SEQUOYAH NUCLEAR PLANT

OFFSITE DOSE CALCULATION MANUAL

TENNESSEE VALLEY AUTHORITY

SEQUOYAH NUCLEAR PLANT
OFFSITE DOSE CALCULATION MANUAL
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Approved by [signature] Date 2/22/90
RARC Chairman

Approved by [signature] Date 2/27/90
Manager, Chemistry & Radiological Services

* Low Power license for Sequoyah unit 1
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*** Date approved by RARC Chairman
**** Revision 23 implements the Nuclear Data Effluent Management Software. This ODCM revision and the software will be implemented concurrently on October 9, 1989. Releases made during the month of October prior to the software implementation will be backfitted to comply with this revision.

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1.0 GASEOUS EFFLUENTS

1.1 RELEASE POINTS DESCRIPTION

There are six exhausts at Sequoyah Nuclear Plant that are monitored for airborne effluents. These are: a Condenser Vacuum Exhaust for each unit, a Service Building Exhaust, an Auxiliary Building Exhaust and a Shield Building Exhaust for each unit. Figure 1.1 provides an outline of the airborne effluent release and discharge points with associated radiation monitor identifications.

Condenser Vacuum Exhaust

The Condenser Vacuum Exhausts (CVEs) are located in the turbine building. They exhaust at a maximum design flow rate of 45 cubic feet per minute. They are monitored by radiation monitors (1)- and (2)-RM-90-99, -119.

Service Building Vent

The Titration Room, Chemistry Lab, Hot Shop, and Health Physics Lab all exhaust to the Service Building Vent. This exhausts at approximately 14,950 cfm and is monitored by radiation monitor 0-RM-90-132.

Auxiliary Building Exhaust (see Figure 1.2 for detail)

The annulus vacuum priming system exhausts through the containment vent to the Auxiliary Building. The Auxiliary Building exhaust mixes with the General Exhaust System and they cumulatively exhaust at a maximum design flow of 228,000 cfm. The exhaust is monitored by radiation monitor 0-RM-90-101.

Shield Building Vent (see Figure 1.2 for detail)

The Auxiliary Building Gas Treatment System (ABGTS) draws from the Auxiliary Building and exhausts to the waste gas header. There are nine Waste Gas Decay Tanks (WGDTs) that also empty into this header. Either ABGTS or the Emergency Gas Treatment System (EGTS) is run to release a WGDT. Each WGDT has a design capacity of 600 cubic feet and a design release rate of 22.5 cfm. Both the Containment Purge and the Incore Instrument Room Purge from each unit tie into the waste gas header. The Containment Purge exhausts at a maximum of 28,000 cfm and is monitored by radiation monitors (1)- (2)-RM-90-130, -131. If the Incore Instrument Room Purge is operating exclusively, it exhausts at 800 cfm. Under emergency conditions, and sometimes during normal operation, the EGTS is used to draw a vacuum in the annulus and exhaust to the Shield Building Vent. Auxiliary Building Isolation starts both the ABGTS and EGTS. The common header exhausts to the

Shield Building Exhaust. There is one exhaust for each unit. This exhausts at a maximum design flow of 28,000 cfm and is monitored by radiation monitors (1)- (2)-RM-90-100.

1.2 DOSE RATE

1.2.1 REQUIREMENTS

The dose rate due to radioactive materials released in gaseous effluents to areas at or beyond the SITE BOUNDARY (UNRESTRICTED AREA) (see Figure 1.3) shall be limited to the following: R24

a. For noble gases: Less than or equal to 500 mrem/yr to the total body and less than or equal to 3000 mrem/yr to the skin, and

b. For Iodine-131, Iodine-133, Tritium, and for all radionuclides in particulate form with half-lives greater than 8 days: Less than or equal to 1500 mrem/yr to any organ.

This requirement is applicable at all times.

This requirement is provided to ensure that the dose at any time at the SITE BOUNDARY from gaseous effluents from all units on the site will be within the annual dose limits of 10 CFR Part 20. The annual dose limits are the doses associated with the concentrations of 10 CFR Part 20, Appendix B, Table II, Column 1. These limits provide reasonable assurance that radioactive material discharged in gaseous effluents will not result in the exposure of a MEMBER OF THE PUBLIC, either within or outside the SITE BOUNDARY, to annual average concentrations exceeding the limits specified in Appendix B, Table II of 10 CFR Part 20 (10 CFR Part 20.106(b)). For MEMBERS OF THE PUBLIC who may at times be within the SITE BOUNDARY, the occupancy of the individual will be sufficiently low to compensate for any increase in the atmospheric diffusion factor above that for the SITE BOUNDARY. The specified release rate limits restrict, at all times, the corresponding gamma and beta dose rates above background to an individual at or beyond the SITE BOUNDARY to less than or equal to 500 mrem/yr to the total 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 an infant via the cow-milk-infant pathway to less than or equal to 1500 mrem/yr for the nearest cow to the plant. This requirement applies to the release of gaseous effluents from all reactors at the site. For units with shared radwaste treatment systems, the gaseous effluents from the shared systems are proportioned among the units sharing that system. R24 R24 R24 R24 R24 R24 R24

If this requirement is not met, the following action will be performed:

With dose rate(s) exceeding the above limits, without delay restore the release rate to within the above limit(s).

To ensure that this requirement is met:

The dose rate due to noble gases in gaseous effluents shall be determined to be within the above limits in accordance with the methodology and parameters in Section 1.2.3, and

The dose rate due to I-131, I-133, Tritium, and for all radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents shall be determined to be within the above limits in accordance with the methodology and parameters in Section 1.2.4 and by obtaining representative samples and performing analyses in accordance with the sampling and analysis program specified in Table 1.1.

1.2.2 REPORTING LIMITS

10 CFR 50.73 requires that any airborne radioactivity release that exceeds 2 times the applicable concentrations of the limits specified in Appendix B, Table II of 10 CFR 20 in UNRESTRICTED AREAs when averaged over a period of one hour be reported to the NRC within 30 days. For the purposes of meeting this requirement, it is assumed that the dose rate limits stated above are the result of offsite concentrations equal to those listed in Appendix B, Table II of 10 CFR 20. R24

1.2.3 NOBLE GAS DOSE RATES

Dose rates are calculated for total body and skin due to submersion within a cloud of noble gases using a semi-infinite cloud model.

1.2.3.1 Total Body Dose Rate

The dose rate to the total body, DR_{TB} in mrem/year, is calculated using the following equation:

$$DR_{TB} = (X/Q)\ F \sum_i C_i\ DFB_i \qquad (1.1)$$

where

X/Q = relative concentration, s/m³. Relative air concentrations are calculated for the land-site boundary in each of the sixteen sectors as described in Section 1.9.2 using the historical meteorological data for the period 1972-1975 given in Table 1.2. For dose rate calculations, the highest value from the sixteen land-site boundary locations is used.
= 5.12E-06 s/m³ (from Table 1.3).

F = flowrate of effluent stream, cc/s.

C_i = concentration of noble gas nuclide i in effluent stream, µCi/cc.

DFB_i = total body dose factor due to gamma radiation for noble gas nuclide i, mrem/y per µCi/m³ (Table 1.4).

1.2.3.2 Skin Dose Rate

The dose rate to the skin, DR_s in mrem/year, is calculated using the following equation:

$$DR_s = (\chi/Q)\ F \sum_i C_i(DF_{Si} + 1.11\ DF_{\gamma i}) \qquad (1.2)$$

where

χ/Q = relative concentration, s/m³. Relative air concentrations are calculated for the land-site boundary in each of the sixteen sectors as described in Section 1.9.2 using the historical meteorological data for the period 1972-1975 given in Table 1.2. For dose rate calculations, the highest value from the sixteen land-site boundary locations is used.
= 5.12E-06 s/m³ (from Table 1.3).

F = flowrate of effluent stream, cc/s.

C_i = concentration of noble gas nuclide i in effluent stream, μCi/cc.

DFS_i = skin dose factor due to beta radiation for noble gas nuclide i, mrem/y per μCi/m³ (Table 1.4).

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

$DF_{\gamma i}$ = dose conversion factor for external gamma for noble gas nuclide i, mrad/year per μCi/m³ (Table 1.4).

1.2.4 I-131, I-133, TRITIUM AND ALL RADIONUCLIDES IN PARTICULATE FORM WITH HALF-LIVES OF GREATER THAN 8 DAYS - ORGAN DOSE RATE

Organ dose rates due to I-131, I-133, Tritium and all radionuclides in particulate form with half-lives of greater than 8 days, DR_{org} in mrem/year, are calculated for all age groups (adult, teen, child, and infant) and all organs (bone, liver, total body, thyroid, kidney, lung, and GI Tract) using the following equation:

$$DR_{org} = F[\ C_T(X/Q)[R_{IT}+R_{CTP}]+\sum_i C_i[(X/Q)R_{Ii}+(D/Q)[R_{CPi}+R_{Gi}]]] \qquad (1.3)$$ R24

where:

- F = flowrate of effluent stream, cc/s.
- C_T = concentration of tritium in effluent stream, μCi/cc.
- X/Q = relative concentration, s/m³. Relative air concentrations are calculated for the land-site boundary in each of the sixteen sectors as described in Section 1.9.2 using the historical meteorological data for the period 1972-1975 given in Table 1.2. For dose rate calculations, the highest value from the sixteen land-site boundary locations is used.
  = 5.12E-06 s/m³ (from Table 1.3).
- R_{IT} = inhalation dose factor for tritium, mrem/year per μCi/m³. Dose factor is calculated as described in Section 1.8.13.
- R_{CTP} = Grass-cow-milk dose factor for tritium, mrem/year per μCi/m³. Dose factor is calculated as described in Section 1.8.7.
- C_i = concentration of nuclide i in effluent stream, μCi/cc.
- R_{Ii} = inhalation dose factor for each identified nuclide i, mrem/year per μCi/m³. Dose factors are calculated as described in Section 1.8.13.
- D/Q = relative deposition, 1/m². Relative deposition is calculated for the land-site boundary in each of the sixteen sectors as described in Section 1.9.3 using the historical meteorological data for the period 1972-1975 given in Table 1.2. For dose rate calculations, the highest value from the sixteen land-site boundary locations is used.
  = 1.29E-08 1/m² (from Table 1.3).
- R_{CPi} = Grass-cow-milk dose factor for each identified nuclide i, m²-mrem/year per μCi/s. Dose factors are calculated as described in Section 1.8.1.
- R_{Gi} = ground plane dose factor for each identified nuclide i, m²-mrem/year per μCi/s. Dose factors are calculated as described in Section 1.8.14.

The maximum organ dose rate is selected from among the dose rates calculated for all the organs and all age groups.

1.3 RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

1.3.1 REQUIREMENT

The radioactive gaseous effluent monitoring instrumentation channels shown in Table 1.5 shall be OPERABLE with their alarm/trip setpoints set to ensure that the limits of Section 1.2 are not exceeded. The alarm/trip setpoints of these channels shall be determined in accordance with the methodology and parameters in Section 1.3.3. R24

This requirement is applicable as shown in Table 1.5.

The radioactive gaseous effluent instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in gaseous effluents during actual or potential releases of gaseous effluents. The alarm/trip setpoints for these instruments shall be calculated in accordance with the procedures in Section 1.3.3 to ensure that the alarm/trip will occur prior to exceeding the limits of 10 CFR Part 20. The OPERABILITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10 CFR Part 50. R24

If this requirement is not met, the appropriate following action(s) will be performed:

a. With a radioactive gaseous effluent monitoring instrumentation channel alarm/trip setpoint less conservative than required above, without delay suspend the release of radioactive gaseous effluents monitored by the affected channel, declare the channel inoperable, or change the setpoint so it is acceptably conservative.

b. With less than the minimum number of radioactive gaseous effluent monitoring instrumentation channels OPERABLE take the action shown in Table 1.5. Exert best efforts to return the instruments to OPERABLE status within 30 days and, if unsuccessful, explain in the next Semi-Annual Effluent Report why the inoperability could not be corrected within 30 days. R24 R24

To ensure that this requirement is met:

Each radioactive gaseous effluent monitoring instrumentation channel shall be demonstrated OPERABLE by performance of the CHANNEL CHECK, SOURCE CHECK, CHANNEL CALIBRATION, and CHANNEL FUNCTIONAL TEST operations at the frequencies shown in Table 1.6. R24 R24 R24

1.3.2 RELEASE SAMPLING

Prior to each release (excluding an Incore Instrument Room Purge), a grab sample is taken and analyzed to determine the concentration, μCi/cc, of each noble gas nuclide. On at least a weekly basis, filters are analyzed to determine the amount of iodines and particulates released. Composite samples are maintained (as required by Table 1.1) to determine the concentration of certain nuclides (Sr-89, Sr-90, and alpha emitters).

For those nuclides whose activities are determined from composite samples the concentrations for the previous composite period will be assumed as the concentration for the next period to perform the calculations in Sections 1.2, 1.4, 1.5 and 1.6. The actual measured concentrations will be used for the dose calculations described in Section 1.7.

INSTRUMENT SETPOINTS

1.3.3.1 Expected Monitor Response

For each release, the expected monitor response, R in cpm, is calculated using the following equation:

$$R = B + \sum_i eff_i C_i \qquad (1.4)$$

where

B = monitor background, cpm.
eff_i = efficiency factor for the monitor for nuclide i, cpm per μCi/cc.
C_i = measured concentration of nuclide i, μCi/cc.

For the noble gas response, the summation in the above equation will be performed over all measured noble gases. Similarly, the responses for iodines and particulates would sum over all measured iodine and particulate nuclides respectively.

1.3.3.2 Calculated Maximum Setpoint

For each release from a release point, a calculated maximum setpoint is determined for the appropriate monitor which corresponds to the most restrictive dose rate limit. This maximum setpoint is calculated as follows:

1. The ratio, r, of the dose rate limit to the calculated dose rate for the release is obtained using the following equation:

$$r = \frac{DR_{lim}}{DR} \qquad (1.5)$$

where

DR_{lim} = the dose rate limit, mrem/year.
= 500 mrem/year to the total body for noble gases,
= 3000 mrem/year to the skin for noble gases, and
= 1500 mrem/year to the maximum organ for iodines and particulates.

DR = the calculated dose rate for the release, mrem/year.
= DR_{TB} for total body (as described in Section 1.2.3.1),
= DR_s for skin (as described in Section 1.2.3.2), and
= DR_{org} for maximum organ (as described in Section 1.2.4).

2. The calculated maximum monitor response, R_{lim} in cpm, corresponding to the dose rate limit is determined using the following equation:

$$R_{lim} = (r(R - B)) + B \qquad (1.6)$$

where

r = ratio of dose rate limit to calculated dose rate for the release, as calculated above. For noble gases, the smaller of the two ratios for total body or skin is used.
R = expected monitor response (as calculated in Section 1.3.3.1), cpm.
b = monitor background, cpm.

3. The calculated maximum setpoint, S_{max} in cpm, corresponding to the dose rate limit is calculated using the following equation:

$$S_{max} = ((A*SF)(R_{lim} - B)) + B \qquad (1.7)$$

where

A = dose rate allocation factor for the release point, dimensionless. The dose rate allocation factors for release points are defined in approved plant procedures.
SF = safety factor for the monitor, dimensionless. Safety factors for each monitor are defined in approved plant procedures.
R_{lim} = the calculated monitor response, as calculated above, cpm.
B = the monitor background, cpm.

1.3.3.3 Normal Default Setpoint

A normal default setpoint is determined for each monitor. The default setpoints for each monitor are defined and documented in approved plant procedures. The default setpoints should be set high enough such that, in most cases, the value will not need to be changed for each release. The default setpoints should be low enough, however, to ensure that the limits given in Section 1.2.1 are not violated, and to ensure that unexpected releases are identified.

1.3.3.4 Actual Monitor Setpoints

The setpoint chosen for a monitor for each release is determined as follows:

1. IF the calculated maximum setpoint is less than the normal default, THEN the setpoint shall be set equal to the calculated maximum setpoint.

2. IF the calculated maximum setpoint is greater than the normal default, AND X[1] times the expected monitor response is less than the normal default setpoint, THEN the setpoint shall be set equal to the normal default setpoint.

3. IF the calculated maximum setpoint is greater than the normal default, AND X[1] times the expected monitor response is greater than the normal default setpoint, THEN the setpoint shall be set equal to X[1] times the expected response.

[1] X is an administrative factor designed to account for expected variations in monitor response. It will be defined in approved plant instructions.

1.4 DOSE - NOBLE GASES

1.4.1 REQUIREMENTS

The air dose due to noble gases released in gaseous effluents from each reactor unit to areas at or beyond the SITE BOUNDARY (see Figure 1.3) shall be limited to the following: R24

a. During any calendar quarter: Less than or equal to 5 mrad for gamma radiation and less than or equal to 10 mrad for beta radiation and

b. During any calendar year: Less than or equal to 10 mrad for gamma radiation and less than or equal to 20 mrad for beta radiation.

This requirement is applicable at all times.

This requirement is provided to implement the requirements of Sections II.B,III.A and IV.A of Appendix I, 10 CFR Part 50. The requirement implements the guides set forth in Section II.B of Appendix I. The action to be taken provide the required operating flexibility and at the same time implements the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in gaseous effluents will be kept "as low a reasonably achievable." The surveillance implements 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 appropriately modeled pathways is unlikely to be substantially underestimated. The dose calculations established in Section 1.4.2 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 Purposes of Evaluating Compliance with 10 CFR Part 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. The ODCM equations provided for determining the air doses at the SITE BOUNDARY are based upon the historical average atmospheric conditions. R24

If this requirement is not met, the following action will be performed:

With the calculated air dose from radioactive noble gases in gaseous effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days, pursuant to Technical Specification 6.9.2, a Special Report which identifies the

cause(s) for exceeding the limit(s) and defines the corrective actions 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.

To ensure that this requirement is met:

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 in Section 1.4.2 at least once per 31 days.

1.4.2 CUMULATIVE DOSE CALCULATIONS - NOBLE GASES

Doses to be calculated are gamma and beta air doses due to exposure to an infinite cloud of noble gases. These doses will be calculated at the land-site boundary location with the highest annual-average X/Q based on 1972-1975 meteorological data (Table 1.2). This location is chosen from the SITE BOUNDARY locations listed in Table 1.3. Dispersion factors are calculated using the methodology described in Section 1.9.2. R24

No credit is taken for radioactive decay.

1.4.2.1 Gamma dose to air

The gamma air dose, D_γ in mrad, is calculated for each release using the following equation:

$$D_\gamma = 1.9E{-}06\ (X/Q)\ \sum_i Q_i\ DF_{\gamma i}\ T \qquad (1.8)$$

where:

1.9E-06 = conversion factor, years per minute.
X/Q = highest land-site boundary annual-average relative concentration, 5.12×10^{-6} s/m³ (from Table 1.3).
Q_i = release rate for nuclide i, µCi/s.
$DF_{\gamma i}$ = dose conversion factor for external gamma for nuclide i (Table 1.4), mrad/year per µCi/m³.
T = duration of release, minutes.

The gamma-air dose calculated by this method will be used in the cumulative dose calculations discussed in Section 1.4.2.3.

1.4.2.2 Beta dose to air

The beta air dose, D_β in mrad, is calculated for each release using the following equation:

$$D_\beta = 1.9E\text{-}06\ (X/Q)\ \Sigma\ Q_i\ DF_{\beta i}\ T \qquad (1.9)$$

where:

1.9E-06 = conversion factor, years per minute.
X/Q = highest land-site boundary annual-average relative concentration, 5.12×10^{-6} s/m³ (from Table 1.3).
Q_i = release rate for nuclide i, µCi/s.
$DF_{\beta i}$ = dose conversion factor for external beta for nuclide i, mrad/year per µCi/m³ (from Table 1.4).
T = duration of release, minutes.

The beta-air dose calculated by this method will be used in the cumulative dose calculations discussed in Section 1.4.2.3.

1.4.2.3 Cumulative Dose - Noble Gas

Quarterly and annual sums of all doses are calculated for each release as described below to compare to the limits listed in Section 1.4.1.

For noble gases, cumulative doses are calculated for gamma and beta air doses. Doses due to each release are summed with the doses for all previous release in the quarter or year to obtain cumulative quarterly and annual doses.

1.4.2.4 Comparison to Limits

The cumulative calendar quarter and calendar year doses are compared to their respective limits once per 31 days to determine compliance.

1.5 CUMULATIVE DOSE - I-131, I-133, TRITIUM AND RADIONUCLIDES IN PARTICULATE FORM

1.5.1 REQUIREMENTS

The dose to a MEMBER OF THE PUBLIC from I-131, I-133, Tritium and all radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents released to areas at or beyond the SITE BOUNDARY (see Figure 1.3) shall be limited to the following from each reactor unit: R24 R24

a. During any calendar quarter: Less than or equal to 7.5 mrem to any organ and,

b. During any calendar year: Less than or equal to 15 mrem to any organ.

This requirement is applicable at all times.

This requirement is provided to implement the requirements of Sections II.C,III.A and IV.A of Appendix I, 10 CFR Part 50. The requirement implements the guides set forth in Section II.C of Appendix I. The action to be taken provides the required operating flexibility and at the same time implements the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in gaseous effluents will be kept "as low as reasonably achievable." Section 1.5.2 calculational methods 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 appropriately modeled pathways is unlikely to be substantially underestimated. Section 1.5.2 calculational methods for calculating the doses due to the actual release rates of the subject materials are consistent with the methodologies provided in NUREG/CR-1004, "A Statistical Analysis of Selected Parameters for Predicting Food Chain Transport and Internal Dose of Radionuclides," October 1979 and Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purposes of Evaluating Compliance with 10 CFR Part 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 I-131, I-133 tritium and all radionuclides in particulate form with half-lives greater than 8 days are dependent on the existing radionuclide pathways to man, beyond the SITE BOUNDARY. The pathways which were examined in the development of these calculations were: 1) individual inhalation of airborne radionuclides, R24 R24

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.

If this requirement is not met, perform the following action:

With the calculated dose from the release of I-131, I-133 tritium and all radionuclides in particulate form with half-lives exceeding 8 days, in gaseous effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days, pursuant to Technical Specification 6.9.2, a Special Report which identifies the cause(s) for exceeding the limit(s) and defines the corrective actions 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.

To ensure that this requirement is met:

Cumulative dose contributions for the current calendar quarter and current calendar year for I-131, I-133 tritium and all radionuclides in particulate form with half-lives exceeding 8 days shall be determined in accordance with the methodology and parameters in Section 1.5.2 at least once per 31 days.

1.5.2 DOSE DUE TO I-131, I-133, TRITIUM AND ALL RADIONUCLIDES IN PARTICULATE FORM WITH HALF-LIVES OF GREATER THAN 8 DAYS

1.5.2.1 Organ dose Calculation

Organ doses due to I-131, I-133, tritium and all radionuclides in particulate form with half-lives of greater than 8 days are calculated for each release for the critical receptor. The critical receptor is defined as the land-site boundary in the sector with the highest annual average X/Q. The annual average X/Q and D/Q are calculated using the methodology in Sections 1.9.2 and 1.9.3 using the historical 1972-1975 meteorological data (Table 1.2). Pathways considered to exist at this location are inhalation, ground plane exposure, grass-cow-milk ingestion, grass-cow-beef ingestion and fresh leafy and stored vegetable ingestion. All age groups are considered (adult, teen, child and infant). Dose factors for these age groups and pathways are calculated as described in Section 1.8. For the ground exposure pathway, which has no age or organ specific dose factors, the total body dose will be added to the internal organ doses for all age groups. No credit is taken for radioactive decay.

The general equation for the calculation of organ dose is:

$$D_{org} = 3.17E\text{-}08\ T \sum_{i} \sum_{P} R_{Pi} [\ W_P\ Q_i\ ] \tag{1.10}$$

where:

3.17E-08 = conversion factor, year/second

T = duration of release, seconds.

R_{Pi} = dose factor for pathway P for each identified nuclide i, m^2-mrem/year per µCi/s for ground plane, grass-cow-milk, grass-cow-meat, and vegetation pathways, and mrem/year per µCi/m^3 for inhalation and tritium ingestion pathways. Equations for calculating these dose factors are given in Section 1.8.

W_P = dispersion factor for the location and pathway,
= X/Q for the inhalation and tritium ingestion pathways,
= 5.12E-06 s/m^3.
= D/Q for the food and ground plane pathways,
= 1.29E-08 m^{-2}

Q_i = release rate for radionuclide i, µCi/s

From the four age groups considered, the maximum is determined by comparing all organ doses for all age groups. The age group with the highest single organ dose is selected as the critical age group. The organ doses for the critical age group will be used in the cumulative doses discussed in section 1.5.2.2.

Reformatting/Repagination changes only

1.5.2.2 Cumulative Doses

Quarterly and annual sums of all doses are calculated for each release as described below to compare to the limits listed in Section 1.5.1.

For maximum organ dose, cumulative quarterly and annual doses are maintained for each of the eight organs considered. The cumulative dose is obtained by summing the doses for each organ of the critical age group (as calculated in Section 1.5.2.1) as determined for each release with the organ doses for all previous releases in the quarter or year to obtain the cumulative quarterly and annual doses. Thus, the cumulative organ doses will be conservative values, consisting of doses belonging to various age groups depending on the mix of radionuclides. The highest of these cumulative organ doses is used for the comparison to the limits described in Section 1.5.1.

1.5.2.3 Comparison to Limits

The cumulative calendar quarter and calendar year doses are compared to their respective limits once per 31 days to determine compliance.

1.6 GASEOUS RADWASTE TREATMENT

1.6.1 REQUIREMENTS

The GASEOUS RADWASTE TREATMENT SYSTEM and the VENTILATION EXHAUST R24
TREATMENT SYSTEM shall be used to reduce radioactive materials in R24
gaseous waste prior to their discharge when the projected gaseous
effluent doses due to gaseous effluent releases to areas at or beyond
The SITE BOUNDARY (see Figure 1.3), when averaged over 31 days, would R24
exceed 0.2 mrad per unit for gamma radiation, and 0.4 mrad per unit
for beta radiation. The appropriate portions of the VENTILATION R24
EXHAUST TREATMENT SYSTEM shall be used to reduce radioactive materials R24
in gaseous waste prior to their discharge when the projected doses due
to gaseous effluents to areas at or beyond the SITE BOUNDARY (See R24
Figure 1.3) when averaged over 31 days would exceed 0.3 mrem per unit
to any organ.

This requirement is applicable at all times.

This 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 reasonably achievable." This requirement implements the requirements of 10 CFR Part 50.36a, General Design Criteria 60 of Appendix A to 10 CFR Part 50, and the design objectives given in Section II.D of Appendix I to 10 CFR Part 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 Section II.B and II.C of Appendix I, 10 CFR Part 50, for gaseous effluents.

If this requirement is not met, perform the following action:

With the gaseous waste being discharged without treatment for more than 31 days and in excess of the above limits, prepare and submit to the Commission within 30 days, pursuant to Technical Specification 6.9.2, a Special Report which includes the following information:

1. Identification of the inoperable equipment or subsystems and the reason for inoperability.
2. Action(s) taken to restore the inoperable equipment to OPERABLE status, and R24
3. Summary description of action(s) taken to prevent a recurrence.

To ensure that this requirement is met:

Doses due to gaseous releases from the site shall be projected at least once per 31 days, in accordance with the methodology and parameters in Section 1.6.2.

1.6.2 DOSE PROJECTIONS

In accordance with Section 1.6.1, dose projections will be performed. This will be done by maintaining running 31-day totals for the gamma dose, the beta dose and the maximum organ dose. Once per 31 days, these 31-day running totals will be compared to the limits given in Section 1.6.1 to determine compliance.

If the projected doses exceed any of these limits, the GASEOUS RADWASTE TREATMENT SYSTEM and the VENTILATION EXHAUST TREATMENT SYSTEM shall be used to reduce radioactive materials in gaseous effluents to areas at or beyond the SITE BOUNDARY. R24 R24 R24

1.6.3 GASEOUS RADWASTE TREATMENT SYSTEM DESCRIPTION

The GASEOUS RADWASTE TREATMENT SYSTEM (GRTS) described below shall be maintained and operated to keep releases ALARA. R24

A flow diagram for the GRTS is given in Figure 1.4. The system consists of two waste-gas compressor packages, nine gas decay tanks, and the associated piping, valves, and instrumentation. Gaseous wastes are received from the following: degassing of the reactor coolant and purging of the volume control tank prior to a cold shutdown, displacing of cover gases caused by liquid accumulation in the tanks connected to the vent header, and boron recycle process operation.

1.7 QUARTERLY DOSE CALCULATIONS

A complete dose analysis utilizing the total estimated gaseous releases for each calendar quarter will be performed and reported as required in Section 5.2. Methodology for this analysis is that which is described in this section using the quarterly release values reported by the plant personnel. All real pathways and receptor locations identified by the most recent land use survey are considered. In addition, actual meteorological data representative of a ground level release for each corresponding calendar quarter will be used. For iodine releases, it is assumed that half the iodine released is in organic form. Organic iodine causes a dose only by inhalation. For cow-milk and beef ingestion doses, the fraction of the time the animals are on stored feed (identified in the survey) is used in the calculation.

The highest organ dose for a real receptor is determined by summing the dose contribution from all identified pathways for each receptor including ground contamination, inhalation, vegetable ingestion (for identified garden locations), cow and/or goat milk ingestion (if a cow or goat is identified for the location), beef ingestion (the beef ingestion dose for the location of highest beef dose for all receptors will be considered the beef dose for all receptors).

1.7.1 NOBLE GAS - GAMMA AIR DOSE

Gamma air doses due to exposure to noble gases, D_γ in mrem, are calculated using the following equation:

$$D_\gamma = \chi_{im} DF_{\gamma i} \qquad (1.11)$$

where:

χ_{im} = concentration of nuclide i at location m, $\mu Ci/m^3$. Air concentrations are calculated as described by Equation 1.16.

$DF_{\gamma i}$ = dose conversion factor for external gamma for nuclide i, mrad/year per $\mu Ci/m^3$ (Table 1.4).

1.7.2 NOBLE GAS - BETA AIR DOSE

Beta air doses due to exposure to noble gases, D_β in mrem, are calculated using the following equation:

$$D_\beta = \chi_{im} DF_{\beta i} \qquad (1.12)$$

where:

χ_{im} = concentration of nuclide i at location m, $\mu Ci/m^3$. Air concentrations are calculated as described by Equation 1.16.

$DF_{\beta i}$ = dose conversion factor for external beta for nuclide i, mrad/year per $\mu Ci/m^3$ (Table 1.4).

1.7.3 RADIOIODINE, PARTICULATE AND TRITIUM - MAXIMUM ORGAN DOSE

Organ doses due to radioiodine, particulate and tritium releases, D_{org} in mrem, are calculated using the following equation:

$$D_{org} = 3.17E\text{-}08((X/Q)\sum_P R_{PT} Q_T \sum_i [(D/Q)\sum_P R_{Pi} + (D/Q)R_{Gi} + (X/Q)R_{Ii}]Q_i) \quad (1.13)$$ R24

where:

3.17E-08 = conversion factor, year/second.

X/Q = Relative concentration for location under consideration, s/m³. Relative concentrations are calculated as described by Equation 1.17.

R_{PT} = ingestion dose factor for pathway P for tritium, m²-mrem/year per µCi/s. Ingestion pathways available for consideration are the same as those listed above for R_{Pi}. Equations for calculating ingestion dose factors for tritium are given in Sections 1.8.7 through 1.8.12.

Q_T = adjusted release rate for tritium for location under consideration, µCi/s. Calculated in the same manner as Q_i above.

R_{Pi} = ingestion dose factor for pathway P for each identified nuclide i (except tritium), m²-mrem/year per µCi/s. Ingestion pathways available for consideration include:
pasture grass-cow-milk ingestion
stored feed-cow-milk ingestion
pasture grass-goat-milk ingestion
stored feed-goat-milk ingestion
pasture grass-beef ingestion
stored feed-beef ingestion
fresh leafy vegetable ingestion
stored vegetable ingestion
Equations for calculating these ingestion dose factors are given in Sections 1.8.1 through 1.8.6.

D/Q = Relative deposition for location under consideration, m⁻². Relative deposition is calculated as described in Equation 1.18.

R_{Gi} = Dose factor for standing on contaminated ground, m²-mrem/year per µCi/s. The equation for calculating the ground plane dose factor is given in Section 1.8.14.

R_{Ii} = Inhalation dose factor, mrem/year per µCi/m³. The equation for calculating the inhalation dose factor is given in Section 1.8.13.

Q_i = adjusted release rate for nuclide i for location under consideration, µCi/s. The initial release rate is adjusted to account for decay between the release point and the location, depending on the frequency of wind speeds applicable to that sector. Hence, the adjusted release rate is equal to the actual release rate decayed for an average travel time during the period.

$$Q_{i0} \sum_{j=1}^{9} f_j \exp(-\lambda_i \, x/u_j) \qquad (1.14)$$

where

Q_{i0} = initial average release rate for nuclide i over the period, µCi/s.
f_j = joint relative frequency of occurrence of winds in windspeed class j blowing toward this exposure point, expressed as a fraction.
λ_i = radiological decay constant for nuclide i, s^{-1}.
x = downwind distance, meters.
u_j = midpoint value of wind speed class interval j, m/s.

1.7.4 POPULATION DOSES

For determining population doses to the 50-mile population around the plant, each compass sector is broken down into elements. These elements are defined in Table 1.7. For each of these sector elements, an average dose is calculated, and then multiplied by the population in that sector element. Dispersion factors are calculated for the midpoint of each sector element (see Table 1.7).

For population doses resulting from ingestion, it is conservatively assumed that all food eaten by the average individual is grown locally.

The general equation used for calculating the population dose in a given sector element is:

$$Dose_{pop} = \sum_{P} RATIO_P * POPN * AGE * 0.001 * DOSE_P \qquad (1.15)$$

where

$RATIO_P$ = ratio of average to maximum dose for pathway P. (Average ingestion rates are obtained from Regulatory Guide 1.109, Table E-4.)
= 0.5 for submersion and ground exposure pathways, a shielding/occupancy factor.

= 1.0 for the inhalation pathway.
= 0.515, 0.515, 0.5, and 0.355 for milk, for infant, child, teen and adult, respectively. (It is assumed that the ratio of average to maximum infant milk ingestion rates is the same as that for child.)
= 1.0, 0.90, 0.91, 0.86 for beef ingestion, for infant, child, teen and adult, respectively.
= 1.0, 0.38, 0.38, 0.37 for vegetable ingestion, for infant, child, teen and adult, respectively. (It is assumed that the average individual eats no fresh leafy vegetables, only stored vegetables.)

POPN = the population of the sector element, persons (Table 1.8).

AGE = fraction of the population belonging to each age group.
= 0.015, 0.168, 0.153, 0.665 for infant, child, teen and adult, respectively (fractions taken from NUREG/CR-1004, Table 3.39).

0.001 = conversion from mrem to rem.

$DOSE_P$ = the dose for pathway P to the maximum individual at the location under consideration, mrem. For ingestion pathways, this dose is multiplied by an average decay correction to account for decay as the food is moved through the food distribution cycle. This average decay correction, ADC, is defined as follows:

For milk and vegetables, $ADC = \exp(-\lambda_i t)$

where

λ_i = decay constant for nuclide i, seconds.

t = distribution time for food product under consideration (values from Regulatory Guide 1.109, Table D-1).
= 1.21E+06 seconds (14 days) for vegetables.
= 3.46E+05 seconds (4 days) for milk.

$$\text{For meat, } ADC = \frac{\exp(-\lambda_i t)\ \lambda_i t_{cb}}{1 - \exp(-\lambda_i t_{cb})}$$

where

λ_i = decay constant for nuclide i, seconds.

t = additional distribution time for meat, over and above the time for slaughter to consumption described in Section 1.8.3, 7 days.

t_{cb} = time to consume a whole beef, as described in Section 1.8.3.

For beef ingestion, the additional factors in the calculation of ADC negate the integration of the dose term over the period during which a whole beef is consumed, for the calculation of population dose. In other words, this assumes that the maximum individual freezes and eats a whole beef, while the average individual buys smaller portions at a time.

Population doses are summed over all sector elements to obtain a total population dose for the 50-mile population.

1.7.5 REPORTING OF DOSES

The calculated quarterly doses and calculated population doses described in this section are reported in the Semi-Annual Effluent Release Report submitted to the NRC for the period ending December 31 of each year.

1.8 GASEOUS RELEASES - Dose Factors

1.8.1 PASTURE GRASS-COW/GOAT-MILK INGESTION DOSE FACTORS - R_{CPi}
(m²-mrem/year per microcuries/second)

$$R_{CPi} = 10^6 DFL_{iao} U_{ap} F_{mi} Q_f \exp(-\lambda_i t_{fm}) f_p \left\{ \frac{r(1-\exp(-\lambda_E t_{ep}))}{Y_p \lambda_E} + \frac{B_{iv}(1-\exp(-\lambda_i t_b))}{P \lambda_i} \right\}$$

where:

10^6	= conversion factor, picocurie/microcurie.
DFL_{iao}	= ingestion dose conversion factor for nuclide i, age group a, organ o, mrem/picocurie (Table 1.9).
U_{ap}	= milk ingestion rate for age group a, liters/year.
F_{mi}	= transfer factor for nuclide i from animal's feed to milk, days/liter (Table 1.10).
Q_f	= animal's consumption rate, kg/day.
λ_i	= decay constant for nuclide i, seconds^{-1} (Table 1.10).
t_{fm}	= transport time from milking to receptor, seconds.
f_p	= fraction of time animal spends on pasture, dimensionless.
r	= fraction of activity retained on pasture grass, dimensionless.
λ_E	= the effective decay constant, due to radioactive decay and weathering, seconds^{-1}, equal to $\lambda_i + \lambda_w$.
λ_w	= weathering decay constant for leaf and plant surfaces, seconds^{-1}.
t_{ep}	= time pasture is exposed to deposition, seconds.
Y_p	= agricultural productivity by unit area of pasture grass, kg/m².
B_{iv}	= transfer factor for nuclide i from soil to vegetation, picocuries/kg (wet weight of vegetation) per picocuries/kg (dry soil).
t_b	= time period over which accumulation on the ground is evaluated, seconds.
P	= effective surface density of soil, kg/m².

NOTE: Factors defined above which do not reference a table for their numerical values are given in Table 1.11.

1.8.2 STORED FEED-COW/GOAT-MILK INGESTION DOSE FACTORS - R_{CSi}
(m²-mrem/year per microcuries/second)

$$R_{CSi} = 10^6\, DFL_{iao}\, U_{ap}\, F_{mi}\, Q_f\, f_s\, \exp(-\lambda_i t_{fm})\, \frac{(1-\exp(-\lambda_i t_{csf}))}{t_{csf}\,\lambda_i}$$

$$\left\{\frac{r(1-\exp(-\lambda_E t_{esf}))}{Y_{sf}\,\lambda_E} + \frac{B_{iv}(1-\exp(-\lambda_i t_b))}{P\,\lambda_i}\right\}$$

where:

10^6	= conversion factor, picocurie/microcurie.
DFL_{iao}	= ingestion dose conversion factor for nuclide i, age group a, organ o, mrem/picocurie (Table 1.9).
U_{ap}	= milk ingestion rate for age group a, liters/year.
F_{mi}	= transfer factor for nuclide i from animal's feed to milk, days/liter (Table 1.10).
Q_f	= animal's consumption rate, kg/day.
f_s	= fraction of time animal spends on stored feed, dimensionless.
λ_i	= decay constant for nuclide i, seconds⁻¹ (Table 1.10).
t_{fm}	= transport time from milking to receptor, seconds.
t_{csf}	= time between harvest of stored feed and consumption by animal, seconds.
r	= fraction of activity retained on pasture grass, dimensionless.
λ_E	= the effective decay constant, due to radioactive decay and weathering, seconds⁻¹, equal to $\lambda_i + \lambda_w$.
λ_w	= weathering decay constant for leaf and plant surfaces, seconds⁻¹.
t_{esf}	= time stored feed is exposed to deposition, seconds.
Y_{sf}	= agricultural productivity by unit area of stored feed, kg/m².
B_{iv}	= transfer factor for nuclide i from soil to vegetation, picocuries/kg (wet weight of vegetation) per picocuries/kg (dry soil).
t_b	= time period over which accumulation on the ground is evaluated, seconds.
P	= effective surface density of soil, kg/m².

NOTE: Factors defined above which do not reference a table for their numerical values are given in Table 1.11.

1.8.3 PASTURE GRASS-BEEF INGESTION DOSE FACTORS - R_{MPi}
(m²-mrem/year per microcuries/second)

$$R_{MPi} = 10^6 \, DFL_{iao} \, U_{am} \, F_{fi} \, Q_f \, \frac{(1-\exp(-\lambda_i t_{cb}))}{\lambda_i \, t_{cb}} \exp(-\lambda_i t_s)$$

$$f_p \left\{ \frac{r(1-\exp(-\lambda_E t_{ep}))}{Y_p \, \lambda_E} + \frac{B_{iv}(1-\exp(-\lambda_i t_b))}{P \, \lambda_i} \right\}$$

where:

10^6 = conversion factor, picocurie/microcurie.
DFL_{iao} = ingestion dose conversion factor for nuclide i, age group a, organ o, mrem/picocurie (Table 1.9).
U_{am} = meat ingestion rate for age group a, kg/year.
F_{fi} = transfer factor for nuclide i from cow's feed to meat, days/kg (Table 1.10).
Q_f = cow's consumption rate, kg/day.
λ_i = decay constant for nuclide i, seconds^{-1} (Table 1.10).
t_{cb} = time for receptor to consume a whole beef, seconds.
t_s = transport time from slaughter to consumer, seconds.
f_p = fraction of time cow spends on pasture, dimensionless.
r = fraction of activity retained on pasture grass, dimensionless.
λ_E = the effective decay constant, due to radioactive decay and weathering, seconds^{-1}, equal to $\lambda_i + \lambda_w$.
λ_w = weathering decay constant for leaf and plant surfaces, seconds^{-1}.
t_{ep} = time pasture is exposed to deposition, seconds.
Y_p = agricultural productivity by unit area of pasture grass, kg/m².
B_{iv} = transfer factor for nuclide i from soil to vegetation, picocuries/kg (wet weight of vegetation) per picocuries/kg (dry soil).
t_b = time over which accumulation on the ground is evaluated, seconds.
P = effective surface density of soil, kg/m².

NOTE: Factors defined above which do not reference a table for their numerical values are given in Table 1.11.

1.8.4 STORED FEED-BEEF INGESTION DOSE FACTORS - R_{MSi}
(m^2-mrem/year per microcuries/second)

$$R_{MSi} = 10^6\, DFL_{iao}\, U_{am}\, F_{fi}\, Q_f\, \frac{(1-\exp(-\lambda_i t_{cb}))}{\lambda_i\, t_{cb}}\, \exp(-\lambda_i t_s)$$

$$f_s\, \frac{(1-\exp(-\lambda_i t_{csf}))}{\lambda_i\, t_{csf}} \left\{ \frac{r(1-\exp(-\lambda_E t_{esf}))}{Y_{sf}\, \lambda_E} + \frac{B_{iv}(1-\exp(-\lambda_i t_b))}{P\, \lambda_i} \right\}$$

where:

10^6 = conversion factor, picocurie/microcurie.
DFL_{iao} = ingestion dose conversion factor for nuclide i, age group a, organ o, mrem/picocurie (Table 1.9).
U_{am} = meat ingestion rate for age group a, kg/year.
F_{fi} = transfer factor for nuclide i from cow's feed to meat, days/kg (Table 1.10).
Q_f = cow's consumption rate, kg/day.
λ_i = decay constant for nuclide i, $seconds^{-1}$ (Table 1.10).
t_{cb} = time for receptor to consume a whole beef, seconds.
t_s = transport time from slaughter to consumer, seconds.
f_s = fraction of time cow spends on stored feed, dimensionless.
t_{csf} = time between harvest of stored feed and consumption by cow, seconds.
r = fraction of activity retained on pasture grass, dimensionless.
t_{esf} = time stored feed is exposed to deposition, seconds.
Y_{sf} = agricultural productivity by unit area of stored feed, kg/m^2.
λ_E = the effective decay constant, due to radioactive decay and weathering, $seconds^{-1}$, equal to $\lambda_i + \lambda_w$.
λ_w = weathering decay constant for leaf and plant surfaces, $seconds^{-1}$.
B_{iv} = transfer factor for nuclide i from soil to vegetation, picocuries/kg (wet weight of vegetation) per picocuries/kg (dry soil).
t_b = time over which accumulation on the ground is evaluated, seconds.
P = effective surface density of soil, kg/m^2.

NOTE: Factors defined above which do not reference a table for their numerical values are given in Table 1.11.

1.8.5 FRESH LEAFY VEGETABLE INGESTION DOSE FACTORS - R_{VFi}
(m²-mrem/year per microcuries/second)

$$R_{VFi} = 10^6 \, DFL_{iao} \, e(-\lambda_i t_{hc}) \, U_{FLa} f_L \{ \frac{r(1-e(-\lambda_E t_e))}{Y_f \, \lambda_E} + \frac{B_{iv}(1-e(-\lambda_i t_b))}{P \, \lambda_i} \}$$

where:

10^6	=	conversion factor, picocurie/microcurie.
DFL_{iao}	=	ingestion dose conversion factor for nuclide i, age group a, organ o, mrem/picocurie (Table 1.9).
λ_i	=	decay constant for nuclide i, $seconds^{-1}$ (Table 1.10).
t_{hc}	=	average time between harvest of vegetables and their consumption and/or storage, seconds.
U_{FLa}	=	consumption rate of fresh leafy vegetables by the receptor in age group a, kg/year.
f_L	=	fraction of fresh leafy vegetables grown locally, dimensionless.
r	=	fraction of deposited activity retained on vegetables, dimensionless.
λ_E	=	the effective decay constant, due to radioactive decay and weathering, $seconds^{-1}$.
	=	$\lambda_i + \lambda_w$
λ_w	=	decay constant for removal of activity on leaf and plant surfaces by weathering, $seconds^{-1}$.
t_e	=	exposure time in garden for fresh leafy and/or stored vegetables, seconds.
Y_f	=	agricultural yield for fresh leafy vegetables, kg/m^2.
B_{iv}	=	transfer factor for nuclide i from soil to vegetables, picocuries/kg (wet weight of vegetation) per picocuries/kg (dry soil).
t_b	=	time period over which accumulation on the ground is evaluated, seconds.
P	=	effective surface density of soil, kg/m^2.

NOTE: Factors defined above which do not reference a table for their numerical values are given in Table 1.11.

1.8.6 <u>STORED VEGETABLE INGESTION DOSE FACTORS</u> - R_{VSi}
m²-mrem/year per microcuries/second)

$$R_{VSi} = 10^6 \, DFL_{iao} \exp(-\lambda_i t_{hc}) \, U_{Sa} f_g \frac{(1-e(-\lambda_i t_{sv}))}{\lambda_i \, t_{sv}}$$

$$\left\{\frac{r(1-e(-\lambda_E t_e))}{Y_{sv} \, \lambda_E} + \frac{B_{iv}(1-e(-\lambda_i t_b))}{P \, \lambda_i}\right\}$$

where:

10^6 = conversion factor, picocurie/microcurie.
DFL_{iao} = ingestion dose conversion factor for nuclide i, age group a, organ o, mrem/picocurie (Table 1.9).
λ_i = decay constant for nuclide i, seconds^{-1} (Table 1.10).
t_{hc} = average time between harvest of vegetables and their consumption and/or storage, seconds.
U_{Sa} = consumption rate of stored vegetables by the receptor in age group a, kg/year.
f_g = fraction of stored vegetables grown locally, dimensionless.
t_{sv} = time between storage of vegetables and their consumption, seconds.
r = fraction of deposited activity retained on vegetables, dimensionless.
λ_E = the effective decay constant, due to radioactive decay and weathering, seconds^{-1}.
= $\lambda_i + \lambda_w$
λ_w = decay constant for removal of activity on leaf and plant surfaces by weathering, seconds^{-1}.
t_e = exposure time in garden for fresh leafy and/or stored vegetables, seconds.
Y_{sv} = agricultural yield for stored vegetables, kg/m².
B_{iv} = transfer factor for nuclide i from soil to vegetables, picocuries/kg (wet weight of vegetation) per picocuries/kg (dry soil).
t_b = time period over which accumulation on the ground is evaluated, seconds.
P = effective surface density of soil, kg/m².

NOTE: Factors defined above which do not reference a table for their numerical values are given in Table 1.11.

1.8.7 <u>TRITIUM-PASTURE GRASS-COW/GOAT-MILK DOSE FACTOR</u> - R_{CTP}
(mrem/year per microcuries/m²)

$$R_{CTP} = 10^3\ 10^6\ DFL_{Tao}\ F_{mT}\ Q_f\ U_{ap}\ [0.75(0.5/H)]\ f_p\ \exp(-\lambda_T t_{fm})$$

where:

10^3	= conversion factor, grams/kg.
10^6	= conversion factor, picocuries/microcuries.
DFL_{Tao}	= ingestion dose conversion factor for tritium for age group a, organ o, mrem/picocurie (Table 1.9).
F_{mT}	= transfer factor for tritium from animal's feed to milk, days/liter (Table 1.10).
Q_f	= animal's consumption rate, kg/day.
U_{ap}	= milk ingestion rate for age group a, liters/year.
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.
H	= absolute humidity of the atmosphere, g/m³.
f_p	= fraction of time animal spends on pasture, dimensionless.
λ_T	= decay constant for tritium, seconds⁻¹ (Table 1.10).
t_{fm}	= transport time from milking to receptor, seconds.

NOTE: Factors defined above which do not reference a table for their numerical values are given in Table 1.11.

1.8.8 TRITIUM-STORED FEED-COW/GOAT-MILK DOSE FACTOR - R_{CTS}
(mrem/year per microcuries/m²)

$$R_{CTS} = 10^3\ 10^6\ DFL_{Tao}\ F_{mT}\ Q_f\ U_{ap}\ [0.75(0.5/H)]\ f_s\ \frac{(1-\exp(-\lambda_T t_{csf}))}{\lambda_T\ t_{csf}}\ \exp(-\lambda_T t_{fm})$$

where:

10^3	= conversion factor, grams/kg.
10^6	= conversion factor, picocuries/microcuries.
DFL_{Tao}	= ingestion dose conversion factor for tritium for age group a, organ o, mrem/picocurie (Table 1.9).
F_{mT}	= transfer factor for tritium from animal's feed to milk, days/liter (Table 1.10).
Q_f	= animal's consumption rate, kg/day.
U_{ap}	= milk ingestion rate for age group a, liters/year.
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.
H	= absolute humidity of the atmosphere, g/m³.
f_s	= fraction of time animal spends on stored feed, dimensionless.
λ_T	= decay constant for tritium, seconds^{-1} (Table 1.10).
t_{csf}	= time between harvest of stored feed and consumption by animal, seconds.
t_{fm}	= transport time from milking to receptor, seconds.

NOTE: Factors defined above which do not reference a table for their numerical values are given in Table 1.11.

1.8.9 **TRITIUM-PASTURE GRASS-BEEF DOSE FACTOR** – R_{MT}
(mrem/year per microcuries/m²)

$$R_{MTP} = 10^3\ 10^6\ DFL_{Tao}\ F_{fT}\ Q_f\ U_{am}\ [0.75(0.5/H)]\ f_p\ \exp(-\lambda_T t_s)\ \frac{(1-\exp(-\lambda_T t_{ep}))}{\lambda_T\ t_{ep}}\ \frac{(1-\exp(-\lambda_T t_{cb}))}{\lambda_T\ t_{cb}}$$

where:

10^3	= conversion factor, grams/kg.
10^6	= conversion factor, picocuries/microcuries.
DFL_{Tao}	= ingestion dose conversion factor for H-3 for age group a, organ o, mrem/picocurie (Table 1.9).
F_{fT}	= transfer factor for H-3 from cow's feed to meat, days/kg (Table 1.10).
Q_f	= cow's consumption rate, kg/day.
U_{am}	= meat ingestion rate for age group a, kg/year.
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.
H	= absolute humidity of the atmosphere, g/m³.
f_p	= fraction of time cow spends on pasture, dimensionless.
λ_T	= decay constant for tritium, seconds⁻¹ (Table 1.10).
t_s	= transport time from slaughter to consumer, seconds.
t_{ep}	= time pasture is exposed to deposition, seconds.
t_{cb}	= time for receptor to consume a whole beef, seconds.

NOTE: Factors defined above which do not reference a table for their numerical values are given in Table 1.11.

1.8.10 <u>TRITIUM-STORED FEED-BEEF DOSE FACTOR</u> - R_{MTS}
(mrem/year per microcuries/m³)

$$R_{MTS} = 10^3\ 10^6\ DFL_{Tao}\ F_{fT}\ Q_f\ U_{am}\ [0.75(0.5/H)]\ f_s \exp(-\lambda_T t_s) \frac{(1-\exp(-\lambda_T t_{ep}))}{\lambda_T\ t_{ep}} \frac{(1-\exp(-\lambda_T t_{cb}))}{\lambda_T\ t_{cb}}$$

where:

10^3	= conversion factor, grams/kg.
10^6	= conversion factor, picocuries/microcuries.
DFL_{Tao}	= ingestion dose conversion factor for H-3 for age group a, organ o, mrem/picocurie (Table 1.9).
F_{fT}	= transfer factor for H-3 from cow's feed to meat, days/kg (Table 1.10).
Q_f	= cow's consumption rate, kg/day.
U_{am}	= meat ingestion rate for age group a, kg/year.
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.
H	= absolute humidity of the atmosphere, g/m³.
f_s	= fraction of time cow spends on stored feed, dimensionless.
λ_T	= decay constant for tritium, seconds^{-1} (Table 1.10).
t_s	= transport time from slaughter to consumer, seconds.
t_{ep}	= time pasture is exposed to deposition, seconds.
t_{cb}	= time for receptor to consume a whole beef, seconds.

NOTE: Factors defined above which do not reference a table for their numerical values are given in Table 1.11.

1.8.11 <u>TRITIUM-FRESH LEAFY VEGETABLES DOSE FACTOR</u> - R_{VTF}
(mrem/year per microcuries/m³)

$$R_{VTF} = 10^3\ 10^6\ DFL_{Tao}\ [0.75(0.5/H)]\ U_{FLa}\ f_L\ \exp(-\lambda_T t_{hc})$$

where:

10^3 = conversion factor, grams/kg.
10^6 = conversion factor, picocuries/microcuries.
DFL_{Tao} = ingestion dose conversion factor for tritium for age group a, organ o, mrem/picocurie (Table 1.9).
0.75 = the fraction of total vegetation that is water.
0.5 = the ratio of the specific activity of the vegetables water to the atmospheric water.
H = absolute humidity of the atmosphere, g/m³.
U_{FLa} = consumption rate of fresh leafy vegetables by the receptor in age group a, kg/year.
f_L = fraction of fresh leafy vegetables grown locally, dimensionless.
λ_T = decay constant for tritium, seconds⁻¹ (Table 1.10).
t_{hc} = time between harvest of vegetables and their consumption and/or storage, seconds.

NOTE: Factors defined above which do not reference a table for their numerical values are given in Table 1.11.

1.8.12 <u>TRITIUM-STORED VEGETABLES DOSE FACTOR</u> - R_{VTS}
(mrem/year per microcuries/m^3)

$$R_{VTS} = 10^3 \, 10^6 \, DFL_{Tao} \, [0.75(0.5/H)] \; U_{Sa} f_g \frac{(1-\exp(-\lambda_T t_{sv}))}{\lambda_T \, t_{sv}} \exp(-\lambda_T t_{hc})$$

where:

10^3	=	conversion factor, grams/kg.
10^6	=	conversion factor, picocuries/microcuries.
DFL_{Tao}	=	ingestion dose conversion factor for tritium for age group a, organ o, mrem/picocurie (Table 1.9).
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.
H	=	absolute humidity of the atmosphere, g/m^3.
U_{Sa}	=	consumption rate of stored vegetables by the receptor in age group a, kg/year.
f_g	=	fraction of stored vegetables grown locally, dimensionless.
λ_T	=	decay constant for tritium, $seconds^{-1}$ (Table 1.10).
t_{sv}	=	time between harvest of stored vegetables and their consumption and/or storage, seconds.
t_{hc}	=	time between harvest of vegetables and their storage, seconds.

NOTE: Factors defined above which do not reference a table for their numerical values are given in Table 1.11.

1.8.13 INHALATION DOSE FACTORS- R_{Ti}
(mrem/year per microcuries/m^3)

$$R_{Ti} = DFA_{iao}\ BR_a\ 10^6$$

where:

DFA_{iao} = inhalation dose conversion factor for nuclide i, age group a and organ o, mrem/picocurie (Table 1.12).
BR_a = breathing rate for age group a, m^3/year (Table 1.11).
10^6 = conversion factor, picocurie/microcurie.

1.8.14 GROUND PLANE DOSE FACTORS - R_{Gi}
(m^2-mrem/year per microcuries/second)

$$R_{Gi} = DFG_{io}\ 1/\lambda_i\ 10^6\ 8760\ [1 - \exp(-\lambda_i t_b)]$$

where:

DF_{Gio} = dose conversion factor for standing on contaminated ground for nuclide i and organ o (total body and skin), mrem/hr per picocurie/m^2 (Table 1.13).
λ_i = decay constant of nuclide i, $seconds^{-1}$ (Table 1.10).
10^6 = conversion factor, picocurie/microcurie.
8760 = conversion factor, hours/year.
t_b = time period over which the ground accumulation is evaluated, seconds (Table 1.11).

1.9 DISPERSION METHODOLOGY

Dispersion factors are calculated for radioactive effluent releases using hourly average meteorological data consisting of wind speed and direction measurements at 10m and temperature measurements at 9m and 46m.

A sector-average dispersion equation consistent with Regulatory Guide 1.111 is used. The dispersion model considers plume depletion (using information from Figure 1.5), and building wake effects. Terrain effects on dispersion are not considered.

Hourly average meteorological data are expressed as a joint-frequency distribution of wind speed, wind direction, and atmospheric stability. The joint-frequency distribution which represents the historical meteorological data for the period January 1972 to December 1975 is given in Table 1.2.

The wind speed classes that are used are as follows:

Number	Range (m/s)	Midpoint (m/s)
1	<0.3	0.13
2	0.3-0.6	0.45
3	0.7-1.5	1.10
4	1.6-2.4	1.99
5	2.5-3.3	2.88
6	3.4-5.5	4.45
7	5.6-8.2	6.91
8	8.3-10.9	9.59
9	>10.9	10.95

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

1.9.1 AIR CONCENTRATION - χ ($\mu Ci/m^3$)

Air concentrations of nuclides at downwind locations are calculated using the following equation:

$$\chi_i = \sum_{j=1}^{9} \sum_{k=1}^{7} (2/\pi)^{1/2} \frac{f_{jk}\, Q_i\, p}{\Sigma_{zk}\, u_j\, (2\pi x/n)} \exp(-\lambda_i\, x/u_j) \quad (1.16)$$

where

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

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Q_i = average annual release rate of radionuclide i, µCi/s.
p = fraction of radionuclide remaining in plume (Figure 1.5).
Σ_{zk} = vertical dispersion coefficient for stability class k which includes a building wake adjustment,
= $(\sigma_{zk}^2 + cA/\pi)^{1/2}$,
or = $\sqrt{3}\ \sigma_{zk}$, whichever is smaller.
where
σ_{zk} is the vertical dispersion coefficient for stability class k (m) (Figure 1.6),
c is a building shape factor (c=0.5),
A is the minimum building cross-sectional area (1800 m^2).
u_j = midpoint value of wind speed class interval j, m/s.
x = downwind distance, m.
n = number of sectors, 16.
λ_i = radioactive decay coefficient of radionuclide i, s^{-1}
$2\pi x/n$ = sector width at point of interest, m.

1.9.2 <u>RELATIVE CONCENTRATION - χ/Q</u> (sec/m^3)

Relative concentrations of nuclides at downwind locations are calculated using the following equation:

$$\chi/Q = \sum_{j=1}^{9} \sum_{k=1}^{7} (2/\pi)^{1/2} \frac{f_{jk}}{\Sigma_{zk}\, u_j\, (2\pi x/n)} \qquad (1.17)$$

where

f_{jk} = joint relative frequency of occurrence of winds in windspeed class j, stability class k, blowing toward this exposure point, expressed as a fraction.
Σ_{zk} = vertical dispersion coefficient for stability class k which includes a building wake adjustment,
= $(\sigma_{zk}^2 + cA/\pi)^{1/2}$,
or = $\sqrt{3}\ \sigma_{zk}$, whichever is smaller.
where
σ_{zk} is the vertical dispersion coefficient for stability class k (m) (Figure 1.6),
c is a building shape factor (c=0.5),
A is the minimum building cross-sectional area (1800 m^2).
u_j = midpoint value of wind speed class interval j, m/s.
x = downwind distance, m.
n = number of sectors, 16.
$2\pi x/n$ = sector width at point of interest, m.

1.9.3 RELATIVE DEPOSITION- D/Q (m^{-2})

Relative deposition of nuclides at downwind locations is calculated using the following equation:

$$D/Q = \sum_{j=1}^{9} \sum_{k=1}^{7} \frac{f_{jk}\ DR}{(2\pi x/n)} \tag{1.18}$$

where

f_k = joint relative frequency of occurrence of winds in windspeed class j and stability class k, blowing toward this exposure point, expressed as a fraction.
DR = relative deposition rate, m^{-1} (from Figure 1.7).
x = downwind distance, m.
n = number of sectors, 16.
$2\pi x/n$ = sector width at point of interest, m.

2.0 LIQUID EFFLUENTS

2.1 RELEASE POINTS

There are four systems from which liquid effluents are released to the environment. These are the Liquid Radwaste System, the Condensate Demineralizer System, the Turbine Building Sump, and the Units 1 and 2 Steam Generator Blowdown. Figure 2.1 provides an outline of the liquid release paths and discharge points with associated flow rates and radiation monitors.

All liquid effluents are ultimately discharged to the Diffuser Pond which releases to the Tennessee River. The Essential Raw Cooling Water (ERCW) provides dilution for liquid effluents at a minimum flow rate of 15,000 gpm. ERCW flow is monitored by radiation monitors 0-RM-133, -134, -140, -141. The inlet of the Diffuser Pond is monitored by radiation monitor 0-RM-90-211.

Liquid Radwaste System

The Liquid Radwaste System processes liquid from the Reactor Building and Auxiliary Building Floor Drains and the laundry/hot shower and chemical drain tanks. Figure 2.2 provides a schematic of the Liquid Radwaste System, showing the liquid pathways, flow rate and radiation monitors. The normal release points for liquid radwaste are the Monitor Tank and the Cask Decontamination Collector Tank (CDCT). The Monitor Tank has a capacity of 22,000 gal and is released routinely at a flow rate of 125 gpm. The CDCT has a capacity of 15,000 gal and is also released routinely at a flow rate of 125 gpm. The Monitor Tank and CDCT discharge to the Cooling Tower Blowdown (CTBD) line as a batch release and are monitored by radiation monitor 0-RM-90-122.

Condensate Demineralizer System

The Condensate Demineralizer System processes liquid wastes coming from the High Crud Tanks (HCT-1 and -2), the Neutralization Tank, and the Non-Reclaimable Waste Tank (NRWT). The HCTs have a capacity of 20,000 gal and a maximum discharge flow rate of 245 gpm. The Neutralization Tank has a capacity of 19,000 gal and a maximum discharge flow rate of 245 gpm. The NRWT has a capacity of 11,000 gal and a maximum discharge flow rate of 245 gpm. The Condensate Demineralizer System is routinely released to the CTBD line and is monitored by radiation monitor 0-RM-90-225.

Turbine Building Sump

The Turbine Building Sump (TBS) normally releases to the Low Volume Waste Treatment Pond (LVWTP) but can be released to the Yard Pond.

The TBS has a capacity of 30,000 gal and a design discharge release rate of 1,750 gpm per pump. TBS releases are monitored by radiation monitor 0-RM-90-212.

Steam Generator Blowdown

The Steam Generator Blowdown (SGBD) is processed in the Steam Generator Draindown Flash Tanks or SGBD Heat Exchangers. The SGBD discharge has a maximum flow rate of 80 gpm per steam generator. SGBD discharges to the CTBD line are continuous and are monitored by radiation monitors (1) (2)-RM-90-120, -121.

2.2 CONCENTRATION

2.2.1 REQUIREMENTS

The concentration of radioactive material released to UNRESTRICTED R24
AREAS (see Figure 1.3) shall be limited to the concentrations R24
specified in 10 CFR Part 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 $2X10^{-4}$ microcuries/ml total activity.

This requirement is applicable at all times.

This requirement is provided to ensure that the concentration of
radioactive materials released in liquid waste effluents to
UNRESTRICTED AREAS will be less than the concentration levels R24
specified in 10 CFR Part 20, Appendix B, Table II, Column 2. This
limitation provides additional assurance that the levels of
radioactive materials in bodies of water in UNRESTRICTED AREAS will R24
result in exposures within (1) the Section II.A design objectives of
Appendix I, 10 CFR 50, to a MEMBER OF THE PUBLIC and (2) the limits of R24
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 of Radiological
Protection (ICRP) Publication 2.

If this requirement is not met, the following action will be performed:

With the concentration of radioactive material released to
UNRESTRICTED AREAS exceeding the above limits, without delay, R24
restore the concentration to within the above limits.

To ensure that this requirement is met:

Radioactive liquid wastes shall be sampled and analyzed according to the sampling and analysis program of Table 2.1 and

The results of the radioactivity analysis shall be used in accordance with the methods in Section 2.2.2 to assure that the concentration at the point of release is maintained within the limits stated above.

2.2.2 MPC-SUM OF THE RATIOS

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

$$R_j = \sum_i \frac{C_i}{MPC_i} \qquad (2.1)$$

where:

R_j = the sum of the ratios for release point j.
MPC_i = the MPC of radionuclide i, as specified in Section 2.2.1, µCi/mL.
C_i = concentration of radionuclide i, µCi/mL.

The sum of the MPC ratios must be ≤ 1 due to the releases from any or all of the release points described above.

The following relationship is used to ensure that this criterion is met:

$$R_{TBS} + \frac{f_1R_1 + f_2R_2 + f_3R_3 + f_4R_4}{F} \leq 1.0 \qquad (2.2)$$

where

R_{TBS} = sum of the ratios of the turbine building sump as determined by equation 2.1.
f_1, f_2, f_3, f_4 = effluent flow rate for radwaste, condensate demineralizer system and each of the steam generators, respectively, gpm.
R_1, R_2, R_3, R_4 = sum of ratios for radwaste, condensate demineralizer system and each of the steam generators, respectively, as determined by equation 2.1.
F = minimum dilution flow rate for CTBD, 15,000 gpm.

2.3 RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

2.3.1 REQUIREMENTS

The radioactive liquid effluent monitoring instrumentation channels shown in Table 2.2 shall be OPERABLE with their alarm/trip setpoints set to ensure that the limits of Section 2.2.1 are not exceeded. The alarm/trip setpoints of these channels shall be determined in accordance with the methodology and parameters in Section 2.3.3. R24

This requirement is applicable during all releases via these pathways.

The radioactive liquid effluent instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in liquid effluents during actual or potential releases of liquid effluents. The alarm/trip setpoints for these instruments shall be calculated in accordance with the procedures in Section 2.3.3 to ensure that the alarm/trip will occur prior to exceeding the limits of 10 CFR Part 20. The OPERABILITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10 CFR Part 50. R24

If this requirement is not met, the appropriate following action(s) will be performed;

a. With a radioactive liquid effluent monitoring instrumentation channel alarm/trip setpoint less conservative than required above, without delay suspend the release of radioactive liquid effluents monitored by the affected channel or declare the channel inoperable, or change the setpoint so that it is acceptably conservative.

b. With less than the minimum number of radioactive liquid effluent monitoring instrumentation channels OPERABLE, take the action shown in Table 2.2. Exert best effort to return the instruments to OPERABLE status within 30 days and, if unsuccessful, explain in the next Semi-Annual Effluent Release Report why the inoperability could not be corrected within 30 days. R24 R24

To ensure that this requirement is met:

Each radioactive liquid effluent monitoring channel shall be demonstrated OPERABLE by performance of the CHANNEL CHECK, CHANNEL CALIBRATION, and CHANNEL FUNCTIONAL TEST operations at the frequencies shown in Table 2.3. R24 R24

2.3.2 RELEASE SAMPLING

Radwaste tanks will be recirculated through two volume changes prior to sampling to ensure that a representative sample is obtained. The condensate demineralizer waste evaporator blowdown tanks cannot be recirculated. However, the contents will be transferred to the waste distillate tanks prior to release.

Condensate demineralizer tanks are routinely continuously released[a] and utilize a composite sampler to obtain a representative sample while being discharged. In the event of an inoperable effluent radiation monitor or composite sampler, a two volume recirculation and two independent samples and analyses will be performed. Releases from the steam generator blowdown and turbine building sump[a] are considered continuous and grab sampled daily.

Prior to a batch release, a grab sample will be taken and analyzed to determine the concentration, µCi/ml, of each gamma-emitting nuclide. For continuous releases, daily grab or composite samples will be taken and analyzed to determine the concentration, µCi/ml, of each gamma-emitting nuclide nuclide. Composite samples are maintained (as required by Table 2.1) to determine the concentration of certain nuclides (H-3, Fe-55, Sr-89, Sr-90, and alpha emitters).

For those nuclides whose activities are determined from composite samples (i.e. Sr-89, Sr-90, Fe-55 and H-3) the concentrations for the previous composite period will be assumed as the concentration for the next period to perform the calculations in Sections 2.2, 2.3, 2.4 and 2.5. The actual measured concentrations will be used for the dose calculations described in Section 2.6.

a Sampling requirements for these release points are applicable only during periods of primary to secondary leakage or the release of radioactivity as detected by the effluent radiation monitor provided the radiation monitor setpoint is at a LLD of ≤ 1E-06 µCi/ml and allowing for background radiation during periods when primary to secondary leakage is occurring.

2.3.3 INSTRUMENT SETPOINTS

Liquid effluent monitor setpoints are determined to ensure that the concentration of radioactive material released at any time from the site to UNRESTRICTED AREAS does not exceed the MPC limits referenced in Section 2.2.1. R24

2.3.3.1 Expected Monitor Response

For each release, the expected monitor response, R in cpm, is calculated using the following equation:

$$R = B + \sum_{i} Eff_i * C_i \qquad (2.3)$$

where

B = monitor background, cpm.

Eff_i = monitor efficiency for nuclide i, cpm per µCi/cc.

C_i = tank concentration of nuclide i, µCi/cc.

2.3.3.2 Calculated Maximum Monitor Setpoint

For each release from a release point, a setpoint is calculated for the appropriate monitor which corresponds to the MPC limit for that release.

The calculated maximum monitor setpoint, S_{max} in cpm, is given by the following equation:

$$S_{max} = (SAF*(R - B)) + B \qquad (2.4)$$

where

SAF = setpoint adjustment factor as calculated below.

R = expected monitor response, cpm, as calculated by equation 2.3 in Section 2.3.3.1.

B = background, cpm.

Setpoint Adjustment Factor - SAF

The SAF is determined by calculating the required dilution factor for the waste stream which will ensure that the MPC limits are met at the UNRESTRICTED AREA boundary. If no dilution is required, then there is no need for a SAF. If dilution is required to meet the MPC limits, the SAF adjusts the monitor to account for any additional dilution over the required amount. The methodology for determining the SAF is given below. R24

1. A required dilution factor, DF_r, is calculated using the following equation:

$$DF_r = \frac{R_j}{SF} \qquad (2.5)$$

where

R_j = sum of the MPC ratios for release point j as calculated in Section 2.2.2.
SF = safety factor for the monitor.

2. The following criteria will be applied to the required dilution factor to determine the SAF:

   A. If the required dilution factor, DF_r is less than or equal to 1, then the SAF = 0.

   B. If the required dilution factor, DF_r, is greater than 1, SAF is calculated using the following equation. This accounts for the downstream dilution of the waste flow over and above the required dilution.

$$SAF = \frac{DF_a}{DF_r}$$

where

DF_r = the required dilution factor as calculated above.
DF_a = the actual dilution factor, calculated using the following equation:

$$DF_a = \frac{FLOW_w + (A * FLOW_{dil})}{FLOW_w} \qquad (2.6)$$

where

$FLOW_w$ = flow of waste stream, gpm.
$FLOW_{dil}$ = flow of the dilution stream, gpm.
A = fraction of dilution flow allocated to this release point. For the TBS, this fraction is zero. The fractions for the remaining 4 release points are defined as the ratio of the allocated minimum CTBD flow for that release point to the total minimum CTBD flow. The minimum CTBD flow allocation for these release points is as follows;

Radwaste	9000 gpm
Condensate demineralizer	3000 gpm
Steam generator blow down (U1)	1500 gpm
Steam generator blow down (U2)	1500 gpm

2.3.3.3 Normal Default Setpoint

A normal default setpoint may be determined for each monitor. A default setpoint for a monitor will be defined and documented in approved plant procedures. A default setpoint should be low enough to ensure that concentration limits defined in Section 2.2.1 are not violated and to ensure that unexpected releases are identified.

2.3.3.4 Actual Monitor Setpoints

The maximum calculated monitor setpoint is determined for each monitor using the methodology in Section 2.3.3.2. The default setpoint is defined in Section 2.3.3.3. The monitor setpoint for the release is determined as described below.

The setpoint chosen for a monitor for each release is determined as follows:

1. IF the calculated maximum setpoint is less than the normal default, THEN the setpoint shall be set equal to the calculated maximum setpoint.

2. IF the calculated maximum setpoint is greater than the normal default, AND X[1] times the expected monitor response is less than the normal default setpoint, THEN the setpoint shall be set equal to the normal default setpoint.

3. IF the calculated maximum setpoint is greater than the normal default, AND X[1] times the expected monitor response is greater than the normal default setpoint, THEN the setpoint shall be set equal to X[1] times the expected response.

[1] X is an administrative factor designed to account for expected variations in monitor response. It will be defined in approved plant instructions.

2.3.4 Post-Release Analysis

A post-release analysis will be done using actual release data to ensure that the limits specified in Section 2.2.1 were not exceeded.

A composite list of concentrations (C_i), by isotope, will be used with the actual waste (f) and dilution (F) flow rates (or volumes) during the release. The data will be substituted into Equation 2.2 to demonstrate compliance with the limits in Section 2.2.1. This data and setpoints will be recorded in auditable records by plant personnel.

2.4 DOSE

2.4.1 REQUIREMENTS

The dose or dose commitment to a MEMBER OF THE PUBLIC from radioactive materials in liquid effluents released to UNRESTRICTED AREAS shall be limited from each reactor unit: R24

a. During any calendar quarter to less than or equal to 1.5 mrem to the total body and to less than or equal to 5 mrem to any organ, and

b. During any calendar year to less than or equal to 3 mrem to the total body and to less than or equal to 10 mrem to any organ.

This requirement is applicable at all times.

This requirement is provided to implement the requirements of Sections II.A, III.A, and IV.A of Appendix I, 10 CFR Part 50. The requirement implements the guide set forth in Section II.A 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 liquid effluents will be kept "as low as reasonable achievable." Also, for fresh water sites with drinking water supplies which can be potentially affected by plant operations, there is reasonable assurance that the operation of the facility will not result in radionuclide concentrations in the finished drinking water that are in excess of the requirements of 40 CFR 141. The dose calculations in this Section 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 appropriately R24 modeled pathways is unlikely to substantially underestimated. The equations specified in this section for calculating the doses due to the actual release rates of radioactive materials in liquid 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 Purposes of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1, October 1977 and Regulatory Guide 1.113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I," April 1977.

This requirement applies to the release of liquid effluents from each reactor at the site. For units with shared radwaste treatment systems, the liquid effluents from the shared systems are proportioned among the units sharing that system.

If this requirement is not met, the following action will be performed:

With the calculated dose from the release of radioactive materials in liquid effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days, pursuant to Technical Specification 6.9.2, a Special Report which identifies the cause(s) for exceeding the limit(s) and defines the corrective actions 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. This special Report shall also include (1) the results of radiological analyses of the drinking water source and (2) the radiological impact on finished drinking water supplies with regard to the requirements of 40 CFR 141 (applicable only if drinking water supply is taken from the receiving water body within three miles downstream of the plant discharge).

To ensure that this requirement is met:

Cumulative dose contributions from liquid effluents for the current calendar quarter and current calendar year shall be determined in accordance with the methodology and parameters in Section 2.4.2 at least once per 31 days.

2.4.2 CUMULATIVE LIQUID EFFLUENT DOSE CALCULATIONS

Doses due to liquid effluents are calculated for each release for all age groups (adult, teen, child and infant) and organs (bone, liver, total body, thyroid, skin, kidney, lung and GI tract). Pathways considered are ingestion of drinking water, fish consumption and recreation-shoreline. The maximum individual dose from drinking water is assumed to be that calculated at the location immediately downstream from the diffuser (see Table 1.1). The maximum individual dose from fish ingestion is assumed to be that calculated for the consumption of fish caught anywhere between the plant and the first downstream dam (Chickamauga Dam). The maximum potential recreation dose is calculated for a location immediately downstream of the plant outfall. Dose factors for these age groups and pathways are calculated as described in Section 2.7. For pathways with no age or organ specific dose factors (i.e. shoreline recreation), the total body dose will be added to the internal organ doses for all age groups.

The general equation for the dose calculations is:

$$\text{Dose} = \sum_i A_{it}\ T\ C_i\ D \qquad (2.7)$$

where:

A_{it} = the total dose factor to the total body or any organ t for nuclide i, mrem/hr per μCi/ml. The total dose factor is the sum of the dose factors for water ingestion, fish ingestion, and shoreline recreation, as defined in Section 2.7.

T = the length of time period over which the concentrations and the flows are averaged for the liquid release, hours.

C_i = the average concentration of radionuclide i, in undiluted liquid effluent during the time period T from any liquid release, μCi/ml.

D = the near field average dilution factor for C_i during any effluent release. D is calculated by the following equation:

$$D = \frac{FLOW_w}{0.60\ \ RF}$$

where:

$FLOW_w$ = maximum undiluted liquid waste flow during the release, cfs. For TBS releases, this term is the diluted waste flow into the pond.

0.60 = mixing factor of effluent in river, defined as the percentage of the riverflow which is available for dilution of the release.

RF = default riverflow, cfs. For each release, this value is set to 7900 cfs (the lowest average quarterly riverflow recorded from the period 1978-1988).

From the four age groups considered, the maximum is determined by comparing all organ doses for all age groups. The age group with the highest single organ dose is selected as the critical age group. The total body and maximum organ doses for the critical age group are used in the calculation of the monthly dose described in Section 2.4.2.2.

2.4.2.2 Monthly Dose Calculations

At the end of each month, the actual average riverflow for the month is used to recalculate the liquid doses. The monthly cumulative dose is defined as the sum of the doses for the critical age group for each release during the month. Thus, the monthly cumulative dose will be a conservative value, consisting of doses belonging to various age groups depending on the mix of radionuclides. These doses are multiplied by the ratio of the default riverflow (7900 cfs) to the actual monthly average riverflow to obtain the monthly dose. The total body and maximum organ doses determined in this manner are then used to determine the cumulative quarterly and annual doses described in Section 2.4.2.3, and for the dose projections described in Section 2.5.3.

2.4.2.3 Cumulative Doses

Quarterly and annual sums of all doses are determined at the end of each month to compare to the limits given in Section 2.4.1. These quarterly and annual sums will be the sum of the monthly cumulative doses described in Section 2.4.2.2 for the appropriate months in the quarter or year. These doses will be used in the comparison to the limits.

2.4.2.4 Comparison to Limits

The cumulative calendar quarter and calendar year doses are compared to the limits in Section 2.4.1 once per 31 days to determine compliance.

2.5 LIQUID WASTE TREATMENT

2.5.1 REQUIREMENT

The liquid radwaste treatment system shall be used to reduce the radioactive materials in liquid wastes prior to their discharge when the projected doses due to the liquid effluent to UNRESTRICTED AREAS (see Figure 1.3) would exceed 0.06 mrem per reactor unit to the total body or 0.2 mrem per reactor unit to any organ in a 31-day period. R24

This requirement is applicable at all times.

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 reasonable achievable." This requirement implements the requirements of 10 CFR Part 50.36a, General Design Criteria 60 of Appendix A to 10 CFR Part 50 and the design objective given in Section II.D of Appendix I to 10 CFR Part 50. The specified limits governing the use of appropriate portions of the liquid radwaste system were specified as a suitable fraction of the dose design objectives set forth in Section II.A of Appendix I, 10 CFR Part 50, for liquid effluents.

If this requirement is not met, the following action will be performed:

With radioactive liquid waste being discharged without treatment and in excess of the above limits, prepare and submit to the Commission within 30 days pursuant to Technical Specification 6.9.2, a Special Report which includes the following information:

1. Identification of the inoperable equipment or subsystems and the reason for inoperability,
2. Action(s) taken to restore the inoperable equipment to OPERABLE status, and R24
3. Summary description of action(s) taken to prevent a recurrence.

To ensure that this requirement is met:

Doses due to liquid releases shall be projected at least once per 31 days, in accordance with the methodology and parameters in Section 2.5.3.

2.5.2 LIQUID RADWASTE TREATMENT SYSTEM

The liquid radwaste treatment system described below shall be maintained and operated to keep releases ALARA.

A flow diagram for the LRTS is given in Figure 2.2. The system consists of one reactor coolant drain tank with two pumps and a floor and equipment drain sump inside the containment of each unit and the following shared equipment inside the auxiliary building: one sump tank and pumps, one tritiated drain collector tank with two pumps and one filter, one floor drain collector tank with two pumps and one filter, a waste condensate tank filter, three waste condensate tanks and two pumps, a chemical drain tank and pump, two laundry and hot shower tanks and pump, a spent resin storage tank, a cask decontamination tank with two pumps and two filters, Auxiliary Building floor end equipment drain sump and pumps, and evaporator with two distillate tanks, a Mobile Waste Demineralizer System (if needed) and the associated piping, valves and instrumentation.

2.5.3 DOSE PROJECTIONS

In accordance with Section 2.5.1, dose projections will be performed by averaging the two previous month's doses as determined in Section 2.4.2.2. To determine compliance with the limits, these averages are assigned as the dose projections for the upcoming month.

The projected doses are compared to the limits of Section 2.5.1. If the projected doses exceed either of these limits, the liquid radwaste treatment system shall be used to reduce the radioactive materials in liquid wastes prior to their discharge to UNRESTRICTED AREAS. R24

2.6 QUARTERLY DOSE CALCULATIONS

A complete dose analysis utilizing the total estimated liquid releases for each calendar quarter will be performed and reported as required in Section 5.2. Methodology for this analysis is that which is described in this section using the quarterly release values reported by the plant personnel. The releases are assumed, for this calculation, to be continuous over the 90 day period.

The average dilution factor, D, used for the quarterly calculations is:

$$D = \frac{1}{RF * 0.60} \quad \text{(for receptors upstream of Chickamauga Dam)} \qquad (2.7)$$

and

$$D = \frac{1}{RF} \quad \text{(for receptors downstream of Chickamauga Dam)} \qquad (2.8)$$

where:

RF = the average actual riverflow for the location at which the dose is being determined, cfs.
0.60 = the fraction of the riverflow available for dilution in the near field, dimensionless.

2.6.1 WATER INGESTION

Water ingestion doses are calculated for each water supply identified within a 50 mile radius downstream of SQN (Table 2.4). Water ingestion doses are calculated for the total body and each internal organ as described below:

$$D_{org} = 10^6 \; 9.80E\text{-}09 \; A_{Wit} \; Q_i \; D \; \exp(-8.64E{+}04 \; \lambda_i \; t_d) \qquad (2.9)$$

where

10^6 = conversion factor, µCi/Ci.
9.80E-09 = conversion factor, cfs per ml/hour.
A_{Wit} = Dose factor for water ingestion for nuclide i, age group t, mrem/hour per µCi/ml, as calculated in Section 2.7.1.
Q_i = Quantity of nuclide i released during the quarter, Curies.
D = dilution factor, as described above, cfs^{-1}.
λ_i = radiological decay constant of nuclide i, $seconds^{-1}$ (Table 1.10).

t_d = decay time for water ingestion, equal to the travel time from the plant to the water supply plus one day to account for the time of processing at the water supply (per Regulatory Guide 1.109), days.
8.64E+04 = conversion factor, seconds per day.

2.6.2 FISH INGESTION

Fish ingestion doses are calculated for each identified reach within a 50 mile radius downstream of SQN (Table 2.4). Individual fish ingestion doses are calculated for the total body and each internal organ as described below:

$$D_{org} = 10^6\ 9.80E\text{-}09\ 0.25\ A_{Fit}\ Q_i\ D\ \exp(-8.64E{+}04\ \lambda_i\ t_d) \qquad (2.10)$$

where

10^6 = conversion factor, μCi/Ci.
9.80E-09 = conversion factor, cfs per ml/hour.
0.25 = fraction of the yearly fish consumption eaten in one quarter, dimensionless.
A_{Fit} = Dose factor for fish ingestion for nuclide i, age group t, mrem/hour per μCi/ml, as calculated in Section 2.7.2.
Q_i = Quantity of nuclide i released during the quarter, Curies.
D = dilution factor, as described above, cfs^{-1}.
λ_i = radiological decay constant of nuclide i, $seconds^{-1}$ (Table 1.10).
t_d = decay time for fish ingestion, equal to the travel time from the plant to the center of the reach plus one day to account for transit through the food chain and food preparation time (per Regulatory Guide 1.109), days.
8.64E+04 = conversion factor, seconds per day.

2.6.3 SHORELINE RECREATION

Recreation doses are calculated for each identified reach within a 50 mile radius downstream of SQN (Table 2.4). It is assumed that the maximum exposed individual spends 500 hours per year on the shoreline at a location immediately downstream from the diffusers. Individual recreation shoreline doses are calculated for the total body and skin as described below:

$$D_{org} = 10^6\ 9.80E\text{-}09\ rf\ A_{Rit}\ Q_i\ D\ \exp(-8.64E{+}04\ \lambda_i\ t_d) \qquad (2.11)$$

where

10^6 = conversion factor, μCi/Ci.
9.80E-09 = conversion factor, cfs per ml/hour.

rf = recreation factor, used to account for the fact that the same amount of time will not be spent at a recreation site during each quarter. Recreation factors used are:
1st quarter - 0.1
2nd quarter - 0.3
3rd quarter - 0.4
4th quarter - 0.2.

A_{Rit} = Dose factor for shoreline recreation for nuclide i, age group t, mrem/hour per µCi/ml, as calculated in Section 2.7.3.

Q_i = quantity of nuclide i released during the quarter, Curies.

D = dilution factor, as described above, cfs^{-1}.

λ_i = radiological decay constant of nuclide i, $seconds^{-1}$ (Table 1.10).

t_d = decay time for recreation, equal to the travel time from the plant to the center of the reach, days.

8.64E+04 = conversion factor, seconds per day.

2.6.4 TOTAL MAXIMUM INDIVIDUAL DOSE

The total maximum individual total body dose is obtained by summing the following for each age group: the highest total body water ingestion dose from among all the public water supplies; the highest total body fish ingestion dose from among all the reaches; and the total body maximum shoreline recreation dose. The total maximum individual organ dose is obtained by summing the following for each organ and each age group: that organ's highest water ingestion dose from among all the public water supplies; that organ's highest fish ingestion dose from among all the reaches; and the total body maximum shoreline recreation dose. The total maximum individual skin dose is that skin dose calculated for the maximum shoreline dose.

2.6.5 POPULATION DOSES

For determining population doses to the 50-mile population around the plant, an average dose is calculated for each age group and each pathway and then multiplied by the population.

For water ingestion, the general equation used for calculating the population doses, POPWTR, in man-rem for a given PWS is:

$$POPWTR_t = 10^{-3} \sum_{m=1}^{5} POP_m \sum_{a=1}^{4} POP_a \; ATMW_a \; TWDOS_{amt} \qquad (2.12)$$

where:

$POPWTR_t$ = water ingestion population dose to organ t, man-rem.

POP_a = fraction of population in each age group a (from NUREG CR-1004, table 3.39).

Adult = 0.665
Child = 0.168
Infant = 0.015
Teen = 0.153

POP_m = population at PWS m. The 4 PWSs and their populations are listed in Table 2.4.

$ATMW_a$ = ratio of average to maximum water ingestion rates for each age group a. Maximum water ingestion rates are given in Table 1.11. Average water ingestion rates, in L/year, (from R.G. 1.109 Table E-4) are:

Adult = 370
Child = 260
Infant = 260
Teen = 260

$TWDOS_{amt}$ = total individual water ingestion dose to organ t at PWS m, to the age group a, as described in Section 2.6.1, mrem.

10^{-3} = conversion factor for rem/mrem.

For population doses resulting from fish ingestion the calculation assumes that all fish caught within a 50-mile radius downstream of SQN are consumed by local population. An additional 7-day decay term is added due to distribution time of sport fish. The general equation for calculating population doses, POPF, in man-rem from fish ingestion of all fish caught within a 50-mile radius downstream is:

$$POPF_t = \frac{453.6 \ HVST \ APR}{10^3 \ 10^3} \sum_{r=1}^{4} \sum_{a=1}^{3} \frac{TFDOS_{art} \ POP_a}{FISH_a \ POP_a} \qquad (2.13)$$

where:

$POPF_t$ = total fish ingestion population dose to organ t, man-rem.
HVST = fish harvest for the Tennessee River, 3.04 lbs/acre/year.
APR = size of reach, acres (Table 2.4).
$TFDOS_{art}$ = total fish ingestion dose to organ t for reach r, for the age group a, as described in Section 2.6.2, mrem.
POP_a = fraction of population in each age group a, as given above.
$FISH_a$ = amount of fish ingested by each age group a, kg/year. Average fish ingestion rates (R.G. 1.109 Table E-4) are:

Adult = 6.9
Child = 2.2
Teen = 5.2

453.6 = conversion factor, g/lb.
10^3 = conversion factor, mrem/rem.
10^3 = conversion factor, g/kg.

For recreation shoreline, the general equation used for calculating the population doses, POPR, in man-rem is:

$$POPR_t = \frac{REQFRA}{10^3 \;\; 8760} \sum_{r=1}^{4} TSHDOS_{rt} \; SHVIS_r \; HRSVIS_r \qquad (2.14)$$

where:

$POPR_t$ = total recreation population dose for all reaches to organ t, man-rem.
REQFRA = fraction of yearly recreation which occurs in that quarter, as given in Section 2.6.3.
$TSHDOS_{rt}$ = total shoreline dose rate for organ t, in reach r, mrem/h.
$SHVIS_r$ = shoreline visits per year at each reach r, (Table 2.4).
$HRSVIS_r$ = length of shoreline recreation visit at reach r, 5 hours.
10^3 = conversion factor, mrem/rem.
8760 = conversion factor, hours/year.

2.7 LIQUID DOSE FACTOR EQUATIONS

2.7.1 WATER INGESTION - A_{Wit} (mrem/hr per µCi/ml)

$$A_{Wit} = \frac{DF_{Liat}\ U_{wa}\ 10^{6}\ 10^{3}}{8760}$$

where:

- DF_{Liat} = ingestion dose conversion factor for nuclide i, age group a, organ t, mrem/pCi, (Table 1.9).
- U_{wa} = water consumption rate for age group a, L/year, (Table 1.11).
- 10^{6} = conversion factor, pCi/µCi.
- 10^{3} = conversion factor, ml/L.
- 8760 = conversion factor, hours per year.

2.7.2 FISH INGESTION - A_{Fit} (mrem/hr per µCi/ml)

$$A_{Fit} = \frac{DF_{Liat}\ U_{fa}\ B_{i}\ 10^{6}\ 10^{3}}{8760}$$

where:

- DF_{Liat} = ingestion dose conversion factor for nuclide i, age group a, organ t, mrem/pCi, (Table 1.9).
- U_{fa} = fish consumption rate for age group a, kg/year, (Table 1.11).
- B_{i} = bioaccumulation factor for nuclide i, pCi/kg per pCi/L, (Table 2.5).
- 10^{6} = conversion factor, pCi/µCi.
- 10^{3} = conversion factor, ml/L.
- 8760 = conversion factor, hours per year.

2.7.3 SHORELINE RECREATION - A_{Rit} (mrem/hr per µCi/ml).

$$A_{Rit} = \frac{DF_{Git}\ K_{c}\ M\ W\ 10^{3}\ 10^{6}\ U}{8760 * 3600\ \lambda_{i}} [1-\exp(-\lambda_{i} t_{b})]$$

where:

- DF_{Git} = dose conversion factor for standing on contaminated ground for nuclide i and organ t (total body and skin), mrem/hr per pCi/m², (Table 1.13).
- K_{c} = transfer coefficient from water to shoreline sediment, L/kg-hr, (Table 1.11).
- M = mass density of sediment, kg/m², (Table 1.11).

K_c	=	transfer coefficient from water to shoreline sediment, L/kg-hr, (Table 1.11).
M	=	mass density of sediment, kg/m^2, (Table 1.11).
W	=	shoreline width factor, dimensionless, (Table 1.11).
10^3	=	conversion factor, ml/L.
10^6	=	conversion factor, pCi/μCi.
3600	=	conversion factor, seconds/hour.
λ_i	=	decay constant for nuclide i, seconds^{-1}, (Table 1.10).
t_b	=	time shoreline is exposed to the concentration on the water, seconds, (Table 1.11).
U	=	usage factor, 500 hours/year.
8760	=	conversion factor, hours/year.

3.0 Radiological Environmental Monitoring

3.1 MINIMUM REQUIRED MONITORING PROGRAM

3.1.1 REQUIREMENT

The radiological environmental monitoring program shall be conducted as specified in Table 3.1.

This requirement is applicable at all times.

The radiological environmental monitoring program required by this section provides measurements of radiation and radioactive materials in those exposure pathways and for those radionuclides, which lead to the highest potential radiation exposures of individuals resulting from the station operation. This monitoring program thereby supplements the radiological effluent monitoring program by verifying that the measurable concentration of radioactive materials and levels of radiation are not higher than expected on the basis of the effluent measurements and modeling of the environmental exposure pathways. The initially specified monitoring program will be effective for at least the first three years of commercial operation. Following this period, program changes may be initiated based on operational experience.

The LLDs required by Table 3.2 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 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, unavoidably small sample sizes, the presence of interfering nuclides, or other uncontrollable circumstances may render these LLDs unachievable. In such cases, the contributing circumstances will be identified and described in the Annual Radiological Environmental Operating Report.

If this requirement is not met, the appropriate following action(s) will be performed:

a. **With the radiological environmental monitoring program not being conducted as specified in Table 3.1, prepare and submit to the Commission, in the Annual Radiological Environmental Operating Report, a description of the reasons for not conducting the program as required and the plans for preventing a recurrence.**

b. **With the level of radioactivity in an environmental sampling medium exceeding the reporting levels of Table 3.3 when averaged over any calendar quarter, prepare and submit to the Commission within 30 days from the end of the affected quarter, pursuant to**

Technical Specification 6.9.2, a Special Report that identifies the cause(s) for exceeding the limit(s) and defines the corrective actions 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 Sections 1.4.1, 1.5.1 and 2.4.1. When one or more of the radionuclides in Table 3.3 is detected in the sampling medium, this report shall be submitted if:

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

When radionuclides other than those in Table 3.3 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 is equal to or greater than the calendar year limits of Sections 1.4.1, 1.5.1 and 2.4.1. 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 Operating Report. R24

c. With milk or fresh leafy vegetable samples unavailable from one or more of the sample locations required by Table 3.1, identify locations for obtaining replacement samples and add them to the radiological environmental monitoring program within 30 days. The specified locations from which samples were unavailable may then be deleted from the monitoring program. Pursuant to Section 5.1, identify the new locations for obtaining replacement samples in the Annual Radiological Environmental Operating Report. A revised figure(s) and table(s) for the ODCM reflecting the new location(s) shall be included in the next Semi-Annual Effluent Release Report pursuant to Section 5.2.

To ensure that this requirement is met:

The radiological environmental monitoring samples shall be collected pursuant to Table 3.1 from the locations given in the tables and figures listed below and shall be analyzed pursuant to the requirements of Table 3.1 and the detection capabilities required by Table 3.2.

3.1.2 <u>MONITORING PROGRAM</u>

An environmental radiological monitoring program shall be conducted in accordance with the above requirement. The monitoring program described in Tables 3.4, 3.5, and 3.6, and in Figures 3.1, 3.2 and 3.3 shall be conducted. Results of this program shall be reported in

accordance with Section 5.1.

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

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

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

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

3.1.3 DETECTION CAPABILITIES

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

3.2 LAND USE CENSUS

3.2.1 REQUIREMENT

A Land Use Census shall be conducted and shall identify within a distance of 8 km (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 then 50 m^2 (500 ft^2) producing fresh leafy vegetables.

This requirement is applicable at all times.

This requirement is provided to ensure that changes in the use of unrestricted areas are identified and that modifications to the monitoring program are made if required by the results of that census. The best survey information from the door-to-door, aerial, or consulting with local agricultural authorities shall be used. This census satisfies the requirements of Section IV.B.3 of Appendix I to 10 CFR Part 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 provide 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 used, 1) that 20% 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.

The results obtained in the Land Use Census will be evaluated in accordance with the following appropriate actions:

a. With a Land Use Census identifying a location(s) that yields a calculated dose or dose commitment 20% greater than the values currently being calculated in Sections 1.4 and 1.5, identify the new location(s) in the next Semi-Annual Effluent Release Report pursuant to Section 5.2.

b. With a Land Use Census identifying a location(s) that yields a calculated dose or dose commitment (via the same pathway) 20% greater than at a location from which samples are currently being obtained in accordance with the requirements of Section 3.1.1, add the new location(s) within 30 days to the radiological environmental monitoring program given in Section 3.1.2, 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 be deleted from this monitoring program after October 31 of the year in which this Land Use Census was conducted. Pursuant to Technical Specification 6.14, submit in the next Semi-Annual Effluent

Release Report documentation for a change in the ODCM including a revised figure(s) and table(s) for the ODCM reflecting the new location(s) with the information supporting the change in sampling locations.

To ensure that this requirement is met:

The Land Use Census shall be conducted during the growing season at least once per 12 months using that information that will provide the best results, such as by a door-to-door survey, mail survey, telephone survey, aerial survey, or by consulting local agricultural authorities. The results of the Land Use Census shall be included in the Annual Radiological Environmental Operating Report pursuant to Section 5.1.

3.2.2 LAND USE CENSUS

A land use survey shall be conducted in accordance with the requirements above. The results of the survey shall be reported in the Annual Radiological Environmental Operating Report.

* Broad leaf vegetation sampling of at least three different kinds of vegetation may be performed at the SITE BOUNDARY in each of two different direction sectors with the highest predicted D/Qs in lieu of the garden census. Specifications for broad leaf vegetation sampling in Table 3.1.4c shall be followed, including analysis of control samples. R24

3.3 INTERLABORATORY COMPARISON PROGRAM

3.3.1 REQUIREMENT

Analyses shall be performed on radioactive materials supplied as part of an Interlaboratory Comparison Program which has been approved by the Commission.

This requirement is applicable at all times.

The requirement for participation in an Interlaboratory Comparison Program is provided to ensure that independent checks on the precision and accuracy of the measurements of radioactive material in environmental sample matrices are performed as part of the quality assurance program for environmental monitoring in order to demonstrate that the results are reasonably valid.

If this requirement is not met, the following action will be performed:

> With analyses not being performed as required above, report the corrective actions being taken to prevent a recurrence to the Commission in the Annual Radiological Environmental Operating Report.

To ensure that this requirement is met:

> A summary of the results obtained as a part of the above required Interlaboratory Comparison Program and in accordance with the guidance below shall be included in the Annual Radiological Environmental Operating Report.

3.3.2 INTERLABORATORY COMPARISON PROGRAM

Analyses shall be performed on radioactive materials supplied as part of an Interlaboratory Comparison Program which has been approved by the NRC. A summary of the results obtained in the intercomparison shall be included in the Annual Radiological Environmental Operating Report (or the EPA program code designation may be provided).

If analyses are not performed as required corrective actions taken to prevent a recurrence shall be reported in the Annual Radiological Environmental Operating Report.

4.0 TOTAL DOSE

4.1 REQUIREMENT

The annual (calendar year) dose or dose commitment to any MEMBER OF THE PUBLIC, due to releases of radioactivity from uranium fuel cycle sources, shall be limited to less than or equal to 25 mrem to the total body or any organ (except the thyroid, which shall be limited to less than or equal to 75 mrem). R24 R24

This requirement is applicable at all times.

This requirement is provided to meet the dose limitations of 40 CFR 190. The action requires the preparation and submittal of a Special Report whenever the calculated doses from plant radioactive effluents exceed twice the design objective doses of Appendix I. For sites containing up to 4 reactors, it is highly unlikely that the resultant dose to a MEMBER OF THE PUBLIC will exceed the dose limits R24 of 40 CFR 190 if the individual reactors remain within the reporting requirement level. The Special Report will describe a course of action which should result in the limitation of dose to a MEMBER OF R24 THE PUBLIC for 12 consecutive months to within the 40 CFR 190 limits. R24 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 R24 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 5 miles must be considered.

If this requirement is not met, the following action will be performed:

With the calculated doses from the release of radioactive materials in liquid or gaseous effluents exceeding twice the limits of Section 1.4.1, 1.5.1, or 2.4.1, calculations should be made to determine if the above limits have been violated. If such is the case, prepare and submit a Special Report to the Director, Nuclear Reactor Regulation, U.S. Regulatory Commission, Washington D.C. 20555, within 30 days, which defines the corrective action to be taken to reduce subsequent releases to prevent recurrence of exceeding the limits above. This Special Report, as defined in 10 CFR Part 20.405c, R24 shall include an analysis which estimates the radiation exposure (dose) to a MEMBER OF THE PUBLIC from uranium fuel cycle sources R24 (including all effluent pathways and direct radiation) for a calendar year that includes the release(s) covered by this report. 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 and including the specified information of Section 190.11(b). Submittal of the report

is considered a timely request, and a variance is granted until the staff action on the request is completed. R24

To ensure that this requirement is met:

Cumulative dose contributions from liquid and gaseous effluents shall be determined in accordance with the methodology and parameters in Sections 1.4.2, 1.5.2, and 2.4.2.

4.2 ANNUAL MAXIMUM INDIVIDUAL DOSES - TOTAL REPORTED DOSE

To determine compliance with 40 CFR 190 as required in Section 5.2, the annual dose contributions to the maximum individual from SQN radioactive effluents and all other nearby uranium fuel cycle sources will be considered. The annual dose to the maximum individual will be conservatively estimated by first, summing the quarterly total body air submersion dose, the quarterly critical organ dose from gaseous effluents, the quarterly total body dose from liquid effluents, the quarterly critical organ dose from liquid effluents, and the direct radiation monitoring program, and then taking the sum for each quarter and summing over the four quarters.

5.0 REPORTING REQUIREMENTS

5.1 ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

The annual radiological environmental operating reports shall include summaries, interpretations, and an analysis of trends of the results of the radiological environmental surveillance activities for the report period, including a comparison with preoperational studies, operational controls (as appropriate), and previous environmental surveillance reports and an assessment of the observed impacts of the plant operation on the environment. The reports shall also include the results of land use censuses required by Section 3.2 and a listing of the new locations for dose calculations and/or environmental monitoring identified by the land use census. If harmful effects or evidence of irreversible damage are detected by the monitoring, the report shall provide an analysis of the problems and a planned course of action to alleviate the problem.

The annual radiological environmental operating reports shall include summarized and tabulated results in the format of Regulatory Guide 4.8, December 1975 of all radiological environmental samples taken during the report period. In the event that some 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 possible in a supplementary report.

The reports shall also include the following: a summary description of the radiological environmental monitoring program; a map of all sampling locations keyed to a table giving distances and directions from one reactor; and the results of licensee participation in the Interlaboratory Comparison Program required by Section 3.3.

5.2 SEMI-ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT

Semiannual radioactive release reports shall include a summary of the quantities of radioactive liquid and gaseous effluents and solid waste released from the unit 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.

The semiannual radioactive release report shall include unplanned releases from the site to unrestricted areas on a quarterly basis and shall also include any changes made to the ODCM pursuant to Technical Specification 6.14.

The semiannual radioactive release report shall include information for solid waste as outlined in the Process Control Program, and shall also include any changes made to the PCP during the reporting period.

The annual radioactive effluent release report (Radiological Impact) to be submitted 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 of wind speed, wind direction, atmospheric stability, and precipitation (if measured) on magnetic tape, or in the form of joint frequency distributions of wind speed, wind direction, and atmospheric stability. In lieu of submission with the annual radioactive effluent release report, this summary of required meteorological data may be retained in site in a file that shall be provided to NRC upon request). This same report shall include an assessment of the radiation doses due to radioactive liquid and gaseous effluents released from the unit or station during the previous calendar year. This same report 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 R24
SITE BOUNDARY (Figure 1.3) during the report period. All assumptions R24
used in making these assessments (i.e., specific activity, exposure time, and location) shall be included in these reports. 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 Sections 1.7 and 2.6.

The annual radioactive effluent release report to be submitted after January 1 of each year shall also include an assessment of radiation doses to the likely most exposed MEMBERS OF THE PUBLIC from reactor R24
releases and other nearby uranium fuel cycle sources (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, in accordance with Section 4.2. Acceptable methods for calculating the dose contribution from liquid and gaseous effluents are given in Regulatory Guide 1.109, Revision 1.

6.0 DEFINITIONS

The defined terms in this section appear in capitalized type in the text and are applicable throughout this ODCM.

6.1 CHANNEL CALIBRATION

A CHANNEL CALIBRATION shall be the adjustment, as necessary, of the channel output such that it responds with the necessary range and accuracy to known values of the parameter which the channel monitors. The CHANNEL CALIBRATION shall encompass the entire channel including the sensor and alarm and/or trip functions, and shall include the CHANNEL FUNCTIONAL TEST. The CHANNEL CALIBRATION may be performed by any series of sequential, overlapping, or total channel steps such that the entire channel is calibrated.

6.1 CHANNEL CHECK

A channel check shall be the qualitative assessement 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.

6.3 CHANNEL FUNCTIONAL TEST

A CHANNEL FUNCTIONAL TEST shall be:

a. Analog channels - the injection of a simulated signal into the channel as close to the sensor as practicable to verify OPERABILITY including alarm and/or trip functions.

b. Bistable channel - the injection of a simulated signal into the sensor to verify OPERABILITY including alarm and/or trip function.

6.4 GASEOUS RADWASTE TREATMENT SYSTEM

A GASEOUS RADWASTE TREATMENT SYSTEM is any system designed and installed to reduce radioactive gaseous effluents by collecting primary coolant system offgases from the primary system and providing for delay or holdup for the purpose of reducing the total radioactivity prior to release to the environement.

6.5 DOSE EQUIVALENT I-131

DOSE EQUIVALENT I-131 shall be that concentration of I-131 (μCi/gram) which alone would produce the same thyroid dose as the quantity and isotopic mixture of I-131, I-132, I-133, I-134, and I-135 actually present. The thyroid dose conversion factors used for this calculation shall be those listed in Table III of TID-14844, "Calculation of Distance Factors for Power and Test Reactor Sites."

6.6 MEMBER(S) OF THE PUBLIC

MEMBER(S) OF THE PUBLIC shall include all individuals who are not occupationally associated with the plant. This category shall include non-employees of the licensee who are permitted to use portions of the site for recreational, occupational, or other purposes not associated with plant functions. This category does not include non-employees such as vending machine servicemen or postmen who, as part of their formal job function, occasionally enter an area that is controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials.

6.7 OPERABLE - OPERABILITY

A system, subsystem, train, component, or device shall be OPERABLE or have OPERABILITY when it is capable of performing its specified function(s), and when all necessary attendant instrumentation, controls, a normal and an emergengy electrical power source, cooling or seal water, lubrication or other auxiliary equipment that are required for the system, subsystem, train, component, or device to perform its function(s) are also capable of performing their related support function.

6.8 MODE

A MODE shall correspond to any one inclusive combination of core reactivity condition, power level, and average reactor coolant temperature specified in Table 1.1 of the SQN Technical Specifications.

6.9 PURGE - PURGING

PURGE or PURGING is the controlled process of discharging air or gas from a confinement to maintain temperature, pressure, humudity, concentration or other operating condition, in such a manner that replacement air or gas is required to purify the confinement.

Page Added

6.10 RATED THERMAL POWER

RATED THERMAL POWER shall be a total reactor core heat transfer rate to the reactor coolant of 3411 MWt.

6.11 SITE BOUNDARY

The SITE BOUNDARY shall be that line beyond which the land is not owned, leased, or otherwise controlled by the licensee (see Figure 1.3)

6.12 SOURCE CHECK

A SOURCE CHECK shall be the qualitative assessment of channel response when the channel sensor is exposed to a radioactive source.

6.13 UNRESTRICTED AREA

An UNRESTRICTED AREA shall be any area, at or beyond the SITE BOUNDARY to which access is not controlled by the licensee for purposed of protection of individuals from exposure to radiation and radioactive materials or any area within the SITE BOUNDARY used for residential quarters or industrial, commercial, institutional, and/or recreational purposes.

6.14 VENTILATION EXHAUST TREATMENT SYSTEM

A VENTILATION EXHAUST TREATMENT SYSTEM is any system designed and installed to reduce gaseous radioiodine or radioactive material in particulate form in effluents by passing ventilation or vent exhaust gases through charcoal adsorbers and/or HEPA filters for the purpose of removing iodines or particulates from the gaseous exhaust stream prior to the release to the environment (such a system is not considered to have any effect on noble gas effluents). Engineered Safety Feature (ESF) atmospheric cleanup systems are not considered to be VENTILATION EXHAUST TREATMENT SYSTEM components.

6.15 VENTING

VENTING is the controlled process of discharging air or gas from a confinement to maintain temperature, pressure, humidity, concentration, or other operating condition, in such a manner that replacement air gas is not provided or required during VENTING. Vent, used in system names, does not imply a VENTING process.

Table 1.1 (Page 1 of 4)

RADIOACTIVE GASEOUS WASTE MONITORING SAMPLING AND ANALYSIS PROGRAM

Gaseous Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) (μCi/ml)[a]
A. Waste Gas Storage Tank	P Each Tank Grab	P Each Tank	Principal Gamma Emitters[g]	1×10^{-4}
B. Containment 1. PURGE	P[i] Each PURGE Grab Sample	D[i] Each PURGE	Principal Gamma Emitters[g] H-3	1×10^{-4} R24 R24 1×10^{-6}
2. Vent	D[j] Each Day Grab Sample	D[j] Each Day	Principal Gamma Emitters[g] H-3	1×10^{-4} 1×10^{-6}
C. Noble Gases and Tritium 1. Condenser Vacuum Exhaust[h] 2. Auxiliary Building Exhaust[b,e] 3. Service Bldg. Exhaust 4. Shield Bldg. Exhaust[b,c,h]	M Grab Sample	M	Principal Gamma Emitters[g] H-3	1×10^{-4} 1×10^{-6}

Table 1.1 (Page 2 of 4)
RADIOACTIVE GASEOUS WASTE MONITORING SAMPLING AND ANALYSIS PROGRAM

Gaseous Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection -LLD (μCi/ml)[a]
D. Iodine and Particulates	Continuous[f] Sampler	W[d] Charcoal Sample	I-131	1×10^{-12}
1. Auxiliary Building Exhaust 2. Shield Building Exhaust	Continuous[f] Sampler	W[d] Particulate Sample	Principal Gamma Emitters[g] (I-131, Others)	1×10^{-11}
	Continuous[f] Sampler	M Composite Particulate Sample	Gross Alpha	1×10^{-11}
	Continuous[f] Sampler	Q Composite Particulate Sample	Sr-89, Sr-90	1×10^{-11}
E. Noble Gases all Release types as listed in C	Continuous[f] Monitor	Noble Gas Monitor	Noble Gases Gross Beta or Gamma	1×10^{-6}

Table 1.1 (Page 3 of 4)
RADIOACTIVE GASEOUS WASTE MONITORING SAMPLING AND ANALYSIS PROGRAM
TABLE NOTATION

P = Completed prior to each release.
D = At least once per 24 hours
M = At least once per 31 days
W = At least once per 7 days
Q = At least once per 92 days

a The LLD is defined, for the purpose 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% probability with only a 5% probability of falsely concluding that a blank observation represents a "real" signal.

For a particular measurement system (which may include radiochemical separation): R24

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

Where:

LLD is the "a priori" lower limit of detection as defined above in microcurie per unit mass or volume,
s_b is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute),
E is the counting efficiency as counts per disintegration,
V is the sample size in units of mass or volume,
2.22×10^6 is the number of disintegrations per minute per microcurie,
Y is the fractional radiochemical yield (when applicable),
λ is the radioactive decay constant for the particular radionuclide, and
Δt is the elapsed time between midpoint of sample collection and time of counting (midpoint).

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

b Sampling and analysis shall also be performed following shutdown, startup, or a thermal power change exceeding 15% of RATED THERMAL R24
POWER within 1 hour unless (1) analysis shows that the DOSE R24
EQUIVALENT I-131 concentration in the primary coolant has not R24
increased more than a factor of 3 and (2) the containment noble gas activity monitor (RE-90-106 or RE-90-112) shows that the radioactivity has not increased by more than a factor of 3.

Table 1.1 (Page 4 of 4)
RADIOACTIVE GASEOUS WASTE MONITORING SAMPLING AND ANALYSIS PROGRAM
TABLE NOTATION

c Tritium grab samples shall be taken at least once per 24 hours when the refueling canal is flooded.

d Samples shall be changed at least once per 7 days and analyses shall be completed within 48 hours after changing (or after removal from sampler). Sampling shall also be performed at least once per 24 hours for at least 2 days following each shutdown from ≥15% RATED THERMAL POWER, startup of ≥15% RATED THERMAL POWER or THERMAL POWER change exceeding 15% of RATED THERMAL POWER in one hour 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. R24 R24 R24

e Tritium grab samples shall be taken at least once per 7 days from the ventilation exhaust from the spent fuel pool area, whenever spent fuel is in the spent fuel pool.

f The ratio of the sample flow rate to the sampled stream flow rate shall be known for the time period covered by each dose or dose rate calculation made in accordance with Sections 1.2, 1.4, and 1.5.

g The principal gamma emitters for which the LLD specification applies exclusively are the following radionuclides: Kr-87, Kr-88, Xe-133, Xe-133m, Xe-135, and Xe-138 for noble gases and Mn-54, Fe-59, I-131, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, Ce-141 and Ce-144 for particulate principal gamma emitters. This list does not mean that only these nuclides are to be detected and reported. Other gamma peaks which are measurable and identifiable, together with the above nuclides, shall also be analyzed and reported in the Semi-annual Radioactive Effluent Release Report pursuant to Section 5.2.

h During releases via this exhaust system.

i PURGING - Applicable in MODES 1, 2, 3 and 4, the upper and lower compartments of the containment shall be sampled prior to PURGING. Prior to breaking containment integrity in MODE 5 or 6, the upper and lower compartments of the containment shall be sampled. The incore instrument room purge sample shall be obtained at the shield building exhaust between 20 and 25 minutes following initiation of the incore instrument room PURGE. R24 R24 R24 R24

j VENTING - Applicable in MODES 1, 2, 3, and 4; the containment will be VENTED to the containment annulus and then to the auxiliary building via containment annulus fans. The lower containment compartment shall be sampled daily when VENTING is to occur to account for the radioactivity being discharged from the VENTING process. R24 R24 R24 R24

Table 1.2 (1 of 7)
JOINT PERCENTAGE FREQUENCIES OF WIND DIRECTION AND WIND SPEED
FOR DIFFERENT STABILITY CLASSES*

Sequoyah Nuclear Plant Meteorological Facility*
Jan. 1, 72 - Dec. 31, 75

Stability Class A
Delta T≤-1.9 deg. C/100m

	Wind Speed (mph)									
	Calm	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	>24.5	Total
N	0.01	0.01	0.01	0.03	0.04	0.04	0.0	0.0	0.0	0.13
NNE	0.0	0.0	0.04	0.19	0.20	0.16	0.01	0.0	0.0	0.60
NE	0.0	0.0	0.08	0.20	0.15	0.13	0.0	0.0	0.0	0.56
ENE	0.0	0.0	0.03	0.03	0.01	0.0	0.0	0.0	0.0	0.07
E	0.0	0.0	0.01	0.0	0.0	0.0	0.0	0.0	0.0	0.01
ESE	0.0	0.0	0.01	0.01	0.0	0.0	0.01	0.0	0.0	0.03
SE	0.0	0.0	0.01	0.02	0.0	0.0	0.0	0.0	0.0	0.03
SSE	0.0	0.0	0.01	0.03	0.02	0.02	0.01	0.0	0.0	0.09
S	0.0	0.0	0.01	0.04	0.06	0.05	0.01	0.0	0.0	0.17
SSW	0.0	0.0	0.01	0.09	0.18	0.16	0.01	0.0	0.0	0.45
SW	0.0	0.0	0.04	0.12	0.10	0.09	0.02	0.0	0.0	0.37
WSW	0.0	0.0	0.02	0.03	0.03	0.02	0.02	0.0	0.0	0.12
W	0.0	0.0	0.01	0.0	0.01	0.02	0.0	0.0	0.0	0.04
WNW	0.0	0.0	0.0	0.0	0.0	0.01	0.01	0.0	0.0	0.02
NW	0.0	0.0	0.01	0.01	0.01	0.05	0.01	0.0	0.0	0.09
NNW	0.0	0.0	0.01	0.0	0.02	0.08	0.01	0.0	0.0	0.12
Sub-total	0.01	0.01	0.31	0.80	0.83	0.83	0.12	0.0	0.0	2.90

958 stability class A occurrences out of total 32723 valid temperature difference readings.

934 valid wind direction/wind speed readings out of total 958 stability class A occurrences.

All columns and calm total 100 percent of net valid readings

* Meteorological Facility located 0.74 miles SW of Sequoyah Nuclear Plant.
Temperature Instruments 33 and 150 feet above ground.
Wind instruments 33 feet above ground.

Table 1.2 (2 of 7)
JOINT PERCENTAGE FREQUENCIES OF WIND DIRECTION AND WIND SPEED
FOR DIFFERENT STABILITY CLASSES*

Sequoyah Nuclear Plant Meteo.ological Facility*
Jan. 1, 72 - Dec. 31, 75

Stability Class B
-1.9 < delta T<-1.7 deg. C/100m

	Wind Speed (mph)									
	Calm	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	>24.5	Total
N	0.0	0.0	0.01	0.01	0.02	0.03	0.0	0.0	0.0	0.07
NNE	0.0	0.0	0.05	0.23	0.20	0.18	0.01	0.0	0.0	0.67
NE	0.01	0.0	0.08	0.29	0.09	0.06	0.0	0.0	0.0	0.52
ENE	0.0	0.0	0.03	0.03	0.01	0.0	0.0	0.0	0.0	0.07
E	0.0	0.0	0.02	0.01	0.0	0.0	0.0	0.0	0.0	0.03
ESE	0.0	0.0	0.0	0.01	0.0	0.0	0.0	0.0	0.0	0.01
SE	0.0	0.0	0.01	0.02	0.0	0.01	0.0	0.0	0.0	0.04
SSE	0.0	0.0	0.01	0.03	0.0	0.02	0.0	0.0	0.0	0.06
S	0.0	0.0	0.03	0.03	0.07	0.04	0.01	0.0	0.0	0.18
SSW	0.0	0.0	0.04	0.09	0.20	0.20	0.03	0.0	0.0	0.56
SW	0.0	0.0	0.03	0.11	0.14	0.10	0.02	0.0	0.0	0.40
WSW	0.0	0.0	0.01	0.01	0.03	0.02	0.01	0.01	0.0	0.09
W	0.0	0.0	0.0	0.0	0.01	0.01	0.0	0.0	0.0	0.02
WNW	0.0	0.0	0.0	0.01	0.01	0.03	0.0	0.0	0.0	0.05
NW	0.0	0.0	0.0	0.0	0.01	0.05	0.0	0.0	0.0	0.06
NNW	0.0	0.0	0.01	0.02	0.02	0.06	0.01	0.0	0.0	0.12
SUB-TOTAL	0.01	0.0	0.33	0.90	0.81	0.81	0.09	0.01	0.0	2.95

969 stability class B occurrences out of total 32723 valid temperature difference readings.

953 valid wind direction/wind speed readings out of total 969 stability class B occurrences.

All columns and calm total 100 percent of net valid readings.

*Meteorological facility located 0.74 miles SW of Sequoyah Nuclear Plant.
Temperature instruments 33 and 150 feet above ground.
Wind instruments 33 feet above ground.

Table 1.2 (3 of 7)
JOINT PERCENTAGE FREQUENCIES OF WIND DIRECTION AND WIND SPEED
FOR DIFFERENT STABILITY CLASSES*

Sequoyah Nuclear Plant Meteorological Facility*
Jan. 1, 72 - Dec. 31, 75

Stability Class C
-1.7 < delta T≤-1.5 deg. C/100m

		Wind Speed (mph)							
	Calm	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	>24.5	Total
N	0.0	0.0	0.01	0.02	0.02	0.02	0.0	0.0	0.0	0.07
NNE	0.0	0.0	0.05	0.12	0.11	0.11	0.0	0.0	0.0	0.39
NE	0.0	0.0	0.05	0.14	0.05	0.03	0.0	0.0	0.0	0.27
ENE	0.0	0.0	0.03	0.02	0.0	0.0	0.0	0.0	0.0	0.05
E	0.0	0.0	0.01	0.01	0.0	0.0	0.0	0.0	0.0	0.02
ESE	0.0	0.0	0.01	0.01	0.0	0.0	0.0	0.0	0.0	0.02
SE	0.0	0.0	0.01	0.01	0.0	0.0	0.0	0.0	0.0	0.02
SSE	0.0	0.0	0.01	0.02	0.0	0.02	0.0	0.0	0.0	0.05
S	0.0	0.0	0.03	0.04	0.06	0.05	0.0	0.0	0.0	0.18
SSW	0.0	0.0	0.01	0.11	0.14	0.13	0.02	0.0	0.0	0.41
SW	0.0	0.0	0.03	0.08	0.12	0.07	0.01	0.0	0.0	0.31
WSW	0.0	0.0	0.01	0.02	0.03	0.02	0.0	0.01	0.0	0.08
W	0.0	0.0	0.0	0.01	0.0	0.01	0.01	0.0	0.0	0.03
WNW	0.0	0.0	0.0	0.01	0.01	0.01	0.0	0.0	0.0	0.03
NW	0.0	0.0	0.0	0.0	0.02	0.03	0.01	0.0	0.0	0.06
NNW	0.0	0.0	0.0	0.02	0.02	0.05	0.0	0.0	0.0	0.09
SUB-TOTAL	0.0	0.0	0.26	0.64	0.58	0.55	0.05	0.0	0.0	2.08

684 stability class C occurrences out of total 32723 valid temperature difference readings.

672 valid wind direction/wind speed readings out of total 684 stability class C occurrences.

All columns and calm total 100 percent of net valid readings.

*Meteorological facility located 0.74 miles SW of Sequoyah Nuclear Plant.
Temperature instruments 33 and 150 feet above ground.
Wind instruments 33 feet above ground.

Table 1.2 (4 of 7)
JOINT PERCENTAGE FREQUENCIES OF WIND DIRECTION AND WIND SPEED
FOR DIFFERENT STABILITY CLASSES*

Sequoyah Nuclear Plant Meteorological Facility*
Jan. 1, 72 - Dec. 31, 75

Stability Class D
-1.5 < delta T≤-0.5 deg. C/100m

Wind Speed (mph)

	Calm	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	>24.5	Total
N	0.003	0.01	0.24	0.22	0.16	0.17	0.0	0.0	0.0	0.80
NNE	0.017	0.06	0.73	1.03	0.84	0.78	0.07	0.0	0.0	3.51
NE	0.006	0.02	0.76	0.88	0.42	0.42	0.05	0.0	0.0	2.55
ENE	0.003	0.01	0.21	0.11	0.03	0.0	0.0	0.0	0.0	0.36
E	0.003	0.01	0.12	0.03	0.02	0.01	0.0	0.0	0.0	0.19
ESE	0.003	0.01	0.06	0.02	0.0	0.0	0.0	0.0	0.0	0.09
SE	0.0	0.0	0.12	0.08	0.0	0.0	0.0	0.0	0.0	0.20
SSE	0.0	0.0	0.15	0.15	0.05	0.06	0.01	0.01	0.0	0.43
S	0.003	0.01	0.31	0.53	0.38	0.25	0.02	0.0	0.0	1.50
SSW	0.003	0.01	0.44	1.25	0.95	0.70	0.07	0.0	0.0	3.42
SW	0.003	0.01	0.47	1.17	1.03	0.52	0.03	0.01	0.0	3.24
WSW	0.0	0.0	0.22	0.34	0.18	0.21	0.07	0.01	0.0	1.03
W	0.003	0.01	0.06	0.08	0.10	0.19	0.02	0.01	0.0	0.47
WNW	0.003	0.01	0.06	0.05	0.11	0.18	0.01	0.0	0.0	0.42
NW	0.0	0.0	0.08	0.08	0.22	0.31	0.03	0.0	0.0	0.72
NNW	0.003	0.01	0.15	0.14	0.25	0.36	0.02	0.0	0.0	0.93
SUB-TOTAL	0.05	0.18	4.18	6.16	4.74	4.16	0.40	0.04	0.0	19.86

6567 stability class D occurrences out of total 32723 valid temperature difference readings.

6345 valid wind direction/wind speed readings out of total 6567 stability class D occurrences.

All columns and calm total 100 percent of net valid readings.

*Meteorological facility located 0.74 miles SW of Sequoyah Nuclear Plant.
Temperature instruments 33 and 150 feet above ground.
Wind instruments 33 feet above ground.

Table 1.2 (5 of 7)
JOINT PERCENTAGE FREQUENCIES OF WIND DIRECTION AND WIND SPEED
FOR DIFFERENT STABILITY CLASSES*

Sequoyah Nuclear Plant Meteorological Facility*
Jan. 1, 72 - Dec. 31, 75

Stability Class E
-0.5 < delta T≤ 1.5 deg. C/100m

		Wind Speed (mph)								
	Calm	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	>24.5	Total
N	0.017	0.23	1.26	0.83	0.39	0.27	0.0	0.0	0.0	2.98
NNE	0.023	0.31	2.83	2.46	1.07	0.92	0.03	0.0	0.0	7.62
NE	0.011	0.15	1.03	0.71	0.31	0.18	0.01	0.0	0.0	2.39
ENE	0.009	0.12	0.48	0.16	0.04	0.0	0.0	0.0	0.0	0.80
E	0.010	0.14	0.24	0.05	0.01	0.01	0.0	0.0	0.0	0.45
ESE	0.007	0.09	0.11	0.01	0.01	0.01	0.01	0.0	0.0	0.24
SE	0.007	0.10	0.37	0.06	0.01	0.01	0.0	0.0	0.0	0.55
SSE	0.008	0.11	0.58	0.24	0.13	0.23	0.04	0.02	0.0	1.35
S	0.013	0.17	1.33	1.49	0.91	1.05	0.08	0.0	0.0	5.03
SSW	0.007	0.10	1.67	2.32	1.67	1.45	0.11	0.0	0.0	7.32
SW	0.013	0.17	1.59	2.07	1.30	0.99	0.10	0.0	0.0	6.22
WSW	0.010	0.13	0.87	0.55	0.35	0.40	0.06	0.0	0.0	2.36
W	0.007	0.10	0.42	0.28	0.21	0.22	0.03	0.0	0.0	1.26
WNW	0.010	0.14	0.37	0.22	0.19	0.27	0.02	0.0	0.0	1.21
NW	0.007	0.10	0.50	0.37	0.43	0.38	0.02	0.0	0.0	1.80
NNW	0.011	0.15	0.80	0.68	0.57	0.40	0.01	0.0	0.0	2.61
Sub-total	0.17	2.31	14.45	12.50	7.60	6.79	0.52	0.02	0.0	44.19

14624 stability class E occurrences out of total 32723 valid temperature difference readings.

14146 valid wind direction/wind speed readings out of total 14624 stability class E occurrences.

All columns and calm total 100 percent of net valid readings.

*Meteorological facility located 0.74 miles SW of Sequoyah Nuclear Plant. Temperature instruments 33 and 150 feet above ground. Wind instruments 33 feet above ground.

Table 1.2 (6 of 7)
JOINT PERCENTAGE FREQUENCIES OF WIND DIRECTION AND WIND SPEED FOR DIFFERENT STABILITY CALSSES*

Sequoyah Nuclear Plant Meteorological Facility*
Jan. 1, 72 - Dec. 31, 75

Stability Class F
1.5 < delta T ≤ 4.0 deg. C/100m

	Wind Speed (mph)									
	Calm	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	>24.5	Total
N	0.011	0.21	1.37	0.44	0.04	0.0	0.0	0.0	0.0	2.06
NNE	0.018	0.35	3.61	0.84	0.05	0.0	0.0	0.0	0.0	4.85
NE	0.011	0.21	1.15	0.28	0.01	0.0	0.0	0.0	0.0	1.65
ENE	0.008	0.16	0.39	0.03	0.0	0.0	0.0	0.0	0.0	0.58
E	0.010	0.20	0.22	0.0	0.0	0.0	0.0	0.0	0.0	0.42
ESE	0.007	0.13	0.18	0.02	0.0	0.0	0.0	0.0	0.0	0.33
SE	0.007	0.14	0.23	0.02	0.0	0.0	0.0	0.0	0.0	0.39
SSE	0.008	0.15	0.37	0.07	0.03	0.01	0.0	0.0	0.0	0.63
S	0.009	0.17	0.77	0.30	0.10	0.06	0.0	0.0	0.0	1.40
SSW	0.006	0.12	1.13	0.71	0.26	0.11	0.0	0.0	0.0	2.33
SW	0.005	0.10	0.99	0.86	0.27	0.13	0.0	0.0	0.0	2.35
WSW	0.005	0.09	0.46	0.19	0.04	0.01	0.0	0.0	0.0	0.79
W	0.004	0.07	0.20	0.07	0.01	0.0	0.0	0.0	0.0	0.35
WNW	0.005	0.10	0.24	0.07	0.01	0.0	0.0	0.0	0.0	0.42
NW	0.003	0.05	0.29	0.15	0.05	0.01	0.0	0.0	0.0	0.55
NNW	0.005	0.09	0.52	0.34	0.05	0.01	0.0	0.0	0.0	1.01
SUB-TOTAL	0.12	2.34	12.12	4.39	0.92	0.34	0.0	0.0	0.0	20.11

6542 stability class F occurrences out of total 32723 valid temperature difference readings.

6461 valid wind direction/wind speed readings out of total 6542 stability class F occurrences.

All columns and calm total 100 percent of net valid readings.

*Meteorological facility located 0.74 miles SW of Sequoyah Nuclear Plant.
Temperature instruments 33 and 150 feet above ground.
Wind instruments 33 feet above ground.

Table 1.2 (7 of 7)
JOINT PERCENTAGE FREQUENCIES OF WIND DIRECTION AND WIND SPEED
FOR DIFFERENT STABILITY CLASSES*

Sequoyah Nuclear Plant Meteorological Facility*
Jan. 1, 72 - Dec. 31, 75

Stability Class G
Delta T > 4.0 deg. C/100m

Wind Speed (mph)

	Calm	0.6-1.4	1.5-3.4	3.5-5.4	5.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	>24.5	Total
N	0.003	0.06	0.33	0.09	0.0	0.0	0.0	0.0	0.0	0.48
NNE	0.005	0.10	1.03	0.20	0.0	0.0	0.0	0.0	0.0	1.33
NE	0.005	0.09	0.74	0.12	0.0	0.0	0.0	0.0	0.0	0.95
ENE	0.007	0.13	0.42	0.02	0.0	0.0	0.0	0.0	0.0	0.57
E	0.007	0.14	0.18	0.01	0.0	0.0	0.0	0.0	0.0	0.33
ESE	0.006	0.11	0.08	0.01	0.0	0.0	0.0	0.0	0.0	0.20
SE	0.005	0.09	0.08	0.0	0.0	0.0	0.0	0.0	0.0	0.17
SSE	0.008	0.16	0.21	0.0	0.01	0.0	0.0	0.0	0.0	0.37
S	0.006	0.11	0.39	0.04	0.02	0.0	0.0	0.0	0.0	0.55
SSW	0.003	0.06	0.48	0.32	0.06	0.01	0.0	0.0	0.0	0.89
SW	0.002	0.03	0.44	0.42	0.0	0.0	0.0	0.0	0.0	0.95
WSW	0.001	0.01	0.11	0.07	0.0	0.0	0.0	0.0	0.0	0.19
W	0.002	0.03	0.08	0.02	0.0	0.0	0.0	0.0	0.0	0.13
WNW	0.001	0.01	0.03	0.01	0.0	0.01	0.0	0.0	0.0	0.06
NW	0.001	0.02	0.06	0.03	0.0	0.0	0.0	0.0	0.0	0.11
NNW	0.001	0.02	0.08	0.03	0.0	0.0	0.0	0.0	0.0	0.13
SUB-TOTAL	0.06	1.17	4.74	1.39	0.09	0.2	0.0	0.0	0.0	7.41

2379 stability class G occurrences out of total 32723 valid temperature difference readings.

2378 valid wind direction/wind speed readings out of total 2379 stability class G occurrences.

All columns and calm total 100 percent of net valid readings.

*Meteorological facility located 0.74 Miles SW of Sequoyah Nuclear Plant.
Temperature instruments 33 and 150 feet above ground.
Wind instruments 33 feet above ground.

Table 1.3
SQN - OFFSITE RECEPTOR LOCATION DATA

POINT		DISTANCE from plant (m)	X/Q (s/m^3)	D/Q ($1/m^2$)
Site Boundary	N	950	5.12E-06	1.29E-08
Site Boundary	NNE	2260	1.93E-06	5.28E-09
Site Boundary	NE	1910	2.32E-06	6.33E-09
Site Boundary	ENE	1680	1.12E-06	2.64E-09
Site Boundary	E	1570	7.10E-07	1.46E-09
Site Boundary	ESE	1460	7.91E-07	1.58E-09
Site Boundary	SE	1460	9.14E-07	2.41E-09
Site Boundary	SSE	1550	1.34E-06	3.23E-09
Site Boundary	S	1570	2.37E-06	4.18E-09
Site Boundary	SSW	1840	4.51E-06	9.26E-09
Site Boundary	SW	2470	1.38E-06	2.63E-09
Site Boundary	WSW	910	2.93E-06	3.86E-09
Site Boundary	W	670	3.63E-06	3.74E-09
Site Boundary	WNW	660	2.49E-06	2.44E-09
Site Boundary	NW	660	2.85E-06	3.67E-09
Site Boundary	NNW	730	3.95E-06	6.59E-09
Liquid Discharge	S	870	N/A	N/A

NOTE: For quarterly airborne dose calculations, doses will also be calculated for all locations identified in the most recent land use census, and for any additional points deemed necessary.

Table 1.4
DOSE FACTORS FOR SUBMERSION IN NOBLE GASES

	Submersion dose mrem/yr per μCi/m³		Air dose mrad/yr per μCi/m³	
	DFB_i	DFS_i	$DF_{\gamma i}$	$DF_{\beta i}$
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

Reference:

Regulatory Guide 1.109, Table B-1.

Table 1.5 (Page 1 of 2)
RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

Instrument	Minimum Channels OPERABLE	Applic-ability	Action
1. WASTE GAS DISPOSAL SYSTEM			
a. Noble Gas Activity Monitor	1	*	40
b. Effluent System Flow Rate Measuring Device	1	*	41
2. CONDENSER VACUUM EXHAUST SYSTEM			
a. Noble Gas Activity Monitor	1	*	42
b. Flow Rate Monitor	1	*	41
3. SHIELD BUILDING EXHAUST SYSTEM			
a. Noble Gas Activity Monitor	1	***	42
b. Iodine Sampler	1	***	44
c. Particulate Sampler	1	***	44
d. Flow Rate Monitor	1	***	41
e. Sampler Flow Rate Monitor	1	***	41
4. AUXILIARY BUILDING VENTILATION SYSTEM			
a. Noble Gas Activity Monitor	1	*	42
b. Iodine Sampler	1	*	44
c. Particulate Sampler	1	*	44
d. Flow Rate Monitor	1	*	41
e. Sampler Flow Rate Monitor	1	*	41
6. SERVICE BUILDING VENTILATION SYSTEM			
a. Noble Gas Activity Monitor	1	*	42
b. Flow Rate Monitor	1	*	41

Table 1.5 (Page 2 of 2)
RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION
TABLE NOTATION R24

* At all times.

R24

*** During shield building exhaust system operation.

ACTION 40 - 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: R24 R24

a. At least two independent samples of the tank's contents are analyzed, and
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 41 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided the flow rate is estimated at least once per 4 hours. R24 R24

ACTION 42 - 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 noble gas gross activity within 24 hours. R24 R24

ACTION 44 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via the affected pathway may continue provided that within 4 hours after the channel has been declared inoperable samples are continuously collected with auxiliary sampling equipment as required in Table 1.1. R24 R24

Table 1.6 (Page 1 of 2)
RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION
SURVEILLANCE REQUIREMENTS

Instrument	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	CHANNEL FUNCTIONAL TEST	MODES in which surveillance Required
1. WASTE GAS DISPOSAL SYSTEM					
a. Noble Gas Activity Monitor	P	P	R(3)	Q(1)	*
b. Flow Rate Monitor	D	N.A.	R	Q	****
2. CONDENSER VACUUM EXHAUST SYSTEM					
a. Noble Gas Activity Monitor	D	M	R(3)	Q(2)	*
b. Flow Rate Monitor	D	N.A.	R	Q	*
3. SHIELD BUILDING EXHAUST SYSTEM					
a. Noble Gas Activity Monitor	D	M	R(3)	Q(2)	***
b. Iodine Sampler	W	N.A.	N.A.	N.A.	***
c. Particulate Sampler	W	N.A.	N.A.	N.A.	***
d. Flow Rate Monitor	D	N.A.	R	Q	***
e. Sampler Flow Rate Monitor	D	N.A.	R	Q	***
4. AUXILIARY BUILDING VENTILATION SYSTEM					
a. Noble Gas Activity Monitor	D	M	R(3)	Q(2)	*
b. Iodine Sampler	W	N.A.	N.A.	N.A.	*
c. Particulate Sampler	W	N.A.	N.A.	N.A.	*
d. Flow Rate Monitor	D	N.A.	R	Q	*
e. Sampler Flow Rate Monitor	D	N.A.	R	Q	*
5. SERVICE BUILDING VENTILATION SYSTEM					
a. Noble Gas Activity Monitor	D	M	R(3)	Q(2)	*
b. Flow Rate Monitor	D	N.A.	R	Q	*

Table 1.6 (Page 2 of 2)
RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION
SURVEILLANCE REQUIREMENTS
TABLE NOTATION

P = Completed prior to each release
R = At least once per 18 months
Q = At lease once per 92 days
D = At least once per 24 hours
N.A. = Not Applicable
M = At least once per 31 days
* At all times.

R24

*** During shield building exhaust system operation.
**** During waste gas releases.

(1) The CHANNEL FUNCTIONAL TEST shall also demonstrate that automatic isolation of this pathway and control room alarm annunciation occurs if any of the following conditions exists: R24
1. Instrument indicates measured levels above the alarm/trip setpoint.
2. Circuit failure.
3. Downscale failure.

(2) The CHANNEL FUNCTION TEST shall also demonstrate that control room alarm annunciation occurs if any of the following conditions exists: R24
1. Instrument indicates measured levels above the alarm setpoint.
2. Circuit failure.
3. Downscale failure.

For the auxiliary building ventilation system, at least once every 18 months, the CHANNEL FUNCTIONAL TEST shall also demonstrate automatic isolation of this pathway if the following condition exists: R24
Instrument indicates measured levels above the alarm/trip setpoint.

(3) The initial CHANNEL CALIBRATION shall be performed using one or more of the reference standards certified by the National Bureau of Standards 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. R24 R24

R24
R24
R24
R24

Table 1.7
SECTOR ELEMENTS CONSIDERED FOR POPULATION DOSES

Range of Sector Element	Midpoint of Sector Element
Site boundary - 1 mile	0.8 mile
1 - 2 miles	1.5 miles
2 - 3 miles	2.5 miles
3 - 4 miles	3.5 miles
4 - 5 miles	4.5 miles
5 - 10 miles	7.5 miles
10 - 20 miles	15 miles
20 - 30 miles	25 miles
30 - 40 miles	35 miles
40 - 50 miles	45 miles

Table 1.8
POPULATION WITHIN EACH SECTOR ELEMENT

	Sector Midpoint (miles)									
	0.8	1.5	2.5	3.5	4.5	7.5	15	25	35	45
N	20	41	213	129	66	1784	5453	3470	2610	11145
NNE	0	30	123	182	62	600	10628	4910	8250	10625
NE	0	0	67	67	94	581	2884	6998	7047	18080
ENE	0	11	24	222	300	773	4707	5747	29477	18679
E	0	70	11	191	137	918	17440	6808	5072	4129
ESE	0	118	113	194	137	1849	46521	5044	1896	13624
SE	0	179	322	168	205	1507	6005	5461	15641	3417
SSE	0	125	370	750	601	2347	13242	8596	34279	11648
S	0	67	143	229	811	3930	28008	26690	19642	11622
SSW	0	82	140	400	170	8927	96966	55597	21349	11978
SW	0	10	306	634	194	9787	94225	23455	11641	11109
WSW	20	190	642	1124	1669	19089	28405	4106	15081	9548
W	10	20	233	657	657	5225	1580	6350	5699	7707
WNW	10	30	365	598	598	2622	6540	4920	6699	2450
NW	50	80	292	569	336	2696	1410	1750	1217	15856
NNW	10	263	80	75	213	1610	471	3130	2835	5719

Table 1.9 (1 of 8)
INGESTION DOSE FACTORS
(mrem/pCi ingested)

ADULT

	bone	liver	t body	thyroid	kidney	lung	gi-lli
H-3	1.05E-07	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	0.00E+00	0.00E+00	0.00E+00	2.17E-05
Cr-51	0.00E+00	0.00E+00	2.66E-09	1.59E-09	5.86E-10	3.53E-09	6.69E-07
Mn-54	0.00E+00	4.57E-06	8.72E-07	0.00E+00	1.36E-06	0.00E+00	1.40E-05
Mn-56	0.00E+00	1.15E-07	2.04E-08	0.00E+00	1.46E-07	0.00E+00	3.67E-06
Fe-55	2.75E-06	1.90E-06	4.43E-07	0.00E+00	0.00E+00	1.06E-06	1.09E-06
Fe-59	4.34E-06	1.02E-05	3.91E-06	0.00E+00	0.00E+00	2.85E-06	3.40E-05
Co-57	0.00E+00	1.75E-07	2.91E-07	0.00E+00	0.00E+00	0.00E+00	4.44E-06
Co-58	0.00E+00	7.45E-07	1.67E-06	0.00E+00	0.00E+00	0.00E+00	1.51E-05
Co-60	0.00E+00	2.14E-06	4.72E-06	0.00E+00	0.00E+00	0.00E+00	4.02E-05
Ni-63	1.30E-04	9.01E-06	4.36E-06	0.00E+00	0.00E+00	0.00E+00	1.88E-06
Ni-65	5.28E-07	6.86E-08	3.13E-08	0.00E+00	0.00E+00	0.00E+00	1.74E-06
Cu-64	0.00E+00	8.33E-08	3.91E-08	0.00E+00	2.10E-07	0.00E+00	7.10E-06
Zn-65	4.84E-06	1.54E-05	6.96E-06	0.00E+00	1.03E-05	0.00E+00	9.70E-06
Zn-69	1.03E-08	1.97E-08	1.37E-09	0.00E+00	1.28E-08	0.00E+00	2.96E-09
Zn-69m	1.70E-07	4.08E-07	3.73E-08	0.00E+00	2.47E-07	0.00E+00	2.49E-05
Br-82	0.00E+00	0.00E+00	2.26E-06	0.00E+00	0.00E+00	0.00E+00	2.59E-06
Br-83	0.00E+00	0.00E+00	4.02E-08	0.00E+00	0.00E+00	0.00E+00	5.79E-08
Br-84	0.00E+00	0.00E+00	5.21E-08	0.00E+00	0.00E+00	0.00E+00	4.09E-13
Br-85	0.00E+00	0.00E+00	2.14E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	2.11E-05	9.83E-06	0.00E+00	0.00E+00	0.00E+00	4.16E-06
Rb-88	0.00E+00	6.05E-08	3.21E-08	0.00E+00	0.00E+00	0.00E+00	8.36E-19
Rb-89	0.00E+00	4.01E-08	2.82E-08	0.00E+00	0.00E+00	0.00E+00	2.33E-21
Sr-89	3.08E-04	0.00E+00	8.84E-06	0.00E+00	0.00E+00	0.00E+00	4.94E-05
Sr-90	7.58E-03	0.00E+00	1.86E-03	0.00E+00	0.00E+00	0.00E+00	2.19E-04
Sr-91	5.67E-06	0.00E+00	2.29E-07	0.00E+00	0.00E+00	0.00E+00	2.70E-05
Sr-92	2.15E-06	0.00E+00	9.30E-08	0.00E+00	0.00E+00	0.00E+00	4.26E-05
Y-90	9.62E-09	0.00E+00	2.58E-10	0.00E+00	0.00E+00	0.00E+00	1.02E-04
Y-91m	9.09E-11	0.00E+00	3.52E-12	0.00E+00	0.00E+00	0.00E+00	2.67E-10
Y-91	1.41E-07	0.00E+00	3.77E-09	0.00E+00	0.00E+00	0.00E+00	7.76E-05
Y-92	8.45E-10	0.00E+00	2.47E-11	0.00E+00	0.00E+00	0.00E+00	1.48E-05
Y-93	2.68E-09	0.00E+00	7.40E-11	0.00E+00	0.00E+00	0.00E+00	8.50E-05
Zr-95	3.04E-08	9.75E-09	6.60E-09	0.00E+00	1.53E-08	0.00E+00	3.09E-05
Zr-97	1.68E-09	3.39E-10	1.55E-10	0.00E+00	5.12E-10	0.00E+00	1.05E-04
Nb-95	6.22E-09	3.46E-09	1.86E-09	0.00E+00	3.42E-09	0.00E+00	2.10E-05
Nb-97	5.22E-11	1.32E-11	4.82E-12	0.00E+00	1.54E-11	0.00E+00	4.87E-08
Mo-99	0.00E+00	4.31E-06	8.20E-07	0.00E+00	9.76E-06	0.00E+00	9.99E-06
Tc-99m	2.47E-10	6.98E-10	8.89E-09	0.00E+00	1.06E-08	3.42E-10	4.13E-07
Tc-101	2.54E-10	3.66E-10	3.59E-09	0.00E+00	6.59E-09	1.87E-10	1.10E-21
Ru-103	1.85E-07	0.00E+00	7.97E-08	0.00E+00	7.06E-07	0.00E+00	2.16E-05
Ru-105	1.54E-08	0.00E+00	6.08E-09	0.00E+00	1.99E-07	0.00E+00	9.42E-06
Ru-106	2.75E-06	0.00E+00	3.48E-07	0.00E+00	5.31E-06	0.00E+00	1.78E-04
Ag-110m	1.60E-07	1.48E-07	8.79E-08	0.00E+00	2.91E-07	0.00E+00	6.04E-05
Sb-124	2.80E-06	5.29E-08	1.11E-06	6.79E-09	0.00E-00	2.18E-06	7.95E-05

Table 1.9 (2 of 8)
INGESTION DOSE FACTORS
(mrem/pCi ingested)

ADULT

	bone	liver	t body	thyroid	kidney	lung	gi-lli
Sb-125	1.79E-06	2.00E-08	4.26E-07	1.82E-09	0.00E-00	1.38E-06	1.97E-05
Te-125m	2.68E-06	9.71E-07	3.59E-07	8.06E-07	1.09E-05	0.00E+00	1.07E-05
Te-127m	6.77E-06	2.42E-06	8.25E-07	1.73E-06	2.75E-05	0.00E+00	2.27E-05
Te-127	1.10E-07	3.95E-08	2.38E-08	8.15E-08	4.48E-07	0.00E+00	8.68E-06
Te-129m	1.15E-05	4.29E-06	1.82E-06	3.95E-06	4.80E-05	0.00E+00	5.79E-05
Te-129	3.14E-08	1.18E-08	7.65E-09	2.41E-08	1.32E-07	0.00E+00	2.37E-08
Te-131m	1.73E-06	8.46E-07	7.05E-07	1.34E-06	8.57E-06	0.00E+00	8.40E-05
Te-131	1.97E-08	8.23E-09	6.22E-09	1.62E-08	8.63E-08	0.00E+00	2.79E-09
Te-132	2.52E-06	1.63E-06	1.53E-06	1.80E-06	1.57E-05	0.00E+00	7.71E-05
I-130	7.56E-07	2.23E-06	8.80E-07	1.89E-04	3.48E-06	0.00E+00	1.92E-06
I-131	4.16E-06	5.95E-06	3.41E-06	1.95E-03	1.02E-05	0.00E+00	1.57E-06
I-132	2.03E-07	5.43E-07	1.90E-07	1.90E-05	8.65E-07	0.00E+00	1.02E-07
I-133	1.42E-06	2.47E-06	7.53E-07	3.63E-04	4.31E-06	0.00E+00	2.22E-06
I-134	1.06E-07	2.88E-07	1.03E-07	4.99E-06	4.58E-07	0.00E+00	2.51E-10
I-135	4.43E-07	1.16E-06	4.28E-07	7.65E-05	1.86E-06	0.00E+00	1.31E-06
Cs-134	6.22E-05	1.48E-04	1.21E-04	0.00E+00	4.79E-05	1.59E-05	2.59E-06
Cs-136	6.51E-06	2.57E-05	1.85E-05	0.00E+00	1.43E-05	1.96E-06	2.92E-06
Cs-137	7.97E-05	1.09E-04	7.14E-05	0.00E+00	3.70E-05	1.23E-05	2.11E-06
Cs-138	5.52E-08	1.09E-07	5.40E-08	0.00E+00	8.01E-08	7.91E-09	4.65E-13
Ba-139	9.70E-08	6.91E-11	2.84E-09	0.00E+00	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
La-140	2.50E-09	1.26E-09	3.33E-10	0.00E+00	0.00E+00	0.00E+00	9.25E-05
La-142	1.28E-10	5.82E-11	1.45E-11	0.00E+00	0.00E+00	0.00E+00	4.25E-07
Ce-141	9.36E-09	6.33E-09	7.18E-10	0.00E+00	2.94E-09	0.00E+00	2.42E-05
Ce-143	1.65E-09	1.22E-06	1.35E-10	0.00E+00	5.37E-10	0.00E+00	4.56E-05
Ce-144	4.88E-07	2.04E-07	2.62E-08	0.00E+00	1.21E-07	0.00E+00	1.65E-04
Pr-143	9.20E-09	3.69E-09	4.56E-10	0.00E+00	2.13E-09	0.00E+00	4.03E-05
Pr-144	3.01E-11	1.25E-11	1.53E-12	0.00E+00	7.05E-12	0.00E+00	4.33E-18
Nd-147	6.29E-09	7.27E-09	4.35E-10	0.00E+00	4.25E-09	0.00E+00	3.49E-05
W-187	1.03E-07	8.61E-08	3.01E-08	0.00E+00	0.00E+00	0.00E+00	2.82E-05
Np-239	1.19E-09	1.17E-10	6.45E-11	0.00E+00	3.65E-10	0.00E+00	2.40E-05

References:

Regulatory Guide 1.109, Table E-11.

Dose Factors for Co-57, Zn-69m, Br-82, Nb-97, Sb-124 and Sb-125 are from NUREG-0172 Age Specific Radiation Dose Commitment Factors for a One Year Chronic Intake,, November, 1977, Table 4.

NOTE: The tritium dose factor for bone is assumed to be equal to the total body dose factor.

Table 1.9 (3 of 8)
INGESTION DOSE FACTORS
(mrem/pCi ingested)

TEEN

	bone	liver	t body	thyroid	kidney	lung	gi-lli
H-3	1.06E-07	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	0.00E+00	0.00E+00	0.00E+00	2.32E-05
Cr-51	0.00E+00	0.00E+00	3.60E-09	2.00E-09	7.89E-10	5.14E-09	6.05E-07
Mn-54	0.00E+00	5.90E-06	1.17E-06	0.00E+00	1.76E-06	0.00E+00	1.21E-05
Mn-56	0.00E+00	1.58E-07	2.81E-08	0.00E+00	2.00E-07	0.00E+00	1.04E-05
Fe-55	3.78E-06	2.68E-06	6.25E-07	0.00E+00	0.00E+00	1.70E-06	1.16E-06
Fe-59	5.87E-06	1.37E-05	5.29E-06	0.00E+00	0.00E+00	4.32E-06	3.24E-05
Co-57	0.00E+00	2.38E-07	3.99E-07	0.00E+00	0.00E+00	0.00E+00	4.44E-06
Co-58	0.00E+00	9.72E-07	2.24E-06	0.00E+00	0.00E+00	0.00E+00	1.34E-05
Co-60	0.00E+00	2.81E-06	6.33E-06	0.00E+00	0.00E+00	0.00E+00	3.66E-05
Ni-63	1.77E-04	1.25E-05	6.00E-06	0.00E+00	0.00E+00	0.00E+00	1.99E-06
Ni-65	7.49E-07	9.57E-08	4.36E-08	0.00E+00	0.00E+00	0.00E+00	5.19E-06
Cu-64	0.00E+00	1.15E-07	5.41E-08	0.00E+00	2.91E-07	0.00E+00	8.92E-06
Zn-65	5.76E-06	2.00E-05	9.33E-06	0.00E+00	1.28E-05	0.00E+00	8.47E-06
Zn-69	1.47E-08	2.80E-08	1.96E-09	0.00E+00	1.83E-08	0.00E+00	5.16E-08
Zn-69m	2.40E-07	5.66E-07	5.19E-08	0.00E+00	3.44E-07	0.00E+00	3.11E-05
Br-82	0.00E+00	0.00E+00	3.04E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-83	0.00E+00	0.00E+00	5.74E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	7.22E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	3.05E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	2.98E-05	1.40E-05	0.00E+00	0.00E+00	0.00E+00	4.41E-06
Rb-88	0.00E+00	8.52E-08	4.54E-08	0.00E+00	0.00E+00	0.00E+00	7.30E-15
Rb-89	0.00E+00	5.50E-08	3.89E-08	0.00E+00	0.00E+00	0.00E+00	8.43E-17
Sr-89	4.40E-04	0.00E+00	1.26E-05	0.00E+00	0.00E+00	0.00E+00	5.24E-05
Sr-90	8.30E-03	0.00E+00	2.05E-03	0.00E+00	0.00E+00	0.00E+00	2.33E-04
Sr-91	8.07E-06	0.00E+00	3.21E-07	0.00E+00	0.00E+00	0.00E+00	3.66E-05
Sr-92	3.05E-06	0.00E+00	1.30E-07	0.00E+00	0.00E+00	0.00E+00	7.77E-05
Y-90	1.37E-08	0.00E+00	3.69E-10	0.00E+00	0.00E+00	0.00E+00	1.13E-04
Y-91m	1.29E-10	0.00E+00	4.93E-12	0.00E+00	0.00E+00	0.00E+00	6.09E-09
Y-91	2.01E-07	0.00E+00	5.39E-09	0.00E+00	0.00E+00	0.00E+00	8.24E-05
Y-92	1.21E-09	0.00E+00	3.50E-11	0.00E+00	0.00E+00	0.00E+00	3.32E-05
Y-93	3.83E-09	0.00E+00	1.05E-10	0.00E+00	0.00E+00	0.00E+00	1.17E-04
Zr-95	4.12E-08	1.30E-08	8.94E-09	0.00E+00	1.91E-08	0.00E+00	3.00E-05
Zr-97	2.37E-09	4.69E-10	2.16E-10	0.00E+00	7.11E-10	0.00E+00	1.27E-04
Nb-95	8.22E-09	4.56E-09	2.51E-09	0.00E+00	4.42E-09	0.00E+00	1.95E-05
Nb-97	7.37E-11	1.83E-11	6.68E-12	0.00E+00	2.14E-11	0.00E+00	4.37E-07
Mo-99	0.00E+00	6.03E-06	1.15E-06	0.00E+00	1.38E-05	0.00E+00	1.08E-05
Tc-99m	3.32E-10	9.26E-10	1.20E-08	0.00E+00	1.38E-08	5.14E-10	6.08E-07
Tc-101	3.60E-10	5.12E-10	5.03E-09	0.00E+00	9.26E-09	3.12E-10	8.75E-17
Ru-103	2.55E-07	0.00E+00	1.09E-07	0.00E+00	8.99E-07	0.00E+00	2.13E-05
Ru-105	2.18E-08	0.00E+00	8.46E-09	0.00E+00	2.75E-07	0.00E+00	1.76E-05
Ru-106	3.92E-06	0.00E+00	4.94E-07	0.00E+00	7.56E-06	0.00E+00	1.88E-04
Ag-110m	2.05E-07	1.94E-07	1.18E-07	0.00E+00	3.70E-07	0.00E+00	5.45E-05
Sb-124	3.87E-06	7.13E-08	1.51E-06	8.78E-09	0.00E-00	3.38E-06	7.80E-05

Table 1.9 (4 of 8)
INGESTION DOSE FACTORS
(mrem/pCi ingested)

TEEN

	bone	liver	t body	thyroid	kidney	lung	gi-lli
Sb-125	2.48E-06	2.71E-08	5.80E-07	2.37E-09	0.00E+00	2.18E-06	1.93E-05
Te-125m	3.83E-06	1.38E-06	5.12E-07	1.07E-06	0.00E+00	0.00E+00	1.13E-05
Te-127m	9.67E-06	3.43E-06	1.15E-06	2.30E-06	3.92E-05	0.00E+00	2.41E-05
Te-127	1.58E-07	5.60E-08	3.40E-08	1.09E-07	6.40E-07	0.00E+00	1.22E-05
Te-129m	1.63E-05	6.05E-06	2.58E-06	5.26E-06	6.82E-05	0.00E+00	6.12E-05
Te-129	4.48E-08	1.67E-08	1.09E-08	3.20E-08	1.88E-07	0.00E+00	2.45E-07
Te-131m	2.44E-06	1.17E-06	9.76E-07	1.76E-06	1.22E-05	0.00E+00	9.39E-05
Te-131	2.79E-08	1.15E-08	8.72E-09	2.15E-08	1.22E-07	0.00E+00	2.29E-09
Te-132	3.49E-06	2.21E-06	2.08E-06	2.33E-06	2.12E-05	0.00E+00	7.00E-05
I-130	1.03E-06	2.98E-06	1.19E-06	2.43E-04	4.59E-06	0.00E+00	2.29E-06
I-131	5.85E-06	8.19E-06	4.40E-06	2.39E-03	1.41E-05	0.00E+00	1.62E-06
I-132	2.79E-07	7.30E-07	2.62E-07	2.46E-05	1.15E-06	0.00E+00	3.18E-07
I-133	2.01E-06	3.41E-06	1.04E-06	4.76E-04	5.98E-06	0.00E+00	2.58E-06
I-134	1.46E-07	3.87E-07	1.39E-07	6.45E-06	6.10E-07	0.00E+00	5.10E-09
I-135	6.10E-07	1.57E-06	5.82E-07	1.01E-04	2.48E-06	0.00E+00	1.74E-06
Cs-134	8.37E-05	1.97E-04	9.14E-05	0.00E+00	6.26E-05	2.39E-05	2.45E-06
Cs-136	8.59E-06	3.38E-05	2.27E-05	0.00E+00	1.84E-05	2.90E-06	2.72E-06
Cs-137	1.12E-04	1.49E-04	5.19E-05	0.00E+00	5.07E-05	1.97E-05	2.12E-06
Cs-138	7.76E-08	1.49E-07	7.45E-08	0.00E+00	1.10E-07	1.28E-08	6.76E-11
Ba-139	1.39E-07	9.78E-11	4.05E-09	0.00E+00	9.22E-11	6.74E-11	1.24E-06
Ba-140	2.84E-05	3.48E-08	1.83E-06	0.00E+00	1.18E-08	2.34E-08	4.38E-05
Ba-141	6.71E-08	5.01E-11	2.24E-09	0.00E+00	4.65E-11	3.43E-11	1.43E-13
Ba-142	2.99E-08	2.99E-11	1.84E-09	0.00E+00	2.53E-11	1.99E-11	9.18E-20
La-140	3.48E-09	1.71E-09	4.55E-10	0.00E+00	0.00E+00	0.00E+00	9.82E-05
La-142	1.79E-10	7.95E-11	1.98E-11	0.00E+00	0.00E+00	0.00E+00	2.42E-06
Ce-141	1.33E-08	8.88E-09	1.02E-09	0.00E+00	4.18E-09	0.00E+00	2.54E-05
Ce-143	2.35E-09	1.71E-06	1.91E-10	0.00E+00	7.67E-10	0.00E+00	5.14E-05
Ce-144	6.96E-07	2.88E-07	3.74E-08	0.00E+00	1.72E-07	0.00E+00	1.75E-04
Pr-143	1.31E-08	5.23E-09	6.52E-10	0.00E+00	3.04E-09	0.00E+00	4.31E-05
Pr-144	4.30E-11	1.76E-11	2.18E-12	0.00E+00	1.01E-11	0.00E+00	4.74E-14
Nd-147	9.38E-09	1.02E-08	6.11E-10	0.00E+00	5.99E-09	0.00E+00	3.68E-05
W-187	1.46E-07	1.19E-07	4.17E-08	0.00E+00	0.00E+00	0.00E+00	3.22E-05
Np-239	1.76E-09	1.66E-10	9.22E-11	0.00E+00	5.21E-10	0.00E+00	2.67E-05

References:

Regulatory Guide 1.109, Table E-12.

Dose Factors for Co-57, Zn-69m, Br-82, Nb-97, Sb-124 and Sb-125 are from NUREG-0172 Age Specific Radiation Dose Commitment Factors for a One Year Chronic Intake,, November, 1977, Table 4.

NOTE: The tritium dose factor for bone is assumed to be equal to the total body dose factor.

Table 1.9 (5 of 8)
INGESTION DOSE FACTORS
(mrem/pCi ingested)

CHILD

	bone	liver	t body	thyroid	kidney	lung	gi-lli
H-3	2.03E-07	2.03E-07	2.03E-07	2.03E-07	2.03E-07	2.03E-07	2.03E-07
C-14	1.21E-05	2.42E-06	2.42E-06	2.42E-06	2.42E-06	2.42E-06	2.42E-06
Na-24	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06
P-32	8.25E-04	3.86E-05	3.18E-05	0.00E+00	0.00E+00	0.00E+00	2.28E-05
Cr-51	0.00E+00	0.00E+00	8.90E-09	4.94E-09	1.35E-09	9.02E-09	4.72E-07
Mn-54	0.00E+00	1.07E-05	2.85E-06	0.00E+00	3.00E-06	0.00E+00	8.98E-06
Mn-56	0.00E+00	3.34E-07	7.54E-08	0.00E+00	4.04E-07	0.00E+00	4.84E-05
Fe-55	1.15E-05	6.10E-06	1.89E-06	0.00E+00	0.00E+00	3.45E-06	1.13E-06
Fe-59	1.65E-05	2.67E-05	1.33E-05	0.00E+00	0.00E+00	7.74E-06	2.78E-05
Co-57	0.00E+00	4.93E-07	9.98E-07	0.00E+00	0.00E+00	0.00E+00	4.04E-06
Co-58	0.00E+00	1.80E-06	5.51E-06	0.00E+00	0.00E+00	0.00E+00	1.05E-05
Co-60	0.00E+00	5.29E-06	1.56E-05	0.00E+00	0.00E+00	0.00E+00	2.93E-05
Ni-63	5.38E-04	2.88E-05	1.83E-05	0.00E+00	0.00E+00	0.00E+00	1.94E-06
Ni-65	2.22E-06	2.09E-07	1.22E-07	0.00E+00	0.00E+00	0.00E+00	2.56E-05
Cu-64	0.00E+00	2.45E-07	1.48E-07	0.00E+00	5.92E-07	0.00E+00	1.15E-05
Zn-65	1.37E-05	3.65E-05	2.27E-05	0.00E+00	2.30E-05	0.00E+00	6.41E-06
Zn-69	4.38E-08	6.33E-08	5.85E-09	0.00E+00	3.84E-08	0.00E+00	3.99E-06
Zn-69m	7.10E-07	1.21E-06	1.43E-07	0.00E+00	7.03E-07	0.00E+00	3.94E-05
Br-82	0.00E+00	0.00E+00	7.55E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-83	0.00E+00	0.00E+00	1.71E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	1.98E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	9.12E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	6.70E-05	4.12E-05	0.00E+00	0.00E+00	0.00E+00	4.31E-06
Rb-88	0.00E+00	1.90E-07	1.32E-07	0.00E+00	0.00E+00	0.00E+00	9.32E-09
Rb-89	0.00E+00	1.17E-07	1.04E-07	0.00E+00	0.00E+00	0.00E+00	1.02E-09
Sr-89	1.32E-03	0.00E+00	3.77E-05	0.00E+00	0.00E+00	0.00E+00	5.11E-05
Sr-90	1.70E-02	0.00E+00	4.31E-03	0.00E+00	0.00E+00	0.00E+00	2.29E-04
Sr-91	2.40E-05	0.00E+00	9.06E-07	0.00E+00	0.00E+00	0.00E+00	5.30E-05
Sr-92	9.03E-06	0.00E+00	3.62E-07	0.00E+00	0.00E+00	0.00E+00	1.71E-04
Y-90	4.11E-08	0.00E+00	1.10E-09	0.00E+00	0.00E+00	0.00E+00	1.17E-04
Y-91m	3.82E-10	0.00E+00	1.39E-11	0.00E+00	0.00E+00	0.00E+00	7.48E-07
Y-91	6.02E-07	0.00E+00	1.61E-08	0.00E+00	0.00E+00	0.00E+00	8.02E-05
Y-92	3.60E-09	0.00E+00	1.03E-10	0.00E+00	0.00E+00	0.00E+00	1.04E-04
Y-93	1.14E-08	0.00E+00	3.13E-10	0.00E+00	0.00E+00	0.00E+00	1.70E-04
Zr-95	1.16E-07	2.55E-08	2.27E-08	0.00E+00	3.65E-08	0.00E+00	2.66E-05
Zr-97	6.99E-09	1.01E-09	5.96E-10	0.00E+00	1.45E-09	0.00E+00	1.53E-04
Nb-95	2.25E-08	8.76E-09	6.26E-09	0.00E+00	8.23E-09	0.00E+00	1.62E-05
Nb-97	2.17E-10	3.92E-11	1.83E-11	0.00E+00	4.35E-11	0.00E+00	1.21E-05
Mo-99	0.00E+00	1.33E-05	3.29E-06	0.00E+00	2.84E-05	0.00E+00	1.10E-05
Tc-99m	9.23E-10	1.81E-09	3.00E-08	0.00E+00	2.63E-08	9.19E-10	1.03E-06
Tc-101	1.07E-09	1.12E-09	1.42E-08	0.00E+00	1.91E-08	5.92E-10	3.56E-09
Ru-103	7.31E-07	0.00E+00	2.81E-07	0.00E+00	1.84E-06	0.00E+00	1.89E-05
Ru-105	6.45E-08	0.00E+00	2.34E-08	0.00E+00	5.67E-07	0.00E+00	4.21E-05
Ru-106	1.17E-05	0.00E+00	1.46E-06	0.00E+00	1.58E-05	0.00E+00	1.82E-04
Ag-110m	5.39E-07	3.64E-07	2.91E-07	0.00E+00	6.78E-07	0.00E+00	4.33E-05
Sb-124	1.11E-05	1.44E-07	3.89E-06	2.45E-08	0.00E+00	6.16E-06	6.94E-05

Table 1.9 (6 of 8)
INGESTION DOSE FACTORS
(mrem/pCi ingested)

CHILD

	bone	liver	t body	thyroid	kidney	lung	gi-lli
Sb-125	7.16E-06	5.52E-08	1.50E-06	6.63E-09	0.00E+00	3.99E-06	1.71E-05
Te-125m	1.14E-05	3.09E-06	1.52E-06	3.20E-06	0.00E+00	0.00E+00	1.10E-05
Te-127m	2.89E-05	7.78E-06	3.43E-06	6.91E-06	8.24E-05	0.00E+00	2.34E-05
Te-127	4.71E-07	1.27E-07	1.01E-07	3.26E-07	1.34E-06	0.00E+00	1.84E-05
Te-129m	4.87E-05	1.36E-05	7.56E-06	1.57E-05	1.43E-04	0.00E+00	5.94E-05
Te-129	1.34E-07	3.74E-08	3.18E-08	9.56E-08	3.92E-07	0.00E+00	8.34E-06
Te-131m	7.20E-06	2.49E-06	2.65E-06	5.12E-06	2.41E-05	0.00E+00	1.01E-04
Te-131	8.30E-08	2.53E-08	2.47E-08	6.35E-08	2.51E-07	0.00E+00	4.36E-07
Te-132	1.01E-05	4.47E-06	5.40E-06	5.51E-06	4.15E-05	0.00E+00	4.50E-05
I-130	2.92E-06	5.90E-06	3.04E-06	6.50E-04	8.82E-06	0.00E+00	2.76E-06
I-131	1.72E-05	1.73E-05	9.83E-06	5.72E-03	2.84E-05	0.00E+00	1.54E-06
I-132	8.00E-07	1.47E-06	6.76E-07	6.82E-05	2.25E-06	0.00E+00	1.73E-06
I-133	5.92E-06	7.32E-06	2.77E-06	1.36E-03	1.22E-05	0.00E+00	2.95E-06
I-134	4.19E-07	7.73E-07	3.58E-07	1.79E-05	1.19E-06	0.00E+00	5.16E-07
I-135	1.75E-06	3.15E-06	1.49E-06	2.79E-04	4.83E-06	0.00E+00	2.40E-06
Cs-134	2.34E-04	3.84E-04	8.10E-05	0.00E+00	1.19E-04	4.27E-05	2.07E-06
Cs-136	2.35E-05	6.47E-05	4.[illegible]E-05	0.00E+00	3.44E-05	5.13E-06	2.27E-06
Cs-137	3.27E-04	3.13E-04	4.62E-05	0.00E+00	1.02E-04	3.67E-05	1.96E-06
Cs-138	2.28E-07	3.17E-07	2.01E-07	0.00E+00	2.23E-07	2.40E-08	1.46E-07
Ba-139	4.14E-07	2.21E-10	1.20E-08	0.00E+00	1.93E-10	1.30E-10	2.39E-05
Ba-140	8.31E-05	7.28E-08	4.85E-06	0.00E+00	2.37E-08	4.34E-08	4.21E-05
Ba-141	2.00E-07	1.12E-10	6.51E-09	0.00E+00	9.69E-11	6.58E-10	1.14E-07
Ba-142	8.74E-08	6.29E-11	4.88E-09	0.00E+00	5.09E-11	3.70E-11	1.14E-09
La-140	1.01E-08	3.53E-09	1.19E-09	0.00E+00	0.00E+00	0.00E+00	9.84E-05
La-142	5.24E-10	1.67E-10	5.23E-11	0.00E+00	0.00E+00	0.00E+00	3.31E-05
Ce-141	3.97E-08	1.98E-08	2.94E-09	0.00E+00	8.68E-09	0.00E+00	2.47E-05
Ce-143	6.99E-09	3.79E-06	5.49E-10	0.00E+00	1.59E-09	0.00E+00	5.55E-05
Ce-144	2.08E-06	6.52E-07	1.11E-07	0.00E+00	3.61E-07	0.00E+00	1.70E-04
Pr-143	3.93E-08	1.18E-08	1.95E-09	0.00E+00	6.39E-09	0.00E+00	4.24E-05
Pr-144	1.29E-10	3.99E-11	6.49E-12	0.00E+00	2.11E-11	0.00E+00	8.59E-08
Nd-147	2.79E-08	2.26E-08	1.75E-09	0.00E+00	1.24E-08	0.00E+00	3.58E-05
W-187	4.29E-07	2.54E-07	1.14E-07	0.00E+00	0.00E+00	0.00E+00	3.57E-05
Np-239	5.25E-09	3.77E-10	2.65E-10	0.00E+00	1.09E-09	0.00E+00	2.79E-05

References:

Regulatory Guide 1.109, Table E-13.

Dose Factors for Co-57, Zn-69m, Br-82, Nb-97, Sb-124 and Sb-125 are from NUREG-0172 Age Specific Radiation Dose Commitment Factors for a One Year Chronic Intake,, November, 1977, Table 4.

NOTE: The tritium dose factor for bone is assumed to be equal to the total body dose factor.

Table 1.9 (7 of 8)
INGESTION DOSE FACTORS
(mrem/pCi ingested)

INFANT

	bone	liver	t body	thyroid	kidney	lung	gi-lli
H-3	3.08E-07	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	0.00E+00	0.00E+00	0.00E+00	2.30E-05
Cr-51	0.00E+00	0.00E+00	1.41E-08	9.20E-09	2.01E-09	1.79E-08	4.11E-07
Mn-54	0.00E+00	1.99E-05	4.51E-06	0.00E+00	4.41E-06	0.00E+00	7.31E-06
Mn-56	0.00E+00	8.18E-07	1.41E-07	0.00E+00	7.03E-07	0.00E+00	7.43E-05
Fe-55	1.39E-05	8.98E-06	2.40E-06	0.00E+00	0.00E+00	4.39E-06	1.14E-06
Fe-59	3.08E-05	5.38E-05	2.12E-05	0.00E+00	0.00E+00	1.59E-05	2.57E-05
Co-57	0.00E+00	1.15E-06	1.87E-06	0.00E+00	0.00E+00	0.00E+00	3.92E-06
Co-58	0.00E+00	3.60E-06	8.98E-06	0.00E+00	0.00E+00	0.00E+00	8.97E-06
Co-60	0.00E+00	1.08E-05	2.55E-05	0.00E+00	0.00E+00	0.00E+00	2.57E-05
Ni-63	6.34E-04	3.92E-05	2.20E-05	0.00E+00	0.00E+00	0.00E+00	1.95E-06
Ni-65	4.70E-06	5.32E-07	2.42E-07	0.00E+00	0.00E+00	0.00E+00	4.05E-05
Cu-64	0.00E+00	6.09E-07	2.82E-07	0.00E+00	1.03E-06	0.00E+00	1.25E-05
Zn-65	1.84E-05	6.31E-05	2.91E-05	0.00E+00	3.06E-05	0.00E+00	5.33E-05
Zn-69	9.33E-08	1.68E-07	1.25E-08	0.00E+00	6.98E-08	0.00E+00	1.37E-05
Zn-69m	1.50E-06	3.06E-06	2.79E-07	0.00E+00	1.24E-06	0.00E+00	4.24E-05
Br-82	0.00E+00	0.00E+00	1.27E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-83	0.00E+00	0.00E+00	3.63E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	3.82E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	1.94E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.70E-04	8.40E-05	0.00E+00	0.00E+00	0.00E+00	4.35E-06
Rb-88	0.00E+00	4.98E-07	2.73E-07	0.00E+00	0.00E+00	0.00E+00	4.85E-07
Rb-89	0.00E+00	2.86E-07	1.97E-07	0.00E+00	0.00E+00	0.00E+00	9.74E-08
Sr-89	2.51E-03	0.00E+00	7.20E-05	0.00E+00	0.00E+00	0.00E+00	5.16E-05
Sr-90	1.85E-02	0.00E+00	4.71E-03	0.00E+00	0.00E+00	0.00E+00	2.31E-04
Sr-91	5.00E-05	0.00E+00	1.81E-06	0.00E+00	0.00E+00	0.00E+00	5.92E-05
Sr-92	1.92E-05	0.00E+00	7.13E-07	0.00E+00	0.00E+00	0.00E+00	2.07E-04
Y-90	8.69E-08	0.00E+00	2.33E-09	0.00E+00	0.00E+00	0.00E+00	1.20E-04
Y-91m	8.10E-10	0.00E+00	2.76E-11	0.00E+00	0.00E+00	0.00E+00	2.70E-06
Y-91	1.13E-06	0.00E+00	3.01E-08	0.00E+00	0.00E+00	0.00E+00	8.10E-05
Y-92	7.65E-09	0.00E+00	2.15E-10	0.00E+00	0.00E+00	0.00E+00	1.46E-04
Y-93	2.43E-08	0.00E+00	6.62E-10	0.00E+00	0.00E+00	0.00E+00	1.92E-04
Zr-95	2.06E-07	5.02E-08	3.56E-08	0.00E+00	5.41E-08	0.00E+00	2.50E-05
Zr-97	1.48E-08	2.54E-09	1.16E-09	0.00E+00	2.56E-09	0.00E+00	1.62E-04
Nb-95	4.20E-08	1.73E-08	1.00E-08	0.00E+00	1.24E-08	0.00E+00	1.46E-05
Nb-97	4.59E-10	9.79E-11	3.53E-11	0.00E+00	7.65E-11	0.00E+00	3.09E-05
Mo-99	0.00E+00	3.40E-05	6.63E-06	0.00E+00	5.08E-05	0.00E+00	1.12E-05
Tc-99m	1.92E-09	3.96E-09	5.10E-08	0.00E+00	4.26E-08	2.07E-09	1.15E-06
Tc-101	2.27E-09	2.86E-09	2.83E-08	0.00E+00	3.40E-08	1.56E-09	4.86E-07
Ru-103	1.48E-06	0.00E+00	4.95E-07	0.00E+00	3.08E-06	0.00E+00	1.80E-05
Ru-105	1.36E-07	0.00E+00	4.58E-08	0.00E+00	1.00E-06	0.00E+00	5.41E-05
Ru-106	2.41E-05	0.00E+00	3.01E-06	0.00E+00	2.85E-05	0.00E+00	1.83E-04
Ag-110m	9.96E-07	7.27E-07	4.81E-07	0.00E+00	1.04E-06	0.00E+00	3.77E-05
Sb-124	2.14E-05	3.15E-07	6.63E-06	5.68E-08	0.00E+00	1.34E-05	6.60E-05

Table 1.9 (8 of 8)
INGESTION DOSE FACTORS
(mrem/pCi ingested)

INFANT

	bone	liver	t body	thyroid	kidney	lung	gi-lli
Sb-125	1.23E-05	1.19E-07	2.53E-06	1.54E-08	0.00E+00	7.72E-06	1.64E-05
Te-125m	2.33E-05	7.79E-06	3.15E-06	7.84E-06	0.00E+00	0.00E+00	1.11E-05
Te-127m	5.85E-05	1.94E-05	7.08E-06	1.69E-05	1.44E-04	0.00E+00	2.36E-05
Te-127	1.00E-06	3.35E-07	2.15E-07	8.14E-07	2.44E-06	0.00E+00	2.10E-05
Te-129m	1.00E-04	3.43E-05	1.54E-05	3.84E-05	2.50E-04	0.00E+00	5.97E-05
Te-129	2.84E-07	9.79E-08	6.63E-08	2.38E-07	7.07E-07	0.00E+00	2.27E-05
Te-131m	1.52E-05	6.12E-06	5.05E-06	1.24E-05	4.21E-05	0.00E+00	1.03E-04
Te-131	1.76E-07	6.50E-08	4.94E-08	1.57E-07	4.50E-07	0.00E+00	7.11E-06
Te-132	2.08E-05	1.03E-05	9.61E-06	1.52E-05	6.44E-05	0.00E+00	3.81E-05
I-130	6.00E-06	1.32E-05	5.30E-06	1.48E-03	1.45E-05	0.00E+00	2.83E-06
I-131	3.59E-05	4.23E-05	1.86E-05	1.39E-02	4.94E-05	0.00E+00	1.51E-06
I-132	1.66E-06	3.37E-06	1.20E-06	1.58E-04	3.76E-06	0.00E+00	2.73E-06
I-133	1.25E-05	1.82E-05	5.33E-06	3.31E-03	2.14E-05	0.00E+00	3.08E-06
I-134	8.69E-07	1.78E-06	6.33E-07	4.15E-05	1.99E-06	0.00E+00	1.84E-06
I-135	3.64E-06	7.24E-06	2.64E-06	6.49E-04	8.07E-06	0.00E+00	2.62E-06
Cs-134	3.77E-04	7.03E-04	7.10E-05	0.00E+00	1.81E-04	7.42E-05	1.91E-06
Cs-136	4.59E-05	1.35E-04	5.04E-05	0.00E+00	5.38E-05	1.10E-05	2.05E-06
Cs-137	5.22E-04	6.11E-04	4.33E-05	0.00E+00	1.64E-04	6.64E-05	1.91E-06
Cs-138	4.81E-07	7.82E-07	3.79E-07	0.00E+00	3.90E-07	6.09E-08	1.25E-06
Ba-139	8.81E-07	5.84E-10	2.55E-08	0.00E+00	3.51E-10	3.54E-10	5.58E-05
Ba-140	1.71E-04	1.71E-07	8.81E-06	0.00E+00	4.06E-08	1.05E-07	4.20E-05
Ba-141	4.25E-07	2.91E-10	1.34E-08	0.00E+00	1.75E-10	1.77E-10	5.19E-06
Ba-142	1.84E-07	1.53E-10	9.06E-09	0.00E+00	8.81E-11	9.26E-11	7.59E-07
La-140	2.11E-08	8.32E-09	2.14E-09	0.00E+00	0.00E+00	0.00E+00	9.77E-05
La-142	1.10E-09	4.04E-10	9.67E-11	0.00E+00	0.00E+00	0.00E+00	6.86E-05
Ce-141	7.87E-08	4.80E-08	5.65E-09	0.00E+00	1.48E-08	0.00E+00	2.48E-05
Ce-143	1.48E-08	9.82E-06	1.12E-09	0.00E+00	2.86E-09	0.00E+00	5.73E-05
Ce-144	2.98E-06	1.22E-06	1.67E-07	0.00E+00	4.93E-07	0.00E+00	1.71E-04
Pr-143	8.13E-08	3.04E-08	4.03E-09	0.00E+00	1.13E-08	0.00E+00	4.29E-05
Pr-144	2.74E-10	1.06E-10	1.38E-11	0.00E+00	3.84E-11	0.00E+00	4.93E-06
Nd-147	5.53E-08	5.68E-08	3.48E-09	0.00E+00	2.19E-08	0.00E+00	3.60E-05
W-187	9.03E-07	6.28E-07	2.17E-07	0.00E+00	0.00E+00	0.00E+00	3.69E-05
Np-239	1.11E-08	9.93E-10	5.61E-10	0.00E+00	1.98E-09	0.00E+00	2.87E-05

References:

Regulatory Guide 1.109, Table E-14.

Dose Factors for Co-57, Zn-69m, Br-82, Nb-97, Sb-124 and Sb-125 are from NUREG-0172 Age Specific Radiation Dose Commitment Factors for a One Year Chronic Intake,, November, 1977, Table 4.

NOTE: The tritium dose factor for bone is assumed to be equal to the total body dose factor.

Table 1.10 (1 of 3)
RADIONUCLIDE DECAY AND STABLE ELEMENT TRANSFER DATA

	Half-Life (minutes)	λ (1/s)	B_{iv}	F_{mi} (cow)	F_{mi} (goat)	F_{fi} (beef)
H-3	6.46E+06	1.79E-09	4.80E+00	1.00E-02	1.70E-01	1.20E-02
C-14	3.01E+09	3.84E-12	5.50E+00	1.20E-02	1.00E-01	3.10E-02
Na-24	9.00E+02	1.28E-05	5.20E-02	4.00E-02	4.00E-02	3.00E-02
P-32	2.06E+04	5.61E-07	1.10E+00	2.50E-02	2.50E-01	4.60E-02
Cr-51	3.99E+04	2.90E-07	2.50E-04	2.20E-03	2.20E-03	2.40E-03
Mn-54	4.50E+05	2.57E-08	2.90E-02	2.50E-04	2.50E-04	8.00E-04
Mn-56	1.55E+02	7.45E-05	2.90E-02	2.50E-04	2.50E-04	8.00E-04
Fe-55	1.42E+06	8.13E-09	6.60E-04	1.20E-03	1.30E-04	1.20E-02
Fe-59	6.43E+04	1.80E-07	6.60E-04	1.20E-03	1.30E-04	1.20E-02
Co-57	3.90E+05	2.96E-08	9.40E-03	1.00E-03	1.00E-03	1.30E-02
Co-58	1.02E+05	1.13E-07	9.40E-03	1.00E-03	1.00E-03	1.30E-02
Co-60	2.77E+06	4.17E-09	9.40E-03	1.00E-03	1.00E-03	1.30E-02
Ni-63	5.27E+07	2.19E-10	1.90E-02	6.70E-03	6.70E-03	5.30E-02
Ni-65	1.51E+02	7.65E-05	1.90E-02	6.70E-03	6.70E-03	5.30E-02
Cu-64	7.62E+02	1.52E-05	1.20E-01	1.40E-02	1.30E-02	9.70E-04
Zn-65	3.52E+05	3.28E-08	4.00E-01	3.90E-02	3.90E-02	3.00E-02
Zn-69m	8.26E+02	1.40E-05	4.00E-01	3.90E-02	3.90E-02	3.00E-02
Zn-69	5.56E+01	2.08E-04	4.00E-01	3.90E-02	3.90E-02	3.00E-02
Br-82	2.12E+03	5.45E-06	7.60E-01	5.00E-02	5.00E-02	2.60E-02
Br-83	1.43E+02	8.08E-05	7.60E-01	5.00E-02	5.00E-02	2.60E-02
Br-84	3.18E+01	3.63E-04	7.60E-01	5.00E-02	5.00E-02	2.60E-02
Br-85	2.87E+00	4.02E-03	7.60E-01	5.00E-02	5.00E-02	2.60E-02
Rb-86	2.69E+04	4.29E-07	1.30E-01	3.00E-02	3.00E-02	3.10E-02
Rb-88	1.78E+01	6.49E-04	1.30E-01	3.00E-02	3.00E-02	3.10E-02
Rb-89	1.54E+01	7.50E-04	1.30E-01	3.00E-02	3.00E-02	3.10E-02
Sr-89	7.28E+04	1.59E-07	1.70E-02	1.40E-03	1.40E-02	6.00E-04
Sr-90	1.50E+07	7.70E-10	1.70E-02	1.40E-03	1.40E-02	6.00E-04
Sr-91	5.70E+02	2.03E-05	1.70E-02	1.40E-03	1.40E-02	6.00E-04
Sr-92	1.63E+02	7.09E-05	1.70E-02	1.40E-03	1.40E-02	6.00E-04
Y-90	3.85E+03	3.00E-06	2.60E-03	1.00E-05	1.00E-05	4.60E-03
Y-91m	4.97E+01	2.32E-04	2.60E-03	1.00E-05	1.00E-05	4.60E-03
Y-91	8.43E+04	1.37E-07	2.60E-03	1.00E-05	1.00E-05	4.60E-03
Y-92	2.12E+02	5.45E-05	2.60E-03	1.00E-05	1.00E-05	4.60E-03
Y-93	6.06E+02	1.91E-05	2.60E-03	1.00E-05	1.00E-05	4.60E-03
Zr-95	9.22E+04	1.25E-07	1.70E-04	5.00E-06	5.00E-06	3.40E-02
Zr-97	1.01E+03	1.14E-05	1.70E-04	5.00E-06	5.00E-06	3.40E-02
Nb-95	5.05E+04	2.29E-07	9.40E-03	2.50E-03	2.50E-03	2.80E-01
Nb-97	7.21E+01	1.60E-04	9.40E-03	2.50E-03	2.50E-03	2.80E-01
Mo-99	3.96E+03	2.92E-06	1.20E-01	7.50E-03	7.50E-03	1.10E-03
Tc-99m	3.61E+02	3.20E-05	2.50E-01	2.50E-02	2.50E-02	4.00E-01
Tc-101	1.42E+01	8.13E-04	2.50E-01	2.50E-02	2.50E-02	4.00E-01
Ru-103	5.67E+04	2.04E-07	5.00E-02	1.00E-06	1.00E-06	4.00E-01
Ru-105	2.66E+02	4.34E-05	5.00E-02	1.00E-06	1.00E-06	4.00E-01
Ru-106	5.30E+05	2.18E-08	5.00E-02	1.00E-06	1.00E-06	4.00E-01
Ag-110m	3.60E+05	3.21E-08	1.50E-01	5.00E-02	5.00E-02	1.70E-02

Table 1.10 (2 of 3)
RADIONUCLIDE DECAY AND STABLE ELEMENT TRANSFER DATA

	Half-Life (minutes)	λ (1/s)	B_{iv}	F_{mi} (cow)	F_{mi} (goat)	F_{fi} (beef)
Sb-124	8.67E+04	1.33E-07	N/A	1.50E-03	1.50E-03	N/A
Sb-125	1.46E+06	7.91E-09	N/A	1.50E-03	1.50E-03	N/A
Te-125m	8.35E+04	1.38E-07	1.30E+00	1.00E-03	1.00E-03	7.70E-02
Te-127m	1.57E+05	7.36E-08	1.30E+00	1.00E-03	1.00E-03	7.70E-02
Te-127	5.61E+02	2.06E-05	1.30E+00	1.00E-03	1.00E-03	7.70E-02
Te-129m	4.84E+04	2.39E-07	1.30E+00	1.00E-03	1.00E-03	7.70E-02
Te-129	6.96E+01	1.66E-04	1.30E+00	1.00E-03	1.00E-03	7.70E-02
Te-131m	1.80E+03	6.42E-06	1.30E+00	1.00E-03	1.00E-03	7.70E-02
Te-131	2.50E+01	4.62E-04	1.30E+00	1.00E-03	1.00E-03	7.70E-02
Te-132	4.69E+03	2.46E-06	1.30E+00	1.00E-03	1.00E-03	7.70E-02
I-130	7.42E+02	1.56E-05	2.00E-02	1.20E-02	4.30E-01	2.90E-03
I-131	1.16E+04	9.96E-07	2.00E-02	1.20E-02	4.30E-01	2.90E-03
I-132	1.38E+02	8.37E-05	2.00E-02	1.20E-02	4.30E-01	2.90E-03
I-133	1.25E+03	9.24E-06	2.00E-02	1.20E-02	4.30E-01	2.90E-03
I-134	5.26E+01	2.20E-04	2.00E-02	1.20E-02	4.30E-01	2.90E-03
I-135	3.97E+02	2.91E-05	2.00E-02	1.20E-02	4.30E-01	2.90E-03
Cs-134	1.08E+06	1.06E-08	1.00E-02	8.00E-03	3.00E-01	1.50E-02
Cs-136	1.90E+04	6.08E-07	1.00E-02	8.00E-03	3.00E-01	1.50E-02
Cs-137	1.59E+07	7.26E-10	1.00E-02	8.00E-03	3.00E-01	1.50E-02
Cs-138	3.22E+01	3.59E-04	1.00E-02	8.00E-03	3.00E-01	1.50E-02
Ba-139	8.31E+01	1.39E-04	5.00E-03	4.00E-04	4.00E-04	3.20E-03
Ba-140	1.8[illegible]E+04	6.28E-07	5.00E-03	4.00E-04	4.00E-04	3.20E-03
Ba-141	1.83E+01	6.21E-04	5.00E-03	4.00E-04	4.00E-04	3.20E-03
Ba-142	1.07E+01	1.08E-03	5.00E-03	4.00E-04	4.00E-04	3.20E-03
La-140	2.41E+03	4.79E-06	2.50E-03	5.00E-06	5.00E-06	2.00E-04
La-142	9.54E+01	1.21E-04	2.50E-03	5.00E-06	5.00E-06	2.00E-04
Ce-141	4.68E+04	2.47E-07	2.50E-03	1.00E-04	1.00E-04	1.20E-03
Ce-143	1.98E+03	5.83E-06	2.50E-03	1.00E-04	1.00E-04	1.20E-03
Ce-144	4.09E+05	2.82E-08	2.50E-03	1.00E-04	1.00E-04	1.20E-03
Pr-143	1.95E+04	5.92E-07	2.50E-03	5.00E-06	5.00E-06	4.70E-03
Pr-144	1.73E+01	6.68E-04	2.50E-03	5.00E-06	5.00E-06	4.70E-03
Nd-147	1.58E+04	7.31E-07	2.40E-03	5.00E-06	5.00E-06	3.30E-03
W-187	1.43E+03	8.08E-06	1.80E-02	5.00E-04	5.00E-04	1.30E-03
Np-239	3.39E+03	3.41E-06	2.50E-03	5.00E-06	5.00E-06	2.00E-04
Ar-41	1.10E+02	1.05E-04	N/A	N/A	N/A	N/A
Kr-83m	1.10E+02	1.05E-04	N/A	N/A	N/A	N/A
Kr-85m	2.69E+02	4.29E-05	N/A	N/A	N/A	N/A
Kr-85	5.64E+06	2.05E-09	N/A	N/A	N/A	N/A
Kr-87	7.63E+01	1.51E-04	N/A	N/A	N/A	N/A
Kr-88	1.70E+02	6.79E-05	N/A	N/A	N/A	N/A
Kr-89	3.16E+00	3.66E-03	N/A	N/A	N/A	N/A
Kr-90	5.39E-01	2.14E-02	N/A	N/A	N/A	N/A
Xe-131m	1.70E+04	6.79E-07	N/A	N/A	N/A	N/A
Xe-133m	3.15E+03	3.67E-06	N/A	N/A	N/A	N/A

Table 1.10 (3 of 3)
RADIONUCLIDE DECAY AND STABLE ELEMENT TRANSFER DATA

	Half-Life (minutes)	λ (1/s)	B_{iv}	F_{mi} (cow)	F_{mi} (goat)	F_{fi} (beef)
Xe-133	7.55E+03	1.53E-06	N/A	N/A	N/A	N/A
Xe-135m	1.54E+01	7.50E-04	N/A	N/A	N/A	N/A
Xe-135	5.47E+02	2.11E-05	N/A	N/A	N/A	N/A
Xe-137	3.83E+00	3.02E-03	N/A	N/A	N/A	N/A
Xe-138	1.41E+01	8.19E-04	N/A	N/A	N/A	N/A

References:

Half lives for all nuclides: DOE-TIC-11026, "Radioactive Decay Data Tables - A handbook of Decay Data for Application to Radiation Dosimetry and Radiological Assessment," D. C. Kocher, 1981.

Transfer factors for Sb- isotopes are from ORNL 4992, "Methodology for Calculating Radiation Doses from Radioactivity Released to the Environment," March 1976, Table 2-7.

Cow-milk transfer factors for Iodine, Strontium, and Cesium nuclides are from NUREG/CR-1004, Table 3.17.

Goat-milk transfer factors for Iodine nuclides are from NUREG/CR-1004, Table 3.17.

Beef transfer factors for Iron, Copper, Molybdenum, and Cesium nuclides are from NUREG/CR-1004, Table 3.18.

All other nuclides' transfer factors are from Regulatory Guide 1.109, Tables E-1 and E-2.

Table 1.11 (1 of 2)
DOSE CALCULATION FACTORS

Factor	Value	Units	Reference
BR_a (infant)	1400	m^3/year	ICRP 23
BR_a (child)	5500	m^3/year	ICRP 23
BR_a (teen)	8000	m^3/year	ICRP 23
BR_a (adult)	8100	m^3/year	ICRP 23
f_g	1		TVA Assumption
f_L	1		R. G. 1.109 (Table E-15)
f_p	1		TVA Assumption
f_s	0		TVA Assumption
H	9	g/m^3	TVA Value
K_c	0.072	L/kg-hr	R. G. 1.109 (Section 2.C.)
M	40	kg/m^2	R. G. 1.109 (Section 2.C.)
P	240	kg/m^2	R. G. 1.109 (Table E-15)
Q_f (cow)	64	kg/day	NUREG/CR-1004 (Sect. 3.4)
Q_f (goat)	08	kg/day	NUREG/CR-1004 (Sect. 3.4)
r	0.47		NUREG/CR-1004 (Sect. 3.2)
t_b	4.73E+08 (15 years)	seconds	R. G. 1.109 (Table E-15)
t_{cb}	7.78E+06 (90 days)	seconds	SQN FSAR Section 11.3.9.1
t_{csf}	1.56E+07 (180 days)	seconds	SQN FSAR Section 11.3.9.1
t_e	5.18E+06 (60 days)	seconds	R. G. 1.109 (Table E-15)
t_{ep}	2.59E+06 (30 days)	seconds	R. G. 1.109 (Table E-15)
t_{esf}	7.78E+06 (90 days)	seconds	R. G. 1.109 (Table E-15)
t_{fm}	8.64E+04 (1 day)	seconds	SQN FSAR Section 11.3.9.1
t_{hc}	8.64E+04 (1 day)	seconds	NUREG/CR-1004, Table 3.40
t_s	1.12E+06 (13 days)	seconds	NUREG/CR-1004, Table 3.40
t_{sv}	2.38E+07 (275 days)	seconds	SQN FSAR Section 11.3.9.1
U_{am} (infant)	0	kg/year	R. G. 1.109 (Table E-5)
U_{am} (child)	41	kg/year	R. G. 1.109 (Table E-5)
U_{am} (teen)	65	kg/year	R. G. 1.109 (Table E-5)
U_{am} (adult)	110	kg/year	R. G. 1.109 (Table E-5)
U_{ap} (infant)	330	L/year	R. G. 1.109 (Table E-5)
U_{ap} (child)	330	L/year	R. G. 1.109 (Table E-5)
U_{ap} (teen)	400	L/year	R. G. 1.109 (Table E-5)
U_{ap} (adult)	310	L/year	R. G. 1.109 (Table E-5)

Reformatting/Repagination changes only

Table 1.11 (2 of 2)
DOSE CALCULATION FACTORS

Factor	Value	Units	Reference	
U_{ra}(infant)	0	kg/year	R. G. 1.109 (Table E-5)	
U_{ra}(child)	6.9	kg/year	R. G. 1.109 (Table E-5)	
U_{ra}(teen)	16	kg/year	R. G. 1.109 (Table E-5)	
U_{ra}(adult)	21	kg/year	R. G. 1.109 (Table E-5)	
U_{FLa} (infant)	0	kg/year	R. G. 1.109 (Table E-5)	
U_{FLa} (child)	26	kg/year	R. G. 1.109 (Table E-5)	
U_{FLa} (teen)	42	kg/year	R. G. 1.109 (Table E-5)	
U_{FLa} (adult)	64	kg/year	R. G. 1.109 (Table E-5)	
U_{Sa} (infant)	0	kg/year	R. G. 1.109 (Table E-5)	
U_{Sa} (child)	520	kg/year	R. G. 1.109 (Table E-5)	
U_{Sa} (teen)	630	kg/year	R. G. 1.109 (Table E-5)	
U_{Sa} (adult)	520	kg/year	R. G. 1.109 (Table E-5)	
U_{wa}(infant)	330	L/year	R. G. 1.109 (Table E-5)	
U_{wa}(child)	510	L/year	R. G. 1.109 (Table E-5)	
U_{wa}(teen)	510	L/year	R. G. 1.109 (Table E-5)	
U_{wa}(adult)	730	L/year	R. G. 1.109 (Table E-5)	
W	0.3	none	R. G. 1.109 (Table A-2)	
Y_f	1.85	kg/m^2	NUREG/CR-1004 (Table 3.4)	
Y_p	1.18	kg/m^2	NUREG/CR-1004 (Table 3.3)	
Y_{sf}	0.64	kg/m^2	NUREG/CR-1004 (Table 3.3)	
Y_{sv}	0.57	kg/m^2	NUREG/CR-1004 (Table 3.4) (value selected is for non-leafy vegetables)	
λ_w (iodines)	7.71E-07 (10.4 d half-life)	sec^{-1}	NUREG/CR-1004 (Table 3.10)	R24
λ_w (particulates)	5.21E-07 (15.4 d half-life)	sec^{-1}	NUREG/CR-1004 (Table 3.10)	R24

Table 1.12 (1 of 8)
INHALATION DOSE FACTORS
(mrem/pCi inhaled)

ADULT

	bone	liver	t body	thyroid	kidney	lung	gi-lli
H-3	1.58E-07	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	0.00E+00	0.00E+00	0.00E+00	1.08E-05
Cr-51	0.00E+00	0.00E+00	1.25E-08	7.44E-09	2.85E-09	1.80E-06	4.15E-07
Mn-54	0.00E+00	4.95E-06	7.87E-07	0.00E+00	1.23E-06	1.75E-04	9.67E-06
Mn-56	0.00E+00	1.55E-10	2.29E-11	0.00E+00	1.63E-10	1.18E-06	2.53E-06
Fe-55	3.07E-06	2.12E-06	4.93E-07	0.00E+00	0.00E+00	9.01E-06	7.54E-07
Fe-59	1.47E-06	3.47E-06	1.32E-06	0.00E+00	0.00E+00	1.27E-04	2.35E-05
Co-57	0.00E+00	8.65E-08	8.39E-08	0.00E+00	0.00E+00	4.62E-05	3.93E-06
Co-58	0.00E+00	1.98E-07	2.59E-07	0.00E+00	0.00E+00	1.16E-04	1.33E-05
Co-60	0.00E+00	1.44E-06	1.85E-06	0.00E+00	0.00E+00	7.46E-04	3.56E-05
Ni-63	5.40E-05	3.93E-06	1.81E-06	0.00E+00	0.00E+00	2.23E-05	1.67E-06
Ni-65	1.92E-10	2.62E-11	1.14E-11	0.00E+00	0.00E+00	7.00E-07	1.54E-06
Cu-64	0.00E+00	1.83E-10	7.69E-11	0.00E+00	5.78E-10	8.48E-07	6.12E-06
Zn-65	4.05E-06	1.29E-05	5.82E-06	0.00E+00	8.62E-06	1.08E-04	6.68E-06
Zn-69	4.23E-12	8.14E-12	5.65E-13	0.00E+00	5.27E-12	1.15E-07	2.04E-09
Zn-69m	1.02E-09	2.45E-09	2.24E-10	0.00E+00	1.48E-09	2.38E-06	1.71E-05
Br-82	0.00E+00	0.00E+00	1.69E-06	0.00E+00	0.00E+00	0.00E+00	1.30E-06
Br-83	0.00E+00	0.00E+00	3.01E-08	0.00E+00	0.00E+00	0.00E+00	2.90E-08
Br-84	0.00E+00	0.00E+00	3.91E-08	0.00E+00	0.00E+00	0.00E+00	2.05E-13
Br-85	0.00E+00	0.00E+00	1.60E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.69E-05	7.37E-06	0.00E+00	0.00E+00	0.00E+00	2.08E-06
Rb-88	0.00E+00	4.84E-08	2.41E-08	0.00E+00	0.00E+00	0.00E+00	4.18E-19
Rb-89	0.00E+00	3.20E-08	2.12E-08	0.00E+00	0.00E+00	0.00E+00	1.16E-21
Sr-89	3.80E-05	0.00E+00	1.09E-06	0.00E+00	0.00E+00	1.75E-04	4.37E-05
Sr-90	1.24E-02	0.00E+00	7.62E-04	0.00E+00	0.00E+00	1.20E-03	9.02E-05
Sr-91	7.74E-09	0.00E+00	3.13E-10	0.00E+00	0.00E+00	4.56E-06	2.39E-05
Sr-92	8.43E-10	0.00E+00	3.64E-11	0.00E+00	0.00E+00	2.06E-06	5.38E-06
Y-90	2.61E-07	0.00E+00	7.01E-09	0.00E+00	0.00E+00	2.12E-05	6.32E-05
Y-91m	3.26E-11	0.00E+00	1.27E-12	0.00E+00	0.00E+00	2.40E-07	1.66E-10
Y-91	5.78E-05	0.00E+00	1.55E-06	0.00E+00	0.00E+00	2.13E-04	4.81E-05
Y-92	1.29E-09	0.00E+00	3.77E-11	0.00E+00	0.00E+00	1.96E-06	9.19E-06
Y-93	1.18E-08	0.00E+00	3.26E-10	0.00E+00	0.00E+00	6.06E-06	5.27E-05
Zr-95	1.34E-05	4.30E-06	2.91E-06	0.00E+00	6.77E-06	2.21E-04	1.88E-05
Zr-97	1.21E-08	2.45E-09	1.13E-09	0.00E+00	3.71E-09	9.84E-06	6.54E-05
Nb-95	1.76E-06	9.77E-07	5.26E-07	0.00E+00	9.67E-07	6.31E-05	1.30E-05
Nb-97	2.78E-11	7.03E-12	2.56E-12	0.00E+00	8.18E-12	3.00E-07	3.02E-08
Mo-99	0.00E+00	1.51E-08	2.87E-09	0.00E+00	3.64E-08	1.14E-05	3.10E-05
Tc-99m	1.29E-13	3.64E-13	4.63E-12	0.00E+00	5.52E-12	9.55E-08	5.20E-07
Tc-101	5.22E-15	7.52E-15	7.38E-14	0.00E+00	1.35E-13	4.99E-08	1.36E-21
Ru-103	1.91E-07	0.00E+00	8.23E-08	0.00E+00	7.29E-07	6.31E-05	1.38E-05
Ru-105	9.88E-11	0.00E+00	3.89E-11	0.00E+00	1.27E-10	1.37E-06	6.02E-06
Ru-106	8.64E-06	0.00E+00	1.09E-06	0.00E+00	1.67E-05	1.17E-03	1.14E-04
Ag-110m	1.35E-06	1.25E-06	7.43E-07	0.00E+00	2.46E-06	5.79E-04	3.78E-05
Sb-124	3.90E-06	7.36E-08	1.55E-06	9.44E-09	0.00E+00	3.10E-04	5.08E-05

Table 1.12 (2 of 8)
INHALATION DOSE FACTORS
(mrem/pCi inhaled)

ADULT

	bone	liver	t body	thyroid	kidney	lung	gi-lli
Sb-125	6.67E-06	7.44E-08	1.58E-06	6.75E-09	0.00E+00	2.18E-04	1.26E-05
Te-125m	4.27E-07	1.98E-07	5.84E-08	1.31E-07	1.55E-06	3.92E-05	8.83E-06
Te-127m	1.58E-06	7.21E-07	1.96E-07	4.11E-07	5.72E-06	1.20E-04	1.87E-05
Te-127	1.75E-10	8.03E-11	3.87E-11	1.32E-10	6.37E-10	8.14E-07	7.17E-06
Te-129m	1.22E-06	5.84E-07	1.98E-07	4.30E-07	4.57E-06	1.45E-04	4.79E-05
Te-129	6.22E-12	2.99E-12	1.55E-12	4.87E-12	2.34E-11	2.42E-07	1.96E-08
Te-131m	8.74E-09	5.45E-09	3.63E-09	6.88E-09	3.86E-08	1.82E-05	6.95E-05
Te-131	1.39E-12	7.44E-13	4.49E-13	1.17E-12	5.46E-12	1.74E-07	2.30E-09
Te-132	3.25E-08	2.69E-08	2.02E-08	2.37E-08	1.82E-07	3.60E-05	6.37E-05
I-130	5.72E-07	1.68E-06	6.60E-07	1.42E-04	2.61E-06	0.00E+00	9.61E-07
I-131	3.15E-06	4.47E-06	2.56E-06	1.49E-03	7.66E-06	0.00E+00	7.85E-07
I-132	1.45E-07	4.07E-07	1.45E-07	1.43E-05	6.48E-07	0.00E+00	5.08E-08
I-133	1.08E-06	1.85E-06	5.65E-07	2.69E-04	3.23E-06	0.00E+00	1.11E-06
I-134	8.05E-08	2.16E-07	7.69E-08	3.73E-06	3.44E-07	0.00E+00	1.26E-10
I-135	3.35E-07	8.73E-07	3.21E-07	5.60E-05	1.39E-06	0.00E+00	6.56E-07
Cs-134	4.66E-05	1.06E-04	9.10E-05	0.00E+00	3.59E-05	1.22E-05	1.30E-06
Cs-136	4.88E-06	1.83E-05	1.38E-05	0.00E+00	1.07E-05	1.50E-06	1.46E-06
Cs-137	5.98E-05	7.76E-05	5.35E-05	0.00E+00	2.78E-05	9.40E-06	1.05E-06
Cs-138	4.14E-08	7.76E-08	4.05E-08	0.00E+00	6.00E-08	6.07E-09	2.33E-13
Ba-139	1.17E-10	8.32E-14	3.42E-12	0.00E+00	7.78E-14	4.70E-07	1.12E-07
Ba-140	4.88E-06	6.13E-09	3.21E-07	0.00E+00	2.09E-09	1.59E-04	2.73E-05
Ba-141	1.25E-11	9.41E-15	4.20E-13	0.00E+00	8.75E-15	2.42E-07	1.45E-17
Ba-142	3.29E-12	3.38E-15	2.07E-13	0.00E+00	2.86E-15	1.49E-07	1.96E-26
La-140	4.30E-08	2.17E-08	5.73E-09	0.00E+00	0.00E+00	1.70E-05	5.73E-05
La-142	8.54E-11	3.88E-11	9.65E-12	0.00E+00	0.00E+00	7.91E-07	2.64E-07
Ce-141	2.49E-06	1.69E-06	1.91E-07	0.00E+00	7.83E-07	4.52E-05	1.50E-05
Ce-143	2.33E-08	1.72E-08	1.91E-09	0.00E+00	7.60E-09	9.97E-06	2.83E-05
Ce-144	4.29E-04	1.79E-04	2.30E-05	0.00E+00	1.06E-04	9.72E-04	1.02E-04
Pr-143	1.17E-06	4.69E-07	5.80E-08	0.00E+00	2.70E-07	3.51E-05	2.50E-05
Pr-144	3.76E-12	1.56E-12	1.91E-13	0.00E+00	8.81E-13	1.27E-07	2.69E-18
Nd-147	6.59E-07	7.62E-07	4.56E-08	0.00E+00	4.45E-07	2.76E-05	2.16E-05
W-187	1.06E-09	8.85E-10	3.10E-10	0.00E+00	0.00E+00	3.63E-06	1.94E-05
Np-239	2.87E-08	2.82E-09	1.55E-09	0.00E+00	8.75E-09	4.70E-06	1.49E-05

Reference:

Regulatory Guide 1.109, Table E-7.

Dose Factors for Co-57, Zn-69m, Br-82, Nb-97, Sb-124 and Sb-125 are from NUREG-0172 Age Specific Radiation Dose Commitment Factors for a One Year Chronic Intake, November 1977, Table 8.

NOTE: The tritium dose factor for bone is assumed to be equal to the total body dose factor.

Table 1.12 (3 of 8)
INHALATION DOSE FACTORS
(mrem/pCi inhaled)

TEEN

	bone	liver	t body	thyroid	kidney	lung	gi-lli
H-3	1.59E-07	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-07	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	0.00E+00	0.00E+00	0.00E+00	1.16E-05
Cr-51	0.00E+00	0.00E+00	1.69E-08	9.37E-09	3.84E-09	2.62E-06	3.75E-07
Mn-54	0.00E+00	6.39E-06	1.05E-06	0.00E+00	1.59E-06	2.48E-04	8.35E-06
Mn-56	0.00E+00	2.12E-10	3.15E-11	0.00E+00	2.24E-10	1.90E-06	7.18E-06
Fe-55	4.18E-06	2.98E-06	6.93E-07	0.00E+00	0.00E+00	1.55E-05	7.99E-07
Fe-59	1.99E-06	4.62E-06	1.79E-06	0.00E+00	0.00E+00	1.91E-04	2.23E-05
Co-57	0.00E+00	1.18E-07	1.15E-07	0.00E+00	0.00E+00	7.33E-05	3.93E-06
Co-58	0.00E+00	2.59E-07	3.47E-07	0.00E+00	0.00E+00	1.68E-04	1.19E-05
Co-60	0.00E+00	1.89E-06	2.48E-06	0.00E+00	0.00E+00	1.09E-03	3.24E-05
Ni-63	7.25E-05	5.43E-06	2.47E-06	0.00E+00	0.00E+00	3.84E-05	1.77E-06
Ni-65	2.73E-10	3.66E-11	1.59E-11	0.00E+00	0.00E+00	1.17E-05	4.59E-06
Cu-64	0.00E+00	2.54E-10	1.06E-10	0.00E+00	8.01E-10	1.39E-06	7.68E-06
Zn-65	4.82E-06	1.67E-05	7.80E-06	0.00E+00	1.08E-05	1.55E-04	5.83E-06
Zn-69	6.04E-12	1.15E-11	8.07E-13	0.00E+00	7.53E-12	1.98E-07	3.56E-08
Zn-69m	1.44E-09	3.39E-09	3.11E-10	0.00E+00	2.06E-09	3.92E-06	2.14E-05
Br-82	0.00E+00	0.00E+00	2.28E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-83	0.00E+00	0.00E+00	4.30E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	5.41E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	2.29E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	2.38E-05	1.05E-05	0.00E+00	0.00E+00	0.00E+00	2.21E-06
Rb-88	0.00E+00	6.82E-08	3.40E-08	0.00E+00	0.00E+00	0.00E+00	3.65E-15
Rb-89	0.00E+00	4.40E-08	2.91E-08	0.00E+00	0.00E+00	0.00E+00	4.22E-17
Sr-89	5.43E-05	0.00E+00	1.56E-06	0.00E+00	0.00E+00	3.02E-04	4.64E-05
Sr-90	1.35E-02	0.00E+00	8.35E-04	0.00E+00	0.00E+00	2.06E-03	9.56E-05
Sr-91	1.10E-08	0.00E+00	4.39E-10	0.00E+00	0.00E+00	7.59E-06	3.24E-05
Sr-92	1.19E-09	0.00E+00	5.08E-11	0.00E+00	0.00E+00	3.43E-06	1.49E-05
Y-90	3.73E-07	0.00E+00	1.00E-08	0.00E+00	0.00E+00	3.66E-05	6.99E-05
Y-91m	4.63E-11	0.00E+00	1.77E-12	0.00E+00	0.00E+00	4.00E-07	3.77E-09
Y-91	8.26E-05	0.00E+00	2.21E-06	0.00E+00	0.00E+00	3.67E-04	5.11E-05
Y-92	1.84E-09	0.00E+00	5.36E-11	0.00E+00	0.00E+00	3.35E-06	2.06E-05
Y-93	1.69E-08	0.00E+00	4.65E-10	0.00E+00	0.00E+00	1.04E-05	7.24E-05
Zr-95	1.82E-05	5.73E-06	3.94E-06	0.00E+00	8.42E-06	3.36E-04	1.86E-05
Zr-97	1.72E-08	3.40E-09	1.57E-09	0.00E+00	5.15E-09	1.62E-05	7.88E-05
Nb-95	2.32E-06	1.29E-06	7.08E-07	0.00E+00	1.25E-06	9.39E-05	1.21E-05
Nb-97	3.92E-11	9.72E-12	3.55E-12	0.00E+00	1.14E-11	4.91E-07	2.71E-07
Mo-99	0.00E+00	2.11E-08	4.03E-09	0.00E+00	5.14E-08	1.92E-05	3.36E-05
Tc-99m	1.73E-13	4.83E-13	6.24E-12	0.00E+00	7.20E-12	1.44E-07	7.66E-07
Tc-101	7.40E-15	1.05E-14	1.03E-13	0.00E+00	1.90E-13	8.34E-08	1.09E-16
Ru-103	2.63E-07	0.00E+00	1.12E-07	0.00E+00	9.29E-07	9.79E-05	1.36E-05
Ru-105	1.40E-10	0.00E+00	5.42E-11	0.00E+00	1.76E-10	2.27E-06	1.13E-05
Ru-106	1.23E-05	0.00E+00	1.55E-06	0.00E+00	2.38E-05	2.01E-03	1.20E-04
Ag-110m	1.73E-06	1.64E-06	9.99E-07	0.00E+00	3.13E-06	8.44E-04	3.41E-05
Sb-124	5.38E-06	9.92E-08	2.10E-06	1.22E-08	0.00E+00	4.81E-04	4.98E-05

Table 1.12 (4 of 8)
INHALATION DOSE FACTORS
(mrem/pCi inhaled)

TEEN

	bone	liver	t body	thyroid	kidney	lung	gi-lli
Sb-125	9.23E-06	1.01E-07	2.15E-06	8.80E-09	0.00E+00	3.42E-04	1.24E-05
Te-125m	6.10E-07	2.80E-07	8.34E-08	1.75E-07	0.00E+00	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	0.00E+00	1.14E-06
I-131	4.43E-06	6.14E-06	3.30E-06	1.83E-03	1.05E-05	0.00E+00	8.11E-07
I-132	1.99E-07	5.47E-07	1.97E-07	1.89E-05	8.65E-07	0.00E+00	1.59E-07
I-133	1.52E-06	2.56E-06	7.78E-07	3.65E-04	4.49E-06	0.00E+00	1.29E-06
I-134	1.11E-07	2.90E-07	1.05E-07	4.94E-06	4.58E-07	0.00E+00	2.55E-09
I-135	4.62E-07	1.18E-06	4.36E-07	7.76E-05	1.86E-06	0.00E+00	8.69E-07
Cs-134	6.28E-05	1.41E-04	6.86E-05	0.00E+00	4.69E-05	1.83E-05	1.22E-06
Cs-136	6.44E-06	2.42E-05	1.71E-05	0.00E+00	1.38E-05	2.22E-06	1.36E-06
Cs-137	8.38E-05	1.06E-04	3.89E-05	0.00E+00	3.80E-05	1.51E-05	1.06E-06
Cs-138	5.82E-08	1.07E-07	5.58E-08	0.00E+00	8.28E-08	9.84E-09	3.38E-11
Ba-139	1.67E-10	1.18E-13	4.87E-12	0.00E+00	1.11E-13	8.08E-07	8.06E-07
Ba-140	6.84E-06	8.38E-09	4.40E-07	0.00E+00	2.85E-09	2.54E-04	2.86E-05
Ba-141	1.78E-11	1.32E-14	5.93E-13	0.00E+00	1.23E-14	4.11E-07	9.33E-14
Ba-142	4.62E-12	4.63E-15	2.84E-13	0.00E+00	3.92E-15	2.39E-07	5.99E-20
La-140	5.99E-08	2.95E-08	7.82E-09	0.00E+00	0.00E+00	2.68E-05	6.09E-05
La-142	1.20E-10	5.31E-11	1.32E-11	0.00E+00	0.00E+00	1.27E-06	1.50E-06
Ce-141	3.55E-06	2.37E-06	2.71E-07	0.00E+00	1.11E-06	7.67E-05	1.58E-05
Ce-143	3.32E-08	2.42E-08	2.70E-09	0.00E+00	1.08E-08	1.63E-05	3.19E-05
Ce-144	6.11E-04	2.53E-04	3.28E-05	0.00E+00	1.51E-04	1.67E-03	1.08E-04
Pr-143	1.67E-06	6.64E-07	8.28E-08	0.00E+00	3.86E-07	6.04E-05	2.67E-05
Pr-144	5.37E-12	2.20E-12	2.72E-13	0.00E+00	1.26E-12	2.19E-07	2.94E-14
Nd-147	9.83E-07	1.07E-06	6.41E-08	0.00E+00	6.28E-07	4.65E-05	2.28E-05
W-187	1.50E-09	1.22E-09	4.29E-10	0.00E+00	0.00E+00	5.92E-06	2.21E-05
Np-239	4.23E-08	3.99E-09	2.21E-09	0.00E+00	1.25E-08	8.11E-06	1.65E-05

Reference:

Regulatory Guide 1.109, Table E-8.

Dose Factors for Co-57, Zn-69m, Br-82, Nb-97, Sb-124 and Sb-125 are from NUREG-0172 <u>Age Specific Radiation Dose Commitment Factors for a One Year Chronic Intake,</u> November 1977, Table 8.

NOTE: The tritium dose factor for bone is assumed to be equal to the total body dose factor.

Table 1.12 (5 of 8)
INHALATION DOSE FACTORS
(mrem/pCi inhaled)

CHILD

	bone	liver	t body	thyroid	kidney	lung	gi-lli
H-3	3.04E-07	3.04E-07	3.04E-07	3.04E-07	3.04E-07	3.04E-07	3.04E-07
C-14	9.70E-06	1.82E-06	1.82E-06	1.82E-06	1.82E-06	1.82E-06	1.82E-06
Na-24	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06
P-32	7.04E-04	3.09E-05	2.67E-05	0.00E+00	0.00E+00	0.00E+00	1.14E-05
Cr-51	0.00E+00	0.00E+00	4.17E-08	2.31E-08	6.57E-09	4.59E-06	2.93E-07
Mn-54	0.00E+00	1.16E-05	2.57E-06	0.00E+00	2.71E-06	4.26E-04	6.19E-06
Mn-56	0.00E+00	4.48E-10	8.43E-11	0.00E+00	4.52E-10	3.55E-06	3.33E-05
Fe-55	1.28E-05	6.80E-06	2.10E-06	0.00E+00	0.00E+00	3.00E-05	7.75E-07
Fe-59	5.59E-06	9.04E-06	4.51E-06	0.00E+00	0.00E+00	3.43E-04	1.91E-05
Co-57	0.00E+00	2.44E-07	2.88E-07	0.00E+00	0.00E+00	1.37E-04	3.58E-06
Co-58	0.00E+00	4.79E-07	8.55E-07	0.00E+00	0.00E+00	2.99E-04	9.29E-06
Co-60	0.00E+00	3.55E-06	6.12E-06	0.00E+00	0.00E+00	1.91E-03	2.60E-05
Ni-63	2.22E-04	1.25E-05	7.56E-06	0.00E+00	0.00E+00	7.43E-05	1.71E-06
Ni-65	8.08E-10	7.99E-11	4.44E-11	0.00E+00	0.00E+00	2.21E-06	2.27E-05
Cu-64	0.00E+00	5.39E-10	2.90E-10	0.00E+00	1.63E-09	2.59E-06	9.92E-06
Zn-65	1.15E-05	3.06E-05	1.90E-05	0.00E+00	1.93E-05	2.69E-04	4.41E-06
Zn-69	1.81E-11	2.61E-11	2.41E-12	0.00E+00	1.58E-11	3.84E-07	2.75E-06
Zn-69m	4.26E-09	7.28E-09	8.59E-10	0.00E+00	4.22E-09	7.36E-06	2.71E-05
Br-82	0.00E+00	0.00E+00	5.66E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-83	0.00E+00	0.00E+00	1.28E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	1.48E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	6.84E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	5.36E-05	3.09E-05	0.00E+00	0.00E+00	0.00E+00	2.16E-06
Rb-88	0.00E+00	1.52E-07	9.90E-08	0.00E+00	0.00E+00	0.00E+00	4.66E-09
Rb-89	0.00E+00	9.33E-08	7.83E-08	0.00E+00	0.00E+00	0.00E+00	5.11E-10
Sr-89	1.62E-04	0.00E+00	4.66E-06	0.00E+00	0.00E+00	5.83E-04	4.52E-05
Sr-90	2.73E-02	0.00E+00	1.74E-03	0.00E+00	0.00E+00	3.59E-03	9.28E-05
Sr-91	3.28E-08	0.00E+00	1.24E-09	0.00E+00	0.00E+00	1.44E-05	4.70E-05
Sr-92	3.54E-09	0.00E+00	1.42E-10	0.00E+00	0.00E+00	6.49E-06	6.55E-05
Y-90	1.11E-06	0.00E+00	2.99E-08	0.00E+00	0.00E+00	7.07E-05	7.24E-05
Y-91m	1.37E-10	0.00E+00	4.98E-12	0.00E+00	0.00E+00	7.60E-07	4.64E-07
Y-91	2.47E-04	0.00E+00	6.59E-06	0.00E+00	0.00E+00	7.10E-04	4.97E-05
Y-92	5.50E-09	0.00E+00	1.57E-10	0.00E+00	0.00E+00	6.46E-06	6.46E-05
Y-93	5.04E-08	0.00E+00	1.38E-09	0.00E+00	0.00E+00	2.01E-05	1.05E-04
Zr-95	5.13E-05	1.13E-05	1.00E-05	0.00E+00	1.61E-05	6.03E-04	1.65E-05
Zr-97	5.07E-08	7.34E-09	4.32E-09	0.00E+00	1.05E-08	3.06E-05	9.49E-05
Nb-95	6.35E-06	2.48E-06	1.77E-06	0.00E+00	2.33E-06	1.66E-04	1.00E-05
Nb-97	1.16E-10	2.08E-11	9.74E-12	0.00E+00	2.31E-11	9.23E-07	7.52E-06
Mo-99	0.00E+00	4.66E-08	1.15E-08	0.00E+00	1.06E-07	3.66E-05	3.42E-05
Tc-99m	4.81E-13	9.41E-13	1.56E-11	0.00E+00	1.37E-11	2.57E-07	1.30E-06
Tc-101	2.19E-14	2.30E-14	2.91E-13	0.00E+00	3.92E-13	1.58E-07	4.41E-09
Ru-103	7.55E-07	0.00E+00	2.90E-07	0.00E+00	1.90E-06	1.79E-04	1.21E-05
Ru-105	4.13E-10	0.00E+00	1.50E-10	0.00E+00	3.63E-10	4.30E-06	2.69E-05
Ru-106	3.68E-05	0.00E+00	4.57E-06	0.00E+00	4.97E-05	3.87E-03	1.16E-04
Ag-110m	4.56E-06	3.08E-06	2.47E-06	0.00E+00	5.74E-06	1.48E-03	2.71E-05
Sb-124	1.55E-05	2.00E-07	5.41E-06	3.41E-08	0.00E+00	8.76E-04	4.43E-05

Table 1.12 (6 of 8)
INHALATION DOSE FACTORS
(mrem/pCi inhaled)

CHILD

	bone	liver	t body	thyroid	kidney	lung	gi-lli
Sb-125	2.66E-05	2.05E-07	5.59E-06	2.46E-08	0.00E+00	6.27E-04	1.09E-05
Te-125m	1.82E-06	6.29E-07	2.47E-07	5.20E-07	0.00E+00	1.29E-04	9.13E-06
Te-127m	6.72E-06	2.31E-06	8.16E-07	1.64E-06	1.72E-05	4.00E-04	1.93E-05
Te-127	7.49E-10	2.57E-10	1.65E-10	5.30E-10	1.91E-09	2.71E-06	1.52E-05
Te-129m	5.19E-06	1.85E-06	8.22E-07	1.71E-06	1.36E-05	4.76E-04	4.91E-05
Te-129	2.64E-11	9.45E-12	6.44E-12	1.93E-11	6.94E-11	7.93E-07	6.89E-06
Te-131m	3.63E-08	1.60E-08	1.37E-08	2.64E-08	1.08E-07	5.56E-05	8.32E-05
Te-131	5.87E-12	2.28E-12	1.78E-12	4.59E-12	1.59E-11	5.55E-07	3.60E-07
Te-132	1.30E-07	7.36E-08	7.12E-08	8.58E-08	4.79E-07	1.02E-04	3.72E-05
I-130	2.21E-06	4.43E-06	2.28E-06	4.99E-04	6.61E-06	0.00E+00	1.38E-06
I-131	1.30E-05	1.30E-05	7.37E-06	4.39E-03	2.13E-05	0.00E+00	7.68E-07
I-132	5.72E-07	1.10E-06	5.07E-07	5.23E-05	1.69E-06	0.00E+00	8.65E-07
I-133	4.48E-06	5.49E-06	2.08E-06	1.04E-03	9.13E-06	0.00E+00	1.48E-06
I-134	3.17E-07	5.84E-07	2.69E-07	1.37E-05	8.92E-07	0.00E+00	2.58E-07
I-135	1.33E-06	2.36E-06	1.12E-06	2.14E-04	3.62E-06	0.00E+00	1.20E-06
Cs-134	1.76E-04	2.74E-04	6.07E-05	0.00E+00	8.93E-05	3.27E-05	1.04E-06
Cs-136	1.76E-05	4.62E-05	3.14E-05	0.00E+00	2.58E-05	3.93E-06	1.13E-06
Cs-137	2.45E-04	2.23E-04	3.47E-05	0.00E+00	7.63E-05	2.81E-05	9.78E-07
Cs-138	1.71E-07	2.27E-07	1.50E-07	0.00E+00	1.68E-07	1.84E-08	7.29E-08
Ba-139	4.98E-10	2.66E-13	1.45E-11	0.00E+00	2.33E-13	1.56E-06	1.56E-05
Ba-140	2.00E-05	1.75E-08	1.17E-06	0.00E+00	5.71E-09	4.71E-04	2.75E-05
Ba-141	5.29E-11	2.95E-14	1.72E-12	0.00E+00	2.56E-14	7.89E-07	7.44E-08
Ba-142	1.35E-11	9.73E-15	7.54E-13	0.00E+00	7.87E-15	4.44E-07	7.41E-10
La-140	1.74E-07	6.08E-08	2.04E-08	0.00E+00	0.00E+00	4.94E-05	6.10E-05
La-142	3.50E-10	1.11E-10	3.49E-11	0.00E+00	0.00E+00	2.35E-06	2.05E-05
Ce-141	1.06E-05	5.28E-06	7.83E-07	0.00E+00	2.31E-06	1.47E-04	1.53E-05
Ce-143	9.[illegible]9E-08	5.37E-08	7.77E-09	0.00E+00	2.26E-08	3.12E-05	3.44E-05
Ce-144	1.83E-03	5.72E-04	9.77E-05	0.00E+00	3.17E-04	3.23E-03	1.05E-04
Pr-143	4.99E-06	1.50E-06	2.47E-07	0.00E+00	8.11E-07	1.17E-04	2.63E-05
Pr-144	1.61E-11	4.99E-12	8.10E-13	0.00E+00	2.64E-12	4.23E-07	5.32E-08
Nd-147	2.92E-06	2.36E-06	1.84E-07	0.00E+00	1.30E-06	8.87E-05	2.22E-05
W-187	4.41E-09	2.61E-09	1.17E-09	0.00E+00	0.00E+00	1.11E-05	2.46E-05
Np-239	1.26E-07	9.04E-09	6.35E-09	0.00E+00	2.63E-08	1.57E-05	1.73E-05

Reference:

Regulatory Guide 1.109, Table E-9.

Dose Factors for Co-57, Zn-69m, Br-82, Nb-97, Sb-124 and Sb-125 are from NUREG-0172 Age Specific Radiation Dose Commitment Factors for a One Year Chronic Intake, November 1977, Table 8.

NOTE: The tritium dose factor for bone is assumed to be equal to the total body dose factor.

Table 1.12 (7 of 8)
INHALATION DOSE FACTORS
(mrem/pCi inhaled)

INFANT

	bone	liver	t body	thyroid	kidney	lung	gi-lli
H-3	4.62E-07	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	0.00E+00	0.00E+00	0.00E+00	1.15E-05
Cr-51	0.00E+00	0.00E+00	6.39E-08	4.11E-08	9.45E-09	9.17E-06	2.55E-07
Mn-54	0.00E+00	1.81E-05	3.56E-06	0.00E+00	3.56E-06	7.14E-04	5.04E-06
Mn-56	0.00E+00	1.10E-09	1.58E-10	0.00E+00	7.86E-10	8.95E-06	5.12E-05
Fe-55	1.41E-05	8.39E-06	2.38E-06	0.00E+00	0.00E+00	6.21E-05	7.82E-07
Fe-59	9.69E-06	1.68E-05	6.77E-06	0.00E+00	0.00E+00	7.25E-04	1.77E-05
Co-57	0.00E+00	4.65E-07	4.58E-07	0.00E+00	0.00E+00	2.71E-04	3.47E-06
Co-58	0.00E+00	8.71E-07	1.30E-06	0.00E+00	0.00E+00	5.55E-04	7.95E-06
Co-60	0.00E+00	5.73E-06	8.41E-06	0.00E+00	0.00E+00	3.22E-03	2.28E-05
Ni-63	2.42E-04	1.46E-05	8.29E-06	0.00E+00	0.00E+00	1.49E-04	1.73E-06
Ni-65	1.71E-09	2.03E-10	8.79E-11	0.00E+00	0.00E+00	5.80E-06	3.58E-05
Cu-64	0.00E+00	1.34E-09	5.53E-10	0.00E+00	2.84E-09	6.64E-06	1.07E-05
Zn-65	1.38E-05	4.47E-05	2.22E-05	0.00E+00	2.32E-05	4.62E-04	3.67E-05
Zn-69	3.85E-11	6.91E-11	5.13E-12	0.00E+00	2.87E-11	1.05E-06	9.44E-06
Zn-69m	8.98E-09	1.84E-08	1.67E-09	0.00E+00	7.45E-09	1.91E-05	2.92E-05
Br-82	0.00E+00	0.00E+00	9.49E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-83	0.00E+00	0.00E+00	2.72E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	2.86E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	1.46E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.36E-04	6.30E-05	0.00E+00	0.00E+00	0.00E+00	2.17E-06
Rb-88	0.00E+00	3.98E-07	2.05E-07	0.00E+00	0.00E+00	0.00E+00	2.42E-07
Rb-89	0.00E+00	2.29E-07	1.47E-07	0.00E+00	0.00E+00	0.00E+00	4.87E-08
Sr-89	2.84E-04	0.00E+00	8.15E-06	0.00E+00	0.00E+00	1.45E-03	4.57E-05
Sr-90	2.92E-02	0.00E+00	1.85E-03	0.00E+00	0.00E+00	8.03E-03	9.36E-05
Sr-91	6.83E-08	0.00E+00	2.47E-09	0.00E+00	0.00E+00	3.76E-05	5.24E-05
Sr-92	7.50E-09	0.00E+00	2.79E-10	0.00E+00	0.00E+00	1.70E-05	1.00E-04
Y-90	2.35E-06	0.00E+00	6.30E-08	0.00E+00	0.00E+00	1.92E-04	7.43E-05
Y-91m	2.91E-10	0.00E+00	9.90E-12	0.00E+00	0.00E+00	1.99E-06	1.68E-06
Y-91	4.20E-04	0.00E+00	1.12E-05	0.00E+00	0.00E+00	1.75E-03	5.02E-05
Y-92	1.17E-08	0.00E+00	3.29E-10	0.00E+00	0.00E+00	1.75E-05	9.04E-05
Y-93	1.07E-07	0.00E+00	2.91E-09	0.00E+00	0.00E+00	5.46E-05	1.19E-04
Zr-95	8.24E-05	1.99E-05	1.45E-05	0.00E+00	2.22E-05	1.25E-03	1.55E-05
Zr-97	1.07E-07	1.83E-08	8.36E-09	0.00E+00	1.85E-08	7.88E-05	1.00E-04
Nb-95	1.12E-05	4.59E-06	2.70E-06	0.00E+00	3.37E-06	3.42E-04	9.05E-06
Nb-97	2.44E-10	5.21E-11	1.88E-11	0.00E+00	4.07E-11	2.37E-06	1.92E-05
Mo-99	0.00E+00	1.18E-07	2.31E-08	0.00E+00	1.89E-07	9.63E-05	3.48E-05
Tc-99m	9.98E-13	2.06E-12	2.66E-11	0.00E+00	2.22E-11	5.79E-07	1.45E-06
Tc-101	4.65E-14	5.88E-04	5.80E-13	0.00E+00	6.99E-13	4.17E-07	6.03E-07
Ru-103	1.44E-06	0.00E+00	4.85E-07	0.00E+00	3.03E-06	3.94E-04	1.15E-05
Ru-105	8.74E-10	0.00E+00	2.93E-10	0.00E+00	6.42E-10	1.12E-05	3.46E-05
Ru-106	6.20E-05	0.00E+00	7.77E-06	0.00E+00	7.61E-05	8.26E-03	1.17E-04
Ag-110m	7.13E-06	5.16E-06	3.57E-06	0.00E+00	7.80E-06	2.62E-03	2.36E-05
Sb-124	2.71E-05	3.97E-07	8.56E-06	7.18E-08	0.00E+00	1.89E-03	4.22E-05

Table 1.12 (8 of 8)
INHALATION DOSE FACTORS
(mrem/pCi inhaled)

INFANT

	bone	liver	t body	thyroid	kidney	lung	gi-lli
Sb-125	3.69E-05	3.41E-07	7.78E-06	4.45E-08	0.00E+00	1.17E-03	1.05E-05
Te-125m	3.40E-06	1.42E-06	4.70E-07	1.16E-06	0.00E+00	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	0.00E+00	1.42E-06
I-131	2.71E-05	3.17E-05	1.40E-05	1.06E-02	3.70E-05	0.00E+00	7.56E-07
I-132	1.21E-06	2.53E-06	8.99E-07	1.21E-04	2.82E-06	0.00E+00	1.36E-06
I-133	9.46E-06	1.37E-05	4.00E-06	2.54E-03	1.60E-05	0.00E+00	1.54E-06
I-134	6.58E-07	1.34E-06	4.75E-07	3.18E-05	1.49E-06	0.00E+00	9.21E-07
I-135	2.76E-06	5.43E-06	1.98E-06	4.97E-04	6.05E-06	0.00E+00	1.31E-06
Cs-134	2.83E-04	5.02E-04	5.32E-05	0.00E+00	1.36E-04	5.69E-05	9.53E-07
Cs-136	3.45E-05	9.61E-05	3.78E-05	0.00E+00	4.03E-05	8.40E-06	1.02E-06
Cs-137	3.92E-04	4.37E-04	3.25E-05	0.00E+00	1.23E-04	5.09E-05	9.53E-07
Cs-138	3.61E-07	5.58E-07	2.84E-07	0.00E+00	2.93E-07	4.67E-08	6.26E-07
Ba-139	1.06E-09	7.03E-13	3.07E-11	0.00E+00	4.23E-13	4.25E-06	3.64E-05
Ba-140	4.00E-05	4.00E-08	2.07E-06	0.00E+00	9.59E-09	1.14E-03	2.74E-05
Ba-141	1.12E-10	7.70E-14	3.55E-12	0.00E+00	4.64E-14	2.12E-06	3.39E-06
Ba-142	2.84E-11	2.36E-14	1.40E-12	0.00E+00	1.36E-14	1.11E-06	4.95E-07
La-140	3.61E-07	1.43E-07	3.68E-08	0.00E+00	0.00E+00	1.20E-04	6.06E-05
La-142	7.36E-10	2.69E-10	6.46E-11	0.00E+00	0.00E+00	5.87E-06	4.25E-05
Ce-141	1.98E-05	1.19E-05	1.42E-06	0.00E+00	3.75E-06	3.69E-04	1.54E-05
Ce-143	2.09E-07	1.38E-07	1.58E-08	0.00E+00	[illegible]	8.30E-05	3.55E-05
Ce-144	2.28E-03	8.65E-04	1.26E-04	0.00E+00	3.84E-04	7.03E-03	1.06E-04
Pr-143	1.00E-05	3.74E-06	4.99E-07	0.00E+00	1.41E-06	3.09E-04	2.66E-05
Pr-144	3.42E-11	1.32E-11	1.72E-12	0.00E+00	4.80E-12	1.15E-06	3.06E-06
Nd-147	5.67E-06	5.81E-06	3.57E-07	0.00E+00	2.25E-06	2.30E-04	2.23E-05
W-187	9.26E-09	6.44E-09	2.23E-09	0.00E+00	0.00E+00	2.83E-05	2.54E-05
Np-239	2.65E-07	2.37E-08	1.34E-08	0.00E+00	4.73E-08	4.25E-05	1.78E-05

Reference:

Regulatory Guide 1.109, Table E-10.

Dose Factors for Co-57, Zn-69m, Br-82, Nb-97, Sb-124 and Sb-125 are from NUREG-0172 Age Specific Radiation Dose Commitment Factors for a One Year Chronic Intake, November 1977, Table 8.

NOTE: The tritium dose factor for bone is assumed to be equal to the total body dose factor.

Table 1.13 (1 of 2)
EXTERNAL DOSE FACTORS FOR STANDING ON CONTAMINATED GROUND
(mrem/h per pCi/m^2)

Nuclide	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-57	1.77E-09	2.21E-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
Zn-69m	5.50E-09	6.59E-09
Br-82	3.18E-08	3.90E-08
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	5.30E-09
Zr-97	5.50E-09	6.40E-09
Nb-95	5.10E-09	6.00E-09
Nb-97	8.11E-09	1.00E-08
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
Sb-124	2.17E-08	2.57E-08

Table 1.13 (2 of 2)
EXTERNAL DOSE FACTORS FOR STANDING ON CONTAMINATED GROUND
(mrem/h per pCi/m^2)

Nuclide	Total Body	Skin
Sb-125	5.48E-09	6.80E-09
Te-125m	3.50E-11	4.80E-11
Te-127m	1.10E-12	1.30E-12
Te-127	1.00E-11	1.10E-11
Te-129m	7.70E-10	9.00E-10
Te-129	7.10E-10	8.40E-10
Te-131m	8.40E-09	9.90E-09
Te-131	2.20E-09	2.60E-06
Te-132	1.70E-09	2.00E-09
I-130	1.40E-08	1.70E-08
I-131	2.80E-09	3.40E-09
I-132	1.70E-08	2.00E-08
I-133	3.70E-09	4.50E-09
I-134	1.60E-08	1.90E-08
I-135	1.20E-08	1.40E-08
Cs-134	1.20E-08	1.40E-08
Cs-136	1.50E-08	1.70E-08
Cs-137	4.20E-09	4.90E-09
Cs-138	2.10E-08	2.40E-08
Ba-139	2.40E-09	2.70E-09
Ba-140	2.10E-09	2.40E-09
Ba-141	4.30E-09	4.90E-09
Ba-142	7.90E-09	9.00E-09
La-140	1.50E-08	1.70E-08
La-142	1.50E-08	1.80E-08
Ce-141	5.50E-10	6.20E-10
Ce-143	2.20E-09	2.50E-09
Ce-144	3.20E-10	3.70E-10
Pr-143	0.0	0.0
Pr-144	2.00E-10	2.30E-10
Nd-147	1.00E-09	1.20E-09
W-187	3.10E-09	3.60E-09
Np-239	9.50E-10	1.10E-09

References:

Regulatory Guide 1.109, Table E-6.

Dose Factors for Co-57, Zn-69m, Br-82, Nb-97, Sb-124 and Sb-125 are from Dose-Rate Conversion Factors for External Exposure to Photon and Electron Radiation from Radionuclides Occurring in Routine Releases from Nuclear Fuel Cycle Facilities, D. C. Kocher, Health Physics Volume 38, April 1980.

Table 2.1 (Page 1 of 4)
RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

Liquid Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) (μCi/ml)[a]
A. Batch Waste Release Tanks[d] 1. Waste Condensate Tanks (3)	P Each Batch	P Each Batch	Principal Gamma Emitters[f]	$5x10^{-7}$
			I-131	$1X10^{-6}$
2. Cask Decontamination Tank	P One Batch/M	M	Dissolved/ Entrained Gases (Gamma Emitters)	$1x10^{-5}$
3. Laundry Tanks (2) 4. Chemical Drain Tank 5. Monitor Tank 6. Distillate Tanks (2)	P Each Batch	M Composite[b]	H-3	$1x10^{-5}$
			Gross Alpha	$1x10^{-7}$
7. Condensate Demineralizer Waste Evaporator Blowdown Tank (1)	P Each Batch	Q Composite[b]	Sr-89, Sr-90	$5x10^{-8}$
			Fe-55	$1x10^{-6}$
B. Continuous Releases[e] 1. Steam Generator[h] Blowdown	D Grab Sample	W Composite[c]	Principal Gamma Emitters[f]	$5x10^{-7}$
			I-131	$1x10^{-6}$
2. Turbine Building[h] Sump	M Grab Sample	M	Dissolved/ Entrained Gases (Gamma Emitters)	$1x10^{-5}$
	D Grab Sample	M Composite[c]	H-3	$1x10^{-5}$
			Gross Alpha	$1x10^{-7}$
	D Grab Sample	Q Composite[c]	Sr-89, Sr-90	$5x10^{-8}$
			Fe-55	$1x10^{-6}$

Table 2.1 (Page 2 of 4)
RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

Liquid Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) (μCi/ml)[a]
C. Periodic Continuous Releases[e,h]	Continuous[g]	W Composite[c]	Principal Gamma Emitters[f]	5×10^{-7}
			I-131	1×10^{-6}
1. Non-Reclaimable Waste Tank 2. High Crud Tanks (2)	M[g] Grab Sample	M	Dissolved and Entrained Gases (Gamma Emitters)	1×10^{-5}
3. Neutralizer Tank	Continuous[g]	M Composite[c]	H-3	1×10^{-5}
			Gross Alpha	1×10^{-7}
	Continuous[g]	Q Composite[c]	Sr-89, Sr-90	5×10^{-8}
			Fe-55	1×10^{-6}

Table 2.1 (Page 3 of 4)
RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM
TABLE NOTATION

P = Completed prior to each release
Q = At least once per 92 days
D = At least once per 24 hours
N.A. = Not Applicable
M = At least once per 31 days

a The LLD is defined for the purpose 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% probability with only a 5% probability of falsely concluding that a blank observation represents a "real" signal.

For a particular measurement system (which may include radiochemical separation): R24

$$LLD = \frac{4.66 s_b}{E \quad V \quad 2.22\times10^6 \quad Y \quad \exp(-\lambda\Delta t)}$$

Where:

LLD is the "a priori" lower limit of detection as defined above in microcurie per unit mass or volume,
s_b is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute),
E is the counting efficiency as counts per disintegration,
V is the sample size in units of mass or volume,
2.22×10^6 is the number of disintegrations per minute per microcurie,
Y is the fractional radiochemical yield (when applicable),
λ is the radioactive decay constant for the particular radionuclide, and
Δt from plant effluents is the elapsed time between midpoint of sample collection and time of counting (midpoint).

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 an a posteriori (after the fact) limit for a particulate measurement.

b 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 which is representative of the liquids released.

Table 2.1 (Page 4 of 4)
RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM
TABLE NOTATION

c Prior to analyses, all samples taken for the composite shall be throughly mixed in order for the composite sample to be representative of the effluent release.

d 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 the method described in Section 2.3.2, to assure representative sampling.

e A continuous release is the discharge of liquid wastes of a nondiscrete volume; e.g., from a volume of system that has an input flow during the continuous release.

f The principal gamma emitters for which the LLD specification applies exclusively are the following radionuclides: Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, Ce-141. Ce-144 shall also be measured with an LLD of 5×10^{-6}. This list does not mean that only these nuclides are to be detected and reported. Other peaks which are measurable and identifiable, together with the above nuclides, shall also be identified and reported.

g Releases from these tanks are continuously composited during releases. With the composite sampler or the sampler flow monitor inoperable, the sampling frequency shall be changed to require representative batch samples from each tank to be released to be taken prior to release and manually composite for these analyses.

h Applicable only during periods of primary to secondary leakage or the release of radioactivity as detected by the effluent radiation monitor provided the radiation monitor setpoint is at a LLD of $\leq 1 \times 10^{-6}$ µCi/ml and allowing for background radiation during periods when primary to secondary leakage is not occurring.

Table 2.2 (Page 1 of 3)
RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

Instrument	Minimum Channels OPERABLE	Action
1. GROSS RADIOACTIVITY MONITORS PROVIDING AUTOMATIC TERMINATION OF RELEASE		
a. Liquid Radwaste Effluent Line	1	30
b. Steam Generator Blowdown Effluent Line	1	31
c. Condensate Demineralizer Effluent Line	1	30
2. GROSS RADIOACTIVITY MONITORS NOT PROVIDING AUTOMATIC TERMINATION OF RELEASE		
a. Essential Raw Cooling Water Effluent Header**	1	32
b. Turbine Building Sump Effluent Line	1	32
3. FLOW RATE MEASUREMENT DEVICES		
a. Liquid Radwaste Effluent Line	1	33
b. Condensate Demineralizer Effluent Line	1	33
c. Steam Generator Blowdown Effluent Line	1	33
d. Cooling Tower Blowdown Effluent Line	1	33
4. TANK LEVEL INDICATING DEVICES		
a. Condensate Storage Tank	1	34
b. Steam Generator Layup Tank*	1	34
5. CONTINUOUS COMPOSITE SAMPLER AND SAMPLE FLOW MONITOR		
a. Condensate Demineralizer Regenerant Effluent Line	1	35

*Required when connected to the secondary system
** Requires minimum of 1 Channel/Header to be OPERABLE.

Table 2.2 (Page 2 of 3)
RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION
TABLE NOTATION

ACTION 30 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases may continue provided that prior to initiating a release:

a. At least two independent samples are analyzed in accordance with Section 2.3.2, and

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 31 - 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 gross radioactivity gamma at a limit of detection of at least 10^{-7} microcuries/gram:

a. At least once per 12 hours when the specific activity of the secondary coolant is greater than or equal to 0.01 microcuries/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 microcuries/gram DOSE EQUIVALENT I-131.

ACTION 32 - 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 gross radioactivity gamma at a limit of detection of at least 10^{-7} microcuries/ml.

ACTION 33 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continued provided the flow rate is estimated at least once per 4 hours during actual releases. Pump curves may be used to estimate flow.

Table 2.2 (Page 3 of 3)
RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION
TABLE NOTATION

ACTION 34 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, liquid additions to this tank may continued provided the tank liquid level is estimated during all liquid additions to the tank.

ACTION 35 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided representative batch samples of each tank to be released are taken prior to release and composited for analysis according to Table 2.1, footnote g.

Table 2.3 (Page 1 of 2)
RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION
SURVEILLANCE REQUIREMENTS

Instrument	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	CHANNEL FUNCTIONAL TEST
1. GROSS BETA OR GAMMA RADIOACTIVITY MONITORS PROVIDING ALARM AND AUTOMATIC TERMINATION OF RELEASE				
a. Liquid Radwaste Effluents Line	D	P	R(3)	Q(1)
b. Steam Generator Blowdown Effluent Line	D	M	R(3)	Q(5)
c. Condensate Demineralizer Effluent Line	D	M	R(3)	Q(5)
2. GROSS BETA OR GAMMA RADIOACTIVITY MONITORS PROVIDING ALARM BUT NOT PROVIDING AUTOMATIC TERMINATION OF RELEASE				
a. Essential Raw Cooling Water Effluent Line	D	M	R(3)	Q(2)
b. Turbine Building Sump Effluent Line	D	M	R(3)	Q(2)
3. FLOW RATE MEASUREMENT DEVICES				
a. Liquid Radwaste Effluent Line	D(4)	N.A.	R	Q
b. Steam Generator Blowdown Effluent Line	D(4)	N.A.	R	Q
c. Condensate Demineralizer Effluent Line	D(4)	N.A.	R	Q
d. Cooling Tower Blowdown Effluent Line	D(4)	N.A.	R	Q
4. TANK LEVEL INDICATING DEVICES				
a. Condensate Storage Tank	D*	N.A.	R	Q
b. Steam Generator Layup Tank	D*	N.A.	R	N.A.
5. CONTINUOUS COMPOSITE SAMPLER AND SAMPLE FLOW MONITOR				
a. Condensate Demineralizer Regenerant Effluent Line	P	N.A.	R	N.A.

Table 2.3 (Page 2 of 2)
RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION
SURVEILLANCE REQUIREMENTS
TABLE NOTATION

P = Completed prior to each release R = At least once per 18 months
Q = At least once per 92 days D = At least once per 24 hours
N.A. = Not Applicable M = At least once per 31 days
* During liquid additions to the tank.

(1) The CHANNEL FUNCTIONAL TEST shall also demonstrate that automatic isolation of this pathway and control room alarm annunciation occurs if any of the following conditions exists:
   1. Instrument indicates measured levels above the alarm/trip setpoint.
   2. Circuit failure.
   3. Downscale failure.

(2) The CHANNEL FUNCTIONAL TEST shall also demonstrate that control room alarm annunciation occurs if any of the following conditions exists:
   1. Instrument indicates measured levels above the alarm setpoint.
   2. Circuit failure.
   3. Downscale failure.

(3) The initial CHANNEL CALIBRATION shall be performed using one or more of the reference standards certified by the National Bureau of Standards 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 on which continuous periodic, or batch releases are made.

(5) The CHANNEL FUNCTIONAL TEST shall also demonstrate that automatic isolation of this pathway and control room alarm annunciation occurs if any of the following conditions occur:
   1. Instrument indicates measured levels above the alarm/trip setpoint.
   2. Circuit failure.

   The CHANNEL FUNCTIONAL TEST shall also demonstrate that control room annunciation occurs if the following condition occurs:
   1. Downscale failure.

Table 2.4
RECEPTORS FOR LIQUID DOSE CALCULATIONS

Tennessee River Reaches Within 50 Mile Radius Downstream of SQN

Name	Beginning TRM	Ending TRM	Size (acres)	Recreation visits/year
Chickamauga Lake below SQN	484.0	471.0	9939	5,226,700
Nickajack Lake (Part 1)	471.0	435.0	5604	240,700
Nickajack Lake (Part 2)	435.0	425.0	5326	607,600
Guntersville Lake	425.0	400.0	6766	104,000

Public Water Supplies Within 50 Mile Radius Downstream of SQN

Name	TRM	Population
E. I. DuPont	469.9	1,400
Chattanooga, TN	465.3	224,000
South Pittsburg, TN	418.0	4,898
Bridgeport, AL	413.6	4,650

Table 2.5
BIOACCUMULATION FACTORS FOR FRESHWATER FISH

H-3	9.0E-01	Tc-99m	1.5E+01
C-14	4.6E+03	Tc-101	1.5E+01
Na-24	1.0E+02	Ru-103	1.0E+01
P-32	1.0E+05	Ru-105	1.0E+01
Cr-51	2.0E+02	Ru-106	1.0E+01
Mn-54	4.0E+02	Ag-110m	0.0E+00
Mn-56	4.0E+02	Sb-124	1.0E+00
Fe-55	1.0E+02	Sb-125	1.0E+00
Fe-59	1.0E+02	Te-125m	4.0E+02
Co-57	5.0E+01	Te-127m	4.0E+02
Co-58	5.0E+01	Te-127	4.0E+02
Co-60	5.0E+01	Te-129m	4.0E+02
Ni-63	1.0E+02	Te-129	4.0E+02
Ni-65	1.0E+02	Te-131m	4.0E+02
Cu-64	5.0E+01	Te-131	4.0E+02
Zn-65	2.0E+03	Te-132	4.0E+02
Zn-69	2.0E+03	I-130	4.0E+01
Zn-69m	2.0E+03	I-131	4.0E+01
Br-82	4.2E+02	I-132	4.0E+01
Br-83	4.2E+02	I-133	4.0E+01
Br-84	4.2E+02	I-134	4.0E+01
Br-85	4.2E+02	I-135	4.0E+01
Rb-86	2.0E+03	Cs-134	1.9E+03
Rb-88	2.0E+03	Cs-136	1.9E+03
Rb-89	2.0E+03	Cs-137	1.9E+03
Sr-89	5.6E+01	Cs-138	1.9E+03
Sr-90	5.6E+01	Ba-139	4.0E+00
Sr-91	5.6E+01	Ba-140	4.0E+00
Sr-92	5.6E+01	Ba-141	4.0E+00
Y-90	2.5E+01	Ba-142	4.0E+00
Y-91m	2.5E+01	La-140	2.5E+01
Y-91	2.5E+01	La-142	2.5E+01
Y-92	2.5E+01	Ce-141	1.0E+00
Y-93	2.5E+01	Ce-143	1.0E+00
Zr-95	3.3E+00	Ce-144	1.0E+00
Zr-97	3.3E+00	Pr-143	2.5E+01
Nb-95	3.0E+04	Pr-144	2.5E+01
Nb-97	3.0E+04	Nd-147	2.5E+01
Mo-99	1.0E+01	W-187	1.2E+03
		Np-239	1.0E+01

References:

Bioaccumulation factors for Sb- nuclides are from ORNL-4992, "A Methodology for Calculating Radiation Doses from Radioactivity Released to the Environment, March 1976, Table 4.12A.

Bioaccumulation factors for Iodine, Cesium, and Strontium nuclides are from NUREG/CR-1004, Table 3.2.4.

All other nuclides' bioaccumulation factors are from Regulatory Guide 1.109, Table A-1.

Table 3.1 (Page 1 of 3)
MINIMUM REQUIRED RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Number of Samples and Sample Locations**	Sampling and Collection Frequency	Type and Frequency of Analysis
1. AIRBORNE			
Radioiodine and Particulates	minimum of 5 locations	Continuous operation of sampler with sample collection as required by dust loading but at least once per 7 days.	Radioiodine canister: Analyze at least once per 7 days for I-131. Particulate sampler: Analyze for gross beta radioactivity ≥ 24 hours following filter change. Perform gamma isotopic analysis on each sample when gross beta activity is > 10 times the yearly mean of control samples. Perform gamma isotopic analysis on composite (by location) sample at least once per 92 days.
2. DIRECT RADIATION	35 to 40 locations with ≥ 2 dosimeters for continuously measuring and recording dose rate at each location.	At least once per 92 days.	Gamma Dose. At least once per 92 days.

** Sample locations are given in Table 3.4.

Table 3.1 (Page 2 of 3)
MINIMUM REQUIRED RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Number of Samples and Sample Locations**	Sampling and Collection Frequency	Type and Frequency of Analysis
3. WATERBORNE			
a. Surface	3 locations	Composite* sample collected over a period of ≤ 31 days.	Gamma isotopic analysis of each composite sample. Tritium analysis of composite sample at least once per 92 days.
b. Ground	2 locations	At least once per 92 days.	Gamma isotopic and tritium analyses of each sample.
c. Drinking	Minimum of 1 location	Composite* sample collected over a period of ≤ 31 days.	Gross beta and gamma isotopic analysis of each composite sample.
	2 locations	Monthly single sample.	Tritium analysis of composite sample at least once per 92 days.
d. Sediment from Shoreline locations	Minimum of 2 locations.	At least once per 184 days	Gamma isotopic analysis of each sample.

* Composite samples shall be collected by collecting an aliquot at intervals not exceeding 2 hours.
** Sample locations are given In Table 3.4.

Table 3.1 (Page 3 of 3)
MINIMUM REQUIRED RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Number of Samples and Sample Locations**	Sampling and Collection Frequency	Type and Frequency of Analysis
4. INGESTION			
a. Milk	3 locations Samples of broad leaf vegetation at offsite location of highest D/Q if milk sample is not available.	At least once per 15 days when animals are on pasture; at least once per 31 days at other times.	Gamma isotopic and I-131 analysis of each sample.
b. Fish and Invertebrates	3 locations	One sample in season, or at least once per 184 days if not seasonal. One sample of each of the following species: 1. Channel Catfish 2. White Crappie 3. Smallmouth Buffalo	Gamma isotopic analysis on edible portions.
c. Food Products	Minimum of 2 locations	At time of harvest. One sample of each of the following classes of food products. 1. Lettuce and/or cabbage 2. Corn 3. Beans 4. Tomatoes	Gamma isotopic analysis on edible portion.

** Sample locations are given in Table 3.4.

Table 3.2 (Page 1 of 2)
MAXIMUM VALUES FOR THE LOWER LIMITS OF DETECTION (LLD)[a,b]

Analysis	Water (pCi/L)	Airborne Particulate or Gases (pCi/m^3)	Fish (pCi/Kg,wet)	Milk (pCi/L)	Food Products (pCi/Kg,wet)	Sediment (pCi/Kg,dry)
gross beta	4	$1x10^{-2}$	N.A.	N.A	N.A.	N.A.
H-3	2000*	N.A	N.A	N.A	N.A.	N.A.
Mn-54	15	N.A.	130	N.A.	N.A.	N.A.
Fe-59	30	N.A.	260	N.A.	N.A.	N.A.
Co-58,60	15	N.A.	130	N.A.	N.A.	N.A.
Zn-65	30	N.A.	260	N.A.	N.A.	N.A.
Zr-95	30	N.A.	N.A.	N.A.	N.A.	N.A.
Nb-95	15	N.A.	N.A.	N.A.	N.A.	N.A.
I-131	1**	$7x10^{-2}$	N.A.	1	60	N.A.
Cs-134	15	$5x10^{-2}$	130	15	60	150
Cs-137	18	$6x10^{-2}$	150	18	80	180
Ba-140	60	N.A.	N.A.	60	N.A.	N.A.
La-140	15	N.A.	N.A.	15	N.A.	N.A.

* If no drinking water pathway exists, a value of 3000 pCi/L may be used.
** If no drinking water pathway exists, a value of 15 pCi/L may be used.

Table 3.2 (Page 2 of 2)
MAXIMUM VALUES FOR THE LOWER LIMITS OF DETECTION (LLD)[a,b]
TABLE NOTATION

a The LLD is defined, for the purpose 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% probability with only a 5% probability of falsely concluding that a blank observation represents a "real" signal.

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

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

Where:

LLD is the "a priori" lower limit of detection as defined above in picocurie per unit mass or volume,
s_b is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute),
E is the counting efficiency as counts per disintegration,
V is the sample size in units of mass or volume,
2.22 is the number of disintegrations per minute per picocurie,
Y is the fractional radiochemical yield (when applicable),
λ is the radioactive decay constant for the particular radionuclide, and
Δt for environmental samples is the elapsed time between sample collection (or end of the sample collection period) and time of counting.

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 an a posteriori (after the fact) limit for a particular measurement. Analysis will be performed in such a manner that the stated LLDs will be achieved under routine conditions.

b Other peaks which are measurable and identifiable, together with the radionuclides in Table 3.2, shall be identified and reported.

Table 3.3
REPORTING LEVELS FOR RADIOACTIVITY CONCENTRATIONS IN ENVIRONMENTAL SAMPLES

Analysis	Water (pCi/L)	Airborne Particulate or gases (pCi/m^3)	Fish (pCi/Kg, wet)	Milk (pCi/L)	Food Products (pCi/Kg, wet)
H-3	2×10^4 (a)	N.A	N.A	N.A.	N.A.
Mn-54	1×10^3	N.A.	3×10^4	N.A.	N.A.
Fe-59	4×10^2	N.A.	1×10^4	N.A.	N.A.
Co-58	1×10^3	N.A.	3×10^4	N.A.	N.A.
Co-60	3×10^2	N.A.	1×10^4	N.A.	N.A.
Zn-65	3×10^2	N.A.	2×10^4	N.A.	N.A.
Zr-Nb-95	4×10^2	N.A.	N.A.	N.A.	N.A.
I-131	2 (b)	0.9	N.A.	3	1×10^2
Cs-134	30	10	1×10^3	60	1×10^3
Cs-137	50	20	2×10^3	70	2×10^3
Ba-La-140	2×10^2	N.A.	N.A.	3×10^2	N.A.

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

(b) If no drinking water pathway exists, a value of 20 pCi/L may be used.

Table 3.4 (Sheet 1 of 4)
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Sample Locations*	Sampling and Collection Frequency	Type and Frequency of Analysis
AIRBORNE			
Particulates	4 samples from locations (in different sectors) at or near the site boundary (LM-2,3,4,and 5) 4 samples from communities approximately 6-10 miles distance from the plant. (PM-2,3,8,and 9) 4 samples from control locations greater than 10 miles from the plant (RM-1,2,3,and 4)	Continuous sampler operation with sample collection once per 7 days (more frequently if required by dust loading)	Analyze for gross beta radioactivity ≥ 24 hours following filter change. Perform gamma isotopic analysis on each sample if gross beta > 10 times yearly mean of control sample. Composite at least once per 31 days (by location for gamma scan).
Radioiodine	Samples from same location as air particulates.	Continuous sampler operation with filter collection once per 7 days	I-131 at least once per 7 days
Soil	Samples from same locations as air particulates	Once per year	Gamma scan, Sr-89, Sr-90 once per year
DIRECT RADIATION	2 or more dosimeters placed at locations (in different sectors at or near the site boundary in each of the 16 sectors. 2 or more dosimeters placed at stations located >5 miles from the plant in each of the 16 sectors	Once per 92 days	Gamma dose at least once per 92 days

* Sample locations are listed in Tables 3.5 and 3.6 and shown on Figures 3.1, 3.2 and 3.3

Table 3.4 (Sheet 2 of 4)
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Sample Locations*	Sampling and Collection Frequency	Type and Frequency of Analysis
DIRECT RADIATION (continued)	2 or more dosimeters in at least 8 additional locations of special interest.		
WATERBORNE			
Surface	TRM 497.0 TRM 483.4 TRM 473.2	Collected by automatic sequential-type sampler** with composite samples collected at least once per 31 days	Gamma scan of each composite sample. Composite for H-3 analysis at least once per 92 days
Ground	1 sample adjacent to plant (location W-6)	At least once per 92 days	Gross beta and gamma scan, Sr-89 Sr-90 and H-3 an-analysis at least once per 92 days
	1 sample from ground water source up-gradient		
Drinking	1 sample at the first potable surface water supply downstream from the plant (TRM 473.0)	Collected by automatic sequential type sampler** with composite sample collected at least once per 31 days	Gross beta and gamma scan of each composite sample. Composite for H-3 Sr-89, Sr-90 at least once per 92 days.
	1 sample at the next 2 downstream potable surface water suppliers (greater than 10 miles downstream) (TRM 470.5 and 465.3)	Grab sample once per 31 days	
	2 samples at control locations (TRM 497.0 and 503.8)***	Samples collected by automatic sequential type sampler with composite sample collected at least once per 31 days.	

* Sample locations are listed in Tables 3.5 and 3.6 and shown on Figures 3.1, 3.2 and 3.3

** Samples shall be collected by collecting an aliquot at intervals not exceeding 2 hours.

*** The surface water sample collected at TRM 497.0 is considered a control for the raw drinking water sample.

Table 3.4 (Sheet 3 of 4)
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Sample Locations*	Sampling and Collection Frequency	Type and Frequency of Analysis
WATERBORNE (continued)			
Sediment	TRM 496.5, TRM 483.4 TRM 480.8, TRM 472.8	At least once per 184 days	Gamma scan of each sample.
Shoreline	TRM 485, TRM 478 TRM 477	At least once per 184 days	Gamma scan of each sample.
INGESTION			
Milk	1 sample from milk producing animals in each of 1-3 areas indicated by the cow census where doses are calculated to be highest. If samples are not available from a milk animal location, doses to that area will be estimated by projecting the doses from concentrations detected in milk from other sectors or samples of vegetation will be taken monthly where milk is not available (Table 3.1, 4d) At least 1 sample from a control location	At least once per 15 days	Gamma isotopic and I-131 analysis of each sample. Sr-89 Sr-90 once per quarter
Fish	1 sample each from Nickajack, Chickamauga, and Watts Bar Reservoirs	At least once per 184 days. One sample of each of the following species: Channel Catfish, Crappie, Smallmouth Buffalo	Gamma scan on edible portion

* Sample locations are listed in Tables 3.5 and 3.6 and shown on Figures 3.1, 3.2 and 3.3

Table 3.4 (Sheet 4 of 4)
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Sample Locations*	Sampling and Collection Frequency	Type and Frequency of Analysis
INGESTION (continued)			
Invertebrates (Asiatic Clams)	2 samples downstream from plant discharge** 1 sample upstream from the plant**	At least once per 184 days	Gamma scan on edible portion
Food Products	1 sample each of principal food products grown at private gardens and/or farms in the immediate vicinity of the plant	At least once per 365 days at time of harvest. The types of foods available for sampling will vary. Following is a list of typical foods which may be available: Cabbage and/or Lettuce Corn Green Beans Potatoes Tomatoes	Gamma scan on edible portion
Vegetation	Samples from farms producing milk but not providing a milk sample (Farm Em)	At least once per 31 days	I-131 and gamma scan at least once per 31 days. Sr-89, Sr-90 analysis at least once per 92 days.

* Sample locations are listed in Tables 3.5 and 3.6 and shown on Figures 3.1, 3.2 and 3.3

** No permanent stations established. Locations depend on availability of clams.

Table 3.5 (1 of 2)
ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM SAMPLING LOCATIONS

Map Location Number [a]	Station	Sector	Approximate Distance (Miles)	Indicator (I) or Control (C)	Samples Collected [b]
2	LM-2	N	0.8	I	AP, CF, S
3	LM-3	SSW	1.2	I	AP, CF, S
4	LM-4	NE	1.5	I	AP, CF, S
5	LM-5	NNE	1.8	I	AP, CF, S
7	PM-2	SW	3.8	I	AP, CF, S
8	PM-3	W	5.6	I	AP, CF, S
9	PM-8	SSW	8.7	I	AP, CF, S
10	PM-9	WSW	2.6	I	AP, CF, S
11	RM-1	SW	16.7	C	AP, CF, S
12	RM-2	NNE	17.8	C	AP, CF, S
13	RM-3	ESE	11.3	C	AP, CF, S
14	RM-4	WNW	18.9	C	AP, CF, S
15	Farm B	NE	43.0	C	M
16	Farm C	NE	16.0	C	M
17	Farm S	NNE	12.0	C	M
18	Farm J	WNW	1.1	I	M
19	Farm HW	NW	1.2	I	M, W[c]
20	Farm EM	N	2.6	I	V
24	Well No. 6	NNE	0.15	I	W
31	TRM[d] 473.0 (C. F. Industries)	--	11.5[e]	I	PW
32	TRM 470.5 (E. I. DuPont)	--	14.0[e]	I	PW
33	TRM 465.3 (Chattanooga)	--	19.2[e]	I	PW
34	TRM 497.0	--	12.5[e]	C[f]	SW
35	TRM 503.8 (Dayton)	--	19.3[e]	C	PW
36	TRM 496.5	--	12.0[e]	C	SD
37	TRM 485.0	--	0.5[e]	C	SS
38	TRM 483.4	--	1.1[e]	I	SD, SW
39	TRM 480.8	--	3.7[e]	I	SD
40	TRM 477.0	--	7.5[e]	I	SS
41	TRM 473.2	--	11.3[e]	I	SW
42	TRM 472.8	--	11.7[e]	I	SD
44	TRM 478.8	--	6.5[e]	I	SS

Table 3.5 (2 of 2)
ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM SAMPLING LOCATIONS

Map Location Number [a]	Station	Sector	Approximate Distance (Miles)	Indicator (I) or Control (C)	Samples Collected [b]
45	TRM 425-471 (Nickajack) Reservoir)	--	--	I	F
46	TRM 471-530 (Chickamauga Reservoir)	--	--	I	F, CL
47	TRM 530-602 (Watts Bar Reservoir)	--	--	C	F
48	Farm H	NE	4.2	I	M

[a] See figures 3.1, 3.2, and 3.3

[b] Sample Codes

AP = Air particulate filter
CF = Charcoal filter
CL = Clams
F = Fish
M = Milk
PW = Public water
R = Rainwater
S = Soil
SD = Sediment
SS = Shoreline sediment
SW = Surface water
V = Vegetation
W = Well water

[c] A control for well water.

[d] TRM = Tennessee River Mile.

[e] Distance from plant discharge (TRM 484.5)

[f] Surface water sample also used as a control for public water.

Table 3.6 (1 of 2)
THERMOLUMINESCENT DOSIMETRY LOCATIONS

Map Location Number	Station	Sector	Approximate Distance (Miles)	Onsite (On)[a] or Offsite (Off)
3	SSW-1A	SSW	1.2	On
4	NE-1A	NE	1.5	On
5	NNE-1	NNE	1.8	On
7	SW-2	SW	3.8	Off
8	W-3	W	5.6	Off
9	SSW-3	SSW	8.7	Off
10	WSW-2A	WSW	2.6	Off
11	SW-3	SW	16.7	Off
12	NNE-4	NNE	17.8	Off
13	ESE-3	ESE	11.3	Off
14	WNW-3	WNW	18.9	Off
49	N-1	N	0.6	On
50	N-2	N	2.1	Off
51	N-3	N	5.2	Off
52	N-4	N	10.0	Off
53	NNE-2	NNE	4.5	Off
54	NNE-3	NNE	12.1	Off
55	NE-1	NE	2.4	Off
56	NE-2	NE	4.1	Off
57	ENE-1	ENE	0.4	On
58	ENE-2	ENE	5.1	Off
59	E-1	E	1.2	On
60	E-2	E	5.2	Off
61	ESE-A	ESE	0.4	On
62	ESE-1	ESE	1.2	On
63	ESE-2	ESE	4.9	Off
64	SE-A	SE	0.4	On
65	SE-B	SE	0.4	On
66	SE-1	SE	1.4	On
67	SE-2	SE	1.9	On
68	SE-4	SE	5.2	Off
69	SSE-1	SSE	1.6	On
70	SSE-2	SSE	4.6	Off
71	S-1	S	1.5	On
72	S-2	S	4.7	Off
73	SSW-1	SSW	0.6	On
74	SSW-2	SSW	4.0	Off
75	SW-1	SW	0.9	On
76	WSW-1	WSW	0.9	On

Table 3.6 (2 of 2)
THERMOLUMINESCENT DOSIMETRY LOCATIONS

Map Location Number	Station	Sector	Approximate Distance (Miles)	Onsite (On)[a] or Offsite (Off)
77	WSW-2	WSW	2.5	Off
78	WSW-3	WSW	5.7	Off
79	WSW-4	WSW	7.8	Off
80	WSW-5	WSW	10.1	Off
81	W-1	W	0.8	On
82	W-2	W	4.3	Off
83	WNW-1	WNW	0.4	On
84	WNW-2	WNW	5.3	Off
85	NW-1	NW	0.4	On
86	NW-2	NW	5.2	Off
87	NNW-1	NNW	0.6	On
88	NNW-2	NNW	1.7	On
89	NNW-3	NNW	5.3	Off

a. TLDs designated onsite are those located two miles or less from the plant. TLDs designated offsite are those located more than two miles from the plant.

Figure 1.1
GASEOUS EFFLUENT RELEASE POINTS

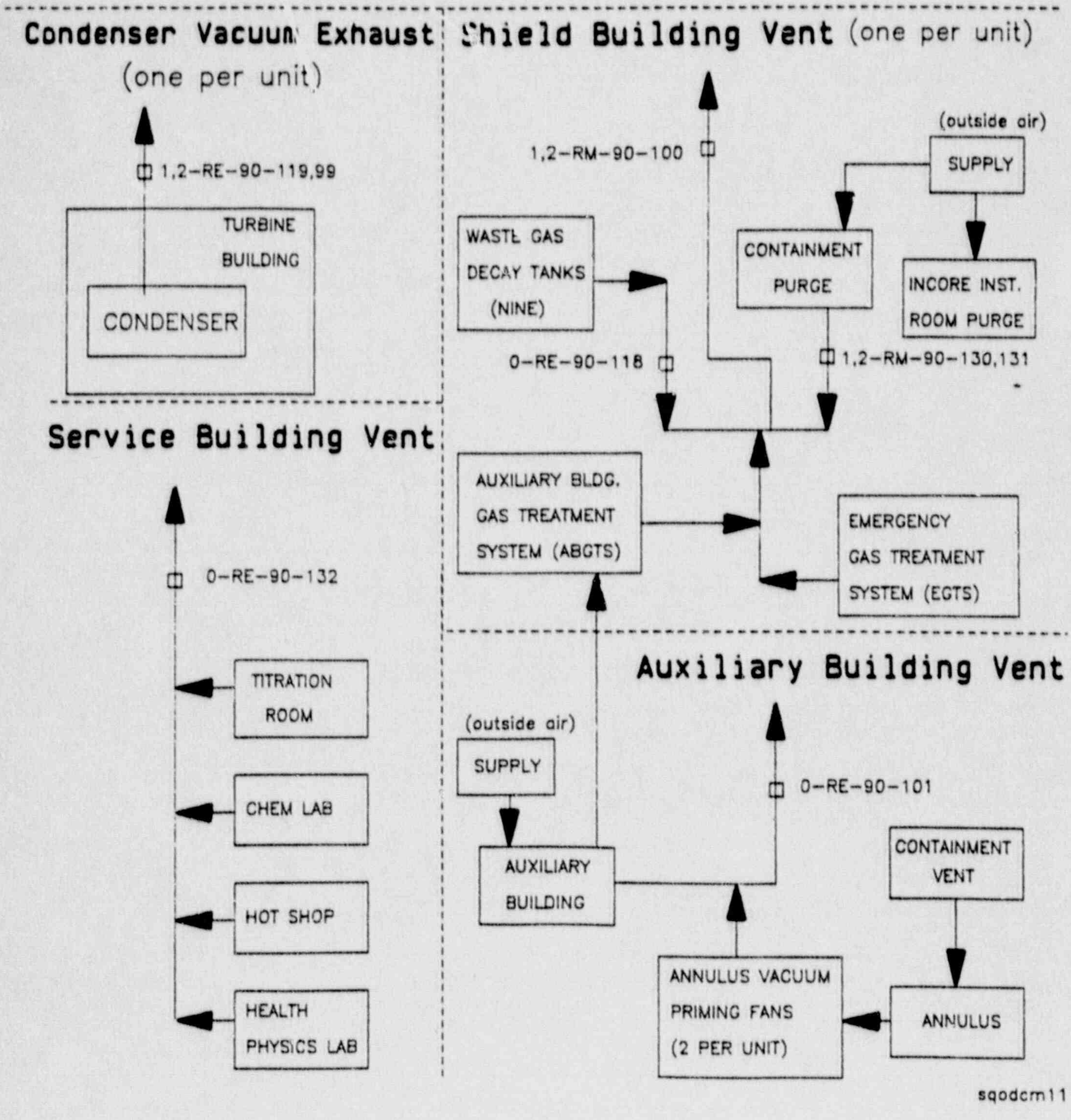

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Figure 1.2
AUXILIARY AND SHIELD BUILDING VENTS (DETAIL)

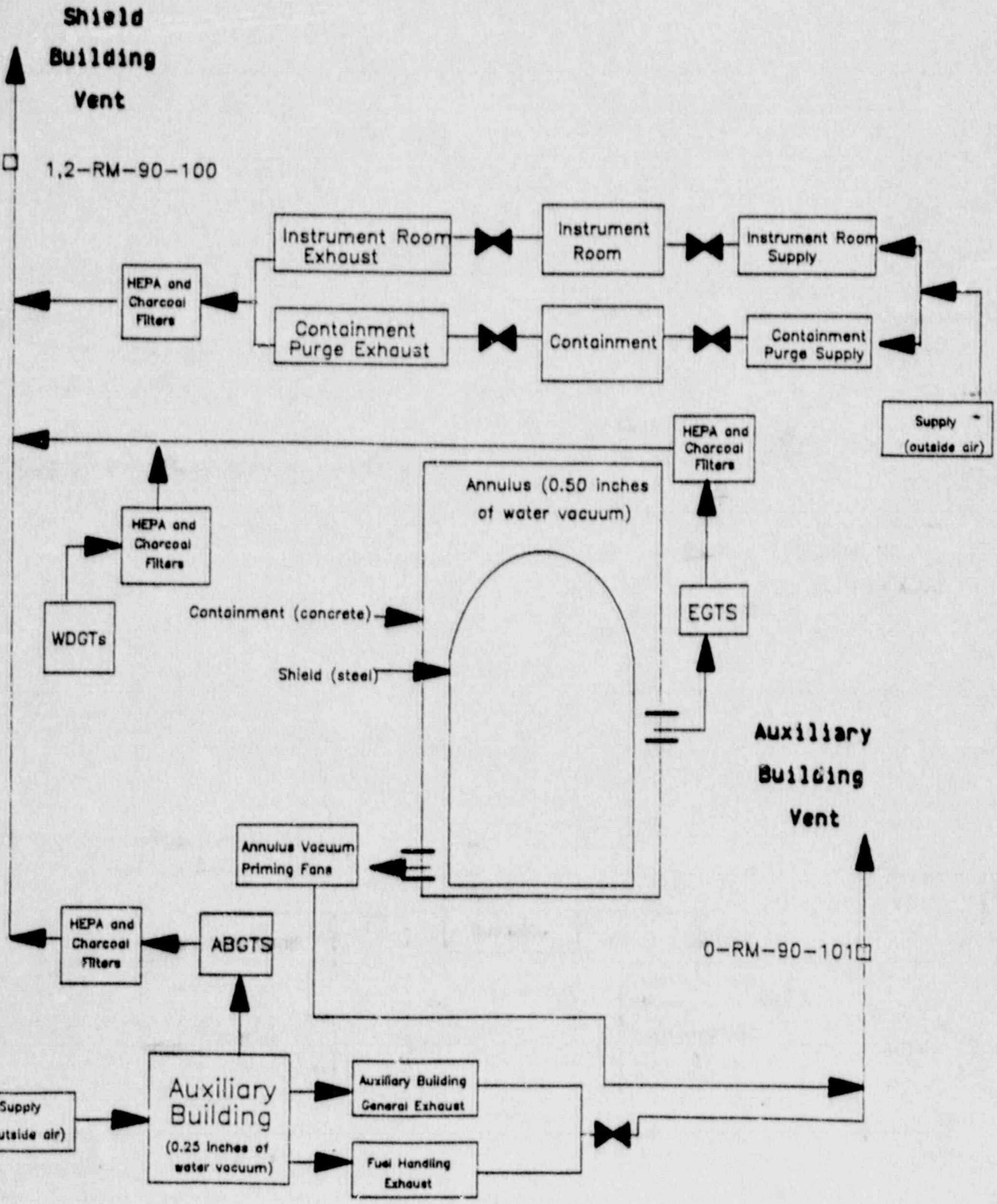

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Figure 1.3
SQN LAND SITE BOUNDARY

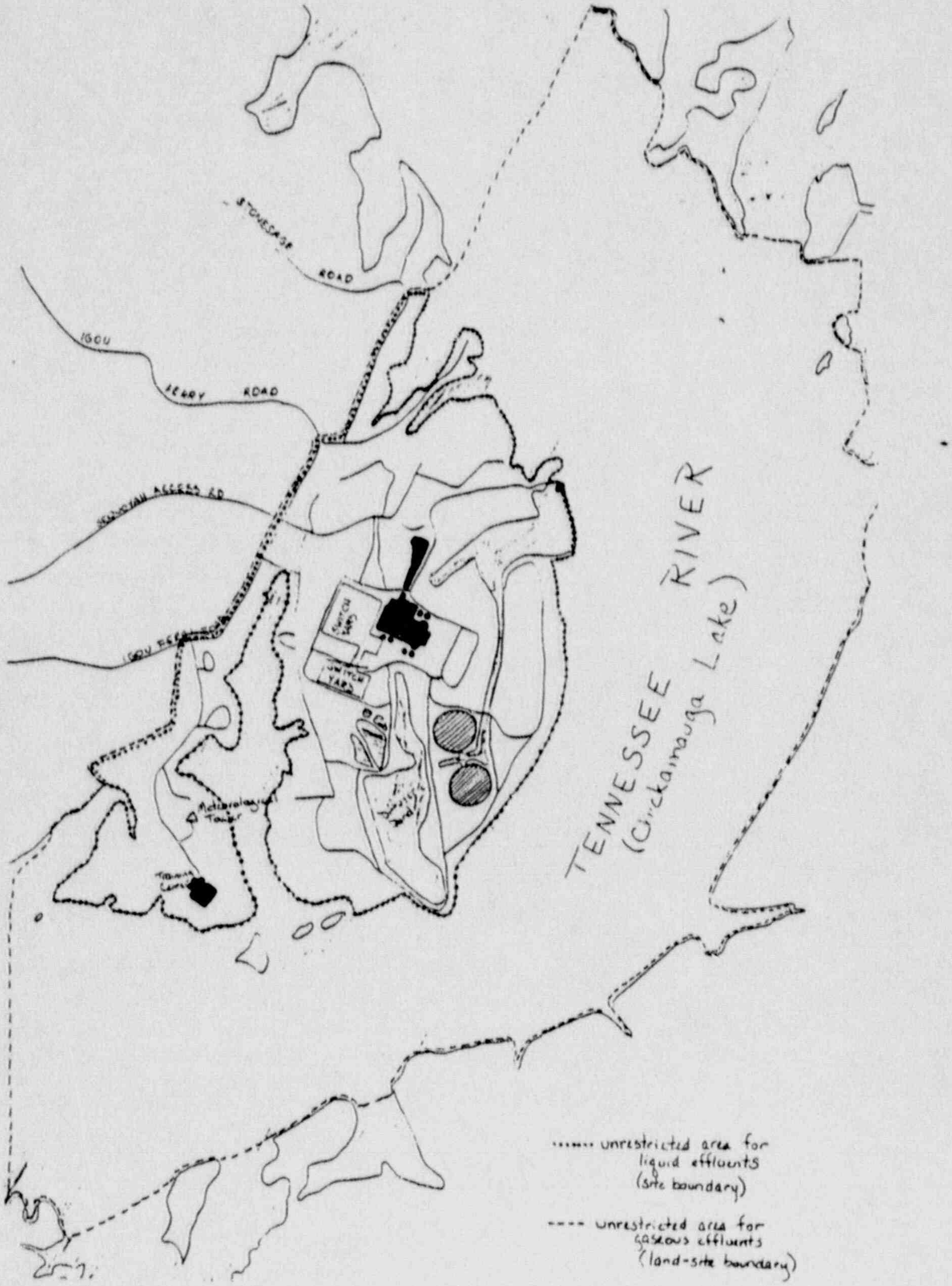

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Figure 1.4
GASEOUS RADWASTE TREATMENT SYSTEM

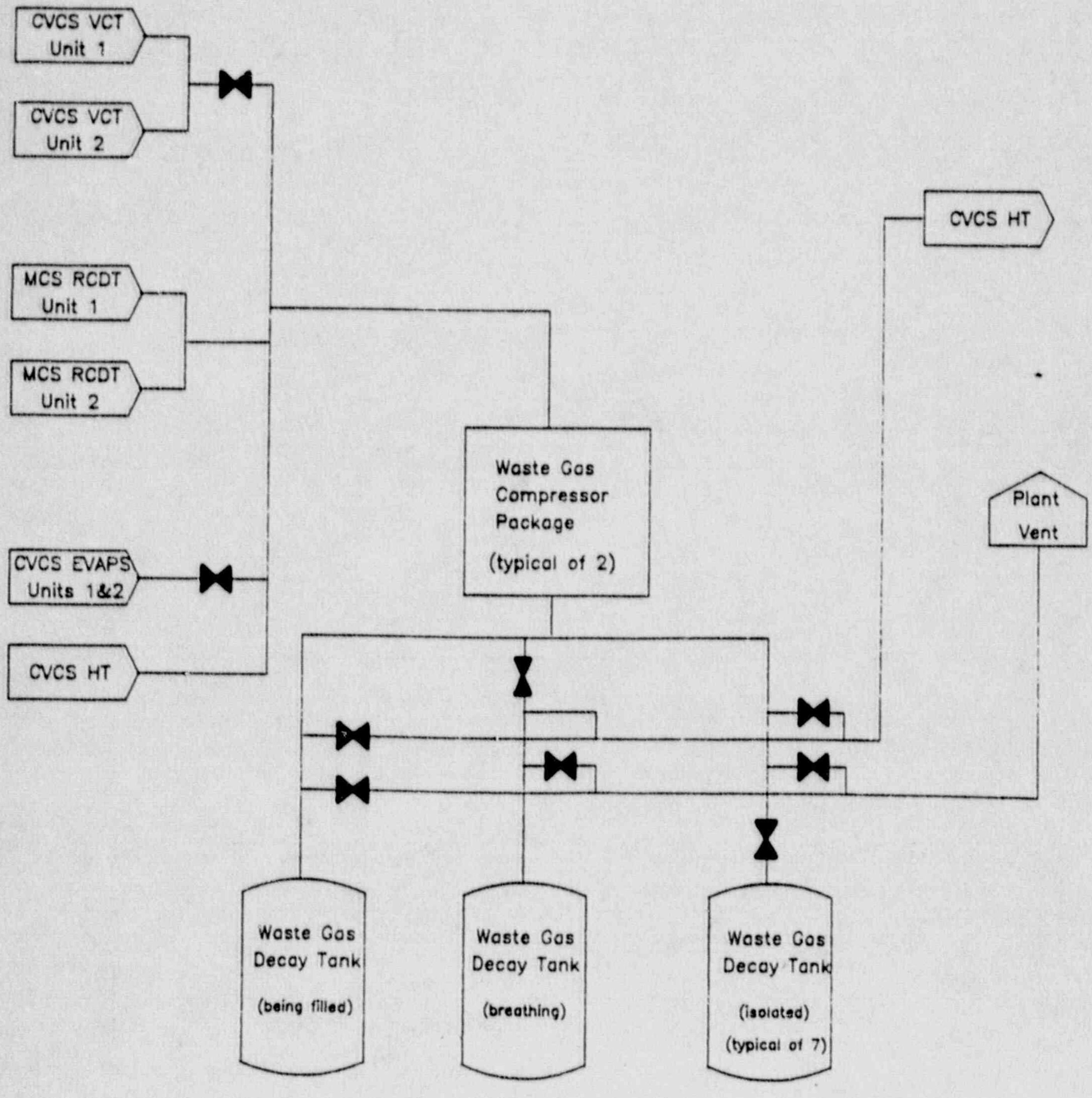

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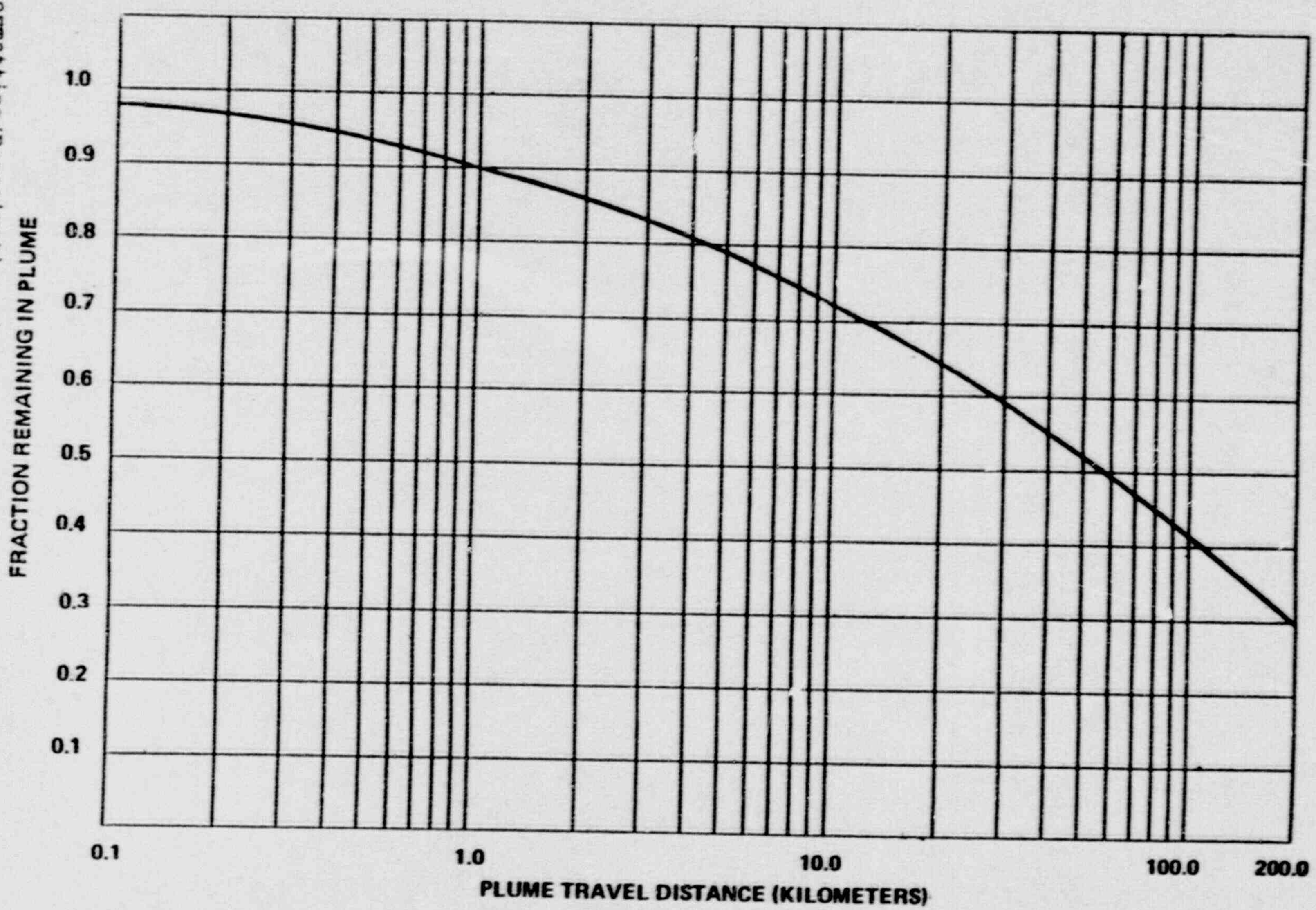
Figure 1.5
PLUME DEPLETION EFFECT FOR GROUND LEVEL RELEASES
(All Stability Classes)



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

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Figure 1.6
VERTICAL STANDARD DEVIATION OF MATERIAL IN A PLUME

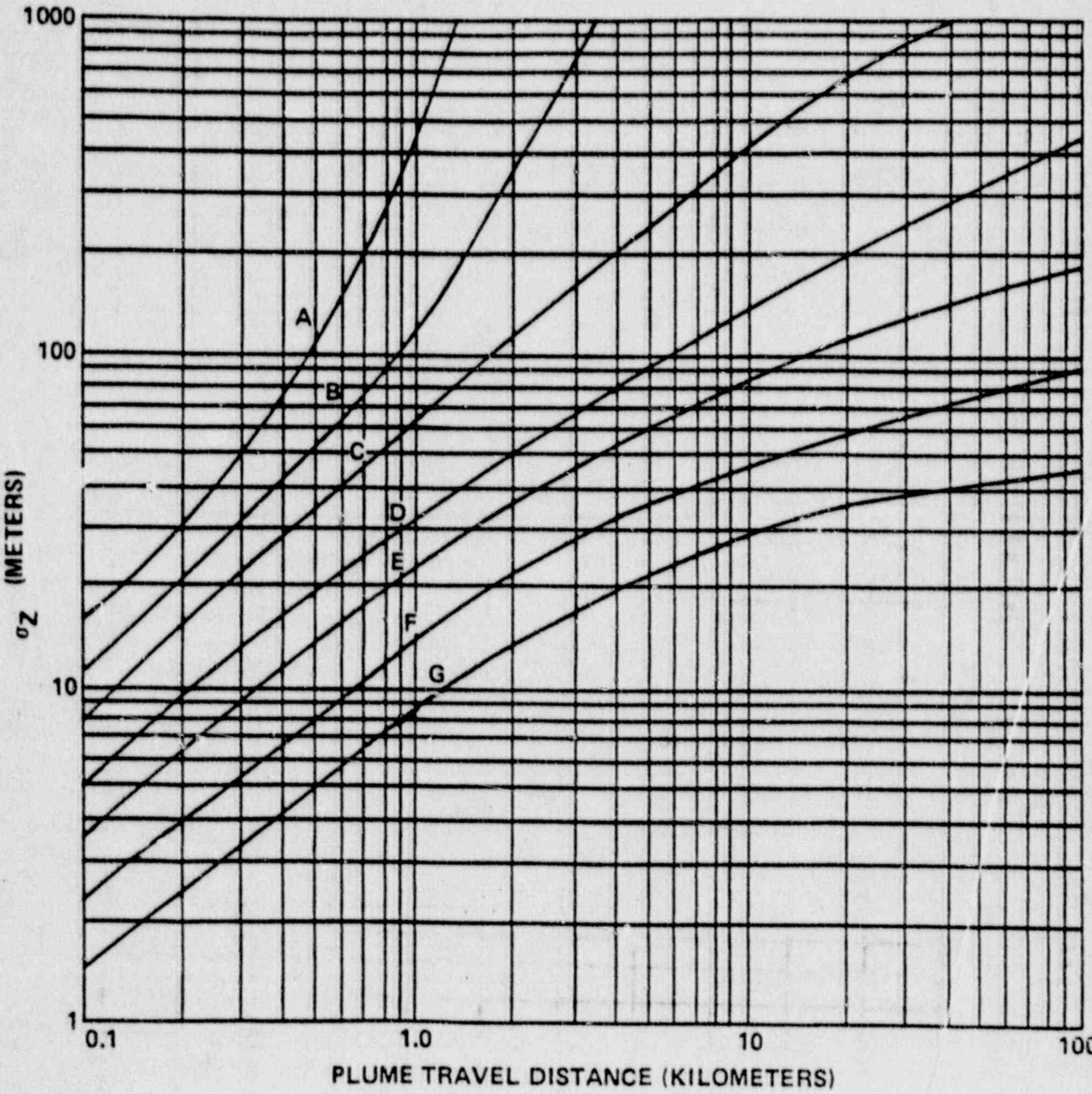

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Figure 1.7
RELATIVE DEPOSITION FOR GROUND LEVEL RELEASES
(All Stability Classes)

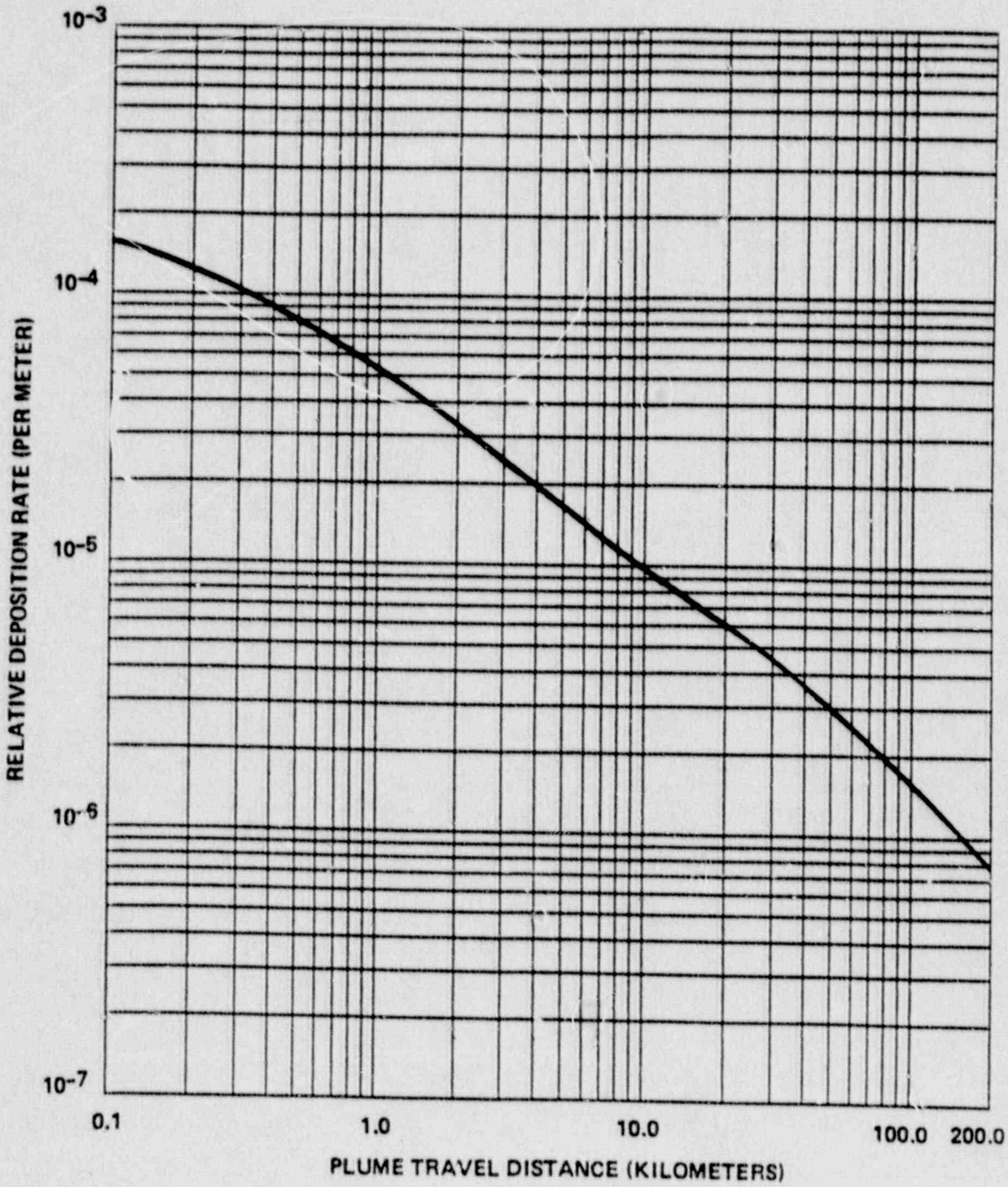

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Figure 2.1
LIQUID EFFLUENT RELEASE POINTS

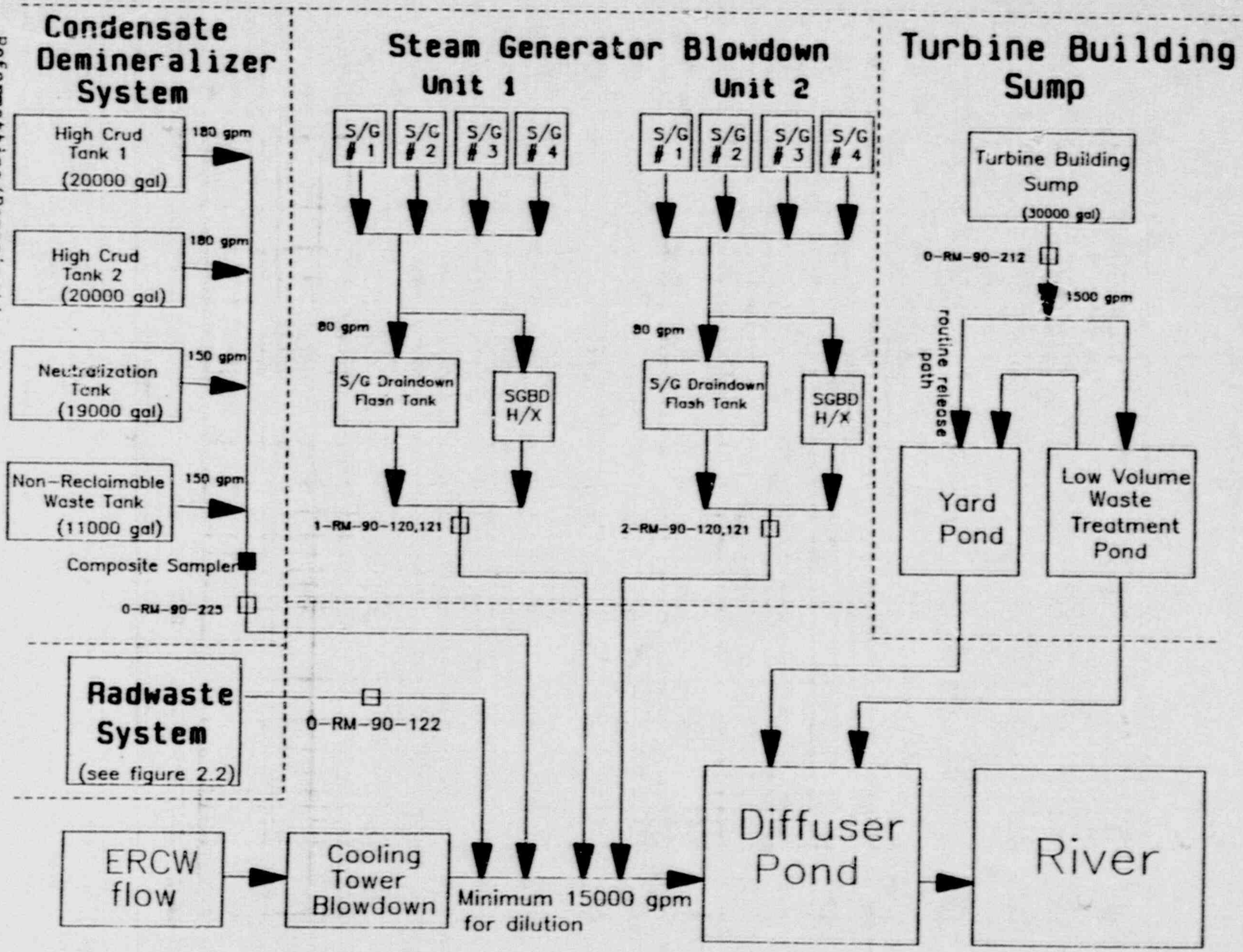

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Figure 2.2
LIQUID RADWASTE SYSTEM

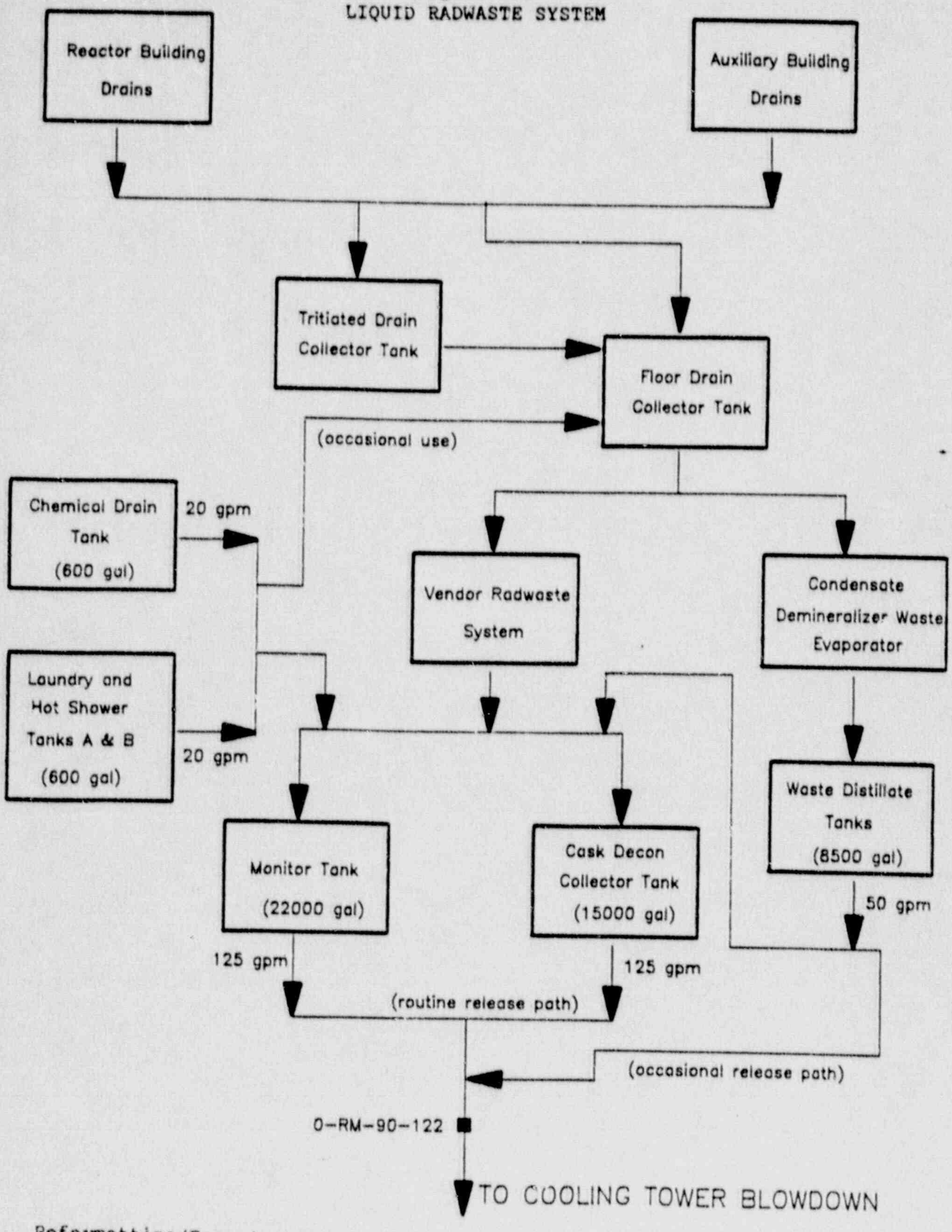

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Figure 3.1

Environmental Radiological Sampling Locations Within 1 Mile of Plant

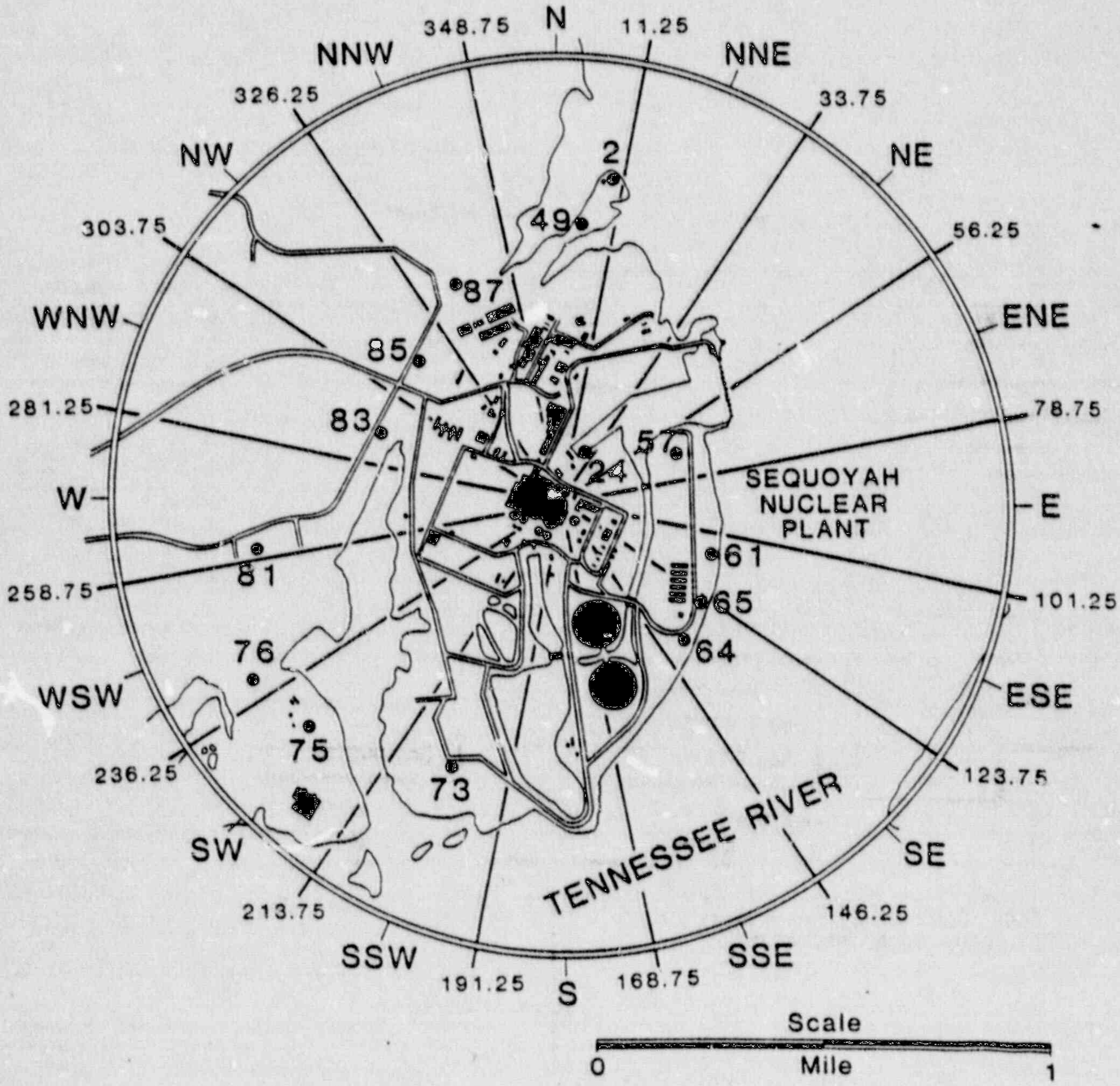

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Figure 3.2

Environmental Radiological Sampling Locations

From 1 to 5 Miles From The Plant

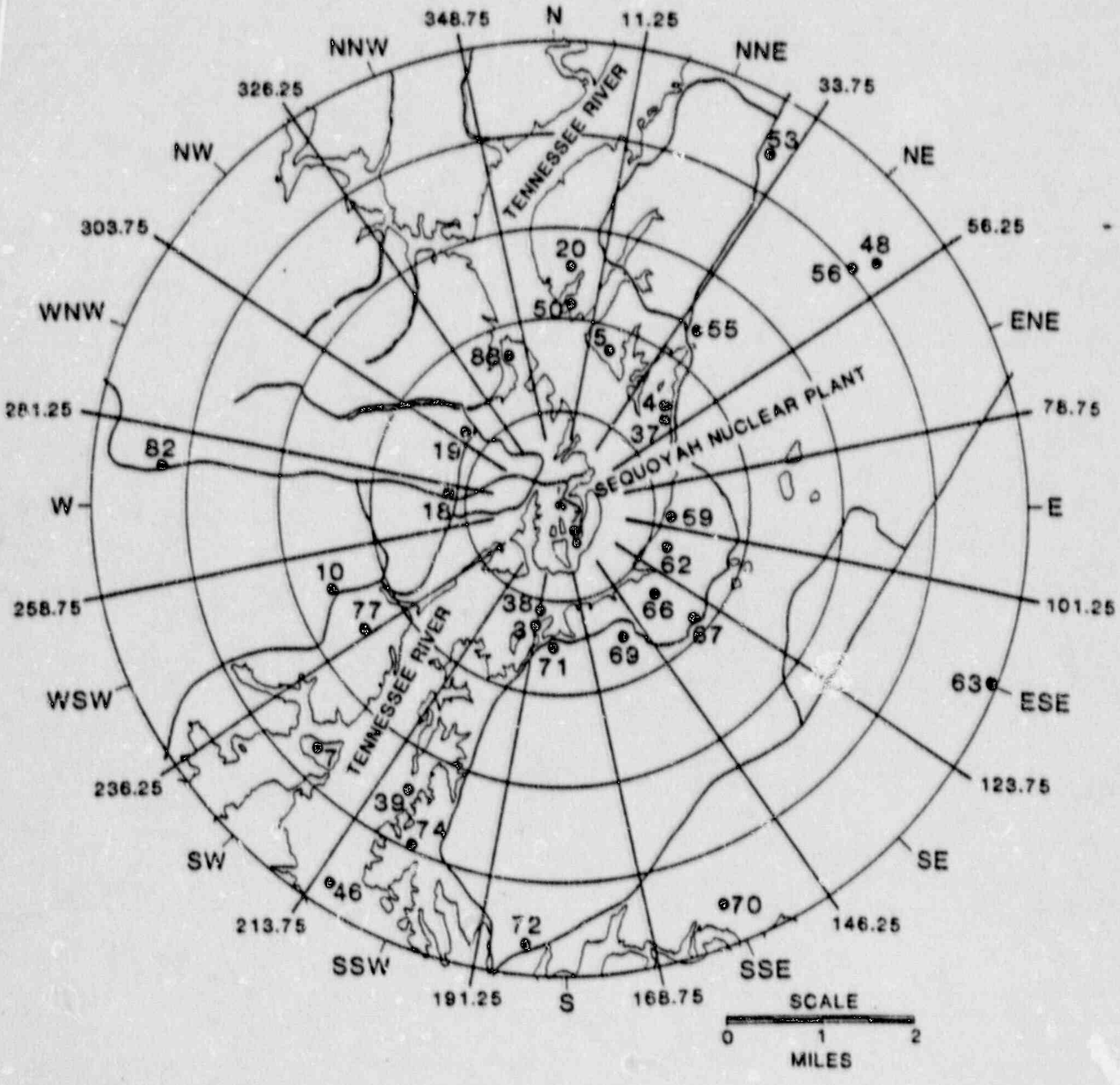

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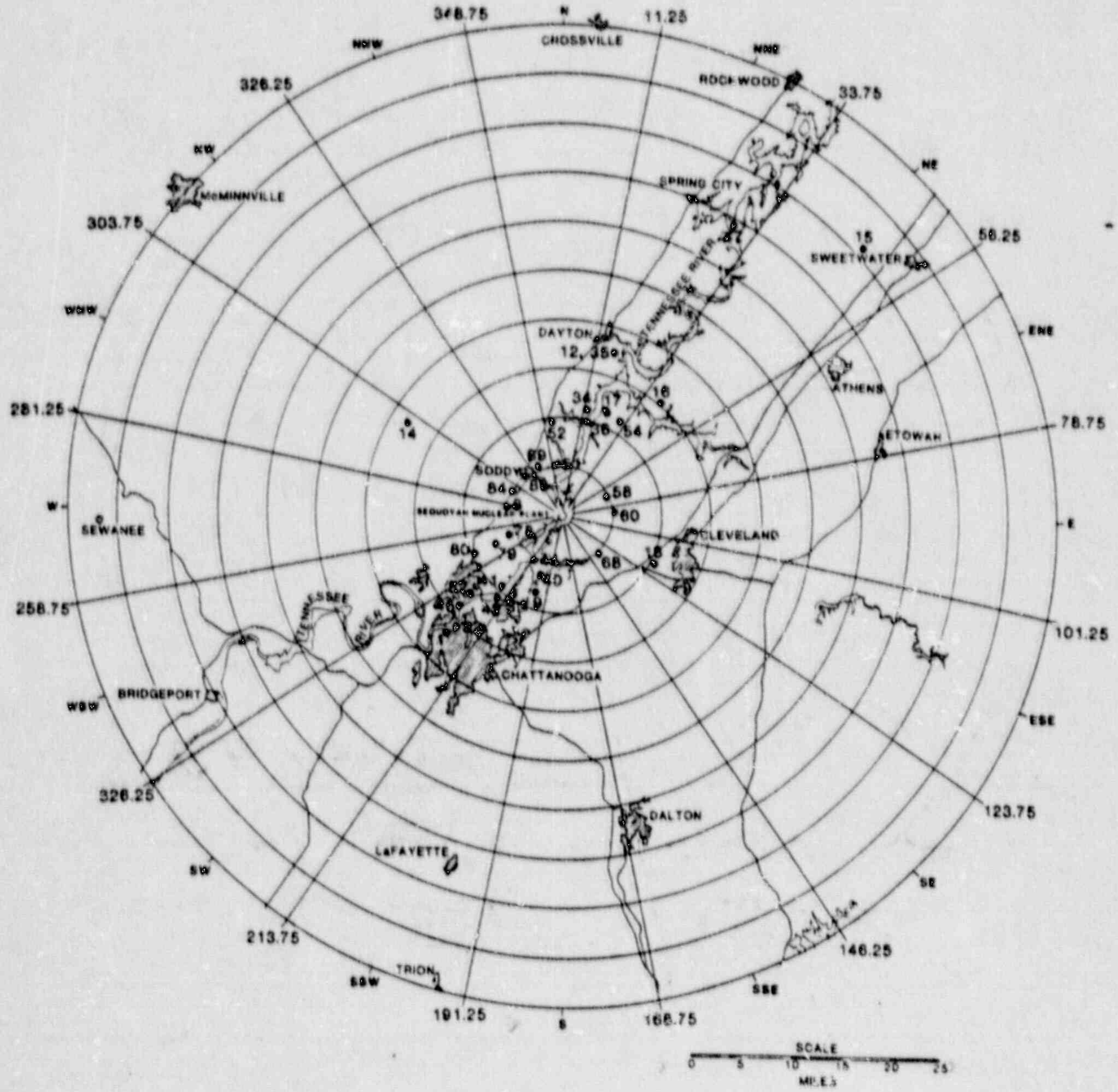
Figure 3.3

Environmental Radiological Sampling Locations Greater Than 5 Miles From The Plant



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