December 27, 1988

Subject: Offsite Dose Calculation Manual
Revision 22

The General Office Radwaste Engineering Staff is transmitting to you this date, Revision 22 of the Offsite Dose Calculation Manual. As this revision only affects McGuire Nuclear Station, the approval of other station managers is not required. Please update your copy No. 1, and discard the affected pages.

REMOVE THESE PAGES		INSERT THESE PAGES	
B-6	Rev. 14	B-6	Rev. 22
B-7	Rev. 14	B-7	Rev. 22
B-12	Rev. 17	B-12	Rev. 22
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B-18	Rev. 17	B-18	Rev. 22
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B-21	Rev. 17	B-21	Rev. 22
Table B5.0-2	Rev. 17	Table B5.0-2	Rev. 22
Figure B5.0-1 (1 of 2)	Rev. 17	Figure B5.0-1 (1 of 2)	Rev. 22

NOTE: As this letter, with it's attachments, contains "LOEP" information, please insert this letter in front of the July 15, 1988 letter.

Approval Date: 12/27/88

Effective Date: 1/1/89

Mary L. Birch
Mary L. Birch
Radiation Protection Manager

Approval Date: 12/20/88

Effective Date: 1/1/89

Tony L. McConnell
T.L. McConnell, Manager
McGuire Nuclear Station

If you have any questions concerning Revision 22, please call Jim Stewart at (704) 373-5444.

James M. Stewart
James M. Stewart, Jr.
Scientist
Radiation Protection

Enclosure

JUSTIFICATIONS FOR REVISION 22

Pages B-8 thru B-20	Updated sections using 1988 Effluent Release Data (first nine months) and the 1988 Land Use Census Data.
Page B-21	Updated the dates the latest Land Use Census was preformed.
Table B5.0-2	Changed per attached October 14, 1988 letter from J W Foster
Figure B5.0-1 (1 of 2)	Changed per attached October 14, 1988 letter from J W Foster

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DUKE POWER

October 14, 1988

Jim Stewart, Jr.
Duke Power Company
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Charlotte, N.C.

Subject: McGuire Nuclear Station
ODCM Changes

Please incorporate the changes marked on attachment 1 into the next revision of the ODCM. The necessary changes are listed below:

- Delete Sample Location #131 Table B5.0-2

- Edit Location #160 on Table B5.0-2. Change 160 to 184.

- Correct 10 Mile Radius Map to Reflect Changes (B.50-1)

J.W. Foster
Station Health Physicist
McGuire Nuclear Station

RJS/ah

attachments

cc: J.W. Foster
W.F. Byrum
P.F. 9. 4. 2

B2.2.1 Noble Gases

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

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

where the terms are defined below.

B2.2.2 Radioiodines, Particulates, and Others

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

where:

K_i = The total body dose factor due to gamma emissions for each identified noble gas radionuclide, in mrem/yr per µCi/m³ from Table 1.2-1.

L_i = The skin dose factor due to beta emissions for each identified noble gas radionuclide, in mrem/yr per µCi/m³ from Table 1.2-1.

M_i = The air dose factor due to gamma emissions for each identified noble gas radionuclide, in mrad/yr per µCi/m³ from Table 1.2-1 (unit conversion constant of 1.1 mrem/mrad converts air dose to skin dose).

P_i = The dose parameter for radionuclides other than noble gases for the inhalation pathway, in mrem/yr per µCi/m³ and for the food and ground plane pathways, in m²·(mrem/yr) per µCi/sec from Table 1.2-2. The dose factors are based on the critical individual organ and most restrictive age group (child or infant).

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

$\overline{\chi/Q}$ = 7.2E-5 sec/m³. The highest calculated annual average relative concentration (dispersion parameter) for any area at or beyond the unrestricted area boundary. The location is the NNE sector @ 0.5 miles.

W = The annual average dispersion or deposition parameter for estimating the dose to an individual at a controlling location in the unrestricted area where the total inhalation, food and ground plane pathway dose is determined to be a maximum based on operational source term data, land use surveys, and NUREG-0133 guidance:

W = 1.3E-6 sec/m³, for the inhalation pathway. The location is the ESE sector @ 1.5 miles.

W = 2.7E-9 meter^{-2}, for the food and gound plane pathways. The location is the ESE sector @ 1.5 miles.

$\tilde{Q}_i = k_1 C_i f \div k_2 = 4.72E{+}2 C_i f$

where:

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

f = the undiluted effluent flow, in cfm

k_1 = conversion factor, 2.83E4 ml/ft^3

k_2 = conversion factor, 6E1 sec/min

B4.0 DOSE CALCULATIONS

B4.1 FREQUENCY OF CALCULATIONS

Dose contributions to the maximum individual shall be calculated at least every 31 days, quarterly, semiannually, and annually (or as required by Technical Specifications) using the methodology in the generic information sections. This methodology shall also be used for any special reports. Dose calculations that are required for individual pre-release calculations, and/or abnormal releases shall not be calculated by using the simplified dose calculations. Station dose projections for these types and others that are known to vary from the station historical averages shall be calculated by using the methodology in the generic information sections. STATION Dose projections may be performed using simplified dose estimates.

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.

B4.2 DOSE MODELS FOR MAXIMUM EXPOSED INDIVIDUAL

B4.2.1 Liquid Effluents

For dose contributions from liquid radioactive releases, dose calculations based on operational source term data and NUREG-0133 guidance indicate that the maximum exposed individual would be an adult who consumed fish caught in the discharge canal and who drank water from the nearest "downstream" potable water intake. The dose from Cs-134 and Cs-137 is calculated to be 57% of that individual's total whole body dose.

B4.2.2 Gaseous Effluents

B4.2.2.1 Noble Gases

For dose contributions from exposure to beta and gamma radiation from noble gases, it is assumed that the maximum exposed individual is an adult at a controlling location in the unrestricted area where the total noble gas dose is determined to be a maximum.

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

For dose contributions from radioiodines, particulates and other radionuclides; it is assumed that the maximum exposed individual is a child or infant at a controlling location in the unrestricted area where the total inhalation, food and ground plane pathway dose is determined to be a maximum based on operational source term data, land use surveys, and NUREG-0133 guidance.

B4.3 SIMPLIFIED DOSE ESTIMATE

B4.3.1 Liquid Effluents

For dose estimates, a simplified calculation based on the assumptions presented in Section B4.2.1 and operational source term data is presented below. Updated operational source term data shall be used to revise these calculations as necessary.

$$D_{WB} = 1.03E{+}6 \sum_{\ell=1}^{m} (F_\ell)(T_\ell)\ (C_{Cs-134} + 0.59\ C_{Cs-137})$$

where:

$1.03E{+}6 = 1.14E{+}05\ (U_{aw}/D_w + U_{af}\ BF_i)\ DF_{ai\tau}\ (1.75)$

where:

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

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

D_w = 1, dilution factor from the near field area to the nearest possible potable water intake (Hunterville Water Intake).

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

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

$DF_{ai\tau}$ = 1.21E-04, adult total body ingestion dose factor for Cs-134 (Table 3.1-2)

1.75 = factor derived from the assumption that 57% of adult whole body dose is contributed by Cs-134 and Cs-137 via the fish and drinking water pathway or 100% ÷ 57% = 1.75

m = number of releases

where:

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

where:

f = liquid radwaste flow, in gpm

σ = recirculation factor at equilibrium, 2.4

F = dilution flow, in gpm

where:

T_ℓ = The length of time, in hours, over which C_{Cs-134}, C_{Cs-137}, and F_ℓ are averaged. (The time period during which all releases (m) are made)

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

C_{Cs-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

B4.3.2 Gaseous Effluents

Meteorological data is provided in Tables B4.0-1 and B4.0-2.

B4.3.2.1 Noble Gases

For dose estimates, simplified dose calculations based on the assumptions in B4.2.2.1 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 parameter is used and that Xenon-133 contributes 66% of the gamma air dose and 85% of the beta air dose.

$$D_\gamma = 8.06E\text{-}10\ [\tilde{Q}]_{Xe\text{-}133}\ (1.52)$$

$$D_\beta = 2.40E\text{-}09\ [\tilde{Q}]_{Xe\text{-}133}\ (1.18)$$

where:

$\overline{X/Q}$ = 7.2E-05 sec/m^3, as defined in Section B2.2.2

8.06E-10 = (3.17E-8)(353) ($\overline{X/Q}$), derived from equation presented in Section 3.1.2.1.

2.40E-09 = (3.17E-08) (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

1.52 = factor derived from the assumption that 66% of the gamma air dose is contributed by Xe-133.

1.18 = factor derived from the assumption that 85% of the beta air dose is contributed by Xe-133.

B4.3.2.2 Radioiodines, Particulates, and Other Radionuclides with T 1/2 > 8 days

For dose estimates, simplified dose calculations based on the assumptions in B4.2.2.2 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 parameters are used and that 97% of the dose results from Iodine-131 ingested by the maximally exposed individual via the goat milk pathway at the controlling location. The simplified dose estimate to the thyroid of a child is:

$$D = 1.84E\text{+}04\ W\ (\tilde{Q})_{I\text{-}131}\ (1.03)$$

where:

W = 2.7E-09 = $\overline{D/Q}$ for food and ground plane pathway, in sec/m^3 from Table B4.0-2 for the controlling location (ESE sector at 1.5 miles).

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

1.84E+04 = (3.17E-08)(R_i^G $[\overline{D/Q}]$) with the appropriate substitutions for infant-goat milk pathway factor, R_i^G $[\overline{D/Q}]$ for Iodine-131. See Section 3.1.2.2.

1.03 = factor derived from the assumption that 97% of the total inhalation, food and ground plane pathway dose to the maximally exposed individual is contributed by I-131 via the goat milk pathway.

B4.4 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 McGuire Nuclear Station must include gaseous dose contributions from Catawba Nuclear Station, which is located approximately thirty miles SSW of McGuire. For this dose assessment, the total body and maximum organ dose contributions to the maximum exposed individual from McGuire liquid releases and the combined Catawba and McGuire gaseous releases are estimated using the following calculations:

$$D_{WB}(T) = D_{WB}(l_m) + D_{WB}(g_m) + D_{WB}(g_c)$$

$$D_{MO}(T) = D_{MO}(l_m) + D_{MO}(g_m) + D_{MO}(g_c)$$

where:

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

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

B4.4.1 LIQUID EFFLUENTS

Liquid pathway dose estimates are based on values and assumptions presented in Section B4.3.1. Station operational source terms shall be used to update these simplified calculations as necessary.

B4.4.1.1 McGuire's Liquid Contributions

Based on operational history, the McGuire fuel cycle whole body dose resulting from McGuire liquid effluent releases ($D_{WB}(l_m)$) is estimated using the simplified dose calculation given below:

$$D_{WB}(l_m) = (1.03E+06)\ (F_\ell)\ (T_\ell)\ (C_{Cs-134} + 0.59\ C_{Cs-137})$$

where:

$$1.03E+06 = 1.14E+05\ (U_{aw}\ /\ D_w + U_{af}\ BF_i)\ (DF_{ait})\ (1.75)$$

where:

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

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

D_w = 1, dilution factor from the near field area to the nearest possible potable water intake (Huntersville 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)

1.75 = Factor derived from the assumption that 57% of the dose is derived from Cs-134 and Cs-137 or 100% / 57% = 1.75

where:

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

where:

f = McGuire's average liquid radwaste flow for the calendar year of interest, in gpm

F = McGuire's average dilution flow for the calendar year of interest, in gpm

σ = 2.4, the recirculation factor at equilibrum

where:

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

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

C_{Cs-137} = The average concentration of Cs-137 in McGuire'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 McGuire fuel cycle organ dose (Adult GI Tract) resulting from McGuire's liquid effluent releases ($D_{MO}(l_m)$) is estimated using the simplified dose calculation given below:

$D_{MO}(1_m) = (1.51E+06)\ (F_\ell)\ (T_\ell)\ (C_{Nb-95})$

where:

$1.51E+06 = 1.14E+05\ (U_{aw}/D_w + U_{af}\ BF_i)(DF_{ait})(1.21)$

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 = 1, dilution factor from the near field area to the nearest possible potable water intake (Huntersville Water Intake).

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

BF_i = 3.00E+04, Bioaccumulation factor for Niobium (Table 3.1-1)

DF_{ait} = 2.10E-05, Adult GI-Tract ingestion dose factor for Nb-95 (Table 3.1-2)

1.21 = Factor derived from the assumption that 83% of the Adult GI-Tract dose is contributed by Nb-95 via the fish and drinking water pathway or 100% / 83% = 1.21

where:

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

where:

f = McGuire's liquid radwaste flow, in gpm

F = McGuire's dilution flow, in gpm

σ = 2.4, the recirculation factor at equilibrum

where:

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

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

B4.4.2 GASEOUS EFFLUENTS

Airborne effluent pathway dose estimates are based on the values and assumptions presented in Sections B4.3.2. and C4.3.2. Operational source term data shall be used to update these calculations as necessary.

B4.4.2.1 McGUIRE'S GASEOUS CONTRIBUTION

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

$$D_{WB}(g_m) = (9.32E-06)(w)(\tilde{Q}_{Xe-133})(S_F)(1.54)$$

where:

w = 7.20E-05 = $\overline{(X/Q)}$ for the plume immersion pathway, in sec/m^3, which corresponds to a location 0.5 miles NNE of the McGuire site (See Table B4.0-1)

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

9.32E-06 = (3.17E-08) ($K_i[\overline{X/Q}]$), 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.

1.54 = The factor derived from the assumption (based on historical data) that 65% of the whole body dose to the maximally exposed individual is contributed by Xe-133.

Based on operational history, the fuel cycle maximum organ dose is the Adult-GI Tract. For McGuire gaseous releases the organ dose ($D_{MO}(g_m)$) will be calculated for the Adult-GI Tract using the simplified dose calculation given below:

$$D_{MO}(g_m) = (3.99E-05)(w)(\tilde{Q}_{H-3})(1.47)$$

where:

w = 7.20E-05, $\overline{X/Q}$ for the inhalation pathway, in sec/m^3 from Table B4.0-1, for the McGuire fuel cycle maximum organ dose controlling location (NNE @ 0.5 miles).

$\tilde{Q}_{H-3}$ = The total H-3 activity released from McGuire during the calendar year of interest, in uCi.

3.99E-05 = (3.17E-08)($R_i^I[\overline{X/Q}]$) with appropriate substitions for the inhalation pathway, $R_i^I[\overline{X/Q}]$ for H-3. See Section 3.1.2.2.

1.47 = The factor derived from the conservative assumption (based on historical data) that 68% of the total inhalation, food and ground plane pathway dose to the maximally exposed individual is contributed by H-3 via the inhalation pathway.

B4.4.2.2 CATAWBA'S GASEOUS CONTRIBUTION

Based on operational history, the McGuire fuel cycle maximum whole body dose resulting from Catawba's gaseous effluent releases ($D_{WB}(g_c)$) is estimated using the simplified dose calculation given below:

$$D_{WB}(g_c) = (9.32E{-}06)(w)(\tilde{Q}_{Xe-133})(S_F)(1.30)$$

where:

w = 3.30E-07, ($\overline{X/Q}$) for the plume immersion pathway which corresponds to a location 5 miles NNE of the Catawba site. (See Table C4.0-1)

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

9.32E-06 = (3.17E-08)($K_i[\overline{X/Q}]$), 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.

1.30 = The factor derived from the conservative assumption (based on historical data) that 77% of the whole body dose to the maximally exposed indiv-dual is contributed by Xe-133 via the plume immersion pathway.

Based on operational history, the fuel cycle maximum organ dose for McGuire is the Adult-GI Tract. For Catawba gaseous releases the organ dose ($D_{MO}(g_c)$) will be calculated for the Adult-GI Tract using the simplified dose calculation given below:

$$D_{MO}(g_c) = (7.23E{-}05)(w)(\tilde{Q}_{H-3})(2.40)$$

where:

w = 3.3E-07 = $\overline{X/Q}$ for the food and ground plane pathway in sec/m^3, for a location 5 miles NNE of the Catawba site (see Table C4.0-1).

$\tilde{Q}_{H-3}$ = The total H-3 activity released from Catawba during the calendar year of interest, in uCi.

7.23E-05 = (3.17E-08)($R_i^V[\overline{X/Q}]$) with appropriate substitions for

the adult-vegetable garden pathway, $R_i^V[\overline{X/Q}]$ for H-3. See Section 3.1.2.2.

2.40 = The factor derived from the assumption (based on historical data) that 41% of the total inhalation, food and ground plane pathway dose to the maximally exposed individual is contributed by H-3 via the vegetable garden pathway.

B5.0 RADIOLOGICAL ENVIRONMENTAL MONITORING

The radiological environmental monitoring program shall be conducted in accordance with Technical Specification 3/4.12. The monitoring program locations and analyses are given in Tables B5.0-1 through B5.0-3 and Figure B5.0-1 Site specific characteristics make groundwater sampling unnecessary. Groundwater recharge is from Lake Norman and local precipitation. The groundwater gradient flows directly to the Catawba River; therefore, contamination of groundwater from liquid effluents is highly improbable. Additionally, two site boundary TLD locations in the NW and NNW sectors do not exist since the required locations are over water.

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 05/11/88 - 05/13/88.

TABLE B5.0-2
(1 of 1)
MCGUIRE RADIOLOGICAL MONITORING PROGRAM SAMPLING LOCATIONS
(OTHER SAMPLING LOCATIONS)

CODE:

W - Weekly
BW - Biweekly
M - Monthly
SM - Semimonthly
Q - Quarterly
SA - Semiannually

	SAMPLING LOCATION DESCRIPTION	Control Locations	Air Radioiodines and Particulates	Surface Water	Drinking Water	Shoreline Sediment	Food Products	Fish	Milk	Broadleaf Vegetation
120	Site Boundary (0.7 mi NNE)		W							M
121	Site Boundary (0.5 mi NE)		W							
125	Site Boundary (0.5 mi SW)		W							M
128	Discharge Canal Bridge (0.4 mi ENE)			BW						
129	Discharge Canal Entrance to Lake Norman (0.6 mi ENE)					SA		SA		
130	Hwy. 73 Bridge Downstream (0.6 mil SW)			BW		SA				
131	Deleted 01/01/89									
132	Charlotte Municipal Water Supply (11.2 mi SSE)				BW					
133	Cornelius (6.2 mi NE)		W							
134	East Lincoln Junior High School (8.7 mi WNW)	X	W							M
135	Plant Marshall Intake Canal (12.0 mi N)	X		BW						
136	Mooresville Municipal Water Supply (12.5 mi NNE)	X			BW					
137	Pinnacle Access Area (12.0 mi N)	X				SA		SA		
138	Henry Cook Dairy (2.75 mi ESE)								SM	
139	William Cook Dairy (2.25 mi E)								SM	
140	Kidd Dairy-Cows (2.8 mi SSE)								SM	
141	Lynch Dairy-Cows (14.8 mi WNW)	X							SM	
142	Davidson Municipal Water Supply (7.5 mi NE)				BW					
158	4-5 Mile Radius (5.0 mi NE)									M
159	4-5 Mile Radius (4.4 mi NNE)(To be deleted 1/1/85 - location #120 will replace)									M
184	5 Mile Radius - Gardens (2.5 mi ENE)						M[(a)]			

(a) during harvest season