January 1, 1998

Subject: Offsite Dose Calculation Manual (ODCM)
Generic Section - Revision 41

The General Office Radiation Protection Staff is transmitting to you this date Revision 41 of the Offsite Dose Calculation Manual's Generic section. As this revision affects the manual's generic section, the approval of each station manager has been obtained. A list of affected pages is given below. Please insert this letter with the attached Justification section in front of the January 1, 1997, Revision 40 letter.

REMOVE THESE PAGES	INSERT THESE PAGES
3-11	3-11

Effective Date: 1/1/98

L. E. Haynes, Technical Manager
Radiation Protection

Effective Date: 1/1/98

R. A. Jones, Manager
Catawba Nuclear Station

Effective Date: 1/1/98

E. M. Geddie, Jr., Manager
McGuire Nuclear Station

Effective Date: 1/1/98

B. L. Peele, Jr., Manager
Oconee Nuclear Station

If you have any questions concerning Revision 41, please call Caryl Ingram at (704) 382-4496.

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Radiation Protection
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<u>JUSTIFICATION FOR REVISION 41</u>

<u>Page 3-11</u>

Information given in Federal Register, Vol. 42, No. 9 (01/13/77) when 40CFR190 was provided in final form provides guidance for utilities on how to show compliance to 40CFR190. The guidance states that contributions from neighboring nuclear sites outside of ten (10) miles from the immediate site should be ignored in assessing compliance to 40CFR190. McGuire and Catawba are located approximately 30 miles apart, and Oconee is located over 100 miles from both McGuire and Catawba. Therefore, information is being provided in the ODCM to make it clear that dose contributions from Oconee, McGuire, and Catawba to each other are insignificant, and are not included in showing compliance to 40CFR190.

OFFSITE DOSE CALCULATION MANUAL

FOR

DUKE POWER NUCLEAR STATIONS

TABLE OF CONTENTS

LIST OF TABLES

INTRODUCTION

The Offsite Dose Calculation Manual (ODCM) provides the methodology and parameters to be used in the calculation of offsite doses due to radioactive liquid and gaseous effluents to assure compliance with the dose limitations of the Selected Licensee Commitments. These dose limitations assure that:

1) the concentration of radioactive liquid effluents released from the site to the unrestricted area will be limited to 10 times the effluent concentration (EC) levels of 10CFR20, Appendix B, Table 2;

2) the exposures to any individual member of the public from radioactive liquid effluents will not result in doses greater than the design objectives of 10CFR50, Appendix I;

3) the dose rate at any time at the site boundary from radioactive gaseous effluents will be limited to: for noble gases; less than or equal to 500 mrem/yr to the whole body and less than or equal to 3000 mrem/yr to the skin; and for iodine-131 and 133, for tritium, and for all radioactive materials in particulate form with half-lives greater than 8 days; less than or equal to 1500 mrem/yr to any organ;

4) the exposure to any individual member of the public from radioactive gaseous effluents will not result in doses greater than the design objectives of 10CFR50, Appendix I; and

5) the dose to any individual member of the public from the nuclear fuel cycle will not exceed the limits of 40CFR190 and 10CFR20.

The methodology used to assure compliance with the dose limitations described above shall also be used to prepare the radioactive liquid and gaseous effluent reports required by the Selected Licensee Commitments and/or Technical Specifications. To assure compliance with 40CFR190 when twice the design objectives of 10CFR50, Appendix I are exceeded, the methodology and parameters to be used in calculating the offsite dose to any individual resulting from the entire fuel cycle except mining and waste management facilities are provided in the ODCM.

The ODCM also provides the methodology and parameters to be used in the calculation of radioactive liquid and gaseous effluent monitoring instrumentation alarm/trip setpoints to assure compliance with the concentration and dose rate limitations of the Selected Licensee Commitments. Changes to the methodology and parameters used in this ODCM shall be reviewed by a knowledgeable individual(s), and approved by the Station Manager and the General Office Radiation Protection Manager prior to implementation, and shall be audited by the Nuclear Safety Review Board. Changes to the ODCM shall be submitted to the Nuclear Regulatory Commission in accordance with plant Selected Licensee Commitments.

Normally GASPAR and LADTAP are used for the calculation of offsite doses, but this document also describes a method for the calculation of offsite doses when GASPAR and/or LADTAP are not available.

The ODCM does not replace any station implementing procedures.

1.0 RELEASE RATE CALCULATIONS

The release rate calculations presented in the following sections are site release limits. Sites containing two or more units shall administratively control releases to assure that the release rate calculations limit releases as stated in the Selected Licensee Commitments. Administrative controls could limit the number of releases occurring at one time and/or apportion the release rate between the units.

1.1 LIQUID EFFLUENTS

To comply with Selected Licensee Commitments and to assure that the concentration of radioactive liquid effluents released from the site to the unrestricted area is limited to 10 times the effluent concentrations (ECs) of 10CFR20, Appendix B, Table 2, Column 2, the following release rate calculation shall be performed:

$$f \leq F \div \left\{ \sigma \sum_{i=1}^{n} \frac{C_i}{(10 \times EC_i)} \right\}$$

where:

C_i = the concentration of radionuclide, 'i', in the undiluted liquid effluent, in μCi/ml.

EC_i = the concentration of radionuclide, 'i', from 10CFR20, Appendix B, Table 2, Column 2, in μCi/ml.

f = the undiluted effluent flow from the tank, in gpm.

F = the dilution flow from the site discharge structure to unrestricted area receiving waters, in gpm.

σ = recirculation factor at equilibrium; this factor accounts for the fraction of discharged water reused by the station; this factor is one for stations on rivers or lakes where discharged water cannot be reused, and varies for sites where water is recirculated and is specified in the appropriate Appendix.

1.2 GASEOUS EFFLUENTS

In order to comply with the Selected Licensee Commitments and to assure that the dose rate, at any time, in the unrestricted area due to radioactive materials released in gaseous effluents from the site is limited to: ≤ 500 mrem/yr to the total body, and ≤ 3000 mrem/yr to the skin for the noble gases, and is limited to ≤ 1500 mrem/yr to any organ for all radioiodine and for all radioactive materials in particulate form, and radionuclides other than noble gases with half lives greater than 8 days, the following release rate calculations shall be performed. These calculations, when solved for 'f', i.e. flowrate, are the release rates for noble gases and for radioiodines, particulates and other radionuclides with half-lives greater than 8 days. The most conservative release rate calculated shall control the release rate.

1.2.1 Noble Gases

$$\sum_i K_i \times \left\{ (\overline{X/Q}) \cdot \tilde{Q}_i \right\} < 500 \text{ mrem/yr, and}$$

$$\sum_i (L_i + 1.1\, M_i) \cdot \left\{ (\overline{X/Q}) \cdot \tilde{Q}_i \right\} < 3000 \text{ mrem/yr}$$

where:

K_i = The total body dose factor due to gamma emissions for each identified noble gas radionuclide, in mrem/yr per $\mu Ci/m^3$ from Table 1.2-1.

L_i = The skin dose factor due to beta emissions for each identified noble gas radionuclide, in mrem/yr per $\mu Ci/m^3$ from Table 1.2-1.

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 1.2-1 (unit conversion constant of 1.1 mrem/mrad converts air dose to skin dose; no correction for structural sheilding is assumed - GASPAR uses a factor of 0.7 reduction in gamma contributions to the skin dose consistant with Regulatory Guide 1.109, equation B-9).

$\overline{X/Q}$ = The highest calculated annual average dispersion parameter for any area at or beyond the unrestricted area boundary.

$\tilde{Q}_i$ = The release rate of radionuclides, 'i', in gaseous effluent from all release points at the site, in $\mu Ci/sec$.

$$\tilde{Q}_i = k_1 C_i f \div k_2 = 4.72E+02 \cdot C_i f$$

where:

C_i = the concentration of radionuclide, "i", in undiluted gaseous effluent, in $\mu Ci/ml$.

f = the undiluted effluent flow, in cfm.

k_1 = conversion factor, 2.83E+04 ml/ft^3.

k_2 = conversion factor, 6.0E+01 sec/min.

1.2.2 Radioiodines, Particulates, and Others

$$\sum_i P_i \times \{ W \cdot \bar{Q}_i \} < 1500 \text{ mrem/yr}$$

where:

P_i = The dose parameter for radionuclides other than noble gases for the inhalation pathway, in mrem/yr per μCi/m^3 and for the food and ground plane pathways in (m^2 x (mrem/yr per μCi/sec)) from Table 1.2-2. The dose factors are based on the critical individual organ and most restrictive age group.

W = The highest calculated annual average dispersion/deposition parameter for estimating the dose to an individual at a controlling location in the unrestricted area.

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

$$\bar{Q}_i = k_1 C_i f \div k_2 = 4.72E{+}02 \cdot C_i f$$

where:

C_i = the concentration of radionuclide, "i", in undiluted gaseous effluent, in μCi/ml.

f = the undiluted effluent flow, in cfm.

k_1 = conversion factor, 2.83E+04 ml/ft^3.

k_2 = conversion factor, 6.0E+01 sec/min.

DOSE FACTORS FOR NOBLE GASES AND DAUGHTERS*

Radionuclide	Total Body Dose Factor K_i** (mrem/yr per µCi/m³)	Skin Dose Factor L_i (mrem/yr per µCi/m³)	Gamma Air Dose Factor M_i (mrad/yr per µCi/m³)	Beta Air Dose Factor N_i (mrad/yr per µCi/m³)
Kr-83m	5.29E-02***	---	1.93E+01	2.88E+02
Kr-85m	8.19E+02	1.46E+03	1.23E+03	1.97E+03
Kr-85	1.13E+01	1.34E+03	1.72E+01	1.95E+03
Kr-87	4.14E+03	9.73E+03	6.17E+03	1.03E+04
Kr-88	1.03E+04	2.37E+03	1.52E+04	2.93E+03
Kr-89	1.16E+04	1.01E+04	1.73E+04	1.06E+04
Kr-90	1.09E+04	7.29E+03	1.63E+04	7.83E+03
Xe-131m	6.40E+01	4.76E+02	1.56E+02	1.11E+03
Xe-133m	1.76E+02	9.94E+02	3.27E+02	1.48E+03
Xe-133	2.06E+02	3.06E+02	3.53E+02	1.05E+03
Xe-135m	2.18E+03	7.11E+02	3.36E+03	7.39E+02
Xe-135	1.27E+03	1.86E+03	1.92E+03	2.46E+03
Xe-137	9.94E+02	1.22E+04	1.51E+03	1.27E+04
Xe-138	6.18E+03	4.13E+03	9.21E+03	4.75E+03
Ar-41	6.19E+03	2.69E+03	9.30E+03	3.28E+03

*The listed dose factors obtained from Regulatory Guide 1.109, Table B-1 are for radionuclides that may be detected in gaseous effluents.

**Includes a residential structure shielding attenuation factor of 0.7.

***7.56E-02 = 7.56×10^{-2}

5.29E-02 = = 5.29×10^{-2}

DOSE PARAMETERS FOR RADIOIODINES AND RADIOACTIVE PARTICULATE GASEOUS EFFLUENTS

(P_i Dose Parameters)

Radio-Nuclide	Pathways: Inhalation (mrem/yr per µCi/m^3)	Pathways: Food and Ground (m^2·mrem/yr per µCi/sec)	Critical Age
H-3	1.12E+03	7.52E+03	Child
Cr-51	1.44E+04	1.84E+07	Adult
Mn-54	1.40E+06	2.35E+09	Adult
Fe-55	1.11E+05	1.11E+09	Child
Fe-59	1.02E+06	2.93E+09	Adult
Co-58	9.28E+05	1.28E+09	Adult
Co-60	5.97E+06	2.57E+10	Adult
Zn-65	9.95E+05	5.44E+09	Child
Sr-89	2.16E+06	4.66E+10	Child
Sr-90	1.01E+08	1.57E+12	Child
Zr-95	1.77E+06	2.93E+09	Adult
Sb-124	2.48E+06	3.99E+09	Adult
I-131	1.48E+07	5.79E+11	Infant
I-133	3.55E+06	5.38E+09	Infant
Cs-134	7.03E+05	1.57E+11	Infant
Cs-136	1.34E+05	1.56E+10	Infant
Cs-137	6.12E+05	1.47E+11	Infant
Ba-140	1.74E+06	3.49E+08	Child
Ce-141	6.13E+05	5.75E+08	Teen
Ce-144	1.34E+07	1.31E+10	Teen

* The P_i values were calculated using the GASPAR computer code by making single computer runs for each radionuclide with the X/Q, D/Q, and Q_i values set to 1. The resulting "dose" values given by GASPAR with all other parameters set to 1 yields the P_i values.

The P_i calculations and GASPAR computer runs can be obtained from the General Office Radiation Protection Group.

2.0 RADIATION MONITORING SETPOINTS

Effluent radiation monitor alarm/trip setpoints shall be determined using the calculations presented in the following sections. The calculations define the relationships between the measured effluent activity, the maximum allowable effluent activity, the effluent flowrate, and the dilution available in the restricted area (as defined for effluent releases in the Selected Licensee Commitments) which must be controlled to assure that the instantaneous release rate is not exceeded.

The setpoints shall be determined for those monitors listed in the appropriate tables of the Selected Licensee Commitments.

2.1 LIQUID MONITORS

The following equation shall be used to calculate liquid radiation monitor setpoints:

$$\frac{Cf}{F + f} \leq (10 \times EC)$$

where:

EC = the effluent concentration from 10CFR20, Appendix B, Table 2, Column 2, in μCi/ml.

C = the radioactivity concentration in μCi/ml, in the effluent line prior to dilution and subsequent release, which may be the setpoint and, if so, represents a value which, if exceeded, would result in concentrations exceeding 10 times EC.

f = the flow measured at the radiation monitor location in gpm.

F = the dilution water flow as measured prior to the release point in gpm.

(Note that if no dilution is provided, $C \leq (10 \times EC)$. Also, note that when (F) is large compared to (f), then $F + f \approx F$.)

2.2 GAS MONITORS

The following equation shall be used to calculate noble gas radiation monitor setpoints based on Xe-133:

$$K_i(X/Q)\tilde{Q}_i < 500$$

$$\tilde{Q}_i = 4.72E+2 \; C \; f \quad \text{(See Section 1.2.1)}$$

where:

C = the gross activity in undiluted effluent, in μCi/ml.

f = the flow from the tank or building and varies for various release sources, in cfm.

K_i = from Table 1.2-1 for Xe-133, 2.06E+02 mrem/yr per $\mu Ci/m^3$.

$\overline{X/Q}$ = the highest calculated annual average dispersion parameter for any area at or beyond the unrestricted area boundary for long term releases.

3.0 DOSE CALCULATIONS

3.1 DOSE MODELS FOR MAXIMUM EXPOSED INDIVIDUAL

3.1.1 Liquid Effluents

Of the possible exposure pathways in the aquatic environment, only two contribute significantly to the total dose; these pathways are ingestion of potable water and aquatic foods. The dose contribution from these pathways for measured quantities of radioactive materials identified in liquid effluents released to unrestricted areas shall be calculated for the maximum exposed individual in each age group using:

$$D_{ao} = \sum_{i} [A_{aoi} C_i] \Delta t F_{\eta}$$

where:

D_{ao} = the cumulative dose commitment for an individual of age group, "a", to the total body or any organ, "o", from the liquid effluent for the total time period, Δt, in mrem.

A_{aoi} = the site related ingestion dose commitment factor for an individual of age group, "a", to the total body or any organ, "o", for each identified principal gamma and beta emitter, "i", in mrem/hr per μCi/ml.

$$A_{aoi} = 1.14E{+}05\ (U_{aw}\sigma_w/D_w + U_{af}\sigma_f BF_i)\ DF_{aoi}$$

where:

1.14E+05 = 10^6 pCi/μCi x 10^3 ml/kg ÷ 8760 hr/yr.

U_{aw} = Water consumption by age group, liters/yr. (Regulatory Guide 1.109)

- infant 330
- child 510
- teen 510
- adult 730

σ_w, σ_f = recirculation factors at equilibrium for the water and fish pathways respectively; these factors account for the fraction of discharged water reused by the station.

D_w = Dilution factor from the near field area to the potable water intake.

U_{af} = Fish consumption by age group, kg/yr.
(Regulatory Guide 1.109)

- infant --
- child 6.9
- teen 16
- adult 21

BF_i = Bioaccumulation factor for radionuclide, "i", in fish, pCi/kg per pCi/liter, from Table 3.1-1.

DF_{aoi} = Dose conversion factor by age group, "a", in pre-selected organ, "o", for radionuclide, "i", in mrem/pCi, from Tables 3.1-2, 3.1-3, 3.1-4, and 3.1-5, respectively.

Using the above information, A_{aoi} values for the four age groups have been calculated for each site. This information is provided in Tables "X"4.0-3 through "X"4.0-6 where "X" is the appendix for the site in question.

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

Δt = the length of time over which C_i and F_η are averaged for all liquid releases, in hours.

F_η = the near field average dilution factor for C_i during any liquid effluent release where:

$$F_\eta = f/(F + f)$$

where:

f = liquid radwaste flow, in gpm.

F = dilution flow, in gpm.

3.1.2 <u>Gaseous Effluents</u>

The dose contributions from measured quantities of radioactive materials identified in gaseous effluent released to unrestricted areas shall be calculated for the maximum gamma and beta air dose from noble gases, and for the maximum exposed individual from radioiodines, particulates, and others using the following equations:

3.1.2.1 Noble Gases

For gamma radiation the air dose, D_γ, in mrads is given as:

$$D_\gamma = 3.17E\text{-}08 \cdot (\overline{X/Q}) \sum_i M_i Q_i$$

For beta radiation the air dose, D_β, in mrads is given as:

$$D_\beta = 3.17E\text{-}08 \cdot (\overline{X/Q}) \sum_i N_i Q_i$$

where:

3.17E-08 = 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, "i", in mrad/yr per $\mu Ci/m^3$ from Table 1.2-1.

N_i = The air dose factor due to beta emissions for each identified noble gas radionuclide, "i", in mrad/yr per $\mu Ci/m^3$ from Table 1.2-1.

$\overline{X/Q}$ = The highest calculated annual average relative concentration for any area at or beyond the site boundary.

Q_i = The release of noble gas radionuclides, "i", in gaseous effluents, in µCi.

3.1.2.2 Radioiodines, Particulates, and Others

These calculations apply to all radioiodines, radioactive materials in particulate form and radionuclides other than noble gases with half-lives greater than 8 days:

$$D_{ao} = 3.17E\text{-}08 (W) \cdot \sum_i R_{aoi} Q_i$$

where:

D_{ao} = The cumulative dose commitment for an individual of age group, "a", to the total body or any organ, "o", from the gaseous effluent, in mrem.

3.17E-08 = 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", in µCi.

W = The annual average dispersion or deposition parameter for estimating the dose to an individual at the controlling location.

$W = (\overline{X/Q})$ for the inhalation pathway, in sec/m^3.

$W = (\overline{D/Q})$ for the food and ground plane pathways, in $meters^{-2}$.

R_{aoi} = The dose factor for each identified radionuclide, "i", in $m^2 \cdot$ (mrem/yr) per µCi/sec or mrem/yr per µCi/m^3, for each age, organ, and pathway. (Tables 3.1-12 through 3.1-30).

where:

Inhalation Pathway Factor, R^I_{aoi} (used with $\overline{X/Q}$)

$$R^I_{aoi} = K' (BR)_a (DFA_i)_a \quad \text{(mrem/yr per µCi/m}^3\text{)}$$

where:

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

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

The breathing rates $(BR)_a$ for the various age groups are tabulated below, as given in Regulatory Guide 1.109.

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

$(DFA_i)_a$ = the maximum organ inhalation dose factor 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 $(DFA_i)_a$. See Tables 3.1-6, 3.1-7, 3.1-8, and 3.1-9. (Taken from Regulatory Guide 1.109)

Ground Plane Pathway Factor, R^G_{aoi} (used with $\overline{D/Q}$)

$$R^G_{aoi} = K'K''(SF)DFG_i \left[(1-\exp(-\lambda_i t))/\lambda_i \right] \quad (m^2 \cdot \text{mrem/yr per µCi/sec})$$

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 x 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), 0.7 (Regulatory Guide 1.109)

Ground plane dose conversion factors, DFG_i, are found in Table 3.1-10.

Grass-Cow-Milk Pathway Factor, R^C_{aoi} (used with $\overline{D/Q}$)

$$R^C_{aoi} = K' \ E \ Q_F(U_{ap}) \ F_m (DFL_i)_a \ \left\{ \frac{(r)}{(\lambda_i + \lambda_w)} \times \left[\frac{f_p \ f_s}{Y_p} (1-\exp(-(\lambda_i + \lambda_w)t_{ep})) \right. \right.$$

$$\left. \left. + \frac{(1-f_p \ f_s)}{Y_S} (1-\exp(-(\lambda_i + \lambda_w)t_{es})) \exp(-\lambda_i t_h) \right] + \frac{B_{iv}}{P\lambda_i} (1-\exp(-\lambda_i t_b)) \right\} \exp(-\lambda_i t_f)$$

($m^2 \cdot$ mrem/yr per μCi/sec)

where:

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

Q_F = the cow's consumption rate, in kg/day (wet weight), (Regulatory Guide 1.109). (Milk Cow = 50, Beef Cattle = 50, Goats = 6).

U_{ap} = the receptor's milk consumption rate for age (a), in liters/yr.
(Regulatory Guide 1.109)
- Infant 330
- Child 330
- Teen 400
- Adult 310

Y_p = the agricultural productivity by unit area of pasture feed grass, in kg/m^2, 0.7.

Y_s = the agricultural productivity by unit area of stored feed, in kg/m^2, 2.0.

F_m = the stable element transfer coefficients, in days/liter, Table 3.1-11.

r = fraction of deposited activity retained on cow's feed grass, r = 1 for radioiodine and r = 0.2 for particulates (Regulatory Guide 1.109).

$(DFL_i)_a$ = the maximum organ ingestion dose factor for the ith radionuclide for the receptor in age group "a", in mrem/pCi. See Tables 3.1-2, 3.1-3, 3.1-4, and 3.1-5.

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

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

t_f = the transport time from pasture to cow, to milk, to receptor, in sec, 1.73 x 10^5 (2 days).

t_h = the transport time from pasture to harvest, to cow, to milk, to receptor, in sec, 7.78 x 10^6 (90 days).

f_p = fraction of the year that the cow is on pasture (dimensionless), 1.0.

f_s = fraction of the cow feed that is pasture grass while the cow is on pasture (dimensionless), 1.0.

E = an adjustment fraction which accounts for the fraction of radionuclides in elemental form which contribute dose for this pathway, E = 0.5 for radioiodine, E = 1.0 for all others.

t_{ep} = period of pasture grass exposure during growing season, in seconds, 2.59 x 10^6 (corresponding to 30 days, Regulatory Guide 1.109).

t_{es} = period of stored feed crop/vegetation exposure during growing season, in seconds, 5.18 x 10^6 (corresponding to 60 days, Regulatory Guide 1.109).

B_{iv} = concentration factor for uptake of radionuclide "i" from soil by edible parts of crops, in pCi/Kg (wet weight) per pCi/Kg dry soil (Regulatory Guide 1.109). See Table 3.1-11.

P = the effective "surface density" for soil, in kg (dry soil)/m^2, 240 (Regulatory Guide 1.109).

t_b = period of long-term buildup for activity in soil, in seconds, 4.73 x 10^8 (corresponding to 15 years, Regulatory Guide 1.109).

The concentration of tritium in milk is based on the airborne concentration rather than the deposition. Therefore, the R^C_{aoi} is based on [X/Q]:

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

where:

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

H = absolute humidity of the atmosphere, 8 gm/m^3, (Regulatory Guide 1.109)

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.

Grass-Cow-Meat Pathway Factor, R^M_{aoi} (used with $\overline{D/Q}$)

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

$$R^M_{aoi} = K' \; E \; Q_F \, (U_{ap}) \; F_f \; (DFL_i)_a \left\{ \frac{(r)}{(\lambda_i + \lambda_w)} \times \left[\frac{f_p f_s}{Y_p} (1-\exp(-(\lambda_i + \lambda_w)t_{ep})) + \frac{(1-f_p f_s)}{y_s} (1-\exp(-(\lambda_i + \lambda_w)t_{es})) \times \exp(-\lambda_i t_h) \right] + \frac{B_{iv}}{P\lambda_i} (1-\exp(-\lambda_i t_b)) \right\} \times \exp(-\lambda_i t_f)$$

(m^2 · mrem/yr per µCi/sec)

where:

F_f = the stable element transfer coefficients, in days/kg, Table 3.1.11.

U_{ap} = the receptor's meat consumption rate for age (a), in kg/yr. (Regulatory Guide 1.109)

- Infant 0
- Child 41
- Teen 65
- Adult 110

t_f = the transport time from pasture to cow, to meat, to receptor, in sec, 1.73×10^6 (20 days).

t_h = the transport time from crop field to receptor, in sec, 7.78×10^6 (90 days).

The concentration of tritium in meat is based on its airborne concentration rather than the deposition. Therefore, the R^M_{aoi} is based on [X/Q]:

R^M_{aoi} = K'K'' $F_f Q_F U_{ap} (DFL_i)_a$ [0.75(0.5/H)] (mrem/yr per µCi/m³)

where all terms are defined above.

Vegetation Pathway Factor, R^V_{aoi} (used with $\overline{D/Q}$)

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 differs only in the time period between harvest and consumption, therefore:

$$R^V_{aoi} = K'\,E\,(DFL_i)_a \left[\frac{(r)}{Y_v(\lambda_i+\lambda_w)}(1-\exp(-(\lambda_i+\lambda_w)t_e)) + \frac{B_{iv}}{P\lambda_i}(1-\exp(-\lambda_i t_b))\right]$$

$$\times\ [U^L_a f_L \exp(-\lambda_i t_L) + U^S_a f_g \exp(-\lambda_i t_h)] \quad (m^2 \cdot \text{mrem/yr per } \mu\text{Ci/sec})$$

where:

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

U^L_a = the consumption rate of fresh leafy vegetation by the receptor in age group (a), in kg/yr. (Regulatory Guide 1.109)

-	Infant	0
-	Child	26
-	Teen	42
-	Adult	64

U^S_a = the consumption rate of stored vegetation by the receptor in age group (a), in kg/yr. (Regulatory Guide 1.109)

-	Infant	0
-	Child	520
-	Teen	630
-	Adult	520

f_L = the fraction of the annual intake of fresh leafy vegetation grown locally, (1.0).

f_g = the fraction of the annual intake of stored vegetation grown locally, (0.76).

t_L = the average time between harvest of leafy vegetation and its consumption, in seconds, 8.6×10^4 (1 day).

t_h = the average time between harvest of stored vegetation and its consumption, in seconds, 5.18×10^6 (60 days).

Y_v = the vegetation area density, 2.0 kg/m^2.

and all other factors are previously defined.

The concentration of tritium in vegetation is based on the airborne concentration rather than the deposition. Therefore, the R^V_{aoi} is based on the [X/Q].

$$R^v_{aoi} = K'K'\text{''} U^L_a f_L + U^S_a f_g (DFL_i)_a \; [0.75(0.5/H)] \quad (\text{mrem/yr per } \mu\text{Ci/m}^3).$$

All terms defined previously.

3.1.3 Direct Radiation

Direct radiation is that radiation from confined sources and does not include any external component from radioactive effluents. The point kernel method has been used to calculate offsite dose rates from radioactive materials stored in the refueling water storage tanks, reactor makeup water storage tanks, and temporary onsite radwaste storage tanks. Dose calculations using this method performed for Duke Nuclear Stations indicate direct radiation doses are much less than 0.01 mrem/yr and, therefore, makes a negligible contribution to individual dose. Likewise, direct and air-scatter radiation dose contributions from the onsite Independent Spent Fuel Storage Installation (ISFSI) at Oconee have been calculated. The maximum dose rate to the nearest potential resident from the Oconee ISFSI is < 0.1 mrem/yr. Direct radiation doses will not be calculated routinely.

3.1.4 Effluent Apportionment

For the Oconee Nuclear Station, dose commitments to members of the public are written in terms of the site rather than on a per unit basis, and, therefore, effluent releases and dose commitments are reported for the entire site. For the McGuire and Catawba Nuclear Stations the effluent releases are apportioned equally to each unit for each site as recommended by Section 3.1 or NUREG-0133, because the shared radwaste treatment systems at each site make it impractical to accurately ascribe releases to a specific reactor unit.

3.2 DOSE PROJECTIONS

Station dose projection calculations are periodically performed to determine the stations's status with respect to meeting annual ALARA goals specified in the Selected Licensing Commitment Manual. Such calculations are used to verify that adequate margin remains during a report period to allow normal station and radwaste system operation, including anticipated operational occurrences, for the remainder of the report period without exceeding applicable goals. Station dose projection calculations can be performed by using generic methodology, LADTAP and/or GASPAR, or by extrapolating from previous months dose calculation results.

3.3 FUEL CYCLE CALCULATIONS

In accordance with the requirements of 40CFR190, the annual dose commitment to any member of the general public shall be calculated to assure that doses are limited to 25 millirems to the total body or any organ with the exception of the thyroid which is limited to 75 millirems. In accordance with the requirements of the Selected Licensee Commitments, the annual dose commitment shall also be calculated any time that one of the quarterly dose limits of the Selected Licensee Commitments is exceeded; these annual dose commitments may not just be calculated for the calendar year.

The "Uranium fuel cycle" is defined in 40CFR Part 190.02(b) as:

> "Uranium fuel cycle means the operations of milling or uranium ore, chemical conversion of uranium, isotopic enrichment of uranium, fabrication of uranium fuel, generation of electricity by a light-water-cooled nuclear power plant using uranium fuel, and reprocessing of spent uranium fuel, to the extent that these directly support the production of electrical power for public use utilizing nuclear energy, but excludes mining operations, operations at waste disposal sites, transportation of any radioactive material in support of these operations, and the reuse of recovered non-uranium special nuclear and by-product materials from the cycle."

Based on this definition of the fuel cycle and the information in 10CFR51, Table S-3, and Wash-1248, the radiological impact of the following operations has been assessed for Duke Nuclear Stations:

3.3.1 Milling

No milling operations occur within fifty miles of any Duke Nuclear Station. The increment of dose from milling operations to any individual within fifty miles of any Duke Nuclear Station is negligible.

3.3.2 Conversion

No uranium hexafluoride production occurs within fifty miles of any Duke Nuclear Station. The increment of dose from UF_6 production to any individual within fifty miles of any Duke Nuclear Station is negligible.

3.3.3 Enrichment

No uranium enrichment operations occur within fifty miles of any Duke Nuclear Station. The increment of dose from enrichment operations to any individual within fifty miles of any Duke Nuclear Station is negligible.

3.3.4 Fuel Fabrication

No fuel fabrication operations occur within fifty miles of any Duke Nuclear Station. The increment of dose from fabrication operations to any individual within fifty miles of any Duke Nuclear Station is negligible.

3.3.5 Nuclear Power Production

The production of electricity for public use using light-water-cooled nuclear power stations results in increments of dose to individuals within fifty miles of any station due to liquid and gaseous effluent releases and direct radiation or skyshine. The increments of dose resulting from liquid and gaseous effluent releases will be calculated using the methodology presented in Sections 3.1.1 and 3.1.2 or the LADTAP and GASPAR computer programs. The dose from direct radiation, skyshine, and radiation from the station storage facilities has been estimated using conservative assumptions (see Section 3.1.3).

In certain situations more than one nuclear power station site may contribute to the doses to be considered in making fuel cycle dose assessments in accordance with 40CFR190. However, since the McGuire and Catawba nuclear stations are located approximately 30 miles apart and the Oconee nuclear station is located over 100 miles from either McGuire or Catawba, the relative dose contribution from each site to the other is insignificant, and can be ignored in assessing compliance with 40CFR190.

3.3.6 Fuel Reprocessing

No fuel reprocessing operations occur within fifty miles of any Duke Nuclear Station. The increment of dose from reprocessing operations to any individual within fifty miles of any Duke Nuclear Station is negligible.

To summarize, only dose increments from nuclear power production operations (Section 3.3.5) need be considered in calculations to demonstrate compliance with the requirements of 40CFR190.

TABLE 3.1-1*
(1 of 1)

BIOACCUMULATION FACTORS TO BE USED IN THE ABSENCE OF SITE-SPECIFIC DATA
(pCi/kg per pCi/liter)

	FRESHWATER	
ELEMENT	FISH	INVERTEBRATE
H	9.0E-01	9.0E-01
Na	1.0E+02	2.0E+02
Cr	2.0E+02	2.0E+03
Mn	4.0E+02	9.0E+04
Fe	1.0E+02	3.2E+03
Co	5.0E+01	2.0E+02
Ni	1.0E+02	1.0E+02
Cu	5.0E+01	4.0E+02
Zn	2.0E+03	1.0E+04
Br	4.2E+02	3.3E+02
Rb	2.0E+03	1.0E+03
Sr	3.0E+01	1.0E+02
Y	2.5E+01	1.0E+03
Zr	3.3E+00	6.7E+00
Nb	3.0E+04	1.0E+02
Mo	1.0E+01	1.0E+01
Tc	1.5E+01	5.0E+00
Ru	1.0E+01	3.0E+02
Rh	1.0E+01	3.0E+02
Te	4.0E+02	6.1E+03
I	1.5E+01	5.0E+00
Cs	2.0E+03	1.0E+03
Ba	4.0E+00	2.0E+02
La	2.5E+01	1.0E+03
Ce	1.0E+00	1.0E+03
Pr	2.5E+01	1.0E+03
Nd	2.5E+01	1.0E+03
W	1.2E+03	1.0E+01
Np	1.0E+01	4.0E+02

* Table taken from Regulatory Guide 1.109 (Revision 1)

TABLE 3.1-2*
(1 OF 3)

INGESTION DOSE FACTORS FOR ADULTS
(mRem per pCi Ingested)

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

* Table taken from Regulatory Guide 1.109 (Revision 1)

TABLE 3.1-2*
(2 OF 3)

INGESTION DOSE FACTORS FOR ADULTS
(mRem per pCi Ingested)

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

* Table taken from Regulatory Guide 1.109 (Revision 1)

TABLE 3.1-2*
(3 OF 3)

INGESTION DOSE FACTORS FOR ADULTS
(mRem per pCi Ingested)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
Ba 140	2.03E-05	2.55E-08	1.33E-06	NO DATA	8.67E-09	1.46E-08	4.18E-05
Ba 141	4.71E-08	3.56E-11	1.59E-09	NO DATA	3.31E-11	2.02E-11	2.22E-17
Ba 142	2.13E-08	2.19E-11	1.34E-09	NO DATA	1.85E-11	1.24E-11	3.00E-26
La 140	2.50E-09	1.26E-09	3.33E-10	NO DATA	NO DATA	NO DATA	9.25E-05
La 142	1.28E-10	5.82E-11	1.45E-11	NO DATA	NO DATA	NO DATA	4.25E-07
Ce 141	9.36E-09	6.33E-09	7.18E-10	NO DATA	2.94E-09	NO DATA	2.42E-05
Ce 143	1.65E-09	1.22E-06	1.35E-10	NO DATA	5.37E-10	NO DATA	4.56E-05
Ce 144	4.88E-07	2.04E-07	2.62E-08	NO DATA	1.21E-07	NO DATA	1.65E-04
Pr 143	9.20E-09	3.69E-09	4.56E-10	NO DATA	2.13E-09	NO DATA	4.03E-05
Pr 144	3.01E-11	1.25E-11	1.53E-12	NO DATA	7.05E-12	NO DATA	4.33E-18
Nd 147	6.29E-09	7.27E-09	4.35E-10	NO DATA	4.25E-09	NO DATA	3.49E-05
W 187	1.03E-07	8.61E-08	3.01E-08	NO DATA	NO DATA	NO DATA	2.82E-05
Np 239	1.19E-09	1.17E-10	6.45E-11	NO DATA	3.65E-10	NO DATA	2.40E-05

* Table taken from Regulatory Guide 1.109 (Revision 1)

TABLE 3.1-3*
(1 OF 3)

INGESTION DOSE FACTORS FOR TEENAGER
(mRem per pCi Ingested)

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

* Table taken from Regulatory Guide 1.109 (Revision 1)

TABLE 3.1-3*
(2 OF 3)

INGESTION DOSE FACTORS FOR TEENAGER
(mRem per pCi Ingested)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
Y 93	3.83E-09	NO DATA	1.05E-10	NO DATA	NO DATA	NO DATA	1.17E-04
Zr 95	4.12E-08	1.30E-08	8.94E-09	NO DATA	1.91E-08	NO DATA	3.00E-05
Zr 97	2.37E-09	4.69E-10	2.16E-10	NO DATA	7.11E-10	NO DATA	1.27E-04
Nb 95	8.22E-09	4.56E-09	2.51E-09	NO DATA	4.42E-09	NO DATA	1.95E-05
Mo 99	NO DATA	6.03E-06	1.15E-06	NO DATA	1.38E-05	NO DATA	1.08E-05
Tc 99M	3.32E-10	9.26E-10	1.20E-08	NO DATA	1.38E-08	5.14E-10	6.08E-07
Tc 101	3.60E-10	5.12E-10	5.03E-09	NO DATA	9.26E-09	3.12E-10	8.75E-18
Ru 103	2.55E-07	NO DATA	1.09E-07	NO DATA	8.99E-07	NO DATA	2.13E-05
Ru 105	2.18E-08	NO DATA	8.46E-09	NO DATA	2.75E-07	NO DATA	1.76E-05
Ru 106	3.92E-06	NO DATA	4.94E-07	NO DATA	7.56E-06	NO DATA	1.88E-04
Ag 110M	2.05E-07	1.94E-07	1.18E-07	NO DATA	3.70E-07	NO DATA	5.45E-05
Te 125M	3.83E-06	1.38E-06	5.12E-07	1.07E-06	NO DATA	NO DATA	1.13E-05
Te 127M	9.67E-06	3.43E-06	1.15E-06	2.30E-06	3.92E-05	NO DATA	2.41E-05
Te 127	1.58E-07	5.60E-08	3.40E-08	1.09E-07	6.40E-07	NO DATA	1.22E-05
Te 129M	1.63E-05	6.05E-06	2.58E-06	5.26E-06	6.82E-05	NO DATA	6.12E-05
Te 129	4.48E-08	1.67E-08	1.09E-08	3.20E-08	1.88E-07	NO DATA	2.45E-07
Te 131M	2.44E-06	1.17E-06	9.76E-07	1.76E-06	1.22E-05	NO DATA	9.39E-05
Te 131	2.79E-08	1.15E-08	8.72E-09	2.15E-08	1.22E-07	NO DATA	2.29E-09
Te 132	3.49E-06	2.21E-06	2.08E-06	2.33E-06	2.12E-05	NO DATA	7.00E-05
I 130	1.03E-06	2.98E-06	1.19E-06	2.43E-04	4.59E-06	NO DATA	2.29E-06
I 131	5.85E-06	8.19E-06	4.40E-06	2.39E-03	1.41E-05	NO DATA	1.62E-06
I 132	2.79E-07	7.30E-07	2.62E-07	2.46E-05	1.15E-06	NO DATA	3.18E-07
I 133	2.01E-06	3.41E-06	1.04E-06	4.76E-04	5.98E-06	NO DATA	2.58E-06
I 134	1.46E-07	3.87E-07	1.39E-07	6.45E-06	6.10E-07	NO DATA	5.10E-09
I 135	6.10E-07	1.57E-06	5.82E-07	1.01E-04	2.48E-06	NO DATA	1.74E-06
Cs 134	8.37E-05	1.97E-04	9.14E-05	NO DATA	6.26E-05	2.39E-05	2.45E-06
Cs 136	8.59E-06	3.38E-05	2.27E-05	NO DATA	1.84E-05	2.90E-06	2.72E-06
Cs 137	1.12E-04	1.49E-04	5.19E-05	NO DATA	5.07E-05	1.97E-05	2.12E-06
Cs 138	7.76E-08	1.49E-07	7.45E-08	NO DATA	1.10E-07	1.28E-08	6.76E-11
Ba 139	1.39E-07	9.78E-11	4.05E-09	NO DATA	9.22E-11	6.74E-11	1.24E-06

* Table taken from Regulatory Guide 1.109 (Revision 1)

TABLE 3.1-3*
(3 OF 3)

INGESTION DOSE FACTORS FOR TEENAGER
(mRem per pCi Ingested)

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

* Table taken from Regulatory Guide 1.109 (Revision 1)

TABLE 3.1-4*
(1 OF 3)

INGESTION DOSE FACTORS FOR CHILD
(mRem per pCi Ingested)

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

* Table taken from Regulatory Guide 1.109 (Revision 1)

TABLE 3.1-4*

INGESTION DOSE FACTORS FOR CHILD
(mRem per pCi Ingested)

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

* Table taken from Regulatory Guide 1.109 (Revision 1)

TABLE 3.1-4*
(3 OF 3)

INGESTION DOSE FACTORS FOR CHILD
(mRem per pCi Ingested)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
Ba 140	8.31E-05	7.28E-08	4.85E-06	NO DATA	2.37E-08	4.34E-08	4.21E-05
Ba 141	2.00E-07	1.12E-10	6.51E-09	NO DATA	9.69E-11	6.58E-10	1.14E-07
Ba 142	8.74E-08	6.29E-11	4.88E-09	NO DATA	5.09E-11	3.70E-11	1.14E-09
La 140	1.01E-08	3.53E-09	1.19E-09	NO DATA	NO DATA	NO DATA	9.84E-05
La 142	5.24E-10	1.67E-10	5.23E-11	NO DATA	NO DATA	NO DATA	3.31E-05
Ce 141	3.97E-08	1.98E-08	2.94E-09	NO DATA	8.68E-09	NO DATA	2.47E-05
Ce 143	6.99E-09	3.79E-06	5.49E-10	NO DATA	1.59E-09	NO DATA	5.55E-05
Ce 144	2.08E-06	6.52E-07	1.11E-07	NO DATA	3.61E-07	NO DATA	1.70E-04
Pr 143	3.93E-08	1.18E-08	1.95E-09	NO DATA	6.39E-09	NO DATA	4.24E-05
Pr 144	1.29E-10	3.99E-11	6.49E-12	NO DATA	2.11E-11	NO DATA	8.59E-08
Nd 147	2.79E-08	2.26E-08	1.75E-09	NO DATA	1.24E-08	NO DATA	3.58E-05
W 187	4.29E-07	2.54E-07	1.14E-07	NO DATA	NO DATA	NO DATA	3.57E-05
Np 239	5.25E-09	3.77E-10	2.65E-10	NO DATA	1.09E-09	NO DATA	2.79E-05

* Table taken from Regulatory Guide 1.109 (Revision 1)

TABLE 3.1-5*
(1 OF 3)

INGESTION DOSE FACTORS FOR INFANT
(mRem per pCi Ingested)

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

* Table taken from Regulatory Guide 1.109 (Revision 1)

TABLE 3.1-5*
(2 OF 3)

INGESTION DOSE FACTORS FOR INFANT
(mRem per pCi Ingested)

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

* Table taken from Regulatory Guide 1.109 (Revision 1)

TABLE 3.1-5*
(3 OF 3)

INGESTION DOSE FACTORS FOR INFANT
(mRem per pCi Ingested)

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

* Table taken from Regulatory Guide 1.109 (Revision 1)

TABLE 3.1-6*
(1 OF 1)

INHALATION DOSE FACTORS FOR ADULTS
(mRem per pCi Inhaled)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	NO DATA	1.58E-07	1.58E-07	1.58E-07	1.58E-07	1.58E-07	1.58E-07
Cr 51	NO DATA	NO DATA	1.25E-08	7.44E-09	2.85E-09	1.80E-06	4.15E-07
Mn 54	NO DATA	4.95E-06	7.87E-07	NO DATA	1.23E-06	1.75E-04	9.67E-06
Fe 55	3.07E-06	2.12E-06	4.93E-07	NO DATA	NO DATA	9.01E-06	7.54E-07
Fe 59	1.47E-06	3.47E-06	1.32E-06	NO DATA	NO DATA	1.27E-04	2.35E-05
Co 58	NO DATA	1.98E-07	2.59E-07	NO DATA	NO DATA	1.16E-04	1.33E-05
Co 60	NO DATA	1.44E-06	1.85E-06	NO DATA	NO DATA	7.46E-04	3.56E-05
Zn 65	4.05E-06	1.29E-05	5.82E-06	NO DATA	8.62E-06	1.08E-04	6.68E-06
Sr 89	8.30E-05	NO DATA	1.09E-06	NO DATA	NO DATA	1.75E-04	4.37E-05
Sr 90	1.24E-02	NO DATA	7.62E-04	NO DATA	NO DATA	1.20E-03	9.02E-05
Zr 95	1.34E-05	4.30E-06	2.91E-06	NO DATA	6.77E-06	2.21E-04	7.88E-05
Mo 99	NO DATA	1.51E-08	2.87E-09	NO DATA	3.64E-08	1.14E-05	3.10E-05
Sb 124	3.90E-06	7.36E-08	1.55E-06	9.44E-09	NO DATA	3.10E-04	5.08E-05
I 131	3.15E-06	4.47E-06	2.56E-06	1.49E-03	7.66E-06	NO DATA	7.85E-07
I 133	1.08E-06	1.85E-06	5.65E-07	2.69E-04	3.23E-06	NO DATA	1.11E-06
Cs 134	4.66E-05	1.06E-04	9.10E-05	NO DATA	3.59E-05	1.22E-05	1.30E-06
Cs 136	4.88E-06	1.83E-05	1.38E-05	NO DATA	1.07E-05	1.50E-06	1.46E-06
Cs 137	5.98E-05	7.76E-05	5.35E-05	NO DATA	2.78E-05	9.40E-06	1.05E-06
Ba 140	4.88E-06	6.13E-09	3.21E-07	NO DATA	2.09E-09	1.59E-04	2.73E-05
Ce 141	2.49E-06	1.69E-06	1.91E-07	NO DATA	7.83E-07	4.52E-05	1.50E-05
Ce 144	4.29E-04	1.79E-04	2.30E-05	NO DATA	1.06E-04	9.72E-04	1.02E-04

* Table taken from NUREG-0597

TABLE 3.1-7*
(1 OF 1)

INHALATION DOSE FACTORS FOR TEENAGER
(mRem per pCi Inhaled)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	NO DATA	1.59E-07	1.59E-07	1.59E-07	1.59E-07	1.59E-07	1.59E-07
Cr 51	NO DATA	NO DATA	1.69E-08	9.37E-09	3.84E-09	2.62E-06	3.75E-07
Mn 54	NO DATA	6.39E-06	1.05E-06	NO DATA	1.59E-06	2.48E-04	8.35E-06
Fe 55	4.18E-06	2.98E-06	6.93E-07	NO DATA	NO DATA	1.55E-06	7.99E-07
Fe 59	1.99E-06	4.62E-06	1.79E-06	NO DATA	NO DATA	1.91E-04	2.23E-05
Co 58	NO DATA	2.59E-07	3.47E-07	NO DATA	NO DATA	1.68E-04	1.19E-05
Co 60	NO DATA	1.89E-06	2.48E-06	NO DATA	NO DATA	1.09E-03	3.24E-05
Zn 65	4.82E-06	1.67E-05	7.80E-06	NO DATA	1.08E-05	1.55E-04	5.83E-06
Sr 89	5.43E-05	NO DATA	1.56E-06	NO DATA	NO DATA	3.02E-04	4.64E-05
Sr 90	1.34E-02	NO DATA	8.35E-04	NO DATA	NO DATA	2.06E-03	9.56E-05
Zr 95	1.82E-05	5.73E-06	3.94E-06	NO DATA	8.42E-06	3.36E-04	1.86E-05
Mo 99	NO DATA	2.11E-08	4.03E-09	NO DATA	5.14E-08	1.92E-05	3.36E-05
Sb 124	5.38E-06	9.92E-08	2.10E-06	1.22E-08	NO DATA	4.81E-04	4.98E-05
I 131	4.43E-06	6.14E-06	3.30E-06	1.83E-03	1.05E-05	NO DATA	8.11E-07
I 133	1.52E-06	2.56E-06	7.78E-07	3.65E-04	4.49E-06	NO DATA	1.29E-06
Cs 134	6.28E-05	1.41E-04	6.86E-05	NO DATA	4.69E-05	1.83E-05	1.22E-06
Cs 136	6.44E-06	2.42E-05	1.71E-05	NO DATA	1.38E-05	2.22E-06	1.36E-06
Cs 137	8.38E-05	1.06E-04	3.89E-05	NO DATA	3.80E-05	1.51E-05	1.06E-06
Ba 140	6.84E-06	8.38E-09	4.40E-07	NO DATA	2.85E-09	2.54E-04	2.86E-05
Ce 141	3.55E-06	2.37E-06	2.71E-07	NO DATA	1.11E-06	7.67E-05	1.58E-05
Ce 144	6.11E-04	2.53E-04	3.28E-05	NO DATA	1.51E-04	1.67E-03	1.08E-04

* Table taken from NUREG-0597

TABLE 3.1-8*
(1 OF 1)

INHALATION DOSE FACTORS FOR CHILD
(mRem per pCi Inhaled)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	NO DATA	3.04E-07	3.04E-07	3.04E-07	3.04E-07	3.04E-07	3.04E-07
Cr 51	NO DATA	NO DATA	4.17E-08	2.31E-08	6.57E-09	4.59E-06	2.93E-07
Mn 54	NO DATA	1.16E-05	2.57E-06	NO DATA	2.71E-06	4.26E-04	6.19E-06
Fe 55	1.28E-05	6.80E-06	2.10E-06	NO DATA	NO DATA	3.00E-05	7.75E-07
Fe 59	5.59E-06	9.04E-06	4.51E-06	NO DATA	NO DATA	3.43E-04	1.91E-05
Co 58	NO DATA	4.79E-07	8.55E-07	NO DATA	NO DATA	2.99E-04	9.29E-06
Co 60	NO DATA	3.55E-06	6.12E-06	NO DATA	NO DATA	1.91E-03	2.60E-05
Zn 65	1.15E-05	3.06E-05	1.90E-05	NO DATA	1.93E-05	2.69E-04	4.41E-06
Sr 89	1.69E-04	NO DATA	4.66E-06	NO DATA	NO DATA	5.83E-04	4.52E-05
Sr 90	2.73E-02	NO DATA	1.74E-03	NO DATA	NO DATA	3.99E-03	9.28E-05
Zr 95	5.13E-05	1.13E-05	1.00E-05	NO DATA	1.16E-05	6.03E-04	1.65E-05
Mo 99	NO DATA	4.66E-08	1.15E-08	NO DATA	1.06E-07	3.66E-05	3.42E-05
Sb 124	1.55E-05	2.00E-07	5.41E-06	3.41E-08	NO DATA	8.76E-04	4.43E-05
I 131	1.30E-05	1.30E-05	7.37E-06	4.39E-03	2.13E-05	NO DATA	7.68E-07
I 133	4.48E-06	5.49E-06	2.08E-06	1.04E-03	9.13E-06	NO DATA	1.48E-06
Cs 134	1.76E-04	2.74E-04	6.07E-05	NO DATA	8.93E-05	3.27E-05	1.04E-06
Cs 136	1.76E-05	4.62E-05	3.14E-05	NO DATA	2.58E-05	3.93E-06	1.13E-06
Cs 137	2.45E-04	2.23E-04	3.47E-05	NO DATA	7.63E-05	2.81E-05	9.78E-07
Ba 140	2.00E-05	1.75E-08	1.17E-06	NO DATA	5.71E-09	4.71E-04	2.75E-05
Ce 141	1.06E-05	5.28E-06	7.83E-07	NO DATA	2.31E-06	1.47E-04	1.53E-05
Ce 144	1.83E-03	5.72E-04	9.77E-05	NO DATA	3.17E-04	3.23E-03	1.05E-04

* Table taken from NUREG-0597

TABLE 3.1-9*
(1 OF 1)

INHALATION DOSE FACTORS FOR INFANT
(mRem per pCi Inhaled)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	NO DATA	4.62E-07	4.62E-07	4.62E-07	4.62E-07	4.62E-07	4.62E-07
Cr 51	NO DATA	NO DATA	6.39E-08	4.11E-08	9.45E-09	9.17E-06	2.55E-07
Mn 54	NO DATA	1.81E-05	3.56E-06	NO DATA	3.56E-06	7.14E-04	5.04E-06
Fe 55	1.41E-05	8.39E-06	2.38E-06	NO DATA	NO DATA	6.21E-05	7.82E-07
Fe 59	9.69E-06	1.68E-05	6.77E-06	NO DATA	NO DATA	7.25E-04	1.77E-05
Co 58	NO DATA	8.71E-07	1.30E-06	NO DATA	NO DATA	5.55E-04	7.95E-06
Co 60	NO DATA	5.73E-06	8.41E-06	NO DATA	NO DATA	3.22E-03	2.28E-05
Zn 65	1.38E-05	4.47E-05	2.22E-05	NO DATA	2.32E-05	4.62E-04	3.67E-05
Sr 89	2.84E-04	NO DATA	8.15E-06	NO DATA	NO DATA	1.45E-03	4.57E-05
Sr 90	2.92E-02	NO DATA	1.85E-03	NO DATA	NO DATA	8.03E-03	9.36E-05
Zr 95	8.24E-05	1.99E-05	1.45E-05	NO DATA	2.22E-05	1.25E-03	1.55E-05
Mo 99	NO DATA	1.18E-07	2.31E-08	NO DATA	1.89E-07	9.63E-05	3.48E-05
Sb 124	2.71E-05	3.97E-07	8.56E-06	7.18E-08	NO DATA	1.89E-03	4.22E-05
I 131	2.71E-05	3.17E-05	1.40E-05	1.06E-02	3.70E-05	NO DATA	7.56E-07
I 133	9.46E-06	1.37E-05	4.00E-06	2.54E-03	1.60E-05	NO DATA	1.54E-06
Cs 134	2.83E-04	5.02E-04	5.32E-05	NO DATA	1.36E-04	5.69E-05	9.53E-07
Cs 136	3.45E-05	9.61E-05	3.78E-05	NO DATA	4.03E-05	8.40E-06	1.02E-06
Cs 137	3.92E-04	4.37E-04	3.25E-05	NO DATA	1.23E-04	5.09E-05	9.53E-07
Ba 140	4.00E-05	4.00E-08	2.07E-06	NO DATA	9.59E-09	1.14E-03	2.74E-05
Ce 141	1.98E-05	1.19E-05	1.42E-06	NO DATA	3.75E-06	3.69E-04	1.54E-05
Ce 144	2.28E-03	8.65E-04	1.26E-04	NO DATA	3.84E-04	7.03E-03	1.06E-04

* Table taken from NUREG-0597

TABLE 3.1-10*
(1 of 2)

EXTERNAL DOSE FACTORS FOR STANDING ON CONTAMINATED GROUND

(mrem/hr per pCi/m^2)

Element	Total Body	Skin
H-3	0.0	0.0
Na-24	2.50E-08	2.90E-08
Cr-51	2.20E-10	2.60E-10
Mn-54	5.80E-09	6.80E-09
Mn-56	1.10E-08	1.30E-08
Fe-55	0.0	0.0
Fe-59	8.00E-09	9.40E-09
Co-58	7.00E-09	8.20E-09
Co-60	1.70E-08	2.00E-08
Ni-63	0.0	0.0
Ni-65	3.70E-09	4.30E-09
Cu-64	1.50E-09	1.70E-09
Zn-65	4.00E-09	4.60E-09
Zn-69	0.0	0.0
Br-83	6.40E-11	9.30E-11
Br-84	1.20E-08	1.40E-08
Br-85	0.0	0.0
Rb-86	6.30E-10	7.20E-10
Rb-88	3.50E-09	4.00E-09
Rb-89	1.50E-08	1.80E-08
Sr-89	5.60E-13	6.50E-13
Sr-91	7.10E-09	8.30E-09
Sr-92	9.00E-09	1.00E-08
Y-90	2.20E-12	2.60E-12
Y-91M	3.80E-09	4.40E-09
Y-91	2.40E-11	2.70E-11
Y-92	1.60E-09	1.90E-09
Y-93	5.70E-10	7.80E-10
Zr-95	5.00E-09	5.80E-09
Zr-97	5.50E-09	6.40E-09
Nb-95	5.10E-09	6.00E-09
Mo-99	1.90E-09	2.20E-09
Tc-99M	9.60E-10	1.10E-09
Tc-101	2.70E-09	3.00E-09
Ru-103	3.60E-09	4.20E-09
Ru-105	4.50E-09	5.10E-09
Ru-106	1.50E-09	1.80E-09
Ag-110M	1.80E-08	2.10E-08
Te-125M	3.50E-11	4.80E-11
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

*Taken from Regulatory Guide 1.109 (Rev. 1)

EXTERNAL DOSE FACTORS FOR STANDING ON CONTAMINATED GROUND

(mrem/hr per pCi/m^2)

Element	Total Body	Skin
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

STABLE ELEMENT TRANSFER DATA

Element	B_{iv} Veg/Soil	F_m(Cow) Milk (d/ℓ)	F_f Meat (d/kg)
H	4.8E+00	1.0E-02**	1.2E-02
Na	5.2E-02	4.0E-02	3.0E-02
Cr	2.5E-04	2.2E-03	2.4E-03
Mn	2.9E-02	2.5E-04	8.0E-04
Fe	6.6E-04	1.2E-03**	4.0E-02
Co	9.4E-03	1.0E-03	1.3E-02
Ni	1.9E-02	6.7E-03	5.3E-02
Cu	1.2E-01	1.4E-02**	8.0E-03
Zn	4.0E-01	3.9E-02	3.0E-02
Rb	1.3E-01	3.0E-02	3.1E-02
Sr	1.7E-02	8.0E-04**	6.0E-04
Y	2.6E-03	1.0E-05	4.6E-03
Zr	1.7E-04	5.0E-06	3.4E-02
Nb	9.4E-03	2.5E-03	2.8E-01
Mo	1.2E-01	7.5E-03	8.0E-03
Tc	2.5E-01	2.5E-02	4.0E-01
Ru	5.0E-02	1.0E-06	4.0E-01
Rh	1.3E+01	1.0E-02	1.5E-03
Ag	1.5E-01	5.0E-02	1.7E-02
Te	1.3E+00	1.0E-03	7.7E-02
I	2.0E-02	6.0E-03**	2.9E-03
Cs	1.0E-02	1.2E-02**	4.0E-03
Ba	5.0E-03	4.0E-04	3.2E-03
La	2.5E-03	5.0E-06	2.0E-04
Ce	2.5E-03	1.0E-04	1.2E-03
Pr	2.5E-03	5.0E-06	4.7E-03
Nd	2.4E-03	5.0E-06	3.3E-03
W	1.8E-02	5.0E-04	1.3E-03
Np	2.5E-03	5.0E-06	2.0E-04

*Taken from Regulatory Guide 1.109 (Rev. 1)

**Nuclide Transfer parameters for Goat's milk

Element	Fm (d/1)
H	0.17
Fe	1.30E-04
Cu	0.013
Sr	0.014
I	0.06
Cs	0.30

TABLE 3.1-12
(1 of 1)
R_i VALUES - GROUND PATHWAY - ALL AGES

NUCLIDE	T.BODY	SKIN
H 3	NO DATA	NO DATA
CR 51	4.65E+06	5.49E+06
MN 54	1.38E+09	1.62E+09
FE 55	NO DATA	NO DATA
FE 59	2.72E+08	3.20E+08
CO 58	3.79E+08	4.44E+08
CO 60	2.15E+10	2.53E+10
ZN 65	7.44E+08	8.56E+08
SR 89	2.16E+04	2.50E+04
SR 90	NO DATA	NO DATA
ZR 95	2.51E+08	2.91+08
MO 99	4.63E+06	4.00E+06
SB 124	5.98E+08	6.91E+08
I 131	8.59E+06	1.04E+07
I 133	1.22E+06	1.49E+06
CS 134	6.82E+09	7.96E+09
CS 136	1.50E+08	1.70E+08
CS 137	1.03E+10	1.20E+10
BA 140	2.05E+07	2.34E+07
CE 141	1.36E+07	1.54E+07
CE 144	6.92E+07	8.01E+07

R_i VALUES - VEGETABLE PATHWAY - ADULT

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	0.0	2.28E+03	2.28E+03	2.28E+03	2.28E+03	2.28E+03	2.28E+03
CR 51	0.0	0.0	4.58E+04	2.74E+04	1.01E+04	6.07E+04	1.15E+07
MN 54	0.0	3.07E+08	5.86E+07	0.0	9.14E+07	0.0	9.41E+08
FE 55	1.99E+08	1.38E+08	3.21E+07	0.0	0.0	7.68E+07	7.90E+07
FE 59	1.23E+08	2.90E+08	1.11E+08	0.0	0.0	8.09E+07	9.66E+08
CO 58	0.0	2.99E+07	6.71E+07	0.0	0.0	0.0	6.07E+08
CO 60	0.0	1.66E+08	3.67E+08	0.0	0.0	0.0	3.12E+09
ZN 65	4.00E+08	1.27E+09	5.76E+08	0.0	8.52E+08	0.0	8.02E+08
SR 89	9.75E+09	0.0	2.80E+08	0.0	0.0	0.0	1.56E+09
SR 90	6.70E+11	0.0	1.64E+11	0.0	0.0	0.0	1.94E+10
ZR 95	1.16E+06	3.73E+05	2.52E+05	0.0	5.85E+05	0.0	1.18E+09
MO 99	0.0	6.20E+06	1.18E+06	0.0	1.40E+07	0.0	1.44E+07
SB 124	1.01E+08	1.91E+06	4.01E+07	2.45E+05	0.0	7.88E+07	2.87E+09
I 131	4.03E+07	5.76E+07	3.30E+07	1.89E+10	9.88E+07	0.0	1.52E+07
I 133	1.04E+06	1.80E+06	5.50E+05	2.65E+08	3.15E+06	0.0	1.62E+06
CS 134	4.54E+09	1.08E+10	8.83E+09	0.0	3.49E+09	1.16E+09	1.89E+08
CS 136	4.23E+07	1.67E+08	1.20E+08	0.0	9.30E+07	1.27E+07	1.90E+07
CS 137	6.63E+09	9.07E+09	5.94E+09	0.0	3.08E+09	1.02E+09	1.76E+08
BA 140	1.28E+08	1.61E+05	8.40E+06	0.0	5.47E+04	9.22E+04	2.64E+08
CE 141	1.94E+05	1.31E+05	1.49E+04	0.0	6.09E+04	0.0	5.02E+08
CE 144	3.15E+07	1.31E+07	1.69E+06	0.0	7.80E+06	0.0	1.06E+10

TABLE 3.1-14
(1 of 1)
R_i VALUES - VEGETABLE PATHWAY - TEENAGER

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	0.0	2.61E+03	2.61E+03	2.61E+03	2.61E+03	2.61E+03	2.61E+03
CR 51	0.0	0.0	6.08E+04	3.38E+04	1.33E+04	8.68E+04	1.02E+07
MN 54	0.0	4.46E+08	8.85E+07	0.0	1.33E+08	0.0	9.15E+08
FE 55	3.10E+08	2.20E+08	5.13E+07	0.0	0.0	1.39E+08	9.51E+07
FE 59	1.75E+08	4.09E+08	1.58E+08	0.0	0.0	1.29E+08	9.68E+08
CO 58	0.0	4.25E+07	9.79E+07	0.0	0.0	0.0	5.86E+08
CO 60	0.0	2.47E+08	5.57E+08	0.0	0.0	0.0	3.22E+09
ZN 65	5.35E+08	1.86E+09	8.66E+08	0.0	1.19E+09	0.0	7.86E+08
SR 89	1.48E+10	0.0	4.24E+08	0.0	0.0	0.0	1.76E+09
SR 90	8.32E+11	0.0	2.05E+11	0.0	0.0	0.0	2.34E+10
ZR 95	1.70E+06	5.38E+05	3.70E+05	0.0	7.90E+05	0.0	1.24E+09
MO 99	0.0	5.69E+06	1.09E+06	0.0	1.30E+07	0.0	1.02E+07
SB 124	1.51E+08	2.78E+06	5.88E+07	3.42E+05	0.0	1.32E+08	3.04E+09
I 131	3.83E+07	5.37E+07	2.88E+07	1.57E+10	9.24E+07	0.0	1.06E+07
I 133	9.63E+05	1.63E+06	4.98E+05	2.28E+08	2.87E+06	0.0	1.24E+06
CS 134	6.90E+09	1.62E+10	7.54E+09	0.0	5.16E+09	1.97E+09	2.02E+08
CS 136	4.33E+07	1.71E+08	1.15E+08	0.0	9.28E+07	1.46E+07	1.37E+07
CS 137	1.06E+10	1.41E+10	4.90E+09	0.0	4.78E+09	1.86E+09	2.00E+08
BA 140	1.38E+08	1.69E+05	8.88E+06	0.0	5.72E+04	1.14E+05	2.12E+08
CE 141	2.78E+05	1.86E+05	2.13E+04	0.0	8.75E+04	0.0	5.32E+08
CE 144	5.04E+07	2.09E+07	2.71E+06	0.0	1.25E+07	0.0	1.27E+10

R_i VALUES - VEGETABLE PATHWAY - CHILD

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	0.0	4.04E+03	4.04E+03	4.04E+03	4.04E+03	4.04E+03	4.04E+03
CR 51	0.0	0.0	1.15E+05	6.40E+04	1.75E+04	1.17E+05	6.12E+06
MN 54	0.0	6.53E+08	1.74E+08	0.0	1.83E+08	0.0	5.48E+08
FE 55	7.62E+08	4.04E+08	1.25E+08	0.0	0.0	2.29E+08	7.49E+07
FE 59	3.88E+08	6.29E+08	3.13E+08	0.0	0.0	1.82E+08	6.54E+08
CO 58	0.0	6.27E+07	1.92E+08	0.0	0.0	0.0	3.66E+08
CO 60	0.0	3.76E+08	1.11E+09	0.0	0.0	0.0	2.08E+09
ZN 65	1.02E+09	2.73E+09	1.70E+09	0.0	1.72E+09	0.0	4.80E+08
SR 89	3.52E+10	0.0	1.00E+09	0.0	0.0	0.0	1.36E+09
SR 90	1.38E+12	0.0	3.49E+11	0.0	0.0	0.0	1.86E+10
ZR 95	3.82E+06	8.40E+05	7.48E+05	0.0	1.20E+06	0.0	8.77E+08
MO 99	0.0	7.77E+06	1.92E+06	0.0	1.66E+07	0.0	6.43E+06
SB 124	3.44E+08	4.46E+06	1.20E+08	7.59E+05	0.0	1.91E+08	2.15E+09
I 131	7.13E+07	7.17E+07	4.08E+07	2.37E+10	1.18E+08	0.0	6.39E+06
I 133	1.76E+06	2.17E+06	8.22E+05	4.03E+08	3.62E+06	0.0	8.75E+05
CS 134	1.56E+10	2.56E+10	5.40E+09	0.0	7.93E+09	2.85E+09	1.38E+08
CS 136	8.16E+07	2.24E+08	1.45E+08	0.0	1.19E+08	1.78E+07	7.88E+06
CS 137	2.49E+10	2.39E+10	3.52E+09	0.0	7.78E+09	2.80E+09	1.50E+08
BA 140	2.76E+08	2.42E+05	1.61E+07	0.0	7.87E+04	1.44E+05	1.40E+08
CE 141	6.45E+05	3.22E+05	4.78E+04	0.0	1.41E+05	0.0	4.02E+08
CE 144	1.22E+08	3.81E+07	6.48E+06	0.0	2.11E+07	0.0	9.93E+09

TABLE 3.1-16
(1 of 1)
R_i VALUES - MEAT PATHWAY - ADULT

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	0.0	3.27E+02	3.27E+02	3.27E+02	3.27E+02	3.27E+02	3.27E+02
CR 51	0.0	0.0	5.86E+03	3.50E+03	1.29E+03	7.77E+03	1.47E+06
MN 54	0.0	6.83E+06	1.30E+06	0.0	2.03E+06	0.0	2.09E+07
FE 55	2.13E+08	1.47E+08	3.43E+07	0.0	0.0	8.20E+07	8.44E+07
FE 59	2.12E+08	4.99E+08	1.91E+08	0.0	0.0	1.39E+08	1.66E+09
CO 58	0.0	1.41E+07	3.17E+07	0.0	0.0	0.0	2.87E+08
CO 60	0.0	5.56E+07	1.23E+08	0.0	0.0	0.0	1.04E+09
ZN 65	3.01E+08	9.57E+08	4.32E+08	0.0	6.40E+08	0.0	6.03E+08
SR 89	2.39E+08	0.0	6.86E+06	0.0	0.0	0.0	3.83E+07
SR 90	9.67E+09	0.0	2.37E+09	0.0	0.0	0.0	2.79E+08
ZR 95	1.47E+06	4.72E+05	3.20E+05	0.0	7.41E+05	0.0	1.50E+09
MO 99	0.0	9.38E+04	1.78E+04	0.0	2.12E+05	0.0	2.17E+05
SB 124	1.55E+07	2.93E+05	6.15E+06	3.76E+04	0.0	1.21E+07	4.40E+08
I 131	4.92E+06	7.03E+06	4.03E+06	2.30E+09	1.21E+07	0.0	1.86E+06
I 133	1.69E-01	2.94E-01	8.97E-02	4.32E+01	5.14E-01	0.0	2.65E-01
CS 134	4.83E+08	1.15E+09	9.39E+08	0.0	3.72E+08	1.23E+08	2.01E+07
CS 136	1.06E+07	4.20E+07	3.03E+07	0.0	2.34E+07	3.21E+06	4.78E+06
CS 137	6.58E+08	9.00E+08	5.89E+08	0.0	3.05E+08	1.02E+08	1.74E+07
BA 140	2.56E+07	3.22E+04	1.68E+06	0.0	1.09E+04	1.84E+04	5.27E+07
CE 141	1.15E+04	7.79E+03	8.84E+02	0.0	3.62E+03	0.0	2.98E+07
CE 144	1.07E+06	4.49E+05	5.76E+04	0.0	2.66E+05	0.0	3.63E+08

TABLE 3.1-17
(1 of 1)
R_i VALUES - MEAT PATHWAY - TEENAGER

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	0.0	1.95E+02	1.95E+02	1.95E+02	1.95E+02	1.95E+02	1.95E+02
CR 51	0.0	0.0	4.68E+03	2.60E+03	1.03E+03	6.69E+03	7.87E+05
MN 54	0.0	5.21E+06	1.03E+06	0.0	1.55E+06	0.0	1.07E+07
FE 55	1.73E+08	1.23E+08	2.86E+07	0.0	0.0	7.78E+07	5.31E+07
FE 59	1.70E+08	3.96E+08	1.53E+08	0.0	0.0	1.25E+08	9.36E+08
CO 58	0.0	1.09E+07	2.51E+07	0.0	0.0	0.0	1.50E+08
CO 60	0.0	4.31E+07	9.72E+07	0.0	0.0	0.0	5.62E+08
ZN 65	2.11E+08	7.34E+08	3.43E+08	0.0	4.70E+08	0.0	3.11E+08
SR 89	2.02E+08	0.0	5.78E+06	0.0	0.0	0.0	2.40E+07
SR 90	6.26E+09	0.0	1.55E+09	0.0	0.0	0.0	1.76E+08
ZR 95	1.18E+06	3.72E+05	2.56E+05	0.0	5.47E+05	0.0	8.58E+08
MO 99	0.0	7.75E+04	1.48E+04	0.0	1.77E+05	0.0	1.39E+05
SB 124	1.27E+07	2.33E+05	4.94E+06	2.87E+04	0.0	1.11E+07	2.55E+08
I 131	4.09E+06	5.72E+06	3.07E+06	1.67E+09	9.85E+06	0.0	1.13E+06
I 133	1.42E-01	2.40E-01	7.32E-02	3.35E+01	4.21E-01	0.0	1.82E-01
CS 134	3.84E+08	9.04E+08	4.19E+08	0.0	2.87E+08	1.10E+08	1.12E+07
CS 136	8.30E+06	3.27E+07	2.19E+07	0.0	1.78E+07	2.80E+06	2.63E+06
CS 137	5.46E+08	7.27E+08	2.53E+08	0.0	2.47E+08	9.61E+07	1.03E+07
BA 140	2.12E+07	2.59E+04	1.36E+06	0.0	8.79E+03	1.74E+04	3.26E+07
CE 141	9.67E+03	6.46E+03	7.42E+02	0.0	3.04E+03	0.0	1.85E+07
CE 144	9.04E+05	3.74E+05	4.86E+04	0.0	2.24E+05	0.0	2.27E+08

R_i VALUES - MEAT PATHWAY - CHILD

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	0.0	2.36E+02	2.36E+02	2.36E+02	2.36E+02	2.36E+02	2.36E+02
CR 51	0.0	0.0	7.31E+03	4.06E+03	1.11E+03	7.40E+03	3.87E+05
MN 54	0.0	5.96E+06	1.59E+06	0.0	1.67E+06	0.0	5.00E+06
FE 55	3.32E+08	1.76E+08	5.45E+07	0.0	0.0	9.95E+07	3.26E+07
FE 59	3.01E+08	4.86E+08	2.42E+08	0.0	0.0	1.41E+08	5.06E+08
CO 58	0.0	1.27E+07	3.90E+07	0.0	0.0	0.0	7.43E+07
CO 60	0.0	5.12E+07	1.51E+08	0.0	0.0	0.0	2.84E+08
ZN 65	3.17E+08	8.45E+08	5.26E+08	0.0	5.33E+08	0.0	1.48E+08
SR 89	3.82E+08	0.0	1.09E+07	0.0	0.0	0.0	1.48E+07
SR 90	8.08E+09	0.0	2.05E+09	0.0	0.0	0.0	1.09E+08
ZR 95	2.09E+06	4.60E+05	4.10E+05	0.0	6.59E+05	0.0	4.80E+08
MO 99	0.0	1.08E+05	2.67E+04	0.0	2.30E+05	0.0	8.92E+04
SB 124	2.29E+07	2.97E+05	8.03E+06	5.06E+04	0.0	1.27E+07	1.43E+08
I 131	7.58E+06	7.62E+06	4.33E+06	2.52E+09	1.25E+07	0.0	6.78E+05
I 133	2.63E-01	3.25E-01	1.23E-01	6.04E+01	5.42E-01	0.0	1.31E-01
CS 134	6.77E+08	1.11E+09	2.34E+08	0.0	3.44E+08	1.24E+08	5.99E+06
CS 136	1.43E+07	3.94E+07	2.55E+07	0.0	2.10E+07	3.13E+06	1.38E+06
CS 137	1.01E+09	9.63E+08	1.42E+08	0.0	3.14E+08	1.13E+08	6.03E+06
BA 140	3.91E+07	3.42E+04	2.28E+06	0.0	1.11E+04	2.04E+04	1.98E+07
CE 141	1.82E+04	9.08E+03	1.35E+03	0.0	3.98E+03	0.0	1.13E+07
CE 144	1.70E+06	5.34E+05	9.10E+04	0.0	2.96E+05	0.0	1.39E+08

TABLE 3.1-19
(1 of 1)
R_i VALUES - COW MILK PATHWAY - ADULT

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	0.0	7.69E+02	7.69E+02	7.69E+02	7.69E+02	7.69E+02	7.69E+02
CR 51	0.0	0.0	2.38E+04	1.42E+04	5.24E+03	3.15E+04	5.98E+06
MN 54	0.0	6.26E+06	1.19E+06	0.0	1.86E+06	0.0	1.92E+07
FE 55	1.82E+07	1.26E+07	2.94E+06	0.0	0.0	7.03E+06	7.22E+06
FE 59	2.37E+07	5.58E+07	2.14E+07	0.0	0.0	1.56E+07	1.86E+08
CO 58	0.0	3.66E+06	8.19E+06	0.0	0.0	0.0	7.41E+07
CO 60	0.0	1.21E+07	2.68E+07	0.0	0.0	0.0	2.28E+08
ZN 65	1.16E+09	3.69E+09	1.67E+09	0.0	2.47E+09	0.0	2.32E+09
SR 89	1.15E+09	0.0	3.30E+07	0.0	0.0	0.0	1.84E+08
SR 90	3.64E+10	0.0	8.93E+09	0.0	0.0	0.0	1.05E+09
ZR 95	7.38E+02	2.37E+02	1.60E+02	0.0	3.71E+02	0.0	7.50E+05
MO 99	0.0	2.32E+07	4.42E+06	0.0	5.25E+07	0.0	5.38E+07
SB 124	2.02E+07	3.81E+05	7.99E+06	4.89E+04	0.0	1.57E+07	5.72E+08
I 131	1.36E+08	1.94E+08	1.11E+08	6.36E+10	3.32E+08	0.0	5.12E+07
I 133	1.80E+06	3.13E+06	9.55E+05	4.61E+08	5.47E+06	0.0	2.82E+06
CS 134	4.15E+09	9.88E+09	8.08E+09	0.0	3.20E+09	1.06E+09	1.73E+08
CS 136	2.33E+08	9.22E+08	6.63E+08	0.0	5.13E+08	7.03E+07	1.05E+08
CS 137	5.57E+09	7.62E+09	4.99E+09	0.0	2.59E+09	8.59E+08	1.47E+08
BA 140	2.39E+07	3.01E+04	1.57E+06	0.0	1.02E+04	1.72E+04	4.93E+07
CE 141	3.99E+03	2.70E+03	3.06E+02	0.0	1.25E+03	0.0	1.03E+07
CE 144	2.64E+05	1.10E+05	1.42E+04	0.0	6.55E+04	0.0	8.93E+07

TABLE 3.1-20
(1 of 1)
R_i VALUES - COW MILK PATHWAY - TEENAGER

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	0.0	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03
CR 51	0.0	0.0	4.15E+04	2.31E+04	9.10E+03	5.93E+04	6.98E+06
MN 54	0.0	1.04E+07	2.07E+06	0.0	3.11E+06	0.0	2.14E+07
FE 55	3.23E+07	2.29E+07	5.34E+06	0.0	0.0	1.45E+07	9.92E+06
FE 59	4.14E+07	9.67E+07	3.73E+07	0.0	0.0	3.05E+07	2.29E+08
CO 58	0.0	6.15E+06	1.42E+07	0.0	0.0	0.0	8.48E+07
CO 60	0.0	2.06E+07	4.63E+07	0.0	0.0	0.0	2.68E+08
ZN 65	1.78E+09	6.18E+09	2.88E+09	0.0	3.96E+09	0.0	2.62E+09
SR 89	2.12E+09	0.0	6.07E+07	0.0	0.0	0.0	2.53E+08
SR 90	5.14E+10	0.0	1.27E+10	0.0	0.0	0.0	1.44E+09
ZR 95	1.29E+03	4.07E+02	2.80E+02	0.0	5.98E+02	0.0	9.39E+05
MO 99	0.0	4.19E+07	7.99E+06	0.0	9.59E+07	0.0	7.50E+07
SB 124	3.60E+07	6.62E+05	1.40E+07	8.16E+04	0.0	3.14E+07	7.25E+08
I 131	2.46E+08	3.44E+08	1.85E+08	1.01E+11	5.93E+08	0.0	6.81E+07
I 133	3.29E+06	5.58E+06	1.70E+06	7.79E+08	9.79E+06	0.0	4.22E+06
CS 134	7.21E+09	1.70E+10	7.87E+09	0.0	5.39E+09	2.06E+09	2.11E+08
CS 136	3.97E+08	1.56E+09	1.05E+09	0.0	8.51E+08	1.34E+08	1.26E+08
CS 137	1.01E+10	1.34E+10	4.68E+09	0.0	4.57E+09	1.78E+09	1.91E+08
BA 140	4.32E+07	5.30E+04	2.78E+06	0.0	1.80E+04	3.56E+04	6.67E+07
CE 141	7.31E+03	4.88E+03	5.61E+02	0.0	2.30E+03	0.0	1.40E+07
CE 144	4.86E+05	2.01E+05	2.61E+04	0.0	1.20E+05	0.0	1.22E+08

TABLE 3.1-21
(1 of 1)
R_i VALUES - COW MILK PATHWAY - CHILD

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	0.0	1.58E+03	1.58E+03	1.58E+03	1.58E+03	1.58E+03	1.58E+03
CR 51	0.0	0.0	8.47E+04	4.70E+04	1.28E+04	8.58E+04	4.49E+06
MN 54	0.0	1.56E+07	4.16E+06	0.0	4.38E+06	0.0	1.31E+07
FE 55	8.11E+07	4.30E+07	1.33E+07	0.0	0.0	2.43E+07	7.97E+06
FE 59	9.61E+07	1.55E+08	7.74E+07	0.0	0.0	4.51E+07	1.62E+08
CO 58	0.0	9.40E+06	2.88E+07	0.0	0.0	0.0	5.48E+07
CO 60	0.0	3.19E+07	9.41E+07	0.0	0.0	0.0	1.77E+08
ZN 65	3.49E+09	9.31E+09	5.79E+09	0.0	5.87E+09	0.0	1.63E+09
SR 89	5.25E+09	0.0	1.50E+08	0.0	0.0	0.0	2.03E+08
SR 90	8.69E+10	0.0	2.20E+10	0.0	0.0	0.0	1.17E+09
ZR 95	3.00E+03	6.59E+02	5.86E+02	0.0	9.43E+02	0.0	6.87E+05
MO 99	0.0	7.62E+07	1.89E+07	0.0	1.63E+08	0.0	6.30E+07
SB 124	8.51E+07	1.10E+06	2.98E+07	1.88E+05	0.0	4.72E+07	5.32E+08
I 131	5.97E+08	6.00E+08	3.41E+08	1.98E+11	9.85E+08	0.0	5.34E+07
I 133	8.00E+06	9.89E+06	3.74E+06	1.84E+09	1.65E+07	0.0	3.98E+06
CS 134	1.66E+10	2.73E+10	5.75E+09	0.0	8.45E+09	3.03E+09	1.47E+08
CS 136	8.97E+08	2.47E+09	1.60E+09	0.0	1.31E+09	1.96E+08	8.67E+07
CS 137	2.43E+10	2.33E+10	3.44E+09	0.0	7.59E+09	2.73E+09	1.46E+08
BA 140	1.04E+08	9.14E+04	6.09E+06	0.0	2.98E+04	5.45E+04	5.29E+07
CE 141	1.80E+04	8.98E+03	1.33E+03	0.0	3.94E+03	0.0	1.12E+07
CE 144	1.20E+06	3.76E+05	6.40E+04	0.0	2.08E+05	0.0	9.80E+07

TABLE 3.1-22
(1 of 1)
R_i VALUES - COW MILK PATHWAY - INFANT

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	0.0	2.40E+03	2.40E+03	2.40E+03	2.40E+03	2.40E+03	2.40E+03
CR 51	0.0	0.0	1.34E+05	8.75E+04	1.91E+04	1.70E+05	3.91E+06
MN 54	0.0	2.90E+07	6.58E+06	0.0	6.43E+06	0.0	1.07E+07
FE 55	9.81E+07	6.34E+07	1.69E+07	0.0	0.0	3.10E+07	8.04E+06
FE 59	1.79E+08	3.13E+08	1.23E+08	0.0	0.0	9.26E+07	1.50E+08
CO 58	0.0	1.88E+07	4.69E+07	0.0	0.0	0.0	4.69E+07
CO 60	0.0	6.52E+07	1.54E+08	0.0	0.0	0.0	1.55E+08
ZN 65	4.69E+09	1.61E+10	7.42E+09	0.0	7.80E+09	0.0	1.36E+10
SR 89	9.98E+09	0.0	2.86E+08	0.0	0.0	0.0	2.05E+08
SR 90	9.45E+10	0.0	2.41E+10	0.0	0.0	0.0	1.18E+09
ZR 95	5.32E+03	1.30E+03	9.20E+02	0.0	1.40E+03	0.0	6.46E+05
MO 99	0.0	1.95E+08	2.08E+07	0.0	2.91E+08	0.0	6.42E+07
SB 124	1.64E+08	2.41E+06	5.08E+07	4.35E+05	0.0	1.03E+08	5.06E+08
I 131	1.25E+09	1.47E+09	6.45E+08	4.82E+11	1.71E+09	0.0	5.24E+07
I 133	1.69E+07	2.46E+07	7.20E+06	4.47E+09	2.89E+07	0.0	4.16E+06
CS 134	2.68E+10	4.99E+10	5.04E+09	0.0	1.29E+10	5.27E+09	1.36E+08
CS 136	1.75E+09	5.15E+09	1.92E+09	0.0	2.05E+09	4.20E+08	7.83E+07
CS 137	3.88E+10	4.54E+10	3.22E+09	0.0	1.22E+10	4.94E+09	1.42E+08
BA 140	2.15E+08	2.15E+05	1.11E+07	0.0	5.10E+04	1.32E+05	5.27E+07
CE 141	3.57E+04	2.18E+04	2.56E+03	0.0	6.71E+03	0.0	1.12E+07
CE 144	1.72E+06	7.03E+05	9.62E+04	0.0	2.84E+05	0.0	9.85E+07

TABLE 3.1-23

(1 of 1)

R_i VALUES - GOAT MILK PATHWAY - ADULT

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	0.0	1.57E+03	1.57E+03	1.57E+03	1.57E+03	1.57E+03	1.57E+03
CR 51	0.0	0.0	2.85E+03	1.71E+03	6.28E+02	3.79E+03	7.17E+05
MN 54	0.0	7.51E+05	1.43E+05	0.0	2.24E+05	0.0	2.30E+06
FE 55	2.37E+06	1.64E+06	3.82E+05	0.0	0.0	9.13E+05	9.39E+05
FE 59	3.09E+06	7.25E+06	2.78E+06	0.0	0.0	2.03E+06	2.42E+07
CO 58	0.0	4.39E+05	9.83E+05	0.0	0.0	0.0	8.89E+06
CO 60	0.0	1.46E+06	3.21E+06	0.0	0.0	0.0	2.73E+07
ZN 65	1.39E+08	4.43E+08	2.00E+08	0.0	2.96E+08	0.0	2.79E+08
SR 89	2.42E+09	0.0	6.93E+07	0.0	0.0	0.0	3.87E+08
SR 90	7.64E+10	0.0	1.87E+10	0.0	0.0	0.0	2.21E+09
ZR 95	8.85E+01	2.84E+01	1.92E+01	0.0	4.46E+01	0.0	9.00E+04
MO 99	0.0	2.78E+06	5.30E+05	0.0	6.31E+06	0.0	6.45E+06
SB 124	2.42E+06	4.57E+04	9.59E+05	5.87E+03	0.0	1.88E+06	6.87E+07
I 131	1.63E+08	2.33E+08	1.33E+08	7.63E+10	3.99E+08	0.0	6.14E+07
I 133	2.16E+06	3.76E+06	1.15E+06	5.53E+08	6.56E+06	0.0	3.38E+06
CS 134	1.25E+10	2.96E+10	2.42E+10	0.0	9.59E+09	3.18E+09	5.19E+08
CS 136	7.00E+08	2.76E+09	1.99E+09	0.0	1.54E+09	2.11E+08	3.14E+08
CS 137	1.67E+10	2.28E+10	1.50E+10	0.0	7.76E+09	2.58E+09	4.42E+08
BA 140	2.87E+06	3.61E+03	1.88E+05	0.0	1.23E+03	2.07E+03	5.92E+06
CE 141	4.79E+02	3.24E+02	3.67E+01	0.0	1.50E+02	0.0	1.24E+06
CE 144	3.17E+04	1.33E+04	1.70E+03	0.0	7.86E+03	0.0	1.07E+07

TABLE 3.1-24
(1 of 1)

R_i VALUES - GOAT MILK PATHWAY - TEENAGER

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	0.0	204E+03	2.04E+03	2.04E+03	2.04E+03	2.04E+03	2.04E+03
CR 51	0.0	0.0	4.98E+03	2.77E+03	1.09E+03	7.11E+03	8.37E+05
MN 54	0.0	1.25E+06	2.48E+05	0.0	3.73E+05	0.0	2.57E+06
FE 55	4.20E+06	2.98E+06	6.95E+05	0.0	0.0	1.89E+06	1.29E+06
FE 59	5.39E+06	1.26E+07	4.85E+06	0.0	0.0	3.96E+06	2.97E+07
CO 58	0.0	7.39E+05	1.70E+06	0.0	0.0	0.0	1.02E+07
CO 60	0.0	2.47E+06	5.56E+06	0.0	0.0	0.0	3.21E+07
ZN 65	2.14E+08	7.42E+08	3.46E+08	0.0	4.75E+08	0.0	3.14E+08
SR 89	4.45E+09	0.0	1.28E+08	0.0	0.0	0.0	5.30E+08
SR 90	1.08E+11	0.0	2.67E+10	0.0	0.0	0.0	3.03E+09
ZR 95	1.55E+02	4.88E+01	3.36E+01	0.0	7.18E+01	0.0	1.13E+05
MO 99	0.0	5.03E+06	9.59E+05	0.0	1.15E+07	0.0	9.00E+06
SB 124	4.31E+06	7.95E+04	1.68E+06	9.79E+03	0.0	3.77E+06	8.70E+07
I 131	2.95E+08	4.13E+08	2.22E+08	1.21E+11	7.12E+08	0.0	8.18E+07
I 133	3.95E+06	6.70E+06	2.04E+06	9.35E+08	1.17E+07	0.0	5.07E+06
CS 134	2.16E+10	5.09E+10	2.36E+10	0.0	1.62E+10	6.17E+09	6.33E+08
CS 136	1.19E+09	4.69E+09	3.15E+09	0.0	2.55E+09	4.03E+08	3.78E+08
CS 137	3.03E+10	4.03E+10	1.40E+10	0.0	1.37E+10	5.33E+09	5.73E+08
BA 140	5.19E+06	6.35E+03	3.34E+05	0.0	2.15E+03	4.27E+03	8.00E+06
CE 141	8.77E+02	5.86E+02	6.73E+01	0.0	2.76E+02	0.0	1.68E+06
CE 144	5.83E+04	2.41E+04	3.14E+03	0.0	1.44E+04	0.0	1.47E+07

TABLE 3.1-25
(1 of 1)
R_i VALUES - GOAT MILK PATHWAY - CHILD

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	0.0	3.23E+03	3.23E+03	3.23E+03	3.23E+03	3.23E+03	3.23E+03
CR 51	0.0	0.0	1.02E+04	5.64E+03	1.54E+03	1.03E+04	5.39E+05
MN 54	0.0	1.87E+06	4.99E+05	0.0	5.25E+05	0.0	1.57E+06
FE 55	1.05E+07	5.59E+06	1.73E+06	0.0	0.0	3.16E+06	1.04E+06
FE 59	1.25E+07	2.02E+07	1.01E+07	0.0	0.0	5.86E+06	2.10E+07
CO 58	0.0	1.13E+06	3.45E+06	0.0	0.0	0.0	6.58E+06
CO 60	0.0	3.83E+06	1.13E+07	0.0	0.0	0.0	2.12E+07
ZN 65	4.19E+08	1.12E+09	6.95E+08	0.0	7.04E+08	0.0	1.96E+08
SR 89	1.10E+10	0.0	3.15E+08	0.0	0.0	0.0	4.27E+08
SR 90	1.82E+11	0.0	4.62E+10	0.0	0.0	0.0	2.46E+09
ZR 95	3.60E+02	7.91E+01	7.04E+01	0.0	1.13E+02	0.0	8.25E+04
MO 99	0.0	9.15E+06	2.26E+06	0.0	1.95E+07	0.0	7.57E+06
SB 124	1.02E+07	1.32E+05	3.58E+06	2.25E+04	0.0	5.67E+06	6.38E+07
I 131	7.16E+08	7.20E+08	4.09E+08	2.38E+11	1.18E+09	0.0	6.41E+07
I 133	9.59E+06	1.19E+07	4.49E+06	2.20E+09	1.98E+07	0.0	4.78E+06
CS 134	4.99E+10	8.18E+10	1.73E+10	0.0	2.54E+10	9.10E+09	4.41E+08
CS 136	2.69E+09	7.40E+09	4.79E+09	0.0	3.94E+09	5.88E+08	2.60E+08
CS 137	7.30E+10	6.98E+10	1.03E+10	0.0	2.28E+10	8.19E+09	4.37E+08
BA 140	1.25E+07	1.10E+04	7.31E+05	0.0	3.57E+03	6.54E+03	6.34E+06
CE 141	2.16E+03	1.08E+03	1.60E+02	0.0	4.72E+02	0.0	1.34E+06
CE 144	1.44E+05	4.51E+04	7.68E+03	0.0	2.50E+04	0.0	1.18E+07

R_i VALUES - GOAT MILK PATHWAY - INFANT

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	0.0	4.90E+03	4.90E+03	4.90E+03	4.90E+03	4.90E+03	4.90E+03
CR 51	0.0	0.0	1.61E+04	1.05E+04	2.29E+03	2.04E+04	4.69E+05
MN 54	0.0	3.48E+06	7.89E+05	0.0	7.72E+05	0.0	1.28E+06
FE 55	1.27E+07	8.24E+06	2.20E+06	0.0	0.0	4.03E+06	1.05E+06
FE 59	2.33E+07	4.07E+07	1.60E+07	0.0	0.0	1.20E+07	1.95E+07
CO 58	0.0	2.26E+06	5.63E+06	0.0	0.0	0.0	5.62E+06
CO 60	0.0	7.82E+06	1.85E+07	0.0	0.0	0.0	1.86E+07
ZN 65	5.63E+08	1.93E+09	8.91E+08	0.0	9.36E+08	0.0	1.63E+09
SR 89	2.10E+10	0.0	6.01E+08	0.0	0.0	0.0	4.31E+08
SR 90	1.98E+11	0.0	5.05E+10	0.0	0.0	0.0	2.48E+09
ZR 95	6.39E+02	1.56E+02	1.10E+02	0.0	1.68E+02	0.0	7.75E+04
MO 99	0.0	2.34E+07	4.56E+06	0.0	3.49E+07	0.0	7.70E+06
SB 124	1.97E+07	2.90E+05	6.10E+06	5.22E+04	0.0	1.23E+07	6.07E+07
I 131	1.49E+09	1.76E+09	7.74E+08	5.79E+11	2.06E+09	0.0	6.29E+07
I 133	2.03E+07	2.95E+07	8.64E+06	5.36E+09	3.47E+07	0.0	4.99E+06
CS 134	8.03E+10	1.50E+11	1.51E+10	0.0	3.86E+10	1.58E+10	4.07E+08
CS 136	5.26E+09	1.55E+10	5.77E+09	0.0	6.16E+09	1.26E+09	2.35E+08
CS 137	1.16E+11	1.36E+11	9.66E+09	0.0	3.66E+10	1.48E+10	4.26E+08
BA 140	2.58E+07	2.58E+04	1.33E+06	0.0	6.12E+03	1.58E+04	6.33E+06
CE 141	4.28E+03	2.61E+03	3.07E+02	0.0	8.05E+02	0.0	1.35E+06
CE 144	2.06E+05	8.44E+04	1.15E+04	0.0	3.41E+04	0.0	1.18E+07

TABLE 3.1-27
(1 of 1)
R_i VALUES - INHALATION PATHWAY - ADULT

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	0.0	1.26E+03	1.26E+03	1.26E+03	1.26E+03	1.26E+03	1.26E+03
CR 51	0.0	0.0	9.99E+01	5.94E+01	2.28E+01	5.94E+04	3.32E+03
MN 54	0.0	3.95E+04	6.29E+03	0.0	9.83E+03	1.40E+06	7.72E+04
FE 55	2.45E+04	1.69E+04	3.94E+03	0.0	0.0	7.20E+04	6.02E+03
FE 59	1.17E+04	2.77E+04	1.05E+04	0.0	0.0	1.01E+06	1.88E+05
CO 58	0.0	1.58E+03	2.07E+03	0.0	0.0	9.27E+05	1.06E+05
CO 60	0.0	1.15E+04	1.48E+04	0.0	0.0	5.96E+06	2.84E+05
ZN 65	3.24E+04	1.03E+05	4.65E+04	0.0	6.89E+04	8.63E+05	5.34E+04
SR 89	3.04E+05	0.0	8.71E+03	0.0	0.0	1.40E+06	3.49E+05
SR 90	9.91E+07	0.0	6.09E+06	0.0	0.0	9.59E+06	7.21E+05
ZR 95	1.07E+05	3.44E+04	2.32E+04	0.0	5.41E+04	1.77E+06	1.50E+05
MO 99	0.0	1.21E+02	2.30E+01	0.0	2.92E+02	9.13E+04	2.48E+05
SB 124	3.12E+04	5.88E+02	1.24E+04	7.54E+01	0.0	2.48E+06	4.06E+05
I 131	2.52E+04	3.57E+04	2.05E+04	1.19E+07	6.12E+04	0.0	6.27E+03
I 133	8.63E+03	1.48E+04	4.51E+03	2.15E+06	2.58E+04	0.0	8.87E+03
CS 134	3.72E+05	8.47E+05	7.27E+05	0.0	2.87E+05	9.75E+04	1.04E+04
CS 136	3.90E+04	1.46E+05	1.10E+05	0.0	8.55E+04	1.20E+04	1.17E+04
CS 137	4.78E+05	6.20E+05	4.27E+05	0.0	2.22E+05	7.51E+04	8.39E+03
BA 140	3.90E+04	4.90E+01	2.56E+03	0.0	1.67E+01	1.27E+06	2.18E+05
CE 141	1.99E+04	1.35E+04	1.53E+03	0.0	6.25E+03	3.61E+05	1.20E+05
CE 144	3.43E+06	1.43E+06	1.84E+05	0.0	8.47E+05	7.76E+06	8.15E+05

TABLE 3.1-28
(1 of 1)
R_i VALUES - INHALATION PATHWAY - TEENAGER

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	0.0	1.27E+03	1.27E+03	1.27E+03	1.27E+03	1.27E+03	1.27E+03
CR 51	0.0	0.0	1.35E+02	7.49E+01	3.07E+01	2.09E+04	3.00E+03
MN 54	0.0	5.10E+04	8.39E+03	0.0	1.27E+04	1.98E+06	6.67E+04
FE 55	3.34E+04	2.38E+04	5.54E+03	0.0	0.0	1.24E+05	6.38E+03
FE 59	1.59E+04	3.69E+04	1.43E+04	0.0	0.0	1.53E+06	1.78E+05
CO 58	0.0	2.07E+03	2.77E+03	0.0	0.0	1.34E+06	9.51E+04
CO 60	0.0	1.51E+04	1.98E+04	0.0	0.0	8.71E+06	2.59E+05
ZN 65	3.85E+04	1.33E+05	6.23E+04	0.0	8.63E+04	1.24E+06	4.66E+04
SR 89	4.34E+05	0.0	1.25E+04	0.0	0.0	2.41E+06	3.71E+05
SR 90	1.08E+08	0.0	6.67E+06	0.0	0.0	1.65E+07	7.64E+05
ZR 95	1.45E+05	4.58E+04	3.15E+04	0.0	6.73E+04	2.68E+06	1.49E+05
MO 99	0.0	1.69E+02	3.23E+01	0.0	4.12E+02	1.54E+05	2.69E+05
SB 124	4.30E+04	7.92E+02	1.68E+04	9.75E+01	0.0	3.84E+06	3.98E+05
I 131	3.54E+04	4.90E+04	2.64E+04	1.46E+07	8.39E+04	0.0	6.48E+03
I 133	1.21E+04	2.05E+04	6.21E+03	2.92E+06	3.59E+04	0.0	1.03E+04
CS 134	5.02E+05	1.13E+06	5.48E+05	0.0	3.75E+05	1.46E+05	9.75E+03
CS 136	5.14E+04	1.93E+05	1.37E+05	0.0	1.10E+05	1.77E+04	1.09E+04
CS 137	6.69E+05	8.47E+05	3.11E+05	0.0	3.04E+05	1.21E+05	8.47E+03
BA 140	5.46E+04	6.69E+01	3.51E+03	0.0	2.28E+01	2.03E+06	2.28E+05
CE 141	2.84E+04	1.89E+04	2.16E+03	0.0	8.87E+03	6.13E+05	1.26E+05
CE 144	4.88E+06	2.02E+06	2.62E+05	0.0	1.21E+06	1.33E+07	8.63E+05

TABLE 3.1-29
(1 of 1)
R_i VALUES - INHALATION PATHWAY - CHILD

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	0.0	1.12E+03	1.12E+03	1.12E+03	1.12E+03	1.12E+03	1.12E+03
CR 51	0.0	0.0	1.54E+02	8.53E+01	2.43E+01	1.70E+04	1.08E+03
MN 54	0.0	4.29E+04	9.50E+03	0.0	1.00E+04	1.57E+06	2.29E+04
FE 55	4.73E+04	2.51E+04	7.76E+03	0.0	0.0	1.11E+05	2.86E+03
FE 59	2.07E+04	3.34E+04	1.67E+04	0.0	0.0	1.27E+06	7.06E+04
CO 58	0.0	1.77E+03	3.16E+03	0.0	0.0	1.10E+06	3.43E+04
CO 60	0.0	1.31E+04	2.26E+04	0.0	0.0	7.06E+06	9.61E+04
ZN 65	4.25E+04	1.13E+05	7.02E+04	0.0	7.13E+04	9.94E+05	1.63E+04
SR 89	5.99E+05	0.0	1.72E+04	0.0	0.0	2.15E+06	1.67E+05
SR 90	1.01E+08	0.0	6.43E+06	0.0	0.0	1.47E+07	3.43E+05
ZR 95	1.90E+05	4.17E+04	3.69E+04	0.0	5.95E+04	2.23E+06	6.10E+04
MO 99	0.0	1.73E+02	4.26E+01	0.0	3.93E+02	1.36E+05	1.27E+05
SB 124	5.73E+04	7.39E+02	2.00E+04	1.26E+02	0.0	3.24E+06	1.64E+05
I 131	4.80E+04	4.80E+04	2.72E+04	1.62E+07	7.87E+04	0.0	2.84E+03
I 133	1.66E+04	2.03E+04	7.68E+03	3.84E+06	3.37E+04	0.0	5.47E+03
CS 134	6.50E+05	1.01E+06	2.24E+05	0.0	3.30E+05	1.21E+05	3.84E+03
CS 136	6.50E+04	1.71E+05	1.16E+05	0.0	9.53E+04	1.45E+04	4.17E+03
CS 137	9.05E+05	8.24E+05	1.28E+05	0.0	2.82E+05	1.04E+05	3.61E+03
BA 140	7.39E+04	6.47E+01	4.32E+03	0.0	2.11E+01	1.74E+06	1.02E+05
CE 141	3.92E+04	1.95E+04	2.89E+03	0.0	8.53E+03	5.43E+05	5.65E+04
CE 144	6.76E+06	2.11E+06	3.61E+05	0.0	1.17E+06	1.19E+07	3.88E+05

TABLE 3.1-30
(1 of 1)

R_i VALUES - INHALATION PATHWAY - INFANT

NUCLIDE	BONE	LIVER	T. BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	0.0	6.46E+02	6.46E+02	6.46E+02	6.46E+02	6.46E+02	6.46E+02
CR 51	0.0	0.0	8.93E+01	5.75E+01	1.32E+01	1.28E+04	3.56E+02
MN 54	0.0	2.53E+04	4.98E+03	0.0	4.98E+03	9.98E+05	7.05E+03
FE 55	1.97E+04	1.17E+04	3.33E+03	0.0	0.0	8.68E+04	1.09E+03
FE 59	1.35E+04	2.35E+04	9.46E+03	0.0	0.0	1.01E+06	2.47E+04
CO 58	0.0	1.22E+03	1.82E+03	0.0	0.0	7.76E+05	1.11E+04
CO 60	0.0	8.01E+03	1.18E+04	0.0	0.0	4.50E+06	3.19E+04
ZN 65	1.93E+04	6.25E+04	3.10E+04	0.0	3.24E+04	6.46E+05	5.13E+04
SR 89	3.97E+05	0.0	1.14E+04	0.0	0.0	2.03E+06	6.39E+04
SR 90	4.08E+07	0.0	2.59E+06	0.0	0.0	1.12E+07	1.31E+05
ZR 95	1.15E+05	2.78E+04	2.03E+04	0.0	3.10E+04	1.75E+06	2.17E+04
MO 99	0.0	1.65E+02	3.24E+01	0.0	2.65E+02	1.35E+05	4.88E+04
SB 124	3.79E+04	5.55E+02	1.20E+04	1.00E+02	0.0	2.64E+06	5.90E+04
I 131	3.79E+04	4.43E+04	1.96E+04	1.48E+07	5.17E+04	0.0	1.06E+03
I 133	1.32E+04	1.92E+04	5.59E+03	3.55E+06	2.24E+04	0.0	2.15E+03
CS 134	3.96E+05	7.02E+05	7.44E+04	0.0	1.90E+05	7.95E+04	1.33E+03
CS 136	4.82E+04	1.34E+05	5.28E+04	0.0	5.63E+04	1.17E+04	1.43E+03
CS 137	5.48E+05	6.11E+05	4.54E+04	0.0	1.72E+05	7.12E+04	1.33E+03
BA 140	5.59E+04	5.59E+01	2.89E+03	0.0	1.34E+01	1.59E+06	3.83E+04
CE 141	2.77E+04	1.66E+04	1.99E+03	0.0	5.24E+03	5.16E+05	2.15E+04
CE 144	3.19E+06	1.21E+06	1.76E+05	0.0	5.37E+05	9.83E+06	1.48E+05

January 1, 1998

Subject: Offsite Dose Calculation Manual (ODCM)
Oconee Nuclear Station Section - Revision 38

The General Office Radiation Protection Staff is transmitting to you this date Revision 38 of the Oconee Offsite Dose Calculation Manual. As this revision only affects Oconee Nuclear Station, the approval of other station managers is not required. A list of affected pages is given below. Please insert this letter with the attached Justification section in front of the January 1, 1997, Revision 37 letter.

REMOVE THESE PAGES	INSERT THESE PAGES
A-3	A-3
Table A4.0-2A (both pages)	Table A4.0-2A (both pages)
Table A4.0-8	Table A4.0-8
A-21	A-21
Table A5.0-2	Table A5.0-2
Table A5.0-3	Table A5.0-3
Effective Date: 1/1/98	Effective Date: 1/1/98

L. E. Haynes, Technical Manager
Radiation Protection

B. L. Peele, Jr., Manager
Oconee Nuclear Station

If you have any questions concerning Revision 38, please call Caryl Ingram at (704) 382-4496.

Caryl D. Ingram, Senior Engineer
Radiation Protection
Station Support Division

<u>JUSTIFICATION FOR REVISION 38</u>

<u>Page A-3</u>

Added clarification to the sentence concerning how Oconee's release rate calculations are performed.

<u>Table A4.0-2A</u>

Revised table to correct typographical errors in the NNE 1.5-2.0, χ/Q and the S 2.5-3.0, χ/Q values. The dose calculations performed with the GASPAR code were using the correct dispersion values.

<u>Table A4.0-8</u>

Revised table based on the 1997 land-use census.

<u>Page A-21</u>

Revised land-use census dates.

<u>Table A5.0-2</u>

Revised sample period code description. Added the "CONTROL" description to location 080 which inadvertently had been omitted.

<u>Table A5.0-3</u>

Revised the "Analysis Schedule" monitoring program information for the "Air Particulates" sample medium.

APPENDIX A

OCONEE NUCLEAR STATION
SITE SPECIFIC INFORMATION

APPENDIX A

TABLE OF CONTENTS

A1.0 OCONEE NUCLEAR STATION RADWASTE SYSTEMS

A1.1 LIQUID RADWASTE PROCESSING

The liquid radwaste system at Oconee Nuclear Station (ONS) is used to collect and treat fluid chemical and radiochemical by-products of unit operation. The systems produce effluents which can be reused in the plant or discharged in small, dilute quantities to the environment. The means of treatment vary with waste type and desired product in the various systems:

A) Filtration - waste sources are filtered prior to processing as necessary.

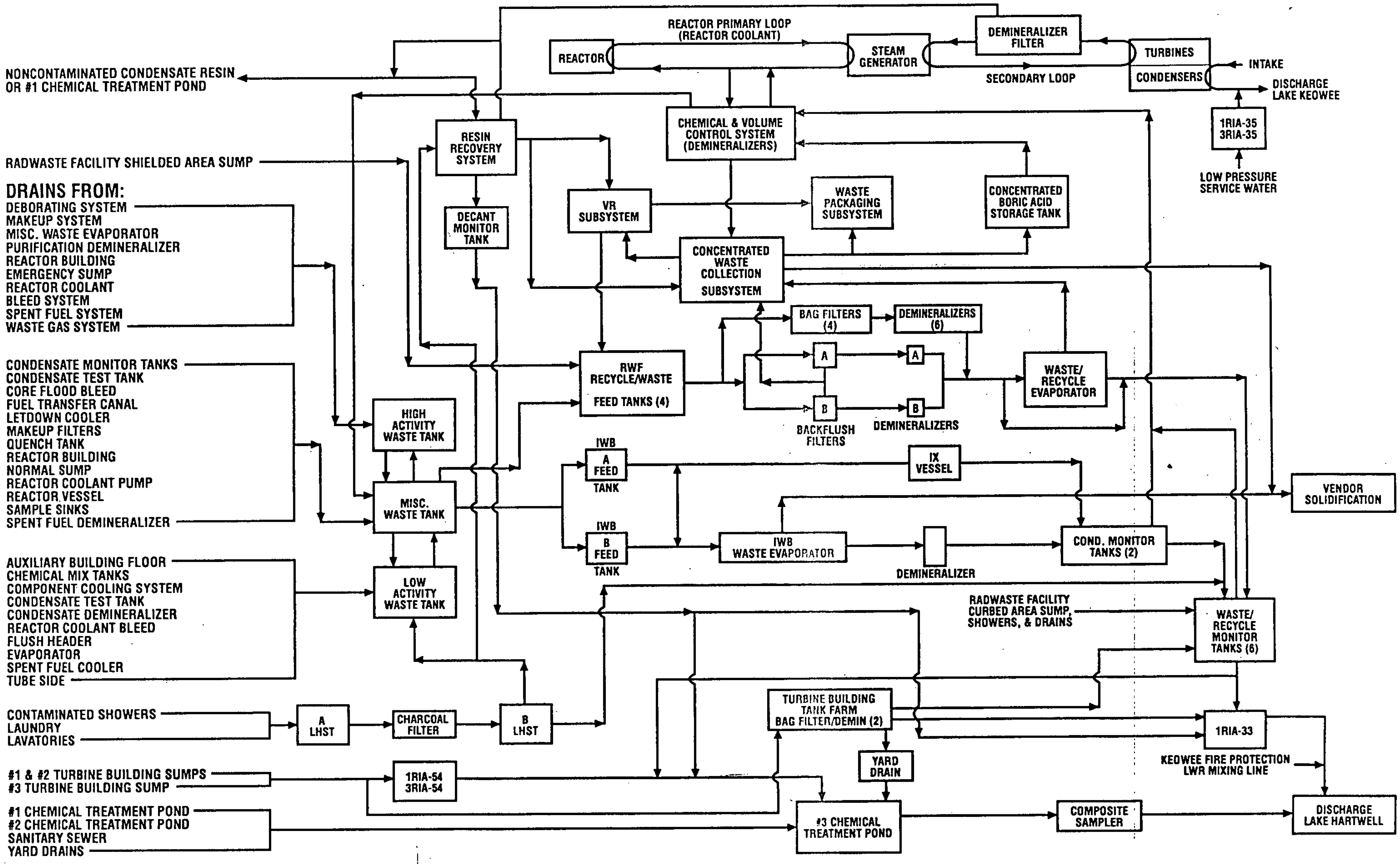
B) Ion Exchange - ion exchange is used to remove radioactive ions from solution. Also, ion exchange is normally used in removing cations (cobalt, manganese) and anions (chloride, fluoride) from evaporator feed and/or distillates in order to purify the distillates for reuse as makeup water. Distillate from the Waste Evaporator System or the Waste and Recycle Evaporator can be treated by this method.

C) Gas Stripping - removal of gaseous radioactive fission products is accomplished in Evaporators and the venting of atmospheric holdup tanks.

D) Distillation - production of pure water from the waste by boiling it away from the contaminated solution which originally contained it is accomplished by both evaporators. Proper control of the process will yield water which can be reused for makeup. Polishing of this product can be achieved by ion exchange as indicated above.

E) Concentration - in all Evaporators, radioactivity and dissolved chemicals are concentrated as water is boiled away. In the case of the Waste Evaporator, the volume of water containing waste chemicals and radionuclides is reduced so that the waste may be more easily and economically solidified and shipped for burial. In the case of the VR dryer, all water is removed and the dry salts are solidified for burial.

Figure A1.0-1 is a schematic representation of the liquid radwaste system at Oconee.



LIQUID RADWASTE SYSTEM
OCONEE NUCLEAR STATION
Figure A1.0-1

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A1.2 GASEOUS WASTE PROCESSING

The purpose of the gaseous waste disposal system is to:

(1) Maintain a non-oxidizing cover gas of nitrogen in tanks and equipment that contain potentially radioactive gas,

(2) Hold up radioactive gas for decay, and

(3) Release gases (radioactive or non-radioactive) to the atmosphere under controlled conditions.

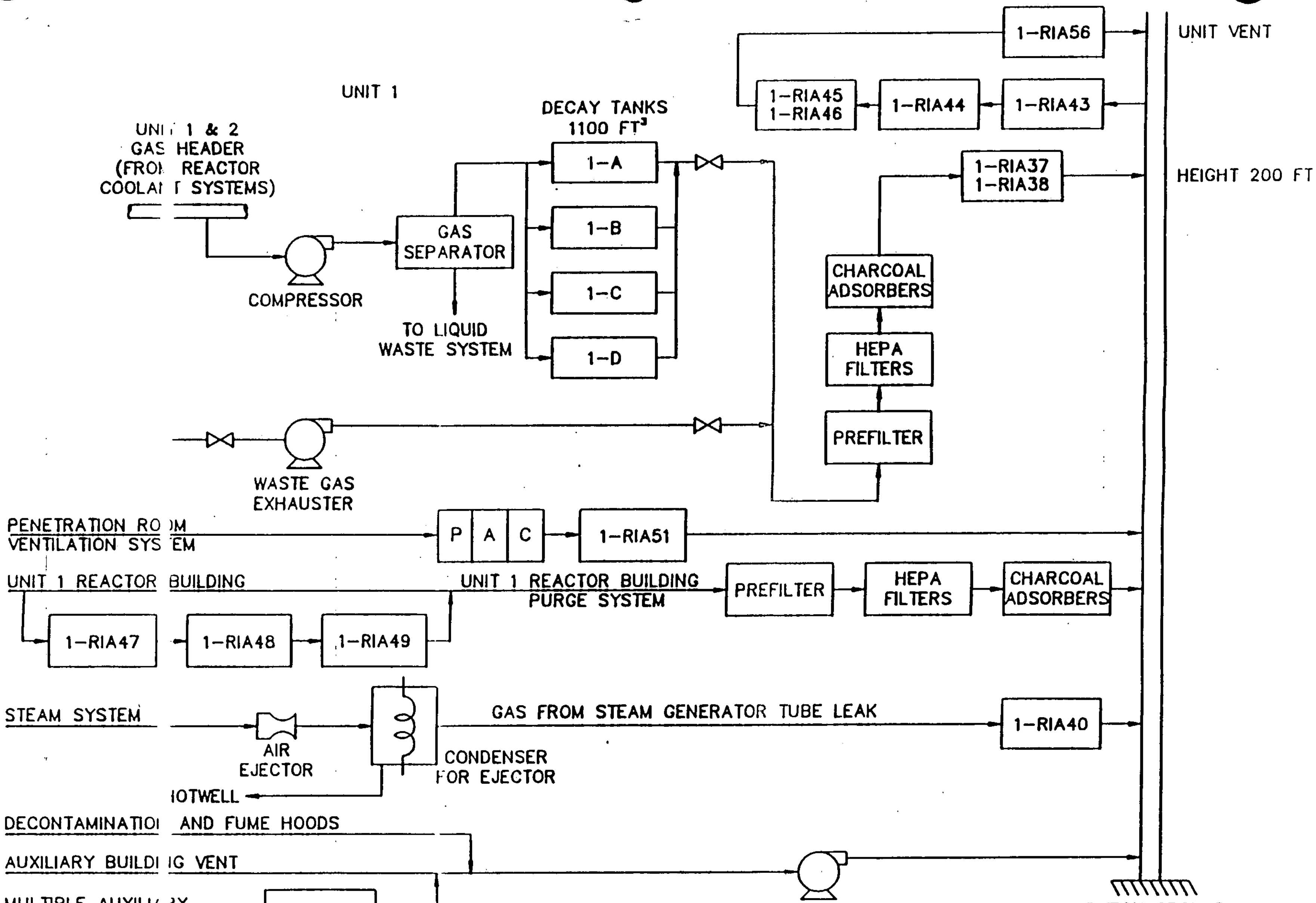
During power operation of the facilities, radioactive materials released to the atmosphere in gaseous effluents include low concentrations of fission product noble gases (krypton and xenon), halogens (mostly iodines), tritium contained in water vapor and particulate material including both fission products and activated corrosion products.

The primary source of gaseous radioactive wastes is from the degassing of the primary coolant during letdown of the cooling water into the various holding tanks. Additional sources of gaseous waste activity include the auxiliary building exhaust, spent fuel area exhaust, the discharge from the steam jet air ejectors, purging and venting of the reactor containment building.

All components that can contain potentially radioactive gases are vented to a vent header. The vent gases are subsequently drawn from this vent header by one of four waste gas compressors or a waste gas exhauster. The waste gas compressor discharges through a waste gas separator to one of seven waste gas tanks. The waste gas tanks and the waste gas exhauster discharge to the unit vent after passing through a filter bank consisting of a prefilter, an absolute filter, and a charcoal filter.

Radioactive gases may be released inside the reactor containment building when components of the primary system are opened to the building atmosphere for operational reasons or where minor leaks occur in the primary system. Prior to access, the reactor containment atmosphere will be monitored for activity and, when necessary, purged through prefilters, high-efficiency particulate air (HEPA) filters and charcoal adsorbers and released to atmosphere through the unit vent. The purge equipment is sized for a flow rate of 50,000 cfm providing approximately 1.5 air changes per hour in the reactor building. Units 1, 2 & 3 have a separate vent stack from each reactor building.

The gaseous waste handling and treatment systems for the Oconee Nuclear Station are shown schematically in Fig. A1.0-2.



GASEOUS WASTE SYSTEM
OCONEE NUCLEAR STATION
FIGURE A1.0-2
PAGE 1 OF 4

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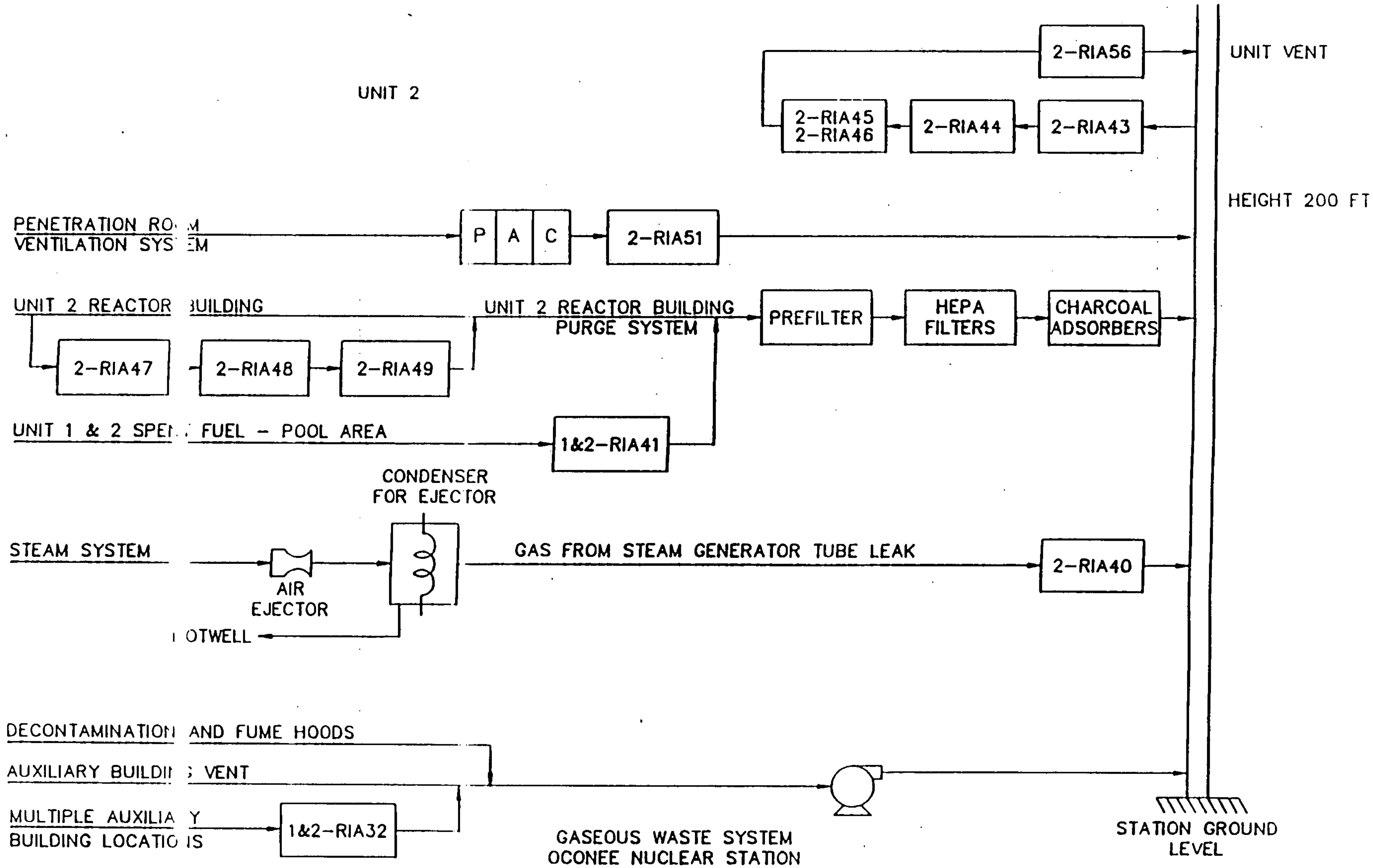

GASEOUS WASTE SYSTEM
OCONEE NUCLEAR STATION
FIGURE A1.0-2
PAGE 2 OF 4

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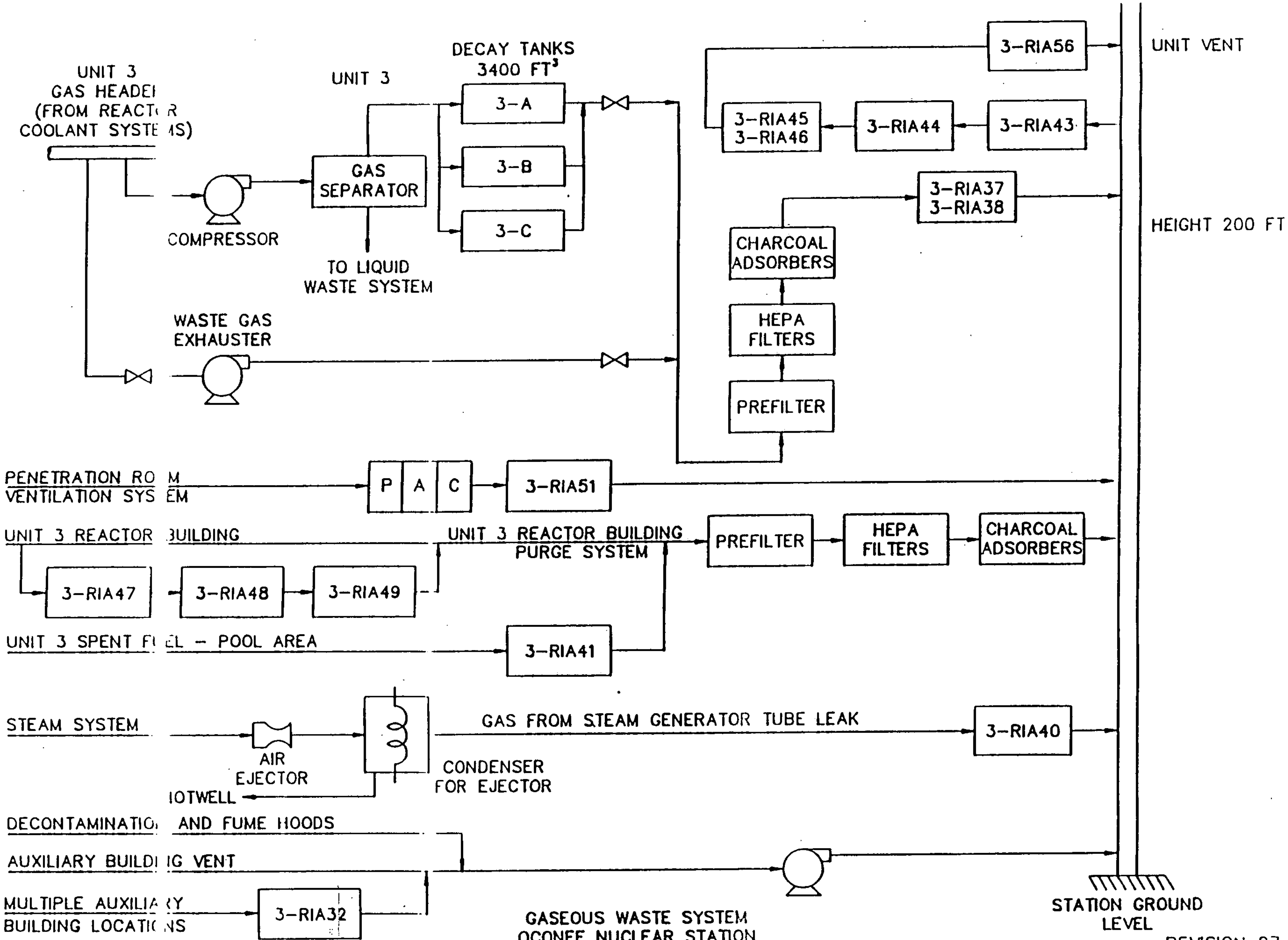

GASEOUS WASTE SYSTEM
OCONEE NUCLEAR STATION
FIGURE A1.0-2
PAGE 3 OF 4

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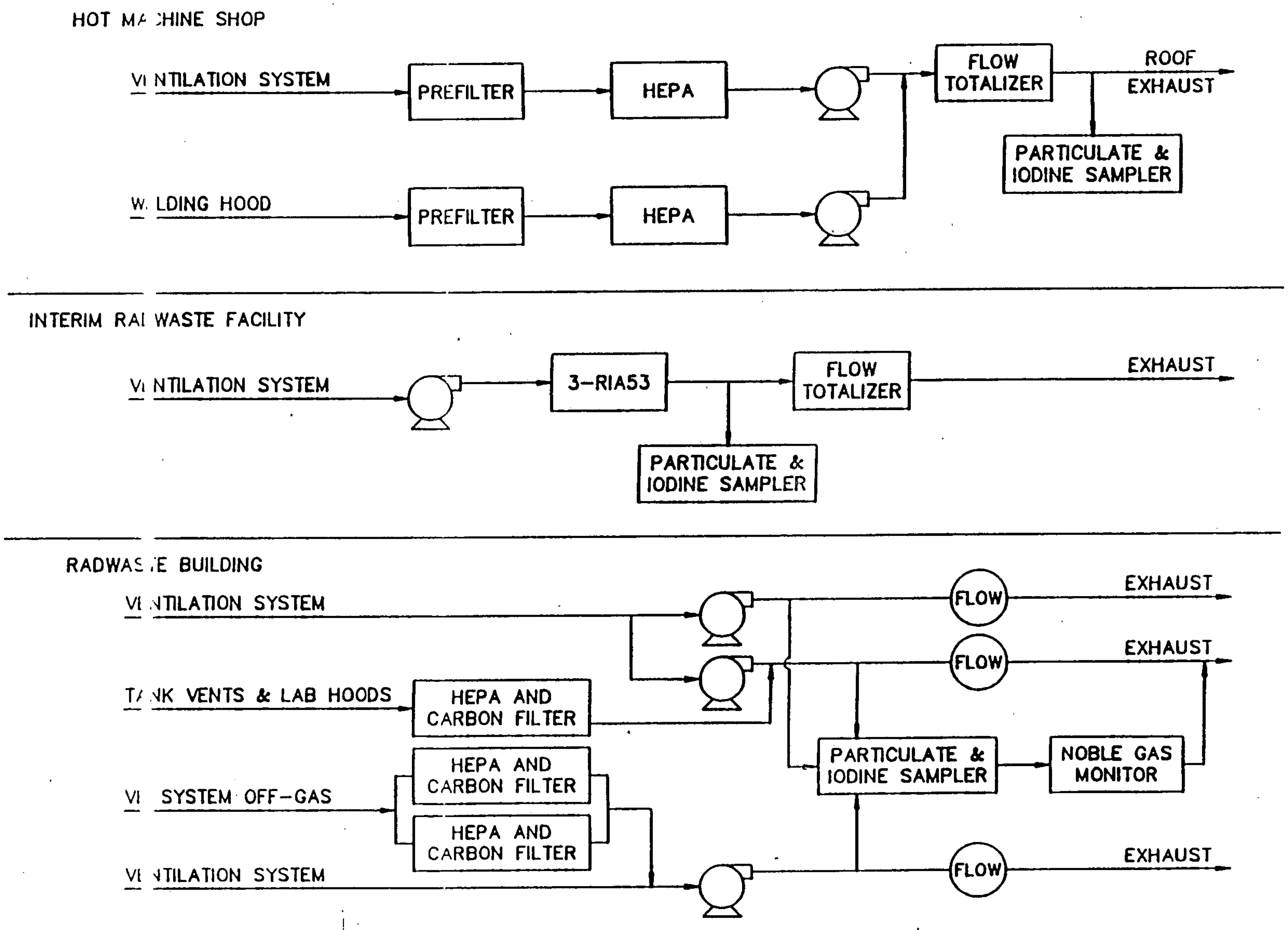

GASEOUS WASTE SYSTEM
OCONEE NUCLEAR STATION
FIGURE A1.0-2
PAGE 4 OF 4

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N89120E

A2.0 RELEASE RATE CALCULATION

Generic release rate methodology is presented in Section 1.0; this methodology with Oconee-specific input data will be used to calculate release rates from Oconee Nuclear Station.

A2.1 LIQUID RELEASE RATE CALCULATIONS

There are two potential release points at Oconee, the liquid radwaste effluent line to the Keowee Hydroelectric Unit Tailrace and the #3 Chemical Treatment Pond effluent line to the Keowee River.

A2.1.1 Liquid Radwaste Effluent Line To The Keowee Hydroelectric Unit Tailrace

To simplify calculations for the liquid radwaste effluent line, it is assumed that no activity above background is present in the #3 Chemical Treatment Pond effluent. This assumption shall be confirmed by radiation monitoring and/or the sampling of the pond's radioactive inputs, and by periodic analysis of the composite sample collected at the #3 Chemical Treatment Pond discharge. For the liquid radwaste effluent line the following calculation shall be performed to determine a discharge flow, in gpm:

$$f \leq F \div \left[\sigma \sum_{i=1}^{n} \frac{C_i}{(10 \times EC_i)}\right]$$

where:

f = the undiluted effluent flow, in gpm.

C_i = the concentration of radionuclide, 'i', in undiluted effluent as determined by laboratory analyses, in µCi/ml.

EC_i = the concentration of radionuclide, 'i', from 10CFR20, Appendix B, Table 2, Column 2. If radionuclide, 'i', is a dissolved noble gas, the EC_i = 1.0E-4 µCi/ml.

F = the dilution flow available, in gpm

typical flow rates are:

3.41E+04 gpm (based on a leakage rate of 38 cfs, plus the Keowee Hydro Fire Protection - LWR mixing line whose flow rate is 38 cfs)

2.9E+6 gpm (based on one hydro unit operating at 50% power, 6600 cfs)

σ = the recirculation factor at equilibrium is 1.0. (See Section 1.1)

A2.1.2 #3 Chemical Treatment Pond Effluent Line

The #3 Chemical Treatment Pond effluent is the release point for station effluents that are normally considered to be non-radioactive; that is, the pond's effluent will not normally contain measurable activity above background. It is assumed that no activity is present in the effluent until indicated by radiation monitoring measurements on the pond's inputs and/or by periodic analyses of the composite sample collected at the pond's discharge point. Inputs to this pond include the plant's yard drain system, the decant water from the Powdex system, the discharge from the Turbine Building Sump system, and Radwaste Facility monitor tanks whose contents have been determined to be below background. Inputs that have radiation monitors associated with them will be set to assure that Selected Licensee Commitment 16.11-1.1 will not be exceeded.

The #3 Chemical Treatment Pond may also be the discharge path for large volumes of slightly contaminated water following a primary-secondary leak so long as administrative procedures are implemented to assure that release rate calculations similiar to that used in Section A2.1.1 are performed, that all detectable radionuclides will be accounted for, and that no station limits will be exceeded.

A2.1.3 Low Pressure Service Water Effluent Line

The Low Pressure Service water effluent is normally considered nonradioactive; that is, it is unlikely the effluent will contain measurable activity above background. It is assumed that no activity is present in the effluent until indicated by radiation monitoring measurements. Radiation monitoring alarm setpoints, in conjunction with administrative controls, assure that release limits are not exceeded.

A2.2 GASEOUS RELEASE RATE CALCULATIONS FOR SEMI-ELEVATED RELEASE POINTS

The unit vents are the release points for waste gas decay tanks, containment building purges, containment building vents, the condenser air ejector, and auxiliary building ventilation. The unit vent is treated as a semi-elevated release point. The applicable dispersion and deposition parameters are provided in Tables A4.0-1a and A4.0-1b respectively.

The condenser air ejector effluent is normally considered nonradioactive; that is, it is unlikely the effluent will contain measureable activity above background. It is assumed that no activity is present in the effluent until indicated by radiation monitoring measurements and by analyses of periodic samples collected from this source. Radiation monitoring alarm/trip setpoints in conjunction with administrative controls assure that release limits are not exceeded; see section on radiation monitoring setpoints.

The following calculations, when solved for flowrate, are the release rates for noble gases and for radioiodines, particulates and other radionuclides with half-lives greater than 8 days; the most conservative of release rates calculated in A2.2.1 and A2.2.2 shall control the release rates for a single release point.

A2.2.1 Release rate limit for noble gases:

$$\sum_i K_i \left[\overline{(X/Q)}\tilde{Q}_i\right] < 500 \text{ mrem/yr, and}$$

$$\sum_i (L_i + 1.1\, M_i) \left[\overline{(X/Q)}\tilde{Q}_i\right] < 3000 \text{ mrem/yr}$$

where the terms are defined below.

A2.2.2 Release rate limit for all radioiodines and radioactive materials in particulate form and radionuclides other than noble gases:

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

where:

K_i = The total body dose factor due to gamma emissions for each identified noble gas radionuclide, in mrem/yr per $\mu Ci/m^3$ from Table 1.2-1.

L_i = The skin dose factor due to beta emissions for each identified noble gas radionuclide, in mrem/yr per $\mu Ci/m^3$ from Table 1.2-1.

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 1.2-1 (unit conversion constant of 1.1 mrem/mrad converts air dose to skin dose).

P_i = The dose parameter for 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 $m^2 \cdot$(mrem/yr) per $\mu Ci/sec$ from Table 1.2-2. The dose factors are based on the critical individual organ and most restrictive age group (child or infant).

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

$\overline{X/Q}$ = 1.672E-6 sec/m³. The highest calculated annual average relative concentration for any area at or beyond the unrestricted area boundary. The location is the SW sector @ 1.0 mile for semi-elevated releases.

W = The highest calculated annual average dispersion/deposition parameter for estimating the dose to an individual at a controlling location in the unrestricted area where the total inhalation, food and ground plane pathway dose resulting from semi-elevated releases is determined to be a maximum based on Table A4.0-1a (X/Q) and Table A4.0-1b (D/Q):

W = 1.672E-6 sec/m³, for the inhalation pathway. The location is the SW sector @ 1.0 mile.

W = 1.205E-08 1/m², for the food and ground plane pathways. The location is the SW sector @ 1.0 mile.

$\bar{Q}_i = k_1 C_i f \div k_2 = 4.72E{+}02\ C_i f$

where:

C_i = the concentration of radionuclide, i, in undiluted gaseous effluent, in µCi/ml.

f = the undiluted effluent flow, in cfm

k_1 = conversion factor, 2.83E+04 ml/ft³

k_2 = conversion factor, 6.0E+01 sec/min

A2.3 GASEOUS RELEASE RATE CALCULATIONS FOR GROUND LEVEL RELEASE POINTS

Hot Machine Shop Building ventilation exhaust, Radwaste Facility Exhaust, and Auxiliary Boiler releases are treated as ground-level release points. The applicable dispersion and deposition parameters are provided in Tables A4.0-2a and A4.0-2b respectively.

It is assumed that no activity is present in effluent from these sources until indicated by radiation monitoring measurements and by analyses of periodic samples collected from these sources. Radiation monitoring alarm/trip setpoints in conjunction with administrative controls assure that release limits are not exceeded; see section on radiation monitoring setpoints.

The following calculations, when solved for flowrate, are the release rates for noble gases and for radioiodines, particulates and other radionuclides with half-lives greater than 8 days; the most conservative of release rates calculated in A2.3.1 and A2.3.2 shall control the release rates for a single release point.

A2.3.1 Release rate limit for noble gases:

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

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

where the terms are defined below:

A2.3.2 Release rate limit for all radioiodines and radioactive materials in particulate form and radionuclides other than noble gases:

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

where:

K_i = The total body dose factor due to gamma emissions for each identified noble gas radionuclide, in mrem/yr per $\mu Ci/m^3$ from Table 1.2-1.

L_i = The skin dose factor due to beta emissions for each identified noble gas radionuclide, in mrem/yr per $\mu Ci/m^3$ from Table 1.2-1.

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 1.2-1 (unit conversion constant of 1.1 mrem/mrad converts air dose to skin dose).

P_i = The dose parameter for 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 $m^2 \cdot$(mrem/yr) per μCi/sec from Table 1.2-2. The dose factors are based on the critical individual organ and most restrictive age group (child or infant).

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

$\overline{X/Q}$ = 7.308E-6 sec/m^3. The highest calculated annual average relative concentration for any area at or beyond the unrestricted area boundary. The location is the SE sector @ 1.0 mile for ground-level releases.

W = The highest calculated annual average dispersion/deposition parameter for estimating the dose to an individual at a controlling location in the unrestricted area where the total inhalation, food and ground plane pathway dose resulting from ground level releases is determined to be a maximum based on Table A4.0-2a (X/Q) and Table A4.0-2b (D/Q):

W = 4.108E-6 sec/m^3, for the inhalation pathway. The location is the SW sector @ 1.0 mile.

W = 1.717E-8 1/m^2, for the food and ground plane pathways. The location is the SW sector @ 1.0 mile.

$$\tilde{Q}_i = k_1 C_i f \div k_2 = 4.72E+02\ C_i f$$

where:

C_i = the concentration of radionuclide, i, in undiluted gaseous effluent, in µCi/ml.

f = the undiluted effluent flow, in cfm

k_1 = conversion factor, 2.83E+04 ml/ft^3

k_2 = conversion factor, 6.0E+01 sec/min

A3.0 RADIATION MONITOR SETPOINTS

Using the generic calculations presented in Section 2.0, final radiation monitoring setpoints are calculated for monitoring as required by the Selected Licensee Commitments.

All final effluent radiation monitors for Oconee are off-line. These monitors alarm on low flow; the minimum flow alarm level for the liquid monitors is 3 gallons per minute and for all gas monitors, except in the Radwaste Facility, is 7 standard cubic feet per minute. These monitors measure the activity in the liquid or gas volume exposed to the detector and are independent of flow rate if a minimum flow rate is assured. The Radwaste Facility gas monitors have a minimum flow alarm level of 2 standard cubic feet per minute and adjusts flow rate as the line flow changes.

Radiation monitoring setpoints calculated in the following sections are expressed in activity concentrations; in reality the monitor readout is in counts per minute, except for the Radwaste Facility gas monitor where its readout is in (μCi/ml). The relationship between concentration and counts per minute shall be established by station procedure using the following relationship: Station radiation monitor setpoint procedures which correlate concentration and counts per minute shall be based on the formula below and will be determined using the monitor's correlation graph. The correlation graph shows concentration (μCi/ml) vs. monitor reading (cpm) based on empirical data.

$$c = \frac{r}{2.22 \times 10^6 \, e \, V}$$

where:

c = the gross activity, in μCi/ml
r = the count rate, in cpm
2.22×10^6 = the disintegration per minute per μCi
e = the counting efficiency, cpm/dpm
v = the volume of fluid exposed to the detector, in ml.

A3.1 LIQUID RADIATION MONITORS

A3.1.1 Liquid Radwaste Effluent Line To The Keowee Hydroelectric Unit Tailrace

As described in Section A2.1.1 of this manual on release rate calculations for the waste liquid effluent, the release is controlled by limiting the flow rate of effluent from the station. Although the release rate is flow rate controlled, the radiation monitor setpoint shall be set to terminate the release if the effluent activity should exceed that used to calculate the release rate. Also, a radiation monitor setpoint shall be set to alarm if the effluent activity should exceed that determined by laboratory analyses.

A3.1.2 Turbine Building Sump Discharge Line

As described in Section A2.1.2 of this manual on release rate calculations for the turbine building sump effluent, the effluent is normally considered nonradioactive; that is, it is unlikely the effluent will contain measurable activity above background. It is assumed that no activity is present in the effluent until indicated by radiation monitoring and by routine analysis of the composite sample collected at the #3 Chemical Treatment Pond. Since the system discharges automatically, the maximum system concentration, which also is the radiation monitor setpoint, is calculated to assure compliance with release limits.

A typical setpoint is calculated as follows:

$$c \leq \frac{10 \times EC \times F}{\sigma f} = 2.0E-4\ \mu Ci/ml$$

where:

c = the gross activity in undiluted effluent, in μCi/ml.

f = the flow rate of undiluted effluent which may vary from 0-750 gpm, but is assumed to be 750 gpm.

EC = 9.0E-07 μCi/ml, the EC for Cs-134, which is the lowest effluent concentration value for any detectable radionuclide that is not known to be absent from the TBS effluent.***

σ = 1 (See Section A2.1.1)

F = the flow may vary from 38 to 6,600 cfs, but is conservatively estimated at 38 cfs (1.7E+04 gpm), the minimum flow available.

A3.1.3 Radwaste Facility Effluent Line To CTP #3

As described in Section A2.1.2 of this manual on release rate calculations, the Radwaste Facility Effluent is normally considered non-radioactive; that is, it is unlikely the effluent will contain measurable activity above background. It is assumed that no activity is present in the effluent until indicated by radiation monitoring and/or by routine analyses of the composite sample collected at the discharge of the #3 Chemical Treatment Pond. In order to assure that no activity is unknowingly discharged into the pond, the inputs to the Radwaste Facility Effluent Line are released in discrete batches where each batch is sampled for activity prior to release.

*** The justification for this assumption is provided in 10 CFR 20, Appendix B, Note 2. A review of past liquid effluent release data shows that Cs-134 has the lowest effluent concentration value for any detectable radionuclide in the effluent. An annual review of the effluent release data will be performed to assure that this assumption remains valid.

A3.1.4 Low Pressure Service Water Discharge Line

As described in Section A2.1.3 of this manual on release rate calculations for the Low Pressure Service water effluent, the effluent is normally considered nonradioactive; that is, it is unlikely the effluent will contain measurable activity above background. It is assumed that no activity is present in the effluent until indicated by radiation monitoring equipment. Since the system discharges automatically, the maximum system concentration which is also the radiation monitor setpoint, is calculated to assure compliance with release limits.

A typical monitor setpoint is calculated as follows:

$$C \leq \frac{EC \times 10 \times F}{\sigma f} = 1.04E\text{-}3\ \mu Ci/ml$$

where:

C = the gross activity in undiluted effluent, in μCi/ml.

f = the flow rate of undiluted effluent which may vary from 0 to 10,500 gpm but is assumed to be 10,500 gpm.

EC = 9.0E-07 μCi/ml, the EC for Cs-134, which is the lowest effluent concentration value for any detectable radionuclide that is not known to be absent from the LPSW effluent. ***

σ = recirculation factor for Lake Keowee, 1.02.

F = the flow rate of the condensate cooling water is based on having seven CCW pumps in operation, 1.24E+06 gpm. Should the number of operating pumps decrease, the setpoint must be recalculated.

*** The justification for this assumption is provided in 10 CFR 20, Appendix B, Note 2. A review of past liquid effluent release data shows that Cs-134 has the lowest effluent concentration value for any detectable radionuclide in the effluent. An annual review of the effluent release data will be performed to assure that this assumption remains valid.

A3.2 GASEOUS RADIATION MONITOR SETPOINTS FOR SEMI-ELEVATED RELEASE POINTS

The following equation shall be used to calculate final effluent noble gas radiation monitor setpoints based on Xe-133:

$K(\overline{X/Q})\tilde{Q} < 500$ mrem (See Section A2.2.1)

$\tilde{Q} = 4.72E+2$ Cf (See Section A2.2.2)

$(K)(\overline{X/Q})(472)(C)(f) < 500$

$$C < \frac{500}{(206)(1.672E-6)(472)} \div f$$

$C < 3.08E+3/f$

where:

C = the gross activity in undiluted effluent, in μCi/ml

f = the flow from the tank or building and varies for various release sources, in cfm

K = from Table 1.2-1 for Xe-133, 2.06E+2 mrem/yr per $\mu Ci/m^3$

$\overline{X/Q}$ = 1.672E-6 sec/m^3, as defined in section A2.2.2.

A3.2.1 Gaseous Radwaste Effluent Line - Waste Gas Decay Tanks

As described in Section 2.2, the release is controlled by limiting the flow rate of the effluent from the station. Although the release rate is flow rate controlled, the radiation monitor setpoint shall be set to terminate the release if the effluent activity should exceed that determined by laboratory analyses and that used to calculate the release rate. A typical radiation monitor setpoint may be calculated as follows:

$C < 3.08E+3/f = 1.03E+02$ μCi/ml

where:

f = 30 cfm

A3.2.2 Unit Vent

As stated in Section A2.2, the unit vent is the release point for waste gas decay tanks, containment building purges, containment building vents, the condenser air ejector, and auxiliary building ventilation. Since all of these releases are through the unit vent, the radiation monitor on the unit vent may be used to assure that station release limits are not exceeded. Depending on the stack flow, a typical radiation monitor setpoint may be calculated as follows:

$$C < 3.08E+3/f = 3.24E-2\ \mu Ci/ml$$

where:

f = 45,000 cfm (auxiliary building) + 50,000 cfm (containment purge) = 95,000 cfm

or

$$C < 3.08E+3/f = 6.84E-2\ \mu Ci/ml$$

where:

f = 45,000 cfm (auxiliary building ventilation)

A3.3 GASEOUS RADIATION MONITOR SETPOINTS FOR GROUND-LEVEL RELEASE POINTS

The following equation shall be used to calculate final effluent noble gas radiation monitor setpoints based on Xe-133:

$$K(\overline{X/Q})\tilde{Q}_i < 500 \text{ mrem (See Section A2.2.1)}$$

$$\tilde{Q}_i = 4.72E{+}2\ C_i f \text{ (See Section A2.2.2)}$$

$$(K)(\overline{X/Q})(472)(C_i)(f) < 500$$

$$C < \frac{500}{(206)(7.308E{-}6)(472)} \div f$$

$$C < 7.04E{+}2/f$$

where:

C = the gross activity in undiluted effluent, in μCi/ml

f = the flow from the tank or building and varies for various release sources, in cfm

K = from Table 1.2-1 for Xe-133, 2.06E+2 mrem/yr per $\mu Ci/m^3$

$\overline{X/Q}$ = 7.308E-6 sec/m^3, as defined in section A2.3.2.

A3.3.1 Interim Radwaste Building Ventilation Exhaust

Ventilation exhaust from the Interim Radwaste Building is considered a separate release point. This exhaust is normally considered non-radioactive; that is, it is possible but unlikely that the effluent will contain measurable activity above background. Since the exhaust is continuous, a maximum concentration of gases in the exhaust, which also is the radiation monitor setpoint, is calculated to assure compliance with release limits. A typical radiation monitor setpoint may be calculated as follows:

$$C < 7.04E{+}2/f = 4.79E{-}2\ \mu Ci/ml$$

where:

f = 1.47E+04 cfm

A3.3.1 Hot Machine Shop Building Ventilation Exhaust

Ventilation exhaust from the Hot Machine Shop is considered to be a separate release point. This filtered exhaust is sampled and analyzed for particulates and radioiodines to assure that the effluent released has not exceeded station release limits. Since it is assumed that no noble gases will be generated by machine shop work, no provision for monitoring noble gas releases are provided.

A3.3.2 Contaminated Oil Burning In Auxiliary Boiler

Contaminated oil may be burned in the auxiliary boiler which is not released through the unit vent and is considered a separate release point. The contaminated oil is filtered, mixed, and sampled to determine the total activity to be released and the allowable release (burn) rate.

By Selected Licensee Commitments, releases from the auxiliary boiler from incineration of contaminated oil must meet the instantaneous release rate for iodines and particulates given in Section A2.2.2. Also, the total dose due to these releases must be less than 0.1% of the allowable yearly dose from particulate gaseous effluents.

Doses from incineration of contaminated oil are calculated for all organs and all pathways using either the models provided in Section 3.1.2.2 of this manual or the GASPAR computer program. Cumulative doses are calculated quarterly at a minimum.

All the activity in the contaminated oil is assumed to be released during incineration and the total is added to the station's quarterly and annual release records.

A3.3.3 Radwaste Facility Ventilation and Process Gas Exhaust

The ventilation and process gas exhaust from the Radwaste Facility is considered a separate release point. This exhaust is sampled continuously for iodine and particulates and noble gases. This data is used in calculations to assure that the effluents released have not exceeded station release limits. A typical radiation monitor setpoint may be calculated as follows:

$$C < 7.04E+2/f = 5.43E-03\ \mu Ci/ml$$

where:

f = 129,700 cfm, The total combined ventilation and process gas exhaust flow.

A4.0 DOSE CALCULATIONS

A4.1 FREQUENCY OF CALCULATIONS

Dose contributions to the maximum exposed individual shall be calculated at least every 31 days, quarterly, and annually using the methodology in the generic information sections or the LADTAP and GASPAR computer programs. Example input templates for Oconee LADTAP and GASPAR computer program calculations are provided in Figures A4.0-1 and A4.0-2. One of these methods shall also be used for any special reports.

Station long-term historical and dose projection calculations are periodically performed to determine the station's status with respect to meeting annual ALARA goals specified in the Oconee Nuclear Station Selected Licensing Commitment Manual. Such calculations are used to verify that adequate margin remains during a report period to allow normal station and radwaste system operation, including anticipated operational occurrences, for the remainder of the report period without exceeding applicable goals. Station dose projections can be performed using generic methodology or the LADTAP and GASPAR computer codes.

Fuel cycle dose calculations shall be performed annually or as required by special reports. Dose contributions shall be calculated using the methodology in the appropriate generic information sections or the LADTAP and GASPAR computer programs.

A4.2 DOSE MODELS FOR MAXIMUM EXPOSED INDIVIDUAL

A4.2.1 Liquid Effluents

Generic methodology for calculating liquid pathway exposures to the maximum exposed individual is presented in Section 3.1.1. Oconee site specific parameters to be used in the generic methodology are presented as follows:

A_{aoi} = Tables A4.0-3 through A4.0-6

F_{η} = $f/(F + f)$ (0.0067 for projections)

where:

F_{η} = Near field dilution factor, dimensionless

f = Oconee average liquid radwaste flow, cfs (7.34 default for projections based on 1990-94 average radwaste flow)

F = Oconee average dilution flow for period of interest, cfs (1091 default for projections based on 1990-94 Keowee Hydro average flow)

An input template for Oconee LADTAP computer program calculations is provided in Figure A4.0-1. The input template includes default dilution parameters. Radionuclide release input (Ci/period) and optional non-default dilution flow (CFS) parameters are necessary to perform LADTAP calculations to determine offsite dose impact from specific releases during the period that dilution flow is averaged over.

A4.2.2 Gaseous Effluents

A4.2.2.1 Noble Gases

Gamma Air and Beta Air Dose

Generic methodology for calculating noble gas airborne pathway gamma air (D_γ) and beta air (D_β) doses is presented in Section 3.1.2.1. Oconee site specific parameters to be used in the generic methodology are presented as follows:

Semi-elevated Releases

$(\overline{X/Q})$ = 1.672E-6 sec/m^3. The highest calculated annual average relative concentration for any area at or beyond the unrestricted area boundary. The location is the SW sector @ 1.0 mile for semi-elevated releases.

Ground Level Releases

$(\overline{X/Q})$ = 7.308E-6 sec/m^3. The highest calculated annual average relative concentration for any area at or beyond the unrestricted area boundary. The location is the SE sector @ 1.0 mile for ground level releases.

An input template for Oconee GASPAR computer program noble gas airborne pathway gamma air (D_γ) and beta air (D_β) dose calculations is provided in Figure A4.0-2. The input template includes the maximum Oconee site specific semi-elevated and ground level annual average relative concentration parameters. Radionuclide release input (Ci/period) and optional non-default relative concentration parameters are necessary to perform GASPAR calculations to determine offsite dose impact from specific releases.

A4.2.2.2 Radioiodines, Particulate, and Other Radionuclides with T 1/2 > 8 Days

Generic methodology for calculating airborne pathway maximum organ (D_{mo}) exposures to the maximum exposed individual is presented in Section 3.1.2.2. External exposure from deposited ground contamination and inhalation exposure pathways, and internal exposure from the vegetable garden pathway are considered to exist at all locations offsite. Other food pathways, which include the meat and milk pathways, are analyzed only at locations where site surveys have verified that meat producing animals, or cow and goat milk producing animals exist, however. Therefore, the location of the maximum

individual may vary depending on the mixture and levels of radionuclides released during a period of time. Additionally, the critical (or limiting) age group and organ will vary based on the location (i.e., combination of dose pathways contributing dose) and mixture/level of radionuclide releases during the release period.

Performing calculations separately for semi-elevated and ground level release types and for all potential maximum locations, age groups and organs assures that a maximum location is identified and that a conservative estimate is obtained for maximum offsite dose impact to any organ or age group. Oconee site specific meteorological dispersion (X/Q) and deposition (D/Q) parameters and applicable terrestrial/food pathways for the potential maximum locations to be analyzed using generic methodology are presented in Table A4.0-7.

An input template for Oconee GASPAR computer program airborne pathway maximum organ (D_{mo}) dose calculations is provided in Figures A4.0-3 through A4.0-10. The input template includes the maximum Oconee site specific semi-elevated and ground level annual average meteorological parameters. Radionuclide release input (Ci/period) and optional non-default meteorological parameters and pathway applicability flags are necessary to perform GASPAR calculations to determine offsite dose impact from specific releases.

An alternative method for estimating offsite dose involves performing calculations for all offsite locations and comparing the combined semi-elevated and ground level release dose totals for each location to determine the maximum organ exposure. Table A4.0-8 provides site survey data indicating the applicable food pathways to be considered for each offsite location.

A4.3 FUEL CYCLE CALCULATIONS

As discussed in Section 3.3.5, more than one nuclear power station site may contribute to the doses to be considered in accordance with 40CFR190. The fuel cycle dose assessments for Oconee Nuclear Station only include liquid and gaseous dose contributions from Oconee Nuclear Station since no other uranium fuel cycle facility contributes significantly to Oconee's maximum exposed individual. For this dose assessment, the total body and maximum organ dose contributions to the maximum exposed individual from Oconee's liquid and gaseous releases are estimated using the following calculations:

$$D_{tb}(T) = D_{tb}(l) + D_{tb}(g_e) + D_{tb}(g_g)$$

$$D_{mo}(T) = D_{mo}(l) + D_{mo}(g_e) + D_{mo}(g_g)$$

where:

$D_{tb}(T)$ = Total estimated fuel cycle total body dose commitment resulting from the combined liquid and gaseous effluents from Oconee during the calendar year of interest, in mrem.

$D_{tb}(l)$ = Estimated fuel cycle total body dose contribution resulting from Oconee liquid effluents during the calendar year of interest, in mrem.

$D_{tb}(g_e)$ = Estimated fuel cycle total body dose contribution resulting from Oconee gaseous effluents released from semi-elevated release points during the calendar year of interest, in mrem.

$D_{tb}(g_g)$ = Estimated fuel cycle total body dose contribution resulting from Oconee gaseous effluents released from ground level release points during the calendar year of interest, in mrem.

$D_{mo}(T)$ = Total estimated fuel cycle maximum organ dose commitment resulting from the combined liquid and gaseous effluents from Oconee during the calendar year of interest, in mrem.

$D_{mo}(l)$ = Estimated fuel cycle maximum organ dose contribution resulting from Oconee liquid effluents during the calendar year of interest, in mrem.

$D_{mo}(g_e)$ = Estimated fuel cycle maximum organ dose contribution resulting from Oconee gaseous effluents released from semi-elevated release points during the calendar year of interest, in mrem.

$D_{mo}(g_g)$ = Estimated fuel cycle maximum organ dose contribution resulting from Oconee gaseous effluents released from ground level release points during the calendar year of interest, in mrem.

A4.3.1 LIQUID EFFLUENTS

Liquid pathway dose estimates are calculated using generic methodology or the LADTAP computer program. The values for $D_{tb}(l)$ and $D_{mo}(l)$ liquid pathway dose contributions are calculated based on the methodology, values and assumptions presented in Section A4.2.1.

A4.3.2 GASEOUS EFFLUENTS

Total Body

The methodology for calculating noble gas airborne pathway total body exposures to the maximum individual, $D_{tb}(g_e)$ and $D_{tb}(g_g)$, is derived from Section 3.1.2.1 generic methodology for gamma air and beta air dose calculations as follows:

$$D_{tb} = 3.17E-8 \; \Sigma_i \; K_i \; [(X/Q)Q_i] \quad \text{mrem/yr}$$

Generic methodology parameters K_i are described and provided in Section 1.2.1. Oconee site specific parameters for semi-elevated and ground level X/Q values are 1.672E-6 and 7.308E-6, respectively, as described in Section A4.2.2.1 for Oconee gamma air and beta air dose calculations.

Maximum Organ

Airborne pathway maximum organ dose estimates are calculated using generic methodology or the GASPAR computer program. The values for $D_{mo}(g_e)$ and $D_{mo}(g_g)$ airborne pathway dose contributions are calculated based on the methodology, presented in Section A4.2.2.2. The maximum organ dose is established by calculating doses to all organs for each potential maximum offsite location identified in Table A4.0-7. Calculations must be performed separately for semi-elevated and ground level gaseous release types and for all potential maximum locations, age groups and organs in order to assure that the maximum location, organ and age group is indeed analyzed and identified. A conservative estimate (i.e., overestimate) of the fuel cycle maximum organ dose is obtained by 1) performing liquid pathway calculations for each age group and organ, 2) performing gaseous pathway calculations for each age group and organ for all potential maximum exposure locations (see Table A4.0-7) 3) adding the exposure values for each airborne release type (i.e., semi-elevated and ground level) to the same organ dose resulting from liquid releases, 4) comparing total organ dose values for each potential limiting gaseous dose location and determining the maximum organ dose values for each age group, and airborne pathway components are added for all organs and determining maximum organ dose values calculated or each potential limiting gaseous dose location age group, and 5) comparing maximum total doses for each organ and age group and determining the maximum (or limiting) organ and age group. A worksheet is presented in Figure A4.0-11.

An alternative method for estimating fuel cycle maximum organ dose involves performing calculations for all offsite locations and comparing the combined liquid, semi-elevated and ground level release dose totals for each location to determine the maximum organ exposure. Table A4.0-8 provides site survey data indicating the applicable food pathways to be considered for each offsite location.

TABLE A4.0-1A

OCONEE NUCLEAR STATION
(1 OF 2)

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

(SEC/M3)

DISTANCE TO THE CONTROL LOCATION, IN MILES

SECTOR	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			5.220E-07	2.650E-07	1.594E-07	1.069E-07	7.719E-08	7.321E-08	5.665E-08	4.542E-08
NNE			8.379E-07	4.734E-07	2.690E-07	2.003E-07	1.385E-07	1.091E-07	8.379E-08	6.676E-08
NE			9.503E-07	6.350E-07	3.962E-07	2.535E-07	1.847E-07	1.497E-07	1.157E-07	9.246E-08
ENE			8.116E-07	4.856E-07	2.919E-07	2.196E-07	1.619E-07	1.239E-07	9.609E-08	7.720E-08
E			5.950E-07	3.202E-07	2.015E-07	2.270E-07	1.745E-07	1.292E-07	1.024E-07	8.308E-08
ESE			4.531E-07	3.300E-07	3.623E-07	4.020E-07	2.822E-07	2.109E-07	1.688E-07	1.405E-07
SE			7.505E-07	4.573E-07	5.490E-07	5.110E-07	3.560E-07	2.648E-07	2.063E-07	1.665E-07
SSE			1.419E-06	7.428E-07	4.527E-07	3.489E-07	2.866E-07	2.131E-07	1.659E-07	1.337E-07
S			1.170E-06	6.099E-07	3.701E-07	2.496E-07	1.810E-07	1.552E-07	1.218E-07	9.867E-08
SSW			1.214E-06	6.327E-07	3.564E-07	2.301E-07	1.621E-07	1.213E-07	9.481E-08	7.660E-08
SW			1.672E-06	7.285E-07	4.057E-07	2.720E-07	1.891E-07	1.400E-07	1.085E-07	8.708E-08
WSW			1.558E-06	6.820E-07	3.804E-07	2.438E-07	1.708E-07	1.271E-07	1.010E-07	8.114E-08
W			1.193E-06	5.214E-07	2.909E-07	1.867E-07	1.372E-07	1.032E-07	8.326E-08	6.654E-08
WNW			4.658E-07	2.480E-07	1.760E-07	1.482E-07	1.024E-07	7.695E-08	5.943E-08	4.796E-08
NW			4.831E-07	2.524E-07	1.965E-07	1.291E-07	9.959E-08	7.356E-08	5.682E-08	4.566E-08
NNW			5.375E-07	2.769E-07	2.128E-07	1.394E-07	1.072E-07	7.913E-08	6.110E-08	4.907E-08

OCONEE NUCLEAR STATION

The values presented in this table were generated by using the computer program XOQDOQ (NUREG/CR-2919) which implements NRC Regulatory Guide 1.111 (1977), and by using the following assumptions:

1. Data Collection Period, 1988 to 1992.
2. Semi-Elevated Releases.
3. Open Terrain Recirculation Correction Factors.
4. No Decay, Undepleted
5. Vent and Building Parameters:

Release Height	(meters) = 60.70	Rep. Wind Height	(meters)	=	60.7
Diameter	(meters) = 1.80	Building Height	(meters)	=	58.0
Exit Velocity	(meters) = 11.10	Bldg. Min. X-Sec. Area	(sq. m.)	=	2296.0
		Heat Emission Rate	(cal/s)	=	0.0

6. At the Release Height:

Vent Release Mode	Wind Speed (meters/sec)
Elevated	Less Than 2.220
Mixed	Between 2.220 and 11.100
Ground Level	Above 11.100

7. At the Measured Wind Speed (10.0 meters):

Vent Release Mode	Wind Speed (meters/sec) Stable Conditions	Wind Speed (meters/sec) Unstable/Neutral Conditions
Elevated	Less Than 0.901	Less Than 1.414
Mixed	Between 0.901 and 4.505	Between 1.414 and 7.072
Ground Level	Above 4.505	Above 7.072

TABLE A4.0-1B

OCONEE NUCLEAR STATION
(1 OF 2)

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

(1/M2)

DISTANCE TO THE CONTROL LOCATION, IN MILES

SECTOR	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			2.890E-09	1.184E-09	6.225E-10	3.812E-10	2.586E-10	3.380E-10	2.510E-10	1.943E-10
NNE			9.113E-09	3.989E-09	2.013E-09	1.248E-09	8.235E-10	8.997E-10	6.667E-10	5.138E-10
NE			1.295E-08	5.666E-09	2.919E-09	1.729E-09	1.145E-09	1.224E-09	9.140E-10	7.067E-10
ENE			7.899E-09	3.385E-09	1.756E-09	1.095E-09	9.819E-10	7.671E-10	5.749E-10	4.466E-10
E			4.454E-09	1.775E-09	9.252E-10	7.164E-10	7.491E-10	5.267E-10	3.981E-10	3.125E-10
ESE			4.361E-09	1.838E-09	1.086E-09	1.322E-09	8.696E-10	6.161E-10	5.153E-10	4.139E-10
SE			3.397E-09	1.385E-09	8.341E-10	1.649E-09	1.080E-09	7.595E-10	5.629E-10	4.340E-10
SSE			3.333E-09	1.323E-09	6.920E-10	4.404E-10	7.307E-10	5.202E-10	3.922E-10	3.091E-10
S			3.192E-09	1.256E-09	6.530E-10	4.020E-10	2.788E-10	2.177E-10	1.759E-10	1.501E-10
SSW			5.190E-09	1.972E-09	9.899E-10	5.895E-10	3.928E-10	2.842E-10	2.192E-10	1.778E-10
SW			1.205E-08	4.399E-09	2.193E-09	1.299E-09	8.521E-10	6.028E-10	4.518E-10	3.546E-10
WSW			1.047E-08	3.824E-09	1.908E-09	1.127E-09	7.422E-10	5.277E-10	3.980E-10	3.145E-10
W			5.577E-09	2.044E-09	1.025E-09	6.094E-10	4.134E-10	3.405E-10	3.962E-10	3.052E-10
WNW			2.185E-09	9.042E-10	5.220E-10	6.464E-10	4.227E-10	3.188E-10	2.360E-10	1.868E-10
NW			2.097E-09	8.759E-10	5.225E-10	3.196E-10	4.521E-10	3.178E-10	2.353E-10	1.812E-10
NNW			2.461E-09	1.028E-09	6.219E-10	3.765E-10	5.128E-10	3.604E-10	2.667E-10	2.054E-10

TABLE A4.0-1B
(2 OF 2)

OCONEE NUCLEAR STATION

The values presented in this table were generated by using the computer program XOQDOQ (NUREG/CR-2919) which implements NRC Regulatory Guide 1.111 (1977), and by using the following assumptions:

1. Data Collection Period, 1988 to 1992.

2. Semi-Elevated Releases.

3. Open Terrain Recirculation Correction Factors.

4. No Decay, Undepleted

5. Vent and Building Parameters:

Release Height	(meters) =	60.70	Rep. Wind Height	(meters)	=	60.7
Diameter	(meters) =	1.80	Building Height	(meters)	=	58.0
Exit Velocity	(meters) =	11.10	Bldg. Min. X-Sec. Area	(sq. m.)	=	2296.0
			Heat Emission Rate	(cal/s)	=	0.0

6. At the Release Height:

Vent Release Mode	Wind Speed (meters/sec)
Elevated	Less Than 2.220
Mixed	Between 2.220 and 11.100
Ground Level	Above 11.100

7. At the Measured Wind Speed (10.0 meters):

Vent Release Mode	Wind Speed (meters/sec)	
	Stable Conditions	Unstable/Neutral Conditions
Elevated	Less Than 0.901	Less Than 1.414
Mixed	Between 0.901 and 4.505	Between 1.414 and 7.072
Ground Level	Above 4.505	Above 7.072

TABLE A4.0-2A

OCONEE NUCLEAR STATION
(1 OF 2)

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

(SEC/M3)

DISTANCE TO THE CONTROL LOCATION, IN MILES

SECTOR	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			2.115E-06	8.389E-07	4.495E-07	2.822E-07	1.952E-07	1.443E-07	1.117E-07	8.961E-08
NNE			2.898E-06	1.137E-06	6.047E-07	3.775E-07	2.602E-07	1.916E-07	1.480E-07	1.184E-07
NE			3.886E-06	1.529E-06	8.158E-07	5.108E-07	3.529E-07	2.604E-07	2.015E-07	1.616E-07
ENE			3.226E-06	1.277E-06	6.848E-07	4.305E-07	2.983E-07	2.207E-07	1.711E-07	1.374E-07
E			3.522E-06	1.410E-06	7.658E-07	4.866E-07	3.400E-07	2.534E-07	1.977E-07	1.596E-07
ESE			5.964E-06	2.407E-06	1.321E-06	8.459E-07	5.950E-07	4.457E-07	3.493E-07	2.832E-07
SE			7.308E-06	2.972E-06	1.631E-06	1.044E-06	7.342E-07	5.497E-07	4.307E-07	3.490E-07
SSE			6.604E-06	2.657E-06	1.440E-06	9.117E-07	6.354E-07	4.723E-07	3.676E-07	2.962E-07
S			5.278E-06	2.121E-06	1.146E-06	7.237E-07	5.032E-07	3.734E-07	2.901E-07	2.335E-07
SSW			3.986E-06	1.589E-06	8.536E-07	5.370E-07	3.721E-07	2.753E-07	2.135E-07	1.714E-07
SW			4.108E-06	1.620E-06	8.628E-07	5.390E-07	3.715E-07	2.735E-07	2.112E-07	1.689E-07
WSW			3.804E-06	1.503E-06	8.018E-07	5.015E-07	3.460E-07	2.549E-07	1.970E-07	1.577E-07
W			2.978E-06	1.186E-06	6.361E-07	3.995E-07	2.765E-07	2.043E-07	1.583E-07	1.270E-07
WNW			2.201E-06	8.791E-07	4.726E-07	2.974E-07	2.062E-07	1.526E-07	1.183E-07	9.502E-08
NW			2.104E-06	8.385E-07	4.499E-07	2.826E-07	1.957E-07	1.447E-07	1.121E-07	8.991E-08
NNW			2.221E-06	8.860E-07	4.755E-07	2.988E-07	2.069E-07	1.529E-07	1.185E-07	9.508E-08

OCONEE NUCLEAR STATION

The values presented in this table were generated by using the computer program XOQDOQ (NUREG/CR-2919) which implements NRC Regulatory Guide 1.111 (1977), and by using the following assumptions:

1. Data Collection Period, 1988 to 1992.

2. Ground Level Releases.

3. Open Terrain Recirculation Correction Factors.

4. No Decay, Undepleted

5. Vent and Building Parameters:

Release Height	(meters) =	10.00	Rep. Wind Height	(meters)	=	10.0
Diameter	(meters) =	0.00	Building Height	(meters)	=	58.0
Exit Velocity	(meters) =	0.00	Bldg. Min. X-Sec. Area	(sq. m.)	=	2296.0
			Heat Emission Rate	(cal/s)	=	0.0

TABLE A4.0-2B

OCONEE NUCLEAR STATION
(1 OF 2)

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

(1/M2)

DISTANCE TO THE CONTROL LOCATION, IN MILES

SECTOR	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			6.916E-09	2.484E-09	1.232E-09	7.255E-10	4.750E-10	3.342E-10	2.477E-10	1.909E-10
NNE			1.642E-08	5.897E-09	2.924E-09	1.722E-09	1.128E-09	7.934E-10	5.880E-10	4.531E-10
NE			2.259E-08	8.114E-09	4.024E-09	2.369E-09	1.551E-09	1.092E-09	8.090E-10	6.235E-10
ENE			1.428E-08	5.130E-09	2.544E-09	1.498E-09	9.810E-10	6.902E-10	5.115E-10	3.942E-10
E			9.899E-09	3.556E-09	1.763E-09	1.038E-09	6.798E-10	4.784E-10	3.545E-10	2.732E-10
ESE			1.336E-08	4.798E-09	2.379E-09	1.401E-09	9.174E-10	6.455E-10	4.784E-10	3.686E-10
SE			1.401E-08	5.034E-09	2.496E-09	1.470E-09	9.625E-10	6.772E-10	5.019E-10	3.868E-10
SSE			1.226E-08	4.404E-09	2.184E-09	1.286E-09	8.420E-10	5.925E-10	4.391E-10	3.384E-10
S			1.008E-08	3.620E-09	1.795E-09	1.057E-09	6.922E-10	4.871E-10	3.610E-10	2.782E-10
SSW			9.941E-09	3.571E-09	1.771E-09	1.043E-09	6.828E-10	4.804E-10	3.560E-10	2.744E-10
SW			1.717E-08	6.169E-09	3.059E-09	1.801E-09	1.180E-09	8.300E-10	6.151E-10	4.740E-10
WSW			1.574E-08	5.655E-09	2.804E-09	1.651E-09	1.081E-09	7.608E-10	5.638E-10	4.345E-10
W			9.988E-09	3.588E-09	1.779E-09	1.048E-09	6.860E-10	4.827E-10	3.577E-10	2.757E-10
WNW			5.953E-09	2.138E-09	1.060E-09	6.244E-10	4.088E-10	2.877E-10	2.132E-10	1.643E-10
NW			5.891E-09	2.116E-09	1.049E-09	6.179E-10	4.046E-10	2.847E-10	2.110E-10	1.626E-10
NNW			6.672E-09	2.397E-09	1.188E-09	6.998E-10	4.582E-10	3.224E-10	2.390E-10	1.841E-10

OCONEE NUCLEAR STATION

The values presented in this table were generated by using the computer program XOQDOQ (NUREG/CR-2919) which implements NRC Regulatory Guide 1.111 (1977), and by using the following assumptions:

1. Data Collection Period, 1988 to 1992.

2. Ground Level Releases.

3. Open Terrain Recirculation Correction Factors.

4. No Decay, Undepleted

5. Vent and Building Parameters:

Release Height	(meters) =	10.00	Rep. Wind Height	(meters)	=	10.0
Diameter	(meters) =	0.00	Building Height	(meters)	=	58.0
Exit Velocity	(meters) =	0.00	Bldg. Min. X-Sec. Area	(sq. m.)	=	2296.0
			Heat Emission Rate	(cal/s)	=	0.0

TABLE A4.0-3
(1 OF 2)

OCONEE NUCLEAR STATION
LIQUID EFFLUENT DOSE - ADULT PARAMETERS
A(I) MREM/HR PER UCI/ML

RADIONUCLIDE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
1 H 3	0.0	2.27E-01	2.27E-01	2.27E-01	2.27E-01	2.27E-01	2.27E-01
11 NA 24	1.35E+02	1.35E+02	1.35E+02	1.35E+02	1.35E+02	1.35E+02	1.35E+02
24 CR 51	0.0	0.0	1.24E+00	7.42E-01	2.74E-01	1.65E+00	3.12E+02
25 MN 54	0.0	4.37E+03	8.33E+02	0.0	1.30E+03	0.0	1.34E+04
25 MN 56	0.0	1.69E-01	3.00E-02	0.0	2.14E-01	0.0	5.39E+00
26 FE 55	6.58E+02	4.55E+02	1.06E+02	0.0	0.0	2.54E+02	2.61E+02
26 FE 59	1.02E+03	2.40E+03	9.22E+02	0.0	0.0	6.72E+02	8.01E+03
27 CO 58	0.0	8.83E+01	1.98E+02	0.0	0.0	0.0	1.79E+03
27 CO 60	0.0	2.56E+02	5.65E+02	0.0	0.0	0.0	4.81E+03
28 NI 63	3.11E+04	2.16E+03	1.04E+03	0.0	0.0	0.0	4.50E+02
28 NI 65	1.72E-01	2.23E-02	1.02E-02	0.0	0.0	0.0	5.67E-01
29 CU 64	0.0	2.68E+00	1.26E+00	0.0	6.76E+00	0.0	2.29E+02
30 ZN 65	2.31E+04	7.35E+04	3.32E+04	0.0	4.92E+04	0.0	4.63E+04
30 ZN 69	1.20E-06	2.30E-06	1.60E-07	0.0	1.50E-06	0.0	3.46E-07
35 BR 83	0.0	0.0	3.86E-02	0.0	0.0	0.0	5.55E-02
35 BR 85	0.0	0.0	0.0	0.0	0.0	0.0	0.0
37 RB 86	0.0	9.74E+04	4.54E+04	0.0	0.0	0.0	1.92E+04
37 RB 88	0.0	3.66E-16	1.94E-16	0.0	0.0	0.0	5.06E-27
37 RB 89	0.0	2.09E-18	1.47E-18	0.0	0.0	0.0	1.22E-31
38 SR 89	2.18E+04	0.0	6.26E+02	0.0	0.0	0.0	3.50E+03
38 SR 90	2.76E+05	0.0	7.40E+04	0.0	0.0	0.0	1.57E+04
38 SR 91	7.05E+01	0.0	2.85E+00	0.0	0.0	0.0	3.36E+02
38 SR 92	3.35E-01	0.0	1.45E-02	0.0	0.0	0.0	6.65E+00
39 Y 90	4.44E-01	0.0	1.19E-02	0.0	0.0	0.0	4.71E+03
39 Y 91M	4.20E-11	0.0	1.63E-12	0.0	0.0	0.0	1.23E-10
39 Y 91	8.34E+00	0.0	2.23E-01	0.0	0.0	0.0	4.59E+03
39 Y 92	4.69E-04	0.0	1.37E-05	0.0	0.0	0.0	8.21E+00
39 Y 93	3.08E-02	0.0	8.51E-04	0.0	0.0	0.0	9.77E+02
40 ZR 95	2.38E-01	7.63E-02	5.16E-02	0.0	1.20E-01	0.0	2.42E+02
40 ZR 97	4.97E-03	1.00E-03	4.58E-04	0.0	1.51E-03	0.0	3.10E+02
41 NB 95	4.38E+02	2.44E+02	1.31E+02	0.0	2.41E+02	0.0	1.48E+06
42 MO 99	0.0	8.02E+01	1.53E+01	0.0	1.82E+02	0.0	1.86E+02
43 TC 99M	5.59E-04	1.58E-03	2.01E-02	0.0	2.40E-02	7.74E-04	9.35E-01
43 TC 101	1.13E-21	1.63E-21	1.60E-20	0.0	2.93E-20	8.32E-22	4.89E-33
44 RU 103	4.35E+00	0.0	1.88E+00	0.0	1.66E+01	0.0	5.08E+02
44 RU 105	8.69E-03	0.0	3.43E-03	0.0	1.12E-01	0.0	5.32E+00
44 RU 106	6.57E+01	0.0	8.32E+00	0.0	1.27E+02	0.0	4.25E+03
47 AG 110M	8.80E-01	8.14E-01	4.83E-01	0.0	1.60E+00	0.0	3.32E+02
52 TE 125M	2.54E+03	9.19E+02	3.40E+02	7.63E+02	1.03E+04	0.0	1.01E+04
52 TE 127M	6.44E+03	2.30E+03	7.85E+02	1.65E+03	2.62E+04	0.0	2.16E+04
52 TE 127	1.78E+01	6.38E+00	3.84E+00	1.32E+01	7.24E+01	0.0	1.40E+03
52 TE 129M	1.08E+04	4.02E+03	1.71E+03	3.71E+03	4.50E+04	0.0	5.43E+04
52 TE 129	1.80E-05	6.75E-06	4.37E-06	1.38E-05	7.55E-05	0.0	1.36E-05
52 TE 131M	9.51E+02	4.65E+02	3.88E+02	7.37E+02	4.71E+03	0.0	4.62E+04
52 TE 131	3.68E-13	1.54E-13	1.16E-13	3.03E-13	1.61E-12	0.0	5.21E-14
52 TE 132	1.95E+03	1.26E+03	1.18E+03	1.39E+03	1.22E+04	0.0	5.97E+04
53 I 130	7.06E+00	2.08E+01	8.21E+00	1.76E+03	3.25E+01	0.0	1.79E+01
53 I 131	1.37E+02	1.96E+02	1.12E+02	6.43E+04	3.36E+02	0.0	5.17E+01
53 I 132	5.32E-03	1.42E-02	4.98E-03	4.98E-01	2.27E-02	0.0	2.67E-03
53 I 133	2.29E+01	3.99E+01	1.22E+01	5.86E+03	6.96E+01	0.0	3.59E+01
53 I 135	1.28E+00	3.34E+00	1.23E+00	2.21E+02	5.36E+00	0.0	3.78E+00
55 CS 134	1.49E+06	3.54E+06	2.89E+06	0.0	1.15E+06	3.80E+05	6.19E+04
55 CS 136	1.48E+05	5.84E+05	4.20E+05	0.0	3.25E+05	4.45E+04	6.63E+04
55 CS 137	1.91E+06	2.61E+06	1.71E+06	0.0	8.86E+05	2.94E+05	5.05E+04
55 CS 138	1.37E-10	2.70E-10	1.34E-10	0.0	1.99E-10	1.96E-11	1.15E-15
56 BA 139	7.09E-06	5.05E-09	2.08E-07	0.0	4.72E-09	2.87E-09	1.26E-05
56 BA 140	1.84E+02	2.32E-01	1.21E+01	0.0	7.87E-02	1.33E-01	3.80E+02
56 BA 141	5.44E-16	4.12E-19	1.84E-17	0.0	3.83E-19	2.34E-19	2.57E-25
56 BA 142	9.69E-25	9.96E-28	6.09E-26	0.0	8.41E-28	5.64E-28	1.36E-42
57 LA 140	9.90E-02	4.99E-02	1.32E-02	0.0	0.0	0.0	3.66E+03
57 LA 142	1.61E-07	7.32E-08	1.82E-08	0.0	0.0	0.0	5.35E-04
58 CE 141	2.20E-02	1.49E-02	1.69E-03	0.0	6.91E-03	0.0	5.69E+01
58 CE 143	2.40E-03	1.78E+00	1.97E-04	0.0	7.82E-04	0.0	6.64E+01
58 CE 144	1.17E+00	4.89E-01	6.28E-02	0.0	2.90E-01	0.0	3.95E+02
59 PR 143	5.23E-01	2.10E-01	2.59E-02	0.0	1.21E-01	0.0	2.29E+03
59 PR 144	7.04E-20	2.92E-20	3.58E-21	0.0	1.65E-20	0.0	1.01E-26
60 ND 147	3.54E-01	4.09E-01	2.45E-02	0.0	2.39E-01	0.0	1.96E+03
74 W 187	1.48E+02	1.23E+02	4.31E+01	0.0	0.0	0.0	4.04E+04
93 NP 239	2.12E-02	2.09E-03	1.15E-03	0.0	6.52E-03	0.0	4.28E+02

Oconee Nuclear Station
Liquid Effluent Dose - Adult Parameters
A_{aoi} mrem/hr per µCi/ml

From Generic Section 3.1.1:

A_{aoi} = the site related ingestion dose commitment factor for an individual of age group, "a", to organ, "o", for each identified principal gamma and beta emitter, "i", in mrem/hr per µCi/ml

A_{aoi} = $1.14E+05\ (U_{aw}\sigma_w/Dw\ \exp(-\lambda_i t_w) + U_{af}\sigma_f BF_i \exp(-\lambda_i t_f))\ DF_{aoi}$

where:
1.14E+05 = 10^6 pCi/µCi x 10^3 ml/kg ÷ 8760 hr/yr

U_{aw} = Water consumption by age group, l/yr

infant	330
child	510
teen	510
adult	730

σ_w, σ_f = Recirculation factors at equilibrium for the water and fish pathways respectively; these factors account for the fraction of discharged water reused by the station
σ_w = 1.00 σ_f = 1.00

D_w = Dilution factor from the near field area to the potable water intake = 10000 (essentially no drinking water pathway)

U_{af} = Fish consumption by age group, kg/yr

infant	---
child	6.9
teen	16
adult	21

BF_i = Bioaccumulation factor for radionuclide, "i", in fish, pCi/kg per pCi/l, from Table 3.1-1

DF_{aoi} = Dose conversion factor for age group, "a", in organ, "o", for radionuclide, "i", in mrem/pCi, from Tables 3.1-2, 3.1-3, 3.1-4, and 3.1-5, respectively

λ_i = radiological decay constant for isotope, i, in 1/hr

t_w, t_f = transport time for the drinking water and fish pathways, hr
t_w = 12 hours t_f = 24 hours

Sample Calculation for Adult, I-131, Thyroid:
A(a,thy,I-131) = 1.14E5 (730*1.0/1.0E4*exp(-3.59E-3*12) + 21*1.0*15* exp(-3.59E-3*24)) 1.95E-3 = 6.43E4 mr/hr per µCi/ml

TABLE A4.0-4
(1 OF 2)

OCONEE NUCLEAR STATION
LIQUID EFFLUENT DOSE - TEEN PARAMETERS
A(I) MREM/HR PER UCI/ML

RADIONUCLIDE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
1 H 3	0.0	1.75E-01	1.75E-01	1.75E-01	1.75E-01	1.75E-01	1.75E-01
11 NA 24	1.39E+02	1.39E+02	1.39E+02	1.39E+02	1.39E+02	1.39E+02	1.39E+02
24 CR 51	0.0	0.0	1.28E+00	7.12E-01	2.81E-01	1.83E+00	2.15E+02
25 MN 54	0.0	4.30E+03	8.52E+02	0.0	1.28E+03	0.0	8.81E+03
25 MN 56	0.0	1.77E-01	3.15E-02	0.0	2.24E-01	0.0	1.16E+01
26 FE 55	6.89E+02	4.89E+02	1.14E+02	0.0	0.0	3.10E+02	2.11E+02
26 FE 59	1.05E+03	2.46E+03	9.50E+02	0.0	0.0	7.76E+02	5.82E+03
27 CO 58	0.0	8.78E+01	2.02E+02	0.0	0.0	0.0	1.21E+03
27 CO 60	0.0	2.56E+02	5.77E+02	0.0	0.0	0.0	3.34E+03
28 NI 63	3.23E+04	2.28E+03	1.09E+03	0.0	0.0	0.0	3.63E+02
28 NI 65	1.86E-01	2.37E-02	1.08E-02	0.0	0.0	0.0	1.29E+00
29 CU 64	0.0	2.82E+00	1.33E+00	0.0	7.14E+00	0.0	2.19E+02
30 ZN 65	2.10E+04	7.28E+04	3.39E+04	0.0	4.66E+04	0.0	3.08E+04
30 ZN 69	1.31E-06	2.49E-06	1.74E-07	0.0	1.63E-06	0.0	4.59E-06
35 BR 83	0.0	0.0	4.19E-02	0.0	0.0	0.0	0.0
35 BR 85	0.0	0.0	0.0	0.0	0.0	0.0	0.0
37 RB 86	0.0	1.05E+05	4.92E+04	0.0	0.0	0.0	1.55E+04
37 RB 88	0.0	3.60E-16	1.92E-16	0.0	0.0	0.0	3.08E-23
37 RB 89	0.0	2.01E-18	1.42E-18	0.0	0.0	0.0	3.07E-27
38 SR 89	2.38E+04	0.0	6.80E+02	0.0	0.0	0.0	2.83E+03
38 SR 90	2.45E+05	0.0	6.57E+04	0.0	0.0	0.0	1.28E+04
38 SR 91	7.65E+01	0.0	3.04E+00	0.0	0.0	0.0	3.47E+02
38 SR 92	3.62E-01	0.0	1.55E-02	0.0	0.0	0.0	9.23E+00
39 Y 90	4.82E-01	0.0	1.30E-02	0.0	0.0	0.0	3.98E+03
39 Y 91M	4.25E-11	0.0	1.63E-12	0.0	0.0	0.0	2.01E-09
39 Y 91	9.06E+00	0.0	2.43E-01	0.0	0.0	0.0	3.71E+03
39 Y 92	5.11E-04	0.0	1.48E-05	0.0	0.0	0.0	1.40E+01
39 Y 93	3.35E-02	0.0	9.20E-04	0.0	0.0	0.0	1.02E+03
40 ZR 95	2.46E-01	7.75E-02	5.33E-02	0.0	1.14E-01	0.0	1.79E+02
40 ZR 97	5.34E-03	1.06E-03	4.86E-04	0.0	1.60E-03	0.0	2.86E+02
41 NB 95	4.41E+02	2.45E+02	1.35E+02	0.0	2.37E+02	0.0	1.05E+06
42 MO 99	0.0	8.55E+01	1.63E+01	0.0	1.96E+02	0.0	1.53E+02
43 TC 99M	5.73E-04	1.60E-03	2.07E-02	0.0	2.38E-02	8.87E-04	1.05E+00
43 TC 101	1.12E-21	1.59E-21	1.56E-20	0.0	2.88E-20	9.70E-22	2.72E-28
44 RU 103	4.57E+00	0.0	1.95E+00	0.0	1.61E+01	0.0	3.82E+02
44 RU 105	9.37E-03	0.0	3.64E-03	0.0	1.18E-01	0.0	7.57E+00
44 RU 106	7.14E+01	0.0	9.00E+00	0.0	1.38E+02	0.0	3.42E+03
47 AG 110M	8.59E-01	8.13E-01	4.94E-01	0.0	1.55E+00	0.0	2.28E+02
52 TE 125M	2.76E+03	9.95E+02	3.69E+02	7.71E+02	0.0	0.0	8.15E+03
52 TE 127M	7.01E+03	2.49E+03	8.34E+02	1.67E+03	2.84E+04	0.0	1.75E+04
52 TE 127	1.94E+01	6.89E+00	4.18E+00	1.34E+01	7.88E+01	0.0	1.50E+03
52 TE 129M	1.16E+04	4.32E+03	1.84E+03	3.76E+03	4.87E+04	0.0	4.37E+04
52 TE 129	1.95E-05	7.27E-06	4.74E-06	1.39E-05	8.18E-05	0.0	1.07E-04
52 TE 131M	1.02E+03	4.90E+02	4.09E+02	7.37E+02	5.11E+03	0.0	3.93E+04
52 TE 131	3.64E-13	1.50E-13	1.14E-13	2.81E-13	1.59E-12	0.0	2.99E-14
52 TE 132	2.06E+03	1.30E+03	1.23E+03	1.37E+03	1.25E+04	0.0	4.13E+04
53 I 130	7.32E+00	2.12E+01	8.46E+00	1.73E+03	3.26E+01	0.0	1.63E+01
53 I 131	1.47E+02	2.06E+02	1.10E+02	6.00E+04	3.54E+02	0.0	4.07E+01
53 I 132	5.56E-03	1.46E-02	5.23E-03	4.91E-01	2.29E-02	0.0	6.34E-03
53 I 133	2.47E+01	4.20E+01	1.28E+01	5.86E+03	7.36E+01	0.0	3.18E+01
53 I 135	1.34E+00	3.45E+00	1.28E+00	2.22E+02	5.45E+00	0.0	3.82E+00
55 CS 134	1.53E+06	3.59E+06	1.67E+06	0.0	1.14E+06	4.36E+05	4.46E+04
55 CS 136	1.49E+05	5.85E+05	3.93E+05	0.0	3.18E+05	5.02E+04	4.71E+04
55 CS 137	2.04E+06	2.72E+06	9.47E+05	0.0	9.25E+05	3.59E+05	3.87E+04
55 CS 138	1.39E-10	2.67E-10	1.33E-10	0.0	1.97E-10	2.29E-11	1.21E-13
56 BA 139	7.57E-06	5.33E-09	2.21E-07	0.0	5.02E-09	3.67E-09	6.75E-05
56 BA 140	1.96E+02	2.41E-01	1.27E+01	0.0	8.16E-02	1.62E-01	3.03E+02
56 BA 141	5.42E-16	4.05E-19	1.81E-17	0.0	3.76E-19	2.77E-19	1.15E-21
56 BA 142	9.50E-25	9.50E-28	5.85E-26	0.0	8.04E-28	6.32E-28	2.92E-36
57 LA 140	1.05E-01	5.16E-02	1.37E-02	0.0	0.0	0.0	2.96E+03
57 LA 142	1.71E-07	7.60E-08	1.89E-08	0.0	0.0	0.0	2.31E-03
58 CE 141	2.38E-02	1.59E-02	1.83E-03	0.0	7.49E-03	0.0	4.55E+01
58 CE 143	2.61E-03	1.90E+00	2.12E-04	0.0	8.50E-04	0.0	5.70E+01
58 CE 144	1.27E+00	5.26E-01	6.83E-02	0.0	3.14E-01	0.0	3.19E+02
59 PR 143	5.68E-01	2.27E-01	2.83E-02	0.0	1.32E-01	0.0	1.87E+03
59 PR 144	7.02E-20	2.87E-20	3.56E-21	0.0	1.65E-20	0.0	7.74E-23
60 ND 147	4.02E-01	4.37E-01	2.62E-02	0.0	2.57E-01	0.0	1.58E+03
74 W 187	1.59E+02	1.30E+02	4.55E+01	0.0	0.0	0.0	3.52E+04
93 NP 239	2.39E-02	2.26E-03	1.25E-03	0.0	7.09E-03	0.0	3.63E+02

Oconee Nuclear Station
Liquid Effluent Dose - Teen Parameters
A_{aoi} mrem/hr per µCi/ml

From Generic Section 3.1.1:

A_{aoi} = the site related ingestion dose commitment factor for an individual of age group, "a", to organ, "o", for each identified principal gamma and beta emitter, "i", in mrem/hr per µCi/ml

A_{aoi} = $1.14E+05\ (U_{aw}\sigma_w/Dw\ \exp(-\lambda_i t_w) + U_{af}\sigma_f BF_i \exp(-\lambda_i t_f))\ DF_{aoi}$

where:
1.14E+05 = 10^6 pCi/µCi x 10^3 ml/kg ÷ 8760 hr/yr

U_{aw} = Water consumption by age group, l/yr

infant	330
child	510
teen	510
adult	730

σ_w, σ_f = Recirculation factors at equilibrium for the water and fish pathways respectively; these factors account for the fraction of discharged water reused by the station
$\sigma_w = 1.00$ $\sigma_f = 1.00$

D_w = Dilution factor from the near field area to the potable water intake = 10000 (essentially no drinking water pathway)

U_{af} = Fish consumption by age group, kg/yr

infant	---
child	6.9
teen	16
adult	21

BF_i = Bioaccumulation factor for radionuclide, "i", in fish, pCi/kg per pCi/l, from Table 3.1-1

DF_{aoi} = Dose conversion factor for age group, "a", in organ, "o", for radionuclide, "i", in mrem/pCi, from Tables 3.1-2, 3.1-3, 3.1-4, and 3.1-5, respectively

λ_i = radiological decay constant for isotope, i, in 1/hr

t_w, t_f = transport time for the drinking water and fish pathways, hr
t_w = 12 hours t_f = 24 hours

Sample Calculation for Teen, I-131, Thyroid:
A(t,thy,I-131) = 1.14E5 (510*1.0/1.0E4*exp(-3.59E-3*12) + 16*1.0*15* exp(-3.59E-3*24)) 2.39E-3 = 6.00E4 mr/hr per µCi/ml

TABLE A4.0-5
(1 OF 2)

OCONEE NUCLEAR STATION
LIQUID EFFLUENT DOSE - CHILD PARAMETERS
A(I) MREM/HR PER UCI/ML

RADIONUCLIDE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
1 H 3	0.0	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01
11 NA 24	1.51E+02	1.51E+02	1.51E+02	1.51E+02	1.51E+02	1.51E+02	1.51E+02
24 CR 51	0.0	0.0	1.37E+00	7.58E-01	2.07E-01	1.38E+00	7.24E+01
25 MN 54	0.0	3.36E+03	8.95E+02	0.0	9.42E+02	0.0	2.82E+03
25 MN 56	0.0	1.61E-01	3.64E-02	0.0	1.95E-01	0.0	2.34E+01
26 FE 55	9.04E+02	4.80E+02	1.49E+02	0.0	0.0	2.71E+02	8.88E+01
26 FE 59	1.28E+03	2.07E+03	1.03E+03	0.0	0.0	5.99E+02	2.15E+03
27 CO 58	0.0	7.01E+01	2.15E+02	0.0	0.0	0.0	4.09E+02
27 CO 60	0.0	2.08E+02	6.13E+02	0.0	0.0	0.0	1.15E+03
28 NI 63	4.23E+04	2.27E+03	1.44E+03	0.0	0.0	0.0	1.53E+02
28 NI 65	2.38E-01	2.24E-02	1.31E-02	0.0	0.0	0.0	2.74E+00
29 CU 64	0.0	2.59E+00	1.57E+00	0.0	6.26E+00	0.0	1.22E+02
30 ZN 65	2.15E+04	5.73E+04	3.56E+04	0.0	3.61E+04	0.0	1.01E+04
30 ZN 69	1.70E-06	2.46E-06	2.27E-07	0.0	1.49E-06	0.0	1.55E-04
35 BR 83	0.0	0.0	5.39E-02	0.0	0.0	0.0	0.0
35 BR 85	0.0	0.0	0.0	0.0	0.0	0.0	0.0
37 RB 86	0.0	1.02E+05	6.25E+04	0.0	0.0	0.0	6.53E+03
37 RB 88	0.0	8.03E-16	5.58E-16	0.0	0.0	0.0	3.94E-17
37 RB 89	0.0	4.27E-18	3.79E-18	0.0	0.0	0.0	3.72E-20
38 SR 89	3.07E+04	0.0	8.78E+02	0.0	0.0	0.0	1.19E+03
38 SR 90	2.67E+05	0.0	7.15E+04	0.0	0.0	0.0	5.40E+03
38 SR 91	9.81E+01	0.0	3.70E+00	0.0	0.0	0.0	2.17E+02
38 SR 92	4.64E-01	0.0	1.86E-02	0.0	0.0	0.0	8.79E+00
39 Y 90	6.24E-01	0.0	1.67E-02	0.0	0.0	0.0	1.78E+03
39 Y 91M	1.08E-10	0.0	3.93E-12	0.0	0.0	0.0	2.11E-07
39 Y 91	1.17E+01	0.0	3.13E-01	0.0	0.0	0.0	1.56E+03
39 Y 92	6.57E-04	0.0	1.88E-05	0.0	0.0	0.0	1.90E+01
39 Y 93	4.31E-02	0.0	1.18E-03	0.0	0.0	0.0	6.42E+02
40 ZR 95	2.99E-01	6.56E-02	5.84E-02	0.0	9.39E-02	0.0	6.85E+01
40 ZR 97	6.80E-03	9.83E-04	5.80E-04	0.0	1.41E-03	0.0	1.49E+02
41 NB 95	5.21E+02	2.03E+02	1.45E+02	0.0	1.90E+02	0.0	3.75E+05
42 MO 99	0.0	8.14E+01	2.01E+01	0.0	1.74E+02	0.0	6.73E+01
43 TC 99M	6.87E-04	1.35E-03	2.23E-02	0.0	1.96E-02	6.84E-04	7.67E-01
43 TC 101	3.33E-21	3.48E-21	4.41E-20	0.0	5.94E-20	1.84E-21	1.11E-20
44 RU 103	5.65E+00	0.0	2.17E+00	0.0	1.42E+01	0.0	1.46E+02
44 RU 105	1.20E-02	0.0	4.35E-03	0.0	1.05E-01	0.0	7.83E+00
44 RU 106	9.19E+01	0.0	1.15E+01	0.0	1.24E+02	0.0	1.43E+03
47 AG 110M	9.76E-01	6.59E-01	5.27E-01	0.0	1.23E+00	0.0	7.84E+01
52 TE 125M	3.54E+03	9.61E+02	4.73E+02	9.95E+02	0.0	0.0	3.42E+03
52 TE 127M	9.04E+03	2.43E+03	1.07E+03	2.16E+03	2.58E+04	0.0	7.32E+03
52 TE 127	2.50E+01	6.74E+00	5.36E+00	1.73E+01	7.11E+01	0.0	9.77E+02
52 TE 129M	1.50E+04	4.19E+03	2.33E+03	4.84E+03	4.41E+04	0.0	1.83E+04
52 TE 129	2.55E-05	7.12E-06	6.05E-06	1.82E-05	7.46E-05	0.0	1.59E-03
52 TE 131M	1.30E+03	4.50E+02	4.79E+02	9.25E+02	4.35E+03	0.0	1.82E+04
52 TE 131	1.08E-12	3.30E-13	3.22E-13	8.28E-13	3.27E-12	0.0	5.69E-12
52 TE 132	2.57E+03	1.14E+03	1.37E+03	1.66E+03	1.06E+04	0.0	1.14E+04
53 I 130	8.96E+00	1.81E+01	9.33E+00	1.99E+03	2.71E+01	0.0	8.47E+00
53 I 131	1.86E+02	1.87E+02	1.06E+02	6.19E+04	3.08E+02	0.0	1.67E+01
53 I 132	6.95E-03	1.28E-02	5.87E-03	5.93E-01	1.96E-02	0.0	1.50E-02
53 I 133	3.14E+01	3.89E+01	1.47E+01	7.22E+03	6.48E+01	0.0	1.57E+01
53 I 135	1.66E+00	2.99E+00	1.41E+00	2.65E+02	4.58E+00	0.0	2.28E+00
55 CS 134	1.84E+06	3.02E+06	6.37E+05	0.0	9.35E+05	3.36E+05	1.63E+04
55 CS 136	1.75E+05	4.82E+05	3.12E+05	0.0	2.57E+05	3.83E+04	1.69E+04
55 CS 137	2.57E+06	2.46E+06	3.63E+05	0.0	8.02E+05	2.89E+05	1.54E+04
55 CS 138	3.21E-10	4.46E-10	2.83E-10	0.0	3.14E-10	3.38E-11	2.05E-10
56 BA 139	1.30E-05	6.92E-09	3.76E-07	0.0	6.04E-09	4.07E-09	7.48E-04
56 BA 140	2.48E+02	2.17E-01	1.45E+01	0.0	7.08E-02	1.30E-01	1.26E+02
56 BA 141	1.62E-15	9.05E-19	5.26E-17	0.0	7.83E-19	5.31E-18	9.21E-16
56 BA 142	2.78E-24	2.00E-27	1.55E-25	0.0	1.62E-27	1.18E-27	3.62E-26
57 LA 140	1.31E-01	4.59E-02	1.55E-02	0.0	0.0	0.0	1.28E+03
57 LA 142	2.24E-07	7.14E-08	2.24E-08	0.0	0.0	0.0	1.41E-02
58 CE 141	3.08E-02	1.54E-02	2.28E-03	0.0	6.73E-03	0.0	1.92E+01
58 CE 143	3.36E-03	1.82E+00	2.64E-04	0.0	7.64E-04	0.0	2.67E+01
58 CE 144	1.64E+00	5.15E-01	8.77E-02	0.0	2.85E-01	0.0	1.34E+02
59 PR 143	7.35E-01	2.21E-01	3.65E-02	0.0	1.19E-01	0.0	7.93E+02
59 PR 144	2.11E-19	6.52E-20	1.06E-20	0.0	3.45E-20	0.0	1.40E-16
60 ND 147	5.16E-01	4.18E-01	3.23E-02	0.0	2.29E-01	0.0	6.62E+02
74 W 187	2.02E+02	1.20E+02	5.37E+01	0.0	0.0	0.0	1.68E+04
93 NP 239	3.08E-02	2.21E-03	1.56E-03	0.0	6.40E-03	0.0	1.64E+02

Oconee Nuclear Station
Liquid Effluent Dose - Child Parameters
A_{aoi} mrem/hr per µCi/ml

From Generic Section 3.1.1:

A_{aoi} = the site related ingestion dose commitment factor for an individual of age group, "a", to organ, "o", for each identified principal gamma and beta emitter, "i", in mrem/hr per µCi/ml

A_{aoi} = $1.14E{+}05\ (U_{aw}\sigma_w/Dw\ \exp(-\lambda_i t_w) + U_{af}\sigma_f BF_i \exp(-\lambda_i t_f))\ DF_{aoi}$

where:
1.14E+05 = 10^6 pCi/µCi x 10^3 ml/kg ÷ 8760 hr/yr

U_{aw} = Water consumption by age group, l/yr

infant	330
child	510
teen	510
adult	730

σ_w, σ_f = Recirculation factors at equilibrium for the water and fish pathways respectively; these factors account for the fraction of discharged water reused by the station
σ_w = 1.00 σ_f = 1.00

D_w = Dilution factor from the near field area to the potable water intake = 10000 (essentially no drinking water pathway)

U_{af} = Fish consumption by age group, kg/yr

infant	---
child	6.9
teen	16
adult	21

BF_i = Bioaccumulation factor for radionuclide, "i", in fish, pCi/kg per pCi/l, from Table 3.1-1

DF_{aoi} = Dose conversion factor for age group, "a", in organ, "o", for radionuclide, "i", in mrem/pCi, from Tables 3.1-2, 3.1-3, 3.1-4, and 3.1-5, respectively

λ_i = radiological decay constant for isotope, i, in 1/hr

t_w, t_f = transport time for the drinking water and fish pathways, hr
t_w = 12 hours t_f = 24 hours

Sample Calculation for Child, I-131, Thyroid:
A(c,thy,I-131) = 1.14E5 (510*1.0/1.0E4*exp(-3.59E-3*12)+ 6.9*1.0*15* exp(-3.59E-3*24)) 5.72E-3 = 6.19E4 mr/hr per µCi/ml

OCONEE NUCLEAR STATION
LIQUID EFFLUENT DOSE - INFANT PARAMETERS
A(I) MREM/HR PER UCI/ML

RADIONUCLIDE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
1 H 3	0.0	1.16E-03	1.16E-03	1.16E-03	1.16E-03	1.16E-03	1.16E-03
11 NA 24	2.19E-02	2.19E-02	2.19E-02	2.19E-02	2.19E-02	2.19E-02	2.19E-02
24 CR 51	0.0	0.0	5.24E-05	3.42E-05	7.47E-06	6.65E-05	1.53E-03
25 MN 54	0.0	7.48E-02	1.69E-02	0.0	1.66E-02	0.0	2.75E-02
25 MN 56	0.0	1.21E-04	2.08E-05	0.0	1.04E-04	0.0	1.09E-02
26 FE 55	5.23E-02	3.38E-02	9.03E-03	0.0	0.0	1.65E-02	4.29E-03
26 FE 59	1.15E-01	2.01E-01	7.91E-02	0.0	0.0	5.94E-02	9.59E-02
27 CO 58	0.0	1.35E-02	3.36E-02	0.0	0.0	0.0	3.36E-02
27 CO 60	0.0	4.06E-02	9.59E-02	0.0	0.0	0.0	9.67E-02
28 NI 63	2.39E+00	1.47E-01	8.28E-02	0.0	0.0	0.0	7.34E-03
28 NI 65	6.52E-04	7.38E-05	3.36E-05	0.0	0.0	0.0	5.62E-03
29 CU 64	0.0	1.19E-03	5.50E-04	0.0	2.01E-03	0.0	2.44E-02
30 ZN 65	6.91E-02	2.37E-01	1.09E-01	0.0	1.15E-01	0.0	2.00E-01
30 ZN 69	5.45E-08	9.82E-08	7.31E-09	0.0	4.08E-08	0.0	8.01E-06
35 BR 83	0.0	0.0	4.22E-05	0.0	0.0	0.0	0.0
35 BR 85	0.0	0.0	0.0	0.0	0.0	0.0	0.0
37 RB 86	0.0	6.28E-01	3.10E-01	0.0	0.0	0.0	1.61E-02
37 RB 88	0.0	1.36E-15	7.46E-16	0.0	0.0	0.0	1.33E-15
37 RB 89	0.0	6.75E-18	4.65E-18	0.0	0.0	0.0	2.30E-18
38 SR 89	9.38E+00	0.0	2.69E-01	0.0	0.0	0.0	1.93E-01
38 SR 90	4.70E+01	0.0	1.27E+01	0.0	0.0	0.0	8.69E-01
38 SR 91	7.83E-02	0.0	2.83E-03	0.0	0.0	0.0	9.27E-02
38 SR 92	3.36E-03	0.0	1.25E-04	0.0	0.0	0.0	3.63E-02
39 Y 90	2.87E-04	0.0	7.70E-06	0.0	0.0	0.0	3.97E-01
39 Y 91M	1.30E-10	0.0	4.41E-12	0.0	0.0	0.0	4.32E-07
39 Y 91	4.23E-03	0.0	1.13E-04	0.0	0.0	0.0	3.03E-01
39 Y 92	2.77E-06	0.0	7.78E-08	0.0	0.0	0.0	5.28E-02
39 Y 93	4.01E-05	0.0	1.09E-06	0.0	0.0	0.0	3.17E-01
40 ZR 95	7.71E-04	1.88E-04	1.33E-04	0.0	2.02E-04	0.0	9.35E-02
40 ZR 97	3.40E-05	5.84E-06	2.67E-06	0.0	5.89E-06	0.0	3.72E-01
41 NB 95	1.56E-04	6.44E-05	3.73E-05	0.0	4.62E-05	0.0	5.44E-02
42 MO 99	0.0	1.13E-01	2.20E-02	0.0	1.68E-01	0.0	3.71E-02
43 TC 99M	1.81E-06	3.74E-06	4.82E-05	0.0	4.02E-05	1.95E-06	1.09E-03
43 TC 101	4.57E-21	5.75E-21	5.69E-20	0.0	6.84E-20	3.14E-21	9.78E-19
44 RU 103	5.52E-03	0.0	1.85E-03	0.0	1.15E-02	0.0	6.71E-02
44 RU 105	7.85E-05	0.0	2.64E-05	0.0	5.77E-04	0.0	3.12E-02
44 RU 106	9.06E-02	0.0	1.13E-02	0.0	1.07E-01	0.0	6.88E-01
47 AG 110M	3.74E-03	2.73E-03	1.81E-03	0.0	3.91E-03	0.0	1.42E-01
52 TE 125M	8.71E-02	2.91E-02	1.18E-02	2.93E-02	0.0	0.0	4.15E-02
52 TE 127M	2.19E-01	7.28E-02	2.66E-02	6.34E-02	5.40E-01	0.0	8.85E-02
52 TE 127	1.55E-03	5.18E-04	3.32E-04	1.26E-03	3.77E-03	0.0	3.24E-02
52 TE 129M	3.72E-01	1.28E-01	5.73E-02	1.43E-01	9.31E-01	0.0	2.22E-01
52 TE 129	8.21E-07	2.83E-07	1.92E-07	6.88E-07	2.04E-06	0.0	6.56E-05
52 TE 131M	4.33E-02	1.74E-02	1.44E-02	3.54E-02	1.20E-01	0.0	2.94E-01
52 TE 131	1.49E-12	5.49E-13	4.17E-13	1.33E-12	3.80E-12	0.0	6.00E-11
52 TE 132	7.04E-02	3.48E-02	3.25E-02	5.14E-02	2.18E-01	0.0	1.29E-01
53 I 130	1.15E-02	2.53E-02	1.02E-02	2.84E+00	2.78E-02	0.0	5.43E-03
53 I 131	1.29E-01	1.52E-01	6.70E-02	5.01E+01	1.78E-01	0.0	5.44E-03
53 I 132	1.68E-04	3.41E-04	1.21E-04	1.60E-02	3.80E-04	0.0	2.76E-04
53 I 133	3.15E-02	4.59E-02	1.34E-02	8.35E+00	5.40E-02	0.0	7.77E-03
53 I 135	3.88E-03	7.71E-03	2.81E-03	6.92E-01	8.60E-03	0.0	2.79E-03
55 CS 134	1.42E+00	2.64E+00	2.67E-01	0.0	6.81E-01	2.79E-01	7.18E-03
55 CS 136	1.68E-01	4.95E-01	1.85E-01	0.0	1.97E-01	4.03E-02	7.51E-03
55 CS 137	1.96E+00	2.30E+00	1.63E-01	0.0	6.17E-01	2.50E-01	7.19E-03
55 CS 138	3.47E-10	5.65E-10	2.74E-10	0.0	2.82E-10	4.40E-11	9.03E-10
56 BA 139	7.83E-06	5.19E-09	2.27E-07	0.0	3.12E-09	3.15E-09	4.96E-04
56 BA 140	6.26E-01	6.26E-04	3.23E-02	0.0	1.49E-04	3.84E-04	1.54E-01
56 BA 141	2.22E-15	1.52E-18	7.00E-17	0.0	9.14E-19	9.25E-19	2.71E-14
56 BA 142	3.78E-24	3.15E-27	1.86E-25	0.0	1.81E-27	1.90E-27	1.56E-23
57 LA 140	6.46E-05	2.55E-05	6.55E-06	0.0	0.0	0.0	2.99E-01
57 LA 142	1.87E-08	6.86E-09	1.64E-09	0.0	0.0	0.0	1.17E-03
58 CE 141	2.93E-04	1.79E-04	2.10E-05	0.0	5.51E-05	0.0	9.23E-02
58 CE 143	4.33E-05	2.87E-02	3.28E-06	0.0	8.37E-06	0.0	1.68E-01
58 CE 144	1.12E-02	4.58E-03	6.27E-04	0.0	1.85E-03	0.0	6.43E-01
59 PR 143	2.98E-04	1.11E-04	1.48E-05	0.0	4.14E-05	0.0	1.57E-01
59 PR 144	2.90E-19	1.12E-19	1.46E-20	0.0	4.06E-20	0.0	5.21E-15
60 ND 147	2.02E-04	2.07E-04	1.27E-05	0.0	7.99E-05	0.0	1.31E-01
74 W 187	2.40E-03	1.67E-03	5.77E-04	0 0	0.0	0.0	9.80E-02
93 NP 239	3.61E-05	3.23E-06	1.82E-06	0.0	6.43E-06	0.0	9.32E-02

Oconee Nuclear Station
Liquid Effluent Dose – Infant Parameters
A_{aoi} mrem/hr per µCi/ml

From Generic Section 3.1.1:

A_{aoi} = the site related ingestion dose commitment factor for an individual of age group, "a", to organ, "o", for each identified principal gamma and beta emitter, "i", in mrem/hr per µCi/ml

A_{aoi} = $1.14E+05\ (U_{aw}\sigma_w/Dw\ \exp(-\lambda_i t_w) + U_{af}\sigma_f BF_i \exp(-\lambda_i t_f))\ DF_{aoi}$

where:
1.14E+05 = 10^6 pCi/µCi x 10^3 ml/kg ÷ 8760 hr/yr

U_{aw} = Water consumption by age group, l/yr

infant	330
child	510
teen	510
adult	730

σ_w, σ_f = Recirculation factors at equilibrium for the water and fish pathways respectively; these factors account for the fraction of discharged water reused by the station
$\sigma_w = 1.00$ $\sigma_f = 1.00$

D_w = Dilution factor from the near field area to the potable water intake = 10000 (essentially no drinking water pathway)

U_{af} = Fish consumption by age group, kg/yr

infant	---
child	6.9
teen	16
adult	21

BF_i = Bioaccumulation factor for radionuclide, "i", in fish, pCi/kg per pCi/l, from Table 3.1-1

DF_{aoi} = Dose conversion factor for age group, "a", in organ, "o", for radionuclide, "i", in mrem/pCi, from Tables 3.1-2, 3.1-3, 3.1-4, and 3.1-5, respectively

λ_i = radiological decay constant for isotope, i, in 1/hr

t_w, t_f = transport time for the drinking water and fish pathways, hr
t_w = 12 hours t_f = 24 hours

Sample Calculation for Infant, I-131, Thyroid:
A(i,thy,I-131) = 1.14E5 (330*1.0/1.0E4*exp(-3.59E-3*12)+ 0*1.0*15* exp(-3.59E-3*24)) 1.39E-2 = 5.01E1 mr/hr per µCi/ml

Table A4.0-7 - Meteorological Parameter and Applicable Pathways Potential Worst-Case Offsite Locations for Analyzing Offsite Doses from Particulate, Iodine and Other Radionuclides

Semi-Elevated Release Worst-Case Locations*

		(X/Q) sec/m^3	(D/Q) 1/m^2
(1)	Inhalation, 1.0 mi, SW	1.672E-6	1.205E-8
(2)	Garden, 1.0 mi, NE	9.503E-7	1.295E-8
(3)	Meat Animal, 1.5 mi, SW	7.285E-7	4.399E-9
(4)	Milk Animal, 4.5 mi, WNW	4.796E-8	1.868E-10
(5)	Combination, 1.0 mi, SW	1.672E-6	1.205E-8

Ground Level Release Worst-Case Locations*

		(X/Q) sec/m^3	(D/Q) 1/m^2
(1)	Inhalation, 1.0 mi, SE	7.308E-6	1.401E-8
(2)	Garden, 1.0 mi, NE	3.886E-6	2.259E-8
(3)	Meat Animal, 1.5 mi, SW	1.620E-6	6.169E-9
(4)	Milk Animal, 4.5 mi, WNW	9.502E-8	1.643E-10
(5)	Combination, 1.0 mi, SW	4.108E-6	1.717E-8

* The Ground Plane, Inhalation, and Vegetable pathways are assumed to exist in each sector for dose calculation purposes. All pathways are assumed to exist at the 5.0-mile boundary in each sector for dose calculation purposes.

TABLE A4.0-8

PATHWAY APPLICABILITY FOR ALL LOCATIONS BASED ON SITE SURVEY*

OCONEE NUCLEAR STATION
(1 of 1)

Distance to the control location in miles

SECTOR	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	X	X	VI	VI	VI	VI	VI	VI	VI	VIMG
NNE	X	X	VI	VI	VI	VI	VIM	VIM	VIM	VIMG
NE	X	X	VI	VI	VI	VI	VIM	VIM	VIM	VIMG
ENE	X	X	VI	VI	VI	VIM	VIM	VIM	VIM	VIMG
E	X	X	VI	VI	VIM	VIM	VIM	VIM	VIM	VIMG
ESE	X	X	VI	VI	VIM	VIM	VIM	VIM	VIM	VIMG
SE	X	X	VI	VI	VI	VI	VI	VI	VIM	VIMG
SSE	X	X	VI	VI	VI	VI	VI	VI	VI	VIMG
S	X	X	VI	VI	VI	VI	VI	VI	VI	VIMG
SSW	X	X	VI	VI	VI	VI	VI	VI	VI	VIMG
SW	X	X	VI	VIM	VIM	VIM	VIM	VIM	VIM	VIMG
WSW	X	X	VI	VI	VI	VI	VI	VI	VI	VIMG
W	X	X	VI	VI	VI	VI	VI	VI	VI	VIMG
WNW	X	X	VI	VI	VIM	VIM	VIM	VIM	VIM	VIMG
NW	X	X	VI	VI	VI	VI	VI	VI	VI	VIMG
NNW	X	X	VI	VI	VI	VI	VI	VI	VI	VIMG

PATHWAYS: X - None V - VEGETABLE M - MEAT G - GOAT MILK C - COW MILK I - INHALATION

* The Vegetable and Inhalation pathways are assumed to exist in each sector for dose calculation purposes. All pathways are assumed to exist at the 5.0-mile boundary in each sector for dose calculation purposes.

FIGURE A4.0-1
(1 of 2)

OCONEE LADTAP INPUT TEMPLATE
FOR LIQUID RADIONUCLIDE RELEASE OFFSITE DOSE CALCULATIONS

```
****** ***************************** TOP OF DATA ******************************
Column ----+----1----+----2----+----3----+----4----+----5----+----6----+----7--
000001   LADTAP INPUT FOR OCONEE ODCM METHOD - DEFAULT DILUTION
000002          0   6.4E+02      1.0        1          2
000003 '   CESIUM BIOACCUMULATION FACTOR ALTERED FROM 2000 TO 10000'
000004 13**  A55 10000  E  T
000005        1.0
000006   LIQUID RELEASE SOURCE TERMS - CURIES PER RELEASE PERIOD
000007   H 3        0.00E+00
000008   NA24       0.00E+00
000009   CR51       0.00E+00
000010   MN54       0.00E+00
000011   MN56       0.00E+00
000012   FE55       0.00E+00
000013   FE59       0.00E+00
000014   CO58       0.00E+00
000015   CO60       0.00E+00
000016   NI63       0.00E+00
000017   NI65       0.00E+00
000018   CU64       0.00E+00
000019   ZN65       0.00E+00
000020   CN69       0.00E+00
000021   BR83       0.00E+00
000022   BR85       0.00E+00
000023   RB86       0.00E+00
000024   RB88       0.00E+00
000025   RB89       0.00E+00
000026   SR89       0.00E+00
000027   SR90       0.00E+00
000028   SR91       0.00E+00
000029   SR92       0.00E+00
000030   Y 90       0.00E+00
000031   Y 91 M     0.00E+00
000032   Y 91       0.00E+00
000033   Y 92       0.00E+00
000034   Y 93       0.00E+00
000035   ZR95       0.00E+00
000036   ZR97       0.00E+00
000037   NB95       0.00E+00
000038   MO99       0.00E+00
000039   TC99 M     0.00E+00
000040   TC101      0.00E+00
000041   RU103      0.00E+00
000042   RU105      0.00E+00
000043   RU106      0.00E+00
000044   AG110M     0.00E+00
000045   TE125M     0.00E+00
000046   TE127M     0.00E+00
000047   TE127      0.00E+00
000048   TE129M     0.00E+00
000049   TE129      0.00E+00
000050   TE131M     0.00E+00
000051   TE131      0.00E+00
000052   TE132      0.00E+00
```

OCONEE LADTAP INPUT TEMPLATE
FOR LIQUID RADIONUCLIDE RELEASE OFFSITE DOSE CALCULATIONS

```
Column ----+----1----+----2----+----3----+----4----+----5----+----6----+----7--
  I 130      0.00E+00
  I 131      0.00E+00
  I 132      0.00E+00
  I 133      0.00E+00
  I 135      0.00E+00
  CS134      0.00E+00
  CS136      0.00E+00
  CS137      0.00E+00
  CS138      0.00E+00
  BA139      0.00E+00
  BA140      0.00E+00
  BA141      0.00E+00
  BA142      0.00E+00
  LA140      0.00E+00
  LA142      0.00E+00
  CE141      0.00E+00
  CE143      0.00E+00
  CE144      0.00E+00
  PR143      0.00E+00
  PR144      0.00E+00
  ND147      0.00E+00
  W 187      0.00E+00
  NP239      0.00E+00
                  0.2       1.0       1.0    10000.       0.0       0.0
****** ***************************** BOTTOM OF DATA ***************************
```

FIGURE A4.0-2

OCONEE GASPAR INPUT TEMPLATE

FOR NOBLE GAS RADIONUCLIDE RELEASE WORST-CASE LOCATIONS

```
****** ***************************** TOP OF DATA ******************************
=COLS> ----+----1----+----2----+----3----+----4----+----5----+----6----+----7--
GASPAR INPUT FOR OCONEE ODCM METHOD - MAX NOBLE GAS DOSE CALCULATIONS
 0          1.0        0.0        0.0        0.0
 1 1
     1.0     1.0     1.0    0.76     1.0
SEMI-ELEVATED NOBLE GAS RELEASE SOURCE TERM - CURIES PER RELEASE PERIOD
       1.0
  AR41       0.00E+00
  KR83 M     0.00E+00
  KR85       0.00E+00
  KR85 M     0.00E+00
  KR87       0.00E+00
  KR88       0.00E+00
  KR89       0.00E+00
  XE131M     0.00E+00
  XE133      0.00E+00
  XE133M     0.00E+00
  XE135      0.00E+00
  XE135M     0.00E+00
  XE137      0.00E+00
  XE138      0.00E+00

  SEMI-ELEV MAX      SW 1.0     1.672E-06 1.672E-06 1.672E-06 1.205E-08

GROUND LEVEL NOBLE GAS RELEASE SOURCE TERM - CURIES PER RELEASE PERIOD
       1.0
  AR41       0.00E+00
  KR83 M     0.00E+00
  KR85       0.00E+00
  KR85 M     0.00E+00
  KR87       0.00E+00
  KR88       0.00E+00
  KR89       0.00E+00
  XE131M     0.00E+00
  XE133      0.00E+00
  XE133M     0.00E+00
  XE135      0.00E+00
  XE135M     0.00E+00
  XE137      0.00E+00
  XE138      0.00E+00

  GROUND MAX         SE 1.0     7.308E-06 7.308E-06 7.308E-06 1.401E-08

****** **************************** BOTTOM OF DATA ****************************
```

FIGURE A4.0-3

OCONEE GASPAR INPUT TEMPLATE

FOR PARTICULATE, IODINE AND OTHER RADIONUCLIDE RELEASE WORST-CASE LOCATIONS

```
****** ****************************** TOP OF DATA ******************************
=COLS> ----+----1----+----2----+----3----+----4----+----5----+----6----+----7--
GASPAR INPUT FOR OCONEE ODCM METHOD - PART, I, AND OTHER - INHALATION
 0          1.0        0.0        0.0        0.0
 1 1
      1.0      1.0      1.0    0.76     1.0
ELEV RELEASE PART, I AND OTHER SOURCES - CURIES PER RELEASE PERIOD
      1.0
  H 3        0.00E+00
  CR51       0.00E+00
  MN54       0.00E+00
  FE55       0.00E+00
  FE59       0.00E+00
  CO58       0.00E+00
  CO60       0.00E+00
  ZN65       0.00E+00
  SR89       0.00E+00
  SR90       0.00E+00
  ZR95       0.00E+00
  MO99       0.00E+00
  I 131      0.00E+00
  I 133      0.00E+00
  CS134      0.00E+00
  CS136      0.00E+00
  CS137      0.00E+00
  BA140      0.00E+00
  CE141      0.00E+00
  CE144      0.00E+00

  LOCATION 1         SW 1.0    1.672E-06 1.672E-06 1.672E-06 1.205E-08

GROUND RELEASE PART, I AND OTHER SOURCES - CURIES PER RELEASE PERIOD
      1.0
  H 3        0.00E+00
  CR51       0.00E+00
  MN54       0.00E+00
  FE55       0.00E+00
  FE59       0.00E+00
  CO58       0.00E+00
  CO60       0.00E+00
  ZN65       0.00E+00
  SR89       0.00E+00
  SR90       0.00E+00
  ZR95       0.00E+00
  MO99       0.00E+00
  I 131      0.00E+00
  I 133      0.00E+00
  CS134      0.00E+00
  CS136      0.00E+00
  CS137      0.00E+00
  BA140      0.00E+00
  CE141      0.00E+00
  CE144      0.00E+00

  LOCATION 1         SE 1.0    7.308E-06 7.308E-06 7.308E-06 1.401E-08

****** ****************************** BOTTOM OF DATA ******************************
```

FIGURE A4.0-3 (Cont'd)

OCONEE GASPAR INPUT TEMPLATE

FOR PARTICULATE, IODINE AND OTHER RADIONUCLIDE RELEASE WORST-CASE LOCATIONS

FOR OTHER LOCATIONS, REPLACE FOLLOWING INPUT LINES:

LOCATION 2 - WORST VEGETABLE GARDEN

```
000001 GASPAR INPUT FOR OCONEE ODCM METHOD - PART, I, AND OTHER - GARDEN
000002  0          1.0         0.0         0.0         0.0
000028   LOCATION 2         NE 1.00    9.503E-07 9.503E-07 9.503E-07 1.295E-08
000053   LOCATION 2         NE 1.00    3.886E-06 3.886E-06 3.886E-06 2.259E-08
```

LOCATION 3 - WORST MEAT ANIMAL

```
000001 GASPAR INPUT FOR OCONEE ODCM METHOD - PART, I, AND OTHER - MEAT
000002  0          1.0         1.0         0.0         0.0
000028   LOCATION 3         SW 1.50    7.285E-07 7.285E-07 7.285E-07 4.399E-09
000053   LOCATION 3         SW 1.50    1.620E-06 1.620E-06 1.620E-06 6.169E-09
```

LOCATION 4 - WORST MILK ANIMAL

```
000001 GASPAR INPUT FOR OCONEE ODCM METHOD - PART, I, AND OTHER - MILK
000002  0          1.0         1.0         0.0         1.0
000028   LOCATION 4        WNW 4.50    4.796E-08 4.796E-08 4.796E-08 1.868E-10
000053   LOCATION 4        WNW 4.50    9.502E-08 9.502E-08 9.502E-08 1.643E-10
```

LOCATION 5 - WORST COMBINATION

```
000001 GASPAR INPUT FOR OCONEE ODCM METHOD - PART, I, AND OTHER - COMBINATION
000002  0          1.0         1.0         0.0         1.0
000028   LOCATION 5         SW 1.00    1.672E-06 1.672E-06 1.672E-06 1.205E-08
000053   LOCATION 5         SW 1.00    4.108E-06 4.108E-06 4.108E-06 1.717E-08
```

Figure A4.0-4 - Fuel Cycle Dose Calculation Worksheet For Organ Doses

Adult Age Group

Liquid Pathway Organ Doses $D_{a,o}(l_o)$

Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI

Airborne Pathway Organ Doses $D_{a,o}(g_e)$ and $D_{a,o}(g_g)$ - Particulate, Iodine and Other Radionuclides with T 1/2 > 8 Days

Location 1 - Worst-case Inhalation Location [1]

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
S-Elev							
Ground							
Total*							

Location 2 - Worst-Case Vegetable Garden Location [2]

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
S-Elev							
Ground							
Total*							

Location 3 - Worst-case Meat Animal Location [3]

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
S-Elev							
Ground							
Total*							

Locations 4 and 5 - Worst-case Milk/Combination Location [4]

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
S-Elev							
Ground							
Total*							

Adult Organ Maximums**

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
Total							

Figure A4.0-4 (Cont'd) - Fuel Cycle Dose Calculation Worksheet For Organ Doses

Teen Age Group

Liquid Pathway Organ Doses $D_{a,o}(l_o)$

Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI

Airborne Pathway Organ Doses $D_{a,o}(g_e)$ and $D_{a,o}(g_g)$ - Particulate, Iodine and Other Radionuclides with T 1/2 > 8 Days

Location 1 - Worst-case Inhalation Location [1]

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
S-Elev							
Ground							
Total*							

Location 2 - Worst-Case Vegetable Garden Location [2]

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
S-Elev							
Ground							
Total*							

Location 3 - Worst-case Meat Animal Location [3]

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
S-Elev							
Ground							
Total*							

Locations 4 and 5 - Worst-case Milk/Combination Location [4]

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
S-Elev							
Ground							
Total*							

Teen Organ Maximums**

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
Total							

Figure A4.0-4 (Cont'd) - Fuel Cycle Dose Calculation Worksheet For Organ Doses

Child Age Group

Liquid Pathway Organ Doses $D_{a,o}(l_o)$

Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
______	______	______	______	______	______	______

Airborne Pathway Organ Doses $D_{a,o}(g_e)$ and $D_{a,o}(g_g)$ - Particulate, Iodine and Other Radionuclides with T 1/2 > 8 Days

Location 1 - Worst-case Inhalation Location [1]

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
S-Elev	______	______	______	______	______	______	______
Ground	______	______	______	______	______	______	______
Total*	______	______	______	______	______	______	______

Location 2 - Worst-Case Vegetable Garden Location [2]

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
S-Elev	______	______	______	______	______	______	______
Ground	______	______	______	______	______	______	______
Total*	______	______	______	______	______	______	______

Location 3 - Worst-case Meat Animal Location [3]

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
S-Elev	______	______	______	______	______	______	______
Ground	______	______	______	______	______	______	______
Total*	______	______	______	______	______	______	______

Locations 4 and 5 - Worst-case Milk/Combination Location [4]

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
S-Elev	______	______	______	______	______	______	______
Ground	______	______	______	______	______	______	______
Total*	______	______	______	______	______	______	______

Child Organ Maximums**

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
Total	______	______	______	______	______	______	______

Figure A4.0-4 (Cont'd) - Fuel Cycle Dose Calculation Worksheet For Organ Doses

Infant Age Group

Liquid Pathway Organ Doses $D_{a,o}(l_o)$

Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI

Airborne Pathway Organ Doses $D_{a,o}(g_e)$ and $D_{a,o}(g_g)$ - Particulate, Iodine and Other Radionuclides with T 1/2 > 8 Days

Location 1 - Worst-case Inhalation Location [1]

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
S-Elev							
Ground							
Total*							

Location 2 - Worst-Case Vegetable Garden Location [2]

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
S-Elev							
Ground							
Total*							

Location 3 - Worst-case Meat Animal Location [3]

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
S-Elev							
Ground							
Total*							

Locations 4 and 5 - Worst-case Milk/Combination Location [4]

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
S-Elev							
Ground							
Total*							

Infant Organ Maximums**

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
Total							

Figure A4.0-4 - Fuel Cycle Dose Calculation Worksheet For Organ Doses

Adult Age Group

Liquid Pathway Organ Doses $D_{a,o}(l_o)$

Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI

Airborne Pathway Organ Doses $D_{a,o}(g_e)$ and $D_{a,o}(g_g)$ - Particulate, Iodine and Other Radionuclides with T 1/2 > 8 Days

Location 1 - Worst-case Inhalation Location [1]

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
S-Elev							
Ground							
Total*							

Location 2 - Worst-Case Vegetable Garden Location [2]

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
S-Elev							
Ground							
Total*							

Location 3 - Worst-case Meat Animal Location [3]

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
S-Elev							
Ground							
Total*							

Locations 4 and 5 - Worst-case Milk/Combination Location [4]

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
S-Elev							
Ground							
Total*							

Adult Organ Maximums**

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
Total							

Figure A4.0-4 (Cont'd) - Fuel Cycle Dose Calculation Worksheet For Organ Doses

Teen Age Group

Liquid Pathway Organ Doses $D_{a,o}(l_o)$

Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
______	______	______	______	______	______	______

Airborne Pathway Organ Doses $D_{a,o}(g_e)$ and $D_{a,o}(g_g)$ - Particulate, Iodine and Other Radionuclides with T 1/2 > 8 Days

Location 1 - Worst-case Inhalation Location [1]

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
S-Elev	______	______	______	______	______	______	______
Ground	______	______	______	______	______	______	______
Total*	______	______	______	______	______	______	______

Location 2 - Worst-Case Vegetable Garden Location [2]

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
S-Elev	______	______	______	______	______	______	______
Ground	______	______	______	______	______	______	______
Total*	______	______	______	______	______	______	______

Location 3 - Worst-case Meat Animal Location [3]

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
S-Elev	______	______	______	______	______	______	______
Ground	______	______	______	______	______	______	______
Total*	______	______	______	______	______	______	______

Locations 4 and 5 - Worst-case Milk/Combination Location [4]

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
S-Elev	______	______	______	______	______	______	______
Ground	______	______	______	______	______	______	______
Total*	______	______	______	______	______	______	______

Teen Organ Maximums**

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
Total	______	______	______	______	______	______	______

Figure A4.0-4 (Cont'd) - Fuel Cycle Dose Calculation Worksheet For Organ Doses

Child Age Group

Liquid Pathway Organ Doses $D_{a,o}(l_o)$

Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
____	____	____	____	____	____	____

Airborne Pathway Organ Doses $D_{a,o}(g_e)$ and $D_{a,o}(g_g)$ - Particulate, Iodine and Other Radionuclides with T 1/2 > 8 Days

Location 1 - Worst-case Inhalation Location [1]

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
S-Elev	____	____	____	____	____	____	____
Ground	____	____	____	____	____	____	____
Total*	____	____	____	____	____	____	____

Location 2 - Worst-Case Vegetable Garden Location [2]

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
S-Elev	____	____	____	____	____	____	____
Ground	____	____	____	____	____	____	____
Total*	____	____	____	____	____	____	____

Location 3 - Worst-case Meat Animal Location [3]

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
S-Elev	____	____	____	____	____	____	____
Ground	____	____	____	____	____	____	____
Total*	____	____	____	____	____	____	____

Locations 4 and 5 - Worst-case Milk/Combination Location [4]

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
S-Elev	____	____	____	____	____	____	____
Ground	____	____	____	____	____	____	____
Total*	____	____	____	____	____	____	____

Child Organ Maximums**

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
Total	____	____	____	____	____	____	____

Figure A4.0-4 (Cont'd) - Fuel Cycle Dose Calculation Worksheet For Organ Doses

Infant Age Group

Liquid Pathway Organ Doses $D_{a,o}(l_o)$

Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI

Airborne Pathway Organ Doses $D_{a,o}(g_e)$ and $D_{a,o}(g_g)$ - Particulate, Iodine and Other Radionuclides with T 1/2 > 8 Days

Location 1 - Worst-case Inhalation Location [1]

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
S-Elev							
Ground							
Total*							

Location 2 - Worst-Case Vegetable Garden Location [2]

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
S-Elev							
Ground							
Total*							

Location 3 - Worst-case Meat Animal Location [3]

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
S-Elev							
Ground							
Total*							

Locations 4 and 5 - Worst-case Milk/Combination Location [4]

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
S-Elev							
Ground							
Total*							

Infant Organ Maximums**

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
Total							

Figure A4.0-4 (Cont.d) - Fuel Cycle Dose Calculation Worksheet for Organ Doses

All Age Groups

Maximum Organ Dose ***

Organ = ________
Age Group = ________
Dose = ________ **mrem/yr**

Meteorological Parameters Used to Evaluate Airborne Pathway Doses:

[1] Semi-elevated evaluation location for Inhalation is 1.0 mi, SW

$\overline{X/Q}$ = 1.672E-06 sec/m^3, $\overline{D/Q}$ = 1.205E-08 1/m^2

Ground Level evaluation location for Inhalation is 1.0 mi, SE

$\overline{X/Q}$ = 7.308E-06 sec/m^3, $\overline{D/Q}$ = 1.401E-08 1/m^2

[2] Semi-elevated evaluation location for the Garden is 1.0 mi, NE

$\overline{X/Q}$ = 9.503E-07 sec/m^3, $\overline{D/Q}$ = 1.295E-08 1/m^2

Ground Level evaluation location for the Garden is 1.0 mi, NE

$\overline{X/Q}$ = 3.886E-06 sec/m^3, $\overline{D/Q}$ = 2.259E-08 1/m^2

[3] Semi-elevated evaluation location for Meat Animal is 1.5 mi, SW

$\overline{X/Q}$ = 7.285E-07 sec/m^3, $\overline{D/Q}$ = 4.399E-09 1/m^2

Ground Level evaluation location for Meat Animal is 1.5 mi, SW

$\overline{X/Q}$ = 1.620E-06 sec/m^3, $\overline{D/Q}$ = 6.169E-09 1/m^2

[4] Semi-elevated evaluation location for Milk/Comb. is 1.0 mi, SW

$\overline{X/Q}$ = 1.672E-06 sec/m^3, $\overline{D/Q}$ = 1.205E-08 1/m^2

Ground Level evaluation location for Milk/Comb. is 1.0 mi, SW

$\overline{X/Q}$ = 4.108E-06 sec/m^3, $\overline{D/Q}$ = 1.717E-08 1/m^2

Notes:

* Fuel cycle dose for age group a and organ o at analyzed limiting food pathway locations ($D_{a,o}(l_o) + D_{a,o}(g_e) + D_{a,o}(g_g)$).

** Limiting dose estimates for each organ for age group a (maximums of "Total*" values calculated for Locations 1 through 5).

*** Limiting dose estimate for any organ or age group (maximum of "Total" value calculated for any age group)

A5.0 RADIOLOGICAL ENVIRONMENTAL MONITORING

The radiological environmental monitoring program shall be conducted in accordance with Selected Licensee Commitment 16.11-6.

The monitoring program locations and analyses are given in Tables A5.0-1 through A5.0-3 and Figure A5.0-1.

Site specific characteristics make ground water sampling and food product sampling unnecessary. Ground water recharge is from precipitation and the ground water gradient is toward the effluent discharge area; therefore, contamination of ground water from liquid effluents is highly improbable. However, some ground water sampling is performed to verify this.

The Duke Power Radiological and Environmental Services laboratory participates in an interlaboratory comparison program. This program is described in the Annual Environmental Operating Report.

The land-use census data is used to identify the location with the highest possible dose for a particular ingestion pathway (milk, meat, etc.). Environmental monitoring measurements taken from these locations are then used to perform dose calculations that serve as a verification of the dose calculations that are performed for technical specification and licensee commitment (i.e., Compliance) purposes.

The dates of the land-use census that were used to identify the controlling receptor sample locations were 08/19/97 - 08/20/97.

The 1997 land-use census did not identify any locations where environmental monitoring samples are required but were not available for collection.

TABLE A5.0-1

OCONEE RADIOLOGICAL MONITORING PROGRAM SAMPLING LOCATIONS

(TLD LOCATIONS)

SAMPLING LOCATION	DESCRIPTION *		SAMPLING LOCATION	DESCRIPTION *	
020	SITE BOUNDARY	(0.1 MILES N)	040	4-5 MILE RADIUS	(4.5 MILES E)
021	SITE BOUNDARY	(0.3 MILES NNE)	041	4-5 MILE RADIUS	(4.0 MILES ESE)
022	SITE BOUNDARY	(0.5 MILES NE)	042	4-5 MILE RADIUS	(5.0 MILES SE)
023	SITE BOUNDARY	(0.9 MILES ENE)	043	4-5 MILE RADIUS	(4.0 MILES SSE)
024	SITE BOUNDARY	(0.8 MILES E)	044	4-5 MILE RADIUS	(4.0 MILES S)
025	SITE BOUNDARY	(0.4 MILES ESE)	045	4-5 MILE RADIUS	(5.0 MILES SSW)
026	SITE BOUNDARY	(0.3 MILES SE)	046	4-5 MILE RADIUS	(4.5 MILES SW)
027	SITE BOUNDARY	(0.4 MILES SSE)	047	4-5 MILE RADIUS	(4.0 MILES WSW)
028	SITE BOUNDARY	(0.5 MILES S)	048	4-5 MILE RADIUS	(4.0 MILES W)
029	SITE BOUNDARY	(0.6 MILES SSW)	049	4-5 MILE RADIUS	(4.0 MILES WNW)
030	SITE BOUNDARY	(0.4 MILES SW)	050	4-5 MILE RADIUS	(4.0 MILES NW)
031	SITE BOUNDARY	(0.3 MILES WSW)	051	4-5 MILE RADIUS	(4.5 MILES NNW)
032	SITE BOUNDARY	(0.2 MILES WNW)	052	SPECIAL INTEREST	(12.0 MILES ENE)
033	SITE BOUNDARY	(0.2 MILES WNW)	053	SPECIAL INTEREST	(11.0 MILES E)
034	SITE BOUNDARY	(0.2 MILES NW)	054	SPECIAL INTEREST	(9.5 MILES ESE)
035	SITE BOUNDARY	(0.2 MILES NNW)	055	SPECIAL INTEREST	(9.5 MILES SSE)
036	4-5 MILE RADIUS	(4.0 MILES N)	056	SPECIAL INTEREST	(8.4 MILES SSW)
037	4-5 MILE RADIUS	(4.5 MILES NNE)	057	SPECIAL INTEREST	(9.0 MILES SW)
038	4-5 MILE RADIUS	(4.0 MILES NE)	058	SPECIAL INTEREST	(9.4 MILES WSW)
039	4-5 MILE RADIUS	(4.0 MILES ENE)	059	SPECIAL INTEREST	(9.2 MILES NW)
			076	SITE BOUNDARY	(0.2 MILES W)

* All sampling locations are collected quarterly

TABLE A5.0-2
(1 OF 1)
OCONEE RADIOLOGICAL MONITORING PROGRAM SAMPLING LOCATIONS
(OTHER SAMPLING LOCATIONS)

CODE:

W - Weekly
SM - Semimonthly
M - Monthly
SA - Semiannually

	SAMPLING LOCATION DESCRIPTION	Air Radioiodines and Particulates	Surface Water	Drinking Water	Shoreline Sediment	Milk	Fish	Broadleaf Vegetation
060	New Greenville Water Intake Rd. (2.6 miles NNE) *	W		M			SA	M
062	Lake Keowee/Hydro Intake (0.8 mile ENE) (CONTROL)		M					
063	Lake Hartwell - Hwy 183 Bridge (0.8 mile ESE) (000.7)		M		SA		SA	
064	Seneca (6.7 miles SSW) (004.1) (CONTROL)			M				
066	Anderson (19.0 miles SSE) (012)			M				
067	Lawrence Ramsey Bridge, Hwy 27 (4.2 miles SSE) (005.2)				SA		SA	
068	High Falls County Park (2.0 miles W) (CONTROL)				SA			
069	Orr's Dairy (4.5 miles WNW) (002.1)					SM		
071	Clemson Dairy (10.3 miles SSE) (006.3)					SM		
073	Tamassee Dar School (9.2 miles NW) (CONTROL)	W						M
074	Keowee Key Resort (2.3 miles NNW)	W						
077	Skimmer Wall (1.0 mile SW)	W						M
078	Recreation Site (0.6 mile WSW)	W						
079	Keowee Dam (0.5 mile NE)	W						M
080	Martin's Dairy (19.0 miles SSE) (CONTROL)					SM		

* Control for Fish only

TABLE A5.0-3
(1 of 1)

OCONEE RADIOLOGICAL MONITORING PROGRAM ANALYSES

SAMPLE MEDIUM	ANALYSIS SCHEDULE	ANALYSES				
		GAMMA ISOTOPIC	TRITIUM	LOW LEVEL I-131	GROSS BETA	TLD
1. Air Radioiodine	Weekly	X				
2. Air Particulates	Weekly				X	
	Quarterly Composite	X				
3. Direct Radiation	Quarterly					X
4. Surface Water	Monthly	X				
	Quarterly Composite		X			
5. Drinking Water	Monthly	X			X	
	Quarterly Composite		X			
6. Shoreline Sediment	Semiannually	X				
7. Milk	Semimonthly	X		X		
8. Fish	Semiannually	X				
9. Broadleaf Vegetation	Monthly	X				

B4.2.2 Gaseous Effluents

B4.2.2.1 Noble Gases

Gamma Air and Beta Air Dose

Generic methodology for calculating noble gas airborne pathway gamma air (D_γ) and beta air (D_β) doses is presented in Section 3.1.2.1. McGuire site specific parameters to be used in the generic methodology are presented as follows:

$(\overline{X/Q})$ = 7.611E-5 sec/m^3. The highest calculated annual average relative concentration for any area at or beyond the restricted area boundary. The location is the NNE sector @ 0.5 mile.

An input template for McGuire GASPAR computer program noble gas airborne pathway gamma air (D_γ) and beta air (D_β) dose calculations is provided in Figure B4.0-2, Location 1. The input template includes the maximum McGuire site specific annual average relative concentration parameters. Radionuclide release input (Ci/period) and optional non-default relative concentration parameters are necessary to perform GASPAR calculations to determine offsite dose impact from specific releases.

B4.2.2.2 Radioiodines, Particulates, and Other Radionuclides with T 1/2 > 8 Days

Generic methodology for calculating airborne pathway maximum organ (D_{MO}) exposures to the maximum individual is presented in Section 3.1.2.2. External exposure from deposited ground contamination and inhalation exposure pathways are considered to exist at all locations offsite. Food pathways (i.e., vegetable, meat and milk) are analyzed only at locations where site surveys have verified vegetable gardens, meat producing animals, or cow/goat milk producing animals exist, however. Therefore, the location of the maximum individual may vary depending on the mixture and levels of radionuclides released during a period of time. Additionally, the critical (or limiting) age group and organ will vary based on the location (i.e., combination of dose pathways contributing dose) and mixture/level of radionuclide releases during the release period.

Performing calculations separately for all potential maximum locations, age groups and organs assures that a maximum location is identified, and that a conservative estimate is obtained for maximum offsite dose impact to any organ or age group . McGuire site specific meteorological dispersion (X/Q) and deposition (D/Q) parameters and applicable terrestrial/food pathways for the potential maximum locations to be analyzed using generic methodology are presented in Table B4.0-7.

An input template for McGuire GASPAR computer program airborne pathway maximum organ (D_{MO}) dose calculations is provided in Figure B4.0-3, Locations 1 - 5. Radionuclide release input (Ci/period) and optional non-default meteorological parameters and pathway applicability flags are necessary to perform GASPAR calculations to determine offsite dose impact from specific releases.

B4.3 FUEL CYCLE CALCULATIONS

As discussed in Section 3.3.5, more than one nuclear power station site may contribute to the doses to be considered in accordance with 40CFR190. The fuel cycle dose assessments for McGuire Nuclear Station only include liquid and gaseous dose contributions from McGuire Nuclear Station since no other uranium fuel cycle facility contributes signicantly to McGuire's maximum exposed individual. For this dose assessment, the total body and maximum organ dose contributions to the maximum exposed individual from McGuire's liquid and gaseous effluents are estimated using the following calculations:

$$D_{WB}(T) = D_{WB}(l) + D_{WB}(g)$$

$$D_{MO}(T) = D_{MO}(l) + D_{MO}(g)$$

where:

$D_{WB}(T)$ = Total estimated fuel cycle whole body dose commitment resulting from the combined liquid and gaseous effluents of McGuire during the calendar year of interest, in mrem.

$D_{MO}(T)$ = Total estimated fuel cycle maxmium organ dose commitment resulting from the combined liquid and gaseous effluents of McGuire during the calendar year of interest, in mrem.

A fuel cycle dose calculation worksheet is provided in Figure B4.0-4.

B4.3.1 LIQUID EFFLUENTS

Liquid pathway dose estimates are calculated using generic methodology or the LADTAP computer program. The values for $D_{WB}(l)$ and $D_{MO}(l)$ liquid pathway dose contributions are calculated based on the methodology, values and assumptions presented in Section B4.2.1.

B4.3.2 GASEOUS EFFLUENTS

Total Body

The methodology for calculating noble gas airborne pathway whole body exposures to the maximum individual, $D_{WB}(g)$, is derived from Section 3.1.2.1 generic methodology for gamma air and beta air dose calculations as follows:

$$D_{WB}(g) = 3.17E-8 \sum_{i=1} K_i \, [\overline{(X/Q)}Q_i] \quad \text{mrem/yr}$$

Generic methodology parameters K_i are described in Section 1.2.1. The McGuire site specific parameter X/Q value is 7.611E-5 sec/m^3 as described in Section B4.2.2.1 for McGuire gamma air and beta air dose calculations.

Maximum Organ

Airborne pathway maximum organ dose estimates are calculated using generic methodology or the GASPAR computer program. The maximum organ dose is established by calculating doses to all organs for each potential maximum offsite location identified in Table B4.0-7. A conservative estimate (i.e., overestimate) of the fuel cycle maximum organ dose is obtained by:

1) determining the locations with the highest exposure releases for each organ;

2) adding the highest exposure value for the airborne release to the same organ dose resulting from liquid releases; and

3) comparing values obtained when the liquid and airborne pathway components are added for all organs and age groups to determine the maximum (or limiting) organ and age group.

TABLE B4.0-1

MCGUIRE NUCLEAR STATION
(1 OF 2)

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

(SEC/M3)

DISTANCE TO THE CONTROL LOCATION, IN MILES

SECTOR	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		4.795E-05	1.220E-05	5.144E-06	2.879E-06	1.871E-06	1.333E-06	1.009E-06	7.985E-07	6.529E-07
NNE		7.611E-05	1.910E-05	8.103E-06	4.553E-06	2.968E-06	2.118E-06	1.607E-06	1.274E-06	1.043E-06
NE		5.330E-05	1.329E-05	5.662E-06	3.191E-06	2.084E-06	1.490E-06	1.132E-06	8.978E-07	7.357E-07
ENE		2.950E-05	7.487E-06	3.166E-06	1.776E-06	1.155E-06	8.237E-07	6.243E-07	4.943E-07	4.044E-07
E		1.742E-05	4.506E-06	1.884E-06	1.049E-06	6.787E-07	4.818E-07	3.638E-07	2.872E-07	2.344E-07
ESE		1.206E-05	3.143E-06	1.303E-06	7.209E-07	4.646E-07	3.288E-07	2.476E-07	1.951E-07	1.589E-07
SE		7.697E-06	2.011E-06	8.234E-07	4.521E-07	2.897E-07	2.040E-07	1.531E-07	1.202E-07	9.763E-08
SSE		6.179E-06	1.613E-06	6.504E-07	3.533E-07	2.246E-07	1.572E-07	1.173E-07	9.173E-08	7.421E-08
S		6.262E-06	1.581E-06	6.263E-07	3.363E-07	2.120E-07	1.475E-07	1.095E-07	8.525E-08	6.872E-08
SSW		7.346E-06	1.836E-06	7.234E-07	3.872E-07	2.435E-07	1.690E-07	1.253E-07	9.745E-08	7.847E-08
SW		8.606E-06	2.206E-06	8.483E-07	4.456E-07	2.759E-07	1.890E-07	1.386E-07	1.066E-07	8.508E-08
WSW		6.424E-06	1.671E-06	6.526E-07	3.466E-07	2.165E-07	1.493E-07	1.101E-07	8.519E-08	6.829E-08
W		3.523E-06	9.147E-07	3.697E-07	2.012E-07	1.281E-07	8.973E-08	6.705E-08	5.245E-08	4.247E-08
WNW		4.063E-06	1.071E-06	4.351E-07	2.376E-07	1.516E-07	1.064E-07	7.963E-08	6.238E-08	5.056E-08
NW		5.543E-06	1.448E-06	5.898E-07	3.226E-07	2.061E-07	1.448E-07	1.085E-07	8.504E-08	6.898E-08
NNW		1.053E-05	2.735E-06	1.131E-06	6.250E-07	4.024E-07	2.845E-07	2.141E-07	1.686E-07	1.372E-07

McGUIRE NUCLEAR STATION

The values presented in this table were generated by using the computer program XOQDOQ (NUREG/CR-2919) which implements NRC Regulatory Guide 1.111 (1977), and by using the following assumptions:

1. Data Collection Period, 1988 to 1992.

2. Ground Level Releases.

3. Open Terrain Recirculation Correction Factors.

4. No Decay, Undepleted

5. Vent and Building Parameters:

Release Height	(meters)	=	40.20	Rep. Wind Height	(meters)	=	10.0
Diameter	(meters)	=	0.00	Building Height	(meters)	=	43.1
Exit Velocity	(meters)	=	0.00	Bldg. Min. X-Sec. Area	(sq. m.)	=	1616.0
				Heat Emission Rate	(cal/s)	=	0.0

TABLE B4.0-2

MCGUIRE NUCLEAR STATION
(1 OF 2)

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

(1/M2)

DISTANCE TO THE CONTROL LOCATION, IN MILES

SECTOR	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		1.031E-07	2.516E-08	9.037E-09	4.482E-09	2.639E-09	1.728E-09	1.216E-09	9.011E-10	6.944E-10
NNE		1.403E-07	3.424E-08	1.230E-08	6.100E-09	3.592E-09	2.352E-09	1.655E-09	1.226E-09	9.451E-10
NE		7.027E-08	1.715E-08	6.161E-09	3.055E-09	1.799E-09	1.178E-09	8.289E-10	6.143E-10	4.734E-10
ENE		3.893E-08	9.504E-09	3.414E-09	1.693E-09	9.969E-10	6.527E-10	4.593E-10	3.404E-10	2.623E-10
E		3.024E-08	7.381E-09	2.651E-09	1.315E-09	7.742E-10	5.069E-10	3.567E-10	2.643E-10	2.037E-10
ESE		3.299E-08	8.052E-09	2.892E-09	1.434E-09	8.445E-10	5.530E-10	3.891E-10	2.884E-10	2.222E-10
SE		2.733E-08	6.673E-09	2.397E-09	1.189E-09	6.999E-10	4.583E-10	3.225E-10	2.390E-10	1.842E-10
SSE		2.765E-08	6.749E-09	2.424E-09	1.202E-09	7.079E-10	4.635E-10	3.262E-10	2.417E-10	1.863E-10
S		4.360E-08	1.064E-08	3.823E-09	1.896E-09	1.116E-09	7.309E-10	5.143E-10	3.811E-10	2.937E-10
SSW		6.929E-08	1.691E-08	6.075E-09	3.013E-09	1.774E-09	1.162E-09	8.174E-10	6.058E-10	4.668E-10
SW		8.605E-08	2.100E-08	7.545E-09	3.742E-09	2.203E-09	1.443E-09	1.015E-09	7.523E-10	5.797E-10
WSW		4.562E-08	1.114E-08	4.000E-09	1.984E-09	1.168E-09	7.648E-10	5.382E-10	3.988E-10	3.073E-10
W		1.268E-08	3.094E-09	1.112E-09	5.512E-10	3.246E-10	2.125E-10	1.495E-10	1.108E-10	8.541E-11
WNW		1.213E-08	2.962E-09	1.064E-09	5.276E-10	3.107E-10	2.034E-10	1.431E-10	1.061E-10	8.175E-11
NW		1.785E-08	4.358E-09	1.565E-09	7.763E-10	4.571E-10	2.993E-10	2.106E-10	1.561E-10	1.203E-10
NNW		2.520E-08	6.152E-09	2.210E-09	1.096E-09	6.453E-10	4.225E-10	2.973E-10	2.203E-10	1.698E-10

McGUIRE NUCLEAR STATION

The values presented in this table were generated by using the computer program XOQDOQ (NUREG/CR-2919) which implements NRC Regulatory Guide 1.111 (1977), and by using the following assumptions:

1. Data Collection Period, 1988 to 1992.

2. Ground Level Releases.

3. Open Terrain Recirculation Correction Factors.

4. No Decay, Undepleted

5. Vent and Building Parameters:

Release Height	(meters)	= 40.20	Rep. Wind Height	(meters)	=	10.0
Diameter	(meters)	= 0.00	Building Height	(meters)	=	43.1
Exit Velocity	(meters)	= 0.00	Bldg. Min. X-Sec. Area	(sq. m.)	=	1616.0
			Heat Emission Rate	(cal/s)	=	0.0

MCGUIRE NUCLEAR STATION
LIQUID EFFLUENT DOSE - ADULT PARAMETERS
A(I) MREM/HR PER UCI/ML

RADIONUCLIDE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
1 H 3	0.0	1.15E+01	1.15E+01	1.15E+01	1.15E+01	1.15E+01	1.15E+01
11 NA 24	4.07E+02	4.07E+02	4.07E+02	4.07E+02	4.07E+02	4.07E+02	4.07E+02
24 CR 51	0.0	0.0	3.08E+00	1.84E+00	6.79E-01	4.09E+00	7.75E+02
25 MN 54	0.0	1.03E+04	1.97E+03	0.0	3.08E+03	0.0	3.17E+04
25 MN 56	0.0	8.54E-01	1.51E-01	0.0	1.08E+00	0.0	2.73E+01
26 FE 55	1.78E+03	1.23E+03	2.86E+02	0.0	0.0	6.84E+02	7.04E+02
26 FE 59	2.76E+03	6.49E+03	2.49E+03	0.0	0.0	1.81E+03	2.16E+04
27 CO 58	0.0	2.77E+02	6.22E+02	0.0	0.0	0.0	5.62E+03
27 CO 60	0.0	8.03E+02	1.77E+03	0.0	0.0	0.0	1.51E+04
28 NI 63	8.40E+04	5.82E+03	2.82E+03	0.0	0.0	0.0	1.21E+03
28 NI 65	2.43E+00	3.16E-01	1.44E-01	0.0	0.0	0.0	8.01E+00
29 CU 64	0.0	1.06E+01	4.97E+00	0.0	2.67E+01	0.0	9.03E+02
30 ZN 65	5.27E+04	1.68E+05	7.58E+04	0.0	1.12E+05	0.0	1.06E+05
30 ZN 69	1.71E-04	3.26E-04	2.27E-05	0.0	2.12E-04	0.0	4.90E-05
35 BR 83	0.0	0.0	2.17E-01	0.0	0.0	0.0	3.13E-01
35 BR 85	0.0	0.0	5.52E-77	0.0	0.0	0.0	0.0
37 RB 86	0.0	2.22E+05	1.04E+05	0.0	0.0	0.0	4.38E+04
37 RB 88	0.0	4.61E-12	2.45E-12	0.0	0.0	0.0	6.37E-23
37 RB 89	0.0	2.64E-14	1.86E-14	0.0	0.0	0.0	1.53E-27
38 SR 89	8.14E+04	0.0	2.34E+03	0.0	0.0	0.0	1.31E+04
38 SR 90	1.03E+06	0.0	2.75E+05	0.0	0.0	0.0	5.85E+04
38 SR 91	4.07E+02	0.0	1.64E+01	0.0	0.0	0.0	1.94E+03
38 SR 92	1.13E+01	0.0	4.87E-01	0.0	0.0	0.0	2.23E+02
39 Y 90	1.89E+00	0.0	5.07E-02	0.0	0.0	0.0	2.00E+04
39 Y 91M	4.05E-07	0.0	1.57E-08	0.0	0.0	0.0	1.19E-06
39 Y 91	3.35E+01	0.0	8.97E-01	0.0	0.0	0.0	1.85E+04
39 Y 92	9.58E-03	0.0	2.80E-04	0.0	0.0	0.0	1.68E+02
39 Y 93	1.93E-01	0.0	5.32E-03	0.0	0.0	0.0	6.11E+03
40 ZR 95	3.71E+00	1.19E+00	8.05E-01	0.0	1.87E+00	0.0	3.77E+03
40 ZR 97	1.19E-01	2.40E-02	1.10E-02	0.0	3.62E-02	0.0	7.43E+03
41 NB 95	9.91E+02	5.51E+02	2.96E+02	0.0	5.45E+02	0.0	3.34E+06
42 MO 99	0.0	5.80E+02	1.10E+02	0.0	1.31E+03	0.0	1.34E+03
43 TC 99M	7.76E-03	2.19E-02	2.79E-01	0.0	3.33E-01	1.07E-02	1.30E+01
43 TC 101	1.42E-17	2.05E-17	2.01E-16	0.0	3.69E-16	1.05E-17	6.17E-29
44 RU 103	2.91E+01	0.0	1.25E+01	0.0	1.11E+02	0.0	3.39E+03
44 RU 105	2.67E-01	0.0	1.06E-01	0.0	3.45E+00	0.0	1.63E+02
44 RU 106	4.37E+02	0.0	5.52E+01	0.0	8.43E+02	0.0	2.83E+04
47 AG 100M	1.87E+01	1.73E+01	1.03E+01	0.0	3.41E+01	0.0	7.07E+03
52 TE 125M	6.01E+03	2.18E+03	8.05E+02	1.81E+03	2.44E+04	0.0	2.40E+04
52 TE 127M	1.53E+04	5.46E+03	1.86E+03	3.90E+03	6.20E+04	0.0	5.12E+04
52 TE 127	4.49E+01	1.61E+01	9.71E+00	3.33E+01	1.83E+02	0.0	3.54E+03
52 TE 129M	2.56E+04	9.54E+03	4.05E+03	8.78E+03	1.07E+05	0.0	1.29E+05
52 TE 129	2.57E-03	9.66E-04	6.26E-04	1.97E-03	1.08E-02	0.0	1.94E-03
52 TE 131M	2.29E+03	1.12E+03	9.32E+02	1.77E+03	1.13E+04	0.0	1.11E+05
52 TE 131	4.63E-09	1.94E-09	1.46E-09	3.81E-09	2.03E-08	0.0	6.56E-10
52 TE 132	4.65E+03	3.01E+03	2.82E+03	3.32E+03	2.90E+04	0.0	1.42E+05
53 I 130	5.63E+01	1.66E+02	6.56E+01	1.41E+04	2.59E+02	0.0	1.43E+02
53 I 131	7.28E+02	1.04E+03	5.96E+02	3.41E+05	1.78E+03	0.0	2.75E+02
53 I 132	5.84E-01	1.56E+00	5.47E-01	5.47E+01	2.49E+00	0.0	2.94E-01
53 I 133	1.52E+02	2.64E+02	8.04E+01	3.88E+04	4.60E+02	0.0	2.37E+02
53 I 135	1.60E+01	4.20E+01	1.55E+01	2.77E+03	6.74E+01	0.0	4.74E+01
55 CS 134	6.79E+05	1.62E+06	1.32E+06	0.0	5.23E+05	1.74E+05	2.83E+04
55 CS 136	6.75E+04	2.66E+05	1.92E+05	0.0	1.48E+05	2.03E+04	3.03E+04
55 CS 137	8.71E+05	1.19E+06	7.80E+05	0.0	4.04E+05	1.34E+05	2.31E+04
55 CS 138	1.11E-06	2.19E-06	1.09E-06	0.0	1.61E-06	1.59E-07	9.36E-12
56 BA 139	2.40E-02	1.71E-05	7.04E-04	0.0	1.60E-05	9.72E-06	4.26E-02
56 BA 140	2.49E+03	3.13E+00	1.63E+02	0.0	1.06E+00	1.79E+00	5.12E+03
56 BA 141	6.86E-12	5.19E-15	2.32E-13	0.0	4.82E-15	2.94E-15	3.23E-21
56 BA 142	1.22E-20	1.25E-23	7.68E-22	0.0	1.06E-23	7.11E-24	1.72E-38
57 LA 140	4.37E-01	2.20E-01	5.82E-02	0.0	0.0	0.0	1.62E+04
57 LA 142	6.10E-05	2.77E-05	6.91E-06	0.0	0.0	0.0	2.02E-01
58 CE 141	1.02E+00	6.90E-01	7.83E-02	0.0	3.21E-01	0.0	2.64E+03
58 CE 143	1.40E-01	1.04E+02	1.15E-02	0.0	4.56E-02	0.0	3.87E+03
58 CE 144	5.37E+01	2.25E+01	2.89E+00	0.0	1.33E+01	0.0	1.82E+04
59 PR 143	2.12E+00	8.51E-01	1.05E-01	0.0	4.92E-01	0.0	9.30E+03
59 PR 144	8.87E-16	3.68E-16	4.51E-17	0.0	2.08E-16	0.0	1.28E-22
60 ND 147	1.44E+00	1.66E+00	9.95E-02	0.0	9.72E-01	0.0	7.98E+03
74 W 187	3.41E+02	2.85E+02	9.97E+01	0.0	0.0	0.0	9.34E+04
93 NP 239	1.56E-01	1.53E-02	8.44E-03	0.0	4.78E-02	0.0	3.14E+03

McGuire Nuclear Station
Liquid Effluent Dose - Adult Parameters
A_{aoi} mrem/hr per µCi/ml

From Generic Section 3.1.1:

A_{aoi} = the site related ingestion dose commitment factor for an individual of age group, "a", to organ, "o", for each identified principal gamma and beta emitter, "i", in mrem/hr per µCi/ml

A_{aoi} = $1.14E{+}05\ (U_{aw}\sigma_w/Dw\ \exp(-\lambda_i t_w) + U_{af}\sigma_f BF_i \exp(-\lambda_i t_f))\ DF_{aoi}$

where:
1.14E+05 = 10^6 pCi/µCi x 10^3 ml/kg ÷ 8760 hr/yr

U_{aw} = Water consumption by age group, l/yr

infant	330
child	510
teen	510
adult	730

σ_w, σ_f = Recirculation factors at equilibrium for the water and fish pathways respectively; these factors account for the fraction of discharged water reused by the station
$\sigma_w = 1.26$ $\sigma_f = 2.26$

D_w = Dilution factor from the near field area to the potable water intake = 1.0

U_{af} = Fish consumption by age group, kg/yr

infant	---
child	6.9
teen	16
adult	21

BF_i = Bioaccumulation factor for radionuclide, "i", in fish, pCi/kg per pCi/l, from Table 3.1-1

DF_{aoi} = Dose conversion factor for age group, "a", in organ, "o", for radionuclide, "i", in mrem/pCi, from Tables 3.1-2, 3.1-3, 3.1-4, and 3.1-5, respectively

λ_i = radiological decay constant for isotope, i, in 1/hr

t_w, t_f = transport time for the drinking water and fish pathways, hr
t_w = 12 hours t_f = 24 hours

Sample Calculation for Adult, I-131, Thyroid:
A(a,thy,I-131) = 1.14E5 (730*1.26/1.0*exp(-3.59E-3*12) + 21*2.26*15* exp(-3.59E-3*24)) 1.95E-3 = 3.41E5 mr/hr per µCi/ml

TABLE B4.0-4
(1 OF 2)

MCGUIRE NUCLEAR STATION
LIQUID EFFLUENT DOSE - TEEN PARAMETERS
A(I) MREM/HR PER UCI/ML

RADIONUCLIDE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
1 H 3	0.0	8.16E+00	8.16E+00	8.16E+00	8.16E+00	8.16E+00	8.16E+00
11 NA 24	4.11E+02	4.11E+02	4.11E+02	4.11E+02	4.11E+02	4.11E+02	4.11E+02
24 CR 51	0.0	0.0	3.16E+00	1.75E+00	6.91E-01	4.50E+00	5.30E+02
25 MN 54	0.0	1.01E+04	2.01E+03	0.0	3.02E+03	0.0	2.08E+04
25 MN 56	0.0	8.53E-01	1.52E-01	0.0	1.08E+00	0.0	5.61E+01
26 FE 55	1.83E+03	1.30E+03	3.03E+02	0.0	0.0	8.25E+02	5.63E+02
26 FE 59	2.81E+03	6.56E+03	2.53E+03	0.0	0.0	2.07E+03	1.55E+04
27 CO 58	0.0	2.69E+02	6.20E+02	0.0	0.0	0.0	3.71E+03
27 CO 60	0.0	7.85E+02	1.77E+03	0.0	0.0	0.0	1.02E+04
28 NI 63	8.59E+04	6.07E+03	2.91E+03	0.0	0.0	0.0	9.66E+02
28 NI 65	2.44E+00	3.12E-01	1.42E-01	0.0	0.0	0.0	1.69E+01
29 CU 64	0.0	1.07E+01	5.05E+00	0.0	2.72E+01	0.0	8.33E+02
30 ZN 65	4.78E+04	1.66E+05	7.74E+04	0.0	1.06E+05	0.0	7.03E+04
30 ZN 69	1.70E-04	3.24E-04	2.27E-05	0.0	2.12E-04	0.0	5.98E-04
35 BR 83	0.0	0.0	2.25E-01	0.0	0.0	0.0	0.0
35 BR 85	0.0	0.0	5.50E-77	0.0	0.0	0.0	0.0
37 RB 86	0.0	2.39E+05	1.12E+05	0.0	0.0	0.0	3.54E+04
37 RB 88	0.0	4.54E-12	2.42E-12	0.0	0.0	0.0	3.89E-19
37 RB 89	0.0	2.53E-14	1.79E-14	0.0	0.0	0.0	3.87E-23
38 SR 89	8.57E+04	0.0	2.45E+03	0.0	0.0	0.0	1.02E+04
38 SR 90	8.82E+05	0.0	2.36E+05	0.0	0.0	0.0	4.59E+04
38 SR 91	4.19E+02	0.0	1.67E+01	0.0	0.0	0.0	1.90E+03
38 SR 92	1.12E+01	0.0	4.78E-01	0.0	0.0	0.0	2.86E+02
39 Y 90	1.97E+00	0.0	5.31E-02	0.0	0.0	0.0	1.63E+04
39 Y 91M	4.02E-07	0.0	1.54E-08	0.0	0.0	0.0	1.90E-05
39 Y 91	3.51E+01	0.0	9.41E-01	0.0	0.0	0.0	1.44E+04
39 Y 92	9.68E-03	0.0	2.80E-04	0.0	0.0	0.0	2.66E+02
39 Y 93	1.99E-01	0.0	5.45E-03	0.0	0.0	0.0	6.07E+03
40 ZR 95	3.56E+00	1.12E+00	7.72E-01	0.0	1.65E+00	0.0	2.59E+03
40 ZR 97	1.18E-01	2.34E-02	1.08E-02	0.0	3.54E-02	0.0	6.33E+03
41 NB 95	9.97E+02	5.53E+02	3.05E+02	0.0	5.36E+02	0.0	2.37E+06
42 MO 99	0.0	5.83E+02	1.11E+02	0.0	1.33E+03	0.0	1.04E+03
43 TC 99M	7.40E-03	2.06E-02	2.67E-01	0.0	3.07E-01	1.15E-02	1.35E+01
43 TC 101	1.41E-17	2.01E-17	1.97E-16	0.0	3.63E-16	1.22E-17	3.43E-24
44 RU 103	2.88E+01	0.0	1.23E+01	0.0	1.02E+02	0.0	2.41E+03
44 RU 105	2.66E-01	0.0	1.03E-01	0.0	3.36E+00	0.0	2.15E+02
44 RU 106	4.48E+02	0.0	5.65E+01	0.0	8.64E+02	0.0	2.15E+04
47 AG 100M	1.69E+01	1.60E+01	9.75E+00	0.0	3.06E+01	0.0	4.50E+03
52 TE 125M	6.52E+03	2.35E+03	8.72E+02	1.82E+03	0.0	0.0	1.92E+04
52 TE 127M	1.65E+04	5.87E+03	1.97E+03	3.94E+03	6.71E+04	0.0	4.12E+04
52 TE 127	4.87E+01	1.73E+01	1.05E+01	3.36E+01	1.97E+02	0.0	3.76E+03
52 TE 129M	2.75E+04	1.02E+04	4.35E+03	8.88E+03	1.15E+05	0.0	1.03E+05
52 TE 129	2.57E-03	9.56E-04	6.24E-04	1.83E-03	1.08E-02	0.0	1.40E-02
52 TE 131M	2.45E+03	1.17E+03	9.78E+02	1.76E+03	1.22E+04	0.0	9.41E+04
52 TE 131	4.59E-09	1.89E-09	1.43E-09	3.53E-09	2.01E-08	0.0	3.76E-10
52 TE 132	4.88E+03	3.09E+03	2.91E+03	3.26E+03	2.97E+04	0.0	9.79E+04
53 I 130	5.50E+01	1.59E+02	6.36E+01	1.30E+04	2.45E+02	0.0	1.22E+02
53 I 131	7.42E+02	1.04E+03	5.58E+02	3.03E+05	1.79E+03	0.0	2.06E+02
53 I 132	5.62E-01	1.47E+00	5.28E-01	4.96E+01	2.32E+00	0.0	6.41E-01
53 I 133	1.55E+02	2.62E+02	8.00E+01	3.66E+04	4.60E+02	0.0	1.98E+02
53 I 135	1.57E+01	4.04E+01	1.50E+01	2.60E+03	6.38E+01	0.0	4.47E+01
55 CS 134	6.96E+05	1.64E+06	7.60E+05	0.0	5.20E+05	1.99E+05	2.04E+04
55 CS 136	6.78E+04	2.67E+05	1.79E+05	0.0	1.45E+05	2.29E+04	2.15E+04
55 CS 137	9.32E+05	1.24E+06	4.32E+05	0.0	4.22E+05	1.64E+05	1.76E+04
55 CS 138	1.09E-06	2.10E-06	1.05E-06	0.0	1.55E-06	1.80E-07	9.51E-10
56 BA 139	2.41E-02	1.69E-05	7.01E-04	0.0	1.60E-05	1.17E-05	2.15E-01
56 BA 140	2.47E+03	3.02E+00	1.59E+02	0.0	1.03E+00	2.03E+00	3.81E+03
56 BA 141	6.83E-12	5.10E-15	2.28E-13	0.0	4.73E-15	3.49E-15	1.46E-17
56 BA 142	1.20E-20	1.20E-23	7.37E-22	0.0	1.01E-23	7.97E-24	3.67E-32
57 LA 140	4.45E-01	2.18E-01	5.81E-02	0.0	0.0	0.0	1.25E+04
57 LA 142	5.96E-05	2.65E-05	6.59E-06	0.0	0.0	0.0	8.06E-01
58 CE 141	1.02E+00	6.79E-01	7.80E-02	0.0	3.20E-01	0.0	1.94E+03
58 CE 143	1.40E-01	1.02E+02	1.14E-02	0.0	4.56E-02	0.0	3.06E+03
58 CE 144	5.38E+01	2.23E+01	2.89E+00	0.0	1.33E+01	0.0	1.35E+04
59 PR 143	2.22E+00	8.86E-01	1.10E-01	0.0	5.15E-01	0.0	7.30E+03
59 PR 144	8.85E-16	3.62E-16	4.49E-17	0.0	2.08E-16	0.0	9.75E-19
60 ND 147	1.57E+00	1.71E+00	1.03E-01	0.0	1.01E+00	0.0	6.18E+03
74 W 187	3.68E+02	3.00E+02	1.05E+02	0.0	0.0	0.0	8.11E+04
93 NP 239	1.65E-01	1.56E-02	8.66E-03	0.0	4.90E-02	0.0	2.51E+03

Table B4.0-4
(2 of 2)

McGuire Nuclear Station
Liquid Effluent Dose - Teen Parameters
A_{aoi} mrem/hr per µCi/ml

From Generic Section 3.1.1:

A_{aoi} = the site related ingestion dose commitment factor for an individual of age group, "a", to organ, "o", for each identified principal gamma and beta emitter, "i", in mrem/hr per µCi/ml

A_{aoi} = $1.14E{+}05\ (U_{aw}\sigma_w/Dw\ \exp(-\lambda_i t_w) + U_{af}\sigma_f BF_i \exp(-\lambda_i t_f))\ DF_{aoi}$

where:
1.14E+05 = 10^6 pCi/µCi x 10^3 ml/kg ÷ 8760 hr/yr

U_{aw} = Water consumption by age group, l/yr

infant	330
child	510
teen	510
adult	730

σ_w, σ_f = Recirculation factors at equilibrium for the water and fish pathways respectively; these factors account for the fraction of discharged water reused by the station
$\sigma_w = 1.26$ $\sigma_f = 2.26$

D_w = Dilution factor from the near field area to the potable water intake = 1.0

U_{af} = Fish consumption by age group, kg/yr

infant	---
child	6.9
teen	16
adult	21

BF_i = Bioaccumulation factor for radionuclide, "i", in fish, pCi/kg per pCi/l, from Table 3.1-1

DF_{aoi} = Dose conversion factor for age group, "a", in organ, "o", for radionuclide, "i", in mrem/pCi, from Tables 3.1-2, 3.1-3, 3.1-4, and 3.1-5, respectively

λ_i = radiological decay constant for isotope, i, in 1/hr

t_w, t_f = transport time for the drinking water and fish pathways, hr
t_w = 12 hours t_f = 24 hours

Sample Calculation for Teen, I-131, Thyroid:
A(t,thy,I-131) = 1.14E5 (510*1.26/1.0*exp(-3.59E-3*12) + 16*2.26*15* exp(-3.59E-3*24)) 2.39E-3 = 3.03E5 mr/hr per µCi/ml

TABLE B4.0-5
(1 OF 2)

MCGUIRE NUCLEAR STATION
LIQUID EFFLUENT DOSE - CHILD PARAMETERS
A(I) MREM/HR PER UCI/ML

RADIONUCLIDE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
1 H 3	0.0	1.52E+01	1.52E+01	1.52E+01	1.52E+01	1.52E+01	1.52E+01
11 NA 24	5.86E+02	5.86E+02	5.86E+02	5.86E+02	5.86E+02	5.86E+02	5.86E+02
24 CR 51	0.0	0.0	3.73E+00	2.07E+00	5.66E-01	3.78E+00	1.98E+02
25 MN 54	0.0	8.37E+03	2.23E+03	0.0	2.35E+03	0.0	7.03E+03
25 MN 56	0.0	1.32E+00	2.99E-01	0.0	1.60E+00	0.0	1.92E+02
26 FE 55	2.89E+03	1.53E+03	4.74E+02	0.0	0.0	8.66E+02	2.83E+02
26 FE 59	4.09E+03	6.61E+03	3.29E+03	0.0	0.0	1.92E+03	6.89E+03
27 CO 58	0.0	2.90E+02	8.87E+02	0.0	0.0	0.0	1.69E+03
27 CO 60	0.0	8.57E+02	2.53E+03	0.0	0.0	0.0	4.75E+03
28 NI 63	1.35E+05	7.23E+03	4.59E+03	0.0	0.0	0.0	4.87E+02
28 NI 65	6.53E+00	6.15E-01	3.59E-01	0.0	0.0	0.0	7.53E+01
29 CU 64	0.0	1.52E+01	9.16E+00	0.0	3.66E+01	0.0	7.12E+02
30 ZN 65	4.96E+04	1.32E+05	8.21E+04	0.0	8.32E+04	0.0	2.32E+04
30 ZN 69	5.02E-04	7.26E-04	6.71E-05	0.0	4.40E-04	0.0	4.58E-02
35 BR 83	0.0	0.0	5.09E-01	0.0	0.0	0.0	0.0
35 BR 85	0.0	0.0	1.64E-76	0.0	0.0	0.0	0.0
37 RB 86	0.0	2.34E+05	1.44E+05	0.0	0.0	0.0	1.51E+04
37 RB 88	0.0	1.01E-11	7.03E-12	0.0	0.0	0.0	4.96E-13
37 RB 89	0.0	5.38E-14	4.78E-14	0.0	0.0	0.0	4.69E-16
38 SR 89	1.65E+05	0.0	4.73E+03	0.0	0.0	0.0	6.41E+03
38 SR 90	1.43E+06	0.0	3.84E+05	0.0	0.0	0.0	2.90E+04
38 SR 91	9.53E+02	0.0	3.60E+01	0.0	0.0	0.0	2.10E+03
38 SR 92	3.18E+01	0.0	1.28E+00	0.0	0.0	0.0	6.03E+02
39 Y 90	4.05E+00	0.0	1.09E-01	0.0	0.0	0.0	1.15E+04
39 Y 91M	1.19E-06	0.0	4.33E-08	0.0	0.0	0.0	2.33E-03
39 Y 91	7.03E+01	0.0	1.88E+00	0.0	0.0	0.0	9.36E+03
39 Y 92	2.68E-02	0.0	7.68E-04	0.0	0.0	0.0	7.76E+02
39 Y 93	4.63E-01	0.0	1.27E-02	0.0	0.0	0.0	6.91E+03
40 ZR 95	9.13E+00	2.01E+00	1.79E+00	0.0	2.87E+00	0.0	2.09E+03
40 ZR 97	3.28E-01	4.74E-02	2.80E-02	0.0	6.81E-02	0.0	7.18E+03
41 NB 95	1.18E+03	4.59E+02	3.28E+02	0.0	4.31E+02	0.0	8.48E+05
42 MO 99	0.0	1.04E+03	2.58E+02	0.0	2.23E+03	0.0	8.62E+02
43 TC 99M	1.85E-02	3.63E-02	6.02E-01	0.0	5.28E-01	1.84E-02	2.07E+01
43 TC 101	4.19E-17	4.39E-17	5.56E-16	0.0	7.48E-16	2.32E-17	1.39E-16
44 RU 103	6.58E+01	0.0	2.53E+01	0.0	1.66E+02	0.0	1.70E+03
44 RU 105	7.52E-01	0.0	2.73E-01	0.0	6.61E+00	0.0	4.91E+02
44 RU 106	1.06E+03	0.0	1.33E+02	0.0	1.44E+03	0.0	1.65E+04
47 AG 100M	4.16E+01	2.81E+01	2.25E+01	0.0	5.24E+01	0.0	3.34E+03
52 TE 125M	8.84E+03	2.40E+03	1.18E+03	2.48E+03	0.0	0.0	8.53E+03
52 TE 127M	2.25E+04	6.07E+03	2.67E+03	5.39E+03	6.42E+04	0.0	1.82E+04
52 TE 127	7.07E+01	1.91E+01	1.52E+01	4.89E+01	2.01E+02	0.0	2.76E+03
52 TE 129M	3.75E+04	1.05E+04	5.81E+03	1.21E+04	1.10E+05	0.0	4.57E+04
52 TE 129	7.60E-03	2.12E-03	1.80E-03	5.42E-03	2.22E-02	0.0	4.73E-01
52 TE 131M	3.34E+03	1.15E+03	1.23E+03	2.37E+03	1.12E+04	0.0	4.68E+04
52 TE 131	1.36E-08	4.16E-09	4.06E-09	1.04E-08	4.13E-08	0.0	7.17E-08
52 TE 132	6.47E+03	2.86E+03	3.46E+03	4.17E+03	2.66E+04	0.0	2.88E+04
53 I 130	1.29E+02	2.61E+02	1.35E+02	2.88E+04	3.90E+02	0.0	1.22E+02
53 I 131	1.63E+03	1.64E+03	9.30E+02	5.41E+05	2.69E+03	0.0	1.46E+02
53 I 132	1.59E+00	2.92E+00	1.34E+00	1.36E+02	4.48E+00	0.0	3.44E+00
53 I 133	3.62E+02	4.47E+02	1.69E+02	8.31E+04	7.46E+02	0.0	1.80E+02
53 I 135	4.01E+01	7.21E+01	3.41E+01	6.39E+03	1.11E+02	0.0	5.49E+01
55 CS 134	8.48E+05	1.39E+06	2.94E+05	0.0	4.31E+05	1.55E+05	7.50E+03
55 CS 136	8.09E+04	2.22E+05	1.44E+05	0.0	1.18E+05	1.77E+04	7.82E+03
55 CS 137	1.19E+06	1.14E+06	1.68E+05	0.0	3.70E+05	1.33E+05	7.11E+03
55 CS 138	3.21E-06	4.46E-06	2.83E-06	0.0	3.14E-06	3.38E-07	2.05E-06
56 BA 139	7.17E-02	3.83E-05	2.08E-03	0.0	3.34E-05	2.25E-05	4.14E+00
56 BA 140	6.48E+03	5.68E+00	3.78E+02	0.0	1.85E+00	3.39E+00	3.29E+03
56 BA 141	2.04E-11	1.14E-14	6.62E-13	0.0	9.86E-15	6.70E-14	1.16E-11
56 BA 142	3.50E-20	2.52E-23	1.95E-21	0.0	2.04E-23	1.48E-23	4.56E-22
57 LA 140	8.99E-01	3.14E-01	1.06E-01	0.0	0.0	0.0	8.76E+03
57 LA 142	1.74E-04	5.54E-05	1.74E-05	0.0	0.0	0.0	1.10E+01
58 CE 141	2.95E+00	1.47E+00	2.18E-01	0.0	6.44E-01	0.0	1.83E+03
58 CE 143	4.06E-01	2.20E+02	3.19E-02	0.0	9.23E-02	0.0	3.22E+03
58 CE 144	1.56E+02	4.89E+01	8.32E+00	0.0	2.71E+01	0.0	1.27E+04
59 PR 143	4.47E+00	1.34E+00	2.22E-01	0.0	7.26E-01	0.0	4.82E+03
59 PR 144	2.65E-15	8.21E-16	1.34E-16	0.0	4.34E-16	0.0	1.77E-12
60 ND 147	3.15E+00	2.55E+00	1.97E-01	0.0	1.40E+00	0.0	4.04E+03
74 W 187	4.79E+02	2.83E+02	1.27E+02	0.0	0.0	0.0	3.98E+04
93 NP 239	4.02E-01	2.88E-02	2.03E-02	0.0	8.34E-02	0.0	2.13E+03

McGuire Nuclear Station
Liquid Effluent Dose - Child Parameters
A_{aoi} mrem/hr per µCi/ml

From Generic Section 3.1.1:

A_{aoi} = the site related ingestion dose commitment factor for an individual of age group, "a", to organ, "o", for each identified principal gamma and beta emitter, "i", in mrem/hr per µCi/ml

A_{aoi} = $1.14E+05\ (U_{aw}\sigma_w/Dw\ \exp(-\lambda_i t_w) + U_{af}\sigma_f BF_i \exp(-\lambda_i t_f))\ DF_{aoi}$

where:
1.14E+05 = 10^6 pCi/µCi x 10^3 ml/kg ÷ 8760 hr/yr

U_{aw} = Water consumption by age group, l/yr

infant	330
child	510
teen	510
adult	730

σ_w, σ_f = Recirculation factors at equilibrium for the water and fish pathways respectively; these factors account for the fraction of discharged water reused by the station
$\sigma_w = 1.26$ $\sigma_f = 2.26$

D_w = Dilution factor from the near field area to the potable water intake = 1.0

U_{af} = Fish consumption by age group, kg/yr

infant	---
child	6.9
teen	16
adult	21

BF_i = Bioaccumulation factor for radionuclide, "i", in fish, pCi/kg per pCi/l, from Table 3.1-1

DF_{aoi} = Dose conversion factor for age group, "a", in organ, "o", for radionuclide, "i", in mrem/pCi, from Tables 3.1-2, 3.1-3, 3.1-4, and 3.1-5, respectively

λ_i = radiological decay constant for isotope, i, in 1/hr

t_w, t_f = transport time for the drinking water and fish pathways, hr
t_w = 12 hours t_f = 24 hours

Sample Calculation for Child, I-131, Thyroid:
A(c,thy,I-131) = 1.14E5 (510*1.26/1.0*exp(-3.59E-3*12) + 6.9*2.26*15* exp(-3.59E-3*24)) 5.72E-3 = 5.41E5 mr/hr per µCi/ml

MCGUIRE NUCLEAR STATION
LIQUID EFFLUENT DOSE - INFANT PARAMETERS
A(I) MREM/HR PER UCI/ML

RADIONUCLIDE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
1 H 3	0.0	1.46E+01	1.46E+01	1.46E+01	1.46E+01	1.46E+01	1.46E+01
11 NA 24	2.75E+02	2.75E+02	2.75E+02	2.75E+02	2.75E+02	2.75E+02	2.75E+02
24 CR 51	0.0	0.0	6.60E-01	4.31E-01	9.41E-02	8.38E-01	1.92E+01
25 MN 54	0.0	9.42E+02	2.14E+02	0.0	2.09E+02	0.0	3.46E+02
25 MN 56	0.0	1.52E+00	2.62E-01	0.0	1.31E+00	0.0	1.38E+02
26 FE 55	6.59E+02	4.26E+02	1.14E+02	0.0	0.0	2.08E+02	5.40E+01
26 FE 59	1.45E+03	2.53E+03	9.97E+02	0.0	0.0	7.48E+02	1.21E+03
27 CO 58	0.0	1.70E+02	4.24E+02	0.0	0.0	0.0	4.23E+02
27 CO 60	0.0	5.12E+02	1.21E+03	0.0	0.0	0.0	1.22E+03
28 NI 63	3.01E+04	1.86E+03	1.04E+03	0.0	0.0	0.0	9.24E+01
28 NI 65	8.21E+00	9.30E-01	4.23E-01	0.0	0.0	0.0	7.08E+01
29 CU 64	0.0	1.50E+01	6.93E+00	0.0	2.53E+01	0.0	3.07E+02
30 ZN 65	8.71E+02	2.99E+03	1.38E+03	0.0	1.45E+03	0.0	2.52E+03
30 ZN 69	6.87E-04	1.24E-03	9.21E-05	0.0	5.14E-04	0.0	1.01E-01
35 BR 83	0.0	0.0	5.31E-01	0.0	0.0	0.0	0.0
35 BR 85	0.0	0.0	2.26E-76	0.0	0.0	0.0	0.0
37 RB 86	0.0	7.91E+03	3.91E+03	0.0	0.0	0.0	2.02E+02
37 RB 88	0.0	1.72E-11	9.40E-12	0.0	0.0	0.0	1.67E-11
37 RB 89	0.0	8.51E-14	5.86E-14	0.0	0.0	0.0	2.90E-14
38 SR 89	1.18E+05	0.0	3.39E+03	0.0	0.0	0.0	2.43E+03
38 SR 90	5.92E+05	0.0	1.60E+05	0.0	0.0	0.0	1.09E+04
38 SR 91	9.86E+02	0.0	3.57E+01	0.0	0.0	0.0	1.17E+03
38 SR 92	4.24E+01	0.0	1.57E+00	0.0	0.0	0.0	4.57E+02
39 Y 90	3.62E+00	0.0	9.70E-02	0.0	0.0	0.0	5.00E+03
39 Y 91M	1.63E-06	0.0	5.56E-08	0.0	0.0	0.0	5.44E-03
39 Y 91	5.32E+01	0.0	1.42E+00	0.0	0.0	0.0	3.82E+03
39 Y 92	3.49E-02	0.0	9.80E-04	0.0	0.0	0.0	6.66E+02
39 Y 93	5.05E-01	0.0	1.37E-02	0.0	0.0	0.0	3.99E+03
40 ZR 95	9.71E+00	2.37E+00	1.68E+00	0.0	2.55E+00	0.0	1.18E+03
40 ZR 97	4.29E-01	7.36E-02	3.36E-02	0.0	7.42E-02	0.0	4.69E+03
41 NB 95	1.97E+00	8.12E-01	4.69E-01	0.0	5.82E-01	0.0	6.85E+02
42 MO 99	0.0	1.42E+03	2.77E+02	0.0	2.12E+03	0.0	4.68E+02
43 TC 99M	2.28E-02	4.71E-02	6.07E-01	0.0	5.07E-01	2.46E-02	1.37E+01
43 TC 101	5.75E-17	7.25E-17	7.17E-16	0.0	8.62E-16	3.95E-17	1.23E-14
44 RU 103	6.95E+01	0.0	2.33E+01	0.0	1.45E+02	0.0	8.46E+02
44 RU 105	9.89E-01	0.0	3.33E-01	0.0	7.27E+00	0.0	3.93E+02
44 RU 106	1.14E+03	0.0	1.43E+02	0.0	1.35E+03	0.0	8.67E+03
47 AG 100M	4.71E+01	3.44E+01	2.28E+01	0.0	4.92E+01	0.0	1.78E+03
52 TE 125M	1.10E+03	3.67E+02	1.48E+02	3.69E+02	0.0	0.0	5.23E+02
52 TE 127M	2.76E+03	9.17E+02	3.35E+02	7.99E+02	6.80E+03	0.0	1.12E+03
52 TE 127	1.95E+01	6.52E+00	4.19E+00	1.58E+01	4.75E+01	0.0	4.09E+02
52 TE 129M	4.69E+03	1.61E+03	7.22E+02	1.80E+03	1.17E+04	0.0	2.80E+03
52 TE 129	1.03E-02	3.57E-03	2.41E-03	8.67E-03	2.58E-02	0.0	8.27E-01
52 TE 131M	5.46E+02	2.20E+02	1.81E+02	4.45E+02	1.51E+03	0.0	3.70E+03
52 TE 131	1.87E-08	6.91E-09	5.25E-09	1.67E-08	4.79E-08	0.0	7.56E-07
52 TE 132	8.87E+02	4.39E+02	4.10E+02	6.48E+02	2.74E+03	0.0	1.62E+03
53 I 130	1.45E+02	3.19E+02	1.28E+02	3.58E+04	3.50E+02	0.0	6.84E+01
53 I 131	1.63E+03	1.92E+03	8.44E+02	6.31E+05	2.24E+03	0.0	6.86E+01
53 I 132	2.12E+00	4.30E+00	1.53E+00	2.01E+02	4.79E+00	0.0	3.48E+00
53 I 133	3.97E+02	5.79E+02	1.69E+02	1.05E+05	6.80E+02	0.0	9.79E+01
53 I 135	4.89E+01	9.72E+01	3.54E+01	8.71E+03	1.08E+02	0.0	3.52E+01
55 CS 134	1.79E+04	3.33E+04	3.36E+03	0.0	8.58E+03	3.52E+03	9.05E+01
55 CS 136	2.12E+03	6.23E+03	2.33E+03	0.0	2.48E+03	5.08E+02	9.46E+01
55 CS 137	2.47E+04	2.90E+04	2.05E+03	0.0	7.77E+03	3.15E+03	9.05E+01
55 CS 138	4.38E-06	7.12E-06	3.45E-06	0.0	3.55E-06	5.54E-07	1.14E-05
56 BA 139	9.87E-02	6.54E-05	2.86E-03	0.0	3.93E-05	3.96E-05	6.25E+00
56 BA 140	7.89E+03	7.89E+00	4.06E+02	0.0	1.87E+00	4.84E+00	1.94E+03
56 BA 141	2.80E-11	1.92E-14	8.82E-13	0.0	1.15E-14	1.17E-14	3.42E-10
56 BA 142	4.77E-20	3.96E-23	2.35E-21	0.0	2.28E-23	2.40E-23	1.97E-19
57 LA 140	8.14E-01	3.21E-01	8.25E-02	0.0	0.0	0.0	3.77E+03
57 LA 142	2.36E-04	8.65E-05	2.07E-05	0.0	0.0	0.0	1.47E+01
58 CE 141	3.69E+00	2.25E+00	2.65E-01	0.0	6.94E-01	0.0	1.16E+03
58 CE 143	5.46E-01	3.62E+02	4.13E-02	0.0	1.05E-01	0.0	2.11E+03
58 CE 144	1.41E+02	5.78E+01	7.91E+00	0.0	2.33E+01	0.0	8.10E+03
59 PR 143	3.76E+00	1.40E+00	1.86E-01	0.0	5.22E-01	0.0	1.98E+03
59 PR 144	3.65E-15	1.41E-15	1.84E-16	0.0	5.11E-16	0.0	6.56E-11
60 ND 147	2.54E+00	2.61E+00	1.60E-01	0.0	1.01E+00	0.0	1.65E+03
74 W 187	3.02E+01	2.10E+01	7.26E+00	0.0	0.0	0.0	1.24E+03
93 NP 239	4.54E-01	4.06E-02	2.30E-02	0.0	8.10E-02	0.0	1.17E+03

McGuire Nuclear Station
Liquid Effluent Dose - Infant Parameters
A_{aoi} mrem/hr per µCi/ml

From Generic Section 3.1.1:

A_{aoi} = the site related ingestion dose commitment factor for an individual of age group, "a", to organ, "o", for each identified principal gamma and beta emitter, "i", in mrem/hr per µCi/ml

A_{aoi} = $1.14E+05 \, (U_{aw}\sigma_w/Dw \, \exp(-\lambda_i t_w) + U_{af}\sigma_f BF_i \exp(-\lambda_i t_f)) \, DF_{aoi}$

where:
1.14E+05 = 10^6 pCi/µCi x 10^3 ml/kg ÷ 8760 hr/yr

U_{aw} = Water consumption by age group, l/yr

infant	330
child	510
teen	510
adult	730

σ_w, σ_f = Recirculation factors at equilibrium for the water and fish pathways respectively; these factors account for the fraction of discharged water reused by the station
$\sigma_w = 1.26$ $\sigma_f = 2.26$

D_w = Dilution factor from the near field area to the potable water intake = 1.0

U_{af} = Fish consumption by age group, kg/yr

infant	---
child	6.9
teen	16
adult	21

BF_i = Bioaccumulation factor for radionuclide, "i", in fish, pCi/kg per pCi/l, from Table 3.1-1

DF_{aoi} = Dose conversion factor for age group, "a", in organ, "o", for radionuclide, "i", in mrem/pCi, from Tables 3.1-2, 3.1-3, 3.1-4, and 3.1-5, respectively

λ_i = radiological decay constant for isotope, i, in 1/hr

t_w, t_f = transport time for the drinking water and fish pathways, hr
t_w = 12 hours t_f = 24 hours

Sample Calculation for Infant, I-131, Thyroid:
A(i,thy,I-131) = 1.14E5 (330*1.26/1.0*exp(-3.59E-3*12) + 0*2.26*15* exp(-3.59E-3*24)) 1.39E-2 = 6.31E5 mr/hr per µCi/ml

Table B4.0-7 - Meteorological Parameter and Applicable Pathways for Potential Worst-Case Offsite Locations for Analyzing Offsite Doses From Particulates, Iodine and Other Radionuclides

Ground Level Release Worst-Case Locations *

	$(\overline{X/Q})$ sec/m^3	$(\overline{D/Q})$ 1/m^2
(1) Inhalation, 0.5 mi, NNE	7.611E-05	1.403E-07
(2) Garden, 0.85 mi, ESE	1.206E-05	3.299E-08
(3) Meat Animal, 1.32 mi, WSW	1.671E-06	1.114E-08
(4) Milk Animal, 1.40 mi, ESE	3.143E-06	8.052E-09
(5) Combination, 0.5 mi, NNE	7.611E-05	1.403E-07

* The Ground Plane and Inhalation pathways are assumed to exist in each sector for dose calculation purposes. All pathways are assumed to exist at the 5.0-mile boundary in each sector for dose calculation purposes.

TABLE B4.0-8

PATHWAY APPLICABILITY FOR ALL LOCATIONS BASED ON SITE SURVEY*
MCGUIRE NUCLEAR STATION
(1 of 1)

Distance to the control location in miles

SECTOR	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	X	I	I	I	I	VI	VI	VI	VI	VIMG
NNE	X	I	I	I	I	VI	VI	VI	VI	VIMG
NE	X	I	I	I	VI	VI	VI	VI	VI	VIMG
ENE	X	I	I	I	I	VI	VI	VIMC	VIMC	VIMG
E	X	VI	VI	VI	VIC	VIC	VIC	VIC	VIMC	VIMG
ESE	X	VI	VIMG	VIMG	VIMG	VIMG	VIMG	VIMG	VIMG	VIMG
SE	X	I	VI	VI	VI	VIM	VIM	VIM	VIM	VIMG
SSE	X	I	VIMG	VIMG	VIMG	VIMG	VIMG	VIMG	VIMG	VIMG
S	X	I	I	I	I	I	VIM	VIM	VIMG	VIMG
SSW	X	I	I	I	I	VIM	VIMG	VIMG	VIMG	VIMG
SW	X	I	I	VI	VI	VI	VI	VI	VI	VIMG
WSW	X	I	VIM	VIM	VIM	VIM	VIM	VIMG	VIMG	VIMG
W	X	VI	VI	VI	VI	VI	VIM	VIMG	VIMG	VIMG
WNW	X	I	I	I	VI	VI	VI	VI	VI	VIMG
NW	X	I	VI	VI	VI	VI	VI	VIM	VIM	VIMG
NNW	X	I	I	VI	VI	VI	VI	VIM	VIM	VIMG

PATHWAYS: X - None V - VEGETABLE M - MEAT G - GOAT MILK C - COW MILK I - INHALATION

* **The Inhalation pathway is assumed to exist in each sector for dose calculational purposes. All pathways are assumed to exist at the 5.0-mile boundary in each sector for dose calculational purposes.**

FIGURE B4.0-1
(1 of 2)

McGUIRE LADTAP INPUT TEMPLATE
FOR LIQUID RADIONUCLIDE RELEASE OFFSITE DOSE CALCULATIONS

```
****** ***************************** TOP OF DATA ******************************
Column ----+----1----+----2----+----3----+----4----+----5----+----6----+----7--
LADTAP INPUT FOR McGUIRE ODCM METHOD - DEFAULT DILUTION
          0   3.3E+03       1.0
       1.0
LIQUID RELEASE SOURCE TERMS - CURIES PER RELEASE PERIOD
H 3          0.00E+00
NA24         0.00E+00
CR51         0.00E+00
MN54         0.00E+00
MN56         0.00E+00
FE55         0.00E+00
FE59         0.00E+00
CO58         0.00E+00
CO60         0.00E+00
NI63         0.00E+00
NI65         0.00E+00
CU64         0.00E+00
ZN65         0.00E+00
CN69         0.00E+00
BR83         0.00E+00
BR85         0.00E+00
RB86         0.00E+00
RB88         0.00E+00
RB89         0.00E+00
SR89         0.00E+00
SR90         0.00E+00
SR91         0.00E+00
SR92         0.00E+00
Y 90         0.00E+00
Y 91 M       0.00E+00
Y 91         0.00E+00
Y 92         0.00E+00
Y 93         0.00E+00
ZR95         0.00E+00
ZR97         0.00E+00
NB95         0.00E+00
MO99         0.00E+00
TC99 M       0.00E+00
TC101        0.00E+00
RU103        0.00E+00
RU105        0.00E+00
RU106        0.00E+00
AG110M       0.00E+00
TE125M       0.00E+00
TE127M       0.00E+00
TE127        0.00E+00
TE129M       0.00E+00
TE129        0.00E+00
TE131M       0.00E+00
TE131        0.00E+00
TE132        0.00E+00
I 130        0.00E+00
I 131        0.00E+00
I 132        0.00E+00
I 133        0.00E+00
I 135        0.00E+00
CS134        0.00E+00
CS136        0.00E+00
CS137        0.00E+00
CS138        0.00E+00
```

FIGURE B4.0-1
(2 of 2)

McGUIRE LADTAP INPUT TEMPLATE
FOR LIQUID RADIONUCLIDE RELEASE OFFSITE DOSE CALCULATIONS

```
Column ----+----1----+----2----+----3----+----4----+----5----+----6----+----7--
000060  BA139     0.00E+00
000061  BA140     0.00E+00
000062  BA141     0.00E+00
000063  BA142     0.00E+00
000064  LA140     0.00E+00
000065  LA142     0.00E+00
000066  CE141     0.00E+00
000067  CE143     0.00E+00
000068  CE144     0.00E+00
000069  PR143     0.00E+00
000070  PR144     0.00E+00
000071  ND147     0.00E+00
000072  W 187     0.00E+00
000073  NP239     0.00E+00
000074
000075
000076                 0.3    0.4425    0.4425    0.7937      0.0       0.0
000077
000078
000079
****** ****************************** BOTTOM OF DATA ***************************
```

FIGURE B4.0-2

MCGUIRE GASPAR INPUT TEMPLATE

FOR NOBLE GAS RADIONUCLIDE RELEASE WORST-CASE LOCATION

```
****** ****************************** TOP OF DATA ******************************
=COLS> ----+----1----+----2----+----3----+----4----+----5----+----6----+----7--
000001 GASPAR INPUT FOR MCGUIRE ODCM METHOD - MAX NOBLE GAS DOSE CALCULATIONS
000002  0          0.0        0.0        0.0        0.0
000003  1 1
000004       1.0       1.0       1.0     0.76      1.0
000005 NOBLE GAS SOURCE TERM - CURIES PER RELEASE PERIOD
000006         1.0
000007   AR41      0.00E+00
000008   KR83 M    0.00E+00
000009   KR85      0.00E+00
000010   KR85 M    0.00E+00
000011   KR87      0.00E+00
000012   KR88      0.00E+00
000013   KR90      0.00E+00
000014   XE131M    0.00E+00
000015   XE133     0.00E+00
000016   XE133M    0.00E+00
000017   XE135     0.00E+00
000018   XE135M    0.00E+00
000019   XE137     0.00E+00
000020   XE138     0.00E+00
000021
000022   LOCATION 1        NNE 0.50   7.611E-05 7.611E-05 7.611E-05 1.403E-07
000023
****** ***************************** BOTTOM OF DATA ****************************
```

FIGURE 84.0-3

MCGUIRE GASPAR INPUT TEMPLATE
FOR PARTICULATE, IODINE AND OTHER NUCLIDES WORST-CASE LOCATIONS

```
****** ****************************** TOP OF DATA ******************************
=COLS> ----+----1----+----2----+----3----+----4----+----5----+----6----+----7--
000001 GASPAR INPUT FOR MCGUIRE ODCM METHOD - PART, I, AND OTHER - INHALATION
000002 0         0.0       0.0       0.0       0.0
000003 1 1
000004      1.0      1.0      1.0     0.76      1.0
000005 PART, I AND OTHER NUCLIDES SOURCE - CURIES PER RELEASE PERIOD
000006        1.0
000007  H 3       0.00E+00
000008  CR51      0.00E+00
000009  MN54      0.00E+00
000010  FE55      0.00E+00
000011  FE59      0.00E+00
000012  CO58      0.00E+00
000013  CO60      0.00E+00
000014  ZN65      0.00E+00
000015  SR89      0.00E+00
000016  SR90      0.00E+00
000017  ZR95      0.00E+00
000018  MO99      0.00E+00
000019  I 131     0.00E+00
000020  I 133     0.00E+00
000021  CS134     0.00E+00
000022  CS136     0.00E+00
000023  CS137     0.00E+00
000024  BA140     0.00E+00
000025  CE141     0.00E+00
000026  CE144     0.00E+00
000027
000028  LOCATION 1      NNE 0.50   7.611E-05 7.611E-05 7.611E-05 1.403E-07
000029
****** **************************** BOTTOM OF DATA ****************************
```

<u>FOR OTHER LOCATIONS, REPLACE FOLLOWING INPUT LINES:</u>

LOCATION 2 - WORST VEGETABLE GARDEN

```
000001 GASPAR INPUT FOR MCGUIRE ODCM METHOD - PART, I, AND OTHER - GARDEN
000002 0         1.0       0.0       0.0       0.0
000028  LOCATION 2      ESE 0.85   1.206E-05 1.206E-05 1.206E-05 3.299E-08
```

LOCATION 3 - WORST MEAT ANIMAL

```
000001 GASPAR INPUT FOR MCGUIRE ODCM METHOD - PART, I, AND OTHER - MEAT
000002 0         1.0       1.0       0.0       1.0
000028  LOCATION 3      WSW 1.32   1.671E-06 1.671E-06 1.671E-06 1.114E-08
```

LOCATION 4 - WORST MILK ANIMAL

```
000001 GASPAR INPUT FOR MCGUIRE ODCM METHOD - PART, I, AND OTHER - MILK
000002 0         1.0       1.0       0.0       1.0
000028  LOCATION 4      ESE 1.40   3.143E-06 3.143E-06 3.143E-06 8.052E-09
```

LOCATION 5 - WORST COMBINATION

```
000001 GASPAR INPUT FOR MCGUIRE ODCM METHOD - PART, I, AND OTHER - COMBINATION
000002 0         0.0       0.0       0.0       0.0
000028  LOCATION 5      NNE 0.50   7.611E-05 7.611E-05 7.611E-05 1.403E-07
```

Figure B4.0-4 - Fuel Cycle Dose Calculation Worksheet For Potential Worst-Case Offsite Locations

Ground Level Release Worst-Case Locations *

	$(\overline{X/Q})$ sec/m³	$(\overline{D/Q})$ 1/m²
(1) Inhalation, 0.5 mi, NNE	7.611E-05	1.403E-07
(2) Garden, 0.85 mi, ESE	1.206E-05	3.299E-08
(3) Meat Animal, 1.32 mi, WSW	1.671E-06	1.114E-08
(4) Milk Animal, 1.40 mi, ESE	3.143E-06	8.052E-09
(5) Combination, 0.5 mi, NNE	7.611E-05	1.403E-07

* The Ground Plane and Inhalation pathways are assumed to exist in each sector for dose calculation purposes. All pathways are assumed to exist at the 5.0-mile boundary in each sector for dose calculation purposes.

Figure B4.0-4 (Cont'd) - Fuel Cycle Dose Calculation Worksheet for Organ Doses

Adult Age Group

Location 1 - Worst-Case Inhalation/Ground Location *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	____	____	____	____	____	____	____
$D_{a,o}(g)$	____	____	____	____	____	____	____
$D_{a,o}(T)$	____	____	____	____	____	____	____

Location 2 - Worst-Case Vegetable Garden Location *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	____	____	____	____	____	____	____
$D_{a,o}(g)$	____	____	____	____	____	____	____
$D_{a,o}(T)$	____	____	____	____	____	____	____

Location 3 - Worst-Case Meat Animal Location *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	____	____	____	____	____	____	____
$D_{a,o}(g)$	____	____	____	____	____	____	____
$D_{a,o}(T)$	____	____	____	____	____	____	____

Location 4 - Worst-Case Milk Animal Location *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	____	____	____	____	____	____	____
$D_{a,o}(g)$	____	____	____	____	____	____	____
$D_{a,o}(T)$	____	____	____	____	____	____	____

Figure B4.0-4 (Cont'd) - Fuel Cycle Dose Calculation Worksheet for Organ Doses

Location 5_1 - Worst-Case Combination 1,2...N Location(s) *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	____	____	____	____	____	____	____
$D_{a,o}(g)$	____	____	____	____	____	____	____
$D_{a,o}(T)$	____	____	____	____	____	____	____

Location 5_2 - Worst-Case Combination 1,2...N Location(s) *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	____	____	____	____	____	____	____
$D_{a,o}(g)$	____	____	____	____	____	____	____
$D_{a,o}(T)$	____	____	____	____	____	____	____

Location 5_N - Worst-Case Combination 1,2...N Location(s) *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	____	____	____	____	____	____	____
$D_{a,o}(g)$	____	____	____	____	____	____	____
$D_{a,o}(T)$	____	____	____	____	____	____	____

Adult Organ Maximums**

Maximum Total

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(T_{max})$	____	____	____	____	____	____	____

Figure B4.0-4 (Cont'd) - Fuel Cycle Dose Calculation Worksheet for Organ Doses

Teen Age Group

Location 1 - Worst-Case Inhalation/Ground Location *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	____	____	____	____	____	____	____
$D_{a,o}(g)$	____	____	____	____	____	____	____
$D_{a,o}(T)$	____	____	____	____	____	____	____

Location 2 - Worst-Case Vegetable Garden Location *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	____	____	____	____	____	____	____
$D_{a,o}(g)$	____	____	____	____	____	____	____
$D_{a,o}(T)$	____	____	____	____	____	____	____

Location 3 - Worst-Case Meat Animal Location *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	____	____	____	____	____	____	____
$D_{a,o}(g)$	____	____	____	____	____	____	____
$D_{a,o}(T)$	____	____	____	____	____	____	____

Location 4 - Worst-Case Milk Animal Location *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	____	____	____	____	____	____	____
$D_{a,o}(g)$	____	____	____	____	____	____	____
$D_{a,o}(T)$	____	____	____	____	____	____	____

Figure B4.0-4
(4 of 10)

Figure B4.0-4 (Cont'd) - Fuel Cycle Dose Calculation Worksheet for Organ Doses

Location 5_1 - Worst-Case Combination 1,2...N Location(s) *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	______	______	______	______	______	______	______
$D_{a,o}(g)$	______	______	______	______	______	______	______
$D_{a,o}(T)$	______	______	______	______	______	______	______

Location 5_2 - Worst-Case Combination 1,2...N Location(s) *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	______	______	______	______	______	______	______
$D_{a,o}(g)$	______	______	______	______	______	______	______
$D_{a,o}(T)$	______	______	______	______	______	______	______

Location 5_N - Worst-Case Combination 1,2...N Location(s) *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	______	______	______	______	______	______	______
$D_{a,o}(g)$	______	______	______	______	______	______	______
$D_{a,o}(T)$	______	______	______	______	______	______	______

Teen Organ Maximums**

Maximum Total

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(T_{max})$	______	______	______	______	______	______	______

Figure B4.0-4
(5 of 10)

Figure B4.0-4 (Cont'd) - Fuel Cycle Dose Calculation Worksheet for Organ Doses

Child Age Group

Location 1 - Worst-Case Inhalation/Ground Location *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	____	____	____	____	____	____	____
$D_{a,o}(g)$	____	____	____	____	____	____	____
$D_{a,o}(T)$	____	____	____	____	____	____	____

Location 2 - Worst-Case Vegetable Garden Location *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	____	____	____	____	____	____	____
$D_{a,o}(g)$	____	____	____	____	____	____	____
$D_{a,o}(T)$	____	____	____	____	____	____	____

Location 3 - Worst-Case Meat Animal Location *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	____	____	____	____	____	____	____
$D_{a,o}(g)$	____	____	____	____	____	____	____
$D_{a,o}(T)$	____	____	____	____	____	____	____

Location 4 - Worst-Case Milk Animal Location *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	____	____	____	____	____	____	____
$D_{a,o}(g)$	____	____	____	____	____	____	____
$D_{a,o}(T)$	____	____	____	____	____	____	____

Figure B4.0-4
(6 of 10)

Figure B4.0-4 (Cont'd) - Fuel Cycle Dose Calculation Worksheet for Organ Doses

Location 5_1 - Worst-Case Combination 1,2...N Location(s) *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	______	______	______	______	______	______	______
$D_{a,o}(g)$	______	______	______	______	______	______	______
$D_{a,o}(T)$	______	______	______	______	______	______	______

Location 5_2 - Worst-Case Combination 1,2...N Location(s) *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	______	______	______	______	______	______	______
$D_{a,o}(g)$	______	______	______	______	______	______	______
$D_{a,o}(T)$	______	______	______	______	______	______	______

Location 5_N - Worst-Case Combination 1,2...N Location(s) *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	______	______	______	______	______	______	______
$D_{a,o}(g)$	______	______	______	______	______	______	______
$D_{a,o}(T)$	______	______	______	______	______	______	______

Child Organ Maximums**

Maximum Total

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(T_{max})$	______	______	______	______	______	______	______

Figure B4.0-4 (Cont'd) - Fuel Cycle Dose Calculation Worksheet for Organ Doses

Infant Age Group

Location 1 - Worst-Case Inhalation/Ground Location *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	___	___	___	___	___	___	___
$D_{a,o}(g)$	___	___	___	___	___	___	___
$D_{a,o}(T)$	___	___	___	___	___	___	___

Location 2 - Worst-Case Vegetable Garden Location *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	___	___	___	___	___	___	___
$D_{a,o}(g)$	___	___	___	___	___	___	___
$D_{a,o}(T)$	___	___	___	___	___	___	___

Location 3 - Worst-Case Meat Animal Location *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	___	___	___	___	___	___	___
$D_{a,o}(g)$	___	___	___	___	___	___	___
$D_{a,o}(T)$	___	___	___	___	___	___	___

Location 4 - Worst-Case Milk Animal Location *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	___	___	___	___	___	___	___
$D_{a,o}(g)$	___	___	___	___	___	___	___
$D_{a,o}(T)$	___	___	___	___	___	___	___

Figure B4.0-4
(8 of 10)

Figure B4.0-4 (Cont'd) - Fuel Cycle Dose Calculation Worksheet for Organ Doses

Location 5_1 - Worst-Case Combination 1,2...N Location(s) *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$							
$D_{a,o}(g)$							
$D_{a,o}(T)$							

Location 5_2 - Worst-Case Combination 1,2...N Location(s) *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$							
$D_{a,o}(g)$							
$D_{a,o}(T)$							

Location 5_N - Worst-Case Combination 1,2...N Location(s) *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$							
$D_{a,o}(g)$							
$D_{a,o}(T)$							

Infant Organ Maximums**

Maximum Total

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(T_{max})$							

Figure B4.0-4
(9 of 10)

All Age Groups

Maximum Organ Dose ***

Organ = **xxxxxxxxxxx**

Age Group = **xxxxxxxxxxx**

Dose = **x.xE-xx mrem/yr**

Notes:

* Fuel cycle dose for each age group, a, and organ, o, at analyzed limiting food pathway locations.
$D_{a,o}(T) = D_{a,o}(l) + D_{a,o}(g)$

** Limiting dose estimates for each organ for age group, a, (maximums of dose values calculated for Locations 1 through 5.)

*** Limiting dose estimate for any organ or age group (maximum of dose values calculated for any age group)

Figure B4.0-4
(10 of 10)

B5.0 RADIOLOGICAL ENVIRONMENTAL MONITORING

The radiological environmental monitoring program shall be conducted in accordance with Selected Licensee Commitment Manual Section 16.11-13. The monitoring program locations and analyses are given in Tables B5.0-1 through B5.0-3 and Figure B5.0-1. Site specific characteristics make groundwater sampling unnecessary. Groundwater recharge is from Lake Norman and local precipitation. The groundwater gradient flows directly to the Catawba River; therefore, contamination of groundwater from liquid effluents is highly improbable. Additionally, two site boundary TLD locations in the N and NNW sectors do not exist since the required locations are over water. However, special interest TLD's have been placed in these sectors on the discharge canal at 0.2 miles.

The Duke Power Radiological and Environmental Services laboratory participates in an interlaboratory comparison program. This program is described in the Annual Environmental Operating Report.

The land-use census data is used to identify the location with the highest possible dose for a particular ingestion pathway (vegetable, milk, meat, etc.). Environmental monitoring measurements taken from these locations are then used to perform dose calculations that serve as a verification of the dose calculations that are performed for technical specification and licensee commitment (i.e., Compliance) purposes.

The dates of the land-use census that were used to identify the controlling receptor sample locations were 06/09/97 - 06/10/97.

The 1997 land-use census did not identify any locations where environmental monitoring samples are required but were not available for collection.

TABLE B5.0-1
(1 of 1)
MCGUIRE RADIOLOGICAL MONITORING PROGRAM SAMPLING LOCATIONS
(TLD LOCATIONS)

SAMPLING LOCATION	DESCRIPTION *		SAMPLING LOCATION	DESCRIPTION *	
143	SITE BOUNDARY	(0.3 MILES NW)	167	4-5 MILE RADIUS	(4.9 MILES SW)
144	SITE BOUNDARY	(0.5 MILES NNE)	168	4-5 MILE RADIUS	(4.6 MILES WSW)
145	SITE BOUNDARY	(0.5 MILES NE)	169	4-5 MILE RADIUS	(4.0 MILES W)
146	SITE BOUNDARY	(0.4 MILES ENE)	170	4-5 MILE RADIUS	(4.3 MILES WNW)
147	SITE BOUNDARY	(0.4 MILES E)	171	4-5 MILE RADIUS	(4.0 MILES NW)
148	SITE BOUNDARY	(0.5 MILES ESE)	172	4-5 MILE RADIUS	(5.7 MILES NNW)
149	SITE BOUNDARY	(0.5 MILES SE)	173	SPECIAL INTEREST	(8.4 MILES NNW)
151	SITE BOUNDARY	(0.4 MILES S)	174	SPECIAL INTEREST	(8.8 MILES WNW)
152	SITE BOUNDARY	(0.4 MILES SSW)	175	CONTROL	(15.5 MILES WNW)
153	SITE BOUNDARY	(0.5 MILES SW)	176	SPECIAL INTEREST	(11.0 MILES SW)
154	SITE BOUNDARY	(0.5 MILES W)	177	SPECIAL INTEREST	(8.8 MILES S)
156	SITE BOUNDARY	(0.5 MILES WNW)	178	SPECIAL INTEREST	(9.3 MILES SE)
157	4-5 MILE RADIUS	(4.7 MILES N)	179	SPECIAL INTEREST	(10.6 MILES ESE)
158	4-5 MILE RADIUS	(4.3 MILES NNE)	180	SPECIAL INTEREST	(12.7 MILES NNE)
159	4-5 MILE RADIUS	(5.0 MILES NE)	181	SPECIAL INTEREST	(7.0 MILES NE)
160	4-5 MILE RADIUS	(4.9 MILES ENE)	182	SPECIAL INTEREST	(6.2 MILES NE)
161	4-5 MILE RADIUS	(4.7 MILES E)	183	SPECIAL INTEREST	(5.8 MILES S)
162	4-5 MILE RADIUS	(4.5 MILES ESE)	186	SPECIAL INTEREST	(0.2 MILES NNW)
163	4-5 MILE RADIUS	(4.9 MILES SE)	187	SPECIAL INTEREST	(0.2 MILES N)
164	4-5 MILE RADIUS	(4.6 MILES SSE)	189	SITE BOUNDARY	(0.4 MILES SSE)
165	4-5 MILE RADIUS	(5.1 MILES S)	190	SITE BOUNDARY	(0.4 MILES WSW)
166	4-5 MILE RADIUS	(5.3 MILES SSW)	191	SPECIAL INTEREST	(2.8 MILES NNE)
			196	SPECIAL INTEREST	(1.0 MILES S)
			197	SPECIAL INTEREST	(1.1 MILES S)
			198	SPECIAL INTEREST	(1.3 MILES S)
			199	SPECIAL INTEREST	(1.5 MILES S)

* All TLD samples are collected quarterly

TABLE B5.0-2
(1 of 1)
MCGUIRE RADIOLOGICAL MONITORING PROGRAM SAMPLING LOCATIONS
(OTHER SAMPLING LOCATIONS)

CODE:

W - Weekly SM - Semimonthly
BW - Biweekly Q - Quarterly
M - Monthly SA - Semiannually

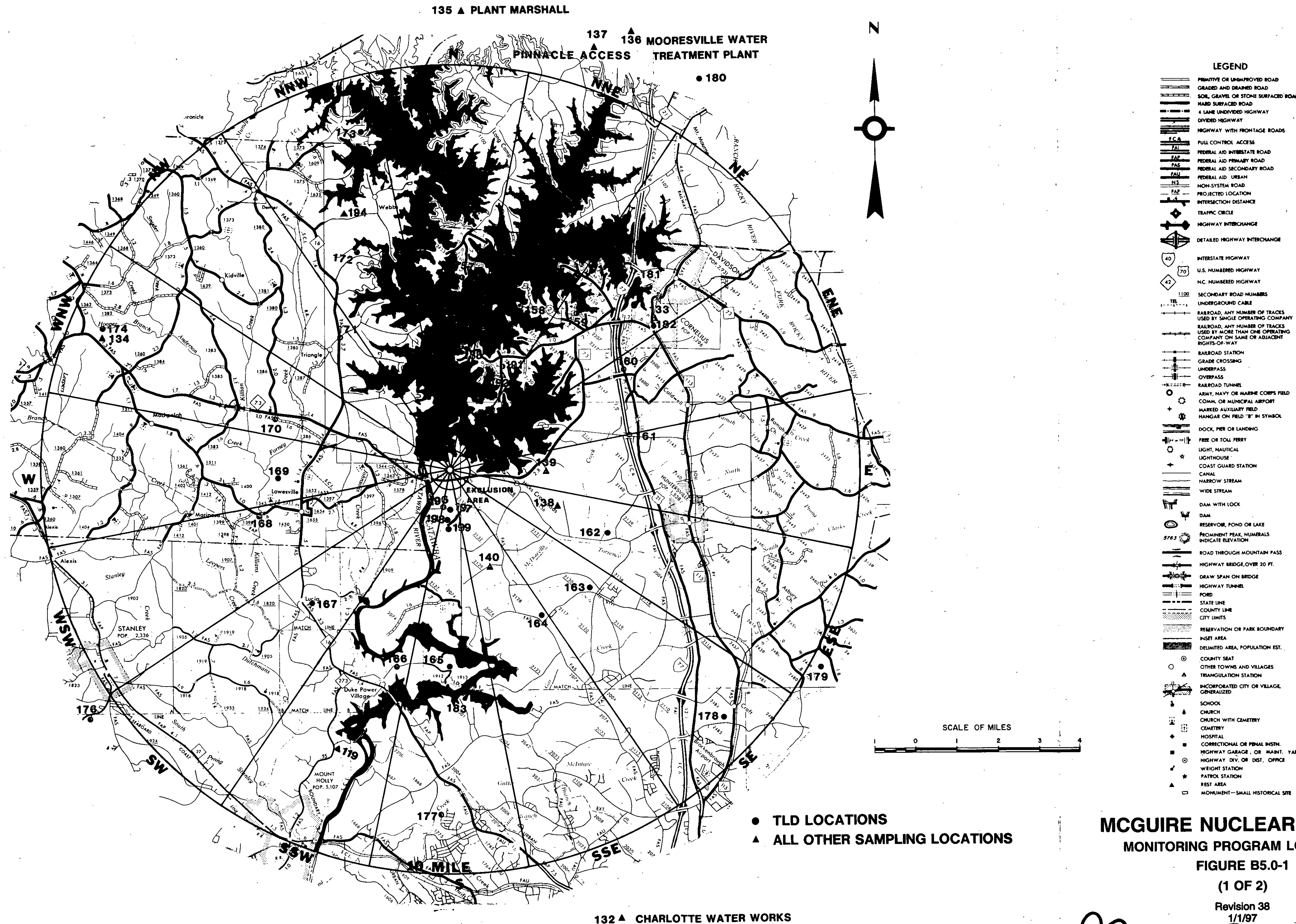
	SAMPLING LOCATION DESCRIPTION	Control Locations	Air Radioiodines and Particulates	Surface Water	Drinking Water	Shoreline Sediment	Food Products	Fish	Milk	Broadleaf Vegetation
119	Mt. Holly Municipal Water Supply (7.4 mi SSW)				BW					
120	Site Boundary (0.5 mi NNE)		W							M[b]
121	Site Boundary (0.5 mi NE)		W							
125	Site Boundary (0.4 mi SW)		W							M[b]
128	Discharge Canal Bridge (0.4 mi NE)			BW						
129	Discharge Canal Entrance to Lake Norman (0.5 mi ENE)					SA		SA		
130	Hwy. 73 Bridge Downstream (0.5 mi SW)					SA				
131	Cowans Ford Dam (0.6 mi WNW)			BW						
132	Charlotte Municipal Water Supply (11.2 mi SSE)				BW					
133	Cornelius (6.2 mi NE)		W							
134	East Lincoln Junior High School (8.8 mi WNW)	X	W							M[b]
135	Plant Marshall Intake Canal (11.9 mi N)	X		BW						
136	Mooresville Municipal Water Supply (12.7 mi NNE)	X			BW					
137	Pinnacle Access Area (12.0 mi N)	X				SA		SA		
138	Henry Cook Dairy (3.1 mi ESE)								SM	
139	William Cook Dairy (2.5 mi E)								SM	
140	Kidd Dairy-Cows (2.8 mi SSE)								SM	
141	Lynch Dairy-Cows (14.8 mi WNW)	X							SM	
188	Garden (2.8 mi N)						M[a]			
192	Peninsula (2.8 mi NNE)		W							
193	Site Boundary (0.2 mi N)									M[b]
194	Lincoln County Water Supply (6.7 mi NNW)				BW					
195	Fishing Access Road (0.2 mi N)		W							

(a) during harvest season
(b) when available

TABLE B5.0-3
(1 of 1)
MCGUIRE RADIOLOGICAL MONITORING PROGRAM ANALYSES

		ANALYSES				
SAMPLE MEDIUM	ANALYSIS SCHEDULE	GAMMA ISOTOPIC	TRITIUM	LOW LEVEL I-131	GROSS BETA	TLD
1. Air Radioiodines	Weekly	X				
2. Air Particulates	Weekly Quarterly	 X			X 	
3. Direct Radiation	Quarterly					X
4. Surface Water	Monthly Composite Quarterly Composite	X 	 X			
5. Drinking Water	Monthly Composite Quarterly Composite	X 	 X		X 	
6. Shoreline Sediment	Semiannually	X				
7. Milk	Semimonthly	X		X		
8. Fish	Semiannually	X				
9. Broadleaf Vegetation	Monthly	X				
10. Food Products	Monthly [(a)]	X				

(a) during harvest season



MCGUIRE NUCLEAR STATION

MONITORING PROGRAM LOCATIONS

FIGURE B5.0-1

(1 OF 2)

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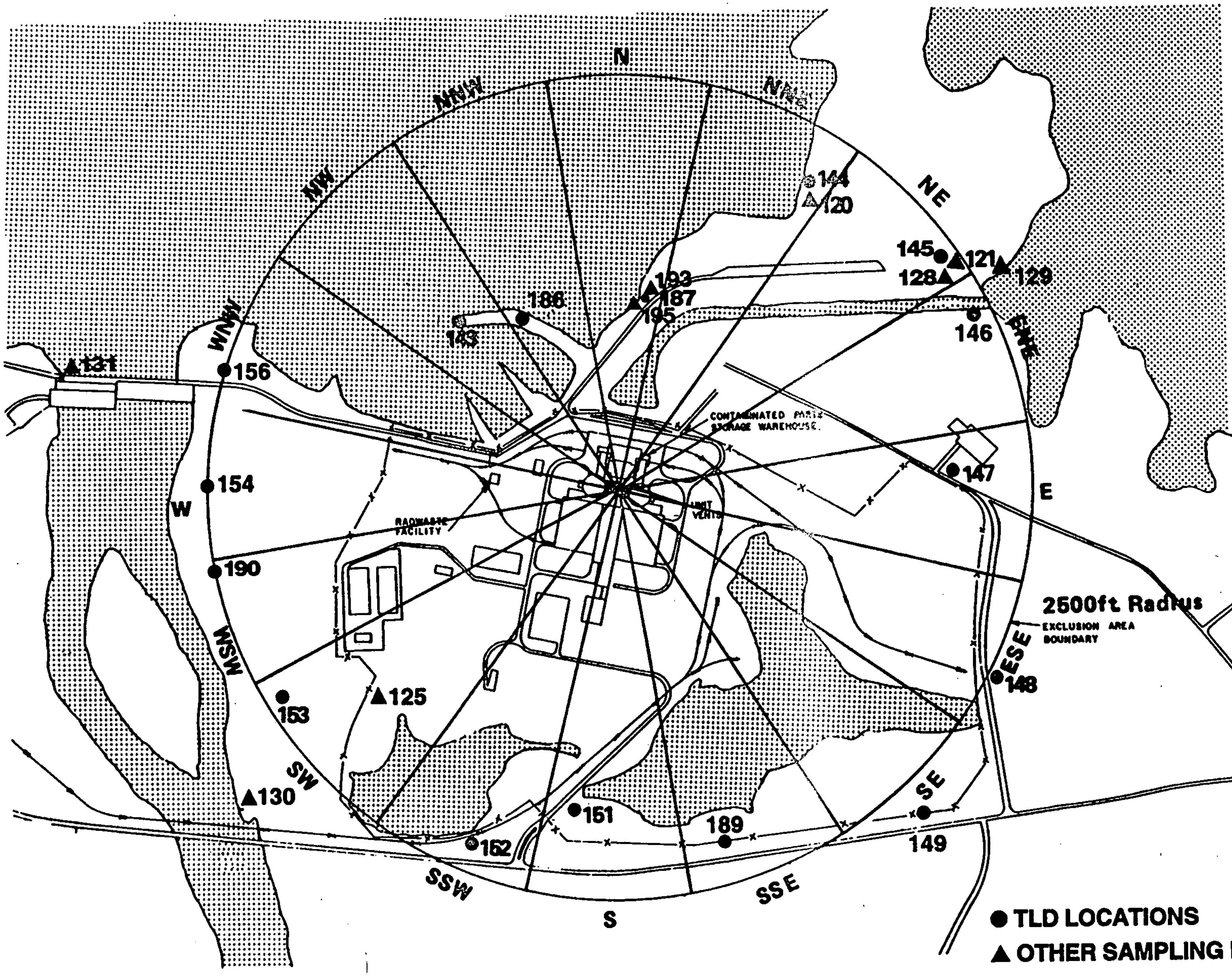


● TLD LOCATIONS

▲ OTHER SAMPLING LOCATIONS

Figure B5.0-1

(2 of 2)

Revision 38
1/1/97

January 1, 1998

Subject: Offsite Dose Calculation Manual (ODCM)
Catawba Nuclear Station Section - Revision 40

The General Office Radiation Protection Staff is transmitting to you this date Revision 40 of the Catawba Offsite Dose Calculation Manual. As this revision only affects Catawba Nuclear Station, the approval of other station managers is not required. A list of affected pages is given below. Please insert this letter with the attached Justification section in front of the January 1, 1997, Revision 39 letter.

REMOVE THESE PAGES	INSERT THESE PAGES
C-3, C-4	C-3, C-4
C-13, C-14	C-13, C-14
Table C4.0-8	Table C4.0-8
Figure C4.0-4 (ten pages)	Figure C4.0-4 (ten pages)
C-15	C-15

Effective Date: 1/1/98

L. E. Haynes, Technical Manager
Radiation Protection

Effective Date: 1/1/98

R. A. Jones, Manager
Catawba Nuclear Station

If you have any questions concerning Revision 40, please call Caryl Ingram at (704) 382-4496.

Caryl D. Ingram, Senior Engineer
Radiation Protection
Station Support Division

Page C-3

Added clarification to the sentence concerning how Catawba's release rate calculations are performed.

Page C-4

Reformatted the WC release source listing. Added the release rate equation for the WC release point.

Pages C-13 and C-14

The changes on both of these pages were to remove information related to McGuire nuclear station effluent dose contributions to Catawba's 40CFR190 fuel cycle dose assessment. Information given in Federal Register, Vol. 42, No. 9 (01/13/77) when 40CFR190 was provided in final form provides guidance for utilities on how to show compliance to 40CFR190. The guidance states that contributions from neighboring nuclear sites outside of ten (10) miles from the immediate site should be ignored in assessing compliance to 40CFR190. Catawba and McGuire are located approximately 30 miles apart, and, therefore, the dose contribution from McGuire to Catawba's 40CFR190 fuel cycle dose assessment is insignificant and does not need to be calculated.

Table C4.0-8

Revised table based on the 1997 land-use census.

Figure C4.0-4 (1 of 10)

Changed revision number to reflect changes to pages 2 of 10 through 10 of 10.

Figure C4.0-4 (2 of 10 through 10 of 10)

Removed McGuire dose contribution input locations in the Catawba 40CFR190 fuel cycle dose calculation worksheet. Information given in Federal Register, Vol. 42, No. 9 (01/13/77) when 40CFR190 was provided in final form provides guidance for utilities on how to show compliance to 40CFR190. The guidance states that contributions from neighboring nuclear sites outside of ten (10) miles from the immediate site should be ignored in assessing compliance to 40CFR190. Catawba and McGuire are located approximately 30 miles apart, and, therefore, the dose contribution from McGuire to Catawba's 40CFR190 fuel cycle dose assessment is insignificant and does not need to be calculated.

Page C-15

Revised land-use census dates.

APPENDIX C

CATAWBA NUCLEAR STATION

SITE SPECIFIC INFORMATION

APPENDIX C - TABLE OF CONTENTS

C1.0 CATAWBA NUCLEAR STATION RADWASTE SYSTEMS

C1.1 LIQUID RADWASTE PROCESSING

The liquid radwaste system at Catawba Nuclear Station (CNS) is used to collect and treat fluid chemical and radiochemical by-products of unit operation. The system produces effluents which can be reused in the plant or discharged in small, dilute quantities to the environment. The means of treatment vary with waste type and desired product in the various systems:

A) Filtration - All waste sources are filtered during processing. In some cases, such as the Laundry and Hot Shower Tank (LHST) Subsystem of the Liquid Waste (WL) System, filtration may be the only treatment required.

B) Adsorption - Adsorption of halides and organic chemicals by activated charcoal (Carbon Filtration) can be used as needed for the waste streams in the WL System.

C) Ion Exchange - Ion exchange is used to remove radioactive cations (cobalt, manganese) and anions (iodone) from the waste streams. This process can be used on all waste streams as needed.

D) Gas Stripping - The fluids processed in the WL System does not contain entrained fission gases. Those fluids that are processed for recycle, however, do contain entrained fission gases. Removal of these gaseous radioactive fission products is accomplished in both the NB and WL Evaporators. These gases are stored in the Waste Gas Holdup System for decay prior to release.

E) Distillation and Concentration - Evaporation is used to process recyclable liquids for reuse in the primary systems. However, the evaporators can be used to process non-recyclable fluids in an emergency situation. In this case, the distillate would be recycled to the primary systems while the concentrates would be solidified and routed to an approved low-level waste disposal site.

Figure C1.0-1 is a schematic representation of the liquid radwaste system at Catawba.

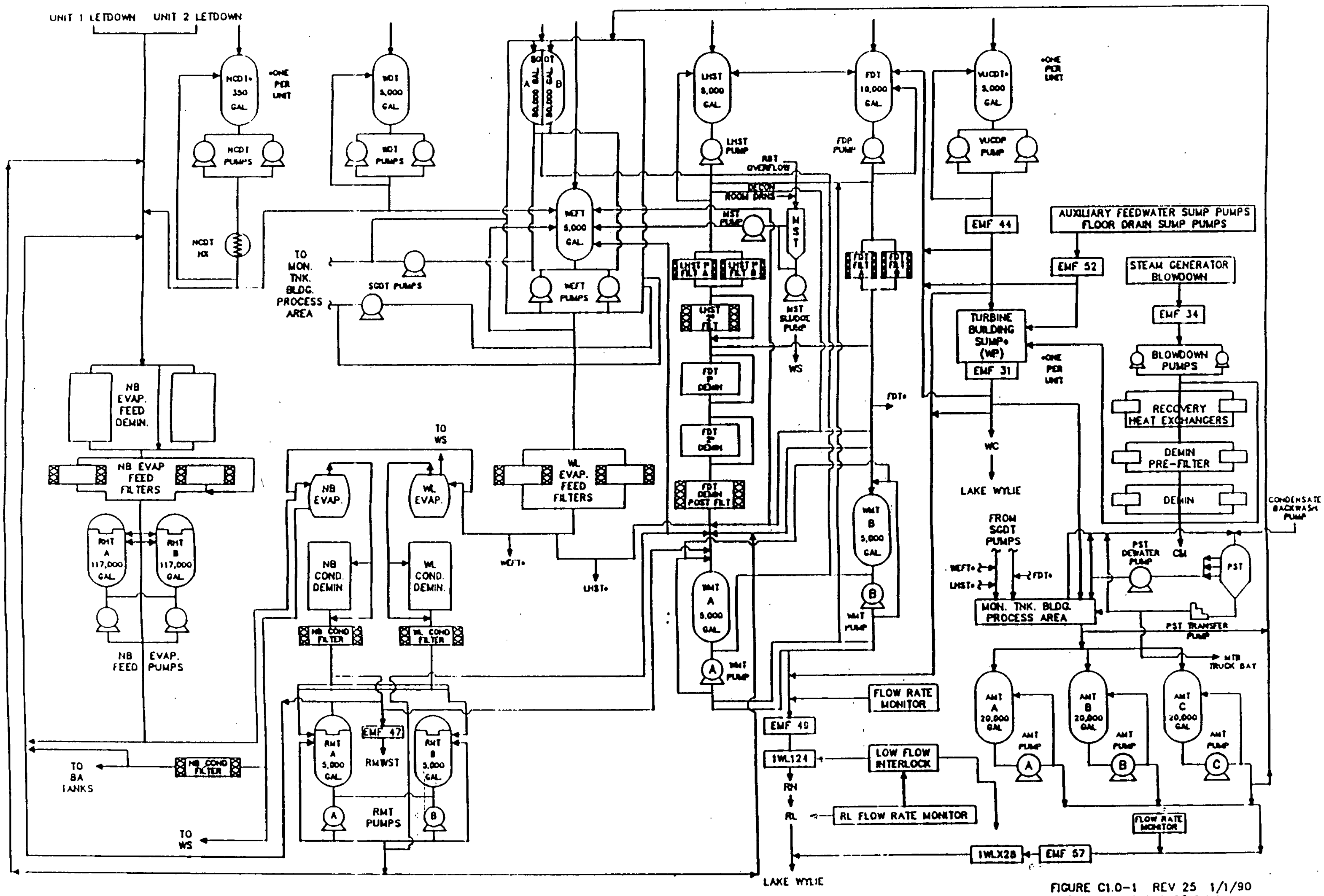


FIGURE C1.0-1 REV 25 1/1/90
CATAWBA NUCLEAR STATION
LIQUID RADWASTE SYSTEM

N88034

Table C1.0-1

ABBREVIATIONS

Systems:

CM - Condensate System
KC - Component Cooling
NB - Boron Recycle
RL - Low Pressure Service Water
RN - Nuclear Service Water System
WC - Conventional Waste Water Treatment
WL - Liquid Waste Recycle
WP - Turbine Building Sump
WS - Nuclear Solid Waste Disposal

Tanks:

BA - Boric Acid Tank
FDT - Floor Drain Tank
LHST - Laundry and Hot Shower Tank
MST - Mixing and Settling Tank
NCDT - Reactor Coolant Drain Tank
RHT - Recycle Holdup Tank
RMT - Recycle Monitor Tank
RMWST - Reactor Makeup Water Storage Tank
SGDT - Steam Generator Drain Tank
VUCDT - Ventilation Unit Condensate Drain Tank
WDT - Waste Drain Tank
WEFT - Waste Evaporator Feed Tank
WMT - Waste Monitor Tank

Table C1.0-1

C1.2 GASEOUS RADWASTE SYSTEMS

The gaseous waste disposal system for Catawba is designed with the capability of processing the fission-product gases from contaminated reactor coolant fluids resulting from operation. The system shown schematically in Fig. C1.0-2 is designed to allow for the retention and subsequent decay of the gaseous fission products generated from the reactor coolant system via the chemical and volume control system and/or the boron recycle system in order to limit the need for intentional discharge of high level radioactive gases from the waste gas holdup tanks. Sources of low-level radioactive gaseous discharge to the environment include periodic purging operations of the containment, the auxiliary building ventilation system, the secondary system air ejector and decayed WG Tanks. With respect to purging operations, the potential contamination is expected to arise from uncollectible reactor coolant leakage. With respect to the air ejector, the potential source of contamination will be from leakage of the reactor coolant to the secondary system through defects in steam generator tubes. The gaseous waste disposal system includes two waste gas compressors, two catalytic hydrogen recombiners, six gas decay storage tanks for use during normal power generation, and two gas decay storage tanks for use during shutdown and startup operations, and for pressure relief.

C1.2.1 Gas Collection System

The gas collection system combines the waste hydrogen and fission gases from the volume control tanks and that from the boron recycle gas stripper evaporator produced during normal operation with the gas collected during the shutdown degasification (high percentage of nitrogen) and cycle it through the catalytic recombiners converting all the hydrogen to water. After the water is removed, the resulting gas stream is transferred from the recombiner into the gas decay tanks, where the accumulated activity may be contained. From the decay tanks the gas will flow back to the compressor suction to complete the circuit.

C1.2.2 Containment and Auxiliary Building Ventilation

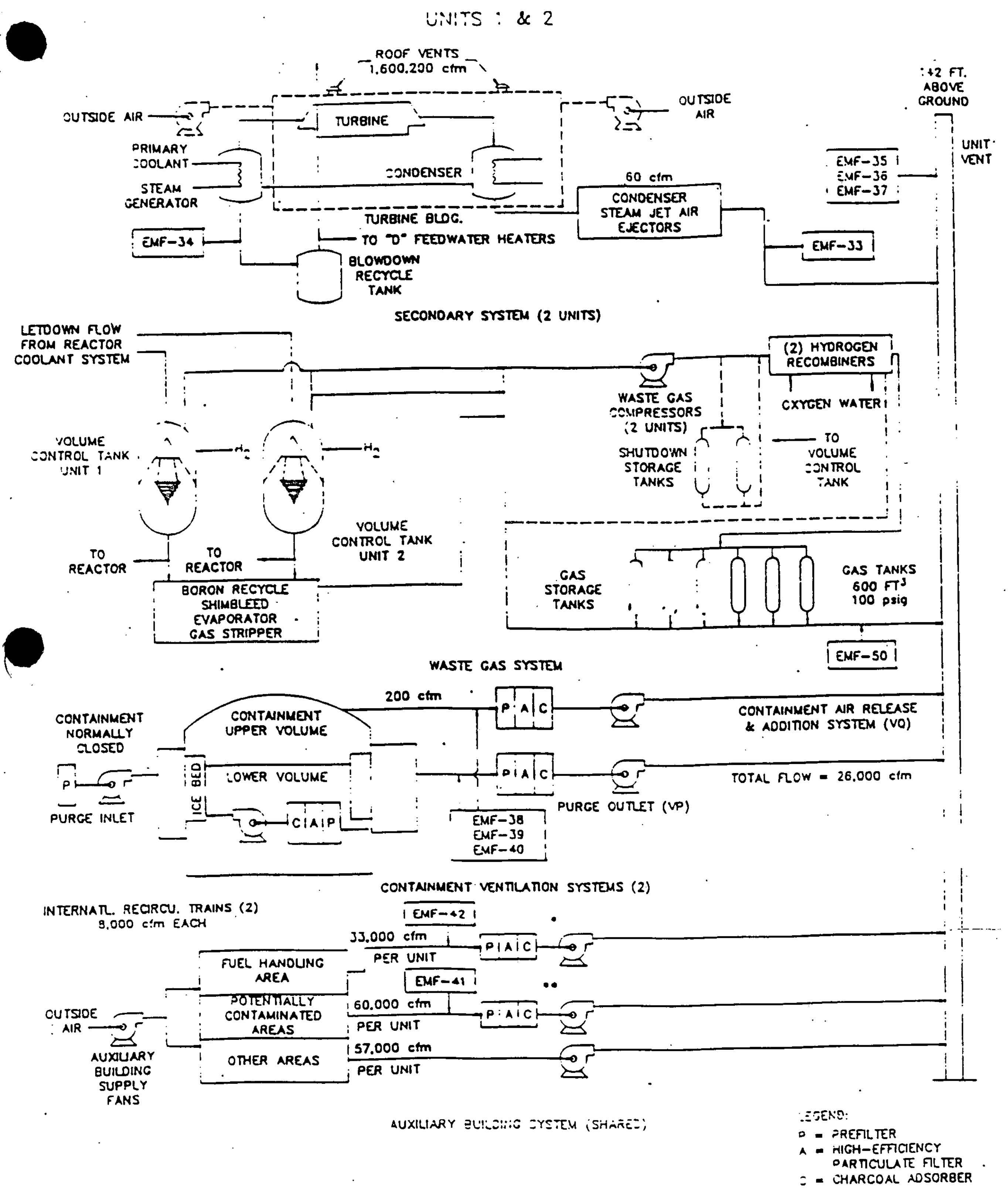
Nonrecyclable reactor coolant leakage occurring either inside the containment or inside the auxiliary building will generate gaseous activity. Gases resulting from leakage inside the containment will be contained until the containment air is released through the VQ or VP system. The containment atmosphere will be discharged through a charcoal adsorber and a particulate filter prior to release to the atmosphere.

Gases resulting from leakage inside the auxiliary building are released, without further decay, to the atmosphere via the auxiliary building ventilation system. The ventilation exhaust from potentially contaminated areas in the auxiliary building is normally unfiltered. However, on a radiation monitor alarm, the exhaust is passed through charcoal adsorbers to reduce releases to the atmosphere.

C1.2.3 Secondary Systems

Normally, condensate flow and steam generator blowdown will go parallel through 4 of the 5 condensate polishing demineralizers to remove activity and harmful ions from the water. Noncondensable gases will be taken from the secondary system by the condenser steam air ejector and are passed through a radiation monitor to the unit vent.

Figure C1.0-2 is a schematic representation of the gaseous radwaste system at Catawba.



• FUEL HANDLING AREA IS NORMALLY UNFILTERED. UPON A RADIATION ALARM BY EMF-42, THE EXHAUST WILL BE DIVERTED TO THE FILTER MODE.

•• POTENTIALLY CONTAMINATED AREAS OF THE AUXILIARY BUILDING ARE NORMALLY UNFILTERED. UPON A RADIATION ALARM BY EMF-41, THE EXHAUST WILL BE DIVERTED TO THE FILTERED MODE.

FIGURE C1.0-2
CATAWBA NUCLEAR STATION
GASEOUS RADWASTE SYSTEM
PAGE 1 OF 2

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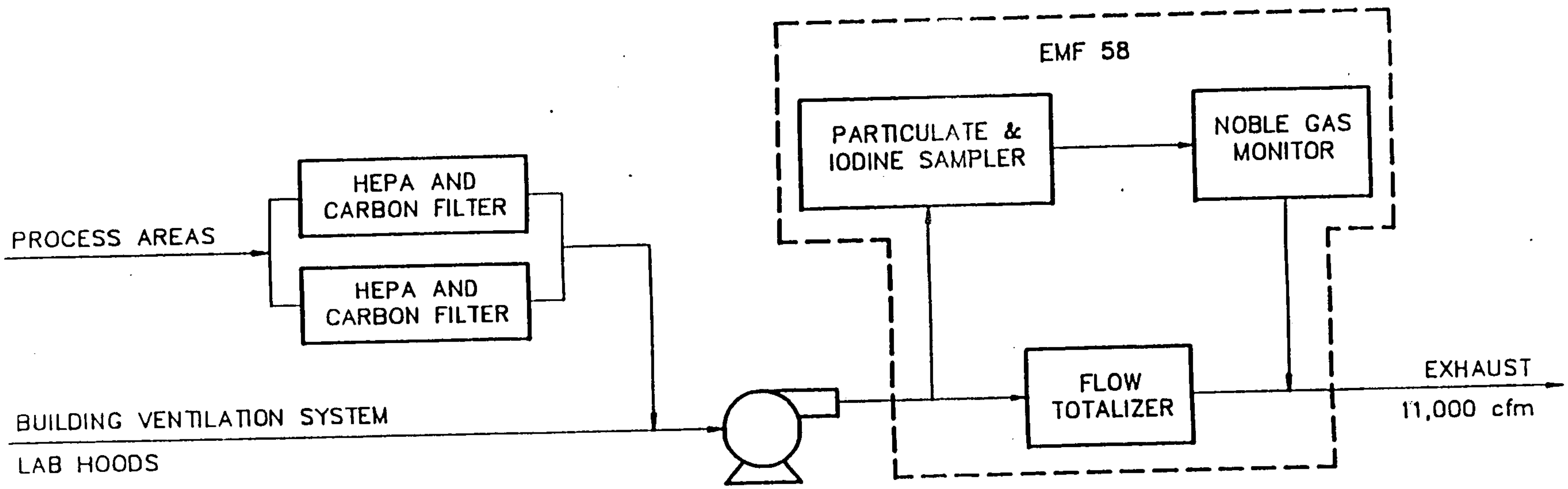
AUXILIARY MONITOR TANK BUILDING



GASEOUS WASTE SYSTEM
CATAWBA NUCLEAR STATION
FIGURE C1.0–2
PAGE 2 OF 2

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1/1/90

N89121E

C2.0 RELEASE RATE CALCULATION

Generic release rate methodology is presented in Section 1.0; this methodology with Catawba-specific input data will be used to calculate release rates for Catawba Nuclear Station.

C2.1 LIQUID RELEASE RATE CALCULATIONS

There are two potential liquid release points at Catawba. They are:

1. Liquid Waste Effluent Discharge Line (WL)
2. Conventional Waste Water Treatment System Effluent Line (WC)

C2.1.1 Liquid Waste Effluent Discharge Line (WL)

There are three low-pressure service water pumps with a minimum flow rate of 16,500 gpm each and four nuclear service water pumps with a minimum flow rate of 9,000 gpm each which provide the required dilution water needed for a release. The LPSW system flow rate monitor has a variable setpoint which terminates the release by closing an isolation valve should the dilution flow fall below the setpoint. Releases can either be made via EMF-49 which uses isolation valve 1WL124, or EMF-57 which uses isolation valve 1WLX28. The following is a typical equation which can be used to calculate a discharge flow, in gpm.

$$f \leq F_{RL} [X] \div [\sigma \sum_i \frac{C_i}{(10 \times EC_i)}]$$

where:

f = the undiluted effluent flow, in gpm.

F_{RL} = actual low pressure service water flowrate, in gpm.

σ = the recirculation factor at equilibrium (dimensionless), 1.0.

C_i = the concentration of radionuclide, i, in undiluted effluent as determined by laboratory analyses, in μCi/ml.

EC_i = the concentration of radionuclide, i, from 10CFR20, Appendix B, Table 2, Column 2. If radionuclide, i, is a dissolved noble gas, the EC_i = 1.0E-04 μCi/ml.

X = factor used to reduce the WL flowrate (f) to allow the WC system to release simultaneously. For example, 0.9 would allow 10% of the stations releases to be WC.

C2.1.2 Conventional Waste Water Treatment System Effluent Line (WC)

The conventional waste water treatment system effluent is potentially radioactive; that is, it is possible the effluent will contain measurable activity above background. It is assumed that no activity is present in the effluent until indicated by periodic analysis of the composite sample collected on that line. The water sources listed below that are normally discharged via the conventional waste water treatment system and/or the Turbine Building Sump (TBS) will be diverted if they will cause the WC discharge to exceed administrative limits designed to ensure that station release limits will not be exceeded.

a. Auxiliary Feedwater Sump Pumps and Floor Drain Sump Pump Line

Normally the discharge line coming from these sumps will discharge into the TBS, but if activity is detected above its monitor's setpoint, the discharge flow will automatically be routed to the floor drain tank for processing and later be discharged through the liquid waste effluent line. Subsequent radioactive releases may be allowed to discharge into the TBS if administratively controlled to assure that release limits are not exceeded.

b. Steam Generator Blowdown Line

Normally the discharge from the Steam Generator Blowdown will be pumped to the TBS, but if activity is detected above its monitor's setpoint, each blowdown flow control valve, the atmospheric vent, and the valve to the TBS will close, thus terminating the discharge. Blowdown can only be continued by venting the steam to "D" heater and pumping the liquid to the condensate system.

c. Turbine Building Sump Discharge Line

Normally the discharge from the TBS will go into the conventional waste water treatment system, but if activity is detected above its monitor's setpoint, the sump pumps A, B, and C will stop and an alarm actuated. The TBS discharge line can then either be routed to the steam generator drain tanks for processing, or allowed to continue being discharged via the circuit with proper administrative controls implemented to assure that release limits are not exceeded.

$$f \leq (F_{CR} \times 0.1) \div \left[\sigma \sum \frac{C}{(10 \times EC)} \right]$$

where:

f = the undiluted effluent flow, in gpm.

F_{CR} = Catawba River flow, at cove beyond WC outflow point, in gpm.

0.1 = conservative factor due to no spargers in use to split flow output to river.

σ = the recirculation factor at equilibrium (dimensionless), 1.0.

C = the gross activity in the in undiluted effluent, in μCi/ml.

EC = 9.0E-07 μCi/ml, the EC value for Cs-134, which is the lowest effluent concentration value for any detectable radionuclide that is not known to be absent from the liquid effluent.

C2.2 GASEOUS RELEASE RATE CALCULATIONS

The unit vent is the release point for waste gas decay tanks, containment air releases, the condenser air ejector, and auxiliary building ventilation. The condenser air ejector effluent is normally considered nonradioactive; that is, it is unlikely the effluent will contain measurable activity above background. It is assumed that no activity is present in the effluent until indicated by radiation monitoring measurements and/or by analyses of periodic samples collected on that line. Radiation monitoring alarm/trip setpoints in conjunction with administrative controls assure that release limits are not exceeded; see section C.3.0 on radiation monitoring setpoints.

The Auxiliary Monitor Tank Building (AMTB) ventilation system and lab hoods are exhausted directly through a vent on the AMTB. The process areas of the AMTB ventilation pass through particulate and charcoal filters. The effluent is normally considered nonradioactive; however, the potential for release of radioactive effluents remains with certain job evolutions that may take place in the AMTB.

The following calculations, when solved for flowrate, are the release rates for noble gases and for radioiodines, particulates and other radionuclides with half-lives greater than 8 days; the most conservative of release rates calculated in C2.2.1 and C2.2.2 shall control the release rate for a single release point. 98% of the controlling release rate calculated is apportioned to the unit vent and 2% is apportioned to the AMTB vent (assuring simultaneous releases from both points do not exceed the controlling release rate for a single point).

C2.2.1 Noble Gases

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

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

where the terms are defined below.

C2.2.2 Radioiodines, Particulates, and Other Radionuclides With T 1/2 > 8 Days

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

where:

K_i = The total body dose factor due to gamma emissions for each identified noble gas radionuclide, in mrem/yr per µCi/m³ from Table 1.2-1.

L_i = The skin dose factor due to beta emissions for each identified noble gas radionuclide, in mrem/yr per µCi/m³ from Table 1.2-1.

M_i = The air dose factor due to gamma emissions for each identified noble gas radionuclide, in mrad/yr per µCi/m³ from Table 1.2-1 (unit conversion constant of 1.1 mrem/mrad converts air dose to skin dose).

P_i = The dose parameter for radionuclides other than noble gases for the inhalation pathway, in mrem/yr per µCi/m³ and for the food and ground plane pathways in m²•(mrem/yr) per µCi/sec from Table 1.2-2. The dose factors are based on the critical individual organ and most restrictive age group (child or infant).

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

$(\overline{X/Q})$ = 3.510E-05 sec/m^3. The highest calculated annual average relative concentration (dispersion parameter) for any area at or beyond the unrestricted area boundary. The location is the NNE sector @ 0.5 mile.

W = The highest calculated annual average dispersion parameter for estimating the dose to an individual at a location in the unrestricted area where the total inhalation, food and ground plane pathway dose is determined to be a maximum based on operational source term data, land use surveys, and NUREG-0133 guidance.

W = 2.208E-05 sec/m^3, for the inhalation pathway. The location is the ENE sector @ 0.5 mile.

W = 4.135E-08 1/$meter^2$, for the food and ground plane pathways. The location is the ENE sector @ 0.5 mile.

$$\tilde{Q}_i = k_1 C_i f \div k_2 = 4.72E{+}2 C_i f$$

where:

C_i = the concentration of radionuclide, i, in undiluted gaseous effluent, in μCi/ml.

f = the undiluted effluent flow, in cfm

k_1 = conversion factor, 2.83E4 ml/ft^3

k_2 = conversion factor, 6E1 sec/min

C3.0 RADIATION MONITOR SETPOINTS

Using the generic calculations presented in Section 2.0, final effluent radiation monitoring setpoints are calculated for monitoring as required by the Technical Specifications.

All radiation monitors for Catawba are off-line except EMF-50 (Waste Gas System) which is in-line. These monitors alarm on low flow; the minimum flow alarm level for both the liquid monitors and the gas monitors is based on the manufacturer's recommendations except EMF-50. These monitors measure the activity in the liquid or gas volume exposed to the detector. Liquid monitors are independent of flow rate if a minimum flow rate is assured. Gaseous monitors are dependent on pressure or vacuum. Particulate monitors are dependent on flow rates.

Radiation monitoring setpoints calculated in the following sections are expressed in activity concentrations; in reality the monitor readout is in counts per minute. Station radiation monitor setpoint procedures which correlate concentration and counts per minute shall be based on the following relationship:

$$c = \frac{r}{2.22 \times 10^6 \; e \; V}$$

where:

c = the gross activity, in μCi/ml
r = the count rate, in cpm
2.22×10^6 = the disintegration per minute per μCi
e = the counting efficiency, cpm/dpm
V = the volume of fluid exposed to the detector, in ml.

For those occurrences when simultaneous releases of radioactive material must be made, monitor setpoints will be adjusted downward in accordance with Station Procedures to insure that instantaneous concentrations will not be exceeded.

C3.1 LIQUID RADIATION MONITORS

C3.1.1 Waste Liquid Effluent Line - EMF 49 and EMF 57

As described in Section C2.1.1 on release rate calculations for the waste liquid effluent, the release is controlled by limiting the flow rate of effluent from the station. Although the release rate is flow rate controlled, the radiation monitor setpoint shall be set to terminate the release if the effluent activity should exceed that determined by laboratory analyses and used to calculate the release rate. A typical radiation monitor setpoint may be calculated as follows:

$$c \leq \frac{10 \times EC \times F}{\sigma f} \leq 2.30\text{E-03 } \mu\text{Ci/ml}$$

where:

c = the gross activity in undiluted effluent, in μCi/ml

f = the flow from the tank may vary from 0-100 gpm but, for this calculation, is assumed to be 100 gpm.

EC = 9.0E-07 μCi/ml, the EC for Cs-134, which is the lowest effluent concentration value for any detectable radionuclide that is not known to be absent from the liquid effluent. ***

σ = the recirculation factor at equilibrium (dimensionless), 1.0.

F = the dilution flow may vary as described in section C2.1.1, but is conservatively estimated at 25,500 gpm, the minimum flow available.

Normally, discharges from the WL system will be limited to either EMF-49 or EMF-57. Simultaneous releases may occur, however, if proper station procedures are followed to insure that instantaneous concentration limits will not be exceeded.

C3.1.2 Section Deleted 1/1/92 Revision 34

C3.1.3 <u>Auxiliary Feedwater Sump Pumps and Floor Drain Sump Pump - EMF 52</u>

As described in Section C2.1.2 on release rate calculations for the auxiliary feedwater sump pumps and floor drain sump pump effluents, it is possible that the effluent will contain measurable activity above background. It is assumed that the effluent activity is less than the monitors setpoint until indicated by a radiation alarm. Since the sumps are discharged automatically, the radiation monitor setpoint will initially be set at 1.0E-06 μCi/ml (the monitor's minimum practical setpoint) plus background to assure that no activity is unknowingly discharged into the Turbine Building sump. The set-point may be changed after initial detection to allow positive control of effluent releases using the guidance given in Section C3.1.5.

C3.1.4 <u>Steam Generator Blowdown Line - EMF 34</u>

As described in Section C2.1.2 on Release Rate Calculations for the Steam Generator Blowdown, it is possible that the effluent will contain measurable activity above its monitor's setpoint. It is assumed that no activity is present in the effluent until indicated by radiation monitoring. Since the Steam Generator Blowdown line is discharged automatically, the radiation monitor setpoint will be initially set at 1.0E-06 μCi/ml (the monitor's minimum practical setpoint) plus background to assure no activity is unknowingly discharged into the Turbine Building sump. The setpoint may be changed after detection to allow positive control of effluent releases using the guidance given in Section C3.1.5.

*** The justification for this assumption is provided in 10 CFR 20, Appendix B, Note 2. A review of past liquid effluent release data shows that Cs-134 has the lowest effluent concentration value for any detectable radionuclide in the effluent. An annual review of the effluent release data will be performed to assure that this assumption remains valid.

C3.1.5 Turbine Building Sump Discharge Line - EMF 31

As described in Section C2.1.2 on release rate calculations for the turbine building sumps, it is possible that the effluent will contain measurable activity above its monitor setpoint. Since the sump contents are discharged automatically, the radiation monitor setpoint will be initially set at 1.0E-06 μCi/ml (the monitor's minimum practical setpoint) plus background to assure that no activity is unknowingly discharged into the WC system. Should radioactive effluent releases need to be made from the TBS via the WC system a typical monitor setpoint may be calculated as follows:

$$c \leq \frac{10 \times EC}{\sigma} \leq 9.00E{-}06 \ \mu Ci/ml$$

where:

c = the gross activity in undiluted effluent, in μCi/ml

EC = 9.0E-07 μCi/ml, the EC for Cs-134, which is the lowest effluent concentration value for any detectable radionuclide that is not known to be absent from the liquid effluent. ***

σ = the recirculation factor at equilibrium (dimensionless), 1.0.

*** The justification for this assumption is provided in 10 CFR 20, Appendix B, Note 2. A review of past liquid effluent release data shows that Cs-134 has the lowest effluent concentration value for any detectable radionuclide in the effluent. An annual review of the effluent release data will be performed to assure that this assumption remains valid.

C3.2 GAS MONITORS

The following equation shall be used to calculate noble gas radiation monitor setpoints based on Xe-133 (Historical data shows that Xe-133 is the predominant isotope):

$$K(\overline{X/Q})\ \tilde{Q}_i < 500 \qquad \text{(see Section C2.2.1)}$$

$$\tilde{Q}_i = 4.72E{+}02\ C_i f \quad \text{(see Section C2.2.2)}$$

$$C_i < 146/f$$

where:

C_i = the gross activity in undiluted effluent, in μCi/ml

f = the flow from the tank or building sources, in cfm

K = from Table 1.2-1 for Xe-133, 2.06E+2 mrem/yr per $\mu Ci/m^3$

$\overline{X/Q}$ = 3.510E-05 sec/m^3, as defined in Section C.2.2.2

As stated in Section C2.2, the unit vent is the release point for the containment purge ventilation system, the containment air release and addition system, the condenser air ejector, and auxiliary building ventilation. The Auxiliary Monitor Tank Building (AMTB) vent is the release point for the AMTB ventilation. 98% of the single point controlling release rate is apportioned to the unit vent and 2% is apportioned to the AMTB vent.

For releases from the containment purge ventilation system, a typical radiation monitor setpoint may be calculated as follows:

$$C_i < .98(146/f) = 8.16E{-}04$$

where:

f = 150,000 cfm (auxiliary building ventilation) + 26,000 cfm (containment purge) = 176,000 cfm

For releases from the AMTB ventilation a typical radiation monitor setpoint may be calculated as follows:

$$C_i < .02(146/f) = 2.66E{-}04$$

where:

f = 11,000 cfm (AMTB ventilation)

For release from the containment air release and addition system, the waste gas decay tanks, the condenser air ejectors, and the auxiliary building ventilation, a typical radiation monitor setpoint may be calculated as follows:

$$C_i < 146/f = 9.77E{-}04$$

where:

f = 150,000 cfm (auxiliary building ventilation)

C4.0 DOSE CALCULATIONS

C4.1 FREQUENCY OF CALCULATIONS

Dose contributions to the maximum individual shall be calculated at least every 31 days, quarterly, and annually using the methodology in the generic information sections or the LADTAP and GASPAR computer programs. Example input templates for Catawba LADTAP and GASPAR computer program calculations are provided in Figures C4.0-1 and C4.0-2. One of these methods shall also be used for any special reports.

Station long-term historical and dose projection calculations are periodically performed to determine the station's status with respect to meeting annual ALARA goals specified in the Catawba Nuclear Station Selected Licensing Commitment Manual. Such calculations are used to verify that adequate margin remains during a report period to allow normal stations and radwaste system operation, including anticipated operational occurrences, for the remainder of the report period without exceeding applicable goals. Station dose projections can be performed using generic methodology or the LADTAP and GASPAR computer codes.

Fuel cycle dose calculations shall be performed annually or as required by special reports. Dose contributions shall be calculated using the methodology in the appropriate generic information sections or the LADTAP and GASPAR computer programs.

C4.2 DOSE MODELS FOR MAXIMUM EXPOSED INDIVIDUAL

C4.2.1 Liquid Effluents

Generic methodology for calculating liquid pathway exposures to the maximum individual is presented in Section 3.1.1. Catawba site specific parameters to be used in the generic methodology are presented as follows:

A_{aoi} = Tables C4.0-3 through C4.0-6

F_η = $f/(F + f)$ (0.006 default for projections)

where:

F_η = Near field dilution factor, dimensionless

f = Catawba average liquid radwaste flow, cfs (0.65 default for projections)

F = Catawba average dilution flow for period of interest, cfs (105 default for projections)

An input template for Catawba LADTAP computer program calculations is provided in Figure C4.0-1. The input template includes default dilution parameters. Radionuclide release input (Ci/period) and optional non-default dilution flow (cfs) parameters are necessary to perform LADTAP calculations to determine offsite dose impact from specific releases during the period that dilution flow is averaged over.

C4.2.2 Gaseous Effluents

C4.2.2.1 Noble Gases

Gamma Air and Beta Air Dose

Generic methodology for calculating noble gas airborne pathway gamma air ($D\gamma$) and beta air (D_β) doses is presented in Section 3.1.2.1. Catawba site specific parameters to be used in the generic methodology are presented as follows:

$\overline{(X/Q)}$ = 3.510E-05 sec/m^3. The highest calculated annual average relative concentration for any area at or beyond the unrestricted area boundary. The location is the NNE sector @ 0.5 mile.

An input template for Catawba GASPAR computer program noble gas airborne pathway gamma air ($D\gamma$) and beta air (D_β) dose calculations is provided in Figure C4.0-2, Location 1. The input template includes the maximum Catawba site specific annual average relative concentration parameters. Radionuclide release input (Ci/period) and optional non-default relative concentration parameters are necessary to perform GASPAR calculations to determine offsite dose impact from specific releases.

C4.2.2.2 Radioiodines, Particulates, and Other Radionuclides with T 1/2 〉 8 days

Generic methodology for calculating airborne pathway maximum organ (D_{mo}) exposures to the maximum individual is presented in Section 3.1.2.2. External exposure from deposited ground contamination and inhalation exposure pathways are considered to exist at all locations offsite. Food pathways (i.e., vegetable, meat and milk) are analyzed only at locations where site surveys have verified vegetable gardens, meat producing animals, or cow/goat milk producing animals exist, however. Therefore, the location of the maximum individual may vary depending on the mixture and levels of radionuclides released during a period of time. Additionally, the critical (or limiting) age group and organ will vary based on the location (i.e., combination of dose pathways contributing dose) and mixture/level of radionuclide releases during the release period.

Performing calculations separately for all potential maximum locations, age groups and organs assures that a maximum location is identified, and that a conservative estimate is obtained for maximum offsite dose impact to any organ or age group. Catawba site specific meteorological dispersion (X/Q) and deposition (D/Q) parameters and applicable terrestrial/food pathways for the potential maximum locations to be analyzed using generic methodology are presented in Table C4.0-7.

An input template for Catawba GASPAR computer program airborne pathway maximum organ (D_{mo}) dose calculations is provided in Figure C4.0-3, Locations 1 - 5. Radionuclide release input (Ci/period) and optional non-default meterological parameters and pathway applicability flags are necessary to perform GASPAR calculations to determine offsite dose impact from specific releases.

C4.3 FUEL CYCLE CALCULATIONS

As discussed in Section 3.3.5, more than one nuclear power station site may contribute to the doses to be considered in accordance with 40CFR190. The fuel cycle dose assessments for Catawba Nuclear Station only include liquid and gaseous dose contributions from Catawba Nuclear Station since no other uranium fuel cycle facility contributes significantly to Catawba's maximum exposed individual. For this dose assessment, the total body and maximum organ dose contributions to the maximum exposed individual from Catawba liquid and gaseous effluents are estimated using the following calculations:

$$D_{WB}(T) = D_{WB}(l) + D_{WB}(g)$$

$$D_{MO}(T) = D_{MO}(l) + D_{MO}(g)$$

where:

$D_{WB}(T)$ = Total estimated fuel cycle whole body dose commitment resulting from the combined liquid and gaseous effluents of Catawba during the calendar year of interest, in mrem.

$D_{MO}(T)$ = Total estimated fuel cycle maximum organ dose commitment resulting from the combined liquid and gaseous effluents of Catawba during the calendar year of interest, in mrem.

A fuel cycle dose calculation worksheet is provided in Figure C.4.0-4.

C4.3.1 Liquid Effluents

Liquid pathway dose estimates are calculated using generic methodology or the LADTAP computer program. The values for $D_{WB}(1)$ and $D_{MO}(1)$ liquid pathway dose contributions are calculated based on the methodology, values and assumptions presented in Section C4.2.1.

C4.3.2 Gaseous Effluents

Total Body

The methodology for calculating noble gas airborne pathway whole body exposures to the maximum individual, $D_{WB}(g)$, is derived from Section 3.1.2.1 generic methodology for gamma air and beta air dose calculations as follows:

$$D_{WB}(g) = 3.17E\text{-}8 \sum_i K_i \left[(\overline{X/Q}) Q_i \right] \quad \text{mrem/yr}$$

Generic methodology parameters K_i are described in Section 1.2.1. The Catawba site specific parameter X/Q value is 3.510E-05 sec/m^3 as described in Section C4.2.2.1 for Catawba gamma air and beta air dose calculations.

Maximum Organ

Airborne pathway maximum organ dose estimates are calculated using generic methodology or the GASPAR computer program. The maximum organ dose is established by calculating doses to all organs for each potential maximum offsite location identified in Table C4.0-7. A conservative estimate (i.e., overestimate) of the fuel cycle maximum organ dose is obtained by:

1) determining the locations with the highest exposure releases for each organ;

2) adding the highest exposure value for the airborne release to the same organ dose resulting from liquid releases; and

3) comparing values obtained when the liquid and airborne pathway components are added for all organs and age groups to determine the maximum (or limiting) organ and age group.

TABLE C4.0-1

CATAWBA NUCLEAR STATION
(1 OF 2)

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

(SEC/M3)

DISTANCE TO THE CONTROL LOCATION, IN MILES

SECTOR	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		2.959E-05	7.879E-06	3.222E-06	1.768E-06	1.133E-06	7.978E-07	5.987E-07	4.701E-07	3.818E-07
NNE		3.510E-05	9.342E-06	3.814E-06	2.091E-06	1.338E-06	9.420E-07	7.066E-07	5.546E-07	4.503E-07
NE		2.927E-05	7.738E-06	3.166E-06	1.738E-06	1.114E-06	7.848E-07	5.891E-07	4.627E-07	3.759E-07
ENE		2.208E-05	5.813E-06	2.406E-06	1.330E-06	8.573E-07	6.065E-07	4.568E-07	3.598E-07	2.931E-07
E		1.858E-05	4.895E-06	2.032E-06	1.126E-06	7.266E-07	5.147E-07	3.880E-07	3.059E-07	2.493E-07
ESE		1.962E-05	5.223E-06	2.163E-06	1.197E-06	7.712E-07	5.457E-07	4.110E-07	3.238E-07	2.637E-07
SE		1.965E-05	5.167E-06	2.151E-06	1.194E-06	7.717E-07	5.471E-07	4.128E-07	3.257E-07	2.656E-07
SSE		2.561E-05	6.751E-06	2.798E-06	1.548E-06	9.982E-07	7.064E-07	5.323E-07	4.194E-07	3.416E-07
S		1.552E-05	4.101E-06	1.642E-06	8.878E-07	5.624E-07	3.926E-07	2.924E-07	2.282E-07	1.843E-07
SSW		8.747E-06	2.267E-06	8.761E-07	4.621E-07	2.872E-07	1.973E-07	1.450E-07	1.118E-07	8.939E-08
SW		5.071E-06	1.328E-06	5.087E-07	2.666E-07	1.648E-07	1.127E-07	8.249E-08	6.340E-08	5.052E-08
WSW		3.265E-06	8.730E-07	3.413E-07	1.815E-07	1.135E-07	7.839E-08	5.786E-08	4.479E-08	3.592E-08
W		2.024E-06	5.307E-07	2.058E-07	1.088E-07	6.771E-08	4.657E-08	3.426E-08	2.644E-08	2.115E-08
WNW		3.468E-06	9.193E-07	3.595E-07	1.913E-07	1.197E-07	8.267E-08	6.104E-08	4.727E-08	3.793E-08
NW		6.249E-06	1.680E-06	6.638E-07	3.558E-07	2.239E-07	1.555E-07	1.153E-07	8.959E-08	7.212E-08
NNW		1.406E-05	3.723E-06	1.508E-06	8.221E-07	5.242E-07	3.678E-07	2.752E-07	2.155E-07	1.747E-07

CATAWBA NUCLEAR STATION

The values presented in this table were generated by using the computer program XOQDOQ (NUREG/CR-2919) which implements NRC Regulatory Guide 1.111 (1977), and by using the following assumptions:

1. Data Collection Period, 1988 to 1992.

2. Ground Level Releases.

3. Open Terrain Recirculation Correction Factors.

4. No Decay, Undepleted

5. Vent and Building Parameters:

Release Height	(meters) =	38.00	Rep. Wind Height	(meters)	=	10.0
Diameter	(meters) =	0.00	Building Height	(meters)	=	41.0
Exit Velocity	(meters) =	0.00	Bldg. Min. X-Sec. Area	(sq. m.)	=	1616.0
			Heat Emission Rate	(cal/s)	=	0.0

TABLE C4.0-2

CATAWBA NUCLEAR STATION
(1 OF 2)

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

(1/M2)

DISTANCE TO THE CONTROL LOCATION, IN MILES

SECTOR	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		8.799E-08	2.148E-08	7.715E-09	3.826E-09	2.253E-09	1.475E-09	1.038E-09	7.693E-10	5.928E-10
NNE		1.078E-07	2.630E-08	9.448E-09	4.686E-09	2.759E-09	1.807E-09	1.271E-09	9.421E-10	7.260E-10
NE		7.653E-08	1.868E-08	6.710E-09	3.328E-09	1.960E-09	1.283E-09	9.028E-10	6.691E-10	5.156E-10
ENE		4.135E-08	1.009E-08	3.626E-09	1.798E-09	1.059E-09	6.933E-10	4.878E-10	3.615E-10	2.786E-10
E		3.246E-08	7.924E-09	2.846E-09	1.411E-09	8.311E-10	5.442E-10	3.829E-10	2.838E-10	2.187E-10
ESE		3.810E-08	9.301E-09	3.341E-09	1.657E-09	9.755E-10	6.388E-10	4.495E-10	3.331E-10	2.567E-10
SE		3.799E-08	9.274E-09	3.331E-09	1.652E-09	9.727E-10	6.369E-10	4.482E-10	3.321E-10	2.560E-10
SSE		7.019E-08	1.713E-08	6.154E-09	3.052E-09	1.797E-09	1.177E-09	8.280E-10	6.136E-10	4.729E-10
S		7.881E-08	1.924E-08	6.910E-09	3.427E-09	2.018E-09	1.321E-09	9.297E-10	6.890E-10	5.310E-10
SSW		6.787E-08	1.657E-08	5.951E-09	2.951E-09	1.738E-09	1.138E-09	8.007E-10	5.934E-10	4.573E-10
SW		3.877E-08	9.464E-09	3.399E-09	1.686E-09	9.926E-10	6.500E-10	4.573E-10	3.389E-10	2.612E-10
WSW		1.476E-08	3.604E-09	1.295E-09	6.420E-10	3.780E-10	2.475E-10	1.742E-10	1.291E-10	9.947E-11
W		7.895E-09	1.927E-09	6.922E-10	3.433E-10	2.021E-10	1.324E-10	9.313E-11	6.902E-11	5.319E-11
WNW		1.087E-08	2.654E-09	9.534E-10	4.728E-10	2.784E-10	1.823E-10	1.283E-10	9.507E-11	7.326E-11
NW		2.319E-08	5.661E-09	2.033E-09	1.008E-09	5.938E-10	3.888E-10	2.736E-10	2.027E-10	1.562E-10
NNW		4.863E-08	1.187E-08	4.264E-09	2.114E-09	1.245E-09	8.152E-10	5.736E-10	4.251E-10	3.276E-10

CATAWBA NUCLEAR STATION

The values presented in this table were generated by using the computer program XOQDOQ (NUREG/CR-2919) which implements NRC Regulatory Guide 1.111 (1977), and by using the following assumptions:

1. Data Collection Period, 1988 to 1992.

2. Ground Level Releases.

3. Open Terrain Recirculation Correction Factors.

4. No Decay, Undepleted

5. Vent and Building Parameters:

Release Height	(meters) =	38.00	Rep. Wind Height	(meters)	=	10.0
Diameter	(meters) =	0.00	Building Height	(meters)	=	41.0
Exit Velocity	(meters) =	0.00	Bldg. Min. X-Sec. Area	(sq. m.)	=	1616.0
			Heat Emission Rate	(cal/s)	=	0.0

CATAWBA NUCLEAR STATION
LIQUID EFFLUENT DOSE - ADULT PARAMETERS
A(I) MREM/HR PER UCI/ML

RADIONUCLIDE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
1 H 3	0.0	4.28E-01	4.28E-01	4.28E-01	4.28E-01	4.28E-01	4.28E-01
11 NA 24	1.37E+02	1.37E+02	1.37E+02	1.37E+02	1.37E+02	1.37E+02	1.37E+02
24 CR 51	0.0	0.0	1.25E+00	7.45E-01	2.75E-01	1.66E+00	3.14E+02
25 MN 54	0.0	4.38E+03	8.35E+02	0.0	1.30E+03	0.0	1.34E+04
25 MN 56	0.0	1.78E-01	3.15E-02	0.0	2.25E-01	0.0	5.67E+00
26 FE 55	6.63E+02	4.58E+02	1.07E+02	0.0	0.0	2.56E+02	2.63E+02
26 FE 59	1.03E+03	2.42E+03	9.29E+02	0.0	0.0	6.77E+02	8.08E+03
27 CO 58	0.0	8.97E+01	2.01E+02	0.0	0.0	0.0	1.82E+03
27 CO 60	0.0	2.60E+02	5.74E+02	0.0	0.0	0.0	4.89E+03
28 NI 63	3.14E+04	2.17E+03	1.05E+03	0.0	0.0	0.0	4.54E+02
28 NI 65	2.09E-01	2.72E-02	1.24E-02	0.0	0.0	0.0	6.89E-01
29 CU 64	0.0	2.76E+00	1.30E+00	0.0	6.97E+00	0.0	2.36E+02
30 ZN 65	2.31E+04	7.36E+04	3.32E+04	0.0	4.92E+04	0.0	4.63E+04
30 ZN 69	4.26E-06	8.15E-06	5.67E-07	0.0	5.29E-06	0.0	1.22E-06
35 BR 83	0.0	0.0	4.09E-02	0.0	0.0	0.0	5.89E-02
35 BR 85	0.0	0.0	1.01E-78	0.0	0.0	0.0	0.0
37 RB 86	0.0	9.74E+04	4.54E+04	0.0	0.0	0.0	1.92E+04
37 RB 88	0.0	8.43E-14	4.47E-14	0.0	0.0	0.0	1.16E-24
37 RB 89	0.0	4.82E-16	3.39E-16	0.0	0.0	0.0	2.80E-29
38 SR 89	2.24E+04	0.0	6.43E+02	0.0	0.0	0.0	3.59E+03
38 SR 90	2.83E+05	0.0	7.59E+04	0.0	0.0	0.0	1.61E+04
38 SR 91	7.50E+01	0.0	3.03E+00	0.0	0.0	0.0	3.57E+02
38 SR 92	5.27E-01	0.0	2.28E-02	0.0	0.0	0.0	1.04E+01
39 Y 90	4.60E-01	0.0	1.24E-02	0.0	0.0	0.0	4.88E+03
39 Y 91M	7.42E-09	0.0	2.87E-10	0.0	0.0	0.0	2.18E-08
39 Y 91	8.61E+00	0.0	2.30E-01	0.0	0.0	0.0	4.74E+03
39 Y 92	6.24E-04	0.0	1.82E-05	0.0	0.0	0.0	1.09E+01
39 Y 93	3.30E-02	0.0	9.13E-04	0.0	0.0	0.0	1.05E+03
40 ZR 95	2.96E-01	9.48E-02	6.42E-02	0.0	1.49E-01	0.0	3.00E+02
40 ZR 97	6.93E-03	1.40E-03	6.39E-04	0.0	2.11E-03	0.0	4.33E+02
41 NB 95	4.38E+02	2.44E+02	1.31E+02	0.0	2.41E+02	0.0	1.48E+06
42 MO 99	0.0	8.75E+01	1.66E+01	0.0	1.98E+02	0.0	2.03E+02
43 TC 99M	6.78E-04	1.91E-03	2.44E-02	0.0	2.91E-02	9.38E-04	1.13E+00
43 TC 101	2.60E-19	3.75E-19	3.68E-18	0.0	6.76E-18	1.92E-19	1.13E-30
44 RU 103	4.70E+00	0.0	2.03E+00	0.0	1.79E+01	0.0	5.49E+02
44 RU 105	1.32E-02	0.0	5.21E-03	0.0	1.71E-01	0.0	8.08E+00
44 RU 106	7.10E+01	0.0	8.98E+00	0.0	1.37E+02	0.0	4.59E+03
47 AG 110M	1.18E+00	1.10E+00	6.51E-01	0.0	2.16E+00	0.0	4.47E+02
52 TE 125M	2.54E+03	9.21E+02	3.40E+02	7.64E+02	1.03E+04	0.0	1.01E+04
52 TE 127M	6.45E+03	2.31E+03	7.87E+02	1.65E+03	2.62E+04	0.0	2.16E+04
52 TE 127	1.79E+01	6.41E+00	3.86E+00	1.32E+01	7.27E+01	0.0	1.41E+03
52 TE 129M	1.08E+04	4.03E+03	1.71E+03	3.71E+03	4.51E+04	0.0	5.44E+04
52 TE 129	6.40E-05	2.41E-05	1.56E-05	4.91E-05	2.69E-04	0.0	4.83E-05
52 TE 131M	9.54E+02	4.66E+02	3.89E+02	7.39E+02	4.73E+03	0.0	4.63E+04
52 TE 131	8.48E-11	3.54E-11	2.68E-11	6.97E-11	3.71E-10	0.0	1.20E-11
52 TE 132	1.96E+03	1.26E+03	1.19E+03	1.40E+03	1.22E+04	0.0	5.98E+04
53 I 130	7.79E+00	2.30E+01	9.07E+00	1.95E+03	3.59E+01	0.0	1.98E+01
53 I 131	1.45E+02	2.07E+02	1.19E+02	6.78E+04	3.55E+02	0.0	5.46E+01
53 I 132	1.57E-02	4.21E-02	1.47E-02	1.47E+00	6.71E-02	0.0	7.91E-03
53 I 133	2.48E+01	4.31E+01	1.31E+01	6.33E+03	7.51E+01	0.0	3.87E+01
53 I 135	1.52E+00	3.97E+00	1.47E+00	2.62E+02	6.37E+00	0.0	4.49E+00
55 CS 134	2.98E+05	7.08E+05	5.79E+05	0.0	2.29E+05	7.61E+04	1.24E+04
55 CS 136	2.96E+04	1.17E+05	8.41E+04	0.0	6.50E+04	8.90E+03	1.33E+04
55 CS 137	3.82E+05	5.22E+05	3.42E+05	0.0	1.77E+05	5.89E+04	1.01E+04
55 CS 138	2.03E-08	4.02E-08	1.99E-08	0.0	2.95E-08	2.91E-09	1.71E-13
56 BA 139	4.45E-04	3.17E-07	1.30E-05	0.0	2.96E-07	1.80E-07	7.88E-04
56 BA 140	2.22E+02	2.79E-01	1.45E+01	0.0	9.48E-02	1.60E-01	4.57E+02
56 BA 141	1.25E-13	9.48E-17	4.24E-15	0.0	8.82E-17	5.38E-17	5.91E-23
56 BA 142	2.23E-22	2.29E-25	1.40E-23	0.0	1.94E-25	1.30E-25	3.14E-40
57 LA 140	1.03E-01	5.19E-02	1.37E-02	0.0	0.0	0.0	3.81E+03
57 LA 142	1.26E-06	5.75E-07	1.43E-07	0.0	0.0	0.0	4.20E-03
58 CE 141	3.97E-02	2.68E-02	3.04E-03	0.0	1.25E-02	0.0	1.03E+02
58 CE 143	4.85E-03	3.59E+00	3.97E-04	0.0	1.58E-03	0.0	1.34E+02
58 CE 144	2.10E+00	8.78E-01	1.13E-01	0.0	5.21E-01	0.0	7.10E+02
59 PR 143	5.40E-01	2.17E-01	2.68E-02	0.0	1.25E-01	0.0	2.37E+03
59 PR 144	1.62E-17	6.73E-18	8.24E-19	0.0	3.80E-18	0.0	2.33E-24
60 ND 147	3.65E-01	4.22E-01	2.53E-02	0.0	2.47E-01	0.0	2.03E+03
74 W 187	1.48E+02	1.23E+02	4.32E+01	0.0	0.0	0.0	4.04E+04
93 NP 239	2.32E-02	2.28E-03	1.26E-03	0.0	7.12E-03	0.0	4.68E+02

Catawba Nuclear Station
Liquid Effluent Dose - Adult Parameters
A_{aoi} mrem/hr per µCi/ml

From Generic Section 3.1.1:

A_{aoi} = the site related ingestion dose commitment factor for an individual of age group, "a", to organ, "o", for each identified principal gamma and beta emitter, "i", in mrem/hr per µCi/ml

A_{aoi} = $1.14E+05\ (U_{aw}\sigma_w/Dw\ \exp(-\lambda_i t_w) + U_{af}\sigma_f BF_i \exp(-\lambda_i t_f))\ DF_{aoi}$

where:

1.14E+05 = 10^6 pCi/µCi x 10^3 ml/kg ÷ 8760 hr/yr

U_{aw} = Water consumption by age group, l/yr

infant	330
child	510
teen	510
adult	730

σ_w, σ_f = Recirculation factors at equilibrium for the water and fish pathways respectively; these factors account for the fraction of discharged water reused by the station
σ_w = 1.00 σ_f = 1.00

D_w = Dilution factor from the near field area to the potable water intake = 43.4 (4453 cfs + 105 cfs)/(105 cfs)
(Avg Wylie Dam Flow + Avg Radwaste Flow)/(Avg Radwaste Flow)

U_{af} = Fish consumption by age group, kg/yr

infant	---
child	6.9
teen	16
adult	21

BF_i = Bioaccumulation factor for radionuclide, "i", in fish, pCi/kg per pCi/l, from Table 3.1-1

DF_{aoi} = Dose conversion factor for age group, "a", in organ, "o", for radionuclide, "i", in mrem/pCi, from Tables 3.1-2, 3.1-3, 3.1-4, and 3.1-5, respectively

λ_i = radiological decay constant for isotope, i, in 1/hr

t_w, t_f = transport time for the drinking water and fish pathways, hr
t_w = 12 hours t_f = 24 hours

Sample Calculation for Adult, I-131, Thyroid:

A(a,thy,I-131) = 1.14E5 (730*1.0/43.4*exp(-3.59E-3*12) + 21*1.0*15* exp(-3.59E-3*24)) 1.95E-3 = 6.78E4 mr/hr per µCi/ml

TABLE C4.0-4
(1 OF 2)

CATAWBA NUCLEAR STATION
LIQUID EFFLUENT DOSE - TEEN PARAMETERS
A(I) MREM/HR PER UCI/ML

RADIONUCLIDE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
1 H 3	0.0	3.16E-01	3.16E-01	3.16E-01	3.16E-01	3.16E-01	3.16E-01
11 NA 24	1.41E+02	1.41E+02	1.41E+02	1.41E+02	1.41E+02	1.41E+02	1.41E+02
24 CR 51	0.0	0.0	1.29E+00	7.14E-01	2.82E-01	1.84E+00	2.16E+02
25 MN 54	0.0	4.30E+03	8.53E+02	0.0	1.28E+03	0.0	8.82E+03
25 MN 56	0.0	1.85E-01	3.29E-02	0.0	2.34E-01	0.0	1.22E+01
26 FE 55	6.94E+02	4.92E+02	1.15E+02	0.0	0.0	3.12E+02	2.13E+02
26 FE 59	1.06E+03	2.48E+03	9.57E+02	0.0	0.0	7.82E+02	5.86E+03
27 CO 58	0.0	8.91E+01	2.05E+02	0.0	0.0	0.0	1.23E+03
27 CO 60	0.0	2.60E+02	5.86E+02	0.0	0.0	0.0	3.39E+03
28 NI 63	3.25E+04	2.30E+03	1.10E+03	0.0	0.0	0.0	3.66E+02
28 NI 65	2.23E-01	2.84E-02	1.30E-02	0.0	0.0	0.0	1.54E+00
29 CU 64	0.0	2.90E+00	1.36E+00	0.0	7.34E+00	0.0	2.25E+02
30 ZN 65	2.10E+04	7.28E+04	3.40E+04	0.0	4.66E+04	0.0	3.08E+04
30 ZN 69	4.35E-06	8.29E-06	5.81E-07	0.0	5.42E-06	0.0	1.53E-05
35 BR 83	0.0	0.0	4.43E-02	0.0	0.0	0.0	0.0
35 BR 85	0.0	0.0	1.01E-78	0.0	0.0	0.0	0.0
37 RB 86	0.0	1.05E+05	4.92E+04	0.0	0.0	0.0	1.55E+04
37 RB 88	0.0	8.29E-14	4.42E-14	0.0	0.0	0.0	7.11E-21
37 RB 89	0.0	4.62E-16	3.27E-16	0.0	0.0	0.0	7.09E-25
38 SR 89	2.43E+04	0.0	6.97E+02	0.0	0.0	0.0	2.90E+03
38 SR 90	2.51E+05	0.0	6.73E+04	0.0	0.0	0.0	1.31E+04
38 SR 91	8.09E+01	0.0	3.22E+00	0.0	0.0	0.0	3.67E+02
38 SR 92	5.52E-01	0.0	2.35E-02	0.0	0.0	0.0	1.41E+01
39 Y 90	4.98E-01	0.0	1.34E-02	0.0	0.0	0.0	4.11E+03
39 Y 91M	7.36E-09	0.0	2.81E-10	0.0	0.0	0.0	3.47E-07
39 Y 91	9.33E+00	0.0	2.50E-01	0.0	0.0	0.0	3.82E+03
39 Y 92	6.66E-04	0.0	1.93E-05	0.0	0.0	0.0	1.83E+01
39 Y 93	3.58E-02	0.0	9.81E-04	0.0	0.0	0.0	1.09E+03
40 ZR 95	3.00E-01	9.47E-02	6.51E-02	0.0	1.39E-01	0.0	2.19E+02
40 ZR 97	7.27E-03	1.44E-03	6.62E-04	0.0	2.18E-03	0.0	3.89E+02
41 NB 95	4.41E+02	2.45E+02	1.35E+02	0.0	2.37E+02	0.0	1.05E+06
42 MO 99	0.0	9.26E+01	1.77E+01	0.0	2.12E+02	0.0	1.66E+02
43 TC 99M	6.84E-04	1.91E-03	2.47E-02	0.0	2.84E-02	1.06E-03	1.25E+00
43 TC 101	2.58E-19	3.67E-19	3.60E-18	0.0	6.63E-18	2.23E-19	6.27E-26
44 RU 103	4.91E+00	0.0	2.10E+00	0.0	1.73E+01	0.0	4.10E+02
44 RU 105	1.38E-02	0.0	5.37E-03	0.0	1.74E-01	0.0	1.12E+01
44 RU 106	7.66E+01	0.0	9.65E+00	0.0	1.48E+02	0.0	3.67E+03
47 AG 110M	1.13E+00	1.07E+00	6.52E-01	0.0	2.04E+00	0.0	3.01E+02
52 TE 125M	2.77E+03	9.97E+02	3.70E+02	7.73E+02	0.0	0.0	8.16E+03
52 TE 127M	7.02E+03	2.49E+03	8.35E+02	1.67E+03	2.85E+04	0.0	1.75E+04
52 TE 127	1.95E+01	6.92E+00	4.20E+00	1.35E+01	7.91E+01	0.0	1.51E+03
52 TE 129M	1.17E+04	4.33E+03	1.85E+03	3.77E+03	4.88E+04	0.0	4.38E+04
52 TE 129	6.54E-05	2.44E-05	1.59E-05	4.67E-05	2.75E-04	0.0	3.58E-04
52 TE 131M	1.02E+03	4.91E+02	4.10E+02	7.39E+02	5.12E+03	0.0	3.94E+04
52 TE 131	8.39E-11	3.46E-11	2.62E-11	6.46E-11	3.67E-10	0.0	6.88E-12
52 TE 132	2.06E+03	1.31E+03	1.23E+03	1.38E+03	1.25E+04	0.0	4.14E+04
53 I 130	8.02E+00	2.32E+01	9.27E+00	1.89E+03	3.58E+01	0.0	1.78E+01
53 I 131	1.54E+02	2.16E+02	1.16E+02	6.31E+04	3.72E+02	0.0	4.27E+01
53 I 132	1.56E-02	4.07E-02	1.46E-02	1.37E+00	6.42E-02	0.0	1.78E-02
53 I 133	2.65E+01	4.50E+01	1.37E+01	6.28E+03	7.89E+01	0.0	3.41E+01
53 I 135	1.57E+00	4.04E+00	1.50E+00	2.60E+02	6.38E+00	0.0	4.48E+00
55 CS 134	3.05E+05	7.18E+05	3.33E+05	0.0	2.28E+05	8.71E+04	8.93E+03
55 CS 136	2.97E+04	1.17E+05	7.86E+04	0.0	6.37E+04	1.00E+04	9.42E+03
55 CS 137	4.09E+05	5.44E+05	1.89E+05	0.0	1.85E+05	7.19E+04	7.74E+03
55 CS 138	2.00E-08	3.84E-08	1.92E-08	0.0	2.83E-08	3.29E-09	1.74E-11
56 BA 139	4.46E-04	3.14E-07	1.30E-05	0.0	2.96E-07	2.16E-07	3.98E-03
56 BA 140	2.33E+02	2.86E-01	1.50E+01	0.0	9.69E-02	1.92E-01	3.60E+02
56 BA 141	1.25E-13	9.32E-17	4.17E-15	0.0	8.65E-17	6.38E-17	2.66E-19
56 BA 142	2.19E-22	2.19E-25	1.35E-23	0.0	1.85E-25	1.46E-25	6.72E-34
57 LA 140	1.09E-01	5.35E-02	1.42E-02	0.0	0.0	0.0	3.07E+03
57 LA 142	1.25E-06	5.55E-07	1.38E-07	0.0	0.0	0.0	1.69E-02
58 CE 141	4.14E-02	2.76E-02	3.17E-03	0.0	1.30E-02	0.0	7.90E+01
58 CE 143	5.04E-03	3.67E+00	4.10E-04	0.0	1.65E-03	0.0	1.10E+02
58 CE 144	2.20E+00	9.09E-01	1.18E-01	0.0	5.43E-01	0.0	5.53E+02
59 PR 143	5.85E-01	2.33E-01	2.91E-02	0.0	1.36E-01	0.0	1.92E+03
59 PR 144	1.62E-17	6.62E-18	8.20E-19	0.0	3.80E-18	0.0	1.78E-20
60 ND 147	4.14E-01	4.50E-01	2.70E-02	0.0	2.64E-01	0.0	1.62E+03
74 W 187	1.60E+02	1.30E+02	4.56E+01	0.0	0.0	0.0	3.52E+04
93 NP 239	2.60E-02	2.45E-03	1.36E-03	0.0	7.69E-03	0.0	3.94E+02

Catawba Nuclear Station
Liquid Effluent Dose - Teen Parameters
A_{aoi} mrem/hr per μCi/ml

From Generic Section 3.1.1:

A_{aoi} = the site related ingestion dose commitment factor for an individual of age group, "a", to organ, "o", for each identified principal gamma and beta emitter, "i", in mrem/hr per μCi/ml

A_{aoi} = 1.14E+05 $(U_{aw}\sigma_w/Dw \exp(-\lambda_i t_w) + U_{af}\sigma_f BF_i \exp(-\lambda_i t_f))\ DF_{aoi}$

where:

1.14E+05 = 10^6 pCi/μCi x 10^3 ml/kg ÷ 8760 hr/yr

U_{aw} = Water consumption by age group, l/yr

infant	330
child	510
teen	510
adult	730

σ_w, σ_f = Recirculation factors at equilibrium for the water and fish pathways respectively; these factors account for the fraction of discharged water reused by the station
σ_w = 1.00 σ_f = 1.00

D_w = Dilution factor from the near field area to the potable water intake = 43.4 (4453 cfs + 105 cfs)/(105 cfs)
(Avg Wylie Dam Flow + Avg Radwaste Flow)/(Avg Radwaste Flow)

U_{af} = Fish consumption by age group, kg/yr

infant	---
child	6.9
teen	16
adult	21

BF_i = Bioaccumulation factor for radionuclide, "i", in fish, pCi/kg per pCi/l, from Table 3.1-1

DF_{aoi} = Dose conversion factor for age group, "a", in organ, "o", for radionuclide, "i", in mrem/pCi, from Tables 3.1-2, 3.1-3, 3.1-4, and 3.1-5, respectively

λ_i = radiological decay constant for isotope, i, in 1/hr

t_w, t_f = transport time for the drinking water and fish pathways, hr
t_w = 12 hours t_f = 24 hours

Sample Calculation for Teen, I-131, Thyroid:
**A(t,thy,I-131) = 1.14E5 (510*1.0/43.4*exp(-3.59E-3*12) + 16*1.0*15*
exp(-3.59E-3*24)) 2.39E-3 = 6.31E4 mr/hr per μCi/ml**

CATAWBA NUCLEAR STATION
LIQUID EFFLUENT DOSE - CHILD PARAMETERS
A(I) MREM/HR PER UCI/ML

RADIONUCLIDE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
1 H 3	0.0	4.16E-01	4.16E-01	4.16E-01	4.16E-01	4.16E-01	4.16E-01
11 NA 24	1.55E+02	1.55E+02	1.55E+02	1.55E+02	1.55E+02	1.55E+02	1.55E+02
24 CR 51	0.0	0.0	1.38E+00	7.64E-01	2.09E-01	1.40E+00	7.30E+01
25 MN 54	0.0	3.37E+03	8.99E+02	0.0	9.46E+02	0.0	2.83E+03
25 MN 56	0.0	1.79E-01	4.03E-02	0.0	2.16E-01	0.0	2.59E+01
26 FE 55	9.19E+02	4.88E+02	1.51E+02	0.0	0.0	2.76E+02	9.03E+01
26 FE 59	1.30E+03	2.10E+03	1.05E+03	0.0	0.0	6.10E+02	2.19E+03
27 CO 58	0.0	7.25E+01	2.22E+02	0.0	0.0	0.0	4.23E+02
27 CO 60	0.0	2.15E+02	6.34E+02	0.0	0.0	0.0	1.19E+03
28 NI 63	4.30E+04	2.30E+03	1.46E+03	0.0	0.0	0.0	1.55E+02
28 NI 65	3.47E-01	3.27E-02	1.91E-02	0.0	0.0	0.0	4.00E+00
29 CU 64	0.0	2.76E+00	1.67E+00	0.0	6.67E+00	0.0	1.30E+02
30 ZN 65	2.15E+04	5.73E+04	3.56E+04	0.0	3.61E+04	0.0	1.01E+04
30 ZN 69	1.08E-05	1.56E-05	1.44E-06	0.0	9.45E-06	0.0	9.82E-04
35 BR 83	0.0	0.0	6.10E-02	0.0	0.0	0.0	0.0
35 BR 85	0.0	0.0	3.01E-78	0.0	0.0	0.0	0.0
37 RB 86	0.0	1.02E+05	6.25E+04	0.0	0.0	0.0	6.54E+03
37 RB 88	0.0	1.85E-13	1.28E-13	0.0	0.0	0.0	9.07E-15
37 RB 89	0.0	9.83E-16	8.74E-16	0.0	0.0	0.0	8.57E-18
38 SR 89	3.25E+04	0.0	9.28E+02	0.0	0.0	0.0	1.26E+03
38 SR 90	2.82E+05	0.0	7.56E+04	0.0	0.0	0.0	5.71E+03
38 SR 91	1.11E+02	0.0	4.21E+00	0.0	0.0	0.0	2.46E+02
38 SR 92	1.02E+00	0.0	4.11E-02	0.0	0.0	0.0	1.94E+01
39 Y 90	6.72E-01	0.0	1.80E-02	0.0	0.0	0.0	1.91E+03
39 Y 91M	2.18E-08	0.0	7.92E-10	0.0	0.0	0.0	4.26E-05
39 Y 91	1.25E+01	0.0	3.34E-01	0.0	0.0	0.0	1.67E+03
39 Y 92	1.12E-03	0.0	3.20E-05	0.0	0.0	0.0	3.23E+01
39 Y 93	4.97E-02	0.0	1.37E-03	0.0	0.0	0.0	7.42E+02
40 ZR 95	4.52E-01	9.95E-02	8.85E-02	0.0	1.42E-01	0.0	1.04E+02
40 ZR 97	1.25E-02	1.81E-03	1.07E-03	0.0	2.59E-03	0.0	2.74E+02
41 NB 95	5.21E+02	2.03E+02	1.45E+02	0.0	1.90E+02	0.0	3.75E+05
42 MO 99	0.0	9.70E+01	2.40E+01	0.0	2.07E+02	0.0	8.02E+01
43 TC 99M	9.96E-04	1.95E-03	3.24E-02	0.0	2.84E-02	9.92E-04	1.11E+00
43 TC 101	7.66E-19	8.02E-19	1.02E-17	0.0	1.37E-17	4.24E-19	2.55E-18
44 RU 103	6.62E+00	0.0	2.54E+00	0.0	1.67E+01	0.0	1.71E+02
44 RU 105	2.52E-02	0.0	9.14E-03	0.0	2.21E-01	0.0	1.64E+01
44 RU 106	1.08E+02	0.0	1.34E+01	0.0	1.45E+02	0.0	1.67E+03
47 AG 110M	1.69E+00	1.14E+00	9.14E-01	0.0	2.13E+00	0.0	1.36E+02
52 TE 125M	3.56E+03	9.65E+02	4.75E+02	9.99E+02	0.0	0.0	3.43E+03
52 TE 127M	9.07E+03	2.44E+03	1.08E+03	2.17E+03	2.59E+04	0.0	7.35E+03
52 TE 127	2.53E+01	6.81E+00	5.42E+00	1.75E+01	7.18E+01	0.0	9.87E+02
52 TE 129M	1.51E+04	4.21E+03	2.34E+03	4.86E+03	4.43E+04	0.0	1.84E+04
52 TE 129	1.63E-04	4.54E-05	3.86E-05	1.16E-04	4.76E-04	0.0	1.01E-02
52 TE 131M	1.31E+03	4.52E+02	4.81E+02	9.30E+02	4.38E+03	0.0	1.84E+04
52 TE 131	2.49E-10	7.60E-11	7.42E-11	1.91E-10	7.54E-10	0.0	1.31E-09
52 TE 132	2.58E+03	1.14E+03	1.38E+03	1.66E+03	1.06E+04	0.0	1.15E+04
53 I 130	1.09E+01	2.21E+01	1.14E+01	2.44E+03	3.31E+01	0.0	1.03E+01
53 I 131	2.08E+02	2.09E+02	1.19E+02	6.93E+04	3.44E+02	0.0	1.86E+01
53 I 132	3.57E-02	6.55E-02	3.01E-02	3.04E+00	1.00E-01	0.0	7.71E-02
53 I 133	3.67E+01	4.54E+01	1.72E+01	8.44E+03	7.57E+01	0.0	1.83E+01
53 I 135	2.32E+00	4.18E+00	1.98E+00	3.70E+02	6.40E+00	0.0	3.18E+00
55 CS 134	3.68E+05	6.04E+05	1.27E+05	0.0	1.87E+05	6.72E+04	3.26E+03
55 CS 136	3.51E+04	9.65E+04	6.24E+04	0.0	5.14E+04	7.66E+03	3.39E+03
55 CS 137	5.15E+05	4.93E+05	7.27E+04	0.0	1.61E+05	5.78E+04	3.09E+03
55 CS 138	5.87E-08	8.16E-08	5.17E-08	0.0	5.74E-08	6.18E-09	3.76E-08
56 BA 139	1.32E-03	7.03E-07	3.82E-05	0.0	6.14E-07	4.14E-07	7.61E-02
56 BA 140	3.56E+02	3.12E-01	2.08E+01	0.0	1.02E-01	1.86E-01	1.80E+02
56 BA 141	3.72E-13	2.08E-16	1.21E-14	0.0	1.80E-16	1.22E-15	2.12E-13
56 BA 142	6.40E-22	4.60E-25	3.57E-23	0.0	3.73E-25	2.71E-25	8.35E-24
57 LA 140	1.42E-01	4.98E-02	1.68E-02	0.0	0.0	0.0	1.39E+03
57 LA 142	3.38E-06	1.08E-06	3.37E-07	0.0	0.0	0.0	2.14E-01
58 CE 141	8.32E-02	4.15E-02	6.16E-03	0.0	1.82E-02	0.0	5.18E+01
58 CE 143	1.06E-02	5.75E+00	8.34E-04	0.0	2.41E-03	0.0	8.43E+01
58 CE 144	4.42E+00	1.38E+00	2.36E-01	0.0	7.66E-01	0.0	3.61E+02
59 PR 143	7.86E-01	2.36E-01	3.90E-02	0.0	1.28E-01	0.0	8.48E+02
59 PR 144	4.85E-17	1.50E-17	2.44E-18	0.0	7.94E-18	0.0	3.23E-14
60 ND 147	5.52E-01	4.47E-01	3.46E-02	0.0	2.45E-01	0.0	7.08E+02
74 W 187	2.02E+02	1.20E+02	5.38E+01	0.0	0.0	0.0	1.68E+04
93 NP 239	3.69E-02	2.65E-03	1.86E-03	0.0	7.65E-03	0.0	1.96E+02

Catawba Nuclear Station
Liquid Effluent Dose - Child Parameters
A_{aoi} mrem/hr per µCi/ml

From Generic Section 3.1.1:

A_{aoi} = the site related ingestion dose commitment factor for an individual of age group, "a", to organ, "o", for each identified principal gamma and beta emitter, "i", in mrem/hr per µCi/ml

A_{aoi} = $1.14E+05\ (U_{aw}\sigma_w/Dw\ \exp(-\lambda_i t_w) + U_{af}\sigma_f BF_i \exp(-\lambda_i t_f))\ DF_{aoi}$

where:

1.14E+05 = 10^6 pCi/µCi x 10^3 ml/kg ÷ 8760 hr/yr

U_{aw} = Water consumption by age group, l/yr

infant	330
child	510
teen	510
adult	730

σ_w, σ_f = Recirculation factors at equilibrium for the water and fish pathways respectively; these factors account for the fraction of discharged water reused by the station
σ_w = 1.00 σ_f = 1.00

D_w = Dilution factor from the near field area to the potable water intake = 43.4 (4453 cfs + 105 cfs)/(105 cfs)
(Avg Wylie Dam Flow + Avg Radwaste Flow)/(Avg Radwaste Flow)

U_{af} = Fish consumption by age group, kg/yr

infant	---
child	6.9
teen	16
adult	21

BF_i = Bioaccumulation factor for radionuclide, "i", in fish, pCi/kg per pCi/l, from Table 3.1-1

DF_{aoi} = Dose conversion factor for age group, "a", in organ, "o", for radionuclide, "i", in mrem/pCi, from Tables 3.1-2, 3.1-3, 3.1-4, and 3.1-5, respectively

λ_i = radiological decay constant for isotope, i, in 1/hr

t_w, t_f = transport time for the drinking water and fish pathways, hr
t_w = 12 hours t_f = 24 hours

Sample Calculation for Child, I-131, Thyroid:
A(c,thy,I-131) = 1.14E5 (510*1.0/43.4*exp(-3.59E-3*12) + 6.9*1.0*15* exp(-3.59E-3*24)) 5.72E-3 = 6.93E4 mr/hr per µCi/ml

TABLE C4.0-6
(1 OF 2)

CATAWBA NUCLEAR STATION
LIQUID EFFLUENT DOSE - INFANT PARAMETERS
A(I) MREM/HR PER UCI/ML

RADIONUCLIDE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
1 H 3	0.0	2.67E-01	2.67E-01	2.67E-01	2.67E-01	2.67E-01	2.67E-01
11 NA 24	5.04E+00	5.04E+00	5.04E+00	5.04E+00	5.04E+00	5.04E+00	5.04E+00
24 CR 51	0.0	0.0	1.21E-02	7.88E-03	1.72E-03	1.53E-02	3.52E-01
25 MN 54	0.0	1.72E+01	3.91E+00	0.0	3.82E+00	0.0	6.33E+00
25 MN 56	0.0	2.78E-02	4.79E-03	0.0	2.39E-02	0.0	2.52E+00
26 FE 55	1.20E+01	7.78E+00	2.08E+00	0.0	0.0	3.80E+00	9.88E-01
26 FE 59	2.65E+01	4.63E+01	1.82E+01	0.0	0.0	1.37E+01	2.21E+01
27 CO 58	0.0	3.11E+00	7.75E+00	0.0	0.0	0.0	7.74E+00
27 CO 60	0.0	9.36E+00	2.21E+01	0.0	0.0	0.0	2.23E+01
28 NI 63	5.50E+02	3.40E+01	1.91E+01	0.0	0.0	0.0	1.69E+00
28 NI 65	1.50E-01	1.70E-02	7.73E-03	0.0	0.0	0.0	1.29E+00
29 CU 64	0.0	2.74E-01	1.27E-01	0.0	4.63E-01	0.0	5.62E+00
30 ZN 65	1.59E+01	5.46E+01	2.52E+01	0.0	2.65E+01	0.0	4.61E+01
30 ZN 69	1.26E-05	2.26E-05	1.68E-06	0.0	9.40E-06	0.0	1.85E-03
35 BR 83	0.0	0.0	9.72E-03	0.0	0.0	0.0	0.0
35 BR 85	0.0	0.0	4.14E-78	0.0	0.0	0.0	0.0
37 RB 86	0.0	1.45E+02	7.15E+01	0.0	0.0	0.0	3.70E+00
37 RB 88	0.0	3.14E-13	1.72E-13	0.0	0.0	0.0	3.05E-13
37 RB 89	0.0	1.56E-15	1.07E-15	0.0	0.0	0.0	5.30E-16
38 SR 89	2.16E+03	0.0	6.20E+01	0.0	0.0	0.0	4.44E+01
38 SR 90	1.08E+04	0.0	2.92E+03	0.0	0.0	0.0	2.00E+02
38 SR 91	1.80E+01	0.0	6.53E-01	0.0	0.0	0.0	2.13E+01
38 SR 92	7.75E-01	0.0	2.88E-02	0.0	0.0	0.0	8.35E+00
39 Y 90	6.62E-02	0.0	1.77E-03	0.0	0.0	0.0	9.14E+01
39 Y 91M	2.99E-08	0.0	1.02E-09	0.0	0.0	0.0	9.95E-05
39 Y 91	9.74E-01	0.0	2.59E-02	0.0	0.0	0.0	6.98E+01
39 Y 92	6.38E-04	0.0	1.79E-05	0.0	0.0	0.0	1.22E+01
39 Y 93	9.23E-03	0.0	2.51E-04	0.0	0.0	0.0	7.29E+01
40 ZR 95	1.78E-01	4.33E-02	3.07E-02	0.0	4.66E-02	0.0	2.16E+01
40 ZR 97	7.84E-03	1.35E-03	6.14E-04	0.0	1.36E-03	0.0	8.58E+01
41 NB 95	3.60E-02	1.48E-02	8.58E-03	0.0	1.06E-02	0.0	1.25E+01
42 MO 99	0.0	2.60E+01	5.07E+00	0.0	3.88E+01	0.0	8.56E+00
43 TC 99M	4.18E-04	8.62E-04	1.11E-02	0.0	9.27E-03	4.50E-04	2.50E-01
43 TC 101	1.05E-18	1.33E-18	1.31E-17	0.0	1.58E-17	7.23E-19	2.25E-16
44 RU 103	1.27E+00	0.0	4.25E-01	0.0	2.65E+00	0.0	1.55E+01
44 RU 105	1.81E-02	0.0	6.09E-03	0.0	1.33E-01	0.0	7.19E+00
44 RU 106	2.09E+01	0.0	2.61E+00	0.0	2.47E+01	0.0	1.58E+02
47 AG 110M	8.62E-01	6.29E-01	4.16E-01	0.0	9.00E-01	0.0	3.26E+01
52 TE 125M	2.01E+01	6.71E+00	2.71E+00	6.76E+00	0.0	0.0	9.56E+00
52 TE 127M	5.05E+01	1.68E+01	6.12E+00	1.46E+01	1.24E+02	0.0	2.04E+01
52 TE 127	3.56E-01	1.19E-01	7.65E-02	2.90E-01	8.69E-01	0.0	7.48E+00
52 TE 129M	8.58E+01	2.94E+01	1.32E+01	3.29E+01	2.14E+02	0.0	5.12E+01
52 TE 129	1.89E-04	6.52E-05	4.42E-05	1.59E-04	4.71E-04	0.0	1.51E-02
52 TE 131M	9.98E+00	4.02E+00	3.32E+00	8.15E+00	2.77E+01	0.0	6.77E+01
52 TE 131	3.42E-10	1.26E-10	9.61E-11	3.05E-10	8.75E-10	0.0	1.38E-08
52 TE 132	1.62E+01	8.03E+00	7.49E+00	1.18E+01	5.02E+01	0.0	2.97E+01
53 I 130	2.65E+00	5.83E+00	2.34E+00	6.54E+02	6.41E+00	0.0	1.25E+00
53 I 131	2.98E+01	3.51E+01	1.54E+01	1.15E+04	4.10E+01	0.0	1.25E+00
53 I 132	3.87E-02	7.86E-02	2.80E-02	3.68E+00	8.77E-02	0.0	6.36E-02
53 I 133	7.27E+00	1.06E+01	3.10E+00	1.92E+03	1.24E+01	0.0	1.79E+00
53 I 135	8.94E-01	1.78E+00	6.48E-01	1.59E+02	1.98E+00	0.0	6.43E-01
55 CS 134	3.27E+02	6.09E+02	6.15E+01	0.0	1.57E+02	6.43E+01	1.65E+00
55 CS 136	3.87E+01	1.14E+02	4.25E+01	0.0	4.54E+01	9.29E+00	1.73E+00
55 CS 137	4.52E+02	5.30E+02	3.75E+01	0.0	1.42E+02	5.76E+01	1.66E+00
55 CS 138	8.01E-08	1.30E-07	6.31E-08	0.0	6.49E-08	1.01E-08	2.08E-07
56 BA 139	1.80E-03	1.20E-06	5.22E-05	0.0	7.19E-07	7.25E-07	1.14E-01
56 BA 140	1.44E+02	1.44E-01	7.43E+00	0.0	3.43E-02	8.86E-02	3.54E+01
56 BA 141	5.12E-13	3.50E-16	1.61E-14	0.0	2.11E-16	2.13E-16	6.25E-12
56 BA 142	8.72E-22	7.25E-25	4.29E-23	0.0	4.17E-25	4.39E-25	3.60E-21
57 LA 140	1.49E-02	5.87E-03	1.51E-03	0.0	0.0	0.0	6.89E+01
57 LA 142	4.31E-06	1.58E-06	3.79E-07	0.0	0.0	0.0	2.69E-01
58 CE 141	6.75E-02	4.12E-02	4.85E-03	0.0	1.27E-02	0.0	2.13E+01
58 CE 143	9.98E-03	6.62E+00	7.55E-04	0.0	1.93E-03	0.0	3.86E+01
58 CE 144	2.58E+00	1.06E+00	1.45E-01	0.0	4.27E-01	0.0	1.48E+02
59 PR 143	6.87E-02	2.57E-02	3.41E-03	0.0	9.55E-03	0.0	3.63E+01
59 PR 144	6.67E-17	2.58E-17	3.36E-18	0.0	9.35E-18	0.0	1.20E-12
60 ND 147	4.65E-02	4.77E-02	2.92E-03	0.0	1.84E-02	0.0	3.02E+01
74 W 187	5.53E-01	3.84E-01	1.33E-01	0.0	0.0	0.0	2.26E+01
93 NP 239	8.31E-03	7.43E-04	4.20E-04	0.0	1.48E-03	0.0	2.15E+01

Catawba Nuclear Station
Liquid Effluent Dose - Infant Parameters
A_{aoi} mrem/hr per µCi/ml

From Generic Section 3.1.1:

A_{aoi} = the site related ingestion dose commitment factor for an individual of age group, "a", to organ, "o", for each identified principal gamma and beta emitter, "i", in mrem/hr per µCi/ml

A_{aoi} = $1.14E+05\ (U_{aw}\sigma_w/Dw\ \exp(-\lambda_i t_w) + U_{af}\sigma_f BF_i \exp(-\lambda_i t_f))\ DF_{aoi}$

where:

1.14E+05 = 10^6 pCi/µCi x 10^3 ml/kg ÷ 8760 hr/yr

U_{aw} = Water consumption by age group, l/yr

infant	330
child	510
teen	510
adult	730

σ_w, σ_f = Recirculation factors at equilibrium for the water and fish pathways respectively; these factors account for the fraction of discharged water reused by the station.
σ_w = 1.00 σ_f = 1.00

D_w = Dilution factor from the near field area to the potable water intake = 43.4 (4453 cfs + 105 cfs)/(105 cfs)
(Avg Wylie Dam Flow + Avg Radwaste Flow)/(Avg Radwaste Flow)

U_{af} = Fish consumption by age group, kg/yr

infant	---
child	6.9
teen	16
adult	21

BF_i = Bioaccumulation factor for radionuclide, "i", in fish, pCi/kg per pCi/l, from Table 3.1-1

DF_{aoi} = Dose conversion factor for age group, "a", in organ, "o", for radionuclide, "i", in mrem/pCi, from Tables 3.1-2, 3.1-3, 3.1-4, and 3.1-5, respectively

λ_i = radiological decay constant for isotope, i, in 1/hr

t_w, t_f = transport time for the drinking water and fish pathways, hr
t_w = 12 hours t_f = 24 hours

Sample Calculation for Infant, I-131, Thyroid:
A(i,thy,I-131) = 1.14E5 (330*1.0/43.4*exp(-3.59E-3*12) + 0*1.0*15* exp(-3.59E-3*24)) 1.39E-2 = 1.15E4 mr/hr per µCi/ml

Table C4.0-7 - Meteorological Parameter and Applicable Pathways for Potential Worst-Case Offsite Locations for Analyzing Offsite Doses From Particulates, Iodine and Other Radionuclides

Ground Level Release Worst-Case Locations *

	$(\overline{X/Q})$ sec/m^3	$(\overline{D/Q})$ 1/m^2
(1) Inhalation, 0.5 mi, NNE	3.510E-05	1.078E-07
(2) Garden, 0.98 mi, S	1.552E-05	7.881E-08
(3) Meat Animal, 2.21 mi, NNW	8.221E-07	2.114E-09
(4) Milk Animal, 1.27 mi, ENE	5.813E-06	1.009E-08
(5) Combination, 0.5 mi, ENE	2.208E-05	4.135E-08

* The Ground Plane and Inhalation pathways are assumed to exist in each sector for dose calculation purposes. All pathways are assumed to exist at the 5.0-mile boundary in each sector for dose calculation purposes.

TABLE C4.0-8

PATHWAY APPLICABILITY FOR ALL LOCATIONS BASED ON SITE SURVEY*
CATAWBA NUCLEAR STATION
(1 of 1)

Distance to the control location in miles

SECTOR	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	X	I	I	VI	VI	VI	VI	VI	VI	VIMG
NNE	X	I	I	VI	VI	VI	VI	VI	VI	VIMG
NE	X	VI	VI	VI	VI	VI	VI	VI	VI	VIMG
ENE	X	VI	VIG	VIG	VIG	VIG	VIG	VIG	VIMG	VIMG
E	X	I	I	I	I	I	I	I	I	VIMG
ESE	X	I	I	I	I	I	I	VI	VI	VIMG
SE	X	I	I	VI	VI	VI	VI	VI	VIMG	VIMG
SSE	X	I	I	VI	VI	VI	VI	VIG	VIG	VIMG
S	X	VI	VI	VI	VI	VI	VI	VI	VIM	VIMG
SSW	X	VI	VI	VI	VI	VI	VIM	VIM	VIM	VIMG
SW	X	VI	VI	VI	VI	VIMG	VIMG	VIMG	VIMG	VIMG
WSW	X	I	I	I	VI	VIMG	VIMG	VIMG	VIMG	VIMG
W	X	VI	VI	VI	VI	VI	VI	VIM	VIM	VIMG
WNW	X	I	VI	VI	VI	VI	VI	VIG	VIMG	VIMG
NW	X	I	IG	VIG	VIMG	VIMG	VIMG	VIMG	VIMG	VIMG
NNW	X	I	I	I	VIM	VIMG	VIMG	VIMG	VIMG	VIMG

PATHWAYS: X - None V - VEGETABLE M - MEAT G - GOAT MILK C - COW MILK I - INHALATION

* **The Inhalation pathway is assumed to exist in each sector for dose calculational purposes. All pathways are assumed to exist at the 5.0-mile boundary in each sector for dose calculational purposes.**

FIGURE C4.0-1
(1 of 2)

CATAWBA LADTAP INPUT TEMPLATE
FOR LIQUID RADIONUCLIDE RELEASE OFFSITE DOSE CALCULATIONS

```
****** ****************************** TOP OF DATA ******************************
Column ----+----1----+----2----+----3----+----4----+----5----+----6----+----7--
LADTAP INPUT FOR CATAWBA ODCM METHOD - DEFAULT DILUTION
      0  1.05E+02       1.0
    1.0
LIQUID RELEASE SOURCE TERMS - CURIES PER RELEASE PERIOD
H 3        0.00E+00
NA24       0.00E+00
CR51       0.00E+00
MN54       0.00E+00
MN56       0.00E+00
FE55       0.00E+00
FE59       0.00E+00
CO58       0.00E+00
CO60       0.00E+00
NI63       0.00E+00
NI65       0.00E+00
CU64       0.00E+00
ZN65       0.00E+00
CN69       0.00E+00
BR83       0.00E+00
BR85       0.00E+00
RB86       0.00E+00
RB88       0.00E+00
RB89       0.00E+00
SR89       0.00E+00
SR90       0.00E+00
SR91       0.00E+00
SR92       0.00E+00
Y 90       0.00E+00
Y 91 M     0.00E+00
Y 91       0.00E+00
Y 92       0.00E+00
Y 93       0.00E+00
ZR95       0.00E+00
ZR97       0.00E+00
NB95       0.00E+00
MO99       0.00E+00
TC99 M     0.00E+00
TC101      0.00E+00
RU103      0.00E+00
RU105      0.00E+00
RU106      0.00E+00
AG110M     0.00E+00
TE125M     0.00E+00
TE127M     0.00E+00
TE127      0.00E+00
TE129M     0.00E+00
TE129      0.00E+00
TE131M     0.00E+00
TE131      0.00E+00
TE132      0.00E+00
I 130      0.00E+00
I 131      0.00E+00
I 132      0.00E+00
I 133      0.00E+00
I 135      0.00E+00
CS134      0.00E+00
CS136      0.00E+00
CS137      0.00E+00
CS138      0.00E+00
```

FIGURE C4.0-1
(2 of 2)

CATAWBA LADTAP INPUT TEMPLATE
FOR LIQUID RADIONUCLIDE RELEASE OFFSITE DOSE CALCULATIONS

```
Column ----+----1----+----2----+----3----+----4----+----5----+----6----+----7--
000060  BA139    0.00E+00
000061  BA140    0.00E+00
000062  BA141    0.00E+00
000063  BA142    0.00E+00
000064  LA140    0.00E+00
000065  LA142    0.00E+00
000066  CE141    0.00E+00
000067  CE143    0.00E+00
000068  CE144    0.00E+00
000069  PR143    0.00E+00
000070  PR144    0.00E+00
000071  ND147    0.00E+00
000072  W 187    0.00E+00
000073  NP239    0.00E+00
000074
000075
000076                0.3       1.0       1.0      43.4       0.0       0.0
000077
000078
000079
****** ***************************** BOTTOM OF DATA **************************
```

FIGURE C4.0-2

CATAWBA GASPAR INPUT TEMPLATE

FOR NOBLE GAS RADIONUCLIDE RELEASE WORST-CASE LOCATION

```
****** ***************************** TOP OF DATA ******************************
=COLS> ----+----1----+----2----+----3----+----4----+----5----+----6----+----7--
000001 GASPAR INPUT FOR CATAWBA ODCM METHOD - MAX NOBLE GAS DOSE CALCULATIONS
000002  0          0.0        0.0        0.0        0.0
000003  1 1
000004      1.0      1.0      1.0    0.76      1.0
000005 NOBLE GAS SOURCE TERM - CURIES PER RELEASE PERIOD
000006        1.0
000007   AR41       0.00E+00
000008   KR83 M     0.00E+00
000009   KR85       0.00E+00
000010   KR85 M     0.00E+00
000011   KR87       0.00E+00
000012   KR88       0.00E+00
000013   KR90       0.00E+00
000014   XE131M     0.00E+00
000015   XE133      0.00E+00
000016   XE133M     0.00E+00
000017   XE135      0.00E+00
000018   XE135M     0.00E+00
000019   XE137      0.00E+00
000020   XE138      0.00E+00
000021
000022   LOCATION 1       NNE 0.50   3.510E-05 3.510E-05 3.510E-05 1.078E-07
000023
****** **************************** BOTTOM OF DATA ****************************
```

FIGURE C4.0-3

CATAWBA GASPAR INPUT TEMPLATE
FOR PARTICULATE, IODINE AND OTHER NUCLIDES WORST-CASE LOCATIONS

```
****** ***************************** TOP OF DATA ******************************
=COLS> ----+----1----+----2----+----3----+----4----+----5----+----6----+----7--
000001 GASPAR INPUT FOR CATAWBA ODCM METHOD - PART, I, AND OTHER - INHALATION
000002  0         0.0        0.0        0.0        0.0
000003  1 1
000004       1.0      1.0      1.0     0.76      1.0
000005 PART, I AND OTHER NUCLIDES SOURCE - CURIES PER RELEASE PERIOD
000006        1.0
000007   H 3       0.00E+00
000008   CR51      0.00E+00
000009   MN54      0.00E+00
000010   FE55      0.00E+00
000011   FE59      0.00E+00
000012   CO58      0.00E+00
000013   CO60      0.00E+00
000014   ZN65      0.00E+00
000015   SR89      0.00E+00
000016   SR90      0.00E+00
000017   ZR95      0.00E+00
000018   MO99      0.00E+00
000019   I 131     0.00E+00
000020   I 133     0.00E+00
000021   CS134     0.00E+00
000022   CS136     0.00E+00
000023   CS137     0.00E+00
000024   BA140     0.00E+00
000025   CE141     0.00E+00
000026   CE144     0.00E+00
000027
000028   LOCATION 1       NNE 0.50   3.510E-05 3.510E-05 3.510E-05 1.078E-07
000029
****** **************************** BOTTOM OF DATA ****************************
```

FOR OTHER LOCATIONS, REPLACE FOLLOWING INPUT LINES:

LOCATION 2 - WORST VEGETABLE GARDEN

```
000001 GASPAR INPUT FOR CATAWBA ODCM METHOD - PART, I, AND OTHER - GARDEN
000002  0         1.0        0.0        0.0        0.0
000028   LOCATION 2         S 0.98   1.552E-05 1.552E-05 1.552E-05 7.881E-08
```

LOCATION 3 - WORST MEAT ANIMAL

```
000001 GASPAR INPUT FOR CATAWBA ODCM METHOD - PART, I, AND OTHER - MEAT
000002  0         1.0        1.0        0.0        1.0
000028   LOCATION 3       NNW 2.21   8.221E-07 8.221E-07 8.221E-07 2.114E-09
```

LOCATION 4 - WORST MILK ANIMAL

```
000001 GASPAR INPUT FOR CATAWBA ODCM METHOD - PART, I, AND OTHER - MILK
000002  0         1.0        0.0        0.0        1.0
000028   LOCATION 4       ENE 1.27   5.813E-06 5.813E-06 5.813E-06 1.009E-08
```

LOCATION 5 - WORST COMBINATION

```
000001 GASPAR INPUT FOR CATAWBA ODCM METHOD - PART, I, AND OTHER - COMBINATION
000002  0         1.0        0.0        0.0        0.0
000028   LOCATION 5       ENE 0.50   2.208E-05 2.208E-05 2.208E-05 4.135E-08
```

Figure C4.0-4 - Fuel Cycle Dose Calculation Worksheet for Potential Worst-Case Offsite Locations

Ground Level Release Worst-Case Locations *

	$(\overline{X/Q})$ sec/m^3	$(\overline{D/Q})$ 1/m^2
(1) Inhalation, 0.5 mi, NNE	3.510E-05	1.078E-07
(2) Garden, 0.98 mi, S	1.552E-05	7.881E-08
(3) Meat Animal, 2.21 mi, NNW	8.221E-07	2.114E-09
(4) Milk Animal, 1.27 mi, ENE	5.813E-06	1.009E-08
(5) Combination, 0.5 mi, ENE	2.208E-05	4.135E-08

* The Ground Plane and Inhalation pathways are assumed to exist in each sector for dose calculation purposes. All pathways are assumed to exist at the 5.0-mile boundary in each sector for dose calculation purposes.

Adult Age Group

Location 1 - Worst-Case Inhalation/Ground Location *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	____	____	____	____	____	____	____
$D_{a,o}(g)$	____	____	____	____	____	____	____
$D_{a,o}(T)$	____	____	____	____	____	____	____

Location 2 - Worst-Case Vegetable Garden Location *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	____	____	____	____	____	____	____
$D_{a,o}(g)$	____	____	____	____	____	____	____
$D_{a,o}(T)$	____	____	____	____	____	____	____

Location 3 - Worst-Case Meat Animal Location *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	____	____	____	____	____	____	____
$D_{a,o}(g)$	____	____	____	____	____	____	____
$D_{a,o}(T)$	____	____	____	____	____	____	____

Location 4 - Worst-Case Milk Animal Location *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	____	____	____	____	____	____	____
$D_{a,o}(g)$	____	____	____	____	____	____	____
$D_{a,o}(T)$	____	____	____	____	____	____	____

Figure C4.0-4
(2 of 10)

Figure C4.0-4 (Cont'd) - Fuel Cycle Dose Calculation Worksheet for Organ Doses

Location 5_1 - Worst-Case Combination 1,2...N Location(s) *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	____	____	____	____	____	____	____
$D_{a,o}(g)$	____	____	____	____	____	____	____
$D_{a,o}(T)$	____	____	____	____	____	____	____

Location 5_2 - Worst-Case Combination 1,2...N Location(s) *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	____	____	____	____	____	____	____
$D_{a,o}(g)$	____	____	____	____	____	____	____
$D_{a,o}(T)$	____	____	____	____	____	____	____

Location 5_N - Worst-Case Combination 1,2...N Location(s) *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	____	____	____	____	____	____	____
$D_{a,o}(g)$	____	____	____	____	____	____	____
$D_{a,o}(T)$	____	____	____	____	____	____	____

Adult Organ Maximums**

Maximum Total

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(T_{max})$	____	____	____	____	____	____	____

Figure C4.0-4
(3 of 10)

Figure C4.0-4 (Cont'd) - Fuel Cycle Dose Calculation Worksheet for Organ Doses

Teen Age Group

Location 1 - Worst-Case Inhalation/Ground Location *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	______	______	______	______	______	______	______
$D_{a,o}(g)$	______	______	______	______	______	______	______
$D_{a,o}(T)$	______	______	______	______	______	______	______

Location 2 - Worst-Case Vegetable Garden Location *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	______	______	______	______	______	______	______
$D_{a,o}(g)$	______	______	______	______	______	______	______
$D_{a,o}(T)$	______	______	______	______	______	______	______

Location 3 - Worst-Case Meat Animal Location *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	______	______	______	______	______	______	______
$D_{a,o}(g)$	______	______	______	______	______	______	______
$D_{a,o}(T)$	______	______	______	______	______	______	______

Location 4 - Worst-Case Milk Animal Location *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	______	______	______	______	______	______	______
$D_{a,o}(g)$	______	______	______	______	______	______	______
$D_{a,o}(T)$	______	______	______	______	______	______	______

Figure C4.0-4 (Cont'd) - Fuel Cycle Dose Calculation Worksheet for Organ Doses

Location 5_1 - Worst-Case Combination 1,2...N Location(s) *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	______	______	______	______	______	______	______
$D_{a,o}(g)$	______	______	______	______	______	______	______
$D_{a,o}(T)$	______	______	______	______	______	______	______

Location 5_2 - Worst-Case Combination 1,2...N Location(s) *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	______	______	______	______	______	______	______
$D_{a,o}(g)$	______	______	______	______	______	______	______
$D_{a,o}(T)$	______	______	______	______	______	______	______

Location 5_N - Worst-Case Combination 1,2...N Location(s) *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	______	______	______	______	______	______	______
$D_{a,o}(g)$	______	______	______	______	______	______	______
$D_{a,o}(T)$	______	______	______	______	______	______	______

Teen Organ Maximums**

Maximum Total

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(T_{max})$	______	______	______	______	______	______	______

Figure C4.0-4 (Cont'd) - Fuel Cycle Dose Calculation Worksheet for Organ Doses

Child Age Group

Location 1 - Worst-Case Inhalation/Ground Location *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	____	____	____	____	____	____	____
$D_{a,o}(g)$	____	____	____	____	____	____	____
$D_{a,o}(T)$	____	____	____	____	____	____	____

Location 2 - Worst-Case Vegetable Garden Location *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	____	____	____	____	____	____	____
$D_{a,o}(g)$	____	____	____	____	____	____	____
$D_{a,o}(T)$	____	____	____	____	____	____	____

Location 3 - Worst-Case Meat Animal Location *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	____	____	____	____	____	____	____
$D_{a,o}(g)$	____	____	____	____	____	____	____
$D_{a,o}(T)$	____	____	____	____	____	____	____

Location 4 - Worst-Case Milk Animal Location *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	____	____	____	____	____	____	____
$D_{a,o}(g)$	____	____	____	____	____	____	____
$D_{a,o}(T)$	____	____	____	____	____	____	____

Figure C4.0-4 (Cont'd) - Fuel Cycle Dose Calculation Worksheet for Organ Doses

Location 5_1 - Worst-Case Combination 1,2...N Location(s) *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$							
$D_{a,o}(g)$							
$D_{a,o}(T)$							

Location 5_2 - Worst-Case Combination 1,2...N Location(s) *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$							
$D_{a,o}(g)$							
$D_{a,o}(T)$							

Location 5_N - Worst-Case Combination 1,2...N Location(s) *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$							
$D_{a,o}(g)$							
$D_{a,o}(T)$							

Child Organ Maximums**

Maximum Total

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(T_{max})$							

Figure C4.0-4
(7 of 10)

Figure C4.0-4 (Cont'd) - Fuel Cycle Dose Calculation Worksheet for Organ Doses

Infant Age Group

Location 1 - Worst-Case Inhalation/Ground Location *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$							
$D_{a,o}(g)$							
$D_{a,o}(T)$							

Location 2 - Worst-Case Vegetable Garden Location *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$							
$D_{a,o}(g)$							
$D_{a,o}(T)$							

Location 3 - Worst-Case Meat Animal Location *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$							
$D_{a,o}(g)$							
$D_{a,o}(T)$							

Location 4 - Worst-Case Milk Animal Location *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$							
$D_{a,o}(g)$							
$D_{a,o}(T)$							

Figure C4.0-4
(8 of 10)

Figure C4.0-4 (Cont'd) - Fuel Cycle Dose Calculation Worksheet for Organ Doses

Location 5_1 - Worst-Case Combination 1,2...N Location(s) *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	______	______	______	______	______	______	______
$D_{a,o}(g)$	______	______	______	______	______	______	______
$D_{a,o}(T)$	______	______	______	______	______	______	______

Location 5_2 - Worst-Case Combination 1,2...N Location(s) *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	______	______	______	______	______	______	______
$D_{a,o}(g)$	______	______	______	______	______	______	______
$D_{a,o}(T)$	______	______	______	______	______	______	______

Location 5_N - Worst-Case Combination 1,2...N Location(s) *

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(l)$	______	______	______	______	______	______	______
$D_{a,o}(g)$	______	______	______	______	______	______	______
$D_{a,o}(T)$	______	______	______	______	______	______	______

Infant Organ Maximums**

Maximum Total

	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
$D_{a,o}(T_{max})$	______	______	______	______	______	______	______

Figure C4.0-4 - Fuel Cycle Dose Calculation Worksheet For
(Cont'd) Food Pathway Organ Doses

All Age Groups

Maximum Organ Dose ***

Organ = **xxxxxxxxxx**

Age Group = **xxxxxxxxxx**

Dose = **x.xE-xx mrem/yr**

Notes:

* Fuel cycle dose for each age group, a, and organ, o, at analyzed limiting food pathway locations.
$D_{a,o}(T) = D_{a,o}(l) + D_{a,o}(g)$

** Limiting dose estimates for each organ for age group, a, (maximums of dose values calculated for Locations 1 through 5.)

*** Limiting dose estimate for any organ or age group (maximum of dose values calculated for any age group)

Figure C4.0-4
(10 of 10)

C5.0 Radiological Environmental Monitoring

The Radiological Environmental Monitoring Program shall be conducted in accordance with Selected Licensee Commitment Manual Section 16.11-13.

The monitoring program locations and analyses are given in Tables C5.0-1 through C5.0-3 and Figure C5.0-1.

The Duke Power Radiological and Environmental Services laboratory participates in an interlaboratory comparison program. This program is described in the Annual Environmental Operating Report.

The land-use census data is used to identify the location with the highest possible dose for a particular ingestion pathway (vegetable, milk, meat, etc.). Environmental monitoring measurements taken from these locations are then used to perform dose calculations that serve as a verification of the dose calculations that are performed for technical specification and licensee commitment (i.e., Compliance) purposes.

The land use census that was used to identify the controlling receptor locations was conducted during July 8, 1997 - July 10, 1997.

The 1997 Land Use Census identified no locations where Radiological Environmental Monitoring Program samples are required to be collected but are unavailable for collection.

TABLE C5.0-1
(1 of 1)
CATAWBA RADIOLOGICAL MONITORING PROGRAM SAMPLING LOCATIONS

(TLD LOCATIONS)

SAMPLING LOCATION	DESCRIPTION		SAMPLING LOCATION	DESCRIPTION	
200	Liberty Hill Road	(0.6M NNE)	232	4-5 MILE RADIUS	(4.1M NE)
201	Bluebird Lane	(0.5M NE)	233	4-5 MILE RADIUS	(3.9M ENE)
203	SITE BOUNDARY	(0.4M ESE)	234	4-5 MILE RADIUS	(4.5M E)
204	SITE BOUNDARY	(0.5M SSW)	235	4-5 MILE RADIUS	(3.9M ESE)
205	Overlook	(0.3M SW)	236	4-5 MILE RADIUS	(4.3M SE)
206	SITE BOUNDARY	(0.7M WNW)	237	4-5 MILE RADIUS	(4.8M SSE)
207	SITE BOUNDARY	(0.9M NNW)	238	4-5 MILE RADIUS	(4.0M S)
212	SPECIAL INTEREST	(3.3M E)	239	4-5 MILE RADIUS	(4.5M SSW)
217	CONTROL	(10.3M SSE)	240	4-5 MILE RADIUS	(4.1M SW)
222	SITE BOUNDARY	(0.7M N)	241	4-5 MILE RADIUS	(4.6M WSW)
223	SITE BOUNDARY	(0.6M E)	242	4-5 MILE RADIUS	(4.6M W)
225	SITE BOUNDARY	(0.7M SE)	243	4-5 MILE RADIUS	(4.4M WNW)
226	Discharge Bridge	(0.5M S)	244	4-5 MILE RADIUS	(4.0M NW)
227	SITE BOUNDARY	(0.5M WSW)	245	4-5 MILE RADIUS	(4.1M NNW)
228	SITE BOUNDARY	(0.6M W)	246	SPECIAL INTEREST	(7.8M ENE)
229	SITE BOUNDARY	(0.8M NW)	247	CONTROL	(7.3M ESE)
230	4-5 MILE RADIUS	(4.4M N)	248	SPECIAL INTEREST	(6.6M S)
231	4-5 MILE RADIUS	(4.2M NNE)	249	SPECIAL INTEREST	(8.1M S)
255	SITE BOUNDARY	(0.6M ENE)	250	SPECIAL INTEREST	(10.4M WSW)
256	SITE BOUNDARY	(0.6M SSE)	251	CONTROL	(9.7M WNW)

CATAWBA RADIOLOGICAL MONITORING PROGRAM SAMPLING LOCATIONS
(OTHER SAMPLING LOCATIONS)

CODE:
W - Weekly
BW - Biweekly
M - Monthly
SM - Semimonthly
Q - Quarterly
SA - Semiannually

Sampling Location Description		Air Radioiodines and Particulates	Surface Water	Drinking Water	Shoreline Sediment	Milk	Fish	Broadleaf Vegetation	Groundwater	Food Products
200	Liberty Hill Road (0.6m NNE)	W						M		
201	Bluebird Lane (0.5m NE)	W						M		
205	Overlook (0.3m SW)	W								
208	Discharge Canal (0.5m S)		BW		SA		SA			
209	Wood Dairy (6.0m SSW)					SM				
210	Ebenezer Access (2.3m SE)				SA					
211	Wylie Dam (4.0m ESE)		BW							
212	Tega Cay (3.3m E)	W								
214	Rock Hill Water Supply (7.3m SE)			BW						
215	River Pointe - Hwy 49 (4.2m NNE) Control		BW		SA					
216	Hwy 49 Bridge (4.0m NNE) Control						SA			
217	Rock Hill Substation (10.3m SSE) Control	W						M		
218	Belmont Water Supply (13.4m NNE) Control			BW						
219	Pursley Dairy (5.7m SW)					SM				
221	Oates Dairy (14.5m NW) Control					SM				
226	Discharge Bridge (0.5m S)							M		
252	Residence (0.7m SW)								Q	
253	Cloninger Irrigated Garden (Downstream within 5 mile radius)									M[(a)]
254	Residence (0.8m N)								Q	

(a) during harvest season

TA[illegible]5.0-3
(1 of 1)

CATAWBA RADIOLOGICAL MONITORING PROGRAM ANALYSES

SAMPLE MEDIUM	ANALYSIS SCHEDULE	ANALYSIS: GAMMA ISOTOPIC	TRITIUM	LOW LEVEL I-131	GROSS BETA	TLD
1. Radioiodine and Particulates	Weekly	X X			 X	
2. Direct Radiation	Quarterly					X
3. Surface Water	Biweekly Monthly Composite Quarterly Composite	 X 	 X	X 		
4. Drinking Water	Biweekly Monthly Composite Quarterly Composite	 X 	 X	X 	 X 	
5. Shoreline Sediment	Semiannually	X				
6. Milk	Semimonthly	X		X		
7. Fish	Semiannually	X				
8. Broadleaf Vegetation	Monthly	X				
9. Groundwater	Quarterly	X	X	X		
10. Food Products	Monthly [a]	X				

(a) during harvest season

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