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AUTH. NAME	AUTHOR AFFILIATION	
TUCKMAN, M.S.	Duke Power Co.	
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Duke Energy Corporation

526 South Church Street
P.O. Box 1006 (EC07H)
Charlotte, NC 28201-1006

(704) 382-2200 OFFICE
(704) 382-4360 FAX

M. S. Tuckman
Executive Vice President
Nuclear Generation

February 3, 1999

U. S. Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

Subject: Duke Energy Corporation
Oconee Nuclear Station, Units 1, 2, and 3
Docket Nos. 50-269, 50-270, 50-287
McGuire Nuclear Station, Units 1 and 2
Docket Nos. 50-369, 50-370
Catawba Nuclear Station, Units 1 and 2
Docket Nos. 50-413, 50-414
Offsite Dose Calculation Manual (ODCM) Revisions

Enclosed are revisions made to the Duke Power Company Offsite Dose Calculations Manual effective January 1, 1999. A complete copy of the entire ODCM is hereby transmitted as required by McGuire and Catawba Technical Specifications Section 5.5.1.c.

The following sections are affected by this revision.

Revision 42	Generic Section
Revision 39	Oconee Nuclear Station
Revision 40	McGuire Nuclear Station
Revision 41	Catawba Nuclear Station

By copy of this letter, the revised pages of the above ODCM sections are transmitted to be inserted in Control Copy No. 33 (assigned to ONRR) and Control Copy No. 34 (assigned to Region II) along with an approval letter for each section. For these copies, please insert revised pages according to the insertion instructions found on the approval letters. The approval letter for the Generic Manual along with the justification for Revision 42 should be placed in front of the entire manual. Each station approval letter (including justifications) should be placed in the front of the respective station manual sections.

If you have any questions, please contact L. B. Jones at (704) 382-4753.

Very truly yours,

M. S. Tuckman

M. S. Tuckman

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February 3, 1999
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Attachments (Original only - entire copy of updated ODCM)

- 1 - Generic Section
- 2 - Oconee Section
- 3 - McGuire Section
- 4 - Catawba Section

xc: With Attachment (Revised Pages)

D. E. LaBarge, Project Manager
ONRR

T. R. Decker, Chief, Radiological Effluents & Chemistry
Region II

Dale Dusenbury
State of North Carolina, Division of Radiation Protection

W/O Attachment

L. A. Reyes, Administrator, Region II
F. Rinaldi, Project Manager, ONRR
P. S. Tam, Project Manager, ONRR
M. A. Scott, Senior Resident Inspector, ONS
S. M. Shaeffer, Senior Resident Inspector, MNS
D. J. Roberts, Senior Resident Inspector, CNS

OFFSITE DOSE CALCULATION MANUAL

FOR

DUKE POWER NUCLEAR STATIONS

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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 RETDAS, a computer code that implements NUREG-0133 methodology, is used for the calculation of offsite doses, but this document also describes a method for the calculation of offsite doses when RETDAS is 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 $\mu\text{Ci/ml}$.

EC_i = the concentration of radionuclide, 'i', from 10CFR20, Appendix B, Table 2, Column 2, in $\mu\text{Ci/ml}$.

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 $\mu\text{Ci}/\text{m}^3$ 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 $\mu\text{Ci}/\text{m}^3$ 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 $\mu\text{Ci}/\text{m}^3$ from Table 1.2-1 (unit conversion constant of 1.1 mrem/mrad converts air dose to skin dose; no correction for structural shielding is assumed - GASPAR uses a factor of 0.7 reduction in gamma contributions to the skin dose consistent 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 $\mu\text{Ci}/\text{sec}$.

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

where:

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

f = the undiluted effluent flow, in cfm.

k_1 = conversion factor, $2.83\text{E}+04 \text{ ml}/\text{ft}^3$.

k_2 = conversion factor, $6.0\text{E}+01 \text{ sec}/\text{min}$.

1.2.2 Radioiodines, Particulates, and Others

$$\sum_i P_i \times \{ W \cdot Q_i \} < 1500 \text{ mrem/yr}$$

where:

P_i = The dose parameter for radionuclides other than noble gases for the inhalation pathway, in mrem/yr per $\mu\text{Ci}/\text{m}^3$ and for the food and ground plane pathways in $(\text{m}^2 \times (\text{mrem/yr per } \mu\text{Ci/sec}))$ 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.

Q_i = The release rate of radionuclide, 'i', in gaseous effluent from all release points at the site, in $\mu\text{Ci}/\text{sec}$.

$$Q_i = k_1 C_i f + k_2 = 4.72\text{E}+02 \cdot C_i f$$

where:

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

f = the undiluted effluent flow, in cfm.

k_1 = conversion factor, $2.83\text{E}+04 \text{ ml}/\text{ft}^3$.

k_2 = conversion factor, $6.0\text{E}+01 \text{ sec}/\text{min}$.

DOSE FACTORS FOR NOBLE GASES AND DAUGHTERS*

Radionuclide	Total Body Dose Factor K_i^{**} (mrem/yr per $\mu\text{Ci}/\text{m}^3$)	Skin Dose Factor L_i (mrem/yr per $\mu\text{Ci}/\text{m}^3$)	Gamma Air Dose Factor M_i (mrad/yr per $\mu\text{Ci}/\text{m}^3$)	Beta Air Dose Factor N_i (mrad/yr per $\mu\text{Ci}/\text{m}^3$)
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.

*** $7.56\text{E}-02 = 7.56 \times 10^{-2}$
 $5.29\text{E}-02 = 5.29 \times 10^{-2}$

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Table 1.2-2
(1 of 1)

DOSE PARAMETERS FOR RADIOIODINES AND RADIOACTIVE
PARTICULATE GASEOUS EFFLUENTS

(P_i Dose Parameters)

Radio- Nuclide	<u>Pathways</u>		<u>Critical Age</u>
	<u>Inhalation (mrem/yr per $\mu\text{Ci}/\text{m}^3$)</u>	<u>Food and Ground (m^2 mrem/yr per $\mu\text{Ci}/\text{sec}$)</u>	
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 GASPARD 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 GASPARD with all other parameters set to 1 yields the P_i values.

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

** The units for the H-3 Food and Ground pathways are the same as the Inhalation pathway.

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 $\mu\text{Ci/ml}$.

C = the radioactivity concentration in $\mu\text{Ci/ml}$, 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:

$$K_i(X/Q)Q_i < 500$$

$$Q_i = 4.72E+2 C f \quad (\text{See Section 1.2.1})$$

where:

C = the gross activity in undiluted effluent, in $\mu\text{Ci/ml}$.

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 $\mu\text{Ci}/\text{m}^3$.

$\overline{x/Q}$ = 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 $\mu\text{Ci/ml}$.

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

where:

$$1.14\text{E}+05 = 10^6 \text{ pCi}/\mu\text{Ci} \times 10^3 \text{ ml/kg} \div 8760 \text{ hr/yr.}$$

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 $\mu\text{Ci/ml}$.

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

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

$$F_n = f/(F + f)$$

where:

f = liquid radwaste flow, in gpm.

F = dilution flow, in gpm.

3.1.2 Gaseous Effluents

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 mrad is given as:

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

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

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

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 $\mu\text{Ci}/\text{m}^3$ 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 $\mu\text{Ci}/\text{m}^3$ 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:

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

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 $\text{m}^2 \cdot (\text{mrem}/\text{yr})$ per $\mu\text{Ci}/\text{sec}$ or mrem/yr per $\mu\text{Ci}/\text{m}^3$, for each age, organ, and pathway. (Tables 3.1-12 through 3.1-30).

where:

Inhalation Pathway Factor, $R_{\text{aoi}}^{\text{I}}$ (used with $\overline{X/Q}$)

$$R_{\text{aoi}}^{\text{I}} = K' (BR)_a (DFA_i)_a \quad (\text{mrem}/\text{yr per } \mu\text{Ci}/\text{m}^3)$$

where:

K' = a constant of unit conversion, $10^6 \text{ pCi}/\mu\text{Ci}$.

$(BR)_a$ = 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.

<u>Age Group (a)</u>	<u>Breathing Rate (m^3/yr)</u>
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, $R_{\text{aoi}}^{\text{G}}$ (used with $\overline{D/Q}$)

$$R_{\text{aoi}}^{\text{G}} = K' K'' (\text{SF}) \text{DFG}_i [(1 - \exp(-\lambda_i t))/\lambda_i] \quad (\text{m}^2 \cdot \text{mrem}/\text{yr per } \mu\text{Ci}/\text{sec})$$

where:

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

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

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

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

DFG_i = the ground plane dose conversion factor for the i th 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_{aoi}^C (used with $\overline{D/Q}$)

$$R_{aoi}^C = K' E Q_F(U_{ap}) F_m(DFL_i)_a \left\{ \frac{(r)}{(\lambda_i + \lambda_w)} \times \left[\frac{f_p f_s}{Y_p} (1 - \exp(-(\lambda_i + \lambda_w)t_{ep})) \right. \right. \\ \left. \left. + \frac{(1-f_p f_s)}{Y_s} (1 - \exp(-(\lambda_i + \lambda_w)t_{es})) \exp(-\lambda_i t_h) \right] + \frac{B_{iv}}{P\lambda_i} (1 - \exp(-\lambda_i t_b)) \right\} \exp(-\lambda_i t_f) \\ (\text{m}^2 \cdot \text{mrem/yr per } \mu\text{Ci/sec})$$

where:

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

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).
- $(\text{DFL}_i)_a$ = the maximum organ ingestion dose factor for the i th 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 i th radionuclide, in sec^{-1} .
- λ_w = the decay constant for removal of activity on leaf and plant surfaces by weathering, $5.73 \times 10^{-7} \text{ sec}^{-1}$ (corresponding to a 14 day half-life).
- t_f = the transport time from pasture to cow, to milk, to receptor, in sec, 1.73×10^5 (2 days).
- t_h = the transport time from pasture to harvest, to cow, to milk, to receptor, in sec, 7.78×10^6 (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, 2.59×10^6 (corresponding to 30 days, Regulatory Guide 1.109).
- t_{es} = period of stored feed crop/vegetation exposure during growing season, in seconds, 5.18×10^6 (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 $\text{pCi/Kg (wet weight) per pCi/Kg dry soil}$ (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, 4.73×10^8 (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_{aoi}^C is based on $[X/Q]$:

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

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_{aoi}^M (used with $\overline{D/Q}$)

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

$$R_{aoi}^M = K' E Q_F (U_{ap}) F_f (DFL_i)_a \left\{ \frac{(r) f_p f_s}{(\lambda_i + \lambda_w)} \times \left[\frac{f_p}{y_p} (1 - \exp(-(\lambda_i + \lambda_w)t_{ep})) \right] \right. \\ \left. + \frac{(1-f_p f_s)}{y_s} (1 - \exp(-(\lambda_i + \lambda_w)t_{es})) \times \exp(-\lambda_i t_h) \right\} + \frac{B_{iv}}{P\lambda_i} (1 - \exp(-\lambda_i t_b)) \} \times \exp(-\lambda_i t_f) \\ (\text{m}^2 \cdot \text{mrem/yr per } \mu\text{Ci/sec})$$

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_{aoi}^M is based on $[X/Q]$:

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

where all terms are defined above.

Vegetation Pathway Factor, R_{aoi}^V (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:

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

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

where:

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

U_a^L = 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_a^S = 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_{aoi}^v is based on the $[X/Q]$.

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

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 $< 0.1 \text{ mrem/yr}$. 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 of 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, RETDAS, 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 RETDAS computer program. 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

<u>ELEMENT</u>	<u>FISH</u>	<u>INVERTEBRATE</u>
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)

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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-ILLI
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-ILLI
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*
(2 OF 3)

INGESTION DOSE FACTORS FOR CHILD
(mRem per pCi Ingested)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
Y 93	1.14E-08	NO DATA	3.13E-10	NO DATA	NO DATA	NO DATA	1.70E-04
Zr 95	1.16E-07	2.55E-08	2.27E-08	NO DATA	3.65E-08	NO DATA	2.66E-05
Zr 97	6.99E-09	1.01E-09	5.96E-10	NO DATA	1.45E-09	NO DATA	1.53E-04
Nb 95	2.25E-08	8.76E-09	6.26E-09	NO DATA	8.23E-09	NO DATA	1.62E-05
Mo 99	NO DATA	1.33E-05	3.29E-06	NO DATA	2.84E-05	NO DATA	1.10E-05
Tc 99M	9.23E-10	1.81E-09	3.00E-08	NO DATA	2.63E-08	9.19E-10	1.03E-06
Tc 101	1.07E-09	1.12E-09	1.42E-08	NO DATA	1.91E-08	5.92E-10	3.56E-09
Ru 103	7.31E-07	NO DATA	2.81E-07	NO DATA	1.84E-06	NO DATA	1.89E-05
Ru 105	6.45E-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*
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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)

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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

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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-ILLI
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/m²)

<u>Element</u>	<u>Total Body</u>	<u>Skin</u>
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)

TABLE 3.1-10

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TABLE 3.1-10 (cont'd)
(2 of 2)
EXTERNAL DOSE FACTORS FOR STANDING ON CONTAMINATED GROUND

<u>Element</u>	(mrem/hr per pCi/m ²)	<u>Skin</u>
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

TABLE 3.1-10
(2 of 2)

TABLE 3.1-11*
(1 of 1)
STABLE ELEMENT TRANSFER DATA

<u>Element</u>	<u>B_{iv} Veg/Soil</u>	<u>F_m (Cow) Milk (d/l)</u>	<u>F_f Meat (d/kg)</u>
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

<u>Element</u>	<u>F_m (d/l)</u>
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

<u>NUCLIDE</u>	<u>T. BODY</u>	<u>SKIN</u>
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	2.91E+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

TABLE 3.1-13
(1 of 1)
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

TABLE 3.1-15
(1 of 1)
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

TABLE 3.1-18
(1 of 1)
 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 3.1-19
(1 of 1)

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 3.1-20
(1 of 1)

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 3.1-21
(1 of 1)

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 3.1-22
(1 of 1)

TABLE 3.1-23
(1 of 1)
R_i VALUES - GOAT MILK PATHWAY - ADULT

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-ILLI
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 3.1-23
(1 of 1)

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 3.1-24
(1 of 1)

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

TABLE 3.1-25
(1 of 1)

TABLE 3.1-26
(1 of 1)
 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 3.1-26
(1 of 1)

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 3.1-27
(1 of 1)

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 3.1-28
(1 of 1)

TABLE 3.1-29
(1 of 1)
R₁ 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 3.1-29
(1 of 1)

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

TABLE 3.1-30
(1 of 1)

January 1, 1999

Subject: Offsite Dose Calculation Manual (ODCM)
Oconee Nuclear Station Section - Revision 39

The General Office Radiation Protection Staff is transmitting to you this date Revision 39 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, 1998, Revision 38 letter.

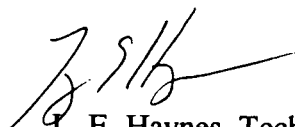
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A-3
A-6
A-8
A-15 through A-18
A-20
Table A4.0-7
Table A4.0-8
Figure A4.0-1 (two pages)
Figure A4.0-2
Figure A4.0-3 (two pages)
Figure A4.0-4 (nine pages)
A-21
Table A5.0-1
Table A5.0-2
Figure A5.0-1 (two pages)

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A-6
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A-20
Table A4.0-7
Table A4.0-8
None (Deletion)
None (Deletion)
None (Deletion)
Figure A4.0-1 (nine pages)
A-21
Table A5.0-1
Table A5.0-2
Figure A5.0-1 (two pages)

Effective Date: 1/1/99



L. E. Haynes, Technical Manager
Radiation Protection

Effective Date: 1/1/99



J. S. Forbes, Manager
Oconee Nuclear Station

If you have any questions concerning Revision 39, please call Caryl Ingram at (704) 382-4496.



Caryl D. Ingram, Senior Engineer
Radiation Protection
Nuclear Services Division

JUSTIFICATION FOR REVISION 39

(page 1 of 3)

Page A-3

For purposes of use in the liquid release rate equation on page A-3 the 10CFR20 effluent concentration (EC) value for noble gases is $1.00\text{E-}05$ $\mu\text{Ci/ml}$. Defining the effective EC value for noble gases as $1.00\text{E-}05$ $\mu\text{Ci/ml}$ for use in the liquid release rate equation ensures that the $1.00\text{E-}04$ $\mu\text{Ci/ml}$ dissolved or entrained noble gases concentration limit from ONS SLC 16.11-1 is not exceeded.

Pages A-6 and A-8

To ensure that release rates are not exceeded, the maximum annual average dispersion and deposition factors are used for estimating the maximum dose rate to an individual from the inhalation, food and ground pathways assuming all pathways are present independent of land use surveys. Land use survey data is used when estimating maximum dose received by an individual from the inhalation, food and ground pathways.

Pages A-15 and A-16

The computer code, RETDAS, has replaced the GASPAR and LADTAP codes for calculating normal operation dose assessment at Duke Power Company. RETDAS, Radioactive Effluent Tracking and Dose Assessment Software, is a database application designed by Vertechs Software Solutions, Inc. to automate many of the tasks required in the administration of effluent releases at Duke's three nuclear plants. RETDAS provides a variety of functions for tracking liquid and gaseous effluents for both continuous and batch releases, as well as custom automated interfaces to third party analytical software such as Canberra's CAS count-room software. RETDAS also performs normal operation effluent dose assessment for Technical Specifications and Selected Licensee Commitments using NUREG-0133 and Regulatory Guide 1.109 dose assessment methodology. RETDAS meets all of the SDQA requirements of NSD-800 for Category C software.

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(page 2 of 3)

Page A-17

Changes to reflect use of RETDAS for dose calculations rather than LADTAP and GASPAR.

To improve the accuracy of the dose estimate to the public from gaseous releases the ground contamination exposure pathway and the inhalation pathway are calculated only for locations where the land use census indicates a resident exists rather than assuming those pathways for all locations.

Page A-18

Changes to reflect use of RETDAS for dose calculations rather than LADTAP and GASPAR.

Page A-20

Changes to reflect use of RETDAS for dose calculations rather than LADTAP and GASPAR.

The figure number for the fuel cycle calculation worksheet was revised due to the deletion of LADTAP/GASPAR related figures.

Table A4.0-7

Revised the maximum meat location and maximum combination location, dispersion factors, and deposition factors based on the 1998 land use census.

Table A4.0-8

Revised table based on the 1998 land use census.

JUSTIFICATION FOR REVISION 39
(page 3 of 3)

Figures A4.0-1 through A4.0-3

Removed the LADTAP and GASPAR input templates since those codes are no longer being used at Duke Power Company for dose assessment.

Figure A4.0-4 (1 of 9 through 9 of 9)

Revised figure number to A4.0-1 to reflect deletion of previous figures A4.0-1 through A4.0-3.

Revised the maximum meat location and maximum combination location, dispersion factors, and deposition factors based on the 1998 land use census on page 9 of 9.

Page A-21

Revised land use census dates.

Tables A5.0-1 and A5.0-2, Figure A5.0-1 (both pages)

The control site for broadleaf vegetation and air has been relocated to Location 081, Duke Power Clemson Operations Center (9.8 miles SE of site) due to new construction at Location 073, Tamassee DAR School (9.2 miles NW of site).

APPENDIX A

OCONEE NUCLEAR STATION
SITE SPECIFIC INFORMATION

APPENDIX A

TABLE OF CONTENTS

	<u>PAGE</u>
A1.0 <u>OCONEE NUCLEAR STATION RADWASTE SYSTEMS</u>	A-1
A2.0 <u>RELEASE RATE CALCULATION</u>	A-3
A3.0 <u>RADIATION MONITOR SETPOINTS</u>	A-9
A4.0 <u>DOSE CALCULATIONS</u>	A-16
A5.0 <u>RADIOLOGICAL ENVIRONMENTAL MONITORING</u>	A-21

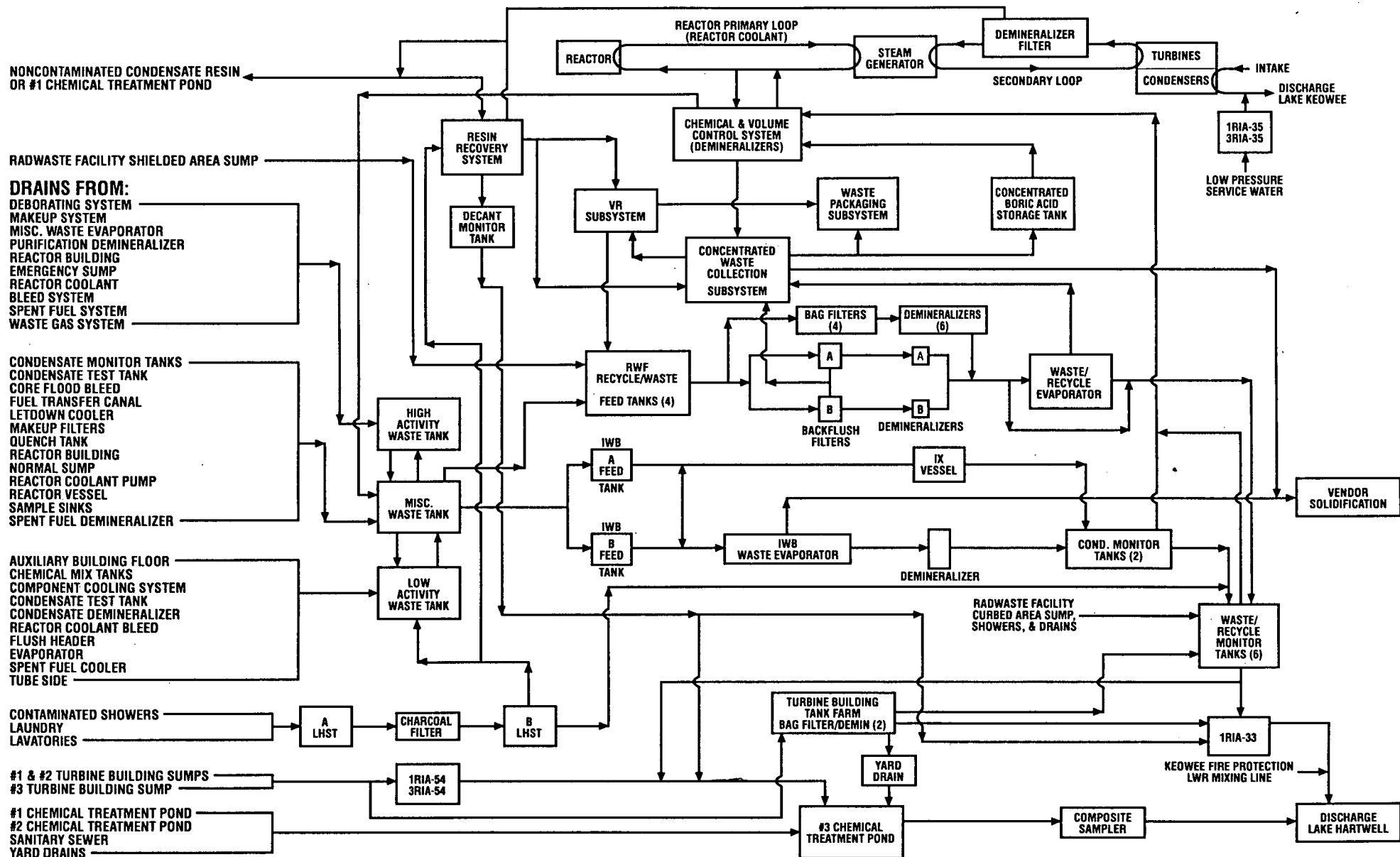
A1.0 OCONEE NUCLEAR STATION RADWASTE SYSTEMS

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**

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.

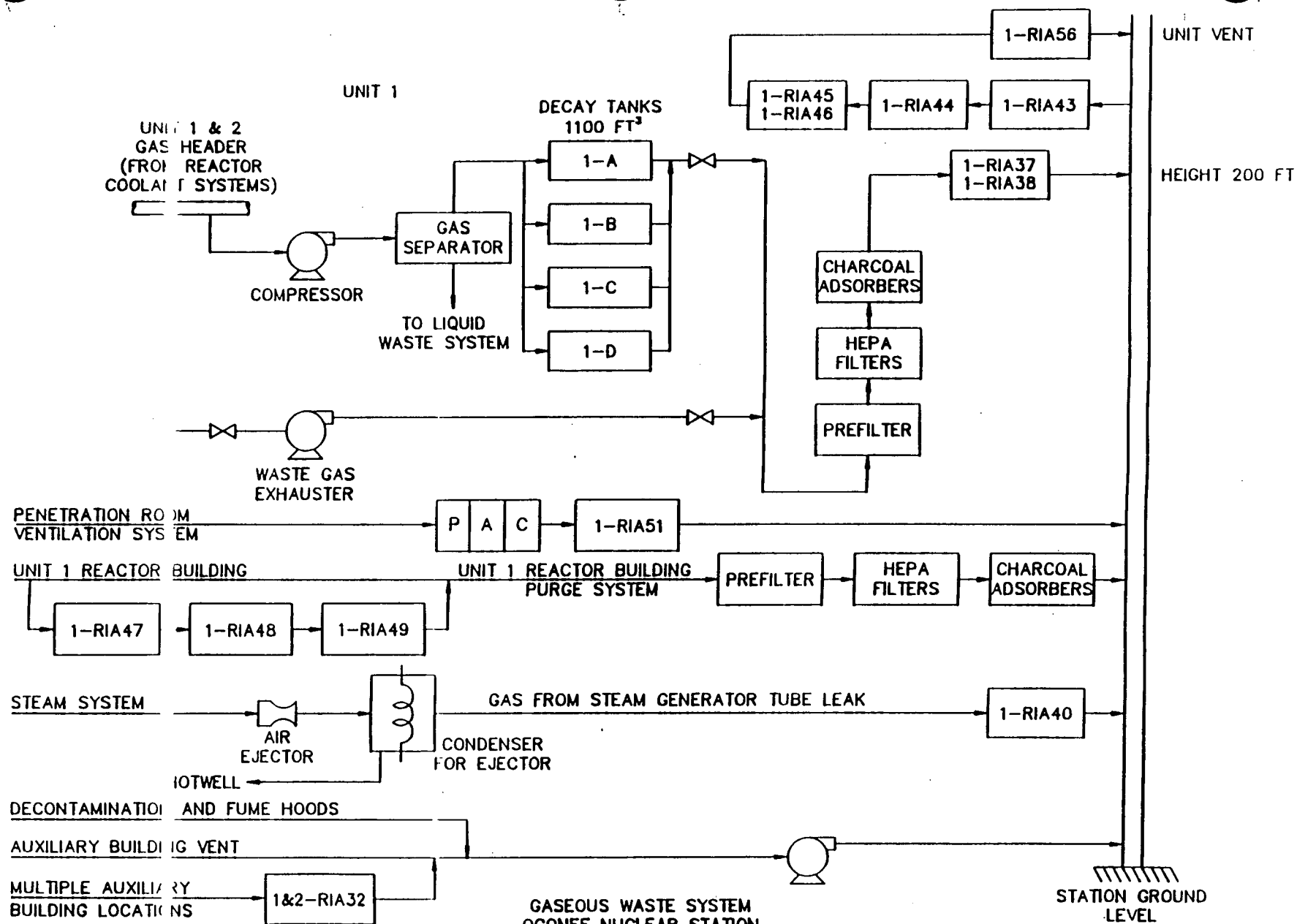
During power operation of the facilities, radioactive materials released to the atmosphere in gaseous effluents include low concentrations of fission product noble gases (krypton and xenon), halogens (mostly iodines), tritium contained in water vapor and particulate material including both fission products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

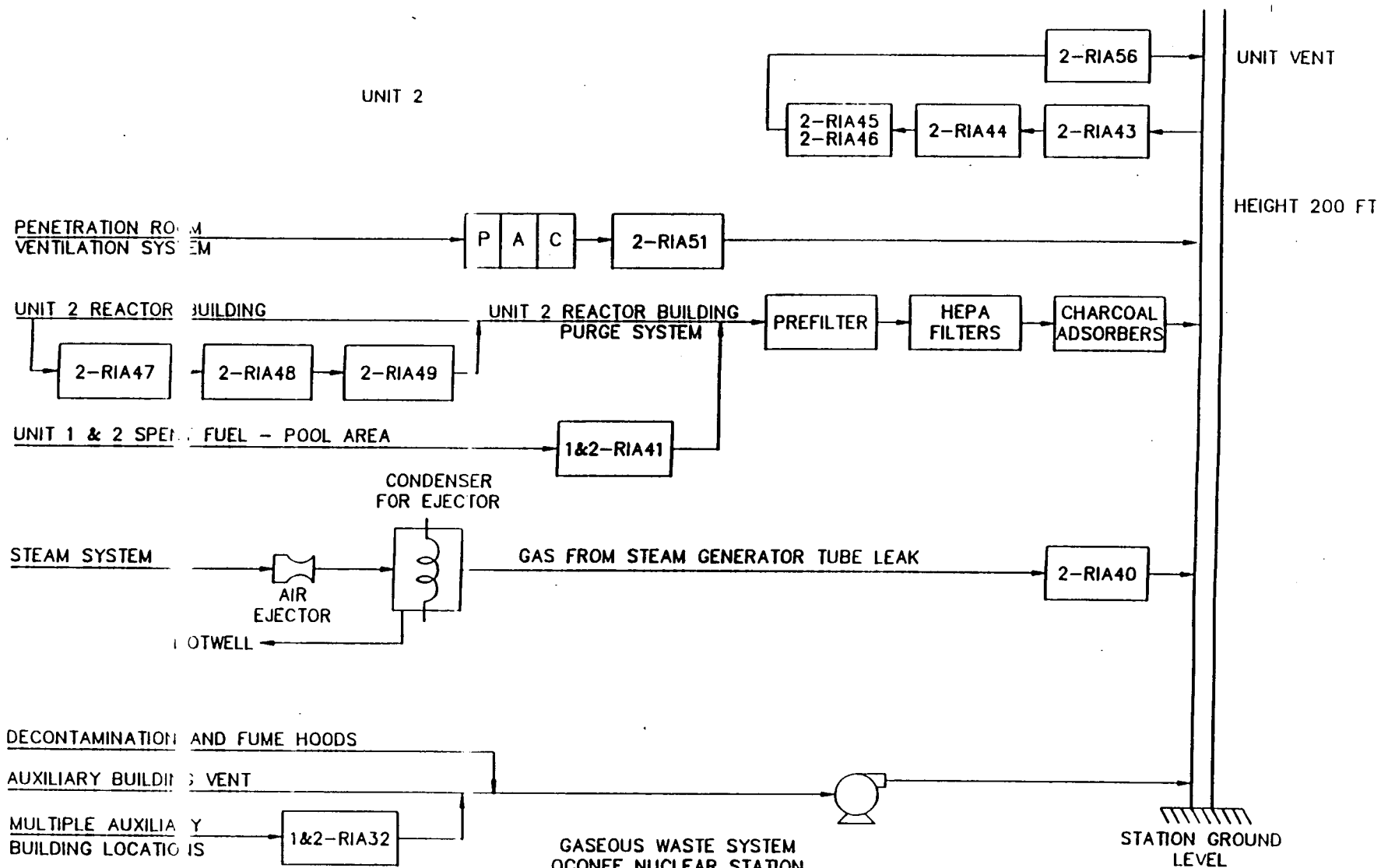
Radioactive gases may be released inside the reactor containment building when components of the primary system are opened to the building atmosphere for operational reasons or where minor leaks occur in the primary system. Prior to access, the reactor containment atmosphere will be monitored for activity 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.



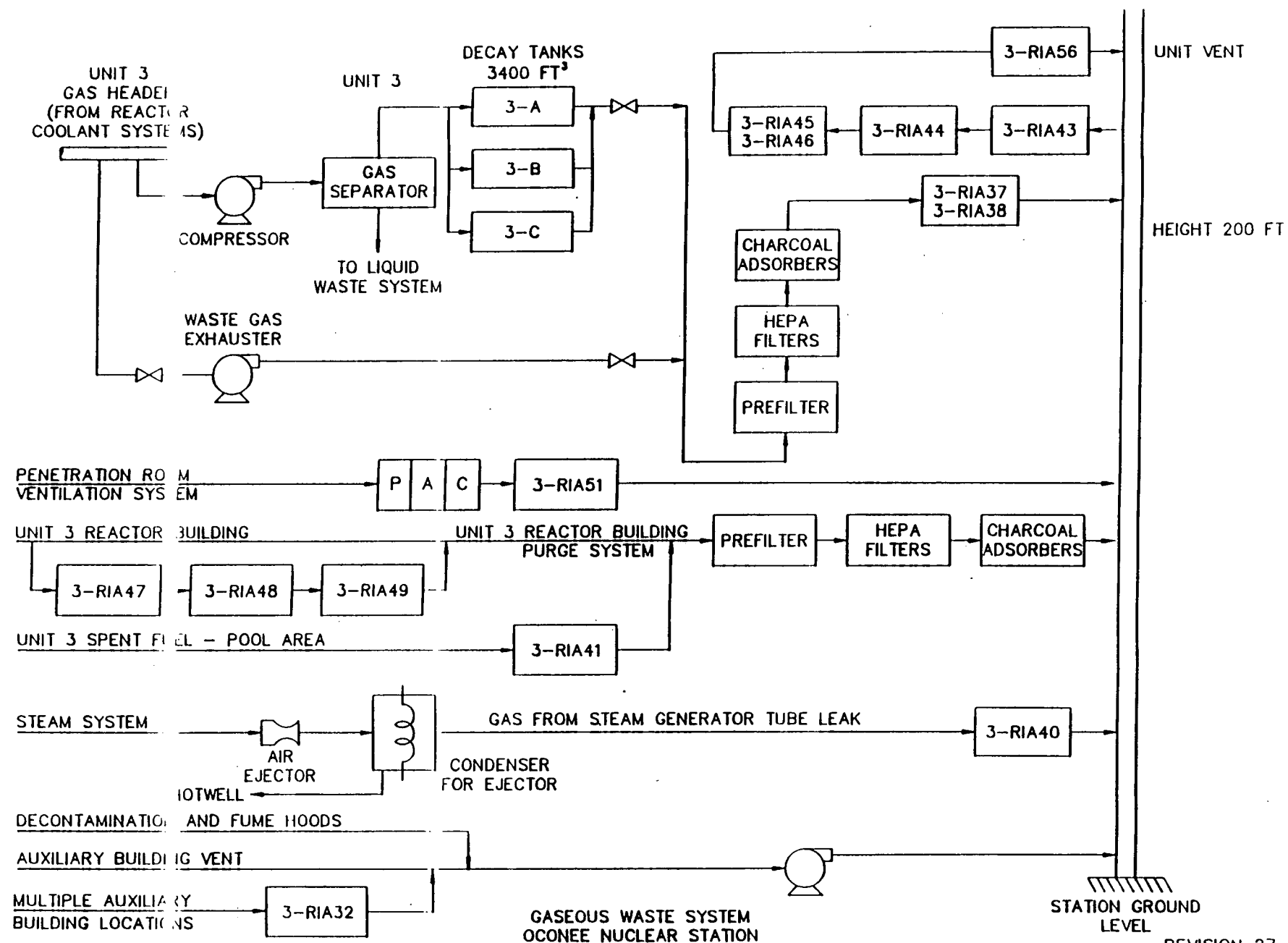
GASEOUS WASTE SYSTEM
OCONEE NUCLEAR STATION
FIGURE A1.0-2
PAGE 1 OF 4

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

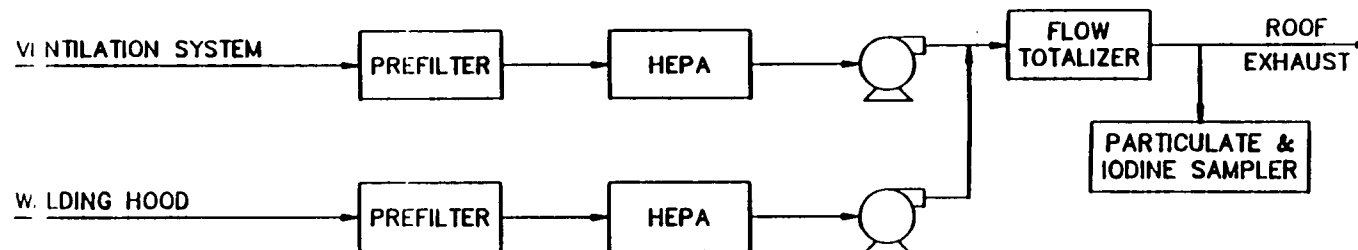
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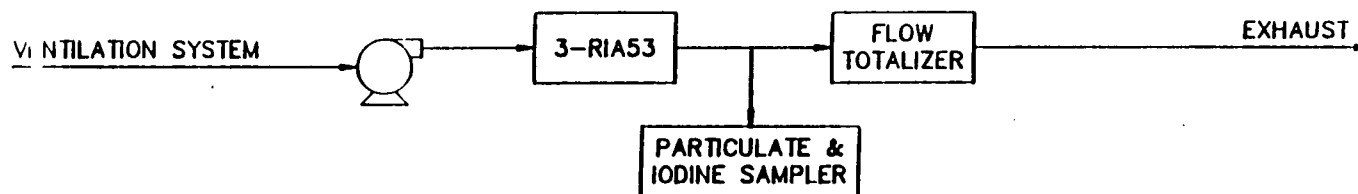
GASEOUS WASTE SYSTEM
 OCONEE NUCLEAR STATION
 FIGURE A1.0-2
 PAGE 3 OF 4

REVISION 27
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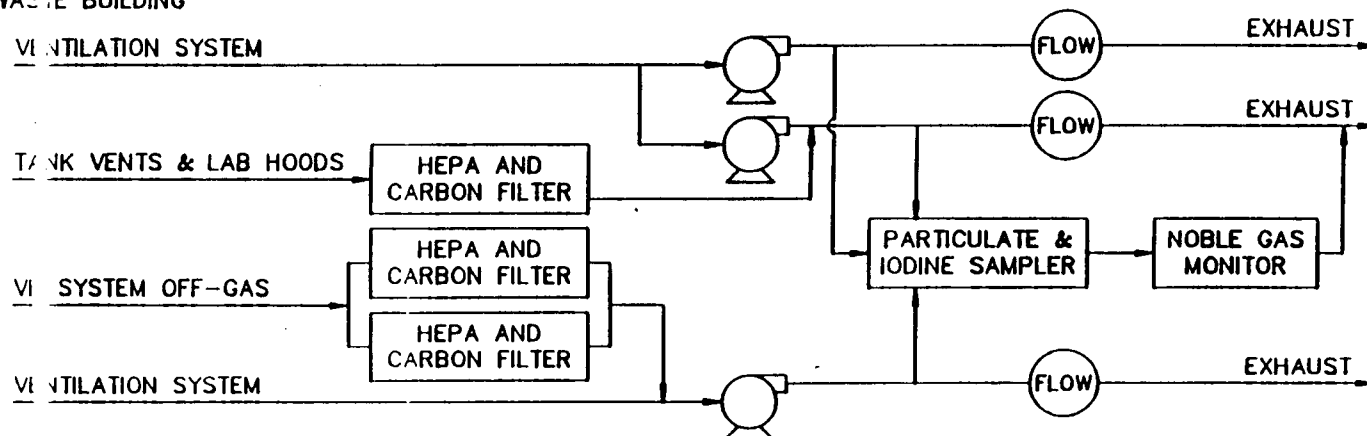
HOT MACHINE SHOP



INTERIM RADIATION WASTE FACILITY



RADWASTE BUILDING



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 $\mu\text{Ci/ml}$.

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 = $1.0\text{E-}5 \mu\text{Ci/ml}$.

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:

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

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

where the terms are defined below.

A2.2.2 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 $\mu\text{Ci}/\text{m}^3$ 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 $\mu\text{Ci}/\text{m}^3$ 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 $\mu\text{Ci}/\text{m}^3$ 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 $\mu\text{Ci}/\text{m}^3$ and for the food and ground plane pathways in $\text{m}^2 \cdot (\text{mrem/yr})$ per $\mu\text{Ci}/\text{sec}$ 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 $\mu\text{Ci/sec}$.

\bar{X}/Q = $1.672\text{E-}6 \text{ sec/m}^3$. 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.

W = The highest calculated annual average dispersion or deposition parameter for estimating the maximum dose rate to an individual from the total inhalation, food and ground pathways resulting from semi-elevated releases:

W = $1.672\text{E-}6 \text{ sec/m}^3$, for the inhalation pathway. The location is the SW sector @ 1.0 mile.

W = $1.295\text{E-}08 \text{ 1/m}^2$, for the food and ground plane pathways. The location is the NE sector @ 1.0 mile.

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

where:

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

f = the undiluted effluent flow, in cfm

k_1 = conversion factor, $2.83\text{E+}04 \text{ ml/ft}^3$

k_2 = conversion factor, $6.0\text{E+}01 \text{ sec/min}$

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:

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

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

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:

$$\sum_i P_i [W Q_i] < 1500 \text{ mrem/yr}$$

where:

K_i = The total body dose factor due to gamma emissions for each identified noble gas radionuclide, in mrem/yr per $\mu\text{Ci}/\text{m}^3$ 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 $\mu\text{Ci}/\text{m}^3$ 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 $\mu\text{Ci}/\text{m}^3$ 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 $\mu\text{Ci}/\text{m}^3$ and for the food and ground plane pathways in $\text{m}^2 \cdot (\text{mrem/yr})$ per $\mu\text{Ci}/\text{sec}$ 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 $\mu\text{Ci/sec}$.

\bar{X}/\bar{Q} = $7.308\text{E-}6 \text{ sec/m}^3$. 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 or deposition parameter for estimating the maximum dose rate to an individual from the total inhalation, food and ground plane pathways resulting from ground level releases:

W = $7.308\text{E-}6 \text{ sec/m}^3$, for the inhalation pathway. The location is the SE sector @ 1.0 mile.

W = $2.259\text{E-}8 \text{ 1/m}^2$, for the food and ground plane pathways. The location is the NE sector @ 1.0 mile.

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

where:

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

f = the undiluted effluent flow, in cfm

k_1 = conversion factor, $2.83\text{E+}04 \text{ ml/ft}^3$

k_2 = conversion factor, $6.0\text{E+}01 \text{ sec/min}$

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 ($\mu\text{Ci/ml}$). 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 ($\mu\text{Ci/ml}$) vs. monitor reading (cpm) based on empirical data.

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

where:

c = the gross activity, in $\mu\text{Ci/ml}$
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:

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

where:

- c = the gross activity in undiluted effluent, in $\mu\text{Ci/ml}$.
- f = the flow rate of undiluted effluent which may vary from 0-750 gpm, but is assumed to be 750 gpm.
- EC = $9.0E-07 \text{ } \mu\text{Ci/ml}$, 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 ($1.7E+04 \text{ gpm}$), 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:

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

where:

C = the gross activity in undiluted effluent, in $\mu\text{Ci/ml}$.

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 = $9.0E-07 \text{ } \mu\text{Ci/ml}$, 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, $1.24E+06 \text{ gpm}$. 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:

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

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

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

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

$$C < 3.08\text{E}+3/f$$

where:

C = the gross activity in undiluted effluent, in $\mu\text{Ci/ml}$

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, $2.06\text{E}+2 \text{ mrem/yr per } \mu\text{Ci/m}^3$

$\bar{X}/\bar{Q} = 1.672\text{E}-6 \text{ sec/m}^3$, 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:

$$C < 3.08\text{E}+3/f = 1.03\text{E}+02 \mu\text{Ci/ml}$$

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:

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

where:

$$f = 45,000 \text{ cfm (auxiliary building)} + 50,000 \text{ cfm (containment purge)} = 95,000 \text{ cfm}$$

or

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

where:

$$f = 45,000 \text{ cfm (auxiliary building ventilation)}$$

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:

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

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

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

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

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

where:

C = the gross activity in undiluted effluent, in $\mu\text{Ci/ml}$

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, $2.06\text{E}+2$ mrem/yr per $\mu\text{Ci/m}^3$

$\overline{X/Q}$ = $7.308\text{E}-6$ 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:

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

where:

$$f = 1.47\text{E}+04 \text{ cfm}$$

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 RETDAS 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:

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

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 RETDAS computer program. 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 RETDAS computer code.

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 RETDAS computer program.

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)

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

$(\overline{X/Q}) = 1.672\text{E-}6 \text{ sec/m}^3$. 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

$(\overline{X/Q}) = 7.308\text{E-}6 \text{ sec/m}^3$. 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.

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. The vegetable garden pathway is assumed to exist at all locations offsite for dose calculation purposes. External exposure from deposited ground contamination and inhalation exposure pathways, and internal exposure from 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 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.

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 RETDAS 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:

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

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 RETDAS 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 A4.0-1.

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)

SECTOR	DISTANCE TO THE CONTROL LOCATION, IN MILES									
	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	2.481E-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

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TABLE A4.0-1A
(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:

<u>Vent Release Mode</u>	<u>Wind Speed (meters/sec)</u>
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):

<u>Vent Release Mode</u>	<u>Wind Speed (meters/sec)</u>	
	<u>Stable Conditions</u>	<u>Unstable/Neutral Conditions</u>
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	

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TABLE A4.0-1B
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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:

<u>Vent Release Mode</u>	<u>Wind Speed (meters/sec)</u>
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):

<u>Vent Release Mode</u>	<u>Wind Speed (meters/sec)</u>	
	<u>Stable Conditions</u>	<u>Unstable/Neutral Conditions</u>
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

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TABLE A4.0-2A
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OCONEE NUCLEAR STATION

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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

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TABLE A4.0-2B
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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

Table A4.0-3
(2 of 2)

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

$$A_{aoi} = 1.14E+05 (U_{aw}\sigma_w/D_w \exp(-\lambda_i t_w) + U_{af}\sigma_f B F_i \exp(-\lambda_i t_f)) D F_{aoi}$$

where:

$$1.14E+05 = 10^6 \text{ pCi}/\mu\text{Ci} \times 10^3 \text{ ml/kg} \div 8760 \text{ hr/yr}$$

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

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

D F_{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:

$$A(a, \text{thy}, \text{I-131}) = 1.14E5 (730 \cdot 1.0 / 1.0E4 \cdot \exp(-3.59E-3 \cdot 12) + 21 \cdot 1.0 \cdot 15 \cdot \exp(-3.59E-3 \cdot 24)) \cdot 1.95E-3 = 6.43E4 \text{ mr/hr per } \mu\text{Ci/ml}$$

TABLE A4.0-4
(1 OF 2)

OCONEE NUCLEAR STATION
LIQUID EFFLUENT DOSE - TEEN PARAMETERS
A(1) 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

Table A4.0-4

(2 of 2)

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

$$A_{aoi} = 1.14E+05 (U_{aw}\sigma_w/D_w \exp(-\lambda_i t_w) + U_{af}\sigma_f B F_i \exp(-\lambda_i t_f)) D F_{aoi}$$

where:

$$1.14E+05 = 10^6 \text{ pCi}/\mu\text{Ci} \times 10^3 \text{ ml/kg} \div 8760 \text{ hr/yr}$$

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

$$\sigma_w = 1.00 \quad \sigma_f = 1.00$$

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

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

D_{F_{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:

$$A(t, \text{thy}, \text{I-131}) = 1.14E5 (510 \cdot 1.0 / 1.0E4 \cdot \exp(-3.59E-3 \cdot 12) + 16 \cdot 1.0 \cdot 15 \cdot \exp(-3.59E-3 \cdot 24)) \cdot 2.39E-3 = 6.00E4 \text{ mr/hr per } \mu\text{Ci/ml}$$

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+05	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

Table A4.0-5

(2 of 2)

Oconee Nuclear Station
Liquid Effluent Dose - Child Parameters
 A_{aoi} mrem/hr per $\mu\text{Ci/ml}$

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 $\mu\text{Ci/ml}$

$$A_{aoi} = 1.14\text{E}+05 (U_{aw}\sigma_w/D_w \exp(-\lambda_i t_w) + U_{af}\sigma_f B F_i \exp(-\lambda_i t_f)) D F_{aoi}$$

where:

$$1.14\text{E}+05 = 10^6 \text{ pCi}/\mu\text{Ci} \times 10^3 \text{ ml/kg} \div 8760 \text{ hr/yr}$$

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

$$\sigma_w = 1.00 \quad \sigma_f = 1.00$$

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

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

$D F_{aoi}$ = 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
 $t_w = 12 \text{ hours} \quad t_f = 24 \text{ hours}$

Sample Calculation for Child, I-131, Thyroid:

$$A(c, \text{thy}, \text{I-131}) = 1.14\text{E}5 (510 \times 1.0 / 1.0\text{E}4 \times \exp(-3.59\text{E}-3 \times 12) + 6.9 \times 1.0 \times 15 \times \exp(-3.59\text{E}-3 \times 24)) 5.72\text{E}-3 = 6.19\text{E}4 \text{ mr/hr per } \mu\text{Ci/ml}$$

TABLE A4.0-6
(1 OF 2)

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	2.98E-04	1.11E-04	1.48E-05	0.0	4.14E-05	0.0	1.57E-01
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

Table A4.0-6

(2 of 2)

Oconee Nuclear Station
Liquid Effluent Dose - Infant Parameters
 A_{aoi} mrem/hr per $\mu\text{Ci/ml}$

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 $\mu\text{Ci/ml}$

$$A_{aoi} = 1.14\text{E}+05 (U_{aw}\sigma_w/D_w \exp(-\lambda_i t_w) + U_{af}\sigma_f B F_i \exp(-\lambda_i t_f)) D F_{aoi}$$

where:

$$1.14\text{E}+05 = 10^6 \text{ pCi}/\mu\text{Ci} \times 10^3 \text{ ml/kg} \div 8760 \text{ hr/yr}$$

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

$$\sigma_w = 1.00 \quad \sigma_f = 1.00$$

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

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

$D F_{aoi}$ = 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
 $t_w = 12 \text{ hours} \quad t_f = 24 \text{ hours}$

Sample Calculation for Infant, I-131, Thyroid:

$$A(i, \text{thy}, \text{I-131}) = 1.14\text{E}5 (330 \cdot 1.0 / 1.0\text{E}4 \cdot \exp(-3.59\text{E}-3 \cdot 12) + 0 \cdot 1.0 \cdot 15 \cdot \exp(-3.59\text{E}-3 \cdot 24)) 1.39\text{E}-2 = 5.01\text{E}1 \text{ mr/hr per } \mu\text{Ci/ml}$$

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

	<u>(X/Q)</u>	<u>(D/Q)</u>
	sec/m ³	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, 2.4 mi, ESE	3.623E-7	1.086E-9
(4) Milk Animal, 4.5 mi, WNW	4.796E-8	1.868E-10
(5) Combination, 1.0 mi, NE	9.503E-7	1.295E-8

Ground Level Release Worst-Case Locations

	<u>(X/Q)</u>	<u>(D/Q)</u>
	sec/m ³	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, 2.4 mi, ESE	1.321E-6	2.379E-9
(4) Milk Animal, 4.5 mi, WNW	9.502E-8	1.643E-10
(5) Combination, 1.0 mi, NE	3.886E-6	2.259E-8

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	V	V	V	VI	VI	VI	VIM	VIMG
NNE	X	X	V	V	VI	VI	VIM	VIM	VIM	VIMG
NE	X	X	VI	VI	VI	VIM	VIM	VIM	VIM	VIMG
ENE	X	X	VI	VI	VI	VI	VI	VI	VI	VIMG
E	X	X	VI	VI	VIM	VIM	VIM	VIM	VIM	VIMG
ESE	X	X	V	VI	VIM	VIM	VIM	VIM	VIM	VIMG
SE	X	X	VI	VI	VI	VI	VI	VI	VI	VIMG
SSE	X	X	V	VI	VI	VI	VI	VI	VI	VIMG
S	X	X	V	VI	VI	VI	VI	VI	VI	VIMG
SSW	X	X	VI	VI	VI	VI	VI	VI	VI	VIMG
SW	X	X	VI	VI	VI	VI	VI	VI	VI	VIMG
WSW	X	X	V	VI	VI	VI	VI	VI	VI	VIMG
W	X	X	V	VI	VI	VI	VI	VIM	VIM	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	V	VI	VI	VI	VI	VI	VI	VIMG

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

* The land use census identifies the nearest inhalation/ground, meat, and milk pathways to the site. The vegetable pathway is assumed to exist in each sector for dose calculation purposes. Locations beyond the nearest pathway are assumed to contain that pathway for dose calculation purposes.

Figure A4.0-1 - 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 A4.0-1 (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 A4.0-1 (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 A4.0-1 (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 A4.0-1 - 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 A4.0-1 (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 A4.0-1 (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 A4.0-1 (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]							
S-Elev							
Ground							
Total*							
Location 2 - Worst-Case Vegetable Garden Location [2]							
S-Elev							
Ground							
Total*							
Location 3 - Worst-case Meat Animal Location [3]							
S-Elev							
Ground							
Total*							
Locations 4 and 5 - Worst-case Milk/Combination Location [4]							
S-Elev							
Ground							
Total*							
Infant Organ Maximums**							
Total							

Figure A4.0-1 (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
 $\bar{X}/\bar{Q} = 1.672\text{E-}06 \text{ sec/m}^3$, $\bar{D}/\bar{Q} = 1.205\text{E-}08 \text{ 1/m}^2$
Ground Level evaluation location for Inhalation is 1.0 mi, SE
 $\bar{X}/\bar{Q} = 7.308\text{E-}06 \text{ sec/m}^3$, $\bar{D}/\bar{Q} = 1.401\text{E-}08 \text{ 1/m}^2$
- [2] Semi-elevated evaluation location for the Garden is 1.0 mi, NE
 $\bar{X}/\bar{Q} = 9.503\text{E-}07 \text{ sec/m}^3$, $\bar{D}/\bar{Q} = 1.295\text{E-}08 \text{ 1/m}^2$
Ground Level evaluation location for the Garden is 1.0 mi, NE
 $\bar{X}/\bar{Q} = 3.886\text{E-}06 \text{ sec/m}^3$, $\bar{D}/\bar{Q} = 2.259\text{E-}08 \text{ 1/m}^2$
- [3] Semi-elevated evaluation location for Meat Animal is 2.4 mi, ESE
 $\bar{X}/\bar{Q} = 3.623\text{E-}07 \text{ sec/m}^3$, $\bar{D}/\bar{Q} = 1.086\text{E-}09 \text{ 1/m}^2$
Ground Level evaluation location for Meat Animal is 2.4 mi, ESE
 $\bar{X}/\bar{Q} = 1.321\text{E-}06 \text{ sec/m}^3$, $\bar{D}/\bar{Q} = 2.379\text{E-}09 \text{ 1/m}^2$
- [4] Semi-elevated evaluation location for Milk is 4.5 mi, WNW
 $\bar{X}/\bar{Q} = 4.796\text{E-}08 \text{ sec/m}^3$, $\bar{D}/\bar{Q} = 1.868\text{E-}10 \text{ 1/m}^2$
Ground Level evaluation location for Milk is 4.5 mi, WNW
 $\bar{X}/\bar{Q} = 9.502\text{E-}08 \text{ sec/m}^3$, $\bar{D}/\bar{Q} = 1.643\text{E-}10 \text{ 1/m}^2$
- [5] Semi-elevated evaluation location for Combination is 1.0 mi, NE
 $\bar{X}/\bar{Q} = 9.503\text{E-}07 \text{ sec/m}^3$, $\bar{D}/\bar{Q} = 1.295\text{E-}08 \text{ 1/m}^2$
Ground Level evaluation location for Combination is 1.0 mi, NE
 $\bar{X}/\bar{Q} = 3.886\text{E-}06 \text{ sec/m}^3$, $\bar{D}/\bar{Q} = 2.259\text{E-}08 \text{ 1/m}^2$

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)

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 09/17/98 - 09/23/98.

The 1998 land use census did not identify any locations where environmental monitoring samples are required but were not available for collection.

TABLE A5.0-1
(1 of 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)
			081	SPECIAL INTEREST	(9.8 MILES SE)

* All sampling locations are collected quarterly

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

CODE:		Air Radioiodines and Particulates	Surface Water	Drinking Water	Shoreline Sediment	Milk	Fish	Broadleaf Vegetation
W - Weekly								
SM - Semimonthly								
M - Monthly								
SA - Semiannually								
SAMPLING LOCATION DESCRIPTION								
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		
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		
081	DP Clemson Operations Center (9.8 miles SE) (CONTROL)	W						M

* Control for Fish only

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TABLE A5.0-3
(1 of 1)

OCONEE RADIOLOGICAL MONITORING PROGRAM ANALYSES

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