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April 17, 2003

U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

ATTENTION: Document Control Desk

SUBJECT: Grand Gulf Nuclear Station (GGNS) 2002 Annual Radioactive Effluent
Release Report (ARERR)
Grand Gulf Nuclear Station
Docket No. 50-416
License No. NPF-29

GNRO-2003/00011

Gentlemen:

Attached is the GGNS Annual Radioactive Effluent Release Report (ARERR) for the period January 1, 2002 through December 31, 2002. This report is submitted in accordance with the requirements of 10CFR50.36a(a)(2) and the GGNS Technical Specification (TS) 5.6.3. The ARERR also complies with the GGNS Offsite Dose Calculation Manual (ODCM).

If you have questions or require additional information concerning these reports, please contact Mr. B. D. Bryant at (601) 437-6316, or this office at (601) 437-6685.

This letter does not contain any commitments.

Yours truly,

A handwritten signature in black ink, appearing to be "CAB/MJL".

CAB/MJL
attachments: 2002 Annual Radioactive Effluent Release Report
cc: (See Next Page)

cc:

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U.S. Nuclear Regulatory Commission ATTN: Mr. David H. Jaffe NRR/DLPM (w/2) ATTN: FOR ADDRESSEE ONLY ATTN: U.S. Postal Delivery Address Only Mail Stop OWFN/7D-1 Washington, D.C. 20555-0001	ALL LETTERS – U.S. POSTAL SERVICE MAIL DELIVERY ADDRESS ONLY

ENTERGY OPERATIONS, INC.
GRAND GULF NUCLEAR STATION

ANNUAL
RADIOACTIVE EFFLUENT RELEASE REPORT

January 1, 2002 - December 31, 2002

mc [signature]

/ 4/15/03

Prepared By

Jim Lavett

/ 4/15/03

Reviewed By

Robert [signature]

/ 4-15-03

Approved By

TABLE OF CONTENTS

	SUBJECT	PAGE
I.	INTRODUCTION	4
II.	DETAILED INFORMATION	5
	A. Regulatory Limits	5
	1. 10CFR20 Limits	5
	a. Fission and Activation Gases	5
	b. Radioiodines and Particulates	5
	c. Liquid Effluents	5
	2. 10CFR50, Appendix I Limits	6
	a. Fission and Activation Gases	6
	b. Radioiodines and Particulates	6
	c. Liquid Effluents	6
	3. 40CFR190 Limits	7
	B. Effluent Concentrations	7
	1. Airborne	7
	2. Liquid	7
	C. Average Energy	7
	D. Measurements and Approximations of Total Activity	8
	1. For Fission and Activation Gases	8
	2. For Particulates and Radioiodines	9
	3. For Continuous Releases	9
	4. For Batch Releases: Gases	9
	5. For Batch Releases: Liquid Effluents	10
	E. Batch Releases	10
	1. Liquid	10
	2. Gaseous	10
	F. Unplanned Releases	11
	1. Liquid	11
	2. Gaseous	11

TABLE OF CONTENTS (CONT'D)

SUBJECT		PAGE
	G. Estimate of Total Error	11
	1. Liquid	11
	2. Gaseous	12
	3. Solid Radioactive Waste	12
	H. Solid Radioactive Waste Shipments	12
	I. Meteorological Data	12
	J. Radioactive Effluent Monitoring Instrumentation Operability	12
	K. Annual Sewage Disposal Summary	12
III.	RADIATION DOSE SUMMARY	13
	A. Water-Related Exposure Pathway	13
	B. Airborne-Related Exposure Pathway	13
IV.	OFFSITE DOSE CALCULATION MANUAL/RADIOACTIVE WASTE TREATMENT SYSTEM CHANGES	15
	A. Offsite Dose Calculation Manual (ODCM)	15
	B. Radioactive Waste Treatment Systems	15
LIST OF TABLES		PAGE
1A	Gaseous Effluents – Summation of All Releases	16
1B	Gaseous Effluents – Elevated Releases	17
1C	Gaseous Effluents – Ground-Level Releases – Continuous	18
1D	Radioactive Gaseous Waste Sampling and Analysis Program	19
2A	Liquid Effluents – Summation of All Releases	20
2B	Liquid Effluents – Continuous and Batch Modes	21
2C	Radioactive Liquid Waste Sampling and Analysis Program	22
3	Solid Radioactive Waste and Irradiated Fuel Shipments	23
LIST OF ATTACHMENTS		PAGE
	Attachment I – Offsite Dose Calculation Manual, Revision 24	
	Attachment II – Supplemental Gross Alpha Release Data for 1990 - 2001	

I. INTRODUCTION

This Annual Radioactive Effluent Release Report (ARERR) for the period of January 1 through December 31, 2002 is submitted in accordance with Offsite Dose Calculation Manual (ODCM), Section 5.6.3 of Grand Gulf Nuclear Station (GGNS) License No. NPF-29. The monitoring of radioactive effluents is referenced in ODCM Appendix A, Sections 6.11 and 6.12.

Airborne discharges at GGNS are considered ground-level releases. All liquid and airborne discharges to the environment were analyzed in accordance with ODCM requirements. All effluent releases were within the concentration and total release limits specified by the ODCM. Projected offsite doses were within the dose limits specified by the ODCM.

The summation of all gaseous releases during the reporting period is given in Table 1A, while elevated releases and ground-level releases are given in Tables 1B and 1C, respectively. Table 1D describes the radioactive gaseous sampling and analysis program implemented at GGNS.

The summation of all liquid releases during the reporting period is given in Table 2A, while continuous and batch mode releases are given in Table 2B. Table 2C describes the radioactive liquid waste sampling and analysis program implemented at GGNS.

Solid radioactive waste and irradiated fuel shipments during the reporting period are summarized in Table 3.

The annual summary of meteorological data (joint frequency distribution) will be maintained on site in a file that shall be provided to the Nuclear Regulatory Commission (NRC) upon request. The option to maintain meteorological data on site is in accordance with ODCM Administrative Controls Section 5.6.3.

II. DETAILED INFORMATION

A. Regulatory Limits

1. 10CFR20 Limits

- a. Fission and Activation Gases - The release rate limit at any time for noble gases to areas at or beyond the site boundary shall be such that:

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

$$= \overline{X/Q} \sum_i K_i Q_i \leq 500 \text{ mrem/yr}$$

$$D_s = \text{average skin dose rate in the current year (mrem/yr)}$$

$$= \overline{X/Q} \sum_i (L_i + 1.1 M_i) Q_i \leq 3000 \text{ mrem/yr}$$

where the terms are defined in the GGNS ODCM.

- b. Radioiodines and Particulates - The release rate limit for the sampling period for all radioiodines, tritium and radioactive materials in particulate form with half-lives greater than 8 days shall be such that:

$$D_o = \text{average organ dose rate in current year (mrem/yr)}$$

$$= \sum_i W P_i \overline{Q_i} \leq 1500 \text{ mrem/yr}$$

where the terms are defined in the GGNS ODCM.

- c. Liquid Effluents - The concentration of radioactive materials released in liquid effluents to unrestricted areas from the site shall not exceed at any time ten times the values specified in 10CFR20, Appendix B, Table 2, Column 2. The concentration of dissolved or entrained noble gases, released in liquid effluents to unrestricted areas from all reactors at the site, shall be limited to 2×10^{-4} microcuries/ml total activity.

II. DETAILED INFORMATION (CONT'D)

2. 10CFR50, Appendix I Limits

- a. Fission and Activation Gases - The dose from noble gases in gaseous effluents to areas at or beyond the site boundary shall be such that:

D_{γ} = air dose due to gamma emissions from noble gases

$$= 3.17 \times 10^{-8} \sum_i M_i \overline{X/Q'} Q_i \leq 5 \text{ mrad/qtr}$$

$$\leq 10 \text{ mrad/yr}$$

D_{β} = air dose due to beta emissions from noble gases

$$= 3.17 \times 10^{-8} \sum_i N_i \overline{X/Q'} Q_i \leq 10 \text{ mrad/qtr}$$

$$\leq 20 \text{ mrad/yr}$$

where the terms are defined in the GGNS ODCM.

- b. Radioiodines and Particulates - The dose to an individual from tritium, I-131, I-133 and radioactive material in particulate form with half-lives greater than 8 days in gaseous effluents shall be such that:

D_p = dose to an individual from tritium, I-131, I-133 and radionuclides in particulate form with half-lives greater than 8 days (mrem)

$$= 3.17 \times 10^{-8} \sum_i R_i W' Q_i \leq 7.5 \text{ mrem/qtr Any Organ}$$

$$\leq 15 \text{ mrem/yr Any Organ}$$

where the terms are defined in the GGNS ODCM.

- c. Liquid Effluents - The dose from radioactive materials in liquid effluents shall be such that:

$$D_{\text{Tau}} = \sum_i [A_{i\text{Tau}} \sum_{l=1}^m \Delta t_l C_{il} F_l] \leq 1.5 \text{ mrem/qtr Total Body}$$

$$\leq 5 \text{ mrem/qtr Any Organ}$$

$$\leq 3 \text{ mrem/yr Total Body}$$

$$\leq 10 \text{ mrem/yr Any Organ}$$

where the terms are defined in the GGNS ODCM.

II. DETAILED INFORMATION (CONT'D)

3. 40CFR190 Limits

Doses are calculated for Fission and Activation Gases; Radioiodines and Particulates; and Liquid Effluents according to equations contained in Sections 2.(a), (b), and (c) respectively, with the exception that the limits applied are:

≤ 25 mrem/yr, Total Body or any Organ except Thyroid

≤ 75 mrem/yr, Thyroid

≤ 10 mrad γ /qtr or ≤ 20 mrad γ /yr, Fission and Activation Gases

≤ 20 mrad β /qtr or ≤ 40 mrad β /yr, Fission and Activation Gases

≤ 15 mrem/qtr or ≤ 30 mrem/yr, any Organ, Iodine and Particulates

≤ 3 mrem/qtr or ≤ 6 mrem/yr, Total Body, Liquid Effluents

≤ 10 mrem/qtr or ≤ 20 mrem/yr, any Organ, Liquid Effluents

B. Effluent Concentrations

1. Airborne

The Effluent Concentration Limit (ECL) of radioactive materials in gaseous effluents is limited by the dose rate restrictions given in Section II.A.1.a. In this case, the ECLs are actually determined by the dose factors in Table 2.1-1 of the GGNS ODCM.

2. Liquid

The Effluent Concentration Limit (ECL) of radioactive materials in liquid effluents is limited by ten times the values in 10CFR20, Appendix B, Table 2, Column 2. The ECL chosen is the most conservative value of either the soluble or insoluble ECL for each radioisotope.

C. Average Energy

Not applicable for GGNS ODCM Appendix A.

II. DETAILED INFORMATION (CONT'D)

D. Measurements and Approximations of Total Activity

The following discussion details the methods used to measure and approximate total activity for the following:

Fission and Activation Gases	Particulates
Radiiodines	Liquid Effluents

Tables 1D and 2C give sampling frequencies and minimum detectable sensitivity requirements for the analysis of gaseous and liquid effluent streams, respectively.

Values in the attached tables given as zero do not necessarily imply that the radionuclides were not present. A zero indicates that the radionuclide was not present at levels greater than the sensitivity requirements shown in Tables 1D and 2C. For some radionuclides, lower detection limits than required may be readily achievable; when a radionuclide is measured below its stated detection limits, it is reported.

1. For Fission and Activation Gases

The following noble gases are considered in evaluating gaseous airborne discharges:

Kr-87	Xe-133	Xe-135
Kr-88	Xe-133m	Xe-138

Periodic grab samples from Station effluent streams are analyzed by a computerized pulse height analyzer system utilizing high-resolution germanium detectors. (See Table 1D for sampling and analytical requirements.) Isotopic values thus obtained are used for dose release rate calculations due to effluent releases as given in Section II.A.1. of this report. Only those radionuclides that are detected are used in this computation. During the period between grab samples, the amount of radioactivity released is based on the effluent monitor readings. Monitors are assigned a calibration factor based upon the last isotopic analysis, using the following relationship:

$$C_i = U_i \div m$$

where

C_i = isotopic calibration factor for isotope i

U_i = concentration of isotope i in the grab sample in $\mu\text{Ci/ml}$.

m = net monitor reading associated with the effluent stream
(determined at the time of grab sampling).

II. DETAILED INFORMATION (CONT'D)

These calibration factors, along with the hourly effluent monitor values and flow rates, are entered into the laboratory computer where the release rates for individual radionuclides are calculated and stored. If no activity is detected in the grab sample, the calibration factor defaults to a historical mixture of Kr-88, Xe-133, Xe-135m, Xe-135, and Xe-138.

2. For Particulates and Radioiodines

The radioiodines and radioactive materials in particulate form to be considered are:

Zn-65	I-133
Mn-54	Cs-134
Fe-59	Cs-137
Co-58	Ce-141
Co-60	Ce-144
Sr-89	I-131
Sr-90	

Other radionuclides with half lives greater than 8 days.

3. For Continuous Releases

Continuous sampling is performed on the continuous release points (i.e., Offgas/Radwaste Building Vent, Containment Purge, Fuel Handling Area Vent, Turbine Building Vent). Particulate material is collected by filtration. Radioiodines are collected by adsorption onto a charcoal filter. Periodically these filters are removed and analyzed on the pulse height analyzer to identify and quantify radioactive materials collected on the filters. Particulate filters are then analyzed for gross alpha and Strontium-89 and -90 as required. Gross alpha determinations are made using 2-pi gas flow proportional counter. Strontium-89 and -90 values are obtained by chemical separation and subsequent analysis using liquid scintillation techniques. Tritium concentrations are determined using distillation and liquid scintillation techniques. During major operational occurrences, the frequency of sampling is increased to satisfy the requirements of footnote "c" of Table 1D, "Radioactive Gaseous Waste Sampling and Analysis," (GGNS ODCM Appendix A, Table 6.11.4-1). Currently, Strontium analysis is performed by a qualified contract laboratory.

4. For Batch Releases: Gases

The processing of batch type releases (from Containment Purge) is analogous to that for continuous releases.

II. DETAILED INFORMATION (CONT'D)

5. For Batch Releases: Liquid Effluents

The radionuclides listed below are considered when evaluating liquid effluents:

H-3	Sr-90
Mn-54	Mo-99
Fe-55	I-131
Co-58	Cs-134
Co-60	Cs-137
Fe-59	Ce-141
Zn-65	Ce-144
Sr-89	

Representative pre-release grab samples are obtained and analyzed as required by Table 2C. Isotopic analyses are performed using the computerized pulse height analysis system previously described. Aliquots of each pre-released sample, proportional to the waste volume released, are composited in accordance with the requirements of Table 2C. Strontium-89, 90 and Iron-55 values are obtained by chemical separation and counting the separated strontium and iron using liquid scintillation techniques. Gross alpha determinations are made using 2-pi gas flow proportional counter. Tritium is determined using distillation and liquid scintillation techniques. Dissolved gases are determined employing grab sampling techniques and then counting on the pulse height analyzer system. Currently, Iron and Strontium analyses are performed by a qualified contract laboratory.

E. Batch Releases

1. Liquid

	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Year
a. Number of releases	1	14	31	10	56
Time Period (in minutes)					
b. Total for all batches	2.66E+02	4.35E+03	9.45E+03	3.04E+03	1.71E+04
c. Max time for a batch	2.66E+02	3.65E+02	3.96E+02	3.25E+02	3.96E+02
d. Avg time for a batch	2.66E+02	3.11E+02	3.05E+02	3.04E+02	3.05E+02
e. Min time for a batch	2.66E+02	2.10E+02	2.65E+02	2.59E+02	2.10E+02

2. Gaseous

No batch releases were made during the report period.

II. DETAILED INFORMATION (CONT'D)

F. Unplanned Releases

1. Liquid

- a. Number of Releases: None
- b. Total Activity Released: 0.00E+00 Ci

2. Gaseous

- a. Number of Releases: None
- b. Total Activity Released: 0.00E+00 Ci

G. Estimate of Total Error

1. Liquid

The maximum errors are collectively estimated to be as follows:

	Fission & Activation Products	Tritium	Dissolved & Entrained Gases	Gross Alpha
Sampling %	2.60E+01	2.60E+01	2.60E+01	2.60E+01
Measurement %	6.80E+01	6.50E+01	6.10E+01	9.20E+01
TOTAL %	7.30E+01	7.00E+01	6.60E+01	9.50E+01

Sampling errors include uncertainty associated with mixing, representative sampling and discharge volume. Measurement errors include uncertainty associated with instrument calibration and the preparation and counting of low-activity samples. Counting errors are based on measurements of blank samples and, for germanium detectors, the least-readily-detectable radioisotope. Calibration errors are calculated by summing the errors associated with the calibration of a particular instrument with a radioactive source.

Total error is calculated by taking the square root of the sum of the squares of the individual errors.

II. DETAILED INFORMATION (CONT'D)

2. Gaseous

The maximum errors (not including sample line loss) are collectively estimated to be as follows:

	Fission & Activation Products	Iodine	Particulate	Alpha	Gross Tritium
Sampling %	3.20E+01	2.30E+01	2.20E+01	2.20E+01	2.30E+01
Measurement %	6.10E+01	6.70E+01	6.50E+01	1.01E+02	6.20E+01
TOTAL %	6.90E+01	7.10E+01	6.90E+01	1.03E+02	6.60E+01

Sampling errors include uncertainty associated with sample flow, vent flow and monitor calibration.

Measurement errors include uncertainty associated with instrument calibration and preparation and counting of low-activity samples. Measurement and total errors are calculated by the same methods used for liquid effluents.

3. Solid Radioactive Waste

See Table 3 for error terms.

H. Solid Radioactive Waste Shipments

See Table 3 for shipment information.

I. Meteorological Data

The data recovery for the reporting period was 98.6%. The predominant wind direction was from the Northeast approximately 10% of the time. The predominant stability class was class "D" approximately 33% of the time. Average wind speed during the reporting period was approximately 4.4 miles per hour.

The annual meteorological data (Hourly Average Data or Joint Frequency Distribution) will be maintained on site in a file that shall be provided to the NRC upon request.

J. Radioactive Effluent Monitoring Instrumentation Operability

No reportable instances of inoperability occurred during the reporting period.

K. Annual Sewage Disposal Summary

There were no sewage disposals in 2002.

III. RADIATION DOSE SUMMARY

Indicated below is the annual summary of offsite doses attributable to GGNS during 2002. Inspection of the values indicate that GGNS releases were within the 10CFR50, Appendix I design objectives.

Since there are no other fuel cycle facilities within 8 km of GGNS, 40CFR190 limits have also been met during this period.

All parameters listed were calculated in accordance with the GGNS ODCM.

A. Water-Related Exposure Pathways

The values calculated in this section utilize the information provided in Tables 2A and 2B of this report and the calculational methodology of the ODCM.

Liquid Effluents

Total body dose and critical organ doses are computed for the maximum exposed individual. The maximum dose contribution from liquid effluents is considered to occur in the adult age group via consumption of fish.

2002 Liquid Effluent Dose (mrem)

	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	TOTAL
Bone	6.61E-05	5.03E-02	1.49E-02	4.23E-03	5.60E-02
Liver	1.96E-04	3.90E-02	4.77E-02	1.50E-02	9.67E-02
Thyroid	7.97E-05	1.71E-03	1.36E-03	3.66E-04	3.16E-03
Kidney	9.91E-05	3.41E-03	2.79E-02	8.28E-03	4.27E-02
Lung	1.06E-04	2.08E-02	2.31E-03	7.99E-04	1.79E-02
GI-LLI	5.62E-04	2.58E-02	5.53E-02	4.94E-02	1.36E-01
Whole Body	1.13E-04	1.09E-02	2.19E-02	6.40E-03	3.91E-02

B. Airborne-Related Exposure Pathways

The values presented in this section utilize information provided in Tables 1A and 1C of this report and the calculational methodology of the ODCM. Dose and dose rates are computed for locations at the site boundary or at unrestricted areas beyond the site boundary. Because members of the public may, on occasion, be found within the site boundary, locations within the site boundary were considered when selecting locations for dose calculations.

Consideration of site boundary locations as well as unrestricted areas within and beyond the site boundary provides assurance that offsite doses will not be substantially underestimated while attempting to provide an accurate dose calculation.

The most limiting location for a member of the public is used for the dose calculations.

During routine operations the dispersion and deposition factors used for dose calculations are from historical annual average meteorological data.

III. RADIATION DOSE SUMMARY (CONT'D)

Organ Dose

The maximum organ dose to a MEMBER OF THE PUBLIC (critical receptor) from radioiodines, tritium and particulates was calculated for this report using the most recent land use census and dispersion and deposition parameters from 2002 meteorological data. The critical receptor residence was determined to be located in the southwest sector at a distance of 1432 meters (0.89 miles) from the plant. Pathways considered for use in the organ dose calculations are inhalation, ground plane, grass/cow/meat and vegetation. There is no grass/cow/milk pathway within five miles of GGNS. It was assumed that the age group receiving the maximum dose lived at the residence and that the receptor consumed food products that were raised or produced at the residence.

Average Total Body and Skin Dose Rate

Individual total body and skin dose rates from exposure to a semi-infinite cloud of noble gas are computed for a location in the southwest sector at a distance of 0.85 miles. This location corresponds to the highest annual average atmospheric dispersion factor for a location at the site boundary.

The total body and skin dose rates reported are the quarterly average of the maximum instantaneous dose rates determined daily during the reporting period and would represent the maximum possible dose rate received by members of the public.

Air Dose From Gamma and Beta Emissions

Air doses from gaseous effluents were calculated for this report using dispersion parameters from the 2002 meteorological data. The highest dispersion factor for an unrestricted area was in the southwest sector at the site boundary, 1368 meters (0.85 miles) from the plant.

Direct Radiation

Direct radiation dose is calculated by subtracting average doses measured by thermoluminescent dosimeter (TLD) badges located at control locations from average doses measured by TLD badges located near the site boundary. GGNS reported measured doses in 2002 as net exposure normalized to 92 days.

2002 Airborne Effluent Dose (mrem)					
	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	TOTAL
Iodine, Tritium & Particulates	1.21E-02	1.07E-02	7.71E-03	8.10E-03	3.86E-02
Percent of Limit	0.16%	0.14%	0.10%	0.11%	0.26%
Fission and Activation Gases					
Total Body Dose Rate (mrem/yr)	7.82E-03	8.12E-03	5.32E-03	7.18E-02	
Percent of Limit	0.002%	0.002%	0.001%	0.014%	
Skin Dose Rate (mrem/yr)	1.49E-02	1.55E-02	1.02E-02	1.24E-01	
Percent of Limit	0.000%	0.001%	0.000%	0.004%	
Gamma Air Dose*	1.73E-03	1.49E-03	9.80E-04	6.18E-03	1.04E-02
Percent of Limit	0.035%	0.030%	0.020%	0.124%	0.104%
Beta Air Dose*	1.87E-03	1.61E-03	1.06E-03	5.23E-03	9.77E-03
Percent of Limit	0.019%	0.016%	0.011%	0.052%	0.049%
Direct Radiation	1.00E-01	1.00E-01	0.00E+00	8.00E-01	1.00E+00

*Measurement units are mrad

**IV. OFFSITE DOSE CALCULATION MANUAL/
RADIOACTIVE WASTE TREATMENT SYSTEM CHANGES**

A. Offsite Dose Calculation Manual (ODCM)

One revision to the ODCM was processed during the reporting period. The changes are summarized below.

Revision 24:

- Changes a statement regarding acceptance criteria for gaseous radiation monitor calibrations. The statement, "The instrument calibration procedures will include checks to ensure that the detector efficiency does not vary by more than $\pm 25\%$." to "The instrument calibration procedures will include checks to ensure that the detector efficiency meets acceptance criteria."

B. Radioactive Waste Treatment Systems

No major changes were made to the liquid, gaseous or solid radwaste treatment systems in 2002.

TABLE 1A
 ENTERGY OPERATIONS, INC.
 GRAND GULF NUCLEAR STATION UNIT 1

EFFLUENT AND WASTE DISPOSAL ANNUAL REPORT
 GASEOUS EFFLUENTS – SUMMATION OF ALL RELEASES

REPORT FOR 2002	Units	QTR 1	QTR 2	QTR 3	QTR 4	YEAR
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Fission and Activation Gases

1. Total Release	Ci	1.02E+01	8.81E+00	5.80E+00	2.75E+01	5.23E+01
2. Average Release Rate	uCi/sec	1.32E+00	1.12E+00	7.29E-01	3.46E+00	1.66E+00
3. Percent of TS Limit	%	3.46E-02	2.98E-02	1.96E-02	1.24E-01	2.58E-01

Iodine-131

1. Total Release	Ci	0.00E+00	1.32E-05	8.29E-06	6.73E-05	8.88E-05
2. Average Release Rate	uCi/sec	0.00E+00	1.68E-06	1.04E-06	8.47E-06	2.82E-06
3. Percent of TS Limit	%	0.00E+00	2.59E-03	1.63E-03	1.32E-02	8.71E-03

Particulates Half Life >= 8 days

1. Total Release	Ci	3.28E-05	0.00E+00	7.41E-06	9.56E-07	4.11E-05
2. Average Release Rate	uCi/sec	4.21E-06	0.00E+00	9.32E-07	1.20E-07	1.30E-06
3. Percent of TS Limit	%	4.35E-05	2.45E-04	4.29E-04	1.63E-03	9.86E-04

Tritium

1. Total Release	Ci	2.30E+01	1.99E+01	1.44E+01	1.33E+01	7.05E+01
2. Average Release Rate	uCi/sec	2.96E+00	2.53E+00	1.81E+00	1.67E+00	2.24E+00
3. Percent of TS Limit	%	1.62E-01	1.40E-01	1.01E-01	9.32E-02	2.48E-01

Gross Alpha Radioactivity

1. Total Release	Ci	4.18E-09	0.00E+00	0.00E+00	2.39E-08	2.81E-08
2. Average Release Rate	uCi/sec	5.37E-10	0.00E+00	0.00E+00	3.01E-09	8.92E-10

TABLE 1B
ENERGY OPERATIONS, INC.
GRAND GULF NUCLEAR STATION UNIT 1
EFFLUENT AND WASTE DISPOSAL ANNUAL REPORT
GASEOUS EFFLUENTS – ELEVATED RELEASES
JANUARY – DECEMBER 2002

(Not Applicable – GGNS Releases Are Considered Ground-Level)

TABLE 1C
 ENTERGY OPERATIONS, INC.
 GRAND GULF NUCLEAR STATION UNIT 1

EFFLUENT AND WASTE DISPOSAL ANNUAL REPORT
 GASEOUS EFFLUENTS – GROUND-LEVEL RELEASE-CONTINUOUS

REPORT FOR 2002	Units	QTR 1	QTR 2	QTR 3	QTR 4	YEAR
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Fission and Activation Gases

AR-41	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
KR-85M	Ci	0.00E+00	0.00E+00	0.00E+00	3.16E+00	3.16E+00
KR-87	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
KR-88	Ci	2.04E-01	1.76E-01	1.16E-01	1.60E+00	2.10E+00
XE-133	Ci	4.79E+00	4.12E+00	2.71E+00	1.07E+01	2.23E+01
XE-135	Ci	4.58E+00	3.94E+00	2.59E+00	1.04E+01	2.15E+01
XE-135M	Ci	5.40E-01	4.65E-01	3.06E-01	1.35E+00	2.66E+00
XE-138	Ci	1.22E-01	1.05E-01	6.94E-02	2.74E-01	5.71E-01
Totals for Period...	Ci	1.02E+01	8.81E+00	5.79E+00	2.75E+01	5.23E+01

Iodines

I-131	Ci	0.00E+00	1.32E-05	8.29E-06	6.73E-05	8.88E-05
I-132	Ci	0.00E+00	0.00E+00	0.00E+00	8.28E-05	8.28E-05
I-133	Ci	5.64E-06	3.17E-05	6.68E-06	2.09E-04	2.53E-04
Totals for Period...	Ci	5.64E-06	4.49E-05	1.50E-05	3.59E-04	4.25E-04

Particulates Half Life >= 8 days

CO-58	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO-60	Ci	0.00E+00	0.00E+00	4.99E-06	0.00E+00	4.99E-06
CR-51	Ci	3.28E-05	0.00E+00	0.00E+00	0.00E+00	3.28E-05
MN-54	Ci	0.00E+00	0.00E+00	2.42E-06	0.00E+00	2.42E-06
RU-106	Ci	0.00E+00	0.00E+00	0.00E+00	9.56E-07	9.56E-07
Totals for Period...	Ci	3.28E-05	0.00E+00	7.41E-06	9.56E-07	4.12E-05

Tritium

H-3	Ci	2.30E+01	1.99E+01	1.44E+01	1.33E+01	7.05E+01
Totals for Period...	Ci	2.30E+01	1.99E+01	1.44E+01	1.33E+01	7.05E+01

Gross Alpha Radioactivity

ALPHA	Ci	4.18E-09	0.00E+00	0.00E+00	2.39E-08	2.81E-08
Totals for Period...	Ci	4.18E-09	0.00E+00	0.00E+00	2.39E-08	2.81E-08

TABLE 1D
 ENTERGY OPERATIONS, INC.
 GRAND GULF NUCLEAR STATION UNIT 1

EFFLUENT AND WASTE DISPOSAL ANNUAL REPORT
 Radioactive Gaseous Waste Sampling and Analysis Program
 JANUARY – DECEMBER 2002

Gaseous Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) (TCi/ml) ^a
A. (1) Radwaste Building Ventilation Exhaust	31 Days Grab Sample (f)	31 Days	Principal Gamma Emitters (b,e) H-3	$\frac{1 \times 10^{-4}}{1 \times 10^{-6}}$
(2) Fuel Handling Area Ventilation Exhaust	Continuous (d)(f)	7 Days (c) Charcoal Sample	I-131 I-133	$\frac{1 \times 10^{-12}}{1 \times 10^{-10}}$
(3) Containment Ventilation Exhaust	Continuous (d)(f)	7 Days (c) Particulate Sample	Principal Gamma Emitters (e) (I-131, Others)	1×10^{-11}
(4) Turbine Building Ventilation Exhaust	Continuous (d)(f)	31 Days Composite Particulate Sample	Gross Alpha	1×10^{-11}
	Continuous (d)(f)	92 Days Composite Particulate Sample	Sr-89, Sr-90	1×10^{-11}
	Continuous (f)	Noble Gas Monitor	Noble Gases Gross Beta or Gamma	1×10^{-6}
B. (1) Offgas Post Treatment Exhaust, whenever there is flow	31 Days Grab Sample (f)	31 Days	Principal Gamma Emitters (e)	1×10^{-4}
(2) Standby Gas Treatment A Exhaust, whenever there is flow	31 Days Grab Sample (f)	31 Days	Principal Gamma Emitters(e)	1×10^{-4}
(3) Standby Gas Treatment B Exhaust, whenever there is flow	31 Days Grab Sample (f)	31 Days	Principal Gamma Emitters(e)	1×10^{-4}

NOTE: Footnotes indicated are listed in GGNS ODCM, Appendix A, Table 6.11.4-1.

TABLE 2A
 ENTERGY OPERATIONS, INC.
 GRAND GULF NUCLEAR STATION UNIT 1

RADIOACTIVE EFFLUENT AND WASTE DISPOSAL ANNUAL REPORT
LIQUID EFFLUENTS - SUMMATION OF ALL RELEASES

REPORT FOR 2002	Units	QTR 1	QTR 2	QTR 3	QTR 4	YEAR
Fission and Activation Products						
1. Total Release	Ci	2.03E-03	2.02E-01	3.23E-02	1.77E-02	2.54E-01
2. Avg. Diluted Conc.	uCi/ml	3.06E-07	2.10E-06	9.63E-08	1.60E-07	4.64E-07
3. Percent of Limit	%	7.50E-03	7.29E-01	1.46E+00	4.26E-01	1.30E+00
Tritium						
1. Total Release	Ci	1.05E+00	2.00E+01	2.56E+01	7.05E+00	5.38E+01
2. Avg. Diluted Conc.	uCi/ml	1.58E-04	2.08E-04	7.65E-05	6.38E-05	9.80E-05
3. Percent of Limit	%	1.58E+00	2.08E+00	7.65E-01	6.38E-01	9.80E-01
Dissolved and Entrained Gases						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Diluted Conc.	uCi/ml	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3. Percent of Limit	%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gross Alpha Radioactivity						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Volume of liquid waste						
Volume of liquid waste	liters	8.90E+04	1.46E+06	3.22E+06	1.03E+06	5.80E+06
Volume of dil. water						
Volume of dil. water	liters	6.54E+06	9.49E+07	3.32E+08	1.10E+08	5.43E+08

TABLE 2B
 ENTERGY OPERATIONS, INC.
 GRAND GULF NUCLEAR STATION UNIT 1

RADIOACTIVE EFFLUENT AND WASTE DISPOSAL ANNUAL REPORT
LIQUID EFFLUENTS – CONTINUOUS AND BATCH MODES

REPORT FOR 2002	Units	QTR 1	QTR 2	QTR 3	QTR 4	YEAR
Fission and Activation Gases						
CO-58	Ci	0.00E+00	4.83E-06	1.71E-04	3.28E-04	5.04E-04
CO-60	Ci	4.89E-05	4.58E-04	7.56E-03	2.25E-03	1.03E-02
CR-51	Ci	1.64E-03	1.35E-03	7.02E-03	6.68E-03	1.67E-02
CS-137	Ci	0.00E+00	0.00E+00	2.64E-05	0.00E+00	2.64E-05
CU-64	Ci	0.00E+00	0.00E+00	3.29E-05	2.87E-04	3.20E-04
FE-55	Ci	3.01E-04	2.00E-01	8.97E-03	3.34E-03	2.13E-01
FE-59	Ci	0.00E+00	0.00E+00	2.77E-04	1.52E-03	1.80E-03
MN-54	Ci	4.53E-05	4.09E-04	6.12E-03	2.58E-03	9.15E-03
NB-95	Ci	0.00E+00	0.00E+00	6.28E-06	8.17E-05	8.80E-05
ZN-65	Ci	0.00E+00	8.11E-05	2.03E-03	6.32E-04	2.75E-03
ZN-69M	Ci	0.00E+00	0.00E+00	5.67E-05	0.00E+00	5.67E-05
ZR-95	Ci	0.00E+00	0.00E+00	0.00E+00	2.82E-05	2.82E-05
Totals for Period...	Ci	2.04E-03	2.02E-01	3.23E-02	1.77E-02	2.55E-01

Tritium						
H-3	Ci	1.05E+00	2.00E+01	2.56E+01	7.05E+00	5.38E+01
Totals for Period...	Ci	1.05E+00	2.00E+01	2.56E+01	7.05E+00	5.38E+01

Dissolved and Entrained Gases						
No Nuclide Activities		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Gross Alpha Radioactivity						
No Nuclide Activities		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

TABLE 2C
 ENTERGY OPERATIONS, INC.
 GRAND GULF NUCLEAR STATION UNIT 1

RADIOACTIVE EFFLUENT AND WASTE DISPOSAL ANNUAL REPORT
 RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM
 JANUARY – DECEMBER 2002

Liquid Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) (TCi/ml)(a)
A. Batch Waste Release Tanks (c)	Prior to Release Each Batch	Prior to Release Each Batch	Principal Gamma Emitters (d) I-131	$\frac{5 \times 10^{-7}}{1 \times 10^{-6}}$
	Prior to Release One Batch /M	31 Days	Dissolved and Entrained Gases (Gamma Emitters)	1×10^{-5}
	Prior to Release Each Batch	31 Days Composite (b)	H-3 Gross Alpha	$\frac{1 \times 10^{-5}}{1 \times 10^{-7}}$
	Prior to Release Each Batch	92 Days Composite (b)	Sr-89, Sr-90 Fe-55	$\frac{5 \times 10^{-8}}{1 \times 10^{-6}}$
B. SSW Basin (Before Blowdown)	Prior to Release Each Blowdown	Prior to Release Each Batch	Principal Gamma Emitters (d) I-131	$\frac{5 \times 10^{-7}}{1 \times 10^{-6}}$

NOTE: Footnotes indicated are listed in GGNS ODCM, Appendix A, Table 6.11.1-1.

TABLE 3
 ENTERGY OPERATIONS, INC.
 GRAND GULF NUCLEAR STATION UNIT 1

RADIOACTIVE EFFLUENT AND WASTE DISPOSAL ANNUAL REPORT
 SOLID RADIOACTIVE WASTE AND IRRADIATED FUEL SHIPMENTS
 JANUARY – DECEMBER 2002

A. Solid Waste Shipped Offsite for Burial or Disposal

1. TYPE OF WASTE	UNITS	1 ST QTR	2 ND QTR	3 RD QTR	4 TH QTR	ESTIMATE TOTAL ERROR (%)
a. RESIN	M ³	8.89E+00	3.91E+00	7.34E+00	7.16E+00	
	*Ci	5.81E+01	3.17E+01	6.51E+01	3.10E+02	7.2E+01
b. DAW	M ³	3.50E-01	2.31E+00	1.54E+00	1.97E+00	
	*Ci	2.30E-01	1.01E+00	1.20E-01	3.50E-01	6.9E+01
c. IRR. COMP.	M ³	None	None	None	None	
	*Ci	None	None	None	None	N/A
d. OTHER	M ³	None	None	None	None	
	*Ci	None	None	None	None	N/A

*Total curie quantity determined by measurement. Total volume used is burial container volume. Resin and DAW solid waste was Class "A" as defined by 10CFR Part 61.

2. Estimate of major nuclide composition (by type of waste as identified above)

a. RESIN

Nuclide	1 ST QTR	2 ND QTR	3 RD QTR	4 TH QTR
Co-60	12	12	12	7
Fe-55	69	72	72	86
Mn-54	14	12	12	6
Cr-51	<1	<1	1	<1
Zn-65	3	<1	<1	<1
H-3	<1	<1	<1	<1
ALL OTHERS	<1	<1	<1	<1

b. DAW - Duratek

Nuclide	1 ST QTR	2 ND QTR	3 RD QTR	4 TH QTR
Co-60	11	9	11	11
H-3	<1	20	<1	<1
Fe-55	83	64	83	84
Mn-54	4	2	4	4
Cr-51	2	2	2	2
All Others	<1	2	<1	<1

c. IRR. COMP.

Nuclide	1 ST QTR	2 ND QTR	3 RD QTR	4 TH QTR
Co-60	N/A	N/A	N/A	N/A
Ni-63	N/A	N/A	N/A	N/A
Fe-55	N/A	N/A	N/A	N/A
Mn-54	N/A	N/A	N/A	N/A
All Others	N/A	N/A	N/A	N/A

d. OTHER

Nuclide	1 ST QTR	2 ND QTR	3 RD QTR	4 TH QTR
N/A	N/A	N/A	N/A	N/A

TABLE 3
 ENTERGY OPERATIONS, INC.
 GRAND GULF NUCLEAR STATION UNIT 1

RADIOACTIVE EFFLUENT AND WASTE DISPOSAL ANNUAL REPORT
 SOLID RADIOACTIVE WASTE AND IRRADIATED FUEL SHIPMENTS (CONT'D)
 JANUARY – DECEMBER 2002

A. Solid Waste Shipped Off Site for Burial or Disposal

3. Solid Waste Disposition

- a. All resin was shipped to Studsvik, LLC. Of Erwin, Tennessee for volume reduction prior to burial.

Studsvik shipped waste to Barnwell, South Carolina or Envirocare of Utah. Resin was dewatered and shipped in steel liners and High Integrity Containers. No solidification agents or absorbents were used.

- b. Dry Active Waste (DAW) was packaged in 20' sealand containers or metal B-25 boxes and shipped to Duratek of Oak Ridge, Tennessee or RACE of Memphis, Tennessee for volume reduction. Duratek and RACE shipped reduced waste to Barnwell, South Carolina or Envirocare of Utah. Reduced volume was used in providing information given in A.1.b.
- c. No waste in this category.
- d. No waste in this category.

NUMBER OF SHIPMENTS	MODE OF TRANSPORTATION	DESTINATION
2	Truck	Barnwell, SC
48	Truck	Envirocare, UT

B. Irradiated Fuel Shipments (Disposition)

NUMBER OF SHIPMENTS	MODE OF TRANSPORTATION	DESTINATION
None	N/A	N/A

C. Annual Sewage Sludge Summary

No sewage sludge was shipped during the reporting period.

NUMBER OF SHIPMENTS	TOTAL GALLONS	AVERAGE Co-60 ACTIVITY (pCi/kg)	AVERAGE Mn-54 ACTIVITY (pCi/kg)	AVERAGE Cs-137 ACTIVITY (pCi/kg)
None	N/A	N/A	N/A	N/A

ATTACHMENT I

OFFSITE DOSE CALCULATION MANUAL
REVISION 24

OFFSITE DOSE CALCULATION MANUAL
GRAND GULF NUCLEAR STATION

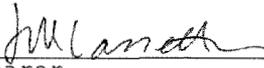
Revision No. 24
Date 11/02

GRAND GULF NUCLEAR STATION
OFFSITE DOSE CALCULATION MANUAL
SAFETY RELATED

EVALUATION APPLICABILITY

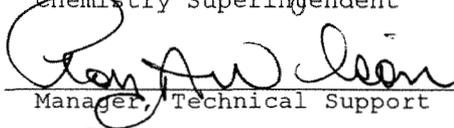
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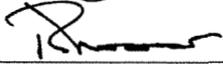
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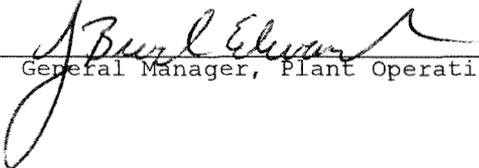
Reviewed/Approved:  / 11/7/02
Preparer Date

Reviewed/Approved:  / 11-7-02
Reviewer Date

Reviewed/Approved:  / 11-7-02
Chemistry Superintendent Date

Reviewed/Approved:  / 11/7/02
Manager, Technical Support Date

Reviewed/Approved:  / 11-7-02
On-Site Safety Review Committee Date

Reviewed/Approved:  / 11-7-02
General Manager, Plant Operations Date

INTRODUCTION

The Offsite Dose Calculation Manual (ODCM) describes the methodology and parameters used in the calculation of offsite doses resulting from radioactive liquid and gaseous effluents, in the calculation of liquid and gaseous effluent monitoring Alarm/Trip Setpoints, and in the conduct of the Radiological Environmental Monitoring Program. The ODCM also contains (1) the Radioactive Effluent Controls and Radiological Environmental Monitoring Programs required by Technical Specification (TS) 5.5.4, and Technical Requirement 7.6.3.2, (2) descriptions of the information that is included in the Annual Radiological Environmental Operating and Annual Radioactive Effluent Release Reports required by TS 5.6.2 and 5.6.3, (3) a list and graphical description of the specific sample locations for the Radiological Environmental Monitoring Program, and (4) diagrams of the liquid and gaseous radwaste treatment systems.

ODCM Revision 24 incorporates the following change:

- Modifies a statement regarding instrument calibration procedures

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 the ODCM.

Changes to the ODCM shall be accomplished as specified in TS 5.5.1. Records of reviews performed for changes made to the ODCM shall be retained for the duration of the Unit Operating License.

ODCM
TABLE OF CONTENTS

		<u>Page</u>
	MANUAL APPROVAL SHEET	i
	INTRODUCTION	ii
	TABLE OF CONTENTS	iii
	LIST OF FIGURES	iv
	LIST OF TABLES	v
	LIST OF REFERENCES	vi
	EFFECTIVE PAGES	vii
1.0	LIQUID EFFLUENTS	
1.1	Liquid Effluent Monitor Setpoints	
1.1.1	Liquid Radwaste Effluent Line Monitors	1.0-1
1.2	Dose Calculations for Liquid Effluents	
1.2.1	Maximum Exposed Individual Model	1.0-7
1.2.2	Dose Projection	1.0-8
1.3	Liquid Radwaste Treatment System	1.0-15
2.0	GASEOUS EFFLUENTS	
2.1	Gaseous Effluent Monitor Setpoints	
2.1.1	Continuous Ventilation Monitors	2.0-1
2.1.2	Text Deleted	2.0-3
2.2	Gaseous Effluent Dose Calculations	
2.2.1	Unrestricted Area Boundary Dose	2.0-7
2.2.2	Unrestricted Area Dose to Individual	2.0-9
2.2.3	Dose Projection	2.0-10b
2.3	Meteorological Model	
2.3.1	Atmospheric Dispersion	2.0-24
2.3.2	Deposition	2.0-25
2.4	Definitions of Gaseous Effluents Parameters	2.0-27
2.5	Gaseous Radwaste Treatment System	2.0-35
2.6	Annual Dose Commitment	2.0-36
2.6.1	Direct Radiation Dose Measurement	2.0-36
3.0	RADIOLOGICAL ENVIRONMENTAL MONITORING	
3.1	Sampling Locations	3.0-1

ODCM
TABLE OF CONTENTS

	<u>Page</u>
APPENDIX A - <u>RADIOLOGICAL EFFLUENT CONTROLS AND</u> <u>RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS</u>	A-0
<u>DEFINITIONS</u>	A-2
1.1 GASEOUS RADWASTE TREATMENT (OFFGAS) SYSTEM	
1.2 MEMBER(s) OF THE PUBLIC	
1.3 OFFSITE DOSE CALCULATION MANUAL (ODCM)	
1.4 PROCESS CONTROL PROGRAM (PCP)	
1.5 SITE BOUNDARY	
1.6 UNRESTRICTED AREA	
1.7 VENTILATION EXHAUST TREATMENT SYSTEM	
<u>SURVEILLANCE FREQUENCY NOTATION (DELETED)</u>	A-4
<u>MODES OF OPERATION (DELETED)</u>	A-5
<u>APPLICABILITY (DELETED)</u>	A-6
<u>ADMINISTRATIVE CONTROLS</u>	A-8
5.6.2 Annual Radiological Environmental Operating Report	A-9
5.6.3 Annual Radioactive Effluent Release Report	A-10

ODCM
TABLE OF CONTENTS

		<u>Page</u>
	LIMITING CONDITIONS FOR OPERATION AND SURVEILLANCE REQUIREMENTS	A-12
6.3	INSTRUMENTATION	
	MONITORING INSTRUMENTATION	
6.3.9	Radioactive Liquid Effluent Monitoring Instrumentation	A-13
6.3.10	Radioactive Gaseous Effluent Monitoring Instrumentation	A-18
6.11	RADIOACTIVE EFFLUENTS	
	LIQUID EFFLUENTS	
6.11.1	Concentration	A-29
6.11.2	Dose/Total Dose	A-34
6.11.3	Liquid Waste Treatment	A-36
	GASEOUS EFFLUENTS	
6.11.4	Dose Rate	A-37
6.11.5	Dose - Noble Gases/Total Dose	A-42
6.11.6	Dose - Iodine-131, Iodine-133, Tritium, and Radionuclides in Particulate Form/Total Dose ..	A-44
6.11.7	Gaseous Radwaste Treatment	A-46
6.11.8	Ventilation Exhaust Treatment	A-47
6.12	RADIOLOGICAL ENVIRONMENTAL MONITORING	
6.12.1	MONITORING PROGRAM AND INTERLABORATORY COMPARISON PROGRAM	A-48
6.12.2	LAND USE CENSUS	A-59

ODCM
TABLE OF CONTENTS

		<u>Page</u>
<u>BASES</u>		<u>A-61</u>
6.3	INSTRUMENTATION	
	MONITORING INSTRUMENTATION	
	6.3.9 Radioactive Liquid Effluent Monitoring Instrumentation	A-62
	6.3.10 Radioactive Gaseous Effluent Monitoring Instrumentation	A-62
6.11	RADIOACTIVE EFFLUENTS	
	LIQUID EFFLUENTS	
	6.11.1 Concentration	A-63
	6.11.2 Dose/Total Dose	A-63
	6.11.3 Liquid Waste Treatment	A-66
	GASEOUS EFFLUENTS	
	6.11.4 Dose Rate	A-66
	6.11.5 Dose - Noble Gases/Total Dose	A-67
	6.11.6 Dose - Iodine-131, Iodine-133, Tritium and Radionuclides in Particulate Form/Total Dose ..	A-69
	6.11.7/ Gaseous Radwaste Treatment and Ventilation	
	6.11.8 Exhaust Treatment	A-71
6.12	RADIOLOGICAL ENVIRONMENTAL MONITORING	
	6.12.1 MONITORING PROGRAM AND INTERLABORATORY COMPARISON PROGRAM	A-72
	6.12.2 LAND USE CENSUS	A-73

ODCM
LIST OF FIGURES

<u>Figure</u>	<u>Title</u>	<u>Page</u>
1.0-1	Example Calibration Curve for Liquid Effluent Monitor.....	1.0-6
1.3-1	Liquid Radwaste Treatment System.....	1.0-16
2.3-1	Plume Depletion Effect for Ground-Level Releases.....	2.0-31
2.3-2	Vertical Standard Deviation of Material in a Plume.....	2.0-32
2.3-3	Relative Deposition for Ground-Level Releases.....	2.0-33
2.3-4	Open Terrain Recirculation Factor.....	2.0-34
2.5-1	Gaseous Radwaste Treatment System.....	2.0-35a
3.0-1	Collection Site Locations, 0-5 Mile Area Map.....	3.0-7
3.0-2	Collection Site Locations, General Area Map, 0-10 Mile Area Map.....	3.0-8

ODCM
LIST OF TABLES

Table	Title	Page
1.2-1	Bioaccumulation Factors.....	1.0-9
1.2-2	Ingestion Dose Conversion Factors For Adults.....	1.0-10
1.2-3	Site Related Ingestion Dose Commitment Factor.....	1.0-13
2.1-1	Dose Factors for Exposure to a Semi-infinite Cloud of Noble Gases.....	2.0-6
2.2-1a	Pathway Dose Factors for LCO 6.11.4 and Section 2.2.1.b.....	2.0-11
2.2-1b	Deleted.....	2.0-13
2.2-2a	Pathway Dose Factors for LCO 6.11.6 and Section 2.2.2.b.....	2.0-15
2.2-2b	Pathway Dose Factors for LCO 6.11.6 and Section 2.2.2.b.....	2.0-17
2.2-2c	Pathway Dose Factors for LCO 6.11.6 and Section 2.2.2.b.....	2.0-19
2.2-2d	Pathway Dose Factors for LCO 6.11.6 and Section 2.2.2.b.....	2.0-21
2.2-3, 2.2-3a, 2.2-3b	Controlling Receptors, Locations and Atmospheric Dispersion Parameters for LCOs 6.11.4, 6.11.5, 6.11.6 and 6.11.8.....	2.0-23
2.3-1	Deleted.....	2.0-26
3.0-1	Air Sampler Collection Sites.....	3.0-2
3.0-2	Miscellaneous Collection Sites.....	3.0-3
3.0-3	TLD Locations.....	3.0-4

ODCM
LIST OF REFERENCES

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12. GIN 99/00152 "Liquid Monitor Trip Setpoint for Tanks with no Gamma Emitters"

ODCM

LIST OF EFFECTIVE PAGES

<u>Page No.</u>	<u>Rev No.</u>
i	24
ii	24
iii	17
iiia	17
iiib	17
iiic	17
iv	17
v	21
vi	22
vii	24
viii	23
viiib	23
1.0-1	17
1.0-2	17
1.0-3	17
1.0-4	15
1.0-5	17
1.0-5a	22
1.0-6	21
1.0-7	17
1.0-8	17
1.0-9	11
1.0-10	0
1.0-11	11
1.0-12	0
1.0-13	22
1.0-14	22
1.0-15	21
1.0-16	21
2.0-1	17
2.0-2	17
2.0-3	2
2.0-4	23
2.0-5	24
2.0-6	22
2.0-7	17
2.0-8	21
2.0-9	17
2.0-10	17
2.0-10a	17
2.0-10b	17
2.0-11	22
2.0-12	22
2.0-13	21
2.0-14	21
2.0-15	22
2.0-16	22

<u>Page No.</u>	<u>Rev No.</u>
2.0-16a	22
2.0-16b	22
2.0-16c	22
2.0-16d	22
2.0-16e	22
2.0-16f	22
2.0-17	22
2.0-18	22
2.0-18a	22
2.0-18b	22
2.0-18c	22
2.0-18d	22
2.0-18e	22
2.0-18f	22
2.0-18g	22
2.0-18h	22
2.0-19	22
2.0-20	22
2.0-20a	22
2.0-20b	22
2.0-20c	22
2.0-20d	22
2.0-20e	22
2.0-20f	22
2.0-20g	22
2.0-20h	22
2.0-21	22
2.0-22	22
2.0-22a	22
2.0-22b	22
2.0-22c	22
2.0-22d	22
2.0-22e	22
2.0-22f	22
2.0-22g	22
2.0-22h	22
2.0-23	23
2.0-23a	17
2.0-23b	23
2.0-24	17
2.0-25	17
2.0-26	17
2.0-27	3
2.0-28	5
2.0-29	21

ODCM

LIST OF EFFECTIVE PAGES

<u>Page No.</u>	<u>Rev No.</u>	<u>Page No.</u>	<u>Rev No.</u>
2.0-30	3		
2.0-31	15		
2.0-32	15		
2.0-33	15		
2.0-34	15		
2.0-35	17		
2.0-35a	8		
2.0-36	20		
2.0-37	20		
3.0-1	17		
3.0-2	20		
3.0-3	20		
3.0-3a	23		
3.0-4	20		
3.0-5	20		
3.0-6	20		
3.0-6a	20		
3.0-6b	13		
3.0-6c	20		
3.0-6d	20		
3.0-7	20		
3.0-8	20		

ODCM

LIST OF EFFECTIVE PAGES

Page No. Rev No.

<u>APPENDIX A</u>	
A-0	17
A-1	17
A-2	17
A-3	17
A-4	17
A-5	17
A-6	17
A-7	17
A-8	17
A-9	22
A-10	17
A-11	17
A-12	17
A-13	18
A-14	17
A-15	17
A-16	17
A-17	18
A-18	17
A-19	23
A-20	19
A-21	17
A-22	17
A-23	17
A-24	18
A-25	21
A-26	18
A-27	18
A-28	21
A-29	17
A-30	17
A-31	17
A-32	17
A-33	17
A-34	17
A-35	17
A-36	17
A-37	17
A-38	17
A-39	17
A-40	17
A-41	17
A-42	17
A-43	17
A-44	17
A-45	17
A-46	17

Page No. Rev No.

A-47	17
A-48	17
A-49	17
A-50	20
A-51	20
A-52	21
A-53	20
A-54	20
A-55	17
A-56	17
A-57	17
A-58	17
A-59	20
A-60	20
A-61	17
A-62	17
A-63	17
A-64	17
A-65	17
A-66	17
A-67	22
A-68	17
A-69	17
A-70	17
A-71	17
A-72	17
A-73	17
A-74	17

1.0 LIQUID EFFLUENTS

1.1 Liquid Effluent Monitor Setpoints

1.1.1 Liquid Radwaste Effluent Line Monitors

Liquid Radwaste Effluent Line Monitors provide alarm and automatic termination of release prior to exceeding ten times the concentration limits specified in 10CFR20, Appendix B, Table 2, Column 2 at the release point to the unrestricted area. To meet this specification and for the purpose of implementation of LCO 6.3.9, the alarm/trip setpoints for liquid effluent monitors and flow measurement devices are set to assure that the following equation is satisfied:

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

where:

C = ten times the effluent concentration limit (LCO 6.11.1) implementing 10CFR20 for the site, in $\mu\text{Ci/ml}$.

c = The setpoint, representative of a radioactivity concentration in $\mu\text{Ci/ml}$, 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 ten times 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.

Step 1)

The method by which this is accomplished is as follows: 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 ODCM Table 6.11.1-1:

$$\sum_i C_i = \sum_g C_g + C_a + \sum_s C_s + C_t + C_f \quad (2)$$

where:

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

C_a = the concentration C_a of gross alpha emitters in liquid waste as measured in the monthly composite sample.

$\sum_s C_s$ = 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.

C_f = the concentration of Fe-55 in liquid waste as measured in the quarterly composite sample.

The C_g term will be included in the analysis of each waste tank batch to be released; terms for alpha, strontiums, tritium and iron are included if analysis of liquid waste 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 ten times the limiting concentration of 10CFR20, Appendix B, Table 2, Column 2 are met at the point of discharge.

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

$$= \left[\sum_g \frac{C_g}{EC_g} + \frac{C_a}{EC_a} + \sum_s \frac{C_s}{EC_s} + \frac{C_t}{EC_t} + \frac{C_f}{EC_f} \right] \times S.F. \quad (3)$$

where:

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

$EC_i =$ EC_g, EC_a, EC_s, EC_t and EC_f are ten times the limiting concentrations of the appropriate radionuclide from 10CFR20, Appendix B, Table 2, Column 2. For dissolved or entrained noble gases, the concentration shall be limited to $2.0E-4$ μ Ci/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 ten times 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 :

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

where:

$F_d = 0.9 \times$ minimum expected dilution flow rate

$f_d =$ 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 ten times the limiting concentrations 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:

$F = F_d = 0.9 \times$ minimum expected dilution flow rate (5)

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

Thus, if instrumentation indicates 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, the release is terminated (manually or automatically).

- Step 5) The radioactivity monitor setpoint may now be specified based on the values of $\sum_i C_i$, F , and f which were specified to provide compliance with ten times the limits of 10CFR20, Appendix B, Table 2, 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:

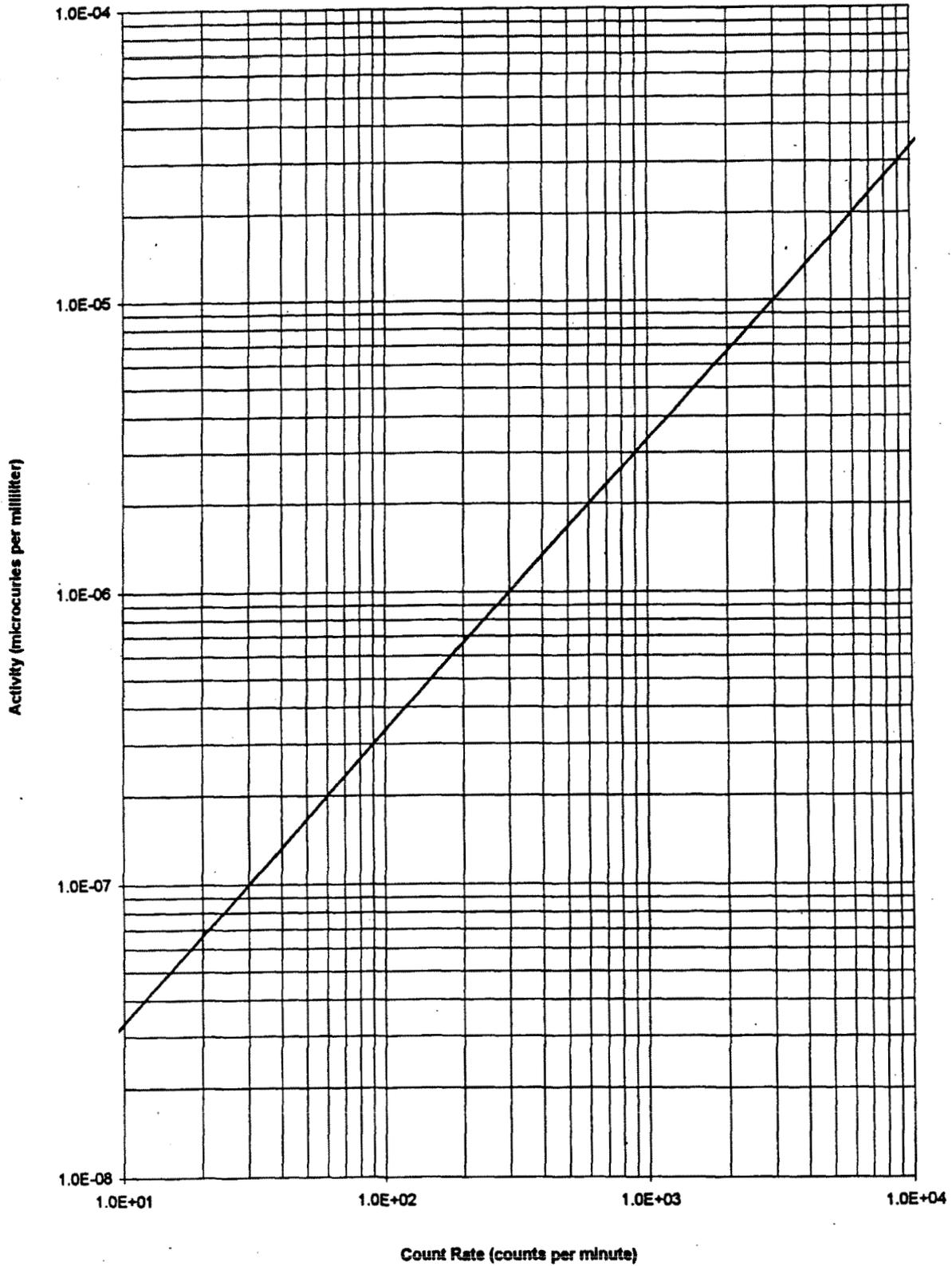
$$C_m = \frac{f_d}{f_a} \sum_g C_g \text{ (}\mu\text{Ci/ml)} \quad (7)$$

where f_a is the actual (or maximum expected) waste tank effluent flow rate. The value of C_m ($\mu\text{Ci/ml}$) is used to determine the monitor setpoint (CPM) from a calibration curve similar to ODCM Figure 1.0-1.

NOTE: Setpoint adjustments are not required if the existing setpoint corresponds to a lower count rate than the calculated value. The actual monitor setpoint is determined from the measured concentration plus background for the detector. 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.

NOTE: For cases where no gamma emitters are detected, i.e.
 $\Sigma C_g = 0$, the monitor setpoint should be set at 2700 cpm
plus background. The 2700 cpm is based on Cesium-137
monitor response and the limits specified in LCO 6.11.1. ⁽¹²⁾

Figure 1.0-1
Example Calibration Curve for Liquid Effluent Monitor



1.2 Dose Calculations for Liquid Effluents

1.2.1 Maximum Exposed Individual Model

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 LCO 6.11.2, 6.11.3, and TS 5.6.3 using the following expression:

$$D_{\text{Tau}} = \sum_i [A_{i\text{Tau}} \sum_{l=1}^m \Delta t_l C_{il} F_l] \quad (\text{millirem}) \quad (8)$$

where:

$A_{i\text{Tau}}$ = Site-related ingestion dose commitment factor for radionuclide i , in millirem/hr per $\mu\text{Ci/ml}$.
 $= K_o U_F B F_i D F_i$

Δt_l = length of the time period over which C_{il} and F_l are averaged for all waste tank liquid releases, in hours.

C_{il} = average concentration of radionuclide i observed in the undiluted waste tank liquid effluent during time period Δt_l from any liquid release from the waste tank, in $\mu\text{Ci/ml}$. Concentrations are determined primarily from a gamma isotopic analysis of the waste tank liquid effluent sample. For Fe-55, 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_{i1} 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 2⁽⁵⁾.

$$= \frac{\text{average undiluted liquid waste flow}}{\text{average flow from site discharge} \times 2}$$

K_o = units conversion factor 1.14×10^5

$$= 10^6 \frac{\text{pCi}}{\mu\text{Ci}} \times 10^3 \frac{\text{ml}}{\text{kg}} \div 8766 \frac{\text{hr}}{\text{yr}}$$

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 ODCM Table 1.2-1.

DF_i = Dose conversion factor for each nuclide, i, for adults in preselected organ, Tau, in mrem/pCi, from ODCM Table 1.2-2.

Calculated values of $A_{i\text{Tau}}$ for radionuclides which might be observed in liquid effluents are given in ODCM Table 1.2-3.

1.2.2

Dose Projection

Doses from liquid effluents to UNRESTRICTED AREAS are projected at least every 31 days as required by LCO 6.11.3.

These projections are made by averaging the doses (D_{Tau}) from previous operating history (normally the previous six months) which is indicative of expected future operations.

TABLE 1.2-1
BIOACCUMULATION FACTORS, (BF₁)
 (pCi/kg per pCi/liter)*

<u>ELEMENT</u>	<u>FRESHWATER FISH</u>	<u>INVERTEBRATE</u>
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
SB	1.0E+00	1.0E+01
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, except for SB which was taken from Reference 2, Table A-8.

TABLE 1.2-2
INGESTION DOSE CONVERSION FACTORS FOR ADULTS, (DF_i)
(mrem per pCi ingested) *

Page 1 of 3

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						
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)

INGESTION DOSE CONVERSION FACTORS FOR ADULTS, (DF₁)

(mrem per pCi ingested) *

Page 2 of 3

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
SB124	2.80E-06	5.29E-08	1.11E-06	6.79E-09	0.0	2.18E-06	7.95E-05
SB125+D	1.79E-06	2.00E-08	4.26E-07	1.82E-09	0.0	1.38E-06	1.97E-05
SB126	1.15E-06	2.34E-08	4.15E-07	7.04E-09	0.0	7.05E-07	9.40E-05
SB127	2.58E-07	5.65E-09	9.90E-08	3.10E-09	0.0	1.53E-07	5.90E-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

* Values taken from Reference 3, Table E-11, except for SB values which were taken from Reference 8, Table 4.

TABLE 1.2-2 (Continued)

INGESTION DOSE CONVERSION FACTORS FOR ADULTS, (DF_i)
 (mrem per pCi ingested) *

Page 3 of 3

NUCLIDE	BONE	LIVER	T. BODY	THYROID	KIDNEY	LUNG	GI-LLI
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
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

SITE RELATED INGESTION DOSE COMMITMENT FACTOR

Page 1 of 2

Release Type: 1 Liquid
 Dose Factor: 0 AiTau ((mrem/hr)/(uCi/ml))*
 AgeGroup: 0 ADULT
 Pathway: 2 Fresh Water Fish - Comm. (FFCM)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
H-3	0.00e+00	2.26e-01	2.26e-01	2.26e-01	2.26e-01	2.26e-01	0.00e+00	2.26e-01
C-14	3.13e+04	6.26e+03	6.26e+03	6.26e+03	6.26e+03	6.26e+03	0.00e+00	6.26e+03
NA-24	4.07e+02	4.07e+02	4.07e+02	4.07e+02	4.07e+02	4.07e+02	0.00e+00	4.07e+02
P-32	4.62e+07	2.87e+06	0.00e+00	0.00e+00	0.00e+00	5.19e+06	0.00e+00	1.79e+06
CR-51	0.00e+00	0.00e+00	7.61e-01	2.81e-01	1.69e+00	3.20e+02	0.00e+00	1.27e+00
MN-54	0.00e+00	4.38e+03	0.00e+00	1.30e+03	0.00e+00	1.34e+04	0.00e+00	8.35e+02
MN-56	0.00e+00	1.10e+02	0.00e+00	1.40e+02	0.00e+00	3.51e+03	0.00e+00	1.95e+01
FE-55	6.58e+02	4.55e+02	0.00e+00	0.00e+00	2.54e+02	2.61e+02	0.00e+00	1.06e+02
FE-59	1.04e+03	2.44e+03	0.00e+00	0.00e+00	6.82e+02	8.14e+03	0.00e+00	9.36e+02
CO-58	0.00e+00	8.92e+01	0.00e+00	0.00e+00	0.00e+00	1.81e+03	0.00e+00	2.00e+02
CO-60	0.00e+00	2.56e+02	0.00e+00	0.00e+00	0.00e+00	4.81e+03	0.00e+00	5.65e+02
NI-63	3.11e+04	2.16e+03	0.00e+00	0.00e+00	0.00e+00	4.50e+02	0.00e+00	1.04e+03
NI-65	1.26e+02	1.64e+01	0.00e+00	0.00e+00	0.00e+00	4.17e+02	0.00e+00	7.49e+00
CU-64	0.00e+00	9.97e+00	0.00e+00	2.51e+01	0.00e+00	8.50e+02	0.00e+00	4.68e+00
ZN-65	2.32e+04	7.37e+04	0.00e+00	4.93e+04	0.00e+00	4.64e+04	0.00e+00	3.33e+04
ZN-69	4.93e+01	9.43e+01	0.00e+00	6.13e+01	0.00e+00	1.42e+01	0.00e+00	6.56e+00
BR-83	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.82e+01	0.00e+00	4.04e+01
BR-84	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.11e-04	0.00e+00	5.24e+01
BR-85	0.00e+00	2.15e+00						
RB-86	0.00e+00	1.01e+05	0.00e+00	0.00e+00	0.00e+00	1.99e+04	0.00e+00	4.71e+04
RB-88	0.00e+00	2.90e+02	0.00e+00	0.00e+00	0.00e+00	4.00e-09	0.00e+00	1.54e+02
RB-89	0.00e+00	1.92e+02	0.00e+00	0.00e+00	0.00e+00	1.12e-11	0.00e+00	1.35e+02
SR-89	2.21e+04	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.55e+03	0.00e+00	6.35e+02
SR-90	5.44e+05	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.57e+04	0.00e+00	1.34e+05
SR-91	4.07e+02	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.94e+03	0.00e+00	1.64e+01
SR-92	1.54e+02	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.06e+03	0.00e+00	6.68e+00
Y-90	5.76e-01	0.00e+00	0.00e+00	0.00e+00	0.00e+00	6.10e+03	0.00e+00	1.54e-02
Y-91	8.44e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.64e+03	0.00e+00	2.26e-01
Y-91M	5.44e-03	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.60e-02	0.00e+00	2.11e-04
Y-92	5.06e-02	0.00e+00	0.00e+00	0.00e+00	0.00e+00	8.86e+02	0.00e+00	1.48e-03
Y-93	1.60e-01	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.09e+03	0.00e+00	4.43e-03
ZR-95	2.40e-01	7.70e-02	0.00e+00	1.21e-01	0.00e+00	2.44e+02	0.00e+00	5.21e-02
ZR-97	1.33e-02	2.68e-03	0.00e+00	4.04e-03	0.00e+00	8.30e+02	0.00e+00	1.22e-03
NB-95	4.47e+02	2.48e+02	0.00e+00	2.46e+02	0.00e+00	1.51e+06	0.00e+00	1.34e+02
MO-99	0.00e+00	1.03e+02	0.00e+00	2.34e+02	0.00e+00	2.39e+02	0.00e+00	1.96e+01
TC-99M	8.87e-03	2.51e-02	0.00e+00	3.81e-01	1.23e-02	1.48e+01	0.00e+00	3.19e-01
TC-101	9.12e-03	1.31e-02	0.00e+00	2.37e-01	6.72e-03	3.95e-14	0.00e+00	1.29e-01
RU-103	4.43e+00	0.00e+00	0.00e+00	1.69e+01	0.00e+00	5.17e+02	0.00e+00	1.91e+00
RU-105	3.69e-01	0.00e+00	0.00e+00	4.76e+00	0.00e+00	2.26e+02	0.00e+00	1.46e-01
RU-106	6.58e+01	0.00e+00	0.00e+00	1.27e+02	0.00e+00	4.26e+03	0.00e+00	8.33e+00
AG-110M	8.81e-01	8.15e-01	0.00e+00	1.60e+00	0.00e+00	3.33e+02	0.00e+00	4.84e-01

* Calculated from Equation 8.

TABLE 1.2-3 (Continued)

SITE RELATED INGESTION DOSE COMMITMENT FACTOR

Page 2 of 2

Release Type: 1 Liquid
 Dose Factor: 0 AiTau ((mrem/hr)/(uCi/ml))*
 AgeGroup: 0 ADULT
 Pathway: 2 Fresh Water Fish - Comm. (FFCM)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
SB-124	6.70e+00	1.27e-01	1.63e-02	0.00e+00	5.22e+00	1.90e+02	0.00e+00	2.66e+00
SB-125	4.29e+00	4.79e-02	4.36e-03	0.00e+00	3.30e+00	4.72e+01	0.00e+00	1.02e+00
TE-125M	2.57e+03	9.30e+02	7.72e+02	1.04e+04	0.00e+00	1.02e+04	0.00e+00	3.44e+02
TE-127	1.05e+02	3.78e+01	7.80e+01	4.29e+02	0.00e+00	8.31e+03	0.00e+00	2.28e+01
TE-127M	6.48e+03	2.32e+03	1.66e+03	2.63e+04	0.00e+00	2.17e+04	0.00e+00	7.90e+02
TE-129	3.01e+01	1.13e+01	2.31e+01	1.26e+02	0.00e+00	2.27e+01	0.00e+00	7.33e+00
TE-129M	1.10e+04	4.11e+03	3.78e+03	4.60e+04	0.00e+00	5.54e+04	0.00e+00	1.74e+03
TE-131	1.89e+01	7.88e+00	1.55e+01	8.26e+01	0.00e+00	2.67e+00	0.00e+00	5.96e+00
TE-131M	1.66e+03	8.10e+02	1.28e+03	8.21e+03	0.00e+00	8.04e+04	0.00e+00	6.75e+02
TE-132	2.41e+03	1.56e+03	1.72e+03	1.50e+04	0.00e+00	7.38e+04	0.00e+00	1.47e+03
I-130	2.71e+01	8.01e+01	6.79e+03	1.25e+02	0.00e+00	6.89e+01	0.00e+00	3.16e+01
I-131	1.49e+02	2.14e+02	7.00e+04	3.66e+02	0.00e+00	5.64e+01	0.00e+00	1.22e+02
I-132	7.29e+00	1.95e+01	6.82e+02	3.11e+01	0.00e+00	3.66e+00	0.00e+00	6.82e+00
I-133	5.10e+01	8.87e+01	1.30e+04	1.55e+02	0.00e+00	7.97e+01	0.00e+00	2.70e+01
I-134	3.81e+00	1.03e+01	1.79e+02	1.64e+01	0.00e+00	9.01e-03	0.00e+00	3.70e+00
I-135	1.59e+01	4.17e+01	2.75e+03	6.68e+01	0.00e+00	4.70e+01	0.00e+00	1.54e+01
CS-134	2.98e+05	7.09e+05	0.00e+00	2.29e+05	7.61e+04	1.24e+04	0.00e+00	5.79e+05
CS-136	3.12e+04	1.23e+05	0.00e+00	6.85e+04	9.38e+03	1.40e+04	0.00e+00	8.86e+04
CS-137	3.82e+05	5.22e+05	0.00e+00	1.77e+05	5.89e+04	1.01e+04	0.00e+00	3.42e+05
CS-138	2.64e+02	5.22e+02	0.00e+00	3.84e+02	3.79e+01	2.23e-03	0.00e+00	2.59e+02
BA-139	9.29e-01	6.62e-04	0.00e+00	6.19e-04	3.75e-04	1.65e+00	0.00e+00	2.72e-02
BA-140	1.94e+02	2.44e-01	0.00e+00	8.30e-02	1.40e-01	4.00e+02	0.00e+00	1.27e+01
BA-141	4.51e-01	3.41e-04	0.00e+00	3.17e-04	1.93e-04	2.13e-10	0.00e+00	1.52e-02
BA-142	2.04e-01	2.10e-04	0.00e+00	1.77e-04	1.19e-04	2.87e-19	0.00e+00	1.28e-02
LA-140	1.50e-01	7.54e-02	0.00e+00	0.00e+00	0.00e+00	5.54e+03	0.00e+00	1.99e-02
LA-142	7.66e-03	3.48e-03	0.00e+00	0.00e+00	0.00e+00	2.54e+01	0.00e+00	8.68e-04
CE-141	2.24e-02	1.52e-02	0.00e+00	7.04e-03	0.00e+00	5.79e+01	0.00e+00	1.72e-03
CE-143	3.95e-03	2.92e+00	0.00e+00	1.29e-03	0.00e+00	1.09e+02	0.00e+00	3.23e-04
CE-144	1.17e+00	4.88e-01	0.00e+00	2.90e-01	0.00e+00	3.95e+02	0.00e+00	6.27e-02
PR-143	5.51e-01	2.21e-01	0.00e+00	1.27e-01	0.00e+00	2.41e+03	0.00e+00	2.73e-02
PR-144	1.80e-03	7.48e-04	0.00e+00	4.22e-04	0.00e+00	2.59e-10	0.00e+00	9.16e-05
ND-147	3.76e-01	4.35e-01	0.00e+00	2.54e-01	0.00e+00	2.09e+03	0.00e+00	2.60e-02
W-187	2.96e+02	2.47e+02	0.00e+00	0.00e+00	0.00e+00	8.10e+04	0.00e+00	8.65e+01
NP-239	2.85e-02	2.80e-03	0.00e+00	8.74e-03	0.00e+00	5.75e+02	0.00e+00	1.54e-03
SB-126	2.75e+00	5.62e-02	1.69e-02	0.00e+00	1.69e+00	2.25e+02	0.00e+00	9.94e-01
SB-127	6.18e-01	1.35e-02	7.42e-03	0.00e+00	3.66e-01	1.41e+02	0.00e+00	2.37e-01

* Calculated from Equation 8.

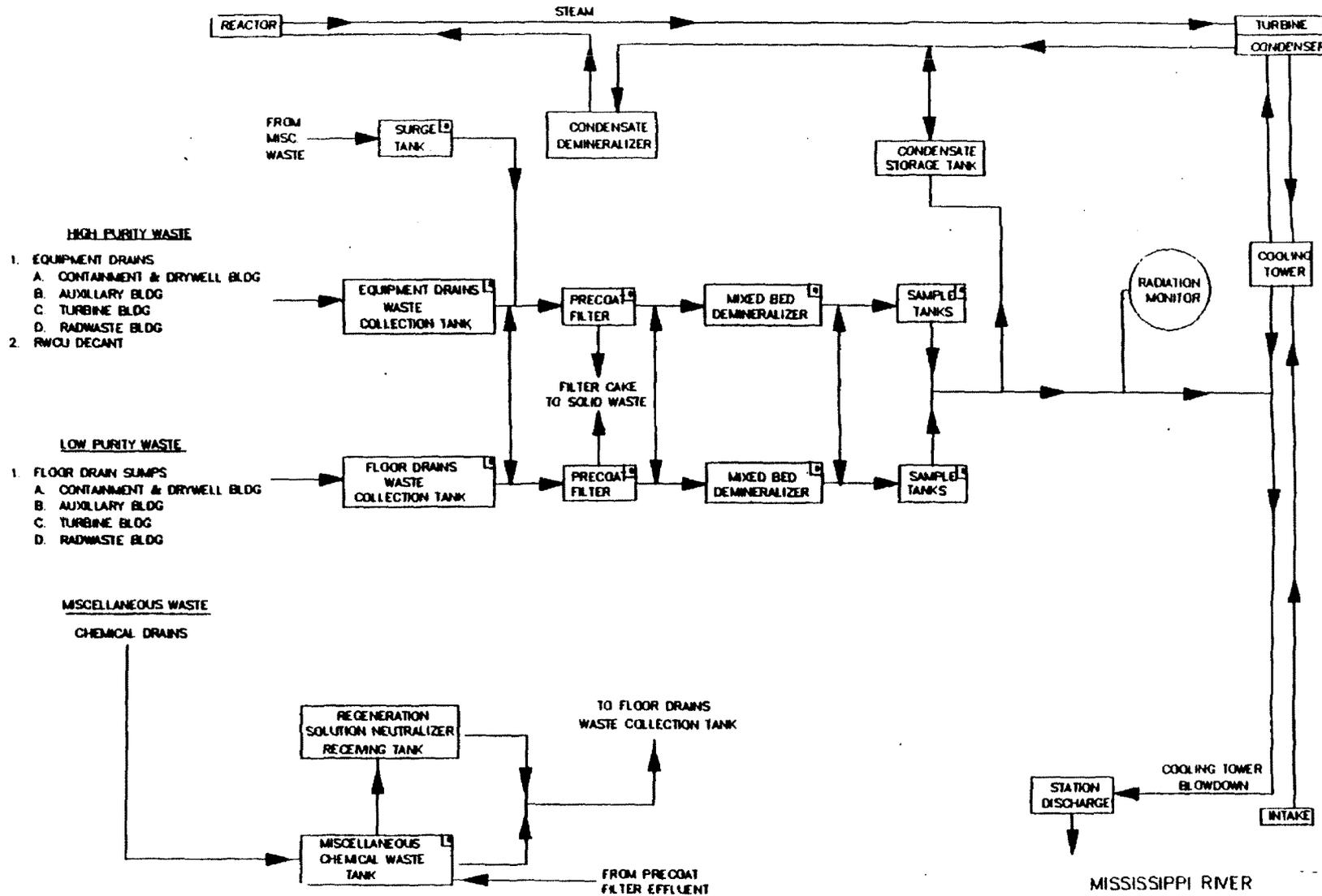
1.3 Liquid Radwaste Treatment System

The essential components of the liquid radwaste treatment system are indicated by an asterisk (*).

NOTES for Figure ODCM 1.3-1

- (1) The essential components outlined on the following page are those necessary to collect, process and sample liquid radwaste prior to discharge to the environment.
- (2) Only one of the following is required in order to process liquid waste.
 - a. Equipment drain filter
 - b. Floor drain filter
 - c. Equipment drain demineralizer
 - d. Floor drain demineralizer
- (3) The Waste Surge Tanks may be used to replace the Waste Collection Tanks.

Figure 1.3-1
Liquid Radwaste Treatment System



2.0 GASEOUS EFFLUENTS

2.1 Gaseous Effluent Monitor Setpoints

2.1.1 Continuous Ventilation Monitors

For the purpose of implementation of LCO 6.3.10, the alarm setpoint level for continuous ventilation noble gas monitors will be calculated as follows:

S_V = count rate (cpm) above background of vent noble gas monitor at the alarm setpoint level

$$PF \times R_t \times D_{TB}$$

= the lesser of or

$$PF \times R_s \times D_{ss}$$

where:

PF = product of allocation factor (AF) and safety factor (SF), normally set at 0.1

AF = allocation factor allowing for a total of four normal effluent release points, normally set at 0.25

SF = safety factor allowing for cumulative uncertainties of measurements, normally set at 0.4

D_{TB} = dose rate limit to the total body of an individual at the SITE BOUNDARY or at UNRESTRICTED AREAS inside the SITE BOUNDARY required to limit dose to 500 mrem in one year
= 500 mrem/yr

D_{ss} = dose rate limit to the skin of the body of an individual at the SITE BOUNDARY or at UNRESTRICTED AREAS inside the SITE BOUNDARY required to limit dose to 3000 mrem in one year
= 3000 mrem/yr

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

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

where:

C = count rate (cpm) above background of the vent monitor
corresponding to grab sample radionuclide
concentrations

$\overline{X/Q}$ = highest sector annual average atmospheric dispersion
at the SITE BOUNDARY or at UNRESTRICTED AREAS inside
the SITE BOUNDARY

= 8.9×10^{-6} sec/m³ in the SW sector

K_i = total body dose factor due to gamma emissions from
each noble gas radionuclide i (mrem/yr per $\mu\text{Ci}/\text{m}^3$)
from ODCM Table 2.1-1

Q'_i = rate of release of noble gas radionuclide i ($\mu\text{Ci}/\text{sec}$)
from the release point

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

$$= C + \overline{X/Q} \left[\sum_i (L_i + 1.1 M_i) Q'_i \right]$$

L_i = skin dose factor due to beta emissions from isotope i
(mrem/yr per $\mu\text{Ci}/\text{m}^3$) from ODCM 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 $\mu\text{Ci}/\text{m}^3$) from ODCM Table 2.1-1

- * The highest annual average X/Q for the GGNS SITE BOUNDARY or UNRESTRICTED AREAS inside the SITE BOUNDARY is at the SITE BOUNDARY, (SW sector, 0.85 miles). This value is taken from ODCM Reference 9, Table 2.

2.1.2

TEXT DELETED

NOTES For Section 2.1.1

- 1) The calculated setpoint values will determine the allowable bounds for the actual setpoint adjustments. That is, setpoint adjustments are not required to be performed if the existing setpoint level corresponds to a count rate that is less than or equal to + 25% of the calculated value. If radionuclides are not detected in the grab sample, then the previously calculated setpoint may remain as the valid setpoint.
- 2) A conservative setpoint may be calculated using a composite total body dose factor. This method may be used when there are no valid isotopics available. The conservative setpoint will be calculated as follows:

$$\begin{aligned} S_v &= \text{count rate (cpm) above background of vent noble gas monitor at the} \\ &\quad \text{alarm setpoint level*} \\ &= PF' \times D_{TB} \times R_t'' \end{aligned}$$

where:

PF' = product of allocation factor (AF) and safety factor (SF'), normally set at 0.1

AF = allocation factor allowing for a total of four normal effluent release points, normally set at 0.25

SF' = safety factor allowing for cumulative uncertainties of measurements, normally set at 0.4.

R_t'' = conservative count rate per mrem/yr to the total body (Xe-133 detection, composite dose factor)
= $\frac{(3.53E-5) (60)}{\bar{X}/\bar{Q} (X) (V) (K)}$

* The setpoint calculation based on a skin dose is not required because the setpoint based on the total body dose is more conservative.

where:

X = Xe-133 volume efficiency factor of the detector system in $\mu\text{Ci}/\text{cc}/\text{cpm}$ as determined by the primary calibration*

V = maximum designed ventilation flow rate in cubic feet per minute (cfm)

$3.53\text{E}-5$ = conversion factor, ft^3 per cc

60 = conversion factor, seconds per minute

K = total body dose factor for historical mixture**,
= $1.51\text{E} + 03$ mrem/yr per $\mu\text{Ci}/\text{m}^3$

Other variables as defined in Section 2.1.1

* The instrument calibration procedures will include checks to ensure that the detector efficiency meets acceptance criteria.

** ODCM Reference 11

TABLE 2.1-1
DOSE FACTORS FOR EXPOSURE TO A SEMI-INFINITE CLOUD OF NOBLE GASES

<u>Nuclide</u>	<u>Y-Body** K_i</u>	<u>B-Skin** L_i</u>	<u>Y-Air* M_i</u>	<u>B-Air* N_i</u>
AR-41	8.84E+03***	2.69E+03	9.30E+03	3.28E+03
KR-83M	7.56E-02	0.00E+00	1.93E+01	2.88E+02
KR-85	1.61E+01	1.34E+03	1.72E+01	1.95E+03
KR-85M	1.17E+03	1.46E+03	1.23E+03	1.97E+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-133	2.94E+02	3.06E+02	3.53E+02	1.05E+03
XE-133M	2.51E+02	9.94E+02	3.27E+02	1.48E+03
XE-135	1.81E+03	1.86E+03	1.92E+03	2.46E+03
XE-135M	3.12E+03	7.11E+02	3.36E+03	7.39E+02
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

Values taken from Reference 3, Table B-1

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

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

$$*** 8.84\text{E}+03 = 8.84 \times 10^3$$

2.2 Gaseous Effluent Dose Calculations

2.2.1 Unrestricted Area Boundary Dose Rate

- a. For the purpose of implementation of LCO 6.11.4.a, the dose rate at the SITE BOUNDARY or at UNRESTRICTED AREAS within the SITE BOUNDARY due to noble gases shall be calculated as follows:

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

$$= \overline{X/Q} \sum K_i Q'_i$$

$$D_s = \text{average skin dose rate in current year}$$

$$(\text{mrem/yr})$$

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

- b. Organ dose rate 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 LCO 6.11.4.b as follows:

$$D_o = \text{average organ dose rate in current year} \\ (\text{mrem/yr})$$

$$= \sum W P_i \overline{Q'_i}$$

i

where:

W = controlling sector annual average atmospheric dispersion at the SITE BOUNDARY or UNRESTRICTED AREAS inside the SITE BOUNDARY for the appropriate pathway

$$\overline{X/Q} = 8.9 \times 10^{-6*} \text{ sec/m}^3 \text{ for inhalation and all tritium pathways}$$

or

$$\overline{D/Q} = 1.6 \times 10^{-8**} \text{ m}^{-2} \text{ for food and ground plane pathways}$$

P_i = the total dose parameter for radionuclide i, (mrem/yr per $\mu\text{Ci/m}^3$) for inhalation and all tritium pathways and (m^2 . mrem/yr per $\mu\text{Ci/sec}$) for food and ground plane pathways, from ODCM Table 2.2-1a

Q'_i = rate of release of noble gas radionuclide i ($\mu\text{Ci/sec}$) from the release point

$\overline{Q'_i}$ = average release rate of isotope i of tritium, I-131, I-133 or other radionuclide in particulate form, with half-lives greater than eight (8) days in the current year ($\mu\text{Ci/sec}$)

* The highest annual average X/Q for the GGNS SITE BOUNDARY or UNRESTRICTED AREAS inside the SITE BOUNDARY is at the SITE BOUNDARY, in the SW sector (0.85 miles). This value is taken from ODCM Reference 9, Table 2.

** The highest annual average D/Q for the GGNS SITE BOUNDARY or UNRESTRICTED AREAS inside the SITE BOUNDARY is at the SITE BOUNDARY in the SSE sector (0.46 miles). This value is taken from ODCM Reference 9, Table 2.

2.2.2 Unrestricted Area Dose to Individual

- a. For the purpose of implementation of LCO 6.11.5, the air dose at the SITE BOUNDARY or at UNRESTRICTED AREAS within the SITE BOUNDARY shall be determined as follows:

D_{γ} = air dose due to gamma emissions from noble gas radionuclide i (mrad)

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

where:

$\overline{X/Q}$ = relative concentration for the SITE BOUNDARY or at UNRESTRICTED AREAS within the SITE BOUNDARY.

$$= 8.9 \times 10^{-6*} \text{ sec/m}^3$$

M_i = air dose factor due to gamma emissions from noble gas radionuclide i (mrad/yr per $\mu\text{Ci/m}^3$) from ODCM Table 2.1-1

* The highest annual average X/Q for the GGNS SITE BOUNDARY or at UNRESTRICTED AREAS within the SITE BOUNDARY is at the SITE BOUNDARY, SW Sector, 0.85 miles. This value is taken from ODCM Reference 9 Table 2.

Q_i = cumulative release of radionuclide i of noble gas, tritium, I-131, I-133, or material in particulate form over the period of interest (μCi)

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)

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

where:

N_i = air dose factor due to beta emissions from noble gas radionuclide i (mrad/yr per $\mu\text{Ci}/\text{m}^3$) from ODCM Table 2.1-1

$\overline{X/Q}$ = relative concentration the SITE BOUNDARY or at UNRESTRICTED AREAS within the SITE BOUNDARY.

$$= 8.9 \times 10^{-6} \text{ sec}/\text{m}^3$$

Q_i = cumulative release of radionuclide i of noble gas, tritium, I-131, I-133, or material in particulate form over the period of interest (μCi)

* The highest annual average X/Q for the GGNS SITE BOUNDARY or at UNRESTRICTED AREAS within the SITE BOUNDARY is at the SITE BOUNDARY, SW Sector, 0.85 miles. This value is taken from ODCM Reference 9 Table 2.

2.2.2 Unrestricted Area Dose to Individual

- 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 LCO 6.11.6 as follows:

$$D_p = \text{dose to an individual from tritium, I-131, I-133 and radionuclides in particulate form, with half-life greater than eight days (mrem)}$$

$$= 3.17 \times 10^{-8} \sum_i R_i W' Q_i$$

where:

W' = relative concentration at a controlling location for an individual

$$\frac{X}{Q'} = 8.3 \times 10^{-6} \text{ sec/m}^3 \text{ for inhalation and all tritium pathways}$$

or

$$\frac{D}{Q'} = 6.7 \times 10^{-9} \text{ m}^{-2} \text{ for food and ground plane pathways}$$

R_i = the total dose factor for radionuclide i, (mrem/yr per μCi/m³) for inhalation and all tritium pathways and (m² . mrem/yr per μCi/sec) for food and ground plane pathways from Tables 2.2-2a - d

- * The highest annual average X/Q and D/Q at or beyond the SITE BOUNDARY is in the SW Sector (0.89 miles). These values are for the controlling offsite receptor. These values are taken from ODCM Reference 9, Table 2.

2.2.2 Unrestricted Area Dose to Individual

Q_i = cumulative release of radionuclide i of noble gas, tritium, I-131, I-133, or material in particulate form over the period of interest (μCi)

- c. For the purpose of implementing TS 5.6.3, dose calculations will be performed using the above equations or with the substitution of average meteorological parameters (most limiting parameters will be used) which prevailed for the period of the report.

2.2.3 Dose Projection

Doses from gaseous effluents to UNRESTRICTED AREAS are projected at least every 31 days as required by LCO 6.11.8. These projections are made by averaging the doses (D_γ , D_β , D_p) from previous operating history (normally the previous six months) which is indicative of future expected operations.

TABLE 2.2-1a

PATHWAY DOSE FACTORS FOR LCO 6.11.4 and
SECTION 2.2.1.b, (P₁)

Page 1 of 2

AGE GROUP	(INFANT)	(N.A.)	(INFANT)
ISOTOPE	INHALATION	GROUND PLANE	FOOD
H-3	6.47E+02	0.00E+00	2.38E+03
C-14	2.65E+04	0.00E+00	2.34E+09
NA-24	1.06E+04	1.99E+07	1.56E+07
P-32	2.03E+06	0.00E+00	1.60E+11
CR-51	1.28E+04	7.85E+06	4.70E+06
MN-54	1.00E+06	1.29E+09	3.90E+07
MN-56	7.17E+04	1.52E+06	2.84E+00
FE-55	8.69E+04	0.00E+00	1.35E+08
FE-59	1.02E+06	4.56E+08	3.92E+08
CO-58	7.77E+05	6.18E+08	6.05E+07
CO-60	4.51E+06	5.17E+09	2.10E+08
NI-63	3.39E+05	0.00E+00	3.49E+10
NI-65	5.01E+04	4.93E+05	3.02E+01
CU-64	1.50E+04	9.80E+05	3.77E+06
ZN-65	6.47E+05	7.90E+08	1.90E+10
ZN-69	1.32E+04	0.00E+00	2.85E-09
BR-83	3.81E+02	1.01E+04	9.27E-01
BR-84	4.00E+02	3.38E+05	1.32E-22
BR-85	2.04E+01	0.00E+00	0.00E+00
RB-86	1.90E+05	1.47E+07	2.23E+10
RB-88	5.57E+02	5.40E+04	1.88E-44
RB-89	3.21E+02	2.11E+05	3.41E-52
SR-89	2.03E+06	3.56E+04	1.26E+10
SR-90	4.09E+07	0.00E+00	1.22E+11
SR-91	7.34E+04	3.58E+06	3.19E+05
SR-92	1.40E+05	1.23E+06	4.96E+01
Y-90	2.69E+05	7.59E+03	9.42E+05
Y-91	2.45E+06	1.70E+06	5.25E+06
Y-91M	2.79E+03	1.66E+05	2.03E-15
Y-92	1.27E+05	3.06E+05	1.02E+01
Y-93	1.67E+05	3.58E+05	1.69E+04
ZR-95	1.75E+06	3.99E+08	8.26E+05
ZR-97	1.40E+05	4.92E+06	4.44E+04
NB-95	4.79E+05	2.29E+08	2.06E+08
MO-99	1.35E+05	6.60E+06	3.10E+08
TC-99M	2.03E+03	3.01E+05	1.64E+04
TC-101	8.44E+02	3.23E+04	4.88E-57
RU-103	5.52E+05	1.80E+08	1.05E+05
RU-105	4.84E+04	1.03E+06	3.18E+00
RU-106	1.16E+07	3.59E+08	1.45E+06
AG-110M	3.67E+06	3.65E+09	1.46E+10

TABLE 2.2-1a (Continued)

PATHWAY DOSE FACTORS FOR LCO 6.11.4 and
SECTION 2.2.1.b, (P_i)

Page 2 of 2

AGE GROUP	(INFANT)	(N.A.)	(INFANT)
ISOTOPE	INHALATION	GROUND PLANE	FOOD
TE-125M	4.47E+05	3.01E+06	1.51E+08
TE-127	2.44E+04	4.70E+03	1.35E+05
TE-127M	1.31E+06	1.40E+05	1.04E+09
TE-129	2.63E+04	4.41E+04	1.81E-07
TE-129M	1.68E+06	3.30E+07	1.39E+09
TE-131	8.22E+03	4.93E+07	1.41E-30
TE-131M	1.99E+05	1.35E+07	2.29E+07
TE-132	3.40E+05	7.09E+06	6.51E+07
I-130	1.60E+06	9.55E+06	8.71E+08
I-131	1.48E+07	2.98E+07	1.05E+12
I-132	1.69E+05	2.09E+06	1.36E+02
I-133	3.56E+06	4.26E+06	9.59E+09
I-134	4.45E+04	7.57E+05	7.87E-10
I-135	6.96E+05	4.21E+06	2.01E+07
CS-134	7.03E+05	3.28E+09	6.80E+10
CS-136	1.35E+05	2.44E+08	5.81E+09
CS-137	6.12E+05	1.34E+09	6.02E+10
CS-138	8.76E+02	5.86E+05	2.09E-22
BA-139	5.10E+04	1.70E+05	2.71E-05
BA-140	1.60E+06	3.35E+07	2.41E+08
BA-141	4.75E+03	6.79E+04	5.08E-44
BA-142	1.55E+03	7.23E+04	1.67E-79
LA-140	1.68E+05	3.12E+07	1.88E+05
LA-142	5.95E+04	1.30E+06	1.08E-05
CE-141	5.17E+05	2.20E+07	1.37E+07
CE-143	1.16E+05	3.75E+06	1.53E+06
CE-144	9.84E+06	6.77E+07	1.33E+08
PR-143	4.33E+05	0.00E+00	7.84E+05
PR-144	4.28E+03	3.02E+03	1.13E-48
ND-147	3.22E+05	1.44E+07	5.73E+05
W-187	3.96E+04	3.90E+06	2.48E+06
NP-239	5.95E+04	2.83E+06	9.42E+04

Units: Inhalation₂ and all tritium pathways - mrem/yr per $\mu\text{Ci}/\text{m}^3$
Others - $\text{m}^2 \cdot \text{mrem}/\text{yr}$ per $\mu\text{Ci}/\text{sec}$

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

TABLE 2.2-1b

TEXT DELETED

TABLE 2.2-1b (Continued)

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TABLE 2.2-2a

PATHWAY DOSE FACTORS FOR LCO 6.11.6 AND
SECTION 2.2.2.b, (R₁)

Page 1 of 8

Release Type: 2 Gaseous
Dose Factor: 2 Ri (m² * (mrem/yr)/(uCi/cc) or (mrem/yr)/(uCi/m³))
AgeGroup: 3 INFANT
Pathway: 0 Ground Plane Deposition (GPD)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
H-3	0.00e+00							
C-14	0.00e+00							
NA-24	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.39e+07	1.20e+07
P-32	0.00e+00							
CR-51	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.50e+06	4.65e+06
MN-54	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.62e+09	1.38e+09
MN-56	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.07e+06	9.03e+05
FE-55	0.00e+00							
FE-59	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.20e+08	2.73e+08
CO-58	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.45e+08	3.80e+08
CO-60	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.53e+10	2.15e+10
NI-63	0.00e+00							
NI-65	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.45e+05	2.97e+05
CU-64	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	6.86e+05	6.05e+05
ZN-65	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	8.57e+08	7.46e+08
ZN-69	0.00e+00							
BR-83	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	7.08e+03	4.87e+03
BR-84	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.37e+05	2.03e+05
BR-85	0.00e+00							
RB-86	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.03e+07	8.98e+06
RB-88	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.78e+04	3.31e+04
RB-89	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.48e+05	1.23e+05
SR-89	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.51e+04	2.16e+04
SR-90	0.00e+00							
SR-91	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.51e+06	2.15e+06
SR-92	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	8.62e+05	7.76e+05
Y-90	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.31e+03	4.50e+03
Y-91	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.21e+06	1.07e+06
Y-91M	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.16e+05	1.00e+05
Y-92	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.14e+05	1.80e+05
Y-93	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.50e+05	1.83e+05
ZR-95	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.85e+08	2.45e+08
ZR-97	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.44e+06	2.96e+06
NB-95	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.61e+08	1.37e+08
MO-99	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.62e+06	3.99e+06
TC-99M	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.11e+05	1.84e+05
TC-101	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.26e+04	2.03e+04
RU-103	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.26e+08	1.08e+08
RU-105	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	7.21e+05	6.36e+05
RU-106	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.04e+08	4.20e+08
AG-110M	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.02e+09	3.45e+09
TE-125M	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.13e+06	1.56e+06
TE-127	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.29e+03	2.99e+03
TE-127M	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.08e+05	9.17e+04
TE-129	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.08e+04	2.61e+04
TE-129M	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.31e+07	1.98e+07
TE-131	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.45e+07	2.92e+07
TE-131M	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	9.46e+06	8.02e+06

TABLE 2.2-2a (Continued)

PATHWAY DOSE FACTORS FOR LCO 6.11.6 AND
SECTION 2.2.2.b, (R_i)

Page 2 of 8

Release Type: 2 Gaseous
Dose Factor: 2 R_i (m² * (mrem/yr)/(uCi/cc) or (mrem/yr)/(uCi/m³))
AgeGroup: 3 INFANT
Pathway: 0 Ground Plane Deposition (GPD)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
TE-132	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.97e+06	4.22e+06
I-130	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	6.68e+06	5.50e+06
I-131	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.09e+07	1.72e+07
I-132	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.47e+06	1.25e+06
I-133	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.98e+06	2.45e+06
I-134	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.30e+05	4.46e+05
I-135	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.95e+06	2.53e+06
CS-134	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	8.05e+09	6.90e+09
CS-136	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.71e+08	1.51e+08
CS-137	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.20e+10	1.03e+10
CS-138	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.10e+05	3.59e+05
BA-139	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.19e+05	1.06e+05
BA-140	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.35e+07	2.05e+07
BA-141	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.75e+04	4.17e+04
BA-142	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.06e+04	4.44e+04
LA-140	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.18e+07	1.92e+07
LA-142	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	9.12e+05	7.60e+05
CE-141	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.54e+07	1.37e+07
CE-143	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.63e+06	2.31e+06
CE-144	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	8.05e+07	6.96e+07
PR-143	0.00e+00							
PR-144	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.11e+03	1.84e+03
ND-147	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.01e+07	8.39e+06
W-187	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.73e+06	2.35e+06
NP-239	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.98e+06	1.71e+06

TABLE 2.2-2a (Continued)

PATHWAY DOSE FACTORS FOR LCO 6.11.6 AND
SECTION 2.2.2.b, (R₁)

Release Type: 2 Gaseous
Dose Factor: 2 Ri (m² * (mrem/yr)/(uCi/cc) or (mrem/yr)/(uCi/m³))
AgeGroup: 3 INFANT
Pathway: 1 Inhalation (INHL)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
H-3	0.00e+00	6.47e+02	6.47e+02	6.47e+02	6.47e+02	6.47e+02	0.00e+00	6.47e+02
C-14	2.65e+04	5.31e+03	5.31e+03	5.31e+03	5.31e+03	5.31e+03	0.00e+00	5.31e+03
NA-24	1.06e+04	1.06e+04	1.06e+04	1.06e+04	1.06e+04	1.06e+04	0.00e+00	1.06e+04
P-32	2.03e+06	1.12e+05	0.00e+00	0.00e+00	0.00e+00	1.61e+04	0.00e+00	7.74e+04
CR-51	0.00e+00	0.00e+00	5.75e+01	1.32e+01	1.28e+04	3.57e+02	0.00e+00	8.95e+01
MN-54	0.00e+00	2.53e+04	0.00e+00	4.98e+03	1.00e+06	7.06e+03	0.00e+00	4.98e+03
MN-56	0.00e+00	1.54e+00	0.00e+00	1.10e+00	1.25e+04	7.17e+04	0.00e+00	2.21e-01
FE-55	1.97e+04	1.18e+04	0.00e+00	0.00e+00	8.69e+04	1.10e+03	0.00e+00	3.33e+03
FE-59	1.36e+04	2.35e+04	0.00e+00	0.00e+00	1.02e+06	2.48e+04	0.00e+00	9.48e+03
CO-58	0.00e+00	1.22e+03	0.00e+00	0.00e+00	7.77e+05	1.11e+04	0.00e+00	1.82e+03
CO-60	0.00e+00	8.02e+03	0.00e+00	0.00e+00	4.51e+06	3.19e+04	0.00e+00	1.18e+04
NI-63	3.39e+05	2.04e+04	0.00e+00	0.00e+00	2.09e+05	2.42e+03	0.00e+00	1.16e+04
NI-65	2.39e+00	2.84e-01	0.00e+00	0.00e+00	8.12e+03	5.01e+04	0.00e+00	1.23e-01
CU-64	0.00e+00	1.88e+00	0.00e+00	3.98e+00	9.30e+03	1.50e+04	0.00e+00	7.74e-01
ZN-65	1.93e+04	6.26e+04	0.00e+00	3.25e+04	6.47e+05	5.14e+04	0.00e+00	3.11e+04
ZN-69	5.39e-02	9.67e-02	0.00e+00	4.02e-02	1.47e+03	1.32e+04	0.00e+00	7.18e-03
BR-83	0.00e+00	3.81e+02						
BR-84	0.00e+00	4.00e+02						
BR-85	0.00e+00	2.04e+01						
RB-86	0.00e+00	1.90e+05	0.00e+00	0.00e+00	0.00e+00	3.04e+03	0.00e+00	8.82e+04
RB-88	0.00e+00	5.57e+02	0.00e+00	0.00e+00	0.00e+00	3.39e+02	0.00e+00	2.87e+02
RB-89	0.00e+00	3.21e+02	0.00e+00	0.00e+00	0.00e+00	6.82e+01	0.00e+00	2.06e+02
SR-89	3.98e+05	0.00e+00	0.00e+00	0.00e+00	2.03e+06	6.40e+04	0.00e+00	1.14e+04
SR-90	4.09e+07	0.00e+00	0.00e+00	0.00e+00	1.12e+07	1.31e+05	0.00e+00	2.59e+06
SR-91	9.56e+01	0.00e+00	0.00e+00	0.00e+00	5.26e+04	7.34e+04	0.00e+00	3.46e+00
SR-92	1.05e+01	0.00e+00	0.00e+00	0.00e+00	2.38e+04	1.40e+05	0.00e+00	3.91e-01
Y-90	3.29e+03	0.00e+00	0.00e+00	0.00e+00	2.69e+05	1.04e+05	0.00e+00	8.82e+01
Y-91	5.88e+05	0.00e+00	0.00e+00	0.00e+00	2.45e+06	7.03e+04	0.00e+00	1.57e+04
Y-91M	4.07e-01	0.00e+00	0.00e+00	0.00e+00	2.79e+03	2.35e+03	0.00e+00	1.39e-02
Y-92	1.64e+01	0.00e+00	0.00e+00	0.00e+00	2.45e+04	1.27e+05	0.00e+00	4.61e-01
Y-93	1.50e+02	0.00e+00	0.00e+00	0.00e+00	7.64e+04	1.67e+05	0.00e+00	4.07e+00
ZR-95	1.15e+05	2.79e+04	0.00e+00	3.11e+04	1.75e+06	2.17e+04	0.00e+00	2.03e+04
ZR-97	1.50e+02	2.56e+01	0.00e+00	2.59e+01	1.10e+05	1.40e+05	0.00e+00	1.17e+01
NB-95	1.57e+04	6.43e+03	0.00e+00	4.72e+03	4.79e+05	1.27e+04	0.00e+00	3.78e+03
MO-99	0.00e+00	1.65e+02	0.00e+00	2.65e+02	1.35e+05	4.87e+04	0.00e+00	3.23e+01
TC-99M	1.40e-03	2.88e-03	0.00e+00	3.11e-02	8.11e+02	2.03e+03	0.00e+00	3.72e-02
TC-101	6.51e-05	8.23e-05	0.00e+00	9.79e-04	5.84e+02	8.44e+02	0.00e+00	8.12e-04
RU-103	2.02e+03	0.00e+00	0.00e+00	4.24e+03	5.52e+05	1.61e+04	0.00e+00	6.79e+02
RU-105	1.22e+00	0.00e+00	0.00e+00	8.99e-01	1.57e+04	4.84e+04	0.00e+00	4.10e-01
RU-106	8.68e+04	0.00e+00	0.00e+00	1.07e+05	1.16e+07	1.64e+05	0.00e+00	1.09e+04
AG-110M	9.98e+03	7.22e+03	0.00e+00	1.09e+04	3.67e+06	3.30e+04	0.00e+00	5.00e+03
TE-125M	4.76e+03	1.99e+03	1.62e+03	0.00e+00	4.47e+05	1.29e+04	0.00e+00	6.58e+02
TE-127	2.23e+00	9.53e-01	1.85e+00	4.86e+00	1.04e+04	2.44e+04	0.00e+00	4.89e-01
TE-127M	1.67e+04	6.90e+03	4.87e+03	3.75e+04	1.31e+06	2.73e+04	0.00e+00	2.07e+03
TE-129	7.88e-02	3.47e-02	6.75e-02	1.75e-01	3.00e+03	2.63e+04	0.00e+00	1.88e-02
TE-129M	1.41e+04	6.09e+03	5.47e+03	3.18e+04	1.68e+06	6.90e+04	0.00e+00	2.23e+03
TE-131	1.74e-02	8.22e-03	1.58e-02	3.99e-02	2.06e+03	8.22e+03	0.00e+00	5.00e-03
TE-131M	1.07e+02	5.50e+01	8.93e+01	2.65e+02	1.99e+05	1.19e+05	0.00e+00	3.63e+01

TABLE 2.2-2a (Continued)

PATHWAY DOSE FACTORS FOR LCO 6.11.6 AND
SECTION 2.2.2.b, (R₁)

Page 4 of 8

Release Type: 2 Gaseous
Dose Factor: 2 Ri (m² * (mrem/yr)/(uCi/cc) or (mrem/yr)/(uCi/m³))
AgeGroup: 3 INFANT
Pathway: 1 Inhalation (INHL)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
TE-132	3.72e+02	2.37e+02	2.79e+02	1.04e+03	3.40e+05	4.41e+04	0.00e+00	1.76e+02
I-130	6.36e+03	1.39e+04	1.60e+06	1.53e+04	0.00e+00	1.99e+03	0.00e+00	5.57e+03
I-131	3.79e+04	4.44e+04	1.48e+07	5.18e+04	0.00e+00	1.06e+03	0.00e+00	1.96e+04
I-132	1.69e+03	3.54e+03	1.69e+05	3.95e+03	0.00e+00	1.90e+03	0.00e+00	1.26e+03
I-133	1.32e+04	1.92e+04	3.56e+06	2.24e+04	0.00e+00	2.16e+03	0.00e+00	5.60e+03
I-134	9.21e+02	1.88e+03	4.45e+04	2.09e+03	0.00e+00	1.29e+03	0.00e+00	6.65e+02
I-135	3.86e+03	7.60e+03	6.96e+05	8.47e+03	0.00e+00	1.83e+03	0.00e+00	2.77e+03
CS-134	3.96e+05	7.03e+05	0.00e+00	1.90e+05	7.97e+04	1.33e+03	0.00e+00	7.45e+04
CS-136	4.83e+04	1.35e+05	0.00e+00	5.64e+04	1.18e+04	1.43e+03	0.00e+00	5.29e+04
CS-137	5.49e+05	6.12e+05	0.00e+00	1.72e+05	7.13e+04	1.33e+03	0.00e+00	4.55e+04
CS-138	5.05e+02	7.81e+02	0.00e+00	4.10e+02	6.54e+01	8.76e+02	0.00e+00	3.98e+02
BA-139	1.48e+00	9.84e-04	0.00e+00	5.92e-04	5.95e+03	5.10e+04	0.00e+00	4.30e-02
BA-140	5.60e+04	5.60e+01	0.00e+00	1.34e+01	1.60e+06	3.84e+04	0.00e+00	2.90e+03
BA-141	1.57e-01	1.08e-04	0.00e+00	6.50e-05	2.97e+03	4.75e+03	0.00e+00	4.97e-03
BA-142	3.98e-02	3.30e-05	0.00e+00	1.90e-05	1.55e+03	6.93e+02	0.00e+00	1.96e-03
LA-140	5.05e+02	2.00e+02	0.00e+00	0.00e+00	1.68e+05	8.48e+04	0.00e+00	5.15e+01
LA-142	1.03e+00	3.77e-01	0.00e+00	0.00e+00	8.22e+03	5.95e+04	0.00e+00	9.04e-02
CE-141	2.77e+04	1.67e+04	0.00e+00	5.25e+03	5.17e+05	2.16e+04	0.00e+00	1.99e+03
CE-143	2.93e+02	1.93e+02	0.00e+00	5.64e+01	1.16e+05	4.97e+04	0.00e+00	2.21e+01
CE-144	3.19e+06	1.21e+06	0.00e+00	5.38e+05	9.84e+06	1.48e+05	0.00e+00	1.76e+05
PR-143	1.40e+04	5.24e+03	0.00e+00	1.97e+03	4.33e+05	3.72e+04	0.00e+00	6.99e+02
PR-144	4.79e-02	1.85e-02	0.00e+00	6.72e-03	1.61e+03	4.28e+03	0.00e+00	2.41e-03
ND-147	7.94e+03	8.13e+03	0.00e+00	3.15e+03	3.22e+05	3.12e+04	0.00e+00	5.00e+02
W-187	1.30e+01	9.02e+00	0.00e+00	0.00e+00	3.96e+04	3.56e+04	0.00e+00	3.12e+00
NP-239	3.71e+02	3.32e+01	0.00e+00	6.62e+01	5.95e+04	2.49e+04	0.00e+00	1.88e+01

TABLE 2.2-2a (Continued)

PATHWAY DOSE FACTORS FOR LCO 6.11.6 AND
SECTION 2.2.2.b, (R₁)

Page 5 of 8

Release Type: 2 Gaseous
Dose Factor: 2 Ri (m² * (mrem/yr)/(uCi/cc) or (mrem/yr)/(uCi/m³))
AgeGroup: 3 INFANT
Pathway: 2 Vegetation (VEG)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
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Not a pathway for this age group

TABLE 2.2-2a (Continued)

PATHWAY DOSE FACTORS FOR LCO 6.11.6 AND
SECTION 2.2.2.b, (R_i)

Page 6 of 8

Release Type: 2 Gaseous
Dose Factor: 2 Ri (m² * (mrem/yr)/(uCi/cc) or (mrem/yr)/(uCi/m³))
AgeGroup: 3 INFANT
Pathway: 4 Grs/Cow/Meat (CMEAT)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
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Not a pathway for this agegroup

TABLE 2.2-2a (Continued)

PATHWAY DOSE FACTORS FOR LCO 6.11.6 AND
SECTION 2.2.2.b, (R_i)

Page 7 of 8

Release Type: 2 Gaseous
Dose Factor: 2 Ri (m² * (mrem/yr)/(uCi/cc) or (mrem/yr)/(uCi/m³))
AgeGroup: 3 INFANT
Pathway: 5 Grs/Cow/Milk (CMILK)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
H-3	0.00e+00	2.38e+03	2.38e+03	2.38e+03	2.38e+03	2.38e+03	0.00e+00	2.38e+03
C-14	2.34e+09	5.00e+08	5.00e+08	5.00e+08	5.00e+08	5.00e+08	0.00e+00	5.00e+08
NA-24	1.56e+07	1.56e+07	1.56e+07	1.56e+07	1.56e+07	1.56e+07	0.00e+00	1.56e+07
P-32	1.60e+11	9.42e+09	0.00e+00	0.00e+00	0.00e+00	2.17e+09	0.00e+00	6.21e+09
CR-51	0.00e+00	0.00e+00	1.05e+05	2.30e+04	2.05e+05	4.70e+06	0.00e+00	1.61e+05
MN-54	0.00e+00	3.90e+07	0.00e+00	8.64e+06	0.00e+00	1.43e+07	0.00e+00	8.84e+06
MN-56	0.00e+00	3.13e-02	0.00e+00	2.69e-02	0.00e+00	2.84e+00	0.00e+00	5.39e-03
FE-55	1.35e+08	8.73e+07	0.00e+00	0.00e+00	4.27e+07	1.11e+07	0.00e+00	2.33e+07
FE-59	2.24e+08	3.92e+08	0.00e+00	0.00e+00	1.16e+08	1.87e+08	0.00e+00	1.54e+08
CO-58	0.00e+00	2.43e+07	0.00e+00	0.00e+00	0.00e+00	6.05e+07	0.00e+00	6.05e+07
CO-60	0.00e+00	8.82e+07	0.00e+00	0.00e+00	0.00e+00	2.10e+08	0.00e+00	2.08e+08
NI-63	3.49e+10	2.16e+09	0.00e+00	0.00e+00	0.00e+00	1.07e+08	0.00e+00	1.21e+09
NI-65	3.51e+00	3.97e-01	0.00e+00	0.00e+00	0.00e+00	3.02e+01	0.00e+00	1.81e-01
CU-64	0.00e+00	1.84e+05	0.00e+00	3.11e+05	0.00e+00	3.77e+06	0.00e+00	8.51e+04
ZN-65	5.55e+09	1.90e+10	0.00e+00	9.23e+09	0.00e+00	1.61e+10	0.00e+00	8.78e+09
ZN-69	1.94e-11	3.49e-11	0.00e+00	1.45e-11	0.00e+00	2.85e-09	0.00e+00	2.60e-12
BR-83	0.00e+00	9.27e-01						
BR-84	0.00e+00	1.32e-22						
BR-85	0.00e+00							
RB-86	0.00e+00	2.23e+10	0.00e+00	0.00e+00	0.00e+00	5.69e+08	0.00e+00	1.10e+10
RB-88	0.00e+00	1.88e-44	0.00e+00	0.00e+00	0.00e+00	1.83e-44	0.00e+00	1.03e-44
RB-89	0.00e+00	3.41e-52	0.00e+00	0.00e+00	0.00e+00	1.16e-52	0.00e+00	2.35e-52
SR-89	1.26e+10	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.59e+08	0.00e+00	3.61e+08
SR-90	1.22e+11	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.52e+09	0.00e+00	3.10e+10
SR-91	2.70e+05	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.19e+05	0.00e+00	9.76e+03
SR-92	4.60e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.96e+01	0.00e+00	1.71e-01
Y-90	6.82e+02	0.00e+00	0.00e+00	0.00e+00	0.00e+00	9.42e+05	0.00e+00	1.83e+01
Y-91	7.33e+04	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.25e+06	0.00e+00	1.95e+03
Y-91M	6.09e-19	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.03e-15	0.00e+00	2.08e-20
Y-92	5.37e-04	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.02e+01	0.00e+00	1.51e-05
Y-93	2.14e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.69e+04	0.00e+00	5.83e-02
ZR-95	6.81e+03	1.66e+03	0.00e+00	1.79e+03	0.00e+00	8.26e+05	0.00e+00	1.18e+03
ZR-97	4.05e+00	6.96e-01	0.00e+00	7.01e-01	0.00e+00	4.44e+04	0.00e+00	3.18e-01
NB-95	5.93e+05	2.44e+05	0.00e+00	1.75e+05	0.00e+00	2.06e+08	0.00e+00	1.41e+05
MO-99	0.00e+00	2.08e+08	0.00e+00	3.10e+08	0.00e+00	6.84e+07	0.00e+00	4.05e+07
TC-99M	2.74e+01	5.65e+01	0.00e+00	6.08e+02	2.95e+01	1.64e+04	0.00e+00	7.28e+02
TC-101	2.28e-59	2.87e-59	0.00e+00	3.42e-58	1.57e-59	4.88e-57	0.00e+00	2.84e-58
RU-103	8.67e+03	0.00e+00	0.00e+00	1.80e+04	0.00e+00	1.05e+05	0.00e+00	2.90e+03
RU-105	8.00e-03	0.00e+00	0.00e+00	5.88e-02	0.00e+00	3.18e+00	0.00e+00	2.69e-03
RU-106	1.90e+05	0.00e+00	0.00e+00	2.25e+05	0.00e+00	1.45e+06	0.00e+00	2.38e+04
AG-110M	3.86e+08	2.82e+08	0.00e+00	4.03e+08	0.00e+00	1.46e+10	0.00e+00	1.86e+08
TE-125M	1.51e+08	5.04e+07	5.08e+07	0.00e+00	0.00e+00	7.19e+07	0.00e+00	2.04e+07
TE-127	6.45e+03	2.16e+03	5.25e+03	1.57e+04	0.00e+00	1.35e+05	0.00e+00	1.39e+03
TE-127M	4.21e+08	1.40e+08	1.22e+08	1.04e+09	0.00e+00	1.70e+08	0.00e+00	5.10e+07
TE-129	2.27e-09	7.81e-10	1.90e-09	5.64e-09	0.00e+00	1.81e-07	0.00e+00	5.29e-10
TE-129M	5.57e+08	1.91e+08	2.14e+08	1.39e+09	0.00e+00	3.33e+08	0.00e+00	8.58e+07
TE-131	3.49e-32	1.29e-32	3.11e-32	8.91e-32	0.00e+00	1.41e-30	0.00e+00	9.79e-33
TE-131M	3.38e+06	1.36e+06	2.75e+06	9.35e+06	0.00e+00	2.29e+07	0.00e+00	1.12e+06

TABLE 2.2-2a (Continued)

PATHWAY DOSE FACTORS FOR LCO 6.11.6 AND
SECTION 2.2.2.b, (R_i)

Page 8 of 8

Release Type: 2 Gaseous
Dose Factor: 2 R_i (m² * (mrem/yr)/(uCi/cc) or (mrem/yr)/(uCi/m³))
AgeGroup: 3 INFANT
Pathway: 5 Grs/Cow/Milk (CMILK)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
TE-132	2.10e+07	1.04e+07	1.54e+07	6.51e+07	0.00e+00	3.85e+07	0.00e+00	9.71e+06
I-130	3.53e+06	7.77e+06	8.71e+08	8.53e+06	0.00e+00	1.67e+06	0.00e+00	3.12e+06
I-131	2.72e+09	3.20e+09	1.05e+12	3.74e+09	0.00e+00	1.14e+08	0.00e+00	1.41e+09
I-132	1.43e+00	2.91e+00	1.36e+02	3.25e+00	0.00e+00	2.36e+00	0.00e+00	1.04e+00
I-133	3.62e+07	5.28e+07	9.59e+09	6.20e+07	0.00e+00	8.93e+06	0.00e+00	1.55e+07
I-134	1.65e-11	3.37e-11	7.87e-10	3.77e-11	0.00e+00	3.49e-11	0.00e+00	1.20e-11
I-135	1.13e+05	2.25e+05	2.01e+07	2.50e+05	0.00e+00	8.13e+04	0.00e+00	8.19e+04
CS-134	3.65e+10	6.80e+10	0.00e+00	1.75e+10	7.18e+09	1.85e+08	0.00e+00	6.87e+09
CS-136	1.98e+09	5.81e+09	0.00e+00	2.32e+09	4.73e+08	8.82e+07	0.00e+00	2.17e+09
CS-137	5.15e+10	6.02e+10	0.00e+00	1.62e+10	6.55e+09	1.88e+08	0.00e+00	4.27e+09
CS-138	8.06e-23	1.31e-22	0.00e+00	6.53e-23	1.02e-23	2.09e-22	0.00e+00	6.35e-23
BA-139	4.29e-07	2.84e-10	0.00e+00	1.71e-10	1.72e-10	2.71e-05	0.00e+00	1.24e-08
BA-140	2.41e+08	2.41e+05	0.00e+00	5.72e+04	1.48e+05	5.92e+07	0.00e+00	1.24e+07
BA-141	4.16e-45	2.85e-48	0.00e+00	1.71e-48	1.73e-48	5.08e-44	0.00e+00	1.31e-46
BA-142	4.05e-80	3.37e-83	0.00e+00	1.94e-83	2.04e-83	1.67e-79	0.00e+00	1.99e-81
LA-140	4.06e+01	1.60e+01	0.00e+00	0.00e+00	0.00e+00	1.88e+05	0.00e+00	4.12e+00
LA-142	1.73e-10	6.35e-11	0.00e+00	0.00e+00	0.00e+00	1.08e-05	0.00e+00	1.52e-11
CE-141	4.34e+04	2.64e+04	0.00e+00	8.15e+03	0.00e+00	1.37e+07	0.00e+00	3.11e+03
CE-143	3.96e+02	2.63e+05	0.00e+00	7.65e+01	0.00e+00	1.53e+06	0.00e+00	3.00e+01
CE-144	2.33e+06	9.52e+05	0.00e+00	3.85e+05	0.00e+00	1.33e+08	0.00e+00	1.30e+05
PR-143	1.49e+03	5.56e+02	0.00e+00	2.07e+02	0.00e+00	7.84e+05	0.00e+00	7.37e+01
PR-144	6.25e-53	2.42e-53	0.00e+00	8.76e-54	0.00e+00	1.13e-48	0.00e+00	3.15e-54
ND-147	8.81e+02	9.05e+02	0.00e+00	3.49e+02	0.00e+00	5.73e+05	0.00e+00	5.54e+01
W-187	6.08e+04	4.23e+04	0.00e+00	0.00e+00	0.00e+00	2.48e+06	0.00e+00	1.46e+04
NP-239	3.64e+01	3.26e+00	0.00e+00	6.50e+00	0.00e+00	9.42e+04	0.00e+00	1.84e+00

Units: Inhalation₂ and all tritium pathways - mrem/yr per $\mu\text{Ci}/\text{m}^3$
Others - m² * mrem/yr per $\mu\text{Ci}/\text{sec}$

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

TABLE 2.2-2b

PATHWAY DOSE FACTORS FOR LCO 6.11.6 AND
SECTION 2.2.2.b, (R_i)

Page 1 of 10

Release Type: 2 Gaseous

Dose Factor: 2 Ri (m² * (mrem/yr)/(uCi/cc) or (mrem/yr)/(uCi/m³))

AgeGroup: 2 CHILD

Pathway: 0 Ground Plane Deposition (GPD)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
H-3	0.00e+00							
C-14	0.00e+00							
NA-24	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.39e+07	1.20e+07
P-32	0.00e+00							
CR-51	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.50e+06	4.65e+06
MN-54	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.62e+09	1.38e+09
MN-56	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.07e+06	9.03e+05
FE-55	0.00e+00							
FE-59	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.20e+08	2.73e+08
CO-58	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.45e+08	3.80e+08
CO-60	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.53e+10	2.15e+10
NI-63	0.00e+00							
NI-65	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.45e+05	2.97e+05
CU-64	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	6.86e+05	6.05e+05
ZN-65	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	8.57e+08	7.46e+08
ZN-69	0.00e+00							
BR-83	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	7.08e+03	4.87e+03
BR-84	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.37e+05	2.03e+05
BR-85	0.00e+00							
RB-86	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.03e+07	8.98e+06
RB-88	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.78e+04	3.31e+04
RB-89	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.48e+05	1.23e+05
SR-89	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.51e+04	2.16e+04
SR-90	0.00e+00							
SR-91	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.51e+06	2.15e+06
SR-92	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	8.62e+05	7.76e+05
Y-90	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.31e+03	4.50e+03
Y-91	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.21e+06	1.07e+06
Y-91M	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.16e+05	1.00e+05
Y-92	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.14e+05	1.80e+05
Y-93	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.50e+05	1.83e+05
ZR-95	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.85e+08	2.45e+08
ZR-97	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.44e+06	2.96e+06
NB-95	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.61e+08	1.37e+08
MO-99	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.62e+06	3.99e+06
TC-99M	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.11e+05	1.84e+05
TC-101	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.26e+04	2.03e+04
RU-103	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.26e+08	1.08e+08
RU-105	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	7.21e+05	6.36e+05
RU-106	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.04e+08	4.20e+08
AG-110M	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.02e+09	3.45e+09
TE-125M	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.13e+06	1.56e+06
TE-127	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.29e+03	2.99e+03
TE-127M	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.08e+05	9.17e+04
TE-129	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.08e+04	2.61e+04
TE-129M	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.31e+07	1.98e+07
TE-131	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.45e+07	2.92e+04
TE-131M	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	9.46e+06	8.02e+06

TABLE 2.2-2b (Continued)

PATHWAY DOSE FACTORS FOR LCO 6.11.6 AND
SECTION 2.2.2.b, (R_i)

Page 2 of 10

Release Type: 2 Gaseous
Dose Factor: 2 R_i (m² * (mrem/yr)/(uCi/cc) or (mrem/yr)/(uCi/m³))
AgeGroup: 2 CHILD
Pathway: 0 Ground Plane Deposition (GPD)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
TE-132	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.97e+06	4.22e+06
I-130	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	6.68e+06	5.50e+06
I-131	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.09e+07	1.72e+07
I-132	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.47e+06	1.25e+06
I-133	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.98e+06	2.45e+06
I-134	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.30e+05	4.46e+05
I-135	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.95e+06	2.53e+06
CS-134	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	8.05e+09	6.90e+09
CS-136	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.71e+08	1.51e+08
CS-137	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.20e+10	1.03e+10
CS-138	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.10e+05	3.59e+05
BA-139	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.19e+05	1.06e+05
BA-140	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.35e+07	2.05e+07
BA-141	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.75e+04	4.17e+04
BA-142	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.06e+04	4.44e+04
LA-140	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.18e+07	1.92e+07
LA-142	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	9.12e+05	7.60e+05
CE-141	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.54e+07	1.37e+07
CE-143	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.63e+06	2.31e+06
CE-144	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	8.05e+07	6.96e+07
PR-143	0.00e+00							
PR-144	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.11e+03	1.84e+03
ND-147	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.01e+07	8.39e+06
W-187	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.73e+06	2.35e+06
NP-239	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.98e+06	1.71e+06

TABLE 2.2-2b (Continued)

PATHWAY DOSE FACTORS FOR LCO 6.11.6 AND
SECTION 2.2.2.b, (R_i)

Page 3 of 10

Release Type: 2 Gaseous
Dose Factor: 2 Ri (m² * (mrem/yr)/(uCi/cc) or (mrem/yr)/(uCi/m³))
AgeGroup: 2 CHILD
Pathway: 1 Inhalation (INHL)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
H-3	0.00e+00	1.13e+03	1.13e+03	1.13e+03	1.13e+03	1.13e+03	0.00e+00	1.13e+03
C-14	3.59e+04	6.73e+03	6.73e+03	6.73e+03	6.73e+03	6.73e+03	0.00e+00	6.73e+03
NA-24	1.61e+04	1.61e+04	1.61e+04	1.61e+04	1.61e+04	1.61e+04	0.00e+00	1.61e+04
P-32	2.61e+06	1.14e+05	0.00e+00	0.00e+00	0.00e+00	4.22e+04	0.00e+00	9.88e+04
CR-51	0.00e+00	0.00e+00	8.55e+01	2.43e+01	1.70e+04	1.08e+03	0.00e+00	1.54e+02
MN-54	0.00e+00	4.29e+04	0.00e+00	1.00e+04	1.58e+06	2.29e+04	0.00e+00	9.51e+03
MN-56	0.00e+00	1.66e+00	0.00e+00	1.67e+00	1.31e+04	1.23e+05	0.00e+00	3.12e-01
FE-55	4.74e+04	2.52e+04	0.00e+00	0.00e+00	1.11e+05	2.87e+03	0.00e+00	7.77e+03
FE-59	2.07e+04	3.35e+04	0.00e+00	0.00e+00	1.27e+06	7.07e+04	0.00e+00	1.67e+04
CO-58	0.00e+00	1.77e+03	0.00e+00	0.00e+00	1.11e+06	3.44e+04	0.00e+00	3.16e+03
CO-60	0.00e+00	1.31e+04	0.00e+00	0.00e+00	7.07e+06	9.62e+04	0.00e+00	2.26e+04
NI-63	8.21e+05	4.63e+04	0.00e+00	0.00e+00	2.75e+05	6.33e+03	0.00e+00	2.80e+04
NI-65	2.99e+00	2.96e-01	0.00e+00	0.00e+00	8.18e+03	8.40e+04	0.00e+00	1.64e-01
CU-64	0.00e+00	1.99e+00	0.00e+00	6.03e+00	9.58e+03	3.67e+04	0.00e+00	1.07e+00
ZN-65	4.26e+04	1.13e+05	0.00e+00	7.14e+04	9.95e+05	1.63e+04	0.00e+00	7.03e+04
ZN-69	6.70e-02	9.66e-02	0.00e+00	5.85e-02	1.42e+03	1.02e+04	0.00e+00	8.92e-03
BR-83	0.00e+00	4.74e+02						
BR-84	0.00e+00	5.48e+02						
BR-85	0.00e+00	2.53e+01						
RB-86	0.00e+00	1.98e+05	0.00e+00	0.00e+00	0.00e+00	7.99e+03	0.00e+00	1.14e+05
RB-88	0.00e+00	5.62e+02	0.00e+00	0.00e+00	0.00e+00	1.72e+01	0.00e+00	3.66e+02
RB-89	0.00e+00	3.45e+02	0.00e+00	0.00e+00	0.00e+00	1.89e+00	0.00e+00	2.90e+02
SR-89	5.99e+05	0.00e+00	0.00e+00	0.00e+00	2.16e+06	1.67e+05	0.00e+00	1.72e+04
SR-90	1.01e+08	0.00e+00	0.00e+00	0.00e+00	1.48e+07	3.43e+05	0.00e+00	6.44e+06
SR-91	1.21e+02	0.00e+00	0.00e+00	0.00e+00	5.33e+04	1.74e+05	0.00e+00	4.59e+00
SR-92	1.31e+01	0.00e+00	0.00e+00	0.00e+00	2.40e+04	2.42e+05	0.00e+00	5.25e-01
Y-90	4.11e+03	0.00e+00	0.00e+00	0.00e+00	2.62e+05	2.68e+05	0.00e+00	1.11e+02
Y-91	9.14e+05	0.00e+00	0.00e+00	0.00e+00	2.63e+06	1.84e+05	0.00e+00	2.44e+04
Y-91M	5.07e-01	0.00e+00	0.00e+00	0.00e+00	2.81e+03	1.72e+03	0.00e+00	1.84e-02
Y-92	2.04e+01	0.00e+00	0.00e+00	0.00e+00	2.39e+04	2.39e+05	0.00e+00	5.81e-01
Y-93	1.87e+02	0.00e+00	0.00e+00	0.00e+00	7.44e+04	3.89e+05	0.00e+00	5.11e+00
ZR-95	1.90e+05	4.18e+04	0.00e+00	5.96e+04	2.23e+06	6.11e+04	0.00e+00	3.70e+04
ZR-97	1.88e+02	2.72e+01	0.00e+00	3.89e+01	1.13e+05	3.51e+05	0.00e+00	1.60e+01
NB-95	2.35e+04	9.18e+03	0.00e+00	8.62e+03	6.14e+05	3.70e+04	0.00e+00	6.55e+03
MO-99	0.00e+00	1.72e+02	0.00e+00	3.92e+02	1.35e+05	1.27e+05	0.00e+00	4.25e+01
TC-99M	1.78e-03	3.48e-03	0.00e+00	5.07e-02	9.51e+02	4.81e+03	0.00e+00	5.77e-02
TC-101	8.10e-05	8.51e-05	0.00e+00	1.45e-03	5.85e+02	1.63e+01	0.00e+00	1.08e-03
RU-103	2.79e+03	0.00e+00	0.00e+00	7.03e+03	6.62e+05	4.48e+04	0.00e+00	1.07e+03
RU-105	1.53e+00	0.00e+00	0.00e+00	1.34e+00	1.59e+04	9.95e+04	0.00e+00	5.55e-01
RU-106	1.36e+05	0.00e+00	0.00e+00	1.84e+05	1.43e+07	4.29e+05	0.00e+00	1.69e+04
AG-110M	1.69e+04	1.14e+04	0.00e+00	2.12e+04	5.48e+06	1.00e+05	0.00e+00	9.14e+03
TE-125M	6.73e+03	2.33e+03	1.92e+03	0.00e+00	4.77e+05	3.38e+04	0.00e+00	9.14e+02
TE-127	2.77e+00	9.51e-01	1.96e+00	7.07e+00	1.00e+04	5.62e+04	0.00e+00	6.11e-01
TE-127M	2.49e+04	8.55e+03	6.07e+03	6.36e+04	1.48e+06	7.14e+04	0.00e+00	3.02e+03
TE-129	9.77e-02	3.50e-02	7.14e-02	2.57e-01	2.93e+03	2.55e+04	0.00e+00	2.38e-02
TE-129M	1.92e+04	6.85e+03	6.33e+03	5.03e+04	1.76e+06	1.82e+05	0.00e+00	3.04e+03
TE-131	2.17e-02	8.44e-03	1.70e-02	5.88e-02	2.05e+03	1.33e+03	0.00e+00	6.59e-03
TE-131M	1.34e+02	5.92e+01	9.77e+01	4.00e+02	2.06e+05	3.08e+05	0.00e+00	5.07e+01

TABLE 2.2-2b (Continued)

PATHWAY DOSE FACTORS FOR LCO 6.11.6 AND
SECTION 2.2.2.b, (R_i)

Page 4 of 10

Release Type: 2 Gaseous
Dose Factor: 2 R_i (m² * (mrem/yr)/(uCi/cc) or (mrem/yr)/(uCi/m³))
AgeGroup: 2 CHILD
Pathway: 1 Inhalation (INHL)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
TE-132	4.81e+02	2.72e+02	3.18e+02	1.77e+03	3.77e+05	1.38e+05	0.00e+00	2.63e+02
I-130	8.18e+03	1.64e+04	1.85e+06	2.45e+04	0.00e+00	5.11e+03	0.00e+00	8.44e+03
I-131	4.81e+04	4.81e+04	1.62e+07	7.88e+04	0.00e+00	2.84e+03	0.00e+00	2.73e+04
I-132	2.12e+03	4.07e+03	1.94e+05	6.25e+03	0.00e+00	3.20e+03	0.00e+00	1.88e+03
I-133	1.66e+04	2.03e+04	3.85e+06	3.38e+04	0.00e+00	5.48e+03	0.00e+00	7.70e+03
I-134	1.17e+03	2.16e+03	5.07e+04	3.30e+03	0.00e+00	9.55e+02	0.00e+00	9.95e+02
I-135	4.92e+03	8.73e+03	7.92e+05	1.34e+04	0.00e+00	4.44e+03	0.00e+00	4.14e+03
CS-134	6.51e+05	1.01e+06	0.00e+00	3.30e+05	1.21e+05	3.85e+03	0.00e+00	2.25e+05
CS-136	6.51e+04	1.71e+05	0.00e+00	9.55e+04	1.45e+04	4.18e+03	0.00e+00	1.16e+05
CS-137	9.07e+05	8.25e+05	0.00e+00	2.82e+05	1.04e+05	3.62e+03	0.00e+00	1.28e+05
CS-138	6.33e+02	8.40e+02	0.00e+00	6.22e+02	6.81e+01	2.70e+02	0.00e+00	5.55e+02
BA-139	1.84e+00	9.84e-04	0.00e+00	8.62e-04	5.77e+03	5.77e+04	0.00e+00	5.37e-02
BA-140	7.40e+04	6.48e+01	0.00e+00	2.11e+01	1.74e+06	1.02e+05	0.00e+00	4.33e+03
BA-141	1.96e-01	1.09e-04	0.00e+00	9.47e-05	2.92e+03	2.75e+02	0.00e+00	6.36e-03
BA-142	5.00e-02	3.60e-05	0.00e+00	2.91e-05	1.64e+03	2.74e+00	0.00e+00	2.79e-03
LA-140	6.44e+02	2.25e+02	0.00e+00	0.00e+00	1.83e+05	2.26e+05	0.00e+00	7.55e+01
LA-142	1.29e+00	4.11e-01	0.00e+00	0.00e+00	8.70e+03	7.59e+04	0.00e+00	1.29e-01
CE-141	3.92e+04	1.95e+04	0.00e+00	8.55e+03	5.44e+05	5.66e+04	0.00e+00	2.90e+03
CE-143	3.66e+02	1.99e+02	0.00e+00	8.36e+01	1.15e+05	1.27e+05	0.00e+00	2.88e+01
CE-144	6.77e+06	2.12e+06	0.00e+00	1.17e+06	1.20e+07	3.89e+05	0.00e+00	3.62e+05
PR-143	1.85e+04	5.55e+03	0.00e+00	3.00e+03	4.33e+05	9.73e+04	0.00e+00	9.14e+02
PR-144	5.96e-02	1.85e-02	0.00e+00	9.77e-03	1.57e+03	1.97e+02	0.00e+00	3.00e-03
ND-147	1.08e+04	8.73e+03	0.00e+00	4.81e+03	3.28e+05	8.21e+04	0.00e+00	6.81e+02
W-187	1.63e+01	9.66e+00	0.00e+00	0.00e+00	4.11e+04	9.10e+04	0.00e+00	4.33e+00
NP-239	4.66e+02	3.35e+01	0.00e+00	9.73e+01	5.81e+04	6.40e+04	0.00e+00	2.35e+01

TABLE 2.2-2b (Continued)

PATHWAY DOSE FACTORS FOR LCO 6.11.6 AND
SECTION 2.2.2.b, (R_i)

Page 5 of 10

Release Type: 2 Gaseous
Dose Factor: 2 Ri (m² * (mrem/yr)/(uCi/cc) or (mrem/yr)/(uCi/m³))
AgeGroup: 2 CHILD
Pathway: 2 Vegetation (VEG)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
H-3	0.00e+00	4.01e+03	4.01e+03	4.01e+03	4.01e+03	4.01e+03	0.00e+00	4.01e+03
C-14	8.89e+08	1.78e+08	1.78e+08	1.78e+08	1.78e+08	1.78e+08	0.00e+00	1.78e+08
NA-24	3.75e+05	3.75e+05	3.75e+05	3.75e+05	3.75e+05	3.75e+05	0.00e+00	3.75e+05
P-32	3.36e+09	1.57e+08	0.00e+00	0.00e+00	0.00e+00	9.30e+07	0.00e+00	1.30e+08
CR-51	0.00e+00	0.00e+00	6.49e+04	1.77e+04	1.19e+05	6.20e+06	0.00e+00	1.17e+05
MN-54	0.00e+00	6.65e+08	0.00e+00	1.86e+08	0.00e+00	5.58e+08	0.00e+00	1.77e+08
MN-56	0.00e+00	1.87e+01	0.00e+00	2.26e+01	0.00e+00	2.71e+03	0.00e+00	4.22e+00
FE-55	8.01e+08	4.25e+08	0.00e+00	0.00e+00	2.40e+08	7.87e+07	0.00e+00	1.32e+08
FE-59	3.97e+08	6.42e+08	0.00e+00	0.00e+00	1.86e+08	6.69e+08	0.00e+00	3.20e+08
CO-58	0.00e+00	6.45e+07	0.00e+00	0.00e+00	0.00e+00	3.76e+08	0.00e+00	1.98e+08
CO-60	0.00e+00	3.78e+08	0.00e+00	0.00e+00	0.00e+00	2.10e+09	0.00e+00	1.12e+09
NI-63	3.95e+10	2.11e+09	0.00e+00	0.00e+00	0.00e+00	1.42e+08	0.00e+00	1.34e+09
NI-65	1.05e+02	9.89e+00	0.00e+00	0.00e+00	0.00e+00	1.21e+03	0.00e+00	5.77e+00
CU-64	0.00e+00	1.09e+04	0.00e+00	2.64e+04	0.00e+00	5.13e+05	0.00e+00	6.60e+03
ZN-65	8.12e+08	2.16e+09	0.00e+00	1.36e+09	0.00e+00	3.80e+08	0.00e+00	1.35e+09
ZN-69	9.30e-06	1.34e-05	0.00e+00	8.15e-06	0.00e+00	8.47e-04	0.00e+00	1.24e-06
BR-83	0.00e+00	5.35e+00						
BR-84	0.00e+00	3.92e-11						
BR-85	0.00e+00							
RB-86	0.00e+00	4.52e+08	0.00e+00	0.00e+00	0.00e+00	2.91e+07	0.00e+00	2.78e+08
RB-88	0.00e+00	4.38e-22	0.00e+00	0.00e+00	0.00e+00	2.15e-23	0.00e+00	3.04e-22
RB-89	0.00e+00	4.69e-26	0.00e+00	0.00e+00	0.00e+00	4.09e-28	0.00e+00	4.17e-26
SR-89	3.59e+10	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.39e+09	0.00e+00	1.03e+09
SR-90	1.24e+12	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.68e+10	0.00e+00	3.15e+11
SR-91	5.22e+05	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.15e+06	0.00e+00	1.97e+04
SR-92	7.24e+02	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.37e+04	0.00e+00	2.90e+01
Y-90	2.31e+04	0.00e+00	0.00e+00	0.00e+00	0.00e+00	6.58e+07	0.00e+00	6.18e+02
Y-91	1.87e+07	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.49e+09	0.00e+00	4.99e+05
Y-91M	9.23e-09	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.81e-05	0.00e+00	3.36e-10
Y-92	1.58e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.57e+04	0.00e+00	4.53e-02
Y-93	2.92e+02	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.35e+06	0.00e+00	8.00e+00
ZR-95	3.87e+06	8.50e+05	0.00e+00	1.22e+06	0.00e+00	8.86e+08	0.00e+00	7.56e+05
ZR-97	5.70e+02	8.23e+01	0.00e+00	1.18e+02	0.00e+00	1.25e+07	0.00e+00	4.86e+01
NB-95	4.10e+05	1.60e+05	0.00e+00	1.50e+05	0.00e+00	2.95e+08	0.00e+00	1.14e+05
MO-99	0.00e+00	7.70e+06	0.00e+00	1.65e+07	0.00e+00	6.37e+06	0.00e+00	1.91e+06
TC-99M	4.70e+00	9.22e+00	0.00e+00	1.34e+02	4.68e+00	5.25e+03	0.00e+00	1.53e+02
TC-101	1.35e-30	1.42e-30	0.00e+00	2.41e-29	7.48e-31	4.50e-30	0.00e+00	1.80e-29
RU-103	1.53e+07	0.00e+00	0.00e+00	3.86e+07	0.00e+00	3.96e+08	0.00e+00	5.89e+06
RU-105	9.13e+01	0.00e+00	0.00e+00	8.02e+02	0.00e+00	5.96e+04	0.00e+00	3.31e+01
RU-106	7.45e+08	0.00e+00	0.00e+00	1.01e+09	0.00e+00	1.16e+10	0.00e+00	9.30e+07
AG-110M	3.21e+07	2.17e+07	0.00e+00	4.04e+07	0.00e+00	2.58e+09	0.00e+00	1.74e+07
TE-125M	3.51e+08	9.52e+07	9.86e+07	0.00e+00	0.00e+00	3.39e+08	0.00e+00	4.68e+07
TE-127	9.97e+03	2.69e+03	6.90e+03	2.84e+04	0.00e+00	3.89e+05	0.00e+00	2.14e+03
TE-127M	1.32e+09	3.56e+08	3.16e+08	3.77e+09	0.00e+00	1.07e+09	0.00e+00	1.57e+08
TE-129	1.20e-03	3.36e-04	8.59e-04	3.52e-03	0.00e+00	7.49e-02	0.00e+00	2.86e-04
TE-129M	8.40e+08	2.35e+08	2.71e+08	2.47e+09	0.00e+00	1.03e+09	0.00e+00	1.30e+08
TE-131	2.59e-15	7.90e-16	1.98e-15	7.84e-15	0.00e+00	1.36e-14	0.00e+00	7.71e-16
TE-131M	1.54e+06	5.33e+05	1.10e+06	5.16e+06	0.00e+00	2.16e+07	0.00e+00	5.67e+05

TABLE 2.2-2b (Continued)

PATHWAY DOSE FACTORS FOR LCO 6.11.6 AND
SECTION 2.2.2.b, (R₁)

Page 6 of 10

Release Type: 2 Gaseous
Dose Factor: 2 Ri (m² * (mrem/yr)/(uCi/cc) or (mrem/yr)/(uCi/m³))
AgeGroup: 2 CHILD
Pathway: 2 Vegetation (VEG)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
TE-132	6.98e+06	3.09e+06	4.50e+06	2.87e+07	0.00e+00	3.11e+07	0.00e+00	3.73e+06
I-130	6.14e+05	1.24e+06	1.37e+08	1.85e+06	0.00e+00	5.80e+05	0.00e+00	6.39e+05
I-131	1.43e+08	1.44e+08	4.75e+10	2.36e+08	0.00e+00	1.28e+07	0.00e+00	8.17e+07
I-132	9.23e+01	1.70e+02	7.87e+03	2.60e+02	0.00e+00	2.00e+02	0.00e+00	7.80e+01
I-133	3.53e+06	4.36e+06	8.11e+08	7.27e+06	0.00e+00	1.76e+06	0.00e+00	1.65e+06
I-134	1.50e-04	2.78e-04	6.40e-03	4.26e-04	0.00e+00	1.85e-04	0.00e+00	1.28e-04
I-135	6.28e+04	1.13e+05	1.00e+07	1.73e+05	0.00e+00	8.61e+04	0.00e+00	5.34e+04
CS-134	1.60e+10	2.63e+10	0.00e+00	8.16e+09	2.93e+09	1.42e+08	0.00e+00	5.55e+09
CS-136	8.23e+07	2.26e+08	0.00e+00	1.21e+08	1.80e+07	7.95e+06	0.00e+00	1.46e+08
CS-137	2.39e+10	2.29e+10	0.00e+00	7.46e+09	2.69e+09	1.43e+08	0.00e+00	3.38e+09
CS-138	6.44e-11	8.95e-11	0.00e+00	6.30e-11	6.78e-12	4.12e-11	0.00e+00	5.67e-11
BA-139	4.96e-02	2.65e-05	0.00e+00	2.31e-05	1.56e-05	2.86e+00	0.00e+00	1.44e-03
BA-140	2.77e+08	2.43e+05	0.00e+00	7.90e+04	1.45e+05	1.40e+08	0.00e+00	1.62e+07
BA-141	2.04e-21	1.14e-24	0.00e+00	9.90e-25	6.72e-24	1.16e-21	0.00e+00	6.65e-23
BA-142	4.06e-39	2.92e-42	0.00e+00	2.36e-42	1.72e-42	5.29e-41	0.00e+00	2.26e-40
LA-140	3.25e+03	1.14e+03	0.00e+00	0.00e+00	0.00e+00	3.17e+07	0.00e+00	3.83e+02
LA-142	3.39e-04	1.08e-04	0.00e+00	0.00e+00	0.00e+00	2.14e+01	0.00e+00	3.38e-05
CE-141	6.56e+05	3.27e+05	0.00e+00	1.43e+05	0.00e+00	4.08e+08	0.00e+00	4.85e+04
CE-143	1.72e+03	9.30e+05	0.00e+00	3.90e+02	0.00e+00	1.36e+07	0.00e+00	1.35e+02
CE-144	1.27e+08	3.99e+07	0.00e+00	2.21e+07	0.00e+00	1.04e+10	0.00e+00	6.78e+06
PR-143	1.46e+05	4.38e+04	0.00e+00	2.37e+04	0.00e+00	1.57e+08	0.00e+00	7.24e+03
PR-144	5.64e-26	1.74e-26	0.00e+00	9.22e-27	0.00e+00	3.75e-23	0.00e+00	2.84e-27
ND-147	7.14e+04	5.79e+04	0.00e+00	3.17e+04	0.00e+00	9.16e+07	0.00e+00	4.48e+03
W-187	6.43e+04	3.81e+04	0.00e+00	0.00e+00	0.00e+00	5.35e+06	0.00e+00	1.71e+04
NP-239	2.56e+03	1.84e+02	0.00e+00	5.31e+02	0.00e+00	1.36e+07	0.00e+00	1.29e+02

TABLE 2.2-2b (Continued)

PATHWAY DOSE FACTORS FOR LCO 6.11.6 AND
SECTION 2.2.2.b, (R_i)

Page 7 of 10

Release Type: 2 Gaseous
Dose Factor: 2 R_i (m² * (mrem/yr)/(uCi/cc) or (mrem/yr)/(uCi/m³))
AgeGroup: 2 CHILD
Pathway: 4 Grs/Cow/Meat (CMEAT)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
H-3	0.00e+00	2.34e+02	2.34e+02	2.34e+02	2.34e+02	2.34e+02	0.00e+00	2.34e+02
C-14	3.83e+08	7.67e+07	7.67e+07	7.67e+07	7.67e+07	7.67e+07	0.00e+00	7.67e+07
NA-24	1.84e-03	1.84e-03	1.84e-03	1.84e-03	1.84e-03	1.84e-03	0.00e+00	1.84e-03
P-32	7.41e+09	3.47e+08	0.00e+00	0.00e+00	0.00e+00	2.05e+08	0.00e+00	2.86e+08
CR-51	0.00e+00	0.00e+00	4.87e+03	1.33e+03	8.90e+03	4.66e+05	0.00e+00	8.78e+03
MN-54	0.00e+00	8.01e+06	0.00e+00	2.25e+06	0.00e+00	6.72e+06	0.00e+00	2.13e+06
MN-56	0.00e+00	1.56e-53	0.00e+00	1.89e-53	0.00e+00	2.26e-51	0.00e+00	3.52e-54
FE-55	4.57e+08	2.43e+08	0.00e+00	0.00e+00	1.37e+08	4.49e+07	0.00e+00	7.51e+07
FE-59	3.76e+08	6.08e+08	0.00e+00	0.00e+00	1.76e+08	6.34e+08	0.00e+00	3.03e+08
CO-58	0.00e+00	1.64e+07	0.00e+00	0.00e+00	0.00e+00	9.59e+07	0.00e+00	5.03e+07
CO-60	0.00e+00	6.93e+07	0.00e+00	0.00e+00	0.00e+00	3.84e+08	0.00e+00	2.04e+08
NI-63	2.91e+10	1.56e+09	0.00e+00	0.00e+00	0.00e+00	1.05e+08	0.00e+00	9.91e+08
NI-65	3.55e-52	3.34e-53	0.00e+00	0.00e+00	0.00e+00	4.10e-51	0.00e+00	1.95e-53
CU-64	0.00e+00	2.77e-07	0.00e+00	6.68e-07	0.00e+00	1.30e-05	0.00e+00	1.67e-07
ZN-65	3.75e+08	1.00e+09	0.00e+00	6.30e+08	0.00e+00	1.76e+08	0.00e+00	6.22e+08
ZN-69	0.00e+00							
BR-83	0.00e+00	8.89e-57						
BR-84	0.00e+00							
BR-85	0.00e+00							
RB-86	0.00e+00	5.76e+08	0.00e+00	0.00e+00	0.00e+00	3.71e+07	0.00e+00	3.55e+08
RB-88	0.00e+00							
RB-89	0.00e+00							
SR-89	4.81e+08	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.86e+07	0.00e+00	1.38e+07
SR-90	1.04e+10	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.40e+08	0.00e+00	2.64e+09
SR-91	2.26e-10	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.99e-10	0.00e+00	8.54e-12
SR-92	1.69e-49	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.19e-48	0.00e+00	6.76e-51
Y-90	1.73e+02	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.92e+05	0.00e+00	4.62e+00
Y-91	1.80e+06	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.40e+08	0.00e+00	4.82e+04
Y-91M	0.00e+00							
Y-92	2.37e-39	0.00e+00	0.00e+00	0.00e+00	0.00e+00	6.84e-35	0.00e+00	6.77e-41
Y-93	6.97e-12	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.04e-07	0.00e+00	1.91e-13
ZR-95	2.67e+06	5.86e+05	0.00e+00	8.39e+05	0.00e+00	6.11e+08	0.00e+00	5.22e+05
ZR-97	3.16e-05	4.57e-06	0.00e+00	6.56e-06	0.00e+00	6.93e-01	0.00e+00	2.70e-06
NB-95	3.10e+06	1.21e+06	0.00e+00	1.13e+06	0.00e+00	2.23e+09	0.00e+00	8.61e+05
MO-99	0.00e+00	1.14e+05	0.00e+00	2.44e+05	0.00e+00	9.44e+04	0.00e+00	2.82e+04
TC-99M	6.02e-21	1.18e-20	0.00e+00	1.72e-19	5.99e-21	6.72e-18	0.00e+00	1.96e-19
TC-101	0.00e+00							
RU-103	1.55e+08	0.00e+00	0.00e+00	3.90e+08	0.00e+00	4.00e+09	0.00e+00	5.95e+07
RU-105	8.48e-28	0.00e+00	0.00e+00	7.45e-27	0.00e+00	5.53e-25	0.00e+00	3.08e-28
RU-106	4.44e+09	0.00e+00	0.00e+00	5.99e+09	0.00e+00	6.90e+10	0.00e+00	5.54e+08
AG-110M	8.39e+06	5.67e+06	0.00e+00	1.06e+07	0.00e+00	6.74e+08	0.00e+00	4.53e+06
TE-125M	5.70e+08	1.54e+08	1.60e+08	0.00e+00	0.00e+00	5.50e+08	0.00e+00	7.59e+07
TE-127	3.99e-10	1.08e-10	2.76e-10	1.14e-09	0.00e+00	1.56e-08	0.00e+00	8.56e-11
TE-127M	1.78e+09	4.78e+08	4.24e+08	5.06e+09	0.00e+00	1.44e+09	0.00e+00	2.11e+08
TE-129	0.00e+00							
TE-129M	1.79e+09	5.00e+08	5.77e+08	5.25e+09	0.00e+00	2.18e+09	0.00e+00	2.78e+08
TE-131	0.00e+00							
TE-131M	6.97e+02	2.41e+02	4.96e+02	2.33e+03	0.00e+00	9.78e+03	0.00e+00	2.57e+02

TABLE 2.2-2b (Continued)

PATHWAY DOSE FACTORS FOR LCO 6.11.6 AND
SECTION 2.2.2.b, (R₁)

Page 8 of 10

Release Type: 2 Gaseous
Dose Factor: 2 Ri (m² * (mrem/yr)/(uCi/cc) or (mrem/yr)/(uCi/m³))
AgeGroup: 2 CHILD
Pathway: 4 Grs/Cow/Meat (CMEAT)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
TE-132	2.09e+06	9.23e+05	1.35e+06	8.57e+06	0.00e+00	9.30e+06	0.00e+00	1.12e+06
I-130	2.92e-06	5.89e-06	6.49e-04	8.81e-06	0.00e+00	2.76e-06	0.00e+00	3.04e-06
I-131	1.65e+07	1.66e+07	5.50e+09	2.73e+07	0.00e+00	1.48e+06	0.00e+00	9.45e+06
I-132	1.05e-58	1.93e-58	8.93e-57	2.95e-58	0.00e+00	2.27e-58	0.00e+00	8.85e-59
I-133	5.64e-01	6.98e-01	1.30e+02	1.16e+00	0.00e+00	2.81e-01	0.00e+00	2.64e-01
I-134	0.00e+00							
I-135	6.86e-17	1.23e-16	1.09e-14	1.89e-16	0.00e+00	9.40e-17	0.00e+00	5.84e-17
CS-134	9.22e+08	1.51e+09	0.00e+00	4.69e+08	1.68e+08	8.16e+06	0.00e+00	3.19e+08
CS-136	1.62e+07	4.45e+07	0.00e+00	2.37e+07	3.54e+06	1.57e+06	0.00e+00	2.88e+07
CS-137	1.33e+09	1.28e+09	0.00e+00	4.16e+08	1.50e+08	7.99e+06	0.00e+00	1.88e+08
CS-138	0.00e+00							
BA-139	0.00e+00							
BA-140	4.39e+07	3.84e+04	0.00e+00	1.25e+04	2.29e+04	2.22e+07	0.00e+00	2.56e+06
BA-141	0.00e+00							
BA-142	0.00e+00							
LA-140	5.66e-02	1.98e-02	0.00e+00	0.00e+00	0.00e+00	5.52e+02	0.00e+00	6.67e-03
LA-142	6.20e-92	1.98e-92	0.00e+00	0.00e+00	0.00e+00	3.92e-87	0.00e+00	6.19e-93
CE-141	2.22e+04	1.11e+04	0.00e+00	4.85e+03	0.00e+00	1.38e+07	0.00e+00	1.64e+03
CE-143	3.14e-02	1.70e+01	0.00e+00	7.14e-03	0.00e+00	2.49e+02	0.00e+00	2.46e-03
CE-144	2.32e+06	7.26e+05	0.00e+00	4.02e+05	0.00e+00	1.89e+08	0.00e+00	1.24e+05
PR-143	3.34e+04	1.00e+04	0.00e+00	5.44e+03	0.00e+00	3.61e+07	0.00e+00	1.66e+03
PR-144	0.00e+00							
ND-147	1.17e+04	9.46e+03	0.00e+00	5.19e+03	0.00e+00	1.50e+07	0.00e+00	7.32e+02
W-187	3.21e-02	1.90e-02	0.00e+00	0.00e+00	0.00e+00	2.67e+00	0.00e+00	8.52e-03
NP-239	4.23e-01	3.04e-02	0.00e+00	8.79e-02	0.00e+00	2.25e+03	0.00e+00	2.14e-02

TABLE 2.2-2b (Continued)

PATHWAY DOSE FACTORS FOR LCO 6.11.6 AND
SECTION 2.2.2.b, (R₁)

Page 9 of 10

Release Type: 2 Gaseous
Dose Factor: 2 Ri (m² * (mrem/yr)/(uCi/cc) or (mrem/yr)/(uCi/m³))
AgeGroup: 2 CHILD
Pathway: 5 Grs/Cow/Milk (CMILK)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
H-3	0.00e+00	1.57e+03	1.57e+03	1.57e+03	1.57e+03	1.57e+03	0.00e+00	1.57e+03
C-14	1.20e+09	2.39e+08	2.39e+08	2.39e+08	2.39e+08	2.39e+08	0.00e+00	2.39e+08
NA-24	8.93e+06	8.93e+06	8.93e+06	8.93e+06	8.93e+06	8.93e+06	0.00e+00	8.93e+06
P-32	7.77e+10	3.64e+09	0.00e+00	0.00e+00	0.00e+00	2.15e+09	0.00e+00	3.00e+09
CR-51	0.00e+00	0.00e+00	5.65e+04	1.54e+04	1.03e+05	5.40e+06	0.00e+00	1.02e+05
MN-54	0.00e+00	2.10e+07	0.00e+00	5.88e+06	0.00e+00	1.76e+07	0.00e+00	5.59e+06
MN-56	0.00e+00	1.28e-02	0.00e+00	1.54e-02	0.00e+00	1.85e+00	0.00e+00	2.88e-03
FE-55	1.12e+08	5.93e+07	0.00e+00	0.00e+00	3.35e+07	1.10e+07	0.00e+00	1.84e+07
FE-59	1.20e+08	1.94e+08	0.00e+00	0.00e+00	5.64e+07	2.03e+08	0.00e+00	9.69e+07
CO-58	0.00e+00	1.21e+07	0.00e+00	0.00e+00	0.00e+00	7.08e+07	0.00e+00	3.71e+07
CO-60	0.00e+00	4.32e+07	0.00e+00	0.00e+00	0.00e+00	2.39e+08	0.00e+00	1.27e+08
NI-63	2.96e+10	1.59e+09	0.00e+00	0.00e+00	0.00e+00	1.07e+08	0.00e+00	1.01e+09
NI-65	1.66e+00	1.56e-01	0.00e+00	0.00e+00	0.00e+00	1.91e+01	0.00e+00	9.11e-02
CU-64	0.00e+00	7.39e+04	0.00e+00	1.79e+05	0.00e+00	3.47e+06	0.00e+00	4.47e+04
ZN-65	4.13e+09	1.10e+10	0.00e+00	6.94e+09	0.00e+00	1.93e+09	0.00e+00	6.85e+09
ZN-69	9.10e-12	1.32e-11	0.00e+00	7.98e-12	0.00e+00	8.29e-10	0.00e+00	1.22e-12
BR-83	0.00e+00	4.37e-01						
BR-84	0.00e+00	6.84e-23						
BR-85	0.00e+00							
RB-86	0.00e+00	8.77e+09	0.00e+00	0.00e+00	0.00e+00	5.64e+08	0.00e+00	5.39e+09
RB-88	0.00e+00	7.17e-45	0.00e+00	0.00e+00	0.00e+00	3.52e-46	0.00e+00	4.98e-45
RB-89	0.00e+00	1.40e-52	0.00e+00	0.00e+00	0.00e+00	1.22e-54	0.00e+00	1.24e-52
SR-89	6.62e+09	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.56e+08	0.00e+00	1.89e+08
SR-90	1.12e+11	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.51e+09	0.00e+00	2.83e+10
SR-91	1.29e+05	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.86e+05	0.00e+00	4.89e+03
SR-92	2.16e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.09e+01	0.00e+00	8.67e-02
Y-90	3.23e+02	0.00e+00	0.00e+00	0.00e+00	0.00e+00	9.19e+05	0.00e+00	8.64e+00
Y-91	3.90e+04	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.20e+06	0.00e+00	1.04e+03
Y-91M	2.87e-19	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.62e-16	0.00e+00	1.04e-20
Y-92	2.53e-04	0.00e+00	0.00e+00	0.00e+00	0.00e+00	7.30e+00	0.00e+00	7.23e-06
Y-93	1.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.50e+04	0.00e+00	2.76e-02
ZR-95	3.83e+03	8.43e+02	0.00e+00	1.21e+03	0.00e+00	8.79e+05	0.00e+00	7.50e+02
ZR-97	1.92e+00	2.77e-01	0.00e+00	3.97e-01	0.00e+00	4.19e+04	0.00e+00	1.63e-01
NB-95	3.18e+05	1.24e+05	0.00e+00	1.16e+05	0.00e+00	2.29e+08	0.00e+00	8.84e+04
MO-99	0.00e+00	8.12e+07	0.00e+00	1.74e+08	0.00e+00	6.72e+07	0.00e+00	2.01e+07
TC-99M	1.32e+01	2.58e+01	0.00e+00	3.75e+02	1.31e+01	1.47e+04	0.00e+00	4.28e+02
TC-101	1.08e-59	1.13e-59	0.00e+00	1.92e-58	5.95e-60	3.58e-59	0.00e+00	1.43e-58
RU-103	4.28e+03	0.00e+00	0.00e+00	1.08e+04	0.00e+00	1.11e+05	0.00e+00	1.65e+03
RU-105	3.79e-03	0.00e+00	0.00e+00	3.33e-02	0.00e+00	2.48e+00	0.00e+00	1.38e-03
RU-106	9.24e+04	0.00e+00	0.00e+00	1.25e+05	0.00e+00	1.44e+06	0.00e+00	1.15e+04
AG-110M	2.09e+08	1.41e+08	0.00e+00	2.63e+08	0.00e+00	1.68e+10	0.00e+00	1.13e+08
TE-125M	7.38e+07	2.00e+07	2.07e+07	0.00e+00	0.00e+00	7.12e+07	0.00e+00	9.84e+06
TE-127	3.04e+03	8.19e+02	2.10e+03	8.64e+03	0.00e+00	1.19e+05	0.00e+00	6.51e+02
TE-127M	2.08e+08	5.60e+07	4.97e+07	5.93e+08	0.00e+00	1.68e+08	0.00e+00	2.47e+07
TE-129	1.07e-09	2.99e-10	7.63e-10	3.13e-09	0.00e+00	6.65e-08	0.00e+00	2.54e-10
TE-129M	2.71e+08	7.58e+07	8.75e+07	7.97e+08	0.00e+00	3.31e+08	0.00e+00	4.21e+07
TE-131	1.64e-32	5.01e-33	1.26e-32	4.97e-32	0.00e+00	8.64e-32	0.00e+00	4.89e-33
TE-131M	1.60e+06	5.53e+05	1.14e+06	5.35e+06	0.00e+00	2.24e+07	0.00e+00	5.88e+05

TABLE 2.2-2b (Continued)

PATHWAY DOSE FACTORS FOR LCO 6.11.6 AND
SECTION 2.2.2.b, (R_i)

Page 10 of 10

Release Type: 2 Gaseous
Dose Factor: 2 Ri (m² * (mrem/yr)/(uCi/cc) or (mrem/yr)/(uCi/m³))
AgeGroup: 2 CHILD
Pathway: 5 Grs/Cow/Milk (CMILK)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
TE-132	1.02e+07	4.52e+06	6.58e+06	4.19e+07	0.00e+00	4.55e+07	0.00e+00	5.46e+06
I-130	1.72e+06	3.47e+06	3.83e+08	5.19e+06	0.00e+00	1.62e+06	0.00e+00	1.79e+06
I-131	1.30e+09	1.31e+09	4.33e+11	2.15e+09	0.00e+00	1.17e+08	0.00e+00	7.45e+08
I-132	6.91e-01	1.27e+00	5.89e+01	1.94e+00	0.00e+00	1.49e+00	0.00e+00	5.84e-01
I-133	1.72e+07	2.12e+07	3.94e+09	3.54e+07	0.00e+00	8.55e+06	0.00e+00	8.03e+06
I-134	7.94e-12	1.48e-11	3.39e-10	2.26e-11	0.00e+00	9.78e-12	0.00e+00	6.79e-12
I-135	5.43e+04	9.78e+04	8.66e+06	1.50e+05	0.00e+00	7.45e+04	0.00e+00	4.62e+04
CS-134	2.26e+10	3.72e+10	0.00e+00	1.15e+10	4.13e+09	2.00e+08	0.00e+00	7.84e+09
CS-136	1.01e+09	2.78e+09	0.00e+00	1.48e+09	2.21e+08	9.77e+07	0.00e+00	1.80e+09
CS-137	3.22e+10	3.09e+10	0.00e+00	1.01e+10	3.62e+09	1.93e+08	0.00e+00	4.56e+09
CS-138	3.82e-23	5.31e-23	0.00e+00	3.74e-23	4.02e-24	2.45e-23	0.00e+00	3.37e-23
BA-139	2.02e-07	1.08e-10	0.00e+00	9.39e-11	6.33e-11	1.16e-05	0.00e+00	5.84e-09
BA-140	1.17e+08	1.03e+05	0.00e+00	3.34e+04	6.12e+04	5.94e+07	0.00e+00	6.84e+06
BA-141	1.96e-45	1.09e-48	0.00e+00	9.48e-49	6.43e-48	1.12e-45	0.00e+00	6.37e-47
BA-142	1.93e-80	1.39e-83	0.00e+00	1.12e-83	8.15e-84	2.51e-82	0.00e+00	1.08e-81
LA-140	1.94e+01	6.80e+00	0.00e+00	0.00e+00	0.00e+00	1.90e+05	0.00e+00	2.29e+00
LA-142	8.24e-11	2.63e-11	0.00e+00	0.00e+00	0.00e+00	5.20e-06	0.00e+00	8.22e-12
CE-141	2.19e+04	1.09e+04	0.00e+00	4.78e+03	0.00e+00	1.36e+07	0.00e+00	1.62e+03
CE-143	1.87e+02	1.01e+05	0.00e+00	4.26e+01	0.00e+00	1.49e+06	0.00e+00	1.47e+01
CE-144	1.62e+06	5.09e+05	0.00e+00	2.82e+05	0.00e+00	1.33e+08	0.00e+00	8.66e+04
PR-143	7.19e+02	2.16e+02	0.00e+00	1.17e+02	0.00e+00	7.75e+05	0.00e+00	3.56e+01
PR-144	2.95e-53	9.11e-54	0.00e+00	4.82e-54	0.00e+00	1.96e-50	0.00e+00	1.48e-54
ND-147	4.44e+02	3.60e+02	0.00e+00	1.98e+02	0.00e+00	5.70e+05	0.00e+00	2.79e+01
W-187	2.89e+04	1.71e+04	0.00e+00	0.00e+00	0.00e+00	2.40e+06	0.00e+00	7.67e+03
NP-239	1.72e+01	1.24e+00	0.00e+00	3.58e+00	0.00e+00	9.15e+04	0.00e+00	8.69e-01

Units: Inhalation₂ and all tritium pathways - mrem/yr per $\mu\text{Ci}/\text{m}^3$
Others - m² . mrem/yr per $\mu\text{Ci}/\text{sec}$

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

TABLE 2.2-2c

PATHWAY DOSE FACTORS FOR LCO 6.11.6 AND
SECTION 2.2.2.b, (R_i)

Page 1 of 10

Release Type: 2 Gaseous
 Dose Factor: 2 R_i (m² * (mrem/yr)/(uCi/cc) or (mrem/yr)/(uCi/m³))
 AgeGroup: 1 TEEN
 Pathway: 0 Ground Plane Deposition (GPD)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
H-3	0.00e+00							
C-14	0.00e+00							
NA-24	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.39e+07	1.20e+07
P-32	0.00e+00							
CR-51	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.50e+06	4.65e+06
MN-54	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.62e+09	1.38e+09
MN-56	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.07e+06	9.03e+05
FE-55	0.00e+00							
FE-59	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.20e+08	2.73e+08
CO-58	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.45e+08	3.80e+08
CO-60	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.53e+10	2.15e+10
NI-63	0.00e+00							
NI-65	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.45e+05	2.97e+05
CU-64	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	6.86e+05	6.05e+05
ZN-65	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	8.57e+08	7.46e+08
ZN-69	0.00e+00							
BR-83	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	7.08e+03	4.87e+03
BR-84	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.37e+05	2.03e+05
BR-85	0.00e+00							
RB-86	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.03e+07	8.98e+06
RB-88	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.78e+04	3.31e+04
RB-89	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.48e+05	1.23e+05
SR-89	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.51e+04	2.16e+04
SR-90	0.00e+00							
SR-91	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.51e+06	2.15e+06
SR-92	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	8.62e+05	7.76e+05
Y-90	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.31e+03	4.50e+03
Y-91	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.21e+06	1.07e+06
Y-91M	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.16e+05	1.00e+05
Y-92	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.14e+05	1.80e+05
Y-93	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.50e+05	1.83e+05
ZR-95	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.85e+08	2.45e+08
ZR-97	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.44e+06	2.96e+06
NB-95	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.61e+08	1.37e+08
MO-99	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.62e+06	3.99e+06
TC-99M	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.11e+05	1.84e+05
TC-101	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.26e+04	2.03e+04
RU-103	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.26e+08	1.08e+08
RU-105	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	7.21e+05	6.36e+05
RU-106	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.04e+08	4.20e+08
AG-110M	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.02e+09	3.45e+09
TE-125M	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.13e+06	1.56e+06
TE-127	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.29e+03	2.99e+03
TE-127M	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.08e+05	9.17e+04
TE-129	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.08e+04	2.61e+04
TE-129M	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.31e+07	1.98e+07
TE-131	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.45e+07	2.92e+07
TE-131M	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	9.46e+06	8.02e+06

TABLE 2.2-2c (Continued)

PATHWAY DOSE FACTORS FOR LCO 6.11.6 AND
SECTION 2.2.2.b, (R₁)

Page 2 of 10

Release Type: 2 Gaseous
Dose Factor: 2 Ri (m² * (mrem/yr)/(uCi/cc) or (mrem/yr)/(uCi/m³))
AgeGroup: 1 TEEN
Pathway: 0 Ground Plane Deposition (GPD)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
TE-132	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.97e+06	4.22e+06
I-130	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	6.68e+06	5.50e+06
I-131	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.09e+07	1.72e+07
I-132	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.47e+06	1.25e+06
I-133	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.98e+06	2.45e+06
I-134	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.30e+05	4.46e+05
I-135	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.95e+06	2.53e+06
CS-134	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	8.05e+09	6.90e+09
CS-136	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.71e+08	1.51e+08
CS-137	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.20e+10	1.03e+10
CS-138	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.10e+05	3.59e+05
BA-139	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.19e+05	1.06e+05
BA-140	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.35e+07	2.05e+07
BA-141	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.75e+04	4.17e+04
BA-142	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.06e+04	4.44e+04
LA-140	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.18e+07	1.92e+07
LA-142	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	9.12e+05	7.60e+05
CE-141	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.54e+07	1.37e+07
CE-143	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.63e+06	2.31e+06
CE-144	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	8.05e+07	6.96e+07
PR-143	0.00e+00							
PR-144	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.11e+03	1.84e+03
ND-147	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.01e+07	8.39e+06
W-187	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.73e+06	2.35e+06
NP-239	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.98e+06	1.71e+06

TABLE 2.2-2c (Continued)

PATHWAY DOSE FACTORS FOR LCO 6.11.6 AND
SECTION 2.2.2.b, (R_i)

Page 3 of 10

Release Type: 2 Gaseous
Dose Factor: 2 Ri (m² * (mrem/yr)/(uCi/cc) or (mrem/yr)/(uCi/m³))
AgeGroup: 1 TEEN
Pathway: 1 Inhalation (INHL)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
H-3	0.00e+00	1.27e+03	1.27e+03	1.27e+03	1.27e+03	1.27e+03	0.00e+00	1.27e+03
C-14	2.60e+04	4.87e+03	4.87e+03	4.87e+03	4.87e+03	4.87e+03	0.00e+00	4.87e+03
NA-24	1.38e+04	1.38e+04	1.38e+04	1.38e+04	1.38e+04	1.38e+04	0.00e+00	1.38e+04
P-32	1.89e+06	1.10e+05	0.00e+00	0.00e+00	0.00e+00	9.28e+04	0.00e+00	7.16e+04
CR-51	0.00e+00	0.00e+00	7.50e+01	3.07e+01	2.10e+04	3.00e+03	0.00e+00	1.35e+02
MN-54	0.00e+00	5.11e+04	0.00e+00	1.27e+04	1.98e+06	6.68e+04	0.00e+00	8.40e+03
MN-56	0.00e+00	1.70e+00	0.00e+00	1.79e+00	1.52e+04	5.74e+04	0.00e+00	2.52e-01
FE-55	3.34e+04	2.38e+04	0.00e+00	0.00e+00	1.24e+05	6.39e+03	0.00e+00	5.54e+03
FE-59	1.59e+04	3.70e+04	0.00e+00	0.00e+00	1.53e+06	1.78e+05	0.00e+00	1.43e+04
CO-58	0.00e+00	2.07e+03	0.00e+00	0.00e+00	1.34e+06	9.52e+04	0.00e+00	2.78e+03
CO-60	0.00e+00	1.51e+04	0.00e+00	0.00e+00	8.72e+06	2.59e+05	0.00e+00	1.98e+04
NI-63	5.80e+05	4.34e+04	0.00e+00	0.00e+00	3.07e+05	1.42e+04	0.00e+00	1.98e+04
NI-65	2.18e+00	2.93e-01	0.00e+00	0.00e+00	9.36e+03	3.67e+04	0.00e+00	1.27e-01
CU-64	0.00e+00	2.03e+00	0.00e+00	6.41e+00	1.11e+04	6.14e+04	0.00e+00	8.48e-01
ZN-65	3.86e+04	1.34e+05	0.00e+00	8.64e+04	1.24e+06	4.66e+04	0.00e+00	6.24e+04
ZN-69	4.83e-02	9.20e-02	0.00e+00	6.02e-02	1.58e+03	2.85e+02	0.00e+00	6.46e-03
BR-83	0.00e+00	3.44e+02						
BR-84	0.00e+00	4.33e+02						
BR-85	0.00e+00	1.83e+01						
RB-86	0.00e+00	1.90e+05	0.00e+00	0.00e+00	0.00e+00	1.77e+04	0.00e+00	8.40e+04
RB-88	0.00e+00	5.46e+02	0.00e+00	0.00e+00	0.00e+00	2.92e-05	0.00e+00	2.72e+02
RB-89	0.00e+00	3.52e+02	0.00e+00	0.00e+00	0.00e+00	3.38e-07	0.00e+00	2.33e+02
SR-89	4.34e+05	0.00e+00	0.00e+00	0.00e+00	2.42e+06	3.71e+05	0.00e+00	1.25e+04
SR-90	1.08e+08	0.00e+00	0.00e+00	0.00e+00	1.65e+07	7.65e+05	0.00e+00	6.68e+06
SR-91	8.80e+01	0.00e+00	0.00e+00	0.00e+00	6.07e+04	2.59e+05	0.00e+00	3.51e+00
SR-92	9.52e+00	0.00e+00	0.00e+00	0.00e+00	2.74e+04	1.19e+05	0.00e+00	4.06e-01
Y-90	2.98e+03	0.00e+00	0.00e+00	0.00e+00	2.93e+05	5.59e+05	0.00e+00	8.00e+01
Y-91	6.61e+05	0.00e+00	0.00e+00	0.00e+00	2.94e+06	4.09e+05	0.00e+00	1.77e+04
Y-91M	3.70e-01	0.00e+00	0.00e+00	0.00e+00	3.20e+03	3.02e+01	0.00e+00	1.42e-02
Y-92	1.47e+01	0.00e+00	0.00e+00	0.00e+00	2.68e+04	1.65e+05	0.00e+00	4.29e-01
Y-93	1.35e+02	0.00e+00	0.00e+00	0.00e+00	8.32e+04	5.79e+05	0.00e+00	3.72e+00
ZR-95	1.46e+05	4.58e+04	0.00e+00	6.74e+04	2.69e+06	1.49e+05	0.00e+00	3.15e+04
ZR-97	1.38e+02	2.72e+01	0.00e+00	4.12e+01	1.30e+05	6.30e+05	0.00e+00	1.26e+01
NB-95	1.86e+04	1.03e+04	0.00e+00	1.00e+04	7.51e+05	9.68e+04	0.00e+00	5.66e+03
MO-99	0.00e+00	1.69e+02	0.00e+00	4.11e+02	1.54e+05	2.69e+05	0.00e+00	3.22e+01
TC-99M	1.38e-03	3.86e-03	0.00e+00	5.76e-02	1.15e+03	6.13e+03	0.00e+00	4.99e-02
TC-101	5.92e-05	8.40e-05	0.00e+00	1.52e-03	6.67e+02	8.72e-07	0.00e+00	8.24e-04
RU-103	2.10e+03	0.00e+00	0.00e+00	7.43e+03	7.83e+05	1.09e+05	0.00e+00	8.96e+02
RU-105	1.12e+00	0.00e+00	0.00e+00	1.41e+00	1.82e+04	9.04e+04	0.00e+00	4.34e-01
RU-106	9.84e+04	0.00e+00	0.00e+00	1.90e+05	1.61e+07	9.60e+05	0.00e+00	1.24e+04
AG-110M	1.38e+04	1.31e+04	0.00e+00	2.50e+04	6.75e+06	2.73e+05	0.00e+00	7.99e+03
TE-125M	4.88e+03	2.24e+03	1.40e+03	0.00e+00	5.36e+05	7.50e+04	0.00e+00	6.67e+02
TE-127	2.01e+00	9.12e-01	1.42e+00	7.28e+00	1.12e+04	8.08e+04	0.00e+00	4.42e-01
TE-127M	1.80e+04	8.16e+03	4.38e+03	6.54e+04	1.66e+06	1.59e+05	0.00e+00	2.18e+03
TE-129	7.10e-02	3.38e-02	5.18e-02	2.66e-01	3.30e+03	1.62e+03	0.00e+00	1.76e-02
TE-129M	1.39e+04	6.58e+03	4.58e+03	5.19e+04	1.98e+06	4.05e+05	0.00e+00	2.25e+03
TE-131	1.58e-02	8.32e-03	1.24e-02	6.18e-02	2.34e+03	1.51e+01	0.00e+00	5.04e-03
TE-131M	9.84e+01	6.01e+01	7.25e+01	4.39e+02	2.38e+05	6.21e+05	0.00e+00	4.02e+01

TABLE 2.2-2c (Continued)

PATHWAY DOSE FACTORS FOR LCO 6.11.6 AND
SECTION 2.2.2.b, (R₁)

Page 4 of 10

Release Type: 2 Gaseous
Dose Factor: 2 Ri (m² * (mrem/yr)/(uCi/cc) or (mrem/yr)/(uCi/m³))
AgeGroup: 1 TEEN
Pathway: 1 Inhalation (INHL)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
TE-132	3.60e+02	2.90e+02	2.46e+02	1.95e+03	4.49e+05	4.63e+05	0.00e+00	2.19e+02
I-130	6.24e+03	1.79e+04	1.49e+06	2.75e+04	0.00e+00	9.12e+03	0.00e+00	7.17e+03
I-131	3.54e+04	4.91e+04	1.46e+07	8.40e+04	0.00e+00	6.49e+03	0.00e+00	2.64e+04
I-132	1.59e+03	4.38e+03	1.51e+05	6.92e+03	0.00e+00	1.27e+03	0.00e+00	1.58e+03
I-133	1.22e+04	2.05e+04	2.92e+06	3.59e+04	0.00e+00	1.03e+04	0.00e+00	6.22e+03
I-134	8.88e+02	2.32e+03	3.95e+04	3.66e+03	0.00e+00	2.04e+01	0.00e+00	8.40e+02
I-135	3.70e+03	9.44e+03	6.21e+05	1.49e+04	0.00e+00	6.95e+03	0.00e+00	3.49e+03
CS-134	5.02e+05	1.13e+06	0.00e+00	3.75e+05	1.46e+05	9.76e+03	0.00e+00	5.49e+05
CS-136	5.15e+04	1.94e+05	0.00e+00	1.10e+05	1.78e+04	1.09e+04	0.00e+00	1.37e+05
CS-137	6.70e+05	8.48e+05	0.00e+00	3.04e+05	1.21e+05	8.48e+03	0.00e+00	3.11e+05
CS-138	4.66e+02	8.56e+02	0.00e+00	6.62e+02	7.87e+01	2.70e-01	0.00e+00	4.46e+02
BA-139	1.34e+00	9.44e-04	0.00e+00	8.88e-04	6.46e+03	6.45e+03	0.00e+00	3.90e-02
BA-140	5.47e+04	6.70e+01	0.00e+00	2.28e+01	2.03e+06	2.29e+05	0.00e+00	3.52e+03
BA-141	1.42e-01	1.06e-04	0.00e+00	9.84e-05	3.29e+03	7.46e-04	0.00e+00	4.74e-03
BA-142	3.70e-02	3.70e-05	0.00e+00	3.14e-05	1.91e+03	4.79e-10	0.00e+00	2.27e-03
LA-140	4.79e+02	2.36e+02	0.00e+00	0.00e+00	2.14e+05	4.87e+05	0.00e+00	6.26e+01
LA-142	9.60e-01	4.25e-01	0.00e+00	0.00e+00	1.02e+04	1.20e+04	0.00e+00	1.06e-01
CE-141	2.84e+04	1.90e+04	0.00e+00	8.88e+03	6.14e+05	1.26e+05	0.00e+00	2.17e+03
CE-143	2.66e+02	1.94e+02	0.00e+00	8.64e+01	1.30e+05	2.55e+05	0.00e+00	2.16e+01
CE-144	4.89e+06	2.02e+06	0.00e+00	1.21e+06	1.34e+07	8.64e+05	0.00e+00	2.62e+05
PR-143	1.34e+04	5.31e+03	0.00e+00	3.09e+03	4.83e+05	2.14e+05	0.00e+00	6.62e+02
PR-144	4.30e-02	1.76e-02	0.00e+00	1.01e-02	1.75e+03	2.35e-04	0.00e+00	2.18e-03
ND-147	7.86e+03	8.56e+03	0.00e+00	5.02e+03	3.72e+05	1.82e+05	0.00e+00	5.13e+02
W-187	1.20e+01	9.76e+00	0.00e+00	0.00e+00	4.74e+04	1.77e+05	0.00e+00	3.43e+00
NP-239	3.38e+02	3.19e+01	0.00e+00	1.00e+02	6.49e+04	1.32e+05	0.00e+00	1.77e+01

TABLE 2.2-2c (Continued)

PATHWAY DOSE FACTORS FOR LCO 6.11.6 AND
SECTION 2.2.2.b, (R₁)

Release Type: 2 Gaseous
Dose Factor: 2 R₁ (m² * (mrem/yr)/(uCi/cc) or (mrem/yr)/(uCi/m³))
AgeGroup: 1 TEEN
Pathway: 2 Vegetation (VEG)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
H-3	0.00e+00	2.59e+03	2.59e+03	2.59e+03	2.59e+03	2.59e+03	0.00e+00	2.59e+03
C-14	3.69e+08	7.38e+07	7.38e+07	7.38e+07	7.38e+07	7.38e+07	0.00e+00	7.38e+07
NA-24	2.40e+05	2.40e+05	2.40e+05	2.40e+05	2.40e+05	2.40e+05	0.00e+00	2.40e+05
P-32	1.61e+09	9.95e+07	0.00e+00	0.00e+00	0.00e+00	1.35e+08	0.00e+00	6.23e+07
CR-51	0.00e+00	0.00e+00	3.42e+04	1.35e+04	8.79e+04	1.03e+07	0.00e+00	6.16e+04
MN-54	0.00e+00	4.54e+08	0.00e+00	1.36e+08	0.00e+00	9.32e+08	0.00e+00	9.01e+07
MN-56	0.00e+00	1.43e+01	0.00e+00	1.81e+01	0.00e+00	9.41e+02	0.00e+00	2.54e+00
FE-55	3.26e+08	2.31e+08	0.00e+00	0.00e+00	1.47e+08	1.00e+08	0.00e+00	5.39e+07
FE-59	1.79e+08	4.18e+08	0.00e+00	0.00e+00	1.32e+08	9.89e+08	0.00e+00	1.61e+08
CO-58	0.00e+00	4.37e+07	0.00e+00	0.00e+00	0.00e+00	6.02e+08	0.00e+00	1.01e+08
CO-60	0.00e+00	2.49e+08	0.00e+00	0.00e+00	0.00e+00	3.24e+09	0.00e+00	5.60e+08
NI-63	1.61e+10	1.13e+09	0.00e+00	0.00e+00	0.00e+00	1.81e+08	0.00e+00	5.45e+08
NI-65	5.73e+01	7.32e+00	0.00e+00	0.00e+00	0.00e+00	3.97e+02	0.00e+00	3.33e+00
CU-64	0.00e+00	8.29e+03	0.00e+00	2.10e+04	0.00e+00	6.43e+05	0.00e+00	3.90e+03
ZN-65	4.24e+08	1.47e+09	0.00e+00	9.42e+08	0.00e+00	6.23e+08	0.00e+00	6.86e+08
ZN-69	5.04e-06	9.61e-06	0.00e+00	6.28e-06	0.00e+00	1.77e-05	0.00e+00	6.72e-07
BR-83	0.00e+00	2.90e+00						
BR-84	0.00e+00	2.31e-11						
BR-85	0.00e+00							
RB-86	0.00e+00	2.74e+08	0.00e+00	0.00e+00	0.00e+00	4.05e+07	0.00e+00	1.29e+08
RB-88	0.00e+00	3.17e-22	0.00e+00	0.00e+00	0.00e+00	2.72e-29	0.00e+00	1.69e-22
RB-89	0.00e+00	3.57e-26	0.00e+00	0.00e+00	0.00e+00	5.46e-35	0.00e+00	2.52e-26
SR-89	1.51e+10	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.80e+09	0.00e+00	4.33e+08
SR-90	7.51e+11	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.11e+10	0.00e+00	1.85e+11
SR-91	2.83e+05	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.29e+06	0.00e+00	1.13e+04
SR-92	3.95e+02	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.01e+04	0.00e+00	1.68e+01
Y-90	1.24e+04	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.03e+08	0.00e+00	3.35e+02
Y-91	7.84e+06	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.22e+09	0.00e+00	2.10e+05
Y-91M	5.04e-09	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.38e-07	0.00e+00	1.93e-10
Y-92	8.59e-01	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.36e+04	0.00e+00	2.49e-02
Y-93	1.58e+02	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.83e+06	0.00e+00	4.34e+00
ZR-95	1.72e+06	5.44e+05	0.00e+00	7.99e+05	0.00e+00	1.26e+09	0.00e+00	3.74e+05
ZR-97	3.12e+02	6.17e+01	0.00e+00	9.36e+01	0.00e+00	1.67e+07	0.00e+00	2.84e+01
NB-95	1.92e+05	1.07e+05	0.00e+00	1.03e+05	0.00e+00	4.56e+08	0.00e+00	5.87e+04
MO-99	0.00e+00	5.64e+06	0.00e+00	1.29e+07	0.00e+00	1.01e+07	0.00e+00	1.08e+06
TC-99M	2.73e+00	7.62e+00	0.00e+00	1.14e+02	4.23e+00	5.00e+03	0.00e+00	9.87e+01
TC-101	7.35e-31	1.04e-30	0.00e+00	1.89e-29	6.37e-31	1.79e-37	0.00e+00	1.03e-29
RU-103	6.82e+06	0.00e+00	0.00e+00	2.40e+07	0.00e+00	5.69e+08	0.00e+00	2.91e+06
RU-105	4.98e+01	0.00e+00	0.00e+00	6.29e+02	0.00e+00	4.02e+04	0.00e+00	1.93e+01
RU-106	3.09e+08	0.00e+00	0.00e+00	5.97e+08	0.00e+00	1.48e+10	0.00e+00	3.90e+07
AG-110M	1.52e+07	1.44e+07	0.00e+00	2.74e+07	0.00e+00	4.03e+09	0.00e+00	8.73e+06
TE-125M	1.49e+08	5.35e+07	4.15e+07	0.00e+00	0.00e+00	4.38e+08	0.00e+00	1.99e+07
TE-127	5.40e+03	1.91e+03	3.73e+03	2.19e+04	0.00e+00	4.17e+05	0.00e+00	1.16e+03
TE-127M	5.52e+08	1.96e+08	1.31e+08	2.24e+09	0.00e+00	1.37e+09	0.00e+00	6.56e+07
TE-129	6.50e-04	2.42e-04	4.64e-04	2.73e-03	0.00e+00	3.56e-03	0.00e+00	1.58e-04
TE-129M	3.61e+08	1.34e+08	1.17e+08	1.51e+09	0.00e+00	1.36e+09	0.00e+00	5.72e+07
TE-131	1.41e-15	5.80e-16	1.08e-15	6.15e-15	0.00e+00	1.16e-16	0.00e+00	4.40e-16
TE-131M	8.44e+05	4.05e+05	6.09e+05	4.22e+06	0.00e+00	3.25e+07	0.00e+00	3.38e+05

TABLE 2.2-2c (Continued)

PATHWAY DOSE FACTORS FOR LCO 6.11.6 AND
SECTION 2.2.2.b, (R₁)

Page 6 of 10

Release Type: 2 Gaseous
Dose Factor: 2 Ri (m² * (mrem/yr)/(uCi/cc) or (mrem/yr)/(uCi/m³))
AgeGroup: 1 TEEN
Pathway: 2 Vegetation (VEG)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
TE-132	3.90e+06	2.47e+06	2.60e+06	2.37e+07	0.00e+00	7.81e+07	0.00e+00	2.32e+06
I-130	3.50e+05	1.01e+06	8.25e+07	1.56e+06	0.00e+00	7.77e+05	0.00e+00	4.04e+05
I-131	7.68e+07	1.08e+08	3.14e+10	1.85e+08	0.00e+00	2.13e+07	0.00e+00	5.78e+07
I-132	5.20e+01	1.36e+02	4.59e+03	2.14e+02	0.00e+00	5.93e+01	0.00e+00	4.88e+01
I-133	1.94e+06	3.28e+06	4.58e+08	5.76e+06	0.00e+00	2.49e+06	0.00e+00	1.00e+06
I-134	8.44e-05	2.24e-04	3.73e-03	3.53e-04	0.00e+00	2.95e-06	0.00e+00	8.03e-05
I-135	3.53e+04	9.10e+04	5.85e+06	1.44e+05	0.00e+00	1.01e+05	0.00e+00	3.37e+04
CS-134	7.10e+09	1.67e+10	0.00e+00	5.31e+09	2.03e+09	2.08e+08	0.00e+00	7.76e+09
CS-136	4.37e+07	1.72e+08	0.00e+00	9.36e+07	1.48e+07	1.38e+07	0.00e+00	1.16e+08
CS-137	1.01e+10	1.35e+10	0.00e+00	4.59e+09	1.78e+09	1.92e+08	0.00e+00	4.70e+09
CS-138	3.54e-11	6.80e-11	0.00e+00	5.02e-11	5.84e-12	3.08e-14	0.00e+00	3.40e-11
BA-139	2.69e-02	1.89e-05	0.00e+00	1.79e-05	1.31e-05	2.40e-01	0.00e+00	7.84e-04
BA-140	1.38e+08	1.69e+05	0.00e+00	5.74e+04	1.14e+05	2.13e+08	0.00e+00	8.91e+06
BA-141	1.11e-21	8.26e-25	0.00e+00	7.67e-25	5.66e-25	2.36e-27	0.00e+00	3.69e-23
BA-142	2.24e-39	2.24e-42	0.00e+00	1.90e-42	1.49e-42	6.88e-51	0.00e+00	1.38e-40
LA-140	1.81e+03	8.89e+02	0.00e+00	0.00e+00	0.00e+00	5.11e+07	0.00e+00	2.37e+02
LA-142	1.87e-04	8.31e-05	0.00e+00	0.00e+00	0.00e+00	2.53e+00	0.00e+00	2.07e-05
CE-141	2.83e+05	1.89e+05	0.00e+00	8.89e+04	0.00e+00	5.40e+08	0.00e+00	2.17e+04
CE-143	9.31e+02	6.78e+05	0.00e+00	3.04e+02	0.00e+00	2.04e+07	0.00e+00	7.57e+01
CE-144	5.28e+07	2.18e+07	0.00e+00	1.30e+07	0.00e+00	1.33e+10	0.00e+00	2.83e+06
PR-143	7.02e+04	2.80e+04	0.00e+00	1.63e+04	0.00e+00	2.31e+08	0.00e+00	3.49e+03
PR-144	3.04e-26	1.24e-26	0.00e+00	7.13e-27	0.00e+00	3.35e-29	0.00e+00	1.54e-27
ND-147	3.62e+04	3.93e+04	0.00e+00	2.31e+04	0.00e+00	1.42e+08	0.00e+00	2.36e+03
W-187	3.54e+04	2.88e+04	0.00e+00	0.00e+00	0.00e+00	7.80e+06	0.00e+00	1.01e+04
NP-239	1.38e+03	1.31e+02	0.00e+00	4.10e+02	0.00e+00	2.10e+07	0.00e+00	7.25e+01

TABLE 2.2-2c (Continued)

PATHWAY DOSE FACTORS FOR LCO 6.11.6 AND
SECTION 2.2.2.b, (R₁)

Page 7 of 10

Release Type: 2 Gaseous
Dose Factor: 2 Ri (m² * (mrem/yr)/(uCi/cc) or (mrem/yr)/(uCi/m³))
AgeGroup: 1 TEEN
Pathway: 4 Grs/Cow/Meat (CMEAT)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
H-3	0.00e+00	1.94e+02	1.94e+02	1.94e+02	1.94e+02	1.94e+02	0.00e+00	1.94e+02
C-14	2.04e+08	4.08e+07	4.08e+07	4.08e+07	4.08e+07	4.08e+07	0.00e+00	4.08e+07
NA-24	1.16e-03	1.16e-03	1.16e-03	1.16e-03	1.16e-03	1.16e-03	0.00e+00	1.16e-03
P-32	3.93e+09	2.43e+08	0.00e+00	0.00e+00	0.00e+00	3.30e+08	0.00e+00	1.52e+08
CR-51	0.00e+00	0.00e+00	3.13e+03	1.23e+03	8.04e+03	9.46e+05	0.00e+00	5.63e+03
MN-54	0.00e+00	7.00e+06	0.00e+00	2.09e+06	0.00e+00	1.44e+07	0.00e+00	1.39e+06
MN-56	0.00e+00	1.17e-53	0.00e+00	1.48e-53	0.00e+00	7.71e-52	0.00e+00	2.08e-54
FE-55	2.38e+08	1.69e+08	0.00e+00	0.00e+00	1.07e+08	7.31e+07	0.00e+00	3.94e+07
FE-59	2.12e+08	4.95e+08	0.00e+00	0.00e+00	1.56e+08	1.17e+09	0.00e+00	1.91e+08
CO-58	0.00e+00	1.41e+07	0.00e+00	0.00e+00	0.00e+00	1.94e+08	0.00e+00	3.24e+07
CO-60	0.00e+00	5.84e+07	0.00e+00	0.00e+00	0.00e+00	7.60e+08	0.00e+00	1.31e+08
NI-63	1.52e+10	1.07e+09	0.00e+00	0.00e+00	0.00e+00	1.71e+08	0.00e+00	5.15e+08
NI-65	1.90e-52	2.43e-53	0.00e+00	0.00e+00	0.00e+00	1.32e-51	0.00e+00	1.11e-53
CU-64	0.00e+00	2.06e-07	0.00e+00	5.21e-07	0.00e+00	1.60e-05	0.00e+00	9.68e-08
ZN-65	2.50e+08	8.69e+08	0.00e+00	5.56e+08	0.00e+00	3.68e+08	0.00e+00	4.05e+08
ZN-69	0.00e+00							
BR-83	0.00e+00	4.73e-57						
BR-84	0.00e+00							
BR-85	0.00e+00							
RB-86	0.00e+00	4.07e+08	0.00e+00	0.00e+00	0.00e+00	6.02e+07	0.00e+00	1.91e+08
RB-88	0.00e+00							
RB-89	0.00e+00							
SR-89	2.54e+08	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.03e+07	0.00e+00	7.28e+06
SR-90	8.05e+09	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.26e+08	0.00e+00	1.99e+09
SR-91	1.21e-10	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.47e-10	0.00e+00	4.80e-12
SR-92	9.02e-50	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.30e-48	0.00e+00	3.85e-51
Y-90	9.13e+01	0.00e+00	0.00e+00	0.00e+00	0.00e+00	7.53e+05	0.00e+00	2.46e+00
Y-91	9.54e+05	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.91e+08	0.00e+00	2.56e+04
Y-91M	0.00e+00							
Y-92	1.26e-39	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.46e-35	0.00e+00	3.65e-41
Y-93	3.71e-12	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.13e-07	0.00e+00	1.02e-13
ZR-95	1.50e+06	4.74e+05	0.00e+00	6.96e+05	0.00e+00	1.09e+09	0.00e+00	3.26e+05
ZR-97	1.70e-05	3.37e-06	0.00e+00	5.10e-06	0.00e+00	9.11e-01	0.00e+00	1.55e-06
NB-95	1.79e+06	9.95e+05	0.00e+00	9.64e+05	0.00e+00	4.25e+09	0.00e+00	5.48e+05
MO-99	0.00e+00	8.21e+04	0.00e+00	1.88e+05	0.00e+00	1.47e+05	0.00e+00	1.57e+04
TC-99M	3.43e-21	9.57e-21	0.00e+00	1.43e-19	5.31e-21	6.29e-18	0.00e+00	1.24e-19
TC-101	0.00e+00							
RU-103	8.57e+07	0.00e+00	0.00e+00	3.02e+08	0.00e+00	7.15e+09	0.00e+00	3.66e+07
RU-105	4.54e-28	0.00e+00	0.00e+00	5.73e-27	0.00e+00	3.67e-25	0.00e+00	1.76e-28
RU-106	2.36e+09	0.00e+00	0.00e+00	4.55e+09	0.00e+00	1.13e+11	0.00e+00	2.97e+08
AG-110M	5.06e+06	4.79e+06	0.00e+00	9.13e+06	0.00e+00	1.35e+09	0.00e+00	2.91e+06
TE-125M	3.03e+08	1.09e+08	8.48e+07	0.00e+00	0.00e+00	8.95e+08	0.00e+00	4.06e+07
TE-127	2.12e-10	7.52e-11	1.47e-10	8.60e-10	0.00e+00	1.64e-08	0.00e+00	4.57e-11
TE-127M	9.42e+08	3.34e+08	2.24e+08	3.82e+09	0.00e+00	2.35e+09	0.00e+00	1.12e+08
TE-129	0.00e+00							
TE-129M	9.49e+08	3.52e+08	3.06e+08	3.97e+09	0.00e+00	3.56e+09	0.00e+00	1.50e+08
TE-131	0.00e+00							
TE-131M	3.75e+02	1.80e+02	2.70e+02	1.87e+03	0.00e+00	1.44e+04	0.00e+00	1.50e+02

TABLE 2.2-2c (Continued)

PATHWAY DOSE FACTORS FOR LCO 6.11.6 AND
SECTION 2.2.2.b, (R_i)

Page 8 of 10

Release Type: 2 Gaseous
Dose Factor: 2 R_i (m² * (mrem/yr)/(uCi/cc) or (mrem/yr)/(uCi/m³))
AgeGroup: 1 TEEN
Pathway: 4 Grs/Cow/Meat (CMEAT)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
TE-132	1.14e+06	7.24e+05	7.63e+05	6.94e+06	0.00e+00	2.29e+07	0.00e+00	6.81e+05
I-130	1.63e-06	4.72e-06	3.85e-04	7.27e-06	0.00e+00	3.63e-06	0.00e+00	1.89e-06
I-131	8.92e+06	1.25e+07	3.64e+09	2.15e+07	0.00e+00	2.47e+06	0.00e+00	6.71e+06
I-132	5.79e-59	1.52e-58	5.11e-57	2.39e-58	0.00e+00	6.60e-59	0.00e+00	5.44e-59
I-133	3.04e-01	5.15e-01	7.19e+01	9.03e-01	0.00e+00	3.90e-01	0.00e+00	1.57e-01
I-134	0.00e+00							
I-135	3.79e-17	9.75e-17	6.27e-15	1.54e-16	0.00e+00	1.08e-16	0.00e+00	3.61e-17
CS-134	5.23e+08	1.23e+09	0.00e+00	3.91e+08	1.49e+08	1.53e+07	0.00e+00	5.71e+08
CS-136	9.39e+06	3.69e+07	0.00e+00	2.01e+07	3.17e+06	2.97e+06	0.00e+00	2.48e+07
CS-137	7.24e+08	9.63e+08	0.00e+00	3.28e+08	1.27e+08	1.37e+07	0.00e+00	3.36e+08
CS-138	0.00e+00							
BA-139	0.00e+00							
BA-140	2.38e+07	2.91e+04	0.00e+00	9.88e+03	1.96e+04	3.67e+07	0.00e+00	1.53e+06
BA-141	0.00e+00							
BA-142	0.00e+00							
LA-140	3.09e-02	1.52e-02	0.00e+00	0.00e+00	0.00e+00	8.73e+02	0.00e+00	4.05e-03
LA-142	3.36e-92	1.49e-92	0.00e+00	0.00e+00	0.00e+00	4.54e-88	0.00e+00	3.71e-93
CE-141	1.18e+04	7.87e+03	0.00e+00	3.71e+03	0.00e+00	2.25e+07	0.00e+00	9.04e+02
CE-143	1.67e-02	1.22e+01	0.00e+00	5.46e-03	0.00e+00	3.66e+02	0.00e+00	1.36e-03
CE-144	1.23e+06	5.08e+05	0.00e+00	3.04e+05	0.00e+00	3.09e+08	0.00e+00	6.60e+04
PR-143	1.77e+04	7.05e+03	0.00e+00	4.10e+03	0.00e+00	5.81e+07	0.00e+00	8.79e+02
PR-144	0.00e+00							
ND-147	6.22e+03	6.77e+03	0.00e+00	3.97e+03	0.00e+00	2.44e+07	0.00e+00	4.05e+02
W-187	1.73e-02	1.41e-02	0.00e+00	0.00e+00	0.00e+00	3.82e+00	0.00e+00	4.94e-03
NP-239	2.25e-01	2.12e-02	0.00e+00	6.66e-02	0.00e+00	3.41e+03	0.00e+00	1.18e-02

TABLE 2.2-2c (Continued)

PATHWAY DOSE FACTORS FOR LCO 6.11.6 AND
SECTION 2.2.2.b, (R_i)

Page 9 of 10

Release Type: 2 Gaseous
Dose Factor: 2 Ri (m² * (mrem/yr)/(uCi/cc) or (mrem/yr)/(uCi/m³))
AgeGroup: 1 TEEN
Pathway: 5 Grs/Cow/Milk (CMILK)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
H-3	0.00e+00	9.94e+02	9.94e+02	9.94e+02	9.94e+02	9.94e+02	0.00e+00	9.94e+02
C-14	4.86e+08	9.72e+07	9.72e+07	9.72e+07	9.72e+07	9.72e+07	0.00e+00	9.72e+07
NA-24	4.29e+06	4.29e+06	4.29e+06	4.29e+06	4.29e+06	4.29e+06	0.00e+00	4.29e+06
P-32	3.15e+10	1.95e+09	0.00e+00	0.00e+00	0.00e+00	2.65e+09	0.00e+00	1.22e+09
CR-51	0.00e+00	0.00e+00	2.77e+04	1.09e+04	7.12e+04	8.38e+06	0.00e+00	4.99e+04
MN-54	0.00e+00	1.40e+07	0.00e+00	4.18e+06	0.00e+00	2.87e+07	0.00e+00	2.78e+06
MN-56	0.00e+00	7.32e-03	0.00e+00	9.27e-03	0.00e+00	4.82e-01	0.00e+00	1.30e-03
FE-55	4.45e+07	3.16e+07	0.00e+00	0.00e+00	2.00e+07	1.37e+07	0.00e+00	7.36e+06
FE-59	5.18e+07	1.21e+08	0.00e+00	0.00e+00	3.81e+07	2.86e+08	0.00e+00	4.67e+07
CO-58	0.00e+00	7.94e+06	0.00e+00	0.00e+00	0.00e+00	1.10e+08	0.00e+00	1.83e+07
CO-60	0.00e+00	2.78e+07	0.00e+00	0.00e+00	0.00e+00	3.62e+08	0.00e+00	6.26e+07
NI-63	1.18e+10	8.35e+08	0.00e+00	0.00e+00	0.00e+00	1.33e+08	0.00e+00	4.01e+08
NI-65	6.78e-01	8.66e-02	0.00e+00	0.00e+00	0.00e+00	4.70e+00	0.00e+00	3.94e-02
CU-64	0.00e+00	4.21e+04	0.00e+00	1.06e+05	0.00e+00	3.26e+06	0.00e+00	1.98e+04
ZN-65	2.11e+09	7.31e+09	0.00e+00	4.68e+09	0.00e+00	3.10e+09	0.00e+00	3.41e+09
ZN-69	3.70e-12	7.05e-12	0.00e+00	4.61e-12	0.00e+00	1.30e-11	0.00e+00	4.94e-13
BR-83	0.00e+00	1.78e-01						
BR-84	0.00e+00	3.02e-23						
BR-85	0.00e+00							
RB-86	0.00e+00	4.73e+09	0.00e+00	0.00e+00	0.00e+00	7.00e+08	0.00e+00	2.22e+09
RB-88	0.00e+00	3.90e-45	0.00e+00	0.00e+00	0.00e+00	3.34e-52	0.00e+00	2.08e-45
RB-89	0.00e+00	7.96e-53	0.00e+00	0.00e+00	0.00e+00	1.22e-61	0.00e+00	5.63e-53
SR-89	2.67e+09	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.18e+08	0.00e+00	7.66e+07
SR-90	6.61e+10	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.86e+09	0.00e+00	1.63e+10
SR-91	5.27e+04	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.39e+05	0.00e+00	2.10e+03
SR-92	8.85e-01	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.26e+01	0.00e+00	3.77e-02
Y-90	1.30e+02	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.08e+06	0.00e+00	3.51e+00
Y-91	1.58e+04	0.00e+00	0.00e+00	0.00e+00	0.00e+00	6.48e+06	0.00e+00	4.24e+02
Y-91M	1.18e-19	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.55e-18	0.00e+00	4.49e-21
Y-92	1.03e-04	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.82e+00	0.00e+00	2.98e-06
Y-93	4.09e-01	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.25e+04	0.00e+00	1.12e-02
ZR-95	1.65e+03	5.21e+02	0.00e+00	7.65e+02	0.00e+00	1.20e+06	0.00e+00	3.58e+02
ZR-97	7.87e-01	1.56e-01	0.00e+00	2.36e-01	0.00e+00	4.22e+04	0.00e+00	7.17e-02
NB-95	1.41e+05	7.81e+04	0.00e+00	7.57e+04	0.00e+00	3.34e+08	0.00e+00	4.30e+04
MO-99	0.00e+00	4.46e+07	0.00e+00	1.02e+08	0.00e+00	8.00e+07	0.00e+00	8.51e+06
TC-99M	5.74e+00	1.60e+01	0.00e+00	2.39e+02	8.89e+00	1.05e+04	0.00e+00	2.08e+02
TC-101	4.39e-60	6.24e-60	0.00e+00	1.13e-58	3.80e-60	1.07e-66	0.00e+00	6.13e-59
RU-103	1.81e+03	0.00e+00	0.00e+00	6.38e+03	0.00e+00	1.51e+05	0.00e+00	7.74e+02
RU-105	1.55e-03	0.00e+00	0.00e+00	1.96e-02	0.00e+00	1.25e+00	0.00e+00	6.03e-04
RU-106	3.75e+04	0.00e+00	0.00e+00	7.23e+04	0.00e+00	1.80e+06	0.00e+00	4.73e+03
AG-110M	9.63e+07	9.11e+07	0.00e+00	1.74e+08	0.00e+00	2.56e+10	0.00e+00	5.54e+07
TE-125M	3.01e+07	1.08e+07	8.40e+06	0.00e+00	0.00e+00	8.87e+07	0.00e+00	4.02e+06
TE-127	1.24e+03	4.38e+02	8.52e+02	5.00e+03	0.00e+00	9.54e+04	0.00e+00	2.66e+02
TE-127M	8.44e+07	2.99e+07	2.01e+07	3.42e+08	0.00e+00	2.10e+08	0.00e+00	1.00e+07
TE-129	4.33e-10	1.62e-10	3.10e-10	1.82e-09	0.00e+00	2.37e-09	0.00e+00	1.05e-10
TE-129M	1.10e+08	4.09e+07	3.55e+07	4.61e+08	0.00e+00	4.13e+08	0.00e+00	1.74e+07
TE-131	6.70e-33	2.76e-33	5.16e-33	2.93e-32	0.00e+00	5.50e-34	0.00e+00	2.09e-33
TE-131M	6.57e+05	3.15e+05	4.74e+05	3.28e+06	0.00e+00	2.53e+07	0.00e+00	2.63e+05

TABLE 2.2-2c (Continued)

PATHWAY DOSE FACTORS FOR LCO 6.11.6 AND
SECTION 2.2.2.b, (R_i)

Page 10 of 10

Release Type: 2 Gaseous
Dose Factor: 2 R_i (m² * (mrem/yr)/(uCi/cc) or (mrem/yr)/(uCi/m³))
AgeGroup: 1 TEEN
Pathway: 5 Grs/Cow/Milk (CMILK)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
TE-132	4.28e+06	2.71e+06	2.85e+06	2.60e+07	0.00e+00	8.57e+07	0.00e+00	2.55e+06
I-130	7.35e+05	2.13e+06	1.73e+08	3.27e+06	0.00e+00	1.63e+06	0.00e+00	8.49e+05
I-131	5.37e+08	7.52e+08	2.19e+11	1.30e+09	0.00e+00	1.49e+08	0.00e+00	4.04e+08
I-132	2.92e-01	7.64e-01	2.58e+01	1.20e+00	0.00e+00	3.33e-01	0.00e+00	2.74e-01
I-133	7.06e+06	1.20e+07	1.67e+09	2.10e+07	0.00e+00	9.06e+06	0.00e+00	3.65e+06
I-134	3.36e-12	8.89e-12	1.48e-10	1.40e-11	0.00e+00	1.17e-13	0.00e+00	3.19e-12
I-135	2.29e+04	5.91e+04	3.80e+06	9.33e+04	0.00e+00	6.55e+04	0.00e+00	2.19e+04
CS-134	9.82e+09	2.31e+10	0.00e+00	7.34e+09	2.80e+09	2.87e+08	0.00e+00	1.07e+10
CS-136	4.48e+08	1.76e+09	0.00e+00	9.60e+08	1.51e+08	1.42e+08	0.00e+00	1.18e+09
CS-137	1.34e+10	1.78e+10	0.00e+00	6.06e+09	2.35e+09	2.53e+08	0.00e+00	6.20e+09
CS-138	1.58e-23	3.03e-23	0.00e+00	2.23e-23	2.60e-24	1.37e-26	0.00e+00	1.51e-23
BA-139	8.20e-08	5.77e-11	0.00e+00	5.44e-11	3.98e-11	7.31e-07	0.00e+00	2.39e-09
BA-140	4.85e+07	5.95e+04	0.00e+00	2.02e+04	4.00e+04	7.49e+07	0.00e+00	3.13e+06
BA-141	7.95e-46	5.94e-49	0.00e+00	5.51e-49	4.07e-49	1.70e-51	0.00e+00	2.66e-47
BA-142	7.98e-81	7.98e-84	0.00e+00	6.75e-84	5.31e-84	2.45e-92	0.00e+00	4.91e-82
LA-140	8.12e+00	3.99e+00	0.00e+00	0.00e+00	0.00e+00	2.29e+05	0.00e+00	1.06e+00
LA-142	3.41e-11	1.52e-11	0.00e+00	0.00e+00	0.00e+00	4.61e-07	0.00e+00	3.77e-12
CE-141	8.88e+03	5.93e+03	0.00e+00	2.79e+03	0.00e+00	1.70e+07	0.00e+00	6.81e+02
CE-143	7.62e+01	5.55e+04	0.00e+00	2.49e+01	0.00e+00	1.67e+06	0.00e+00	6.20e+00
CE-144	6.58e+05	2.72e+05	0.00e+00	1.63e+05	0.00e+00	1.66e+08	0.00e+00	3.54e+04
PR-143	2.90e+02	1.16e+02	0.00e+00	6.74e+01	0.00e+00	9.55e+05	0.00e+00	1.44e+01
PR-144	1.19e-53	4.87e-54	0.00e+00	2.79e-54	0.00e+00	1.31e-56	0.00e+00	6.03e-55
ND-147	1.81e+02	1.97e+02	0.00e+00	1.16e+02	0.00e+00	7.11e+05	0.00e+00	1.18e+01
W-187	1.19e+04	9.71e+03	0.00e+00	0.00e+00	0.00e+00	2.63e+06	0.00e+00	3.40e+03
NP-239	7.00e+00	6.60e-01	0.00e+00	2.07e+00	0.00e+00	1.06e+05	0.00e+00	3.67e-01

Units: Inhalation and all tritium pathways mrem/yr per $\mu\text{Ci}/\text{m}^3$
Others - m^2 . mrem/yr per $\mu\text{Ci}/\text{sec}$

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

TABLE 2.2-2d

PATHWAY DOSE FACTORS FOR LCO 6.11.6 AND
SECTION 2.2.2.b, (R_i)

Page 1 of 10

Release Type: 2 Gaseous
Dose Factor: 2 R_i (m² * (mrem/yr)/(uCi/cc) or (mrem/yr)/(uCi/m³))
AgeGroup: 0 ADULT
Pathway: 0 Ground Plane Deposition (GPD)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
H-3	0.00e+00							
C-14	0.00e+00							
NA-24	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.39e+07	1.20e+07
P-32	0.00e+00							
CR-51	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.50e+06	4.65e+06
MN-54	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.62e+09	1.38e+09
MN-56	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.07e+06	9.03e+05
FE-55	0.00e+00							
FE-59	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.20e+08	2.73e+08
CO-58	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.45e+08	3.80e+08
CO-60	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.53e+10	2.15e+10
NI-63	0.00e+00							
NI-65	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.45e+05	2.97e+05
CU-64	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	6.86e+05	6.05e+05
ZN-65	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	8.57e+08	7.46e+08
ZN-69	0.00e+00							
BR-83	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	7.08e+03	4.87e+03
BR-84	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.37e+05	2.03e+05
BR-85	0.00e+00							
RB-86	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.03e+07	8.98e+06
RB-88	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.78e+04	3.31e+04
RB-89	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.48e+05	1.23e+05
SR-89	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.51e+04	2.16e+04
SR-90	0.00e+00							
SR-91	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.51e+06	2.15e+06
SR-92	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	8.62e+05	7.76e+05
Y-90	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.31e+03	4.50e+03
Y-91	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.21e+06	1.07e+06
Y-91M	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.16e+05	1.00e+05
Y-92	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.14e+05	1.80e+05
Y-93	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.50e+05	1.83e+05
ZR-95	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.85e+08	2.45e+08
ZR-97	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.44e+06	2.96e+06
NB-95	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.61e+08	1.37e+08
MO-99	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.62e+06	3.99e+06
TC-99M	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.11e+05	1.84e+05
TC-101	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.26e+04	2.03e+04
RU-103	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.26e+08	1.08e+08
RU-105	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	7.21e+05	6.36e+05
RU-106	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.04e+08	4.20e+08
AG-110M	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.02e+09	3.45e+09
TE-125M	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.13e+06	1.56e+06
TE-127	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.29e+03	2.99e+03
TE-127M	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.08e+05	9.17e+04
TE-129	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.08e+04	2.61e+04
TE-129M	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.31e+07	1.98e+07
TE-131	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.45e+07	2.92e+04
TE-131M	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	9.46e+06	8.02e+06

TABLE 2.2-2d (Continued)

PATHWAY DOSE FACTORS FOR LCO 6.11.6 AND
SECTION 2.2.2.b, (R₁)

Page 2 of 10

Release Type: 2 Gaseous
Dose Factor: 2 R₁ (m² * (mrem/yr)/(uCi/cc) or (mrem/yr)/(uCi/m³))
AgeGroup: 0 ADULT
Pathway: 0 Ground Plane Deposition (GPD)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-Ili	Skin	TB
TE-132	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.97e+06	4.22e+06
I-130	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	6.68e+06	5.50e+06
I-131	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.09e+07	1.72e+07
I-132	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.47e+06	1.25e+06
I-133	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.98e+06	2.45e+06
I-134	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.30e+05	4.46e+05
I-135	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.95e+06	2.53e+06
CS-134	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	8.05e+09	6.90e+09
CS-136	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.71e+08	1.51e+08
CS-137	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.20e+10	1.03e+10
CS-138	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.10e+05	3.59e+05
BA-139	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.19e+05	1.06e+05
BA-140	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.35e+07	2.05e+07
BA-141	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.75e+04	4.17e+04
BA-142	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.06e+04	4.44e+04
LA-140	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.18e+07	1.92e+07
LA-142	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	9.12e+05	7.60e+05
CE-141	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.54e+07	1.37e+07
CE-143	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.63e+06	2.31e+06
CE-144	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	8.05e+07	6.96e+07
PR-143	0.00e+00							
PR-144	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.11e+03	1.84e+03
ND-147	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.01e+07	8.39e+06
W-187	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.73e+06	2.35e+06
NP-239	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.98e+06	1.71e+06

TABLE 2.2-2d (Continued)

PATHWAY DOSE FACTORS FOR LCO 6.11.6 AND
SECTION 2.2.2.b, (R_i)

Page 3 of 10

Release Type: 2 Gaseous
Dose Factor: 2 R_i (m² * (mrem/yr)/(uCi/cc) or (mrem/yr)/(uCi/m³))
AgeGroup: 0 ADULT
Pathway: 1 Inhalation (INHL)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
H-3	0.00e+00	1.26e+03	1.26e+03	1.26e+03	1.26e+03	1.26e+03	0.00e+00	1.26e+03
C-14	1.82e+04	3.41e+03	3.41e+03	3.41e+03	3.41e+03	3.41e+03	0.00e+00	3.41e+03
NA-24	1.02e+04	1.02e+04	1.02e+04	1.02e+04	1.02e+04	1.02e+04	0.00e+00	1.02e+04
P-32	1.32e+06	7.71e+04	0.00e+00	0.00e+00	0.00e+00	8.64e+04	0.00e+00	5.01e+04
CR-51	0.00e+00	0.00e+00	5.95e+01	2.28e+01	1.44e+04	3.32e+03	0.00e+00	1.00e+02
MN-54	0.00e+00	3.96e+04	0.00e+00	9.84e+03	1.40e+06	7.74e+04	0.00e+00	6.30e+03
MN-56	0.00e+00	1.24e+00	0.00e+00	1.30e+00	9.44e+03	2.02e+04	0.00e+00	1.83e-01
FE-55	2.46e+04	1.70e+04	0.00e+00	0.00e+00	7.21e+04	6.03e+03	0.00e+00	3.94e+03
FE-59	1.18e+04	2.78e+04	0.00e+00	0.00e+00	1.02e+06	1.88e+05	0.00e+00	1.06e+04
CO-58	0.00e+00	1.58e+03	0.00e+00	0.00e+00	9.28e+05	1.06e+05	0.00e+00	2.07e+03
CO-60	0.00e+00	1.15e+04	0.00e+00	0.00e+00	5.97e+06	2.85e+05	0.00e+00	1.48e+04
NI-63	4.32e+05	3.14e+04	0.00e+00	0.00e+00	1.78e+05	1.34e+04	0.00e+00	1.45e+04
NI-65	1.54e+00	2.10e-01	0.00e+00	0.00e+00	5.60e+03	1.23e+04	0.00e+00	9.12e-02
CU-64	0.00e+00	1.46e+00	0.00e+00	4.62e+00	6.78e+03	4.90e+04	0.00e+00	6.15e-01
ZN-65	3.24e+04	1.03e+05	0.00e+00	6.90e+04	8.64e+05	5.34e+04	0.00e+00	4.66e+04
ZN-69	3.38e-02	6.51e-02	0.00e+00	4.22e-02	9.20e+02	1.63e+01	0.00e+00	4.52e-03
BR-83	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.32e+02	0.00e+00	2.41e+02
BR-84	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.64e-03	0.00e+00	3.13e+02
BR-85	0.00e+00	1.28e+01						
RB-86	0.00e+00	1.35e+05	0.00e+00	0.00e+00	0.00e+00	1.66e+04	0.00e+00	5.90e+04
RB-88	0.00e+00	3.87e+02	0.00e+00	0.00e+00	0.00e+00	3.34e-09	0.00e+00	1.93e+02
RB-89	0.00e+00	2.56e+02	0.00e+00	0.00e+00	0.00e+00	9.28e-12	0.00e+00	1.70e+02
SR-89	3.04e+05	0.00e+00	0.00e+00	0.00e+00	1.40e+06	3.50e+05	0.00e+00	8.72e+03
SR-90	9.92e+07	0.00e+00	0.00e+00	0.00e+00	9.60e+06	7.22e+05	0.00e+00	6.10e+06
SR-91	6.19e+01	0.00e+00	0.00e+00	0.00e+00	3.65e+04	1.91e+05	0.00e+00	2.50e+00
SR-92	6.74e+00	0.00e+00	0.00e+00	0.00e+00	1.65e+04	4.30e+04	0.00e+00	2.91e-01
Y-90	2.09e+03	0.00e+00	0.00e+00	0.00e+00	1.70e+05	5.06e+05	0.00e+00	5.61e+01
Y-91	4.62e+05	0.00e+00	0.00e+00	0.00e+00	1.70e+06	3.85e+05	0.00e+00	1.24e+04
Y-91M	2.61e-01	0.00e+00	0.00e+00	0.00e+00	1.92e+03	1.33e+00	0.00e+00	1.02e-02
Y-92	1.03e+01	0.00e+00	0.00e+00	0.00e+00	1.57e+04	7.35e+04	0.00e+00	3.02e-01
Y-93	9.44e+01	0.00e+00	0.00e+00	0.00e+00	4.85e+04	4.22e+05	0.00e+00	2.61e+00
ZR-95	1.07e+05	3.44e+04	0.00e+00	5.42e+04	1.77e+06	1.50e+05	0.00e+00	2.33e+04
ZR-97	9.68e+01	1.96e+01	0.00e+00	2.97e+01	7.87e+04	5.23e+05	0.00e+00	9.04e+00
NB-95	1.41e+04	7.82e+03	0.00e+00	7.74e+03	5.05e+05	1.04e+05	0.00e+00	4.21e+03
MO-99	0.00e+00	1.21e+02	0.00e+00	2.91e+02	9.12e+04	2.48e+05	0.00e+00	2.30e+01
TC-99M	1.03e-03	2.91e-03	0.00e+00	4.42e-02	7.64e+02	4.16e+03	0.00e+00	3.70e-02
TC-101	4.18e-05	6.02e-05	0.00e+00	1.08e-03	3.99e+02	1.09e-11	0.00e+00	5.90e-04
RU-103	1.53e+03	0.00e+00	0.00e+00	5.83e+03	5.05e+05	1.10e+05	0.00e+00	6.58e+02
RU-105	7.90e-01	0.00e+00	0.00e+00	1.02e+00	1.10e+04	4.82e+04	0.00e+00	3.11e-01
RU-106	6.91e+04	0.00e+00	0.00e+00	1.34e+05	9.36e+06	9.12e+05	0.00e+00	8.72e+03
AG-110M	1.08e+04	1.00e+04	0.00e+00	1.97e+04	4.63e+06	3.02e+05	0.00e+00	5.94e+03
TE-125M	3.42e+03	1.58e+03	1.05e+03	1.24e+04	3.14e+05	7.06e+04	0.00e+00	4.67e+02
TE-127	1.40e+00	6.42e-01	1.06e+00	5.10e+00	6.51e+03	5.74e+04	0.00e+00	3.10e-01
TE-127M	1.26e+04	5.77e+03	3.29e+03	4.58e+04	9.60e+05	1.50e+05	0.00e+00	1.57e+03
TE-129	4.98e-02	2.39e-02	3.90e-02	1.87e-01	1.94e+03	1.57e+02	0.00e+00	1.24e-02
TE-129M	9.76e+03	4.67e+03	3.44e+03	3.66e+04	1.16e+06	3.83e+05	0.00e+00	1.58e+03
TE-131	1.11e-02	5.95e-03	9.36e-03	4.37e-02	1.39e+03	1.84e+01	0.00e+00	3.59e-03
TE-131M	6.99e+01	4.36e+01	5.50e+01	3.09e+02	1.46e+05	5.56e+05	0.00e+00	2.90e+01

TABLE 2.2-2d (Continued)

PATHWAY DOSE FACTORS FOR LCO 6.11.6 AND
SECTION 2.2.2.b, (R₁)

Page 4 of 10

Release Type: 2 Gaseous
Dose Factor: 2 Ri (m² * (mrem/yr)/(uCi/cc) or (mrem/yr)/(uCi/m³))
AgeGroup: 0 ADULT
Pathway: 1 Inhalation (INHL)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
TE-132	2.60e+02	2.15e+02	1.90e+02	1.46e+03	2.88e+05	5.10e+05	0.00e+00	1.62e+02
I-130	4.58e+03	1.34e+04	1.14e+06	2.09e+04	0.00e+00	7.69e+03	0.00e+00	5.28e+03
I-131	2.52e+04	3.58e+04	1.19e+07	6.13e+04	0.00e+00	6.28e+03	0.00e+00	2.05e+04
I-132	1.16e+03	3.26e+03	1.14e+05	5.18e+03	0.00e+00	4.06e+02	0.00e+00	1.16e+03
I-133	8.64e+03	1.48e+04	2.15e+06	2.58e+04	0.00e+00	8.88e+03	0.00e+00	4.52e+03
I-134	6.44e+02	1.73e+03	2.98e+04	2.75e+03	0.00e+00	1.01e+00	0.00e+00	6.15e+02
I-135	2.68e+03	6.98e+03	4.48e+05	1.11e+04	0.00e+00	5.25e+03	0.00e+00	2.57e+03
CS-134	3.73e+05	8.48e+05	0.00e+00	2.87e+05	9.76e+04	1.04e+04	0.00e+00	7.28e+05
CS-136	3.90e+04	1.46e+05	0.00e+00	8.56e+04	1.20e+04	1.17e+04	0.00e+00	1.10e+05
CS-137	4.78e+05	6.21e+05	0.00e+00	2.22e+05	7.52e+04	8.40e+03	0.00e+00	4.28e+05
CS-138	3.31e+02	6.21e+02	0.00e+00	4.80e+02	4.86e+01	1.86e-03	0.00e+00	3.24e+02
BA-139	9.36e-01	6.66e-04	0.00e+00	6.22e-04	3.76e+03	8.96e+02	0.00e+00	2.74e-02
BA-140	3.90e+04	4.90e+01	0.00e+00	1.67e+01	1.27e+06	2.18e+05	0.00e+00	2.57e+03
BA-141	1.00e-01	7.53e-05	0.00e+00	7.00e-05	1.94e+03	1.16e-07	0.00e+00	3.36e-03
BA-142	2.63e-02	2.70e-05	0.00e+00	2.29e-05	1.19e+03	1.57e-16	0.00e+00	1.66e-03
LA-140	3.44e+02	1.74e+02	0.00e+00	0.00e+00	1.36e+05	4.58e+05	0.00e+00	4.58e+01
LA-142	6.83e-01	3.10e-01	0.00e+00	0.00e+00	6.33e+03	2.11e+03	0.00e+00	7.72e-02
CE-141	1.99e+04	1.35e+04	0.00e+00	6.26e+03	3.62e+05	1.20e+05	0.00e+00	1.53e+03
CE-143	1.86e+02	1.38e+02	0.00e+00	6.08e+01	7.98e+04	2.26e+05	0.00e+00	1.53e+01
CE-144	3.43e+06	1.43e+06	0.00e+00	8.48e+05	7.78e+06	8.16e+05	0.00e+00	1.84e+05
PR-143	9.36e+03	3.75e+03	0.00e+00	2.16e+03	2.81e+05	2.00e+05	0.00e+00	4.64e+02
PR-144	3.01e-02	1.25e-02	0.00e+00	7.05e-03	1.02e+03	2.15e-08	0.00e+00	1.53e-03
ND-147	5.27e+03	6.10e+03	0.00e+00	3.56e+03	2.21e+05	1.73e+05	0.00e+00	3.65e+02
W-187	8.48e+00	7.08e+00	0.00e+00	0.00e+00	2.90e+04	1.55e+05	0.00e+00	2.48e+00
NP-239	2.30e+02	2.26e+01	0.00e+00	7.00e+01	3.76e+04	1.19e+05	0.00e+00	1.24e+01

TABLE 2.2-2d (Continued)

PATHWAY DOSE FACTORS FOR LCO 6.11.6 AND
SECTION 2.2.2.b, (R_i)

Page 5 of 10

Release Type: 2 Gaseous
Dose Factor: 2 R_i (m² * (mrem/yr)/(uCi/cc) or (mrem/yr)/(uCi/m³))
AgeGroup: 0 ADULT
Pathway: 2 Vegetation (VEG)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
H-3	0.00e+00	2.26e+03	2.26e+03	2.26e+03	2.26e+03	2.26e+03	0.00e+00	2.26e+03
C-14	2.28e+08	4.55e+07	4.55e+07	4.55e+07	4.55e+07	4.55e+07	0.00e+00	4.55e+07
NA-24	2.71e+05	2.71e+05	2.71e+05	2.71e+05	2.71e+05	2.71e+05	0.00e+00	2.71e+05
P-32	1.40e+09	8.72e+07	0.00e+00	0.00e+00	0.00e+00	1.58e+08	0.00e+00	5.42e+07
CR-51	0.00e+00	0.00e+00	2.77e+04	1.02e+04	6.15e+04	1.17e+07	0.00e+00	4.64e+04
MN-54	0.00e+00	3.13e+08	0.00e+00	9.31e+07	0.00e+00	9.58e+08	0.00e+00	5.97e+07
MN-56	0.00e+00	1.59e+01	0.00e+00	2.01e+01	0.00e+00	5.06e+02	0.00e+00	2.81e+00
FE-55	2.10e+08	1.45e+08	0.00e+00	0.00e+00	8.08e+07	8.31e+07	0.00e+00	3.38e+07
FE-59	1.26e+08	2.96e+08	0.00e+00	0.00e+00	8.27e+07	9.87e+08	0.00e+00	1.14e+08
CO-58	0.00e+00	3.08e+07	0.00e+00	0.00e+00	0.00e+00	6.24e+08	0.00e+00	6.90e+07
CO-60	0.00e+00	1.67e+08	0.00e+00	0.00e+00	0.00e+00	3.14e+09	0.00e+00	3.69e+08
NI-63	1.04e+10	7.21e+08	0.00e+00	0.00e+00	0.00e+00	1.51e+08	0.00e+00	3.49e+08
NI-65	6.15e+01	7.99e+00	0.00e+00	0.00e+00	0.00e+00	2.03e+02	0.00e+00	3.65e+00
CU-64	0.00e+00	9.15e+03	0.00e+00	2.31e+04	0.00e+00	7.80e+05	0.00e+00	4.29e+03
ZN-65	3.17e+08	1.01e+09	0.00e+00	6.75e+08	0.00e+00	6.36e+08	0.00e+00	4.56e+08
ZN-69	5.38e-06	1.03e-05	0.00e+00	6.69e-06	0.00e+00	1.55e-06	0.00e+00	7.16e-07
BR-83	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.46e+00	0.00e+00	3.10e+00
BR-84	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.99e-16	0.00e+00	2.54e-11
BR-85	0.00e+00							
RB-86	0.00e+00	2.19e+08	0.00e+00	0.00e+00	0.00e+00	4.33e+07	0.00e+00	1.02e+08
RB-88	0.00e+00	3.43e-22	0.00e+00	0.00e+00	0.00e+00	4.74e-33	0.00e+00	1.82e-22
RB-89	0.00e+00	3.96e-26	0.00e+00	0.00e+00	0.00e+00	2.30e-39	0.00e+00	2.79e-26
SR-89	9.95e+09	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.60e+09	0.00e+00	2.86e+08
SR-90	6.05e+11	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.75e+10	0.00e+00	1.48e+11
SR-91	3.03e+05	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.45e+06	0.00e+00	1.23e+04
SR-92	4.24e+02	0.00e+00	0.00e+00	0.00e+00	0.00e+00	8.41e+03	0.00e+00	1.84e+01
Y-90	1.33e+04	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.41e+08	0.00e+00	3.57e+02
Y-91	5.12e+06	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.82e+09	0.00e+00	1.37e+05
Y-91M	5.41e-09	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.59e-08	0.00e+00	2.10e-10
Y-92	9.14e-01	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.60e+04	0.00e+00	2.67e-02
Y-93	1.69e+02	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.35e+06	0.00e+00	4.66e+00
ZR-95	1.18e+06	3.77e+05	0.00e+00	5.92e+05	0.00e+00	1.20e+09	0.00e+00	2.55e+05
ZR-97	3.37e+02	6.80e+01	0.00e+00	1.03e+02	0.00e+00	2.11e+07	0.00e+00	3.11e+01
NB-95	1.42e+05	7.91e+04	0.00e+00	7.82e+04	0.00e+00	4.80e+08	0.00e+00	4.25e+04
MO-99	0.00e+00	6.14e+06	0.00e+00	1.39e+07	0.00e+00	1.42e+07	0.00e+00	1.17e+06
TC-99M	3.10e+00	8.75e+00	0.00e+00	1.33e+02	4.29e+00	5.18e+03	0.00e+00	1.11e+02
TC-101	7.90e-31	1.14e-30	0.00e+00	2.05e-29	5.82e-31	3.42e-42	0.00e+00	1.12e-29
RU-103	4.77e+06	0.00e+00	0.00e+00	1.82e+07	0.00e+00	5.57e+08	0.00e+00	2.05e+06
RU-105	5.36e+01	0.00e+00	0.00e+00	6.93e+02	0.00e+00	3.28e+04	0.00e+00	2.12e+01
RU-106	1.93e+08	0.00e+00	0.00e+00	3.72e+08	0.00e+00	1.25e+10	0.00e+00	2.44e+07
AG-110M	1.05e+07	9.75e+06	0.00e+00	1.92e+07	0.00e+00	3.98e+09	0.00e+00	5.79e+06
TE-125M	9.67e+07	3.50e+07	2.91e+07	3.93e+08	0.00e+00	3.86e+08	0.00e+00	1.30e+07
TE-127	5.73e+03	2.06e+03	4.25e+03	2.33e+04	0.00e+00	4.52e+05	0.00e+00	1.24e+03
TE-127M	3.49e+08	1.25e+08	8.92e+07	1.42e+09	0.00e+00	1.17e+09	0.00e+00	4.26e+07
TE-129	6.94e-04	2.61e-04	5.33e-04	2.92e-03	0.00e+00	5.24e-04	0.00e+00	1.69e-04
TE-129M	2.51e+08	9.37e+07	8.62e+07	1.05e+09	0.00e+00	1.26e+09	0.00e+00	3.97e+07
TE-131	1.51e-15	6.32e-16	1.24e-15	6.63e-15	0.00e+00	2.14e-16	0.00e+00	4.78e-16
TE-131M	9.12e+05	4.46e+05	7.06e+05	4.52e+06	0.00e+00	4.43e+07	0.00e+00	3.72e+05

TABLE 2.2-2d (Continued)

PATHWAY DOSE FACTORS FOR LCO 6.11.6 AND
SECTION 2.2.2.b, (R_i)

Page 6 of 10

Release Type: 2 Gaseous
Dose Factor: 2 Ri (m² * (mrem/yr)/(uCi/cc) or (mrem/yr)/(uCi/m³))
AgeGroup: 0 ADULT
Pathway: 2 Vegetation (VEG)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
TE-132	4.29e+06	2.77e+06	3.06e+06	2.67e+07	0.00e+00	1.31e+08	0.00e+00	2.60e+06
I-130	3.91e+05	1.15e+06	9.78e+07	1.80e+06	0.00e+00	9.93e+05	0.00e+00	4.55e+05
I-131	8.07e+07	1.16e+08	3.79e+10	1.98e+08	0.00e+00	3.05e+07	0.00e+00	6.62e+07
I-132	5.76e+01	1.54e+02	5.40e+03	2.46e+02	0.00e+00	2.90e+01	0.00e+00	5.40e+01
I-133	2.08e+06	3.63e+06	5.33e+08	6.33e+06	0.00e+00	3.26e+06	0.00e+00	1.11e+06
I-134	9.33e-05	2.54e-04	4.39e-03	4.03e-04	0.00e+00	2.21e-07	0.00e+00	9.07e-05
I-135	3.91e+04	1.02e+05	6.75e+06	1.64e+05	0.00e+00	1.16e+05	0.00e+00	3.78e+04
CS-134	4.67e+09	1.11e+10	0.00e+00	3.60e+09	1.19e+09	1.94e+08	0.00e+00	9.08e+09
CS-136	4.27e+07	1.68e+08	0.00e+00	9.37e+07	1.28e+07	1.91e+07	0.00e+00	1.21e+08
CS-137	6.36e+09	8.70e+09	0.00e+00	2.95e+09	9.81e+08	1.68e+08	0.00e+00	5.70e+09
CS-138	3.84e-11	7.58e-11	0.00e+00	5.57e-11	5.50e-12	3.23e-16	0.00e+00	3.75e-11
BA-139	2.86e-02	2.04e-05	0.00e+00	1.91e-05	1.16e-05	5.07e-02	0.00e+00	8.38e-04
BA-140	1.29e+08	1.62e+05	0.00e+00	5.49e+04	9.25e+04	2.65e+08	0.00e+00	8.42e+06
BA-141	1.18e-21	8.95e-25	0.00e+00	8.32e-25	5.08e-25	5.58e-31	0.00e+00	4.00e-23
BA-142	2.43e-39	2.50e-42	0.00e+00	2.11e-42	1.42e-42	3.43e-57	0.00e+00	1.53e-40
LA-140	1.98e+03	9.99e+02	0.00e+00	0.00e+00	0.00e+00	7.33e+07	0.00e+00	2.64e+02
LA-142	2.04e-04	9.27e-05	0.00e+00	0.00e+00	0.00e+00	6.77e-01	0.00e+00	2.31e-05
CE-141	1.97e+05	1.33e+05	0.00e+00	6.19e+04	0.00e+00	5.09e+08	0.00e+00	1.51e+04
CE-143	9.97e+02	7.37e+05	0.00e+00	3.24e+02	0.00e+00	2.75e+07	0.00e+00	8.15e+01
CE-144	3.29e+07	1.38e+07	0.00e+00	8.16e+06	0.00e+00	1.11e+10	0.00e+00	1.77e+06
PR-143	6.27e+04	2.52e+04	0.00e+00	1.45e+04	0.00e+00	2.75e+08	0.00e+00	3.11e+03
PR-144	3.24e-26	1.34e-26	0.00e+00	7.58e-27	0.00e+00	4.66e-33	0.00e+00	1.65e-27
ND-147	3.33e+04	3.85e+04	0.00e+00	2.25e+04	0.00e+00	1.85e+08	0.00e+00	2.30e+03
W-187	3.80e+04	3.18e+04	0.00e+00	0.00e+00	0.00e+00	1.04e+07	0.00e+00	1.11e+04
NP-239	1.43e+03	1.40e+02	0.00e+00	4.37e+02	0.00e+00	2.88e+07	0.00e+00	7.73e+01

TABLE 2.2-2d (Continued)

PATHWAY DOSE FACTORS FOR LCO 6.11.6 AND
SECTION 2.2.2.b, (R_i)

Page 7 of 10

Release Type: 2 Gaseous
Dose Factor: 2 R_i (m² * (mrem/yr)/(uCi/cc) or (mrem/yr)/(uCi/m³))
AgeGroup: 0 ADULT
Pathway: 4 Grs/Cow/Meat (CMEAT)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
H-3	0.00e+00	3.25e+02	3.25e+02	3.25e+02	3.25e+02	3.25e+02	0.00e+00	3.25e+02
C-14	2.41e+08	4.83e+07	4.83e+07	4.83e+07	4.83e+07	4.83e+07	0.00e+00	4.83e+07
NA-24	1.45e-03	1.45e-03	1.45e-03	1.45e-03	1.45e-03	1.45e-03	0.00e+00	1.45e-03
P-32	4.65e+09	2.89e+08	0.00e+00	0.00e+00	0.00e+00	5.23e+08	0.00e+00	1.80e+08
CR-51	0.00e+00	0.00e+00	4.21e+03	1.55e+03	9.34e+03	1.77e+06	0.00e+00	7.04e+03
MN-54	0.00e+00	9.18e+06	0.00e+00	2.73e+06	0.00e+00	2.81e+07	0.00e+00	1.75e+06
MN-56	0.00e+00	1.44e-53	0.00e+00	1.83e-53	0.00e+00	4.60e-52	0.00e+00	2.56e-54
FE-55	2.93e+08	2.03e+08	0.00e+00	0.00e+00	1.13e+08	1.16e+08	0.00e+00	4.73e+07
FE-59	2.65e+08	6.24e+08	0.00e+00	0.00e+00	1.74e+08	2.08e+09	0.00e+00	2.39e+08
CO-58	0.00e+00	1.83e+07	0.00e+00	0.00e+00	0.00e+00	3.70e+08	0.00e+00	4.09e+07
CO-60	0.00e+00	7.52e+07	0.00e+00	0.00e+00	0.00e+00	1.41e+09	0.00e+00	1.66e+08
NI-63	1.89e+10	1.31e+09	0.00e+00	0.00e+00	0.00e+00	2.73e+08	0.00e+00	6.33e+08
NI-65	2.27e-52	2.94e-53	0.00e+00	0.00e+00	0.00e+00	7.47e-52	0.00e+00	1.34e-53
CU-64	0.00e+00	2.52e-07	0.00e+00	6.36e-07	0.00e+00	2.15e-05	0.00e+00	1.18e-07
ZN-65	3.56e+08	1.13e+09	0.00e+00	7.57e+08	0.00e+00	7.13e+08	0.00e+00	5.12e+08
ZN-69	0.00e+00							
BR-83	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	8.08e-57	0.00e+00	5.61e-57
BR-84	0.00e+00							
BR-85	0.00e+00							
RB-86	0.00e+00	4.87e+08	0.00e+00	0.00e+00	0.00e+00	9.60e+07	0.00e+00	2.27e+08
RB-88	0.00e+00							
RB-89	0.00e+00							
SR-89	3.01e+08	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.83e+07	0.00e+00	8.65e+06
SR-90	1.24e+10	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.59e+08	0.00e+00	3.05e+09
SR-91	1.43e-10	0.00e+00	0.00e+00	0.00e+00	0.00e+00	6.83e-10	0.00e+00	5.79e-12
SR-92	1.08e-49	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.13e-48	0.00e+00	4.66e-51
Y-90	1.08e+02	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.15e+06	0.00e+00	2.91e+00
Y-91	1.13e+06	0.00e+00	0.00e+00	0.00e+00	0.00e+00	6.23e+08	0.00e+00	3.03e+04
Y-91M	0.00e+00							
Y-92	1.49e-39	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.61e-35	0.00e+00	4.36e-41
Y-93	4.39e-12	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.39e-07	0.00e+00	1.21e-13
ZR-95	1.87e+06	6.01e+05	0.00e+00	9.43e+05	0.00e+00	1.91e+09	0.00e+00	4.07e+05
ZR-97	2.04e-05	4.12e-06	0.00e+00	6.22e-06	0.00e+00	1.27e+00	0.00e+00	1.88e-06
NB-95	2.30e+06	1.28e+06	0.00e+00	1.26e+06	0.00e+00	7.75e+09	0.00e+00	6.87e+05
MO-99	0.00e+00	9.93e+04	0.00e+00	2.25e+05	0.00e+00	2.30e+05	0.00e+00	1.89e+04
TC-99M	4.32e-21	1.22e-20	0.00e+00	1.86e-19	5.98e-21	7.23e-18	0.00e+00	1.56e-19
TC-101	0.00e+00							
RU-103	1.05e+08	0.00e+00	0.00e+00	4.01e+08	0.00e+00	1.23e+10	0.00e+00	4.53e+07
RU-105	5.43e-28	0.00e+00	0.00e+00	7.02e-27	0.00e+00	3.32e-25	0.00e+00	2.15e-28
RU-106	2.80e+09	0.00e+00	0.00e+00	5.40e+09	0.00e+00	1.81e+11	0.00e+00	3.54e+08
AG-110M	6.68e+06	6.18e+06	0.00e+00	1.22e+07	0.00e+00	2.52e+09	0.00e+00	3.67e+06
TE-125M	3.59e+08	1.30e+08	1.08e+08	1.46e+09	0.00e+00	1.43e+09	0.00e+00	4.81e+07
TE-127	2.50e-10	8.98e-11	1.85e-10	1.02e-09	0.00e+00	1.97e-08	0.00e+00	5.41e-11
TE-127M	1.12e+09	3.99e+08	2.85e+08	4.53e+09	0.00e+00	3.74e+09	0.00e+00	1.36e+08
TE-129	0.00e+00							
TE-129M	1.13e+09	4.23e+08	3.89e+08	4.73e+09	0.00e+00	5.71e+09	0.00e+00	1.79e+08
TE-131	0.00e+00							
TE-131M	4.49e+02	2.20e+02	3.48e+02	2.23e+03	0.00e+00	2.18e+04	0.00e+00	1.83e+02

TABLE 2.2-2d (Continued)

PATHWAY DOSE FACTORS FOR LCO 6.11.6 AND
SECTION 2.2.2.b, (R_i)

Page 8 of 10

Release Type: 2 Gaseous
Dose Factor: 2 R_i (m² * (mrem/yr)/(uCi/cc) or (mrem/yr)/(uCi/m³))
AgeGroup: 0 ADULT
Pathway: 4 Grs/Cow/Meat (CMEAT)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
TE-132	1.40e+06	9.03e+05	9.98e+05	8.70e+06	0.00e+00	4.27e+07	0.00e+00	8.48e+05
I-130	2.03e-06	5.98e-06	5.07e-04	9.33e-06	0.00e+00	5.15e-06	0.00e+00	2.36e-06
I-131	1.07e+07	1.54e+07	5.03e+09	2.63e+07	0.00e+00	4.05e+06	0.00e+00	8.80e+06
I-132	7.13e-59	1.91e-58	6.68e-57	3.04e-58	0.00e+00	3.58e-59	0.00e+00	6.68e-59
I-133	3.63e-01	6.31e-01	9.28e+01	1.10e+00	0.00e+00	5.68e-01	0.00e+00	1.93e-01
I-134	0.00e+00							
I-135	4.66e-17	1.22e-16	8.04e-15	1.96e-16	0.00e+00	1.38e-16	0.00e+00	4.50e-17
CS-134	6.58e+08	1.57e+09	0.00e+00	5.07e+08	1.68e+08	2.74e+07	0.00e+00	1.28e+09
CS-136	1.20e+07	4.75e+07	0.00e+00	2.65e+07	3.63e+06	5.40e+06	0.00e+00	3.42e+07
CS-137	8.72e+08	1.19e+09	0.00e+00	4.05e+08	1.35e+08	2.31e+07	0.00e+00	7.81e+08
CS-138	0.00e+00							
BA-139	0.00e+00							
BA-140	2.88e+07	3.61e+04	0.00e+00	1.23e+04	2.07e+04	5.92e+07	0.00e+00	1.88e+06
BA-141	0.00e+00							
BA-142	0.00e+00							
LA-140	3.76e-02	1.90e-02	0.00e+00	0.00e+00	0.00e+00	1.39e+03	0.00e+00	5.01e-03
LA-142	4.06e-92	1.85e-92	0.00e+00	0.00e+00	0.00e+00	1.35e-88	0.00e+00	4.60e-93
CE-141	1.40e+04	9.50e+03	0.00e+00	4.41e+03	0.00e+00	3.63e+07	0.00e+00	1.08e+03
CE-143	1.99e-02	1.47e+01	0.00e+00	6.47e-03	0.00e+00	5.49e+02	0.00e+00	1.62e-03
CE-144	1.46e+06	6.09e+05	0.00e+00	3.62e+05	0.00e+00	4.93e+08	0.00e+00	7.83e+04
PR-143	2.10e+04	8.42e+03	0.00e+00	4.86e+03	0.00e+00	9.20e+07	0.00e+00	1.04e+03
PR-144	0.00e+00							
ND-147	7.06e+03	8.16e+03	0.00e+00	4.77e+03	0.00e+00	3.92e+07	0.00e+00	4.88e+02
W-187	2.07e-02	1.73e-02	0.00e+00	0.00e+00	0.00e+00	5.66e+00	0.00e+00	6.04e-03
NP-239	2.57e-01	2.53e-02	0.00e+00	7.90e-02	0.00e+00	5.19e+03	0.00e+00	1.40e-02

TABLE 2.2-2d (Continued)

PATHWAY DOSE FACTORS FOR LCO 6.11.6 AND
SECTION 2.2.2.b, (R_i)

Page 9 of 10

Release Type: 2 Gaseous
Dose Factor: 2 R_i (m² * (mrem/yr)/(uCi/cc) or (mrem/yr)/(uCi/m³))
AgeGroup: 0 ADULT
Pathway: 5 Grs/Cow/Milk (CMILK)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
H-3	0.00e+00	7.63e+02	7.63e+02	7.63e+02	7.63e+02	7.63e+02	0.00e+00	7.63e+02
C-14	2.63e+08	5.27e+07	5.27e+07	5.27e+07	5.27e+07	5.27e+07	0.00e+00	5.27e+07
NA-24	2.46e+06	2.46e+06	2.46e+06	2.46e+06	2.46e+06	2.46e+06	0.00e+00	2.46e+06
P-32	1.71e+10	1.06e+09	0.00e+00	0.00e+00	0.00e+00	1.92e+09	0.00e+00	6.60e+08
CR-51	0.00e+00	0.00e+00	1.71e+04	6.29e+03	3.79e+04	7.18e+06	0.00e+00	2.86e+04
MN-54	0.00e+00	8.41e+06	0.00e+00	2.50e+06	0.00e+00	2.58e+07	0.00e+00	1.61e+06
MN-56	0.00e+00	4.13e-03	0.00e+00	5.24e-03	0.00e+00	1.32e-01	0.00e+00	7.32e-04
FE-55	2.51e+07	1.74e+07	0.00e+00	0.00e+00	9.68e+06	9.95e+06	0.00e+00	4.05e+06
FE-59	2.97e+07	6.98e+07	0.00e+00	0.00e+00	1.95e+07	2.33e+08	0.00e+00	2.68e+07
CO-58	0.00e+00	4.72e+06	0.00e+00	0.00e+00	0.00e+00	9.56e+07	0.00e+00	1.06e+07
CO-60	0.00e+00	1.64e+07	0.00e+00	0.00e+00	0.00e+00	3.08e+08	0.00e+00	3.62e+07
NI-63	6.73e+09	4.66e+08	0.00e+00	0.00e+00	0.00e+00	9.73e+07	0.00e+00	2.26e+08
NI-65	3.70e-01	4.81e-02	0.00e+00	0.00e+00	0.00e+00	1.22e+00	0.00e+00	2.20e-02
CU-64	0.00e+00	2.36e+04	0.00e+00	5.95e+04	0.00e+00	2.01e+06	0.00e+00	1.11e+04
ZN-65	1.37e+09	4.37e+09	0.00e+00	2.92e+09	0.00e+00	2.75e+09	0.00e+00	1.97e+09
ZN-69	2.01e-12	3.84e-12	0.00e+00	2.50e-12	0.00e+00	5.78e-13	0.00e+00	2.67e-13
BR-83	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.39e-01	0.00e+00	9.65e-02
BR-84	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.33e-28	0.00e+00	1.69e-23
BR-85	0.00e+00							
RB-86	0.00e+00	2.60e+09	0.00e+00	0.00e+00	0.00e+00	5.12e+08	0.00e+00	1.21e+09
RB-88	0.00e+00	2.14e-45	0.00e+00	0.00e+00	0.00e+00	2.96e-56	0.00e+00	1.14e-45
RB-89	0.00e+00	4.50e-53	0.00e+00	0.00e+00	0.00e+00	2.61e-66	0.00e+00	3.16e-53
SR-89	1.45e+09	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.33e+08	0.00e+00	4.16e+07
SR-90	4.68e+10	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.35e+09	0.00e+00	1.15e+10
SR-91	2.87e+04	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.37e+05	0.00e+00	1.16e+03
SR-92	4.84e-01	0.00e+00	0.00e+00	0.00e+00	0.00e+00	9.58e+00	0.00e+00	2.09e-02
Y-90	7.10e+01	0.00e+00	0.00e+00	0.00e+00	0.00e+00	7.52e+05	0.00e+00	1.90e+00
Y-91	8.59e+03	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.73e+06	0.00e+00	2.30e+02
Y-91M	6.42e-20	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.89e-19	0.00e+00	2.49e-21
Y-92	5.57e-05	0.00e+00	0.00e+00	0.00e+00	0.00e+00	9.75e-01	0.00e+00	1.63e-06
Y-93	2.22e-01	0.00e+00	0.00e+00	0.00e+00	0.00e+00	7.03e+03	0.00e+00	6.12e-03
ZR-95	9.44e-02	3.03e+02	0.00e+00	4.75e+02	0.00e+00	9.59e+05	0.00e+00	2.05e+02
ZR-97	4.32e-01	8.72e-02	0.00e+00	1.32e-01	0.00e+00	2.70e+04	0.00e+00	3.99e-02
NB-95	8.25e+04	4.59e+04	0.00e+00	4.54e+04	0.00e+00	2.79e+08	0.00e+00	2.47e+04
MO-99	0.00e+00	2.47e+07	0.00e+00	5.60e+07	0.00e+00	5.73e+07	0.00e+00	4.71e+06
TC-99M	3.31e+00	9.35e+00	0.00e+00	1.42e+02	4.58e+00	5.53e+03	0.00e+00	1.19e+02
TC-101	2.40e-60	3.46e-60	0.00e+00	6.22e-59	1.77e-60	1.04e-71	0.00e+00	3.39e-59
RU-103	1.02e+03	0.00e+00	0.00e+00	3.88e+03	0.00e+00	1.19e+05	0.00e+00	4.39e+02
RU-105	8.51e-04	0.00e+00	0.00e+00	1.10e-02	0.00e+00	5.20e-01	0.00e+00	3.36e-04
RU-106	2.04e+04	0.00e+00	0.00e+00	3.94e+04	0.00e+00	1.32e+06	0.00e+00	2.58e+03
AG-110M	5.82e+07	5.39e+07	0.00e+00	1.06e+08	0.00e+00	2.20e+10	0.00e+00	3.20e+07
TE-125M	1.63e+07	5.91e+06	4.90e+06	6.53e+07	0.00e+00	6.51e+07	0.00e+00	2.18e+06
TE-127	6.66e+02	2.39e+02	4.94e+02	2.71e+03	0.00e+00	5.26e+04	0.00e+00	1.44e+02
TE-127M	4.58e+07	1.64e+07	1.17e+07	1.86e+08	0.00e+00	1.54e+08	0.00e+00	5.58e+06
TE-129	2.35e-10	8.85e-11	1.81e-10	9.89e-10	0.00e+00	1.78e-10	0.00e+00	5.74e-11
TE-129M	6.02e+07	2.25e+07	2.07e+07	2.51e+08	0.00e+00	3.03e+08	0.00e+00	9.52e+06
TE-131	3.66e-33	1.53e-33	3.01e-33	1.61e-32	0.00e+00	5.19e-34	0.00e+00	1.16e-33
TE-131M	3.61e+05	1.76e+05	2.80e+05	1.79e+06	0.00e+00	1.75e+07	0.00e+00	1.47e+05

TABLE 2.2-2d (Continued)

PATHWAY DOSE FACTORS FOR LCO 6.11.6 AND
SECTION 2.2.2.b, (R_i)

Page 10 of 10

Release Type: 2 Gaseous
Dose Factor: 2 Ri (m² * (mrem/yr)/(uCi/cc) or (mrem/yr)/(uCi/m³))
AgeGroup: 0 ADULT
Pathway: 5 Grs/Cow/Milk (CMILK)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
TE-132	2.39e+06	1.55e+06	1.71e+06	1.49e+07	0.00e+00	7.32e+07	0.00e+00	1.45e+06
I-130	4.18e+05	1.23e+06	1.05e+08	1.92e+06	0.00e+00	1.06e+06	0.00e+00	4.86e+05
I-131	2.96e+08	4.23e+08	1.39e+11	7.26e+08	0.00e+00	1.12e+08	0.00e+00	2.43e+08
I-132	1.65e-01	4.40e-01	1.54e+01	7.02e-01	0.00e+00	8.27e-02	0.00e+00	1.54e-01
I-133	3.87e+06	6.73e+06	9.88e+08	1.17e+07	0.00e+00	6.04e+06	0.00e+00	2.05e+06
I-134	1.89e-12	5.13e-12	8.89e-11	8.15e-12	0.00e+00	4.47e-15	0.00e+00	1.83e-12
I-135	1.29e+04	3.38e+04	2.23e+06	5.42e+04	0.00e+00	3.82e+04	0.00e+00	1.25e+04
CS-134	5.65e+09	1.35e+10	0.00e+00	4.35e+09	1.45e+09	2.35e+08	0.00e+00	1.10e+10
CS-136	2.63e+08	1.04e+09	0.00e+00	5.78e+08	7.92e+07	1.18e+08	0.00e+00	7.48e+08
CS-137	7.38e+09	1.01e+10	0.00e+00	3.43e+09	1.14e+09	1.95e+08	0.00e+00	6.61e+09
CS-138	8.69e-24	1.72e-23	0.00e+00	1.26e-23	1.25e-24	7.32e-29	0.00e+00	8.50e-24
BA-139	4.43e-08	3.16e-11	0.00e+00	2.95e-11	1.79e-11	7.86e-08	0.00e+00	1.30e-09
BA-140	2.69e+07	3.38e+04	0.00e+00	1.15e+04	1.93e+04	5.54e+07	0.00e+00	1.76e+06
BA-141	4.33e-46	3.27e-49	0.00e+00	3.04e-49	1.86e-49	2.04e-55	0.00e+00	1.46e-47
BA-142	4.41e-81	4.53e-84	0.00e+00	3.83e-84	2.57e-84	0.00e+00	0.00e+00	2.77e-82
LA-140	4.52e+00	2.28e+00	0.00e+00	0.00e+00	0.00e+00	1.67e+05	0.00e+00	6.03e-01
LA-142	1.89e-11	8.60e-12	0.00e+00	0.00e+00	0.00e+00	6.28e-08	0.00e+00	2.14e-12
CE-141	4.84e+03	3.28e+03	0.00e+00	1.52e+03	0.00e+00	1.25e+07	0.00e+00	3.72e+02
CE-143	4.15e+01	3.07e+04	0.00e+00	1.35e+01	0.00e+00	1.15e+06	0.00e+00	3.39e+00
CE-144	3.58e+05	1.50e+05	0.00e+00	8.87e+04	0.00e+00	1.21e+08	0.00e+00	1.92e+04
PR-143	1.58e+02	6.34e+01	0.00e+00	3.66e+01	0.00e+00	6.92e+05	0.00e+00	7.83e+00
PR-144	6.45e-54	2.68e-54	0.00e+00	1.51e-54	0.00e+00	9.28e-61	0.00e+00	3.28e-55
ND-147	9.41e+01	1.09e+02	0.00e+00	6.36e+01	0.00e+00	5.22e+05	0.00e+00	6.51e+00
W-187	6.51e+03	5.45e+03	0.00e+00	0.00e+00	0.00e+00	1.78e+06	0.00e+00	1.90e+03
NP-239	3.67e+00	3.61e-01	0.00e+00	1.13e+00	0.00e+00	7.40e+04	0.00e+00	1.99e-01

Units: Inhalation₂ and all tritium pathways - mrem/yr per $\mu\text{Ci}/\text{m}^3$
Others - m² . mrem/yr per $\mu\text{Ci}/\text{sec}$

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

TABLE 2.2-3

CONTROLLING RECEPTORS, LOCATIONS, AND ATMOSPHERIC DISPERSION PARAMETERS*
for LCO 6.11.5, 6.11.6, AND 6.11.8

SECTOR	DIRECTION	NEAREST RESIDENCE, MILES**	D/Q	x/Q	NEAREST GARDEN, MILES**	D/Q
A	N	1.2	5.50E-9	2.88E-6	1.8	2.74E-9
B	NNE	1.2	3.80E-9	1.90E-6	>5	N/A
C	NE	0.7	6.1E-9	2.30E-6	0.7	6.1E-9
D	ENE	1.2	2.67E-9	9.46E-7	3.2	3.96E-10
E	E	0.8	2.96E-9	1.17E-6	0.9	2.96E-09
F	ESE	2.3	6.5E-10	2.57E-7	4.9	1.55E-10
G	SE	2.1	7.7E-10	3.10E-7	4.0	2.36E-10
H	SSE	1.1	4.1E-9	1.50E-6	>5	N/A
J	S	2.9	1.06E-9	6.57E-7	2.9	1.06E-9
K	SSW	2.2	1.3E-9	1.40E-6	2.2	1.3E-9
L	SW	0.89	6.7E-9	8.30E-6	0.89	6.7E-9
M	WSW	>5	N/A	N/A	>5	N/A
N	W	>5	N/A	N/A	>5	N/A
P	WNW	>5	N/A	N/A	>5	N/A
Q	NW	>5	N/A	N/A	>5	N/A
R	NNW	1.1	3.6E-9	2.60E-6	1.1	3.6E-9

Table 2.2-3 based on 1999 Land Use Census, onsite gardens are not considered for the Land Use Census.

The most limiting age group, child, is assumed.

* Values from ODCM Reference 9.

** Distances shown are actual miles in each sector. In cases where dispersion parameters were not available for a location they were taken from the closest distance interval to the plant.

N/A: No residence/garden within 5 miles.

TABLE 2.2-3a

SITE BOUNDARY ATMOSPHERIC DISPERSION PARAMETERS*
for LCO 6.11.4

SECTOR	DIRECTION	SITE BOUNDARY DISTANCE, MILES**	x/Q	D/Q
A	N	0.79	4.1E-6	8.2E-9
B	NNE	0.66	3.6E-6	7.7E-9
C	NE	0.63	2.5E-6	6.6E-9
D	ENE	0.63	2.0E-6	5.8E-9
E	E	0.55	1.9E-6	4.9E-9
F	ESE	0.55	2.0E-6	5.9E-9
G	SE	0.51	2.8E-6	8.2E-9
H	SSE	0.46	5.6E-6	1.6E-8
J	S	0.61	5.8E-6	1.2E-8
K	SSW	0.65	8.4E-6	1.0E-8
L	SW	0.85	8.9E-6	7.2E-9
M	WSW	1.07	8.4E-6	5.1E-9
N	W	1.14	5.4E-6	3.4E-9
P	WNW	1.34	2.6E-6	1.9E-9
Q	NW	1.37	1.6E-6	1.6E-9
R	NNW	1.02	2.8E-6	4.0E-9

The most limiting age group, infant, is assumed.

* Values from ODCM Reference 9.

** Distances shown are actual miles in each sector.

TABLE 2.2-3b

ADDITIONAL RECEPTOR LOCATIONS WITHIN THE SITE BOUNDARY

SECTOR	DIRECTION	MILES	DESCRIPTION	x/Q*	D/Q*
B	NNE	0.5	Recreational Vehicle Laydown Area	5.438E-6	1.204E-8
R	NNW	0.5	Energy Services Center ¹	8.422E-6	1.310E-8
Q	NW	0.75	Gin Lake ¹	3.958E-6	4.531E-9
P	WNW	0.75	Hamilton Lake ¹	6.266E-6	5.215E-9

¹These locations occupy multiple sectors. In each case the SITE BOUNDARY locations used in the dose calculation was limiting.

*Values from ODCM Reference 9

2.3 Meteorological Model

2.3.1 Atmospheric Dispersion

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

$$X/Q = \frac{2.03 \delta k}{ru\Sigma}$$

where:

- r = distance (m) from release point to location of interest
- δ = plume depletion factor at distance r from ODCM Figure 2.3-1
- u = wind speed at ground level (m/sec)
- k = open terrain recirculation factor at distance r, from ODCM Figure 2.3-4 (not used)
- Σ = the lesser of $(\sigma^2 + \frac{b^2}{\pi})^{1/2}$ 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 T, from ODCM Figure 2.3-2
- T = temperature differential with vertical separation ($^{\circ}\text{K}/100\text{m}$)
- b = height of the reactor building = 53.3m

2.3.2 Deposition

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

$$\begin{aligned} D/Q &= \text{relative deposition per unit area (m}^{-2}\text{)} \\ &= \frac{2.55}{r} (D_g) \end{aligned}$$

where:

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

X/Q and D/Q values were calculated using the methodology of NUREG/CR-2919 "XOQDOQ: Computer Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations".

GGNS gaseous releases are ground level.

Additional information on the X/Q and D/Q calculations can be found in ODCM References 9 and 10.

"TEXT DELETED"

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 $\mu\text{Ci/ml}$ 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 radio-nuclide i (mrad) (2.2.2.a)
- D _{γ} = air dose due to gamma emissions from noble gas radio-nuclide i (mrad) (2.2.2.a)
- D/Q = relative deposition per unit area (m^{-2}) (2.3.2)
- σ = 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 ^89Kr , the most restrictive isotope (mrem/yr per $\mu\text{Ci}/\text{m}^3$), from Table 2.1-1 (2.1.2)
- K_i = total body dose factor due to gamma emissions from isotope i (mrem/yr per $\mu\text{Ci}/\text{m}^3$) 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)
- L = skin dose factor for ^89Kr , the most restrictive isotope (mrem/yr per $\mu\text{Ci}/\text{m}^3$) from Table 2.1-1 (2.1.2)
- L_i = skin dose factor due to beta emissions from isotope i (mrem/yr per $\mu\text{Ci}/\text{m}^3$), from Table 2.1-1 (2.1.1)
- M = air dose factor for ^89Kr , the most restrictive isotope (mrad/yr per $\mu\text{Ci}/\text{m}^3$) from Table 2.1-1 (2.1.2)
- M_i = air dose factor due to gamma emissions from isotope i (mrad/yr per $\mu\text{Ci}/\text{m}^3$) 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 $\mu\text{Ci}/\text{m}^3$) from Table 2.1-1 (2.2.2.a)
- P_i = dose parameter for radionuclide i , (mrem/yr per $\mu\text{Ci}/\text{m}^3$) for inhalation from (m² mrem/yr per $\mu\text{Ci}/\text{sec}$) for other pathways, from Table 2.2-1 (2.2.1.b).
- Q_i' = rate of release of noble gas radionuclide i ($\mu\text{Ci}/\text{sec}$) (2.1.1)
- \overline{Q}_i' = average release rate for the current year ($\mu\text{Ci}/\text{sec}$) of isotope i of tritium, I-131, I-133 or other radionuclide in particulate form, with half-life greater than eight (8) days (2.2.1.b)
- Q_i = cumulative release of radionuclide i of noble gas, tritium, I-131, I-133, or material in particulate form over the period of interest (μCi) (2.2.2.a) (2.2.2.b)

2.4 Definitions of Gaseous Effluents Parameters (Continued)

- $\overline{Q''}_i$ = assigned release rate value of, for example, 1.0 $\mu\text{Ci}/\text{sec}$, Xe-133; related to definition of C' for the vent. (Note 3)
- R_i = dose factor for radionuclide i, (mrem/yr per $\mu\text{Ci}/\text{m}^3$) or ($\text{m}^2 \cdot \text{mrem}/\text{yr}$ per $\mu\text{Ci}/\text{sec}$)
- 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. (2.1.2)
- r = distance (m) from release point to location of interest for dispersion calculation. (2.3.1)

2.4 Definitions of Gaseous Effluents Parameters (Continued)

- S_v = count rate of station vent noble gas monitor at alarm setpoint level. (2.1.1)
- Σ = 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 ($^{\circ}\text{K}/100\text{m}$). (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/m^3). (2.2.1.b)
- W' = relative concentration for unrestricted areas (sec/m^3). (2.2.2.b)
- X/Q = atmospheric dispersion (sec/m^3) (2.3.1)
- $\overline{X/Q}$ = highest sector annual average atmospheric dispersion at the unrestricted area boundary (sec/m^3) (2.1.1)
- $\overline{X/Q}'$ = relative concentration for unrestricted areas (sec/m^3) (2.2.2.a)

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

Graph taken from Reference 7, Figure 2

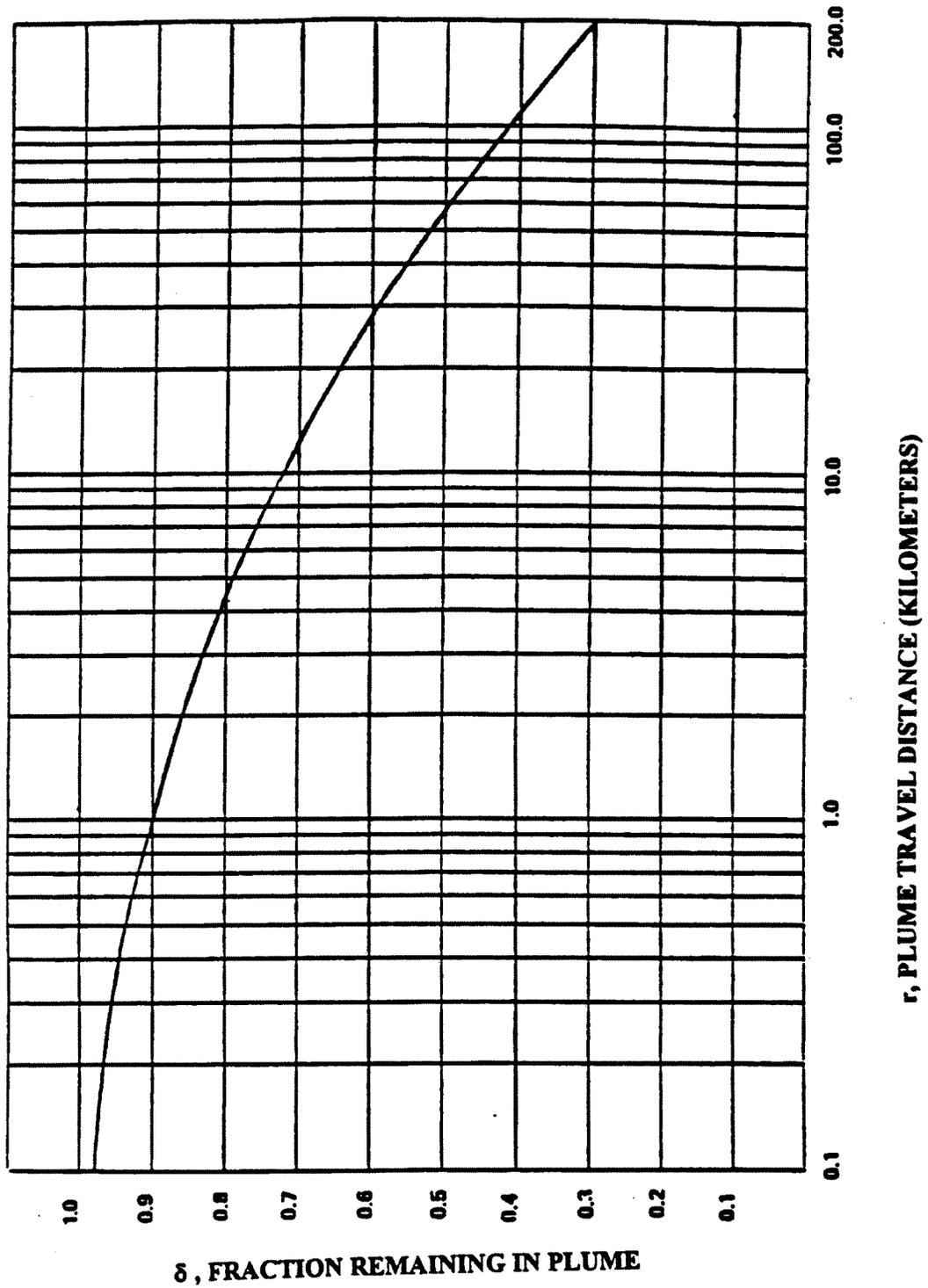
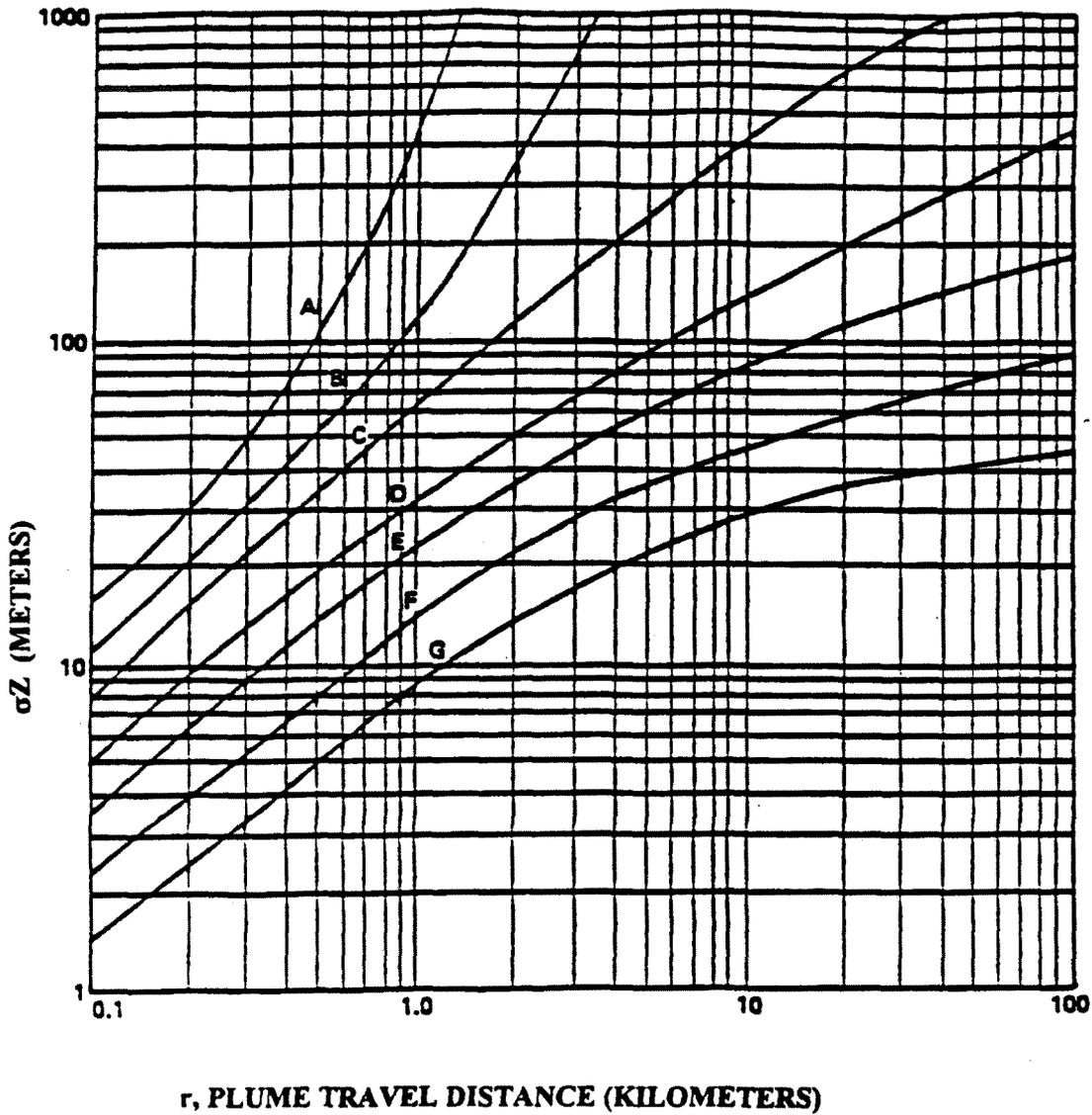


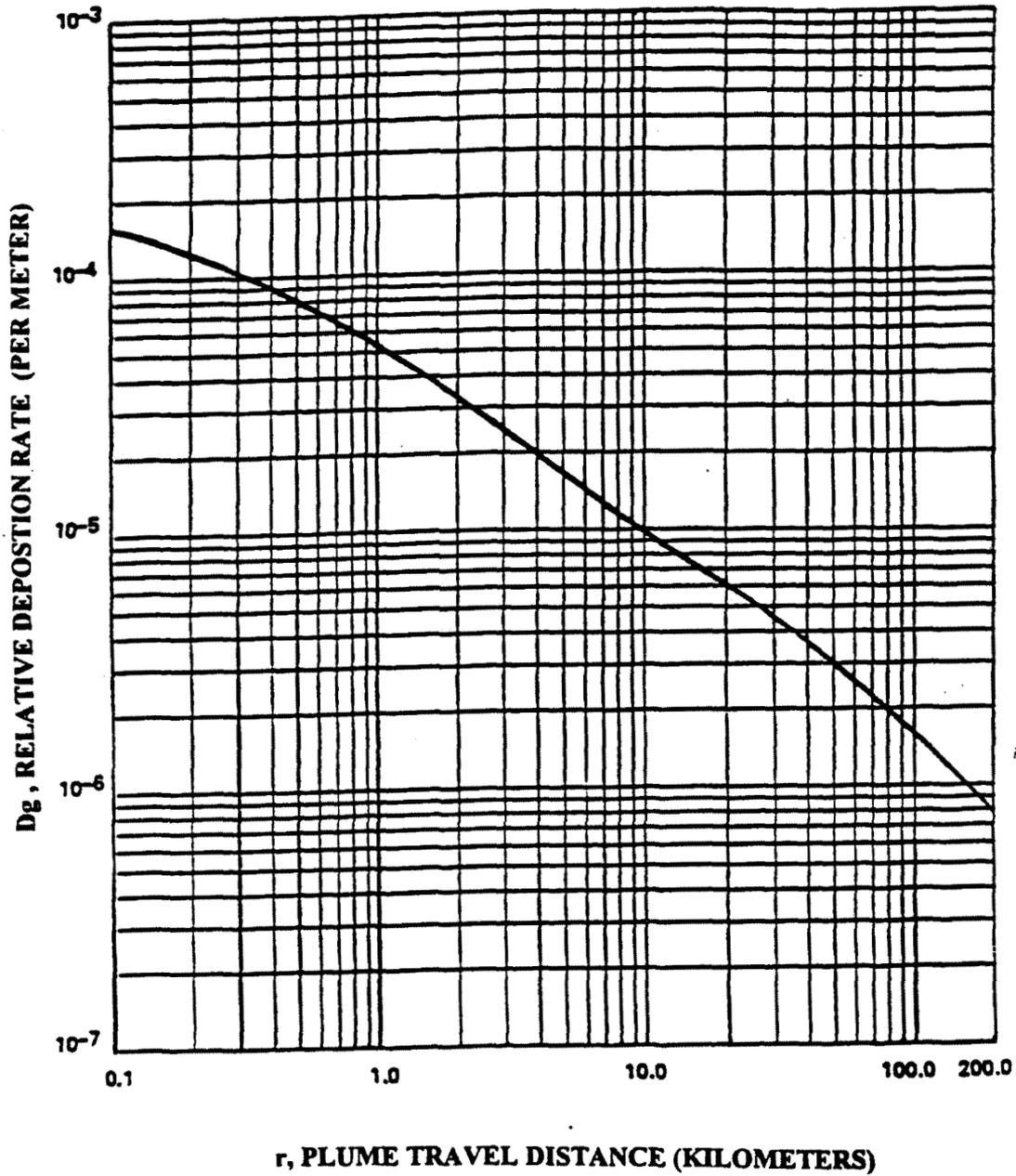
Figure 2.3-2
Vertical Standard Deviation of Material in a Plume
 (Letters denote Pasquill Stability Class)



Temperature Change with Height (T) (°K/100m)	Pasquill Category	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

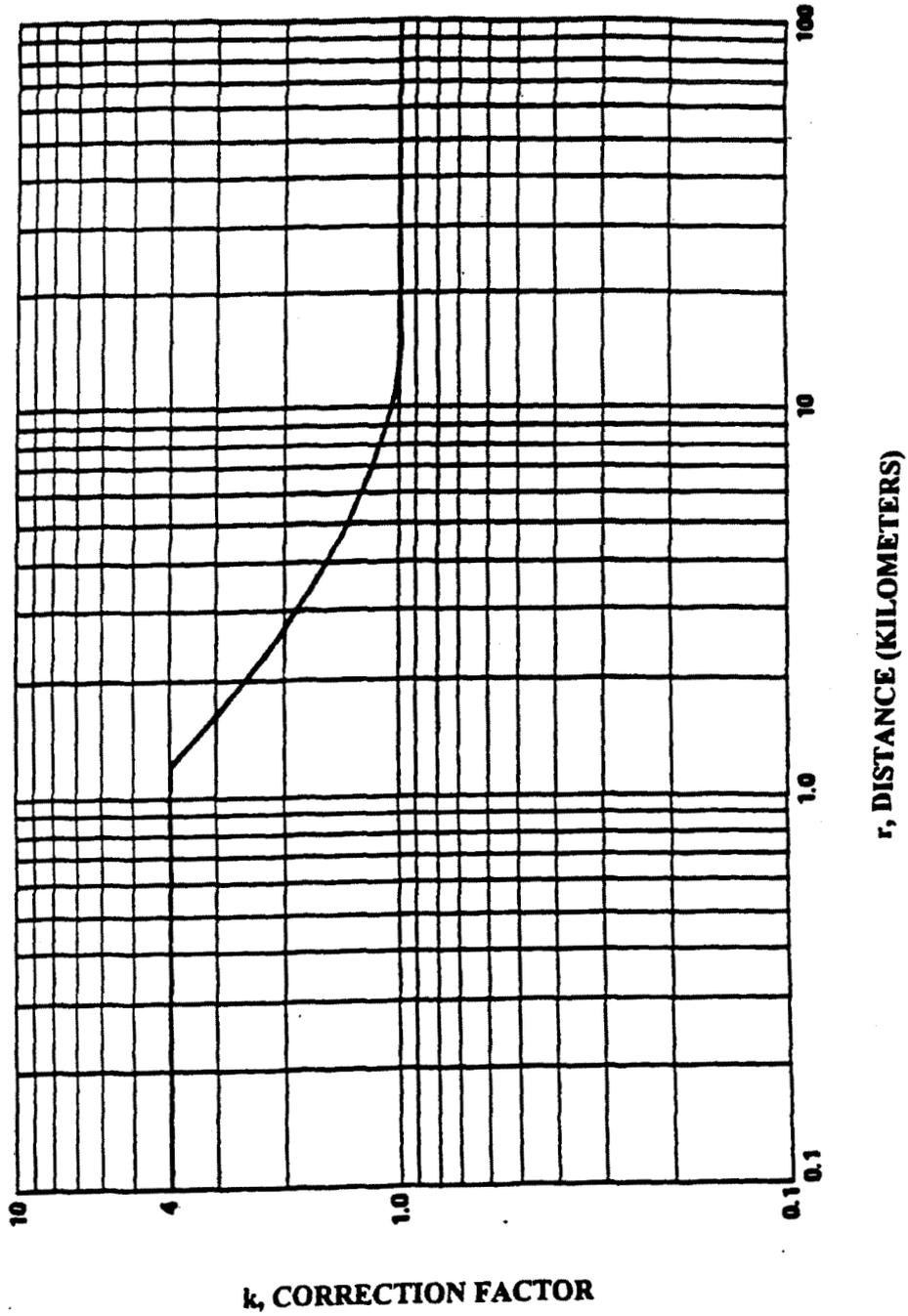
Graph taken from Reference 7, Figure 1

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



Graph taken from Reference 7, Figure 6

Figure 2.3-4 Open Terrain Recirculation Factor



Graph taken from Reference 6, Figure 2

2.5 Gaseous Radwaste Treatment System

The instruments required to be checked by LCO 6.11.7 to ensure that the GASEOUS RADWASTE TREATMENT (Offgas) SYSTEM is functioning are:

1. Adsorber train bypass switch (1N64-HS-M611)
2. Bypass valve indication (1N64-F045)

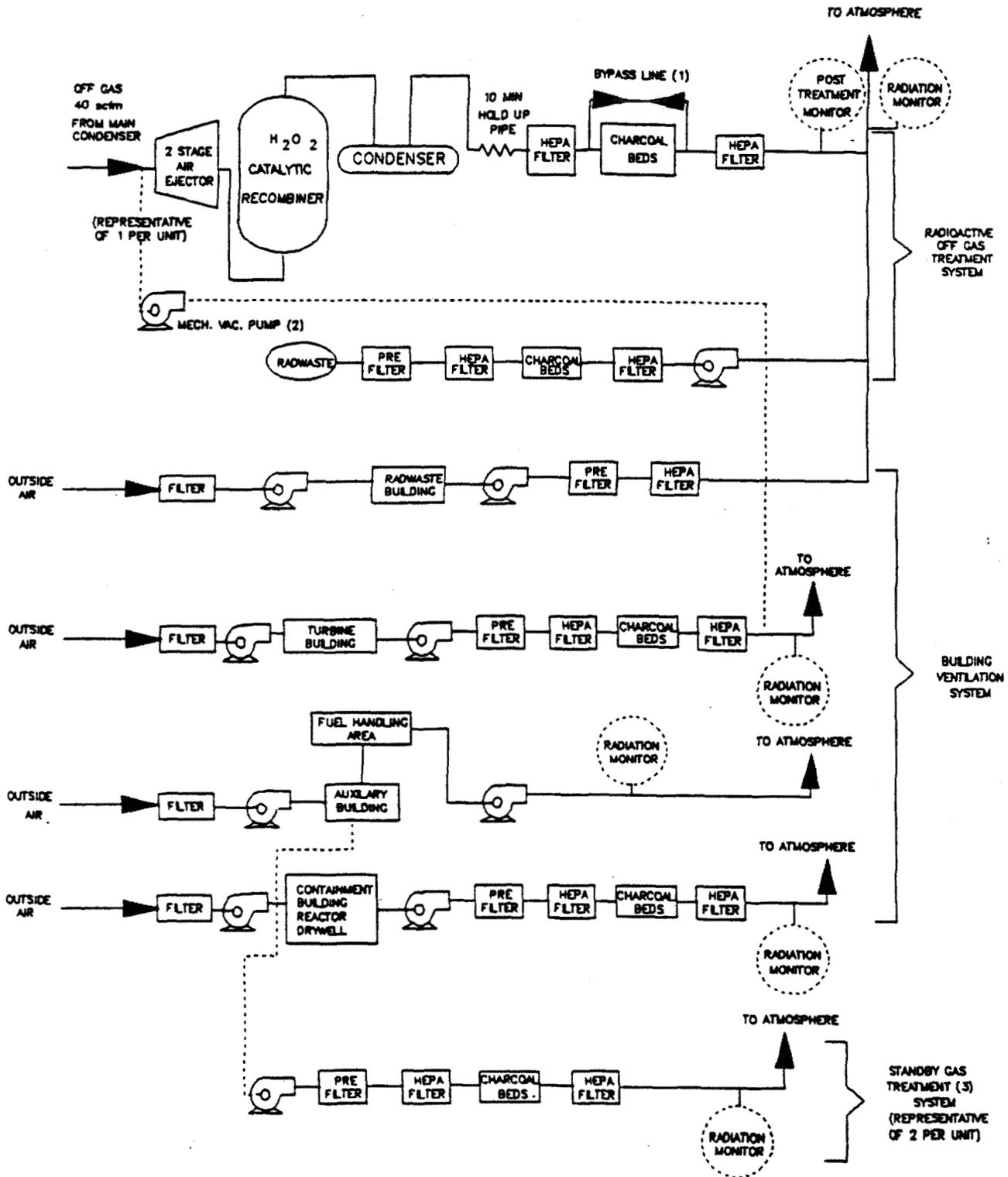
When the adsorber train bypass switch is in the TREAT position and the bypass valve indicates closed, the GASEOUS RADWASTE TREATMENT (Offgas) SYSTEM is functioning.

NOTES for ODCM Figure 2.5-1

A flow diagram for the Gaseous Radwaste Treatment System is provided on the following page. Notes for the diagram are listed below.

- (1) The charcoal beds are bypassed during startup until an adequate dewpoint is obtained in the process stream.
- (2) This pathway may be utilized for power levels $\leq 5\%$.
- (3) Standby Gas Treatment System not normally operated.

Figure 2.5-1
Gaseous Radwaste Treatment System



2.6 Annual Dose Commitment

If required, the annual (calendar year) dose or dose commitment to any MEMBER OF THE PUBLIC will be calculated by summing the following doses for the calendar year:

- Direct radiation dose
- Liquid effluent dose (D_{Tau})
- Noble gas dose (D_{γ} , D_{β})
- Particulate dose (D_p)

These calculations are required only if the liquid or gaseous effluents exceed twice the limits of LCOs 6.11.2, 6.11.5 and 6.11.6.

2.6.1 Direct Radiation Dose Measurement

LCOs 6.11.2, 6.11.5 and 6.11.6 require the determination of cumulative dose contributions to a MEMBER OF THE PUBLIC from direct radiation from the reactor units and from radwaste storage tanks. This requirement is applicable only under conditions set forth in Action B.1 of the applicable LCO. This determination is made by the utilization of direct radiation measurements from indicator thermoluminescent dosimeters (TLDs) located near the GGNS property line in eight of the 16 meteorological sectors.

Measurements from these TLDs represent the direct radiation generated by the facility plus normal background radiation. The locations are identified in ODCM Table 3.0-3 by the following TLD numbers:

M-16	M-22	M-23
M-19	M-25	M-17
M-21	M-28	

Control TLDs are also utilized to differentiate between background radiation and direct radiation from the facility. The following two TLDs are designated as controls based on the criterion that they are located ten miles or greater from the facility. Exact locations are identified in ODCM Table 3.0-3.

M-14

M-33

The difference between the averaged quarterly radiation measurements of the indicator TLDs and the control TLDs represents the direct radiation dose to a MEMBER OF THE PUBLIC from the operating facility.

3.0 RADIOLOGICAL ENVIRONMENTAL MONITORING

3.1 Sampling Locations

Sampling locations to fulfill the requirements of LCO 6.12.1, as described in ODCM Table 6.12.1-1, are identified in ODCM Tables 3.0-1 through 3.0-3 and shown on maps in ODCM Figures 3.0-1 and 3.0-2.

ODCM

TABLE 3.0-1

AIR SAMPLER COLLECTION SITES

AIR SAMPLERS

<u>NUMBER</u>	<u>FIGURE</u>	<u>LOCATION</u>
AS-1 PG	3.0-2	Southeast of GGNS at the Port Gibson City Barn (Sector G Radius, 5.5 miles)
AS-3 61VA	3.0-2	NNE of GGNS on Hwy. 61, north of the Vicksburg Airport (Sector B Radius, 18 miles)
AS-7 UH	3.0-1	SSE of GGNS at the IBEW Union Hall (Sector H Radius, 0.5 miles)

ODCM

TABLE 3.0-2

MISCELLANEOUS COLLECTION SITES

Page 1 of 2

<u>MILK SAMPLES (CONTROL LOCATION)</u>	<u>FIGURE</u>	
ALCONT	3.0-2	Located SSW of GGNS at Alcorn State University (Sector K Radius 10.5 miles)
 <u>GROUND WATER</u>		
PGWELL	3.0-1	PORT GIBSON WELLS - Taken from distribution system or one of the five wells (Sector G Radius 5.0 miles)
Construction Water Well	3.0-1	GGNS CONSTRUCTION WATER WELL - Taken from distribution system or the well (Sector P Radius 0.4 miles)
 <u>SURFACE WATER</u>		
Upstream	3.0-1	At least 4500 ft upstream of the GGNS discharge point into the Mississippi River to allow adequate mixing of the Mississippi and Big Black Rivers (Sector Q-R, 1.8 miles)
Downstream	3.0-1	At least 5000 ft downstream of the GGNS discharge point into the Mississippi River near Radial Well No. 1 (Sector N, 1.6 miles)
MS River Downstream	3.0-1	Downstream of the GGNS discharge point (during a liquid radwaste discharge) in the Mississippi River near Radial Well No. 5 (Sector Q-P, 1.3 miles)

ODCM

TABLE 3.0-2 (Continued)

MISCELLANEOUS COLLECTION SITES

Page 2 of 2

SEDIMENT SAMPLES

FIGURE

SEDHAM	3.0-1	Downstream of the GGNS discharge point in the Mississippi River near Hamilton Lake outlet (Sector N, 1.6 miles)
SEDCONT	3.0-1	Upstream of the GGNS discharge point in the Mississippi River (Minimum of 100 yds)

VEGETATION

Broadleaf Vegetation	3.0-1	S of GGNS near former Training Center on Bald Hill Road (Sector J, 0.4 miles)
----------------------	-------	-------------------------------------------------------------------------------

NOTE:

The above location is located inside the SITE BOUNDARY. The sampling site exceeds the requirements of LCO 6.12.1.

Alcorn State University SSW of GGNS (Sector K, 10.5 miles) when available, otherwise a location 15-30 km distant

FISH SAMPLES

Fish and Invertebrates

Downstream of the GGNS discharge point into the Mississippi River

Upstream of the GGNS discharge point into the Mississippi River uninfluenced by plant operations

ODCM

TABLE 3.0-3

TLD LOCATIONS

Page 1 of 2

<u>TLD NO.</u>	<u>LOCATION</u>	<u>FIGURE</u>	<u>SECTOR</u>	<u>MILE</u>
M-01	Across the road from Lake Claiborne entry gate	3.0-2	E	3.5
M-07	AS-1 PG, Port Gibson City Barn	3.0-2	G	5.5
M-09	Warner Tully Y-Camp	3.0-2	D	3.5
M-10	Grand Gulf Military Park	3.0-1	A	1.5
M-14 (CONTROL)	AS-3-61VA, Hwy. 61, north of Vicksburg Airport	3.0-2	B	18.0
M-16	Meteorological Tower	3.0-1	A	0.9
M-17	S Side, Grand Gulf Road	3.0-1	C	0.5
M-19	Eastern SITE BOUNDARY property line, NNE of HWSA	3.0-1	E	0.5
M-21	Near former Training Center Building, on Bald Hill Road	3.0-1	J	0.4
M-22	Former RR entrance crossing on Bald Hill Road	3.0-1	G	0.5
M-23	Gin Lake Road 50 yards north of Heavy Haul Road on power pole	3.0-1	Q	0.5
M-25	Radial Well Number 1	3.0-1	N	1.6
M-28	Former Glodjo residence	3.0-1	L	0.9
M-33 (CONTROL)	Newellton, Louisiana, Water Tower	3.0-2	P	12.5
M-36	Curve on HW 608, point nearest GGNS at power pole	3.0-2	P	5.0
M-38	Lake Bruin State Park, entrance road	3.0-2	M	9.5
M-39	St. Joseph, Louisiana, Aux. Water Tank	3.0-2	M	13.0
M-40	Headley Drive, near River Port entrance	3.0-2	M	2.3

ODCM

TABLE 3.0-3 (Continued)

TLD LOCATIONS

Page 2 of 2

<u>TLD NO.</u>	<u>LOCATION</u>	<u>FIGURE</u>	<u>SECTOR</u>	<u>MILE</u>
M-48	0.4 miles South on Mont Gomer Road on west side	3.0-2	K	4.8
M-49	Fork in Bessie Weathers Road/ Shaifer Road	3.0-2	H	4.5
M-50	Panola Hunting Club entrance	3.0-2	B	5.3
M-55	Near Ingelside Karnac Ferry Road/ Ashland Road Intersection	3.0-2	D	5.0
M-57	Hwy. 61, behind the Welcome to Port Gibson sign at Glensdale Subdivision	3.0-2	F	4.5
M-94	Sector R near Meterological tower	3.0-1	R	0.8

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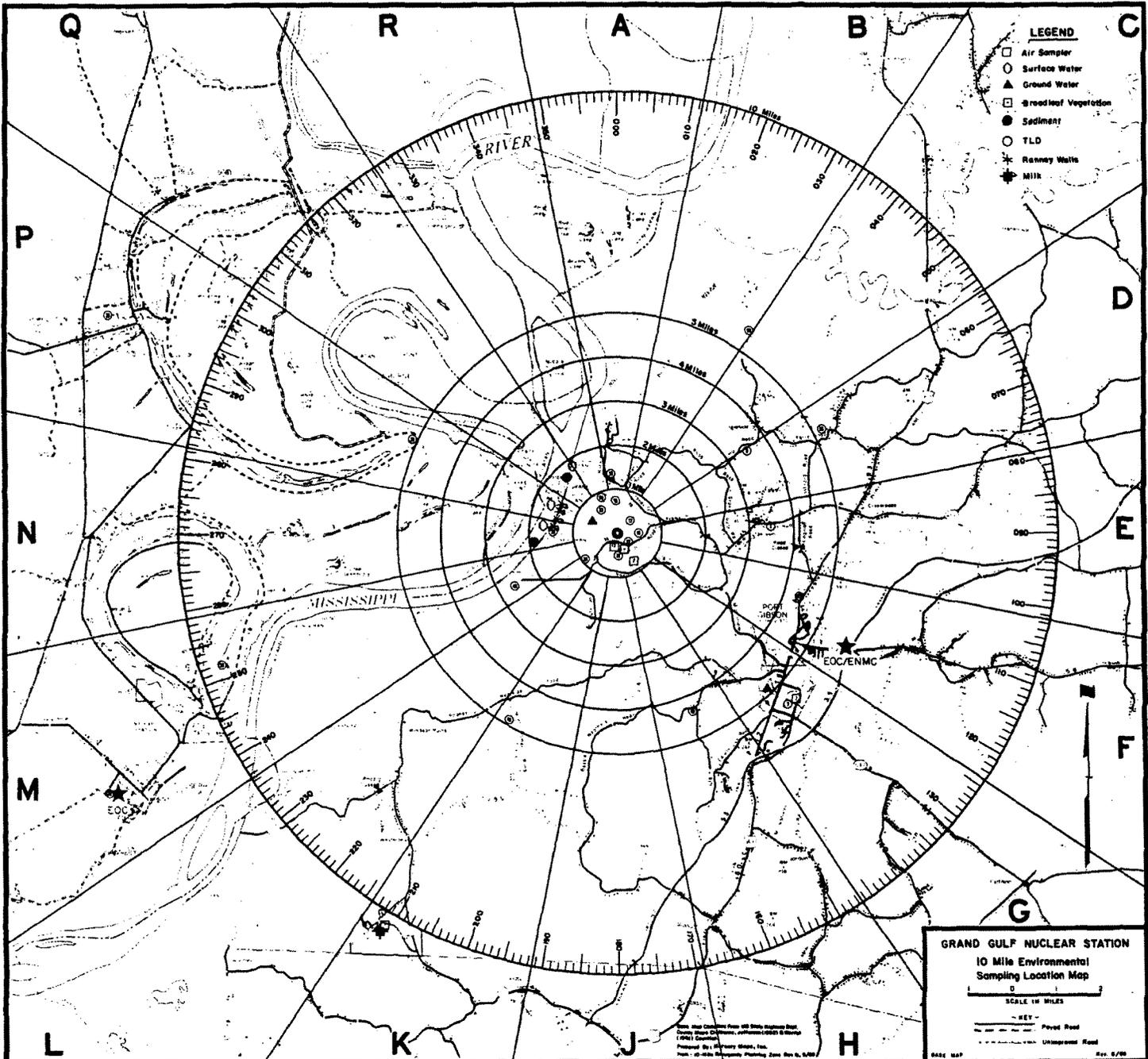
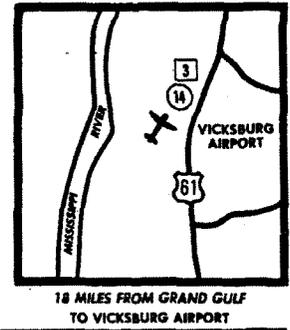
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Figure 3.0-2
 Collection Site Locations, General Area Map,
 0-10 Mile Area Map



OFFSITE DOSE CALCULATION MANUAL

APPENDIX A

RADIOLOGICAL EFFLUENT CONTROLS AND
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

"TEXT DELETED"

1.0 DEFINITIONS

GASEOUS RADWASTE TREATMENT (OFFGAS) SYSTEM

1.1 The GASEOUS RADWASTE TREATMENT (OFFGAS) SYSTEM is the system designed and installed to reduce radioactive gaseous effluents by collecting primary coolant system offgases from the primary system and providing for delay or holdup for the purpose of reducing the total radioactivity prior to release to the environment.

MEMBER(S) OF THE PUBLIC

1.2 MEMBER(S) OF THE PUBLIC shall include individuals in a controlled or unrestricted area. However, an individual is not a member of the public during any period in which the individual receives an occupational dose.

OFFSITE DOSE CALCULATION MANUAL (ODCM)

1.3 The OFFSITE DOSE CALCULATION MANUAL (ODCM) shall contain the methodology and parameters used in the calculation of offsite doses resulting from radioactive gaseous and liquid effluents, in the calculation of gaseous and liquid effluent monitoring Alarm/Trip Setpoints, and in the conduct of the Environmental Radiological Monitoring Program. The ODCM shall also contain (1) the Radioactive Effluent Controls and Radiological Environmental Monitoring Programs required by Technical Specification 5.5.4 and Technical Requirement 7.6.3.2 and (2) descriptions of the information that should be included in the Annual Radiological Environmental Operating and Annual Radioactive Effluent Release Reports required by Technical Specifications 5.6.2 and 5.6.3.

PROCESS CONTROL PROGRAM (PCP)

1.4 The PROCESS CONTROL PROGRAM (PCP) shall contain the current formulas, sampling, analyses, test, and determinations to be made to ensure that processing and packaging of solid radioactive wastes based on demonstrated processing of actual or simulated wet solid wastes will be accomplished in such a way as to assure compliance with 10CFR Parts 20, 61, and 71, State regulations, burial ground requirements, and other requirements governing the disposal of solid radioactive waste.

SITE BOUNDARY

1.5 The SITE BOUNDARY shall be that line beyond which the land or property is not owned, leased, or otherwise controlled by the licensee.

UNRESTRICTED AREA

1.6 An UNRESTRICTED AREA shall be any area, at or beyond the SITE BOUNDARY, access to which is not controlled by the licensee for the purposes of protection of individuals from exposure to radiation and radioactive materials, or any area within the SITE BOUNDARY used for residential quarters or for industrial commercial, institutional, and/or recreational purposes. The UNRESTRICTED AREA and SITE BOUNDARY are synonymous with the exception of areas over bodies of water.

VENTILATION EXHAUST TREATMENT SYSTEM

1.7 A VENTILATION EXHAUST TREATMENT SYSTEM is any system designed and installed to reduce gaseous radiiodine or radioactive material in particulate form in effluents by passing ventilation or vent exhaust gases through charcoal adsorbers and/or HEPA filters for the purpose of removing iodines or particulates from the gaseous exhaust stream prior to the release to the environment (such a system is not considered to have any effect on noble gas effluents). Engineered Safety Feature (ESF) atmospheric cleanup systems are not considered to be VENTILATION EXHAUST TREATMENT SYSTEM components.

Additional Definitions are listed in Technical Specification Section 1.1.

TABLE 1.1

SURVEILLANCE FREQUENCY NOTATION

Surveillance Frequencies are specified in individual LCOs. For more information see Technical Specification Section 1.4.

TABLE 1.2

MODES

Modes of operation are shown in Technical Specification Table 1.1-1

3.0 APPLICABILITY

LIMITING CONDITION FOR OPERATION (LCO)

See Technical Specification Section 3.0 for LCO Applicability.

APPLICABILITY

SURVEILLANCE REQUIREMENTS (SR)

See Technical Specification Section 3.0 for SR applicability.

SECTION 5.0

ADMINISTRATIVE CONTROLS

5.0 ADMINISTRATIVE CONTROLS

5.6.2 ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

Routine radiological environmental operating reports covering the operation of the unit during the previous calendar year shall be submitted before May 1 of each year.

The annual radiological environmental operating reports shall include summaries, interpretations, and an analysis of trends of the results of the radiological environmental surveillance activities for the report period, including a comparison with preoperational studies, operational controls (as appropriate), and previous environmental surveillance reports and an assessment of the observed impacts of the plant operation on the environment. The reports shall also include the results of land use censuses required by LCO 6.12.2. If harmful effects or evidence of irreversible damage are detected by the monitoring, the report shall provide an analysis of the problem and a planned course of action to alleviate the problem.

The annual radiological environmental operating reports shall include summarized and tabulated results in the format of the Table in the Radiological Assessment Branch Technical Position, Revision 1, November 1979 of all radiological environmental samples taken during the report period. Deviations from the sampling program identified in LCO 6.12.1 shall be reported. In the event that some results are not available for inclusion with the report, the report shall be submitted noting and explaining the reasons for the missing results. The missing data shall be submitted as soon as possible in a supplementary report.

The reports shall also include the following:

- 1) a summary description of the radiological environmental monitoring program;
- 2) a map of all sampling locations keyed to a table giving distances and directions from one reactor;
- 3) and the results of licensee (or offsite laboratory's) participation in the Interlaboratory Comparison Program, required by LCO 6.12.1.

5.0 ADMINISTRATIVE CONTROLS

5.6.3 ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT

A Radioactive Effluent Release Report covering the operation of the unit during the previous year shall be submitted before May 1 of each year.

- a. The Radioactive Effluent Release Report shall include a summary of the quantities of radioactive liquid and gaseous effluents and solid waste released from the unit as outlined in Regulatory Guide 1.21, "Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants," Revision 1, June 1974, with data summarized on a quarterly basis following the format of Appendix B thereof. For solid wastes, the format for Table 3 and Appendix B shall be supplemented with three additional categories: class of solid wastes (as defined by 10 CFR Part 61), type of container (e.g., Steel Liner, High Integrity Container) and SOLIDIFICATION Agent or absorbent (e.g., cement, urea formaldehyde).

The Radioactive Effluent Release Report shall include an annual summary of hourly meteorological data collected over the previous year. This annual summary may be either in the form of an hour-by-hour listing on magnetic tape of wind speed, wind direction, atmospheric stability, and precipitation (if measured), or in the form of joint frequency distributions of wind speed, wind direction, and atmospheric stability.* This same report shall include an assessment of the radiation doses due to the radioactive liquid and gaseous effluents released from the unit or station during the previous calendar year. This same report shall also include an assessment of the radiation doses from radioactive liquid and gaseous effluents to MEMBERS OF THE PUBLIC due to their activities inside the SITE BOUNDARY during the reporting period. All assumptions used in making these assessments, i.e., specific activity, exposure time, and location, shall be included in these reports. The meteorological conditions concurrent with the time of release of radioactive materials in gaseous effluents, as determined by sampling frequency and measurement or historical annual average meteorological conditions, shall be used for determining the gaseous pathway doses. The assessment of radiation doses shall be performed in accordance with the methodology and parameters in the OFFSITE DOSE CALCULATION MANUAL (ODCM).

The Radioactive Effluent Release Report shall also include an assessment of radiation doses to the likely most exposed MEMBER OF THE PUBLIC from reactor releases and other nearby uranium fuel cycle sources, including doses from primary effluent pathways and direct radiation, for the previous calendar year to show conformance with 40 CFR Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operation." Acceptable methods for calculating the dose contribution from liquid and gaseous effluents are given in Regulatory Guide 1.109, Rev 1, October 1977 and NUREG - 0133.

The Radioactive Effluent Release Report shall include a list and description of unplanned releases from the site to UNRESTRICTED AREAS of radioactive materials in gaseous and liquid effluents made during the reporting period.

The Radioactive Effluent Release Report shall include any changes made during the reporting period to the OFFSITE DOSE CALCULATION MANUAL (ODCM), pursuant to Technical Specification 5.5.1, as well as any major change to Liquid, Gaseous, or Solid Radwaste Treatment Systems. It shall also include a listing of new locations for dose calculations and/or environmental monitoring identified by the Land Use Census pursuant to LCO 6.12.2.

* In lieu of submission with the Radioactive Effluent Release Report, the licensee has the option of retaining this summary of required meteorological data onsite in a file that shall be provided to the NRC on request.

5.0 ADMINISTRATIVE CONTROLS

5.6.3 ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT (Continued)

The Radioactive Effluent Release Report shall also include the following: an explanation as to why the inoperability of liquid or gaseous effluent monitoring instrumentation was not corrected within the time specified in LCOs 6.3.9 or 6.3.10, and description of the events leading to liquid holdup tanks exceeding the limits of Technical Specification 5.5.8.b.

- b. Major changes to the Radioactive Waste Treatment System (liquid, gaseous and solid**) shall be reported to the Commission in the Annual Radioactive Effluent Release Report for the period in which the evaluation was reviewed by the PSRC.
- (1) A summary of the evaluation that led to the determination that the change could be made in accordance with 10 CFR 50.59;
 - (2) Sufficient detailed information to totally support the reason for the change without benefit of additional or supplemental information;
 - (3) A detailed description of the equipment, components and processes involved and the interfaces with other plant systems;
 - (4) An evaluation of the change which shows the predicted releases of radioactive materials in liquid and gaseous effluents and/or quantity of solid waste that differ from those previously predicted in the license application and amendments thereto;
 - (5) An evaluation of the change which shows the expected maximum exposures to MEMBERS OF THE PUBLIC in the UNRESTRICTED AREA and to the general population that differ from those previously estimated in the license application and amendments thereto;
 - (6) A comparison of the predicted releases of radioactive materials, in liquid and gaseous effluents and in solid waste, to the actual releases for the period before when the changes are to be made;
 - (7) An estimate of the exposure to plant operating personnel as a result of the change; and
 - (8) Documentation of the fact that the change was reviewed and found acceptable by the PSRC.

** The information called for in this Specification may be submitted as part of the next UFSAR update.

SECTION 6.0
LIMITING CONDITIONS FOR OPERATION
AND
SURVEILLANCE REQUIREMENTS

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
<p>B. As required by Required Action A.2 and referenced in Table 6.3.9-1.</p>	<p>B.1 At least two independent samples are analyzed in accordance with LCO 6.11.1.</p> <p><u>AND</u></p> <p>B.2 At least two technically qualified members of the Facility Staff independently verify the release rate calculations and discharge path valve line-up.</p> <p><u>AND</u></p> <p>B.3 Restore channel to operable.</p>	<p>Prior to each release.</p> <p>Prior to each release.</p> <p>14 days</p>
<p>C. As required by Required Action A.2 and referenced in Table 6.3.9-1.</p>	<p>C.1 Estimate the flow rate for the affected pathway during actual releases. Pump curves may be used to estimate flow.</p> <p><u>AND</u></p> <p>C.2 Restore channel to operable.</p>	<p>Once per 4 hours</p> <p>30 days</p>
<p>D. Required Action and associated Completion Time of Condition B or C not met.</p>	<p>D.1 Suspend release of radioactive effluent via affected pathway.</p> <p><u>AND</u></p> <p>D.2 Initiate action to explain why this inoperability was not corrected in a timely manner in the next Annual Radioactive Effluent Release Report.</p>	<p>Immediately</p> <p>Immediately</p>

SURVEILLANCE REQUIREMENTS

-----NOTES-----
 Refer to Table 6.3.9-1 to determine which SRs apply to each channel.

SURVEILLANCE	FREQUENCY
SR 6.3.9.1 -----NOTE----- For flow rate measurement devices a CHANNEL CHECK shall consist of verifying indication of flow during periods of release. A CHANNEL CHECK shall be made at least once per 24 hours on days which batch releases are made. ----- Perform CHANNEL CHECK.	24 hours
SR 6.3.9.2 Perform a source check, a qualitative assessment of channel response when the channel sensor is exposed to a radioactive source.	Prior to each release.
SR 6.3.9.3 -----NOTE----- The CHANNEL FUNCTIONAL TEST shall also demonstrate that automatic isolation of this pathway and control room alarm annunciation occur if any of the following conditions exists: 1. Instrument indicates measured levels above the alarm/trip setpoint. 2. Circuit failure. 3. Instrument indicates a downscale failure. 4. Instrument controls not set in operate mode. ----- Perform CHANNEL FUNCTIONAL TEST.	92 days

(continued)

SURVEILLANCE	FREQUENCY
SR 6.3.9.4 Perform CHANNEL FUNCTIONAL TEST.	92 days
SR 6.3.9.5 -----NOTE----- The initial CHANNEL CALIBRATION shall be performed using one or more of the reference standards certified by the National Institute of Standards and Technology (NIST) or using standards that have been obtained from suppliers that participate in measurement assurance activities with NIST. These standards shall permit calibrating the system over its intended range of energy and measurement range. For subsequent CHANNEL CALIBRATION, sources that have been related to the initial calibration shall be used. ----- Perform a CHANNEL CALIBRATION.	12 months
SR 6.3.9.6 Perform a CHANNEL CALIBRATION	18 months

TABLE 6.3.9-1

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

<u>INSTRUMENT</u>	<u>MINIMUM CHANNELS OPERABLE</u>	<u>CONDITIONS REFERENCED FROM REQUIRED ACTION A.2</u>	<u>SURVEILLANCE REQUIREMENTS</u>
1. GROSS RADIOACTIVITY MONITORS PROVIDING ALARM AND AUTOMATIC TERMINATION OF RELEASE			
a. Liquid Radwaste Effluent Line	1	B	SR 6.3.9.1 SR 6.3.9.2 SR 6.3.9.3 SR 6.3.9.5
2. FLOW RATE MEASUREMENT DEVICES			
a. Liquid Radwaste Effluent Line	1	C	SR 6.3.9.1 SR 6.3.9.4 SR 6.3.9.6
b. Discharge Canal or Circulating Water Blowdown	1	C	SR 6.3.9.1 SR 6.3.9.4 SR 6.3.9.6

6.3 INSTRUMENTATION

6.3.10 RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

LCO 6.3.10 The radioactive gaseous effluent monitoring instrumentation channels shown in Table 6.3.10-1 shall be OPERABLE with their alarm/trip setpoints set to ensure that the limits of LCO 6.11.4 are not exceeded. The alarm/trip setpoints of these channels shall be determined in accordance with the OFFSITE DOSE CALCULATION MANUAL (ODCM).

APPLICABILITY: As shown in Table 6.3.10-1

ACTIONS

-----NOTES-----

1. Separate Condition entry is allowed for each Channel.
 2. The provisions of Specification 3.0.3 and 3.0.4 are not applicable.
-

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or more required channels inoperable.	A.1 Suspend release of radioactive effluent via affected pathway.	Immediately
	<p style="text-align: center;"><u>OR</u></p> <p style="text-align: center;">-----NOTES----- Once required Action A.2 is entered the Completion Time for Condition Referenced on Table 6.3.10-1 can not be restarted by reentering Required Action A.1. -----</p> <p>A.2 Enter the Condition referenced in Table 6.3.10-1 for the channel.</p>	Immediately

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
<p>B. As required by Required Action A.2 and referenced in Table 6.3.10-1.</p>	<p>B.1 Take grab samples during release.</p> <p>AND</p> <p>B.2 Analyze the above required samples for gross activity.</p> <p>AND</p> <p>B.3 Restore channel to operable.</p>	<p>Once per 8 hours</p> <p>Within 24 hours of taking the sample</p> <p>30 days</p>
<p>C. As required by Required Action A.2 and referenced in Table 6.3.10-1.</p>	<p>C.1 Establish an alternate means to collect samples required by Table 6.11.4-1.</p> <p>AND</p> <p>C.2 Enter Condition D for the alternate sample established in C.1.</p> <p>AND</p> <p>C.3 Restore channel to operable.</p>	<p>Immediately</p> <p>Immediately</p> <p>30 days</p>
<p>D. As required by Required Action A.2 and referenced in Table 6.3.10-1 or Required Action C.2.</p>	<p>D.1 Estimate flow rate.</p> <p>AND</p> <p>D.2 Restore channel to operable.</p>	<p>Once per 8 hours</p> <p>30 days</p>

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
<p>G. As required by Required Action A.2 and referenced in Table 6.3.10-1.</p>	<p>G.1 Take grab samples during release.</p> <p><u>AND</u></p> <p>G.2 Analyze the above required samples for gross activity.</p> <p><u>AND</u></p> <p>G.3 Restore channel to operable.</p>	<p>Once per 4 hours</p> <p>Within 24 hours of taking the sample</p> <p>30 days</p>
<p>H. Required Actions and associated Completion Times of Condition B,C,D,E or G not met.</p>	<p>H.1 Suspend release of radioactive effluent via this pathway.</p> <p><u>AND</u></p> <p>H.2 Initiate action to explain why this inoperability was not corrected in a timely manner in the next Annual Radioactive Effluent Release Report.</p>	<p>Immediately</p> <p>Immediately</p>
<p>I. Required Action and associated Completion Time of Condition F not met.</p>	<p>I.1 Be in MODE 3</p> <p><u>AND</u></p> <p>I.2 Be in MODE 4</p>	<p>12 hours</p> <p>36 hours</p>

SURVEILLANCE REQUIREMENTS

-----NOTES-----

1. Refer to Table 6.3.10-1 to determine which SRs apply to each channel.
 2. When a monitor is placed in an inoperable status solely for performance of required Surveillance's, entry into associated Conditions and Required Actions in accordance with LCO 6.3.10 may be delayed for up to 1 hour.
-

SURVEILLANCE	FREQUENCY
SR 6.3.10.1 Perform CHANNEL CHECK.	24 hours
SR 6.3.10.2 Perform CHANNEL CHECK.	7 days
SR 6.3.10.3 -----NOTE----- 1. Not required to be performed in MODES 1 and 2 for the offgas pre-treatment monitor if inaccessible due to a high radiation area. 2. Not required to be performed for the offgas pretreatment monitor when entering MODES 3 and 4 from MODES 1 or 2 until 8 hours after entering MODE 3 or 4 if monitor was inaccessible due to a high radiation area. ----- Perform SOURCE CHECK , a qualitative assessment of channel response when the channel sensor is exposed to a radioactive source.	31 days
SR 6.3.10.4 -----NOTE----- The CHANNEL FUNCTIONAL TEST shall also demonstrate the automatic isolation capability of the instrumentation for this pathway and the control room alarm annunciation capability, if any of the following conditions exists: 1. Instrument indicates measured levels above the alarm/trip setpoint. 2. Circuit failure. 3. Instrument indicates a downscale failure. 4. Instrument controls not set in operate mode. ----- Perform CHANNEL FUNCTIONAL TEST.	92 days

(continued)

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE	FREQUENCY
<p>SR 6.3.10.5 -----NOTE----- The CHANNEL FUNCTIONAL TEST shall also demonstrate that control room alarm annunciation occur if any of the following conditions exists:</p> <ol style="list-style-type: none"> 1. Instrument indicates measured levels above the alarm/trip setpoint. 2. Circuit failure. 3. Instrument indicates a downscale failure. 4. Instrument controls not set in operate mode. <p>----- Perform CHANNEL FUNCTIONAL TEST.</p>	<p>92 days</p>
<p>SR 6.3.10.6 -----NOTE----- Compare the measured flow rate to the expected design flow rate for existing plant conditions.</p> <p>----- Perform CHANNEL FUNCTIONAL TEST.</p>	<p>92 days</p>
<p>SR 6.3.10.7 -----NOTE----- 1. The initial CHANNEL CALIBRATION shall be performed using one or more of the reference standards certified by the National Institute of Standards and Technology (NIST) or using standards that have been obtained from suppliers that participate in measurement assurance activities with NIST. These standards shall permit calibrating the system over its intended range of energy and measurement range. For subsequent CHANNEL CALIBRATION, sources that have been related to the initial calibration shall be used.</p> <p>2. The offgas pre-treatment and offgas post-treatment sensors will be calibrated for mr/hr or cpm from the calibration standard. The conversion to release rate will be performed during subsequent unit operation, but within one week.</p> <p>----- Perform a CHANNEL CALIBRATION.</p>	<p>12 months</p>
<p>SR 6.3.10.8 Perform a CHANNEL CALIBRATION</p>	<p>18 months</p>

TABLE 6.3.10-1

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

<u>INSTRUMENT</u>	<u>MINIMUM CHANNELS OPERABLE</u>	<u>APPLICABILITY</u>	<u>CONDITIONS REFERENCED FROM REQUIRED ACTION A.2</u>	<u>SURVEILLANCE REQUIREMENTS</u>
1. RADWASTE BUILDING VENTILATION MONITORING SYSTEM				
a. Noble Gas Activity Monitor Providing Alarm	1	(a)	B	SR 6.3.10.1 SR 6.3.10.3 SR 6.3.10.5 SR 6.3.10.7
b. Iodine Sampler	1	(a)	C	SR 6.3.10.2
c. Particulate Sampler	1	(a)	C	SR 6.3.10.2
d. Effluent System Flow Rate Measuring Device	1	(a)	D	SR 6.3.10.1 SR 6.3.10.6 SR 6.3.10.8
e. Sampler Flow Rate Measuring Device	1	(a)	D	SR 6.3.10.1 SR 6.3.10.8
2. CONTAINMENT VENTILATION MONITORING SYSTEM				
a. Noble Gas Activity Monitor Providing Alarm	1	(a)	B	SR 6.3.10.1 SR 6.3.10.3 SR 6.3.10.5 SR 6.3.10.7

TABLE 6.3.10-1 (Continued)

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

<u>INSTRUMENT</u>	<u>MINIMUM CHANNELS OPERABLE</u>	<u>APPLICABILITY</u>	<u>CONDITIONS REFERENCED FROM REQUIRED ACTION A.2</u>	<u>SURVEILLANCE REQUIREMENTS</u>
b. Iodine Sampler	1	(a)	C	SR 6.3.10.2
c. Particulate Sampler	1	(a)	C	SR 6.3.10.2
d. Effluent System Flow Rate				
1. High Volume Flow Device	1	(d)	D	SR 6.3.10.1 SR 6.3.10.6 SR 6.3.10.8
2. Low Volume Flow Device	1	(e)	D	SR 6.3.10.1 SR 6.3.10.6 SR 6.3.10.8
e. Sampler Flow Rate Measuring Device	1	(a)	D	SR 6.3.10.1 SR 6.3.10.8
3. TURBINE BLDG. VENTILATION MONITORING SYSTEM				
a. Noble Gas Activity Providing Alarm	1	(a)	B	SR 6.3.10.1 SR 6.3.10.3 SR 6.3.10.5 SR 6.3.10.7
b. Iodine Sampler	1	(a)	C	SR 6.3.10.2
c. Particulate Sampler	1	(a)	C	SR 6.3.10.2
d. Effluent System Flow Rate Measuring Device	1	(a)	D	SR 6.3.10.1 SR 6.3.10.6 SR 6.3.10.8
e. Sampler Flow Rate Measuring Device	1	(a)	D	SR 6.3.10.1 SR 6.3.10.8

TABLE 6.3.10-1 (Continued)

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

<u>INSTRUMENT</u>	<u>MINIMUM CHANNELS OPERABLE</u>	<u>APPLICABILITY</u>	<u>CONDITIONS REFERENCED FROM REQUIRED ACTION A.2</u>	<u>SURVEILLANCE REQUIREMENTS</u>
4. FUEL HANDLING AREA VENTILATION MONITORING SYSTEM				
a. Noble Gas Activity Providing Alarm	1	(a)	B	SR 6.3.10.1 SR 6.3.10.3 SR 6.3.10.5 SR 6.3.10.7
b. Iodine Sampler	1	(a)	C	SR 6.3.10.2
c. Particulate Sampler	1	(a)	C	SR 6.3.10.2
d. Effluent Flow Rate Measuring Device	1	(a)	D	SR 6.3.10.1 SR 6.3.10.6 SR 6.3.10.8
e. Sampler Flow Rate Measuring Device	1	(a)	D	SR 6.3.10.1 SR 6.3.10.8
5. OFFGAS PRE-TREATMENT MONITOR				
a. Noble Gas Activity Monitor Providing Alarm	1	(c)	F	SR 6.3.10.1 SR 6.3.10.3 SR 6.3.10.5 SR 6.3.10.7

TABLE 6.3.10-1 (Continued)

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

<u>INSTRUMENT</u>	<u>MINIMUM CHANNELS OPERABLE</u>	<u>APPLICABILITY</u>	<u>CONDITIONS REFERENCED FROM REQUIRED ACTION A.2</u>	<u>SURVEILLANCE REQUIREMENTS</u>
6. OFFGAS POST-TREATMENT MONITOR				
a. Noble Gas Activity Monitor Providing Alarm and Automatic Termination of Release	2	(b)	E	SR 6.3.10.1 SR 6.3.10.3 SR 6.3.10.4 SR 6.3.10.7
7. STANDBY GAS TREATMENT EXHAUST MONITORING SYSTEM (A&B)				
a. Noble Gas Activity Monitor Providing Alarm	1/system	(a)	G	SR 6.3.10.1 SR 6.3.10.3 SR 6.3.10.5 SR 6.3.10.7

TABLE 6.3.10-1 (Continued)

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION
TABLE NOTATION

- (a) At all times.
- (b) During main condenser offgas treatment system operation.
- (c) When any steam jet air ejector (SJAE) is in operation.
- (d) During containment high volume purge.
- (e) During containment low volume purge.

6.11 RADIOACTIVE EFFLUENTS

6.11.1 LIQUID EFFLUENTS CONCENTRATION

LCO 6.11.1 The concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS shall be limited to ten times the effluent concentrations specified in 10 CFR Part 20, Appendix B, Table 2, Column 2 for radionuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the concentration shall be limited to 2×10^{-4} microcuries/ml total activity.

APPLICABILITY: At all times.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. The concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS exceeds the above limits.	A.1 Restore the concentration to within the above limits. <u>AND</u> A.2 Declare the liquid effluent waste treatment system inoperable.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE	FREQUENCY
SR 6.11.1.1 The radioactivity content of each batch of radioactive liquid waste shall be determined before release by sampling and analysis in accordance with (ODCM) Table 6.11.1-1.	Per (ODCM) Table 6.11.1-1.
SR 6.11.1.2 Post-release analyses of samples composited from batch releases shall be performed in accordance with (ODCM) Table 6.11.1-1.	Per (ODCM) Table 6.11.1-1.

TABLE 6.11.1-1

RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

Liquid Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) ($\mu\text{Ci/ml}$) (a)
A. Batch Waste Release Tanks (c)	Prior to Release Each Batch	Prior to Release Each Batch	Principal Gamma Emitters (d)	5×10^{-7}
			I-131	1×10^{-6}
	Prior to Release One Batch/M	31 days	Dissolved and Entrained Gases (Gamma emitters)	1×10^{-5}
			H-3	1×10^{-5}
				Gross Alpha
Prior to Release Each Batch	31 days Composite (b)	Sr-89, Sr-90	5×10^{-8}	
		Fe-55	1×10^{-6}	
B. SSW Basin (before blowdown)	Prior to Release Each Blowdown	Prior to Release Each Batch	Principal Gamma Emitters (d)	5×10^{-7}
			I-131	1×10^{-6}

TABLE 6.11.1-1 (Continued)

RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

TABLE NOTATION

- a. The LLD is the smallest concentration of radioactive material in a sample that will yield a net count (above system background) that will be detected with 95% probability with only 5% probability of falsely concluding that a blank observation represents a "real" signal.

For a particular measurement system (which may include radiochemical separation):

$$\text{LLD} = \frac{4.66 s_b}{\text{_____}}$$

where

$$E \cdot V \cdot 2.22 \times 10^6 \cdot Y \cdot \exp(-\lambda \Delta t)$$

- LLD is the "a priori" lower limit of detection as defined above (as μCi per unit mass or volume). (Current literature defines the LLD as the detection capability for the instrumentation only, and the MDC, minimum detectable concentration, as the detection capability for a given instrument, procedure, and type of sample.)
- s_b is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute)
- E is the counting efficiency (as counts per disintegration)
- V is the sample size (in units of mass or volume)
- 2.22×10^6 is the number of disintegrations per minute per microcurie
- Y is the fractional radiochemical yield (when applicable)
- λ is the radioactive decay constant for the particular radionuclide
- Δt is the elapsed time between sample collection (or end of the sample collection period) and time of counting

The value of s_b used in the calculation of the LLD for a particular measurement system should be based on the actual observed variance of the background counting rate or of the counting rate of the blank samples (as appropriate) rather than on an unverified theoretically predicated variance.

Typical values of E, V, Y and Δt should be used in the calculation.

It should be recognized that the LLD is defined as an a priori (before the fact) limit representing the capability of a measurement system and not as a posteriori (after the fact) limit for a particular measurement.

TABLE 6.11.1-1 (Continued)

RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

TABLE NOTATION (Continued)

- b. A composite sample is one in which the quantity of liquid sampled is proportional to the quantity of liquid waste discharged and in which the method of sampling employed results in a specimen which is representative of the liquids released.
- c. A batch release is the discharge of liquid wastes of a discrete volume. Before sampling for analyses, each batch shall be isolated, and then thoroughly mixed to assure representative sampling.
- d. The principal gamma emitters for which the LLD specification applies exclusively are the following radionuclides: Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, Ce-141, and Ce-144. This list does not mean that only these nuclides are to be detected and reported. Other peaks which are measurable and identifiable, together with the above nuclides, shall also be identified and reported.

6.11 RADIOACTIVE EFFLUENTS

6.11.2 LIQUID EFFUENT DOSE

LCO 6.11.2 The dose or dose commitment to a MEMBER OF THE PUBLIC from radioactive materials in liquid effluents released to UNRESTRICTED AREAS shall be:

- a. ≤ 1.5 mrem to the total body and ≤ 5 mrem to any organ, during any calendar quarter, and
- b. ≤ 3 mrem to the total body and ≤ 10 mrem to any organ, during any calendar year.

APPLICABILITY: At all times.

ACTIONS

-----NOTES-----

- 1. The provisions of Specification 3.0.3 are not applicable.
 - 2. Separate Condition entry is allowed for each of the above limits.
-

<u>CONDITION</u>	<u>REQUIRED ACTION</u>	<u>COMPLETION TIME</u>
A. The calculated dose from the release of radioactive materials in liquid effluents greater than any of the above limits.	A.1 Initiate action to prepare and submit a Special Report within 30 days. <u>AND</u> A.2 Declare the liquid effluent waste treatment system inoperable.	Immediately

(continued)

<p>B. The calculated doses from the release of radioactive materials in liquid effluents greater than twice any of the above limits.</p>	<p>B.1 Initiate action to calculate the direct radiation contributions from the reactor unit and from outside storage tanks to determine whether the total annual dose or dose commitment to any MEMBER OF THE PUBLIC greater than:</p> <p>a) 25 mrem to the total body or any organ, except the thyroid.</p> <p><u>OR</u></p> <p>b) 75 mrem to the thyroid.</p>	<p>Immediately</p>
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SURVEILLANCE REQUIREMENTS

SURVEILLANCE	FREQUENCY
<p>SR 6.11.2.1 Cumulative dose contributions from liquid effluents for the current calendar quarter and the current calendar year shall be determined in accordance with the methodology and parameters of the ODCM.</p>	<p>31 days</p>

6.11 RADIOACTIVE EFFLUENTS

6.11.3 LIQUID EFFLUENT WASTE TREATMENT

LCO 6.11.3 The liquid radwaste system shall be used to reduce the radioactive materials in liquid wastes before their discharge when the projected doses due to the liquid effluent to UNRESTRICTED AREAS would be > 0.06 mrem to the total body or > 0.2 mrem to any organ, in a 31-day period.

APPLICABILITY: At all times.

ACTIONS

-----NOTES-----
 The provisions of Specification 3.0.3 are not applicable.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Radioactive liquid waste being discharged without treatment and in excess of the above limits.	A.1 Initiate action to prepare and submit, a Special Report within 30 days.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE	FREQUENCY
SR 6.11.3.1 Doses due to liquid releases to UNRESTRICTED AREAS shall be projected in accordance with methodology and parameters in the ODCM. <u>AND</u> -----NOTE----- Not required to be met when the projected dose less than or equal to the above limit. ----- Verify the liquid effluent waste treatment system is being used to reduce radioactive materials before discharge.	31 days

6.11 RADIOACTIVE EFFLUENTS

6.11.4 GASEOUS EFFLUENTS - DOSE RATE

LCO 6.11.4 The dose rate due to radioactive materials released in gaseous effluents from the site to areas at and beyond the SITE BOUNDARY shall be:

- a. For noble gases: ≤ 500 mrem/yr to the total body and ≤ 3000 mrem/yr to the skin, and
- b. For all iodine-131, iodine-133, tritium and all radionuclides in particulate form with half lives greater than 8 days: ≤ 1500 mrem/yr to any organ.

APPLICABILITY: At all times.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Dose rate exceeding the above limits.	A.1 Decrease the release rate to within the above limit(s). <u>AND</u> A.2 Declare the ventilation exhaust treatment system inoperable.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE	FREQUENCY
SR 6.11.4.1 The dose rate due to noble gases in gaseous effluents shall be determined to be within the above limits by obtaining representative samples and performing analyses in accordance with (ODCM) Table 6.11.4-1.	Per (ODCM) Table 6.11.4-1.
SR 6.11.4.2 The dose rate due to iodine-131, iodine-133, tritium and to radionuclides in particulate form with half lives greater than 8 days in gaseous effluents shall be determined to be within the above limits by obtaining representative samples and performing analyses in accordance with (ODCM) Table 6.11.4-1.	Per (ODCM) Table 6.11.4-1.

TABLE 6.11.4-1
RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM

Gaseous Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) ($\mu\text{Ci/ml}$) (a)
A. (1) Radwaste Building Ventilation Exhaust	31 days Grab Sample (f)	31 days	Principal Gamma Emitters (b, e)	1×10^{-4}
			H-3	1×10^{-6}
(2) Fuel Handling Area Ventilation Exhaust	Continuous (d) (f)	7 days (c) Charcoal Sample	I-131	1×10^{-12}
			I-133	1×10^{-10}
(3) Containment Ventilation Exhaust	Continuous (d) (f)	7 days (c) Particulate Sample	Principal Gamma Emitters (e) (I-131, Others)	1×10^{-11}
(4) Turbine Building Ventilation Exhaust	Continuous (d) (f)	31 days Composite Particulate Sample	Gross Alpha	1×10^{-11}
			Sr-89, Sr-90	1×10^{-11}
			Noble Gas Monitor	1×10^{-6}
B. (1) Offgas Post Treatment Exhaust, whenever there is flow	31 days Grab Sample (f)	31 days	Principal Gamma Emitters (e)	1×10^{-4}
(2) Standby Gas Treatment A Exhaust, whenever there is flow				
(3) Standby Gas Treatment B Exhaust, whenever there is flow				

See "Table Notation" which follows.

TABLE 6.11.4-1 (Continued)

RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM

TABLE NOTATION

- a. The LLD is the smallest concentration of radioactive material in a sample that will yield a net count (above system background) that will be detected with 95% probability with only 5% probability of falsely concluding that a blank observation represents a "real" signal.

For a particular measurement system (which may include radiochemical separation):

$$\text{LLD} = \frac{4.66 s_b}{E \cdot V \cdot 2.22 \times 10^6 \cdot Y \cdot \exp(-\lambda \Delta t)}$$

where

- LLD is the "a priori" lower limit of detection as defined above (as μCi per unit mass or volume). (Current literature defines the LLD as the detection capability for the instrumentation only, and the MDC, minimum detectable concentration, as the detection capability for a given instrument, procedure, and type of sample.)
- s_b is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute)
- E is the counting efficiency (as counts per disintegration)
- V is the sample size (in units of mass or volume)
- 2.22×10^6 is the number of disintegrations per minute per microcurie
- Y is the fractional radiochemical yield (when applicable)
- λ is the radioactive decay constant for the particular radionuclide
- Δt is the elapsed time between sample collection (or end of the sample collection period) and time of counting

The value of s_b used in the calculation of the LLD for a particular measurement system should be based on the actual observed variance of the background counting rate or of the counting rate of the blank samples (as appropriate) rather than on an unverified theoretically predicated variance.

Typical values of E, V, Y and Δt should be used in the calculation.

It should be recognized that the LLD is defined as an a priori (before the fact) limit representing the capability of a measurement system and not as a posteriori (after the fact) limit for a particular measurement.

TABLE 6.11.4-1 (Continued)

RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM

TABLE NOTATION (Continued)

- b. Analyses shall also be performed following startup from cold shutdown, or a THERMAL POWER change exceeding 15 percent of the RATED THERMAL POWER within a one hour period. This requirement does not apply if:
- (1) routine analysis required by the Surveillance Requirements of LCO 3.4.8 shows that the DOSE EQUIVALENT I-131 concentration in the primary coolant has not increased more than a factor of 3; and
 - (2) the noble gas monitor shows that effluent activity has not increased more than a factor of 3.
- c. Samples shall be changed at least once per 7 days and analyses shall be completed within 48 hours after changing or after removal from sampler. Sampling and analyses shall be performed at least once per 24 hours for at least 7 days following each shutdown, startup or THERMAL POWER change exceeding 15 percent of RATED THERMAL POWER in one hour. When samples collected for 24 hours are analyzed, the corresponding LLD's may be increased by a factor of 10. This requirement does not apply if:
- (1) routine analysis required by the Surveillance Requirements of LCO 3.4.8 shows that the DOSE EQUIVALENT I-131 concentration in the primary coolant has not increased more than a factor of 3; and
 - (2) the noble gas monitor shows that effluent activity has not increased more than a factor of 3.
- d. The ratio of the sample flow rate to the sampled stream flow rate shall be known for the time period covered by each dose or dose rate calculation made in accordance with LCOs 6.11.4 and 6.11.6.
- e. The principal gamma emitters for which the LLD specification applies exclusively are the following radionuclides: Kr-87, Kr-88, Xe-133, Xe-133m, Xe-135, and Xe-138 for gaseous emissions and Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, Ce-141 and Ce-144 for particulate emissions. This list does not mean that only these nuclides are to be detected and reported. Other peaks which are measurable and identifiable, together with the above nuclides, shall also be identified and reported.
- f. When a monitor is placed in an inoperable status solely for performance of required Surveillance's, entry into associated Conditions and Required Actions in accordance with LCO 6.3.10 may be delayed for up to 1 hour.

6.11 RADIOACTIVE EFFLUENTS

6.11.5 GASEOUS EFFLUENT DOSE - NOBLE GASES

LCO 6.11.5 The air dose due to noble gases released in gaseous effluents, from the site to areas at and beyond the SITE BOUNDARY shall be:

- a. ≤ 5 mrad for gamma radiation and ≤ 10 mrad for beta radiation, during any calendar quarter and
- b. ≤ 10 mrad for gamma radiation and ≤ 20 mrad for beta radiation during any calendar year.

APPLICABILITY: At all times.

ACTIONS

-----NOTES-----

- 1. The provisions of Specification 3.0.3 are not applicable.
 - 2. Separate Condition entry is allowed for each of the above limits.
-

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. The calculated air dose from the radioactive noble gases in gaseous effluents greater than any of the above limits.	A.1 Initiate action to prepare and submit, a Special Report within 30 days. <u>AND</u> A.2 Declare the ventilation exhaust treatment system inoperable.	Immediately

(continued)

<p>B. The calculated doses from the release of radioactive materials in gaseous effluents greater than twice any of the above limits.</p>	<p>B.1 Initiate action to calculate the direct radiation contributions from the reactor unit and from outside storage tanks to determine whether the total annual dose or dose commitment to any MEMBER OF THE PUBLIC greater than:</p> <p>a) 25 mrem to the total body or any organ, except the thyroid.</p> <p><u>OR</u></p> <p>b) 75 mrem to the thyroid.</p>	<p>Immediately</p>
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SURVEILLANCE REQUIREMENTS

SURVEILLANCE	FREQUENCY
<p>SR 6.11.5.1 Cumulative dose contributions for noble gases for the current calendar quarter and current calendar year shall be determined in accordance with the methodology and parameters in the ODCM.</p>	<p>31 days</p>

6.11 RADIOACTIVE EFFLUENTS

6.11.6 GASEOUS EFFLUENT DOSE - IODINE-131, IODINE-133, TRITIUM AND RADIONUCLIDES IN PARTICULATE FORM

LCO 6.11.6 The dose to a MEMBER OF THE PUBLIC from iodine-131, iodine-133, tritium and radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents released, from the site to areas at and beyond the SITE BOUNDARY shall be:

- a. ≤ 7.5 mrem to any organ during any calendar quarter, and
- b. ≤ 15 mrem to any organ during any calendar year.

APPLICABILITY: At all times.

ACTIONS

-----NOTES-----

- 1. The provisions of Specification 3.0.3 are not applicable.
 - 2. Separate Condition entry is allowed for each of the above limits.
-

CONDITION	REQUIRED ACTION	COMPLETION TIME
<p>A. The calculated dose from the release of iodine-131, iodine-133, tritium and radionuclides in particulate form, with half-lives greater than 8 days, in gaseous effluents greater than any of the above limits.</p>	<p>A.1 Initiate action to prepare and submit, a Special Report within 30 days.</p> <p><u>AND</u></p> <p>A.2 Declare the ventilation exhaust treatment system inoperable.</p>	<p>Immediately</p>

(continued)

<p>B. The calculated doses from the release of radioactive materials in gaseous effluents greater than twice any of the above limits.</p>	<p>B.1 Initiate action to calculate the direct radiation contributions from the reactor unit and from outside storage tanks to determine whether the total annual dose or dose commitment to any MEMBER OF THE PUBLIC greater than:</p> <p>a) 25 mrem to the total body or any organ, except the thyroid.</p> <p><u>OR</u></p> <p>b) 75 mrem to the thyroid.</p>	<p>Immediately</p>
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SURVEILLANCE REQUIREMENTS		
SURVEILLANCE	FREQUENCY	
<p>SR 6.11.6.1 Cumulative dose contributions from iodine-131, iodine-133, tritium and radionuclides in particulate form with half-lives greater than 8 days for the current calendar quarter and current calendar year shall be determined in accordance with the methodology and parameters in the ODCM.</p>	<p>31 days</p>	

6.11 RADIOACTIVE EFFLUENTS

6.11.7 GASEOUS RADWASTE TREATMENT

LCO 6.11.7 The GASEOUS RADWASTE TREATMENT (OFFGAS) SYSTEM shall be in operation.

APPLICABILITY: When the steam jet air ejector (SJAE) is in operation.

ACTIONS

-----NOTES-----
 The provisions of Specification 3.0.3 are not applicable.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Gaseous radwaste from the SJAE being discharged without treatment.	A.1 Restore treatment to this discharge.	7 days
B. Required Action A.1 and Associated Completion Time not met.	B.1 Initiate action to prepare and submit a Special Report to the Commission within 30 days.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE	FREQUENCY
SR 6.11.7.1 Ensure that the GASEOUS RADWASTE TREATMENT (OFFGAS) SYSTEM is operating.	12 hours

6.11 RADIOACTIVE EFFLUENTS

6.11.8 VENTILATION EXHAUST TREATMENT SYSTEM

LCO 6.11.8 The VENTILATION EXHAUST TREATMENT SYSTEM shall be used to reduce radioactive materials in gaseous waste before their discharge when the projected dose due to gaseous effluent releases to areas at and beyond the SITE BOUNDARY in a 31 day period would exceed 0.3 mrem to any organ.

APPLICABILITY: At all times.

ACTIONS

-----NOTES-----
 The provisions of Specification 3.0.3 are not applicable.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Gaseous waste being discharged without treatment and greater than the above limit.	A.1 Initiate action to prepare and submit a Special Report to the Commission within 30 days.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE	FREQUENCY
SR 6.11.8.1 Doses due to gaseous releases to areas at and beyond the SITE BOUNDARY shall be projected in accordance with the methodology and parameters in the ODCM. <u>AND</u> -----NOTE----- 1. Not required to be met when the ventilation exhaust treatment system is undergoing routine maintenance. 2. Not required to be met when the projected dose less than or equal to the above limit. ----- Verify the ventilation exhaust treatment system is operating.	31 days

6.12 RADIOLOGICAL ENVIRONMENTAL MONITORING

6.12.1 MONITORING PROGRAM

LCO 6.12.1 The radiological environmental monitoring program shall be conducted as specified in ODCM Table 6.12.1-1. The results of this program shall be validated by use of an Interlaboratory Comparison Program corresponding to samples required by ODCM Table 6.12.1-1.

APPLICABILITY: At all times.

ACTIONS

-----NOTES-----
 The provisions LCO 3.0.3 are not applicable.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. The radiological environmental monitoring program not being conducted as specified in ODCM Table 6.12.1-1. <u>OR</u> The required Interlaboratory Comparison Program not performed.	A.1 Initiate action to include in the next Annual Radiological Environmental Operating Report, a description of the reasons for not conducting the program as required and the plans for preventing a recurrence.	Immediately
B. The level of radioactivity as the result of plant effluent in an environmental sampling medium at a specified location exceeding the reporting levels of ODCM Table 6.12.1-2 when averaged over any calendar quarter.	B.1 Initiate action to prepare and submit a Special Report within 30 days.	Immediately

(continued)

TABLE 6.12.1-1
OPERATIONAL RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Number of Samples (a) and Locations	Sampling and Collection Frequency (a)	Type and Frequency of Analysis
<u>AIRBORNE</u>			
Radioiodine and Particulates	Samples from 3 locations:	Continuous sampler operation with sample collection per 7 days or as required by dust loading, whichever is more frequent	Radioiodine Cannister: I-131; 7 days
	1 sample close to the SITE BOUNDARY having the highest calculated annual average groundlevel D/Q.		
	1 sample from the vicinity of a community having the highest calculated annual average groundlevel D/Q.		
	1 sample from a control location 15-30 km (10-20 miles) distance (d)		
<u>DIRECT RADIATION (e)</u>	16 stations with two or more dosimeters or one instrument for measuring and recording dose rate continuously. The stations will be placed in accessible sectors alternating between inner and outer ring locations*: 1) an inner ring of stations in the general areas of the SITE BOUNDARY 2) an outer ring approximately 3 to 5 miles from the site.	92 days	Gamma dose; 92 days
	8 additional stations should be placed in special interest areas such as population centers, nearby residences, schools, and in 1 or 2 areas to serve as control stations.		

TABLE 6.12.1-1 (Continued)

OPERATIONAL RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

<u>Exposure Pathway and/or Sample</u>	<u>Number of Samples(a) and Locations</u>	<u>Sampling and Collection Frequency(a)</u>	<u>Type and Frequency of Analysis</u>
<u>WATERBORNE</u>			
Surface	1 sample upstream 1 sample downstream	92 days	Gamma isotopic(c) and tritium analyses; 92 days
	1 sample downstream during a Liquid Radwaste Discharge	366 days	Gamma isotopic(c) and tritium analyses; 366 days
Ground	Samples from 2 sources	366 days	Gamma isotopic(c) and tritium; 366 days
Sediment from Shoreline	1 sample from downstream area 1 sample from upstream area	366 days	Gamma isotopic(c); 366 days
<u>INGESTION</u>			
Milk	1 sample from milking animals within 8 km if milk is available commercially.	92 days when required	Gamma isotopic(c) and I-131; 92 days
	1 control sample (only if indicator exists) > 8 km if milk is available		

TABLE 6.12.1-1 (Continued)

OPERATIONAL RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

<u>Exposure Pathway and/or Sample</u>	<u>Number of Samples(a) and Locations</u>	<u>Sampling and Collection Frequency(a)</u>	<u>Type and Frequency of Analysis</u>
Food Products	1 sample of broad leaf vegetation grown in one of two different offsite locations with highest anticipated annual average ground level D/Q if milk sampling is not performed	92 days when available	Gamma isotopic(c) and I-131; 92 days
	1 sample of similar vegetation grown 15-30 km distant if milk sampling is not performed	92 days when available	Gamma isotopic(c) and I-131; 92 days
Fish	1 sample in vicinity of GGNS discharge point	366 days	Gamma isotopic (c) on edible portion; 366 days
	1 sample uninfluenced by GGNS discharge	366 days	Gamma isotopic (c) on edible portion; 366 days

TABLE 6.12.1-1 (Continued)

OPERATIONAL RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

TABLE NOTATION

- * As described in the ODCM. If a location is not accessible, instruments may be placed in an adjacent inner or outer location.
- a Specific parameters of distance and direction sector from the centerline of one reactor, and additional description where pertinent, shall be provided for each and every sample location in Table 6.12.1-1 in the table(s) and figure(s) in the ODCM. Refer to NUREG-0133, "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants," October 1978, and to Radiological Assessment Branch Technical Position, Revision 1, November 1979. Deviations are permitted from the required sampling schedule if specimens are unobtainable due to hazardous conditions, seasonal unavailability, malfunction of automatic sampling equipment and other legitimate reasons. If specimens are unobtainable due to sampling equipment, malfunction, every effort shall be made to complete corrective action before the end of the next sampling period. All above deviations from the sampling schedule shall be documented in the Annual Radiological Environmental Operating Report.

It is recognized that, at times, it may not be possible or practicable to continue to obtain samples of the media of choice at the most desired location or time. In these instances suitable alternative media and locations may be chosen for the particular pathway in question and appropriate substitutions made within 30 days in the radiological environmental monitoring program. Identify the cause of the unavailability of samples for that pathway and identify the new location(s) for obtaining replacement samples in the next Annual Radioactive Effluent Release Report and also include in the report a revised figure(s) and table(s) for the ODCM reflecting the new location(s).

- b Particulate sample filters should be analyzed for gross beta 24 hours or more after sampling to allow for radon and thoron daughter decay. If gross beta activity in air or water is greater than ten times the yearly mean of control samples for any medium, gamma isotopic analysis should be performed on the individual samples.
- c Gamma isotopic analysis means the identification and quantification of gamma-emitting radionuclides that may be attributable to the effluents from the facility.
- d The purpose of this sample is to obtain background information.

TABLE 6.12.1-1 (Continued)

OPERATIONAL RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

TABLE NOTATION (Continued)

- e One or more instruments, such as a pressurized ion chamber, for measuring and recording dose rate continuously may be used in place of, or in addition to, integrating dosimeters. For the purposes of this table, a thermoluminescent dosimeter may be considered to be one phosphor and two or more phosphors in a packet may be considered as two or more dosimeters. Film badges should not be used for measuring direct radiation.

TABLE 6.12.1-2

REPORTING LEVELS FOR RADIOACTIVITY CONCENTRATIONS IN ENVIRONMENTAL SAMPLES

Reporting Levels^b

Analysis	Water (pCi/l)	Airborne Particulate or Gases (pCi/m ³)	Fish (pCi/Kg, wet)	Milk (pCi/l)	Food Products (pCi/Kg, wet)
H-3	2×10^4 ^a	NA	NA	NA	NA
Mn-54	1×10^3	NA	3×10^4	NA	NA
Fe-59	4×10^2	NA	1×10^4	NA	NA
Co-58	1×10^3	NA	3×10^4	NA	NA
Co-60	3×10^2	NA	1×10^4	NA	NA
Zn-65	3×10^2	NA	2×10^4	NA	NA
Zr-Nb-95	4×10^2	NA	NA	NA	NA
I-131	2	0.9	NA	3	1×10^2
Cs-134	30	10	1×10^3	60	1×10^3
Cs-137	50	20	2×10^3	70	2×10^3
Ba-La-140	2×10^2	NA	NA	3×10^2	NA

^a For drinking water samples. This is a 40 CFR Part 141 value. If no drinking water pathway exists, a value of 3×10^4 pCi/l may be used.

^b See BASES 6.12.1 for reporting requirements when multiple or unlisted radionuclides are detected.

TABLE 6.12.1-3

MAXIMUM VALUES FOR THE LOWER LIMITS OF DETECTION (LLD) (a,b)

Analysis	Water (pCi/l)	Airborne Particulate or Gas (pCi/m ³)	Fish (pCi/kg, wet)	Milk (pCi/l)	Broad Leaf Vegetation (pCi/kg, wet)	Sediment (pCi/kg, dry)
Gross beta	4	1 x 10 ⁻²	NA	NA	NA	NA
H-3	2 x 10 ³ (d)	NA	NA	NA	NA	NA
Mn-54	15	NA	1.3 x 10 ²	NA	NA	NA
Fe-59	30	NA	2.6 x 10 ²	NA	NA	NA
Co-58, 60	15	NA	1.3 x 10 ²	NA	NA	NA
Zn-65	30	NA	2.6 x 10 ²	NA	NA	NA
Zr-95	30	NA	NA	NA	NA	NA
Nb-95	15	NA	NA	NA	NA	NA
I-131	1 (c)	7 x 10 ⁻²	NA	1	60	NA
Cs-134	15	5 x 10 ⁻²	1.3 x 10 ²	15	60	1.5 x 10 ²
Cs-137	18	6 x 10 ⁻²	1.5 x 10 ²	18	80	1.8 x 10 ²
Ba-140	60	NA	NA	60	NA	NA
La-140	15	NA	NA	15	NA	NA

TABLE 6.12.1-3 (Continued)

MAXIMUM VALUES FOR THE LOWER LIMITS OF DETECTION (LLD)
TABLE NOTATION

- a. Acceptable detection capabilities for thermoluminescent dosimeters used for environmental measurements are given in Regulatory Guide 4.13.
- b. Table 6.12.1-3 indicates acceptable detection capabilities for radioactive materials in environmental samples. These detection capabilities are tabulated in terms of the lower limits of detection (LLDs). The LLD is defined, for purposes of this guide, as the smallest concentration of radioactive material in a sample that will yield a net count (above system background) that will be detected with 95% probability with only 5% probability of falsely concluding that a blank observation represents a "real" signal.

For a particular measurement system (which may include radiochemical separation):

$$LLD = \frac{4.66 s_b}{E \cdot V \cdot 2.22 \cdot Y \cdot \exp(-\lambda \Delta t)}$$

where

- LLD is the "a priori" lower limit of detection as defined above (as pCi per unit mass or volume). (Current literature defines the LLD as the detection capability for the instrumentation only, and the MDC, minimum detectable concentration, as the detection capability for a given instrument, procedure, and type of sample.)
- s_b is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute)
- E is the counting efficiency (as counts per disintegration)
- V is the sample size (in units of mass or volume)
- 2.22 is the number of disintegrations per minute per picocurie
- Y is the fractional radiochemical yield (when applicable)
- λ is the radioactive decay constant for the particular radionuclide
- Δt is the elapsed time between sample collection (or end of the sample collection period) and time of counting

The value of s_b used in the calculation of the LLD for a particular measurement system should be based on the actual observed variance of the background counting rate or of the counting rate of the blank samples (as appropriate) rather than on an unverified theoretically predicated variance.

TABLE 6.12.1-3 (Continued)

MAXIMUM VALUES FOR THE LOWER LIMITS OF DETECTION (LLD)

TABLE NOTATION (Continued)

Typical values of E, V, Y and Δt should be used in the calculation.

It should be recognized that the LLD is defined as an a priori (before the fact) limit representing the capability of a measurement system and not as a posteriori (after the fact) limit for a particular measurement. Occasionally background fluctuations, unavoidable small sample size, the presence of interfering nuclides, or other uncontrollable circumstances may render these LLDs unachievable. In such cases, the contributing factors should be identified and described in the Annual Radiological Environmental Operating Report.

- c. LLD for drinking water samples. If no drinking water pathway exists, the LLD of gamma isotopic may be used.
- d. If no drinking water pathway exists, a value of 3×10^3 pCi/1 may be used.

6.12 RADIOLOGICAL ENVIRONMENTAL MONITORING

6.12.2 LAND USE CENSUS

LCO 6.12.2 A land use census shall be conducted and shall identify within a distance of 8 km (5 miles) the location in each of the 16 meteorological sectors of the nearest milk animal, the nearest residence and the nearest garden of greater than 50 m² (500 ft²) producing broad leaf vegetation. Broad leaf vegetation sampling may be performed at the SITE BOUNDARY in one of two different offsite locations with the highest predicted D/Qs in lieu of the garden census.

APPLICABILITY: At all times.

ACTIONS

-----NOTES-----
 The provisions of LCO 3.0.3 are not applicable.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. A land use census identifies a location(s) which yields a calculated dose or dose commitment greater than the values currently being calculated in LCO 6.11.6.	A.1 Initiate action to identify the new location(s) in the next Annual Radioactive Effluent Release Report.	Immediately
B. A land use census identifies a location(s) which yields a calculated dose or dose commitment (via the same exposure pathway) 20 percent greater than at a location from which samples are currently being obtained in accordance with LCO 6.12.1.	B.1 Initiate action to identify these higher dose location(s) in the next Annual Radioactive Effluent Release Report. <u>AND</u> B.2 Add these location(s) to the radiological environmental monitoring program.	Immediately 30 days

SURVEILLANCE REQUIREMENTS

SURVEILLANCE	FREQUENCY
SR 6.12.2.1 Conduct a land use census during the growing season. The land use census shall verify the appropriateness of the sample location used to fulfill the requirements of LCO 6.12.1	Once per 2 years

BASES FOR
SECTION 6.0
LIMITING CONDITIONS FOR OPERATION
AND
SURVEILLANCE REQUIREMENTS

6.3 INSTRUMENTATION

BASES

6.3.9 RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

The LCO for radioactive liquid effluent monitoring instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in liquid effluents during actual or potential releases of liquid effluents. The alarm/trip setpoints for these instruments shall be calculated in accordance with the procedures in the ODCM to ensure that the alarm/trip will occur before exceeding ten times the effluent concentration limits of 10 CFR Part 20. The OPERABILITY and use of this instrumentation is consistent with the requirements of General design Criteria 60, 63 and 64 of Appendix A to 10 CFR 50.

6.3.10 RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

The LCO for radioactive gaseous effluent monitoring instrumentation is provided to monitor and control, as applicable, gaseous effluents during actual or potential releases. Those instruments that monitor the activity of gaseous effluents being released to the environment shall have their alarm/trip setpoints calculated in accordance with the methods in the ODCM to ensure that the alarm/trip will occur before exceeding the limits of 10 CFR Part 20. Other instruments that monitor offgas processing, (i.e., Offgas Pre-Treatment Monitor and Offgas Post-Treatment Monitor) are calibrated according to plant procedures. The OPERABILITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63 and 64 of Appendix A to 10 CFR Part 50.

6.11 RADIOACTIVE EFFLUENTS

BASES

LIQUID EFFLUENTS

6.11.1 CONCENTRATION

This LCO is provided to ensure that the concentration of radioactive materials released in liquid waste effluents to UNRESTRICTED AREAS will be less than ten times the effluent concentration values specified in Appendix B, Table 2, Column 2 to 10 CFR 20.1001-20.2402. It provides operational flexibility for releasing liquid effluents in concentrations to follow the Section II.A and II.C design objectives of Appendix I to 10 CFR Part 50. This limitation provides reasonable assurance that the levels of radioactive materials in bodies of water in UNRESTRICTED AREAS will result in exposures within (1) the Section II.A design objectives of Appendix I, 10 CFR 50, to a MEMBER OF THE PUBLIC, and (2) restrictions authorized by 10 CFR 20.1301(e). The concentration limit for dissolved or entrained noble gases is based upon the assumption that Xe-135 is the controlling radionuclide and its effluent concentration in air (submersion) was converted to an equivalent concentration in water. This LCO does not affect the requirement to comply with the annual limitations of 10 CFR 20.1301(a).

The results of pre-release analyses and post release analyses (of composited samples) shall be used with the calculational methods and parameters in the ODCM to assure that the concentrations at the point of release are maintained within the limits.

The required detection capabilities for radioactive materials in liquid waste samples are tabulated in terms of the lower limits of detection (LLDs). Detailed discussion of the LLD, and other detection limits, can be found in:

- (1) HASL Procedures Manual, HASL-300.
- (2) Currie, L. A., "Limits for Qualitative Detection and Quantitative Determination - Application to Radiochemistry," Anal. Chem. 40, 586-93 (1968).
- (3) Hartwell, J. K., "Detection Limits for Radioisotopic Counting Techniques," Atlantic Richfield Hanford Company Report ARH-2537 (June 22, 1972).

6.11.2 DOSE

This LCO is provided to implement the requirements of Sections II.A, III.A and IV.A of Appendix I, 10 CFR Part 50. The ACTION statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I which assure that the releases of radioactive material in liquid effluents to UNRESTRICTED AREAS will be kept "as low as is reasonably achievable." Also, for fresh water sites with drinking water supplies which can be potentially affected by plant operations, there is reasonable assurance that the operation of the facility will not result in radionuclide concentrations in the finished drinking water that are in excess of the requirements of 40 CFR 141. The dose calculations in the ODCM implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data, such that the actual exposure of a MEMBER OF THE PUBLIC through appropriate pathways is unlikely to be substantially underestimated.

RADIOACTIVE EFFLUENTS

BASES

6.11.2 DOSE (Continued)

The equations specified in the ODCM for calculating the doses due to the actual release rates of radioactive materials in liquid effluents are consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1, October 1977 and Regulatory Guide 1.113, "Estimating Aquatic Dispersion of Effluent from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I," April 1977.

This LCO, in conjunction with LCOs 6.11.5 and 6.11.6 is also provided to meet the dose limitation of 40 CFR 190 that has been incorporated into 10 CFR 20.1301(d). Even if a site contained up to four reactors, it is highly unlikely that the resultant dose to a MEMBER OF THE PUBLIC will exceed the dose limits of 40 CFR 190 if the individual reactors remain within twice the dose design objectives of 10 CFR 50 Appendix I, and the direct radiation doses from the units (including outside storage tanks, etc.) are kept small.

Special Report:

LCO 6.11.2 requires preparation and submittal of a report in accordance with 10 CFR 50.4 and as defined in 10 CFR 20.2203(a)(4), if the dose design objectives of 10 CFR 50 Appendix I are exceeded.

If either the quarterly or the annual limit is exceeded, the report will:

- (1) identify the cause(s) for exceeding the limit(s),
- (2) define the corrective actions that have been taken to reduce the releases, and
- (3) define the corrective actions to be taken to ensure that future releases will be in compliance with the limits.

If a drinking water supply is taken from the receiving water body within three miles downstream of the plant discharge, the report shall also include:

- (1) results of radiological analyses of the drinking water source, and
- (2) the radiological impact on finished drinking water supplies with regard to the requirements of 40 CFR 141.

If the doses exceed the limits of 40 CFR 190, 25 mrems to the whole body or any organ, except the thyroid, which is limited to 75 mrems, the report shall:

- (1) define the corrective action to be taken to reduce subsequent releases to prevent recurrence of exceeding the above limits,
- (2) include the schedule for achieving conformance with the above limits,
- (3) include an analysis that estimates the radiation exposure (dose) to a MEMBER OF THE PUBLIC from uranium fuel cycle sources, including all effluent pathways and direct radiation, for the calendar year that includes the release(s) covered by this report,
- (4) describe the levels of radiation and concentrations of radioactive material involved,
- (5) describe the cause of the exposure level or concentrations involved,

RADIOACTIVE EFFLUENTS

BASES

6.11.2 DOSE (Continued)

- (6) describe a course of action that should result in the limitation of the annual dose to a MEMBER OF THE PUBLIC to within the 40 CFR 190 limits.

For the purposes of the report it may be assumed that the dose commitment to the MEMBER OF THE PUBLIC from other uranium fuel cycle sources is negligible, with the exception that the dose distribution from other nuclear fuel cycle facilities at the same site or within a radius of 8 kilometers must be considered.

The Special Report with a request for a variance (provided the release conditions resulting in a violation of 40 CFR 190 have not already been corrected), in accordance with the provisions of 40 CFR 190.11 and 10 CFR 20.2203(a)(4), is considered to be a timely request and fulfills the requirements of 40 CFR 190 until NRC staff action is completed. The variance only relates to the limits of 40 CFR 190, and does not apply in any way to other requirements for dose limitations of 10 CFR 20, as addressed in LCOs 6.11.1 and 6.11.4. An individual is not considered a MEMBER OF THE PUBLIC during any period in which he/she is engaged in carrying out any operation that is part of the nuclear fuel cycle.

Demonstration of compliance with the limits of 40 CFR 190 or with the design objectives of Appendix I to 10 CFR 50 will be considered to demonstrate compliance with the 0.1 rem limit of 10 CFR 20.1301.

RADIOACTIVE EFFLUENTS

BASES

6.11.3 LIQUID WASTE TREATMENT

The LCO that the appropriate portions of this system be used when specified provides assurance that the releases of radioactive materials in liquid effluents will be kept "as low as is reasonably achievable." This LCO implements the requirements of 10 CFR Part 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50 and the design objective given in Section II.D of Appendix I to 10 CFR Part 50. The specified limit governing the use of appropriate portions of the liquid radwaste treatment system were specified as a suitable fraction of the dose design objectives set forth in Section II.A of Appendix I, 10 CFR Part 50, for liquid effluents.

Special Report:

LCO 6.11.3 requires preparation and submittal of a report in accordance with 10 CFR 50.4 if radioactive liquid waste is being discharged without treatment and in excess of the limits. The report shall include:

- (1) an explanation why liquid radwaste was being discharged without treatment,
- (2) identification of any inoperable equipment or subsystems which resulted in liquid radwaste being discharged without treatment,
- (3) the reason for the inoperability
- (4) action(s) taken to restore the inoperable equipment to an OPERABLE status,
- (5) summary descriptions of actions taken to prevent a recurrence.

GASEOUS EFFLUENTS

6.11.4 DOSE RATE

This LCO provides reasonable assurance that radioactive material discharged in gaseous effluents will not result in the exposure of a MEMBER OF THE PUBLIC in an UNRESTRICTED AREA, either at or beyond the SITE BOUNDARY in excess of the design objectives of Appendix I to 10 CFR Part 50. This specification is provided to ensure that gaseous effluents from all units on the site will be appropriately controlled. It provides operational flexibility for releasing gaseous effluents to satisfy the Section II.A and II.C design objectives of Appendix I to 10 CFR Part 50. For MEMBERS OF THE PUBLIC who may at times be within the SITE BOUNDARY, the occupancy of that MEMBER OF THE PUBLIC will usually be sufficiently low to compensate for the reduced atmosphere dispersion of gaseous effluents relative to that for the SITE BOUNDARY. The calculational methods and parameters in the ODCM are used to assure that the dose rates are maintained within the limits. Examples of calculations for such MEMBERS OF THE PUBLIC, with the appropriate occupancy factors, shall be given in the ODCM. The specified release rate limits restrict, at all times, the corresponding dose rates above background to a MEMBER OF THE PUBLIC at or beyond the SITE BOUNDARY to less than or equal to 500 mrem/year to the total body or to less than or equal to 3000 mrem/year to the skin. These releases rate limits also restrict, at all times, the corresponding thyroid dose rate above background to a child via the inhalation pathway to less than or equal to 1500 mrem/year. This specification does not affect the requirement to comply with the annual limitations of 10 CFR 20.1301(a).

The dose rate due to radioactive gaseous effluents shall be determined in accordance with the methodology and parameters of the ODCM.

RADIOACTIVE EFFLUENTS

BASES

6.11.4 DOSE RATE (Continued)

The required detection capabilities for radioactive materials in gaseous waste samples are tabulated in terms of the lower limits of detection (LLDs). Detailed discussion of the LLD, and other detection limits, can be found in:

- (1) HASL Procedures Manual, HASL-300 (revised annually).
- (2) Currie, L. A., "Limits for Qualitative Detection and Quantitative Determination - Application to Radiochemistry," Anal. Chem. 40, 586-93 (1968).
- (3) Hartwell, J. K., "Detection Limits for Radioisotopic Counting Techniques," Atlantic Richfield Hanford Company Report ARH-2537 (June 22, 1972).

6.11.5 DOSE - NOBLE GASES

This LCO is provided to implement the requirements of Sections II.B, III.A and IV.A of Appendix I, 10 CFR Part 50. The Limiting Condition for Operation implements the guides set forth in Section II.B of Appendix I. The ACTION statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in gaseous effluents to UNRESTRICTED AREAS will be kept "as low as is reasonably achievable."

The Surveillance Requirements implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data such that the actual exposure of a MEMBER OF THE PUBLIC through appropriate pathways is unlikely to be substantially underestimated. The dose calculations established in the ODCM for calculating the doses due to the actual release rates of radioactive noble gases in gaseous effluents are consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1, October 1977 and Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water Cooled Reactors," Revision 1, July 1977. The ODCM equations provided for determining the air doses at and beyond the SITE BOUNDARY are based upon the historical average atmospheric conditions.

This LCO, in conjunction with LCOs 6.11.2 and 6.11.6 is also provided to meet the dose limitation of 40 CFR 190 that has been incorporated into 10 CFR 1301(d). Even if a site contained up to four reactors, it is highly unlikely that the resultant dose to a MEMBER OF THE PUBLIC will exceed the dose limits of 40 CFR 190 if the individual reactors remain within twice the dose design objectives of 10 CFR 50 Appendix I, and if the direct radiation doses from the units (including outside storage tanks, etc.) are kept small.

RADIOACTIVE EFFLUENTS

BASES

6.11.5 DOSE - NOBLE GASES (Continued)

Special Report:

LCO 6.11.5 requires preparation and submittal of a report in accordance with 10 CFR 50.4 and as defined in 10 CFR 20.2203(a)(4), if the dose design objectives of 10 CFR 50 Appendix I are exceeded.

If either the quarterly or the annual limit is exceeded, the report will:

- (1) identify the cause(s) for exceeding the limit(s),
- (2) define the corrective actions that have been taken to reduce the releases, and
- (3) define the corrective actions to be taken to ensure that future releases will be in compliance with the limits.

If the doses exceed the limits of 40 CFR 190, 25 mrem to the whole body or any organ, except the thyroid, which is limited to 75 mrem, the report shall:

- (1) define the corrective action to be taken to reduce subsequent releases to prevent recurrence of exceeding the above limits,
- (2) include the schedule for achieving conformance with the above limits,
- (3) include an analysis that estimates the radiation exposure (dose) to a MEMBER OF THE PUBLIC from uranium fuel cycle sources, including all effluent pathways and direct radiation, for the calendar year that includes the release(s) covered by this report,
- (4) describe the levels of radiation and concentrations of radioactive material involved,
- (5) describe the cause of the exposure level or concentrations involved,
- (6) describe a course of action that should result in the limitation of the annual dose to a MEMBER OF THE PUBLIC to within the 40 CFR 190 limits.

For the purposes of the report it may be assumed that the dose commitment to the MEMBER OF THE PUBLIC from other uranium fuel cycle sources is negligible, with the exception that the dose distribution from other nuclear fuel cycle facilities at the same site or within a radius of 8 kilometers must be considered.

The Special Report with a request for a variance (provided the release conditions resulting in a violation of 40 CFR 190 have not already been corrected), in accordance with the provisions of 40 CFR 190.11 and 10 CFR 20.2203(a)(4), is considered to be a timely request and fulfills the requirements of 40 CFR 190 until NRC staff action is completed.

The variance only relates to the limits of 40 CFR 190, and does not apply in any way to other requirements for dose limitations of 10 CFR 20, as addressed in LCOs 6.11.1 and 6.11.4. An individual is not considered a MEMBER OF THE PUBLIC during any period in which he/she is engaged in carrying out any operation that is part of the nuclear fuel cycle.

Demonstration of compliance with the limits of 40 CFR 190 or with the design objectives of Appendix I to 10 CFR 50 will be considered to demonstrate compliance with the 0.1 rem limit of 10 CFR 20.1301.

RADIOACTIVE EFFLUENTS

BASES

6.11.6 DOSE - IODINE-131, IODINE-133, TRITIUM AND RADIONUCLIDES IN PARTICULATE FORM

This LCO is provided to implement the requirements of Sections II.C, III.A and IV.A of Appendix I, 10 CFR Part 50. The Limiting Conditions for Operation are the guides set forth in Section II.C of Appendix I. The ACTION statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive materials in gaseous effluents to UNRESTRICTED AREAS will be kept "as low as is reasonably achievable." The ODCM calculational methods specified in the Surveillance Requirements implement the requirements in Section III.A. of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data, such that the actual exposure of a MEMBER OF THE PUBLIC through appropriate pathways is unlikely to be substantially underestimated. The ODCM calculational methods for calculating the doses due to the actual release rates of the subject materials are consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I,"

Revision 1, October 1977 and Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," Revision 1, July 1977. These equations also provide for determining the actual doses based upon the historical average atmospheric conditions. The release rate specifications for iodine-131, iodine-133, tritium and radionuclides in particulate form are dependent on the existing radionuclide pathway to man in the areas at and beyond the SITE BOUNDARY. The pathways which were examined in the development of these calculations were: (1) individual inhalation of airborne radionuclides, (2) deposition of radionuclides onto green leafy vegetation with subsequent consumption by man, (3) deposition onto grassy areas where milk animals and meat-producing animals graze with consumption of the milk and meat by man, and (4) deposition on the ground with subsequent exposure of man.

This LCO, in conjunction with LCOs 6.11.2 and 6.11.5 is also provided to meet the dose limitation of 40 CFR 190 that has been incorporated into 10 CFR 1301(d). Even if a site contained up to four reactors, it is highly unlikely that the resultant dose to a MEMBER OF THE PUBLIC will exceed the dose limits of 40 CFR 190 if the individual reactors remain within twice the dose design objectives of 10 CFR 50 Appendix I, and if the direct radiation doses from the units (including outside storage tanks, etc.) are kept small.

Special Report:

LCO 6.11.6 requires preparation and submittal of a report in accordance with 10 CFR 50.4 and as defined in 10 CFR 20.2203(a)(4), if the dose design objectives of 10 CFR 50 Appendix I are exceeded.

If either the quarterly or the annual limit is exceeded, the report will:

- (1) identify the cause(s) for exceeding the limit(s),
- (2) define the corrective actions that have been taken to reduce the releases, and
- (3) define the corrective actions to be taken to ensure that future releases will be in compliance with the limits.

RADIOACTIVE EFFLUENTS

BASES

6.11.6 DOSE - IODINE-131, IODINE-133, TRITIUM AND RADIONUCLIDES IN PARTICULATE FORM (Continued)

If the doses exceed the limits of 40 CFR 190, 25 mrems to the whole body or any organ, except the thyroid, which is limited to 75 mrems, the report shall:

- (1) define the corrective action to be taken to reduce subsequent releases to prevent recurrence of exceeding the above limits,
- (2) include the schedule for achieving conformance with the above limits,
- (3) include an analysis that estimates the radiation exposure (dose) to a MEMBER OF THE PUBLIC from uranium fuel cycle sources, including all effluent pathways and direct radiation, for the calendar year that includes the release(s) covered by this report,
- (4) describe the levels of radiation and concentrations of radioactive material involved,
- (5) describe the cause of the exposure level or concentrations involved,
- (6) describe a course of action that should result in the limitation of the annual dose to a MEMBER OF THE PUBLIC to within the 40 CFR 190 limits.

For the purposes of the report it may be assumed that the dose commitment to the MEMBER OF THE PUBLIC from other uranium fuel cycle sources is negligible, with the exception that the dose distribution from other nuclear fuel cycle facilities at the same site or within a radius of 8 kilometers must be considered.

The Special Report with a request for a variance (provided the release conditions resulting in a violation of 40 CFR 190 have not already been corrected), in accordance with the provisions of 40 CFR 190.11 and 10 CFR 20.2203(a)(4), is considered to be a timely request and fulfills the requirements of 40 CFR 190 until NRC staff action is completed.

The variance only relates to the limits of 40 CFR 190, and does not apply in any way to other requirements for dose limitations of 10 CFR 20, as addressed in LCOs 6.11.1 and 6.11.4. An individual is not considered a MEMBER OF THE PUBLIC during any period in which he/she is engaged in carrying out any operation that is part of the nuclear fuel cycle.

Demonstration of compliance with the limits of 40 CFR 190 or with the design objectives of Appendix I to 10 CFR 50 will be considered to demonstrate compliance with the 0.1 rem limit of 10 CFR 20.1301.

RADIOACTIVE EFFLUENTS

BASES

6.11.7 and 6.11.8 GASEOUS RADWASTE TREATMENT AND VENTILATION EXHAUST TREATMENT

The OPERABILITY of the GASEOUS RADWASTE TREATMENT (OFFGAS) SYSTEM and the VENTILATION EXHAUST TREATMENT SYSTEM ensures that the system will be available for use whenever gaseous effluents require treatment before release to the environment. The requirement that the appropriate portions of the system be used, when specified, provides reasonable assurance that the releases of radioactive materials in gaseous effluents will be kept "as low as is reasonably achievable." This specification implements the requirements of 10 CFR Part 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50, and the design objectives given in Section II.D of Appendix I to 10 CFR Part 50. The specified limits governing the use of appropriate portions of the system were specified as a suitable fraction of the dose design objectives set forth in Section II.B and II.C of Appendix I, 10 CFR 50, for gaseous effluents.

Special Report:

LCOs 6.11.7 and 6.11.8 require preparation and submittal of a report in accordance with 10 CFR 50.4 including:

- (1) an explanation of why gaseous radwaste was being discharged without treatment,
- (2) identification of the inoperable equipment or subsystems which resulted in gaseous radwaste being discharged without treatment,
- (3) the reason for the inoperability,
- (4) action(s) taken to restore the inoperable equipment to an OPERABLE status,
- (5) summary descriptions of action(s) taken to prevent a recurrence.

LCO 6.11.8 is not applicable to the Turbine Building ventilation exhaust unless filtration media is installed.

Instruments checked to ensure the GASEOUS RADWASTE TREATMENT (OFFGAS) SYSTEM is functioning are:

- (1) Adsorber Train Bypass Switch (1N64-HS-M611),
- (2) Bypass Valve Indication (1N64-F045).

When the Adsorber Train Bypass Switch is in the TREAT position and the bypass valve indicates CLOSED, the GASEOUS RADWASTE TREATMENT (OFFGAS) SYSTEM is functioning.

6.12 RADIOLOGICAL ENVIRONMENTAL MONITORING

BASES

6.12.1 MONITORING PROGRAM

The radiological monitoring program required by this LCO provides measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides, which lead to the highest potential radiation exposures of MEMBERS OF THE PUBLIC resulting from the station operation. This monitoring program implements Section IV.B.2 of Appendix I to 10 CFR Part 50 and thereby supplements the radiological effluent monitoring program by verifying that the measurable concentrations of radioactive materials and levels of radiation are not higher than expected on the basis of the effluent measurements and modeling of the environmental exposure pathways. The initially specified monitoring program will be effective for at least the first three years of commercial operation. Following this period, program changes may be initiated based on operational experience.

The detection capabilities required by Table 6.12.1-3 are state-of-the-art for routine environmental measurements in industrial laboratories. It should be recognized that the LLD is defined as an "a priori" (before the fact) limit representing the capability of a particular measurement. Analyses shall be performed in such a manner that the stated LLDs will be achieved under routine conditions. Occasionally background fluctuations, unavoidably small sample sizes, the presence of interfering nuclides, or other uncontrollable circumstances may render these LLDs unachievable. In such cases, the contributing factors will be identified and described in the Annual Radiological Environmental Operating Report.

For a more complete discussion of the LLD, and other detection limits, see the following:

- (1) HASL Procedure Manual, HASL-300 (revised annually).
- (2) Currie, L. A., "Limits for Qualitative Detection and Quantitative Determination - Application to Radiochemistry," Anal.Chem. 40, 586-93 (1968).
- (3) Hartwell, J. K., "Detection Limits for Radioisotopic Counting Techniques," Atlantic Richfield Hanford Company Report ARH-2537 (June 22, 1972).

If milk or broadleaf vegetation sampling locations are relocated, the cause shall be reported in the next Annual Radioactive Effluent Release Report. Also, include in this report, revised ODCM figure(s) and table(s) reflecting the new locations. The specific locations from which samples were unavailable may then be deleted from the radiological environmental monitoring program and the table(s) in the ODCM, provided the locations from which the replacement samples were obtained are added to the table(s) as replacement locations.

The requirement for participation in an approved Interlaboratory Comparison Program is provided to ensure that independent checks on the precision and accuracy of the measures of radioactive material in environmental sample matrices are performed as part of the quality assurance program for environmental monitoring in order to demonstrate that the results are valid for the purposes of Section IV.B.2 of Appendix I to 10 CFR Part 50.

6.12 RADIOLOGICAL ENVIRONMENTAL MONITORING

BASES

6.12.1 MONITORING PROGRAM (Continued)

Special Report:

LCO 6.12.1 requires preparation and submittal of a report in accordance with 10 CFR 50.4 when:

- (1) the level of radioactivity as a result of plant effluents in an environmental sampling medium at a specified location exceeds the reporting level(s) in ODCM Table 6.12.1-2 when averaged over a calendar quarter, or
- (2) more than one of the radio nuclides in ODCM Table 6.12.1-2 are detected in the sampling medium and
$$\frac{\text{concentration (1)}}{\text{reporting level (1)}} + \frac{\text{concentration (2)}}{\text{reporting level (2)}} + \dots \geq 1.0, \text{ or}$$
- (3) radio nuclides other than those in ODCM Table 6.12.1-2 are detected, and the potential annual dose to a MEMBER OF THE PUBLIC is equal to or greater than the calendar year limits of LCOs 6.11.2, 6.11.5 and 6.11.6.

The report shall:

- (1) identify the cause(s) for exceeding the limit(s), and
- (2) define the corrective actions to be taken to reduce radioactive effluents so the potential annual dose to a MEMBER OF THE PUBLIC is less than the calendar year limits of LCOs 6.11.2, 6.11.5 and 6.11.6.

The Special Report is not required if the measured level of radioactivity is not the result of plant effluents; however in such an event, the condition shall be reported and identified in the Annual Radiological Environmental Operating Report.

6.12.2 LAND USE CENSUS

This LCO is provided to ensure that changes in the use of areas at and beyond the SITE BOUNDARY are identified and that modifications to the radiological environmental monitoring program are made if required by the results of the census. The best information from door-to-door survey, visual or aerial survey or from consulting with local agricultural authorities shall be used. This census satisfies the requirements of Section IV.B.3 of Appendix I to 10 CFR Part 50. Restricting the census to gardens of greater than 50 m² provides assurance that significant exposure pathways via leafy vegetables will be identified and monitored since a garden of this size is the minimum required to produce the quantity (26 kg/year) of leafy vegetables assumed in Regulatory Guide 1.109 for consumption by a child. To determine this minimum garden size, the following assumptions were made: (1) 20% of the garden was used for growing broad leaf vegetation (i.e., similar to lettuce and cabbage), and (2) a vegetation yield of 2 kg/m². Specifications for broad leaf vegetation sampling in the Table 6.12.1-1 shall be followed, including analysis of control samples.

6.12 RADIOLOGICAL ENVIRONMENTAL MONITORING

BASES

6.12.2 LAND USE CENSUS (Continued)

The land use census should utilize information which provides the best results, such as a door-to-door-survey, an aerial survey or by consulting local agriculture authorities. The results of the land use census shall be included in the Annual Radiological Environmental Operating Report pursuant to Technical Specification 5.6.2.

When the Land Use Census requires addition of sampling location(s) to the Environmental Monitoring Program, the sampling locations(s) having the lowest calculated dose or dose commitments(s), via the same exposure pathway, may be deleted from the monitoring program. This deletion may take place after October 31 of the year in which this land use census was conducted.

The new sampling location(s) shall be identified in the next Annual Radioactive Effluent Release Report including a revised figure(s) and table(s) for the ODCM.

ATTACHMENT II
SUPPLEMENTAL GROSS ALPHA RELEASE DATA
1990 - 2001

The table contains corrected Curie totals for Gaseous Releases Gross Alpha. While some quarter individual curie values increased, the total curies released for the period 1990 – 2001 are less than previously reported. 10CFR20 Appendix B Concentration limits were not exceeded.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Qtr1	4.57E-09	8.58E-08	3.89E-09	2.01E-08	5.56E-08	1.02E-09	2.65E-08	5.99E-10	0.00E+00	0.00E+00	0.00E+00	5.51E-10
Qtr2	1.95E-09	1.08E-09	0.00E+00	6.01E-10	4.55E-07	4.90E-08	0.00E+00	5.14E-10	0.00E+00	1.88E-08	0.00E+00	0.00E+00
Qtr3	7.73E-08	1.03E-09	5.28E-08	3.49E-08	7.50E-08	2.56E-08	2.48E-08	0.00E+00	0.00E+00	0.00E+00	1.26E-09	0.00E+00
Qtr4	3.41E-08	2.13E-08	3.74E-08	4.70E-08	6.70E-08	2.97E-08	4.70E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.11E-08
Total	1.18E-07	1.09E-07	9.41E-08	1.03E-07	6.53E-07	1.05E-07	5.60E-08	1.11E-09	0.00E+00	1.88E-08	1.26E-09	4.17E-08