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10 CFR 50.36(a)(2)

GNRO-2019/00024

April 30, 2019

U.S. Nuclear Regulatory Commission  
Attn: Document Control Desk  
Washington, DC 20555-0001

SUBJECT: Grand Gulf Nuclear Station Annual Radioactive Effluent Release Report  
(ARERR)  
Grand Gulf Nuclear Station, Unit 1  
Docket No. 50-416  
License No. NPF-29

Dear Sir or Madam:

Attached is the Grand Gulf Nuclear Station Annual Radioactive Effluent Release Report for the time period of January 1, 2018 through December 31, 2018. This report is submitted in accordance with the requirements of 10 CFR 50.36(a)(2) and GGNS Unit 1 Technical Specification 5.6.3.

This letter contains no new commitments. If you have any questions or require additional information, please contact George Wynn at 601-437-1426.

Sincerely,

A handwritten signature in cursive script that reads "Eric A. Larson".

Eric A. Larson

EAL/dre

Attachment: Grand Gulf Nuclear Station 2018 Annual Radioactive Effluent Release Report and Offsite Dose Calculation Manual

cc: see next page

cc: U.S. Nuclear Regulatory Commission  
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Attachment 1 to GNRO-2019/00024

Grand Gulf Nuclear Station 2018 Annual Radioactive Effluent Release Report

and

Offsite Dose Calculation Manual



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GRAND GULF NUCLEAR STATION

**ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT**

JANUARY 1, 2018 – DECEMBER 31, 2018

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## **I. INTRODUCTION**

This Annual Radioactive Effluent Release Report (ARERR) for the period of January 1 through December 31, 2018 is submitted in accordance with Technical Specifications, Section 5.6.3, of Grand Gulf Nuclear Station (GGNS) License Number NPF-29. The monitoring of radioactive effluents is referenced in Offsite Dose Calculation Manual (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.

Table 1A reports the summation of all known gaseous releases.

Table 1B reporting of elevated gaseous releases are not applicable at GGNS.

Table 1C reports the summation of all known ground-level gaseous releases.

Table 1D describes the radioactive gaseous sampling and analysis program implemented at GGNS.

Table 2A reports the summation of all liquid releases.

Table 2B reports the continuous and batch mode liquid releases.

Table 2C describes the radioactive liquid waste sampling and analysis program implemented at GGNS.

Table 3 summarizes the solid radioactive waste and irradiated fuel shipments.

Attachment I reports the Groundwater Protection Initiative (GPI) well sample tritium and gamma results not included in the 2018 Annual Radiological Environmental Operating Report (AREOR).

The annual summary of meteorological data (Joint Frequency Distribution) is maintained on site in accordance with ODCM Administrative Controls Section 5.6.3, and shall be provided to the Nuclear Regulatory Commission (NRC) upon request.

## II. DETAILED INFORMATION

### A. Regulatory Limits

#### 1. ODCM Control 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, Tritium 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  $2 \times 10^{-4}$  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:

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

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

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

$D_{\beta}$  = 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. Radiiodines, Tritium 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:

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

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

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

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

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:

$\leq 25$  mrem/yr, Total Body or any Organ except Thyroid

$\leq 75$  mrem/yr, Thyroid

$\leq 10$  mrad  $\gamma$ /qtr or  $\leq 20$  mrad  $\gamma$ /yr, Fission and Activation Gases

$\leq 20$  mrad  $\beta$ /qtr or  $\leq 40$  mrad  $\beta$ /yr, Fission and Activation Gases

$\leq 15$  mrem/qtr or  $\leq 30$  mrem/yr, any Organ, Iodine and Particulates

$\leq 3$  mrem/qtr or  $\leq 6$  mrem/yr, Total Body, Liquid Effluents

$\leq 10$  mrem/qtr or  $\leq 20$  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.

Gaseous dose rates rather than ECL are used to calculate permissible release rates for gaseous releases. The maximum permissible dose rates for gaseous releases are defined in the GGNS ODCM 6.11.4.a as 500 mrem/yr (Total Body) and 3000 mrem/yr (Skin) and in 6.11.4.b as 1500 mrem/yr (Organ).

#### 2. Liquid

The 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.

## II. DETAILED INFORMATION (CONT'D)

### C. Average Energy

Not applicable for GGNS ODCM Appendix A.

The GGNS ODCM limits the instantaneous dose equivalent rates due to the release of noble gases to less than or equal to 500 mrem/year to the total body and less than or equal to 3000 mrem/year to the skin. The average beta and gamma energies of the radionuclide mixture in releases of fission and activation gases as described in Regulatory Guide 1.21, "Measuring, Evaluation, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants," may be used to calculate doses in lieu of more sophisticated software.

The GGNS radioactive effluent programs employs the methodologies presented in U.S. NRC 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 NUREG-0133, "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants, October 1978. Therefore, average energies are not applicable to GGNS.

### D. Measurements and Approximations of Total Activity

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

Fission and Activation Gases	Particulates
Radioiodines	Liquid Effluents

Tables 1D and 2C give sampling frequencies and Lower Limit of Detection 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 levels than required may be readily achievable; when a radionuclide is measured below its stated detection limits, it is reported.

## II. DETAILED INFORMATION (CONT'D)

### 1. Fission and Activation Gases

The principal gamma emitters for which the LLD specification in Table 1D applies exclusively are:

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

Periodic grab samples from Station effluent streams are analyzed by gamma spectral analysis 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. The radionuclides that are detected are used in this computation. When no radionuclides are detected, a historical default mixture is used. 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).

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 default mixture of Kr-88, Xe-133, Xe-135m, Xe-135, and Xe-138.

## II. DETAILED INFORMATION (CONT'D)

### 2. Particulates and Radioiodines

The principal gamma emitters for which the LLD specification in Table 1D applies exclusively are:

Zn-65	Mo-99
Mn-54	Cs-134
Fe-59	Cs-137
Co-58	Ce-141
Co-60	Ce-144
Sr-89	I-131
Sr-90	I-133

### 3. Continuous Releases

Continuous sampling is performed on the continuous release points:

- Offgas/Radwaste Building
- Containment Building
- Fuel Handling Area
- Turbine Building
- Turbine Building Occasional Release Point (when releasing)

Particulate material is collected by filtration. Radioiodines are collected by adsorption onto a charcoal filter. Periodically these filters are removed and analyzed by gamma spectral analysis utilizing high-resolution Germanium detectors to identify and quantify radioactive materials collected. Particulate filters are then analyzed for gross alpha and Strontium-89/90 as required. Strontium analysis is performed by a qualified contract laboratory.

Gross alpha is analyzed using a gas flow proportional detector. Strontium-89/90 values are obtained by chemical separation and subsequent counting analysis using a gas flow proportional detector. Tritium concentrations are determined using distillation and a liquid scintillation detector.

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).

Carbon-14 (C-14) activity of 10.46 Curies released this year in gaseous form was obtained by estimation using EPRI spreadsheet BWR Source Term Calculation (MAL-1)\_r1 and the information in NEAD-NS-11-0060-Rev1-EC42519 and adjusted by 208.3 full power production days. Carbon-14 activity reported in Tables 1A and 1C of this report and based on a constant release rate throughout the quarter.

### 4. Batch Releases: Gases

Gaseous batch releases are not normally performed at GGNS.

II. **DETAILED INFORMATION (CONT'D)**

5. Batch Releases: Liquid Effluents

The principal gamma emitters for which the LLD specification in Table 2C applies exclusively are:

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 described in Table 2C. Isotopic analyses are performed by gamma spectral analysis utilizing high-resolution germanium detectors. Aliquots of each pre-released sample, proportional to the waste volume released, are composited in accordance with the requirements listed in Table 2C.

Iron and Strontium analyses are performed by a qualified contract laboratory. Strontium-89/90 and Iron-55 values are obtained by individual chemical separations. Strontium-89/90 is analyzed using a gas flow proportional detector. Iron-55 is analyzed using a low energy photon detector. Gross alpha is analyzed using a gas flow proportional detector. Tritium is distilled and then analyzed using a liquid scintillation detector. Dissolved gases are determined from grab samples analyzed by gamma spectral analysis utilizing high-resolution germanium detectors.

E. Batch Releases

1. Liquid

<i>Time periods in minutes</i>	1st QTR	2nd QTR	3rd QTR	4th QTR	YEAR
<b>Number of Releases</b>	17	42	53	15	127
<b>Total Release Time</b>	5.30E+03	1.32E+04	1.55E+04	4.39E+03	3.83E+04
<b>Maximum Release Time</b>	3.82E+02	4.05 E+02	3.36E+02	3.14E+02	4.05E+02
<b>Average Release Time</b>	3.12E+02	3.14E+02	2.92E+02	2.92E+02	3.02E+02
<b>Minimum Release Time</b>	2.90E+02	2.67E+02	3.00E+00	1.50E+02	3.00E+00
<b>Average Dilution Water Flow (GPM)</b>	6.23E+03	9.95E+03	5.97E+03	4.94E+03	7.24E+03

During the second and third quarters, significantly more releases occurred during Rad Waste System repairs and recovery plan actions. The unusually low Minimum Release Time for third quarter resulted from a liquid discharge that terminated shortly after starting due to high activity on the liquid effluent radiation monitor. After the monitor was flushed, the tank was resampled and discharged under a new release permit.

## II. DETAILED INFORMATION (CONT'D)

### 2. Gaseous

No batch releases occurred during the report period.

### F. Abnormal Releases

#### 1. Liquid

- a. Number of Releases: 0
- b. Total Activity Released: 0.00E+00 Ci

No abnormal liquid releases were identified for this reporting period.

#### 2. Gaseous

- a. Number of Releases: 1
- b. Total Activity Released: 1.36E-02 Ci

One abnormal release occurred during the reporting period. On 5/27/18, a plant system was drained into the outside Condensate Storage Tank basin to support system repairs during a refueling outage. A conservative calculation for basin evaporative losses estimated the tritium activity release indicated above. The activity was insignificant (< 0.1%) when compared to the total gaseous tritium released in 2018, and is not included in the gaseous effluent totals of this report. This event is documented in CR-GGN-2018-6199 and CR-GGN-2018-6224.

### G. Estimate of Total Error

#### 1. Liquid

The maximum errors are collectively estimated to be as follows:

<i>Error values in %</i>	<b>Fission &amp; Activation Products</b>	<b>Tritium</b>	<b>Dissolved &amp; Entrained Gases</b>	<b>Gross Alpha</b>
<b>Sampling</b>	2.60E+01	2.60E+01	2.60E+01	2.60E+01
<b>Measurement</b>	6.80E+01	6.50E+01	6.10E+01	9.20E+01
<b>TOTAL</b>	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. For germanium detectors, the least-readily-detectable radioisotope is used to determine the counting error. Calibration errors are calculated by summing the errors associated with the calibration of a particular instrument with a radioactive source.

The 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:

<i>Error values in %</i>	<b>Fission &amp; Activation Products</b>	<b>Iodine</b>	<b>Particulate</b>	<b>Gross Alpha</b>	<b>Tritium</b>
<b>Sampling</b>	3.20E+01	2.30E+01	2.20E+01	2.20E+01	2.30E+01
<b>Measurement</b>	6.10E+01	6.70E+01	6.50E+01	1.01E+02	6.20E+01
<b>TOTAL</b>	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 and total errors are calculated by the same methods used for liquid effluents.

### 3. Solid Radioactive Waste

Estimated Total Error % for all waste types is  $\pm 25\%$ . Sampling errors include uncertainty associated with mixing and representative sampling.

#### H. Solid Radioactive Waste Shipments

See Table 3 for shipment information.

#### I. Meteorological Data

The data recovery for the reporting period was 99.6%. The predominant wind direction was from the east-northeast approximately 9.4% of the time. The predominant stability class was class "D" approximately 28.1% of the time. Average wind speed during the reporting period was approximately 3.9 miles per hour at the 33-foot elevation.

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

#### J. Radioactive Effluent Monitoring Instrumentation Operability

On 5/10/19, the Liquid Rad Waste Effluent Flow Monitor had been inoperable for 30 days during a refueling outage whereby normal Circulating Water blowdown flow was unavailable. The flow monitor returned to operable status when the Circulating Water system was restored during plant startup. CR-GGN-2018-5368 documents this condition.

#### K. Annual Sewage Disposal Summary

There were no sewage disposals in 2018.



### III. RADIATION DOSE SUMMARY

Indicated below is the annual summary of offsite doses attributable to GGNS during 2018. Inspection of the values indicates 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 were also met during this period.

#### 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 calculation 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.

Table III.A 2018 Liquid Effluent Dose

<i>Dose in mrem</i>	1st QTR	2nd QTR	3rd QTR	4th QTR	TOTAL
<b>Bone</b>	1.58E-02	3.13E-02	7.05E-02	.188E-02	1.27E-01
<b>Liver</b>	3.45E-02	5.58E-02	1.27E-01	2.68E-02	2.29E-01
<b>Thyroid</b>	6.87E-04	9.07E-04	9.60E-04	3.80E-04	2.88E-03
<b>Kidney</b>	1.72E-02	2.28E-02	5.25E-02	9.37E-03	9.56E-02
<b>Lung</b>	2.60E-03	5.89E-03	1.13E-02	3.39E-03	2.19E-02
<b>GI-LLI</b>	2.22E-02	2.66E-02	5.20E-02	2.71E-03	1.00E-01
Applicable Limit	5	5	5	5	10
Percent of Limit	6.89E-01	1.12E+00	2.54E+00	5.35E-01	2.29E+00
<b>Whole Body</b>	1.95E-02	3.61E-02	8.09E-02	1.77E-02	1.45E-01
Applicable Limit	1.5	1.5	1.5	1.5	3
Percent of Limit	1.30E+00	2.41E+00	5.40E+00	1.18E+00	4.83E+00

#### B. Airborne-Related Exposure Pathways

The values presented in this section utilize information provided in Tables 1A and 1C of this report and the calculation methodology of the ODCM. Dose and dose rates are computed for locations at the site boundary or at unrestricted areas within the site boundary. Because members of the public, on occasion, may be found within the site boundary, two fishing lakes, the recreational vehicle laydown area, and the GGNS Energy Services Center locations were also evaluated.

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.

Doses for a MEMBER OF THE PUBLIC are computed based on 2018 meteorological data and on the most recent land use census, with the most limiting location used.

During normal operations, the dispersion and deposition factors used for dose calculations are from 10-year 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 2018 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. This dose is documented in the following table as two separate entries. The first organ dose entry excludes C-14 while the second entry includes organ dose from tritium, radioiodines, particulates, and C-14.

#### Average Total Body and Skin Dose Rate

Individual total body and skin dose rates from exposure to a semi-infinite cloud of noble gas was calculated for a location in the southwest sector at a distance of 1368 meters (0.85 miles) from the plant. This location corresponds to the highest annual average atmospheric dispersion factor for a location at or within the site boundary based on historical 10-year average meteorological data.

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 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 historical 10-year average 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 2018 as net exposure normalized to 92 days.

#### Carbon-14

Carbon-14 (C-14) is a naturally occurring isotope of carbon. Nuclear weapons testing in the 1950s and 1960s significantly increased the amount of C-14 in the atmosphere. Carbon-14 is also produced in commercial nuclear reactors, but the amounts produced are much less than those produced naturally or from weapons testing. In recent years, the analytical methods for determining C-14 have improved. Coincidentally the radioactive effluents from commercial nuclear power plants have also decreased to the point that C-14 has emerged as a principal radionuclide in gaseous effluents.

**III. RADIATION DOSE SUMMARY (CONT'D)**

The only significant dose pathway to a MEMBER OF THE PUBLIC from C-14 release is through consumption of vegetation. Vegetation incorporates C-14 in form of carbon dioxide (CO<sub>2</sub>) during photosynthesis so doses are calculated based on the CO<sub>2</sub> fraction of the carbon released in gaseous form. A CO<sub>2</sub> fraction of 95% is used based on EPRI Technical Report 1021106, "Estimation of Carbon-14 in Nuclear Power Plant Gaseous Effluents." The highest atmospheric dispersion factor for an actual garden based on the land use census was used to determine dose from C-14. Carbon-14 is dispersed as a gas (CO<sub>2</sub>) to the garden location, where it is then incorporated into plant material.

Carbon-14 dose is calculated to a MEMBER OF THE PUBLIC for the most age restrictive group (Child) and organ (bone) at the garden location. This dose is then added to dose for the same organ from tritium, iodine, and particulates. This organ dose is recorded and compared to the limit in the following table.

Table III.B 2018 Airborne Effluent Dose

	1st QTR	2nd QTR	3rd QTR	4th QTR	TOTAL
<b>Iodine, Tritium &amp; Particulates (excluding Carbon-14)</b>					
Child (mrem)	9.41E-03	2.37E-03	2.16E-03	4.38E-03	1.83E-02
Organ	Thyroid	Thyroid	Thyroid	Thyroid	Thyroid
Applicable Limit	7.5	7.5	7.5	7.5	15
Percent of Limit	1.25E-01	3.16E-02	2.88E-02	5.84E-02	1.22E-01
<b>Iodine, Tritium &amp; Particulates (including Carbon-14)</b>					
Child (mrem)	7.77E-01	7.00E-02	6.29E-01	9.72E-01	2.45E+00
Organ	Bone	Bone	Bone	Bone	Bone
Applicable Limit	7.5	7.5	7.5	7.5	15
Percent of Limit	1.04E+01	9.33E-01	8.38E+00	1.30E+01	1.63E+01
<b>Total Body Dose Rate (mrem/yr)</b>	5.65E+00	1.49E-01	1.27E+00	5.55E-01	
Applicable Limit	500	500	500	500	
Percent of Limit	1.13E-00	2.98E-02	2.54E-01	1.11E-01	
<b>Skin Dose Rate (mrem/yr)</b>	1.08E+01	2.85E-01	2.42E+00	9.31E-01	
Applicable Limit	3000	3000	3000	3000	
Percent of Limit	3.60E-01	9.50E-03	8.07E-02	3.10E-02	
<b>Gamma Air Dose (mrad)</b>	1.50E-01	2.89E-03	1.04E-02	7.88E-03	1.71E-01
Applicable Limit	5	5	5	5	10
Percent of Limit	3.00E+00	5.79E-02	2.08E-01	1.58E-01	1.71E+00
<b>Beta Air Dose (mrad)</b>	1.59E-01	3.12E-03	1.07E-02	7.72E-03	1.80E-01
Applicable Limit	10	10	10	10	20
Percent of Limit	1.59E+00	3.12E-02	1.07E-01	7.72E-02	9.01E-01
<b>Direct Radiation (mrem)</b>	0.00E+00	1.00E-01	1.00E-01	9.00E-01	1.10E+00

### **III. RADIATION DOSE SUMMARY (CONT'D)**

The first quarter doses in Table III.B attributed to noble gases were significantly higher than the remaining quarters due to continued operation with steam leaks that caused elevated response on the Turbine Building Vent effluent radiation monitor due to presence of N-13 in the sample stream. The effluent dose was calculated conservatively using the default mixture when no noble gas was detected in grab samples, and the higher reported effluent activity was driven by the elevated monitor response. Steam leaks were repaired during refueling outage in subsequent quarter.

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

#### **A. Offsite Dose Calculation Manual (ODCM)**

The ODCM was revised in August 2018 to:

1. Revise historic atmospheric dispersion and deposition constants with 2007-2016 annual averages, including constants for "daylight hours only".
2. Added a new air sampler location.

#### **B. Radioactive Waste Treatment Systems**

No major changes to the liquid or gaseous radioactive waste treatment systems occurred during this reporting period.

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

GASEOUS EFFLUENTS - SUMMATION OF ALL RELEASES

REPORT FOR 2018	Units	QTR 1	QTR 2	QTR 3	QTR 4	YEAR
<b>FISSION AND ACTIVATION GASES</b>						
1. Total Release	Ci	4.39E+02	8.75E+00	2.94E+01	2.21E+01	4.99E+02
2. Avg. Release Rate	uCi/sec	5.64E+01	1.11E+00	3.70E+00	2.78E+00	1.58E+01
3. Percent of TS Limit						
a. Gamma Air	%	N/A	N/A	N/A	N/A	N/A
b. Beta Air	%	N/A	N/A	N/A	N/A	N/A
<b>IODINE-131</b>						
1. Total Release	Ci	2.68E-04	3.29E-05	4.34E-05	1.55E-04	4.99E-04
2. Avg. Release Rate	uCi/sec	3.44E-05	4.19E-06	5.47E-06	1.95E-05	1.58E-05
3. Percent of TS Limit	%	N/A	N/A	N/A	N/A	N/A
<b>PARTICULATES - HALF LIFE ≥ 8 DAYS</b>						
1. Total Release	Ci	1.55E-05	1.33E-05	3.36E-07	5.60E-06	3.47E-05
2. Avg. Release Rate	uCi/sec	1.99E-06	1.69E-06	4.23E-08	7.05E-07	1.10E-06
3. Percent of TS Limit	%	N/A	N/A	N/A	N/A	N/A
<b>TRITIUM</b>						
1. Total Release	Ci	7.03E+00	2.56E+00	2.05E+00	2.96E+00	1.46E+01
2. Avg. Release Rate	uCi/sec	9.04E-01	3.26E-01	2.57E-01	3.72E-01	4.63E-01
3. Percent of TS Limit	%	N/A	N/A	N/A	N/A	N/A
<b>CARBON-14</b>						
1. Total Release	Ci	3.30E+00	2.91E-01	2.70E+00	4.17E+00	1.05E+01
2. Avg. Release Rate	uCi/sec	4.20E-01	3.74E-02	3.39E-01	5.24E-01	3.32E-01
<b>GROSS ALPHA RADIOACTIVITY</b>						
1. Total Release	Ci	7.55E-10	0.00E+00	0.00E+00	3.21E-08	3.29E-08
2. Avg. Release Rate	uCi/sec	9.71E-11	0.00E+00	0.00E+00	4.04E-09	1.04E-09

NOTE: Limits are applicable to dose, not concentration. See Table III.B on page 16 for percentage of dose limits.

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

GASEOUS EFFLUENTS – ELEVATED RELEASES

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

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

GASEOUS EFFLUENTS – GROUND-LEVEL RELEASE-CONTINUOUS

REPORT FOR 2018	Units	QTR 1	QTR 2	QTR 3	QTR 4	YEAR
<b>FISSION AND ACTIVATION GASES</b>						
AR-41	Ci	2.39E+00	0.00E+00	3.84E-01	0.00E+00	2.77E+00
KR-85M	Ci	3.07E-01	1.02E-01	0.00E+00	0.00E+00	4.09E-01
KR-88	Ci	8.70E+00	1.68E-01	5.79E-01	4.04E-01	9.85E+00
XE-133	Ci	2.04E+02	4.08E+00	1.36E+01	9.48E+00	2.31E+02
XE-135	Ci	1.95E+02	3.79E+00	1.30E+01	9.49E+00	2.21E+02
XE-135M	Ci	2.31E+01	5.11E-01	1.53E+00	2.48E+00	2.76E+01
XE-138	Ci	5.22E+00	1.01E-01	3.47E-01	2.43E-01	5.91E+00
		-----	-----	-----	-----	-----
Total for Period	Ci	4.39E+02	8.75E+00	2.94E+01	2.21E+01	4.99E+02
<b>IODINES</b>						
I-131	Ci	2.68E-04	3.29E-05	4.34E-05	1.55E-04	4.99E-04
I-133	Ci	6.94E-04	4.59E-05	7.46E-05	6.78E-05	8.83E-04
I-135	Ci	3.14E-04	0.00E+00	0.00E+00	0.00E+00	3.14E-04
		-----	-----	-----	-----	-----
Total for Period	Ci	1.28E-03	7.89E-05	1.18E-04	2.23E-04	1.70E-03
<b>PARTICULATES - HALF LIFE ≥ 8 DAYS</b>						
CO-58	Ci	3.93E-06	0.00E+00	0.00E+00	2.77E-06	6.70E-06
CO-60	Ci	5.75E-06	4.37E-06	0.00E+00	1.71E-06	1.18E-05
CS-137	Ci	0.00E+00	7.53E-07	0.00E+00	0.00E+00	7.53E-07
MN-54	Ci	1.30E-06	0.00E+00	0.00E+00	8.60E-07	2.16E-06
RU-106	Ci	4.50E-06	0.00E+00	0.00E+00	0.00E+00	4.50E-06
SE-75	Ci	0.00E+00	8.18E-06	3.36E-07	2.60E-07	8.78E-06
		-----	-----	-----	-----	-----
Total for Period	Ci	1.55E-05	1.33E-05	3.36E-07	5.60E-06	3.47E-05
<b>OTHER</b>						
H-3	Ci	7.03E+00	2.56E+00	2.05E+00	2.96E+00	1.46E+01
C-14	Ci	3.30E+00	2.91E-01	2.70E+00	4.17E+00	1.05E+01
Gross Alpha	Ci	7.55E-10	0.00E+00	0.00E+00	3.21E-08	3.29E-08

NOTE: Only radionuclides with positive results reported.

TABLE 1D  
 ENTERGY OPERATIONS, INC.  
 GRAND GULF NUCLEAR STATION UNIT 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) (uCi/ml) (a)
A. (1) Radwaste Building Ventilation Exhaust  (2) Fuel Handling Area Ventilation Exhaust  (3) Containment Ventilation Exhaust  (4A) Turbine Building Ventilation Exhaust  (4B) Turbine Building Occasional Release Point (g) (when in service)	31 Days Grab Sample (f)	31 Days	Principal Gamma Emitters (b,e)	1.00E-04
			H-3	1.00E-06
	Continuous (d) (f)	7 Days (c) Charcoal Sample	I-131	1.00E-12
			I-133	1.00E-10
	Continuous (d) (f)	7 Days (c) Particulate Sample	Principal Gamma Emitters (e) (I-131, Others)	1.00E-11
	Continuous (d) (f)	31 Days Composite Particulate Sample	Gross Alpha	1.00E-11
	Continuous (d) (f)	92 Days Composite Particulate Sample	Sr-89, Sr-90	1.00E-11
Continuous (f)	Noble Gas Monitor	Noble Gases Gross Beta or Gamma	1.00E-06	
B. (1) Offgas Post Treatment Exhaust, whenever there is flow	31 Days Grab Sample (f)	31 Days	Principal Gamma Emitters (e)	1.00E-04
(2) Standby Gas Treatment A Exhaust, whenever there is flow	31 Days Grab Sample (f)	31 Days	Principal Gamma Emitters (e)	1.00E-04
(3) Standby Gas Treatment B Exhaust, whenever there is flow	31 Days Grab Sample (f)	31 Days	Principal Gamma Emitters (e)	1.00E-04

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

LIQUID EFFLUENTS – SUMMATION OF ALL RELEASES

REPORT FOR 2018	Units	QTR 1	QTR 2	QTR 3	QTR 4	YEAR
<b>FISSION AND ACTIVATION PRODUCTS</b>						
1. Total Release	Ci	8.60E-03	1.53E-02	1.63E-02	1.99E-03	4.21E-02
2. Avg. Diluted Conc.	uCi/ml	6.80E-08	3.04E-08	4.58E-08	2.37E-08	3.95E-08
3. Percent of Limit	%	N/A	N/A	N/A	N/A	N/A
<b>TRITIUM</b>						
1. Total Release	Ci	8.70E+00	1.83E+01	1.17E+01	3.85E+00	4.25E+01
2. Avg. Diluted Conc.	uCi/ml	6.87E-05	3.65E-05	3.28E-05	4.60E-05	3.98E-05
3. Percent of Limit	%	N/A	N/A	N/A	N/A	N/A
<b>DISSOLVED AND ENTRAINED GASES</b>						
1. Total Release	Ci	1.29E-05	5.67E-05	0.00E+00	0.00E+00	6.96E-05
2. Avg. Diluted Conc.	uCi/ml	1.02E-10	1.13E-10	0.00E+00	0.00E+00	6.52E-11
3. Percent of Limit	%	N/A	N/A	N/A	N/A	N/A
<b>GROSS ALPHA RADIOACTIVITY</b>						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
<b>VOLUME</b>						
Liquid Waste	liters	1.82E+06	4.58E+06	5.32E+06	1.53E+06	1.33E+07
Dilution Water	liters	1.25E+08	4.97E+08	3.50E+08	8.21E+07	1.05E+09

NOTE: Limits are applicable to dose, not concentration. See Table III.A on page 14 for percentage of dose limits.

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

LIQUID EFFLUENTS – CONTINUOUS AND BATCH MODES

REPORT FOR 2018	Units	QTR 1	QTR 2	QTR 3	QTR 4	YEAR
-----------------	-------	-------	-------	-------	-------	------

FISSION AND ACTIVATION GASES						
AG-110M	Ci	1.09E-04	5.40E-04	1.23E-04	0.00E+00	7.72E-04
AS-76	Ci	0.00E+00	3.45E-04	1.29E-04	0.00E+00	4.74E-04
CO-58	Ci	5.02E-04	5.21E-04	5.43E-04	0.00E+00	1.57E-03
CO-60	Ci	3.08E-03	4.44E-03	1.14E-02	4.53E-04	1.94E-02
CR-51	Ci	7.11E-04	5.75E-04	1.16E-04	5.40E-05	1.46E-03
CS-134	Ci	1.23E-05	7.58E-05	7.84E-05	3.95E-06	1.70E-04
CS-137	Ci	6.57E-05	2.61E-04	3.81E-04	1.06E-04	8.14E-04
FE-55	Ci	2.32E-03	6.37E-03	0.00E+00	1.26E-03	9.95E-03
FE-59	Ci	1.19E-04	4.45E-05	1.70E-05	0.00E+00	1.81E-04
IA-140	Ci	0.00E+00	0.00E+00	4.39E-05	0.00E+00	4.39E-05
MN-54	Ci	1.02E-03	1.06E-03	2.09E-03	6.31E-05	4.23E-03
NA-24	Ci	0.00E+00	1.89E-05	2.70E-05	0.00E+00	4.59E-05
NB-95	Ci	0.00E+00	2.77E-05	0.00E+00	0.00E+00	2.77E-05
PT-195M	Ci	0.00E+00	9.14E-05	4.26E-05	0.00E+00	1.34E-04
RU-106	Ci	0.00E+00	5.57E-05	1.68E-04	2.68E-05	2.51E-04
SB-125	Ci	2.33E-05	1.05E-04	0.00E+00	0.00E+00	1.29E-04
SR-92	Ci	7.19E-06	2.29E-05	0.00E+00	0.00E+00	3.01E-05
ZN-65	Ci	6.39E-04	7.12E-04	1.09E-03	1.55E-05	2.46E-03
ZR-97	Ci	0.00E+00	1.44E-05	0.00E+00	0.00E+00	1.44E-05
-----						
Total for Period	Ci	8.60E-03	1.53E-02	1.63E-02	1.99E-03	4.21E-02

TRITIUM						
Total for Period	Ci	8.70E+00	1.83E+01	1.17E+01	3.85E+00	4.25E+01

DISSOLVED AND ENTRAINED GASES						
XE-133	Ci	0.00E+00	4.97E-05	0.00E+00	0.00E+00	4.97E-05
XE-135	Ci	1.29E-05	7.04E-06	0.00E+00	0.00E+00	1.99E-05
-----						
Total for Period	Ci	1.29E-05	5.67E-05	0.00E+00	0.00E+00	6.96E-05

GROSS ALPHA RADIOACTIVITY						
Total for Period	Ci	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 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)	5.00E-07
			I-131	1.00E-06
	Prior to Release One Batch/Month	31 Days	Dissolved and Entrained Gases (Gamma Emitters)	1.00E-05
	Prior to Release Each Batch	31 Days Composite (b)	H-3	1.00E-05
			Gross Alpha	1.00E-07
	Prior to Release Each Batch	92 Days Composite (b)	Sr-89, Sr-90	5.00E-08
Fe-55			1.00E-06	
B. SSW Basin (Before Blowdown)	Prior to Release Each Blowdown	Prior to Release Each Batch	Principal Gamma Emitters (d)	5.00E-07
			I-131	1.00E-06

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

SOLID RADIOACTIVE WASTE AND IRRADIATED FUEL SHIPMENTS

A. SOLID WASTE SHIPPED OFFSITE FOR BURIAL OR DISPOSAL (NOT IRRADIATED FUEL)

1. Type of Waste	Unit	Class A	Class B	Class C	Estimated Total Error
a. Spent resins, filter sludges, evaporator bottoms, etc.	m <sup>3</sup>	2.50E+02	0.00E+00	0.00E+00	± 25%
	Ci	1.14E+02	0.00E+00	0.00E+00	
b. Dry compressible waste, contaminated equipment, etc.	m <sup>3</sup>	1.46E+03	0.00E+00	0.00E+00	± 25%
	Ci	1.07E+00	0.00E+00	0.00E+00	
c. Irradiated components, control rods, etc.	m <sup>3</sup>	0.00E+00	0.00E+00	8.43E-01	± 25%
	Ci	0.00E+00	0.00E+00	6.71E+04	
d. Other: Oily waste drums	m <sup>3</sup>	5.74E+02	0.00E+00	0.00E+00	± 25%
	Ci	2.44E-01	0.00E+00	0.00E+00	

2. Estimate of Major Nuclide Composition (by type of waste)

a. Spent resins, filter sludges, evaporator bottoms, etc.

Isotope (> 0.1%)	Percent	Curies
H-3	0.97	1.11E+00
C-14	2.20	2.52E+00
Cr-51	0.48	5.45E-01
Mn-54	7.08	8.09E+00
Fe-55	50.35	5.76E+01
Co-58	1.43	1.63E+00
Co-60	32.18	3.68E+01
Ni-63	0.94	1.08E+00
Zn-65	3.28	3.75E+00
Ag-110m	0.16	1.78E-01
Sb-125	0.10	1.17E-01
Cs-134	0.19	2.15E-01
Cs-137	0.45	5.12E-01
Ce-144	0.12	1.37E-01

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

SOLID RADIOACTIVE WASTE AND IRRADIATED FUEL SHIPMENTS

b. Dry compressible waste, contaminated equipment, etc.

Isotope (> 0.1%)	Percent	Curies
H-3	0.83	8.84E-03
Mn-54	8.57	9.12E-02
Fe-55	36.2	3.85E-01
Co-58	0.67	7.14E-03
Co-60	35.7	3.80E-01
Ni-63	0.19	2.07E-03
Zn-65	1.42	1.51E-02
Sr-90	0.12	1.30E-03
Zr-95	4.63	4.93E-02
Nb-95	9.22	9.82E-02
Sn-113	0.31	3.31E-03
Sb-125	1.35	1.44E-02
Cs-137	0.38	4.03E-03
Ce-144	0.38	4.08E-03

c. Irradiated components, control rods, etc.

Isotope (> 0.1%)	Percent	Curies
Mn-54	0.42	2.81E+02
Fe-55	47.72	2.87E+04
Co-60	48.49	3.25E+04
Ni-63	7.73	5.19E+03
Sb-125	0.52	3.51E+02

TABLE 3 - Continued  
 ENERGENCY OPERATIONS, INC.  
 GRAND GULF NUCLEAR STATION UNIT 1

SOLID RADIOACTIVE WASTE AND IRRADIATED FUEL SHIPMENTS

d. Other: Oil drum sealant, mixed waste for volume reduction

Isotope (> 0.1%)	Percent	Curies
H-3	0.82	2.00E-03
Mn-54	8.57	2.09E-02
Fe-55	35.9	8.75E-02
Co-58	0.70	1.71E-03
Co-60	35.34	8.61E-02
Ni-63	0.19	4.69E-04
Zn-65	1.43	3.47E-03
Sr-90	0.12	2.95E-04
Zr-95	4.85	1.18E-02
Nb-95	9.65	2.35E-02
Sn-113	0.32	7.74E-04
Sb-125	1.34	3.27E-03
Cs-137	0.37	9.12E-04
Ce-144	0.38	9.35E-04

3. Solid Waste Disposition

Number of Shipments	Destination Name	City	State	Mode of Transportation
3	EnergySolutions, Clive Disposal Site (Bulk Waste Facility)	Clive	UT	Hittman
26	EnergySolutions, Clive Disposal Site (Containerized Waste Facility)	Clive	UT	Hittman
5	EnergySolutions Services, Inc. Memphis Facility	Memphis	TN	Hittman
31	EnergySolutions, Inc. Bear Creek Road	Oak Ridge	TN	Hittman
8	EnergySolutions Gallaher Road Facility	Oak Ridge	TN	Hittman
4	EnergySolutions Erwin Resin Solutions	Erwin	TN	Hittman
6	Waste Control Specialists, LLC Compact Waste Disposal Facility	Andrews	TX	Hittman

TABLE 3 - Continued  
ENERGY OPERATIONS, INC.  
GRAND GULF NUCLEAR STATION UNIT 1

SOLID RADIOACTIVE WASTE AND IRRADIATED FUEL SHIPMENTS

B. Irradiated Fuel Shipments (Disposition)

<b>Number of Shipments</b>	<b>Mode of Transportation</b>	<b>Destination</b>
None	N/A	N/A

**ATTACHMENT I**

**Nuclear Energy Institute (NEI) Groundwater Protection Initiative Sample Results**

**JANUARY – DECEMBER 2018**

GPI Ground Water samples were collected from onsite Dewatering Wells (DW), Monitoring Wells (MW), Observation Wells (OW), and Sump Wells (SW). Samples were analyzed for Tritium and selected samples were analyzed for gamma and/or hard to detect (HTD) isotopes (Gross Alpha, Iron-55, Nickel-63, Strontium-89 and Strontium-90). Analyses are to the Lower Level of Detection (LLD) values for the GGNS Radiological Environmental Monitoring Program.

No dose to the public is attributed to ground water since wells with results above MDA are bounded by wells which are less than minimum detectable activity (< MDA). Tritium, gamma and/or HTD results are shown in the table below.

All results were less than Reporting Levels of GGNS-ODCM table 6.12.1-2.

<u>LOCATION</u>	<u>DATE</u>	<u>TRITIUM (pCi/L)</u>	<u>GAMMA (pCi/L)</u>
DW-01	02/22/18	948	< MDA
DW-01	06/06/18	1,980	< MDA
DW-01	12/05/18	2,020	< MDA
DW-02	02/21/18	722	< MDA
DW-02	06/06/18	< 570	< MDA
DW-02	09/18/18	744	< MDA
DW-02	12/05/18	< 592	< MDA
DW-03	02/22/18	< 581	< MDA
DW-03	06/06/18	< 512	< MDA
DW-03	09/19/18	744	< MDA
DW-03	12/05/18	< 572	< MDA
DW-04	02/20/18	< 544	< MDA
DW-04	06/06/18	< 511	< MDA
DW-04	09/19/18	880	< MDA
DW-04	12/06/18	< 582	< MDA
DW-07	02/20/18	4,010	< MDA
DW-07	06/06/18	3,630	< MDA
DW-07	09/18/18	3,540	< MDA
DW-07	12/04/18	2,690	< MDA
MW-01	02/20/18	< 558	< MDA
MW-01	06/06/18	1,020	< MDA
MW-01	09/18/18	972	< MDA
MW-01	12/05/18	692	< MDA



<u>LOCATION</u>	<u>DATE</u>	<u>TRITIUM (pCi/L)</u>	<u>GAMMA (pCi/L)</u>
MW-04	02/22/18	< 590	< MDA
MW-04	06/06/18	< 528	< MDA
MW-04	09/19/18	< 562	< MDA
MW-04	12/06/18	< 585	< MDA
MW-05	09/20/18	< 598	< MDA
MW-06	02/21/18	1,460	< MDA
MW-06	06/05/18	1,640	< MDA
MW-06	09/20/18	1,390	< MDA
MW-06	12/06/18	1,650	< MDA
MW-100B	12/04/18	< 575	< MDA
MW-101B	02/21/18	< 491	< MDA
MW-101B	06/05/18	< 505	< MDA
MW-101B	09/18/18	< 596	< MDA
MW-101B	12/05/18	< 579	< MDA
MW-102B	12/05/18	< 587	< MDA
MW-103B	12/04/18	< 575	< MDA
MW-104B	12/04/18	< 572	< MDA
MW-105B	02/20/18	617	< MDA
MW-105B	06/05/18	< 580	< MDA
MW-105B	09/18/18	< 577	< MDA
MW-105B	12/04/18	< 581	< MDA
MW-106B	02/21/18	< 491	< MDA
MW-106B	06/05/18	< 496	< MDA
MW-106B	09/18/18	< 586	< MDA
MW-106B	12/05/18	< 568	< MDA
MW-107B	02/20/18	953	< MDA
MW-107B	06/06/18	679	< MDA
MW-107B	09/18/18	1,010	< MDA
MW-107B	12/04/18	1,090	< MDA
MW-108B	02/20/18	880	< MDA
MW-108B	06/05/18	1,060	< MDA
MW-108B	09/20/18	1,300	< MDA
MW-108B	12/04/18	920	< MDA

<u>LOCATION</u>	<u>DATE</u>	<u>TRITIUM (pCi/L)</u>	<u>GAMMA (pCi/L)</u>
MW-109B	02/21/18	916	< MDA
MW-109B	06/05/18	855	< MDA
MW-109B	09/20/18	1150	< MDA
MW-109B	12/06/18	< 586	< MDA
MW-110B	02/20/18	< 580	< MDA
MW-110B	06/05/18	< 504	< MDA
MW-110B	09/18/18	< 600	< MDA
MW-110B	12/04/18	< 594	< MDA
MW-111B	02/22/18	< 577	< MDA
MW-111B	06/06/18	1,900	< MDA
MW-111B	12/05/18	< 583	< MDA
MW-112B	02/22/18	< 576	< MDA
MW-112B	06/06/18	652	< MDA
MW-112B	09/19/18	812	< MDA
MW-112B	12/05/18	< 598	< MDA
MW-113B	02/20/18	< 492	< MDA
MW-113B	06/05/18	< 505	< MDA
MW-113B	09/18/18	< 561	< MDA
MW-113B	12/05/18	< 571	< MDA
MW-114B	02/20/18	1,490	< MDA
MW-114B	06/05/18	1,310	< MDA
MW-114B	09/18/18	2,380	< MDA
MW-114B	12/05/18	1,580	< MDA
MW-115B	02/22/18	< 593	< MDA
MW-115B	06/06/18	941	< MDA
MW-115B	09/19/18	1,030	< MDA
MW-115B	12/05/18	1,210	< MDA
MW-116B	02/22/18	< 501	< MDA
MW-116B	06/06/18	< 508	< MDA
MW-116B	09/19/18	< 582	< MDA
MW-116B	12/05/18	< 596	< MDA
MW-118B	02/22/18	< 592	< MDA
MW-118B	06/06/18	1,690	< MDA
MW-118B	09/19/18	1,950	< MDA
MW-118B	12/05/18	< 566	< MDA

<u>LOCATION</u>	<u>DATE</u>	<u>TRITIUM (pCi/L)</u>	<u>GAMMA (pCi/L)</u>
MW-119B	12/05/18	< 580	< MDA
MW-120B	12/05/18	< 520	< MDA
MW-121B	12/04/18	< 577	< MDA
MW-122B	02/21/18	< 497	< MDA
MW-122B	06/05/18	< 510	< MDA
MW-122B	09/19/18	< 566	< MDA
MW-122B	12/05/18	< 578	< MDA
MW-123B	02/22/18	< 579	< MDA
MW-123B	06/06/18	< 518	< MDA
MW-123B	09/19/18	< 579	< MDA
MW-123B	12/05/18	< 595	< MDA
MW1007C	09/19/18	< 593	< MDA
MW1009C	09/18/18	< 585	< MDA
MW1012C	09/19/18	< 593	< MDA
MW1020C	09/18/18	< 586	< MDA
MW1024C	09/19/18	< 595	< MDA
MW1027C	09/19/18	< 594	< MDA
MW1042C	09/19/18	< 591	< MDA
MW1082C	09/18/18	< 587	< MDA
MW1134C	09/18/18	< 600	< MDA
P-05	09/20/18	< 587	< MDA
SW-102	06/05/18	< 504	< MDA
SW-103A	02/20/18	< 397	< MDA
SW-103A	06/05/18	< 498	< MDA
SW-103A	09/19/18	< 579	< MDA
SW-103A	12/05/18	< 562	< MDA

< MDA - Less than Minimum Detectable Activity

**GRAND GULF NUCLEAR STATION**

**OFFSITE DOSE CALCULATION MANUAL**

**DOCKET NO. 50-416**

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 Requirements Manual (TRM) 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.

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.

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REVISION TABLE

The following ODCM Revision Table represents changes to the ODCM listed in the order of the most recent change:

Description of Change(s)	Revision Number	Month/Year of Change	Affected Page Number (s)
<ul style="list-style-type: none"> <li>• Corrections to Table 6.11.4-1 from LBDCR 2017-017 (Corrections implemented via LBDCR 2018-126)</li> </ul>	41	01/2019	A-39, A-41
<ul style="list-style-type: none"> <li>• Revise Tables 2.2-3, 2.2-3a, and 2.2-3b to replace X/Q and D/Q values with 2007-2016 annual averages. Update Reference 19. Add Reference 20.</li> <li>• Add air sample location to Table 3.0-1 and to Figure 3.0-1.</li> </ul>	40	08/2018	i, vi, vii, viia, viii, 2.0-23, 2.0-23a, 2.0-23b, 3.0-2, 3.0-7, A-11, A-11a, A-23, A-23a, A-27, A-50, A-52
<ul style="list-style-type: none"> <li>• Revise ODCM to align usage of FUNCTIONAL versus OPERABLE</li> </ul>	LBDCR 15051	1/2017	A-13, A-14, A-17, A-18, A-19, A-20, A-21, A-22, A-24, A-25, A-26, A-27, A-29, A-34, A-37, A-42, A-44, A-62, A-66, A-71,
<ul style="list-style-type: none"> <li>• Corrects Revision Table and List of Effective Pages Information for LBDCR 2017-00012 and LBDCR 2017-00008 (Ref CR-GGN-2017-6796 CA4)</li> </ul>	LBDCR 18012	2/2018	i, viii
<ul style="list-style-type: none"> <li>• Revise Table 6.3.10-1 Section 3B to include note h. Note h is to acknowledge ≤4 Turbine Building roof hatches may be open in Modes 4 and 5. LDCR 2012-017</li> </ul>	39	03/2012	i, vii, viia, viib, 2.0-35, A-26, A-28, A-39, A-41
<ul style="list-style-type: none"> <li>• Revise 6.3.9 to add condition E. Condition E is to acknowledge that as long as flow is monitored and measured, there is no need to suspend dilution flow activities LBDCR 12-012</li> </ul>	38	03/2012	i, ia, vii, viib, A-14
<ul style="list-style-type: none"> <li>• Revise Tables 2.2-3, 2.2-3a and 2.2-3b to replace X/Q and D/Q values with 2001-2005 annual averages, change to Reference 19, say 2008 Land Use Census utilized, and specify method of calculating parameters for unavailable location.</li> <li>• Added second onsite vegetation sample location to Tables 2.2-3b and 3.0-2 and to Figure 3.0-1.</li> <li>• Renumbered pages 2.0-24a and 2.0-25.</li> <li>• Deleted Pages 3.0-6a, 6b, 6c, and 6d</li> <li>• Deleted Section 2.4, "Definitions of Gaseous Effluents Parameters" since included throughout Section 2.0. Reference: LBDCR 2008-034</li> </ul>	37	02/2009	i, ii, iii, vii, viia, 2.0-23, 2.0-23a, 2.0-23b  2.0-25 thru 2.0-30  3.0-3a 3.0-7
<ul style="list-style-type: none"> <li>• Adds Table 2.2-1.b, "Pathway Dose Factors for LCO 6.11.4 and Section 2.2.1.b, (Pi)", for age group "Child".</li> <li>• Changes note for Section 2.2.1.b to use Child Inhalation Pi values from Table 2.2-1b. Reference: LBDCR 2008-014</li> </ul>	36	11/2008	i, ii, iia, v, vii, 2.0-8, 2.0-13, 2.0-14

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2.	Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10CFR50, Appendix I, U.S. NRC Regulatory Guide 1.109 (March 1976).
3.	Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10CFR50, Appendix I, U.S. NRC Regulatory Guide 1.109, Rev. 1 (October 1977).
4.	"Environmental Report," Mississippi Power and Light Company, Grand Gulf Nuclear Station, Units 1 and 2.
5.	"Final Safety Analysis Report," Mississippi Power and Light Company, Grand Gulf Nuclear Station.
6.	Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light - Water - Cooled Reactors, U.S. NRC Regulatory Guide 1.111 (March 1976).
7.	Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light - Water - Cooled Reactors, U.S. NRC Regulatory Guide 1.111, Rev. 1 (July 1977).
8.	Age-Specific Radiation Dose Commitment Factors for a One-Year Chronic Intake, NUREG-0172, November 1977.
9.	EER 93-6246 "X/Q and D/Q Atmospheric Dispersion and Deposition Factors".
10.	NPE Calculation #XC-Q1111-94002, Revision 2.
11.	GIN 97/01515 "Determination of Composite Dose Factor based on GGNS Historical Gaseous Releases".
12.	GIN 99/00152 "Liquid Monitor Trip Setpoint for Tanks with no Gamma Emitters"
13.	NUREG/CR-2919, "XOQDOQ: Computer Program for the meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations".
14.	NPE Calculation #XC-Q1111-01008, Revision 0
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16.	GIN-2002/00718 "Historical ODCM Meteorological Model and Recirculation Factor Calculation Analysis".
17.	GIN-2001/01196 "Liquid Process and Liquid Effluent Radiation Monitor Calibration Basis".
18.	GIN-2005/00562 "Radiological Assessment of Storm Drain Tritium discharges at the Grand Gulf Nuclear Station.
19.	GIN-2017/00046 "Review of 2007-2016 Annual Average Relative Concentration and Relative Deposition".
20.	GIN-2018-00104 "2007-2016 Annual Average Relative Concentration and Relative Deposition Daylight hours Only."

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A-9	22
A-10	17
A-11	40
A-11a	40
A-12	17
A-12a	27
A-13	LBDCR 15051
A-14	LBDCR 15051
A-15	17
A-16	17
A-17	LBDCR 15051
A-18	LBDCR 15051
A-19	LBDCR 15051
A-20	LBDCR 15051
A-21	LBDCR 15051
A-22	LBDCR 15051
A-23	40
A-23a	40
A-24	LBDCR 15051
A-25	LBDCR 15051
A-26	LBDCR 15051
A-27	40
A-28	39
A-29	LBDCR 15051
A-30	17
A-31	17
A-32	17
A-33	17
A-34	LBDCR 15051
A-35	17
A-36	17
A-37	LBDCR 15051
A-38	17
A-39	41
A-40	17
A-41	41

A-42	LBDCR 15051
A-43	17
A-44	LBDCR 15051
A-45	17
A-46	17
A-47	17
A-48	17
A-49	17
A-50	35
A-51	32
A-52	35
A-53	35
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	LBDCR 15051
A-63	17
A-64	17
A-65	17
A-66	LBDCR 15051
A-67	22
A-68	17
A-69	17
A-70	17
A-71	LBDCR 15051
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. The method by which this is accomplished is as follows:

Step 1) The isotopic concentration for a waste tank to be released is obtained from the sum of the measured concentrations as determined by the analysis required in 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.

$$\begin{aligned}
 \text{D.F.} &= \left[ \sum_i \frac{C_i}{EC_i} \right] \times \text{S.F.} \\
 &= \left[ \sum_g \frac{C_g}{EC_g} + \frac{C_a}{EC_a} + \sum_s \frac{C_s}{EC_s} + \frac{C_t}{EC_t} + \frac{C_f}{EC_f} \right] \times \text{S.F.} \quad (3)
 \end{aligned}$$

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  $2.0E-4$   $\mu\text{Ci/ml}$  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, when determining the setpoint,  $S_p$  the summation of the gamma emitters in the tank is used and  $S_p$  is determined as follows:

$$S_p(\text{cpm}) = (f_d/f_a \times \sum C_g \times \text{MRF})$$

Where:

$f_d$  = maximum permissible waste tank effluent flow rate (gpm)

$f_a$  = actual or maximum expected waste tank effluent flow rate (gpm)

$\sum C_g$  = Summation of all detected gamma emitters (uCi/ml)

MRF = Monitor Response Factor (cpm/uCi/ml) (Figure 1.0-1)<sup>(17)</sup>

For waste tanks where the quantity of gamma emitters does not produce a significant response above background,  $S_p$ , may be determined as follows:

If  $S_p = 0$ , i.e. no gamma emitters present, then  $S_p = 2700$  cpm

Or

If  $S_p < (\text{Monitor Error} \times \text{Background})$ , then  $S_p = (\text{Monitor Error} \times \text{Background})$ . Provided that the error times the background is not greater than 2700 cpm.

Note: 2700 cpm is based on Cesium-137 monitor response and

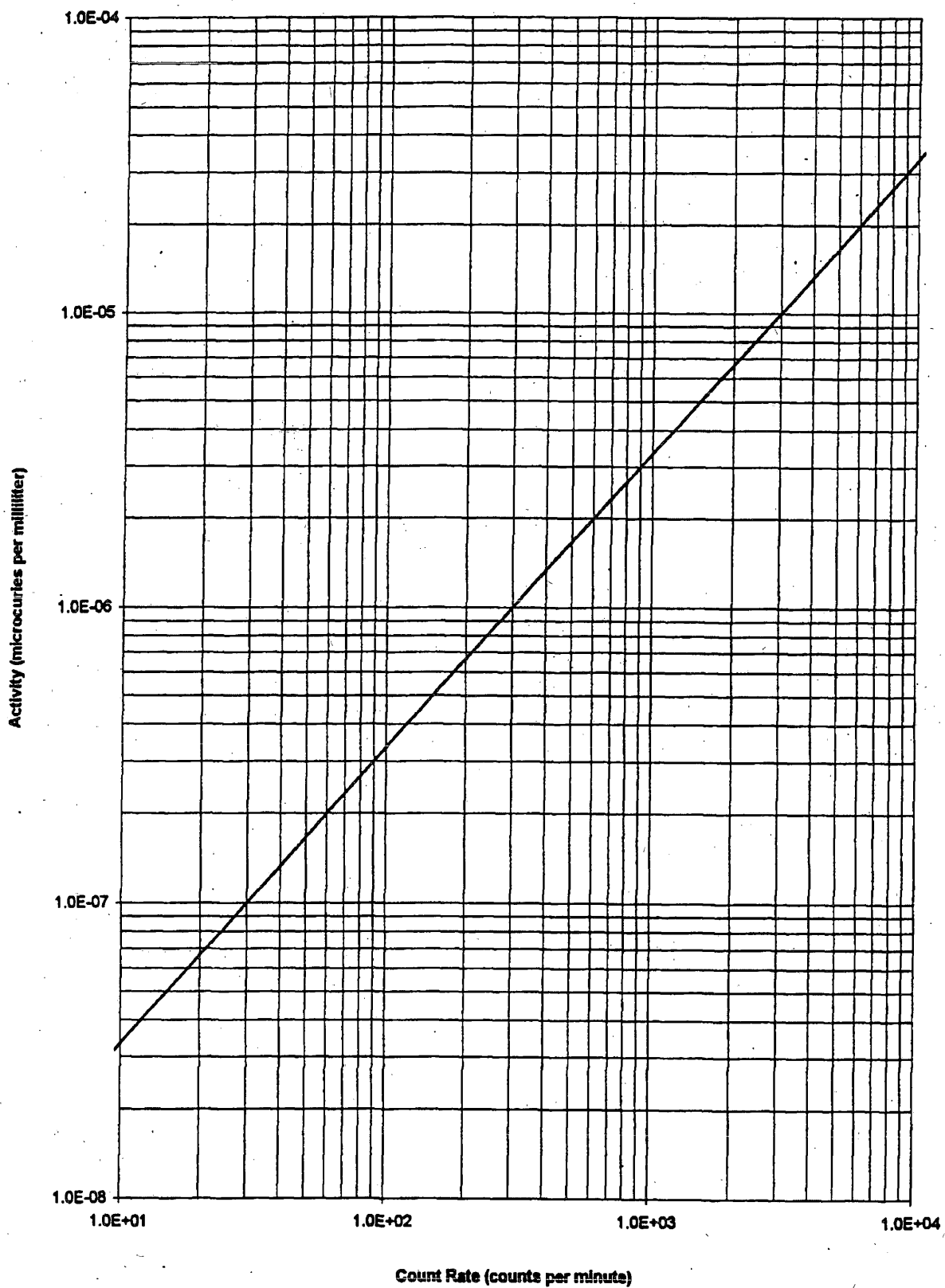
the limits specified in LCO 6.11.1. <sup>(12)</sup>

The Monitor Error will normally be set at 25% (based on the calibration error) <sup>(17)</sup>.

The liquid monitor trip setpoint =  $S_p$  + Monitor Background

NOTE: Setpoint adjustments are not required if the existing setpoint corresponds to a lower count rate than the calculated value. The setpoint contains a factor of conservatism, even if the calculated maximum waste tank flow rate is attainable, since the calculated rate contains the safety factor margin, waste tank effluent flow rate margin, and the dilution flow rate margin. In practice, the actual waste tank effluent flow rate normally is many times less than the calculated tank flow rate, thus providing an additional conservatism during release.

Figure 1.0-1  
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 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  $\mu\text{Ci/ml}$ .

$$= K_o U_F B F_i D F_i$$

$\Delta t_l$  = length of the time period over which  $C_{il}$  and  $F_l$  are averaged for all liquid releases, in hours.

$C_{il}$  = average concentration of radionuclide  $i$  observed in the undiluted liquid effluent during time period  $\Delta t_l$  from any liquid release in  $\mu\text{Ci/ml}$ .

Concentrations are determined in accordance with the requirements of Table 6.11.1-1, 6.12-1-1 and 6.12.1-3. For composite samples, 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.

$F_1$  = Dilution factor for  $C_{i1}$  during any liquid effluent release. For releases via the discharge basin,  $F_1$  is the dilution in the near field and is 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<sup>(5)</sup>

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

For releases via the 007 outfall,  $F_1$  is defined as the 007 outfall runoff to the total runoff into Hamilton Lake. It is the environmental dilution derived from the lowest historical annual precipitation as recorded in the FSAR = 0.10<sup>(18)</sup>

$$K_o = \text{units conversion factor } 1.14 \times 10^5$$

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

$U_F$  = adult fish consumption (21 kg/yr) <sup>(3)</sup>.

$BF_i$  = 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  $A_{i\tau}$  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, (BF<sub>1</sub>)  
 (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<sub>1</sub>)  
(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	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06
-----							
-							
P 32	1.93E-04	1.20E-05	7.46E-06	NO DATA	NO DATA	NO DATA	2.17E-05
CR 51	NO DATA	NO DATA	2.66E-09	1.59E-09	5.86E-10	3.53E-09	6.69E-07
MN 54	NO DATA	4.57E-06	8.72E-07	NO DATA	1.36E-06	NO DATA	1.40E-05
-----							
-							
MN 56	NO DATA	1.15E-07	2.04E-08	NO DATA	1.46E-07	NO DATA	3.67E-06
FE 55	2.75E-06	1.90E-06	4.43E-07	NO DATA	NO DATA	1.06E-06	1.09E-06
FE 59	4.34E-06	1.02E-05	3.91E-06	NO DATA	NO DATA	2.85E-06	3.40E-05
-----							
-							
CO 58	NO DATA	7.45E-07	1.67E-06	NO DATA	NO DATA	NO DATA	1.51E-05
CO 60	NO DATA	2.14E-06	4.72E-06	NO DATA	NO DATA	NO DATA	4.02E-05
NI 63	1.30E-04	9.01E-06	4.36E-06	NO DATA	NO DATA	NO DATA	1.88E-06
-----							
-							
NI 65	5.28E-07	6.86E-08	3.13E-08	NO DATA	NO DATA	NO DATA	1.74E-06
CU 64	NO DATA	8.33E-08	3.91E-08	NO DATA	2.10E-07	NO DATA	7.10E-06
ZN 65	4.84E-06	1.54E-05	6.96E-06	NO DATA	1.03E-05	NO DATA	9.70E-06
-----							
-							
ZN 69	1.03E-08	1.97E-08	1.37E-09	NO DATA	1.28E-08	NO DATA	2.96E-09
BR 83	NO DATA	NO DATA	4.02E-08	NO DATA	NO DATA	NO DATA	5.79E-08
BR 84	NO DATA	NO DATA	5.21E-08	NO DATA	NO DATA	NO DATA	4.09E-13
-----							
-							
BR 85	NO DATA	NO DATA	2.14E-09	NO DATA	NO DATA	NO DATA	LT E-24
RB 86	NO DATA	2.11E-05	9.83E-06	NO DATA	NO DATA	NO DATA	4.16E-06
RB 88	NO DATA	6.05E-08	3.21E-08	NO DATA	NO DATA	NO DATA	8.36E-19
-----							
-							
RB 89	NO DATA	4.01E-08	2.82E-08	NO DATA	NO DATA	NO DATA	2.33E-21
SR 89	3.08E-04	NO DATA	8.84E-06	NO DATA	NO DATA	NO DATA	4.94E-05
SR 90	7.58E-03	NO DATA	1.86E-03	NO DATA	NO DATA	NO DATA	2.19E-04
-----							
-							
SR 91	5.67E-06	NO DATA	2.29E-07	NO DATA	NO DATA	NO DATA	2.70E-05
SR 92	2.15E-06	NO DATA	9.30E-08	NO DATA	NO DATA	NO DATA	4.26E-05
Y 90	9.62E-09	NO DATA	2.58E-10	NO DATA	NO DATA	NO DATA	1.02E-04
-----							
-							
Y 91M	9.09E-11	NO DATA	3.52E-12	NO DATA	NO DATA	NO DATA	2.67E-10
Y 91	1.41E-07	NO DATA	3.77E-09	NO DATA	NO DATA	NO DATA	7.76E-05
Y 92	8.45E-10	NO DATA	2.47E-11	NO DATA	NO DATA	NO DATA	1.48E-05

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



TABLE 1.2-2 (Continued)

INGESTION DOSE CONVERSION FACTORS FOR ADULTS, (DF<sub>i</sub>)

(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<sub>i</sub>)  
(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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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

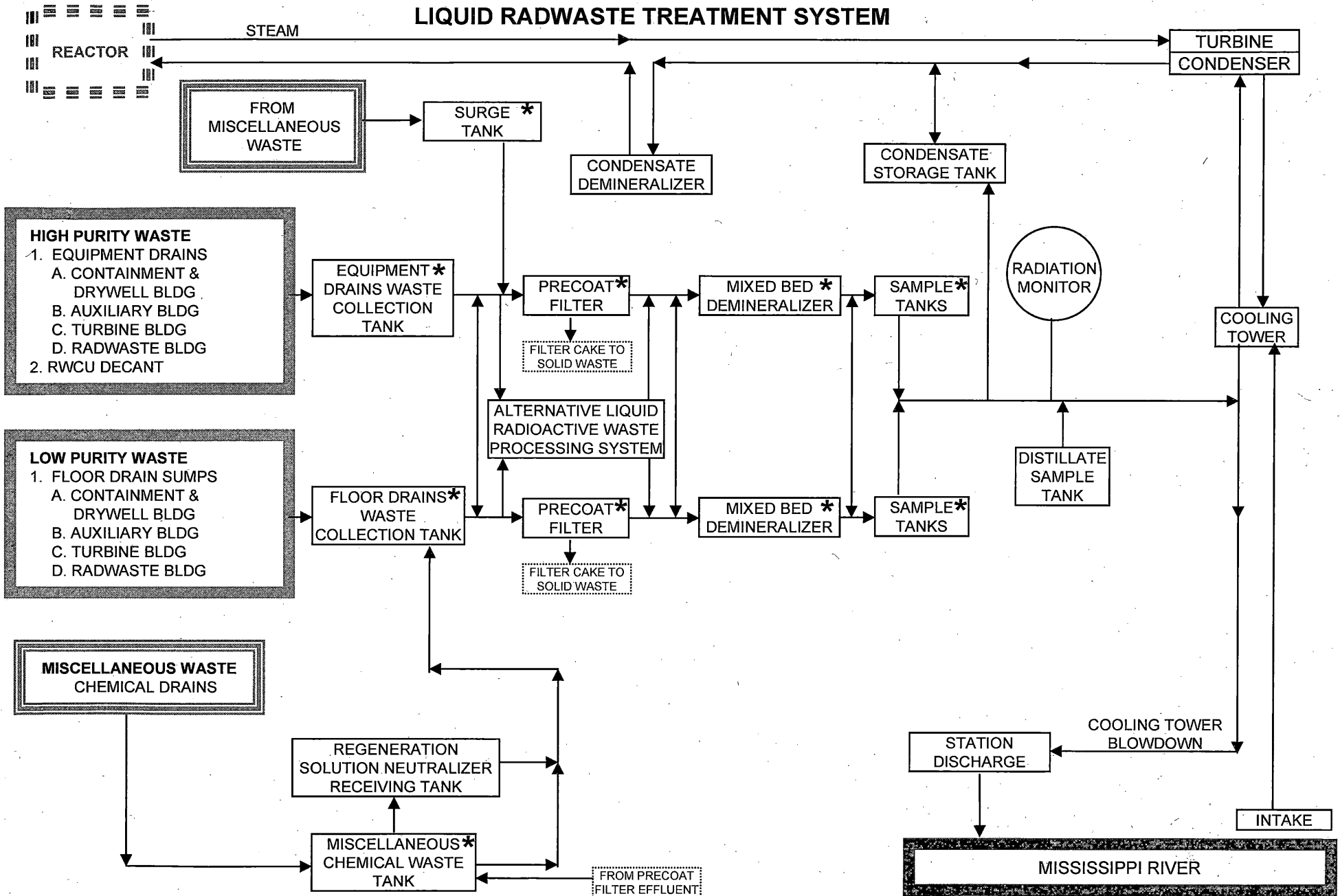
The essential components of the liquid radwaste treatment system are indicated by an asterisk (\*).

The radwaste system includes provisions for use of alternate liquid radioactive processing equipment. This system may be used in place of the precoat filters and may contain strainers, carbon bed filters, cartridge filters, a reverse osmosis unit or other components which process liquid radioactive wastes. Bypassing the precoat filter (an essential component) is acceptable provided that the effluent from the alternative system provides the same level of filtration required for the precoat filters.

#### 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

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

where:

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

$\overline{X/Q}$  = highest historical annual average atmospheric  
dispersion at the SITE BOUNDARY or at UNRESTRICTED  
AREAS inside the SITE BOUNDARY from Table 2.2-3a or  
Table 2.2-3b

$K_i$  = 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

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

$L_i$  = 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



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:  
 $S_v$  = count rate (cpm) above background of vent noble gas monitor at the

alarm setpoint level\*

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

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)

$$= \frac{(3.53E-5) (60)}{X/Q (X) (V) (K)}$$

\* 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  
 $\mu\text{Ci/cc/cpm}$  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,  $\text{ft}^3$  per cc

60 = conversion factor, seconds per minute

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

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<sub>i</sub></u>	<u>B-Skin** L<sub>i</sub></u>	<u>Y-Air* M<sub>i</sub></u>	<u>B-Air* N<sub>i</sub></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

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

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

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

## 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:

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

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

where:

W = highest historical annual average atmospheric dispersion at the SITE BOUNDARY or UNRESTRICTED AREAS inside the SITE BOUNDARY for the appropriate pathway from Table 2.2-3a or 2.2-3b.

Use  $X/Q$  for inhalation and all tritium pathways  
or

Use  $D/Q$  for food and ground plane pathways

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

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

\* Use child/inhalation pathway from Table 2.2-1b unless land use census identifies an infant/grass/cow/milk pathway. Then Table 2.2-1a may apply.

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:

$$D_{\gamma} = \text{air dose due to gamma emissions from noble gas radionuclide } i \text{ (mrad)}$$
$$= 3.17 \times 10^{-8} \sum_i M_i \overline{X/Q'} \overline{Q}_i$$

where:

$\overline{X/Q'}$  = highest historical annual average atmospheric for the SITE BOUNDARY or at UNRESTRICTED AREAS within the SITE BOUNDARY from Table 2.2-3a or 2.2-3b.

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

$Q_i$  = cumulative release of radionuclide i of noble gas, tritium, I-131, I-133, or material in particulate form over the period of interest ( $\mu\text{Ci}$ )

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

$D_\beta$  = 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

$\overline{X/Q'}$  = highest historical annual average atmospheric dispersion for the SITE BOUNDARY or at UNRESTRICTED AREAS within the SITE BOUNDARY, from Table 2.2-3a or 2.2-3b.

$Q_i$  = cumulative release of radionuclide i of noble gas, tritium, I-131, I-133, or material in particulate form over the period of interest ( $\mu\text{Ci}$ )



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:

$W'$  = historical annual average  $X/Q$  and  $D/Q$  at a controlling location for an individual from Table 2.2-3\*

$X/Q'$  = for inhalation and all tritium pathways

or

$D/Q'$  = for food and ground plane pathways

$R_i$  = the total dose factor for radionuclide  $i$ ,  
(mrem/yr per  $\mu\text{Ci}/\text{m}^3$ ) for inhalation and all tritium pathways and ( $\text{m}^2 \cdot \text{mrem}/\text{yr}$  per  $\mu\text{Ci}/\text{sec}$ ) for food and ground plane pathways from Tables 2.2-2a - d

\* Dose for each controlling receptor in Table 2.2-3 is calculated and the highest dose is selected for implementation of LCO 6.11.6. The most limiting age group, child, is assumed. In accordance with ODCM Reference 1, historical annual average atmospheric dispersion conditions are used. However, "real time" annual average dispersion conditions are coupled with the annual release and summarized in the Annual Radioactive Effluent Release Report.

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 ( $\mu\text{Ci}$ )

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 ( $D_\gamma$ ,  $D_\beta$ ,  $D_P$ ) 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, (P<sub>i</sub>)

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<sub>i</sub>)

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

PATHWAY DOSE FACTORS FOR LCO 6.11.4 AND  
SECTION 2.2.1.b, (Pi)

Page 1 of 2

AGE GROUP	( CHILD )	( N.A. )	( CHILD )*
ISOTOPE	INHALATION	GROUND PLANE	GRS/ANL/MEAT
H-3	1.13E+03	0.00E+00	1.83E+02
C-14	3.59E+04	0.00E+00	2.99E+08
NA-24	1.61E+04	1.98E+07	1.35E-03
P-32	2.61E+06	0.00E+00	5.78E+09
CR-51	1.70E+04	7.85E+06	3.64E+05
MN-54	1.58E+06	1.29E+09	6.25E+06
MN-56	1.23E+05	1.52E+06	1.90E-51
FE-55	1.11E+05	0.00E+00	3.57E+08
FE-59	1.27E+06	4.56E+08	4.94E+08
CO-58	1.11E+06	6.18E+08	7.49E+07
CO-60	7.07E+06	5.17E+09	2.99E+08
NI-63	8.21E+05	0.00E+00	2.27E+10
NI-65	8.40E+04	4.93E+05	3.17E-51
CU-64	3.67E+04	9.80E+05	1.09E-05
ZN-65	9.95E+05	7.90E+08	7.80E+08
ZN-69	1.02E+04	0.00E+00	0.00E+00
BR-83	4.74E+02	1.01E+04	7.43E-57
BR-84	5.48E+02	3.38E+05	0.00E+00
BR-85	2.53E+01	0.00E+00	0.00E+00
RB-86	1.98E+05	1.47E+07	4.54E+08
RB-88	5.62E+02	5.40E+04	0.00E+00
RB-89	3.45E+02	2.11E+05	0.00E+00
SR-89	2.16E+06	3.56E+04	3.76E+08
SR-90	1.01E+08	0.00E+00	8.11E+09
SR-91	1.74E+05	3.58E+06	4.13E-10
SR-92	2.42E+05	1.23E+06	2.72E-48
Y-90	2.68E+05	7.59E+03	3.81E+02
Y-91M	2.81E+03	1.66E+05	0.00E+00
Y-91	2.63E+06	1.70E+06	1.87E+08
Y-92	2.39E+05	3.06E+05	5.43E-35
Y-93	3.89E+05	3.58E+05	1.21E-07
ZR-95	2.23E+06	3.99E+08	4.76E+08
ZR-97	3.51E+05	4.92E+06	5.47E-01
NB-95	6.14E+05	2.29E+08	1.74E+09
MO-99	1.35E+05	6.60E+06	1.92E+05
TC-99M	4.81E+03	3.01E+05	5.39E-18
TC-101	5.85E+02	3.23E+04	0.00E+00
RU-103	6.62E+05	1.80E+08	3.13E+09
RU-105	9.95E+04	1.03E+06	4.59E-25
RU-106	1.43E+07	3.59E+08	5.38E+10
AG-110M	5.48E+06	3.65E+09	5.26E+08

TABLE 2.2-1b (Continued)

PATHWAY DOSE FACTORS FOR LCO 6.11.4 AND  
SECTION 2.2.1.b, (Pi)

Page 2 of 2

AGE GROUP	( CHILD )	( N.A. )	( CHILD )*
ISOTOPE	INHALATION	GROUND PLANE	GRS/ANL/MEAT
TE-125M	4.77E+05	3.01E+06	4.44E+08
TE-127M	1.48E+06	1.39E+05	3.95E+09
TE-127	5.62E+04	4.70E+03	1.25E-08
TE-129M	1.76E+06	3.30E+07	4.09E+09
TE-129	2.55E+04	4.41E+04	0.00E+00
TE-131M	3.08E+05	1.35E+10	7.66E+03
TE-131	2.05E+03	4.93E+07	0.00E+00
TE-132	3.77E+05	7.09E+06	7.27E+06
I-130	1.85E+06	9.55E+06	5.27E-04
I-131	1.62E+07	2.98E+07	4.29E+09
I-132	1.94E+05	2.09E+06	1.90E-57
I-133	3.85E+06	4.26E+06	1.02E+05
I-134	5.07E+04	7.57E+05	0.00E+00
I-135	7.92E+05	4.21E+06	8.10E-15
CS-134	1.01E+06	3.28E+09	1.18E+09
CS-136	1.71E+05	2.44E+08	3.45E+07
CS-137	9.07E+05	1.34E+09	1.04E+09
CS-138	8.40E+02	5.86E+05	0.00E+00
BA-139	5.77E+04	1.70E+05	0.00E+00
BA-140	1.74E+06	3.35E+07	3.42E+07
BA-141	2.92E+03	6.79E+04	0.00E+00
BA-142	1.64E+03	7.23E+04	0.00E+00
LA-140	2.26E+05	3.12E+07	4.28E+02
LA-142	7.59E+04	1.30E+06	0.00E+00
CE-141	5.44E+05	2.20E+07	1.08E+07
CE-143	1.27E+05	3.75E+06	1.96E+02
CE-144	1.20E+07	6.77E+07	1.48E+08
PR-143	4.33E+05	0.00E+00	2.82E+07
PR-144	1.57E+03	3.02E+03	0.00E+00
ND-147	3.28E+05	1.44E+07	1.17E+07
W-187	9.10E+04	3.90E+06	2.18E+00
NP-239	6.40E+04	2.83E+06	1.74E+03

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

Others -  $\text{m}^2$  . mrem/yr per  $\mu\text{Ci}/\text{sec}$

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

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

TABLE 2.2-2a

PATHWAY DOSE FACTORS FOR LCO 6.11.6 AND  
SECTION 2.2.2.b, (R<sub>1</sub>)

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Release Type: 2 Gaseous  
Dose Factor: 2 Ri (m<sup>2</sup> \* (mrem/yr)/(uCi/sec) or (mrem/yr)/(uCi/m<sup>3</sup>))  
AgeGroup: 3 INFANT  
Pathway: 0 Ground Plane Deposition (GPD)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
H-3	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
C-14	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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<sub>1</sub>)

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Release Type: 2 Gaseous  
Dose Factor: 2 Ri (m<sup>2</sup> \* (mrem/yr)/(uCi/sec) or (mrem/yr)/(uCi/m<sup>3</sup>))  
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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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, (R<sub>i</sub>)

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Release Type: 2 Gaseous

Dose Factor: 2 Ri (m<sup>2</sup> \* (mrem/yr)/(uCi/sec) or (mrem/yr)/(uCi/m<sup>3</sup>))

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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.81e+02
BR-84	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.00e+02
BR-85	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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, (R<sub>i</sub>)

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Release Type: 2 Gaseous  
 Dose Factor: 2 R<sub>i</sub> (m<sup>2</sup> \* (mrem/yr)/(uCi/sec) or (mrem/yr)/(uCi/m<sup>3</sup>))  
 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, (R<sub>1</sub>)

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Release Type: 2 Gaseous  
Dose Factor: 2 Ri (m<sup>2</sup> \* (mrem/yr)/(uCi/sec) or (mrem/yr)/(uCi/m<sup>3</sup>))  
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<sub>i</sub>)

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Release Type: 2 Gaseous  
Dose Factor: 2 Ri (m<sup>2</sup> \* (mrem/yr)/(uCi/sec) or (mrem/yr)/(uCi/m<sup>3</sup>))  
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<sub>i</sub>)

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Release Type: 2 Gaseous  
Dose Factor: 2 Ri (m<sup>2</sup> \* (mrem/yr)/(uCi/sec) or (mrem/yr)/(uCi/m<sup>3</sup>))  
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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	9.27e-01
BR-84	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.32e-22
BR-85	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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<sub>i</sub>)

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Release Type: 2 Gaseous  
Dose Factor: 2 R<sub>i</sub> (m<sup>2</sup> \* (mrem/yr)/(uCi/sec) or (mrem/yr)/(uCi/m<sup>3</sup>))  
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: Inhalation<sub>2</sub> and all tritium pathways - mrem/yr per  $\mu\text{Ci}/\text{m}^3$   
Others - m<sup>2</sup> \* 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<sub>1</sub>)

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Release Type: 2 Gaseous

Dose Factor: 2 Ri (m<sup>2</sup> \* (mrem/yr)/(uCi/sec) or (mrem/yr)/(uCi/m<sup>3</sup>))

AgeGroup: 2 CHILD

Pathway: 0 Ground Plane Deposition (GPD)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
H-3	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
C-14	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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<sub>1</sub>)

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Release Type: 2 Gaseous  
Dose Factor: 2 R<sub>1</sub> (m<sup>2</sup> \* (mrem/yr)/(uCi/sec) or (mrem/yr)/(uCi/m<sup>3</sup>))  
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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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<sub>i</sub>)

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Release Type: 2 Gaseous  
Dose Factor: 2 Ri (m<sup>2</sup> \* (mrem/yr)/(uCi/sec) or (mrem/yr)/(uCi/m<sup>3</sup>))  
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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.74e+02
BR-84	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.48e+02
BR-85	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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<sub>1</sub>)

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Release Type: 2 Gaseous  
Dose Factor: 2 Ri (m<sup>2</sup> \* (mrem/yr)/(uCi/sec) or (mrem/yr)/(uCi/m<sup>3</sup>))  
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<sub>1</sub>)

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Release Type: 2 Gaseous  
Dose Factor: 2 R<sub>1</sub> (m<sup>2</sup> \* (mrem/yr)/(uCi/sec) or (mrem/yr)/(uCi/m<sup>3</sup>))  
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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.35e+00
BR-84	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.92e-11
BR-85	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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, (R<sub>i</sub>)

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Release Type: 2 Gaseous  
Dose Factor: 2 Ri (m<sup>2</sup> \* (mrem/yr)/(uCi/sec) or (mrem/yr)/(uCi/m<sup>3</sup>))  
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<sub>i</sub>)

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Release Type: 2 Gaseous  
Dose Factor: 2 Ri (m<sup>2</sup> \* (mrem/yr)/(uCi/sec) or (mrem/yr)/(uCi/m<sup>3</sup>))  
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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
BR-83	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	8.89e-57
BR-84	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
BR-85	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
RB-89	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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

GRAND GULF, UNIT 1

2.0-18e

Revision 25 - 01/03

TABLE 2.2-2b (Continued)

PATHWAY DOSE FACTORS FOR LCO 6.11.6 AND  
SECTION 2.2.2.b, (R<sub>i</sub>)

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Release Type: 2 Gaseous  
Dose Factor: 2 Ri (m<sup>2</sup> \* (mrem/yr)/(uCi/sec) or (mrem/yr)/(uCi/m<sup>3</sup>))  
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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
BA-139	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
BA-142	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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, (R<sub>1</sub>)

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Release Type: 2 Gaseous  
Dose Factor: 2 Ri (m<sup>2</sup> \* (mrem/yr)/(uCi/sec) or (mrem/yr)/(uCi/m<sup>3</sup>))  
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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.37e-01
BR-84	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	6.84e-23
BR-85	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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<sub>i</sub>)

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Release Type: 2 Gaseous  
Dose Factor: 2 R<sub>i</sub> (m<sup>2</sup> \* (mrem/yr)/(uCi/sec) or (mrem/yr)/(uCi/m<sup>3</sup>))  
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: Inhalation<sub>2</sub> and all tritium pathways - mrem/yr per  $\mu\text{Ci}/\text{m}^3$   
Others - m<sup>2</sup> . 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<sub>i</sub>)

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Release Type: 2 Gaseous  
Dose Factor: 2 R<sub>i</sub> (m<sup>2</sup> \* (mrem/yr)/(uCi/sec) or (mrem/yr)/(uCi/m<sup>3</sup>))  
AgeGroup: 1 TEEN  
Pathway: 0 Ground Plane Deposition (GPD)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
H-3	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
C-14	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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 2.2-2c (Continued)  
 PATHWAY DOSE FACTORS FOR LCO 6.11.6 AND  
 SECTION 2.2.2.b, (R<sub>1</sub>)

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Release Type: 2 Gaseous  
 Dose Factor: 2 Ri (m<sup>2</sup> \* (mrem/yr)/(uCi/sec) or (mrem/yr)/(uCi/m<sup>3</sup>))  
 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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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<sub>1</sub>)

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Release Type: 2 Gaseous  
Dose Factor: 2 R<sub>i</sub> (m<sup>2</sup> \* (mrem/yr)/(uCi/sec) or (mrem/yr)/(uCi/m<sup>3</sup>))  
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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.44e+02
BR-84	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.33e+02
BR-85	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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, (R<sub>i</sub>)

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Release Type: 2 Gaseous  
Dose Factor: 2 R<sub>i</sub> (m<sup>2</sup> \* (mrem/yr)/(uCi/sec) or (mrem/yr)/(uCi/m<sup>3</sup>))  
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
CF-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, (R<sub>1</sub>)

Release Type: 2 Gaseous  
Dose Factor: 2 R<sub>1</sub> (m<sup>2</sup> \* (mrem/yr)/(uCi/sec) or (mrem/yr)/(uCi/m<sup>3</sup>))  
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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.90e+00
BR-84	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.31e-11
BR-85	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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, (R<sub>1</sub>)

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Release Type: 2 Gaseous  
Dose Factor: 2 Ri (m<sup>2</sup> \* (mrem/yr)/(uCi/sec) or (mrem/yr)/(uCi/m<sup>3</sup>))  
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, (R<sub>1</sub>)

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Release Type: 2 Gaseous  
Dose Factor: 2 Ri (m<sup>2</sup> \* (mrem/yr)/(uCi/sec) or (mrem/yr)/(uCi/m<sup>3</sup>))  
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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
BR-83	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.73e-57
BR-84	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
BR-85	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
RB-89	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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<sub>1</sub>)

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Release Type: 2 Gaseous  
Dose Factor: 2 Ri (m<sup>2</sup> \* (mrem/yr)/(uCi/sec) or (mrem/yr)/(uCi/m<sup>3</sup>))  
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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
BA-139	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
BA-142	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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<sub>1</sub>)

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Release Type: 2 Gaseous  
Dose Factor: 2 Ri (m<sup>2</sup> \* (mrem/yr)/(uCi/sec) or (mrem/yr)/(uCi/m<sup>3</sup>))  
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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.78e-01
BR-84	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.02e-23
BR-85	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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<sub>1</sub>)

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Release Type: 2 Gaseous  
Dose Factor: 2 Ri (m<sup>2</sup> \* (mrem/yr)/(uCi/sec) or (mrem/yr)/(uCi/m<sup>3</sup>))  
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
NF-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 -  $\text{m}^2$  . 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<sub>1</sub>)

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Release Type: 2 Gaseous  
Dose Factor: 2 Ri (m<sup>2</sup> \* (mrem/yr)/(uCi/sec) or (mrem/yr)/(uCi/m<sup>3</sup>))  
AgeGroup: 0 ADULT  
Pathway: 0 Ground Plane Deposition (GPD)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
H-3	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
C-14	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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, (R<sub>i</sub>)

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Release Type: 2 Gaseous

Dose Factor: 2 Ri (m<sup>2</sup> \* (mrem/yr)/(uCi/sec) or (mrem/yr)/(uCi/m<sup>3</sup>))

AgeGroup: 0 ADULT

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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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<sub>i</sub>)

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Release Type: 2 Gaseous  
Dose Factor: 2 Ri (m<sup>2</sup> \* (mrem/yr)/(uCi/sec) or (mrem/yr)/(uCi/m<sup>3</sup>))  
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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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, (R<sub>1</sub>)

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Release Type: 2 Gaseous  
 Dose Factor: 2 Ri (m<sup>2</sup> \* (mrem/yr)/(uCi/sec) or (mrem/yr)/(uCi/m<sup>3</sup>))  
 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<sub>i</sub>)

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Release Type: 2 Gaseous  
Dose Factor: 2 Ri (m<sup>2</sup> \* (mrem/yr)/(uCi/sec) or (mrem/yr)/(uCi/m<sup>3</sup>))  
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	0.00e+00	9.31e+07	0.00e+00	9.58e+08	0.00e+00
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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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<sub>i</sub>)

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Release Type: 2 Gaseous  
Dose Factor: 2 Ri (m<sup>2</sup>) \* (mrem/yr)/(uCi/sec) or (mrem/yr)/(uCi/m<sup>3</sup>)  
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<sub>i</sub>)

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Release Type: 2 Gaseous  
Dose Factor: 2 Ri (m<sup>2</sup> \* (mrem/yr)/(uCi/sec) or (mrem/yr)/(uCi/m<sup>3</sup>))  
AgeGroup: 0 ADULT  
Pathway: 4 Grs/Cow/Meat (CMEAT)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-L11	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
BR-85	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
RB-89	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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<sub>i</sub>)

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Release Type: 2 Gaseous  
 Dose Factor: 2 Ri (m<sup>2</sup> \* (mrem/yr)/(uCi/sec) or (mrem/yr)/(uCi/m<sup>3</sup>))  
 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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
BA-139	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
BA-142	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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<sub>i</sub>)

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Release Type: 2 Gaseous  
 Dose Factor: 2 R<sub>i</sub> (m<sup>2</sup> \* (mrem/yr)/(uCi/sec) or (mrem/yr)/(uCi/m<sup>3</sup>))  
 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	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	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	6.63e+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<sub>i</sub>)

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Release Type: 2 Gaseous  
Dose Factor: 2 Ri (m<sup>2</sup> \* (mrem/yr)/(uCi/sec) or (mrem/yr)/(uCi/m<sup>3</sup>))  
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: Inhalation<sub>2</sub> and all tritium pathways - mrem/yr per  $\mu\text{Ci}/\text{m}^3$   
Others - m<sup>2</sup> \* 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**	X/Q*	D/Q*	NEAREST GARDEN, MILES**	D/Q*	DAYLIGHT ONLY X/Q***
A	N	1.02	8.5E-7	3.8E-9	1.02	3.8E-9	6.60 E-7
B	NNE	1.51	3.1E-7	1.5E-9	1.52	1.5E-9	2.70 E-7
C	NE	0.70	7.6E-7	5.2E-9	4.14	2.4E-10	4.80 E-8
D	ENE	2.60	8.9E-8	4.9E-10	4.50	1.8E-10	3.90 E-8
E	E	0.83	5.3E-7	3.1E-9	0.89	2.8E-9	4.90 E-7
F	ESE	2.25	8.5E-8	3.8E-10	4.49	1.1E-10	2.70 E-8
G	SE	3.72	5.1E-8	2.0E-10	4.20	1.6E-10	3.90 E-8
H	SSE	1.10	5.7E-7	3.2E-9	4.31	2.9E-10	5.60 E-8
J	S	3.14	1.9E-7	6.5E-10	3.16	6.5E-10	1.30 E-7
K	SSW	2.20	7.1E-7	1.4E-9	2.18	1.4E-9	4.10 E-7
L	SW	0.89	6.0E-6	7.6E-9	0.89	7.6E-9	2.70 E-6
M	WSW	>5	N/A	N/A	>5	N/A	N/A
N	W	>5	N/A	N/A	>5	N/A	N/A
P	WNW	>5	N/A	N/A	>5	N/A	N/A
Q	NW	>5	N/A	N/A	>5	N/A	N/A
R	NNW	1.44	5.4E-7	2.1E-9	>5	N/A	3.90 E-7

Table 2.2-3 locations based on 2016 Land Use Census, onsite vegetation sample locations are not considered for the Land Use Census.

\* Values from ODCM Reference 19.

\*\* Distances shown are actual miles in each sector. In cases where dispersion and deposition parameters were not available for a location, they were calculated based on values at known distances.

\*\*\* Values from ODCM Reference 20.

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	1.2E-6	5.9E-9
B	NNE	0.66	1.1E-6	6.0E-9
C	NE	0.63	9.1E-7	6.2E-9
D	ENE	0.63	8.5E-7	5.6E-9
E	E	0.55	1.0E-6	6.2E-9
F	ESE	0.55	8.1E-7	4.2E-9
G	SE	0.51	1.2E-6	6.2E-9
H	SSE	0.46	2.3E-6	1.4E-8
J	S	0.61	2.4E-6	1.1E-8
K	SSW	0.65	4.4E-6	1.1E-8
L	SW	0.85	6.5E-6	8.2E-9
M	WSW	1.07	4.3E-6	4.5E-9
N	W	1.14	2.9E-6	3.8E-9
P	WNW	1.34	1.4E-6	2.8E-9
Q	NW	1.37	8.2E-7	3.0E-9
R	NNW	1.02	9.1E-7	3.7E-9

\* Values from ODCM Reference 19.

\*\* Distances shown are actual miles in each sector.

TABLE 2.2-3b

ADDITIONAL RECEPTOR LOCATIONS WITHIN THE SITE BOUNDARY\*\*

For LCO 6.11.4

SECTOR	DIRECTION	MILES	DESCRIPTION	x/Q*	D/Q*	Unrestricted Area Within Site Boundary	Daylight Only x/Q***
B	NNE	0.5	Recreational Vehicle Laydown Area	1.7E-6	9.5E-9	Yes	NA
R	NNW	0.5	Energy Services Center <sup>1</sup>	2.7E-6	1.2E-8	Yes	NA
Q	NW	0.75	Gin Lake <sup>1</sup>	2.0E-6	8.3E-9	Yes	NA
P	WNW	0.75	Hamilton Lake <sup>1</sup>	3.3E-6	7.5E-9	Yes	NA
J	S	0.40	Onsite vegetation sample locations	4.6E-6	2.2E-8	Yes	3.4E-6
H	SSE	0.46	Onsite vegetation sample location	2.3E-6	1.4E-8	Yes	2.2E-6

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

\*Values from ODCM Reference 19

\*\*The X/Q and D/Q factors from ODCM References 14 and 19 may be used to evaluate dose to members of the public that are located inside the site boundary.

If appropriate, occupancy factors should be applied to the dose calculation.

\*\*\* Values from ODCM Reference 20.

## 2.3 Meteorological Model

### 2.3.1 Atmospheric Dispersion (Annual Average)

The XOQDOQ software, NUREG/CR-2919, Computer Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations, or similar, should be used to calculate atmospheric dispersion factors for routine continuous long term releases. Software input parameters use the normal settings as described in Table 2.1 of NUREG/CR-2919 with the following exceptions:

Calm values are distributed in a separate windspeed category (i.e., 1<sup>st</sup> windspeed category) with the same proportion and direction as the direction frequency of the 2<sup>nd</sup> windspeed class. (Reference 10,14,15)

No terrain recirculation factor is applied. (Reference 5, Section 3A)

0.224 m/sec for calm (Reference 7, 15)

14 windspeed categories are used (Reference 14,15)

7 stability classes, A-G (Reference 10,14,15)

1 release exit point (Reference 10,14,15)

10 meter for measured wind, ground level release (Reference 7, 10, 14, 15)

No decay

Normally, maximum windspeed categories are 0.224, 0.5, 0.75, 1.00, 1.25, 1.50, 1.75, 2.00, 2.50, 3.00, 4.00, 5.00, 7.00, 13.00 (m/sec) (Reference 14, 15)

Height of vent's release point = 31 meters (Reference 15)

Height of vent's building = 53.3 meters (Reference 15)

Minimum cross-sectional area for the vent's building = 2729 meters<sup>2</sup> (Reference 14, 15)



2.3.2 Atmospheric Dispersion (Hourly Average)

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

$$X/Q = \frac{\text{atmospheric dispersion (sec/m}^3\text{)}}{2.03 \delta k / ru\Sigma}$$

where:

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

$\delta$  = plume depletion factor at distance r from ODCM Figure 2.3-1

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

k = open terrain recirculation factor at distance r, from ODCM Reference 16

$\Sigma$  = the lesser of  $(\sigma^2 + b^2/2\pi)^{1/2}$  or  $(3)^{1/2}\sigma$

where:

$\sigma$  = vertical standard deviation (m) of the plume at distance r for ground level releases under the stability category indicated by  $\Delta T$ , from ODCM Figure 2.3-2

$\Delta T$  = temperature differential with vertical separation ( $^{\circ}\text{F}/40\text{m}$ )

b = height of the reactor building = 53.3m

2.3.3 Deposition (Hourly Average)

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

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

where:

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

$k$  = open Terrain Recirc Factor (ODCM Reference 16)

$r$  = distance from release point (meters)

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

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

Graph taken from Reference 7, Figure 2

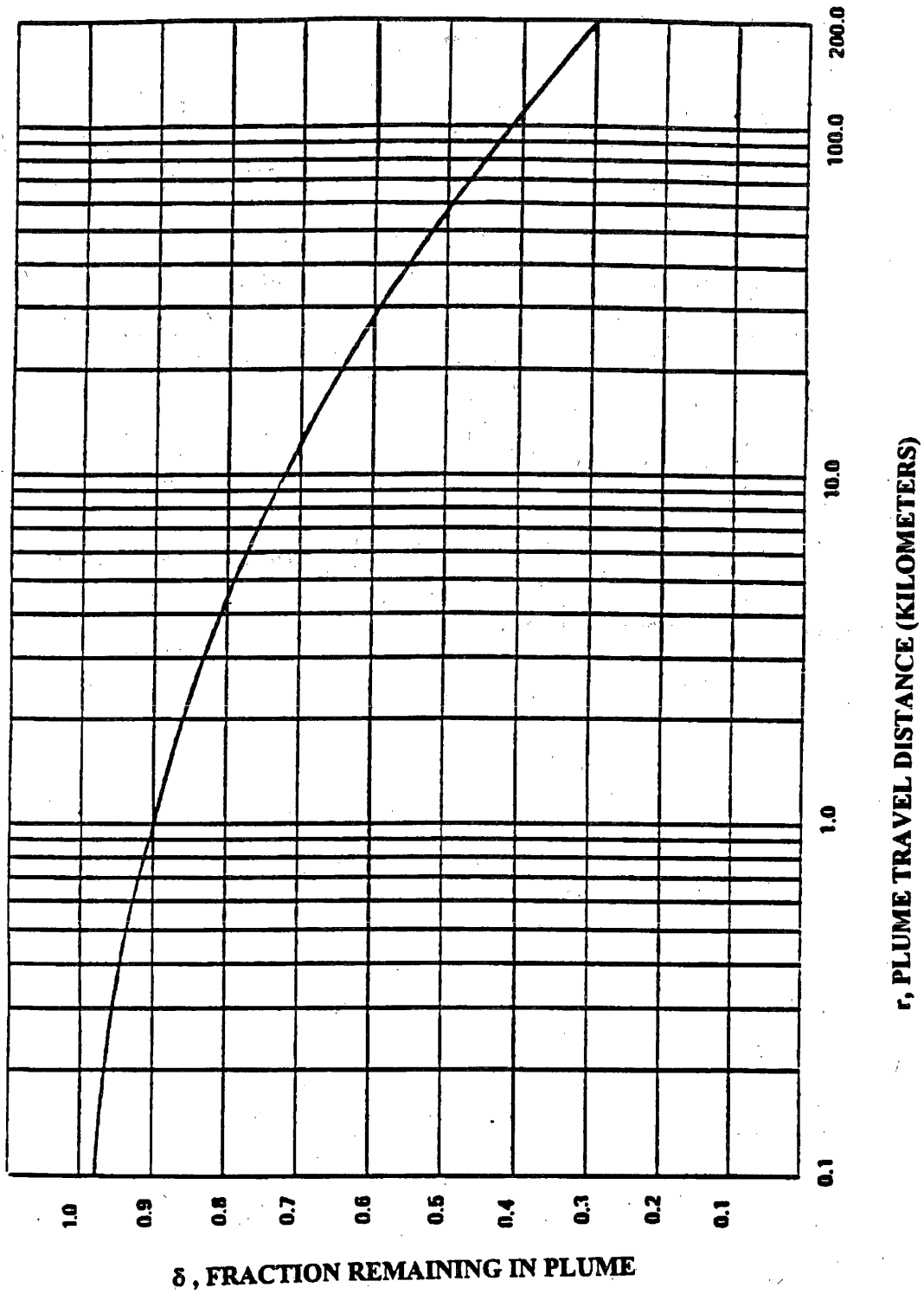
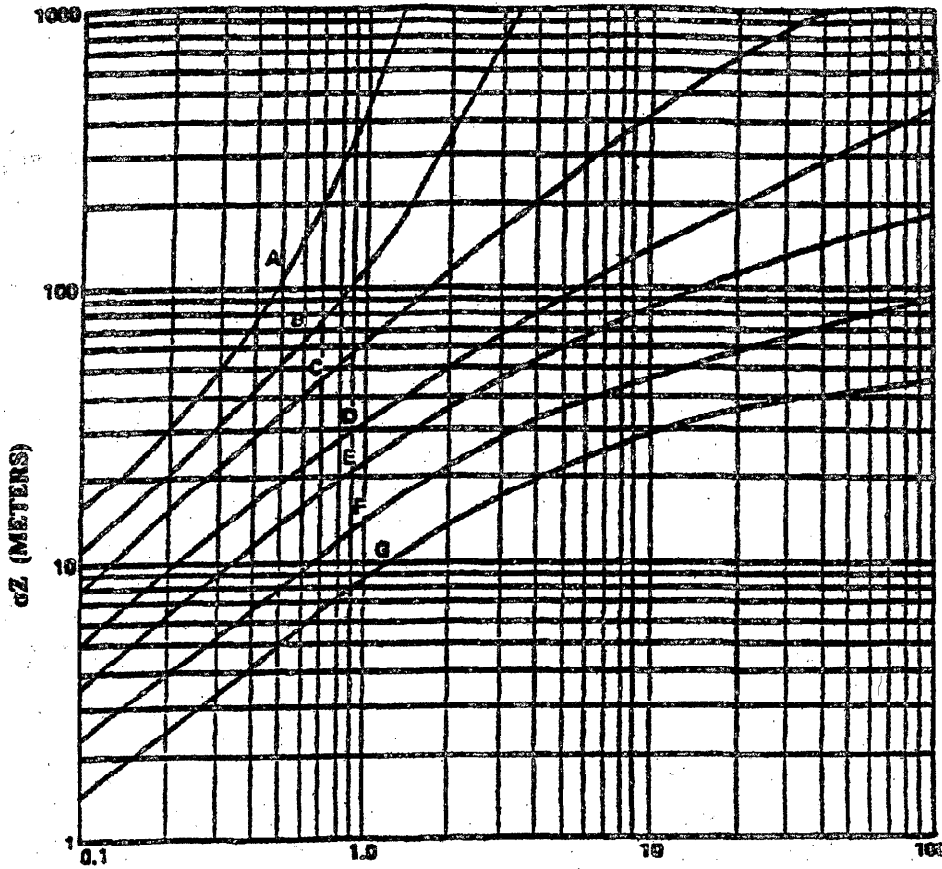


Figure 2.3-2  
 Vertical Standard Deviation of Material in a Plume  
 (Letters denote Pasquill Stability Class)



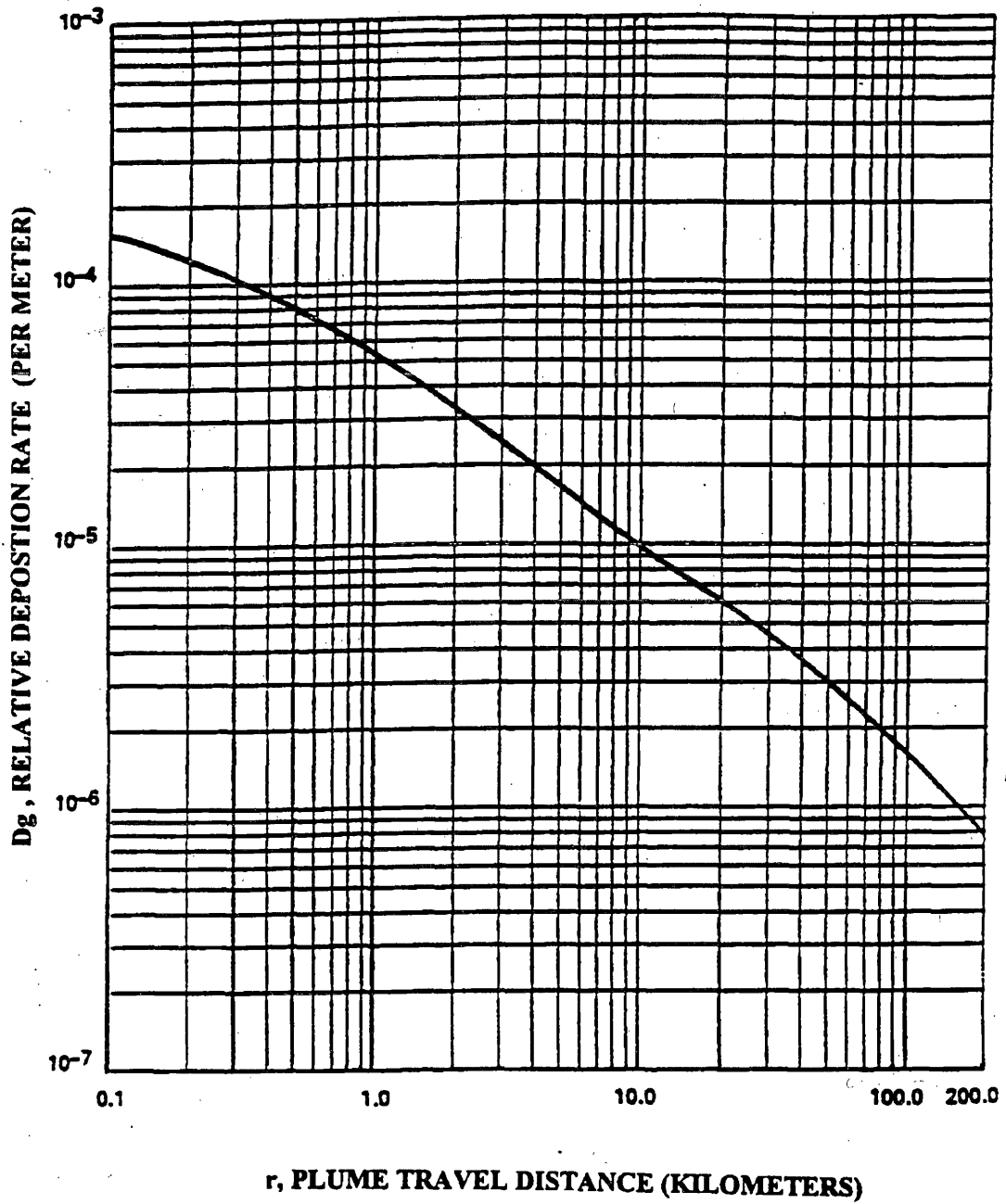
$r$ , PLUME TRAVEL DISTANCE (KILOMETERS)

Temperature Change with Height ( $\Delta T$ ) ( $^{\circ}\text{F}/46\text{m}$ )	Pasquill Category	Stability Classification
$\leq -1.37$	A	Extremely Unstable
$> -1.37$ and $\leq -1.22$	B	Moderately Unstable
$> -1.22$ and $\leq -1.08$	C	Slightly Unstable
$> -1.08$ and $\leq -0.36$	D	Neutral
$> -0.36$ and $\leq 1.08$	E	Slightly Stable
$> 1.08$ and $\leq 2.88$	F	Moderately Stable
$> 2.88$	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

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## 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.
- (4) In modes 1, 2 and 3, the south-east most smoke hatch of the turbine building may be used as an occasional release point provided that the proper monitoring equipment is used. During Modes 4 & 5 up to four roof hatches may be used and release rates estimated based on calculated flow rates and measured activity.

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 ( $D_{\text{Tau}}$ )
- Noble gas dose ( $D_{\gamma}$ ,  $D_{\beta}$ )
- 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.

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-97	M-100
M-19	M-25	M-95	M-98	
M-21	M-28	M-96	M-99	

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)
AS-20 GR	3.0-1	SSE of GGNS at the Former Glodjo residence (Sector L, Radius 0.9 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	3.0-2	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 Q 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 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 P, 1.3 miles)
Storm Drain Outfall 007 miles)	3.0-1	Outfall 007 (Sector N, 0.2 miles)
GRAND GULF, UNIT 1	3.0-3	

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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)
----------------------	-------	---

OR

SSE of GGNS near former Training Center on Bald Hill Road (Sector H, 0.46 miles)

NOTE:

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

	3.0-2	Alcorn State University SSW of GGNS (Sector K, 10.5 miles) any alternate location 15-30 km distant may be used.
--	-------	---

FISH SAMPLES

Fish and Invertebrates	3.0-1	Downstream of the GGNS discharge point into the Mississippi River
	3.0-1	Upstream of the GGNS discharge point into the Mississippi River uninfluenced by plant operations

GRAND GULF, UNIT 1

3.0-3a

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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	3.0-1	E	3.5
M-07	AS-1 PG, Port Gibson City Barn	3.0-2	G	5.5
M-09	Warner Tully Y-Camp	3.0-1	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-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 0.5 Bald Hill Road		3.0-1	G
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	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	3.0-1	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
M-95	Spoils Area, fence of old storage area, near entrance gate	3.0-1	F	0.5
M-96	North Gate fence	3.0-1	B	0.7
M-97	Grand Gulf Road entrance gate to spoils area	3.0-1	D	0.8
M-98	Bald Hill Road, across from Union Hall, in curve	3.0-1	H	0.5
M-99	North Fence of old Ball Field Near utility pole	3.0-1	K	0.4
M-100	Grand Gulf Road, across from L. Frazier	3.0-1	C	0.6

GRAND GULF, UNIT 1

3.0-5

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"TEXT DELETED"

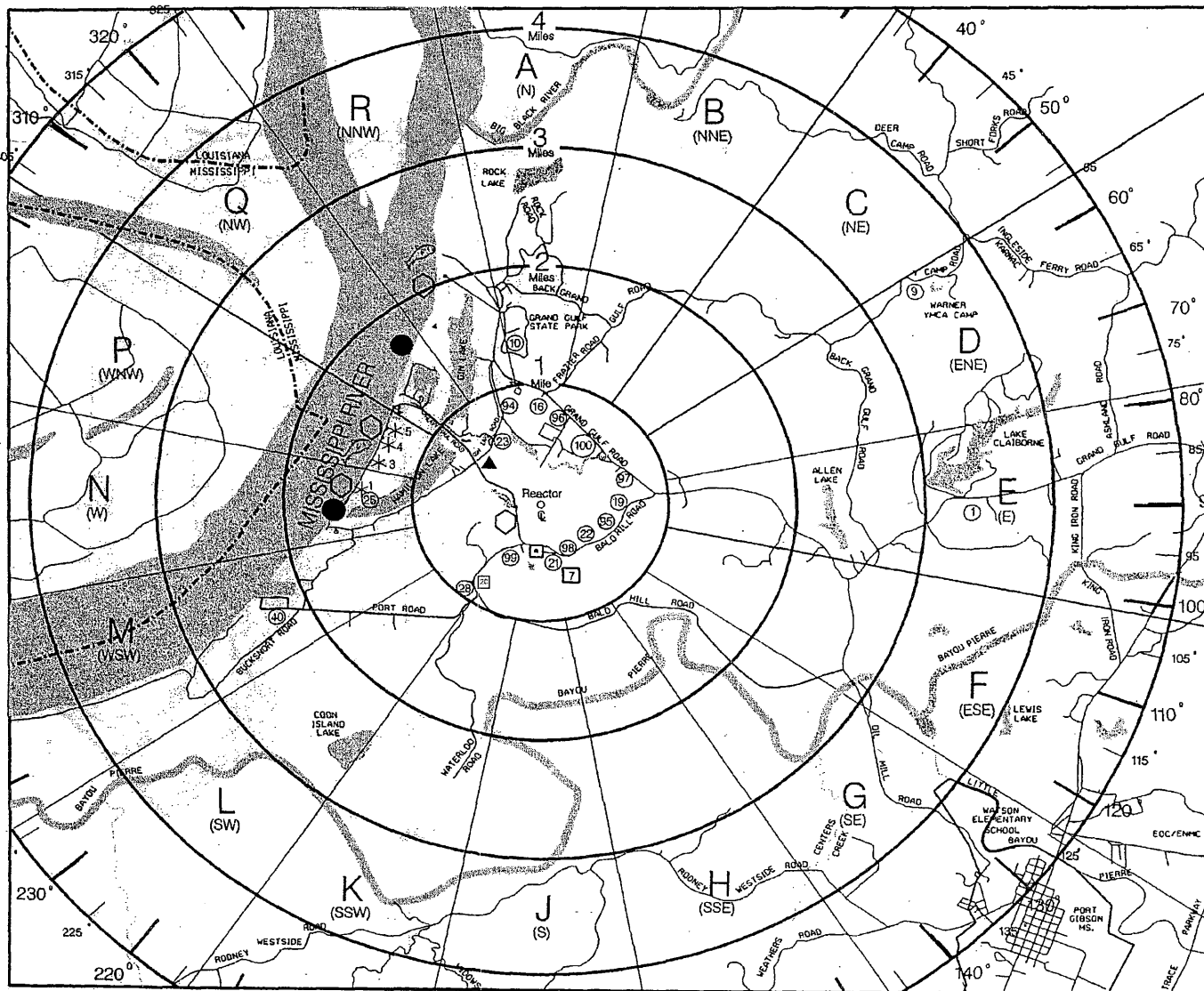


FIGURE 3.0-1  
Collection Site Locations  
0-4 Mile Area Map

**LEGEND**

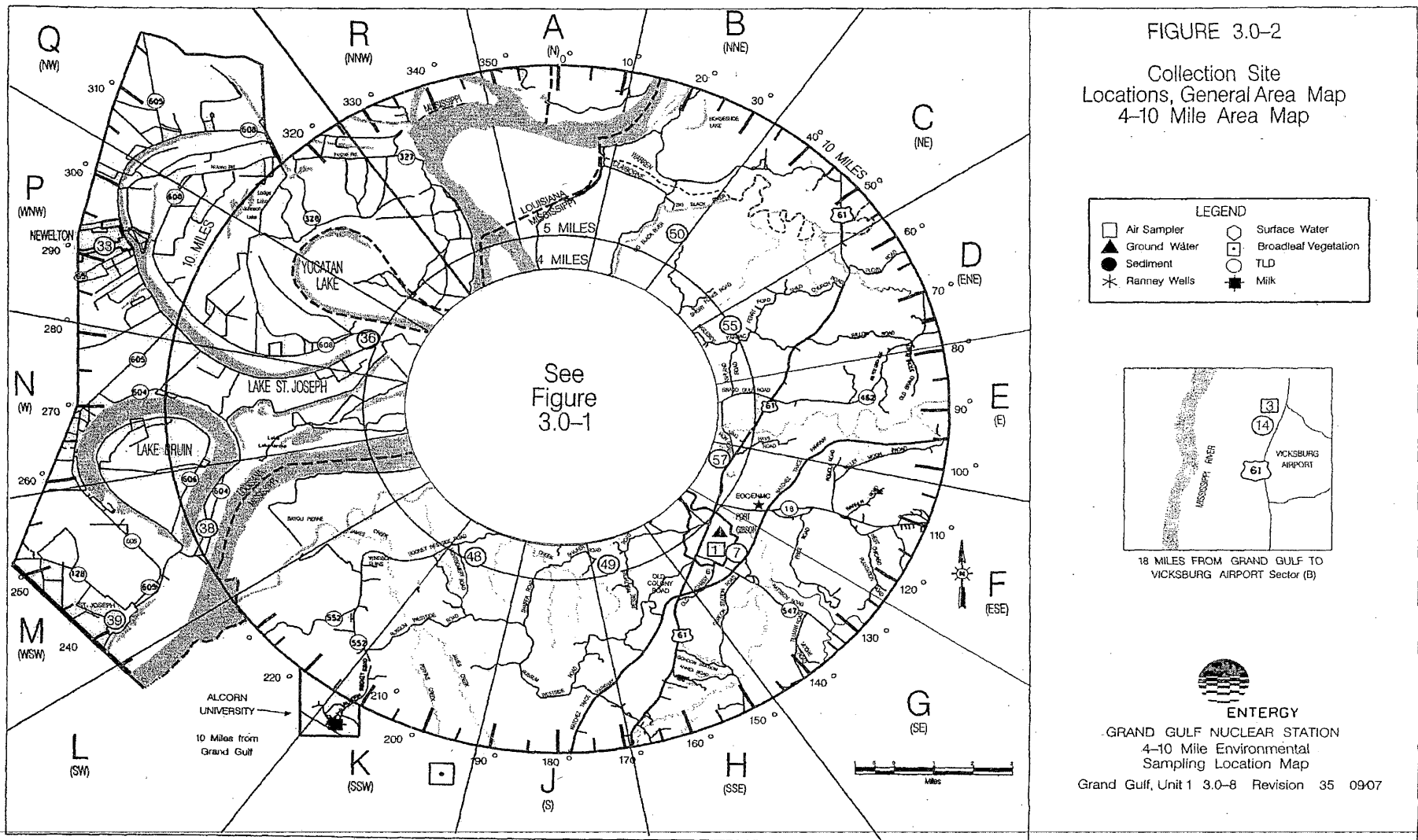
- Fish
- Air Sampler
- Surface Water
- Ground Water
- Broadleaf Vegetation
- Sediment
- TLD
- Ranney Wells
- Milk

**ENERGY**

GRAND GULF NUCLEAR STATION  
0-4 Mile Environmental  
Sampling Location Map

SCALE IN MILES

Figure 3.0-2  
 Collection Site Locations, General Area Map,  
 4-10 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 radioiodine 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.

## 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 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 OSRC.
- (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 OSRC.

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

## 5.0 ADMINISTRATIVE CONTROLS

---

### 5.6.3 ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT (Continued)

- c. The Radioactive Effluent Release Report shall also include a summary of the quantities of radioactive solid waste released from the unit as outlined in Regulatory Guide 1.21, "Measuring, Evaluating, and Report 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 following the format of Appendix B and Table 3.

The following information for each type of solid waste shipped off-site will be included in the report:

- (1) The total quantity in cubic meters and the total radioactivity in curies for the categories or types of waste.
  - (a) Spent resins, filter sludges, evaporator bottoms
  - (b) Dry compressible waste, contaminated equipment, etc.
  - (c) Irradiated components, control rods, etc.
  - (d) Other (furnish description)
- (2) An estimate of the major nuclide composition in the categories of waste in 5.6.3.c(1),
- (3) The disposition of solid waste shipments, identifying the number of shipments, the mode of transport, and the destination.
- (4) The disposition of irradiated fuel shipments, identifying the number of shipments, the mode of transport, and the destination.

Estimates of the total error associated with certain total values should be provided in each report. These error values should be the best effort of and overall estimate of the errors associated with the totals in the report.

SECTION 6.0  
LIMITING CONDITIONS FOR OPERATION  
AND  
SURVEILLANCE REQUIREMENTS

6.0 LIMITING CONDITION FOR OPERATION (LCO) APPLICABILITY

---

- LCO 6.0.1      When a Technical Specification (if LCO 3.0.3 is not applicable) or an Offsite Dose Calculation Manual LCO is not met and the associated ACTIONS are not met, an associated ACTION is not provided, or if directed by the associated ACTIONS, the following actions shall be taken:
1.      Develop and implement compensatory actions as needed.
  2.      Verify that a required safety function is not compromised by the inoperabilities.
  3.      Develop a plan for exiting LCO 6.0.1.
  4.      Obtain Duty Manager approval of the compensatory actions and a plan for exiting LCO 6.0.1 within 4 hours.

Where corrective measures are completed that permit operation in accordance with the LCO or ACTIONS, completion of the actions required by LCO 6.0.1 is not required.

LCO 6.0.1 is always applicable to Offsite Dose Calculation Manual LCOs and only applicable to Technical Specification LCOs if LCO 3.0.3 is not applicable.

LCO 6.0.1 is not to be voluntarily entered and actions to exit LCO 6.0.1 must be pursued without delay and in a controlled manner.

6.3 INSTRUMENTATION

6.3.9 RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

LCO 6.3.9 The radioactive liquid effluent monitoring instrumentation channels shown in Table 6.3.9-1 shall be FUNCTIONAL with required alarm/trip setpoints set to ensure that the limits of LCO 6.11.1 are not exceeded. The alarm/trip setpoints of these channels shall be determined in accordance with the OFFSITE DOSE CALCULATION MANUAL (ODCM).

APPLICABILITY: At all times.

ACTIONS

-----NOTES-----

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

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or more required channels nonfunctional.	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 B or C can not be restarted by reentering Required Action A.1. -----</p> <p>A.2 Enter the Condition referenced in Table 6.3.9-1 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 6.3.9-1.</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 FUNCTIONAL.</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 or discharge canal flow monitor may be used to estimate flow.</p> <p><u>AND</u></p> <p>C.2 Restore channel to FUNCTIONAL.</p>	<p>Once per 4 hours</p> <p>30 days</p>
<p>D. Required Action and associated Completion Time of Condition B 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 nonfunctionality was not corrected in a timely manner in the next Annual Radioactive Effluent Release Report.</p>	<p>Immediately</p> <p>Immediately</p>
<p>E. Required Action and associated Completion Time of Condition C not met.</p>	<p>E.1 Initiate action to explain why this nonfunctionality was not corrected in a timely manner in the next Annual Radioactive Effluent Release Report.</p>	<p>Immediately</p>

SURVEILLANCE REQUIREMENTS

-----NOTES-----

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

SURVEILLANCE	FREQUENCY
<p>SR 6.3.9.1</p> <p>-----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.</p> <p>-----</p> <p>Perform CHANNEL CHECK.</p>	<p>24 hours</p>
<p>SR 6.3.9.2</p> <p>Perform a source check, a qualitative assessment of channel response when the channel sensor is exposed to a radioactive source.</p>	<p>Prior to each release.</p>
<p>SR 6.3.9.3</p> <p>-----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:</p> <ol style="list-style-type: none"> <li>1. Instrument indicates measured levels above the alarm/trip setpoint.</li> <li>2. Circuit failure.</li> <li>3. Instrument indicates a downscale failure.</li> <li>4. Instrument controls not set in operate mode.</li> </ol> <p>-----</p> <p>Perform CHANNEL FUNCTIONAL TEST.</p>	<p>92 days</p>

(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 FUNCTIONAL</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. 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 FUNCTIONAL 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 LCO 3.0.4 are not applicable.
- 

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or more required channels nonfunctional.	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-----</p> 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 style="text-align: center;">-----</p> A.2 Enter the Condition referenced in Table 6.3.10-1 for the channel.	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><u>AND</u></p> <p>B.2 Analyze the above required samples for gross activity.</p> <p><u>AND</u></p> <p>B.3 Restore channel to FUNCTIONAL.</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><u>AND</u></p> <p>C.2 Enter Condition D for the alternate sample established in C.1.</p> <p><u>AND</u></p> <p>C.3 Restore channel to FUNCTIONAL.</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><u>AND</u></p> <p>D.2 Restore channel to FUNCTIONAL.</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 FUNCTIONAL.</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 nonfunctionality 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 Enter LCO 6.0.1</p>	<p>Immediately</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 nonfunctional 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"> <li>1. Instrument indicates measured levels above the alarm/trip setpoint.</li> <li>2. Circuit failure.</li> <li>3. Instrument indicates a downscale failure.</li> <li>4. For SGTS "A" radioactivity monitoring, Instrument Controls not set in operate mode. For SGTS "B" radioactivity monitoring, in deferred. For all other equipment, Instrument Controls not set in operate mode.</li> </ol> <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 m<sup>r</sup>/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>



SR 6.3.10.8

-----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.

-----  
Perform a CHANNEL CALIBRATION

18 months

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 6.3.10.8
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 FUNCTIONAL</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 6.3.10.8
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
3A. 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 6.3.10.8
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 FUNCTIONAL</u>	<u>APPLICABILITY</u>	<u>CONDITIONS REFERENCED FROM REQUIRED ACTION A.2</u>	<u>SURVEILLANCE REQUIREMENTS</u>
3B. TURBINE BUILDING OCCASIONAL RELEASE POINT MONITORING SYSTEM				
a. Noble Gas Activity Providing Alarm	1	(f)	Immediately isolate	SR 6.3.10.1(g) SR 6.3.10.3(g) SR 6.3.10.5(g) SR 6.3.10.7(g)
b. Iodine Sampler	1	(f)	Immediately isolate	SR 6.3.10.2(g)
c. Particulate Sampler	1	(f)	Immediately isolate	SR 6.3.10.2(g)
d. Effluent System Flow Rate Measuring Device	1	(f)	Immediately isolate	SR 6.3.10.1(g) SR 6.3.10.6(g) SR 6.3.10.8(g)
e. Sampler Flow Rate Measuring Device	1	(f)	Immediately isolate	SR 6.3.10.1(g) SR 6.3.10.8(g)
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 6.3.10.8
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 FUNCTIONAL</u>	<u>APPLICABILITY</u>	<u>CONDITIONS REFERENCED FROM REQUIRED ACTION A.2</u>	<u>SURVEILLANCE REQUIREMENTS</u>
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
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)				
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
8. STANDBY GAS TREATMENT EXHAUST MONITORING SYSTEM (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 6.3.10.8

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.
- (f) In modes 1, 2 and 3, when in service.
- (g) Prior to each use and at the specified frequency.
- (h) When in modes 4, & 5, UP TO 4 Turbine roof hatches may be open as long as the radionuclide concentrations are  $\leq 30\%$  of the ODCM dose limits in 6.11.4 and 6.11.6.
- (i) When in modes 4 and 5, this monitoring instrumentation is not required.

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  $2 \times 10^{-4}$  microcuries/ml total activity.

APPLICABILITY: At all times.

ACTIONS

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

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)	$5 \times 10^{-7}$
			I-131	$1 \times 10^{-6}$
	Prior to Release One Batch/M	31 days	Dissolved and Entrained Gases (Gamma emitters)	$1 \times 10^{-5}$
			Prior to Release Each Batch	31 days Composite (b)
	Prior to Release Each Batch	92 days Composite (b)	Gross Alpha	$1 \times 10^{-7}$
			Sr-89, Sr-90	$5 \times 10^{-8}$
			Fe-55	$1 \times 10^{-6}$
			B. SSW Basin (before blowdown)	Prior to Release Each Blowdown
I-131	$1 \times 10^{-6}$			

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):

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

where

- LLD is the "a priori" lower limit of detection as defined above (as  $\mu\text{Ci}$  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)
- $2.22 \times 10^6$  is the number of disintegrations per minute per microcurie
- Y is the fractional radiochemical yield (when applicable)
- $\lambda$  is the radioactive decay constant for the particular radionuclide
- $\Delta t$  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  $\Delta t$  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 EFFLUENT 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.  $\leq 1.5$  mrem to the total body and  $\leq 5$  mrem to any organ, during any calendar quarter, and
- b.  $\leq 3$  mrem to the total body and  $\leq 10$  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 nonfunctional.	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>
--	--	--------------------

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:  $\leq 500$  mrem/yr to the total body and  $\leq 3000$  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:  $\leq 1500$  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 nonfunctional.	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) (uCi/ml) (a)
A. (1) Radwaste Building Ventilation Exhaust	31 days Grab Sample (f)	31 days	Principal Gamma Emitters (b,e)	1x10 <sup>-4</sup>
			H-3	1x10 <sup>-6</sup>
(2) Fuel Handling Area Ventilation Exhaust	Continuous (d) (f)	7 days (c) Charcoal Sample	I-131	1x10 <sup>-12</sup>
			I-133	1x10 <sup>-10</sup>
(3) Containment Ventilation Exhaust	Continuous (d) (f)	7 days (c) Particulate Sample	Principal Gamma Emitters (e) (I-131, Others)	1x10 <sup>-11</sup>
(4A) Turbine Building Ventilation Exhaust	Continuous (d) (f)	31 days Composite Particulate Sample	Gross Alpha	1x10 <sup>-11</sup>
(4B) Turbine Building Occasional Release Point (g) (when in service)	Continuous (d) (f)	92 days Composite Particulate Sample	Sr-89, Sr-90	1x10 <sup>-11</sup>
			Continuous (f)	Noble Gas Monitor
B. (1) Offgas Post Treatment Exhaust, whenever there is flow	31 days Grab Sample (f)	31 days	Principal Gamma Emitters (e)	1x10 <sup>-4</sup>
(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):  
 $4.66 s_b$

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

where

LLD is the "a priori" lower limit of detection as defined above (as  $\mu\text{Ci}$  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)

$2.22 \times 10^6$  is the number of disintegrations per minute per microcurie

Y is the fractional radiochemical yield (when applicable)

$\lambda$  is the radioactive decay constant for the particular radionuclide

$\Delta t$  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  $\Delta t$  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 a nonfunctional status solely for performance of required Surveillances, entry into associated Conditions and Required Actions in accordance with LCO 6.3.10 may be delayed for up to 1 hour.
- g. When in modes 4 and 5, continuous noble gas monitor alarm is not required.

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.  $\leq 5$  mrad for gamma radiation and  $\leq 10$  mrad for beta radiation, during any calendar quarter and
- b.  $\leq 10$  mrad for gamma radiation and  $\leq 20$  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 nonfunctional.	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.  $\leq 7.5$  mrem to any organ during any calendar quarter, and
- b.  $\leq 15$  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
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.	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 nonfunctional.	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>OR</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 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)

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
C. Milk or broad leaf vegetation sampling is relocated from one or more of the sample locations required by ODCM Table 6.12.1-1.	C.1 Initiate action to identify this changed location(s) in the next Annual Radioactive Effluent Release Report.	Immediately
	<u>AND</u> C.2 Add this location(s) to the radiological environmental monitoring program.	30 days

SURVEILLANCE REQUIREMENTS

SURVEILLANCE	FREQUENCY
SR 6.12.1.1 Radiological environmental monitoring samples shall be collected pursuant to ODCM Table 6.12.1-1 from the locations given in the table and figures in the ODCM and shall be analyzed pursuant to the requirements of ODCM Tables 6.12.1-1 and 6.12.1-3.	Per ODCM Table 6.12.1-1.
SR 6.12.1.2 Conduct an Interlaboratory Comparison Program and include a summary of the results in the Annual Radiological Environmental Operating Report.	366 days

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
<b>AIRBORNE</b>			
Radioiodine and Particulates	<p>Samples from 3 locations:</p> <p>1 sample close to the SITE BOUNDARY having the highest calculated annual average groundlevel D/Q.</p> <p>1 sample from the vicinity of a community having the highest calculated annual average groundlevel D/Q.</p> <p>1 sample from a control location 15-30 km (10-20 miles) distance(d)</p>	<p>Continuous sampler operation with sample collection per 7 days or as required by dust loading, whichever is more frequent</p>	<p>Radioiodine Cannister: I-131; 7 days</p> <p>Particulate Sampler: Gross beta radio-activity following filter change(b), composite (by location) for gamma isotopic(c); 92 days</p>
DIRECT RADIATION(e)	<p>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*:</p> <ol style="list-style-type: none"> <li>1) an inner ring of stations in the general areas of the SITE BOUNDARY</li> <li>2) an outer ring approximately 3 to 5 miles from the site.</li> </ol> <p>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.</p> <p>5 additional stations will be placed in locations in the general area of the site boundary to supplement the inner ring monitoring locations.</p>	92 days	Gamma dose; 92 days

TABLE 6.12.1-1 (Continued)

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>WATERBORNE</u>			
Surface	1 sample upstream 1 sample downstream	92 days	Gamma isotopic(c) and tritium analyses; 92 days
	One sample downstream during a liquid Radwaste Discharge	366 days	Gamma Isotopic (c) and tritium analyses; 366 days
	1 sample from Outfall 007	31 days	Tritium; 31 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

Exposure Pathway and/or Sample	Number of Samples(a) and Locations	Sampling and Collection Frequency(a)	Type and Frequency of Analysis
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 (e) in vicinity of GGNS discharge point	366 days	Gamma isotopic(c) on edible portion; 366 days
	1 sample (e) 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.
- e Commercially important species preferred (catfish, buffalo); however, if unavailable, other species may be substituted.

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<sup>b</sup>

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

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

<sup>b</sup> 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 <sup>3</sup> )	Fish (pCi/kg, wet)	Milk (pCi/l)	Broad Leaf Vegetation (pCi/kg, wet)	Sediment (pCi/kg, dry)
Gross beta	4	1 x 10 <sup>-2</sup>	NA	NA	NA	NA
H-3	2 x 10 <sup>3</sup> (d)	NA	NA	NA	NA	NA
Mn-54	15	NA	1.3 x 10 <sup>2</sup>	NA	NA	NA
Fe-59	30	NA	2.6 x 10 <sup>2</sup>	NA	NA	NA
Co-58,60	15	NA	1.3 x 10 <sup>2</sup>	NA	NA	NA
Zn-65	30	NA	2.6 x 10 <sup>2</sup>	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 <sup>-2</sup>	NA	1	60	NA
Cs-134	15	5 x 10 <sup>-2</sup>	1.3 x 10 <sup>2</sup>	15	60	1.5 x 10 <sup>2</sup>
Cs-137	18	6 x 10 <sup>-2</sup>	1.5 x 10 <sup>2</sup>	18	80	1.8 x 10 <sup>2</sup>
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)

$\lambda$  is the radioactive decay constant for the particular radionuclide

$\Delta t$  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  $\Delta t$  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 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  $3 \times 10^3$  pCi/l 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 m<sup>2</sup> (500 ft<sup>2</sup>) 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

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#### 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 FUNCTIONALITY 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 FUNCTIONALITY 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

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#### 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

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#### 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 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,

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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.

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#### 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 nonfunctional equipment or subsystems which resulted in liquid radwaste being discharged without treatment,
- (3) the reason for the nonfunctionality
- (4) action(s) taken to restore the nonfunctional equipment to an FUNCTIONAL status,
- (5) summary descriptions of actions taken to prevent a recurrence.

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##### 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 release 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.

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#### 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.

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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 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.

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#### 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.

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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 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.



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#### 6.11.7 and 6.11.8 GASEOUS RADWASTE TREATMENT AND VENTILATION EXHAUST TREATMENT

The FUNCTIONALITY 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 nonfunctional equipment or subsystems which resulted in gaseous radwaste being discharged without treatment,
- (3) the reason for the nonfunctionality,
- (4) action(s) taken to restore the nonfunctional equipment to an FUNCTIONAL 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

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#### 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

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#### 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 m<sup>2</sup> 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/m<sup>2</sup>. 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

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#### 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.