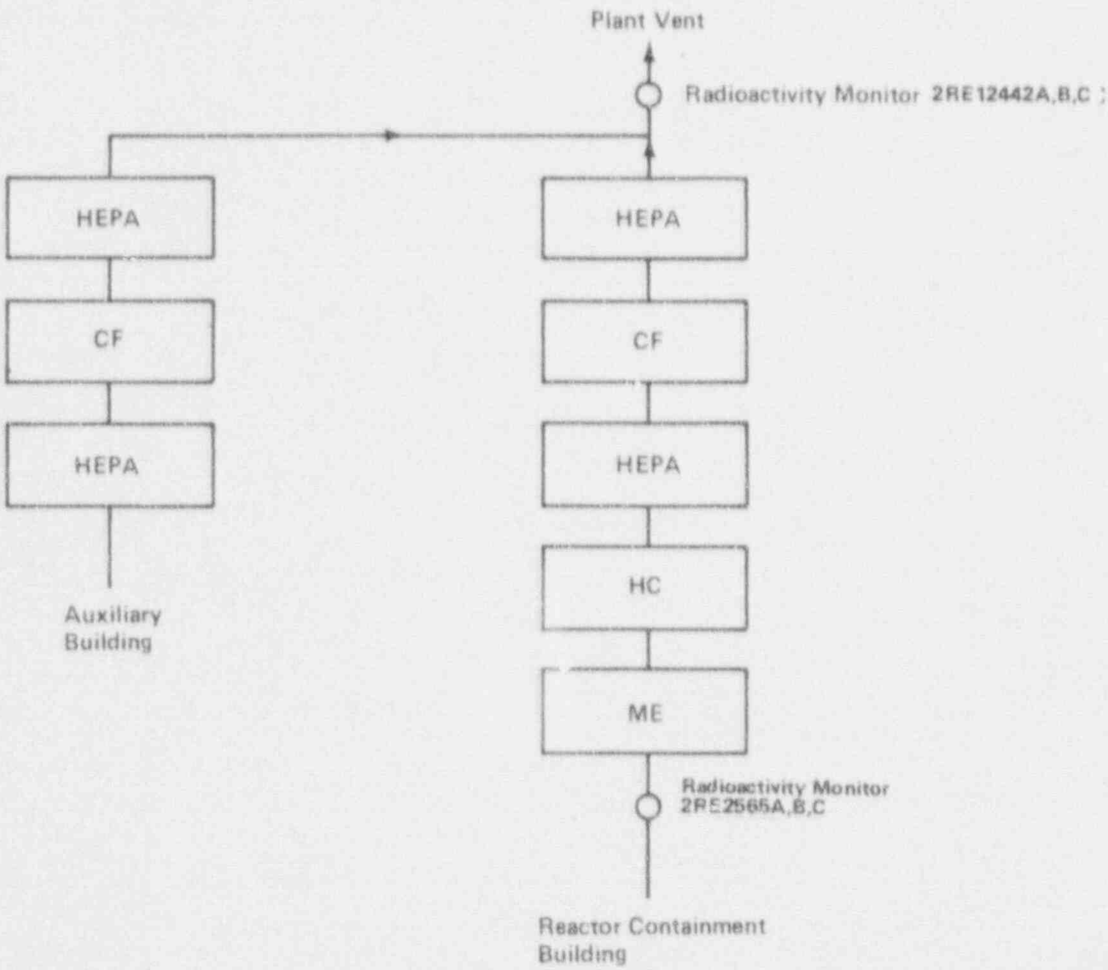
FIGURE 2.6-1



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.

Georgia Power	VOGTLE ELECTRIC GENERATING PLANT UNIT 1 AND UNIT 2	VENTILATION EXHAUST TREATMENT SYSTEM UNIT 1 (PLANT VENT)
		FIGURE 2.6-2



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

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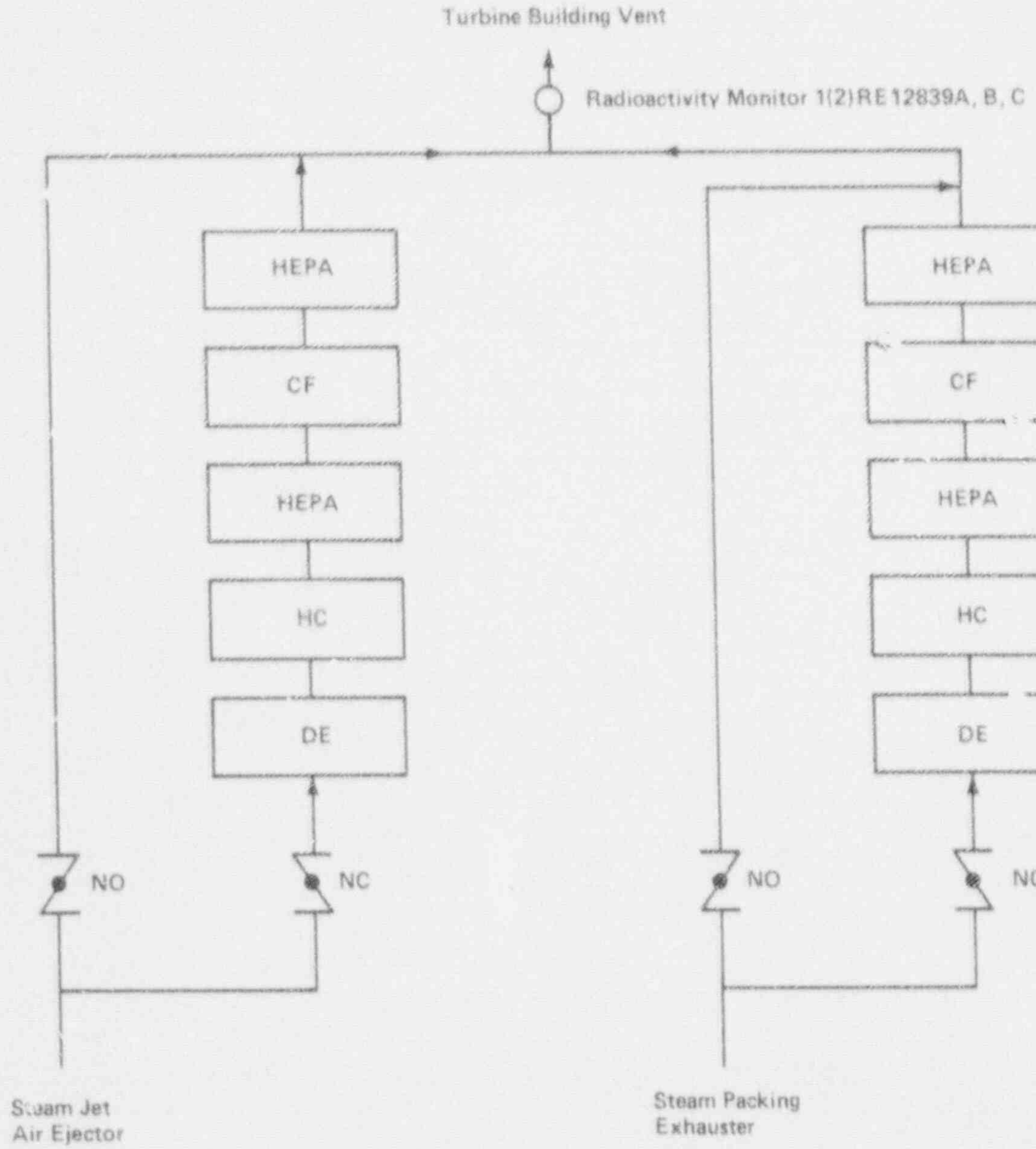
VOGTLE
ELECTRIC GENERATING PLANT
UNIT 1 AND UNIT 2

VENTILATION EXHAUST TREATMENT SYSTEM
Unit 2 (Plant Vent)

FIGURE 2.6-3



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

NOTE: This is typical of both units.

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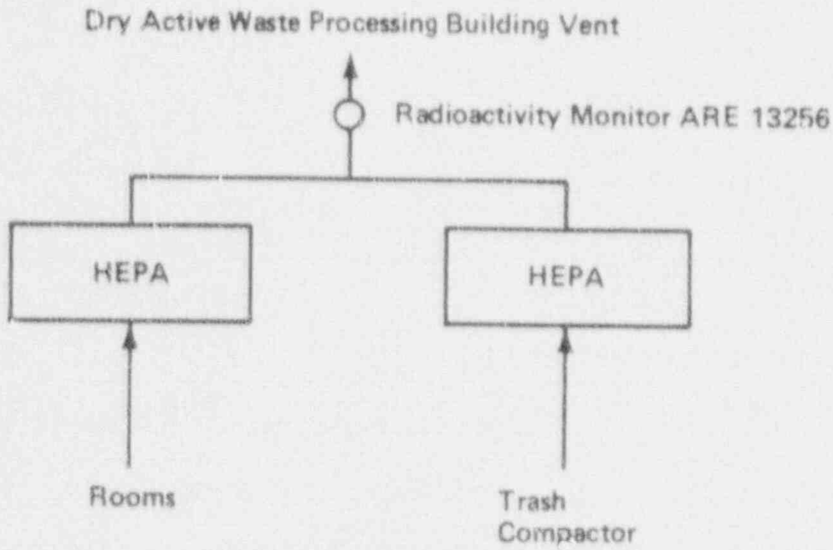
VOGTLE
ELECTRIC GENERATING PLANT
UNIT 1 AND UNIT 2

VENTILATION EXHAUST TREATMENT SYSTEM
(Turbine Building)

FIGURE 2.6-4



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VOGTLE
ELECTRIC GENERATING PLANT
UNIT 1 AND UNIT 2

VENTILATION EXHAUST TREATMENT SYSTEM
(DAW Process Building)

FIGURE 2.6-5

433-9

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 subsections 3.1.1 and 3.1.2.

TABLE 3.0-1 (SHEET 1 OF 3)

RADIOLOGICAL ENVIRONMENTAL SAMPLING LOCATIONS

LOCATION NUMBER	DESCRIPTIVE LOCATION	DIRECTION	DISTANCE (miles)	SAMPLE TYPE(1)
1	Hancock Landing Road	N	1.1	D
2	River Bank	NNE	0.8	D
3	Discharge Area	NE	0.6	A
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	1.7	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
13	River Road	W	1.3	D,V
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
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	Nathaniel Howard Road	WNW	5.0	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	14.9	D,A
37	Substation (Waynesboro)	WSW	17.5	D,V

TABLE 3.0-1 (SHEET 2 OF 3)

RADIOLOGICAL ENVIRONMENTAL SAMPLING LOCATIONS

LOCATION NUMBER	DESCRIPTIVE LOCATION	DIRECTION	DISTANCE (miles)	SAMPLE TYPE(1)
43	Employees Recreation Area	SW	2.2	D
80	Augusta Water Treatment Plant	NNW	24.5	W(2)
81	Savannah River (RM 153.1)	N	2.2	F(3)
82	Savannah River (RM 151.2)	NNE	0.8	R
83	Savannah River (RM 150.4)	ENE	0.8	R
84	Savannah River (RM 149.5)	ESE	1.6	R,S(4)
85	Savannah River (RM 146.7)	ESE	5.0	F(3)
87	Beaufort-Jasper Water Treatment Plant; Beaufort, S.C.	SE	76	W(5)
88	Cherokee Hill Water Treatment Plant; Port Wentworth, Ga.	SSE	72	W(6)
98	W. C. Dixon Dairy	SE	9.8	M
99	Boyceland Dairy	W	24.5	M

TABLE NOTATIONS:

(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) The intake for the Augusta Water Treatment Plant is located on the Augusta Canal. The entrance to this canal is at river mile (RM) 207 on the Savannah River. The canal effectively parallels the river. The pumping station is 3.5 miles down the canal and only a few tenths of a mile from the river (across land).

(3) About a 5-mile stretch of the river is generally needed to obtain adequate fish samples. Samples are normally gathered between RM 153 and 158 for upriver collections and between RMs 144 and 149.4 for downriver collections.

TABLE 3.0-1 (SHEET 3 OF 3)

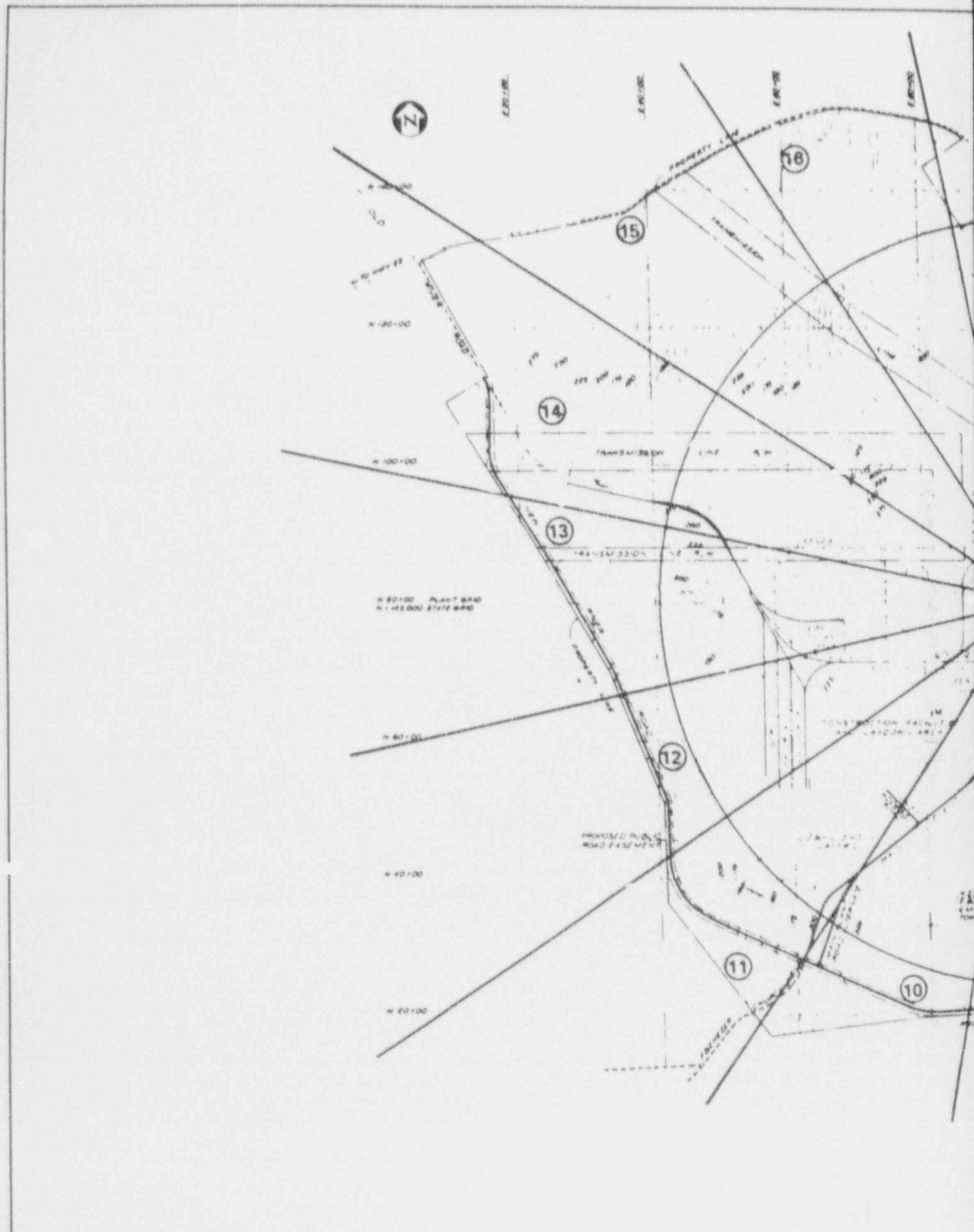
RADIOLOGICAL ENVIRONMENTAL SAMPLING LOCATIONS

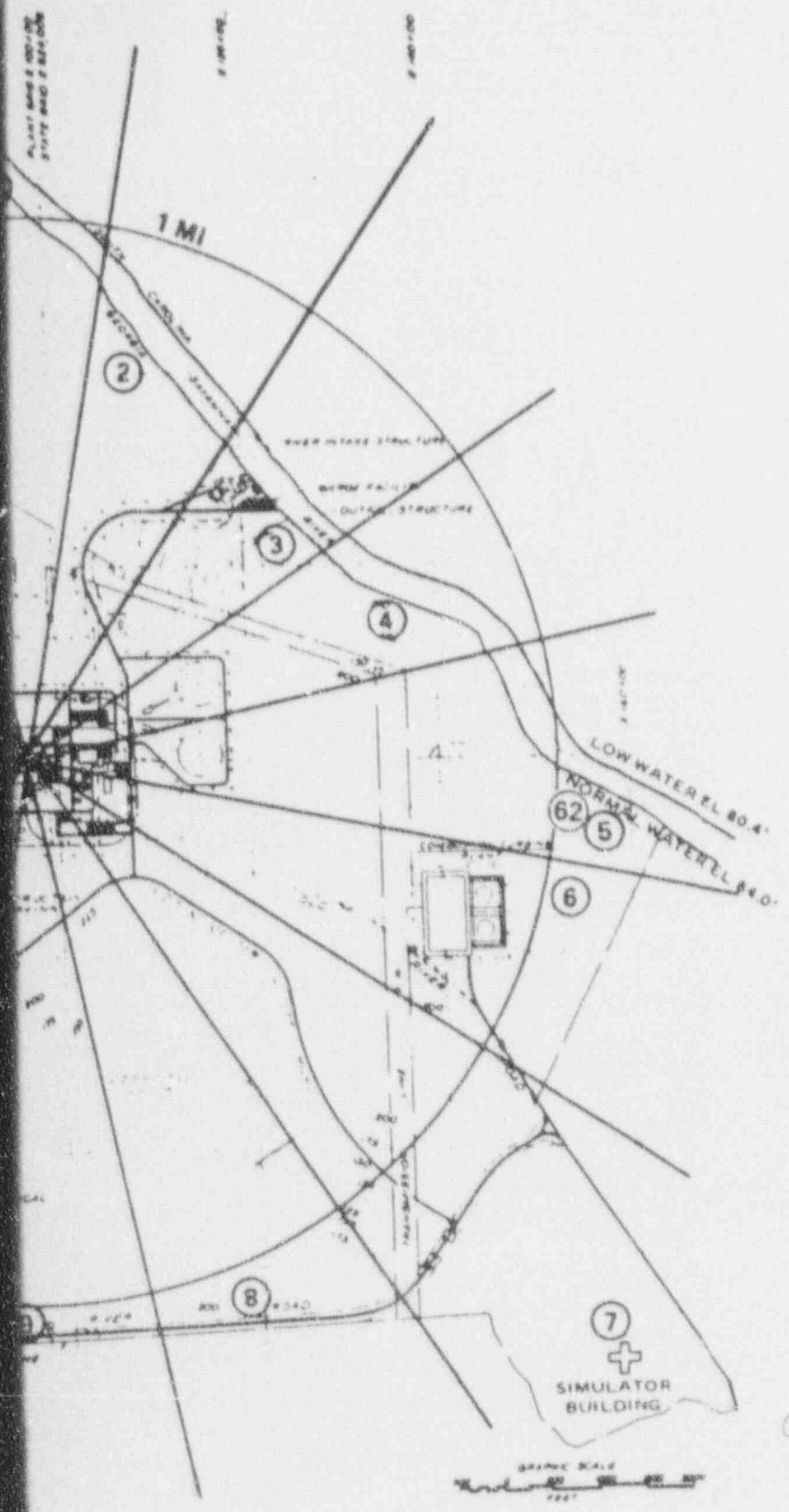
Table Notations (Continued)

(4) Sediment is collected at locations with existing or potential recreational value. Because high water shifting of the river bottom or other reasons could cause a suitable location for sediment collection to become unavailable or unsuitable, a stretch of the river between RM 148.5 and 150.5 which is downriver of the discharge is assigned for sediment collections. In practice, collections are normally made at RM 150.2.

(5) The intake for the Beaufort-Jasper Water Treatment Plant is located at the end of a canal which begins at RM 59.3 on the Savannah River. This intake is about 16 miles by line of sight down the canal from its beginning on the Savannah River.

(6) The intake for the Cherokee Hill Water Treatment Plant is located on Abercorn Creek which is about one and a quarter creek miles from its mouth on the Savannah River at RM 29.


16
15
14
13
12
11
10
N 120+00
N 100+00
N 60+00
N 40+00
N 20+00
PROPOSED PUBLIC ROAD EASEMENT



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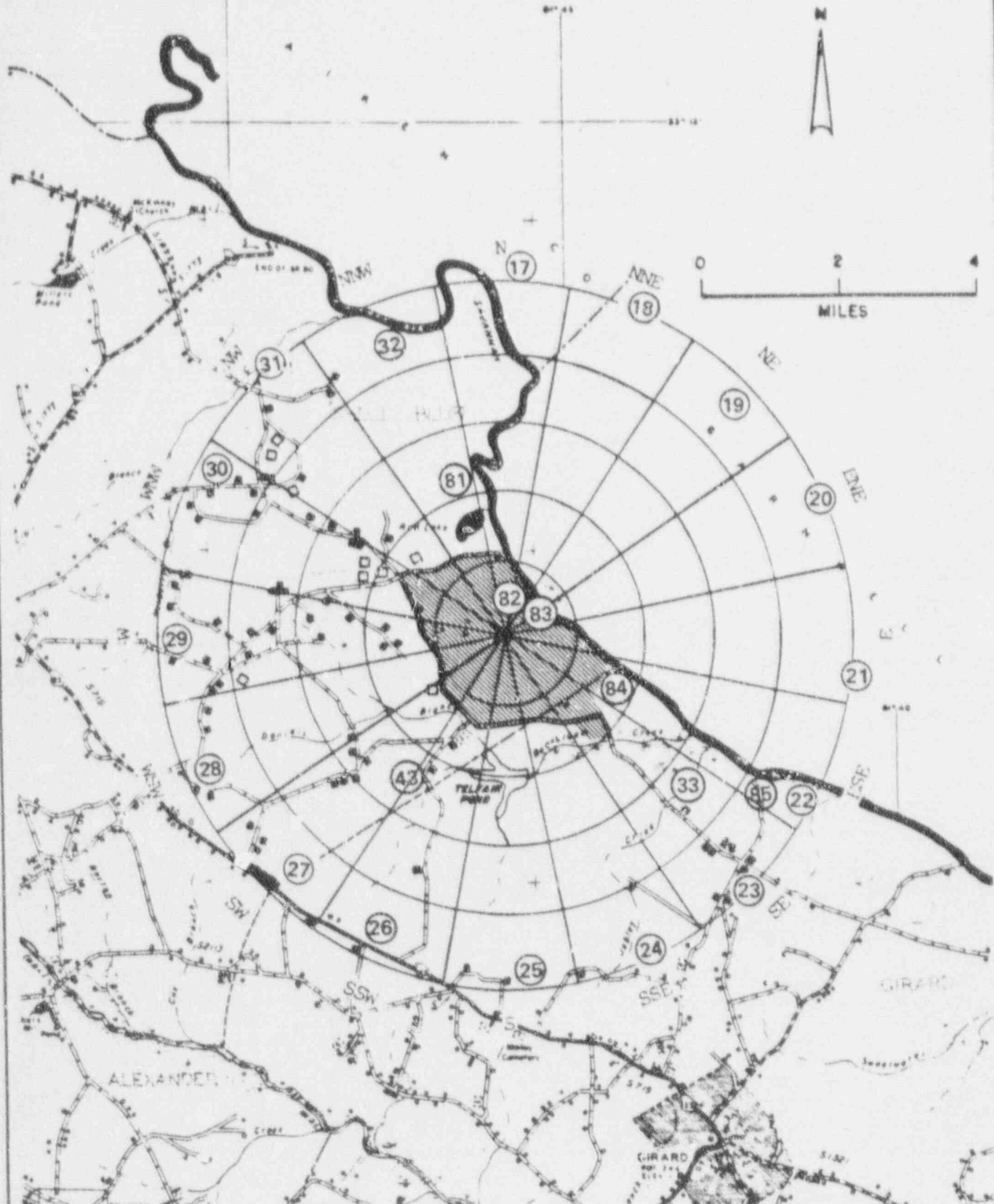
ELECTRIC GENERATING PLANT
UNIT 1 AND UNIT 2

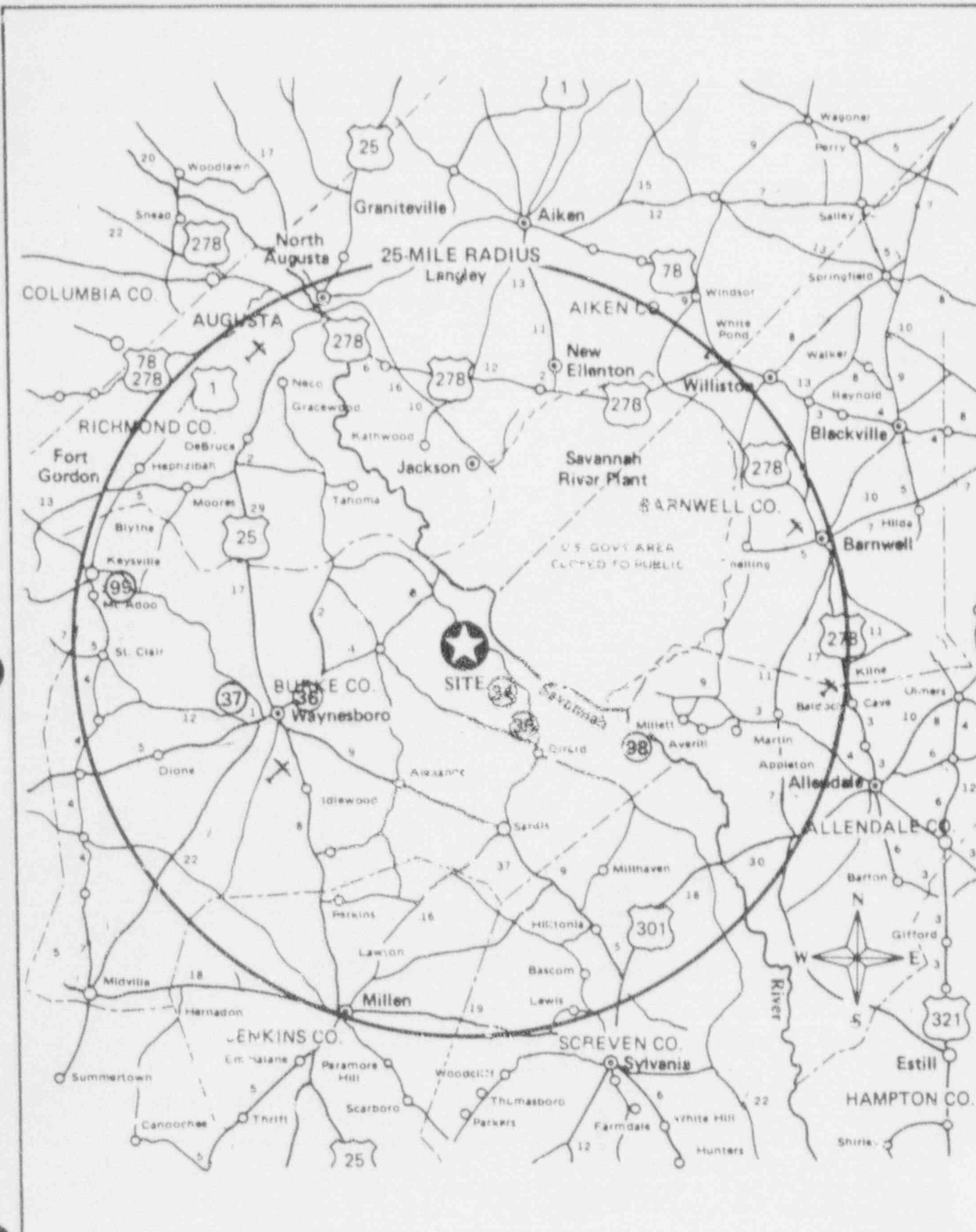
TERRESTRIAL STATIONS NEAR SITE BOUNDARY

FIGURE 3.0-1



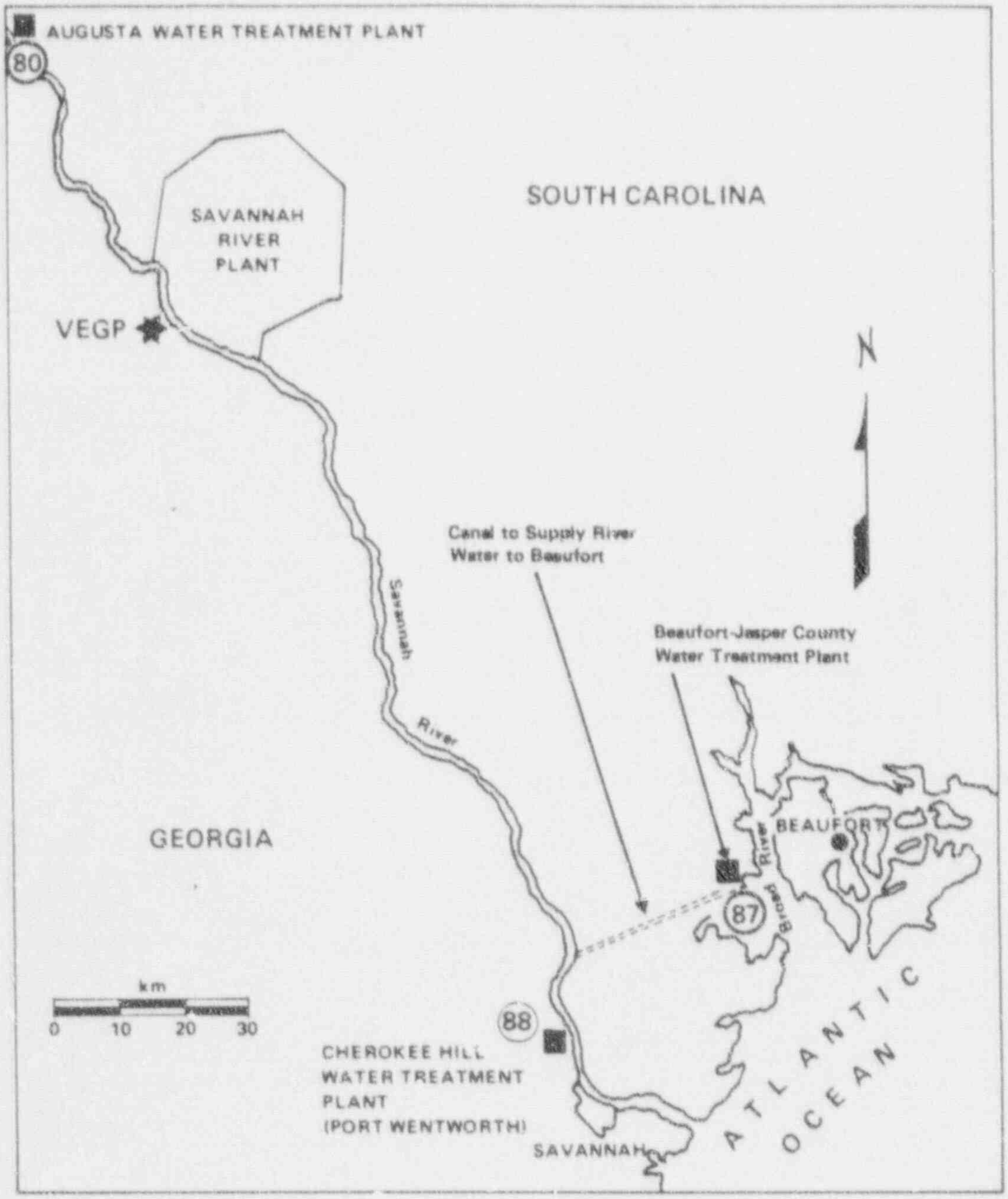
Georgia Power VOGTLE ELECTRIC GENERATING PLANT UNIT 1 AND UNIT 2	TERRESTRIAL STATIONS BEYOND SITE BOUNDARY OUT TO APPROXIMATELY 5 miles AND AQUATIC STATIONS
	FIGURE 3.0-2

433-9



Georgia Power VOGTLE ELECTRIC GENERATING PLANT UNIT 1 AND UNIT 2	TERRESTRIAL STATIONS BEYOND 5 miles
	FIGURE 3.0-3

433-9



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VOGTLE
ELECTRIC GENERATING PLANT
UNIT 1 AND UNIT 2

DRINKING-WATER STATIONS

FIGURE 3.0-4

433-9

3.1 Limits of Operation

3.1.1 Conduct of the Radiological Environmental Monitoring Program

The Radiological Environmental Monitoring Program shall be conducted as specified in table 3.1-1. This limit applies at all times for all modes of operation.

3.1.1.1 Reporting of Abnormal Conditions

If the Radiological Environmental Monitoring Program is not being conducted as specified in table 3.1-1, prepare and submit to the NRC, in the Annual Radiological Environmental Surveillance Report required by Technical Specification 6.8.1.3, a description of the reasons for not conducting the program as required and the plans for preventing a recurrence.

If the confirmed* level of radioactivity as the result of plant effluents in an environmental sampling medium at a specified location exceeds the reporting levels of table 3.1-2 when averaged over any calendar quarter, prepare and submit to the NRC within 30 days, pursuant to Technical Specification 6.8.2, a special report that identifies the cause(s) for exceeding the limit(s) and defines the corrective action(s) to be taken to reduce radioactive effluents so that the potential annual dose** to a member of the public is less than the calendar year limits of subsections 1.5.2 , 2.5.2, or 2.5.3. When more than one of the radionuclides in table 3.1-2 are detected in the sampling medium, this report shall be submitted if:

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*A confirmatory reanalysis of the original, a duplicate, or a new sample may be desirable or appropriate. The result of the confirmatory analysis shall be completed at the earliest time consistent with the analysis but in any case within 30 days.

**The methodology and parameters used to estimate the potential annual dose to a member of the public shall be indicated in this report.

$$\frac{\text{concentration (1)}}{\text{reporting level (1)}} + \frac{\text{concentration (2)}}{\text{reporting level (2)}} + \ldots \geq 1.0$$

When radionuclides other than those in table 3.1-2 are detected and are the result of plant effluents, this report shall be submitted if the potential annual dose* to a member of the public from all radionuclides is equal to or greater than the calendar-year limits of subsections 1.5.2, 2.5.2, or 2.5.3. This report is not required if the measured level of radioactivity was not the result of plant effluents. However, in such an event, the condition shall be reported and described in the Annual Radiological Environmental Surveillance Report required by Technical Specification 6.8.1.3.

If milk or vegetation samples are unavailable from one or more of the sample locations required by table 3.1-1, identify specific locations for obtaining replacement samples, and add them within 30 days to the Radiological Environmental Monitoring Program given in section 3.0. The specific locations from which samples were unavailable may then be deleted from the monitoring program. Pursuant to Technical Specification 6.13, submit in the next Semiannual Radioactive Effluent Release Report documentation for a change in the ODCM including a revised figure(s) and table for this ODCM reflecting the new location(s), with supporting information identifying the cause of the unavailability of samples and justifying the selection of the new location(s) for obtaining samples. These limits do not affect mode changes.

3.1.1.2 Collection and Analysis of Samples

To assure that these limits are not exceeded, the radiological environmental monitoring samples shall be collected pursuant to table 3.1-1 from the specific locations given in the table and figure(s) in section 3.0 and shall be analyzed pursuant to the requirements of table 3.1-1 and the detection capabilities required by table 3.1-3.

*The methodology and parameters used to estimate the potential annual dose to a member of the public shall be indicated in this report.

3.1.1.3 Basis for the Radiological Environmental Monitoring Program

The Radiological Environment Monitoring Program required by this specification provides representative measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides that lead to the highest potential radiation exposure of members of the public resulting from the plant operation. This monitoring program implements section IV.B.2, Appendix I, 10 CFR 50, and thereby supplements the Radiological Effluent Monitoring Program by measuring concentrations of radioactive materials and levels of radiation that may be compared with those expected on the basis of the effluent measurements and the modeling of the environmental exposure pathways. Guidance for this monitoring program is provided by the "Radiological Assessment Branch Technical Position on Environmental Monitoring," Revision 1, November 1979. The initially specified monitoring program will be effective for at least the first 3 years of commercial operation. Following this period, program changes may be initiated based on operational experience.

The required detection capabilities for environmental sample analyses are tabulated in terms of the LLDs. The LLDs required by table 3.1-3 are considered optimum for routine environmental measurements in industrial laboratories. It should be recognized that the LLD is defined as an *a priori* (before the fact) limit representing the capability of a measurement system and not as an *a posteriori* (after the fact) limit for a particular measurement.

Detailed discussion of the LLD, and other detection limits, can be found in L. A. Currie, "Limits for Qualitative Detection and Quantitative Determination - Application to Radiochemistry," Anal. Chem. 40, 586-93, 1968, and J. K. Hartwell, "Detection Limits for Radioanalytical Counting Techniques," Atlantic Richfield Hanford Company Report ARH-SA-215, June 1975.

3.1.2 Land Use Census

A land use census shall be conducted and shall identify within a distance of 5 miles the location in each of the 16 meteorological sectors of the nearest milk animal, the nearest residence, and the nearest garden of greater than 500 ft^2 producing broad leaf vegetation. Land within the Savannah River plant may be excluded from this survey. This limit applies at all times for all modes of operation.

3.1.2.1 Identification of New Critical Locations

If a land use census identifies a location(s) that yields a calculated dose or dose commitment greater than the values currently being calculated in subsection 2.5.3 pursuant to Technical Specification 6.8.1.4, identify the new location(s) in the next Semiannual Radioactive Effluent Release Report.

If a land use census identifies a location(s) that yields a calculated dose or dose commitment (via the same exposure pathway) 20 percent greater than at a location from which samples are currently being obtained in accordance with subsection 3.1.1, add the new location(s) within 30 days to the Radiological Environmental Monitoring Program given in section 3.0, if samples are available. The sampling location(s) (excluding the control-station location) having the lowest calculated dose or dose commitment(s), via the same exposure pathway, may then be deleted from this monitoring program. Pursuant to Technical Specification 6.13, submit in the next Semiannual Radioactive Effluent Release Report documentation for a change in this ODCM including a revised figure(s) and table(s) reflecting the new location(s) with information supporting the change in sampling locations. These limits do not affect modes changes.

3.1.2.2 Conduct of Census

To assure that these limits are not exceeded, the land use census shall be conducted during the growing season at least once per 12 months using that information that will provide good results, such as by a door-to-door survey, by visual survey from automobile or aircraft, by consulting local agriculture authorities, or by some combination of these methods as feasible. The results of the land use census shall be included in the Annual Radiological Environmental Surveillance Report pursuant to Technical Specification 6.8.1.3.

3.1.2.3 Identification of Changes

This specification is provided to ensure that changes in the use of areas at and beyond the site boundary are identified and that modifications to the Radiological Environmental Monitoring Program are made if required by the results of this census. The best information from the door-to-door survey, from aerial survey, or from consulting with local agricultural authorities shall be used. This census satisfies the requirements of section IV.B.3, Appendix I, 10 CFR 50. Restricting the census to gardens of greater than 500 ft^2 provides assurance that significant exposure pathways via leafy vegetables will be identified and monitored since a garden of this size is the minimum required to produce the quantity (26 kg/yr) of leafy vegetables assumed in Regulatory Guide 1.109 for consumption by a child. To determine this minimum garden size, the following assumptions were made: (1) 20 percent of the garden was used for growing broad leaf vegetation (i.e., similar to lettuce and cabbage) and (2) a vegetation yield of 2 kg/m^2 was obtained.

TABLE 3.1-1 (SHEET 1 OF 6)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS[1]	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
1. Direct Radiation[2]	Thirty-six routine monitoring stations, either with two or more dosimeters or with one instrument for measuring and recording dose rate continuously, placed as follows: An inner ring of stations, one in each meteorological sector in the general area of the site boundary. An outer ring of stations, one in each meteorological sector in the 6-mile range from the site. The balance of the stations to be placed in special interest areas such as population centers, nearby residences, schools, and in one or two areas to serve as control stations.	Quarterly.	Gamma dose quarterly.

TABLE 3.1-1 (SHEET 2 OF 6)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS[1]	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
2. Airborne			
Radioiodine and Particulates	Samples from five locations. Three samples from close to the three site boundary locations, in different sectors. One sample from the vicinity of a community having the highest calculated annual average ground-level D/Q. One sample from a control location, as, for example, a population center 10 to 20 miles distant and in the least prevalent wind direction.	Continuous sampler operation with sample collection weekly, or more frequently if required by dust loading.	<u>Radioiodine Cannister</u>: I-131 analysis weekly. <u>Particulate Sampler</u>: Gross beta radioactivity analysis following filter change,[3] and gamma isotopic analysis[4] of composite (by location) quarterly.
3. Waterborne			
a. Surface[5]	One sample upstream. One sample downstream.	Composite sample over 1-month period.[6]	Gamma isotopic analysis[4] monthly; composite for tritium analysis quarterly.

TABLE 3.1-1 (SHEET 3 OF 6)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS[1]	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
3. Waterborne (Continued)			
b. Drinking	Two samples at each of one to three of the nearest water treatment plants that could be affected by its discharge. Two samples at a control location.	Composite sample of river water near intake at each water treatment plant over 2-week period[6] when I-131 analysis is performed, monthly composite otherwise; and grab sample of finished water at each water treatment plant every 2 weeks or monthly, as appropriate.	I-131 analysis on each sample when the dose calculated for the consumption of the water is greater than 1 mrem per year[7]. Composite for gross beta and gamma isotopic analyses[4] monthly. Composite for tritium analysis quarterly.
c. Sediment from Shoreline	One sample from downstream area with existing or potential recreational value.	Semiannually.	Gamma isotopic analysis[4] semiannually.
4. Ingestion			
a. Milk	Samples from milking animals in three locations within 3 miles distance having the highest dose potential; if there are none, then one sample from milking animals[8] in each of three areas between 3 and 5 miles distance where doses are calculated to be greater than 1 mrem per yr.[7]	Semimonthly.	Gamma isotopic analysis[4][9] semimonthly.

TABLE 3.1-1 (SHEET 4 OF 6)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS[1]	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
4. Ingestion (Continued)			
a. Milk	One sample from milking animals[8] at a control location about 10 miles distant or beyond and preferably in a wind direction of lower prevalence.		
b. Fish	At least one sample of any commercially and recreationally important species in vicinity of plant discharge area.	Semiannually.	Gamma isotopic analysis[4] on edible portions.
	At least one sample of any species in areas not influenced by plant discharge.		
	At least one sample of any anadromous species in vicinity of plant discharge.	During spring spawning season.	Gamma isotopic analyses[4] on edible portion.
c. Grass or Leafy Vegetation	One sample from two onsite locations near the site boundary in different sectors.	Monthly during growing season.	Gamma isotopic.[4][9]
	One sample from a control location about 15 miles distant.	Monthly during growing season.	Gamma isotopic.[4][9]

TABLE 3.1-1 (SHEET 5 OF 6)

TABLE NOTATIONS

(1) Specific parameters of distance and direction sector from a point midway between the center of the two reactors, and additional description where pertinent, shall be provided for each and every sample location in table 3.1-1 in a table and figure(s) in this ODCM. Each sample location will be designated by a number, name, or some other label. Refer to NUREG-0133, "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants," October 1978 and to "Radiological Assessment Branch Technical Position," Revision 1, November 1979.

Deviations are permitted from the required sampling schedule if specimens are unobtainable due to circumstances, such as hazardous conditions, seasonal unavailability, and malfunction of sampling equipment. If specimens are unobtainable due to sampling equipment malfunction, effort shall be made to complete corrective action prior to the end of the next sampling period. All deviations from the sampling schedule shall be documented in the Annual Radiological Environmental Surveillance Report pursuant to Technical Specification 6.8.1.3.

It is recognized that, at times, it may not be possible or practicable to continue to obtain samples of the media of choice at the most desired location or time. In these instances, suitable alternative media and locations may be chosen for the particular pathway in question and appropriate substitutions, if available, will be made within 30 days in the Radiological Environmental Monitoring Program given in this ODCM. Pursuant to Technical Specification 6.13, submit in the next Semiannual Radioactive Effluent Release Report documentation for a change in this ODCM, including a revised figure(s) and table reflecting the new location(s), if any, with supporting information identifying the cause of the unavailability of samples for the pathway and justifying the selection of the new location(s) for obtaining samples or the unavailability of suitable new locations.

(2) One or more instruments, such as a pressurized ion chamber, for measuring and recording dose rate continuously, may be used in place of or in addition to integrating dosimeters. For the purpose of this table, a thermoluminescent dosimeter (TLD) is considered to be one phosphor; two or more phosphors in a packet are considered as two or more dosimeters. Film badges shall not be used as dosimeters for measuring direct radiation.

(3) Airborne particulate sample filters shall be analyzed for gross beta radioactivity 24 hours or more after sampling to allow for radon and thoron daughter decay. If gross beta activity in air particulate samples is greater than 10 times the yearly mean of control samples, gamma isotopic analysis shall be performed on the individual samples.

TABLE 3.1-1 (SHEET 6 OF 6)

TABLE NOTATIONS

(4) Gamma isotopic analysis means the identification and quantification of gamma-emitting radionuclides that may be attributable to the effluents from the facility.

(5) The upstream sample shall be taken at a distance beyond significant influence of the discharge. The downstream sample shall be taken in an area beyond but near the mixing zone.

(6) Composite sample aliquots shall be collected at time intervals that are very short (e.g., hourly) relative to the compositing period (e.g., monthly) in order to assure obtaining a representative sample.

(7) The dose shall be calculated for the maximum organ and age group, using the methodology and parameters in the ODCM.

(8) A milking animal is a cow or goat producing milk for human consumption.

(9) If gamma isotopic analysis is not sensitive enough to meet the lower limit of detection for I-131, a separate analysis for I-131 will be performed.

TABLE 3.1-2

REPORTING LEVELS FOR RADIOACTIVITY CONCENTRATIONS IN ENVIRONMENTAL SAMPLES

REPORTING LEVELS

ANALYSIS	WATER (pCi/l)	AIRBORNE PARTICULATE OR GASES (pCi/m³)	FISH (pCi/kg, wet)	MILK (pCi/l)	GRASS OR LEAFY VEGETATION (pCi/kg, wet)
H-3	20,000*				
Mn-54	1,000		30,000		
Fe-59	400		10,000		
Co-58	1,000		30,000		
Co-60	300		10,000		
Zn-65	300		20,000		
Zr-95	400				
Nb-95	400				
I-131	2	0.9		3	100
Cs-134	30	10	1,000	60	1,000
Cs-137	50	20	2,000	70	2,000
Ba-140	200			200	
La-140	100			300	

*For drinking water samples. This is 40 CFR 141 value. If no drinking water pathway exists, a value of 30,000 pCi/l may be used.

TABLE 3.1-3 (SHEET 1 OF 3)

DETECTION CAPABILITIES FOR ENVIRONMENTAL SAMPLE ANALYSIS[1][2]

LOWER LIMIT OF DETECTION (LLD)[3]

ANALYSIS	WATER (pCi/l)	AIRBORNE PARTICULATE OR GASES (pCi/m^3)	FISH (pCi/kg, wet)	MILK (pCi/l)	GRASS OR LEAFY VEGETATION (pCi/kg, wet)	SEDIMENT (pCi/kg, dry)
Gross Beta	4	0.01				
H-3	2000[4]					
Mn-54	15		130			
Fe-59	30		260			
Co-58	15		130			
Co-60	15		130			
Zn-65	30		260			
Zr-95	30					
Nb-95	15					
I-131	1[5]	0.07		1	60	
Cs-134	15	0.05	130	15	60	150
Cs-137	18	0.06	150	18	80	180
Ba-140	60			60		
La-140	15			15		

TABLE 3.1-3 (SHEET 2 OF 3)

TABLE NOTATIONS

(1) This list does not mean that only these nuclides are to be considered. Other peaks that are identifiable as plant effluents, together with those of the above nuclides, shall also be analyzed and reported in the Annual Radiological Environmental Surveillance Report pursuant to Technical Specification 6.8.1.3.

(2) Required detection capabilities for thermoluminescent dosimeters used for environmental measurements shall be in accordance with the recommendations of Regulatory Guide 4.13.

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

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

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

where:

LLD = the *a priori* lower limit of detection (picoCuries per unit mass or volume)

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

E = the counting efficiency (counts per disintegration)

V = the sample size (units of mass or volume)

TABLE 3.1-3 (SHEET 3 OF 3)

TABLE NOTATIONS (Continued)

2.22 = the number of disintegrations per minute per picoCurie

Y = the fractional radiochemical yield, when applicable

λ = the radioactive decay constant for the practicular radionuclide (sec^{-1})

Δt = the elapsed time between sample collection, or end of the sample collection period, and time of counting (sec)

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

It should be recognized that the LLD is defined as an *a priori* (before the fact) limit representing the capability of a measurement system and not as an *a posteriori* (after the fact) limit for a particular measurement. Analyses shall be performed in such a manner that the stated LLDs will be achieved under routine conditions. Occasionally background fluctuations, unavoidable small sample sizes, the presence of interfering nuclides, or other uncontrollable circumstances may render these LLDs unachievable. In such cases, the contributing factors shall be identified and described in the Annual Radiological Environmental Surveillance Report pursuant to Technical Specification 6.8.1.3.

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

(5) If no drinking water pathway exists, a value of 15 pCi/l may be used.

3.2 INTERLABORATORY COMPARISON PROGRAM

3.2.1 Requirements

Analysis shall be performed on all radioactive materials, supplied as part of an interlaboratory comparison program that has been approved by the NRC, that correspond to samples and analysis required by table 3.1-1. This limit applies at all times for all modes of operation.

3.2.2 Deviations

If analyses are not being performed as required above, report the corrective actions taken to prevent a recurrence to the NRC in the Annual Radiological Environmental Surveillance Report pursuant to Technical Specification 6.8.1.3.

3.2.3 Summary of Results

To assure that these limits are not exceeded, a summary of the results obtained as part of the above required interlaboratory comparison program shall be included in the Annual Radiological Environmental Surveillance Report pursuant to Technical Specification 6.8.1.3.

3.2.4 Basis

The requirement for participation in an approved interlaboratory comparison program is provided to ensure that independent checks on the precision and accuracy of the measurements of radioactive materials in environmental sample matrices are performed as part of the quality assurance program for environmental monitoring in order to demonstrate that the results are valid for the purposes of section IV.B.2, Appendix I, 10 CFR 50.

4.0 TOTAL DOSE DETERMINATIONS

Subsection 2.5.5 addresses the requirements of 40 CFR 190 and 10 CFR 20.105(c), which pertain to limitation of annual doses to 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 subsection 2.5.5, total dose determinations will be made by calculating doses due to liquid effluents in accordance with subsection 1.5.2 by calculating doses due to gaseous effluents in accordance with subsection 2.5.3 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 section 1.2. Methodology for calculating individual doses due to gaseous effluents was presented in paragraph 2.2.2.2.

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 by calculating total-body doses due to noble gas releases and organ doses due to radioiodine, tritium, and particulates in gaseous releases. 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.)

Annual average atmospheric dispersion and deposition values for these two locations, expected occupancy factors, (for an individual during the year), and applicable age groups are presented in table 5.0-1.

Total-body doses due to noble gases are determined using the following equation:

$$D_{tb} = 3.17E\text{-}8 \left[\left[(X/Q)_G \sum_i K_i \tilde{Q}_{ig} + (X/Q)_M \sum_i K_i \tilde{Q}_{im} \right] \right] \quad (OF)$$

where $(\overline{X/Q})_G$ and $(\overline{X/Q})_M$ are ground-level and mixed-mode dispersion terms for the location of interest; K_i is the total-body dose factor from table 2.1-1; and OF is the occupancy factor. Other terms are described in subsection 2.2.2.

Organ doses due to radioiodine, tritium, and particulates in gaseous releases are determined in accordance with the methodology presented in paragraph 2.2.2.2 (equation (21)). Only the inhalation pathway (equation (22)) and the ground-plane pathway (equation (23)) are applicable for locations inside the site boundary. After doses are calculated for the locations of interest inside the site boundary, using parameters from

table 5.0-1, the results are multiplied by the appropriate occupancy factors to determine doses to individuals at the locations of interest inside the site boundary.

TABLE 5.0-1 (SHEET 1 OF 2)

LOCATION-SPECIFIC PARAMETERS FOR LOCATIONS
INSIDE THE SITE BOUNDARY

Location: Visitors Center; SE at 447 meters

Age group: Child

Estimated occupancy factor: 4.6E-4 (4 hours)

Ground-level dispersion and deposition parameters:

$(\overline{X/Q})$ = 5.93E-6 s/m³

Depleted: $(\overline{X/Q})$ = 5.58E-6 s/m³

$(\overline{D/Q})$ = 2.28E-8 1/m²

Mixed-mode dispersion and deposition parameters:

$(\overline{X/Q})$ = 7.12E-7 s/m³

Depleted: $(\overline{X/Q})$ = 6.74E-7 s/m³

$(\overline{D/Q})$ = 5.77E-9 1/m²

Location: Plant Wilson; ESE at 1420 meters

Age group: Adult

Estimated occupancy factor: 2.28E-1 (2000 hours)*

Ground-level dispersion and deposition parameters:

$(\overline{X/Q})$ = 9.45E-7 s/m³

Depleted: $(\overline{X/Q})$ = 8.34E-7 s/m³

$(\overline{D/Q})$ = 4.20E-9 1/m²

TABLE 5.0-1 (SHEET 2 OF 2)

Mixed-mode dispersion and deposition parameters:

$(\overline{X/Q}) = 1.76E\text{-}7\ s/m^3$

Depleted: $(\overline{X/Q}) = 1.59E\text{-}7\ s/m^3$

$(\overline{D/Q}) = 2.07E\text{-}9\ 1/m^2$

*This value is based on a 40-hour work week, assuming an individual is assigned to the facility for the entire year.

6.0 REPORTS

6.1 ANNUAL RADIOLOGICAL ENVIRONMENTAL SURVEILLANCE REPORT***

6.1.1 Due Date

Routine Annual Radiological Environmental Surveillance Reports covering activities of the radiological environmental monitoring program during the previous calendar year shall be submitted prior to May 1 of each year. The initial report shall be submitted prior to May 1 of the year following initial criticality and shall include copies of reports of the preoperational radiological environmental monitoring program of the plant for at least two years prior to initial criticality.

6.1.2 Evaluation Content Requirement

The Annual Radiological Environmental Surveillance Report shall include summaries, interpretations, and an analysis of trends of the results of the radiological environmental surveillance activities for the report period, including, as appropriate, a comparison with preoperational studies, with operational controls, and with previous environmental surveillance reports, and an assessment of any observed impacts of plant operations on the environment. The report shall also include the results of the land use census required by section 3.1.2.

6.1.3 Data Content Requirement

The Annual Radiological Environmental Surveillance Report shall include the results of analysis of all radiological environmental samples and of all environmental radiation measurements taken during the period pursuant to the

***A single submittal may be made for Units 1 and 2.

locations specified in the table and figures in section 3.f, as well as summarized and tabulated results of these analyses and measurements in the format of the table in the Radiological Assessment Branch Technical Position, Revision 1, November 1979. The radiological level of radionuclides, which are naturally occurring, not included in the plant effluents, need not be reported. In the event that some individual results are not available for inclusion with the report, the report shall be submitted noting and explaining the reasons for the missing results. The missing data shall be submitted as soon as practicable in a supplementary report.

6.1.4 Program Content Requirement

The report shall also include the following: a summary description of the radiological environmental monitoring program, at least two legible maps covering all sampling locations keyed to a table giving distances and directions from a point midway between the two reactors, the results of licensee participation in the interlaboratory comparison program and the corrective action taken if the specified program is not being performed, reasons for not conducting the radiological environmental monitoring program and discussion of all deviations from the sampling schedule, discussion of environmental sample measurements that exceed the reporting levels but are not the result of plant effluents, and discussion of all analyses in which the LLD required was not achieved.

6.2 SEMIANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT*

Routine Semiannual Radioactive Effluent Release Reports covering the operation of the unit during the previous 6 months of operation shall be submitted within 60 days after January 1 and July 1 of each year.

6.2.1 Gaseous and Liquid Effluent Summaries

The Semiannual Radioactive Effluent Release Reports shall include a summary of the quantities of radioactive liquid and gaseous effluents and solid waste released from both units as outlined in Regulatory Guide 1.21, "Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants," Revision 1, June 1974, with data summarized on a quarterly basis following the format of Appendix B thereof. For solid wastes, the format for table 3 in Appendix B shall be supplemented with three additional categories: class of solid wastes (as defined by 10 CFR 61), type of container (e.g., LSA, type A, type B, large quantity), and solidification agent or absorbent (e.g., cement, urea formaldehyde).

6.2.2 Meterological Data Summary

The Semiannual Radioactive Effluent Release Report to be submitted within 60 days after January 1 of each year shall include an annual summary of hourly meteorological data collected over the previous year. This annual summary may be either in the form of an hour-by-hour listing on magnetic tape of wind speed, wind direction, atmospheric stability, and precipitation (if measured), or in the form of joint frequency distributions of windspeed, wind direction,

*A single submittal may be made for Units 1 and 2. The submittal should combine those sections that are common to both units at the plant; however, the submittal shall specify the releases of gaseous and liquid radioactive material from each unit.

and atmospheric stability.* This same report shall include an assessment of released from each unit during the previous calendar year. This same report the radiation doses due to the radioactive liquid and gaseous effluents shall also include an assessment of the radiation doses from radioactive liquid and gaseous effluents to members of the public due to their activities inside the site boundary during the report period. All assumptions used in making these assessments (i.e., specific activity, exposure time, and location) shall be included in these reports. Historical annual average meteorological conditions or the meteorological conditions concurrent with the time of release of radioactive materials in gaseous effluents, as determined by sampling frequency and measurement, shall be used for determining the gaseous pathway doses. The assessment of radiation doses shall be performed in accordance with the methodology and parameters in this manual.

6.2.3 Radiation Doses to the Public

The Semiannual Radioactive Effluent Release Report to be submitted within 60 days after January 1 of each year shall also include an assessment of radiation doses to the likely most exposed member of the public from reactor releases and other uranium fuel cycle sources within 8 km, including doses from primary effluent pathways and direct radiation, for the previous calendar year to show conformance with 40 CFR 190, "Environmental Radiation Protection Standards for Nuclear Power Operation." Acceptable methods for calculating the dose contribution from liquid and gaseous effluents are given in Regulatory Guide 1.109, Revision 1, October 1977.

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*In lieu of submission with the Semiannual Radioactive Effluent Release Report, the licensee has the option of retaining this summary of required meteorological data on site in a file that shall be provided to the NRC upon request.

6.2.4 Unplanned Releases

The Semiannual Radioactive Effluent Release Reports shall include a list and description of unplanned releases from the site to unrestricted areas of radioactive materials in gaseous and liquid effluents made during the reporting period.

6.2.5 Changes to the ODCM

The Semiannual Radioactive Effluent Release Reports shall include any changes made during the reporting period to the Offsite Dose Calculation Manual (ODCM), pursuant to Technical Specification 6.13, as well as any major change to liquid, gaseous, or solid radwaste treatment systems pursuant to subsection 6.2.7. It shall also include a listing of new locations for dose calculations and/or environmental monitoring identified by the land use census pursuant to subsection 3.1.2.

6.2.6 Inoperable Liquid or Gaseous Effluent Monitoring Instrumentation

The Semiannual Radioactive Effluent Release Reports shall also include the following: an explanation as to why the inoperability of liquid or gaseous effluent monitoring instrumentation was not corrected within the time specified in subsection 1.5.4 or 2.5.6, respectively, and description of the events leading to liquid holdup tanks or gas storage tanks exceeding the limits of Technical Specification 3 11.1.4 or 3.11.2.6, respectively.

6.2.7 <u>Major Changes to Liquid, Gaseous, and Solid Radwaste Treatment Systems*</u>

Licensee-initiated major changes to the radwaste treatment systems (liquid, gaseous, and solid)

a. Shall be reported to the NRC in the Semiannual Radioactive Effluent Release Report for the period in which the evaluation was reviewed by the PRB. The discussion of each change shall contain the following:

1) A summary of the evaluation that led to the determination that the change could be made in accordance with 10 CFR 50.59.

2) Sufficient detailed information to totally support the reason for the change without benefit of additional or supplemental information.

3) A detailed description of the equipment, components, and processes involved and the interfaces with other plant systems.

4) An evaluation of the change, which shows the predicted releases of radioactive materials in liquid and gaseous effluents and/or quantity of solid waste that differ from those previously predicted in the license application and amendments thereto.

5) An evaluation of the change, which shows the expected maximum exposures to a member of the public in the unrestricted area and to the general population that differ from those previously estimated in the license application and amendments thereto.

*Licensees may choose to submit the information called for in this specification as part of the annual FSAR update.

6) A comparison of the predicted releases of radioactive materials, in liquid and gaseous effluents and in solid waste, to the actual releases for the period prior to when the change is to be made.

7) An estimate of the exposure to plant operating personnel as a result of the change.

8) Documentation of the fact that the change was reviewed and found acceptable by the PRB.

b. Shall become effective upon approval by the General Manager - Nuclear Plant.

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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.

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

5. Vogtle Electric Generating Plant Units 1 and 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.

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

12. Vogtle Electric Generating Plant Land Use Survey - 1988, Georgia Power Company, April 1988.

13. Letter to Southern Company Services from Pickard Lowe, and Garrick, Inc., Washington, D.C., April 27, 1988.

14. Kahn, Bernd, et. al, "Bioaccumulation of P-32 in Bluegill and [illegible]h," NUREG/CR-3981, February 1985.

15. Letter to Bill Ollinger, Georgia Power Company, from T. L. Broadwell, Georgia Power Company, Atlanta, Georgia, June 22, 1988.

16. Letter to Bill Ollinger, Georgia Power Company, from R. J. Just, Georgia Power Company, Atlanta, Georgia, July 8, 1988.

17. Memo from S. E. Ewald, Georgia Power Company, to C. C. Eckert, Georgia Power Company, May 9, 1988.

18. Memo from A. C. Stalker, Georgia Power Company, to D. F. Hallman, Georgia Power Company, February 5, 1987.