December 26, 1990

SUBJECT: Offsite Dose Calculation Manual
Revision 29

The General Offsite Radiation Protection Staff is transmitting to you this date, Revision 29 of the Offsite Dose Calculation Manual. As this revision only affects Oconee Nuclear Station, the approval of other station managers is not required. Please update your copy No. _____, and discard the affected pages.

REMOVE THESE PAGES	INSERT THESE PAGES
Pages A-16 thru Page A-24 Rev. 27	Pages A-16 thru Page A-24 Rev. 29
A-25 Rev. 27	A-25 Rev. 29
Tabls A5.0-2 Rev. 27	Table A5.0-2 Rev. 29

NOTE: As this letter, with its attachments, contains "LOEP" information, please insert this letter in front of the December 29, 1989 letter.

Approval Date: 12/17/90

Effective Date: 1/1/91

Mary L. Birch
Radiation Protection Manager

Approval Date: 12-17-90

Effective Date: 1/1/91

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JUSTIFICATIONS FOR REVISION 29

Pages A-16 thru A-24	Updated section using dose calculations based on 1990 Effluent Release data (first nine months) and the 1990 Land Use Census Data.
Page A-25	Changed the dates the latest Land Use Census was performed.
Table A5.0-2	Changed name of location 069 from "Powell Residence" to "ORR's Dairy".

A4.3 SIMPLIFIED DOSE ESTIMATES

A4.3.1 Liquid Effluents

For dose estimates, a simplified calculation based on the assumptions presented in Section A4.2.1 and operational source term data is presented below. Updated operational source term data shall be used to revise these calculations as necessary.

$$D_{WB} = 7.01E5 \sum_{\ell=1}^{m} (F_\ell)(T_\ell)\ (C_{Cs\text{-}134} + 0.59\ C_{Cs\text{-}137})$$

where:

$7.01E5 = 1.14E{+}05\ (U_{aw}/D_w + U_{af}\ BF_i)\ DF_{ait}$ (1.21)

where:

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

U_{aw} = 730 kg/yr, adult water consumption

D_w = 27.5, dilution factor from the near field area to the nearest possible potable water intake.

U_{af} = 21 kg/yr, adult fish consumption

BF_i = 2.00E+03, bioaccumulation factor for Cesium (Table 3.1-1)

DF_{ait} = 1.21E-04, adult, total body, ingestion dose factor (Table 3.1-2)

1.21 = factor derived from the assumption that 83% of dose is from Cs-134 and Cs-137 or 100% ÷ 83% = 1.21

where:

$$F_\ell = \frac{f\sigma}{F + f}$$

f = liquid radwaste flow, in gpm

σ = recirculation factor at equilibrium, 1.0

F = dilution flow, in gpm

and where:

T_ℓ = the length of time, in hours, over which $C_{Cs\text{-}134}$, $C_{Cs\text{-}137}$, and F_ℓ are averaged

$C_{Cs\text{-}134}$ = the average concentration of Cs-134 in undiluted effluent, in µCi/ml, during the time period considered.

$C_{Cs\text{-}137}$ = the average concentration of Cs-137 in undiluted effluent, in µCi/ml, during the time period considered.

0.59 = the ratio of the adult total body ingestion dose factors for Cs-134 and Cs-137 or 7.14E-05 ÷ 1.21E-04 = 0.59

A4.3.2 Gaseous Effluents From Semi-Elevated Release Points

Meteorological data for Unit Vent releases is provided in Tables A4.0-1a and A4.0-1b.

A4.3.2.1 Noble Gases

For dose estimates, simplified dose calculations based on the assumptions in A4.2.2.1 and operational source term data are presented below. Updated operational source term data shall be used to revise those calculations as necessary. These calculations further assume that the annual average dispersion parameter is used and that Xenon-133 contributes 92% of the gamma air dose and 87% of the beta air dose for semi-elevated releases. 76%

$$D_\gamma = 2.91E\text{-}12 \left[\tilde{Q} \right]_{Xe\text{-}133} (1.32)$$

$$D_\beta = 8.65E\text{-}12 \left[\tilde{Q} \right]_{Xe\text{-}133} (1.15)$$

where:

2.91E-12 = (3.17E-8) (353) $(\overline{X/Q})$, derived from equation presented in Section 3.1.2.1.

8.65E-12 = (3.17E-8) (1050) $(\overline{X/Q})$, derived from equation presented in Section 3.1.2.1.

$\left[\tilde{Q} \right]_{Xe\text{-}133}$ = the total Xenon-133 activity released in µCi

$\overline{X/Q}$ = 2.60E-7 sec/m³, the semi-elevated release dispersion parameter $(\overline{X/Q})$ corresponding to the controlling location (S @ 1.0 miles) defined in Section A4.2.2.1.

1.32 = factor derived from the assumption that 92% of the Gamma Air dose is contributed by Xe-133 76%

1.15 = factor derived from the assumption that 87% of the Beta-Air dose is contributed by Xe-133

A4.3.2.2 Radioiodines, Particulates, and Other Radionuclides with T 1/2 > 8 Days

For dose estimates, simplified dose calculations based on the assumptions in A4.2.2.2 and operational source term data are presented below. Updated operational source term data shall be used to revise these calculations as necessary. These calculations further assume that the annual average dispersion/deposition parameter is used and that 99% of the semi-elevated release dose results from Iodine-131 ingested by the maximally exposed individual via the cow milk pathway at the controlling location. The simplified dose estimate for exposure to the thyroid of an infant is:

$$D = 1.53E4\ W\ (\tilde{Q})_{I\text{-}131}\ (1.01)$$

where:

W = 9.2E-10, the semi-elevated release deposition parameter ($\overline{D/Q}$) for food and ground plane pathway, in m^{-2} corresponding to the controlling location (WNW @ 4.0 miles) defined in Section A4.2.2.2.

$(\tilde{Q})_{I\text{-}131}$ = the total Iodine-131 activity released in µCi.

1.53E4 = (3.17E-08) (R_i^C [$\overline{D/Q}$]) with the appropriate substitutions for the cow milk pathway factor, R_i^C [$\overline{D/Q}$], for Iodine-131. See Section 3.1.2.2.

1.01 = factor derived from the assumption that 99% of the total inhalation, food and ground plane pathway dose to the maximally exposed individual is contributed by I-131 via the cow milk pathway.

A4.3.3 Gaseous Effluents From Ground-Level Release Points

Meteorological data for Hot Machine Shop Building Ventilation exhaust, Radwaste Facility exhaust, and Interim Radwaste Building releases is provided in Tables A4.0-2a and A4.0-2b.

A4.3.3.1 Noble Gases

For dose estimates, simplified dose calculations based on the assumptions in A4.2.2.1 and operational and design basis source term data are presented below. These calculations further assume that the annual average dispersion parameter is used and that Xenon-133 contributes 98% of the gamma air dose and 99% of the beta air dose for ground-level releases.

$$D_\gamma = 1.03E\text{-}10\ [\ \tilde{Q}\ ]_{Xe\text{-}133}\ (1.02)$$

$$D_\beta = 3.06E\text{-}10\ [\ \tilde{Q}\ ]_{Xe\text{-}133}\ (1.01)$$

where:

1.03E-10 = (3.17E-8) (353) $(\overline{X/Q})$, derived from equation presented in Section 3.1.2.1.

3.06E-10 = (3.17E-8) (1050) $(\overline{X/Q})$, derived from equation presented in Section 3.1.2.1.

$[\tilde{Q}]_{Xe\text{-}133}$ = the total Xenon-133 activity released in µCi

$\overline{X/Q}$ = 9.2E-6 sec/m³, the ground level release dispersion parameter $(\overline{X/Q})$ corresponding to the controlling location (S @ 1.0 miles) defined in Section A4.2.2.1.

1.02 = factor derived from the assumption that 98% of the Gamma Air dose is contributed by Xe-133

1.01 = factor derived from the assumption that 99% of the Beta-Air dose is contributed by Xe-133

A4.3.3.2 Radioiodines, Particulates, and Other Radionuclides with T 1/2 > 8 Days

For dose estimates, simplified dose calculations based on the assumptions in A4.2.2.2 and operational and design basis source term data are presented below. These calculations further assume that the annual average dispersion/deposition parameters are used and that 60% of the ground-level release dose is from I-131 ingested by the maximally exposed individual via the cow milk pathway at the controlling location. The simplified dose estimate for exposure to the infant thyroid is:

$$D = 1.53E4\ W\ (\tilde{Q})_{I\text{-}131}\ (1.67)$$

where:

W = 2.10E-10 $(\overline{D/Q})$ for food and ground plane pathway, in m^{-2} corresponding to the controlling location (WNW @ 4.0 miles) defined in Section A4.2.2.2.

$(\tilde{Q})_{I\text{-}131}$ = the total I-131 activity released from Oconee ground-level release points in µCi.

1.53E4 = (3.17E-08) $(R_i^C[\overline{D/Q}])$ with the appropriate substitutions for the infant-cow milk pathway, $(R_i^C[\overline{D/Q}])$, for I-131. See Section 3.1.2.2.

1.67 = factor derived from the assumption that 60% of the total inhalation, food and ground plane pathway dose to the maximally exposed individual is contributed by I-131 via the cow milk pathway.

A4.4 FUEL CYCLE CALCULATIONS

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

$D_{WB}(T)$ $\quad D_T = D_{WB}(l_o) + D_{WB}(g_e) + D_{WB}(g_g)$

$D_{MO}(T)$ $\quad D_T = D_{MO}(l_o) + D_{MO}(g_e) + D_{MO}(g_g)$

where:

$D_{WB}(T)$ = Total estimated fuel cycle whole body dose commitment resulting from the combined liquid and gaseous effluents from Oconee 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.

A4.4.1 LIQUID EFFLUENTS

Liquid pathway dose estimates are based on values and assumptions presented in Section A.4.3.1. Station operational source terms shall be used to update these simplified calculations as necessary.

Based on operational history, the Oconee fuel cycle maximum exposed individual whole body dose resulting from Oconee's liquid effluent releases ($D_{WB}(l_o)$) is estimated using the simplified dose calculation given below:

$$D_{WB}(l_o) = (7.01E5) (F_\ell) (T_\ell) (C_{Cs-134} + 0.59\ C_{Cs-137})$$

where:

$$7.01E5 = 1.14E+05 (U_{aw} / D_w + U_{af} \times BF_i) (DF_{ait}) (1.21)$$

where:

$1.14E+05 = (1.0E-06$ pCi/uCi x $1.0E+03$ ml/kg) / (8760 hr/yr)

U_{aw} = 730 ℓ/yr, Adult water consumption

D_w = 27.5, Dilution factor from the near field area to the nearest possible potable water intake

U_{af} = 21 kg/yr, Adult fish consumption

BF_i = 2.00E+03, Bioaccumulation factor for Cesium (Table 3.1-1)

DF_{ait} = 1.21E-04, Adult total body ingestion dose factor for Cs-134 (Table 3.1-2)

1.21 = Factor derived from the assumption that 83% of the dose is derived from Cs-134 and Cs-137 or 100% / 83% = 1.21

where:

$F_\ell = (f)\ (\sigma)\ /\ (F + f)$

where:

f = Oconee's liquid radwaste flow, in gpm

F = Oconee's dilution flow, in gpm

σ = 1.0, the recirculation factor at equilibrium

where:

T_ℓ = 8760 hours, the time period of time over which C_{Cs-134}, C_{Cs-137} and F_ℓ are averaged.

C_{Cs-134} = The average concentration of Cs-134 in Oconee's undiluted effluent, in uCi/ml, during the calendar year of interest.

C_{Cs-137} = The average concentration of Cs-137 in Oconee's undiluted effluent, in uCi/ml, during the calendar year of interest.

0.59 = The ratio of the adult total body ingestion dose factors for Cs-134 and Cs-137 or 7.14E-05 / 1.21E-04 = 0.59

Based on operational history, the Oconee fuel cycle maximum exposed individual maximum organ dose (Adult GI-Track) resulting from Oconee's liquid effluent releases ($D_{MO}(1_o)$) is estimated using the simplified dose calculation given below:

$$D_{MO}(1_o) = (\ 1.92E6\ )\ (\ F_\ell\ )\ (\ T_\ell\ )\ (\ C_{Nb-95}\ )$$

where:

$$1.92E6 = 1.14E+05\ (\ U_{aw}\ /\ D_w + U_{af} \times BF_i\ )\ (\ DF_{ait}\ )\ (\ 1.27\ )$$

where:

1.14E+05 = (1.0E+06 pCi/uCi x 1.0E+03 ml/kg) / (8760 hr/yr)

U_{aw} = 730 ℓ/yr, Adult water consumption

D_w = 27.5, Dilution factor from the near field area to the nearest possible potable water intake

U_{af} = 21 kg/yr, Adult fish consumption

BF_i = 3.0E4, Bioaccumulation factor for Niobium (Table 3.1-1)

DF_{ait} = 2.10E-5, Adult GI-track ingestion dose factor for Nb-95 (Table 3.1-2)

1.27 = Factor derived from the assumption that 79% of the dose is derived from Nb-95 or 100% / 79% = 1.27

where:

$F_\ell = (f)\ (\sigma)\ /\ (F + f)$

where:

f = Oconee's liquid radwaste flow, in gpm

F = Oconee's dilution flow, in gpm

σ = 1.0, the recirculation factor at equilibrium

where:

T_ℓ = 8760 hours, the time period of time over which C_{Nb-95} and F_ℓ are are averaged.

C_{Nb-95} = The average concentration of Nb-95 in Oconee's undiluted effluent, in uCi/ml, during the calendar year of interest.

A4.4.2 GASEOUS EFFLUENTS FROM SEMI-ELEVATED RELEASE POINTS

Airborne effluent pathway dose estimates are based on the values and assumptions presented in Section A4.3.2. Station operational source term data shall be used to update these calculations as necessary.

Based on operational history, the Oconee fuel cycle maximum exposed individual whole body dose resulting from Oconee's semi-elevated gaseous effluent releases ($D_{WB}(g_e)$) is estimated using the simplified dose calculation given below:

$$D_{WB}(g_e) = (\ 9.32E\text{-}06\ )\ (\ w\ )\ (\ \tilde{Q}_{Xe\text{-}133}\ )\ (S_F)\ (\ 1.37\ )$$

where:

w = 2.6E-7 = $\overline{(X/Q)}$ defined in Section A4.3.2.1.

$\tilde{Q}_{Xe-133}$ = The total Xe-133 activity released from Oconee during the calendar year of interest, in uCi.

9.32E-06 = (3.17E-08) (K_i), with appropriate substitutions for whole body exposure in a semi-infinite cloud of Xe-133. See Section 1.2.1.

S_F = 0.7 = External radiation shielding factor for individuals.

1.37 = The factor derived from the conservative assumption (based on historical data) that 73% of the whole body dose to the maximally exposed individual is contributed by Xe-133.

Based on operational history, the Oconee fuel cycle maximum exposed individual maximum organ dose (Adult GI-Track) resulting from Oconee's semi-elevated gaseous effluent releases ($D_{MO}(g_e)$) is conservatively estimated using the simplified dose calculation given below:

$$D_{MO}(g_e) = (3.27E+2) (W) (\tilde{Q}_{Cs-137}) (4.35)$$

where:

3.27E2 = (3.17E-8) (R_i^G $[\overline{D/Q}]$) with appropriate substitutions for the ground plane pathway factor, R_i^G $[\overline{D/Q}]$, for Cesium-137. See Section 3.1.2.2.

$(\tilde{Q})_{Cs-137}$ = the total Cs-137 activity released in µCi.

W = 4.5E-9, the semi-elevated release deposition parameter $(\overline{D/Q})$ for food and ground plane pathway, in m^{-2} corresponding to the controlling location S @ 1.0 miles.

4.35 = factor derived from the assumption that 23% of the total inhalation, food, and ground plane pathway dose to the maximally exposed individual is contributed by Cs-137 via the ground plane pathway.

A4.4.3 GASEOUS EFFLUENTS FROM GROUND-LEVEL RELEASE POINTS

Airborne effluent pathway dose estimates are based on the values and assumptions presented in Section A4.3.2. Station operational source term data shall be used to update these calculations as necessary.

Based on design basis source term data and operational history, the Oconee fuel cycle maximum exposed individual whole body dose resulting from Oconee's ground-level gaseous effluent releases ($D_{WB}(g_g)$) is estimated using the simplified dose calculation given below:

$$D_{WB}(g_g) = (9.32E-06) (w) (\tilde{Q}_{Xe-133}) (S_F) (1.03)$$

where:

w = 9.2E-6 = $(\overline{X/Q})$ as defined in Section A4.3.3.1.

$\tilde{Q}_{Xe-133}$ = The total Xe-133 activity released from Oconee during the calendar year of interest, in uCi.

9.32E-06 = (3.17E-08) (K_i), with appropriate substitutions for whole body exposure in a semi-infinite cloud of Xe-133. See Section 1.2.1.

S_F = 0.7 = External radiation shielding factor for individuals.

1.03 = The factor derived from the conservative assumption (based on historical data) that 97% of the whole body dose to the maximally exposed individual is contributed by Xe-133.

Based on design basis source term data and operational history, the Oconee fuel cycle maximum exposed individual maximum organ dose (Adult GI-Track) resulting from Oconee's ground-level gaseous effluent releases ($D_{MO}(g_g)$) is conservatively estimated using the simplified dose calculation given below:

$$D_{MO}(g) = (3.27E+2) (W) (\tilde{Q}_{Cs-137}) (4.55)$$

where:

3.27E2 = (3.17E-8) (R_i^G $[\overline{D/Q}]$) with appropriate substitutions for the ground plane pathway factor, R_i^G $[\overline{D/Q}]$, for Cesium-137. See Section 3.1.2.2.

$(\tilde{Q})_{Cs-137}$ = the total Cs-137 activity released in μCi.

W = 2.1E-8, the ground-level release deposition parameter ($\overline{D/Q}$) for food and ground plane pathway, in m^{-2} corresponding to the controlling location S @ 1.0 miles.

4.55 = factor derived from the assumption that 22% of the total inhalation, food, and ground plane pathway dose to the maximally exposed individual is contributed by Cs-137 via the ground plane pathway.

A5.0 RADIOLOGICAL ENVIRONMENTAL MONITORING

The radiological environmental monitoring program shall be conducted in accordance with Technical Specification 4.11.

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. Food products will not be sampled since lake water irrigation of crops is not practiced in the vicinity.

The laboratory performing the radiological environmental analyses shall participate in an interlaboratory comparison program which has been approved by the NRC. This program is the Environmental Protection Agency's (EPA's) Environmental Radioactivity Laboratory Intercomparison Studies (Crosscheck) Program, our participation code is CP.

The dates of the land-use census that was used to identify the controlling receptor locations was 07/26/90 - 08/02/90.

TAB[illegible]5.0-2
([illegible]F 1)

OCONEE RADIOLOGICAL MONITORING PROGRAM SAMPLING LOCATIONS
(OTHER SAMPLING LOCATIONS)

CODE:

W - Weekly (≤ 7 days)
SM - Semimonthly (≤ 15 days)
M - Monthly (≤ 31 days)
SA - Semiannually (≤ 184 days)

	SAMPLING LOCATION DESCRIPTION	Air Radioiodines and Particulates	Surface Water	Drinking Water	Shoreline Sediment	Milk	Fish	Broadleaf Vegetation
028	Site Boundary (0.5 miles S)							M
060	New Greenville Water Intake Rd. (2.5 miles NNE) *	W		M			SA	M
061	Old Hwy. 183 (1.5 miles SSW)	W						
062	Lake Keowee/Hydro Intake (0.7 mile ENE) (CONTROL)		M					
063	Lake Hartwell - Hwy 183 Bridge (0.8 mile ESE) (000.7)		M		SA		SA	
064	Seneca (6.7 miles SW) (004.1) (CONTROL)			M				
065	Clemson (8.1 miles SSE) (006.1) DELETED			M				
066	Anderson (19.0 miles SSE) (012) (CONTROL FOR MILK ONLY)			M		SM		
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		
072	Hwy 130 (1.7 miles S)	W						
073	Tamassee Dar School (9.0 miles NW) (CONTROL)	W						M
074	Keowee Key Resort (1.7 miles NNW)	W						
075	Willimon Residence (6.0 miles NE) DELETED					SM		

* Control for Fish only

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