OFFSITE DOSE CALCULATION MANUAL

GRAND GULF NUCLEAR STATION

Revision No. 1

Date 7/83

GRAND GULF NUCLEAR STATION

OFFSITE DOSE CALCULATION MANUAL

SAFETY RELATED

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INTRODUCTION

The OFFSITE DOSE CALCULATION MANUAL is a supporting document of the RADIOLOGICAL EFFLUENT TECHNICAL SPECIFICATIONS. As such the ODCM describes the methodology and parameters to be used in the calculation of offsite doses due to radioactive liquid and gaseous effluents and in the calculation of liquid and gaseous effluent monitoring instrumentation alarm/trip setpoints. The ODCM contains a list and graphical description of the specific sample locations for the radiological environmental monitoring program. A minimum OPERABLE configuration of the liquid and gaseous radwaste treatment systems is also included.

The ODCM will be maintained at the Station for use as a reference guide and training document of accepted methodologies and calculations. Changes in the calculational methods or parameters will be incorporated into the ODCM in order to assure that the ODCM represents the present methodology in all applicable areas. Computer software to perform the described calculations will be maintained current with this ODCM.

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LIST OF REFERENCES

1. Boegli, T. S., R. R. Bellamy, W. L. Britz, and R. L. Waterfield, "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants", NUREG-01-33 (October 1978).

2. Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10CFR50, Appendix I, U.S. NRC Regulatory Guide 1.109 (March 1976).

3. Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10CFR50, Appendix I, U.S. NRC Regulatory Guide 1.109, Rev. 1 (October 1977).

4. "Environmental Report", Mississippi Power and Light Company, Grand Gulf Nuclear Station, Units 1 and 2.

5. "Final Safety Analysis Report", Mississippi Power and Light Company, Grand Gulf Nuclear Station.

6. Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light - Water - Cooled Reactors, U.S. NRC Regulatory Guide 1.111 (March 1976).

7. Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light - Water - Cooled Reactors, U.S. NRC Regulatory Guide 1.111, Rev. 1 (July 1977).

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1.0 LIQUID EFFLUENTS

1.1 Liquid Effluent Monitor Setpoints

1.1 Liquid Radwaste Effluent Line Monitors

Liquid Radwaste Effluent Line Monitors provide alarm and automatic termination of release prior to exceeding the concentration limits specified in 10CFR20, Appendix B, Table II, Column 2 at the release point to the unrestricted area. To meet this specification and for the purpose of implementation of specification 3.3.7.11 of the RETS, the alarm/trip setpoints for liquid effluent monitors and flow measurement devices are set to assure that the following equation is satisfied:

$$\frac{cf}{F + f} \leq C \qquad (1)$$

where:

C = the effluent concentration limit (RETS Specification 3.11.1.1) implementing 10CFR20 for the site, in uCi/ml.

c = The setpoint, representative of a radioactivity concentration in uCi/ml, of the radioactivity monitor measuring the radioactivity in the waste tank effluent line prior to dilution and subsequent release; the setpoint, which is inversely proportional to the volumetric flow of the effluent line and directly proportional to the volumetric flow of the dilution stream plus the waste tank effluent stream, represents a value which, if exceeded, would result in concentrations exceeding the limits of 10CFR20 in the unrestricted area.

f = the waste tank effluent flow setpoint as measured at the radiation monitor location, in volume per unit time, but in the same units as F, below.

F = the dilution water flow setpoint as measured prior to the release point, in volume per unit time.

At Grand Gulf Unit 1, the available dilution water flow (F) should be constant for a given release, and the waste tank flow (f) and monitor setpoint (c) are set to meet the condition of equation 1 for a given effluent concentration, C. The method by which this is accomplished is as follows: | 1

Step 1) The isotopic concentration for a waste tank to be released is obtained from the sum of the measured concentrations as determined by the analysis required in the RETS Table 4.11.1.1.1-1: | 1

$$\sum_i C_i = \sum_g C_g + (\sum C_a + C_s + C_t) \qquad (2)$$

where:

$\sum C_g$ = the sum of concentrations C_g of each measured gamma emitter observed by gamma-ray spectroscopy of the waste sample.

$\sum C_a$ = the sum of concentrations C_a of alpha emitters in liquid waste as measured in the monthly composite sample.

$\sum C_s$ = the measured concentrations of Sr-89 and Sr-90 in liquid waste as observed in the quarterly composite sample.

C_t = the measured concentration of H-3 in liquid waste as determined from analysis of the monthly composite sample.

The C_g term will be included in the analysis of each waste tank batch to be released; terms for alpha, strontiums, and tritium may be included if analysis of reactor water has shown the presence of these isotopes.

Step 2) The measured radionuclide concentrations are used to calculate a Dilution Factor, D.F., which is the ratio of total dilution flow rate to waste tank effluent flow rate required to assure that the limiting concentration of 10CFR20, Appendix B, Table II, Column 2 are met at the point of discharge.

$$DF = \left[\sum_i \frac{C_i}{MPC_i}\right] \times S.F.$$

$$= \left[\sum_g \frac{C_i}{MPC_g} + \left(\sum_a \frac{C_a}{MPC_a} + \frac{C_s}{MPC_s} + \frac{C_t}{MPC_t}\right)\right] \times S.F. \quad (3)$$

Where:

C_i = C_g, C_a, C_s, and C_t; measured concentrations as defined in Step 1. Terms C_a, C_s, and C_t will be included in the calculation as appropriate.

MPC_i = MPC_g, MPC_s, and MPC_t are limiting concentrations of the appropriate radionuclide from 10CFR20, Appendix B, Table II, Column 2. For dissolved or entrained noble gases, the concentration shall be limited to 2.0E-4 uCi/ml total activity.

S.F. = an administrative safety factor normally applied at Grand Gulf which causes the calculated Dilution Factor to be two (2) times larger than the dilution factor required for compliance with 10CFR20 limits.

Step 3) The maximum permissible waste tank effluent flow rate prior to dilution, f_d, is calculated based on a fixed fraction of the dilution flow rate, F_d:

$$f_d \leq \frac{F_d + f_d}{D.F.} \approx \frac{F_d}{D.F.} \qquad \text{for } F_d \gg f_d \qquad (4)$$

where:

F_d = 0.9 x minimum expected dilution flow rate | 1

f_d = maximum permissible waste tank effluent flow rate

D.F. = Dilution Factor from Step 2.

NOTE: Equation 4 is valid only for D.F. $>$ 1; for D.F. $\leq$ 1, the waste tank effluent concentration meets the limits of 10CFR20 without dilution, and f_d may take on any desired value.

Step 4) The dilution flow rate setpoint for minimum dilution flow rate, F, and waste tank flow rate setpoint for maximum waste tank effluent flow rate, f are calculated as follows:

$F = F_d$ = 0.9 x minimum expected dilution flow rate (5) | 1

$f = 0.9 \times f_d$ = 0.9 x calculated maximum waste tank flow rate for the stated release conditions. (6)

Thus, a control room alarm occurs if the dilution flow rate falls below the assumed flow rate of 90 percent of the actual dilution flow, or if the waste tank effluent flow rate exceeds 90 percent of the calculated maximum waste tank effluent flow rate, and the release is terminated.

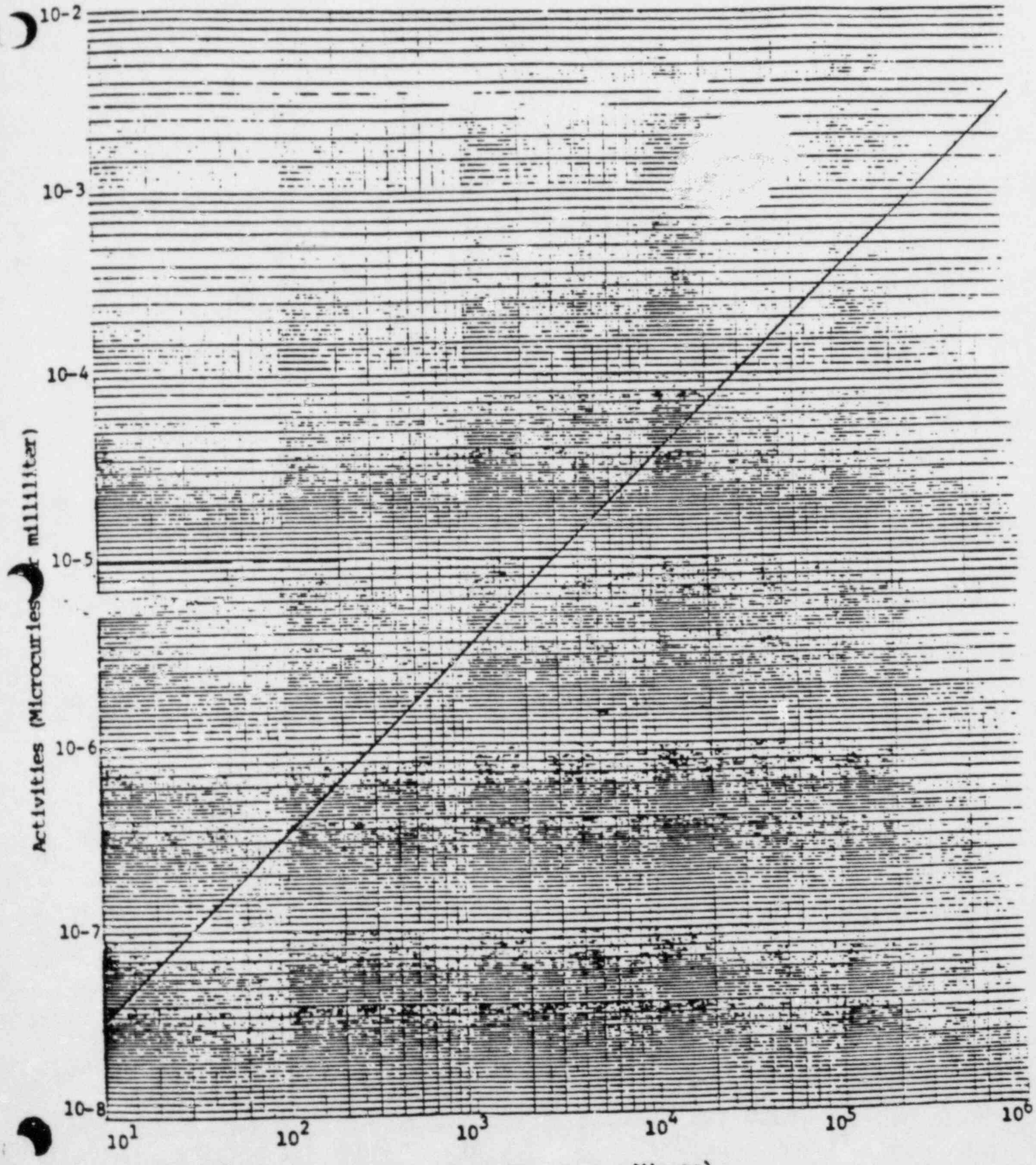
Step 5) The radioactivity monitor setpoint may now be specified based on the values of $\sum C_i$, F, and f which were specified to provide compliance with the limits of 10CFR20, Appendix B, Table II, Column 2. The monitor response is primarily to gamma radiation; therefore, the actual setpoint is based on $\sum_g C_g$. The setpoint concentration, C_m is determined as follows:

$$C_m = \left(\frac{f_d}{f_a}\right) \sum_g C_g \ (uCi/ml) \qquad (7)$$

where f_a is the actual (or maximum expected) effluent flow rate. The value of C_m (uCi/ml) is used to determine the monitor setpoint (CPM) from the calibration curve of Figure 1.0-1.

NOTE: The setpoint contains a factor of conservatism, even if the calculated maximum waste tank flow rate is attainable, since the calculated rate contains the safety factor margin, waste tank effluent flow rate margin, and the dilution flow rate margin. In practice, the actual waste tank effluent flow rate normally is many times less than the calculated tank flow rate, thus providing an additional conservatism during release.

Figure 1.0-1 Calibration Curve for Liquid Effluent Monitor



1.2 Dose Calculation for Liquid Effluents

1.2.1 The dose contribution to the maximum exposed individual from all radionuclides identified in waste tank liquid effluents released to unrestricted areas is calculated for the purpose of implementing RETS Specifications 3.11.1.2, 4.11.1.2 and 4.11.1.3.1 using the following expression: | 1

$$D_{Tau} = \sum_i \left[A_{iTau} \sum_{1=1}^{m} \Delta t \; C_{i1} \; F_1 \right] \quad \text{(millirem)} \quad (8) \quad (1)$$

where:

A_{iTau} = Site-related ingestion dose commitment factor, in millirem/hr per uCi/ml.

= $K_o \; U_F \; BF_i \; DF_i$

Δt_1 = length of the 1 th time period over which C_{i1} and F_1 are averaged for all waste tank liquid releases, in hours.

C_{i1} = average concentration of radionuclide i observed in the undiluted waste tank liquid effluent during time period Δt_1 from any liquid release from the waste tank, in uCi/ml. Concentrations are determined primarily from a gamma isotopic analysis of the waste tank liquid effluent sample. For Sr-89, Sr-90, H-3, the last measured value from the most recent monthly and quarterly composite samples will be used in the dose calculation. Note: LLD values are not used in dose calculations.

F_1 = near field average dilution factor for C_i during any liquid effluent release. Defined as the ratio of the average undiluted liquid waste flow during release to the product of the average flow from the site discharge structure to unrestricted receiving waters times the applicable factor of 5[2].

$$= \frac{\text{average undiluted liquid waste flow}}{\text{average flow from site discharge} \times 5}$$

K_o = units conversion factor 1.14×10^5

$$= \left(10^6 \ \frac{pCi}{uCi} \times 10^3 \ \frac{ml}{Kg} \div 8766 \ \frac{hr}{yr}\right)$$

U_F = adult fish consumption (21 kg/yr)[3].

BF_i = Bioaccumulation factor for each nuclide, i, in fish, in pCi/kg per pCi/l from Table 1.2-1 (taken from Reference 3, Table A-1).

DF_i = Dose conversion factor for each nuclide, i, for adults in preselected organ, Tau, in mrem/pCi, from Table 1.2-2 (taken from Reference 3, Table E-11).

Calculated values of A_{iTau} for radionuclides which might be observed in liquid effluents is given in Table 1.2-3.

TABLE 1.2-1

BIOACCUMULATION FACTORS (BFi)

(pCi/kg per pCi/liter)*

FRESHWATER

ELEMENT	FISH	INVERTEBRATE
H	9.0E-01	9.0E-01
C	4.6E-03	9.1E-03
NA	1.0E-02	2.0E-02
P	1.0E-05	2.0E-04
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

*Values in Table 1.2-1 are taken from Reference 3, Table A-1.

TABLE 1.2-2
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INGESTION DOSE CONVERSION FACTORS FOR ADULTS (DFi)
(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
C 14	2.84E-06	5.68E-07	5.68E-07	5.68E-07	5.68E-07	5.68E-07	5.68E-07
NA 24	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06
P 32	1.93E-04	1.20E-05	7.46E-06	NO DATA	NO DATA	NO DATA	2.17E-05
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

* Values taken from Reference 3, Table E-11.

TABLE 1.2-2 (Continued)

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INGESTION DOSE CONVERSION FACTORS FOR ADULTS (DFi)

(mrem per pCi ingested) *

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
Y 93	2.68E-09	NO DATA	7.40E-11	NO DATA	NO DATA	NO DATA	8.50E-05
ZR 95	3.04E-08	9.75E-09	6.60E-09	NO DATA	1.53E-08	NO DATA	3.09E-05
ZR 97	1.68E-09	3.39E-10	1.55E-10	NO DATA	5.12E-10	NO DATA	1.05E-04
NB 95	6.22E-09	3.46E-09	1.86E-09	NO DATA	3.42E-09	NO DATA	2.10E-05
MO 99	NO DATA	4.31E-06	8.20E-07	NO DATA	9.76E-06	NO DATA	9.99E-06
TC 99M	2.47E-10	6.98E-10	8.89E-09	NO DATA	1.06E-08	3.42E-10	4.13E-07
TC101	2.54E-10	3.66E-10	3.59E-09	NO DATA	6.59E-09	1.87E-10	1.10E-21
RU103	1.85E-07	NO DATA	7.97E-08	NO DATA	7.06E-07	NO DATA	2.16E-05
RU105	1.54E-08	NO DATA	6.08E-09	NO DATA	1.99E-07	NO DATA	9.42E-06
RU106	2.75E-06	NO DATA	3.48E-07	NO DATA	5.31E-06	NO DATA	1.78E-04
AG110M	1.60E-07	1.48E-07	8.79E-08	NO DATA	2.91E-07	NO DATA	6.04E-05
TE125M	2.68E-06	9.71E-07	3.59E-07	8.06E-07	1.09E-05	NO DATA	1.07E-05
TE127M	6.77E-06	2.42E-06	8.25E-07	1.73E-06	2.75E-05	NO DATA	2.27E-05
TE127	1.10E-07	3.95E-08	2.38E-08	8.15E-08	4.48E-07	NO DATA	8.68E-06
TE129M	1.15E-05	4.29E-06	1.82E-06	3.95E-06	4.80E-05	NO DATA	5.79E-05
TE129	3.14E-08	1.18E-08	7.65E-09	2.41E-08	1.32E-07	NO DATA	2.37E-08
TE131M	1.73E-06	8.46E-07	7.05E-07	1.34E-06	8.57E-06	NO DATA	8.40E-05
TE131	1.97E-08	8.23E-09	6.22E-09	1.62E-08	8.63E-08	NO DATA	2.79E-09
TE132	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
CS134	6.22E-05	1.48E-04	1.21E-04	NO DATA	4.79E-05	1.59E-05	2.59E-06
CS136	6.51E-06	2.57E-05	1.85E-05	NO DATA	1.43E-05	1.96E-06	2.92E-06
CS137	7.97E-05	1.09E-04	7.14E-05	NO DATA	3.70E-05	1.23E-05	2.11E-06
CS138	5.52E-08	1.09E-07	5.40E-08	NO DATA	8.01E-08	7.91E-09	4.65E-13
BA139	9.70E-08	6.91E-11	2.84E-09	NO DATA	6.46E-11	3.92E-11	1.72E-07

* Values taken from Reference 3, Table E-11.

TABLE 1.2-2 (Continued)
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INGESTION DOSE CONVERSION FACTORS FOR ADULTS (DFi)
(mrem per pci ingested) *

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
BA140	2.03E-05	2.55E-08	1.33E-06	NO DATA	8.67E-09	1.46E-08	4.18E-05
BA141	4.71E-08	3.56E-11	1.59E-09	NO DATA	3.31E-11	2.02E-11	2.22E-17
BA142	2.13E-08	2.19E-11	1.34E-09	NO DATA	1.85E-11	1.24E-11	3.00E-26
LA140	2.50E-09	1.26E-09	3.33E-10	NO DATA	NO DATA	NO DATA	9.25E-05
LA142	1.28E-10	5.82E-11	1.45E-11	NO DATA	NO DATA	NO DATA	4.25E-07
CE141	9.36E-09	6.33E-09	7.18E-10	NO DATA	2.94E-09	NO DATA	2.42E-05
CE143	1.65E-09	1.22E-06	1.35E-10	NO DATA	5.37E-10	NO DATA	4.56E-05
CE144	4.88E-07	2.04E-07	2.62E-08	NO DATA	1.21E-07	NO DATA	1.65E-04
PR143	9.20E-09	3.69E-09	4.56E-10	NO DATA	2.13E-09	NO DATA	4.03E-05
PR144	3.01E-11	1.25E-11	1.53E-12	NO DATA	7.05E-12	NO DATA	4.33E-18
ND147	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
NP239	1.19E-09	1.17E-10	6.45E-11	NO DATA	3.65E-10	NO DATA	2.40E-05

* Values taken from Reference 3, Table E-11.

TABLE 1.2-3
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GRAND GULF SITE RELATED INGESTION DOSE COMMITMENT FACTOR, A_{iTau}
(mrem/hr per uCi/ml) *

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H-3	0.00E+00	2.26E-01	2.26E-01	2.26E-01	2.26E-01	2.26E-01	2.26E-01
C-14	3.13E+04	6.26E+03	6.26E+03	6.26E+03	6.26E+03	6.26E+03	6.26E+03
Na-24	4.07E+02	4.07E+02	4.07E+02	4.07E+02	4.07E+02	4.07E+02	4.07E+02
P-32	4.62E+07	2.87E+06	1.79E+06	0.00E+00	0.00E+00	0.00E+00	5.19E+06
Cy-51	0.00E+00	0.00E+00	1.27E+00	7.61E-01	2.81E-01	1.69E+00	3.20E+02
Mn-54	0.00E+00	4.38E+08	8.35E+02	0.00E+00	1.30E+03	0.00E+00	1.34E+04
Mn-56	0.00E+00	1.10E+02	1.95E+01	0.00E+00	1.40E+02	0.00E+00	3.51E+03
Fe-55	6.58E+02	4.55E+02	1.06E+02	0.00E+00	0.00E+00	2.54E+02	2.61E+02
Fe-59	1.04E+03	2.44E+03	9.36E+02	0.00E+00	0.00E+00	6.82E+02	8.14E+03
Co-58	0.00E+00	8.92E+01	2.00E+02	0.00E+00	0.00E+00	0.00E+00	1.81E+03
Co-60	0.00E+00	2.56E+02	5.65E+02	0.00E+00	0.00E+00	0.00E+00	4.81E+03
Ni-63	3.11E+04	2.16E+03	1.04E+03	0.00E+00	0.00E+00	0.00E+00	4.50E+02
Ni-65	1.26E+02	1.64E+01	7.49E+00	0.00E+00	0.00E+00	0.00E+00	4.17E+02
Cu-64	0.00E+00	9.97E+00	4.68E+00	0.00E+00	2.51E+01	0.00E+00	8.50E+02
Zn-65	2.32E+04	7.37E+04	3.33E+04	0.00E+00	4.93E+04	0.00E+00	4.64E+04
Zn-69	4.93E+01	9.43E+01	6.56E+00	0.00E+00	6.13E+01	0.00E+00	1.42E+01
Br-83	0.00E+00	0.00E+00	4.04E+01	0.00E+00	0.00E+00	0.00E+00	5.82E+01
Br-84	0.00E+00	0.00E+00	5.24E+01	0.00E+00	0.00E+00	0.00E+00	4.11E-04
BR-85	0.00E+00	0.00E+00	2.15E+00	0.00E+00	0.00E+00	0.00E+00	1.01E-15
Rb-86	0.00E+00	1.01E+05	4.71E+04	0.00E+00	0.00E+00	0.00E+00	1.99E+04
Rb-88	0.00E+00	2.90E+02	1.54E+02	0.00E+00	0.00E+00	0.00E+00	4.00E-09
Rb-89	0.00E+00	1.92E+02	1.35E+02	0.00E+00	0.00E+00	0.00E+00	1.12E-11
Sr-89	2.21E+04	0.00E+00	6.35E+02	0.00E+00	0.00E+00	0.00E+00	3.55E+03
Sr-90	5.44E+05	0.00E+00	1.34E+05	0.00E+00	0.00E+00	0.00E+00	1.57E+04
Sr-91	4.07E+02	0.00E+00	1.64E+01	0.00E+00	0.00E+00	0.00E+00	1.94E+03
Sr-92	1.54E+02	0.00E+00	6.68E+00	0.00E+00	0.00E+00	0.00E+00	3.06E+03
Y-90	5.76E-01	0.00E+00	1.54E-02	0.00E+00	0.00E+00	0.00E+00	6.10E+03
Y-91m	5.44E-03	0.00E+00	2.11E-04	0.00E+00	0.00E+00	0.00E+00	1.60E-02
Y-91	8.44E+00	0.00E+00	2.26E-01	0.00E+00	0.00E+00	0.00E+00	4.64E+03
Y-92	5.06E-02	0.00E+00	1.48E-03	0.00E+00	0.00E+00	0.00E+00	8.86E+02
Y-93	1.60E-01	0.00E+00	4.43E-03	0.00E+00	0.00E+00	0.00E+00	5.09E+03
Zr-95	2.40E-01	7.70E-02	5.21E-02	0.00E+00	1.21E-01	0.00E+00	2.44E+02
Zr-97	1.33E-02	2.68E-03	1.22E-03	0.00E+00	4.04E-03	0.00E+00	8.30E+02
Nb-95	4.47E+02	2.48E+02	1.34E+02	0.00E+00	2.46E+02	0.00E+00	1.51E+06
Mo-99	0.00E+00	1.03E+02	1.96E+01	0.00E+00	2.34E+02	0.00E+00	2.39E+02
Tc-99m	8.87E-03	2.51E-02	3.19E-01	0.00E+00	3.81E-01	1.23E-02	1.48E+01
Tc-101	9.12E-03	1.31E-02	1.29E-01	0.00E+00	2.37E-01	6.72E-03	3.95E-14
Ru-103	4.43E+00	0.00E+00	1.91E+00	0.00E+00	1.69E+01	0.00E+00	5.17E+02
Ru-105	3.69E-01	0.00E+00	1.46E-01	0.00E+00	4.76E+00	0.00E+00	2.26E+02

1

* Calculated from Equation 8.

TABLE 1.2-3 (Continued)

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GRAND GULF SITE RELATED INGESTION DOSE COMMITMENT FACTOR, A_{iTau}

(mrem/hr per uCi/ml) *

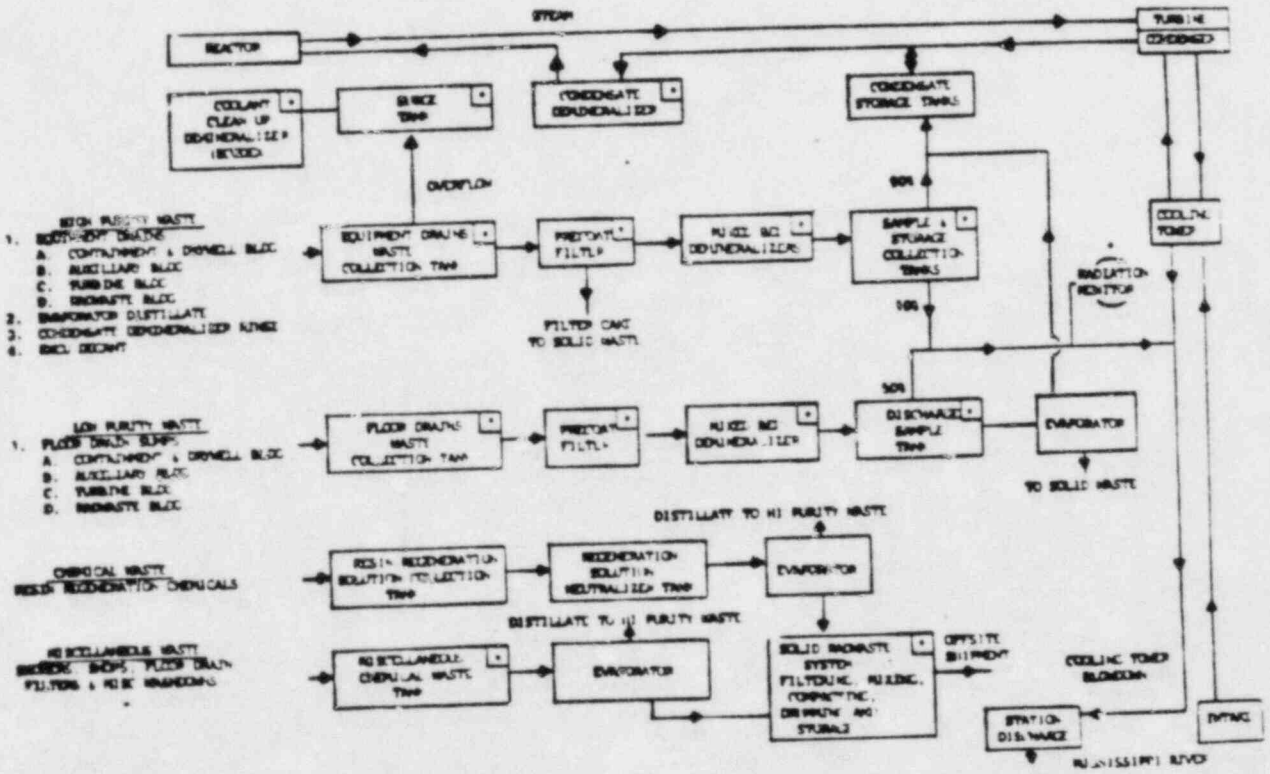
NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
Ru-106	6.58E+01	0.00E+00	8.33E+00	0.00E+00	1.27E+02	0.00E+00	4.26E+03
Ag-110m	8.81E-01	8.15E-01	4.84E-01	0.00E+00	1.60E+00	0.00E+00	3.30E+02
Te-125m	2.57E+03	9.30E+02	3.44E+02	7.72E+02	1.04E+04	0.00E+00	1.02E+04
Te-127m	6.48E+03	2.32E+03	7.90E-02	1.66E+03	2.63E+04	0.00E+00	2.17E+04
Te-127	1.05E+02	3.78E+01	2.28E+01	7.80E+01	4.29E+02	0.00E+00	8.31E+03
Te-129m	1.10E+04	4.11E+03	1.74E+03	3.78E+03	4.60E+04	0.00E+00	5.54E+04
Te-129	3.01E+01	1.13E+01	7.33E+00	2.31E+01	1.26E+02	0.00E+00	2.27E+01
Te-131m	1.66E+03	8.10E+02	6.75E+02	1.28E+03	8.21E+03	0.00E+00	8.04E+04
Te-131	1.89E+01	7.88E+00	5.96E+00	1.55E+01	8.26E+01	0.00E+00	2.67E+00
Te-132	2.41E+03	1.56E+03	1.47E+03	1.72E+03	1.50E+04	0.00E+00	7.38E+04
I-130	2.71E+01	8.01E+01	3.16E+01	6.79E+03	1.25E+02	0.00E+00	6.89E+01
I-131	1.49E+02	2.14E+02	1.22E+02	7.00E+04	3.66E+02	0.00E+00	5.64E+01
I-132	7.29E+00	1.95E+01	6.82E+00	6.82E+02	3.11E+01	0.00E+00	3.66E+00
I-133	5.10E+01	8.87E+01	2.70E+01	1.30E+04	1.55E+02	0.00E+00	7.97E+01
I-134	3.81E+00	1.03E+01	3.70E+00	1.79E+02	1.64E+01	0.00E+00	9.01E-03
I-135	1.59E+01	4.17E+01	1.54E+01	2.75E+03	6.68E+01	0.00E+00	4.70E+01
Cs-134	2.98E+05	7.09E+05	5.79E+05	0.00E+00	2.29E+05	7.61E+04	1.24E+04
Cs-136	3.12E+04	1.23E+05	8.86E+04	0.00E+00	6.85E+04	9.38E+03	1.40E+04
Cs-137	3.82E+05	5.22E+05	3.42E+05	0.00E+00	1.77E+05	5.89E+04	1.01E+04
Cs-138	2.64E+02	5.22E+02	2.59E+02	0.00E+00	3.84E+02	3.79E+01	2.23E-03
Ba-139	9.29E-01	6.62E-04	2.72E-02	0.00E+00	6.19E-04	3.75E-04	1.65E+00
Ba-140	1.9 E+02	2.44E-01	1.27E+01	0.00E+00	8.30E-02	1.40E-01	4.00E+02
Ba-141	4.5 E-01	3.41E-04	1.52E-02	0.00E+00	3.17E-04	1.93E-04	2.13E-10
Ba-142	2.04E-01	2.10E-04	1.28E-02	0.00E+00	1.77E-04	1.19E-04	2.87E-19
La-140	1.50E-01	7.54E-02	1.99E-02	0.00E+00	0.00E+00	0.00E+00	5.54E+03
La-142	7.66E-03	3.48E-03	8.68E-04	0.00E+00	0.00E+00	0.00E+00	2.54E+01
Ce-141	2.24E-02	1.52E-02	1.72E-03	0.00E+00	7.04E-03	0.00E+00	5.79E+01
Ce-143	3.95E-03	2.92E+00	3.23E-04	0.00E+00	1.29E-03	0.00E+00	1.09E-02
Ce-144	1.17E+00	4.88E-01	6.27E-02	0.00E+00	2.90E-01	0.00E+00	3.95E+02
Pr-143	5.51E-01	2.21E-01	2.73E-02	0.00E+00	1.27E-01	0.00E+00	2.41E+03
Pr-144	1.80E-03	7.48E-04	9.16E-05	0.00E+00	4.22E-04	0.00E+00	2.59E-10
Nd-147	3.76E-01	4.35E-01	2.60E-02	0.00E+00	2.54E-01	0.00E+00	2.09E+03
W-187	2.96E+02	2.47E+02	8.65E+01	0.00E+00	0.00E+00	0.00E+00	8.10E+04
Np-239	2.85E-02	2.80E-03	1.54E-03	0.00E+00	8.74E-03	0.00E+00	5.75E-02

1

* Calculated from Equation 8.

1.3 Liquid Radwaste Treatment System

The essential components of the liquid radwaste treatment system for the OPERABILITY requirement of RETS Specification 3/4.11.1.3 are indicated below by an asterisk (*).



(A COMMON SYSTEM SCALED TO A PER UNIT BASIS)

Taken from Reference 4, Figure 3-7.

2.0 GASEOUS EFFLUENTS

2.1 Gaseous Effluent Monitor Setpoints

2.1.1 For the purpose of implementation of Specification 3.3.7.12 of the RETS, the alarm setpoint level for continuous ventilation noble gas monitors will be calculated as follows:

S_V = Count rate of vent noble gas monitor at alarm setpoint level

$$= \text{the lesser of} \begin{cases} 0.25 \times R_t \times D_{TB} \\ \text{or} \\ 0.25 \times R_s \times D_{ss} \end{cases} \quad (1)$$

Where,

0.25 = safety factor allowing for cumulative uncertainties of measurements

D_{TB} = Dose rate limit to the total body of an individual in an unrestricted area required to limit dose to 500 mrem in one year.

$$= \frac{500 - F\left[(\overline{X/Q}) \sum_i K_i \overline{Q}_i\right]}{(1 - F)}$$

D_{ss} = Dose rate limit to the skin of the body of an individual in an unrestricted area required to limit dose to 3000 mrem in one year.

$$= \frac{3000 - F\left[(\overline{X/Q}) \sum_i (L_i + 1.1\, M_i) \overline{Q}_i\right]}{(1 - F)}$$

R_t = count rate per mrem/yr to the total body

$$= C \div \left[\overline{X/Q} \sum_i K_i \dot{Q}_i\right]$$

See Note 2

Where,

C = count rate of the vent monitor corresponding to grab sample radionuclide concentrations

$\overline{X/Q}$ = highest sector annual average atmospheric dispersion at the unrestricted area boundary

= 5.176×10^{-6}* sec/m^3 in the WSW sector.

K_i = total body dose factor due to gamma emissions from each noble gas radionuclide i (mrem/yr per uCi/m^3) from Table 2.1-1.

$\dot{Q}_i$ = rate of release of noble gas radionuclide, i (uCi/sec), from release point

F = fraction of current year elapsed at time of calculation

$\overline{Q}_i$ = average rate of release of noble gas radionuclide i for the elapsed fraction of the year F (uCi/sec) from release point

R_s = count rate per mrem/yr to the skin

$$= C \div \left[\overline{X/Q} \sum_i (L_i + 1.1\, M_i)\, \dot{Q}_i \right]$$ See note 2

L_i = skin dose factor due to beta emissions from isotope i (mrem/yr per uCi/m^3) from Table 2.1-1

1.1 = mrem skin dose per mrad air dose

M_i = air dose factor due to gamma emissions from isotope i (mrad/yr per uCi/m^3) from Table 2.1-1

* Value taken from Reference 4, Table 6.1.26.

2.1.2 Containment Purge Monitor

The setpoint level for discharge through the containment purge system monitor, S_d, will be calculated in a corresponding manner:

$$S_d = \text{the lesser of} \begin{cases} 0.25 \times r_t \times D'_{TB} \\ \text{or} \\ 0.25 \times r_s \times D'_{ss} \end{cases} \quad (2)$$

Where,

$$D'_{TB} = \frac{500 - F\left[(\overline{X/Q}) \sum_i K_i \overline{q}_i\right]}{(1 - F)}$$

$$D'_{ss} = \frac{3000 - F\left[(\overline{X/Q}) \sum_i (L_i + 1.1 M_i) \overline{q}_i\right]}{(1 - F)}$$

r_t = count rate per mrem/yr to the total body

$$= c \div \left[\overline{X/Q} \sum_i K_i \dot{q}_i\right]$$ See Note 2

c = count rate of the containment purge monitor for radionuclide concentrations to be discharged.

$\dot{q}_i$ = rate of release of noble gas radionuclide i (uCi/sec)

$\overline{q}_i$ = average rate of release of noble gas radionuclide i from the ventilation system for the elapsed fraction of the year F (uCi/sec).

r_s = count rate per mrem/yr to the skin

$$= c \div \left[\overline{X/Q} \sum_i (L_i + 1.1 M_i) \dot{q}_i\right]$$ See Note 2

R_s'' = conservative count rate per mrem/yr to the skin

$$= C' \div \left[\overline{X/Q} \times (L + 1.1M) \times \dot{Q}'' \right]$$

Where

L = skin dose factor for Kr-89, the most restrictive isotope, from Table 2.1-1,

M = air dose factor for Kr-89, the most restrictive isotope, from Table 2.1-1.

D''_{TB} = 500 mrem/yr

D''_{ss} = 3000 mrem/yr

r_t'' = conservative count rate per mrem/yr to the total body for containment purge only

$$= c' \div \left[\overline{X/Q} \times K \times \dot{q}'' \right]$$

Where,

$\dot{q}''$ = release rate from the containment purge (may be determined for maximum flow from the system and the concentration specified for c' above).

c' = count rate of the containment purge monitor corresponding to a 1.0 uCi/ml concentration of Xe-133,

r_s'' = conservative count rate per mrem/yr to the skin for containment purge only,

$$= c' \div \left[\overline{X/Q} \times (L + 1.1M) \times \dot{q}'' \right]$$

TABLE 2.1-1

DOSE FACTORS FOR EXPOSURE TO A SEMI-INFINITE CLOUD OF NOBLE GASES

Nuclide	Y-Body**(K)i	B-Skin**(L)i	Y-Air*(M)i	B-Air*(N)i
Kr-85m	1.17E+03***	1.46E+03	1.23E+03	1.97E+03
Kr-85	1.61E+01	1.34E+03	1.72E+01	1.95E+03
Kr-87	5.92E+03	9.73E+03	6.17E+03	1.03E+04
Kr-88	1.47E+04	2.37E+03	1.52E+04	2.93E+03
Kr-89	1.66E+04	1.01E+04	1.73E+04	1.06E+04
Kr-90	1.56E+04	7.29E+03	1.63E+04	7.83E+03
Xe-131m	9.15E+01	4.76E+02	1.56E+02	1.11E+03
Xe-133m	2.51E+02	9.94E+02	3.27E+02	1.48E+03
Xe-133	2.94E+02	3.06E+02	3.53E+02	1.05E+03
Xe-135m	3.12E+03	7.11E+02	3.36E+03	7.39E+02
Xe-135	1.81E+03	1.86E+03	1.92E+03	2.46E+03
Xe-137	1.42E+03	1.22E+04	1.51E+03	1.27E+04
Xe-138	8.83E+03	4.13E+03	9.21E+03	4.75E+03
Ar-41	8.84E+03	2.69E+03	9.30E+03	3.28E+03

Values taken from Reference 3, Table B-1

* $\frac{\text{mrad} - \text{m}^3}{\text{uCi} - \text{yr}}$

** $\frac{\text{mrem} - \text{m}^3}{\text{uCi} - \text{yr}}$

*** 1.17E+03 = 1.17×10^3

2.2 Gaseous Effluent Dose Calculations

2.2.1.a For the purpose of implementation of Specification 3.11.2.1.a, the dose at the unrestricted area boundary due to noble gases shall be calculated as follows:

D_{tb} = average total body dose rate in current year (mrem/yr)

$$= \overline{X/Q} \sum_i K_i \overline{Q}_i$$

D_s = average skin dose rate in current year (mrem/yr)

$$= \overline{X/Q} \sum (L_i + 1.1\, M_i)\, \overline{Q}_i$$

2.2.1.b Organ doses due to tritium, I-131, I-133 and all radioactive materials in particulate form, with half-lives greater than eight days will be calculated for the purpose of implementation of Specification 3.11.2.1.b. as follows: |1

D_o = average organ dose rate in current year (mrem/yr)

$$= \sum_i W \; P_i \, \overline{Q'}_i \qquad \text{where} \qquad |1$$

W = controlling sector annual average atmospheric dispersion at the unrestricted area boundary for the appropriate pathway.

$$= \begin{cases} \overline{X/Q} & \text{for inhalation (Section 2.1.1)} \\ \overline{D/Q} = 1.301 \times 10^{-8*}\ m^{-2} & \text{for other pathways in the SSE* sector} \end{cases}$$

* Value taken from Reference 4, Table 6.1.26.

P_i = dose parameter for radionuclide i, (mrem/yr per uCi/m^3) for inhalation and (M^2 • mrem/yr per uCi/sec) for other pathways, from Table 2.2-1.a-b. | 1

$\overline{Q'}_i$ = average release rate of isotope i of radioiodine or other radionuclide in particulate form, with half-life greater than eight (8) days in the current year (uCi/sec).

2.2.2.a For the purpose of implementation of Specification 3.11.2.2, the air dose in unrestricted areas shall be determined as follows:

D_γ = air dose due to gamma emissions from noble gas radionuclide i (mrad)

$$= 3.17 \times 10^{-8} \sum_i M_i \ \overline{X/Q'} \ \tilde{Q}_i$$

Where,

$\overline{X/Q'}$ = relative concentration for unrestricted areas

$= 5.176 \times 10^{-6*}$ sec/m^3, in the WSW sector

M_i = air dose factor due to gamma emissions from noble gas radionuclide i (mrad/yr per uCi/m^3) from Table 2.1-1

$\tilde{Q}_i$ = cumulative release of noble gas radionuclide i over the period of interest (uCi)

Note: 3.17×10^{-8} is the inverse of the number of seconds per year, and

D_β = air dose due to beta emissions from noble gas radionuclide i (mrad)

* Value taken from Reference 4, Table 6.1.26.

$$= 3.17 \times 10^{-8} \sum_i N_i \overline{X/Q'} \tilde{Q}_i$$

Where,

N_i = air dose factor due to beta emissions from noble gas radionuclide i (mrad/yr per uCi/m^3) from Table 2.1-1

$\overline{X/Q'}$ = relative concentration for unrestricted areas

= $5.176 \times 10^{-6*}$ sec/m^3, in the WSW sector

$\tilde{Q}_i$ = cumulative release of noble gas radionuclide i over the period of interest (uCi).

2.2.2.b Dose to an individual from tritium, I-131, I-133 and radioactive materials in particulate form, with half-lives greater than eight (8) days will be calculated for the purpose of implementation of Specification 3.11.2.3 as follows: |1

D_p = dose to an individual from radioiodines and radionuclides in particulate form, with half-life greater than eight days (mrem)

$$= 3.17 \times 10^{-8} \sum_i R_i \quad W' \tilde{Q}'_i$$

Where,

W' = relative concentration for unrestricted areas

$$= \begin{cases} \overline{X/Q'} = \underline{3.001 \times 10^{-6*}} \text{ for inhalation} \\ \overline{D/Q'} = \underline{4.440 \times 10^{-9*}} \ m^{-2} \text{ for other pathways in the SW Sector} \end{cases}$$

* Values taken from Reference 4, Table 6.1.26

R_i = dose factor for radionuclide i, (mrem/yr per uCi/m^3) or (m^2 . mrem/yr per uCi/sec) from Tables 2.2-2a - d | 1

$\tilde{Q}'_i$ = cumulative release of radionuclide i of iodine or material in particulate form over the period of interest (uCi)

2.2.2.c For the purpose of implementing Specification 6.9.1.13, of the RETS dose calculations will be performed using the above equations with the substitution of average meteorological parameters which prevailed for the period of the report.

* Values taken from Reference 4, Table 6.1.26.

TABLE 2.2-1a

PATHWAY DOSE FACTORS (Pi) FOR TECHNICAL SPECIFICATION 3.11.2.1 and SECTION 2.2.1.b

1

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AGE GROUP	(INFANT)	(N.A.)	(INFANT)
ISOTOPE	INHALATION	GROUND PLANE	FOOD
H-3	6.468E+02	0.000E+00	2.382E+03
C-14	2.646E+04	0.000E+00	2.340E+09
NA-24	1.056E+04	1.979E+07	1.542E+07
P-32	2.030E+06	0.000E+00	1.602E+11
CR-51	1.284E+04	7.864E+06	4.700E+06
MN-54	9.996E+05	1.287E+09	3.900E+07
MN-56	7.168E+04	1.525E+06	2.862E+00
FE-55	8.694E+04	0.000E+00	1.351E+08
FE-59	1.015E+06	4.562E+08	3.919E+08
CO-58	7.770E+05	6.194E+08	6.055E+07
CO-60	4.508E+06	5.172E+09	2.098E+08
NI-63	3.388E+05	0.000E+00	3.493E+10
NI-65	5.012E+04	4.930E+05	3.020E+01
CU-64	1.498E+04	9.823E+05	3.807E+06
ZN-65	6.468E+05	7.907E+08	1.904E+10
ZN-69	1.322E+04	0.000E+00	3.855E-09
BR-83	3.808E+02	1.011E+04	9.339E-01
BR-84	4.004E+02	3.376E+05	1.256E-22
BR-85	2.044E+01	0.000E+00	0.000E+00
RB-86	1.904E+05	1.478E+07	2.234E+10
RB-88	5.572E+02	5.399E+04	1.874E-44
RB-89	3.206E+02	2.075E+05	4.193E-53
SR-89	2.030E+06	3.560E+04	1.258E+10
SR-90	4.088E+07	0.000E+00	1.216E+11
SR-91	7.336E+04	3.587E+06	3.215E+05
SR-92	1.400E+05	1.233E+06	5.005E+01
Y-90	2.688E+05	7.583E+03	9.406E+05
Y-91M	2.786E+03	1.658E+05	1.876E-15
Y-91	2.450E+06	1.702E+06	5.251E+06
Y-92	1.266E+05	3.060E+05	1.026E+01
Y-93	1.666E+05	3.620E+05	1.776E+04
ZR-95	1.750E+06	3.975E+08	8.257E+05
ZR-97	1.400E+05	4.921E+06	4.446E+04
NB-95	4.788E+05	2.291E+08	2.062E+08
MO-99	1.348E+05	6.608E+06	3.108E+08
TC-99M	2.030E+03	3.013E+05	1.646E+04
TC-101	8.442E+02	3.253E+04	1.423E-56
RU-103	5.516E+05	1.804E+08	1.055E+05
RU-105	4.844E+04	1.030E+06	3.204E+00
RU-106	1.156E+07	3.590E+08	1.445E+06
AG-110M	3.668E+06	3.649E+09	1.461E+10

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TABLE 2.2-1a (Continued)

PATHWAY DOSE FACTORS (Pi) FOR TECHNICAL SPECIFICATION 3.11.2.1 and SECTION 2.2.1.b

AGE GROUP	(INFANT)	(N.A.)	(INFANT)
ISOTOPE	INHALATION	GROUND PLANE	FOOD
TE-125M	4.466E+05	3.001E+06	1.508E-08
TE-127M	1.312E+06	1.395E+05	1.037E+09
TE-127	2.436E+04	4.704E+03	1.359E+05
TE-129M	1.680E+06	3.290E+07	1.392E+09
TE-129	2.632E+04	4.395E+04	1.678E-07
TE-131M	1.988E+05	1.351E+07	2.288E+07
TE-131	8.218E+03	4.929E+07	1.384E-30
TE-132	3.402E+05	7.098E+06	6.513E+07
I-130	1.596E+06	9.560E+06	8.754E+08
I-131	1.484E+07	2.985E+07	1.053E+12
I-132	1.694E+05	2.075E+06	1.188E+02
I-133	3.556E+06	4.259E+06	9.601E+09
I-134	4.452E+04	7.578E+05	8.402E-10
I-135	6.958E+05	4.210E+06	2.002E+07
CS-134	7.028E+05	3.282E+09	6.801E+10
CS-136	1.345E+05	2.432E+08	5.795E+09
CS-137	6.118E+05	1.337E+09	6.024E+10
CS-138	8.764E+02	5.860E+05	2.180E-22
BA-139	5.096E+04	1.705E+05	2.874E-05
BA-140	1.596E+06	3.352E+07	2.410E+08
BA-141	4.746E+03	6.762E+04	3.141E-44
BA-142	1.554E+03	7.234E+04	0.000E+00
LA-140	1.680E+05	3.114E+07	1.880E+05
LA-142	5.950E+04	1.269E+06	6.019E-06
CE-141	5.166E+05	2.199E+07	1.366E+07
CE-143	1.162E+05	3.753E+06	1.536E+06
CE-144	9.842E+06	6.761E+07	1.334E+08
PR-143	4.326E+05	0.000E+00	7.845E+05
PR-144	4.284E+03	3.017E+03	1.171E-48
ND-147	3.220E+05	1.441E+07	5.743E+05
W-187	3.962E+04	3.915E+06	2.501E+06
NP-239	5.950E+04	2.823E+06	9.400E+04

Units: Inhalation and all tritium pathways - mrem/yr per uCi/m³
Others - m³ . mrem/yr per uCi/sec

Values based on standard NUREG-0133, Section 5.2.1 assumptions unless otherwise indicated.

TABLE 2.2-1b

PATHWAY DOSE FACTORS (Pi) FOR TECHNICAL SPECIFICATIONS 3.11.2.1 and SECTION 2.2.1.b

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AGE GROUP	(CHILD)	(N. A.)	(CHILD)
ISOTOPE	INHALATION	GROUND PLANE	GRS/ANL/MEAT
H-3	1.125E+03	0.000E+00	1.826E+02
C-14	3.589E+04	0.000E+00	2.991E+08
NA-24	1.610E+04	1.385E+07	1.345E-03
P-32	2.605E+06	0.000E+00	5.781E+09
CR-51	1.698E+04	5.506E+06	3.636E+05
MN-54	1.576E+06	1.625E+09	6.249E+06
MN-56	1.232E+05	1.068E+06	1.901E-51
FE-55	1.110E+05	0.000E+00	3.566E+08
FE-59	1.269E+06	3.204E+08	4.943E+08
CO-58	1.106E+06	4.464E+08	7.485E+07
CO-60	7.067E+06	2.532E+10	2.993E+08
NI-63	8.214E+05	0.000E+00	2.272E+10
NI-65	8.399E+04	3.451E+05	3.167E-51
CU-64	3.670E+04	6.876E+05	1.087E-05
ZN-65	9.953E+05	8.583E+08	7.801E+08
ZN-69	1.018E+04	0.000E+00	0.000E+00
BR-83	4.736E+02	7.079E+03	7.425E-57
BR-84	5.476E+02	2.363E+05	0.000E+00
BR-85	2.531E+01	0.000E+00	0.000E+00
RB-86	1.983E+05	1.035E+07	4.536E+08
RB-88	5.624E+02	3.779E+04	0.000E+00
RB-89	3.452E+02	1.452E+05	0.000E+00
SR-89	2.157E+06	2.509E+04	3.756E+08
SR-90	1.010E+08	0.000E+00	8.111E+09
SR-91	1.739E+05	2.511E+06	4.128E-10
SR-92	2.424E+05	8.631E+05	2.724E-40
Y-90	2.679E+05	5.308E+03	3.806E+05
Y-91M	2.812E+03	1.161E+05	0.000E+00
Y-91	2.627E+06	1.207E+06	1.872E+08
Y-92	2.390E+05	2.142E+05	5.428E-35
Y-93	3.885E+05	2.534E+05	1.207E-07
ZR-95	2.231E+06	2.837E+08	4.763E+08
ZR-97	3.511E+05	3.445E+06	5.471E-01
NB-05	6.142E+05	1.605E+08	1.738E+09
MO-99	1.354E+05	4.626E+06	1.915E+05
TC-99M	4.810E+03	2.109E+05	5.394E-18
TC-101	5.846E+02	2.277E+04	0.000E+00
RU-103	6.623E+05	1.265E+08	3.127E+09
RU-105	9.953E+04	7.212E+05	4.590E-25
RU-106	1.432E+07	5.049E+08	5.384E+10
AG-110M	5.476E+06	4.019E+09	5.259E+08

TABLE 2.2-1b (Continued)

PATHWAY DOSE FACTORS (Pi) FOR TECHNICAL SPECIFICATIONS 3.11.2.1 and SECTION 2.2.1.b

1

AGE GROUP	(CHILD)	(N. A.)	(CHILD)*
ISOTOPE	INHALATION	GROUND PLANE	GRS/ANL/MEAT
TE-125M	4.773E+05	2.128E+06	4.438E+08
TE-127M	1.480E+06	1.083E+05	3.947E+09
TE-127	5.624E+04	3.293E+03	1.254E-08
TE-129M	1.761E+06	2.305E+07	4.091E+09
TE-129	2.549E+04	3.076E+04	0.000E+00
TE-131M	3.078E+05	9.459E+06	7.656E+03
TE-131	2.054E+03	3.450E+07	0.000E+00
TE-132	3.774E+05	4.968E+06	7.274E+06
I-130	1.846E+06	6.692E+06	5.271E-04
I-131	1.624E+07	2.089E+07	4.293E+09
I-132	1.935E+05	1.452E+06	1.895E-57
I-133	3.848E+06	2.981E+06	1.017E+02
I-134	5.069E+04	5.305E+05	0.000E+00
I-135	7.918E+05	2.947E+06	8.104E-15
CS-134	1.014E+06	8.007E+09	1.180E+09
CS-136	1.709E+05	1.702E+08	3.452E+07
CS-137	9.065E+05	1.201E+10	1.040E+09
CS-138	8.399E+02	4.102E+05	0.000E+00
BA-139	5.772E+04	1.194E+05	0.000E+00
BA-140	1.743E+06	2.346E+07	3.420E+07
BA-141	2.919E+03	4.734E+04	0.000E+00
BA-142	1.643E+03	5.064E+04	0.000E+00
LA-140	2.257E+05	2.180E+07	4.284E+02
LA-142	7.585E+04	8.886E+05	0.000E+00
CE-141	5.439E+05	1.540E+07	1.078E+07
CE-143	1.273E+05	2.627E+06	1.963E+02
CE-144	1.195E+07	8.032E+07	1.476E+08
PR-143	4.329E+05	0.000E+00	2.815E+07
PR-144	1.565E+03	2.112E+03	0.000E+00
ND-147	3.282E+05	1.009E+07	1.174E+07
W-187	9.102E+04	2.740E+06	2.176E+00
NP-239	6.401E+04	1.976E+06	1.741E+03

Units: Inhalation and all tritium pathways - mrem/yr per uCi/m^3 1
Others - m^2 . mrem/yr per uCi/sec

Values based on standard NUREG-0133, Section 5.3.1 assumptions unless otherwise indicated.

* Meat consumption assumed 75 percent beef and 25 percent mutton.

TABLE 2.2-2a

PATHWAY DOSE FACTORS (Ri) FOR TECHNICAL SPECIFICATIONS 4.11.2.3 AND SECTION 2.2.2.b

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AGE GROUP	(INFANT)	(N.A.)	(INFANT)	(INFANT)	(INFANT)
ISOTOPE	INHALATION	GROUND PLANE	GRS/COW/MILK	GRS/COW/MEAT	VEGETATION
H-3	6.468E+02	0.000E+00	2.382E+03	0.000E+00	0.000E+00
C-14	2.646E+04	0.000E+00	2.340E+09	0.000E+00	0.000E+00
NA-24	1.056E+04	1.385E+07	1.542E+07	0.000E+00	0.000E+00
P-32	2.030E+06	0.000E+00	1.602E+11	0.000E+00	0.000E+00
CR-51	1.284E+04	5.506E+06	4.700E+06	0.000E+00	0.000E+00
MN-54	9.996E+05	1.625E+09	3.900E+07	0.000E+00	0.000E+00
MN-56	7.168E+04	1.068E+06	2.862E+00	0.000E+00	0.000E+00
FE-55	8.694E+04	0.000E+00	1.351E+08	0.000E+00	0.000E+00
FE-59	1.015E+06	3.204E+08	3.919E+08	0.000E+00	0.000E+00
CO-58	7.770E+05	4.464E+08	6.055E+07	0.000E+00	0.000E+00
CO-60	4.508E+06	2.532E+10	2.098E+08	0.000E+00	0.000E+00
NI-63	3.388E+05	0.000E+00	3.493E+10	0.000E+00	0.000E+00
NI-65	5.012E+04	3.451E+05	3.020E+01	0.000E+00	0.000E+00
CU-64	1.498E+04	6.876E+05	3.807E+06	0.000E+00	0.000E+00
ZN-65	6.468E+05	8.583E+08	1.904E+10	0.000E+00	0.000E+00
ZN-69	1.322E+04	0.000E+00	3.855E-09	0.000E+00	0.000E+00
BR-83	3.808E+02	7.079E+03	9.339E-01	0.000E+00	0.000E+00
BR-84	4.004E+02	2.363E+05	1.256E-22	0.000E+00	0.000E+00
BR-85	2.044E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	1.904E+05	1.035E+07	2.234E+10	0.000E+00	0.000E+00
RB-88	5.572E+02	3.779E+04	1.874E-44	0.000E+00	0.000E+00
RB-89	3.206E+02	1.452E+05	4.193E-53	0.000E+00	0.000E+00
SR-89	2.030E+06	2.509E+04	1.258E+10	0.000E+00	0.000E+00
SR-90	4.088E+07	0.000E+00	1.216E+11	0.000E+00	0.000E+00
SR-91	7.336E+04	2.511E+06	3.215E+05	0.000E+00	0.000E+00
SR-92	1.400E+05	8.631E+05	5.005E+01	0.000E+00	0.000E+00
Y-90	2.688E+05	5.308E+03	9.406E+05	0.000E+00	0.000E+00
Y-91M	2.786E+03	1.161E+05	1.876E-15	0.000E+00	0.000E+00
Y-91	2.450E+06	1.207E+06	5.251E+06	0.000E+00	0.000E+00
Y-92	1.266E+05	2.142E+05	1.026E+01	0.000E+00	0.000E+00
Y-93	1.666E+05	2.534E+05	1.776E+04	0.000E+00	0.000E+00
ZR-95	1.750E+06	2.837E+08	8.257E+05	0.000E+00	0.000E+00
ZR-97	1.400E+05	3.445E+06	4.446E+04	0.000E+00	0.000E+00
NB-95	4.788E+05	1.605E+08	2.062E+08	0.000E+00	0.000E+00
MO-99	1.348E+05	4.626E+06	3.108E+08	0.000E+00	0.000E+00
TC-99M	2.030E+03	2.109E+05	1.646E+04	0.000E+00	0.000E+00
TC-101	8.442E+02	2.277E+04	1.423E-56	0.000E+00	0.000E+00
RU-103	5.516E+05	1.265E+08	1.005E+05	0.000E+00	0.000E+00
RU-105	4.844E+04	7.212E+05	3.204E+00	0.000E+00	0.000E+00
RU-106	1.156E+07	5.049E+08	1.445E+06	0.000E+00	0.000E+00
AG-110M	3.668E+06	4.019E+09	1.461E+10	0.000E+00	0.000E+00

TABLE 2.2-2a (Continued)

PATHWAY DOSE FACTORS (Ri) FOR TECHNICAL SPECIFICATIONS 4.11.2.3 AND SECTION 2.2.2.b

AGE GROUP	(INFANT)	(N.A.)	(INFANT)	(INFANT)	(INFANT)
ISOTOPE	INHALATION	GROUND PLANE	GRS/COW/MILK	GRS/COW/MEAT	VEGETATION
TE-125M	4.466E+05	2.128E+06	1.508E+08	0.000E+00	0.000E+00
TE-127M	1.312E+06	1.083E+05	1.037E+09	0.000E+00	0.000E+00
TE-127	2.436E+04	3.293E+03	1.359E+05	0.000E+00	0.000E+00
TE-129M	1.680E+06	2.305E+07	1.392E+09	0.000E+00	0.000E+00
TE-129	2.632E+04	3.076E+04	1.678E-07	0.000E+00	0.000E+00
TE-131M	1.988E+05	9.459E+06	2.288E+07	0.000E+00	0.000E+00
TE-131	8.218E+03	3.450E+07	1.384E-30	0.000E+00	0.000E+00
TE-132	3.403E+05	4.968E+06	6.513E+07	0.000E+00	0.000E+00
I-130	1.596E+06	6.692E+06	8.754E+08	0.000E+00	0.000E+00
I-131	1.484E+07	2.089E+07	1.053E+12	0.000E+00	0.000E+00
I-132	1.694E+05	1.452E+06	1.188E+02	0.000E+00	0.000E+00
I-133	3.556E+06	2.981E+06	9.601E+09	0.000E+00	0.000E+00
I-134	4.452E+04	5.305E+05	8.402E-10	0.000E+00	0.000E+00
I-135	6.958E+05	2.947E+06	2.002E+07	0.000E+00	0.000E+00
CS-134	7.028E+05	8.007E+09	6.801E+10	0.000E+00	0.000E+00
CS-136	1.345E+05	1.702E+08	5.795E+09	0.000E+00	0.000E+00
CS-137	6.118E+05	1.201E+10	6.024E+10	0.000E+00	0.000E+00
CS-138	8.764E+02	4.102E+05	2.180E-22	0.000E+00	0.000E+00
BA-139	5.096E+04	1.194E+05	2.874E-05	0.000E+00	0.000E+00
BA-140	1.596E+06	2.346E+07	2.410E+08	0.000E+00	0.000E+00
BA-141	4.746E+03	4.734E+04	3.141E-44	0.000E+00	0.000E+00
BA-142	1.554E+03	5.064E+04	0.000E+00	0.000E+00	0.000E+00
LA-140	1.680E+05	2.180E+07	1.880E+05	0.000E+00	0.000E+00
LA-142	5.950E+04	8.886E+05	6.019E-06	0.000E+00	0.000E+00
CE-141	5.166E+05	1.540E+07	1.366E+07	0.000E+00	0.000E+00
CE-143	1.162E+05	2.627E+06	1.536E+06	0.000E+00	0.000E+00
CE-144	9.842E+06	8.032E+07	1.334E+08	0.000E+00	0.000E+00
PR-143	4.326E+05	0.000E+00	7.845E+05	0.000E+00	0.000E+00
PR-144	4.284E+03	2.112E+03	1.171E-48	0.000E+00	0.000E+00
ND-147	3.220E+05	1.009E+07	5.743E+05	0.000E+00	0.000E+00
W-187	3.962E+04	2.740E+06	2.501E+06	0.000E+00	0.000E+00
NP-239	5.950E+04	1.976E+06	9.400E+04	0.000E+00	0.000E+00

Units: Inhalation and all tritium pathways - mrem/yr per uCi/m³
Others - m³ . mrem/yr per uCi/sec

Values based on standard NUREG-0133, Section 5.3.1 assumptions unless otherwise indicated.

TABLE 2.2-2b

PATHWAY DOSE FACTORS (Ri) FOR TECHNICAL SPECIFICATIONS 4.11.2.3 AND SECTION 2.2.2.b

AGE GROUP	(CHILD)	(N.A.)	(CHILD)	(CHILD)	(CHILD)
ISOTOPE	INHALATION	GROUND PLANE	GRS/COW/MILK	GRS/COW/MEAT	VEGETATION
H-3	1.125E+03	0.000E+00	1.570E+03	2.341E+02	4.008E-03
C-14	3.589E+04	0.000E+00	1.195E+09	3.834E+08	8.894E+08
NA-24	1.610E+04	1.385E+07	8.853E+06	1.725E-03	3.729E-05
P-32	2.605E+06	0.000E+00	7.775E+10	7.411E+09	3.366E+09
CR-51	1.698E+04	5.506E+06	5.398E+06	4.661E+05	6.213E+06
MN-54	1.576E+06	1.625E+09	2.097E+07	8.011E+06	6.648E+08
MN-56	1.232E+05	1.068E+06	1.865E+00	2.437E-51	2.723E+03
FE-55	1.110E+05	0.000E+00	1.118E+08	4.571E+08	8.012E+08
FE-59	1.269E+06	3.204E+08	2.025E+08	6.338E+08	6.693E+08
CO-58	1.106E+06	4.464E+08	7.080E+07	9.596E+07	3.771E+08
CO-60	7.067E+06	2.532E+10	2.391E+08	3.838E+08	2.095E+09
NI-63	8.214E+05	0.000E+00	2.964E+10	2.912E+10	3.949E+10
NI-65	8.399E+04	3.451E+05	1.909E+01	4.061E-51	1.211E+03
CU-64	3.670E+04	6.876E+05	3.502E+06	1.393E-05	5.159E+05
ZN-65	9.953E+05	8.583E+08	1.101E+10	1.000E+09	2.164E+09
ZN-69	1.018E+04	0.000E+00	1.123E-09	0.000E+00	9.893E-04
BR-83	4.736E+02	7.079E+03	4.399E-01	9.519E-57	5.369E+00
BR-84	5.476E+02	2.363E+05	6.508E-23	0.000E+00	3.822E-11
BR-85	2.531E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	1.983E+05	1.035E+07	8.804E+09	5.816E+08	4.584E+08
RB-88	5.624E+02	3.779E+04	7.150E-45	0.000E+00	4.374E-22
RB-89	3.452E+02	1.452E+05	1.715E-53	0.000E+00	1.642E-26
SR-89	2.157E+06	2.509E+04	6.618E+09	4.815E+08	3.593E+10
SR-90	1.010E+08	0.000E+00	1.117E+11	1.040E+10	1.243E-12
SR-91	1.739E+05	2.511E+06	2.878E+05	5.292E-10	1.157E+06
SR-92	2.424E+05	8.631E+05	4.134E+01	3.492E-48	1.378E+04
Y-90	2.679E+05	5.308E+03	9.171E+05	4.879E+05	6.569E+07
Y-91M	2.812E+03	1.161E+05	5.198E-16	0.000E+00	1.737E-05
Y-91	2.627E+06	1.207E+06	5.199E+06	2.400E+08	2.484E+09
Y-92	2.390E+05	2.142E+05	7.310E+00	6.959E-35	4.576E+04
Y-93	3.885E+05	2.534E+05	1.573E+04	1.547E-07	4.482E+06
ZR-95	2.231E+06	2.837E+08	8.786E+05	6.106E+08	8.843E+08
ZR-97	3.511E+05	3.445E+06	4.199E+04	7.015E-01	1.248E+07
NB-95	6.142E+05	1.605E+08	2.287E+08	2.228E+09	2.949E+08
MO-99	1.354E+05	4.626E+06	1.738E+08	2.456E+05	1.647E+07
TC-99M	4.810E+03	2.109E+05	1.474E+04	6.915E-18	5.255E+03
TC-101	5.846E+02	2.277E+04	5.593E-58	0.000E+00	4.123E-29
RU-103	6.623E+05	1.265E+08	1.108E+05	4.009E+09	3.971E+08
RU-105	9.953E+04	7.212E+05	2.493E+00	5.885E-25	5.981E+04
RU-106	1.432E+07	5.049E+08	1.437E+06	6.902E+10	1.159E+10
AG-110M	5.476E+06	4.019E+09	1.678E+10	6.742E+08	2.581E+09

TABLE 2.2-2b (Continued)

PATHWAY DOSE FACTORS (Ri) FOR TECHNICAL SPECIFICATIONS 4.11.2.3 AND SECTION 2.2.2.b

AGE GROUP	(CHILD)	(N.A.)	(CHILD)	(CHILD)	(CHILD)
ISOTOPE	INHALATION	GROUND PLANE	GRS/COW/MILK	GRS/COW/MEAT	VEGETATION
TE-125M	4.773E+05	2.128E+06	7.377E+07	5.690E+08	3.506E-08
TE-127M	1.480E+06	1.083E+05	5.932E+08	5.060E+09	3.769E+09
TE-127	5.624E+04	3.293E+03	1.191E+05	1.607E-08	3.903E+05
TE-129M	1.761E+06	2.305E+07	7.961E+08	5.245E+09	2.460E+09
TE-129	2.549E+04	3.076E+04	6.166E-08	0.000E+00	7.204E-02
TE-131M	3.078E+05	9.459E+06	2.244E+07	9.815E+03	2.163E+07
TE-131	2.054E+03	3.450E+07	8.489E-32	0.000E+00	1.349E-14
TE-132	3.774E+05	4.968E+06	4.551E+07	9.325E+06	3.111E+07
I-130	1.846E+06	6.692E+06	3.845E+08	6.758E-04	1.370E+08
I-131	1.624E+07	2.089E+07	4.333E+11	5.503E+09	4.754E+10
I-132	1.935E+05	1.452E+06	5.129E+01	2.429E-57	7.314E+03
I-133	3.848E+06	2.981E+06	3.945E+09	1.304E+02	8.113E+08
I-134	5.069E+04	5.305E+05	3.624E-10	0.000E+00	6.622E-03
I-135	7.918E+05	2.947E+06	8.607E+06	1.039E-14	9.973E+06
CS-134	1.104E+06	8.007E+09	3.715E+10	1.513E+09	2.631E+10
CS-136	1.709E+05	1.702E+08	2.773E+09	4.426E+07	2.247E+08
CS-137	9.065E+05	1.201E+10	3.224E+10	1.334E+09	2.392E+10
CS-138	8.399E+02	4.102E+05	5.528E-23	0.000E+00	9.133E-11
BA-139	5.772E+04	1.194E+05	1.231E-05	0.000E+00	2.950E+00
BA-140	1.743E+06	2.346E+07	1.171E+08	4.384E+07	2.767E+08
BA-141	2.919E+03	4.734E+04	1.210E-45	0.000E+00	1.605E-21
BA-142	1.643E+03	5.064E+04	0.000E+00	0.000E+00	4.105E-39
LA-140	2.257E+05	2.180E+07	1.894E+05	5.492E+02	3.166E+07
LA-142	7.585E+04	8.886E+05	2.904E-06	0.000E+00	1.582E+01
CE-141	5.439E+05	1.540E+07	1.361E+07	1.382E+07	4.082E+08
CE-143	1.273E+05	2.627E+06	1.488E+06	2.516E+02	1.364E+07
CE-144	1.195E+07	8.032E+07	1.326E+08	1.893E+08	1.039E+10
[illegible]	4.329E+05	0.000E+00	7.754E+05	3.609E+07	1.575E+08
PR-144	1.565E+03	2.112E+03	2.040E-50	0.000E+00	3.829E-23
ND-147	3.282E+05	1.009E+07	5.712E+05	1.505E+07	9.197E+07
W-187	9.102E+04	2.740E+06	2.420E+06	2.790E+00	5.380E+06
NP-239	6.401E+04	1.976E+06	9.138E+04	2.232E+03	1.357E+07

Units: Inhalation and all tritium pathways - mrem/yr per uCi/m³
Others - m² . mrem/yr per uCi/sec

Values based on standard NUREG-0133, Section 5.3.1 assumptions unless otherwise indicated.

TABLE 2.2-2c

PATHWAY DOSE FACTORS (Ri) FOR TECHNICAL SPECIFICATIONS 4.11.2.3 AND SECTION 2.2.2.b

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AGE GROUP	(TEENAGER)	(N.A.)	(TEENAGER)	(TEENAGER)	(TEENAGER)
ISOTOPE	INHALATION	GROUND PLANE	GRS/COW/MILK	GRS/COW/MEAT	VEGETATION
H-3	1.272E+03	0.000E+00	9.941E+02	1.938E+02	2.588E-03
C-14	2.600E+04	0.000E+00	4.859E+08	2.040E+08	3.690E-08
NA-24	1.376E+04	1.385E+07	4.255E+06	1.084E-03	2.389E+05
P-32	1.888E+06	0.000E+00	3.153E+10	3.931E+09	1.608E+09
CR-51	2.096E+04	5.506E+06	8.387E+06	9.471E+05	1.037E+07
MN-54	1.984E+06	1.625E+09	2.875E+07	1.436E+07	9.320E+08
MN-56	5.744E+04	1.068E+06	4.856E-01	8.302E-52	9.451E+02
FE-55	1.240E+05	0.000E+00	4.454E+07	2.382E+08	3.259E+08
FE-59	1.528E+06	3.204E+08	2.861E+08	1.171E+09	9.895E+08
CO-58	1.344E+06	4.464E+08	1.095E+08	1.942E+08	6.034E+08
CO-60	8.720E+06	2.532E+10	3.621E+08	7.600E+08	3.238E+09
NI-63	5.800E+05	0.000E+00	1.182E+10	1.519E+10	1.606E+10
NI-65	3.672E+04	3.451E+05	4.692E+00	1.305E-51	3.966E+02
CU-64	6.144E+04	6.876E+05	3.293E+06	1.713E-05	6.465E+05
ZN-65	1.240E+06	8.583E+08	7.315E+09	8.688E+08	1.471E+09
ZN-69	1.584E+03	0.000E+00	1.760E-11	0.000E+00	2.067E-05
BR-83	3.440E+02	7.079E+03	1.790E-01	5.066E-57	2.911E+00
BR-84	4.328E+02	2.363E+05	2.877E-23	0.000E+00	2.251E-11
BR-85	1.832E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	1.904E+05	1.035E+07	4.746E+09	4.101E+08	2.772E+08
RB-88	5.456E+02	3.779E+04	3.886E-45	0.000E+00	3.168E-22
RB-89	3.520E+02	1.452E+05	9.774E-54	0.000E+00	1.247E-26
SR-89	2.416E+06	2.509E+04	2.674E+09	2.545E+08	1.513E+10
SR-90	1.080E+08	0.000E+00	6.612E+10	8.049E+09	7.507E+11
SR-91	2.592E+05	2.511E+06	2.409E+05	5.794E-10	1.291E+06
SR-92	1.192E+05	8.631E+05	2.277E+01	2.516E-48	1.012E+04
Y-90	5.592E+05	5.308E+03	1.074E+06	7.470E+05	1.025E+08
Y-91M	3.200E+03	1.161E+05	5.129E-18	0.000E+00	2.285E-07
Y-91	2.936E+06	1.207E+06	6.475E+06	3.910E+08	3.212E+09
Y-92	1.648E+05	2.142E+05	2.828E+00	3.522E-35	2.360E+04
Y-93	5.792E+05	2.534E+05	1.312E+04	1.688E-07	4.983E+06
ZR-95	2.688E+06	2.837E+08	1.201E+06	1.092E+09	1.253E+09
ZR-97	6.304E+05	3.445E+06	4.225E+04	9.231E-01	1.673E+07
NB-95	7.512E+05	1.605E+08	3.338E+08	4.251E+09	4.551E+08
MO-99	2.688E+05	4.626E+06	1.023E+08	1.892E+05	1.293E+07
TC-99M	6.128E+03	2.109E+05	1.055E+04	6.471E-18	5.011E+03
TC-101	6.672E+02	2.277E+04	3.287E-58	0.000E+00	3.229E-29
RU-103	7.832E+05	1.265E+08	1.513E+05	7.162E+09	5.706E+08
RU-105	9.040E+04	7.212E+05	1.263E+00	3.900E-25	4.039E+04
RU-106	1.608E+07	5.049E+08	1.799E+06	1.130E+11	1.484E+10
AG-110M	6.752E+06	4.019E+09	2.559E+10	1.345E+09	4.031E+09

TABLE 2.2-2c (Continued)

PATHWAY DOSE FACTORS (Ri) FOR TECHNICAL SPECIFICATIONS 4.11.2.3 AND SECTION 2.2.2.b

AGE GROUP	(TEENAGER)	(N.A.)	(TEENAGER)	(TEENAGER)	(TEENAGER)
ISOTOPE	INHALATION	GROUND PLANE	GRS/COW/MILK	GRS/COW/MEAT	VEGETATION
TE-125M	5.360E+05	2.128E+06	8.863E+07	8.941E+08	4.375E-08
TE-127M	1.656E+06	1.083E+05	3.420E+08	3.816E+09	2.236E-09
TE-127	8.080E+04	3.293E+03	9.572E+04	1.689E-08	4.180E+05
TE-129M	1.976E+06	2.305E+07	4.602E+08	3.966E+09	1.508E+09
TE-129	3.296E+03	3.076E+04	2.196E-09	0.000E+00	3.418E-03
TE-131	6.208E+05	9.459E+06	2.529E+07	1.447E+04	3.248E+07
TE-131	2.336E+03	3.450E+07	2.879E-32	0.000E+00	6.099E-15
TE-132	4.632E+05	4.968E+06	8.581E+07	2.300E+07	7.818E+07
I-130	1.488E+06	6.692E+06	1.742E+08	4.005E-04	8.276E-07
I-131	1.464E+07	2.089E+07	2.195E+11	3.646E+09	3.140E+10
I-132	1.512E+05	1.452E+06	2.242E+07	1.389E-57	4.262E+03
I-133	2.920E+06	2.981E+06	1.674E+09	7.234E+01	4.587E-08
I-134	3.952E+04	5.305E+05	1.583E-10	0.000E+00	3.854E-03
I-135	6.208E+05	2.947E+06	3.777E+06	5.963E-15	5.832E+06
CS-134	1.128E+06	8.007E+09	2.310E+10	1.231E+09	1.671E+10
CS-136	1.936E+05	1.702E+08	1.759E+09	3.671E+07	1.708E+08
CS-137	8.480E+05	1.201E+10	1.781E+10	9.634E+08	1.348E+10
CS-138	8.560E+02	4.102E+05	3.149E-23	0.000E+00	6.935E-11
BA-139	6.464E+03	1.194E+05	7.741E-07	0.000E+00	2.472E-01
BA-140	2.032E+06	2.346E+07	7.483E+07	3.663E+07	2.130E+08
BA-141	3.288E+03	4.734E+04	4.922E-46	0.000E+00	8.699E-22
BA-142	1.912E+03	5.064E+04	0.000E+00	0.000E+00	2.269E-39
LA-140	4.872E+05	2.180E+07	2.291E+05	8.689E+02	5.104E+07
LA-142	1.200E+04	8.886E+05	2.574E-07	0.000E+00	1.868E+00
CE-141	6.136E+05	1.540E+07	1.696E+07	2.252E+07	5.404E+08
CE-143	2.552E+05	2.627E+06	1.671E+06	3.695E+02	2.040E+07
CE-144	1.336E+07	8.032E+07	1.655E+08	3.089E+08	1.326E+10
PR-143	4.832E+05	0.000E+00	9.553E+05	5.817E+07	2.310E+08
PR-144	1.752E+03	2.112E+03	1.238E-53	0.000E+00	3.097E-26
ND-147	3.720E+05	1.009E+07	7.116E+05	2.452E+07	1.424E+08
W-187	1.768E+05	2.740E+06	2.646E+06	3.989E+00	7.839E+06
NP-239	1.320E+05	1.976E+06	1.060E+05	3.387E+03	2.097E+07

Units: Inhalation and all tritium pathways - mrem/yr per uCi/m³
Others - m³ . mrem/yr per uCi/sec

Values based on standard NUREG-0133, Section 5.3.1 assumptions unless otherwise indicated.

TABLE 2.2-2d

PATHWAY DOSE FACTORS (Ri) FOR TECHNICAL SPECIFICATIONS 4.11.2.3 AND SECTION 2.2.2.b

AGE GROUP	(ADULT)	(N. A.)	(ADULT)	(ADULT)	(ADULT)
ISOTOPE	INHALATION	GROUND PLANE	GRS/COW/MILK	GRS/COW/MEAT	VEGETATION
H-3	1.264E+03	0.000E+00	7.629E+02	3.248E+02	2.26[illegible]E-03
C-14	1.816E+04	0.000E+00	2.634E+08	2.414E+08	2.276E-08
NA-24	1.024E+04	1.385E+07	2.438E+06	1.356E-03	2.690E-05
P-32	1.320E+06	0.000E+00	1.709E+10	4.651E+09	1.403E+09
CR-51	1.440E+04	5.506E+06	7.187E+06	1.772E+06	1.168E+07
MN-54	1.400E+06	1.625E+09	2.578E+07	2.812E+07	9.585E+08
MN-56	2.024E+04	1.068E+06	1.328E-01	4.958E-52	5.082E+02
FE-55	7.208E+04	0.000E+00	2.511E+07	2.933E+08	2.096E+08
FE-59	1.016E+06	3.204E+08	2.326E+08	2.080E+09	9.875E+08
CO-58	9.280E+05	4.464E+08	9.565E+07	3.703E+08	6.252E+08
CO-60	5.968E+06	2.532E+10	3.082E+08	1.413E+09	3.139E+09
NI-63	4.320E+05	0.000E+00	6.729E+09	1.888E+10	1.040E-10
NI-65	1.232E+04	3.451E+05	1.219E+00	7.405E-52	2.026E+02
CU-64	4.896E+04	6.876E+05	2.031E+06	2.307E-05	7.841E+05
ZN-65	8.640E+05	8.583E+08	4.365E+09	1.132E+09	1.009E+09
ZN-69	9.200E+02	0.000E+00	5.207E-12	0.000E+00	1.202E-05
BR-83	2.408E+02	7.079E+03	1.399E-01	8.648E-57	4.475E+00
BR-84	3.128E+02	2.363E+05	1.609E-23	0.000E+00	2.475E-11
BR-85	1.280E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	1.352E+05	1.035E+07	2.604E+09	4.914E+08	2.217E+08
RB-88	3.872E+02	3.779E+04	2.139E-45	0.000E+00	3.428E-22
RB-89	2.560E+02	1.452E+05	5.523E-54	0.000E+00	1.385E-26
SR-89	1.400E+06	2.509E+04	1.451E+09	3.014E+08	9.961E+09
SR-90	9.920E+07	0.000E+00	4.680E+10	1.244E+10	6.046E+11
SR-91	1.912E+05	2.511E+06	1.377E+05	7.233E-10	1.451E+06
SR-92	4.304E+04	8.631E+05	9.675E+00	2.334E-48	8.452E+03
Y-90	5.056E+05	5.308E+03	7.511E+05	1.141E+06	1.410E+08
Y-91M	1.920E+03	1.161E+05	1.743E-19	0.000E+00	1.527E-08
Y-91	1.704E+06	1.207E+06	4.726E+06	6.231E+08	2.814E+09
Y-92	7.352E+04	2.142E+05	9.772E-01	2.657E-35	1.603E+04
Y-93	4.216E+05	2.534E+05	7.388E+03	2.075E-07	5.517E+06
ZR-95	1.768E+06	2.837E+08	9.587E+05	1.903E+09	1.194E+09
ZR-97	5.232E+05	3.445E+06	2.707E+04	1.292E+00	2.108E+07
NB-95	5.048E+05	1.605E+08	2.786E+08	7.748E+09	4.798E+08
MO-99	2.480E+05	4.626E+06	5.741E+07	2.318E+05	1.426E+07
TC-99M	4.160E+03	2.109E+05	5.553E+03	7.439E-18	5.187E+03
TC-101	3.992E+02	2.277E+04	1.813E-58	0.000E+00	3.502E-29
RU-103	5.048E+05	1.265E+08	1.189E+05	1.299E+10	5.577E+08
RU-105	4.816E+04	7.212E+05	5.240E-01	3.533E-25	3.294E+04
RU-106	9.360E+06	5.049E+08	1.320E+06	1.811E+11	1.247E+10
AG-110M	4.632E+06	4.019E+09	2.198E+10	2.523E+09	3.979E+09

TABLE 2.2-2d (Continued)

PATHWAY DOSE FACTORS (Ri) FOR TECHNICAL SPECIFICATIONS 4.11.2.3 AND SECTION 2.2.2.b

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AGE GROUP	(ADULT)	(N. A.)	(ADULT)	(ADULT)	(ADULT)
ISOTOPE	INHALATION	GROUND PLANE	GRS/COW/MILK	GRS/COW/MEAT	VEGETATION
TE-125M	3.136E+05	2.128E+06	6.626E+07	1.460E+09	3.927E-08
TE-127M	9.600E+05	1.083E+05	1.860E+08	4.531E+09	1.418E+09
TE-127	5.736E+04	3.293E+03	5.278E+04	2.034E-08	4.532E+05
TE-129M	1.160E+06	2.305E+07	3.028E+08	5.698E+09	1.261E+09
TE-129	1.936E+03	3.076E+04	9.167E-10	0.000E+00	2.806E-03
TE-131M	5.560E+05	9.459E+06	1.753E+07	2.190E+04	4.428E+07
TE-131	1.392E+03	3.450E+07	1.578E-32	0.000E+00	6.575E-15
TE-132	5.096E+05	4.968E+06	7.324E+07	4.287E+07	1.312E+08
I-130	1.136E+06	6.692E+06	1.050E+08	5.272E-04	9.809E+07
I-131	1.192E+07	2.089E+07	1.388E+11	5.034E+09	3.785E-10
I-132	1.144E+05	1.452E+06	1.342E+01	1.816E-57	5.016E+03
I-133	2.152E+06	2.981E+06	9.891E+08	9.336E+01	5.331E+08
I-134	2.984E+04	5.305E+05	9.491E-11	0.000E+00	4.544E-03
I-135	4.480E+05	2.947E+06	2.217E+06	7.644E-15	6.731E+06
CS-134	8.480E+05	8.007E+09	1.345E+10	1.565E+09	1.110E+10
CS-136	1.464E+05	1.702E+08	1.036E+09	4.724E+07	1.675E+08
CS-137	6.208E+05	1.201E+10	1.010E+10	1.193E+09	8.696E+09
CS-138	6.208E+02	4.102E+05	1.786E-23	0.000E+00	7.730E-11
BA-139	3.760E+03	1.194E+05	8.322E-08	0.000E+00	5.225E-02
BA-140	1.272E+06	2.346E+07	5.535E+07	5.917E+07	2.646E+08
BA-141	1.936E+03	4.734E+04	2.677E-46	0.000E+00	9.305E-22
BA-142	1.192E+03	5.064E+04	0.000E+00	0.000E+00	2.463E-39
LA-140	4.584E+05	2.180E+07	1.672E+05	1.385E+03	7.327E+07
LA-142	6.328E+03	8.886E+05	3.503E-08	0.000E+00	4.999E-01
CE-141	3.616E+05	1.540E+07	1.253E+07	3.632E+07	5.097E+08
CE-143	2.264E+05	2.627E+06	1.149E+06	5.547E+02	2.758E+07
CE-144	7.776E+06	8.032E+07	1.209E+08	4.928E+08	1.112E+10
PR-143	2.808E+05	0.000E+00	6.923E+05	9.204E+07	2.748E+08
PR-144	1.016E+03	2.112E+03	6.716E-54	0.000E+00	3.303E-26
ND-147	2.208E+05	1.009E+07	5.231E+05	3.935E+07	1.853E+08
W-187	1.552E+05	2.740E+06	1.796E+06	5.912E+00	1.046E+07
NP-239	1.192E+05	1.976E+06	7.385E+04	5.152E+03	2.872E+07

Units: Inhalation and all tritium pathways - mrem/yr per uCi/m³
Others - m³ . mrem/yr per uCi/sec

Values based on standard NUREG-0133, Section 5.3.1 assumptions unless otherwise indicated.

TABLE 2.2-3

CONTROLLING RECEPTORS, LOCATIONS, AND PATHWAYS

Sector	Distance (Meters)	Pathway	Age Group	Origin (for info only)
N	2816	Vegetation	Child	- garden
NNE	2414	Vegetation	Child	- garden
NE	1062	Inhal/Grd Plane	Infant	- residence
ENE	4828	Vegetation	Child	- garden
E	2414	Vegetation	Child	- garden
ESE	4426	Vegetation	Child	- garden
SE	3299	Inhal/Grd Plane	Infant	- residence
SSE	1690	Inhal/Grd Plane	Infant	- residence
S	1770	Inhal/Grd Plane	Infant	- residence
SSW	3734	Inhal/Grd Plane	Infant	- residence
SW	1432	Inhal/Grd Plane	Infant	- residence
WSW	8047	Cow/Milk	Infant	- hypothetical
W	8047	Cow/Milk	Infant	- hypothetical
WNW	6437	Inhal/Grd Plane	Infant	- residence
NW	8047	Cow/Milk	Infant	- hypothetical
NNW	1738	Inhal/Grd Plane	Infant	- residence

Table based on Reference 4, Tables 5.2.8 and 6.1.26.

2.3 Meteorological Model

2.3.1 The atmospheric dispersion for all gaseous releases is calculated using a ground-level, wake-split form of the straight line flow model.

X/Q = atmospheric dispersion (sec/m^3)

$$= \frac{2.03\ \delta\ k}{ru\ \sum}$$

Where,

r = distance (m) from release point to location of interest

δ = plume depletion factor at distance r from Figure 2.3-1.

u = wind speed at ground level (m/sec)

k = open terrain recirculation factor at distance r, from Figure 2.3.4

$\sum$ = the lesser of $(\sigma^2 + \frac{b^2}{\pi})^{\frac{1}{2}}$ or $\sqrt{3}\,\sigma$

Where,

σ = vertical standard deviation (m) of the plume at distance r for ground-level releases under the stability category indicated by $\dot{T}$, from Figure 2.3-2.

$\dot{T}$ = temperature differential with vertical separation (°K/100m)

b = height of the reactor building = 53.3m.

2.3.2 Relative deposition per unit area for all releases is calculated for a ground level release as follows:

D/Q = relative deposition per unit area (m^{-2})

$$= \frac{2.55}{r} (D_g)$$

Where,

D_g = relative deposition rate at distance r for ground level releases from Figure 2.3-3.

TABLE 2.3-1

ATMOSPHERIC DISPERSION PARAMETERS* FOR TECHNICAL SPECIFICATIONS 4.11.2.1.1, 4.11.2.2, 4.11.2.3, 4.11.2.5.1

SECTOR	X/Q	D/Q
N	5.468×10^{-7}	1.840×10^{-9}
NNE	4.079×10^{-7}	1.600×10^{-9}
NE	1.121×10^{-6}	5.759×10^{-9}
ENE	7.044×10^{-8}	3.207×10^{-10}
E	2.283×10^{-7}	1.093×10^{-9}
ESE	7.188×10^{-8}	3.520×10^{-10}
SE	1.817×10^{-7}	8.420×10^{-10}
SSE	7.600×10^{-7}	3.300×10^{-9}
S	1.219×10^{-6}	3.809×10^{-9}
SSW	4.113×10^{-7}	8.261×10^{-10}
SW	3.001×10^{-6}	4.440×10^{-9}
WSW	3.931×10^{-7}	3.177×10^{-10}
W	4.259×10^{-7}	3.476×10^{-10}
WNW	4.359×10^{-7}	4.662×10^{-10}
NW	1.548×10^{-7}	2.733×10^{-10}
NNW	1.373×10^{-6}	4.174×10^{-9}

* Reference: Grand Gulf Nuclear Station, Environmental Report, Table 6.1.26.

2.4 Definitions of Gaseous Effluents Parameters

b = height of reactor building (m) (2.3.1)

C = count rate of the station vent monitor corresponding to grab sample radionuclide concentrations (2.1.1)

C' = count rate of station vent monitor corresponding to a 1.0 uCi/ml concentration of Xe-133 (2.1.2)

c = count rate of the containment purge monitor for radionuclide concentrations to be discharged (2.1.2)

c' = count rate of the containment purge monitor corresponding to a 1.0 uCi/ml concentration of Xe-133 (2.1.2)

D_g = relative deposition rate for ground level releases from Figure 2.3-3 (m^{-1}) (2.3.2)

D_o = average organ dose rate in current year (mrem) (2.2.1.b)

D_p = dose to an individual from radioiodines and radionuclides in particulate form, with half-life greater than eight days (mrem) (2.2.2.b)

D_s = average skin dose rate in current year (mrem) (2.2.1.a)

D_{tb} = average total body dose rate in current year (mrem) (2.2.1.a)

D_β = air dose due to beta emissions from noble gas radionuclide i (mrad) (2.2.2.a)

D_γ = air dose due to gamma emissions from noble gas radionuclide i (mrad) (2.2.2.a)

D/Q = relative deposition per unit area (m^{-2}) (2.3.2)

δ = plume depletion factor at distance r for appropriate stability class and effective height from Figures 2.3-2 and 2.3-3. (2.3.1)

F = fraction of current year elapsed at time of calculation (2.1.1)

k = open terrain recirculation factor at distance r from Figure 2.3-1 (2.3.1)

2.4 Definitions of Gaseous Effluents Parameters (Continued)

K = total body dose factor for Kr-89, the most restrictive isotope (mrem/yr per uCi/m³), from Table 2.1-1 (2.1.2)

K_i = total body dose factor due to gamma emissions from isotope i (mrem/yr per uCi/m³) from Table 2.1-1 (2.1.1)

D_{TB} = limiting dose rate to the total body based on the limit of 500 mrem in one year. (2.1.1)

D_{ss} = limiting dose rate to the skin based on the limit of 3000 mrem in one year. (2.1.1)

D'_{TB} = limiting dose rate to the total body based on the limit of 500 mrem in one year (containment purge) (2.1.2)

D'_{ss} = limiting dose rate to the skin based on the limit of 3000 mrem in one year (containment purge) (2.1.2)

D''_{TB} = limiting dose rate to the total body based on the conservative dose rate of 500 mrem/year. (Note 2)

D''_{ss} = limiting dose rate to the skin based on the conservative dose rate of 3000 mrem/year. (Note 2)

L = skin dose factor for Kr-89, the most restrictive isotope (mrem/yr per uCi/m³) from Table 2.1-1 (2.1.2)

L_i = skin dose factor due to beta emissions from isotope i (mrem/yr per uCi/m³) from Table 2.1-1 (2.1.1)

M = air dose factor for Kr-89, the most restrictive isotope (mrad/yr per uCi/m³), from Table 2.1-1 (2.1.2)

M_i = air dose factor due to gamma emissions from isotope i (mrad/yr per uCi/m³) from Table 2.1-1 (2.1.1)

N_i = air dose factor due to beta emissions from noble gas radionuclide i (mrad/yr per uCi/m³) from Table 2.1-1 (2.2.2.a)

P_i = dose parameter for radionuclide i, (mrem/yr per uCi/m³) for inhalation from (m³ · mrem/yr per uCi/sec) for other pathways, from Table 2.2-1 (2.2.1.b)

$\dot{Q}_i$ = rate of release of noble gas radionuclide i (uCi/sec) (2.1.1)

$\overline{Q}_i$ = average rate of release of noble gas radionuclide i for the elapsed fraction of the year F (uCi/sec) (2.1.1)

2.4 Definitions of Gaseous Effluents Parameters (Continued)

$\overline{Q'}_i$ = average release rate of isotope i of radioiodine or other radionuclide in particulate form, with half-life greater than eight (8) days in the current year (uCi/sec) (2.2.1.b)

$\tilde{Q}_i$ = cumulative release of noble gas radionulide i over the period of interest (uCi) (2.2.2.a)

$\tilde{Q}'_i$ = cumulative release of radionuclide i of iodine or material in particulate form over the period of interest (uCi) (2.2.2.b)

$\dot{q}_i$ = rate of release of noble gas radionuclide i (uCi/sec) (2.1.2)

$\overline{q}_i$ = average rate of release of noble gas radionuclide i from the elapsed fraction of the year F (uCi/sec) (2.1.2)

$\dot{Q}''$ = assigned release rate value of, for example, 1.0 uCi/sec, Xe-133; related to definition of C' for the vent. (Note 3)

$\dot{q}''$ = release rate from containment purge associated with maximum flow from system and concentration specified for c'. (Note 3)

R_i = dose factor for radionuclide i, (mrem/yr per uCi/m^3) or (m^2 • mrem/yr per uCi/sec)

R_s = count rate per mrem/yr to the skin. (2.1.1)

R_t = count rate per mrem/yr to the total body. (2.1.1)

R''_s = conservative count rate per mrem/yr to the skin. (2.1.2)

R''_t = conservative count rate per mrem/yr to the total body (Xe-133 detection, Kr-89 dose). (2.1.2)

r = distance (m) from release point to location of interest for dispersion calculation. (2.3.1)

r_s = count rate per mrem/yr to the skin for containment purge monitor only. (2.1.2)

r_t = count rate per mrem/yr to the total body for containment purge monitor only. (2.1.2)

r''_s = conservative count rate per mrem/yr to the skin for containment purge only. (2.1.2)

2.4 Definitions of Gaseous Effluents Parameters (Continued)

r''_t = conservative count rate per mrem/yr to the total body for containment purge only. (2.1.2)

S_d = count rate of containment purge noble gas monitor at alarm setpoint level. (2.1.2)

S_v = count rate of station vent noble gas monitor at alarm setpoint level. (2.1.1)

$\sum$ = vertical standard deviation of the plume with building wake correction (m). (2.3.1)

σ = vertical standard deviation (m) of the plume at distance r for effective height under stability category indicated by T(m) from Figure 2.3-2. (2.3.1)

$\dot{T}$ = temperature differential with vertical separation (°K/100m). (2.3.1)

u = wind speed at ground level (m/sec). (2.3.1)

W = controlling sector annual average atmospheric dispersion at the site boundary for the appropriate pathway (sec/m³). (2.2.1.b)

W' = relative concentration for unrestricted areas (sec/m³). (2.2.2.b)

X/Q = atmospheric dispersion (sec/m³) (2.3.1)

$\overline{X/Q}$ = highest sector annual average atmospheric dispersion at the unrestricted area boundary (sec/m³) (2.1.1)

$\overline{X/Q}'$ = relative concentration for unrestricted areas (sec/m³) (2.2.2.a)

Figure 2.3-1 Plume Depletion Effect for Ground Level Releases
(All Atmospheric Stability Classes)

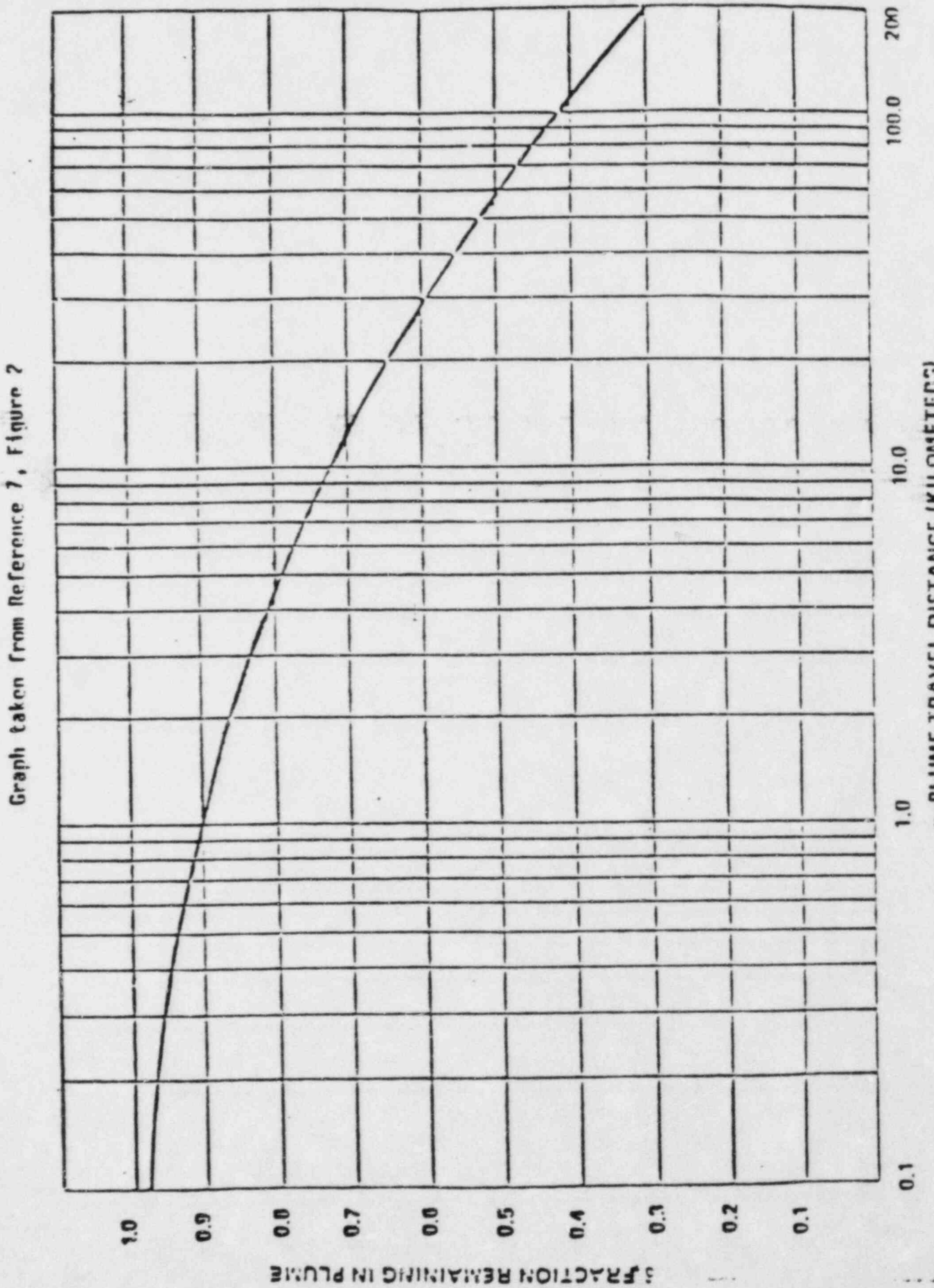
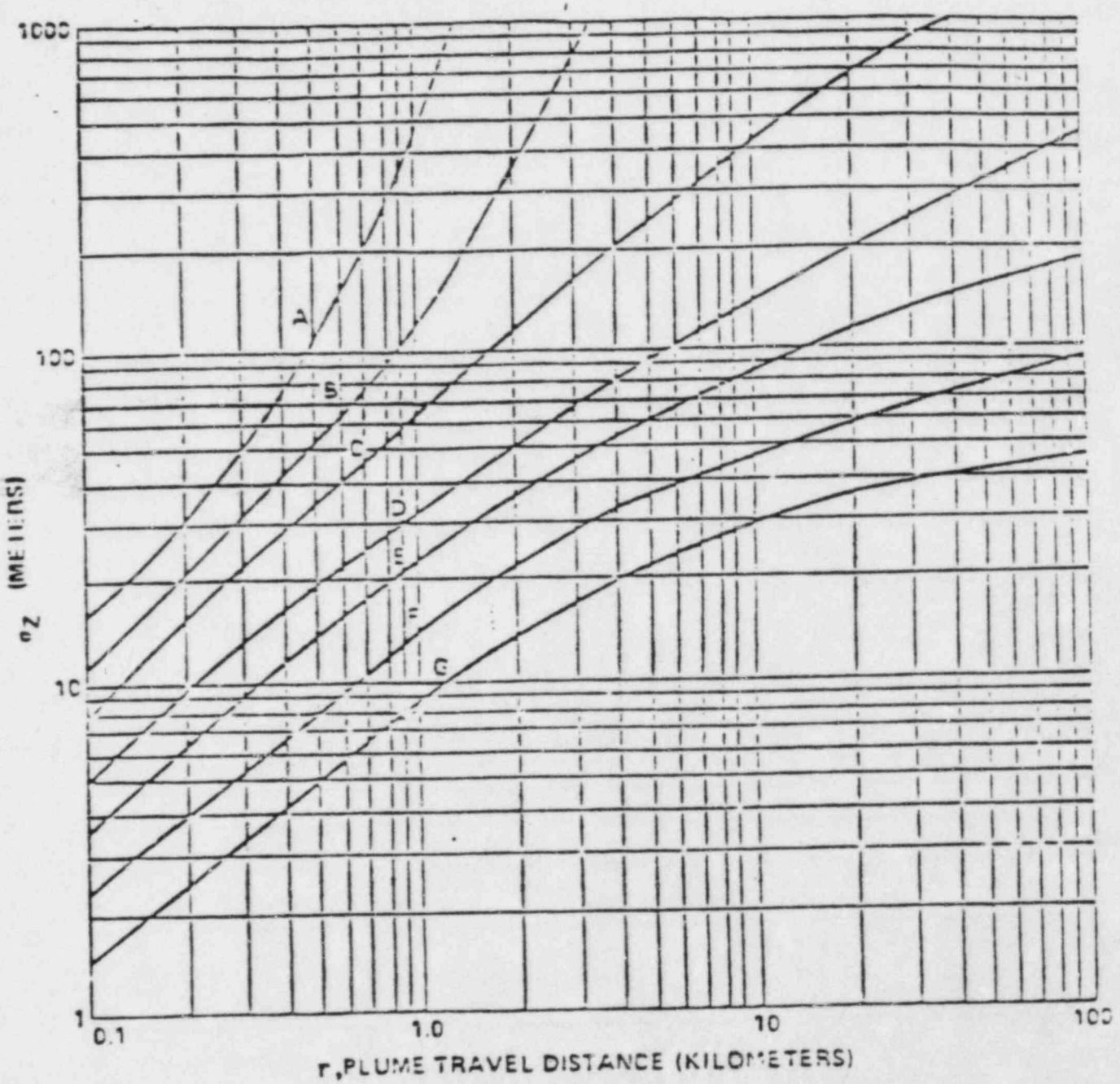


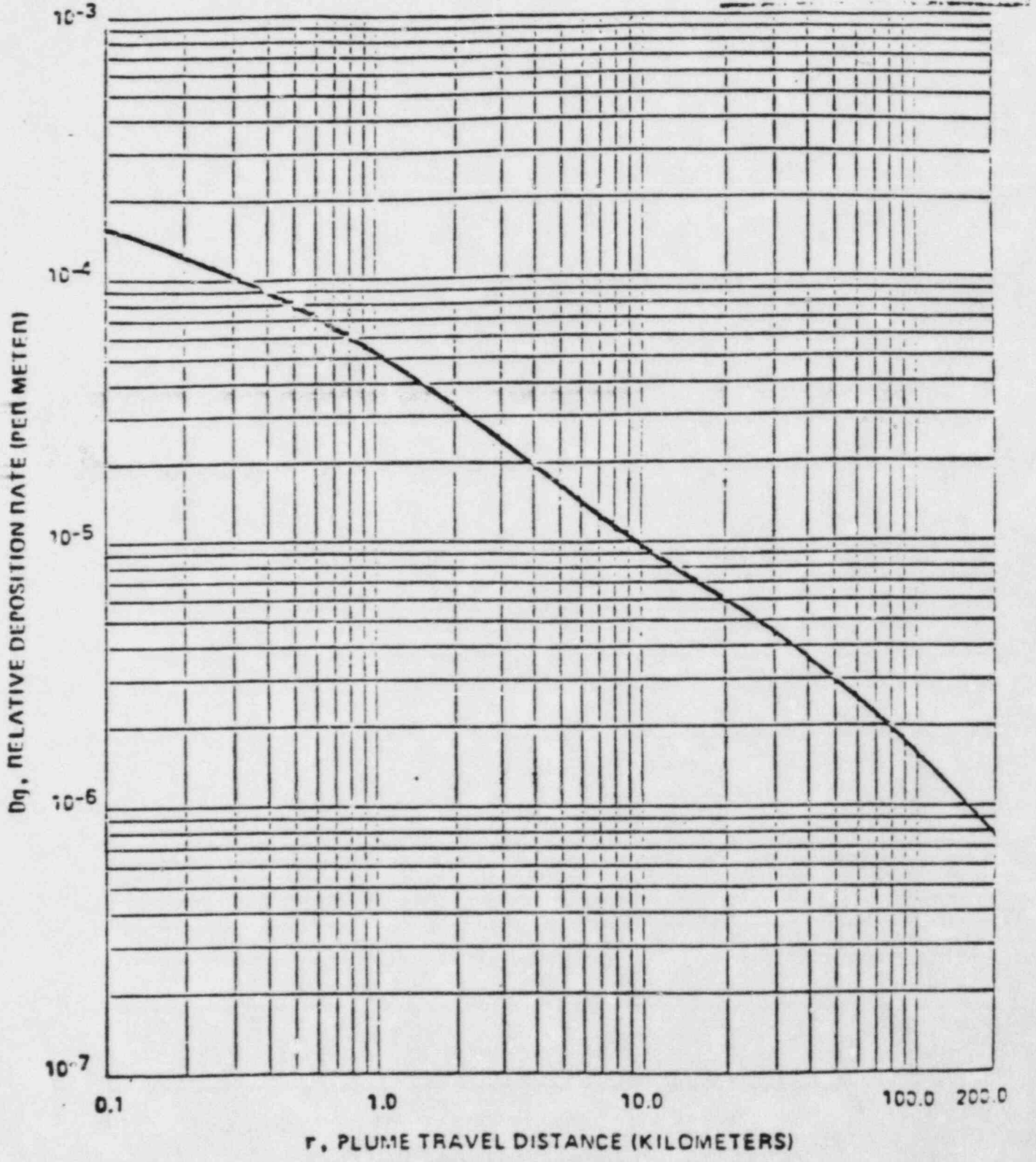
Figure 2.3-2 Vertical Standard Deviation of Material in a Plume (Letters denote Pasquill Stability Class)



Graph taken from Reference 7, Figure 1

Temperature Change with Height (°K/100 m)	Pasquill Categories	Stability Classification
≤ -1.9	A	Extremely unstable
-1.9 to -1.7	B	Moderately unstable
-1.7 to -1.5	C	Slightly unstable
-1.5 to -0.5	D	Neutral
-0.5 to 1.5	E	Slightly stable
1.5 to 4.0	F	Moderately stable
> 4.0	G	Extremely stable

Figure 2.3-3 Relative Deposition for Ground-Level Releases (All Atmospheric Stability Classes)



Graph taken from Reference 7, Figure 6

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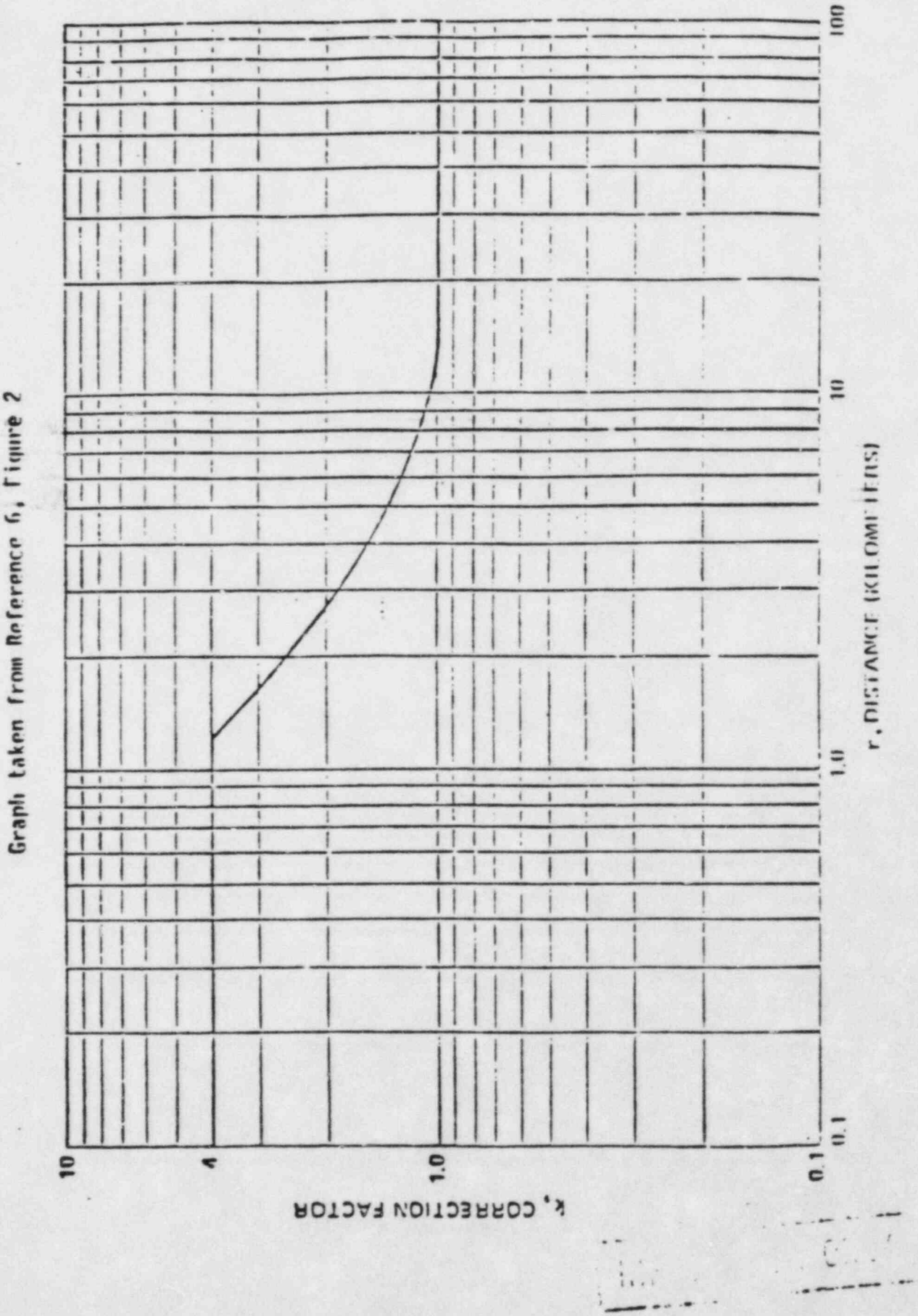
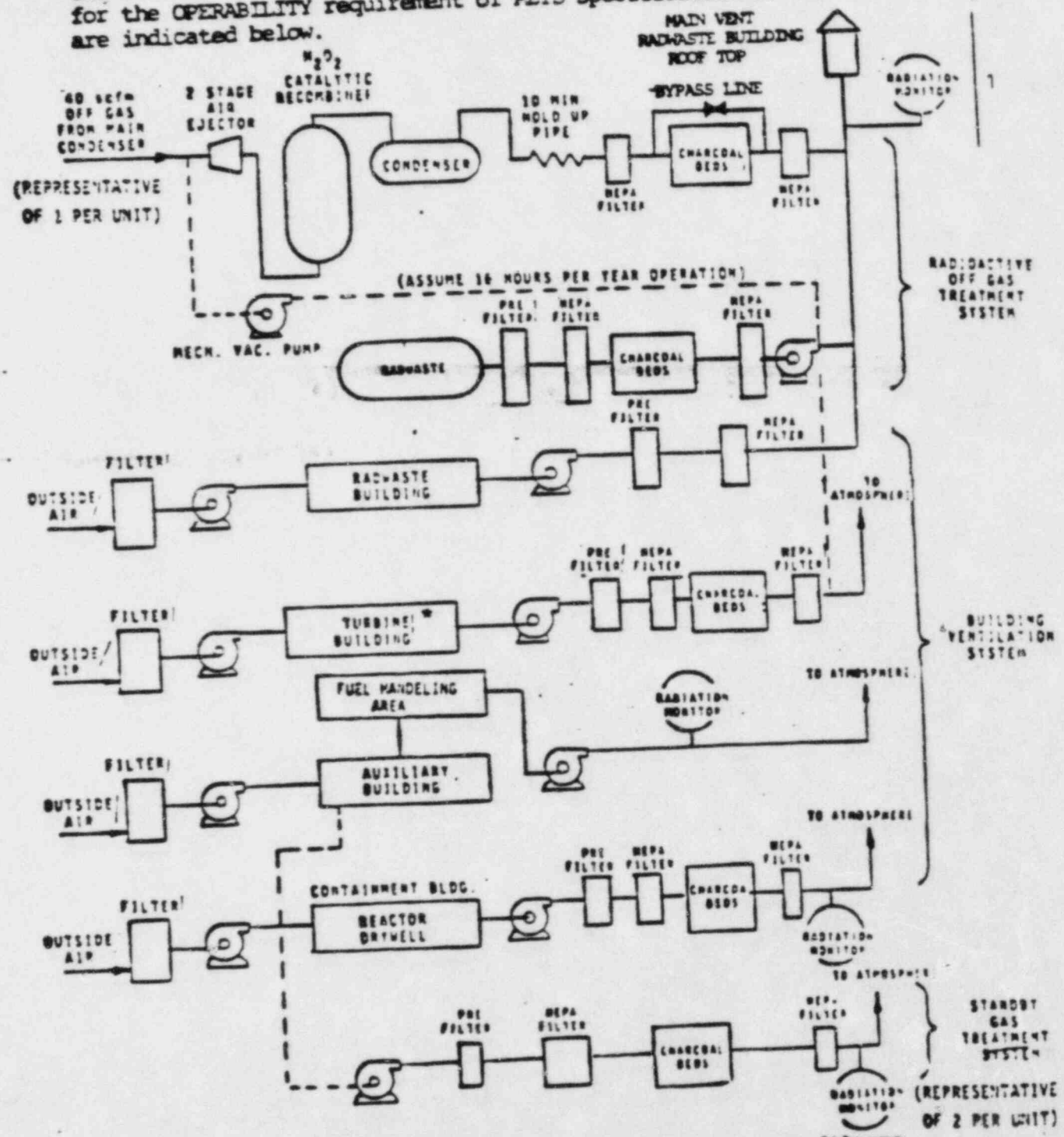
Figure 2.3-4 Open Terrain Recirculation Factor



2.5 GASEOUS RADWASTE TREATMENT SYSTEM

The essential components of the gaseous radwaste treatment system for the OPERABILITY requirement of PETS Specification 3/4.11.2.4 are indicated below.



*During normal operations the demister and filter units (prefilters, charcoal filters and HEPA filters) are not installed in the filter train. However, the filter train is available to be operable at a later date when the filter and demister are installed.

Taken from Reference 4, Figure 3-8.

3.0 RADIOLOGICAL ENVIRONMENTAL MONITORING

Sampling locations as required in section 3/4.12.1 of the Radiological Effluent Technical Specification are described in Table 3.0-1 through 3.0-3 and shown on maps in Figures 3.0-1 through 3.0-4. | 1

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TABLE 3.0-1

AIR SAMPLER COLLECTION SITES

AIR SAMPLERS

NUMBER	FIGURE	LOCATION
* AS-1 PG	3.0-3	Southwest of GGNS at the Port Gibson City Barn. (Sector G Radius 5 miles)
AS-2 61N	3.0-2	North Northeast of GGNS, on Hwy 61 South across from the Yokena Church. Approximately 20 miles from GGNS. (Sector B Radius 13 miles)
* AS-3 61 VA	3.0-2	North Northeast of GGNS on Hwy 61 south at the Vicksburg Airport. (Sector B Radius 18 miles)
* AS-4 GJOE	3.0-1	Southwest of GGNS. Glodjo property on Waterloo Road. (Sector L Radius .9 miles)
* AS-5 TC	3.0-1	South of GGNS behind MP&L training center building. (Sector J Radius .5 miles)
AS-6 RS	3.0-1	Northeast of GGNS, South of Grand Gulf Road. (Sector C Radius .8 miles)
* AS-7 MT	3.0-1	North of GGNS. Located next to the met tower and met tower control building. (Sector A Radius .8 miles)
AS-8 WR	3.0-1	East of GGNS, located at Maggie Jackson's trailer on Waterloo Road near the Eastern Site Boundary. (Sector E Radius .5 miles)
AS-9 GGMP	3.0-1	North of GGNS, located in Grand Gulf Military Park. (Sector A Radius 1.5 miles)
AS-10 NLT	3.0-3	West Northwest of GGNS, located at Newellton, Louisiana. (Sector P Radius 12.5 miles)
AS-11 STJ	3.0-3	West Southwest of GGNS, located at St. Joseph, Louisiana. (Sector M Radius 13.0 miles)

* Technical Specification requirements

From Grand Gulf Nuclear Station's Annual Radiological Environmental Operating Report, 1982.

TABLE 3.0-2

MISCELLANEOUS COLLECTION SITES

	Figure	
MILK SAMPLES (CONTROL LOCATION)		
Alcorn State University*	3.0-3	Located Southwest of GGNS. (Sector K Radius 10.5 miles)
Rosco Johnson farm	3.0-3	Located Southeast of GGNS. (Sector G Radius 9 miles)
Hazetta Warren farm	3.0-3	Located in Louisiana West Northwest of GGNS. (Sector N Radius 8.5 miles)
CISTERN WATER		
1. Trimble Cistern*	3.0-4	Located east of GGNS at the Trimble Tenant House. (Sector E Radius .5 miles)
2. Willis Cistern*	3.0-3	Located at the C.E. Willis house East Northeast of GGNS across from the Shiloh Baptist Church. (Sector D Radius 6 miles)
GROUND WATER		
1. PGWELL*	3.0-4	PORT GIBSON WELL - Taken at Port Gibson City Water lift Station. (Sector G Radius 5.0 miles)
2. GGMPWELL	3.0-4	GRAND GULF MILITARY PARK - Taken from faucet at the Grand Gulf Military Park. (Sector A Radius 1.7 miles)
3. TRIMWELL*	3.0-4	TRIMBLE house faucet. (Sector E Radius 0.7 miles)
4. LAKE BRUIN	3.0-3	Taken from faucet at the bath house in Lake Bruin State Park, Louisiana. (Sector M Radius 9.9 miles)

* Technical Specification requirements

From Grand Gulf Nuclear Station's Annual Radiological Environmental Operating Report, 1982.

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TABLE 3.0-2 (CONTINUED)

Page 2 of 2

	Figure	
SURFACE WATER		
Upstream *	3.0-4	500-1500 yards upstream of the GGNS outfall to allow adequate mixing of the Mississippi and Big Black Rivers. (Sector Q)
Downstream *	3.0-4	1500 yards downstream of GGNS outfall, near the most southern radial well. (Sector N)
Discharge Basin *	3.0-4	West of GGNS, 0.5 miles, Sector P
VEGETATION		
Broad Leaf Vegetation*	3.0-4	South of GGNS in the MP&L garden near the training center, or South Southwest in Glodjo garden, or areas adjacent to these gardens. (Sector J, 0.4 miles)
		Lake Claiborne Willis garden (Sector E, 3.0 miles) 1
		Nelson Truck Farm (Sector E, 4.5 miles)
FISH SAMPLES		
Catfish *	3.0-4	Downstream of the discharge point in the Mississippi River
	3.0-4	Upstream of Discharge Point uninfluenced by Plant Operations.
SEDIMENT SAMPLES *		
	3.0-4	Collected semiannually during the low water periods of the Tidal Basin - samples taken downstream of the outfall in the vicinity of the boat landing near Hamilitaon Lake outlet and in the Barge Slip. (Sector N and Q, 2 miles)

* Technical Specification requirements
From Grand Gulf Nuclear Station's Annual Radiological Environmental Operating Report, 1982.

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TABLE 3.0-3
TLD LOCATIONS

TLD NO.	LOCATION	FIGURE	SECTOR	MILE
* M-01	REA Pole-East of Entry Gate at Lake Claiborne	3.0-3	E	3.5
M-02	REA Pole Left of Entry Gate Windsor Ruins	3.0-3	L	7.0
M-03	REA Pole-East Side Hwy 61 P.G. Country Club entrance	3.0-3	H	7.0
M-04	MP&L Pole-Hwy 547 North Side Between Twin Power Poles		G	7.5
M-05	50 yards North of Hwy 18 Approximately 5 miles East of U.S. 61	3.0-3	F	9.0
M-06	REA Pole-East of Willows Beyond MMB Church MS Hwy 462		E	8.0
* M-07	Port Gibson City Barn AS-1	3.0-3	G	5.5
M-08	West Side Big Black River South Entrance	3.0-3	C	8.5
* M-09	Oak Tree Hanger-South Warner Tully Camp	3.0-3	D	3.5
* M-10	Entrance Gate Grand Gulf Military Park	3.0-1	R	1.5
M-11	Hwy 61 3 miles North of Big Black River at Twin Tower	3.0-3	C	10.5
M-12	Hwy 61 at AS-2-61 North Yokena	3.0-2	B	13.0
M-13	Hwy 61 LeTourneau Hill West Side of Road	3.0-2	B	15.0
* M-14 (CONTROL)	Hwy 61 AS-3-61VA at Casket Company	3.0-2	B	18.0

* Technical Specification requirements
From Grand Gulf Nuclear Station's Annual Radiological Environmental Operating Report, 1982.

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TABLE 3.0-3 (CONTINUED)

TLD LOCATIONS

TLD NO.	LOCATION	FIGURE	SECTOR	MILE
M-15	Barge Slip (South edge)	3.0-1	P	1.5
* M-16	AS-7 MET Tower	3.0-1	A	1.0
M-17	AS-6-RS Grand Gulf Road	3.0-1	C	0.5
* M-18	Railroad Crossing Eastern Site Boundary	3.0-1	F	0.5
M-19	Behind Burn Pit on Fence at Eastern Site Boundary	3.0-1	E	0.5
M-20	Eastern Site Boundary Behind Burn Pit (Pine)	3.0-1	F	0.5
M-21	AS-5-TC Training Center	3.0-1	J	0.5
M-22	South of RR Entrance Crossing 100 Yards on West Side	3.0-1	G	0.5
M-23	County Road/Heavy Haul Road 50 Yards North on Power Pole	3.0-1	Q	0.5
M-24	Upper Grand Gulf Landing	3.0-1	R	2.0
* M-25	Hamilton Lake Boat Launch	3.0-1	N	1.0
M-26	Hamilton Lake Outfall	3.0-1	N	1.0
* M-27	South Point Site Boundary 200 Yards along Property Line	3.0-1	M	1.0
* M-28	AS-4-Glodjo Residence Glodjo	3.0-1	L	1.0
M-29	In sharp curve of Waterloo Road to Waterloo Plantation	3.0-1	K	1.5
* M-30	Arnold Acres Trailer Park Entrance	3.0-1	J	1.0
M-31	Duplicate TLD Installed at designated Site Number	-	-	-

* Technical Specification requirements

From Grand Gulf Nuclear Station's Annual Radiological Environmental Operating Report, 1982.

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TABLE 3.0-3 (CONTINUED)

TLD LOCATIONS

TLD NO.	LOCATION	FIGURE	SECTOR	MILE
M-32	Duplicate TLD Installed at designated Site Number	-	-	-
* M-33	Newellton, Louisiana Water Tower	3.0-3	P	12.0
* M-34	Primary Levee at End of Country Road at Point Pleasant, Louisiana	3.0-3	R	7.5
* M-35	Mor Landing - Lake Yucatan	3.0-3	Q	8.0
* M-36	Curve on 608 Point Nearest GGNS, at Power Pole	3.0-3	P	5.0
M-37	Winter Quarters Home	3.0-3	N	7.5
* M-38	Lake Bruin State Park Second Pole	3.0-3	M	9.0
* M-39	St. Joseph, Louisiana, Aux. Water Tank	3.0-3	M	12.0
* M-00	Maintained in lead shield during the exposure period	-	-	-
* M-40	International Paper Road, Approximately 5 miles from Site	3.0-3	M	5.0
* M-41	Heavy Haul Road - J Pipe on Concrete Block	3.0-1	P	1.0
* M-42	Heavy Haul Road North Iron Gate	3.0-1	Q	1.0
* M-43	Gin Lake Entrance	3.0-1	R	1.2
* M-44	Truck Bypass on Grand Gulf Road	3.0-1	C	0.5
* M-45	Visitor Center Gate East Side	3.0-1	D	0.5

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* Technical Specification requirements

From Grand Gulf Nuclear Station's Annual Radiological Environmental Operating Report, 1982.

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TABLE 3.0-3 (CONTINUED)

TLD LOCATIONS

TLD NO.	LOCATION	FIGURE	SECTOR	MILE
* M-46	Power Pole Across from Grand Gulf/Waterloo roads intersection	3.0-1	E	1.0
* M-47	Bridge 0.6 miles past Rodney Road/Greenwood Road intersection North Side	3.0-3	L	5.0
* M-48	Property Line Fence 0.4 miles on Greenwood Road on West Side	3.0-3	K	5.0
* M-49	Fork in Weathers Road	3.0-3	H	4.5
* M-50	Big Black River Boat Landing		B	5.0
* M-51	Power Pole 0.5 miles on Gravel Road to Big Black on West Side	3.0-3	C	5.0
* M-52	Power Pole-Waterloo Road Marked with White Paint	3.0-1	K	1.0
* M-53	Arnold Acres Property Fence Past Trailer Park	3.0-1	H	1.0
* M-54	Bottom of Curve Arnold Acres	3.0-1	G	1.0
* M-55	Behind Bonner's Beauty Shop at MSBH Air Sample	3.0-3	D	5.0
* M-56	Hwy 61 South at "All Creatures Veterinary Hospital"	3.0-3	G	5.0
* M-57	Hwy 61 North Behind the Welcome to Port Gibson sign	3.0-3	F	4.5
* M-58	Big Bayou Pierre Bridge Southwest End	3.0-3	E	5.0
* M-59	Off Levee at Winter Quarters Hunting Camp	3.0-3	N	5.1

* Technical Specification requirements

From Grand Gulf Nuclear Station's Annual Radiological Environmental Operating Report, 1982.

ODCM

TABLE 3.0-3 (CONTINUED)

TLD LOCATIONS

TLD NO.	LOCATION	FIGURE	SECTOR	MILE
M-60	Duplicate TLD	-	-	-
M-61	Protected area fence by the vehicle entrance gate	Not Shown	P	Onsite
M-62	Protected area fence North-east corner MP&L parking lot	"	N parking lot	"
M-63	Protected area fence middle MP&L parking lot	"	N	"
M-64	Protected area fence South-east corner MP&L parking	"	M	"
M-65	South protected area fence behind MP&L warehouse	"	L	"
M-66	South protected area fence across from cooling tower	"	K	"
M-67	South protected area fence West end North fence	"	J	"
M-68	East protected area fence across from chlorination tank	"	H	"
M-69	East protected area fence near electric Buss	"	G	"
M-70	North fence behind turbine bldg.	"	F	"
M-71	166' level on Unit 2 side of plant turbine bldg.	"	C	"
M-72	166' level turbine bldg. Unit 2 side	"	B	"
M-73	Corner of fence outside control bldg.	"	P	"

* Technical Specification requirements

From Grand Gulf Nuclear Station's Annual Radiological Environmental Operating Report, 1982.

ODCM

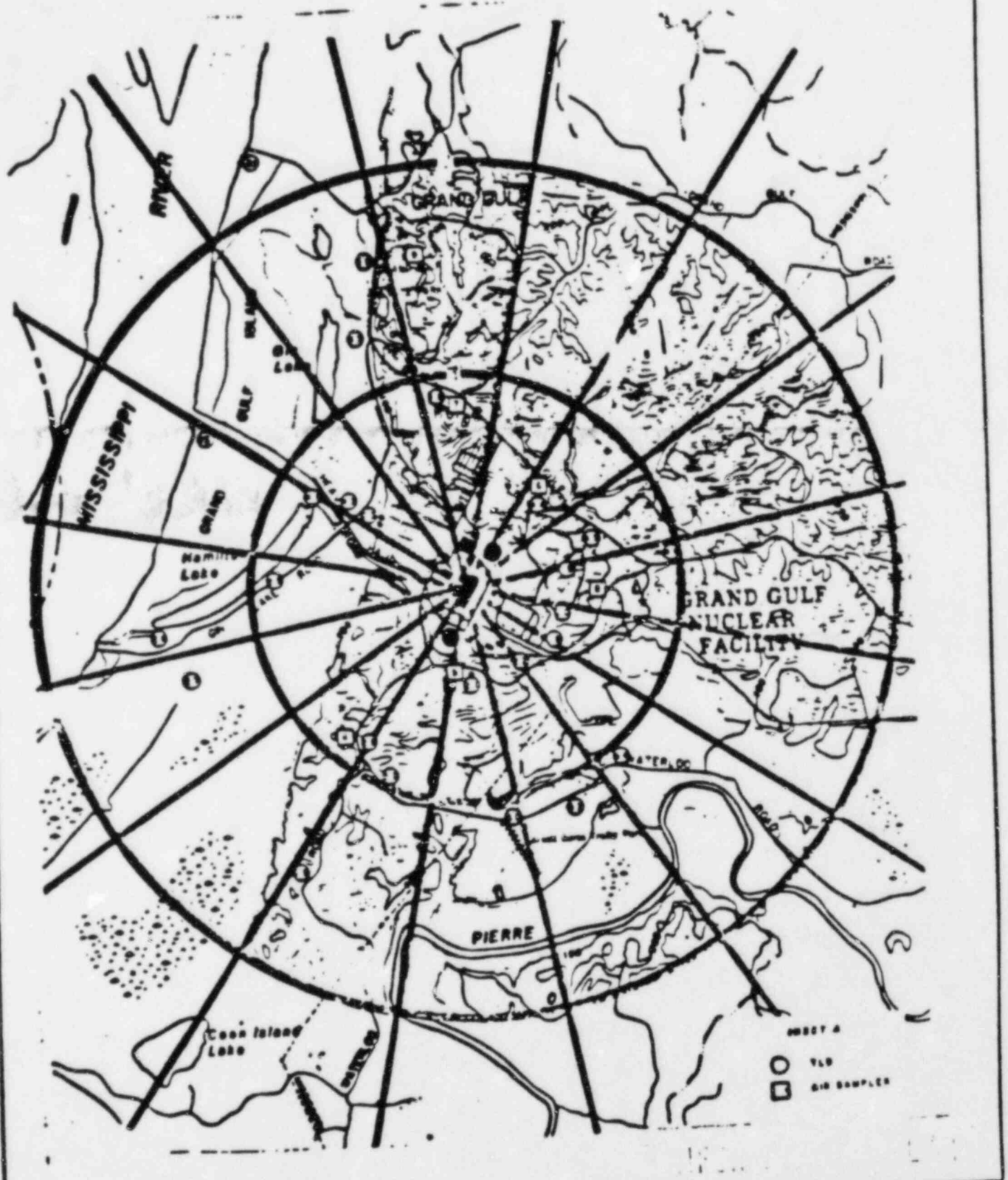
TABLE 3.0-3 (CONTINUED)

TLD LOCATIONS

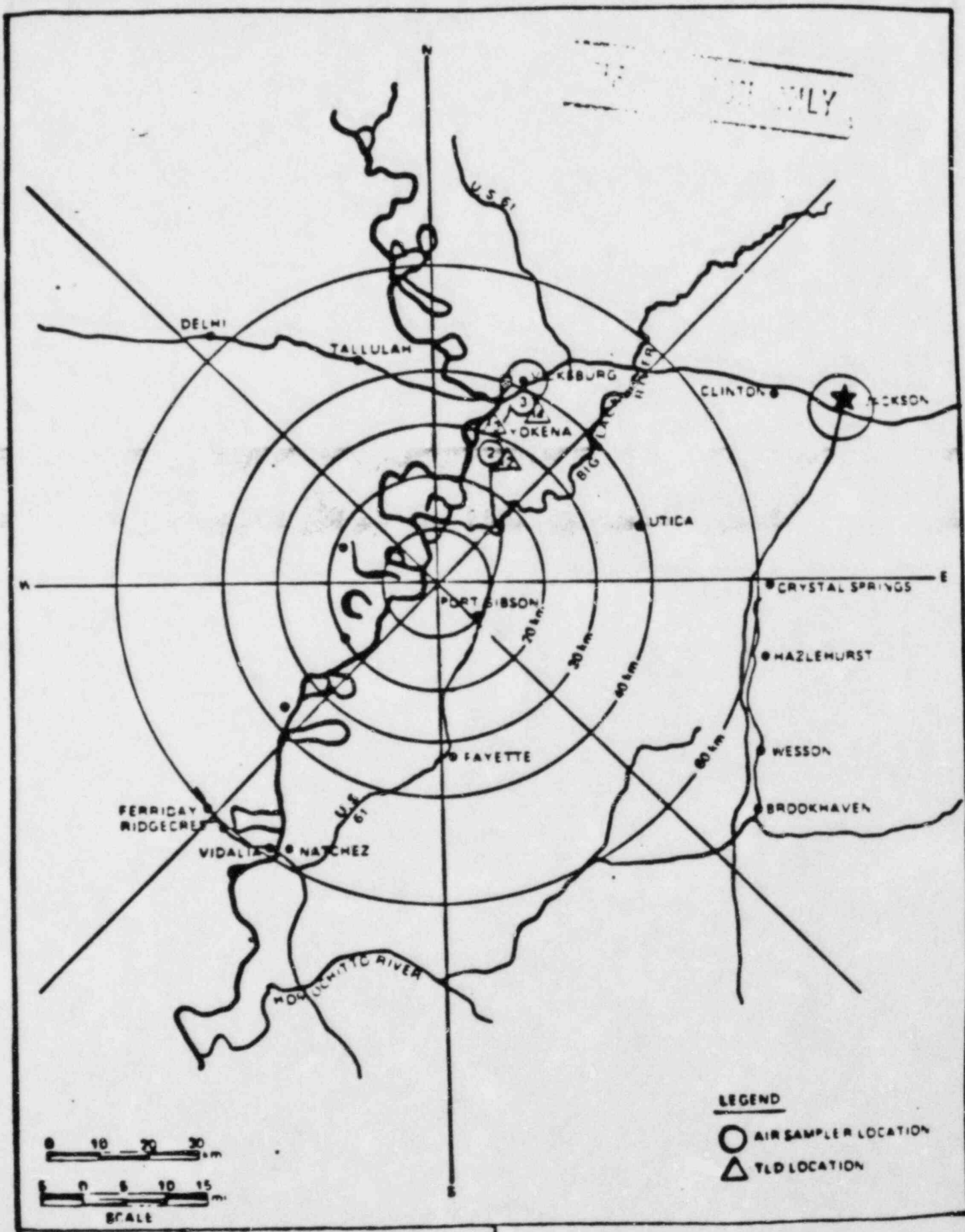
TLD NO.	LOCATION	FIGURE Not Shown	SECTOR	MILE
M-74	Midway of North fence	"	P	Onsite
M-75	Corner in fence in front of Maintenance Shop	"	A	"
M-76	Southeast corner SSW Basins	"	A	"
M-77	Protected area fence beside maintenance shop	"	R	"
M-78	Outside vault in Admin. Bldg.	"	Q	"
M-79	Wall in Central Records	"	Q	"
M-80	Wall in Central Records Old library location	"	Q	"
M-81	Inside Admin. Bldg., 2nd floor, northeast wall	"	Q	"
M-82	Tech Support Area	"	Q	"
M-83	Tech Support Secretary	"	Q	"
M-84	Security Island	"	P	"
M-85	Rotating duplicate	-	-	-
* M-86	Bechtel Gate North Site Boundary	3.0-1	B	0.5
* M-87	Intersection of Rodney Road & transmission line	3.0-3	J	4.5

1

* Technical Specification requirements
From Grand Gulf Nuclear Station's Annual Radiological Environmental Operating Report, 1982.

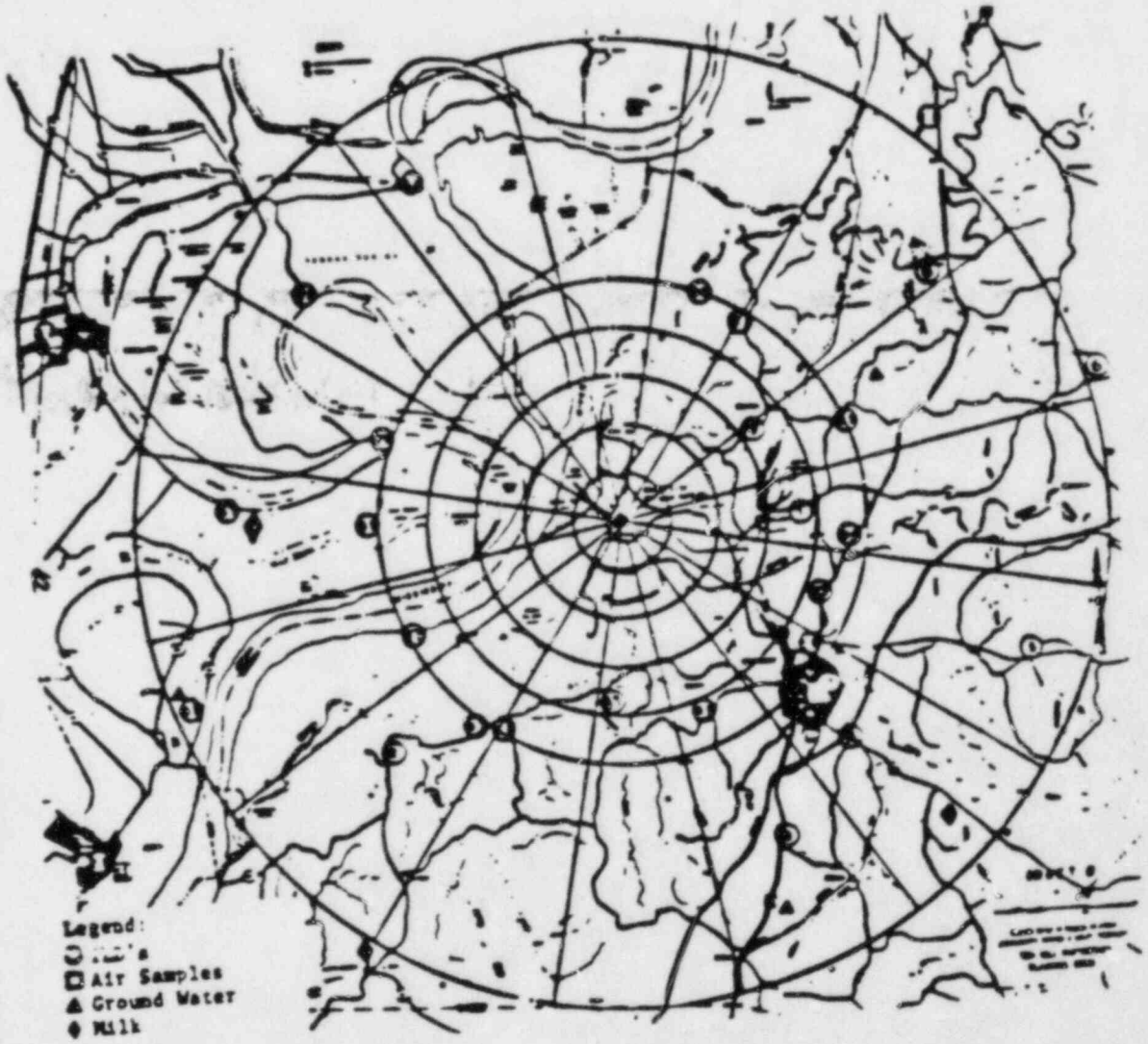


MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNIT 1 & 2 ODCM	COLLECTION SITE LOCATIONS GENERAL AREA MAP FIGURE 3.0-1



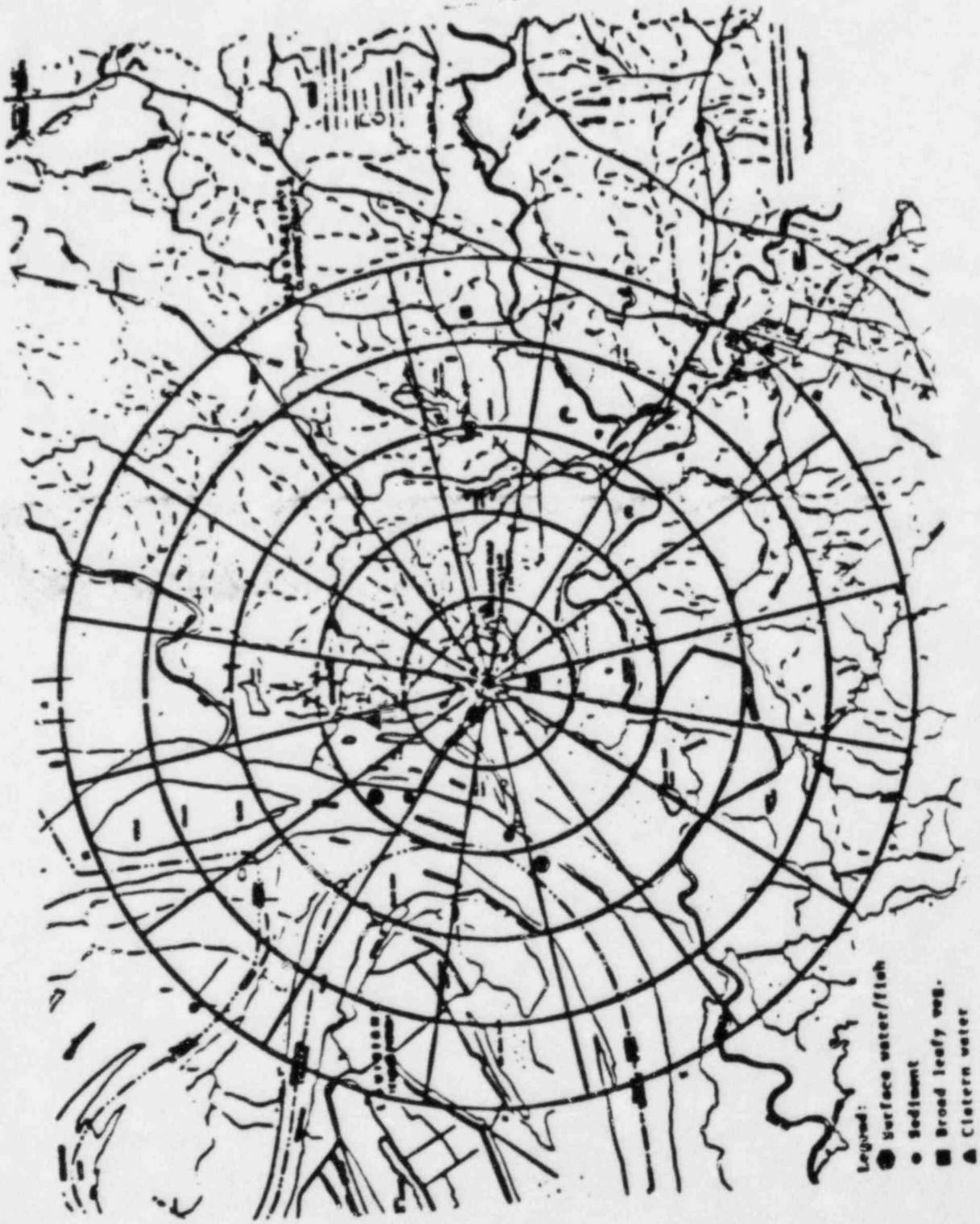
MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ODCM	COLLECTION SITE LOCATIONS GENERAL AREA MAP FIGURE 3.0-2

ONLY !



MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ODCM

COLLECTION SITE LOCATIONS
SITE PERIMETER
FIGURE 3.0-3



MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ODCM	COLLECTION SITE LOCATIONS GENERAL AREA MAP FIGURE 3.0-4

GRAND GULF NUCLEAR STATION

PROCESS CONTROL PROGRAM (PCP)

TYPICAL INSTRUCTIONS/REQUIREMENTS

TO BE PROVIDED FOR

SOLIDIFICATION OF RADWASTE SLURRIES AND

EVAPORATOR BOTTOMS CONCENTRATES

A. INTRODUCTION

1. The Grand Gulf Radwaste Solidification System provides for the solidification and packaging of radioactive wastes to ensure meeting the requirements of 10CFR Part 20 and 10CFR Part 71 prior to shipment of radioactive wastes from the site. Various types of radioactive wastes; e.g., filter sludges, spent resins of evaporator bottoms, etc. are mixed with Portland cement and conditioning additives to produce a monolithic solid without free liquid.

2. The Grand Gulf Technical Specification in section 4.11.3.2 defines the frequency of sampling of batches of radwaste and the additional sampling requirements which are invoked if either a solidification batch or a representative test sample fails to solidify.

3. Until such time that changes to the permanent plant radwaste solidification system based on contractor recommendations can be completed, a temporary radwaste solidification system and attendent services will be performed by a contractor with equipment and methodology as reviewed and approved by the Nuclear Regulatory Commission. The contractor and his process control program shall follow the required sampling frequencies and processing restrictions as specified for Grand Gulf. This PCP describes the classification of wastes, waste pretreatment and solidification and defines the required verification of solidification which is free from liquid.

B. CLASSIFICATION OF WASTE STREAMS

1. The Grand Gulf radwaste streams to be solidified have been classified into nine generic categories as follows:

Stream #1 - Waste Surge Tanks or Condensate Phase Separator Tanks (condensate filter backwash)

Stream #2 - RWCU Phase Separator Tanks (RWCU and FPCC filter demineralizer backwash)

Stream #3 - Liquid Radwaste Floor Drain Filter (Ecodex)

Stream #4 - Liquid Radwaste Equipment Filter (Ecodex)

Stream #5 - Resins H-OH from Condensate and Liquid Radwaste

Stream #6 - Evaporator Bottoms from Resin Regeneration

Stream #7 - Evaporator Bottoms from miscellaneous chemicals

Stream #8 - Evaporator Bottoms from Floor Drain Wastes

Stream #9 - Future

2. If the sampling program indicates a trend in specific generic type constituents beyond the specified limits originally established, the Process Control Program will be modified to assure continuing production of acceptable solidified wastes as follows:

a. New specific generic types will be established with appropriate changes to the proportion of solidification agent(s).

1. These new specific generic types will be tested in a manner similar to the original test program.

b. Tests will be conducted to determine the acceptable changes in the specified limits for existing generic types based on the analysis trends.

C. Conditioning of Specific Batches of Waste

Conditioning Waste Holding Tank contents for solidification as a specific generic type will consist of adjusting the water content of the slurry to within the solids/liquid specified limits and pH to within the pH specified limits for the particular waste. In the event that the specific activity of the waste exceeds the limits for maximum activity which can be safely processed by the contractor in the temporary radwaste solidification system, the contents of the Waste Holding Tank will be diluted per directions from the Chemistry/Radiation Control Superintendent, or his designee, until the specific activity of the waste has been reduced to a level which can be safety processed in the solidification system.

1. The Solid Radwaste System will be operated in accordance with GGNS operating procedures in a manner which will permit segregation of waste inputs into generic batches. With proper segregation, the only parameters that are variable are pH and percent solids. Classified wastes will be conditioned to adjust the pH and solid/liquid content within specified limits and then solidified as a batch with no further additions of solids or liquids into the respective Waste Holding Tank(s) until the batch is completely processed.

2. Waste Holding Tanks A and B should be normally used only to collect radwaste equipment drain filter and floor drain filter discharges (Ecodex) respectively. Liquid additions may be from the Condensate and Refueling Water Storage and Transfer System (CRWST) or regenerant evaporator bottoms.

3. Waste Holding Tank C should normally be used for spent resin discharges and filter and filter/demin (Ecodex) sludge with liquid additions from regenerant evaporator bottoms or CRWST.

4. Evaporator bottoms should normally be processed through waste holding tank C.

5. Reactor Water Cleanup System (RWCU) filter/demin sludge (Ecodex) is, typically, approximately one hundred times higher in specific activity than other sludges processed and should be segregated from other wastes and handled with extra care. RWCU filter/demineralizer sludge is normally processed through Waste Holding Tank C.

6. The operator will determine which specific generic batch the waste input represents (using methodology specified in Section D) and select the corresponding generic batch position before starting the solidification process.

   a. The operator is not authorized to "adjust" the individual process pump speed settings without specific authorization from the Chemistry/Radiation Control Superintendent, or his designee.

   b. If the waste input cannot be classified into a specific generic batch using Section D, a sample of the waste input will be obtained and analyzed. Process selection is then made using Section E.

7. Batches should be processed from the Waste Holding Tank expeditiously so as to eliminate potential cross-contamination with an unanalyzed batch.

8. Radwaste filter sludge as transferred to the Waste Holding Tank may have an excess of solids and therefore need liquid added to prepare it for solidification as generic stream #3 or #4 (20% or 27% solids).

   a. With the agitator OFF, add regenerant evaporator bottoms (preferred source) or condensate and refueling water until there is an observable change in tank level.

      NOTE: This will assure that the filter sludge is sufficiently wet to prevent agitator overload.

   b. Turn ON agitator and add liquid to obtain a 20% or 27% by weight mixture.

   c. Start the agitator at least 30 minutes prior to solidifying to assure a homogeneous mixture.

9. RWCU and FPCC filter/demin sludge as transferred to the Waste Holding Tank will have an excess amount of water which must be reduced to prepare it for solidification as generic batch #2.

   a. Transfer sludge from phase separators until the level in the Waste Holding Tank is in accordance with approved operating procedures.

   b. Allow contents to settle for at least four hours, then decant excess liquid to the RWCU phase separator until the decant pump trips.

      NOTE: This will leave approximately 1" of free standing water above the sludge.

   c. Start the agitator and add liquid from the regenerant evaporator bottoms (preferred source) or condensate and refueling water to obtain a 27% by weight mixture.

d. Start the agitator at least 30 minutes prior to solidifying to assure a homogeneous mixture.

10. Spent resin beads as transferred to the Waste Holding Tank have an excess amount of water which must be reduced to prepare it for solidification as generic stream #5.

a. Transfer resin from the spent resin tank until the level in the Waste Holding Tank is in accordance with approved operating procedures.

b. Allow contents to settle for at least 30 minutes, then decant excess liquid to the RWCU phase separator until the decant pump trips.

c. The mixture is now ready to process with approximately 25% by weight of solids.

d. Start the agitator at least 30 minutes prior to solidifying to assure a homogenous mixture.

11. Regenerant evaporator bottoms as transferred from the evaporator bottoms tank may be added (after pH adjustment) to filter, demineralizer, or filter/demineralizer sludges to adjust liquid content as required for specific generic batches or may be solidified directly (i.e., without combining with any additional water as a generic batch.)

12. Evaporator bottoms as transferred to the Waste Holding Tank will be solidified directly as generic waste stream #6, #7, or #8.

D. <u>Classifying Waste Holding Tank Contents Into Specific Generic Batches</u>

1. A knowledge of the sources of sludge and segregation of specific types of waste inputs is essential.

2. The operator will determine from the Water Treatment/Radwaste Logbook the type and volume of waste to be transferred to the Waste Holding Tank. Typical inputs will be:

   a. Spent resin tank contents; bead resin from the condensate cleanup demineralizer or radwaste (i.e., floor drain or equipment drain) demineralizers.

   b. Filter sludge from the condensate cleanup filter; (Ecodex).

   c. Filter sludge from the RWCU and FPCC filter/demineralizers; (Ecodex).

   d. Filter sludge from radwaste (i.e., floor drain or equipment drain) filters; Ecodex.

   e. Evaporator bottoms from regeneration of resin will normally be 25% sodium sulphate with trace amounts of other dissolved solids and suspended solids.

   f. Evaporator bottoms from floor drains will normally be 25% to 50% suspended solids with dissolved solids significantly below saturation.

   g. Evaporator bottoms from miscellaneous chemical waste will normally contain dissolved solids from water treatment chemicals (sodium nitrate, TSP), pH neutralizers (H_2SO_4 or NaOH), miscellaneous laboratory wastes and trace amounts of suspended solids.

3. If the operator can not obtain adequate information from the inline instruments (pH, conductivity, and radioactivity) to classify the waste as a specific generic type designated for solidification, a grab sample will be taken, analyzed and classified. If the batch does not fall within the specified limits for any of the specified generic types, processing will be in accordance with Section E.

4. A sampling program will be established to ascertain that the various individual batches are within established specified limits for specific generic batches. Plant chemistry will perform sample analysis as follows:

NOTE: The sample shall be analyzed for pH, conductivity, total suspended solids (TSS), silica or presence of oil or grease to determine if its constituents are similar to the original specific generic type or may be solidified in the laboratory using the proportions of solidifying agents specified for the original specific generic type.

a. If any sample indicates an off-standard batch (i.e., outside the specified limits for the specific generic type), the sampling frequency will be increased to a higher rate.

b. Samples will be analyzed from each batch of miscellaneous chemical evaporator bottoms to assure the batch is within the specified limits for the generic type.

E. Adjustment/Conditioning of Unclassified Batches of Waste

Adjustment/conditioning of unclassified batches of waste (i.e., wastes not classified as a generic batch).

1. If a batch of waste cannot be identified as a specific generic batch designated in C.8 through 12, a grab sample of the mixture will be obtained and the following steps will be performed:

a. The chemist will analyze the test sample for activity, pH, conductivity, TSS, silica, and presence of oil or grease.

b. With the above data, the operator will adjust the waste to within the specified limits of a generic batch.

c. A sample of the batch will be mixed with cement and sodium silicate according to ratios specified for that generic batch and verified to solidify after a 30 minute curing time with no free water.

d. If the batch is not solidifiable using any of the specific generic batch feed rates available, the operator will receive guidance from the Chemistry/Radiation Control Superintendent, or his designee.

F. Sampling for Verification of Solidification System

1. For batches of specific generic wastes processed according to Section C above, (other than every tenth or twentieth batch) no effluent sampling for verification of solidification is required since these have been proven to be solidifiable in the preoperational test program and this process control program.

2. For batches of unclassified wastes processed according to Section E above, a grab sample will be obtained and analyzed to determine if its constituents are within the specified parameters of a generic type.

3. If the test sample of unclassified waste fails to fall within the specified limits for a generic type of waste, the following shall be done in compliance with ALARA philosophy:

a. Effluent will be collected in three 500ml plastic beakers.

b. Three proportions of solidifying agents, specified by the Chemistry/Radiation Control Superintendent, or his designee, will be added to the three test samples.

c. The three test samples will be allowed to cure.

d. The cured product will be split to verify the mass is a solid with definite shape and no free water.

e. The test sample proportions used to produce the best product, as determined by the Chemistry/Radiation Control Superintendent, will be used for solidification of the unclassified waste.

G. Interfaces:

1. The Radwaste Solidification System receives wet waste inputs from the following:

   a. Equipment Drain Filter (D001),

   b. Floor Drain Filter (D003),

   c. Evaporator Bottoms Tanks (A014 A and B)

   d. Spent Resin Tank (A007)

   e. RWCU Phase Separator Tanks (A010 A and B)

   f. Waste Surge Tanks (A002 A and B)

   g. Condensate Phase Separator Tanks (A016 A and B)

2. Support Systems include:

   a. Radwaste Building Ventilation

   b. Condensate and Refueling Waste Storage

   c. Liquid Radwaste

   d. Equipment and Floor Drains

   e. Instrument Air

   f. Service Air

   g. 125V DC

   h. 480V DC

i. 120/208V DC

j. Overhead Crane

k. Portable Lead Shielding

H. Operable Solidification System Equipment required is identified in paragraph G.1 and in the contractor's Topical Report as approved by the PSRC.

I. Administrative Controls:

1. Administrative procedures will require that:

a. Directions for extensive or complex jobs where reliance on memory cannot be trusted shall require the written procedure to be present and referred to directly.

b. Directives shall include appropriate quantitative and/or qualitative criteria for verifying that the specified activities have been satisfactorily accomplished.

J. Sampling and Process Parameters:

1. This section will establish the program of sampling, analysis, and verification of solidification, which is necessary to insure complete solidification of each type of radioactive waste.

2. The minimum sampling requirement for verification of solidification is every tenth batch of each type of waste except for floor and equipment filter sludges which will be required to have one representative sample at least every twentieth batch.

3. The representative test specimen will be obtained for verification of solidification from the first five (5) batches of each generic stream after the plant startup to obtain operational characteristics of process parameters.

4. Verification of solidification is as follows:

   a. Three test samples (500ml) will be taken in plastic beakers.

   b. The design proportions of solidifying agents will be added to all test samples.

   c. Test samples will be allowed to cure. The cured product will be split to verify the mass is a solid with definite shape and no free water.

   d. All test samples must pass solidification tests. If sample fails test, retest as per Section F.

5. Upon verification of solidification of a specific generic classification of waste, the process parameters and specified limits will be logged on the operator's work sheet. The amounts of Portland cement and other required additives (e.g., acid/caustic for pH adjustment, etc.) as logged will subsequently be used for that generic classification of waste.

K. Packaging Procedures

The total contained activity, external dose rate and physical form of solidified waste will be verified to be within limits prior to shipment.

1. Containers will be sampled for surface activity and decontaminated, as necessary, prior to storage in compliance with ALARA philosophy.

2. The curie content of each container will be estimated from the following parameters:

   a. Type of waste contained (corrosion products, fission products or mixed).

   b. Mid plane, centerline container dose rate.

c. Density of material in container.

d. Geometric configuration.

e. Correction factor (C).

3. An isotopic analysis will be performed on every tenth batch of waste input to the solidification system to ensure classified waste is within specified limits.

   a. Total activity in a container will be calculated from the isotopic analysis.

   b. The calculated activity will be compared to the estimated activity.

   c. The correction factor (C) will be adjusted, as necessary, to assure that the estimated activity is greater than or equal to the calculated activity.

4. Plant operating procedures shall be provided and followed to assure that the requirements of 49CFR Parts 100 to 199, "Transportation", 10CFR20, and 10CFR70 are met.