DRAFT OF CRYSTAL RIVER - UNIT 3

OFFSITE DOSE CALCULATION MANUAL

APRIL 19, 1979

(for use with Draft of Crystal River - Unit 3 Technical Specifications, April 19, 1979, Based on NUREG-0472, Revision 2, February 1978)

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1.0 Introduction

This Offsite Dose Calculation Manual (ODCM) describes the methodology and parameters to be used in the calculation of offsite doses due to radioactive gaseous and liquid effluents and in the calculation of gaseous and liquid effluent monitoring instrumentation alarm/trip setpoints consistent with the applicable Limiting Conditions for Operation (LCOs) contained in the Appendix A Technical Specifications for Crystal River Unit 3.

2.0 Radfioactive Liquid Effluent Instrumentation Setpoint (Specification 3.3.3.8)

3.0 Radoiactive Gaseous Process and Effluent Instrumentation Setpoints (Specification 3.3.3.9)

The radiological effluent Technical Specifications require alarm/trip setpoints for radiation monitors and flow measurement devices for each effluent line. Setpoint values are to be calculated to assure that alarm and trip actions occur prior to exceeding the limits of 10 CFR 20 at the release point to the unrestricted area. The calculated alarm and trip action setpoints to be specified in the ODCM for each radioactive liquid effluent line monitor and flow measurement device must satisfy the following equation:

$$\frac{cf}{F+f} \leq C$$

where:

C = the effluent concentration limit (Specification 3.11.1) implementing 10 CFR 20 for the site, in µCi/ml

c = The setpoint, in µCi/ml, of the radioactivity monitor measuring the radioactivity concentration in the effluent line prior to dilution and subsequent release; the setpoint, which is proportional to the volumetric flow of the effluent line and inversely proportional to the volumetric flow of the dilution stream plus the effluent stream, represents a value which, if exceeded, would result in concentrations exceeding the limits of 10 CFR 20 in the unrestricted area

f = the flow setpoint as measured at the radiation monitor location, in volume per unit time, but in the same units as F, below

F = the dilution water flow setpoint as measured prior to the release point, in volume per unit time.

(Note that if no dilution is provided, $c \leq C$. Also, note that when (F) is large compared to (f), then $F+f \simeq F$.)

The equation is satisfied when the following alarm/trip setpoints are provided for each effluent line in the ODCM:

$f \leq \frac{CF}{c}$ (in ml/sec; for example).

$F \leq \frac{cf}{C}$ (in ml/sec; for example).

$c \leq \frac{CF}{f}$ (in µCi/ml; for example).

Some plants may be operated using a fixed value for o[illegible] re of these three variables, c, f or F.

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Example 1

By using a constant capacity radwaste system discharge pump (on the undiluted stream) the value of (f) is fixed; therefore, the setpoints to be given are:

$f =$ ______________________ ml/sec (fixed)

$F >$ ______________________ ml/sec = cf/C

$c =$ ______________________ xF μCi/ml $\leq CF/f$

If $c = 3\times10^{-8}$ μCi/ml, $f = 4000$ ml/sec and $F > 4\times10^{6}$ ml/sec, the radiation monitor setpoint is calculated as follows:

$$c \leq CF/f$$

$$= \frac{(3\times10^{-8})F}{4000} = 7.5\times10^{-12}F \text{ μCi/ml.}$$

If F is measured at some value in excess of the limiting value (the limiting value is 4×10^{6} ml/sec in this example), then c may be established proportionately. If $F = 8\times10^{6}$ ml/sec, the alarm setpoint is:

$$c = 7.5\times10^{-12}F(\text{μCi/ml per ml/sec})(\text{ml/sec})$$

$$= 7.5\times10^{-12}\ (8\times106) = 6\times10^{-5} \text{ μCi/ml.}$$

In this case, the alarm setpoint for the radioactive liquid effluent line nomitor can be established at 6×10^{-5} μCi/ml, provided that an automatic isolation/control trip action occurs to satisfy the condition:

$$c/F < 7x5\times10^{-12} \text{ μCi/ml per ml/sec.}$$

Example 2

By using a constant capacity dilution pump (on the dilution stream prior to a mixing box), the value of (F) is fixed; therefore, the setpoints to be given are:

$f <$ ______________________ ml/sec = CF/c

$F =$ ______________________ ml/sec (fixed)

$c =$ ______________________ x (1/f)μCi/ml $\leq CF/f$

If $C = 3\times10^{-8}$ μCi/ml, $F = 4\times10^{6}$ ml/sec and $f < 4000$ ml/sec, the radiation monitor setpoint is calculated as follows:

$$c \leq CF/f$$

$$= \frac{(3\times10^{-8} \times 4\times10^{6})}{f} = 0.12(1/f) \text{ μCi/ml.}$$

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If f is measured at some value less than the limiting value (the limiting value is 4000 ml/sec in this example), then c may be established proportionately. If f = 1000 ml/sec, the alarm setpoint is:

$$c = 0.12(1/f)(\mu Ci/sec)(sec/ml)$$

$$= \frac{0.12}{1000} = 1.2\text{x}10^{-4}\ \mu Ci/ml.$$

In this case, the alarm setpont for the radioactive liquid effluent line monitor can be established at $1.2\text{x}10^{-4}$ μCi/ml, <u>provided</u> that an automatic isolation/control trip action occurs to satisfy the condition:

$$cf > 0.12\ \mu Ci/sec.$$

<u>Value of c</u>

A detailed description of the method to be used to obtain the value of (c) should be provided. Since (c) is dependent on the radionuclide distribution, yields, calibration and the monitor's parameters, each of these variables should be considered and the fixed or adjustable setpoint method of determination described for each effuent monitor. This may be accomplished by tabulation.

4.0 Radioactive Liquid Effluent Dose Calculations

4.1 Radioactive Liquid Effluent Cumulative Dose (Specification 4.11.1.2)

The dose contributions for the total time period $\sum_{\ell=1}^{m} \Delta t_\ell$ shall be determined by calculation at least once per 31 days and a cumulative summation of these total body and any organ doses shall be maintained for each calendar quarter. These dose contributions shall be calculated for all radionuclides identified in liquid effluents released to unrestricted areas using the following expression:

$$D_t = \sum_i [A_{it} \sum_{\ell=1}^{m} \Delta t_\ell \, C_{i\ell} \, F_\ell]$$

where:

D_t = the cumulative dose or dose commitment to the total body or an organ t from the liquid effluents for the total time period $\sum_{\ell=1}^{m} \Delta t_\ell$ in mrem

Δt_ℓ = the length of the ℓ^{th} time period over which $C_{i\ell}$ and F_ℓ are averaged for all liquid releases, in hours.

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

A_{it} = the site related ingestion dose or dose commitment factor to the total body or any organ t for each identified principal gamma and betta emitter listed in Table 4.1-1, in mrem-ml per hr-µCi.

F_ℓ = the near field average dilution factor for $C_{i\ell}$ during any liquid effluent release. Defined as the ratio of the maximum undiluted liquid waste flow during release to the produce of the average flow from the site discharge structure to unrestricted receiving water times 1.0.

For radionuclides not determined in each batch or weekly composite, the dose contribution to the current calendar quarter cumulative summation may be approximated by assuming an average monthly concentration based on the previous monthly or quarterly composite analyses. However, for reporting purposes, the calculated dose contributions shall be based on the actual composite analyses.

The dose factor A_{it} for each nuclide, i, embodies the dose factors, pathway transfer factors (e.g., bioaccumulation factors), pathway usage factors, and dilution factors for the points of pathway origin. The adult total body dose factor and the <u>maximum</u> adult organ dose factor for each radionuclide will be used from Table E-11 of Regulatory Guide 1.109; thus the list contains critical organ dose factors for various organs. The dose factor is written:

$$A_{it} = k_o(U_w/D_w + U_f BF_i + U_i BI_i)DF_i$$

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where:

A_{it} = composite dose parameter for the total body or critical organ of an adult for nuclide, i, for all appropriate pathways, mrem/hr per µCi/ml.

k_o = units conversion factor, $1.14 \times 10^5 = 10^6$ pCi/µCi x 10^3ml/kg ÷ 8750 hr/yr.

U_w = 730 kg/hr, adult water consumption (fresh water site only).

U_f = 21 kg/hr, adult fish consumption (all sites).

U_i = 5 kg/yr, adult invertebrate consumption (salt water site only).

BF_i = Bioaccumulation factor for nuclide, i, in fish (fresh or salt water site, as applicable), pCi/kg per Ci/l, from Table A-1 of Regulatory Guide 1.109 (Rev. 1, 10/77).

BI_i = Bioaccumulation factor for nuclide, i, in invertebrates (salt water only), pCi/kg per pCi/l, from Table A-1 of Regulatory Guide 1.109 (Rev. 1, 10/77).

DF_i = Dose conversion factor for nuclide, i, for adults in pre-selected organ, t, in mrem/pCi, from Table E-11 of Regulatory Guide 1.109 (Rev. 1, 10/77).

D_w = Dilution factor from the near field area within one-quarter mile of the release point(s) to the potable water intake for the adult water consumption (fresh water site only).

Inserting the usage factors of Regulatory Guide 1.109 (Rev. 1, 10/77) as appropriate into the equation gives the following expression:

$$A_{it} = 1.14 \times 10^5 (21 BF_i + 5 BI_i) DF_i$$

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Table 4.1-1

LIQUID EFFLUENT INGESTION DOSE FACTORS

Radionuclide	BF (ℓ/kg)	BI (ℓ/kg)	Critical Organ	DF (mrem/pCi)	A_{it} Dose or Dose Commitment Factors (mrem-ml per hr-μCi)	
					Total Body	Critical Organs
H-3	9.0E-01	9.3E-01	All	1.05E-07	2.80E-01	2.80E-01
Na-24	6.7E-02	1.9E-01	All	1.70E-06	4.60E-01	4.60E-01
P-32	2.9E+04	3.0E+04	Bone	1.93E-04	6.45E+05	1.67E+07
Cr-51	4.0E+02	2.0e+03	GI-LLI	6.69E-07	5.58E+00	1.40E+03
Mn-54	5.5E+02	4.0E+02	GI-LLI	1.40E-05	1.35E+03	2.16E+04
Fe-55	3.0E+03	2.0E+04	Bone	2.75E-06	8.23E+03	5.11E+04
Fe-59	3.0E+0[illegible]	2.0E+04	GI-LLI	3.40E-05	7.27E+04	6.32E+05
Co-58	1.0E+02	1.0E+03	GI-LLI	1.51E-05	1.35E+03	1.22E+04
Co-60	1.0E+02	1.0E+03	GI-LLI	4.02E-05	3.82E+05	3.25E+04
Zn-65	2.0E+03	5.0E+04	Liver	1.54E-05	2.32E+05	5.13E+05
Sr-89	2.0E+00	2.0E+01	Bone	3.08E-04	1.43E+02	4.99E+03
Sr-90	2.0E+00	2.0E+01	Bone	7.58E-03	3.01E+04	1.23E+05
Zr-95	2.0E+02	8.0E+01	GI-LLI	3.09E-05	3.50E+00	1.62E+04
Nb-95	3.0E+04	1.0E+02	GI-LLI	2.10E-05	1.34E+02	1.51E+06
Mo-99	1.0E+01	1.0E+01	GI-LLI	9.99E-06	2.43E+01	2.96E+02
Tc-99M	1.0E+01	5.0E+01	GI-LLI	4.13E-07	5.00E-01	2.17E+01
Ag-110m			GI-LLI	6.04E-05	2.55E-01	1.75E+02
I-131	1.0E+01	5.0E+01	Thyroid	1.95E-03	1.79E+02	1.02E+05
I-132	1.0E+01	5.0E+01	Thyroid	1.90E-05	1.00E+01	9.96E+02
I-133	1.0E+01	5.0E+01	Thyroid	3.63E-04	3.95E+01	1.90E+04
I-135	1.0E+01	5.0E+01	Thyroid	7.65E-05	2.24E+01	4.01E+03
Cs-134	4.0E+01	2.5E+01	Liver	1.48E-04	1.33E+04	1.63E+04
Cs-137	4.0E+01	2.5E+01	Liver	1.09E-04	7.85E+03	1.20E+04
Ba-140	1.0E+01	1.0E+02	GI-LLI	4.18E-05	1.08E+02	3.38E+03
La-140	2.5E+01	1.0E+03	GI-LLI	9.25E-05	2.00E-01	5.83E+04
Ce-141	1.0E+01	6.0E+02	GI-LLI	2.42E-05	3.00E-01	8.86E+03
Ce-144	1.0E+01	6.0E+02	GI-LLI	1.65E-04	9.60E+00	6.04E+04
Np-239	1.0E+01	1.0E+01	GI-LLI	2.40E-05	1.91E-03	7.11E+02

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4.2 Radioactive Liquid Effluent Projected Dose (Specification 4.11.1.3)

5.0 Radioactive Gaseous Effluent Dose Calculations

5.1 Radioactive Gaseous Effluent Noble Gas Dose Rate (Specification 4.11.2.1.1)

a. Release rate limit for noble gases:

$$\sum_i [K_i \, (\overline{x/Q}) \, \dot{Q}_i] < 500 \text{ mrem/yr, and}$$

$$\sum_i [(L_i + 1.1 \, M_i)(\overline{x/Q}) \, \dot{Q}_i)] < 3000 \text{ mrem/yr}$$

mrem/yr

where:

K_i = The total body dose factor due to gamma emissions for each identified noble gas radionuclide, in mrem/yr per $\mu Ci/m^3$.

L_i = The skin dose factor due to beta emissions for each identified noble gas radionuclide, in mrem/yr per $\mu Ci/m^3$.

M_i = The air dose factor due to gamma emissions for each identified noble gas radionuclide, in mrad/yr per $\mu Ci/m^3$ (unit conversion constant of 1.1 mrem/mrad converts air dose to skin dose).

$\dot{Q}_i$ = The release rate of radionuclides, i, add in gaseous effluent from all release points at the site in μCi/sec.

$(\overline{x/Q})$ = _____ sec/m^3. The highest calculated annual average relative concentration for any area at or beyond the exclusion area boundary.

5.2 Gaseous Effluents Other than Noble Gas Dose Rate (Specification 4.11.2.1.4)

Release rate limit for all radionuclides and radioactive materials in particulate form and radionuclides other than noble gases:

$$\sum_i P_i \, [W \, \dot{Q}_i] < 1500 \text{ mrem/yr}$$

where:

P_i = The dose factor for radioiodines, radioactive materials in particulate form and radionuclides other than noble gases for the inhalation pathway, in mrem/yr per $\mu Ci/m^3$ and for the food and ground plane pathways in m^2 (mrem/yr) per μCi/sec from Table 4.11-4. The dose factors are based on the critical individual organ and most restrictive age group (infant).

W = The high calculated annual average dispersion parameter for estimating the dose to an individual at the controlling location:

W = _____ sec/m^3, for the inhalation pathway. The location is the exclusion area boundary in the __________ sector.

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W = ____ meter^{-2}, for th food and ground plant pathways. The location is the exclusion area boundary in the ________ sector.

$\dot{Q}_i$ = The release rate of radionuclides, i, add in gaseous effluent from all release points at the site in μCi/sec.

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SPECIAL NOTES: (1) In all cases, the tritium releases use the first W parameter, based on relative concentration (sec/m^3). (2) All radioiodines are assumed to be released in elemental form. If analysis includes the capability of determining elemental and nonelemental forms in all releases, the food pathway parameter may be adjusted accordingly.

The dose rate from the ith radionuclide (except tritium) is:

$$P_i(\text{inhalation})(\overline{X/Q})\ Q + [P_i(\text{food}) + P_i(\text{ground plant})]\ (\overline{D/Q})\ Q\ (\text{mrem/yr})$$

and for tritium, is:

$$P_i(\text{inhalation})(\overline{X/Q})\ Q + P_i(\text{food})(\overline{X/Q})\ Q = 3.0 \times 10^3(\overline{X/Q})\ Q\ (\text{mrem/yr})$$

Calculation of P_i (Inhalation)

$$P_i = K'(BR)\ DFA_i\ (\text{mrem/yr per } \mu Ci/m^3)$$

where:

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

BR = the breathing rate of the infant age group, in m^3/yr.

DFA_i = the maximum organ inhalation dose factor for the infant age group for the ith radionuclide, in mrem/pCi. The total body is considered as an organ in the selection of DFA_i.

The age group considered is the infant group. The infant's breathing rate is taken as 1400 m^3/yr from Table E-5 of Regulatory Guide 1.109 (Rev. 1, 10/77). The inhalation dose factors for the infant, DFA_i are presented in Table E-10 of Regulatory Guide 1.109, in units of mrem/pCi.

Resolution of the units yields:

$$P_i\ (\text{inhalation}) = 1.4 \times 10^9\ DFA_i$$

Calculation of P_i (Ground Plane)

$$P_i = K'K''DFG_i\ (1-e^{-\lambda_i t})\lambda_i\ (m^2.\text{mrem/yr per } \mu Ci/sec)$$

where:

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

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

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

t = the exposure period, 3.15×10^7 sec (1 year).

DFG_i = the ground plane dose conversion factor for the ith radionculide (mrem/hr per pCi/m^2).

The deposition rate onto the ground plane results in a ground plane concentration that is assumed to persist over a year with radiological decay the only operating removal mechanism for each radionuclide. The ground plane dose conversion factors for the ith radionuclide, DFG_i, are presented in Table E-6 of Regulatory Guide 1.109 (Rev. 1, 10/77), in units of mrem/hr per pCi/m^2).

Resolution of the units yields:

$$P_i \text{ (Ground)} = 8.76 \times 19^9 \, DFG_i \, (1-e^{-\lambda_i t})/\lambda_i.$$

Calculation of P_i (Food)

$$P_i = K'r \frac{Q_F(U_{ap})}{Y_p(\lambda_i+\lambda_w)} F_m \, DFL_i \, [e^{-\lambda_i t_f}] \, (m^2 \cdot \text{mrem/yr per } \mu\text{Ci/sec})$$

where:

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

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

U_{ap} = The infant's milk consumption rate, in liters/yr.

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

F_m = the stable element transfer coefficients, in days/liter.

r = fraction of deposited activity retained on cow's feed grass.

DFL_i = the maximum organ ingestion dose factor for the ith radionuclide, in mrem/pCi.

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

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

t_f = the transport time from pasture to cow, to milk, to infant, in sec.

A fraction of the airborne deposition is captured by the ground plant vegetation cover. The captured material is removed from the vegetation (grass) by both radiological decay and weathering processes.

The values of Q_F, U_{ap}, and Y_p are provided in Regulatory Guide 1.109 (Rev. 1, 10/77), Tables E-3, E-5, and E-15, as 50 kg/day, 330 liters/day and 0.7 kg/m^2 respectively. The value t_f is provided in Regulatory Guide 1.109 (Rev. 1, 10/77), Table E-15, as 2 days (1.73×10^5 seconds). The fraction, r, has a value of 1.0 for radioiodines and o.2 for particulates, as presented in Regulatory Guide 1.109, (Rev. 1, 10/77), Table E-15.

Table E-1 of Regulatory Guide 1.109 (Rel, 10/77) provides the stable element transfer coefficients, F_m, and Table E-14 provides the ingestion dose factors, DFL_i, for the infant's organs. The organ with the maximum value of DFL_i is to be used.

Resolution of the units yields:

$$P_i \text{ (food)} = 2.4 \times 10^{10} \frac{rF_m}{\lambda_i + \lambda_w} DFL_i [e^{-\lambda_i t_f}] (m^2 \text{.mrem/yr per } \mu Ci/sec)$$

for all radionuclides, except tritium.

The concentration of tritium in milk is based on its airborne concentration rather than the deposition rate.

$$P_i = K'K''F_m Q_F U_{ap} DFL_i \, [0.75(0.5/H)] \text{ (mrem/yr per } \mu Ci/m^3)$$

where:

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

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

0.75 = the fraction of total feed that is water.

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

From Table E-1 and E-14 of Regulatory Guide 1.109 (Rev. 1, 10/77), the values of F_m and DFL_i for tritium are 1.0×10^{-2} day/liter and 3.08×10^{-7} mrem per pCi, respectively. Assuming an average absolute humidity of 8 grams/meter^3, the resolution of units yields:

$$P_i \text{ (food)} = 2.4 \times 10^3 \text{ mrem/yr per } \mu Ci/m^3$$

for tritium, only.

5.3 Radioactive Gaseous Effluent Noble Gas Cumulative Dose (Specification 4.11.2.2)

The air dose due to noble gases released in gaseous effluents from the site shall be limited during any calendar quarter to the following expressions:

For gamma radiation:

$$3.17 \times 10^{-8} \sum_i M_i \left((\overline{x/Q})\, Q_i + (\overline{x/q})\, q_i \right) \leq 5 \text{ mrad, and}$$

for beta radiation:

$$3.17 \times 10^{-8} \sum_i N_i \left((\overline{x/Q})\, Q_i + (\overline{x/q})\, q_i \right) \leq 10 \text{ mrad}$$

where:

3.17×10^{-8} = The inverse of the number of seconds in a year.

M_i = The air dose factor due to gamma emissions for each identified noble gas radionuclide, in mrad/yr per $\mu Ci/m^3$ from Table 4.11-3.

N_i = The air dose factor due to beta emissions for each identified noble gas radionuclide, in mrad/yr per $\mu Ci/m^3$ from Table 4.11-3.

$\overline{x/Q}$ = _____ sec/m^3. The highest calculated annual average relative concentration for any area at or beyond the exclusion area boundary for long term releases (greater than 500 hrs/year).

$\overline{x/q}$ = _____ sec/m^3. The relative concentration for any area at or beyond the exclusion area boundary for short term releases (equal to or less than 500 hrs/yr).

Q_i = The release of noble gas radionuclides, i, in gaseous effluents, for long term releases (greater than 500 hrs/yr), in μCi. Releases shall be cumulative over the calendar quarter.

q_i = The release of noble gas radionuclides, i, in gaseous effluents, for short term releases (equal to or less than 500 hrs/yr), in μCi. Releases shall be cumulative over the calendar quarter.

5.4 Radioactive Gaseous Effluent Other than Noble Gas Cumulative Dose (Specification 4.11.2.3)

The dose to an individual from radioiodines, radioactive materials in particulate form and radionuclides other than noble gases in gaseous effluents released to unrestricted areas shall be limited during any calendar year to the following expression:

$$3.17 \times 10^{-8} \sum_i R_i \, (W \, Q_i + w \, q_i) \leq 7.5 \text{ mrem, and}$$

where:

3.17×10^{-8} = The inverse of the number of seconds in a year.

Q_i = The release of radioiodines, radioactive materials in particulate form and radionuclides other than noble gases in gaseous effluents, i, for long term releases (greater than 500 hrs/yr), in μCi. Releases shall be cumulative over the calendar quarter or year as appropriate.

q_i = The release of radioiodines, radioactive materials in particulate form and radionuclides other than noble gases in gaseous effluents, i, for short term releases (equal to or less than 500 hrs/yr), in μCi. Releases shall be cumulative over the calendar quarter or year as appropriate.

W = The annual average dispersion parameter for estimating the dose to an individual at the controlling location for long term releases (greater than 500 hrs/yr):

W = $\overline{x/Q}$ for the inhalation pathway, in sec/m^3 from Table 4.11-6a.

W = $\overline{D/Q}$ for the food and ground plane pathways, in meters^{-2} from Table 4.11-6b.

w = The dispersion parameter for estimating the dose to at the controlling location for short term releases less than 500 hrs/yr):

w = $\overline{x/q}$ for the inhalation pathway, in sec/m^3 from Table 4.11-6c.

w = $\overline{D/q}$ for the food and ground plane pathway, in meters^{-2} from Table 4.11-6d.

R_i = The dose factor for each identified radionuclide, i, in m^2 mrem/yr per μCi/sec or mrem/yr per μCi/m^3 from Table 4/11-7. The dose factors are based on the most critical individual organ and most restrictive age group from historical dose calculations.

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For the direction sectors with existing pathways within 5 miles from the unit, use the values of R_i for these pathways. If no real pathway exists within 5 miles from the center of the building complex, use the cow-milk R_i assuming that this pathway exists at the 4.5 to 5.0 mile distance in the worst sector. If the R_i for an existing pathway within 5 miles is less than a cow-milk R_i at 4.5 to 5.0 miles, then use the value of the cow-milk R_i at 4.5 to 5.0 miles. The values used for calculating dose contributions shall be consistent with the results of the land use census performed pursuant to Specification 3.12.2. The controlling value for each radionuclide of Table 4.11-7 shall be determined and made effective within 30 days after the completion of each required land use census. The parameters W and w shall correspond to the applicable R_i for the same sector, pathway and location condition.

SPECIAL NOTES: (1) In all cases, the tritium releases use the first W or w parameter, based on relative concentration (sec/m^3). (2) All radioiodines are assumed to be released in elemental form. If analysis includes the capabiity of determining the elemental and nonelemental forms in all releases, the food pathway parameters may be adjusted accordingly.

In developing the R_i values, separate expressions are written for each of the potential pathways. These expressions are similar to those developed in Section 5.2 of this manual for P_i, and are denoted by $R_i^G[D/Q]$, $R_i^I[x/Q]$, $R_i^C[D/Q]$, $R_i^M[D/Q]$ and $R_i^V[D/Q]$, where the superscripts G, I, C, M, and V refer to ground plane, inhalation, cow's milk, meat and vegetation, respectively. The 'argument' notation, [ ], indicates the appropriate dispersion parameter, W, to be applied with the R_i factor. Note that the argument is not included in the following expressions. In the case of tritium, the dispersion parameter, W, is always taken as $(\overline{x/Q})$. The R_i parameter is independent of long-term or short-term releases.

Inhalation Pathway Factor, $R_i^I[x/Q]$

$$R_i^I[x/Q] = K'(BR)_a\ (DFA_i)_a\ \text{(mrem/yr per } \mu Ci/m^3)$$

where:

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

$(BR)_a$ = the breathing rate of the receptor of age group (a), in m^3/yr.

$(DFA_i)a$ = the maximum organ inhalation dose factor for the receptor of age group (a) for the ith radionuclide, in mrem/pCi. The total body is considered as an organ in the selection of $(DFA_i)a$.

The breathing rates $(BR)_a$ for the various age groups are tabulated below, as given in Table E-5 of Regulatory Guide 1.109 (Rev. 1, 10/77).

Age Group (a)	Breathing Rate (m^3/yr)
Infant	1400
Child	3700
Teen	8000
Adult	8000

Inhalation dose factors $(DFA_i)_a$ for the various age groups are given in Tables E-7 through E-10 of Regulatory Guide 1.109 (Rev. 1, 10/77).

Ground Plane Pathway Factor, $R^G_i[D/Q]$

$$R^G_i[D/Q] = K'K''(SF)DFG_i[1-e^{-\lambda_i t})/\lambda_i] \quad (m^2.mrem/yr \text{ per } \mu Ci/sec)$$

where:

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

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

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

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

DFG_i = the ground plane dose conversion factor for the ith radionuclide (mrem/hr per pCi/m^2).

SF = the shielding factor (dimensionless).

A shielding factor of 0.7 is suggested in Table E-15 of Regulatory Guide 1.109 (Rev. 1 10/77). A tabulation of DFG_i values is presented in Table E-6 of Regulatory Guide 1.109.

Grass-Cow-Milk Pathway Factor, $R^C_i[D/Q]$

$$R^C_i[D/Q] = K' \frac{Q_F(U_{ap})}{\lambda_i+\lambda_w} F_m(r)(DFL_i)_a \left[\frac{f_p f_s}{Y_p} + \frac{(1-f_p f_s)e^{-\lambda_i t_f}}{Y_s}\right] e^{-\lambda_i t_f}$$

(m^2.mrem/yr per μCi/sec)

where:

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

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

U_{ap} = the receptor's milk consumption rate for age (a), in liters/yr.

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

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

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F_m = the stable element transfer coefficients, in days/liter.

r = fraction of deposited activity retained on cow's feed grass.

$(DFL_i)_a$ = the maximum organ ingestion dose factor for the ith radionuclide for the receptor in age group (a), in mrem/pCi.

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

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

t_f = the transport time from pasture to cow, to milk, to receptor, in sec.

t_h = the transport time from pasture, to harvest, to cow, to milk, to receptor, in sec.

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

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

SPECIAL NOTE: The above equation is applicable in the case that the milk animal is a goat.

Milk cattle are considered to be fed from two potential sources, pasture grass and stored feeds. Following the development in Regulatory Guide 1.109 (Rev. 1, 10/77), the values of f_p and f_s will be considered unity, in lieu of site specific information provided in the annual land census report by the licensee.

Tabulated below are the appropriate parameter values and their reference to Regulatory Guide 1.109 (Rev. 1, 10/77). In the case that the milk animal is a goat, rather than a cow, refer to Regulatory Guide 1.109 for the appropriate parameter values.

Parameter	Value	Table R.G. 1.109 Rev. 1, 10/77
r (dimensionless)	1.0 for radioiodine	E-15
	0.2 for particulates	E-15
F_m (days/liter)	Each stable element	E-1
U_{ap} (liters/yr)-Infant	330	E-5
-Child	330	E-5
-Teen	400	E-5
-Adult	310	E-5
$(DFL_i)_a$ (mrem/pCi)	Each radionuclide	E-11 to E-14
Y_p (kg/m^2)	0.7	E-15
Y_s (kg/m^2)	2.0	E-15
t_f (seconds)	1.73×10^5 (2 days)	E-15
t_h (seconds)	7.78×10^6 (90 days)	E-15
Q_F (kg/day)	50	E-3

The concentration of tritium in milk is based on the airborne concentration rather than the deposition. Therefore, the RC_i is based on [x/Q]:

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$$R_i^C[\chi/Q] = K'K''F_m Q_F U_{ap}(DFL_i)_a\,[0.75(0.5/H]\text{(mrem/yr per }\mu\text{Ci/m}^3)$$

where:

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

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

0.75 = the fraction of total feed that is water.

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

and other parameters and values are given above. The value of H may be considered as 8 grams/meter^3, in lieu of site specific informtion (Ref. 6).

Grass-Cow-Meat Pathway Factor, $R_i^M[D/Q]$

The integrated concentration in meat follows in a similar manner to the development for the milk pathway, therefore:

$$R_i^M[D/Q] = K'\,\frac{Q_F(U_{ap})}{\lambda_i+\lambda_w}\,F_f(r)(DFL_i)_a\left[\frac{f_p f_s}{Y_p} + \frac{(1-f_p f_s)e^{-\lambda_i t_h}}{Y_s}\right]e^{-\lambda_i t_f}$$

(m^2.mrem/yr per μCi/sec)

where:

F_f = the stable element transfer coefficients, in days/kg.

U_{ap} = the receptor's meat consumption rate for age (a), in kg/yr.

t_f = the transport time from pasture to receptor, in sec.

t_h = the transport time from crop field to receptor, in sec.

Tabulated below are the appropriate parameter values and their reference to Regulatory Guide 1.109 (Rev. 1, 10/77).

Parameter	Value	Table R.G. 1.109 Rev. 1, 10/77
r (dimensionless)	1.0 for radioiodine	E-15
	0.2 for particulates	E-15
F_f (days/liter)	Each stable element	E-1
U_{ap} (kg/yr) - Infant	0	E-5
- Child	41	E-5
- Teen	65	E-5
- Adult	110	E-5
$(DFL_i)_a$ (mrem/pCi)	Each radionuclide	E-11 to E-14
Y_p (kg/m^2)	0.7	E-15
Y_s (kg/m^2)	2.0	E-15
t_f (seconds)	1.73×10^6 (20 days)	E-15
t_h (seconds)	7.78×10^6 (90 days)	E-15
Q_F (kg/day)	50	E-3

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The concentration of tritium in meat is based on the airborne concentration rather than the deposition. Therefore, the R_i^M is based on [x/Q]:

$$R_i^M[x/Q] = K'K''F_f Q_F U_{ap}(DFL_i)_a \; [0.75(0.5/H](\text{mrem/yr per } \mu Ci/m^3)$$

where all terms are defined above and Section 5.2 of this manual.

Vegetation Pathway Factor, $F_i^V[D/Q]$

The integrated concentration in vegetation consumed by man follows the expression developed in the derivation of the milk factor. Man is considered to consume two types of vegetation (fresh and stored) that differ only in the time period between harvest and consumption, therefore:

$$R_i^V[D/Q) = K'\left[\frac{(r)}{Y_v(\lambda_i \lambda_w)}\right](DFL_i)_a\left[U_a^L f_L e^{-\lambda_i t_L} \quad U_a^S f_g e^{-\lambda_i t_h}\right]$$

(m^2.mrem/yr per μCi/sec)

where:

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

U_a^L = the consumption rate of fresh leafy vegetation by the receptor in age group (a), in kg/yr.

U_a^S = the consumption rate of stored vegetation by the receptor in age group (a), in kg/yr.

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

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

t_L = the average time between harvest of leafy vegetation and its consumption, in seconds.

t_h = the average time between harvest of stored vegetation and its consumption, in seconds.

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

and all other factors are defined in Section 5.2 of this manual.

Tabulated below are the appropriate parameter values and their reference to Regulatory Guide 1.109 (Rev. 1, 10/77).

Parameter	Value	Table R.G. 1.109 Rev. 1, 10/77
r (dimensionless)	1.0 for radioiodine	E-1
	0.2 for particulates	E-1
$(DFL_i)_a$ (mrem/pCi)	Each radionuclide	E-11 to E-14
U_a^L (kg/yr)-Infant	0	E-5
-Child	26	E-5
-Teen	42	E-5

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-Adult	64	E-5
U^S (kg/yr)-Infant	0	E-5
-Child	520	E-5
-Teen	630	E-5
-Adult	520	E-5
f_L (dimensionless)	site specific (default = 1.0)	
f_g (dimensionless)	site specific (default = 0.76)	
t_L (seconds)	8.6×10^4 (1 day)	E-15
t_h (seconds)	5.18×10^6 (60 days)	E-15
Y_v (kg/m^2)	2.0	E-15

The concentration of tritium in vegetation is based on the airborne concentration rather than the deposition. Therefore, the R_i^V is based on [x/Q]:

$$R_i^V[x/Q] = K'K' \; U_a^L f_L + U_a^S f_g \; (DFL_i)_a \; [0.75(0.5/H)] \text{(mrem/yr per } \mu Ci/m^3).$$

where all terms have been defined above and in Section 5.2 of this manual.

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5.5 Radioactive Gaseous Effluent Projected Dose (Specification 4.11.2.4.1)

The dose contributions shall be calculated for all radionuclides in gaseous effluents projected to be released to outside the exclusion area during any projected 31 day period using the following expressions:

For noble gases, the gamma radiation:

$$3.17 \times 10^{-8} \sum_i M_i \left(\overline{(x/Q)}\, Q_i + \overline{(x/q)}\, q_i \right) \leq 0.05 \text{ mrad, and}$$

For noble gases, the beta radiation:

$$3.17 \times 10^{-8} \sum_i N_i \left(\overline{(x/Q)}\, Q_i + \overline{(x/q)}\, q_i \right) \leq 0.10 \text{ mrad, and}$$

For radioiodines, radioactive materials in particulate form and radionuclides other than noble gases:

$$3.17 \times 10^{-8} \sum_i R_i \left(W\, Q_i + w\, q_i \right) \leq 0.075 \text{ mrem}$$

where:

Q_i = The projected release over the next 7 days of radionuclides, i, in gaseous effluents for long term releases (greater than 500 hrs/yr), in µCi.

q_i = The projected release over the next 7 days of radionuclides, i, in gaseous effluents for short term releases (equal to or less than 500 hrs/yr), in µCi.

and all other terms are defined in Sections 5.3 and 5.4.

TABLE 5.1-1

DOSE FACTORS FOR NOBLE GASES AND DAUGHTERS

Radionuclide	Total Body Dose Factor K_i (mrem/yr per μCi/m^3)	Skin Dose Factor L_i (mrem/yr per μCi/m^3)	Gamma Air Dose Factor M_i (mrad/yr per μCi/m^3)	Beta Air Dose Factor N_i (mrad/yr per μCi/m^3)
Ar-41	8.84E+03	2.69E+03	9.30E+03	3.28E+03
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
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

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TABLE 5.2-1

DOSE PARAMETERS FOR RADIOIODINES, RADIOACTIVE MATERIAL IN PARTICULATE FORM AND RADIONUCLIDES OTHER THAN NOBLE GASES IN GASEOUS EFFLUENTS

Radio-nuclide	P_i Inhalation Pathway (mrem/yr per μCi/m^3)	P_i Food and Ground Pathways (m^2. mrem/yr per μCi/sec)	Radio-nuclide	P_i Inhalation Pathway (mrem/yr per μCi/m^3)	P_i Food & Ground Pathways (m^2. mrem/yr per μCi/sec)
H-3	6.5E+02	2.4E+03	Sb-125	1.5E+04	1.1E+09
P-32	2.0E+06	1.5E+11	Te-127m	3.8E+04	7.4E+10
Mn-54	2.5E+04	1.1E+09	Te-129m	3.2E+04	1.3E+09
Fe-59	2.4E+04	7.0E+08	I-131	1.5E+07	1.1E+12
Co-58	1.1E+04	5.7E+08	I-132		
Co-60	3.2E+04	4.6E+09	I-133	3.6E+06	9.6E+09
Zn-65	6.3E+04	1.7E+10	I-134		
Rb-88			I-135		
Rb-89			Cs-134	7.0E+05	5.3E+10
Sr-89	4.0E+05	1.0E+10	Cs-136	1.3E+05	5.4E+09
Sr-90	4.1E+07	9.5E+10	Cs-137	6.1E+05	4.7E+10
Zr-95	2.2E+04	3.5E+08	Ba-140	5.6E+04	2.4E+08
Nb-95	1.3E+04	3.6E+08	La-140		
Cd-115m	7.0E+04	4.8E+07	Ce-141	2.2E+04	8.7E+07
Sn-123	2.9E+05	3.4E+09	Ce-144	1.5E+05	6.5E+08
Sn-126	1.2E+06	1.1E+09	Unidentified**	4.1E+07	9.5E+10

**If Sr-90 analysis is performed, use P_i given in Ru-106 for unidentified components.
If Sr-90 and Ru-106 analyses are performed, use P_i given in I-131 for unidentified components.
If Sr-90, Ru-106 and I-131 analyses are performed, use P_i given in P-32 for unidentified components.

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TABLE 5.1-2

DISPERSION PARAMETER $(\overline{\chi/Q})$ FOR LONG TERM RELEASES > 500 HR/YR OR > 125 HR/QTR

	Distance to the control location, in miles									
Sector 0	0-0.5	0.5-1.0	1.0-1.5	1.5-2.0	2.0-2.5	2.5-3.0	3.0-3.5	3.5-4.0	4.0-4.5	4.5-5.0
N	N/A	2.3E-06	8.2E-07	3.6E-07	2.1E-07	1.3E-07	9.6E-08	7.3E-08	5.7E-08	4.7E-08
NNE	N/A	2.3E-06	8.1E-07	3.6E-07	2.0E-07	1.3E-07	9.5E-08	7.1E-08	5.6E-08	4.6E-08
NE	N/A	2.9E-06	1.0E-06	4.3E-07	2.5E-07	1.6E-07	1.1E-07	8.6E-08	6.7E-08	5.5E-08
ENE	N/A	3.4E-06	1.2E-06	5.1E-07	2.9E-07	1.9E-07	1.3E-07	1.0E-07	7.9E-08	6.4E-08
E	N/A	N/A	1.4E-06	6.0E-07	3.4E-07	2.2E-07	1.6E-07	1.2E-07	9.2E-08	7.5E-08
ESE	N/A	N/A	1.2E-06	5.4E-07	3.1E-07	2.0E-07	1.4E-07	1.1E-07	8.6E-08	7.0E-08
SE	N/A	N/A	N/A	4.3E-07	2.5E-07	1.6E-07	1.2E-07	8.9E-08	7.0E-08	5.7E-08
SSE	N/A	N/A	N/A	3.8E-07	2.2E-07	1.4E-07	1.0E-07	7.9E-08	6.2E-08	5.1E-08
S	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SSW	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SW	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
WSW	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
W	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
WNW	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
NW	N/A	N/A	2.3E-06	1.0E-06	6.1E-07	4.1E-07	2.9E-07	2.3E-07	1.8E-07	1.5E-07
NNW	N/A	3.4E-06	1.2E-06	5.4E-07	3.1E-07	2.0E-07	1.5E-07	1.1E-07	8.8E-08	7.2E-08

TABLE 5.1-3

DISPERSION PARAMETER ($\overline{D/Q}$) FOR LONG TERM RELEASES > 500 HR/YR OR > 125 HR/QTR

	Distance to the control location, in miles									
Sector θ	0-0.5	0.5-1.0	1.0-1.5	1.5-2.0	2.0-2.5	2.5-3.0	3.0-3.5	3.5-4.0	4.0-4.5	4.5-5.0
N	N/A	2.3E-06	8.2E-07	3.6E-07	2.1E-07	1.3E-07	9.6E-08	7.3E-08	5.7E-08	4.7E-08
NNE	N/A	2.3E-06	8.1E-07	3.6E-07	2.0E-07	1.3E-07	9.5E-08	7.1E-08	5.6E-08	4.6E-08
NE	N/A	2.9E-06	1.0E-06	4.3E-07	2.5E-07	1.6E-07	1.1E-07	8.6E-08	6.7E-08	5.5E-08
ENE	N/A	3.4E-06	1.2E-06	5.1E-07	2.9E-07	1.9E-07	1.3E-07	1.0E-07	7.9E-08	6.4E-08
E	N/A	N/A	1.4E-06	6.0E-07	3.4E-07	2.2E-07	1.6E-07	1.2E-07	9.2E-08	7.5E-08
ESE	N/A	N/A	1.2E-06	5.4E-07	3.1E-07	2.0E-07	1.4E-07	1.1E-07	8.6E-08	7.0E-08
SE	N/A	N/A	N/A	4.3E-07	2.5E-07	1.6E-07	1.2E-07	8.9E-08	7.0E-08	5.7E-08
SSE	N/A	N/A	N/A	3.8E-07	2.2E-07	1.4E-07	1.0E-07	7.9E-08	6.2E-08	5.1E-08
S	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SSW	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SW	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
WSW	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
W	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
WNW	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
NW	N/A	N/A	2.3E-06	1.0E-06	6.1E-07	4.1E-07	2.9E-07	2.3E-07	1.8E-07	1.5E-07
NNW	N/A	3.4E-06	1.2E-06	5.4E-07	3.1E-07	2.0E-07	1.5E-07	1.1E-07	8.8E-08	7.2E-08

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TABLE 5.1-4

DISPERSION PARAMETER $(\overline{x/q})$ FOR SHORT TERM RELEASES $\leq$ 500 HR/YR OR $\leq$ 125 HR/QTR

	Distance to the control location, in miles									
Sector 0	0-0.5	0.5-1.0	1.0-1.5	1.5-2.0	2.0-2.5	2.5-3.0	3.0-3.5	3.5-4.0	4.0-4.5	4.5-5.0
N	N/A	1.5E-08	4.9E-09	1.9E-09	1.0E-09	6.3E-10	4.2E-10	3.0E-10	2.3E-10	1.8E-10
NNE	N/A	1.8E-08	5.7E-09	2.3E-09	1.2E-09	7.3E-10	4.9E-10	3.6E-10	2.7E-10	2.1E-10
NE	N/A	2.0E-08	6.4E-09	2.5E-09	1.3E-09	8.2E-10	5.5E-10	4.0E-10	3.0E-10	2.3E-10
ENE	N/A	2.5E-08	8.2E-09	3.2E-09	1.7E-09	1.0E-09	7.1E-10	5.1E-10	3.8E-10	[illegible].0E-10
E	N/A	N/A	1.2E-08	4.6E-09	2.4E-09	1.5E-09	1.0E-09	7.2E-10	5.4E-10	4.2E-10
ESE	N/A	N/A	9.1E-09	3.6E-09	1.9E-09	1.2E-09	7.9E-10	5.7E-10	4.3E-10	3.3E-10
SE	N/A	N/A	N/A	2.1E-09	1.1E-09	6.8E-10	4.6E-10	3.3E-10	2.5E-10	1.9E-10
SSE	N/A	N/A	N/A	1.5E-09	8.0E-10	4.9E-10	3.3E-10	2.4E-10	1.8E-10	1.4E-10
S	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SSW	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SW	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
WSW	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
W	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
WNW	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
NW	N/A	N/A	7.1E-09	2.8E-09	1.5E-09	9.0E-10	6.1E-10	4.4E-10	3.3E-10	2.6E-10
NNW	N/A	1.5E-08	4.8E-09	1.9E-09	1.0E-09	6.2E-10	4.2E-10	3.0E-10	2.3E-10	1.8E-10

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TABLE 5.1-5

DISPERSION PARAMETER ($\overline{D/q}$) FOR SHORT TERM RELEASES $\leq$ 500 HR/YR OR $\leq$ 125 HR/QTR

	Distance to the control location, in miles									
Sector 0	0-0.5	0.5-1.0	1.0-1.5	1.5-2.0	2.0-2.5	2.5-3.0	3.0-3.5	3.5-4.0	4.0-4.5	4.5-5.0
N	N/A	1.5E-08	4.9E-09	1.9E-09	1.0E-09	6.3E-10	4.2E-10	3.0E-10	2.3E-10	1.8E-10
NNE	N/A	1.8E-08	5.7E-09	2.3E-09	1.2E-09	7.3E-10	4.9E-10	3.6E-10	2.7E-10	2.1E-10
NE	N/A	2.0E-08	6.4E-09	2.5E-09	1.3E-09	8.2E-10	5.5E-10	4.0E-10	3.0E-10	2.3E-10
ENE	N/A	2.5E-08	8.2E-09	3.2E-09	1.7E-09	1.0E-09	7.1E-10	5.1E-10	3.8E-10	3.0E-10
E	N/A	N/A	1.2E-08	4.6E-09	2.4E-09	1.5E-09	1.0E-09	7.2E-10	5.4E-10	4.2E-10
ESE	N/A	N/A	9.1E-09	3.6E-09	1.9E-09	1.2E-09	7.9E-10	5.7E-10	4.3E-10	3.3E-10
SE	N/A	N/A	N/A	2.1E-09	1.1E-09	6.8E-10	4.6E-10	3.3E-10	2.5E-10	1.9E-10
SSE	N/A	N/A	N/A	1.5E-09	8.0E-10	4.9E-10	3.3E-10	2.4E-10	1.8E-10	1.4E-10
S	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SSW	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SW	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
WSW	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
W	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
WNW	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
NW	N/A	N/A	7.1E-09	2.8E-09	1.5E-09	9.0E-10	6.1E-10	4.4E-10	3.3E-10	2.6E-10
NNW	N/A	1.5E-08	4.8E-09	1.9E-09	1.0E-09	6.2E-10	4.2E-10	3.0E-10	2.3E-10	1.8E-10

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TABLE 5.4-1

PATHWAY DOSE FACTORS DUE TO RADIONUCLIDES OTHER THAN NOBLE GASES

Radionuclide	Inhalation Pathway R_i (mrem/yr per $\mu Ci/m^3$)	Meat Pathway R_i (m^2.mrem/yr per μCi/sec)	Ground Plane Pathway R_i (m^2.mrem/yr per μCi/sec)	Cow-Milk-Infant Pathway R_i (m^2.mrem/yr per μCi/sec)	Leafy Vegetables Pathway (m^2.mrem/yr per μCi/sec)

6.0 Radiological Environmental Monitoring

6.1 Replacement of Sample Locations (Specification 3.12.1, Action c)

6.2 Census Results (Specification 3.12.2, Actions a and b)

7.0 Assessment of Dose for Semiannual Radioactive Effluent Release Reports Specification 6.9.1.9)

8.0 Revisions to the ODCM (Specification 6.14.2)

Changes to the ODCM shall be made by the following method:

1. Shall be submitted to the Commission by inclusion in the Monthly Operating Report within 90 days in which the change(s) was made effective and shall contain:

   a. sufficiently detailed information to totally support the rationale for the change without benefit of additional or supplemental information. Information submitted should consist of a package of those pages of ODCM to be changed with each page numbered and provided with an approval and date box, together with appropriate analyses or evaluations justifying the change(s);

   b. a determination that the change will not reduce the accuracy or reliability of dose calculations or setpoint determinations; and

   c. documentation of the fact that the change has been reviewed by the PRC and approved by the Plant Manager.

2. Shall become effective upon review by the PRC and approval by the Plant Manager.