SECTION 6.0

LIQUID EFFLUENTS

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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 6.1 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 6.2 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.

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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.

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6.1 LIQUID RELEASES

6.1.1 Pre-Release Analysis

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. Composite samples are maintained (as required by Table 2.2-1) to determine the concentration of certain nuclides (H-3, Fe-55, Sr-89, Sr-90, and alpha emitters). R27

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 6.3 and 6.5. The actual measured concentrations will be used for the dose calculations described in Section 6.6.

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.

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6.1.2 MPC-Sum of the Ratios

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

$$R_j = \sum_i \frac{C_i}{MPC_i} \qquad (6.1)$$

where:

R_j = the sum of the ratios for release point j.
MPC_i = the MPC of radionuclide i, 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:

$$R_{TBS} + \frac{f_1R_1 + f_2R_2 + f_3R_3 + f_4R_4}{F} \leq 1.0 \qquad (6.2)$$

where

R_{TBS} = sum of the ratios of the turbine building sump as determined by equation 6.1.
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 6.1.
F = minimum dilution flow rate for CTBD, 15,000 gpm.

6.1.3 Post-Release Analysis

A post-release analysis will be done using actual release data to ensure that the limits specified in ODCM Control 1.2.1.1 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 6.2 to demonstrate compliance with the limits in ODCM Control 1.2.1.1. This data and setpoints will be recorded in auditable records by plant personnel.

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

6.2 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 ODCM Control 1.2.1.1 and to identify any unexpected releases.

6.2.1 Discharge Point Monitor Setpoints (0-RE-90-211, 0-RE-90-133,134,140,141) R27

The setpoints for the discharge point monitor, RE-90-211, and for ERCW monitors (RE-90-133,134,140,141) are set to ensure that the concentration of radioactive materials released at any time from the site do not exceed the limits given in ODCM Control 1.2.1.1. The setpoints for these monitors will be set to alarm if the activity in the stream exceeds a value of 1E-06 µCi/ml. R27

6.2.2 Release Point Monitor Setpoints (0-RM-90-122; 0-RM-90-225; 0-RM-90-212; 1,2-RM-90-120,121) R27

There are five release point effluent monitors: the Liquid Radwaste System radiation monitor 0-RM-90-122; the Condensate Demineralizer System radiation monitor 0-RM-90-225; the Turbine Building Sump radiation monitor 0-RM-90-212; and the Steam Generator Blowdown (SGBD) radiation monitors 1,2-RM-90-120,121. R27

The batch release points, the Liquid Radwaste System and the Condensate Demineralizer System (if being released in a batch mode), are looking at an undiluted waste stream as it comes out of a tank. The purpose of the monitor setpoints for these batch releases is to identify any release that is larger than expected and would have the potential to exceed the 10 CFR 20 limits after dilution. Setpoints are calculated as described in Section 6.2.3.

The continuous release points, the Condensate Demineralizer System, the Steam Generator Blowdowns and Turbine Building Sump, will not be releasing radioactivity unless there is a primary to secondary leak. When there is no identified primary to secondary leakage, these release points are monitored to indicate the presence of elevated activity levels in these systems. In accordance with the requirements of ODCM Table 2-2.1 footnote h, the setpoints for these monitors will be set to alarm if the activity in the stream exceeds a value of $1 x 10^{-6}$ µCi/ml.

When there is identified primary to secondary leakage, the continuous release points are monitored to identify any release that is larger than expected and would have the potential to exceed the 10 CFR 20 limits after dilution. The monitor setpoints are calculated in the same manner as the batch release point monitor setpoints, described in Section 6.2.3, when this is the case. When these release points are being treated in this manner, a single batch release is defined as all effluent released through this point on a continuous bases for a period of time (usually one week).

6.2.3 Batch Release Point Monitor Setpoint

For each release from a release point, two setpoints are calculated: one based on the monitor response to the contents of the effluent stream; and another based on the predicted response of the monitor to the activity in the release stream if it were large enough to exceed the 10 CFR 20 limits after dilution. The expected monitor response, R in cpm, is calculated using equation 6.3 below. The maximum calculated setpoint, S_{max}, is calculated using Equation 6.4 below. A comparison is made between these two calculated setpoints to determine which is used. The actual monitor setpoint for the release is set equal to X times the expected monitor response, or to the maximum calculated setpoint, whichever is less. X is an administrative factor designed to account for expected variations in monitor response (it will be defined in approved plant instructions). The X times expected response setpoint allows for the identification of any release of radioactivity above the expected amount. The maximum calculated setpoint ensures that the release will be stopped if it exceeds the 10 CFR 20 concentration limits after dilution.

Expected response

$$R = B + \sum_i Eff_i * C_i \qquad (6.3)$$

where

B = monitor background, cpm.

Eff_i = monitor efficiency for nuclide i, cpm per μCi/ml. R27

C_i = tank concentration of nuclide i, μCi/ml. R27

Calculated Maximum Monitor Setpoint

$$S_{max} = \frac{SF\ (F_w + (A * F_{dil}))}{F_w\ R_j}\ (R - B) + B \qquad (6.4)$$

where

SF = safety factor for the monitor.

F_w = flow of waste stream, gpm.

F_{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

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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 Blowdown (U1)	1500 gpm
Steam Generator Blowdown (U2)	1500 gpm

NOTE: These allocation factors may be adjusted for a particular release if it is known that there are no releases being made through other release points into the CTBD. For example, if there are no releases being made through the Condensate Demineralizer or either Steam Generator Blowdown, the allocation factor for the Radwaste System may be calculated using the entire 15,000 gpm flow rate. In addition, if the CTBD flow rate is greater than 15,000 gpm, the additional flow rate may be used in the calculation of the allocation factors.

R_j = sum of the MPC ratios for release point j as calculated in Section 6.1.2.

R = expected monitor response, cpm, as calculated above.

B = background, cpm.

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6.3 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. 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 6.7. 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:

$$\text{Dose} = \sum_i A_{it}\ T\ C_i\ D \qquad (6.5)$$

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 6.7.

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).

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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 6.3.1.

6.3.1 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 6.3.2, and for the dose projections described in Section 6.5.

6.3.2 Cumulative Doses

Quarterly and annual sums of all doses are determined at the end of each month to compare to the limits given in ODCM Control 1.2.1.2. These quarterly and annual sums will be the sum of the monthly cumulative doses described in Section 6.3.1 for the appropriate months in the quarter or year. These doses will be used in the comparison to the limits.

6.3.3 Comparison to Limits

The cumulative calendar quarter and calendar year doses are compared to the limits in ODCM Control 1.2.1.2 once per 31 days to determine compliance.

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6.4 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 6.2. 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.

6.5 DOSE PROJECTIONS

In accordance with ODCM Surveillance Requirement 2.2.1.3, dose projections will be performed by averaging the two previous month's doses as determined in Section 6.3.1. 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 ODCM Control 1.2.1.3. 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.

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6.6 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 ODCM Administrative Control 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:

$$D = \frac{1}{RF * 0.60} \quad \text{(for receptors upstream of Chickamauga Dam)} \qquad (6.6)$$

and

$$D = \frac{1}{RF} \quad \text{(for receptors downstream of Chickamauga Dam)} \qquad (6.7)$$

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.

6.6.1 WATER INGESTION

Water ingestion doses are calculated for each water supply identified within a 50 mile radius downstream of SQN (Table 6.1). Water ingestion doses are calculated for the total body and each internal organ as described below:

$$D_{org} = 10^6 \; 9.80E\text{-}09 \; A_{Wit} \; Q_i \; D \; \exp(-8.64E{+}04 \; \lambda_i \; t_d) \qquad (6.8)$$

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 6.7.1.
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 6.2).

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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.

6.6.2 FISH INGESTION

Fish ingestion doses are calculated for each identified reach within a 50 mile radius downstream of SQN (Table 6.1). Individual fish ingestion doses are calculated for the total body and each internal organ as described below:

$$D_{org} = 10^6 \ 9.80E\text{-}09 \ 0.25 \ A_{Fit} \ Q_i \ D \ \exp(-8.64E{+}04 \ \lambda_i \ t_d) \quad (6.9)$$

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 6.7.2.
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 6.2).
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.

6.6.3 SHORELINE RECREATION

Recreation doses are calculated for each identified reach within a 50 mile radius downstream of SQN (Table 6.1). 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:

$$D_{org} = 10^6 \ 9.80E\text{-}09 \ rf \ A_{Rit} \ Q_i \ D \ \exp(-8.64E{+}04 \ \lambda_i \ t_d) \quad (6.10)$$

where

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

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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.

λ_{Rit} = Dose factor for shoreline recreation for nuclide i, age group t, mrem/hour per µCi/ml, as calculated in Section 6.7.3.

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 6.2).

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.

6.6.4 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.

6.6.5 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:

$$POPWTR_t = 10^{-3} \sum_{m=1}^{5} POP_m \sum_{a=1}^{4} POP_a \ ATMW_a \ TWDOS_{amt} \qquad (6.11)$$

where:

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

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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 6.1.

$ATMW_a$ = ratio of average to maximum water ingestion rates for each age group a. Maximum water ingestion rates are given in Table 6.3. 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 6.6.1, 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:

$$POPF_t = \frac{453.6 \quad HVST \; APR}{10^3 \quad 10^3} \sum_{r=1}^{4} \sum_{a=1}^{3} \frac{TFDOS_{art} \quad POP_a}{FISH_a \quad POP_a} \qquad (6.12)$$

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 6.1).
$TFDOS_{art}$ = total fish ingestion dose to organ t for reach r, for the age group a, as described in Section 6.6.2, 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.

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

$$POPR_t = \frac{REQFRA}{10^3 \quad 8760} \sum_{r=1}^{4} TSHDOS_{rt} \; SHVIS_r \; HRSVIS_r \qquad (6.13)$$

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 6.6.3.
$TSHDOS_{rt}$ = total shoreline dose rate for organ t, in reach r, mrem/h.
$SHVIS_r$ = shoreline visits per year at each reach r, (Table 6.1).
$HRSVIS_r$ = length of shoreline recreation visit at reach r, 5 hours.
10^3 = conversion factor, mrem/rem.
8760 = conversion factor, hours/year.

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6.7 LIQUID DOSE FACTOR EQUATIONS

6.7.1 WATER INGESTION - λ_{Wit} (mrem/hr per μCi/ml)

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

where:

DF_{Liat} = ingestion dose conversion factor for nuclide i, age group a, organ t, mrem/pCi, (Table 6.4).
U_{wa} = water consumption rate for age group a, L/year, (Table 6.3).
10^6 = conversion factor, pCi/μCi.
10^3 = conversion factor, ml/L.
8760 = conversion factor, hours per year.

6.7.2 FISH INGESTION - λ_{Fit} (mrem/hr per μCi/ml)

$$\lambda_{Fit} = \frac{DF_{Liat}\ U_{fa}\ B_i\ 10^6\ 10^3}{8760}$$

where:

DF_{Liat} = ingestion dose conversion factor for nuclide i, age group a, organ t, mrem/pCi, (Table 6.4).
U_{fa} = fish consumption rate for age group a, kg/year, (Table 6.3).
B_i = bioaccumulation factor for nuclide i, pCi/kg per pCi/L, (Table 6.5).
10^6 = conversion factor, pCi/μCi.
10^3 = conversion factor, ml/L.
8760 = conversion factor, hours per year.

6.7.3 SHORELINE RECREATION - λ_{Rit} (mrem/hr per μCi/ml).

$$\lambda_{Rit} = \frac{DF_{Git}\ K_c\ M\ W\ 10^3\ 10^6\ U}{8760 * 3600\ \lambda_i}\ [1-\exp(-\lambda_i t_b)]$$

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/m^2, (Table 6.6).
K_c = transfer coefficient from water to shoreline sediment, L/kg-hr, (Table 6.3).
M = mass density of sediment, kg/m^2, (Table 6.3).

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W	=	shoreline width factor, dimensionless, (Table 6.3).
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 6.2).
t_b	=	time shoreline is exposed to the concentration on the water, seconds, (Table 6.3).
U	=	usage factor, 500 hours/year.
8760	=	conversion factor, hours/year.

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Table 6.1
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

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Table 6.2 (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

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Table 6.2 (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)	
Ag-110m	3.60E+05	3.21E-08	1.50E-01	5.00E-02	5.00E-02	1.70E-02	
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	
Sn-125	1.39E+04	8.32E-07	N/A	N/A	N/A	N/A	R25
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	1.84E+04	6.28E-07	5.00E-03	4.00E-04	4.00E-04	3.20E-03	
Ba-141	1.83E+01	6.31E-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	

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Table 6.2 (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-133m	3.15E+03	3.67E-06	N/A	N/A	N/A	N/A
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.

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Table 6.3 (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)
U_{fa}(infant)	0	kg/year	R. G. 1.109 (Table E-5)
U_{fa}(child)	6.9	kg/year	R. G. 1.109 (Table E-5)
U_{fa}(teen)	16	kg/year	R. G. 1.109 (Table E-5)

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Table 6.3 (2 of 2)
DOSE CALCULATION FACTORS

Factor	Value	Units	Reference
U_{fa}(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)
λ_w (particulates)	5.21E-07 (15.4 d half-life)	sec^{-1}	NUREG/CR-1004 (Table 3.10)

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Table 6.4 (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

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Table 6.4 (2 of 8)
INGESTION DOSE FACTORS
(mrem/pCi ingested)

ADULT

	bone	liver	t body	thyroid	kidney	lung	gi-lli	
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	
Sb-125	1.79E-06	2.00E-08	4.26E-07	1.82E-09	0.00E-00	1.38E-06	1.97E-05	
Sn-125	8.33E-06	1.68E-07	3.78E-07	1.39E-07	0.00E-00	0.00E-00	1.04E-04	R25
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	

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

REFERENCES:

Regulatory Guide 1.109, Table E-11.

Dose Factors for Co-57, Zn-69m, Br-82, Nb-97, Sn-125, 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. R25

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Table 6.4 (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

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Table 6.4 (4 of 8)
INGESTION DOSE FACTORS
(mrem/pCi ingested)

TEEN

	bone	liver	t body	thyroid	kidney	lung	gi-lli	
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	
Sb-125	2.48E-06	2.71E-08	5.80E-07	2.37E-09	0.00E+00	2.18E-06	1.93E-05	
Sn-125	1.19E-05	2.37E-07	5.37E-07	1.86E-07	0.00E+00	0.00E+00	1.12E-04	R25
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	

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

REFERENCES:

Regulatory Guide 1.109, Table E-12.

Dose Factors for Co-57, Zn-69m, Br-82, Nb-97, Sn-125, 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. R25

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Table 6.4 (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

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Table 6.4 (6 of 8)
INGESTION DOSE FACTORS
(mrem/pCi ingested)

CHILD

	bone	liver	t body	thyroid	kidney	lung	gi-lli	
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	
Sb-125	7.16E-06	5.52E-08	1.50E-06	6.63E-09	0.00E+00	3.99E-06	1.71E-05	
Sn-125	3.55E-05	5.35E-07	1.59E-06	5.55E-07	0.00E+00	0.00E+00	1.10E-05	R25
Te-125m	1.14E-05	3.09E-06	1.52E-06	3.20E-05	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	6.51E-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	7.78E-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	6.46E-05	4.18E-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	

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

REFERENCES:

Regulatory Guide 1.109, Table E-13.

Dose Factors for Co-57, Zn-69m, Br-82, Nb-97, Sn-125, 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. R25

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Table 6.4 (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

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Table 6.4 (8 of 8)
INGESTION DOSE FACTORS
(mrem/pCi ingested)

INFANT

	bone	liver	t body	thyroid	kidney	lung	gi-lli	
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	
Sb-125	1.23E-05	1.19E-07	2.53E-06	1.54E-08	0.00E+00	7.72E-06	1.64E-05	
Sn-125	7.41E-05	1.38E-06	3.29E-06	1.36E-06	0.00E+00	0.00E+00	1.11E-04	R25
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	

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

REFERENCES:

Regulatory Guide 1.109, Table E-14.

Dose Factors for Co-57, Zn-69m, Br-82, Nb-97, Sn-125, 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. R25

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Table 6.5
BIOACCUMULATION FACTORS FOR FRESHWATER FISH
(µCi/kg per µCi/ml)

H-3	9.0E-01	Y-91m	2.5E+01	I-134	4.0E+01	
C-14	4.6E+03	Y-91	2.5E+01	I-135	4.0E+01	
Na-24	1.0E+02	Y-92	2.5E+01	Cs-134	1.9E+03	
P-32	1.0E+05	Y-93	2.5E+01	Cs-136	1.9E+03	
Cr-51	2.0E+02	Zr-95	3.3E+00	Cs-137	1.9E+03	
Mn-54	4.0E+02	Zr-97	3.3E+00	Cs-138	1.9E+03	
Mn-56	4.0E+02	Nb-95	3.0E+04	Ba-139	4.0E+00	
Fe-55	1.0E+02	Nb-97	3.0E+04	Ba-140	4.0E+00	
Fe-59	1.0E+02	Mo-99	1.0E+01	Ba-141	4.0E+00	
Co-57	5.0E+01	Tc-99m	1.5E+01	Ba-142	4.0E+00	
Co-58	5.0E+01	Tc-101	1.5E+01	La-140	2.5E+01	
Co-60	5.0E+01	Ru-103	1.0E+01	La-144	2.5E+01	
Ni-63	1.0E+02	Ru-105	1.0E+01	Ce-141	1.0E+00	
Ni-65	1.0E+02	Ru-106	1.0E+01	Ce-143	1.0E+00	
Cu-64	5.0E+01	Ag-110m	2.31E+00	Ce-144	1.0E+00	R25
Zn-65	2.0E+03	Sb-124	1.0E+00	Pr-144	2.5E+01	
Zn-69	2.0E+03	Sb-125	1.0E+00	Pr-143	2.5E+01	
Zn-69m	2.0E+03	Sn-125	3.0E+03	Nd-147	2.5E+01	R25
Br-82	4.2E+02	Te-125m	4.0E+02	W-187	1.2E+03	
Br-83	4.2E+02	Te-127m	4.0E+02	Np-239	1.0E+01	
Br-84	4.2E+02	Te-127	4.0E+02			
Br-85	4.2E+02	Te-129m	4.0E+02			
Rb-86	2.0E+03	Te-129	4.0E+02			
Rb-88	2.0E+03	Te-131m	4.0E+02			
Rb-89	2.0E+03	Te-131	4.0E+02			
Sr-89	5.6E+01	Te-132	4.0E+02			
Sr-90	5.6E+01	I-130	4.0E+01			
Sr-91	5.6E+01	I-131	4.0E+01			
Sr-92	5.6E+01	I-132	4.0E+01			
Y-90	2.5E+01	I-133	4.0E+01			

REFERENCES:

Bioaccumulation factors for Ag-110m, Sb-124, Sb-125 and Sn-125 are from ORNL-4992, "A Methodology for Calculating Radiation Doses from Radioactivity Released to the Environment," March 1976, Table 4.12A. R25

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.

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Table 6.6 (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	5.80E-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

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Table 6.6 (2 of 2)
EXTERNAL DOSE FACTORS FOR STANDING ON CONTAMINATED GROUND
(mrem/h per pCi/m^2)

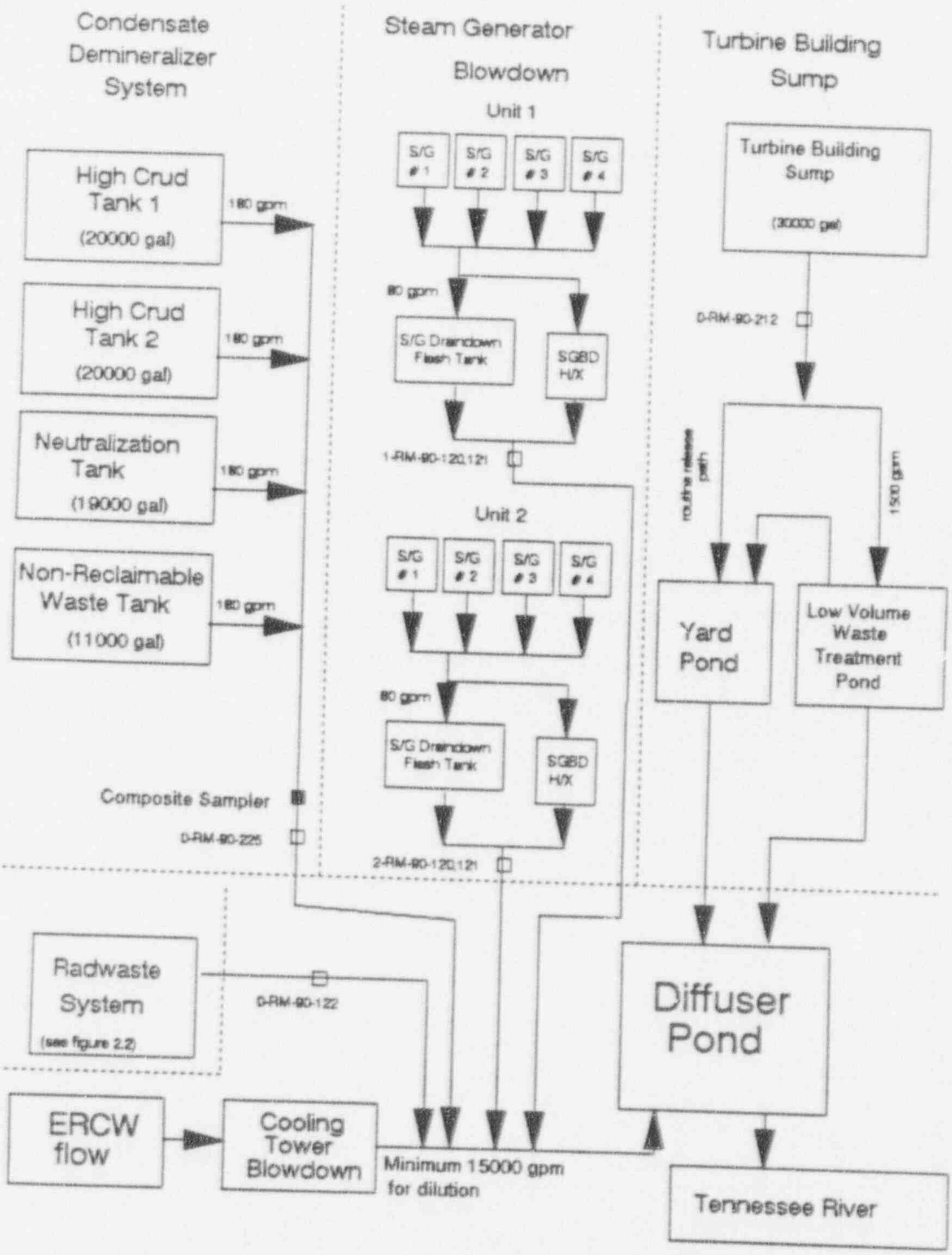
Nuclide	Total Body	Skin	
Ag-110m	1.80E-08	2.10E-08	
Sb-124	2.17E-08	2.57E-08	
Sb-125	5.48E-09	6.80E-09	
Sn-125	3.58E-09	4.51E-09	R25
Te-125m	3.50E-11	4.80E-11	
Te-127m	1.10E-12	1.30E-12	
Te-127	1.00E-11	1.10E-11	
Te-129m	7.70E-10	9.00E-10	
Te-129	7.10E-10	8.40E-10	
Te-131m	8.40E-09	9.90E-09	
Te-131	2.20E-09	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.

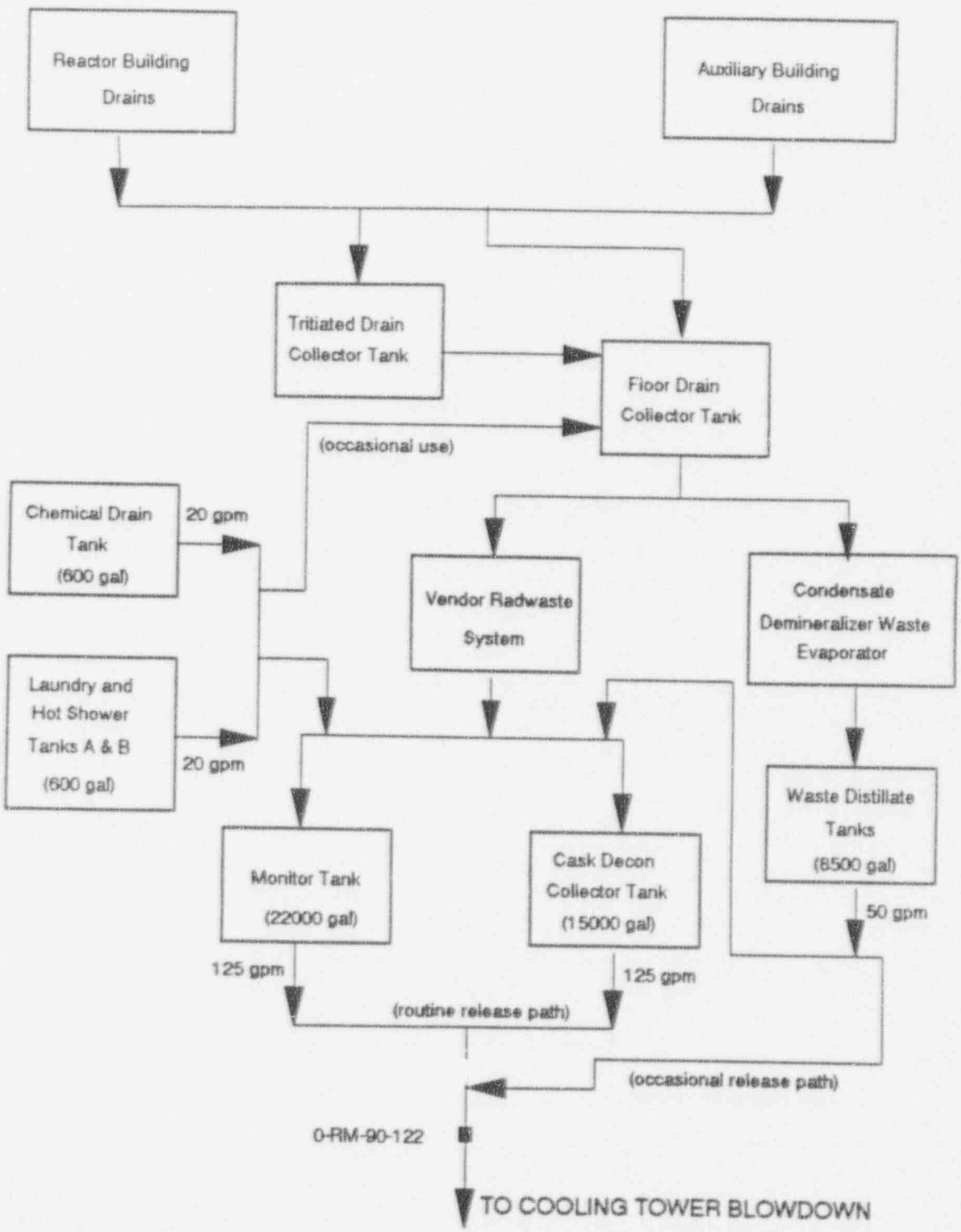
Dose Factors for Co-57, Zn-69m, Br-82, Nb-97, Sn-125, Sb-124 and Sb-125 are from <u>Dose-Rate Conversion Factors for External Exposure to Photon and Electron Radiation from Radionuclides Occurring in Routine Releases from Nuclear Fuel Cycle Facilities</u>, D. C. Kocher, Health Physics Volume 38, April 1980. R25

Figure 6.1
LIQUID EFFLUENT RELEASE POINTS



OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Figure 6.2
LIQUID RADWASTE SYSTEM



SECTION 7.0

GASEOUS EFFLUENTS

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

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 7.1 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 1,2-RM-90-99,119. R27

Service Building Vent

Various low-level sources exhaust to the Service Building Vent. This R25
exhausts at a total design flow of approximately 14,950 cfm. The portion R27
this total flow originating from the Titration Room, the Waste Baler Room, R27
and the Chemistry Lab is monitored by radiation monitor 0-RM-90-132. R27

Auxiliary Building Exhaust (see Figure 7.2 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 7.2 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 R27
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-RE-90-400. R27

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

7.1 INSTRUMENT SETPOINTS

Airborne effluent monitor setpoints are determined to ensure that the dose rate at the SITE BOUNDARY does not exceed the dose rate limits given in ODCM Control 1.2.2.1 and to identify any unexpected releases.

7.1.1 Release Point Monitor Setpoints (1,2-RM-90-130,131 0-RM-90-118) R27

7.1.1.1 Containment Purge Effluent Monitors (1,2-RM-90-130,131) R27

These monitors are set at a cpm value equal to a percentage of the Technical Specification Limit of 8.5×10^{-3} µCi/cc of Xe-133 (Technical Specification 3.3.2.1, Table 3.3-4).

7.1.1.2 Waste Gas Decay Tank Effluent Monitor (0-RM-90-118)

For each release from a waste gas decay tank, two setpoints are calculated for the monitor: one based on the expected response of the monitor to the radioactivity in the effluent stream; and a calculated maximum setpoint which corresponds to the most restrictive dose rate limit given in ODCM Control 1.2.2.1. The expected monitor response is calculated as described below in Equation 7.1. The maximum calculated setpoint is calculated as described below in Equation 7.2. A comparison is made between these two calculated setpoints to determine which is used. The actual monitor setpoint for the release is set equal to X times the expected monitor response, or to the maximum calculated setpoint, whichever is less. X is an administrative factor designed to account for expected variations in monitor response (it will be defined in approved plant instructions). The X times expected response setpoint allows for the identification of any release of radioactivity above the expected amount. The maximum calculated setpoint ensures that the release will be stopped if it exceeds the 10 CFR 20 dose rate limits after dilution. R27

Expected Monitor Response

$$R = B + \sum_i eff_i C_i \qquad (7.1)$$

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.

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Calculated Maximum Setpoint

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

$$S_{max} = \left(A \; SF \; \left(\frac{DR_{lim}}{DR} (R - B) \right) \right) + B \qquad (7.2)$$

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.

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 7.2.3.1),
= DR_s for skin (as described in Section 7.2.3.2), and
= DR_{org} for maximum organ (as described in Section 7.2.4).

R = expected monitor response (as calculated in Equation 7.1), cpm.

B = the monitor background, cpm. R27

7.1.2 Discharge Point Monitor Setpoints (1,2-RE-90-400, 0-RM-90-101, 0-RM-90-132, 1,2-RM-90-99,119) R27 R27

A normal default setpoint is determined for each discharge point monitor as described in Section 7.1.3. These setpoints on the discharge monitors will routinely be set equal to the default setpoints. When release permits are generated, the expected response and maximum calculated setpoints are calculated for the appropriate discharge monitor as described in Section 7.1.1.2. A comparison is made between the three setpoints as described below to choose the appropriate setpoint for the monitor during the release (after the release, the monitor should be returned to the default setpoint). For almost all releases, the setpoint for the discharge monitor will be the default setpoint. R27 R27

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

IF X[1] times the expected monitor response is less than the calculated maximum setpoint:

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

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

NOTE: For the shield building exhaust monitors (1,2-RE-90-400), the above calculations and comparisons are performed in cpm, then the final resulting setpoint is converted to units of µCi/sec. R27

7.1.3 Discharge Point Effluent Monitor Default Setpoints

7.1.3.1 Shield Building Vents (1,2-RE-90-400), Auxiliary Building Vent (0-RM-90-101), and Service Building Vent (0-RM-90-132) R27

These discharge point effluent monitors are set to ensure compliance with ODCM Control 1.2.2.1. The default setpoints are defined as the maximum calculated setpoint described by Equation 7.2, calculated for Xe-133. The default setpoints for the shield building monitors are calculated in units of µCi/sec. R27 R27

7.1.3.2 Condenser Vacuum Exhaust Vent (1,2-RM-90-99,119) R27

This discharge point effluent monitor is set to ensure compliance with ODCM Control 1.2.2.1 and to identify the presence of primary to secondary leakage of radioactivity. The default setpoint is determined by calculating the maximum calculated setpoint described by Equation 7.2 for Xe-133, and then taking a percentage of this value as the setpoint. Once a primary to secondary leak is identified, the setpoint on this monitor may be adjusted upward to enable it to be used to identify any further increases in the leak rate. R27

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

7.2 GASEOUS EFFLUENTS - DOSE RATES

7.2.1 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 in ODCM Control 1.2.2.1 are the result of offsite concentrations equal to those listed in Appendix B, Table II of 10 CFR 20.

7.2.2 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 2.2-2) 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 7.3, 7.4, and 7.5. The actual measured concentrations will be used for the dose calculations described in Section 7.6.

7.2.3 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.

7.2.3.1 Total Body Dose Rate

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

$$DR_{TB} = (X/Q)\ F \sum_i C_i\ DF_{Bi} \qquad (7.3)$$

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 7.8.2 using the historical meteorological data for the period

1972-1975 given in Table 7.2. For dose rate calculations, the highest value from the sixteen land-site boundary locations is used.
= 5.12E-06 s/m^3 (from Table 7.1).

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 $\mu Ci/m^3$ (Table 7.3). R27

7.2.3.2 Skin Dose Rate

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

$$DR_s = (\chi/Q)\ F \sum_i C_i(DFS_i + 1.11\ DF_{\gamma i}) \qquad (7.4)$$

where

χ/Q = relative concentration, s/m^3. Relative air concentrations are calculated for the land-site boundary in each of the sixteen sectors as described in Section 7.8.2 using the historical meteorological data for the period 1972-1975 given in Table 7.2. For dose rate calculations, the highest value from the sixteen land-site boundary locations is used.
= 5.12E-06 s/m^3 (from Table 7.1).

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 $\mu Ci/m^3$ (Table 7.3). R27

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 $\mu Ci/m^3$ (Table 7.3). R27

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

7.2.4 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:

$$DR_{org} = F[\, C_T(X/Q)[R_{IT}+R_{CTP}] + \sum_i C_i[(X/Q)R_{Ii} + (D/Q)[R_{CPi}+R_{Gi}]]] \qquad (7.5)$$

where:

F = flowrate of effluent stream, cc/s.

C_T = concentration of tritium in effluent stream, µCi/cc.

X/Q = relative concentration, s/m^3. Relative air concentrations are calculated for the land-site boundary in each of the sixteen sectors as described in Section 7.8.2 using the historical meteorological data for the period 1972-1975 given in Table 7.2. For dose rate calculations, the highest value from the sixteen land-site boundary locations is used.
= 5.12E-06 s/m^3 (from Table 7.1).

R_{IT} = inhalation dose factor for tritium, mrem/year per $\mu Ci/m^3$. Dose factor is calculated as described in Section 7.7.13.

R_{CTP} = Grass-cow-milk dose factor for tritium, mrem/year per $\mu Ci/m^3$. Dose factor is calculated as described in Section 7.7.7.

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

R_{Ii} = inhalation dose factor for each identified nuclide i, mrem/year per $\mu Ci/m^3$. Dose factors are calculated as described in Section 7.7.13.

D/Q = relative deposition, $1/m^2$. Relative deposition is calculated for the land-site boundary in each of the sixteen sectors as described in Section 7.8.3 using the historical meteorological data for the period 1972-1975 given in Table 7.2. For dose rate calculations, the highest value from the sixteen land-site boundary locations is used.
= 1.29E-08 $1/m^2$ (from Table 7.1).

R_{CPi} = Grass-cow-milk dose factor for each identified nuclide i, m^2-mrem/year per µCi/s. Dose factors are calculated as described in Section 7.7.1.

R_{Gi} = ground plane dose factor for each identified nuclide i, m^2-mrem/year per µCi/s. Dose factors are calculated as described in Section 7.7.14.

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

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7.3 DOSE - 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 χ/Q based on 1972-1975 meteorological data (Table 7.2). This location is chosen from the SITE BOUNDARY locations listed in Table 7.1. Dispersion factors are calculated using the methodology described in Section 7.8.2. R27

No credit is taken for radioactive decay.

7.3.1 Gamma dose to air

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

$$D_\gamma = 1.9E\text{-}06\ (\chi/Q) \sum_i Q_i\ DF_{\gamma i}\ T \qquad (7.6)$$

where:

1.9E-06 = conversion factor, years per minute.
χ/Q = highest land-site boundary annual-average relative concentration, 5.12×10^{-6} s/m^3 (from Table 7.1).
Q_i = release rate for nuclide i, µCi/s.
$DF_{\gamma i}$ = dose conversion factor for external gamma for nuclide i (Table 7.3), mrad/year per µCi/m^3. R27
T = duration of release, minutes.

The gamma-air dose calculated by this method will be used in the cumulative dose calculations discussed in Section 7.3.3.

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7.3.2 Beta dose to air

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

$$D_\beta = 1.9E\text{-}06\ (X/Q) \sum_i Q_i\ DF_{\beta i}\ T \qquad (7.7)$$

where:

1.9E-06 = conversion factor, years per minute.
X/Q = highest land-site boundary annual-average relative concentration, 5.12×10^{-6} s/m^3 (from Table 7.1).
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/m^3 (from Table 7.3).
T = duration of release, minutes. R27

The beta-air dose calculated by this method will be used in the cumulative dose calculations discussed in Section 7.3.3.

7.3.3 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 ODCM Control 1.2.2.2.

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.

7.3.4 Comparison to Limits

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

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

7.4.1 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 7.8.2 and 7.8.3 using the historical 1972-1975 meteorological data (Table 7.2). 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 7.7. 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:

$$D_{org} = 3.17E\text{-}08 \; T \sum_{i} \sum_{P} R_{Pi} \; [\; W_P \; Q_i \;] \qquad (7.8)$$

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 7.7.
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 7.4.2.

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7.4.2 Cumulative Doses

Quarterly and annual sums of all doses are calculated for each release as described below to compare to the limits listed in ODCM Control 1.2.2.3.

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 7.4.1) 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 ODCM Control 1.2.2.3.

7.4.3 Comparison to Limits

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

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7.5 DOSE PROJECTIONS

In accordance with ODCM Surveillance Requirement 2.2.2.4, 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 ODCM Control 1.2.2.4 to determine compliance. R27

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.

7.5.1 GASEOUS RADWASTE TREATMENT SYSTEM DESCRIPTION

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

A flow diagram for the GRTS is given in Figure 7.3. The system consists of two waste-gas compressor packages, nine gas decay tanks, and the associated piping, valves, and instrumentation. Gaseous wastes are received from the following: degassing of the reactor coolant and purging of the volume control tank prior to a cold shutdown, displacing of cover gases caused by liquid accumulation in the tanks connected to the vent header, and boron recycle process operation.

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7.6 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 ODCM Administrative Control 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).

7.6.1 NOBLE GAS - GAMMA AIR DOSE

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

$$D_\gamma = \chi_{im} \, DF_{\gamma i} \qquad (7.9)$$

where:

χ_{im} = concentration of nuclide i at location m, $\mu Ci/m^3$. Air concentrations are calculated as described by Equation 7.14.

$DF_{\gamma i}$ = dose conversion factor for external gamma for nuclide i, mrad/year per $\mu Ci/m^3$ (Table 7.3). R27

7.6.2 NOBLE GAS - BETA AIR DOSE

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

$$D_\beta = \chi_{im} \, DF_{\beta i} \qquad (7.10)$$

where:

χ_{im} = concentration of nuclide i at location m, $\mu Ci/m^3$. Air concentrations are calculated as described by Equation 7.14.

$DF_{\beta i}$ = dose conversion factor for external beta for nuclide i, mrad/year per $\mu Ci/m^3$ (Table 7.3). R27

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7.6.3 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:

$$D_{org} = 3.17E\text{-}08((^X/_Q)\sum_P R_{PT}Q_T \sum_i [(^D/_Q)\sum_P R_{Pi} + (^D/_Q)R_{Gi} + (^X/_Q)R_{Ii}]Q_i) \quad (7.11)$$

where:

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

$^X/_Q$ = Relative concentration for location under consideration, s/m^3. Relative concentrations are calculated as described by Equation 7.15.

R_{PT} = ingestion dose factor for pathway P for tritium, m^2-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 7.7.7 through 7.7.12.

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), m^2-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 7.7.1 through 7.7.6.

$^D/_Q$ = Relative deposition for location under consideration, m^{-2}. Relative deposition is calculated as described in Equation 7.16.

R_{Gi} = Dose factor for standing on contaminated ground, m^2-mrem/year per µCi/s. The equation for calculating the ground plane dose factor is given in Section 7.7.14.

R_{Ii} = Inhalation dose factor, mrem/year per µCi/m^3. The equation for calculating the inhalation dose factor is given in Section 7.7.13.

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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.

$$Q_{i0} \sum_{j=1}^{9} f_j \exp(-\lambda_i \, x/u_j) \qquad (7.12)$$

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.

7.6.4 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 7.4. For each of these sector elements, R27
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 7.4). R27

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:

$$Dose_{pop} = \sum_{P} RATIO_P * POPN * AGE * 0.001 * DOSE_P \qquad (7.13)$$

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.

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= 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 7.5). R27

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 7.7.3, 7 days.

t_{cb} = time to consume a whole beef, as described in Section 7.7.3.

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.

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

7.6.5 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.

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7.7 GASEOUS RELEASES - Dose Factors

7.7.1 PASTURE GRASS-COW/GOAT-MILK INGESTION DOSE FACTORS - R_{CPi}
(m^2-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 6.4).
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 6.2).
Q_f = animal's consumption rate, kg/day.
λ_i = decay constant for nuclide i, seconds^{-1} (Table 6.2).
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/m^2.
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/m^2.

NOTE: Factors defined above which do not reference a table for their numerical values are given in Table 6.3.

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7.7.2 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 6.4).
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 6.2).
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 6.2).
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 6.3.

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7.7.3 PASTURE GRASS-BEEF INGESTION DOSE FACTORS - R_{MPi}
(m^2-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 6.4).
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 6.2).
Q_f	= cow's consumption rate, kg/day.
λ_i	= decay constant for nuclide i, seconds^{-1} (Table 6.2).
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/m^2.
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 6.3.

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7.7.4 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 6.4).
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 6.2).
Q_f = cow's consumption rate, kg/day.
λ_i = decay constant for nuclide i, $seconds^{-1}$ (Table 6.2).
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 6.3.

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

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

where:

10^6 = conversion factor, picocurie/microcurie.
DFL_{iao} = ingestion dose conversion factor for nuclide i, age group a, organ o, mrem/picocurie (Table 6.4).
λ_i = decay constant for nuclide i, seconds^{-1} (Table 6.2).
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 6.3.

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7.7.6 STORED VEGETABLE INGESTION DOSE FACTORS - 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 6.4).
λ_i = decay constant for nuclide i, seconds^{-1} (Table 6.2).
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/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 6.3.

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

7.7.7 TRITIUM-PASTURE GRASS-COW/GOAT-MILK DOSE FACTOR - R_{CTP}
(mrem/year per microcuries/m^3)

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

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 6.4).
F_{mT} = transfer factor for tritium from animal's feed to milk, days/liter (Table 6.2).
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/m^3.
f_p = fraction of time animal spends on pasture, dimensionless.
λ_T = decay constant for tritium, seconds^{-1} (Table 6.2).
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 6.3.

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

7.7.8 TRITIUM-STORED FEED-COW/GOAT-MILK DOSE FACTOR - R_{CTS}
(mrem/year per microcuries/m^3)

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

where: R25

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 6.4).
F_{fT}	= transfer factor for H-3 from cow's feed to meat, days/kg (Table 6.2).
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/m^3.
f_s	= fraction of time cow spends on stored feed, dimensionless.
λ_T	= decay constant for tritium, $seconds^{-1}$ (Table 6.2).
t_s	= transport time from slaughter to consumer, seconds.
t_{csf}	= time to consume stored feed, seconds.
t_{cb}	= time for receptor to consume a whole beef, seconds. R25

NOTE: Factors defined above which do not reference a table for their numerical values are given in Table 6.3.

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

7.7.9 TRITIUM-PASTURE GRASS-BEEF DOSE FACTOR - R_{MT}
(mrem/year per microcuries/m^3)

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

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 6.4).
F_{fT}	= transfer factor for H-3 from cow's feed to meat, days/kg (Table 6.2).
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/m^3.
f_p	= fraction of time cow spends on pasture, dimensionless.
λ_T	= decay constant for tritium, $seconds^{-1}$ (Table 6.2).
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 6.3.

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

7.7.10 TRITIUM-STORED FEED-BEEF DOSE FACTOR - R_{MTS}
(mrem/year per microcuries/m^3)

$$R_{MTS} = 10^3\ 10^6\ DFL_{Tao}\ F_{fT}\ Q_f\ U_{am}\ [0.75(0.5/H)]\ f_s\ \exp(-\lambda_T t_s)\ \frac{(1-\exp(-\lambda_T t_{ep}))}{\lambda_T\ t_{csf}}\ \frac{(1-\exp(-\lambda_T t_{cb}))}{\lambda_T\ t_{cb}}$$ R25

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 6.4).
F_{fT} = transfer factor for H-3 from cow's feed to meat, days/kg (Table 6.2).
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/m^3.
f_s = fraction of time cow spends on stored feed, dimensionless.
λ_T = decay constant for tritium, seconds^{-1} (Table 6.2).
t_s = transport time from slaughter to consumer, seconds.
t_{csf} = time to consume stored feed, seconds. R25
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 6.3.

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

7.7.11 TRITIUM-FRESH LEAFY VEGETABLES DOSE FACTOR - R_{VTF}
(mrem/year per microcuries/m^3)

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

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 6.4).
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/m^3.
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 6.2).
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 6.3.

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

7.7.12 TRITIUM-STORED VEGETABLES DOSE FACTOR - 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 6.4).
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 6.2).
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 6.3.

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

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

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

where:

DFA_{iao} = inhalation dose conversion factor for nuclide i, age group a and organ o, mrem/picocurie (Table 7.7).
BR_a = breathing rate for age group a, m^3/year (Table 6.3).
10^6 = conversion factor, picocurie/microcurie.

7.7.14 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 6.6).
λ_i = decay constant of nuclide i, $seconds^{-1}$ (Table 6.2).
10^6 = conversion factor, picocurie/microcurie.
8760 = conversion factor, hours/year.
t_b = time period over which the ground accumulation is evaluated, seconds (Table 6.3).

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

7.8 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 7.4), 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 7.2.

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.

7.8.1 AIR CONCENTRATION - X ($\mu Ci/m^3$)

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

$$X_i = \sum_{j=1}^{9} \sum_{k=1}^{7} (2/\pi)^{1/2} \frac{f_{jk} Q_i P}{\Sigma_{zk} u_j (2\pi x/n)} \exp(-\lambda_i x/u_j) \qquad (7.14)$$

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.

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Q_i = average annual release rate of radionuclide i, µCi/s.
P = fraction of radionuclide remaining in plume (Figure 7.4).
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 7.5),
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.

7.8.2 RELATIVE CONCENTRATION - X/Q (sec/m^3)

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

$$X/Q = \sum_{j=1}^{9} \sum_{k=1}^{7} (2/\pi)^{1/2} \frac{f_{jk}}{\Sigma_{zk}\ u_j\ (2\pi x/n)} \qquad (7.15)$$

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 7.5),
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.

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

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

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

$$D/Q = \sum_{j=1}^{9} \sum_{k=1}^{7} \frac{f_{jk}\, DR}{(2\pi x/n)} \qquad (7.16)$$

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 7.6).

x = downwind distance, m.

n = number of sectors, 16.

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

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Table 7.1
SQN - OFFSITE RECEPTOR LOCATION DATA

POINT		DISTANCE from plant (m)	X/Q (s/m³)	D/Q (1/m²)
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.

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Table 7.2 (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.

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Table 7.2 (2 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 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.

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Table 7.2 (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.

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Table 7.2 (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.

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Table 7.2 (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 7.2 (6 of 7)
JOINT PERCENTAGE FREQUENCIES OF WIND DIRECTION AND WIND SPEED
FOR DIFFERENT STABILITY CLASSES* R27

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.

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Table 7.2 (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	0.0	0.0	0.0	0.0	0.06
NW	0.001	0.02	0.06	0.03	0.0	0.01	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.

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Table 7.3
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 7.4
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

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Table 7.5
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

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Table 7.6 (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

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Table 7.6 (2 of 8)
INHALATION DOSE FACTORS
(mrem/pCi inhaled)

ADULT

	bone	liver	t body	thyroid	kidney	lung	gi-lli	
Sb-124	3.90E-06	7.36E-08	1.55E-06	9.44E-09	0.00E+00	3.10E-04	5.08E-05	
Sb-125	6.67E-06	7.44E-08	1.58E-06	6.75E-09	0.00E+00	2.18E-04	1.26E-05	
Sn-125	1.16E-06	3.12E-08	7.03E-08	2.59E-08	0.00E+00	7.37E-05	6.81E-05	R25
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	1.95E-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	

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

Reference:
Regulatory Guide 1.109, Table E-7.
Dose Factors for Co-57, Zn-69m, Br-82, Nb-97, Sn-125, 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. R25

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Table 7.6 (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-06	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	7.7E-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

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Table 7.6 (4 of 8)
INHALATION DOSE FACTORS
(mrem/pCi inhaled)

				TEEN				
	bone	liver	t body	thyroid	kidney	lung	gi-lli	
Sb-124	5.38E-06	9.92E-08	2.10E-06	1.22E-08	0.00E+00	4.81E-04	4.98E-05	
Sb-125	9.23E-06	1.01E-07	2.15E-06	8.80E-09	0.00E+00	3.42E-04	1.24E-05	
Sn-125	1.66E-06	4.42E-08	9.99E-08	3.45E-08	0.00E+00	1.26E-04	7.29E-05	R25
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.[illegible]E-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	

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

Reference:
Regulatory Guide 1.109, Table E-8.
Dose Factors for Co-57, Zn-69m, Br-82, Nb-97, Sn-125, 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. R25

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Table 7.6 (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	3.99E-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

Reformatting/Renumbering Changes Only

Table 7.6 (6 of 8)
INHALATION DOSE FACTORS
(mrem/pCi inhaled)

CHILD

	bone	liver	t body	thyroid	kidney	lung	gi-lli	
Sb-124	1.55E-05	2.00E-07	5.41E-06	3.41E-08	0.00E+00	8.76E-04	4.43E-05	
Sb-125	2.66E-05	2.05E-07	5.59E-06	2.46E-08	0.00E+00	6.27E-04	1.09E-05	
Sn-125	4.95E-06	9.94E-08	2.95E-07	1.03E-07	0.00E+00	2.43E-04	7.17E-05	R25
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	[illegible]	1.17E-06	0.00E+00	5.71E-09	4.71E-04	2.75E-05	
Ba-141	5.29E-11	2.95E-14	[illegible]	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	9.89E-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	

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

Reference:
Regulatory Guide 1.109, Table E-9.
Dose Factors for Co-57, Zn-69m, Br-82, Nb-97, Sn-125, 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. R25

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Table 7.6 (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	6.93E-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

Reformatting/Renumbering Changes Only

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Table 7.6 (8 of 8)
INHALATION DOSE FACTORS
(mrem/pCi inhaled)

INFANT

	bone	liver	t body	thyroid	kidney	lung	gi-lli	
Sb-124	2.71E-05	3.97E-07	8.56E-06	7.18E-08	0.00E+00	1.89E-03	4.22E-05	
Sb-125	3.69E-05	3.41E-07	7.78E-06	4.45E-08	0.00E+00	1.17E-03	1.05E-05	
Sn-125	1.01E-05	2.51E-07	6.00E-07	2.47E-07	0.00E+00	6.43E-04	7.26E-05	R25
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	4.03E-08	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	

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

Reference:

Regulatory Guide 1.109, Table E-10.

Dose Factors for Co-57, Zn-69m, Br-82, Nb-97, Sn-125, 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. R25

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Figure 7.1
GASEOUS EFFLUENT RELEASE POINTS

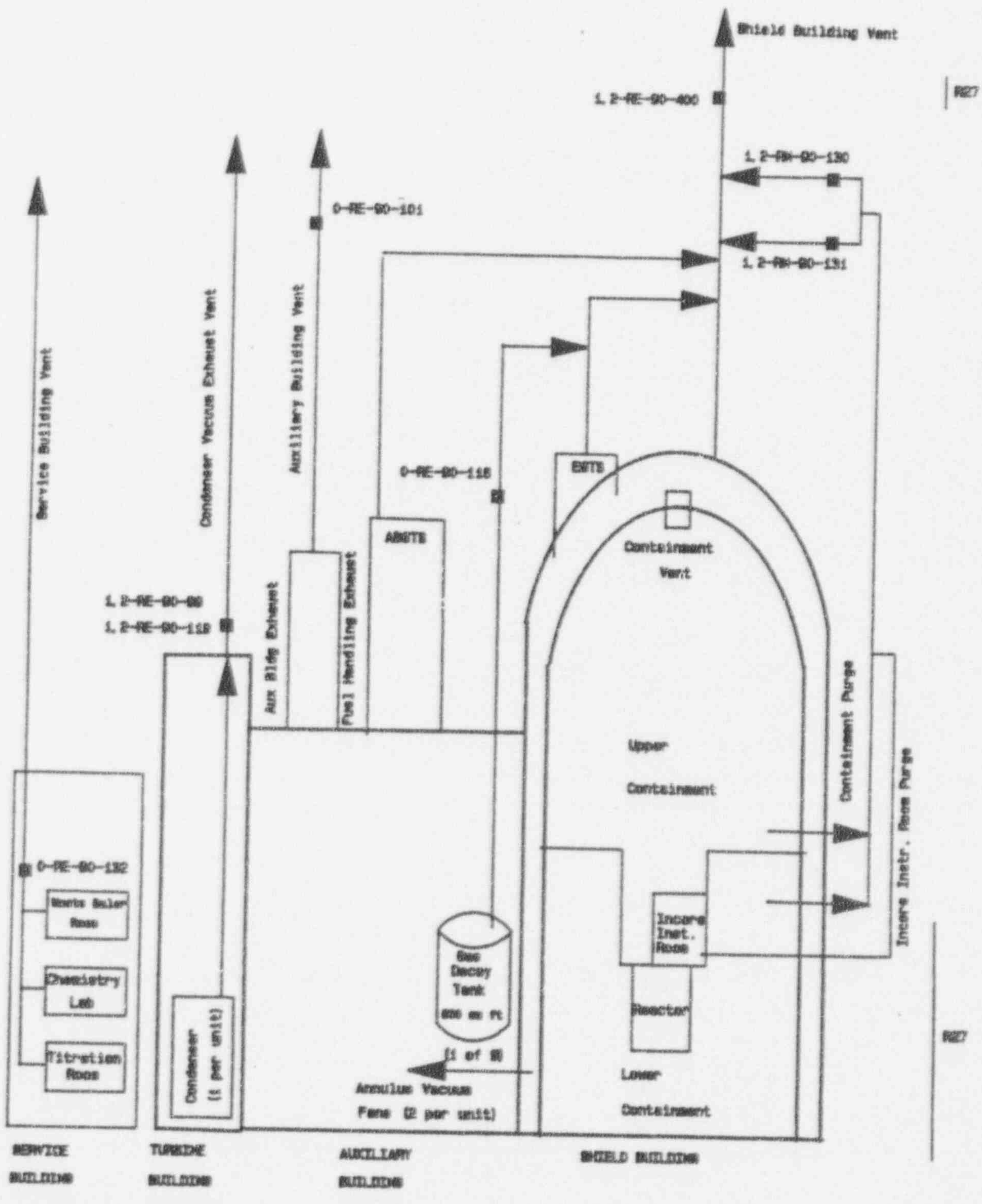
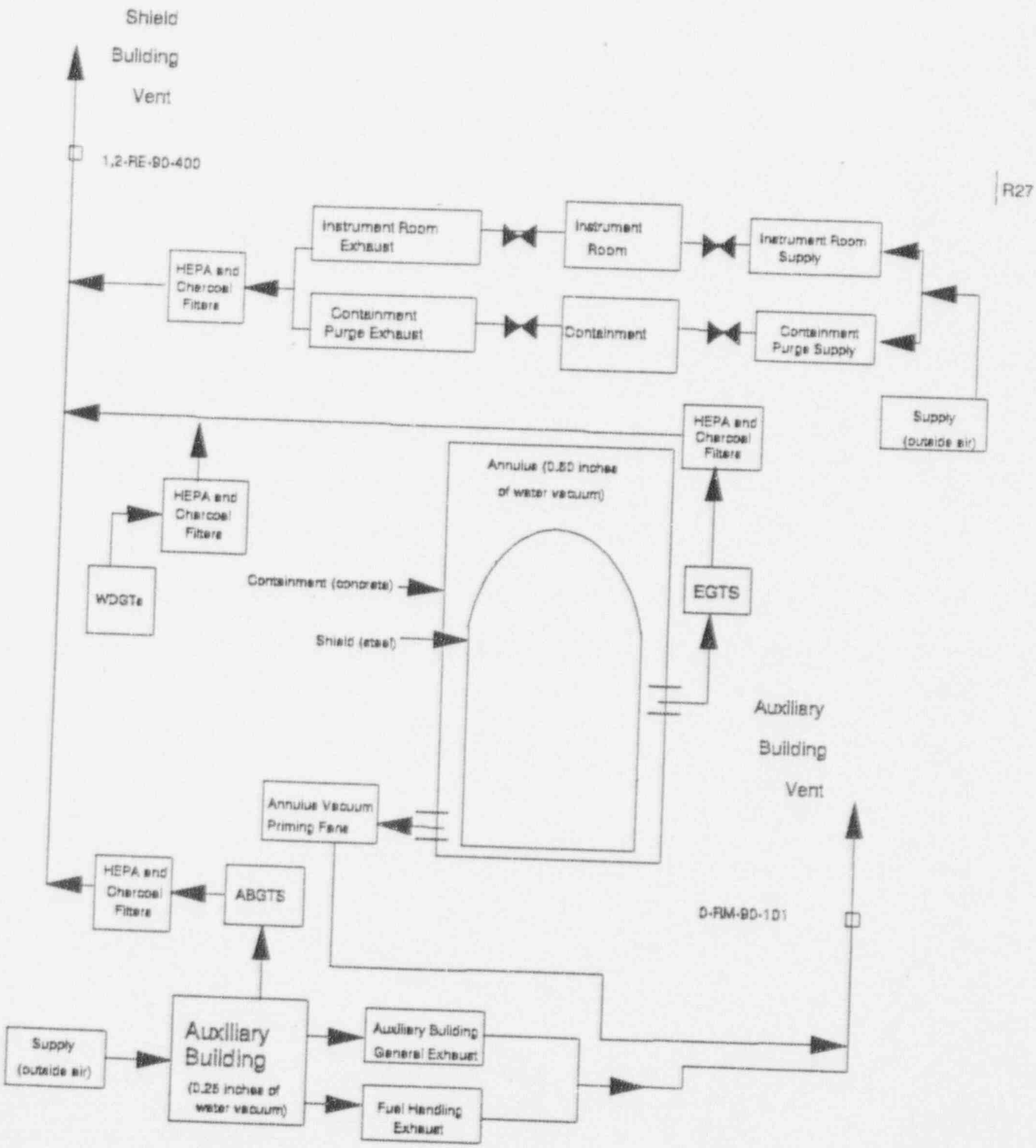
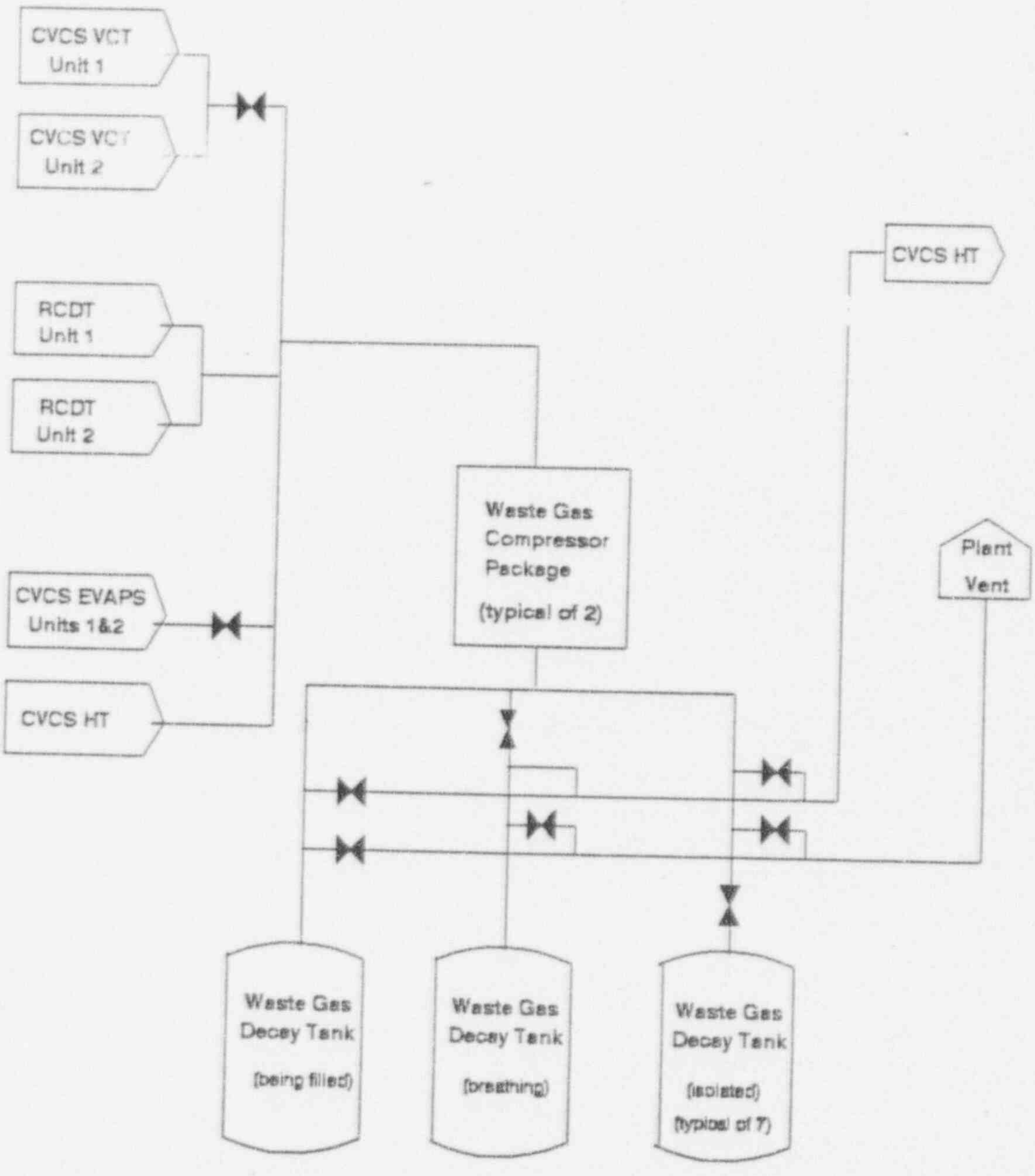


Figure 7.2
AUXILIARY AND SHIELD BUILDING VENTS (DETAIL)



OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Figure 7.3
GASEOUS RADWASTE TREATMENT SYSTEM



R27

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Figure 7.4
PLUME DEPLETION EFFECT FOR GROUND LEVEL RELEASES
(All Stability Classes)

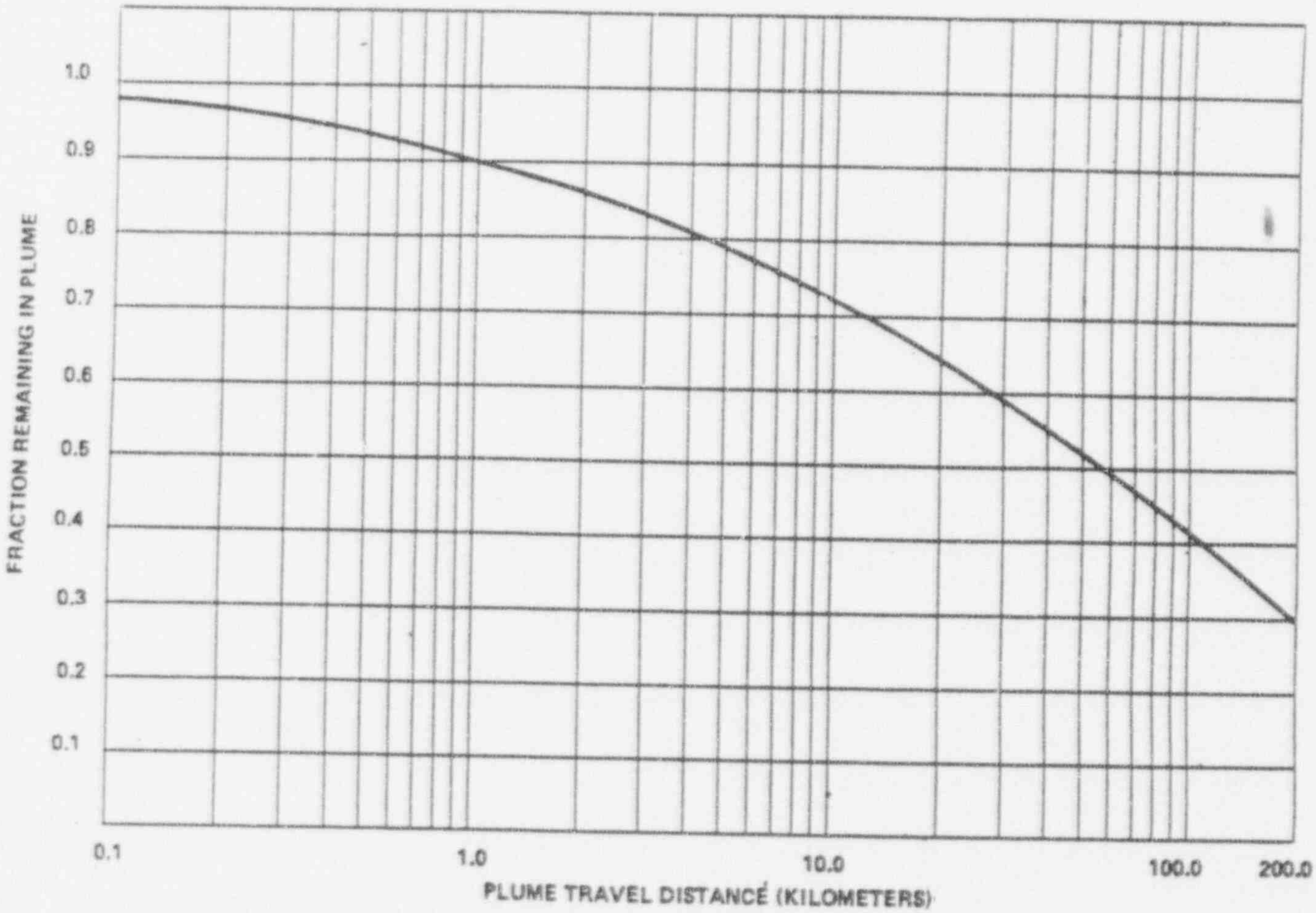


Figure 7.5
VERTICAL STANDARD DEVIATION OF MATERIAL IN A PLUME

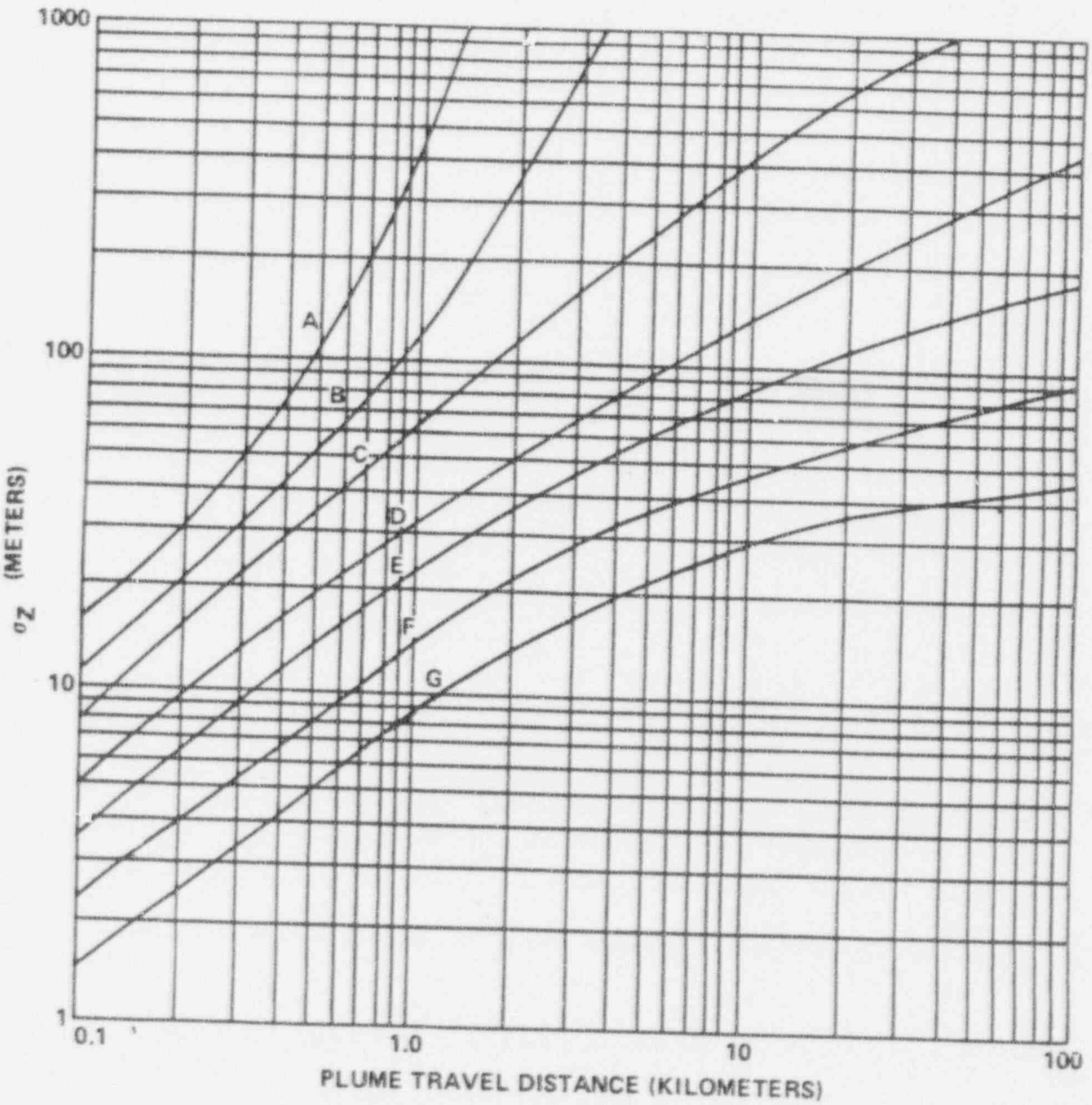
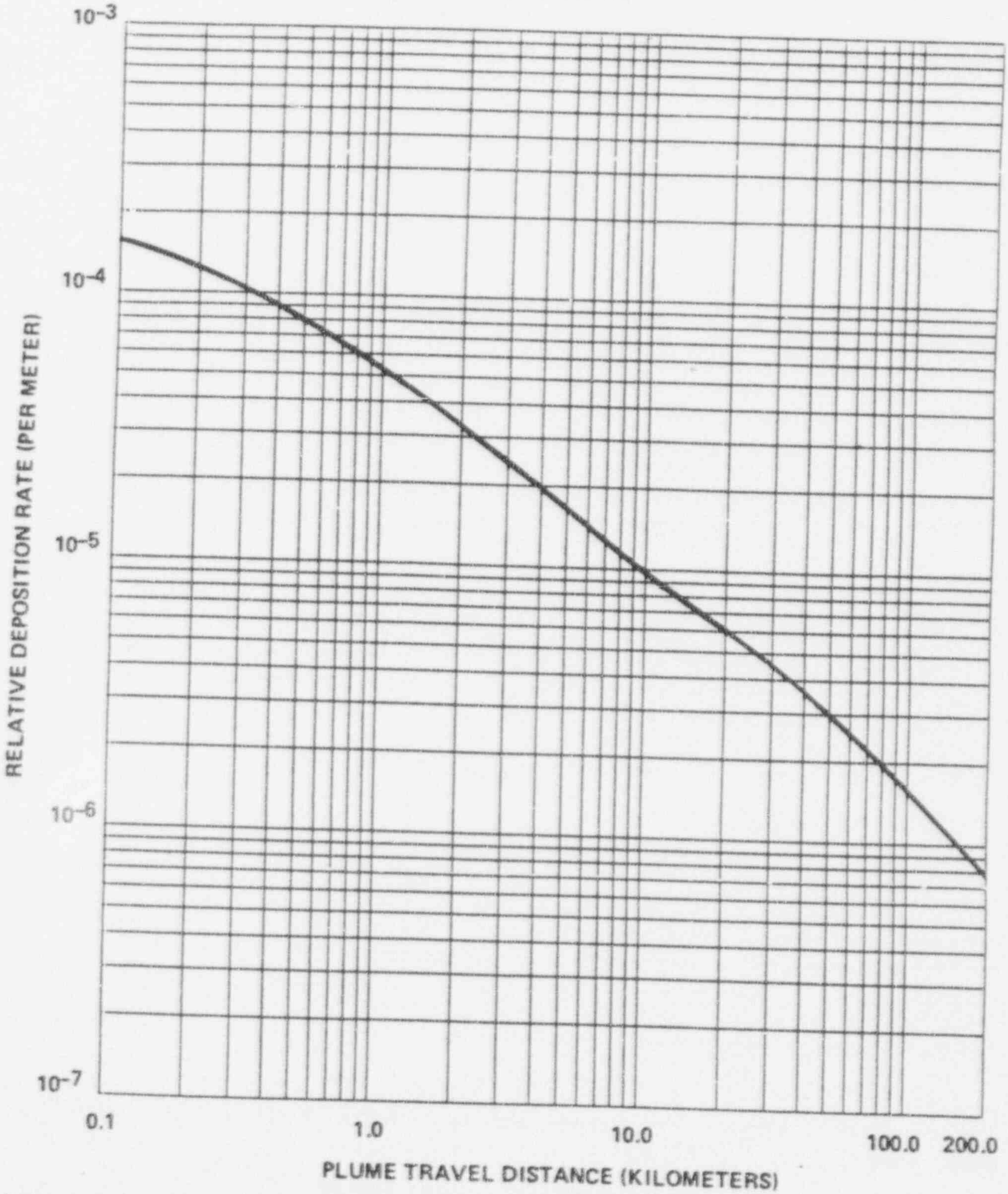


Figure 7.6
RELATIVE DEPOSITION FOR GROUND LEVEL RELEASES
(All Stability Classes)



SECTION 8.0

TOTAL DOSE

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

8.1 ANNUAL MAXIMUM INDIVIDUAL DOSES - TOTAL REPORTED DOSE

To determine compliance with 40 CFR 190 as required in ODCM Administrative Control 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.

SECTION 9.0

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

9.1 MONITORING PROGRAM

An environmental radiological monitoring program shall be conducted in accordance with ODCM Control 1.3.1. The monitoring program described in Tables 9.1, 9.2, and 9.3, and in Figures 9.1, 9.2 and 9.3 shall be conducted. Results of this program shall be reported in accordance with ODCM Administrative Control 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.

9.2 DETECTION CAPABILITIES

Analytical techniques shall be such that the detection capabilities listed in Table 2.3-3 are achieved. R27

9.3 LAND USE CENSUS

A land use survey shall be conducted in accordance with Control 1.3.2. The results of the survey shall be reported in the Annual Radiological Environmental Operating Report.

9.4 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.

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Table 9.1 (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.	Once per 92 days	Gamma dose at least once per 92 days

* Sample locations are listed in Table and 9.3 and shown on Figures 9.1, 9.2 and 9.3

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Table 9.1 (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 placed at stations located >5 miles from the plant in each of the 16 sectors 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) 1 sample from groundwater source up-gradient	At least once per 92 days	Gross beta and gamma scan, Sr-89 Sr-90 and H-3 analysis at least once per 92 days	
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.	R25

* Sample locations are listed in Tables 9.2 and 9.3 and shown on Figures 9.1, 9.2 and 9.3

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

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Table 9.1 (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 Drinking (continued)	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.		R25
Sediment	TRM 496.5, 483.4, 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 high- 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	At least once per 15 days	Gamma isotopic and I-131 analysis of each sample. Sr-89, Sr-90 once per quarter	

* Sample locations are listed in Tables 9.2 and 9.3 and shown on Figures 9.1, 9.2 and 9.3

** 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.

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Table 9.1 (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 Milk (continued)	At least 1 sample from a control location			
Fish	1 sample each from 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	R28
Invertebrates (Asiatic Clams)	1 sample downstream from plant discharge** 1 sample upstream from the plant**	At least once per 184 days	Gamma scan on edible portion	R28
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) Control sample from one control dairy farm (Farm S)	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.	R25 R25 R25

* Sample locations are listed in Tables 9.2 and 9.3 and shown on Figures 9.1, 9.2 and 9.3

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

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Table 9.2 (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	2.0	I	AP, CF, S	R28
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, V	R25
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	

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Table 9.2 (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]	
						R28
46	TRM 471-530 (Chickamauga Reservoir)	--	--	I/C	F, CL	R25
47	TRM 530-602 (Watts Bar Reservoir)	--	--	C	F	
48	Farm H	NE	4.2	I	M	

[a] See figures 9.1, 9.2, and 9.3 R27

[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.

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Table 9.3 (1 of 2)
THERMOLUMINESCENT DOSIMETRY LOCATIONS

Map Location Number	Station	Sector	Approximate Distance (Miles)	Onsite (On)[a] or Offsite (Off)	
3	SSW-1C	SSW	2.0	On	R28
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	0.3	On	R25
62	ESE-1	ESE	1.2	On	
63	ESE-2	ESE	4.9	Off	
64	SE-A	SE	0.4	On	
65	E-A	E	0.3	On	R25
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	

[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.

OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

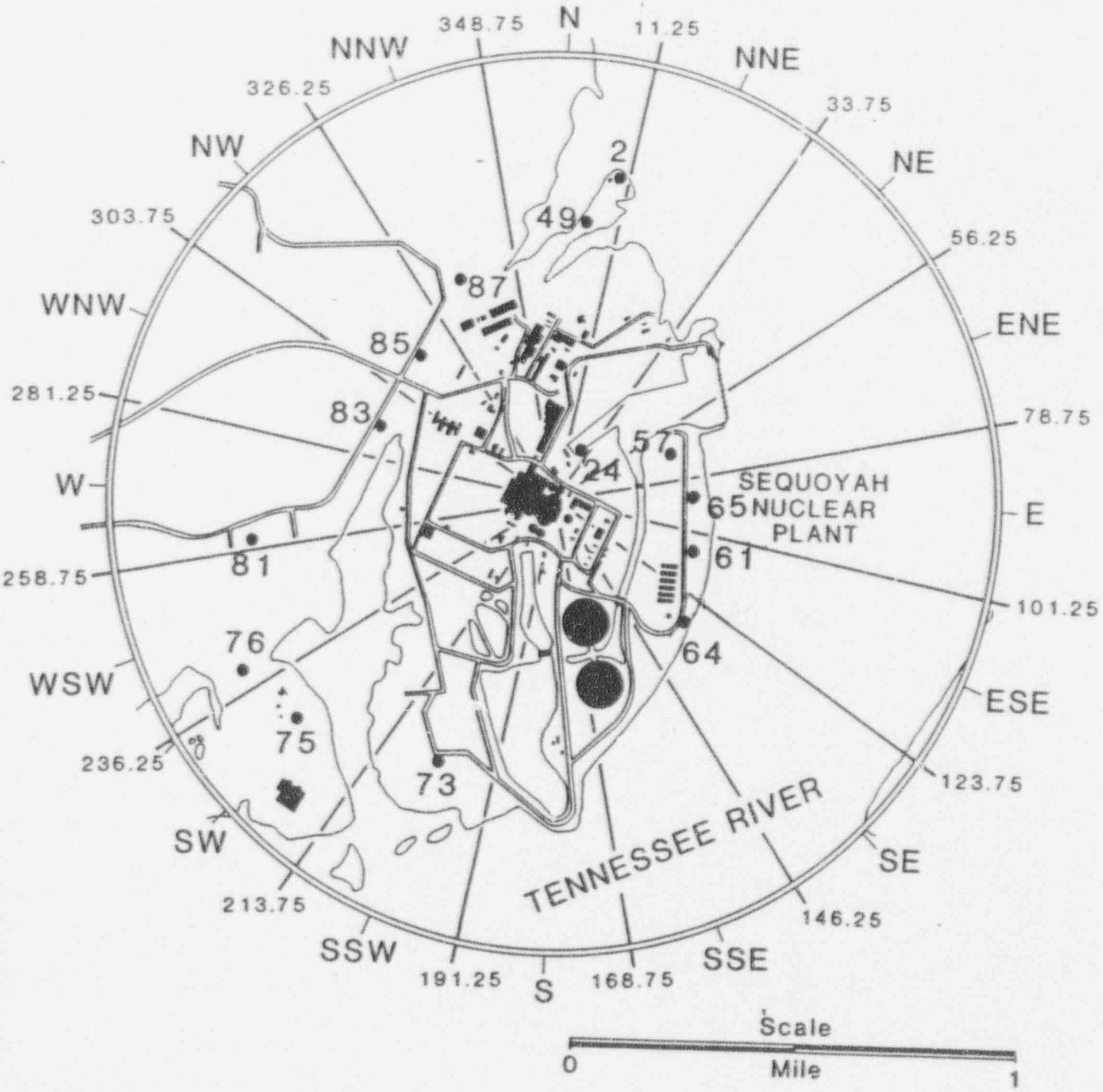
Table 9.3 (2 of 2)
THERMOLUMINESCENT DOSIMETRY LOCATIONS

Map Location Number	Station	Sector	Approximate Distance (Miles)	Onsite (On)[a] or Offsite (Off)
75	SW-1	SW	0.9	On
76	WSW-1	WSW	0.9	On
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
90	SSW-1B	SSW	1.5	On R28

[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.

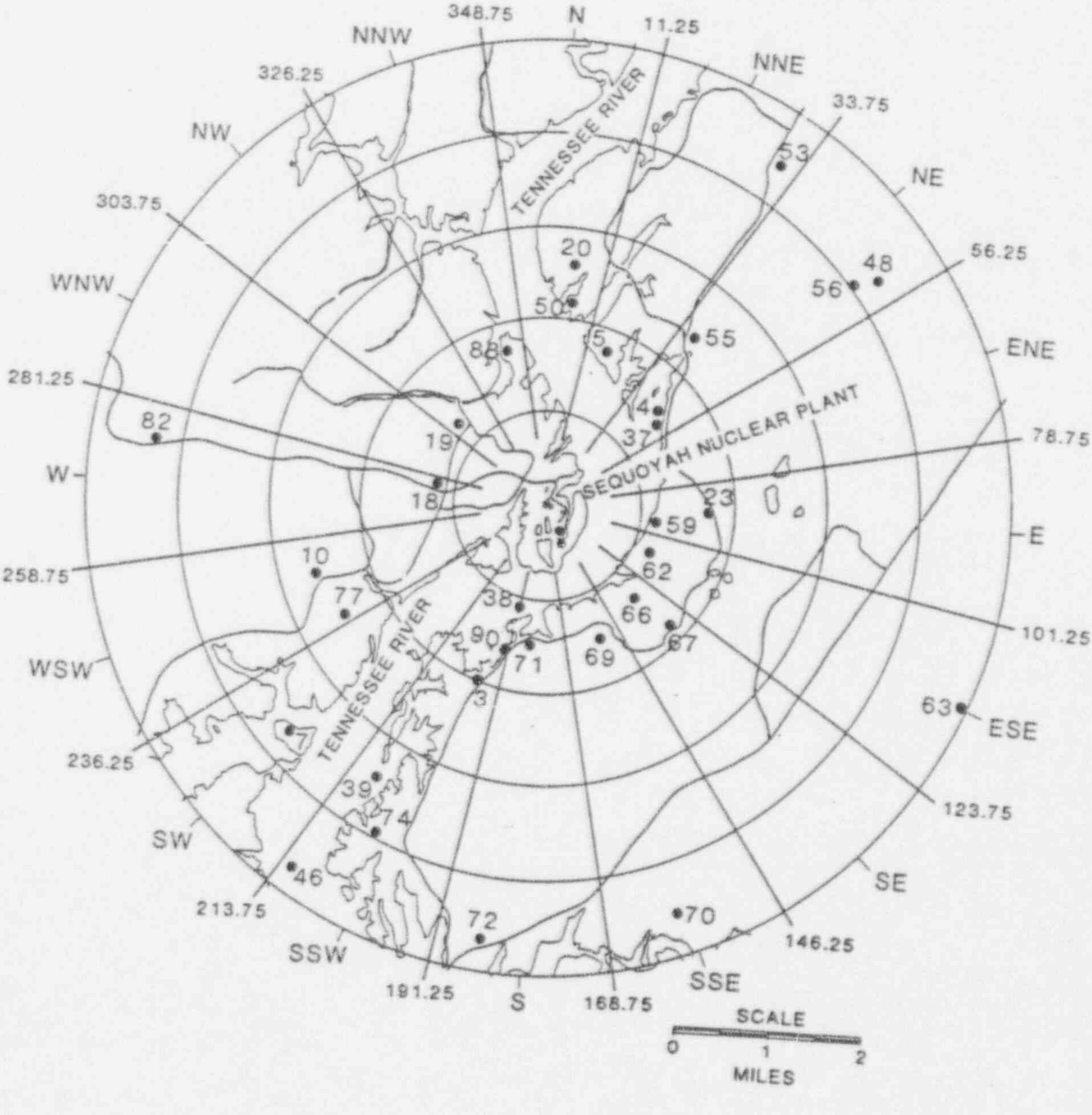
OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Figure 9.1
ENVIRONMENTAL MONITORING LOCATIONS
WITHIN ONE MILE OF THE PLANT



OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Figure 9.2
ENVIRONMENTAL MONITORING LOCATIONS
FROM ONE TO FIVE MILES FROM THE PLANT



OFFSITE DOSE CALCULATION/ENVIRONMENTAL MONITORING METHODOLOGIES

Figure 9.3
ENVIRONMENTAL MONITORING LOCATIONS
GREATER THAN FIVE MILES FROM THE PLANT