OFFSITE DOSE CALCULATION MANUAL

1.0 PURPOSE

The purpose of the Offsite Dose Calculation Manual (ODCM) is to provide the methods and parameters used to calculate offsite doses resulting from radioactive effluent releases, calculate effluent radiation monitor trip/alarm setpoints, and to conduct the environmental monitoring program. The methods used conform to the requirements of the Radiological Effluent Technical Specifications.

2.0 REFERENCES

2.1 Radiological Effluent Technical Specifications

2.2 Regulatory Guide 1.109

3.0 APPLICATION

The ODCM (Basis) forms the basis for the offsite dose calculations described in the liquid and gaseous waste procedures. | PMF 89-230

4.0 PROCEDURE

4.1 Offsite Dose Calculation Manual

Follow the methodology in the ODCM (Basis) to calculate offsite doses resulting from radioactive effluent releases and to calculate radiation monitor trip setpoints. | PMF 89-230

5.0 CONDENSED PROCEDURE

As described in the liquid and gaseous waste procedures.

6.0 CALCULATIONS

As described in Basis. The required calculations are also described in the liquid and gaseous waste procedures. |PMF 89-230

BASIS

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OFFSITE DOSE CALCULATION MANUAL

(ODCM)

CALVERT CLIFFS NUCLEAR POWER PLANT

BALTIMORE GAS AND ELECTRIC COMPANY

ODCM BASIS

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LIST OF ATTACHMENTS

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1.0 SETPOINTS

1.1 Liquid Effluents

1.1.1 In accordance with the requirements of Technical specification 3.3.3.10, alarm setpoints shall be established for the liquid effluent monitoring instrumentation to ensure that the concentration of radioactive material released in liquid effluents does not exceed the limits of 10CFR20, Appendix B, Table II, Column 2.

1.1.2 The setpoint shall be established taking credit for operation of the applicable number of circulating water pumps (normally a minimum of five (5)). |PMF 89-191

1.1.3 Setpoint shall be determined as follows:

$$SP = \Sigma (A_i \times \text{RMS Response}_i) \times \frac{\text{Dilution Water Flow Rate}}{\text{Discharge Flow Rate}} + \text{Bkgd}$$

Where:

SP = Setpoint (cpm)

A_i = Specific Activity (µCi/ml) of radionuclide i. For liquid waste this mixture shall include Co-58 (45%), Cs-137 (15%), I-131 (15%), Ag-110m (10%), Cs-134 (5%), Co-60 (5%) and I-133 (5%). This mixture was derived from actual 1984, 1985, and 1986 liquid release data. The actual µCi/ml shall be determined using the appropriate MPC data as defined in 10CFR20, Appendix B, Table II, Column 2.

RMS Response $_i$ = Monitor sensitivity (cpm/μCi/ml) for radionuclide i

Dilution Water Flow Rate = Dilution from circulating water pumps (normally 1E+06 gpm). PMF-89-191

Discharge Flow Rate = Maximum liquid effluent flow rate into circulating water (gpm).

a. Liquid Waste (120 gpm)
b. Steam Generator Blowdown (225 gpm per generator)

Bkgd = RMS background level (cpm)

1.1.4 If fewer than five (5) circulating water pumps are running in the conduit being discharged to, then a setpoint change should be initiated for monitored releases. PMF-89-191

1.1.5 Administrative controls shall be utilized to insure that 10CFR20 limits are not exceeded for the restrictive case where Iodine 131 represents 100% of the activity. PMF-89-191

1.2 Gaseous Effluents

1.2.1 In accordance with the requirements of Technical Specification 3.3.3.11, alarm setpoints shall be established for the gaseous effluent monitoring instrumentation to ensure that the dose rate due to radioactive materials released in gaseous effluents does not exceed 500 mrem/yr (total body) or 3000 mrem/yr (skin).

1.2.2 Setpoint shall be determined as follows:

$$SP = \Sigma \frac{(A_i \text{ X RMS Response}_i)}{(X/Q) \text{ X } (F)} + \text{Bkgd}$$

2.2.2 Steam Generator Blowdown is normally discharged to the condensate system and recycled. Discrete volumes are occasionally discharged to the Chesapeake Bay in a batch form rather than a continuous type effluent.

2.2.3 Prior to discharge a grab sample of the waste stream(s) shall be collected and analyzed to verify compliance with 10CRF20 Appendix B, Table II, column 2.

$$\sum \frac{A_i}{MPC_i} \times \frac{\text{Discharge Flow Rate}}{\text{Dilution Water Flow Rate}} \leq 1$$

Where:

A_i = specific activity (μCi/ml) of isotope i from waste stream sample

MPC_i = 10CFR20 limit, Appendix B, Table II, Column 2 (μCi/ml) (The soluble MPC shall be used if the radionuclide solubility state is unknown.)

Discharge Flow Rate = flow rate (gpm) of waste stream into circulating water.

Dilution Water Flow Rate = dilution from circulating water pumps (normally 1E+06 gpm) |PMF-89-191

2.2.4 Reactor Coolant and Miscellaneous Waste Tank Volumes shall be recirculated prior to sample collection to ensure a representative sample for analysis.

2.2.5 A liquid waste discharge permit shall be prepared for routine batch radioactive liquid releases. The permit shall document the release conditions and approvals, sample analysis results and compliance with the Radiological Effluent Technical Specifications.

2.2.6 If fewer than 5 circulating water pumps are running in the conduit being discharged to then the dilution flow should be reduced accordingly. PMF-89-191

2.2.7 In lieu of using the pre-release sample for post release accounting and monthly/quarterly analyses, a representative composite sample may be collected during the release and used for dose commitment and reporting requirements.

2.3 Liquid Effluent Dose

2.3.1 Technical Specification 3.11.1.2 limits the dose or dose commitment to members of the public from radioactive materials in liquid effluents from the Calvert Cliffs Nuclear Power Plant to:

- during any calendar quarter;
  - $\leq$ 3.0 mrem to total body
  - $\leq$ 10.0 mrem to any organ
- during any calendar year;
  - $\leq$ 6.0 mrem to total body
  - $\leq$ 20.0 mrem to any organ.

Dose due to liquid effluents may be calculated using the equations in Section 2.3.2 or 2.3.4.

2.3.2 Dose Commitment (Expanded Equation)

2.3.5 Dose Commitment (Justification for Simplified Approach)

The radioactive liquid effluents for the years 1986, 1987 and 1988 were evaluated to determine the dose contribution of the radionuclide distribution. This analysis was performed to evaluate the use of a limited dose analysis for determining environmental doses, providing a simplified method of determining compliance with the dose limits of Technical Specification 3.11.1.2. For the radionuclide distribution of effluents from Calvert Cliffs, the controlling organ is either the thyroid or the GI-LLI. The calculated thyroid dose is almost exclusively dictated by the radioiodine releases; the GI-LLI dose is primarily a function of the Co-58, Co-60, Nb-95, and Ag-110m releases. The radionuclides, Co-58, Co-60, Cs-134 and Cs-137 contribute essentially all of the calculated total body dose. The results of this evaluation are presented in Attachment (5).

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For purposes of simplifying the details of the dose calculation, it is conservative to identify a controlling, dose significant radionuclide and limit the calculation to the use of the dose conversion factor for this nuclide. Multiplication of the total release (i.e., cumulative activity for all radionuclides) by this dose conversion factor provides for a conservative simplified dose calculation.

For the evaluation of the maximum organ dose, it is conservative to use the I-131 thyroid dose conversion (1.02E+05 mrem/hr per µCi/ml, thyroid). The radionuclide Ag-110m has a higher dose conversion factor (5.9E+05 mrem\hr per µCi/ml, GI-LLI). However, since Ag-110m releases are typically less than 5% of the total releases, it is conservative (while not being overly restrictive) to use the I-131 factor.

By this approach, the maximum organ dose will be routinely overestimated. For 1986, using the simplified conservative method would overestimate the maximum organ dose by a factor of 1.7; for 1987, the conservatism is a factor 2.4; and for 1988, a factor 2.7. For the total body calculation, the Cs-134 dose factor (1.33E+04 mrem/hr per µCi/ml, total body) is the highest among the identified dominant nuclides. There are several reactor-generated radionuclides with higher values (e.g, Zn-65); however, in terms of an overall dose significance, the contribution of these nuclides will be minor, attributable to relative abundances in the effluent streams. For 1986, using this simplified conservative dose calculation would overestimate the total body dose by a factor of 4.7; for 1987, the conservatism in a factor of 2.8; and for 1988, a factor 2.5. | PMF 89-230

For evaluating compliance with the dose limits of Technical Specification 3.11.1.2, the following simplified equations may be used:

Total Body

$$D_{tb} = \frac{1.67E\text{-}02 \times V}{CW} \times C_{Cs\text{-}134} \times \Sigma A_i$$

Where :

D_{tb} = dose to the total body (mrem)

1.67E-02 = conversion factor (hr/min)

V = volume of liquid effluent released (gal)

CW = average circulating water discharge rate during release period (gal/min)

$C_{Cs\text{-}134}$ = 1.33E+04, total body ingestion dose conversion factor for Cs-134 (mrem/hr per µCi/ml)

W = atmospheric dispersion parameter (X/Q or D/Q) to the controlling location. |PMF |89-230

X/Q = atmospheric dispersion for radiochemical particulates via the inhalation pathway and for tritium via all pathways (seconds/m^3).

D/Q= atmospheric deposition for radioiodine and particulates (excluding tritium) via ingestion pathway. (m^{-2}).

R_i = dose factor for radionuclide i, (mrem/yr per $\mu Ci/m^3$) or (m^2 - mrem/yr per μCi/sec) from Attachment 7 for each age group a and the applicable pathway p. Values for R_i were derived in accordance with the methods described in NUREG-0133.

$\dot{Q}_i$ = cumulative release over the period of interest for radionuclide i - I-131 or radioactive material in particulate form with half-life greater than 8 days "("μCi).

The controlling pathway and location for the CCNPP has been determined to be goat-milk pathway at 4800 meters, SSW. At this location the X/Q = 6.8E-8 seconds/m^3 and the D/Q = 4.5E-10m^{-2}. The small amounts of tritium discharged from the plant main vents are not considered in offsite particulate dose assessments. This is justified because modeling evaluations show that the maximum expected doses would be several orders of magnitude below the regulatory limits. |PMF |89-230

3.4.4 Gaseous Dose - Radioiodine and Particulates (Simplified Equation)

In lieu of the individual radionuclide (I-131 and particulates) dose assessment as presented above, the following simplified dose calculational equation may be used for verifying compliance with the dose limits of T.S. 3.11.2.3.

$$D_{max} = 3.17E\text{-}08 \times W \times R_{I\text{-}131} \times \Sigma \dot{Q}_i$$

Where:

D_{max} = maximum organ dose (mrem)

$R_{I\text{-}131}$ = I-131 dose parameter for the thyroid for the identified controlling pathway

= 1.27E+12, infant thyroid dose parameter with the controlling goat-milk pathway (m^2 - mrem/yr per μCi/sec) PMF 89-230

The ground plane exposure and inhalation pathways need not be considered when the above simplified calculation is used because of the overall negligible contribution of these pathways to the total thyroid dose. It is recognized that for some particulate radionuclides (e.g., Co-60 and Cs-137), the ground exposure pathway may represent a higher dose contribution than either the vegetation or milk pathway. However, use of the I-131 thyroid dose parameter for all radionuclides will maximize the organ dose calculation, especially considering that no other radionuclide has a higher dose parameter for any organ via any pathway than I-131 for the thyroid via the applicable vegetation or milk pathway.

N_i = the air dose factor due to beta emissions from each noble gas radionuclide i released |PMF |89-191

To determine the appropriate effective factors to be used and to evaluate the degree of variability, the atmospheric radioactive effluents for 3 years have been evaluated. Attachment 8 presents the results of this evaluation.

As demonstrated by the data in Attachment (8), the effective dose transfer factors vary little from year to year. The maximum observed variability from the average value is less than 10%. The variability is minor considering other areas of uncertainty and conservatism inherent in the environmental dose calculation models.

For evaluating compliance with the dose limits of Technical Specification 3.11.2.2, the following simplified equations may be used:

$$\dot{D}\delta = 3.17E\text{-}08 \times X/Q \times M_{eff} \times \Sigma \dot{Q}_i$$

$$\dot{D}\beta = 3.17E\text{-}08 \times X/Q \times N_{eff} \times \Sigma \dot{Q}_i$$

Where:

$\dot{D}\delta$ = air dose due to gamma emissions for the cumulative release of all noble gases (mrad)

$\dot{D}\beta$ = air dose due to beta emissions for the cumulative release of all noble gases (mrad)

X/Q = atmospheric dispersion to the controlling site boundary (sec/m^3)

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ATTACHMENT 5

ADULT DOSE CONTRIBUTIONS
FISH AND SHELLFISH PATHWAY

Radionuclide	1986			1987			1988		
	Ci/yr	Total Body T.B. Dose Fraction	GI-LLI Dose Fraction	Ci/yr	Total Body T.B. Dose Fraction	GI-LLI Dose Fraction	Ci/yr	Total Body T.B. Dose Fraction	GI-LLI Dose Fraction
Co-58	0.4720	0.1269	0.0547	1.6600	0.0910	0.0907	0.4785	0.0453	0.0585
Co-60	0.1240	0.0943	0.0383	0.1650	0.0256	0.0241	0.0331	0.0089	0.0108
Nb-95	0.0386	0.0010	0.5539	0.0985	0.0005	0.6667	0.0317	0.0030	0.4799
Ag-110m	0.0572	0.0098	0.3211	0.0688	0.0024	0.1823	0.0721	0.0044	0.4275
Cs-134	0.1170	0.3085	0.0003	0.8000	0.4328	0.0010	0.4478	0.4176	0.0013
Cs-137	0.2590	0.4046	0.0006	1.1700	0.3746	0.0012	0.9308	0.5124	0.0022
Total Fraction		0.9451	0.9689		0.9269	0.9660		0.9915	0.9802

ATTACHMENT 7 (CON'T)
GASEOUS EFFLUENTS - PATHWAY DOSE PARAMETERS
RIO, GRASS-GOAT-MILK PATHWAY DOSE FACTORS - INFANT
Units are m2*mrem/yr per μCi/sec

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
H-3	0.000E+00	4.860E+03	4.860E+03	4.860E+03	4.860E+03	4.860E+03	4.860E+03
C-14	3.230E+06	6.890E+05	6.890E+05	6.890E+05	6.890E+05	6.890E+05	6.890E+05
NA-24	1.930E+06	1.930E+06	1.930E+06	1.930E+06	1.930E+06	1.930E+06	1.930E+06
P-32	1.920E+11	1.130E+10	7.450E+09	0.000E+00	0.000E+00	0.000E+00	2.600E+09
CR-51	0.000E+00	0.000E+00	1.940E+04	1.260E+04	2.760E+03	2.460E+04	5.650E+05
MN-54	0.000E+00	4.670E+06	1.060E+06	0.000E+00	1.040E+06	0.000E+00	1.720E+06
MN-56	0.000E+00	3.850E-03	6.630E-04	0.000E+00	3.310E-03	0.000E+00	3.490E-01
FE-55	1.760E+06	1.130E+06	3.030E+05	0.000E+00	0.000E+00	5.540E+05	1.440E+05
FE-59	2.920E+06	5.110E+06	2.010E+06	0.000E+00	0.000E+00	1.510E+06	2.440E+06
CO-57	0.000E+00	1.070E+06	1.750E+06	0.000E+00	0.000E+00	0.000E+00	3.660E+06
CO-58	0.000E+00	2.910E+06	7.270E+06	0.000E+00	0.000E+00	0.000E+00	7.260E+06
CO-60	0.000E+00	1.060E+07	2.500E+07	0.000E+00	0.000E+00	0.000E+00	2.520E+07
NI-63	4.190E+09	2.590E+08	1.450E+08	0.000E+00	0.000E+00	0.000E+00	1.290E+07
NI-65	4.210E-01	4.770E-02	2.170E-02	0.000E+00	0.000E+00	0.000E+00	3.630E+00
CU-64	0.000E+00	2.090E+04	9.680E+03	0.000E+00	3.540E+04	0.000E+00	4.290E+05
ZN-65	6.660E+08	2.280E+09	1.050E+09	0.000E+00	1.110E+09	0.000E+00	1.930E+09
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-82	0.000E+00	0.000E+00	2.330E+07	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	0.000E+00	0.000E+00	1.190E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	2.670E+09	1.320E+09	0.000E+00	0.000E+00	0.000E+00	6.830E+07
RB-88	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-89	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-89	2.640E+10	0.000E+00	7.580E+08	0.000E+00	0.000E+00	0.000E+00	5.430E+08
SR-90	2.550E+11	0.000E+00	6.500E+10	0.000E+00	0.000E+00	0.000E+00	3.190E+09
SR-91	6.180E+05	0.000E+00	2.240E+04	0.000E+00	0.000E+00	0.000E+00	7.310E+05
SR-92	9.760E+00	0.000E+00	3.620E-01	0.000E+00	0.000E+00	0.000E+00	1.050E+02
Y-90	8.160E+01	0.000E+00	2.190E+00	0.000E+00	0.000E+00	0.000E+00	1.130E+05
Y-91M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y-91	8.800E+03	0.000E+00	2.340E+02	0.000E+00	0.000E+00	0.000E+00	6.310E+05
Y-92	6.270E-05	0.000E+00	1.760E-06	0.000E+00	0.000E+00	0.000E+00	1.200E+10
Y-93	2.700E-01	0.000E+00	7.350E-03	0.000E+00	0.000E+00	0.000E+00	2.130E+03
ZR-95	8.190E+02	2.000E+02	1.420E+02	0.000E+00	2.150E+02	0.000E+00	9.940E+00
ZR-97	4.790E-01	8.220E-02	3.760E-02	0.000E+00	8.290E-02	0.000E+00	5.240E+03
NB-95	7.120E+04	2.930E+04	1.690E+04	0.000E+00	2.100E+04	0.000E+00	2.470E+07
NB-97	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.440E-07
MO-99	0.000E+00	2.540E+07	4.960E+06	0.000E+00	3.800E+07	0.000E+00	8.830E+06
TC-99M	3.230E+00	6.660E+00	8.570E+01	0.000E+00	7.160E+01	3.480E+00	1.930E+03
TC-101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-103	1.040E+03	0.000E+00	3.490E+02	0.000E+00	2.170E+03	0.000E+00	1.270E+04
RU-105	9.670E-04	0.000E+00	3.260E-04	0.000E+00	7.110E-03	0.000E+00	3.850E-01
RU-106	2.280E+04	0.000E+00	2.850E+03	0.000E+00	2.700E+04	0.000E+00	1.730E+05
RH-103M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH-106	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG-110M	4.630E+07	3.380E+07	2.240E+07	0.000E+00	4.840E+07	0.000E+00	1.750E+09
SB-124	2.510E+07	3.700E+05	7.790E+06	6.670E+04	0.000E+00	1.570E+07	7.750E+07
SB-125	1.790E+07	1.740E+05	3.690E+06	2.250E+04	0.000E+00	1.130E+07	2.390E+07
TE-125M	1.810E+07	6.050E+06	2.450E+06	6.090E+06	0.000E+00	0.000E+00	8.620E+06

ATTACHMENT 7 (CON'T)
GASEOUS EFFLUENTS - PATHWAY DOSE PARAMETERS
RIO, GRASS-GOAT-MILK PATHWAY DOSE FACTORS - INFANT

Units are m2*mrem/yr per μCi/sec

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
TE-127M	5.050E+07	1.680E+07	6.120E+06	1.460E+07	1.240E+08	0.000E+00	2.040E+07
TE-127	7.800E+02	2.610E+02	1.680E+02	6.350E+02	1.900E+03	0.000E+00	1.640E+04
TE-129M	6.710E+07	2.300E+07	1.030E+07	2.580E+07	1.680E+08	0.000E+00	4.010E+07
TE-129	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.000E-08
TE-131M	4.050E+05	1.630E+05	1.350E+05	3.310E+00	1.120E+06	0.000E+00	2.750E+06
TE-131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-132	2.520E+06	1.250E+06	1.170E+06	1.840E+06	7.820E+06	0.000E+00	4.620E+06
I-130	4.320E+06	9.510E+06	3.820E+06	7.000E+08	1.040E+07	0.000E+00	2.040E+06
I-131	3.270E+09	3.850E+09	1.690E+09	1.270E+12	4.500E+09	0.000E+00	1.370E+08
I-132	1.710E+00	3.470E+00	1.230E+00	1.630E+02	3.870E+00	0.000E+00	2.810E+00
I-133	4.460E+07	6.490E+07	1.900E+07	1.180E+10	7.630E+07	0.000E+00	1.100E+07
I-134	0.000E+00	0.000E+00	0.000E+00	1.210E-09	0.000E+00	0.000E+00	0.000E+00
I-135	1.460E+05	2.900E+05	1.060E+05	2.600E+07	3.230E+05	0.000E+00	1.050E+05
CS-134	1.090E+11	2.040E+11	2.060E+10	0.000E+00	5.250E+10	2.150E+10	5.540E+08
CS-136	5.880E+09	1.730E+10	6.460E+09	0.000E+00	6.900E+09	1.410E+09	2.630E+08
CS-137	1.540E+11	1.810E+11	1.280E+10	0.000E+00	4.850E+10	1.960E+10	5.650E+08
CS-138	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-139	5.450E-08	0.000E+00	1.580E-09	0.000E+00	0.000E+00	0.000E+00	3.450E-06
BA-140	2.890E+07	2.890E+04	1.490E+06	0.000E+00	6.870E+03	1.780E+04	7.110E+06
BA-141	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA-140	4.840E+00	1.910E+00	4.900E-01	0.000E+00	0.000E+00	0.000E+00	2.240E+04
LA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.250E-07
CE-141	5.200E+03	3.170E+03	3.730E+02	0.000E+00	9.780E+02	0.000E+00	1.640E+06
CE-143	4.800E+01	3.180E+04	3.630E+00	0.000E+00	9.270E+00	0.000E+00	1.860E+05
CE-144	2.790E+05	1.140E+05	1.560E+04	0.000E+00	4.620E+04	0.000E+00	1.600E+07
PR-143	1.790E+02	6.710E+01	8.890E+00	0.000E+00	2.490E+01	0.000E+00	9.470E+04
PR-144	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND-147	1.060E+02	1.090E+02	6.660E+00	0.000E+00	4.190E+01	0.000E+00	6.890E+04
W-187	7.350E+03	5.110E+03	1.770E+03	0.000E+00	0.000E+00	0.000E+00	3.000E+05
NP-239	4.360E+00	3.900E-01	2.210E-01	0.000E+00	7.780E-01	0.000E+00	1.130E+04

ATTACHMENT 7 (CON'T)
GASEOUS EFFLUENTS - PATHWAY DOSE PARAMETERS
RIO, GRASS-GOAT-MILK PATHWAY DOSE FACTORS - CHILD

Units are m2*mrem/yr per μCi/sec

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
H-3	0.000E+00	3.200E+03	3.200E+03	3.200E+03	3.200E+03	3.200E+03	3.200E+03
C-14	1.650E+06	3.290E+05	3.290E+05	3.290E+05	3.290E+05	3.290E+05	3.290E+05
NA-24	1.110E+06	1.110E+06	1.110E+06	1.110E+06	1.110E+06	1.110E+06	1.110E+06
P-32	9.330E+10	4.370E+09	3.600E+09	0.000E+00	0.000E+00	0.000E+00	2.580E+09
CR-51	0.000E+00	0.000E+00	1.220E+04	6.790E+03	1.860E+03	1.240E+04	6.490E+05
MN-54	0.000E+00	2.510E+06	6.690E+05	0.000E+00	7.050E+05	0.000E+00	2.110E+06
MN-56	0.000E+00	1.570E-03	3.550E-04	0.000E+00	1.900E-03	0.000E+00	2.280E-01
FE-55	1.450E+06	7.700E+05	2.390E+05	0.000E+00	0.000E+00	4.360E+05	1.430E+05
FE-59	1.570E+06	2.530E+06	1.260E+06	0.000E+00	0.000E+00	7.350E+05	2.640E+06
CO-57	0.000E+00	4.600E+05	9.320E+05	0.000E+00	0.000E+00	0.000E+00	3.770E+06
CO-58	0.000E+00	1.460E+06	4.460E+06	0.000E+00	0.000E+00	0.000E+00	8.500E+06
CO-60	0.000E+00	5.180E+06	1.530E+07	0.000E+00	0.000E+00	0.000E+00	2.870E+07
NI-63	3.560E+09	1.900E+08	1.210E+08	0.000E+00	0.000E+00	0.000E+00	1.280E+07
NI-65	1.990E-01	1.870E-02	1.090E-02	0.000E+00	0.000E+00	0.000E+00	2.290E+00
CU-64	0.000E+00	8.410E+03	5.080E+03	0.000E+00	2.030E+04	0.000E+00	3.950E+05
ZN-65	4.960E+08	1.320E+09	8.220E+08	0.000E+00	8.330E+08	0.000E+00	2.320E+08
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-82	0.000E+00	0.000E+00	1.390E+07	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	0.000E+00	0.000E+00	5.620E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	1.050E+09	6.470E+08	0.000E+00	0.000E+00	0.000E+00	6.770E+07
RB-88	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-89	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-89	1.390E+10	0.000E+00	3.970E+08	0.000E+00	0.000E+00	0.000E+00	5.380E+08
SR-90	2.350E+11	0.000E+00	5.950E+10	0.000E+00	0.000E+00	0.000E+00	3.190E+09
SR-91	2.970E+05	0.000E+00	1.120E+04	0.000E+00	0.000E+00	0.000E+00	6.550E+05
SR-92	4.590E+10	0.000E+00	1.840E-01	0.000E+00	0.000E+00	0.000E+00	8.690E+01
Y-90	3.860E+01	0.000E+00	1.030E+00	0.000E+00	0.000E+00	0.000E+00	1.100E+05
Y-91M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.800E-17
Y-91	4.690E+03	0.000E+00	1.250E+02	0.000E+00	0.000E+00	0.000E+00	6.250E+05
Y-92	2.950E-05	0.000E+00	8.440E-07	0.000E+00	0.000E+00	0.000E+00	8.520E-01
Y-93	1.270E-01	0.000E+00	3.480E-03	0.000E+00	0.000E+00	0.000E+00	1.890E+03
ZR-95	4.610E+02	1.010E+02	9.030E+01	0.000E+00	1.450E+02	0.000E+00	1.060E+05
ZR-97	2.260E-01	3.270E-02	1.930E-02	0.000E+00	4.690E-02	0.000E+00	4.950E+03
NB-95	3.810E+04	1.480E+04	1.060E+04	0.000E+00	1.390E+04	0.000E+00	2.750E+07
NB-97	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO-99	0.000E+00	9.950E+06	2.460E+06	0.000E+00	2.120E+07	0.000E+00	8.230E+06
TC-99M	1.550E+00	3.040E+00	5.040E+01	0.000E+00	4.420E+01	1.550E+00	1.730E+03
TC-101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-103	5.150E+02	0.000E+00	1.980E+02	0.000E+00	1.300E+03	0.000E+00	1.330E+04
RU-105	4.590E-04	0.000E+00	1.660E-04	0.000E+00	4.030E-03	0.000E+00	2.990E-01
RU-106	1.110E+04	0.000E+00	1.380E+03	0.000E+00	1.500E+04	0.000E+00	1.720E+05
RH-103M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH-106	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG-110M	2.510E+07	1.690E+07	1.350E+07	0.000E+00	3.150E+07	0.000E+00	2.010E+09
SB-124	1.300E+07	1.690E+05	4.570E+06	2.880E+04	0.000E+00	7.240E+06	8.150E+07
SB-125	1.040E+07	8.050E+04	2.190E+06	9.670E+03	0.000E+00	5.820E+06	2.490E+07
TE-125M	8.850E+06	2.400E+06	1.180E+06	2.480E+06	0.000E+00	0.000E+00	8.540E+06

ATTACHMENT 7 (CON'T)
GASEOUS EFFLUENTS - PATHWAY DOSE PARAMETERS
RIO, GRASS-GOAT-MILK PATHWAY DOSE FACTORS - CHILD

Units are m2*mrem/yr per μCi/sec

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
TE-127M	2.500E+07	6.720E+06	2.960E+06	5.970E+06	7.120E+07	0.000E+00	2.020E+07
TE-127	3.670E+02	9.910E+01	7.880E+01	2.540E+02	1.050E+03	0.000E+00	1.440E+04
TE-129M	3.270E+07	9.130E+06	5.080E+06	1.050E+07	9.600E+07	0.000E+00	3.990E+07
TE-129	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.340E-09
TE-131M	1.920E+05	6.640E+04	7.070E+04	1.370E+05	6.430E+05	0.000E+00	2.690E+06
TE-131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-132	1.230E+06	5.420E+05	6.550E+05	7.900E+05	5.040E+06	0.000E+00	5.460E+06
I-130	2.100E+06	4.250E+06	2.190E+06	4.680E+08	6.350E+06	0.000E+00	1.990E+06
I-131	1.570E+09	1.570E+09	8.950E+08	5.210E+11	2.580E+09	0.000E+00	1.400E+08
I-132	8.230E-01	1.510E+00	6.960E-01	7.020E+01	2.320E+00	0.000E+00	1.780E+00
I-133	2.110E+07	2.610E+07	9.880E+06	4.850E+09	4.350E+07	0.000E+00	1.050E+07
I-134	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-135	7.000E+04	1.260E+05	5.960E+04	1.120E+07	1.930E+05	0.000E+00	9.600E+04
CS-134	6.790E+10	1.110E+11	2.350E+10	0.000E+00	3.450E+10	1.240E+10	6.010E+08
CS-136	3.010E+09	8.280E+09	5.360E+09	0.000E+00	4.410E+09	6.580E+08	2.910E+08
CS-137	9.670E+10	9.260E+10	1.370E+10	0.000E+00	3.020E+10	1.090E+10	5.800E+08
CS-138	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-139	2.560E-08	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.480E-06
BA-140	1.410E+07	1.230E+04	8.210E+05	0.000E+00	4.010E+03	7.340E+03	7.120E+06
BA-141	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA-140	2.310E+00	8.090E-01	2.730E-01	0.000E+00	0.000E+00	0.000E+00	2.260E+04
LA-142	4.770E-12	1.520E-12	4.770E-13	0.000E+00	0.000E+00	0.000E+00	3.020E-07
CE-141	2.620E+03	1.310E+03	1.940E+02	0.000E+00	5.730E+02	0.000E+00	1.630E+06
CE-143	2.270E+01	1.230E+04	1.780E+00	0.000E+00	5.150E+00	0.000E+00	1.800E+05
CE-144	1.950E+05	6.100E+04	1.040E+04	0.000E+00	3.380E+04	0.000E+00	1.590E+07
PR-143	8.670E+01	2.600E+01	4.300E+00	0.000E+00	1.410E+01	0.000E+00	9.350E+04
PR-144	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND-147	5.340E+01	4.320E+01	3.350E+00	0.000E+00	2.370E+01	0.000E+00	6.850E+04
W-187	3.490E+03	2.070E+03	9.270E+02	0.000E+00	0.000E+00	0.000E+00	2.900E+05
NP-239	2.060E+00	1.480E-01	1.040E-01	0.000E+00	4.280E-01	0.000E+00	1.100E+04

ATTACHMENT 7 (CON'T)
GASEOUS EFFLUENTS - PATHWAY DOSE PARAMETERS
RIO, GRASS-GOAT-MILK PATHWAY DOSE FACTORS - TEEN

Units are m2*mrem/yr per µCi/sec

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
H-3	0.000E+00	2.030E+03	2.030E+03	2.030E+03	2.030E+03	2.030E+03	2.030E+03
C-14	6.700E+05	1.340E+05	1.340E+05	1.340E+05	1.340E+05	1.340E+05	1.340E+05
NA-24	5.330E+05	5.330E+05	5.330E+05	5.330E+05	5.330E+05	5.330E+05	5.330E+05
P-32	3.780E+10	2.340E+09	1.470E+09	0.000E+00	0.000E+00	0.000E+00	3.180E+09
CR-51	0.000E+00	0.000E+00	6.000E+03	3.330E+03	1.310E+03	8.560E+03	1.010E+06
MN-54	0.000E+00	1.680E+06	3.330E+05	0.000E+00	5.010E+05	0.000E+00	3.440E+06
MN-56	0.000E+00	9.010E-04	1.600E-04	0.000E+00	1.140E-03	0.000E+00	5.930E-02
FE-55	5.790E+05	4.100E+05	9.570E+04	0.000E+00	0.000E+00	2.600E+05	1.780E+05
FE-59	6.750E+05	1.580E+06	6.090E+05	0.000E+00	0.000E+00	4.970E+05	3.730E+06
CO-57	0.000E+00	2.690E+05	4.520E+05	0.000E+00	0.000E+00	0.000E+00	5.030E+06
CO-58	0.000E+00	9.540E+05	2.200E+06	0.000E+00	0.000E+00	0.000E+00	1.310E+07
CO-60	0.000E+00	3.340E+06	7.510E+06	0.000E+00	0.000E+00	0.000E+00	4.350E+07
NI-63	1.420E+09	1.000E+08	4.810E+07	0.000E+00	0.000E+00	0.000E+00	1.590E+07
NI-65	8.130E-02	1.040E-02	4.730E-03	0.000E+00	0.000E+00	0.000E+00	5.640E-01
CU-64	0.000E+00	4.790E+03	2.250E+03	0.000E+00	1.210E+04	0.000E+00	3.710E+05
ZN-65	2.530E+08	8.780E+08	4.090E+08	0.000E+00	5.620E+08	0.000E+00	3.720E+08
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-82	0.000E+00	0.000E+00	6.670E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	0.000E+00	0.000E+00	2.290E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	5.670E+08	2.670E+08	0.000E+00	0.000E+00	0.000E+00	8.400E+07
RB-88	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-89	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-89	5.620E+09	0.000E+00	1.160E+08	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-90	1.390E+11	0.000E+00	3.430E+10	0.000E+00	0.000E+00	0.000E+00	6.690E+08
SR-91	1.210E+05	0.000E+00	4.810E+03	0.000E+00	0.000E+00	0.000E+00	3.900E+09
SR-92	1.880E+00	0.000E+00	8.010E-02	0.000E+00	0.000E+00	0.000E+00	4.790E+01
Y-90	1.560E+01	0.000E+00	4.200E-01	0.000E+00	0.000E+00	0.000E+00	1.290E+05
Y-91M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y-91	1.900E+03	0.000E+00	5.090E+01	0.000E+00	0.000E+00	0.000E+00	7.780E+05
Y-92	1.200E-05	0.000E+00	3.480E-07	0.000E+00	0.000E+00	0.000E+00	3.300E-01
Y-93	5.160E-02	0.000E+00	1.410E-03	0.000E+00	0.000E+00	0.000E+00	1.580E+03
ZR-95	1.990E+02	6.260E+01	4.310E+01	0.000E+00	9.200E+01	0.000E+00	1.450E+05
ZR-97	9.300E-02	1.840E-02	8.480E-03	0.000E+00	2.790E-02	0.000E+00	4.980E+03
NB-95	1.690E+04	9.370E+03	5.160E+03	0.000E+00	9.080E+03	0.000E+00	4.010E+07
NB-97	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.610E-09
MO-99	0.000E+00	5.470E+06	1.040E+06	0.000E+00	1.250E+07	0.000E+00	9.800E+06
TC-99M	6.770E-01	1.890E+00	2.450E+01	0.000E+00	2.810E+01	1.050E+00	1.240E+03
TC-101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-103	2.180E+02	0.000E+00	9.310E+01	0.000E+00	7.670E+02	0.000E+00	1.820E+04
RU-105	1.880E-04	0.000E+00	7.290E-05	0.000E+00	2.370E-03	0.000E+00	1.520E-01
RU-106	4.500E+03	0.000E+00	5.670E+02	0.000E+00	8.680E+03	0.000E+00	2.160E+05
RH-103M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH-106	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG-110M	1.160E+07	1.090E+07	6.650E+06	0.000E+00	2.090E+07	0.000E+00	3.070E+09
SB-124	5.510E+06	1.020E+05	2.150E+06	1.250E+04	0.000E+00	4.810E+06	1.110E+08
SB-125	4.380E+06	4.790E+04	1.030E+06	4.190E+03	0.000E+00	3.850E+06	3.410E+07
TE-125M	3.600E+06	1.300E+06	4.820E+05	1.010E+06	0.000E+00	0.000E+00	1.060E+07

ATTACHMENT 7 (CON'T)
GASEOUS EFFLUENTS - PATHWAY DOSE PARAMETERS
RIO, GRASS-GOAT-MILK PATHWAY DOSE FACTORS - TEEN
Units are m2*mrem/yr per μCi/sec

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
TE-127M	1.010E+07	3.590E+06	1.200E+06	2.410E+06	4.100E+07	0.000E+00	2.520E+07
TE-127	1.490E+02	5.290E+01	3.210E+01	1.030E+02	6.050E+02	0.000E+00	1.150E+04
TE-129M	1.330E+07	4.920E+06	2.100E+06	4.280E+06	5.550E+07	0.000E+00	4.980E+07
TE-129	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-131M	7.890E+04	3.780E+04	3.150E+04	5.690E+04	3.940E+05	0.000E+00	3.030E+06
TE-131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-132	5.130E+05	3.250E+05	3.060E+05	3.430E+05	3.120E+06	0.000E+00	1.030E+07
I-130	8.990E+05	2.600E+06	1.040E+06	2.120E+08	4.010E+06	0.000E+00	2.000E+06
I-131	6.450E+08	9.030E+08	4.850E+08	2.640E+11	1.560E+09	0.000E+00	1.790E+08
I-132	3.480E-01	9.110E-01	3.270E-01	3.070E+01	1.430E+00	0.000E+00	3.970E-01
I-133	8.690E+06	1.470E+07	4.500E+06	2.060E+09	2.590E+07	0.000E+00	1.120E+07
I-134	5.180E-12	1.370E-11	4.930E-12	2.290E-10	2.160E-11	0.000E+00	1.810E-13
I-135	2.960E+04	7.620E+04	2.820E+04	4.900E+06	1.200E+05	0.000E+00	8.440E+04
CS-134	2.940E+10	6.930E+10	3.210E+10	0.000E+00	2.200E+10	8.410E+09	8.620E+08
CS-136	1.330E+09	5.250E+09	3.530E+09	0.000E+00	2.860E+09	4.510E+08	4.230E+08
CS-137	4.020E+10	5.340E+10	1.860E+10	0.000E+00	1.820E+10	7.060E+09	7.600E+08
CS-138	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-139	1.040E-08	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.310E-08
BA-140	5.830E+06	7.140E+03	3.750E+05	0.000E+00	2.420E+03	4.800E+03	8.980E+06
BA-141	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA-140	9.760E-01	4.750E-01	1.260E-01	0.000E+00	0.000E+00	0.000E+00	2.730E+04
LA-142	1.980E-12	8.780E-13	2.190E-13	0.000E+00	0.000E+00	0.000E+00	2.670E-08
CE-141	1.060E+03	7.110E+02	8.170E+01	0.000E+00	3.350E+02	0.000E+00	2.030E+06
CE-143	9.230E+00	6.720E+03	7.500E-01	0.000E+00	3.010E+00	0.000E+00	2.020E+05
CE-144	7.900E+04	3.270E+04	4.240E+03	0.000E+00	1.950E+04	0.000E+00	1.990E+07
PR-143	3.500E+01	1.400E+01	1.740E+00	0.000E+00	8.130E+00	0.000E+00	1.150E+05
PR-144	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND-147	2.180E+01	2.370E+01	1.420E+00	0.000E+00	1.390E+01	0.000E+00	8.530E+04
W-187	1.440E+03	1.170E+03	4.110E+02	0.000E+00	0.000E+00	0.000E+00	3.180E+05
NP-239	8.390E-01	7.910E-02	4.390E-02	0.000E+00	2.480E-01	0.000E+00	1.270E+04

ATTACHMENT 7 (CON'T)
GASEOUS EFFLUENTS - PATHWAY DOSE PARAMETERS
RIO, GRASS-GOAT-MILK PATHWAY DOSE FACTORS - ADULT
Units are m2*mrem/yr per µCi/sec

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
H-3	0.000E+00	1.560E+03	1.560E+03	1.560E+03	1.560E+03	1.560E+03	1.560E+03
C-14	3.630E+05	7.260E+04	7.260E+04	7.260E+04	7.260E+04	7.260E+04	7.260E+04
NA-24	3.050E+05	3.050E+05	3.050E+05	3.050E+05	3.050E+05	3.050E+05	3.050E+05
P-32	2.050E+10	1.270E+09	7.930E+08	0.000E+00	0.000E+00	0.000E+00	2.310E+09
CR-51	0.000E+00	0.000E+00	3.430E+03	2.050E+03	7.560E+02	4.560E+03	8.640E+05
MN-54	0.000E+00	1.010E+06	1.920E+05	0.000E+00	3.000E+05	0.000E+00	3.090E+06
MN-56	0.000E+00	5.080E-04	9.010E-05	0.000E+00	6.450E-04	0.000E+00	1.620E-02
FE-55	3.260E+05	2.250E+05	5.260E+04	0.000E+00	0.000E+00	1.260E+05	1.290E+05
FE-59	3.870E+05	9.090E+05	3.490E+05	0.000E+00	0.000E+00	2.540E+05	3.030E+06
CO-57	0.000E+00	1.540E+05	2.550E+05	0.000E+00	0.000E+00	0.000E+00	3.900E+06
CO-58	0.000E+00	5.660E+05	1.270E+06	0.000E+00	0.000E+00	0.000E+00	1.150E+07
CO-60	0.000E+00	1.970E+06	4.340E+06	0.000E+00	0.000E+00	0.000E+00	3.700E+07
NI-63	8.070E+08	5.600E+07	2.710E+07	0.000E+00	0.000E+00	0.000E+00	1.170E+07
NI-65	4.440E-02	5.770E-03	2.630E-03	0.000E+00	0.000E+00	0.000E+00	1.460E-01
CU-64	0.000E+00	2.690E+03	1.260E+03	0.000E+00	6.770E+03	0.000E+00	2.290E+05
ZN-65	1.650E+08	5.240E+08	2.370E+08	0.000E+00	3.500E+08	0.000E+00	3.300E+08
ZN-69	6.240E-13	1.190E-12	8.290E-14	0.000E+00	7.750E-13	0.000E+00	1.790E-13
BR-82	0.000E+00	0.000E+00	3.900E+06	0.000E+00	0.000E+00	0.000E+00	4.470E+06
BR-83	0.000E+00	0.000E+00	1.240E-02	0.000E+00	0.000E+00	0.000E+00	1.790E-02
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	3.110E+08	1.450E+08	0.000E+00	0.000E+00	0.000E+00	6.140E+07
RB-88	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-89	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-89	3.050E+09	0.000E+00	8.740E+07	0.000E+00	0.000E+00	0.000E+00	4.890E+08
SR-90	9.830E+10	0.000E+00	2.410E+10	0.000E+00	0.000E+00	0.000E+00	2.840E+09
SR-91	6.580E+04	0.000E+00	2.660E+03	0.000E+00	0.000E+00	0.000E+00	3.130E+05
SR-92	1.030E+00	0.000E+00	4.440E-02	0.000E+00	0.000E+00	0.000E+00	2.030E+01
Y-90	8.480E+00	0.000E+00	2.280E-01	0.000E+00	0.000E+00	0.000E+00	8.990E+04
Y-91M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y-91	1.030E+03	0.000E+00	2.760E+01	0.000E+00	0.000E+00	0.000E+00	5.680E+05
Y-92	6.510E-06	0.000E+00	1.900E-07	0.000E+00	0.000E+00	0.000E+00	1.140E-01
Y-93	2.800E-02	0.000E+00	7.720E-04	0.000E+00	0.000E+00	0.000E+00	8.870E+02
ZR-95	1.140E+02	3.640E+01	2.470E+01	0.000E+00	5.710E+01	0.000E+00	1.150E+05
ZR-97	5.110E-02	1.030E-02	4.710E-03	0.000E+00	1.560E-02	0.000E+00	3.190E+03
NB-95	9.900E+03	5.510E+03	2.960E+03	0.000E+00	5.440E+03	0.000E+00	3.340E+07
NB-97	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO-99	0.000E+00	3.030E+06	5.760E+05	0.000E+00	6.860E+06	0.000E+00	7.020E+06
TC-99M	3.900E-01	1.100E+00	1.400E+01	0.000E+00	1.670E+01	5.400E-01	6.520E+02
TC-101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-103	1.220E+02	0.000E+00	5.270E+01	0.000E+00	4.670E+02	0.000E+00	1.430E+04
RU-105	1.030E-04	0.000E+00	4.060E-05	0.000E+00	1.330E-03	0.000E+00	6.290E-02
RU-106	2.450E+03	0.000E+00	3.100E+02	0.000E+00	4.730E+03	0.000E+00	1.580E+05
RH-103M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH-106	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG-110M	6.990E+06	6.470E+06	3.840E+06	0.000E+00	1.270E+07	0.000E+00	2.640E+09
SB-124	3.090E+06	5.840E+04	1.220E+06	7.490E+03	0.000E+00	2.410E+06	8.770E+07
SB-125	2.450E+06	2.740E+04	5.840E+05	2.490E+03	0.000E+00	1.890E+06	2.700E+07
TE-125M	1.950E+06	7.080E+05	2.620E+05	5.880E+05	7.950E+06	0.000E+00	7.810E+06

ATTACHMENT 7 (CON'T)
GASEOUS EFFLUENTS - PATHWAY DOSE PARAMETERS
RIO, GRASS-GOAT-MILK PATHWAY DOSE FACTORS - ADULT

Units are m2*mrem/yr per μCi/sec

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
TE-127M	5.490E+06	1.960E+06	6.690E+05	1.400E+06	2.230E+07	0.000E+00	1.840E+07
TE-127	8.060E+01	2.890E+01	1.740E+01	5.970E+01	3.280E+02	0.000E+00	6.360E+03
TE-129M	7.250E+06	2.710E+06	1.150E+06	2.490E+06	3.030E+07	0.000E+00	3.650E+07
TE-129	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-131M	4.330E+04	2.120E+04	1.770E+04	3.360E+04	2.150E+05	0.000E+00	2.100E+06
TE-131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-132	2.870E+05	1.860E+05	1.740E+05	2.050E+05	1.790E+06	0.000E+00	8.790E+06
I-130	5.110E+05	1.510E+06	5.950E+05	1.280E+08	2.350E+06	0.000E+00	1.300E+06
I-131	3.560E+08	5.090E+08	2.920E+08	1.670E+11	8.720E+08	0.000E+00	1.340E+08
I-132	1.960E-01	5.250E-01	1.840E-01	1.840E+01	8.360E-01	0.000E+00	9.860E-02
I-133	4.760E+06	8.280E+06	2.520E+06	1.220E+09	1.440E+07	0.000E+00	7.440E+06
I-134	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-135	1.670E+04	4.360E+04	1.610E+04	2.880E+06	6.990E+04	0.000E+00	4.920E+04
CS-134	1.700E+10	4.030E+10	3.300E+10	0.000E+00	1.310E+10	4.330E+09	7.060E+08
CS-136	7.840E+08	3.090E+09	2.230E+09	0.000E+00	1.720E+09	2.360E+08	3.520E+08
CS-137	2.210E+10	3.030E+10	1.980E+10	0.000E+00	1.030E+10	3.420E+09	5.860E+08
CS-138	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-139	5.640E-09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.000E-08
BA-140	3.230E+06	4.050E+03	2.110E+05	0.000E+00	1.380E+03	2.320E+03	6.650E+06
BA-141	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA-140	5.380E-01	2.710E-01	1.990E+04	0.000E+00	0.000E+00	0.000E+00	1.990E+04
LA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.640E-09
CE-141	5.810E+02	3.930E+02	4.450E+01	0.000E+00	1.820E+02	0.000E+00	1.500E+06
CE-143	5.020E+00	3.710E+03	4.110E-01	0.000E+00	1.630E+00	0.000E+00	1.390E+05
CE-144	4.290E+04	1.790E+04	2.300E+03	0.000E+00	1.060E+04	0.000E+00	1.450E+07
PR-143	1.910E+01	7.650E+00	9.450E-01	0.000E+00	4.410E+00	0.000E+00	8.350E+04
PR-144	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND-147	1.130E+01	1.310E+01	7.820E-01	0.000E+00	7.640E+00	0.000E+00	6.270E+04
W-187	7.870E+02	6.580E+02	2.300E+02	0.000E+00	0.000E+00	0.000E+00	2.160E+05
NP-239	4.390E-01	4.320E-02	2.380E-02	0.000E+00	1.350E-01	0.000E+00	8.860E+03

ATTACHMENT 8

GASEOUS EFFLUENTS - EFFECTIVE DOSE FACTORS FOR NOBLE GASES

Year	Total Body Effective Dose Factor K_{eff} (mrem/yr per μCi/m^3)	Skin Effective Dose Factor (L+1.1M) (mrem/yr per μCi/m^3)	Gamma Air Effective Dose Factor M_{eff} (mrad/yr per μCi/m^3)	Beta Air Effective Dose Factor N_{eff} (mrad/yr per μi/m^3)
1986	3.3E+2	7.9E+2	3.9E+2	1.1E+3
1987	3.4E+2	8.1E+2	4.0E+2	1.1E+3
1988	3.9E+2	9.6E+2	4.5E+2	1.2E+3
Average	3.5E+2	8.5E+2	4.1E+2	1.1E+3

ATTACHMENT 9

LOCATIONS OF THE ENVIRONMENTAL SAMPLING SITES FOR THE CALVERT CLIFFS NUCLEAR POWER PLANT

SITE	SAMPLE	SECTOR	DISTANCE * KM	MI	DESCRIPTION
1	DR1	NW	0.6	0.4	Onsite, Along Cliffs
2	DR2	WNW	2.7	1.7	Rt. 765, Auto Dump
3	DR3	W	2.3	1.4	Rt. 765, Giovanni's Tavern (Knotty Pine)
4	DR4	WSW	2.0	1.2	Rt. 765, Across From White Sand
5	DR5	SW	2.4	1.5	Rt. 765, at Johns Creek
6	DR6,A4	SSW	2.9	1.8	Rt. 765, at Lusby
7	DR7,A1, Ib4,Ib5, Ib6	S	0.7	0.5	Onsite, Before Entrance to Camp Conoy
8	DR8,A2	SSE	2.5	1.5	Camp Conoy Road, at the Emergency Siren
9	DR9,A3	SE	2.6	1.6	Bay Breeze Road
10	DR10	NW	6.4	4.0	Calvert Beach Rd. & Decatur St.
11	DR11	WNW	6.6	4.1	Dirt Rd, uff Mackall & Parran Roads
12	DR12	W	6.7	4.2	Bowen & Mackall Rds.
13	DR13	WSW	6.1	3.8	Mackall Rd, near Wallville
14	DR14	SW	6.4	4.0	Rodney Point
15	DR15	SSW	6.2	3.9	Mill Bridge & Turner Roads

* From the Central Point Between the Two Containment Buildings.

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ATTACHMENT 3 (CON'T)

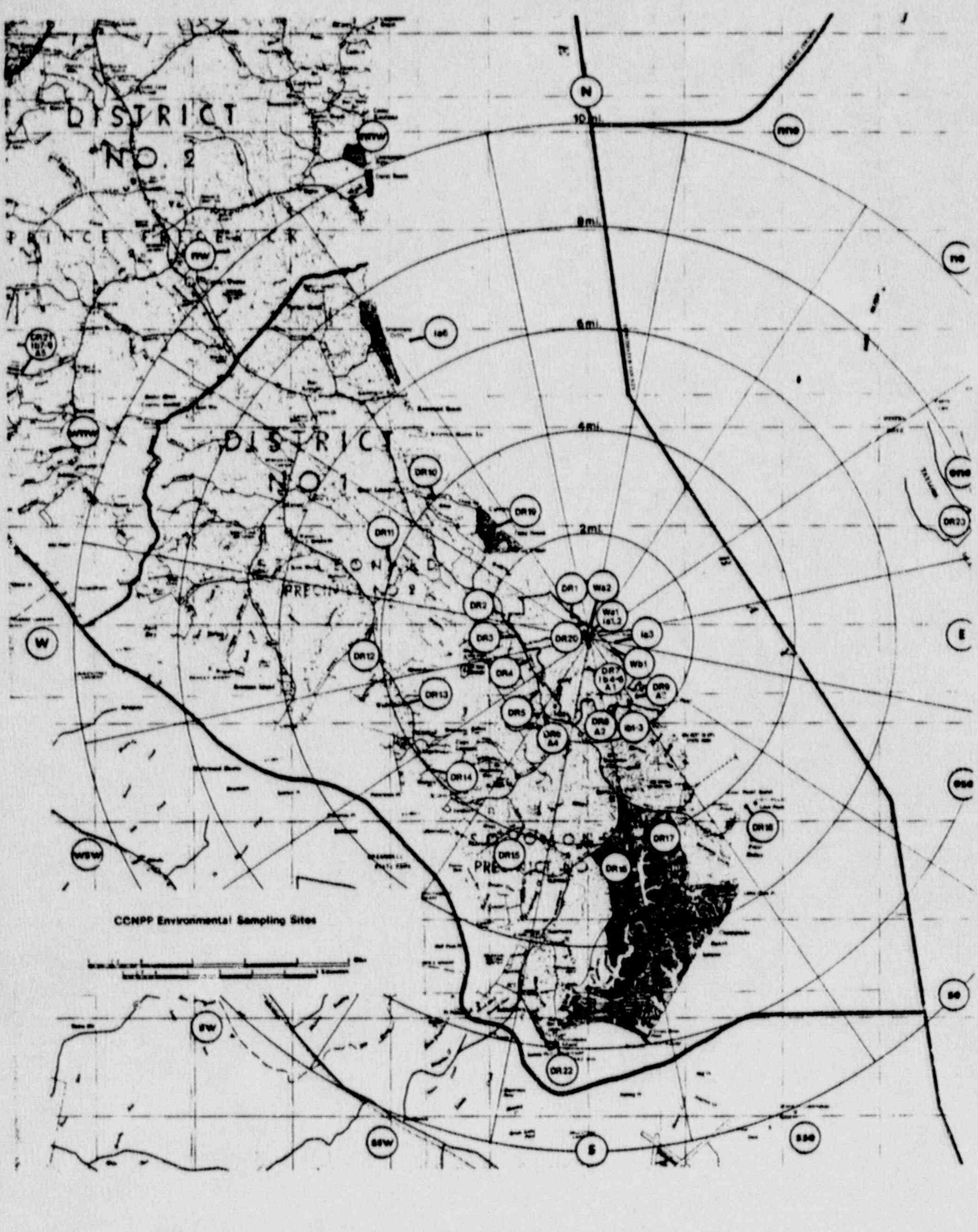
LOCATIONS OF THE ENVIRONMENTAL SAMPLING SITES FOR THE CALVERT CLIFFS NUCLEAR POWER PLANT

SITE	SAMPLE	SECTOR	DISTANCE * KM	MI	DESCRIPTION
16	DR16	S	6.5	4.1	Across from Appeal School
17	DR17	SSE	5.9	3.7	Cove Point & Little Cove Point Roads
18	DR18	SE	7.1	4.5	Cove Point
19	DR19	NW	4.4	2.8	Long Beach
20	DR20	NNW	0.4	0.3	Onsite, near shore
21	DR21,A5, Ib7, Ib8, Ib9	WNW	19.3	12.1	At the Emergency Offsite Facility, off Route 231
22	DR22	S	12.5	7.8	Solomons Island
23	DR23	ENE	12.6	7.9	Taylors Island
24	Wa1,Ia1, Ia2	NNE&NE	0.2	0.1	Discharge Vicinity
25	Wa2	N	0.3	0.2	Discharge Area
26	Wb1	ESE	0.6	0.4	Shoreline at Camp Conoy
27	Ib1,Ib2, Ib3	SSE	2.6	1.6	Garden Plot off Bay Breeze Road
28	Ia4,Ia5	N/A	N/A	N/A	Patuxent River
29	Ia3	E	0.9	0.6	Camp Conoy
30	Ia6	NNW	10.7	6.7	Kenwood Beach

* From the Central Point Between the Two Containment Buildings.

ATTACHMENT 10

MAP OF ENVIRONMENTAL SAMPLING SITES
(10 MILE RADIUS)



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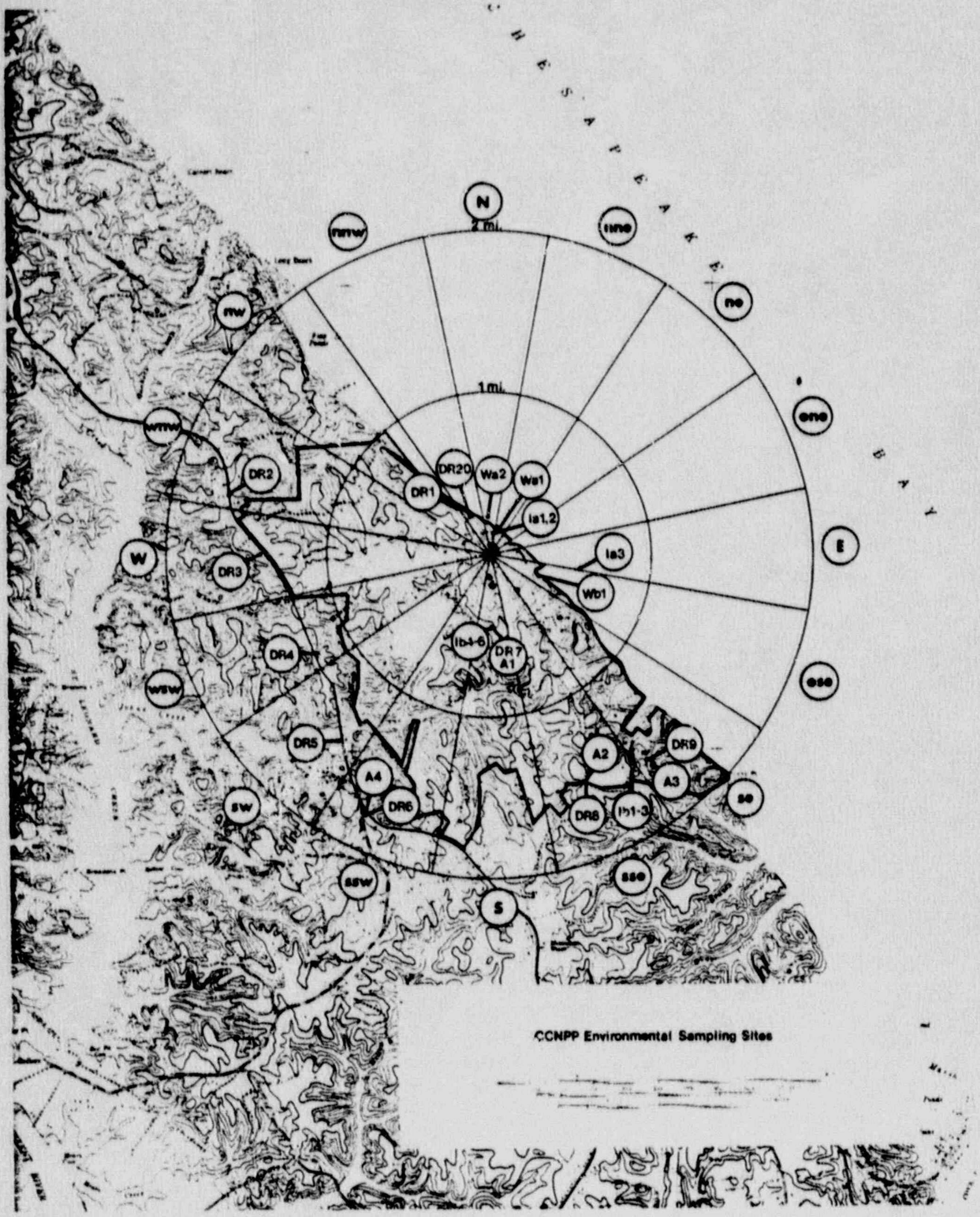
ATTACHMENT 11

MAP OF ENVIRONMENTAL SAMPLING SITES
(2 MILE RADIUS)



UPDATE TO PREVIOUS REPORTS

1ST AND 2ND HALF OF 1988

TABLE 2A - REG GUIDE 1.21

CALVERT CLIFFS NUCLEAR POWER PLANT
EFFLUENT AND WASTE DISPOSAL SEMI-ANNUAL REPORT
FIRST HALF - 1988

LIQUID EFFLUENTS - SUMMATION OF ALL RELEASES

A. FISSION AND ACTIVATION PRODUCTS	UNITS	1ST QUARTER	2ND QUARTER	EST.TOTAL ERROR,%
1. Total Release (not including tritium,gases,alpha)	Ci	7.40E-01	9.53E-01	2.16E+01
2. Average diluted concentration during period	uCi/ml	1.24E-09	1.60E-09	
3. Percent of tech.spec.limit(1)	%	4.60E-01	2.37E+00	
4. Percent of tech.spec.limit(2)	%	2.30E-01	1.18E+00	
5. Percent of tech.spec.limit(3)	%	6.28E-01	2.61E-01	
6. Percent of tech.spec.limit(4)	%	3.14E-01	1.30E-01	
B. TRITIUM				
1. Total Release	Ci	1.40E+02	6.99E+01	1.81E+01
2. Average diluted concentration during period	uCi/ml	2.35E-07	1.17E-07	
3. Percent of applicable limit(5)	%	7.83E-03	3.90E-03	
C. DISSOLVED AND ENTRAINED GASES				
1. Total Release	Ci	9.48E-02	1.48E-01	2.00E+01
2. Average diluted concentration during period	uCi/ml	1.59E-10	2.49E-10	

TABLE 2B - REG GUIDE 1.21

CALVERT CLIFFS NUCLEAR POWER PLANT
EFFLUENT AND WASTE DISPOSAL SEMI-ANNUAL REPORT
FIRST HALF - 1988

LIQUID EFFLUENTS

NUCLIDES RELEASED		UNITS	CONTINUOUS MODE (1) 1ST QUARTER	CONTINUOUS MODE (1) 2ND QUARTER	BATCH MODE 1ST QUARTER	BATCH MODE 2ND QUARTER
Beryllium	-7	Ci	0	0	-	7.97E-05
Sodium	-24	Ci	0	0	1.10E-05	1.04E-03
Chromium	-51	Ci	0	0	2.69E-05	8.10E-02
Manganese	-54	Ci	0	0	2.28E-03	4.78E-03
Cobalt	-57	Ci	0	0	6.17E-05	2.03E-04
Cobalt	-58	Ci	0	0	9.36E-02	3.32E-01
Cobalt	-60	Ci	0	0	5.31E-03	1.69E-02
Iron	-59	Ci	0	0	-	2.16E-04
Strontium	-89	Ci	0	0	<2.88E-04	7.96E-04
Strontium	-90	Ci	0	0	<4.23E-05	2.11E-04
Zirconium	-95	Ci	0	0	-	1.23E-02
Niobium	-95	Ci	0	0	1.31E-03	2.27E-02
Niobium	-97	Ci	0	0	-	5.83E-03
Molybdenum	-99	Ci	0	0	-	9.60E-05
Technicium	-99m	Ci	0	0	6.52E-04	1.92E-03
Ruthenium	-103	Ci	0	0	-	2.86E-03
Silver	-108m	Ci	0	0	-	1.84E-05
Silver	-110m	Ci	0	0	1.51E-02	4.17E-02
Tin	-113	Ci	0	0	-	4.89E-04
Antimony	-124	Ci	0	0	-	1.62E-02
Antimony	-125	Ci	0	0	4.23E-02	8.47E-02

TABLE 2B - REG GUIDE 1.21 (Cont.)

CALVERT CLIFFS NUCLEAR POWER PLANT
EFFLUENT AND WASTE DISPOSAL SEMI-ANNUAL REPORT
FIRST HALF - 1988

LIQUID EFFLUENTS

		CONTINUOUS MODE (1)		BATCH MODE	
		1ST	2ND	1ST	2ND
NUCLIDES RELEASED	UNITS	QUARTER	QUARTER	QUARTER	QUARTER
Tellurium -129	Ci	0	0	-	4.47E-05
Tellurium -132	Ci	0	0	1.07E-05	6.64E-04
Iodine -131	Ci	0	0	7.25E-02	1.60E-01
Iodine -132	Ci	0	0	2.39E-05	1.68E-03
Iodine -133	Ci	0	0	5.47E-03	7.63E-03
Iodine -135	Ci	0	0	3.08E-04	9.29E-05
Cesium -134	Ci	0	0	1.88E-01	5.35E-02
Cesium -136	Ci	0	0	3.19E-03	8.74E-04
Cesium -137	Ci	0	0	3.09E-01	1.02E-01
Lanthanum -140	Ci	0	0	1.99E-04	1.28E-04
Cerium -141	Ci	0	0	-	5.74E-04
Total For Period	Ci	0	0	7.40E-01	9.53E-01

TABLE 2A - REG GUIDE 1.21

CALVERT CLIFFS NUCLEAR POWER PLANT
EFFLUENT AND WASTE DISPOSAL SEMI-ANNUAL REPORT
SECOND HALF - 1988

LIQUID EFFLUENTS - SUMMATION OF ALL RELEASES

A. FISSION AND ACTIVATION PRODUCTS	UNITS	3RD QUARTER	4TH QUARTER	EST.TOTAL ERROR,%
1. Total Release (not including tritium,gases,alpha)	Ci	8.62E-01	8.96E-02	2.16E+01
2. Average diluted concentration during period	uCi/ml	1.45E-09	1.51E-10	
3. Percent of tech.spec.limit(1)	%	6.24E-01	2.09E-01	
4. Percent of tech.spec.limit(2)	%	3.12E-01	1.04E-01	
5. Percent of tech.spec.limit(3)	%	8.13E-01	4.86E-02	
6. Percent of tech.spec.limit(4)	%	4.06E-01	2.43E-02	
B. TRITIUM				
1. Total Release	Ci	1.64E+02	2.50E+02	1.81E+01
2. Average diluted concentration during period	uCi/ml	2.76E-07	4.20E-07	
3. Percent of applicable limit(5)	%	9.20E-03	1.40E-02	
C. DISSOLVED AND ENTRAINED GASES				
1. Total Release	Ci	7.20E-02	5.92E-02	2.00E+01
2. Average diluted concentration during period	uCi/ml	1.21E-10	9.95E-11	

TABLE 2B - REG GUIDE 1.21

CALVERT CLIFFS NUCLEAR POWER PLANT
EFFLUENT AND WASTE DISPOSAL SEMI-ANNUAL REPORT
SECOND HALF - 1988

LIQUID EFFLUENTS

NUCLIDES RELEASED		UNITS	CONTINUOUS MODE 3RD QUARTER	CONTINUOUS MODE 4TH QUARTER	BATCH MODE 3RD QUARTER	BATCH MODE 4TH QUARTER
Sodium	-24	Ci	(1)	(1)	1.69E-04	1.02E-05
Chromium	-51	Ci	(1)	(1)	4.36E-03	(2)
Manganese	-54	Ci	(1)	(1)	1.23E-03	5.25E-04
Cobalt	-58	Ci	(1)	(1)	4.57E-02	7.18E-03
Iron	-59	Ci	(1)	(1)	(2)	(2)
Cobalt	-60	Ci	(1)	(1)	7.85E-03	3.07E-03
Zinc	-65	Ci	(1)	(1)	(2)	(2)
Strontium	-89	Ci	(1)	(1)	1.80E-03	7.99E-04
Strontium	-90	Ci	(1)	(1)	<1.31E-04	<1.07E-04
Zirconium	-95	Ci	(1)	(1)	1.71E-03	2.55E-03
Niobium	-95	Ci	(1)	(1)	5.02E-03	2.66E-03
Niobium	-97	Ci	(1)	(1)	1.15E-02	1.23E-04
Technicium	-99m	Ci	(1)	(1)	1.02E-03	4.22E-05
Ruthenium	-103	Ci	(1)	(1)	(2)	1.50E-04
Silver	-110m	Ci	(1)	(1)	1.36E-02	1.74E-03
Tin	-113	Ci	(1)	(1)	9.00E-04	7.78E-04
Antimony	-124	Ci	(1)	(1)	1.35E-03	2.92E-03
Antimony	-125	Ci	(1)	(1)	2.73E-02	1.53E-02
Iodine	-131	Ci	(1)	(1)	3.78E-02	9.00E-03
Iodine	-132	Ci	(1)	(1)	7.74E-06	(2)

TABLE 2B - REG GUIDE 1.21 (Cont.)

CALVERT CLIFFS NUCLEAR POWER PLANT
EFFLUENT AND WASTE DISPOSAL SEMI-ANNUAL REPORT
SECOND HALF - 1988

LIQUID EFFLUENTS

			Continuous Mode		Batch Mode	
NUCLIDES RELEASED		UNITS	3RD QUARTER	4TH QUARTER	3RD QUARTER	4TH QUARTER
Iodine	-133	Ci	(1)	(1)	1.06E-02	1.68E-03
Iodine	-135	Ci	(1)	(1)	2.67E-04	(2)
Cesium	-134	Ci	(1)	(1)	1.97E-01	9.27E-03
Cesium	-136	Ci	(1)	(1)	5.58E-04	(2)
Cesium	-137	Ci	(1)	(1)	4.92E-01	2.78E-02
Barium	-140	Ci	(1)	(1)	(2)	1.72E-05
Cerium	-141	Ci	(1)	(1)	(2)	(2)
Cerium	-144	Ci	(1)	(1)	2.74E-05	2.18E-03
Lanthanum	-142	Ci	(1)	(1)	(2)	1.66E-03
Mercury	-203	Ci	(1)	(1)	(2)	5.28E-05
Total For Period		Ci	(1)	(1)	8.62E-01	8.96E-02