

Enclosure 3
RA-25-0095

ENCLOSURE 3: HNP Annual Radioactive Effluent Release Report



Shearon Harris Nuclear Power Plant Unit 1

Annual Radioactive Effluent Release Report

January 1, 2024, through December 31, 2024

Docket 50-400



Introduction

The Annual Radioactive Effluent Release Report is pursuant to Shearon Harris Nuclear Power Plant Technical Specification 6.9.1.4 and ODCM Section F.2. The below listed attachments to this report provide the required information. In addition, the ODCM is included pursuant to Shearon Harris Nuclear Power Plant Technical Specification 6.14.

Attachment 1	Summary of Gaseous and Liquid Effluents
Attachment 2	Supplemental Information
Attachment 3	Solid Radioactive Waste Disposal
Attachment 4	Meteorological Data
Attachment 5	Unplanned Offsite Releases
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Attachment 1
Summary of Gaseous and Liquid Effluents

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

ATTACHMENT 1

Summary of Gaseous and Liquid Effluents

This attachment includes a summary of the quantities of radioactive liquid and gaseous effluents as outlined in Regulatory Guide 1.21, Appendix B.

Attachment 1

Summary of Gaseous and Liquid Effluents

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

Gaseous Effluents - Summation of All Releases

	<u>Units</u>	<u>Qtr 1</u>	<u>Qtr 2</u>	<u>Qtr 3</u>	<u>Qtr 4</u>	<u>Year</u>
A. Fission and Activation Gases						
1. Total Release	Ci	0.00E+00	1.22E-01	0.00E+00	0.00E+00	1.22E-01
2. Avg. Release Rate	μCi/sec	0.00E+00	1.55E-02	0.00E+00	0.00E+00	3.88E-03
B. Iodine-131						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Release Rate	μCi/sec	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C. Particulates Half-Life ≥ 8 days						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Release Rate	μCi/sec	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Tritium						
1. Total Release	Ci	4.23E+01	2.76E+01	2.79E+01	3.30E+01	1.31E+02
2. Avg. Release Rate	μCi/sec	5.39E+00	3.52E+00	3.51E+00	4.15E+00	4.14E+00
E. Gross Alpha						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Attachment 1
Summary of Gaseous and Liquid Effluents

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

Gaseous Effluents - Elevated Releases - Continuous Mode *

	<u>Units</u>	<u>Qtr 1</u>	<u>Qtr 2</u>	<u>Qtr 3</u>	<u>Qtr 4</u>	<u>Year</u>
A. Fission and Activation Gases						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	-	-	-	-	-
B. Iodines						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	-	-	-	-	-
C. Particulates Half-Life $\geq$ 8 days						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	-	-	-	-	-
D. Tritium						
N/A	Ci	-	-	-	-	-
E. Gross Alpha						
Total for Period	Ci	-	-	-	-	-

* Shearon Harris Nuclear Power Plant Unit 1 does not have elevated releases.

Attachment 1
Summary of Gaseous and Liquid Effluents

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

Gaseous Effluents - Elevated Releases - Batch Mode *

	<u>Units</u>	<u>Qtr 1</u>	<u>Qtr 2</u>	<u>Qtr 3</u>	<u>Qtr 4</u>	<u>Year</u>
A. Fission and Activation Gases						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	-	-	-	-	-
B. Iodines						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	-	-	-	-	-
C. Particulates Half-Life $\geq$ 8 days						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	-	-	-	-	-
D. Tritium						
N/A	Ci	-	-	-	-	-
E. Gross Alpha						
Total for Period	Ci	-	-	-	-	-

* Shearon Harris Nuclear Power Plant Unit 1 does not have elevated releases.

Attachment 1

Summary of Gaseous and Liquid Effluents

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

Gaseous Effluents - Ground Releases - Continuous Mode

	<u>Units</u>	<u>Qtr 1</u>	<u>Qtr 2</u>	<u>Qtr 3</u>	<u>Qtr 4</u>	<u>Year</u>
A. Fission and Activation Gases						
Xe-133	Ci	0.00E+00	1.22E-01	0.00E+00	0.00E+00	1.22E-01
Total for Period	Ci	0.00E+00	1.22E-01	0.00E+00	0.00E+00	1.22E-01
B. Iodines						
None	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C. Particulates Half-Life $\geq$ 8 days						
None	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Tritium						
H-3	Ci	4.23E+01	2.76E+01	2.79E+01	3.30E+01	1.31E+02
E. Gross Alpha						
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Attachment 1
Summary of Gaseous and Liquid Effluents

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

Gaseous Effluents - Ground Releases - Batch Mode

	<u>Units</u>	<u>Qtr 1</u>	<u>Qtr 2</u>	<u>Qtr 3</u>	<u>Qtr 4</u>	<u>Year</u>
A. Fission and Activation Gases						
None	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
B. Iodines						
None	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C. Particulates Half-Life ≥ 8 days						
None	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Tritium						
H-3	Ci	0.00E+00	9.37E-03	1.34E-04	2.42E-04	9.75E-03
E. Gross Alpha						
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Attachment 1 **Summary of Gaseous and Liquid Effluents**

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

Gaseous Effluents - Mixed-Mode Releases - Continuous Mode *

	<u>Units</u>	<u>Qtr 1</u>	<u>Qtr 2</u>	<u>Qtr 3</u>	<u>Qtr 4</u>	<u>Year</u>
A. Fission and Activation Gases						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	-	-	-	-	-
B. Iodines						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	-	-	-	-	-
C. Particulates Half-Life ≥ 8 days						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	-	-	-	-	-
D. Tritium						
N/A	Ci	-	-	-	-	-
E. Gross Alpha						
Total for Period	Ci	-	-	-	-	-

* Shearon Harris Nuclear Power Plant Unit 1 does not have mixed-mode releases.

Attachment 1

Summary of Gaseous and Liquid Effluents

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

Gaseous Effluents - Mixed-Mode Releases - Batch Mode *

	<u>Units</u>	<u>Qtr 1</u>	<u>Qtr 2</u>	<u>Qtr 3</u>	<u>Qtr 4</u>	<u>Year</u>
A. Fission and Activation Gases						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	-	-	-	-	-
B. Iodines						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	-	-	-	-	-
C. Particulates Half-Life ≥ 8 days						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	-	-	-	-	-
D. Tritium						
N/A	Ci	-	-	-	-	-
E. Gross Alpha						
Total for Period	Ci	-	-	-	-	-

* Shearon Harris Nuclear Power Plant Unit 1 does not have mixed-mode releases.

Attachment 1

Summary of Gaseous and Liquid Effluents

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

Liquid Effluents - Summation of All Releases

	<u>Units</u>	<u>Qtr 1</u>	<u>Qtr 2</u>	<u>Qtr 3</u>	<u>Qtr 4</u>	<u>Year</u>
A. Fission and Activation Products*						
1. Total Release	Ci	5.81E-04	1.33E-03	2.88E-03	7.29E-04	5.52E-03
2. Avg. Diluted Conc.	µCi/ml	1.23E-10	4.65E-10	5.47E-10	2.47E-10	3.46E-10
B. Tritium						
1. Total Release	Ci	1.67E+02	1.68E+02	5.12E+01	3.49E+01	4.21E+02
2. Avg. Diluted Conc.	µCi/ml	2.05E-05	3.57E-05	9.06E-06	1.08E-05	1.90E-05
C. Dissolved & Entrained Gases						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Diluted Conc.	µCi/ml	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Gross Alpha						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Diluted Conc.	µCi/ml	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
E. Volume of Liquid Waste						
1. Batch Releases	liters	6.39E+05	9.00E+05	1.13E+06	6.40E+05	3.31E+06
2. Continuous Releases	liters	1.15E+07	4.12E+07	1.34E+07	1.19E+07	7.80E+07
F. Volume of Dilution Water						
1. Batch Releases	liters	4.73E+09	2.87E+09	5.26E+09	2.95E+09	1.58E+10
2. Continuous Releases	liters	4.73E+09	2.87E+09	5.26E+09	2.95E+09	1.58E+10

* Excludes tritium, dissolved and entrained noble gases, and gross alpha.

Attachment 1
Summary of Gaseous and Liquid Effluents

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

Liquid Effluents - Continuous Mode

	<u>Units</u>	<u>Qtr 1</u>	<u>Qtr 2</u>	<u>Qtr 3</u>	<u>Qtr 4</u>	<u>Year</u>
A. Fission and Activation Products						
None	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
B. Tritium						
H-3	Ci	6.59E-02	5.45E-01	1.13E-01	1.15E-01	8.39E-01
C. Dissolved & Entrained Gases						
None	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Gross Alpha						
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Attachment 1

Summary of Gaseous and Liquid Effluents

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

Liquid Effluents - Batch Mode

	<u>Units</u>	<u>Qtr 1</u>	<u>Qtr 2</u>	<u>Qtr 3</u>	<u>Qtr 4</u>	<u>Year</u>
A. Fission and Activation Products						
Cr-51	Ci	0.00E+00	9.04E-05	3.59E-05	0.00E+00	1.26E-04
Mr-54	Ci	2.06E-05	7.36E-06	2.10E-04	3.03E-06	2.41E-04
Fe-55	Ci	7.73E-05	2.04E-04	2.84E-04	2.01E-04	7.66E-04
Fe-59	Ci	0.00E+00	8.26E-06	0.00E+00	0.00E+00	8.62E-06
Co-57	Ci	0.00E+00	0.00E+00	2.39E-06	0.00E+00	2.39E-06
Co-58	Ci	4.08E-06	4.69E-04	8.43E-04	8.01E-05	1.40E-03
Co-60	Ci	2.39E-04	2.63E-04	6.58E-04	1.73E-04	1.33E-03
Ni-63	Ci	7.60E-05	2.27E-04	5.18E-04	2.61E-04	1.08E-03
Se-75	Ci	0.00E+00	0.00E+00	3.38E-05	0.00E+00	3.38E-05
Zr-95	Ci	6.91E-06	0.00E+00	2.07E-05	0.00E+00	2.76E-05
Nb-95	Ci	8.69E-06	1.36E-05	4.44E-05	0.00E+00	6.67E-05
Sb-124	Ci	0.00E+00	9.52E-06	1.00E-05	0.00E+00	1.95E-05
Sb-125	Ci	1.04E-04	3.84E-05	1.86E-04	1.10E-05	3.39E-04
Cs-137	Ci	4.46E-05	0.00E+00	3.26E-05	0.00E+00	7.72E-05
Total for Period	Ci	5.81E-04	1.33E-03	2.88E-03	7.29E-04	5.52E-03
B. Tritium						
H-3	Ci	1.67E+02	1.67E+02	5.11E+01	3.48E+01	4.20E+02
C. Dissolved & Entrained Gases						
None	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Gross Alpha						
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Attachment 2
Supplemental Information

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

ATTACHMENT 2

Supplemental Information

This attachment includes supplemental information to the gaseous and liquid effluents report.

Attachment 2 Supplemental Information

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

I. Regulatory Limits - Per Unit

A. Noble Gases - Air Dose

1. Calendar Quarter Gamma Dose	=	5 mRAD
2. Calendar Quarter Beta Dose	=	10 mRAD
3. Calendar Year Gamma Dose	=	10 mRAD
4. Calendar Year Beta Dose	=	20 mRAD

B. Liquid Effluents - Dose

1. Calendar Quarter Total Body Dose	=	1.5 mREM
2. Calendar Quarter Organ Dose	=	5 mREM
3. Calendar Year Total Body Dose	=	3 mREM
4. Calendar Year Organ Dose	=	10 mREM

C. Gaseous Effluents - Iodine-131 & 133, Tritium, and Particulates with Half-lives > 8 days

1. Calendar Quarter Organ Dose	=	7.5 mREM
2. Calendar Year Organ Dose	=	15 mREM

II. Maximum Permissible Effluent Concentrations

A. Gaseous Effluents

1. Information found in Offsite Dose Calculation Manual

B. Liquid Effluents

1. Information found in 10 CFR Part 20, Appendix B, Table 2, Column 2

III. Average Energy

(Not applicable)

IV. Measurements and Approximations of Total Radioactivity

Analyses of specific radionuclides in selected or composited samples as described in the ODCM are used to determine the radionuclide composition of the effluent. A summary description of the method used for estimating overall errors associated with radioactivity measurements is provided as part of this attachment.

V. Batch Releases

A. Liquid Effluents

	Jan - Jun	Jul - Dec
1. Number of Batch Releases	= 19	22
2. Total Time Period for Batch Releases (min)	= 1.60E+04	2.07E+04
3. Maximum Time Period for a Batch Release (min)	= 1.10E+03	1.24E+03
4. Average Time Period for a Batch Release (min)	= 8.40E+02	9.41E+02
5. Minimum Time Period for a Batch Release (min)	= 7.20E+02	7.30E+02
6. Average Stream Flow During Release Periods (gpm)	= 1.08E+04	9.65E+03

B. Gaseous Effluents

	Jan - Jun	Jul - Dec
1. Number of Batch Releases	= 2	5
2. Total Time Period for Batch Releases (min)	= 3.30E+03	1.54E+03
3. Maximum Time Period for a Batch Release (min)	= 3.17E+03	3.38E+02
4. Average Time Period for a Batch Release (min)	= 1.65E+03	3.08E+02
5. Minimum Time Period for a Batch Release (min)	= 1.22E+02	2.78E+02

VI. Abnormal Releases

See Attachment 5, Unplanned Offsite Releases.

Attachment 2 Supplemental Information

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

Carbon-14

Carbon-14 (C-14), with a half-life of 5730 years, is a naturally occurring isotope of carbon produced by cosmic ray interactions in the atmosphere. Nuclear weapons testing in the 1950s and 1960s significantly increased the amount of C-14 in the atmosphere. C-14 is also produced in commercial nuclear reactors, but the amounts produced are much less than those produced naturally or from weapons testing.

In Regulatory Guide 1.21, Revision 2, "Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste", the NRC recommends U.S. nuclear power plants evaluate whether C-14 is a "principal radionuclide", and if so, report the amount of C-14 released. Improvements over the years in effluent management practices and fuel performance have resulted in a decrease in gaseous radionuclide (non-C-14) concentrations, and a change in the distribution of gaseous radionuclides released to the environment. As a result, many sites show C-14 has become a "principal radionuclide" for the gaseous effluent pathway, as defined in Regulatory Guide 1.21, Rev. 2.

The concentration and offsite dose from C-14 has been estimated by using a calculation approach, assuming typical or maximum values for the various calculation parameters. Because the dose contribution of C-14 from liquid radioactive waste is much less than that contributed by gaseous radioactive waste, evaluation of C-14 in liquid radioactive waste is not required (Ref. Reg. Guide 1.21, Rev. 2).

The quantity of gaseous C-14 released to the environment can be estimated by use of a C-14 source term scaling factor based on power generation (Ref. Reg. Guide 1.21, Rev. 2). Many documents provide information related to the magnitude of C-14 in typical effluents from commercial nuclear power plants. Those documents suggest that nominal annual releases of C-14 in gaseous effluents are approximately 5 to 7.3 curies from PWRs (Ref. Reg. Guide 1.21, Rev. 2). For Shearon Harris Nuclear Power Plant 2024 ARERR, a source term scaling factor was calculated using an annual release rate of 7.3 curies/ year and the actual 2024 EFPD of 327.43 days. Using the source term scaling factor from Shearon Harris Nuclear Power Plant in 2024 results in a site total C-14 gaseous release estimate to the environment of 8.19 Curies.

The resultant offsite doses were based upon this source term and the dose calculations described in NRC Regulatory Guide 1.109, Revision 1, and the Shearon Harris Nuclear Power Plant ODCM. The estimated C-14 dose impact on the maximum organ dose from airborne effluents released from Shearon Harris Nuclear Power Plant in 2024 was well below the 10CFR 50, Appendix I, ALARA design objective (i.e., 15 mrem/yr. per unit). Based on the calculations performed, bone dose to a child 1.81 miles from the plant in the NNE sector had the highest estimated dose of 7.65E-01 mREM/year.

	<u>Units</u>	<u>1st Qtr</u>	<u>2nd Qtr</u>	<u>3rd Qtr</u>	<u>4th Qtr</u>	<u>Year</u>
1. EFPD	Days	89.60	53.90	91.95	91.98	327.43
2. C-14 Activity Released	Ci	2.24	1.35	2.30	2.30	8.19
3. C-14 Total Body Dose	mREM	4.12E-02	2.48E-02	4.34E-02	4.32E-02	1.53E-01
4. C-14 Organ Dose	mREM	2.07E-01	1.24E-01	2.18E-01	2.17E-01	7.65E-01

Receptor Location: 1.81 mi NNE
Critical Age: CHILD
Critical Organ: BONE

Attachment 2 Supplemental Information

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

Dose from Returned/Re-used of Previously Discharge Plant Effluents

Cooling Tower Plume

Tritium in Cooling Tower plume creates an exposure pathway to a member of the public. Murray and Trettel, Inc. was contracted to perform an evaluation of the dose to a member of the public from exposure to tritium in the Cooling Tower plume. Results of the plume exposure are contained in report "*Impact of Tritium Release from the Cooling Tower at the Harris Nuclear Plant for 2024*". Using the methodology described in ODCM 2.3.2, the following is a summary of tritium activity released through the Cooling Tower plume and resulting dose for 2024.

	<u>Units</u>	<u>Qtr 1</u>	<u>Qtr 2</u>	<u>Qtr 3</u>	<u>Qtr 4</u>	<u>Year</u>
1. H-3 Activity Released	Ci	2.85E+01	1.43E+01	2.40E+01	2.48E+01	9.15E+01
2. H-3 Dose	mREM	4.98E-04	2.49E-04	4.19E-04	4.33E-04	1.60E-03

Receptor Location 1.55 mi NNW
Critical Age CHILD
Critical Organ N/A *

Harris Lake Evaporation

Evaporation of water containing tritium in Harris Lake creates an exposure pathway to a member of the public. Murray and Trettel, Inc. was contracted to perform an evaluation of the dose to a member of the public from evaporation of tritium in Harris Lake. Results of the evaluation are contained in report "*Impact of Tritium Release from the Water Reservoir (Lake Harris) at the Harris Nuclear Plant for 2024*". Using the methodology described in ODCM 2.3.3, the following is a summary of tritium activity released through evaporation and resulting dose for 2024.

	<u>Units</u>	<u>Qtr 1</u>	<u>Qtr 2</u>	<u>Qtr 3</u>	<u>Qtr 4</u>	<u>Year</u>
1. H-3 Activity Released	Ci	1.26E+01	3.54E+01	3.00E+01	1.03E+01	8.82E+01
2. H-3 Dose	mREM	1.13E-02	3.18E-02	2.67E-02	9.12E-03	7.90E-02

Receptor Location 4.16 mi SSW
Critical Age CHILD
Critical Organ N/A *

Drinking Water at Harris Plant and the Harris Energy and Environmental (HE&EC) Training Centers

Concentrations of radionuclides used in this specific drinking water pathway are determined by averaging the monthly concentrations detected in environmental location (REMP) DW-51. In 2024, no plant related gamma emitting radionuclides were detected. Tritium was detected each month, as expected. Using the methodology described in ODCM 2.3.1, the following is a summary of average concentration consumed and resulting dose for 2024.

	<u>Units</u>	<u>Year</u>
1. Avg. H-3 Concentration	pCi/L	2.10E+03
2. H-3 Dose	mREM	5.76E-02

Critical Age ADULT
Critical Organ N/A *

* The dose factor for H-3 is the same for all organs and Total Body (with the exception of Bone, which is 0.00E+00).

Attachment 2 Supplemental Information

Shearon Harris Nuclear Power Plant Unit 1 Period 1/1/2024 - 12/31/2024

Tritium in Fish from Harris Lake ^{NOTE}

Concentrations of radionuclides used in this specific fish consumption pathway are determined by averaging the monthly concentrations detected in environmental location (REMP) SW-26. In 2024, no plant related gamma emitting radionuclides were detected. Tritium was detected each month, as expected. Since tritium is consistently detected in Harris Lake REMP samples, tritium concentration in the fish is assumed to be in equilibrium with Harris Lake. Using the methodology and data described in NRC Regulatory Guide 1.109, Rev.1, October 1977, Equation A-1, Table E-5, and Table E-11, the following is a summary of average concentration consumed and resulting dose for 2024.

	<u>Units</u>	<u>Year</u>
1. Avg. H-3 Concentration	pCi/L	4.43E+03
2. H-3 Dose	mREM	8.79E-03

Critical Age ADULT
Critical Organ N/A *

* *The dose factor for H-3 is the same for all organs and Total Body (with the exception of Bone, which is 0.00E+00).*

NOTE: This information was previously included in the Shearon Harris Nuclear Power Plant AREOR. DRR 2008147 was written to include the fish dose calculation methodology in ODCM revision 26, and report in the ARERR.

Attachment 2
Supplemental Information

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

Overall Estimate of Error for Effluent Radioactivity Release Reported

The estimated percentage of overall error for Gaseous effluent release data at Shearon Harris Nuclear Power Plant Unit 1 is listed below. These values were derived by taking the square root of the sum of the squares of the discrete individual estimates of error.

1. Fission and Activation Gases	=	± 52.7%
2. Particulates	=	± 33.8%
3. Iodine	=	± 30.4%
4. Tritium	=	± 52.2%

The estimated percentage of overall error for Liquid effluent release data at Shearon Harris Nuclear Power Plant Unit 1 is listed below. These values were derived by taking the square root of the sum of the squares of the discrete individual estimates of error.

1. Fission and Activation Products and Dissolved and Entrained Noble Gases	=	± 32.8%
2. Tritium	=	± 54.3%

Attachment 2 Supplemental Information

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

Summary of Changes in Land Use Census Affecting Effluent Dose Calculations

The 2024 Land Use Census was performed June 10-11, 2024. The following are changes to residences, gardens, and milk animals from the previous year.

RESIDENCES

- The residence in the NW sector at 2.11 miles was replaced by a residence at 2.15 miles.

GARDENS

NOTE: There were no gardens identified, by the land use census, as being irrigated from Harris Lake (Shearon Harris Reservoir).

- The garden in the NNE sector at 1.81 miles was replaced by a garden at 3.40 miles.
- The garden in the ENE sector at 1.78 miles was no longer present. No other gardens were identified in this sector.
- The garden in the ESE sector at 4.63 miles was replaced by a garden at 2.83 miles.
- The garden in the SSE sector at 4.82 miles was no longer present. No other gardens were identified in this sector.
- The garden in the SSW sector at 3.94 miles was replaced by a garden at 3.82 miles.
- The garden in the SW sector at 4.32 miles was no longer present. No other gardens were identified in this sector.
- The garden in the W sector at 2.82 miles was replaced by a garden at 4.51 miles.
- The garden in the NW sector at 2.58 miles was replaced by a garden at 2.90 miles.

MEAT ANIMALS

NOTE: Meat animals were only identified at the nearest garden or closer in each sector, and poultry and egg laying animals were not classified as meat animals for the 2024 census.

- The meat animal in the N sector at 2.21 miles was no longer present. No other meat animals were identified in this sector.
- A new meat animal location was identified in the NNE sector at 1.94 miles.

MILK ANIMALS

- No changes were noted with the milk animals during the 2024 land use census.
- Manco Dairy (control milk location 5, located 19.31 km from the site) ceased operation on February 13, 2023 (NCR # 02460334) and a replacement control location could not be located. This location was removed from the HNP ODCM Revision 30 that was approved January 18, 2024.

There were no changes to environmental monitoring locations.

Attachment 3
Solid Radioactive Waste Disposal

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

ATTACHMENT 3

Solid Radioactive Waste Disposal

This attachment includes a summary of the solid waste shipped off-site for burial and/or disposal, including:

- Container volume
- Total Curie content
- Principal Radionuclides
- Source/Type of waste
- Solidification agent or absorbent
- Type of shipping container
- Number of shipments
- Other relevant information as necessary

Attachment 3

Solid Radioactive Waste Disposal

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

1. Solid Waste Shipped for Burial or Disposal (WASTE CLASS A)

NOTE: Values reported in Attachment 3 section 1.A.a, b, c & 1.B.a, b, c refers to radioactive solid waste materials shipped in 2024 to a vendor for processing and subsequent burial.

A. Type of Waste

a. Spent resins.

Note: Waste shipped in 2024 for processing and subsequent burial

Number of Shipments	4
Activity Shipped	1.60 E+01 Curies
Quantity Shipped	17.76 m ³
Solidification Agent	N/A
Container Type	14-215 Cask as General Design
Shipment Form	Gross Dewatered

b. Dry Active Waste (DAW), mechanical filters, contaminated equipment, etc.

Note: Waste shipped in 2024 for processing and subsequent burial.

Number of Shipments	5
Activity Shipped	1.59 E-00 Curies
Quantity Shipped	179.56 m ³
Solidification Agent	N/A
Container Type	General Design
Shipment Form	Compacted, Non-Compacted

c. Irradiated components, control rods, etc. (Ex-core detector)

Note: * No waste of this type was shipped during the report period

d. Other: GAC Vessels

Note: Waste shipped in 2024 for processing and subsequent burial.

Number of Shipments	1
Activity Shipped	5.19 E-02 Curies
Quantity Shipped	0.85 m ³
Solidification Agent	N/A
Container Type	General Design
Shipment Form	Dewatered, Non-Compacted

Attachment 3 Solid Radioactive Waste Disposal

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

1. Solid Waste Shipped for Burial or Disposal (WASTE CLASS A)- Continued

B. Estimate of Major Nuclide Composition (by type of Waste)

a. Spent Radwaste Bead Resin.

Note: Waste shipped in 2024 for processing and subsequent burial.

Class A Spent Resin Totals

Resin			
Isotope	Activity(mCi)	Activity (Ci)	Abundance
H-3	6.99E+02	6.99E-01	4.36%
C-14	1.37E+01	1.37E-02	0.09%
Mn-54	3.12E+02	3.12E-01	1.95%
Fe-55	1.11E+04	1.11E+01	69.24%
Co-60	1.72E+03	1.72E+00	10.73%
Ni-59	8.19E+00	8.19E-03	0.05%
Ni-63	1.54E+03	1.54E+00	9.61%
Sr-90	2.77E+00	2.77E-03	0.02%
Nb-95	1.89E-02	1.89E-05	0.00%
Sb-125	1.75E+00	8.17E-02	0.51%
Cs-137	5.53E+02	5.53E-01	3.45%
I-129	1.94E-01	1.94E-04	0.00%
Tc-99	6.28E-01	6.28E-04	0.00%
Grand Tot	1.60E+04	1.60E+01	100.00%

Attachment 3 Solid Radioactive Waste Disposal

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

1. Solid Waste Shipped for Burial or Disposal (WASTE CLASS A)- Continued

B. Estimate of Major Nuclide Composition (by type of Waste) - Continued

b. Dry Active Waste (DAW), mechanical filters, contaminated equipment, etc.

Note: Waste shipped in 2024 for processing and subsequent burial.

Class A DAW Totals

DAW			
Isotope	Activity(mCi)	Activity (Ci)	Abundance
H-3	1.02E+02	1.02E-01	6.42%
C-14	2.61E+01	2.61E-02	1.64%
Cr-51	6.65E+01	6.65E-02	4.19%
Mn-54	2.82E+01	2.82E-02	1.78%
Fe-55	3.98E+02	3.98E-01	25.06%
Fe-59	7.68E-02	7.68E-05	0.00%
Co-57	2.53E-01	2.53E-04	0.02%
Co-58	5.25E+01	5.25E-02	3.31%
Co-60	3.49E+02	3.49E-01	21.97%
Ni-63	1.17E+02	1.17E-01	7.37%
Sr-90	8.19E-02	8.19E-05	0.01%
Zr-95	1.75E+02	1.75E-01	11.02%
Nb-95	2.46E+02	2.46E-01	15.49%
Tc-99	6.35E+00	6.35E-03	0.40%
Sn-113	3.03E-01	3.03E-04	0.02%
Sb-124	2.15E-01	2.15E-04	0.01%
Sb-125	7.94E+00	7.94E-03	0.50%
Cs-134	1.08E-03	1.08E-06	0.00%
Cs-137	1.25E+01	1.25E-02	0.79%
Ce-144	9.26E-03	9.26E-06	0.00%
Pu-238	6.11E-04	6.11E-07	0.00%
Cm-243	8.76E-04	8.76E-07	0.00%
I-129	4.90E-01	4.90E-04	0.03%
Grand Total	1.59E+03	1.59E+00	100.00%

c. Irradiated components, control rods, etc.

Note: No waste of this type was shipped during the report period

Attachment 3 Solid Radioactive Waste Disposal

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

1. Solid Waste Shipped for Burial or Disposal (WASTE CLASS A)- Continued

B. Estimate of Major Nuclide Composition (by type of Waste)- Continued

d. Other (GAC Vessels)

Note: Waste shipped in 2024 for processing and subsequent burial

Class A Other (GAC Vessels) Totals

GAC Vessels			
Isotope	Activity(mCi)	Activity (Ci)	Abundance
H-3	1.37E+01	1.37E-02	26.42%
C-14	5.61E-01	5.61E-04	1.08%
Mn-54	1.28E-01	1.28E-04	0.25%
Fe-55	8.67E+00	8.67E-03	16.72%
Co-57	2.13E-03	2.13E-06	0.00%
Co-58	1.19E-05	1.19E-08	0.00%
Co-60	1.53E+01	1.53E-02	29.51%
Ni-63	1.28E+01	1.28E-02	24.68%
Sb-125	4.60E-01	4.60E-04	0.89%
Cs-137	1.03E-01	1.03E-04	0.20%
I-129	1.52E-02	1.52E-05	0.03%
Tc-99	1.16E-01	1.16E-04	0.22%
Grand Total	5.19E+01	5.19E-02	100.00%

C. Solid Waste Disposal

Number of Shipments 10
Mode of Transportation Truck
Destination Energy Solutions

Note: Waste shipped in 2024 for processing and subsequent burial

Attachment 3
Solid Radioactive Waste Disposal

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

2. Solid Waste Shipped for Burial or Disposal (WASTE CLASS B)
 - A. Type of Waste
 - a. Spent resins
*No waste of this type was shipped during this Report Period.
 - b. Dry Active Waste (DAW), mechanical filters, contaminated equipment, etc.
*No waste of this type was shipped during this Report Period.
 - c. Irradiated components, control cods, etc.
*No waste of this type was shipped during this Report Period.
 - d. Other (Describe)
*No waste of this type was shipped during this Report Period.
 - B. Estimate of Major Nuclide Composition (by type of Waste)
 - a. Dry Active Waste (DAW), mechanical filters, contaminated equipment, etc.
*No waste of this type was shipped during this Report Period.
 - C. Solid Waste Disposal
*No waste of this type was shipped during this Report Period.

Attachment 3
Solid Radioactive Waste Disposal

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

3. Solid Waste Shipped for Burial or Disposal (WASTE CLASS C)

A. Type of Waste

- a. Spent resins, filter sludge's, evaporator bottoms, etc.

*No waste of this type was shipped during this Report Period.

- b. Dry Active Waste (DAW), mechanical filters, contaminated equipment, etc.

*No waste of this type was shipped during this Report Period.

- c. Irradiated Components, Control Rods, etc.

*No waste of this type was shipped during this Report Period.

- d. Other (Describe)

*No waste of this type was shipped during this Report Period.

B. Estimate of Major Nuclide Composition (by type of Waste)

N/A

C. Solid Waste Disposal

N/A

Attachment 4
Meteorological Data

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

ATTACHMENT 4

Meteorological Data

This attachment includes a summary of meteorological joint frequency distributions of wind speed, wind direction, and atmospheric stability (hours of occurrence) at the lower level.

Attachment 4 Meteorological Data

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

Stability Class	Wind Speed (m/s)	Hours of Occurrence															
		Sector															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
A	0.46-0.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.76-1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1.01-1.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1.26-1.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1.51-2.00	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
	2.01-3.00	0	0	0	5	1	1	0	2	0	0	0	0	0	0	0	0
	3.01-4.00	0	2	2	2	1	1	0	4	0	0	0	0	0	0	0	1
	4.01-5.00	0	2	1	0	0	0	0	1	0	0	0	0	0	0	0	0
	5.01-6.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	6.01-8.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10.01-Max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B	0.46-0.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.76-1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1.01-1.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1.26-1.50	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
	1.51-2.00	0	0	1	3	4	0	3	0	2	0	0	0	0	1	1	0
	2.01-3.00	2	10	10	22	14	8	6	8	6	3	7	4	1	1	0	3
	3.01-4.00	5	7	4	5	2	1	0	2	13	7	7	3	2	5	5	4
	4.01-5.00	0	4	3	0	0	0	0	2	2	5	4	2	1	2	4	2
	5.01-6.00	0	1	0	0	0	0	0	0	0	2	2	1	1	2	0	0
	6.01-8.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10.01-Max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment 4 Meteorological Data

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

Stability Class	Wind Speed (m/s)	Hours of Occurrence															
		Sector															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
C	0.46-0.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.76-1.00	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
	1.01-1.25	0	0	0	1	0	1	2	0	0	1	0	0	0	0	0	0
	1.26-1.50	0	0	1	1	6	1	1	3	1	4	1	2	2	1	2	0
	1.51-2.00	1	5	5	11	4	5	10	12	16	2	14	6	6	8	6	3
	2.01-3.00	22	23	31	23	14	13	7	10	33	19	36	25	11	11	20	18
	3.01-4.00	7	21	14	2	2	2	0	3	10	17	18	23	17	16	11	18
	4.01-5.00	2	4	3	0	0	0	0	0	0	4	7	9	3	10	7	11
	5.01-6.00	0	0	0	0	0	0	0	0	0	1	2	6	4	3	1	1
	6.01-8.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10.01-Max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D	0.46-0.75	7	10	3	2	3	4	4	4	4	5	1	1	7	4	6	3
	0.76-1.00	21	9	13	10	13	8	4	8	10	13	10	12	11	7	14	12
	1.01-1.25	24	9	17	18	10	9	4	16	25	13	18	9	15	8	13	13
	1.26-1.50	18	30	21	12	17	16	20	24	23	33	28	18	17	17	17	27
	1.51-2.00	45	60	57	35	31	27	27	44	59	71	68	42	19	21	36	40
	2.01-3.00	80	110	69	41	39	33	38	57	111	162	97	103	37	34	52	79
	3.01-4.00	31	43	18	6	6	9	8	23	43	54	45	37	26	17	33	38
	4.01-5.00	6	7	7	5	6	6	4	6	15	21	18	11	18	17	6	10
	5.01-6.00	1	4	0	1	0	2	0	7	3	18	3	12	6	4	3	3
	6.01-8.00	0	0	0	0	2	0	0	3	1	5	1	0	1	1	0	0
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10.01-Max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment 4 Meteorological Data

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

Stability Class	Wind Speed (m/s)	Hours of Occurrence															
		Sector															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
E	0.46-0.75	13	16	16	10	8	10	8	4	11	10	10	7	10	3	12	1
	0.76-1.00	20	21	26	19	14	11	19	13	19	23	12	17	12	9	10	18
	1.01-1.25	20	19	13	14	11	15	14	14	20	16	20	13	10	7	8	8
	1.26-1.50	38	32	16	9	12	7	24	16	33	16	23	16	10	10	9	17
	1.51-2.00	33	44	30	12	13	6	13	16	25	54	56	33	10	15	16	25
	2.01-3.00	24	31	19	2	7	3	3	10	45	87	42	23	11	21	6	20
	3.01-4.00	0	0	2	0	0	0	0	0	10	28	12	1	1	4	2	4
	4.01-5.00	0	0	0	0	0	0	0	0	0	8	10	1	0	1	2	0
	5.01-6.00	0	0	0	0	0	0	0	0	0	4	3	0	0	0	0	0
	6.01-8.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10.01-Max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F	0.46-0.75	8	13	26	15	8	1	3	6	9	11	11	9	5	9	15	9
	0.76-1.00	11	19	23	17	6	5	9	1	2	11	11	7	9	3	10	14
	1.01-1.25	14	14	18	12	3	7	2	4	2	7	11	5	3	6	2	7
	1.26-1.50	12	9	10	5	0	1	1	3	0	4	5	4	5	4	1	7
	1.51-2.00	8	5	4	2	2	0	1	0	3	6	4	3	0	0	1	3
	2.01-3.00	1	0	0	0	0	0	1	0	3	4	0	0	0	0	0	0
	3.01-4.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	4.01-5.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	5.01-6.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	6.01-8.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10.01-Max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment 4 Meteorological Data

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

Stability Class	Wind Speed (m/s)	Hours of Occurrence															
		Sector															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
G	0.46-0.75	41	49	43	20	9	6	3	1	3	4	6	9	13	19	38	61
	0.76-1.00	18	11	15	13	4	0	0	1	1	2	7	6	6	5	13	22
	1.01-1.25	7	6	4	3	1	0	0	1	1	2	2	2	0	1	1	10
	1.26-1.50	3	2	1	0	0	0	0	0	0	2	0	0	0	1	1	3
	1.51-2.00	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	2.01-3.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	3.01-4.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	4.01-5.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	5.01-6.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	6.01-8.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10.01-Max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment 5
Unplanned Offsite Releases

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

ATTACHMENT 5

Unplanned Offsite Releases

This attachment includes a summary of the unplanned offsite releases of gaseous and liquid radioactive effluents.

Attachment 5
Unplanned Offsite Releases

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

Shearon Harris Nuclear Power Plant had zero (0) unplanned liquid releases in 2024.

Shearon Harris Nuclear Power Plant had zero (0) unplanned gaseous releases in 2024.

Attachment 6
Assessment of Radiation Dose from Radioactive Effluents to Members of the Public

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

ATTACHMENT 6

Assessment of Radiation Dose from Radioactive Effluents to Members of the Public

(Includes fuel cycle dose calculation results)

This attachment includes an assessment of radiation doses to the maximum exposed member of the public due to radioactive liquid and gaseous effluents released from the site for each calendar quarter for the calendar year of the report as well as the total dose for the calendar year.

This attachment also includes an assessment of radiation doses to the maximum exposed member of the public from all uranium fuel cycle sources within 8 km of the site for the calendar year of this report to show conformance with 40 CFR Part 190.

Methods for calculating the dose contribution from liquid and gaseous effluents are given in the Offsite Dose Calculation Manual (ODCM).

Attachment 6

Assessment of Radiation Dose from Radioactive Effluents to Members of the Public

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

Gaseous Effluents Dose Summary

	<u>Units</u>	<u>Qtr 1</u>	<u>Qtr 2</u>	<u>Qtr 3</u>	<u>Qtr 4</u>	<u>Year</u>
A. Noble Gases						
1. Maximum Beta Air	mRAD	0.00E+00	7.29E-05	0.00E+00	0.00E+00	7.29E-05
(a) Limit	mRAD	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
(b) % of Limit		0.00E+00	7.29E-04	0.00E+00	0.00E+00	3.65E-04
2. Maximum Gamma Air	mRAD	0.00E+00	2.45E-05	0.00E+00	0.00E+00	2.45E-05
(a) Limit	mRAD	5.00E+00	5.00E+00	5.00E+00	5.00E+00	1.00E+01
(b) % of Limit		0.00E+00	4.90E-04	0.00E+00	0.00E+00	2.45E-04

Receptor Location 2.14 km SW
Critical Age CHILD

B. Iodine, H-3, & Particulates						
1. Maximum Organ Dose	mREM	1.69E-01	1.10E-01	1.11E-01	1.31E-01	5.21E-01
(a) Limit	mREM	7.50E+00	7.50E+00	7.50E+00	7.50E+00	1.50E+00
(b) % of Limit		2.25E+00	1.47E+00	1.48E+00	1.75E+00	3.48E+00

Receptor Location 2.14 km SW
Critical Age CHILD
Critical Organ LIVER

Attachment 6 **Assessment of Radiation Dose from Radioactive Effluents to Members of the Public**

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

Liquid Effluents Dose Summary

	<u>Units</u>	<u>Qtr 1</u>	<u>Qtr 2</u>	<u>Qtr 3</u>	<u>Qtr 4</u>	<u>Year</u>
A. Batch Mode						
1. Maximum Organ Dose	mREM	6.94E-02	6.50E-02	5.26E-02	1.39E-02	2.01E-01
(a) Limit	mREM	5.00E+00	5.00E+00	5.00E+00	5.00E+00	1.00E+01
(b) % of Limit		1.39E+00	1.30E+00	1.05E+00	2.79E-01	2.01E+00
2. Maximum Total Body Dose	mREM	7.04E-02	5.51E-02	2.59E-02	1.36E-02	1.65E-01
(a) Limit	mREM	1.50E+00	1.50E+00	1.50E+00	1.50E+00	3.00E+00
(b) % of Limit		4.69E+00	3.67E+00	1.73E+00	9.05E-01	5.50E+00

Receptor Location 2.19 km S

Critical Age ADULT

Critical Organ GI-LI

Attachment 6 Assessment of Radiation Dose from Radioactive Effluents to Members of the Public

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

40 CFR Part 190 Uranium Fuel Cycle Dose Calculation Results

In accordance with the requirements of 40 CFR Part 190, the annual dose commitment to any member of the general public shall be calculated to assure that doses are limited to 25 millirems to the total body or any organ with the exception of the thyroid which is limited to 75 millirems. The fuel cycle dose assessment for Shearon Harris Nuclear Power Plant includes liquid and gaseous effluent dose contributions from the plant. Direct and air-scatter dose from the reactor building and other onsite structures does not contribute measurable dose to the maximum exposed individual based on review of the 2024 environmental TLD data. No other uranium fuel cycle facility contributes significantly to the maximum exposed individual. Included below is an estimate of the dose contributed by Carbon-14 (Ref. Attachment 2, Supplemental Information, of this report for further information). Also included is dose from H-3 in the Shearon Harris Nuclear Power Plant Cooling Tower plume, evaporation of H-3 in Harris Lake, H-3 in on-site drinking water, and H-3 in fish from Harris Lake. The combined dose to a maximum exposed individual from effluent releases, combined with the additional dose pathways, is below 40 CFR Part 190 limits as shown by the following summary.

Note: The 40 CFR Part 190 effluent dose analysis to the maximum exposed individual from liquid and gas releases does not include the dose from noble gases (i.e., total body and skin) due to the low significance compared to other dose pathways.

40 CFR Part 190 Effluent Dose Summary			
A. Gaseous Effluent Dose		E. Harris Lake Evaporation H-3 Dose	
1. Location	2.14 km SW	1. Location	4.16 mi SSW
2. Critical Age	CHILD	2. Critical Age	CHILD
3. Critical Organ	LIVER	3. Critical Organ	N/A
4. Organ Dose (mREM)	5.21E-01	4. Organ Dose (mREM)	7.90E-02
5. Total Body Dose (mREM)	5.21E-01	5. Total Body Dose (mREM)	7.90E-02
B. Liquid Effluent Dose		F. Drinking Water H-3 Dose	
1. Location	2.19 km S	1. Location	On Site
2. Critical Age	ADULT	2. Critical Age	ADULT
3. Critical Organ	GI-LI	3. Critical Organ	N/A
4. Organ Dose (mREM)	2.01E-01	4. Organ Dose (mREM)	5.76E-02
5. Total Body Dose (mREM)	1.65E-01	5. Total Body Dose (mREM)	5.76E-02
C. Carbon-14 Dose		G. H-3 in Fish from Harris Lake	
1. Location	1.81 mi NNE	1. Location	Harris Lake
2. Critical Age	CHILD	2. Critical Age	ADULT
3. Critical Organ	BONE	3. Critical Organ	N/A
4. Organ Dose (mREM)	7.65E-01	4. Organ Dose (mREM)	8.79E-03
5. Total Body Dose (mREM)	1.53E-01	5. Total Body Dose (mREM)	8.79E-03
D. Cooling Tower Plume H-3 Dose			
1. Location	1.55 mi NNW		
2. Critical Age	CHILD		
3. Critical Organ	N/A		
4. Organ Dose (mREM)	1.60E-03		
5. Total Body Dose (mREM)	1.60E-03		

Attachment 6

Assessment of Radiation Dose from Radioactive Effluents to Members of the Public

Shearon Harris Nuclear Power Plant Unit 1 **Period 1/1/2024 - 12/31/2024**

Dose contributions from Carbon-14 in gaseous effluents have been determined from ODCM 3.3.2, Carbon-14. The maximum dose rate to the nearest real individual from the release of Carbon-14 in batch and continuous gaseous effluents is conservatively calculated to be $7.65\text{E-}01$ mrem/yr based on $8.19\text{E+}00$ Curies released in 2024 (Ref. Attachment 2, Supplemental Information, of this report).

Dose contributions from Tritium in the Shearon Harris Nuclear Power Plant Cooling Tower plume have been determined from ODCM 2.3, Doses from Return/Re-use of Previously Discharged Radioactive Effluents. The maximum dose rate to the nearest real individual from the release of Tritium the plume is conservatively calculated to be $1.60\text{E-}03$ mrem/yr based on $9.15\text{E+}01$ Curies released in 2024 (Ref. Attachment 2, Supplemental Information, of this report).

Dose contributions from evaporation of Tritium Harris Lake have been determined from ODCM 2.3, Doses from Return/Re-use of Previously Discharged Radioactive Effluents. The maximum dose rate to the nearest real individual from evaporation of Tritium in Harris Lake is conservatively calculated to be $7.90\text{E-}02$ mrem/yr based on $8.82\text{E+}01$ Curies released in 2024 (Ref. Attachment 2, Supplemental Information, of this report).

Dose contributions from Tritium in drinking water at the HE&EC Training Centers and Harris Nuclear Plant have been determined from 2.3, Doses from Return/Re-use of Previously Discharged Radioactive Effluents. The maximum dose rate to the nearest real individual from consuming the drinking water is conservatively calculated to be $5.76\text{E-}02$ mrem/yr based on an average concentration of $2.10\text{E+}03$ pCi/L consumed in 2024 (Ref. Attachment 2, Supplemental Information, of this report).

Dose contributions from Tritium in fish in Harris Lake have been determined using NRC Regulatory Guide 1.109, Rev.1, October 1977, Equation A-1, and data from REMP location SW-26. This information was previously included in the Shearon Harris Nuclear Power Plant AREOR. DRR 2008147 was written to include the fish dose calculation methodology in ODCM revision 26, and report in the ARERR. The maximum dose rate to the nearest real individual from consuming the fish in Harris Lake is conservatively calculated to be $8.79\text{E-}03$ mrem/yr based on an average concentration of $4.43\text{E+}03$ pCi/L consumed in 2024 (Ref. Attachment 2, Supplemental Information, of this report).

Total dose from liquid and gaseous effluents from Shearon Harris Nuclear Power Plant and the additional pathways mentioned above is conservatively estimated to be less than 2 mrem/yr for total body and organ. It is recognized summing dose for different organs and age groups is not entirely accurate. However, the sum of the organ and age specific doses will always be less than the sum of the maximums of each. Therefore, summing the maximum values of each provides the most conservative value to ensure compliance with 40 CFR 190. The dose from all pathways related to operation of Shearon Harris Nuclear Power Plant meets the 40 CFR Part 190 requirements of an annual dose commitment to any member of the general public of less than 25 mrem total body or any organ and 75 mrem to the thyroid.

Attachment 7
Information to Support the NEI Ground Water Protection Initiative

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

ATTACHMENT 7

Information to Support the NEI Ground Water Protection Initiative

This attachment includes a summary of voluntary reports made in accordance with the NEI Ground Water Protection Initiative and a summary of ground water well sample data.

Attachment 7

Information to Support the NEI Ground Water Protection Initiative

Shearon Harris Nuclear Power Plant Unit 1 Period 1/1/2024 - 12/31/2024

Duke Energy implemented a Ground Water Protection program in 2007. This initiative was developed to ensure timely and effective management of situations involving inadvertent releases of licensed material to ground water. As part of this program, Shearon Harris Nuclear Plant monitored 34 wells. Wells are typically sampled on a quarterly, semi-annually or annual basis. Ground water samples are regularly analyzed for tritium and gamma emitters. No gamma radionuclides, other than naturally occurring radionuclides, were identified in well samples during 2024.

Results from sampling during 2024 confirmed existing knowledge of tritium concentrations in site ground water. Per NEI 07-07 the results of the Groundwater Monitoring Wells included in the REMP are not listed in this report but included in the AREOR. Results from wells not included in the REMP that were sampled during 2024 are shown in the table below. No events meeting the criteria for voluntary notification per NEI 07-07, Industry Ground Water Protection Initiative, occurred at Shearon Harris Nuclear Plant in 2024.

Well name	Number of Samples in 2024	Number of Positive H-3 Samples in 2024	Average H-3 Activity (pCi/L)**	Minimum H-3 Activity (pCi/L)	Maximum H-3 Activity (pCi/L)	Depth of Well (ft)
76	4	4	6.24E+02	2.38E+02	8.56E+02	11
HMW1S	2	2	3.43E+02	2.71E+02	4.14E+02	26.5
HMW2S	2	0	<LLD	<LLD	<LLD	22.5
HMW3S	1	0	<LLD	<LLD	<LLD	26
HMW4D	2	0	<LLD	<LLD	<LLD	57.5
HMW4S	2	0	<LLD	<LLD	<LLD	30
HMW5S	1	0	<LLD	<LLD	<LLD	32
HMW6S	2	2	3.75E+02	2.50E+02	4.99E+02	31.5
HMW7S	1	0	<LLD	<LLD	<LLD	24
HMW8S	1	1	3.15E+02	3.15E+02	3.15E+02	26
HMW9S	1	0	<LLD	<LLD	<LLD	31
HMW10S	1	0	<LLD	<LLD	<LLD	31.5
HMW11S	1	0	<LLD	<LLD	<LLD	26.5

* <LLD = less than the lower limit of detection, typically 250 pCi/L

** Average taken of only positive H-3 samples, when positive results were identified.

Attachment 8
Inoperable Equipment

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

ATTACHMENT 8

Inoperable Equipment

This attachment includes an explanation of inoperable instruments related to effluent monitoring in excess of allowed time defined by licensing bases and an explanation of temporary outside liquid storage tanks exceeding 10 Curies total activity (excluding tritium and dissolved or entrained noble gases).

Attachment 8 Inoperable Equipment

Shearon Harris Nuclear Power Plant Unit 1 Period 1/1/2024 - 12/31/2024

Shearon Harris Nuclear Power Plant had two (2) instances of inoperable equipment related to effluent monitoring in excess of ODCM limits during 2024. Details of the incidents are described below.

Shearon Harris Nuclear Power Plant did not experience any temporary unprotected outside liquid storage tanks exceeding 10 Curies total activity (excluding tritium and dissolved or entrained noble gases) during 2024.

NCR 02511695

Effluent radiation monitor REM-21WS-3542 (Secondary Waste Sample Tank) was declared inoperable on 3/6/2024 due to loss of sample flow condition and was not restored to a functional status within 30 days as required by Shearon Harris Nuclear Power Plant ODCM Operational Requirement 3.3.3.10. During advanced troubleshooting, several additional independent issues were identified including flow issues, failed check source, and detector issues. Once the detector was replaced the site faced challenges due to having limited proficiency and qualifications in calibrating and aligning the detector. Coordination between the site and the industry SME was required to restore the radiation monitor. REM-21WS-3542 was restored to a functional status on 9/23/24. During the time period when REM-21WS-3542 was inoperable, all actions per ODCM Table 3.3-12 were completed as required.

NCR02515843

Effluent REM-1SW-3500A (Normal Service Water Return to Circulating Water System from Waste Processing Building) was declared inoperable on 4/4/2024 to allow for Pre-Stressed Concrete Cylinder Piping (PCCP) work and was not restored to a functional status within 30 days as required by Shearon Harris Nuclear Power Plant ODCM Operational Requirement 3.3.3.10. During restoration of REM-1SW-3500A, following the completion of the PCCP work, a heat exchanger leak was identified. Due to the extent of planning and time required to repair the heat exchanger leak, REM-1SW-3500A remained inoperable for greater than 30 days. REM-1SW-3500A was restored to a functional status on 6/19/2024. During the time period when REM-1SW-3500A was inoperable, all actions per ODCM Table 3.3-12 were completed as required.

Attachment 9
Summary of Changes to the Offsite Dose Calculation Manual

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

ATTACHMENT 9

Summary of Changes to the Offsite Dose Calculation Manual

This attachment includes a summary of changes to the ODCM and Radiological Effluent Controls.

Attachment 9
Summary of Changes to the Offsite Dose Calculation Manual

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

ODCM Revision 30

The Shearon Harris Nuclear Power Plant Offsite Dose Calculation Manual Revision 30 was issued and made effective January 18, 2024. The most recent revision is Revision 30 (see attached).

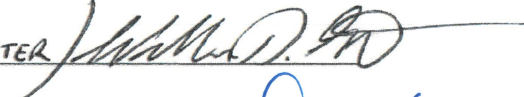
SHEARON HARRIS NUCLEAR POWER PLANT
OFFSITE DOSE CALCULATION MANUAL

(ODCM)

Revision 30

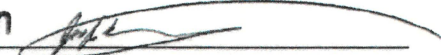
Docket No. STN-50-400

DUKE ENERGY PROGRESS, Inc
Formerly known as Carolina Power & Light Company

Approval by ORC Chairman (Print / Sign) WILLIAM GUNTER / 

Approval by General Manager - Harris Plant (Print / Sign) David Hoffman / 

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Effective Date 1/18/2024

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ODCM REV. 30 CHANGE SUMMARY

Note: Section 7.0.c is met by all changes becoming effective & implemented on date of revision approval per TS 6.14.b.

Revision 30 to the ODCM is as follows:

DRR's 2475324, 2443233, 2443236, 2463891, 2443229, 2443231

Section	Page	Description
Table of Contents	i	Changed to "ODCM REV. 30 CHANGE SUMMARY"
	i, ii, iv	Changed to correct page numbers to reflect revision changes
	iv	Added Figure 4.1-4
ODCM REV. 30 CHANGE SUMMARY	v	Changed to reflect changes made in Rev. 30
2.2.1	2-13	Added "2.2.1 Cumulation of Doses (continued)" to top of page
2.3.3	2-19	Added "2.3.3 Tritium dose to nearest lake resident from lake evaporation (continued)" to top of page
		Changed "are be" to "is"
	2-20	Added "2.3.3 Tritium dose to nearest lake resident from lake evaporation (continued)" to top of page
Table 2.1-1 a	2-21	Changed "@" to "at"
3.3.1	3-22	Added "3.3.1 Noble Gases (continued)" to top of page
3.3.2	3-24	Removed mention of age groupings
	3-27	
Table 4.1	4-2	Updated sample point description for sample point 4
	4-4	Changed "@" to "at" on sample point 27
		Changed location 19 description from 4.95 mi to 5.0 mi
	4-5	Deleted "at" from sample point 31 description
	4-6	Added note 20 to Surface Water sampling frequency
	4-9	Added note 20 to Drinking Water sampling frequency
	4-11	Deleted sample location 300
		Changed location 102 from 2.82 mi to 2.8 mi
Notes to Table 4.1	4-13	Deleted "during growing season" and added note 19 to Broadleaf Vegetation
	4-14	Added notes 19 and 20
		Note 1- Added "Figure 4.1-4"
		Note 8- Changed "4-14" to "4-13"
		Note 9- Added "As of Revision 30 of this ODCM, there are no identified control milk locations"
		Note 12- corrected grammatical issues
		Note 15- Removed "Typically leaves are only present during the growing season May through October."
		Note 18- Changed "Revision 29" to "Revision 30"
Table 4.2	4-15	Changed Site #5 location description
		Removed note (a) and changed previous note (b) to note (a)
		Updated SW sample location 26 from M/Q to M
		Removed sample location 300
		Added footnote (b) to bottom of the table and to location 26 for SA in SS column
		Changed location column header to "Location Distance and Sector"
Table 4.3	4-16	Updated the following site's location column to match descriptions in Table 4.1: 4, 14, 27, 31, 32, 50, 99, and 130.
		Changed location 19 description from 4.95 mi to 5.0 mi
Figure 4.1-2	4-18	Updated with new one-mile map
Figure 4.1-4	4-20	Removed sample location 300
5.0	5-1	Changed "is" to "are"
		Updated fourth paragraph to show the correct reference material (from Procedure 84750 to Procedure 84525)
Table 3.12-1	D-31	4.a (Milk)-Updated sampling and collection frequency
	D-32	4.c (Food Products)- Updated sampling and collection frequency
	D-34	Note 9- Added "As of Revision 30 of this ODCM, there are no identified irrigated gardens."
E.2. 3/4.11.2.3	E-5	Changed "reasonable" to "reasonably"

1.0 INTRODUCTION

The Off-Site Dose Calculation Manual (ODCM) provides the information and methodologies to be used by Shearon Harris Nuclear Power Plant (SHNPP) to ensure compliance with Operational Requirements 3.3.3.10, 3.3.3.11, 3/4.11.1, 3/4.11.2, 3/4.11.4, 4.12.1, 4.12.2, and 4.12.3 and reporting requirements in Appendix F of the ODCM. These operational requirements are those related to normal liquid and gaseous radiological effluents, environmental monitoring, and reporting. They are intended to show compliance with 10CFR20-based requirements, 10CFR50.36a, Appendix I of 10CFR50, and 40CFR190 in terms of appropriate monitoring instrumentation, setpoints, dose rate, and cumulative dose limitations. Off-site dose estimates from non-routine releases will be included in the cumulative dose estimates for the plant to comply with Appendix I of 10CFR50.

The ODCM is based on "Westinghouse Standard Technical Specifications" (NUREG 1301), "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants" (NUREG 0133), and guidance from the United States Nuclear Regulatory Commission (NRC). Specific plant and Nuclear Generation Group (NGG) procedures implement the ODCM program requirements.

The ODCM has been prepared as generically as possible in order to minimize the need for future revisions. However, some changes to the ODCM are expected in the future. Any such changes will be properly reviewed and approved as indicated in Administrative Controls Section 6.14 of the SHNPP Technical Specifications.

The assessment of annual radiation doses to members of the public from radioactive liquid and gaseous effluents from the plant is estimated using the methodology in the ODCM for the report period. These off-site dose estimates for each calendar year are reported in the Annual Radioactive Effluent Release Report required by Appendix F of the ODCM.

2.0 LIQUID EFFLUENTS

Radioactive materials released in liquid effluents from SHNPP to unrestricted areas are required to demonstrate compliance with 10 CFR 50 Appendix I (ODCM Operational Requirement 3.11.1.2) and, on an annual average basis, be limited to the concentrations specified in 10 CFR 20, Appendix B, Table 2, Column 2. For dissolved or entrained noble gases, the concentration shall be limited to $2\text{E-}4 \mu\text{Ci/ml}$ total activity. On an individual release basis, the release concentration for liquid effluents will be limited to ten times (10x) the concentrations specified in 10 CFR 20, Appendix B, Table 2, Column 2, Effluent Concentration (ODCM Operational Requirement 3.11.1.1). The liquid effluent release point is at the point of discharge from the Cooling Tower Blowdown Line into Harris Lake (see Figure 2.1-3 and T/S Figure 5.1-3).

Figure 2.1-1, Liquid Waste Processing Flow Diagram, and Figure 2.1-2 Liquid Effluent Flow Stream Diagram, show how effluents are processed and where they are released.

Effluent monitor identification numbers are provided in Appendix C. Liquid effluent dilution prior to release to Harris Lake is provided by the Cooling Tower Blowdown Line. Concurrent batch releases shall not occur at SHNPP.

The Secondary Waste Sample Tank (SWST) and the Normal Service Water (NSW) system have a low potential for radioactive effluent releases. These releases are checked by effluent monitors on the SWST (Figure 2.1-2) and the NSW lines (Figure 2.1-3).

The Turbine Building floor drains and the outside tank area drains (Figure 2.1-4) are monitored effluent lines with low probability of radioactive contamination.

The radioactive liquid waste sampling and analysis required for batch and continuous releases are found in Table 4.11-1 of the ODCM Operational Requirements.

The SHNPP ODCM uses the Canberra, Inc, Effluent Management System (OpenEMS) software for automating the necessary calculations and recordkeeping.

2.1 Compliance with 10 CFR 20

10 CFR 20.1301 requires that the total effective dose equivalent to individual members of the public will not exceed 0.1 rem (100 mrem) in a year.

10 CFR 20.1302 states that a licensee can show compliance with the annual dose limit of 20.1301 by demonstrating that the annual average concentration of radioactive material released in liquid effluents at the boundary of the unrestricted area does not exceed the values specified in 10 CFR 20, Appendix B, Table 2, Column 2.

ODCM Operational Requirement 3.11.1.1 states that, on an individual release basis, the concentration of radioactive material released in liquid effluents to unrestricted area shall be limited to 10 times the values specified in 10 CFR 20, Appendix B, Table 2, Column 2.

ODCM Operational Requirement 3.3.10 requires that radioactive effluent instrumentation have alarm/trip setpoints that will ensure that an alarm/trip will occur prior to exceeding 10 times the limits of ODCM Operational Requirement 3.11.1.1. for principal gamma emitters.

Liquid effluent monitors have two setpoints, the high alarm and the alert alarm. The high alarm setpoint, S_{max} , provides alarm and isolation if the radionuclide concentrations, when diluted, would approach the ODCM Operational Requirement limits for concentrations in unrestricted areas. Alert alarm setpoints, S_{alert} , are set at a fraction of the S_{max} to provide an early warning of the approach to ODCM Operational Requirement limits.

2.1.1 Batch Releases

Radioactive liquids are routinely released as batches from Treated Laundry and Hot Shower Tanks (TL&HST), Waste Evaporator Condensate Tank. Batch releases may also originate from the Secondary Waste Sample Tank (SWST) and Waste Monitor Tanks (WMT). These tanks are shown in Figures 2.1-1 and 2.1-2. Based on analysis of the tank contents, the tank release rate is adjusted, based on the Cooling Tower Blowdown Line flow rate, to dilute the tank activities to 50 percent of the allowable concentrations at the release point to Harris Lake.

The ODCM software calculates a nuclide specific response setpoint which is based on the sum of responses for each nuclide. The nuclide specific response setpoint equates all gamma-emitting nuclides to Cs-137, to which the monitor is calibrated.

If analysis of the batch sample indicates all gamma-emitting nuclides are < LLD, (as defined in ODCM Operational Requirement Table 4.11-1), the tank gamma activity, C_i , may be assumed to consist only of Cs-134. This nuclide has the lowest Effluent Concentration Limit (ECL) of any to be found in liquid effluents and provides a conservative basis for a monitor setpoint.

2.1.1 Batch Releases (continued)

1. Minimum Tank Mixing Time

Footnote 2 to ODCM Operational Requirement Table 4.11-1 requires that the method used to mix an isolated effluent tank prior to sampling and analysis be described.

Equation 2.1-1 below provides an acceptable method for ensuring a well mixed tank so that a representative sample can be taken for radioactivity or other appropriate analyses.

$$R = \frac{(V) (E) (N)}{(RR) (60)} \quad (2.1-1)$$

where:

R = Minimum allowable mixing time, hr

V = Tank capacity, gal

E = Eductor factor

RR = Pump design recirculation flow rate, gpm

N = Number of tank volumes for turnover; this will be a minimum of two

60 = 60 min/hr

Table 2.1-1a lists the tank capacities, eductor factors, and pump design recirculation flow rates for individual liquid effluent release tanks.

Table 2.1-1b lists actual operational tank capacities, educator factors, pump recirculation flows and pressures. These values are used by operations to ensure adequate mixing of two tank volumes.

The greater of the two minimum mixing times is used for determining time for obtaining a representative sample for release.

2.1.1 Batch Releases (continued)

2. Required Dilution Factor

ODCM Operational Requirement 3.11.1.1 requires that the sum of concentrations divided by ECL values must not exceed 10 for an individual release. Therefore:

$$\sum_i \frac{C_i}{ECL_i} \leq 10 \quad (2.1-2)$$

where:

C_i = the concentration of nuclide i to be released

ECL_i = the Effluent Concentration Limit for nuclide i from 10CFR20, Appendix B, Table 2, Column 2.

If the summation is greater than 10, dilution is required. The total required dilution factor, D_{req} , is the minimum acceptable dilution factor required to meet the limits of ODCM Operational Requirement 3.11.1.1, based on pre-release and composite analysis.

$$D_{req} = D_{req,g} + D_{req,ng} \quad (2.1-3)$$

where:

$D_{req,g}$ = Required dilution factor for gamma-emitters

$$= \frac{\sum_{i=g} \frac{C_i}{ECL_i}}{f \bullet R_{max}} \quad (2.1-4)$$

f = 0.5

= A safety factor to assure that the nuclide concentrations are 50% of the ODCM Operational Requirement limit at the point of discharge.

R_{max} = The maximum ECL ratio for the release point (normally set to 10).

2.1.1 Batch Releases (continued)

$D_{req,ng}$ = Required dilution factor for non-gamma-emitters

$$= \frac{\sum_{i=ng} \frac{C_i}{ECL_i}}{f \cdot R_{max}} + \frac{r}{f \cdot R_{max}} \quad (2.1-5)$$

and

f = 0.5

= A safety factor to assure that the nuclide concentrations are 50% of the ODCM Operational Requirement limit at the point of discharge.

r = 1

= the ratio of the maximum tritium concentration to the H-3 ECL, to take into account that tritium is potentially being released via the settling basin discharge to the cooling tower discharge line. The maximum tritium value is set to 1.0E-03, which is the H-3 ECL.
NOTE: site has a target limit of 2.0E-04 $\mu\text{Ci/ml}$.

R_{max} = The maximum ECL ratio for the release point (normally set to 10).

The sums include gamma-emitters (g) and non-gamma-emitters (ng), respectively.

The measured concentration of each gamma-emitting nuclide, including noble gases, is reported in $\mu\text{Ci/ml}$. If no gamma activity is detectable then an activity of 9E-07 $\mu\text{Ci/ml}$ of Cs-134 is assumed for setpoint calculations. The measured concentration of non-gamma emitters is determined by analysis of the liquid effluent or previous composite sample, and is reported in $\mu\text{Ci/ml}$.

2.1.1 Batch Releases (continued)

3. Maximum Waste Flow

For liquid releases, the maximum permissible waste flow rate for this release, $W_{\max}$ is the minimum of R_{cwmax} and R_{wmax} ,

where

$$R_{\text{CWMAX}} = \frac{F_{\text{avail}} \bullet f_{\text{alloc}}}{D_{\text{req}}} \quad (2.1-6)$$

R_{wmax} = Liquid effluent tank discharge flow rate, as specified in Table 2.1-1b.
This value is the same as F_{waste} .

and

F_{avail} = The available dilution flow is the minimum dilution stream flow (Cooling Tower Blowdown) that can be ensured for the period of the release. Since only one batch release occurs at a time out of a single discharge point, the flow is not corrected for other releases in progress, for any activity in the dilution stream, or reduced by a safety factor. The minimum dilution flow rate for each setting is shown in Table 2.1-2.

f_{alloc} = Fraction of the available dilution volume which may be assigned to a particular release to ensure discharge point limits are not exceeded by simultaneous radioactive liquid releases. The value of f_{alloc} is based on assumed operational considerations for simultaneous releases.

= 0.8 for a batch release and 0.2 for a continuous release.

4. Minimum Dilution Flow Rate

The Minimum Dilution Flow Rate (min dflow) is the minimum Cooling Tower discharge flow necessary to dilute the release to less than ODCM Operational Requirement Limits.

If $D_{\text{req}} \leq 1$, the minimum dilution flow rate is set to 0.0. If $D_{\text{req}} > 1$, the minimum dilution flow rate is determined as follows:

$$\text{min\_dflow} = \frac{F_{\text{waste}} \bullet D_{\text{req}}}{f_{\text{alloc}}} \quad (2.1-7)$$

where

F_{waste} = waste flow anticipated for this release

2.1.1 Batch Releases (continued)

5. Post Dilution Concentration

The post dilution concentration of a nuclide assumes that a fraction of the available dilution volume is unavailable due to simultaneous radioactive batch and continuous releases.

$$C_{post\ i} = \frac{C_i \times F_{waste}}{F_{avail} \times f_{alloc}} \quad (2.1-8)$$

(2.1-7)

where

$C_{post\ i}$ = dilution of nuclide i by the dilution stream

The sum of the post dilution concentrations divided by ECL values must not exceed 10 for an individual release.

$$\sum \frac{C_{post\ i}}{ECL_i} \leq 10 \quad (2.1-9)$$

6. Setpoint Calculations

The ODCM software calculates a nuclide specific response setpoint, which is based on the sum of responses for each nuclide. The setpoint equates all gamma-emitting nuclides to Cs-137, to which the monitor is calibrated. The setpoint is listed in terms of Cs-equiv and the units are $\mu\text{Ci/ml}$.

If analysis of the batch sample indicates all gamma-emitting nuclides are $< \text{LLD}$, (as defined in ODCM Operational Requirement Table 4.11-1), the tank gamma activity, C_i , may be assumed to consist only of Cs-134. This nuclide has the lowest ECL of any to be found in liquid effluents and provides a conservative basis for a monitor setpoint.

(1) Maximum setpoint value, based on Nuclide Specific Response

$$S_{max} (\text{Cs-equiv}) = (S_{adj} \bullet R_{mon}) + B \quad (2.1-10)$$

where

S_{adj} = Setpoint adjustment factor.

$$= \frac{\frac{f_{alloc} \bullet F_{avail}}{F_{waste}} - D_{req,ng}}{D_{req,g}} \quad (2.1-11)$$

S_{adj} should always be greater than 1 to ensure that adequate dilution flow is available for the release.

B = monitor background ($\mu\text{Ci/ml}$)

2.1.1 Batch Releases (continued)

$$R_{\text{mon}} = \sum \text{slope}_i \bullet C_i$$

where the sum extends over all nuclides which have response factors stored in the database for the monitor of interest

and

slope_i = the Liquid Effluent Monitor Gamma Sensitivities (from Table 2.1-4) for nuclide i, relative to Cs-137. To make nuclide i relative to Cs-137, the nuclide sensitivity is divided by the Cs-137 sensitivity.

$$= \frac{\text{Sensitivity (nuclide i)}}{\text{Cs-137 Sensitivity}}$$

(2) Monitor alert alarm setpoint, S_{alert} (Cs-equiv)

An Alert Alarm setpoint is calculated to provide an operator with adequate warning that the high alarm setpoint is being approached. S_{alert} is calculated from the nuclide specific response setpoint.

$$S_{\text{alert}} = [(S_{\text{max}} - B) \bullet F_x] + B \quad (2.1-12)$$

where:

F_x = A value <1.0 designed to provide an operator with adequate warning that the high alarm setpoint is being approached.

(3) Check for Excessive Monitor Background

In order to differentiate between the S_{alert} and the statistical fluctuations associated with a high monitor background, a check for excessive monitor background is made. As a check, verify that the minimum detectable concentration (MDC) for the monitor is less than 0.1 of the net S_{alert} ; therefore, background is acceptable if:

$$\text{MDC} \leq 0.1[(S_{\text{max}} - B) \bullet F_x] \quad (2.1-13)$$

where:

$$\text{MDC} = \frac{2 \sqrt{\frac{\text{Bkg}}{2\tau}}}{E_m} \quad (2.1-14)$$

where:

τ = Signal Processor Time constant, minutes. (Table 2.1-3)

Bkg = Background Count Rate, in cpm

$$= B / E_m$$

E_m = Monitor efficiency for the Cs-137 gamma energy, cpm/ $\mu\text{Ci/ml}$ determined by primary calibration.

If not, postpone the release and decontaminate or replace the sample chamber to reduce the background, then recalculate S_{max} and S_{alert} using the new, lower background.

2.1.1 Batch Releases (continued)

7. Post-Release Compliance

After the release is made, actual concentrations are used to check 10 CFR 20 limits, and the actual dilution flow and waste flow are used instead of the anticipated dilution flow and waste flow.

For batch releases, the duration is determined from the start and end dates and times of the release. This is used with the actual release volume to calculate the release rate.

2.1.2 Continuous Releases

The continuous releases from the SWST and the NSW return lines are monitored as shown in Figures 2.1-2 and 2.1-3. The function of these monitors, in contrast to the isolation function of batch release tank monitors, is to provide an indication of low levels of radioactivity in the effluent. The continuous effluent monitor setpoint is based on an assumed FSAR nuclide mix for the SWST (from Table 11.2.1-5 of the FSAR).

The software does not calculate continuous release setpoints.

1. Monitor High Alarm Setpoint, $S_{\max}$ ($\mu\text{Ci/ml}$).

$$S_{\max} = \frac{0.1 (ECL_{\text{eff}} \bullet \text{Sens}_{\text{eff}}) + B_{\text{kg}}}{E_m} \quad (2.1-15)$$

where:

ECL_{eff} = Weighted Effluent Concentration Limit for the SWST nuclides listed in Table 11.2.1-5 of the FSAR.

Sens_{eff} = $\sum_g (\text{Sens}_i \times \% \text{ abundance})$ for the SWST nuclide mix, $\text{cpm}/\mu\text{Ci/ml}$.

2. Monitor Alert Alarm Setpoint, S_{alert} (Cs-equiv)

$$S_{\text{alert}} = [(S_{\max} - B) \bullet F_x] + B \quad (2.1-16)$$

When the monitor is operable and not in alarm, analysis of weekly composite samples is not required by ODCM Operational Requirement Table 4.11-1.

If the monitor is in alarm or the presence of non-naturally occurring radioactivity > effluent LLD is confirmed, the releases may continue provided the sampling and analysis required by ODCM Operational Requirement Table 4.11-1 are performed. The results of the sample analysis will be evaluated for compliance with ODCM Operational Requirement 3.11.1.1.

The monitor alarm setpoints may be recalculated using the methodology in Section 2.1.1 with the results of the gamma analysis and analyses of the composite sample.

3. Check for Excessive Monitor Background

Monitor background is considered excessive when the minimum detectable concentration (MDC) for the monitor is $>0.01 ECL_{\text{eff}}$. Therefore, background is acceptable if:

$$\text{MDC} \leq \frac{0.01 (ECL_{\text{eff}} \bullet \text{Sens}_{\text{eff}})}{E_m} \quad (2.1-17)$$

2.1.3 Other Liquid Releases

1. Outdoor Tank Area Drain Effluent Line

The outdoor tank area drain effluent line routes rainwater collected in the outdoor tank area to the storm drain system and from there directly to the lake. The line is monitored for radioactivity by the Tank Area Drain Transfer Pump Monitor. Because no radioactivity is normally expected in this line, the monitor high alarm and alert alarm setpoints are determined using the methodology in Section 2.1.2. If the setpoint is exceeded, the discharge pump is automatically secured. Effluent can then be diverted to the floor drain system for processing and eventual release (see Figures 2.1-1 and 2.1-2).

2. Turbine Building Floor Drains Effluent Line

Water collected in the turbine building floor drains is normally routed to the yard oil separator for release to the environment via the waste neutralization system and then to the cooling tower discharge line. Tritium is expected to be detected in this pathway from sources such as background from the lake. Because no other radioactivity is normally expected in this path, the setpoints for the turbine building drain monitor are determined using the methodology in Section 2.1.2. Should the setpoint be exceeded, the release is automatically terminated. Effluent can then be diverted to the secondary waste treatment system for processing and eventual release (see Figures 2.1-1 and 2.1-2).

2.2 Compliance with 10 CFR 50 Appendix I

2.2.1 Cumulation of Doses

The dose contribution from each release of liquid effluents will be calculated and a cumulative summation of the total body and each organ dose will be maintained for each 31 days (monthly), each calendar quarter, and the year.

The dose is the total over all pathways which apply to that receptor. A receptor is defined by receptor ID, age group (infant, child, teen, or adult), sector, and distance from the plant.

The dose contribution for batch releases and all defined periods of continuous release received by receptor "r" from a released nuclide "i" will be calculated using the following equation:

$$D_{itr} = A_{itr} \bullet \sum \Delta t_s C_{is} F_{rs} \quad (2.2-1)$$

where:

D_{itr}	=	the cumulative dose or dose commitment to the total body or an organ "τ" by nuclide "i" for receptor "r" from the liquid effluents for the total time period of the release, in mrem.
A_{itr}	=	site-related ingestion dose or dose commitment factor for receptor "r" to the total body or organ "τ" for nuclide "i", in mrem/hr per μCi/ml.
Δt_s	=	length of time period 's', over which the concentration and F value are averaged, for all liquid releases, in hours.
C_{is}	=	the average concentration of nuclide "i" in undiluted liquid effluent during time period Δt_s from any liquid release, in μCi/ml.
F_{rs}	=	the near field average dilution factor for receptor "r" during any liquid effluent release

Where:

$$F_{rs} = \frac{F_{waste}}{F_{waste} + F_{avail}} \bullet R_{mix} \quad (2.2-2)$$

and

R_{mix}	=	mixing ratio
	=	fraction of the release that reaches the receptor. At the SHNPP, this value is set to 1.

Also, the sum extends over all time periods 's'.

In the case of a continuous secondary waste sample tank radioactive release, C_i = the concentration of nuclide "i" in the SWST composite sample. For the NSW, C_i = concentration of nuclide "i" in the cooling tower basin and F_{waste} = discharge from the cooling tower basin while F_{avail} = the flow from the makeup after crosstie. For a release through the Turbine Building Floor Drain Line to the waste neutralization system, C_i = the Turbine Building floor drain sample activity, F_{waste} = discharge from the Turbine Building floor drain line, and F_{avail} = the average flow during the period of the total Cooling Tower discharge. The total Cooling Tower discharge is the sum of the Cooling Tower Blowdown flow and the Cooling Tower Bypass Line flow.

When there is a primary-to-secondary leak, the change in concentration of tritium in the steam generators times the secondary losses (balance of plant), will be used for effluent accountability. The secondary loss rate will also be used for volume accountability.

2.2.1 Cumulation of Doses (continued)

The dose factor $A_{i\tau}$ (see NUREG-0133, Section 4.3.1) was calculated for an adult for each isotope "i" using the following equation:

$$A_{i\tau} = 1.14E + 05 \left(\frac{730}{D_w} + 21BF_i \right) DF_{i\tau} \cdot e^{-\lambda_i t_p} \quad (2.2-3)$$

where:

$A_{i\tau}$ = The ingestion dose commitment factor to the whole body or any organ " τ " for an adult for each nuclide "i". Corresponding to fish consumption from the Harris Lake (dilution = 1) and drinking water from Lillington (dilution = 13.95).
= Values for the adult total body and organs in mrem/hr per $\mu\text{Ci/ml}$ are given in Table 2.2-1.

1.14E+05 = Unit Conversion Factor

$$= \frac{10^6 \text{ pci}}{1 \text{ } \mu\text{Ci}} \cdot \frac{1000 \text{ ml}}{1 \text{ liter}} \cdot \frac{1 \text{ yr}}{8760 \text{ hrs}} \quad (2.2-4)$$

21 = Adult fish consumption rate (from Table E-5 of Regulatory Guide 1.109, Rev. 1), kg/yr;

730 = Adult water consumption rate (from Table E-5 of Regulatory Guide 1.109, Rev. 1), liters/yr.

D_w = Dilution factor for the drinking water pathway

= 13.95

BF_i = Bioaccumulation factor for nuclide "i" in fish (from Table A-1 of Regulatory Guide 1.109, Rev. 1), pCi/kg per pCi/l

$DF_{i\tau}$ = Dose conversion factor for nuclide "i" for adults for a particular organ τ (from Table E-11 of Regulatory Guide 1.109, Rev. 1), mrem/pCi

λ_i = Radiological decay constant of nuclide "i," hr^{-1} ;

$$= \frac{0.693}{(t_{1/2})_i}$$

$(t_{1/2})_i$ = Radiological half-life of nuclide "i," hr;

t_p = Average transport time to reach point of exposure, hr;

= 12 hours. The more limiting decay time for the drinking water and fish exposure pathways (Reg. Guide 1.109, Appendix A, Rev. 1).

Table 2.2-1 presents the $A_{i\tau}$ values for an adult receptor. Values of $e^{-\lambda_i t_p}$ are presented in Table 2.1-4 for each nuclide "i".

2.2.2 Comparison Against Limits

The sum of the cumulative dose from all batch and any continuous releases for a quarter is compared to one-half the design objectives for total body and any organ. The sum of the cumulative doses from all releases for a calendar year is compared to the design objective doses. The following relationships should hold for the SHNPP to show compliance with ODCM Operational Requirement 3.11.1.2.

For the calendar quarter:

$$D_{itr} \leq 1.5 \text{ mrem total body} \quad (2.2-5)$$

$$D_{itr} \leq 5 \text{ mrem any organ} \quad (2.2-6)$$

For the calendar year:

$$D_{itr} \leq 3 \text{ mrem total body} \quad (2.2-7)$$

$$D_{itr} \leq 10 \text{ mrem any organ} \quad (2.2-8)$$

where:

$$D_{itr} = \text{Cumulative total dose to any organ } t \text{ or the total body from all releases, mrem:}$$

The quarterly limits given above represent one-half the annual design objective of 10 CFR 50, Appendix I, Section II.A. If any of the limits in equations (2.2-5) through (2.2-8) are exceeded, a special report pursuant to SHNPP Technical Specification 6.9.2 must be filed with the NRC. This report complies with Section IV.A of Appendix I, 10 CFR 50.

The calculations described in Section 2.2.1 will be used to ensure compliance with the limits in 10 CFR 50 Appendix I for each release. Summation of doses for all releases for the quarter and year are compared to the limits in 10CFR50 Appendix I to ensure compliance.

The SHNPP ODCM uses a "modified" NUREG 0133 equation with conservative assumptions. It calculates the dose to a single maximum (ALARA) individual. The ALARA individual is an individual that consumes fish caught in the Harris Lake (dilution of 1.0) and receives their drinking water from Lillington, North Carolina (dilution 13.95).

After the release is made, the doses are compared to the 10CFR50 limits. The actual dilution flow and waste flow are used instead of the anticipated dilution flow and waste flow.

For batch releases, the duration is determined from the actual start and end dates and times of the release. This is used with the actual volume input to calculate the release rate. Each month the dilution volume is updated for times when no releases were being made in order to update the quarterly and yearly doses for comparison with the 10CFR50 Appendix I limits.

2.2.3 Projection of Doses

Dose projections for this section are required at least once per 31 days (monthly) in ODCM Operational Requirement 4.11.1.3.1 whenever the liquid radwaste treatment systems are not being fully utilized.

The doses will be calculated using Equation 2.2-1, and projected using the following expression:

$$D_{pr} = (D_{\tau} \bullet p) + D_{ar} \quad (2.2-9)$$

where:

D_{pr}	=	the 31 Day Projected Dose by organ τ
D_{τ}	=	sum of all open and closed release points from the start of the quarter to the end of the current release in mrem per organ τ .
p	=	the Projection Factor which is the result of 31 divided by the number of days from start of the quarter to the end of the release.
D_{ar}	=	Additional Anticipated Dose for liquid releases by organ r and quarter of release.

NOTE: The 31-Day Projected Dose values appear on the Standard Permit Reports. The 31-day dose projections include any additional dose.

When possible, expected operational evolutions (i.e., outages, increased power levels, major planned liquid releases, etc.) should be accounted for in the dose projections. This may be accomplished by using the source-term data from similar historical operating experiences where practical and adding the dose as Additional Anticipated Dose.

To show compliance with ODCM Operational Requirement 3.11.1.3, the projected 31-day dose should be compared to the following limits:

$$D_{pr} \leq 0.06 \text{ mrem for total body} \quad (2.2-10)$$

and

$$D_{pr} \leq 0.2 \text{ mrem for any organ} \quad (2.2-11)$$

If the projections exceed either Expressions 2.3-2 or 2.3-3, then the appropriate portions of the liquid radwaste treatment system shall be used to reduce releases of radioactivity.

2.3 Doses from Return/Re-use of Previously Discharged Radioactive Effluents

Known Potential Pathways from Return/Re-use of Previously Discharge Effluents

The dose contribution from return/re-use of previously radioactive effluents (tritium from the lake) should be calculated at the end of each year. If the dose from the particular pathway is greater than 10 percent of the total dose from all pathways from plant releases (liquid, gaseous, iodine's particulates > 8 day half-life's & tritium from gaseous releases) the dose from the return of previously discharged effluents is to be reported in annual effluent report. The total body, each organ, and each age group if applicable the dose should be calculated at the end of year unless it is known to be less than 10 percent of all doses.

The current potential pathways are evaporation from the cooling tower, dose to the county fire training personnel & HE&EC Training center that is being used of offsite personnel, the dose to the nearest resident to the lake from lake evaporation, and the consumption of fish from Harris Lake.

- 2.3.1 The dose from drinking water to the worker at the Wake County Fire Training Center and/or HE&EC Training Center are to be calculated as follows:

Worker Drinking Water Pathway –

$$R_{apj} = U_{ap} * D_{apj} * C_{ip} \quad (2.3-1)$$

Where;

R_{apj} =	Annual dose to organ j of individual of age group (adult in this case) from tritium in p pathway (ingestion), mrem/yr
U_{ap} =	Usage term, 730 liters/year per Reg. 1.109 based on 50 weeks/year, this equals 14.6 liters/week or 2.085 liters/day. Half of the water is consumed at work 1.042 liters/day times 5 workdays/week times 50 weeks /year equals 261 liters/year of drinking water from HNP.
C_{ip} =	Concentration (picoCurie/liter) of drinking water obtained from the annual average monthly composite from DW-51
D_{api} =	Dose factor specific to age group (adult in this case), for nuclide i (H-3 in this case) in units of mrem/picoCurie, 1.05E-07 mrem/pCi for total body & all organs with the exception of bone which has no dose
R_{apj} =	(261 liters/yr) * (1.05E-07 mrem/pCi) * (concentration pCi/L from DW-51)

2.3.2 Tritium dose to the nearest resident from the Cooling Tower (CT) Plume.

The dose from inhalation to the nearest resident from the cooling tower plume is calculated by the following meteorology for the current year (using the elevated mode of release), the monthly composite tritium analysis from the cooling tower blowdown, and the evaporation rate from the top of the cooling tower.

The dose from Cooling Tower Plume can be calculated as follows:

$$D_{Ttr} = (3.17E - 08) * (R_{Ttr}) * (X/Q_{Elv}) \sum Q_{VT} \quad (2.3-2)$$

where:

D_{Ttr} = the cumulative dose or dose commitment to the total body or an organ "τ" by Tritium for receptor "r" from the CT Plume for the total time period of the release, in mrem.

$3.17 E-08$ = The inverse of the number of seconds in a year (sec/year)⁻¹

R_{Ttr} = Dose factor for an organ "τ" for the tritium from the inhalation pathway in mrem/hr per μCi/ml.

X/Q_{Elv} = The highest elevated calculated annual average relative concentration for the nearest resident from the Cooling Tower (sec/m³).

Q_{VT} = $Ev_r * \Delta t_s * C_{TBD} * q_t$
The total tritium (μCi) released from the top of the Cooling Tower.

where:

Ev_r = the average evaporation rate from top of the Cooling Tower (C_{TBD})* (3785 ml/gal) = ml/min.

C_{TBD} = Average Cooling Tower Blowdown flow rate (gpm)

Δt_s = length of time period 's', over which the monthly tritium concentration value for Cooling Tower Tritium is used (number of days) * (1440 min/day) = minutes

q_t = Tritium concentration in Cooling Tower Blowdown for the time period (μCi/ml).

2.3.3 Tritium dose to the nearest lake resident from lake evaporation.

The dose from inhalation to the nearest resident to the lake from lake evaporation is calculated by the meteorology for the current year (using the ground level mode of release), the monthly composite tritium analysis from Harris Lake Spillway, and the evaporation rate from the lake.

1. Release Calculation from Evaporation:

Three methods are used to calculate monthly lake evaporation to the environment from the reservoir.

- a. Analytical Method: Calculation of monthly evaporation using an empirical analytical formula developed by Meyer (1905) based on Dalton's Law.

$$Ev = C * (Es - Ed) * (1 + U_{25}/10) \quad (2.3-3)$$

Where:

Ev	=	evaporation from a lake or pond in inches per month times 25.4 mm/inch times meter/1000mm equals meters of evaporation
C	=	Coefficient that equals 11 for small lakes and reservoirs 15 for shallow ponds (for Harris Lake use 11)
Es	=	saturation vapor pressure (inches of Hg) of air at the water temperature (1 foot deep)
Ed	=	actual vapor pressure (inches of Hg) of air, equals to Es * Relative Humidity (RH) in fraction
U ₂₅	=	average wind velocity (miles/hr) at a height of 25 feet above the lake or surrounding areas

- b. Derive the average evaporation rate from historical data.

Monthly historical evaporation data are available for the Chapel Hill station.

- c. When available, use the monthly published evaporation rates by the State Climate Office of North Carolina.

Calculate the average evaporation rate from the above three methods (if data is obtainable from all three) for each month.

2. Yearly Calculation of Tritium Release from Lake (μCi)

$$Q_T = \sum (L_{area} * EV_{ave} * (L_{TConc} * 1E-09)) \quad (2.3-4)$$

Where:

Q _T	=	Yearly Tritium Release from Lake (Ci)
L _{area}	=	Lake area, 4169.61 acres which equals 1.687E+07 square meters
EV _{ave}	=	evaporation from a lake or pond in inches per month times 25.4 mm/inch times meter/1000mm equals meters of evaporation
L _{TConc}	=	monthly lake Tritium concentration from SW-26, pCi/l
1E-09	=	Ci/1.0E12 pCi * liter/1000 cm ³ * 100 cm/meter * 100 cm/meter * 100 cm/meter = Curies/meter ³

2.3.3 Tritium dose to the nearest lake resident from lake evaporation (continued)

3. Lake Harris total surface area is 4169.61 acres. Being a large body of water, the lake was divided into thirteen sections for analysis using Auto CAD Engineering Software. The area of each section and its centroid location were calculated (see Figure 2.3-1) and the following list for the respective section areas. The distances from the centroid to each nearest resident and its downwind sector are now established.

Lake Sect.	Area Acres	Area m ²
1	316.40	1.280E+06
2	276.55	1.119E+06
3	156.32	6.326E+05
4	220.74	8.933E+05
5	230.05	9.310E+05
6	388.74	1.573E+06
7	392.03	1.587E+06
8	579.23	2.344E+06
9	426.97	1.728E+06
10	429.05	1.736E+06
11	316.52	1.281E+06
12	193.90	7.847E+05
13	243.10	9.838E+05
Total	4169.61	1.687E+07

The impact of each lake section is calculated and then summed to determine the impact of the point of interest. The tritium concentration from each section of the lake to the point of interest for all points of interest is calculated as follows:

$$q_{Tsect} = \sum (Q_T * X/Q * 3.17E+04) \quad (2.3-5)$$

Where:

$$q_{Tsect} = \text{Total tritium concentration from the thirteen lake sections at point of interest (X,pCi/m}^3\text{)}$$

$$Q_T = \text{Yearly Tritium Release from Lake Section, (Ci/yr)}$$

$$X/Q = \text{The relative concentration at the point of interest from lake section X, (sec/m}^3\text{)}$$

$$3.17E+04 = \text{Conversion factor, (1.0E+12 pCi/Ci)/(8760 hr/yr)*(3600 sec/hr)}$$

2.3.3 Tritium dose to the nearest lake resident from lake evaporation (continued)

The dose for each age group at each point of interest is to be calculated as follows:

$$\text{Dose}_{a,\text{poi}} = (q_{\text{Tsect}}) * (\text{DFA})_a * (\text{BR})_a \quad (2.3-6)$$

Where:

$\text{Dose}_{a,\text{poi}}$	=	Total tritium dose for age group (a) at point of interest (mrem) for the year
q_{Tsect}	=	Total tritium concentration from the thirteen lake sections at point of interest (pCi/m ³)
$(\text{DFA})_a$	=	Organ inhalation factor for tritium at the point of interest of age group "a" (mrem/pCi), for tritium the dose factor is same for the liver, total body, thyroid, kidney, lung, and Gi-LLi (no bone dose). Infant = 4.62 E-07, Child = 3.04 E-07, Teen = 1.59 E-07, and Adult 1.58 E-07, mrem/pCi.
$(\text{BR})_a$	=	Breathing rate of age group "a" (m ³ /yr), Infant = 1400, Child = 3700, Teen = 8000, and Adult = 8000 m ³ /yr

2.3.4 The dose from the consumption of fish from Harris Lake.

The concentration of tritium in fish is directly related to the concentration of tritium in the water. Equilibrium ratios between the concentration of tritium in the water and concentration of tritium in the flesh is based upon the bioaccumulation factor for tritium. Because the adult age group will always have the maximum dose from fish consumption, adult is only age group considered.

Fish consumption Dose –

$$R_{\text{apj}} = U_{\text{ap}} * D_{\text{apj}} * C_{\text{ip}} * \text{BF}_i \quad (2.3-7)$$

Where;

R_{apj}	=	Annual dose to organ j of individual of age group (adult in this case) from tritium in p pathway (ingestion), mrem/yr
U_{ap}	=	Usage term, 21 kg/yr per Reg. Guide 1.109 Table E-11 for an adult
C_{ip}	=	Concentration (pCi/L) of drinking water obtained from the annual average monthly composite from SW-26
D_{api}	=	Dose factor specific to age group (adult in this case), for nuclide i (H-3 in this case) in units of mrem/pCi, 1.05E-07 mrem/pCi for total body & all organs with the exception of bone which is no dose
BF_i	=	Bioaccumulation factor for nuclide "i" in fish (from Table A-1 of Regulatory Guide 1.109, Rev. 1), pCi/kg per pCi/l, 0.90 pCi/kg per pCi/L

TABLE 2.1-1a

LIQUID EFFLUENT RELEASE TANKS AND PUMPS DESIGN BASIS ⁽¹⁾

Tank ⁽²⁾	No. of Tanks	PUMP DESIGN CAPACITY (gpm)		Eductor Factor	Tank Design Capacity (gal)	Tank Capacity at Overflow Line (gal)	Radiation Effluent Monitor ID
		Discharge	Recirculation				
SWST	1	100	100	0.2	25,000	23,922	REM-3542
WECT	2	35	100	1.0	10,000	9,649	REM-3541
WMT	2	35 ⁽³⁾	100	0.25	25,000	24,135	REM-3541
TL&HS	2	100	100	0.25	25,000	24,261	REM-3540

¹ Reference SHNPP FSAR Tables 11.5.1-1 and 11.2.1-7

² SWST: Secondary Waste Sample Tank
WECT: Waste Evaporator Condensate Tank
WMT: Waste Monitor Tank
TL&HS: Treated Laundry and Hot Shower Tank

³ Waste Monitor Tanks pump capacity is increased to 100 gpm when the waste monitor tanks are used as an alternate secondary waste sample tank

TABLE 2.1-1b

LIQUID EFFLUENT RELEASE TANKS AND PUMPS FOR NORMAL OPERATIONS ⁽⁴⁾

Tank ⁽²⁾	No. of Tanks	PUMP CAPACITY			Eductor Factor	Operational Tank Capacity (gal)	Radiation Effluent Monitor ID
		Discharge (gpm)	Recirculation (gpm)	Pressure (psig)			
SWST	1	100	80	≤71	0.2	24,093	REM-3542
WECT	2	35	35	≤110	1.0	9,588	REM-3541
WMT ⁽³⁾	2	35	80	≤101	0.25	24,112	REM-3541
TL&HS	2	35	80	≤91	0.25	24,241	REM-3540

⁴ Typical values used for normal operations.

The settling basin has two pumps. When one pump is running, the design flow rate is 500 gpm. When both pumps are running, the design flow rate is 800 gpm.

TABLE 2.1-2

Setpoints for Cooling Tower Blowdown Dilution Flow Rates (F_{avail})

Setting	Trip Flow Rate (gpm)	Minimum Dilution Flow Rate (gpm)
1	4,000 $\pm$ 5%	3,800
2	7,000 $\pm$ 5%	6,650
3	11,000 $\pm$ 5%	10,450
4	15,000 $\pm$ 5%	14,250

TABLE 2.1-3

Signal Processor Time Constants (τ) for GA Technologies
RD-53 Liquid Effluent Monitors

Detector Background (cpm)	τ (min)
$10^1 - 10^2$	10
$10^2 - 10^3$	10^3 /cpm bkg
$10^3 - 10^4$	10^3 /cpm bkg
$10^4 - 10^5$	10^3 /cpm bkg
$10^5 - 10^6$	0.01
$10^6 - 10^7$	0.01

TABLE 2.1-4

Nuclide Parameters

Nuclide	Half-Life (hr)	λ (hr ⁻¹)	$e^{-\lambda t}$	Sensitivity (cpm/ μ Ci/ml)	Slope	Sensitivity TB Bldg. Drain Only (cpm/ μ Ci/ml)
H-3	1.08E+05	6.44E-06	1.00E+00	0.00E+00	0.00E+00	0.00E+00
C-14	5.02E+07	1.38E-08	1.00E+00	0.00E+00	0.00E+00	0.00E+00
F-18	1.83E+00	3.78E-01	1.07E-02	0.00E+00	0.00E+00	7.78E+07
Na-24	1.50E+01	4.62E-02	5.74E-01	9.36E+07	9.00E-01	9.11E+07
P-32	3.43E+02	2.02E-03	9.76E-01	0.00E+00	0.00E+00	0.00E+00
Cr-51	6.65E+02	1.04E-03	9.88E-01	1.61E+07	1.55E-01	2.79E+06
Mn-54	7.50E+03	9.24E-05	9.99E-01	1.03E+08	9.90E-01	4.45E+07
Mn-56	2.58E+00	2.68E-01	4.00E-02	1.01E+08	9.71E-01	6.41E+07
Fe-55	2.37E+04	2.93E-05	1.00E+00	0.00E+00	0.00E+00	0.00E+00
Fe-59	1.07E+03	6.47E-04	9.92E-01	1.26E+08	1.21E+00	4.58E+07
Co-57	6.50E+03	1.07E-04	9.99E-01	0.00E+00	0.00E+00	5.82E+06
Co-58	1.70E+03	4.08E-04	9.95E-01	1.46E+08	1.40E+00	5.68E+07
Co-60	4.62E+04	1.50E-05	1.00E+00	1.89E+08	1.82E+00	9.07E+07
Ni-63	8.78E+05	7.89E-07	1.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni-65	2.52E+00	2.75E-01	3.67E-02	2.24E+07	2.15E-01	1.96E+07
Cu-64	1.27E+01	5.46E-02	5.19E-01	5.16E+07	4.96E-01	1.46E+07
Zn-65	5.87E+03	1.18E-04	9.99E-01	5.24E+07	5.04E-01	2.41E+07
Zn-69	9.27E-01	7.48E-01	1.26E-04	2.22E+03	2.13E-05	5.00E+02
Zn-69m	1.38E+01	5.03E-02	5.47E-01	0.00E+00	0.00E+00	3.52E+07
Br-82	3.53E+01	1.96E-02	7.90E-01	0.00E+00	0.00E+00	1.43E+08
Br-83	2.38E+00	2.91E-01	3.05E-02	1.95E+06	1.88E-02	5.74E+05
Br-84	5.30E-01	1.31E+00	1.53E-07	6.50E+07	6.25E-01	5.06E+07
Br-85	4.78E-02	1.45E+01	3.02E-76	6.76E+06	6.50E-02	3.21E+06
Rb-86	4.48E+02	1.55E-03	9.82E-01	8.39E+06	8.07E-02	3.96E+06
Rb-88	2.97E-01	2.34E+00	6.66E-13	1.45E+07	1.39E-01	1.83E+07
Rb-89	2.57E-01	2.70E+00	8.43E-15	1.22E+08	1.17E+00	7.00E+07
Sr-89	1.21E+03	5.71E-04	9.93E-01	1.46E+04	1.40E-04	6.72E+03
Sr-90	2.50E+05	2.77E-06	1.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-91	9.50E+00	7.30E-02	4.17E-01	8.16E+07	7.85E-01	3.48E+07
Sr-92	2.72E+00	2.55E-01	4.68E-02	1.01E+08	9.71E-01	4.61E+07
Y-90	6.42E+01	1.08E-02	8.78E-01	0.00E+00	0.00E+00	0.00E+00
Y-91	1.41E+03	4.93E-04	9.94E-01	2.83E+05	2.72E-03	1.36E+05
Y-91m	8.28E-01	8.37E-01	4.36E-05	1.28E+08	1.23E+00	3.96E+07
Y-92	3.53E+00	1.96E-01	9.50E-02	2.76E+07	2.65E-01	1.17E+07
Y-93	1.01E+01	6.86E-02	4.39E-01	1.37E+07	1.32E-01	3.96E+06
Zr-95	1.54E+03	4.51E-04	9.95E-01	1.07E+08	1.03E+00	4.35E+07
Zr-97	1.68E+01	4.12E-02	6.10E-1	2.68E+07	2.58E-01	9.16E+06
Nb-95	8.42E+02	8.24E-04	9.90E-01	1.06E+08	1.02E+00	4.41E+07
Nb-97	1.20E+00	5.771E-01	9.86E-04	0.00E+00	0.00E+00	4.33E+07
Mo-99	6.60E+01	1.05E-02	8.82E-01	3.47E+07	3.34E-01	9.38E+06
Tc-99m	6.02E+00	1.15E-01	2.51E-01	1.11E+08	1.07E+00	7.33E+06

TABLE 2.1-4

Nuclide Parameters
(continued)

Nuclide	Half-Life (hr)	λ (hr ⁻¹)	$e^{-\lambda t}$	Sensitivity (cpm/ μ Ci/ml)	Slope	Sensitivity TB Bldg. Drain Only (cpm/ μ Ci/ml)
Tc-101	2.37E-01	2.93E+00	5.45E-16	1.66E+08	1.60E+00	2.92E+07
Ru-103	9.45E+02	7.33E-04	9.91E-01	1.38E+08	1.33E+00	3.83E+07
Ru-105	4.43E+00	1.56E-01	1.53E-01	1.71E+08	1.64E+00	5.21E+07
Ru-106	8.83E+03	7.85E-05	9.99E-01	4.52E+07	4.35E-01	1.43E+07
Ag-110m	6.00E+03	1.16E-04	9.99E-01	3.22E+08	3.10E+00	1.41E+08
Sn-113	2.76E+03	2.51E-04	9.97E-01	3.08E+06	2.96E-02	4.28E+05
Sb-124	1.45E+03	4.80E-04	9.94E-01	1.59E+08	1.53E+00	8.31E+07
Sb-125	2.43E+04	2.85E-05	1.00E+00	1.21E+08	1.16E+00	3.20E+07
Te-125m	1.39E+03	4.98E-04	9.94E-01	3.00E+05	2.88E-03	1.17E+04
Te-127m	2.62E+03	2.65E-04	9.97E-01	1.33E+04	1.28E-04	6.29E+03
Te-127	9.35E+00	7.41E-02	4.11E-01	1.97E+06	1.89E-02	4.14E+05
Te-129m	8.07E+02	8.59E-04	9.90E-01	5.17E+06	4.97E-02	1.95E+06
Te-129	1.16E+00	5.98E-01	7.69E-04	1.58E+07	1.52E-01	4.02E+06
Te-131m	3.00E+01	2.31E-02	7.58E-01	2.17E+08	2.09E+00	7.37E+07
Te-131	4.17E-01	1.66E+00	2.14E-09	1.50E+08	1.44E+00	2.58E+07
Te-132	7.82E+01	8.87E-03	8.99E-01	1.39E+08	1.34E+00	1.69E+07
I-130	1.24E+01	5.60E-02	5.10E-01	4.13E+08	3.97E+00	1.41E+08
I-131	1.93E+02	3.59E-03	9.58E-01	1.55E+08	1.49E+00	3.21E+07
I-132	2.30E+00	3.01E-01	2.69E-02	3.31E+08	3.18E+00	1.30E+08
I-133	2.08E+01	3.33E-02	6.71E-01	1.39E+08	1.34E+00	4.28E+07
I-134	8.77E-01	7.91E-01	7.58E-05	3.08E+08	2.96E+00	1.31E+08
I-135	6.62E+00	1.05E-01	2.84E-01	1.03E+08	9.90E-01	5.82E+07
Cs-134	1.80E+04	3.85E-05	1.00E+00	2.60E+08	2.50E+00	9.68E+07
Cs-136	3.17E+02	2.19E-03	9.74E-01	3.37E+08	3.24E+00	1.11E+08
Cs-137	2.65E+05	2.62E-06	1.00E+00	1.04E+08	1.00E+00	3.90E+07
Cs-138	5.37E-01	1.29E+00	1.86E-07	1.15E+08	1.11E+00	8.43E+07
Ba-139	1.39E+00	5.00E-01	2.46E-03	2.34E+07	2.25E-01	2.17E+06
Ba-140	3.07E+02	2.26E-03	9.73E-01	6.01E+07	5.78E-01	1.45E+07
Ba-141	3.05E-01	2.27E+00	1.43E-12	2.53E+08	2.43E+00	5.42E+07
Ba-142	1.78E-01	3.89E+00	5.54E-21	1.47E+08	1.41E+00	4.44E+07
La-140	4.02E+01	1.73E-02	8.13E-01	1.53E+08	1.47E+00	9.06E+07
La-142	1.59E+00	4.36E-01	5.35E-03	9.59E+07	9.22E-01	7.75E+07
Ce-141	7.80E+02	8.89E-04	9.89E-01	6.11E+07	5.88E-01	4.29E+06
Ce-143	3.30E+01	2.10E-02	7.77E-01	9.60E+07	9.23E-01	1.90E+07
Ce-144	6.82E+03	1.02E-04	9.99E-01	1.30E+07	1.25E-01	7.96E+05
Pr-143	3.25E+02	2.13E-03	9.75E-01	1.08E+02	1.04E-06	5.27E-01
Pr-144	2.88E-01	2.40E+00	2.96E-13	1.68E+06	1.62E-02	1.14E+06
Nd-147	2.63E+02	2.63E-03	9.69E-01	2.86E+07	2.75E-01	8.08E+06
Hf-181	1.02E+03	6.80E-04	9.92E-01	2.08E+08	2.00E+00	4.14E+07
W-187	2.38E+01	2.91E-02	7.05E-01	1.04E+08	1.00E+00	3.09E+07
Np-239	5.65E+01	1.23E-02	8.63E-01	1.13E+08	1.09E+00	1.01E+07

TABLE 2.1-4

Nuclide Parameters
(continued)

Nuclide	Half-Life (hr)	λ (hr ⁻¹)	$e^{-\lambda t}$	Sensitivity (cpm/ μ Ci/ml)	Slope	Sensitivity TB Bldg. Drain Only (cpm/ μ Ci/ml)
Ar-41	1.83E+00	3.78E-01	1.07E-02	9.28E+07	8.92E-01	4.51E+07
Kr-83m	1.83E+00	3.78E-01	1.07E-02	0.00E+00	0.00E+00	0.00E+00
Kr-85	9.40E+04	7.37E-06	1.00E+00	6.20E+05	5.96E-03	1.75E+05
Kr-85m	4.48E+00	1.55E-01	1.56E-01	1.20E+08	1.15E+00	1.12E+07
Kr-87	1.27E+00	5.45E-01	1.44E-03	9.19E+07	8.84E-01	3.22E+07
Kr-88	2.83E+00	2.45E-01	5.31E-02	7.49E+07	7.20E-01	5.19E+07
Kr-89	5.27E-02	1.32E+01	2.58E-69	1.39E+08	1.34E+00	6.52E+07
Kr-90	8.95E-03	7.72E+01	0.00E+00	1.59E+08	1.53E+00	5.43E+07
Xe-131m	2.85E+02	2.45E-03	9.71E-01	2.62E+06	2.52E-02	2.21E+05
Xe-133	1.23E+02	5.51E-03	9.36E-01	9.90E+04	9.52E-04	9.33E+03
Xe-133m	5.25E+01	1.32E-02	8.53E-01	1.59E+07	1.53E-01	2.02E+06
Xe-135	9.12E+00	7.60E-02	4.02E-01	1.47E+08	1.41E+00	2.10E+07
Xe-135m	2.57E-01	2.70E+00	8.43E-15	1.14E+08	1.10E+00	3.30E+07
Xe-137	6.38E-02	1.09E+01	2.57E-57	4.85E+07	4.66E-01	1.32E+07
Xe-138	2.35E-01	2.95E+00	4.25E-16	1.20E+08	1.15E+00	4.25E+07

Notes to Table 2.1-4

Sensitivity = 80% of weighted response to 100 - 1400 keV gammas for offline and an adjacent to line monitor which are sodium iodide (NaI) detectors (reference GA Manual E-115-904, June 1980, and Figure 5, Expected Energy Response Normalized for one gamma per disintegration, Drawing 0360-8934 Rev A, page 14, respectively). Abundances for each gamma from "Radioactive Decay Tables" by David C. Kocher (Report DOE/TIC-11026, Washington, D.C., 1981)

Slope = The Liquid Effluent Monitor Gamma Sensitivities for nuclide "i", relative to Cs-137. To make nuclide "i" relative to Cs-137, the nuclide sensitivity is divided by the Cs-137 sensitivity. This column does not apply to TB Drains monitor.

TABLE 2.2-1

A_{it} VALUES FOR THE ADULT FOR THE SHEARON HARRIS NUCLEAR POWER PLANT

$$A_{it,r,p} = 1.14E+05 \left(\frac{730}{D_w} + 21BF_i \right) DF_{it} \bullet e^{-\lambda_i t_p}$$

(mrem/hr per $\mu\text{Ci/ml}$)

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	Gi-LLi
H-3	0.00E+00	8.54E-01	8.54E-01	8.54E-01	8.54E-01	8.54E-01	8.54E-01
C-14	3.13E+04	6.27E+03	6.27E+03	6.27E+03	6.27E+03	6.27E+03	6.27E+03
Na-24	2.40E+02	2.40E+02	2.40E+02	2.40E+02	2.40E+02	2.40E+02	2.40E+02
P-32	4.52E+07	2.81E+06	1.75E+06	0.00E+00	0.00E+00	0.00E+00	5.08E+06
Cr-51	0.00E+00	0.00E+00	1.28E+00	7.63E-01	2.81E-01	1.69E+00	3.21E+02
Mn-54	0.00E+00	4.41E+03	8.41E+02	0.00E+00	1.31E+03	0.00E+00	1.35E+04
Mn-56	0.00E+00	4.44E+00	7.87E-01	0.00E+00	5.63E+00	0.00E+00	1.42E+02
Fe-55	6.76E+02	4.67E+02	1.09E+02	0.00E+00	0.00E+00	2.60E+02	2.68E+02
Fe-59	1.06E+03	2.49E+03	9.54E+02	0.00E+00	0.00E+00	6.95E+02	8.29E+03
Co-57	0.00E+00	2.20E+01	3.66E+01	0.00E+00	0.00E+00	0.00E+00	5.58E+02
Co-58	0.00E+00	9.33E+01	2.09E+02	0.00E+00	0.00E+00	0.00E+00	1.89E+03
Co-60	0.00E+00	2.69E+02	5.94E+02	0.00E+00	0.00E+00	0.00E+00	5.06E+03
Ni-63	3.20E+04	2.21E+03	1.07E+03	0.00E+00	0.00E+00	0.00E+00	4.62E+02
Ni-65	4.76E+00	6.19E-01	2.82E-01	0.00E+00	0.00E+00	0.00E+00	1.57E+01
Cu-64	0.00E+00	5.45E+00	2.56E+00	0.00E+00	1.37E+01	0.00E+00	4.64E+02
Zn-65	2.32E+04	7.39E+04	3.34E+04	0.00E+00	4.94E+04	0.00E+00	4.65E+04
Zn-69M	4.46E+02	1.07E+03	9.79E+01	0.00E+00	6.48E+02	0.00E+00	6.54E+04
Zn-69	6.25E-03	1.20E-02	8.32E-04	0.00E+00	7.77E-03	0.00E+00	1.80E-03
Se-75	6.04E+02	2.32E+02	4.65E+03	2.32E+02	4.65E+01	5.58E+02	6.51E+02
Br-82	0.00E+00	0.00E+00	1.81E+03	0.00E+00	0.00E+00	0.00E+00	2.07E+03
Br-83	0.00E+00	0.00E+00	1.24E+00	0.00E+00	0.00E+00	0.00E+00	1.79E+00
Br-84	0.00E+00	0.00E+00	8.07E-06	0.00E+00	0.00E+00	0.00E+00	6.33E-11
Rb-86	0.00E+00	9.95E+04	4.63E+04	0.00E+00	0.00E+00	0.00E+00	1.96E+04
Rb-88	0.00E+00	1.94E-10	1.03E-10	0.00E+00	0.00E+00	0.00E+00	2.67E-21
Rb-89	0.00E+00	1.62E-12	1.14E-12	0.00E+00	0.00E+00	0.00E+00	9.43E-26
Sr-89	2.38E+04	0.00E+00	6.84E+02	0.00E+00	0.00E+00	0.00E+00	3.82E+03
Sr-90	5.91E+05	0.00E+00	1.45E+05	0.00E+00	0.00E+00	0.00E+00	1.71E+04
Sr-91	1.84E+02	0.00E+00	7.43E+00	0.00E+00	0.00E+00	0.00E+00	8.77E+02
Sr-92	7.84E+00	0.00E+00	3.39E-01	0.00E+00	0.00E+00	0.00E+00	1.55E+02
Y-90	5.57E-01	0.00E+00	1.49E-02	0.00E+00	0.00E+00	0.00E+00	5.91E+03
Y-91M	2.61E-07	0.00E+00	1.01E-08	0.00E+00	0.00E+00	0.00E+00	7.67E-07
Y-91	9.24E+00	0.00E+00	2.47E-01	0.00E+00	0.00E+00	0.00E+00	5.09E+03
Y-92	5.29E-03	0.00E+00	1.55E-04	0.00E+00	0.00E+00	0.00E+00	9.27E+01
Y-93	7.75E-02	0.00E+00	2.14E-03	0.00E+00	0.00E+00	0.00E+00	2.46E+03
Zr-95	4.20E-01	1.35E-01	9.12E-02	0.00E+00	2.11E-01	0.00E+00	4.27E+02
Zr-97	1.42E-02	2.87E-03	1.31E-03	0.00E+00	4.34E-03	0.00E+00	8.90E+02
Nb-95	4.43E+02	2.47E+02	1.33E+02	0.00E+00	2.44E+02	0.00E+00	1.50E+06

TABLE 2.2-1

(Continued)

A_{it} VALUES FOR THE ADULT FOR THE SHEARON HARRIS NUCLEAR POWER PLANT
(mrem/hr per $\mu\text{Ci/ml}$)

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	Gi-LLi
Nb-97	3.70E-03	9.36E-04	3.42E-04	0.00E+00	1.09E-03	0.00E+00	3.45E+00
Mo-99	0.00E+00	1.14E+02	2.17E+01	0.00E+00	2.58E+02	0.00E+00	2.64E+02
Tc-99M	2.60E-03	7.35E-03	9.36E-02	0.00E+00	1.12E-01	3.60E-03	4.35E+00
Tc-101	5.81E-18	8.37E-18	8.21E-17	0.00E+00	1.51E-16	4.28E-18	2.52E-29
Ru-103	5.49E+00	0.00E+00	2.37E+00	0.00E+00	2.10E+01	0.00E+00	6.41E+02
Ru-105	7.07E-02	0.00E+00	2.79E-02	0.00E+00	9.13E-01	0.00E+00	4.32E+01
Ru-106	8.23E+01	0.00E+00	1.04E+01	0.00E+00	1.59E+02	0.00E+00	5.33E+03
Ag-110M	1.84E+00	1.70E+00	1.01E+00	0.00E+00	3.34E+00	0.00E+00	6.93E+02
Sn-113	2.52E+03	9.68E+02	1.94E+04	9.68E+02	1.94E+02	2.32E+03	2.71E+03
Sn-117M	2.39E+03	9.20E+02	1.84E+04	9.20E+02	1.84E+02	2.21E+03	2.58E+03
Sb-124	2.33E+01	4.40E-01	9.24E+00	5.65E-02	0.00E+00	1.82E+01	6.62E+02
Sb-125	1.50E+01	1.67E-01	3.57E+00	1.52E-02	0.00E+00	1.16E+01	1.65E+02
Sb-126	2.74E+02	5.58E+00	9.90E+01	1.68E+00	0.00E+00	1.68E+02	2.24E+04
Te-125M	2.57E+03	9.32E+02	3.44E+02	7.73E+02	1.05E+04	0.00E+00	1.03E+04
Te-127m	6.51E+03	2.33E+03	7.94E+02	1.66E+03	2.65E+04	0.00E+00	2.18E+04
Te-127	4.36E+01	1.57E+01	9.44E+00	3.23E+01	1.78E+02	0.00E+00	3.44E+03
Te-129M	1.10E+04	4.10E+03	1.74E+03	3.77E+03	4.59E+04	0.00E+00	5.53E+04
Te-129	2.33E-02	8.76E-03	5.68E-03	1.79E-02	9.80E-02	0.00E+00	1.76E-02
Te-131M	1.27E+03	6.19E+02	5.16E+02	9.80E+02	6.27E+03	0.00E+00	6.14E+04
Te-131	4.07E-08	1.70E-08	1.28E-08	3.35E-08	1.78E-07	0.00E+00	5.76E-09
Te-132	2.19E+03	1.41E+03	1.33E+03	1.56E+03	1.36E+04	0.00E+00	6.69E+04
I-130	1.62E+01	4.77E+01	1.88E+01	4.05E+03	7.45E+01	0.00E+00	4.11E+01
I-131	1.67E+02	2.39E+02	1.37E+02	7.84E+04	4.10E+02	0.00E+00	6.31E+01
I-132	2.29E-01	6.12E-01	2.14E-01	2.14E+01	9.75E-01	0.00E+00	1.15E-01
I-133	4.00E+01	6.95E+01	2.12E+01	1.02E+04	1.21E+02	0.00E+00	6.25E+01
I-134	3.37E-04	9.15E-04	3.27E-04	1.59E-02	1.46E-03	0.00E+00	7.98E-07
I-135	5.29E+00	1.38E+01	5.11E+00	9.13E+02	2.22E+01	0.00E+00	1.56E+01
Cs-134	2.99E+05	7.10E+05	5.81E+05	0.00E+00	2.30E+05	7.63E+04	1.24E+04
Cs-136	3.05E+04	1.20E+05	8.65E+04	0.00E+00	6.69E+04	9.17E+03	1.37E+04
Cs-137	3.83E+05	5.23E+05	3.43E+05	0.00E+00	1.78E+05	5.91E+04	1.01E+04
Cs-138	4.92E-05	9.72E-05	4.82E-05	0.00E+00	7.14E-05	7.06E-06	4.15E-10
Ba-139	3.72E-03	2.65E-06	1.09E-04	0.00E+00	2.48E-06	1.50E-06	6.60E-03
Ba-140	3.08E+02	3.86E-01	2.02E+01	0.00E+00	1.31E-01	2.21E-01	6.33E+02
Ba-141	1.05E-12	7.94E-16	3.55E-14	0.00E+00	7.38E-16	4.51E-16	4.95E-22
Ba-142	1.84E-21	1.89E-24	1.16E-22	0.00E+00	1.60E-24	1.07E-24	2.59E-39
La-140	1.34E-01	6.75E-02	1.78E-02	0.00E+00	0.00E+00	0.00E+00	4.96E+03
La-142	4.51E-05	2.05E-05	5.11E-06	0.00E+00	0.00E+00	0.00E+00	1.50E-01

TABLE 2.2-1

(Continued)

A_{it} VALUES FOR THE ADULT FOR THE SHEARON HARRIS NUCLEAR POWER PLANT
(mrem/hr per $\mu\text{Ci/ml}$)

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLi
Ce-141	7.76E-02	5.24E-02	5.95E-03	0.00E+00	2.44E-02	0.00E+00	2.01E+02
Ce-143	1.07E-02	7.94E+00	8.79E-04	0.00E+00	3.50E-03	0.00E+00	2.97E+02
Ce-144	4.08E+00	1.71E+00	2.19E-01	0.00E+00	1.01E+00	0.00E+00	1.38E+03
Pr-143	5.91E-01	2.37E-01	2.93E-02	0.00E+00	1.37E-01	0.00E+00	2.59E+03
Pr-144	5.88E-16	2.44E-16	2.99E-17	0.00E+00	1.38E-16	0.00E+00	8.46E-23
Nd-147	4.02E-01	4.64E-01	2.78E-02	0.00E+00	2.71E-01	0.00E+00	2.23E+03
W-187	2.10E+02	1.75E+02	6.12E+01	0.00E+00	0.00E+00	0.00E+00	5.74E+04
Np-239	3.08E-02	3.03E-03	1.67E-03	0.00E+00	9.44E-03	0.00E+00	6.21E+02

Figure 2.1-1

Liquid Waste Processing Flow Diagram

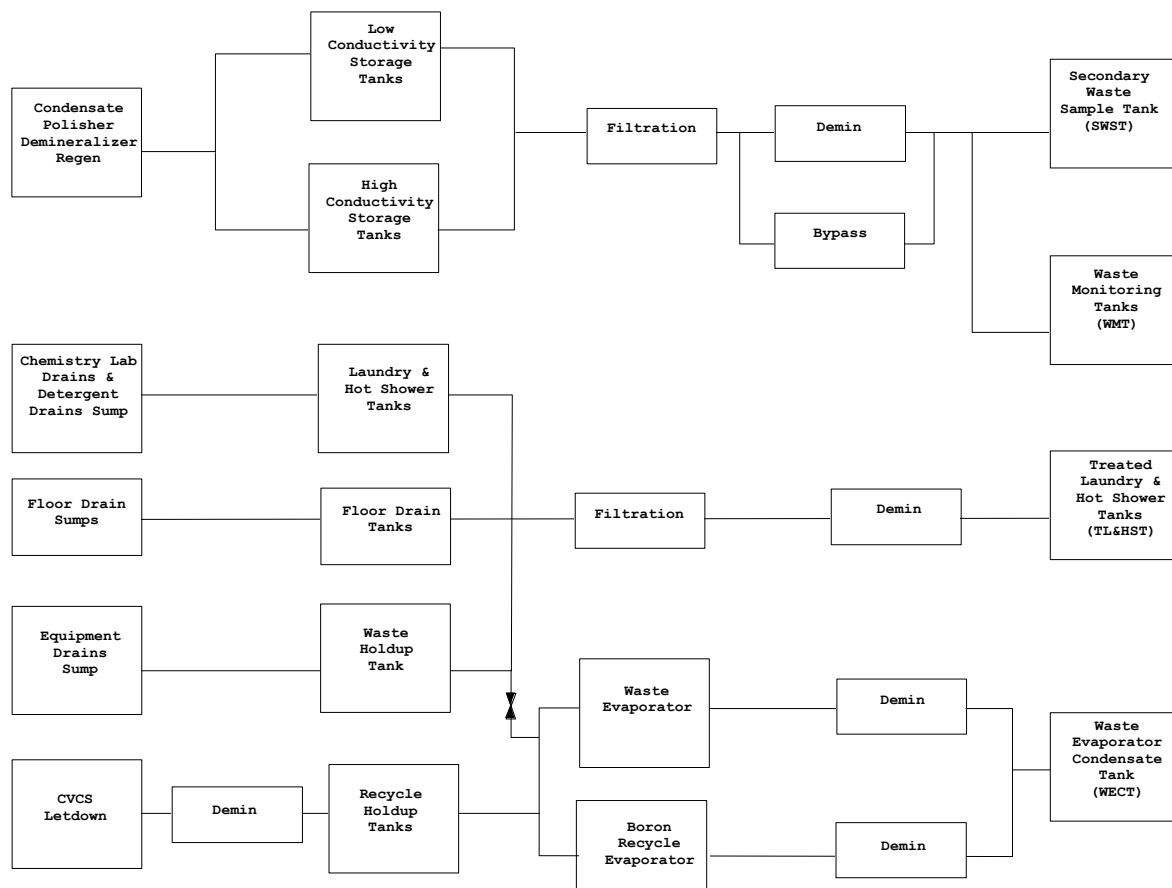


Figure 2.1-2

Liquid Effluent Flow Stream Diagram

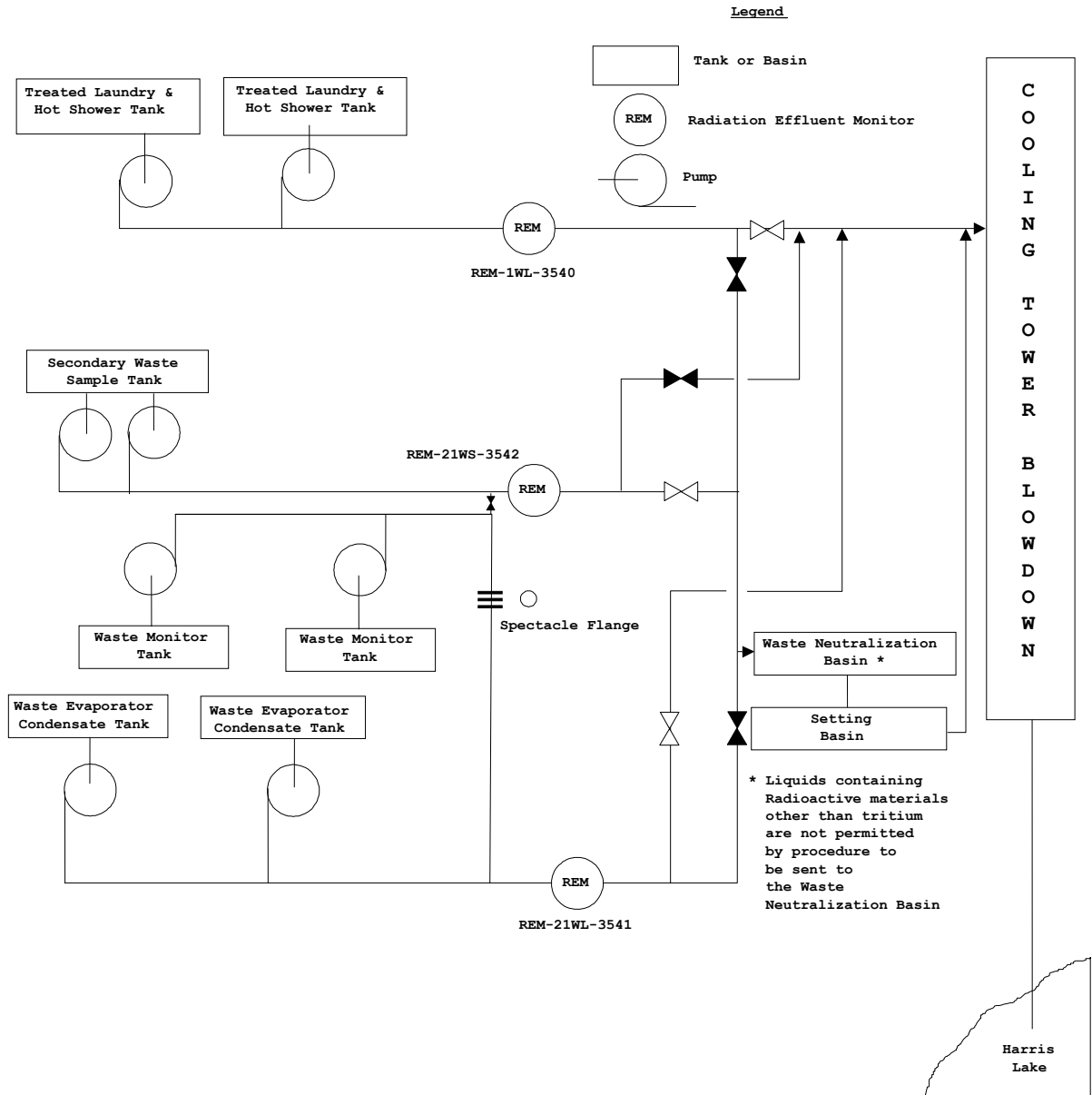


Figure 2.1-3

Normal Service Water Flow Diagram

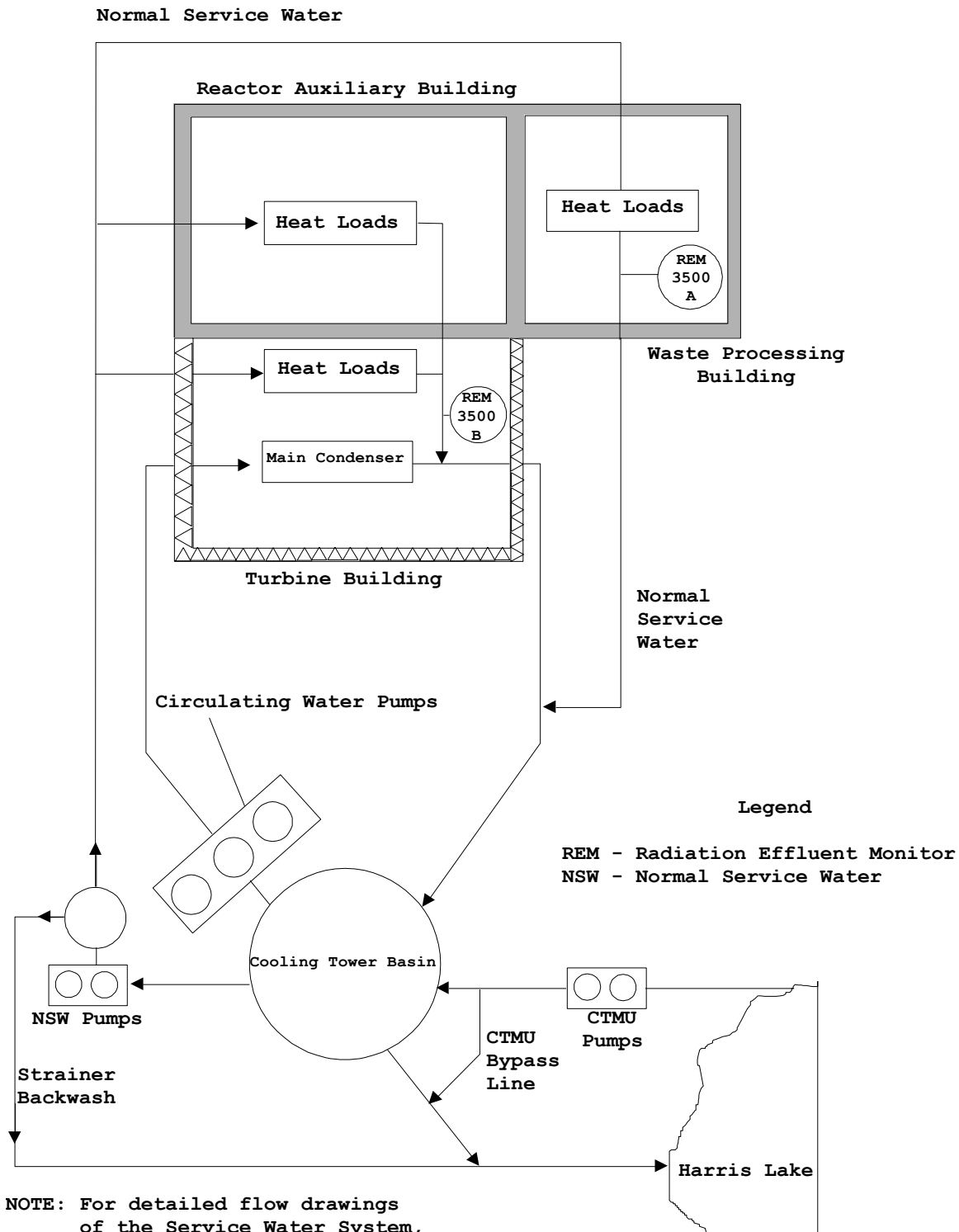


Figure 2.1-4

Other Liquid Effluent Pathways

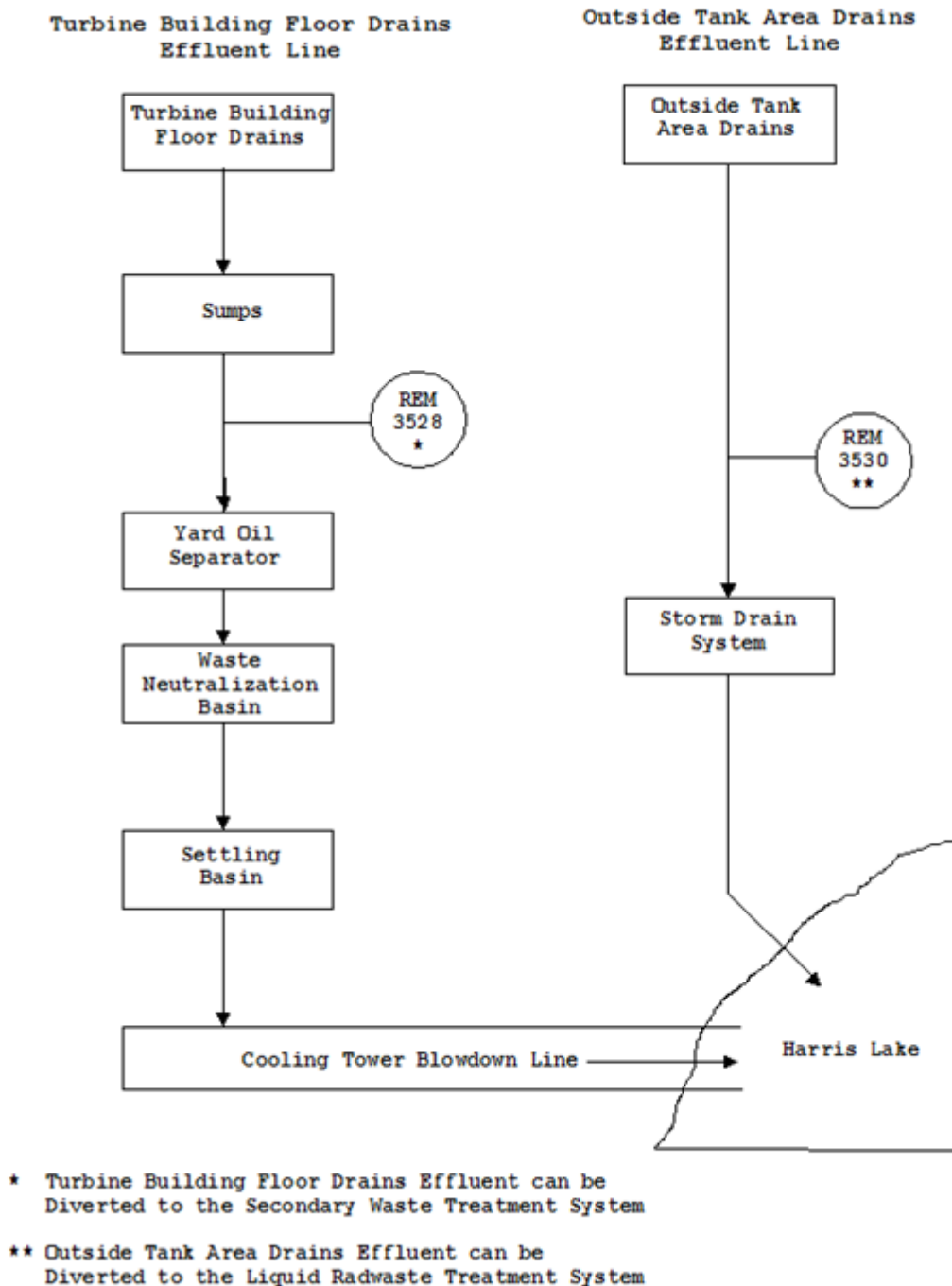
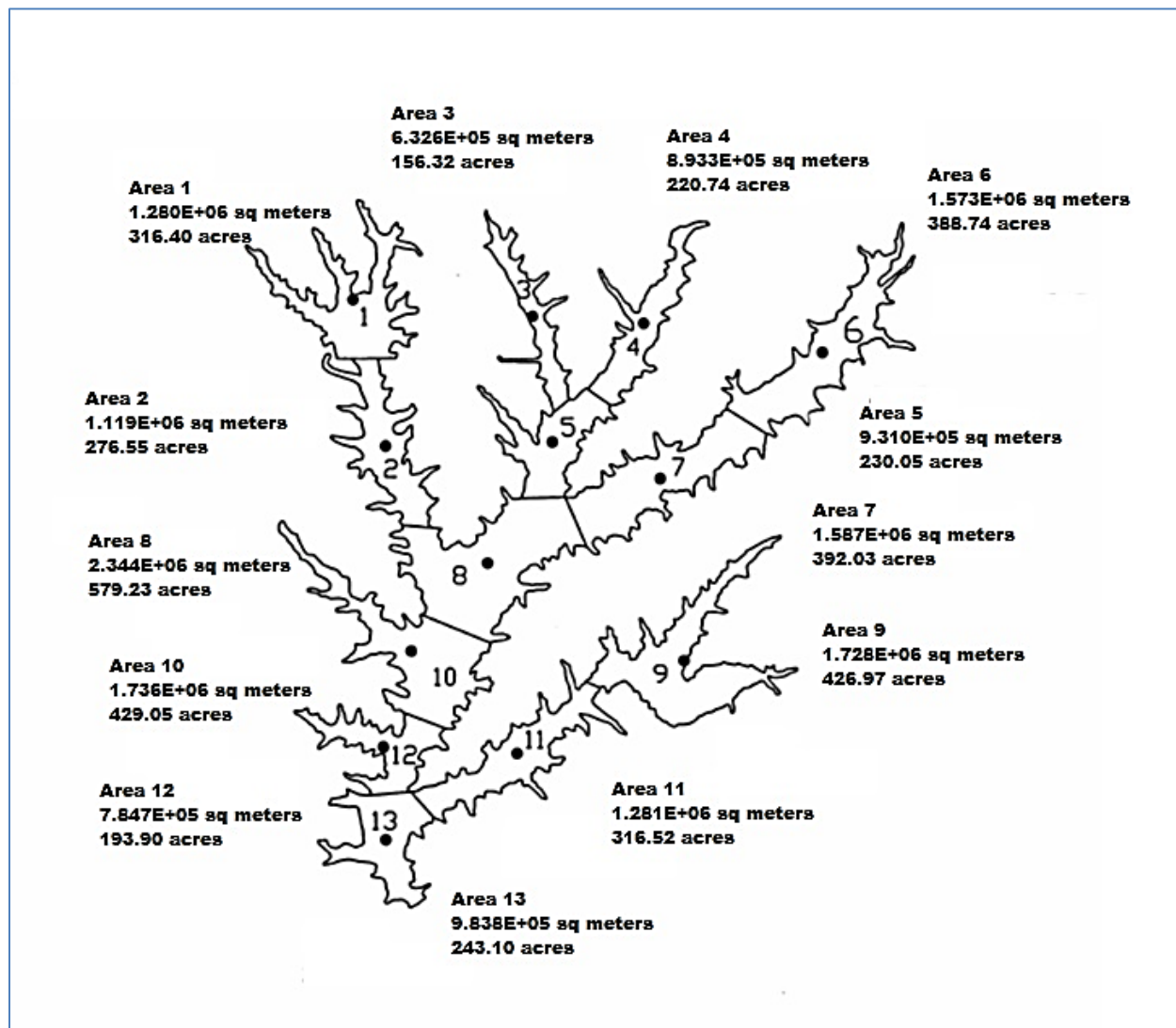


Figure 2.3-1

Map of Harris Lake for Evaporation Dose Calculation



3.0 GASEOUS EFFLUENTS

At SHNPP there are four gaseous effluent discharge points: Plant Vent Stack 1, Turbine Building Vent Stack 3A, and the Waste Processing Building Vent Stacks 5 and 5A. During refueling outage, the Equipment Hatch is removed and has potential airborne particulate releases. These are shown in Figures 3.1, 3.2, and 3.3 along with their tributaries. Minor release pathways, such as steam leaks, steam dumps, and open penetrations are evaluated for significant of release. All gaseous effluent releases at the plant are considered ground releases.

3.1 Monitor Alarm Setpoint Determination (ODCM Operational Requirement 3.3.3.11)

This section provides the methodology for stack effluent monitor setpoints to ensure that the dose rates from noble gases at the site boundary do not exceed the limits of 500 mrem/year to the whole body or 3000 mrem/year to the skin as specified in ODCM Operational Requirement 3.11.2.1. The 500 mrem/year to the whole body or 3000 mrem/year to the skin limits are more conservative than the 10 CFR 50.73 limits concerning airborne radioactivity release concentrations to unrestricted areas, and therefore the setpoint methodology set forth here is based on the limits of 500 mrem/year to the whole body or 3000 mrem/year to the skin.

The radioactivity effluent monitors for each stack and for specific effluent streams are shown in Figures 3.1 and 3.3 and are listed in Appendix C.

Gamma spectroscopy analysis of the gas sample should provide the nuclide identification and activity. However, in the case where the noble gas activities are < LLD the relative nuclide composition can be assumed from the GALE code activities for projected normal operating releases (Table 3.1-1). The GALE code is used to establish a default setpoint for each vent stack. This setpoint will be used as a "fixed" setpoint until a more conservative setpoint is calculated, using either a different assumed mix or actual sample results.

3.1.1 Default Continuous Release Monitor Setpoints Using a Conservative mix (GALE code)

The following methodology is the default setpoint for the continuous release vent stacks based on conservative assumptions of mix (GALE code) and maximum stack flow rate.

1. Determine the noble gas radionuclide activity (Q_i) in μCi , and the activity release rate $\dot{Q}_i$ in $\mu\text{Ci/sec}$ for each nuclide "i". $\dot{Q}_i$ is the release rate of nuclide "i" in gaseous effluent from discharge point "v", in $\mu\text{Ci/sec}$.

$$Q_i = C_i \bullet F_v \bullet \text{duration} \bullet 28316.85 \quad (3.1-1a)$$

and

$$\dot{Q}_i = C_i \bullet F_v \bullet 28316.85 / 60 \quad (3.1-1b)$$

where:

v = index over all vent stacks

C_i = concentration of nuclide, in $\mu\text{Ci/cc}$

= the GALE code activities from Table 3.1-1.

F_v = effluent release rate or vent flow rate in cfm

= the maximum effluent design flow rate at the point of discharge (acfm) from Table 3.1-3.

duration = duration of release, in minutes

28316.85 = conversion factor for cc/ft^3

60 = seconds per minute

2. Determine the maximum whole body and skin dose rate (mrem/year) during the release.

$$Q_{m-wb} = \overline{(X / Q)} [\sum_i K_i \dot{Q}_i] \quad (3.1-2a)$$

and

$$Q_{m-s} = \overline{(X / Q)} [\sum_i (L_i + 1.1M_i) \dot{Q}_i] \quad (3.1-2b)$$

where:

i = index over all nuclides

K_i = the total body dose factor due to gamma emissions for noble gas radionuclide i (in mrem/yr per $\mu\text{Ci/m}^3$), from Table 3.2-3.

L_i = The skin dose factor due to beta emissions for noble gas radionuclide i (mrem/yr per $\mu\text{Ci/m}^3$), from Table 3.2-3

M_i = The air dose factor due to gamma emissions for noble gas radionuclide i (mrad/yr per $\mu\text{Ci/m}^3$). A unit conversion constant of 1.1 mrad/mrem converts air dose to skin dose, from Table 3.2-3

$\overline{X/Q}$ = The highest calculated annual average relative concentration for any sector at or beyond the exclusion boundary (sec/m^3)

= $1.8\text{E-}05 \text{ sec/m}^3$ (Site Boundary SW) from Table A1 through A4, Appendix A

3.1.1 Default Continuous Release Monitor Setpoints Using a Conservative mix (GALE code) (continued)

3. Determine the ratio of dose rate limit to dose rate.

$$\text{Whole Body ratio} = \frac{500}{Q_{m-wb}} \quad (3.1-3a)$$

and

$$\text{Skin ratio} = \frac{3000}{Q_{m-s}} \quad (3.1-3b)$$

where:

500 = site dose rate limit for whole body in mrem/year.

3000 = site dose rate limit for skin in mrem/year.

4. Determine $S_{\max}$, the maximum concentration setpoint in $\mu\text{Ci/cc}$, and $RR_{\max}$ the maximum release rate setpoint in $\mu\text{Ci/sec}$ for the monitor.

$$S_{\max} = (f_s \bullet f_{\text{alloc}} \bullet \text{nratio} \bullet \Sigma C_i) + B_{\text{kg}} \quad (3.1-4a)$$

and

$$RR_{\max} = S_{\max} \bullet F_v \bullet 28316.852 / 60 \quad (3.1-4b)$$

where

f_s = safety factor for the discharge point

= 0.5

f_{alloc} = dose rate allocation factor for the discharge point

= fraction of the radioactivity from the site that may be released via the monitored pathway to ensure that the site boundary limit is not exceeded by simultaneous releases. These values are based on current plant conditions and ideal values that can be procedurally controlled are in Table 3.1-3. The sum of the allocation factors must be ≤ 1 .

nratio = lesser of the ratios

B_{kg} = Monitor background, in $\mu\text{Ci/cc}$

= 0 for calculation of default setpoint.

3.1.1 Default Continuous Release Monitor Setpoints Using a Conservative mix (GALE code) (continued)

Using the GALE code activities from Table 3.1-1 and the maximum effluent design flow rate, continuous release stack maximum setpoints in $\mu\text{Ci/cc}$ and $\mu\text{Ci/sec}$ are determined. These values will be used as default values for the stack monitors. Based on sampling and analysis, the setpoint will be recalculated. If the sample analysis setpoint is higher than the default setpoint, the setpoint will not be changed. If the sample analysis setpoint is lower than the default, the setpoint will be changed to reflect the more conservative setpoint. When the setpoint changes again, the more conservative setpoint, comparing the default (GALE code) and sample analysis, will be used.

5. Determine S_{alert} , the gas channel alert alarm setpoint in $\mu\text{Ci/cc}$, and RR_{alert} the gas channel alert alarm release rate setpoint in $\mu\text{Ci/sec}$.

$$S_{\text{alert}} = [(S_{\text{max}} - \text{Bkg}) A_f] + \text{Bkg} \quad (3.1-5a)$$

and

$$RR_{\text{alert}} = [(RR_{\text{max}} - \text{Bkg}_{\text{rr}}) A_f] + \text{Bkg}_{\text{rr}} \quad (3.1-5b)$$

where:

$$A_f = \text{A value} < 1.0 \text{ designed to alert the operator that the high alarm setpoint is being approached.}$$

$$\text{Bkg}_{\text{rr}} = \text{Bkg} \bullet F_v \bullet 28316.85 / 60$$

3.1.2 Monitor Setpoints Using Sample Results

In Stacks 1 and 5, the potential exists for batch releases concurrent with the normal continuous ventilation flow of effluents. The sources of batch releases for the Plant Vent Stack 1 include containment normal and pre-entry purge and pressure relief. Batch release sources for Vent Stack 5 include releases from the waste gas decay tanks (WGDT). In these cases, the monitor setpoint must reflect the contribution of both the continuous and batch sources.

The following methodology will calculate a setpoint for the continuous release vent stacks based on actual sample results and for batch releases occurring concurrently with continuous releases.

1. Determine the noble gas radionuclide activity (Q_i) in μCi , and the activity release rate $\dot{Q}_i$ in $\mu\text{Ci/sec}$ for each nuclide "i". $\dot{Q}_i$ is the average release rate of nuclide "i" in gaseous effluent from discharge point "v", in $\mu\text{Ci/sec}$. Noble gases may be averaged over a period of 1 hour.

$$Q_i = C_i \bullet F_v \bullet \text{duration} \bullet 28316.85 \quad (3.2-1a)$$

and

$$\dot{Q}_i = C_i \bullet F_v \bullet 28316.85 / 60 \quad (3.2-1b)$$

where:

$$C_i = \begin{aligned} & \text{concentration of nuclide, in } \mu\text{Ci/cc} \\ & = \text{the measured concentration from a stack effluent sample or pre-release sample.} \\ & \quad \text{If there is no activity in the sample, then the GALE code activities from Table 3.1-1 will be used.} \end{aligned}$$

$$= \frac{\text{WGDTs}}{(\mu\text{Ci/cc from analysis of WGDT})(6.45 \text{ E-}05) + (\mu\text{Ci/cc from analysis/GALE Code of Vent Stack 5})(0.9999)}$$

$$= \frac{\text{Containment Normal Purge (Batch)}}{(\mu\text{Ci/cc from analysis of Containment})(3.60 \text{ E-}03) + (\mu\text{Ci/cc from analysis/GALE Code of PV Stack 1})(0.9964)}$$

$$= \frac{\text{Containment Pre-entry Purge (Batch)}}{(\mu\text{Ci/cc from analysis of Containment})(8.19 \text{ E-}02) + (\mu\text{Ci/cc from analysis/GALE Code of PV Stack 1})(0.9181)}$$

$$6.45 \text{ E-}05 = \text{Dilution factor WGDT} = (15 \text{ acfm}) / (232,500 \text{ acfm} + 15 \text{ acfm})$$

$$0.9999 = \text{Dilution factor Vent Stack 5} \\ = 232,500 \text{ acfm} / (232,500 \text{ acfm} + 15 \text{ acfm})$$

$$3.60 \text{ E-}03 = \text{Dilution factor Normal Purge} \\ = 1500 \text{ acfm} / (415,000 \text{ acfm} + 1500 \text{ acfm})$$

$$0.9964 = \text{Dilution factor PV-1} = 415,000 \text{ acfm} / (415,000 \text{ acfm} + 1500 \text{ acfm})$$

$$8.19 \text{ E-}02 = \text{Dilution factor Pre-entry Purge (Batch)} \\ = 37,000 \text{ acfm} / (415,000 \text{ acfm} + 37,000 \text{ acfm})$$

$$0.9181 = \text{Dilution factor PV-1} \\ = 415,000 \text{ acfm} / (415,000 \text{ acfm} + 37,000 \text{ acfm})$$

3.1.2 Monitor Setpoints Using Sample Results (continued)

- F_v = effluent release rate or vent flow rate in CFM
- = for continuous releases, the measured effluent flow rate, or the maximum effluent design flow rate at the point of release (acfm) from Table 3.1-3.
- = for batch releases, the release flow rate, in acfm
- = 1,500 acfm for containment normal purge + 415,000 acfm from Plant Vent Stack 1
- = 37,000 acfm for containment pre-entry purge + 415,000 acfm from Plan Vent Stack 1
- = 15 acfm for Waste Gas Decay Tank prerelease permits + 232,500 acfm from Vent Stack 5

for posting Waste Gas Decay Tank and Containment Pressure releases the following is used for effluent accountability.

$$= \frac{2.26E + 06 \left(\frac{\Delta P_c}{14.7} \right) \left(\frac{273^\circ}{T_c} \right)}{t}$$

for a containment pressure release

$$= \frac{600 \left(\frac{\Delta P_t}{14.7} \right) \left(\frac{273^\circ}{T_t} \right)}{t}$$

for a Waste Gas Decay Tank release

where:

2.26E+06 and 600 are the volumes in ft³ of the containment and decay tank, respectively, and T_c , T_t , ΔP_c , and ΔP_t are the estimated, respective temperature and change in pressure (psig) following the release of the containment and decay tank; and,

14.7 psi = 1 atmosphere pressure

t = Length of release, min

$\Delta P_c, \Delta P_t$ = change in pressure (psig) following the release of the containment or decay tank

273°K = 0°C

T_t, T_c = 273°K + C°

duration = duration of release, in minutes

28316.85 = conversion factor for cc/ft³

3.1.2 Monitor Setpoints Using Sample Results (continued)

2. Determine the maximum whole body and skin dose rate (mrem/year) during the release by summing together the dose rates for this release with all concurrent releases for the time of the release.

$$Q_{m-wb} = \overline{(X/Q)} [\sum_i K_i \dot{Q}_i] \quad (3.2-2a)$$

and

$$Q_{m-s} = \overline{(X/Q)} [\sum_i (L_i + 1.1M_i) \dot{Q}_i] \quad (3.2-2b)$$

where:

i = index over all radionuclides

K_i = the total body dose factor due to gamma emissions for noble gas radionuclide i (mrem/yr per μCi/m³), from Table 3.2-3.

L_i = The skin dose factor due to beta emissions for noble gas radionuclide i (mrem/yr per μCi/m³), from Table 3.2-3

M_i = The air dose factor due to gamma emissions for noble gas radionuclide i (mrad/yr per μCi/m³). A unit conversion constant of 1.1 mrad/mrem converts air dose to skin dose, from Table 3.2-3

$\overline{X/Q}$ = The highest calculated annual average relative concentration for any sector at or beyond the exclusion boundary (sec/m³)

= 1.8E-05 sec/m³ (Site Boundary SW) from Table A1 through A4, Appendix A

3.1.2 Monitor Setpoints Using Sample Results (continued)

3. Determine the ratio of dose rate limit to dose rate.

$$\text{Whole Body ratio} = \frac{500}{Q_{m-wb}} \quad (3.2-3a)$$

and

$$\text{Skin ratio} = \frac{3000}{Q_{m-s}} \quad (3.2-3b)$$

where:

500 = site dose rate limit for whole body in mrem/year.

3000 = site dose rate limit for skin in mrem/year.

4. Determine $S_{\max}$, the maximum concentration setpoint in $\mu\text{Ci/cc}$, and $RR_{\max}$ the maximum release rate setpoint in $\mu\text{Ci/sec}$ for the monitor.

$$S_{\max} = (f_s \cdot f_{\text{alloc}} \cdot n\text{ratio} \cdot \sum C_i) + B_{\text{kg}} \quad (3.2-4a)$$

and

$$RR_{\max} = S_{\max} \cdot F_v \cdot 28316.85 / 60 \quad (3.2-4b)$$

where:

f_s = safety factor for the discharge point

= 0.5

f_{alloc} = dose rate allocation factor for the discharge point

= fraction of the radioactivity from the site that may be released via the monitored pathway to ensure that the site boundary limit is not exceeded by simultaneous releases. These values are based on current plant conditions and ideal values that can be procedurally controlled are in Table 3.1-3. The sum of the allocation factors must be ≤ 1 .

$n\text{ratio}$ = lesser of the ratios

B_{kg} = Monitor background, in $\mu\text{Ci/cc}$

= measured background at time of release or 0.

3.1.2 Monitor Setpoints Using Sample Results (continued)

5. Determine S_{alert} , the gas channel alert alarm setpoint in $\mu\text{Ci/cc}$, and RR_{alert} the gas channel alert alarm release rate setpoint in $\mu\text{Ci/sec}$.

$$S_{\text{alert}} = [(S_{\text{max}} - \text{Bkg}) A_f] + \text{Bkg} \quad (3.2-5a)$$

and

$$RR_{\text{alert}} = [(RR_{\text{max}} - \text{Bkg}_{\text{rr}}) A_f] + \text{Bkg}_{\text{rr}} \quad (3.2-5b)$$

where:

$$A_f = \text{A value} < 1.0 \text{ designed to alert the operator that the high alarm setpoint is being approached.}$$

$$\text{Bkg}_{\text{rr}} = \text{Bkg} \bullet F_v \bullet 28316.85 / 60$$

3.1.3 Effluent Monitoring During Hogging Operations

If the reactor has been shut down for greater than 30 days, the condenser vacuum pump discharge during initial hogging operations at plant start-up and prior to turbine operation may be routed as dual exhaust to (1) the Turbine Vent Stack 3A and (2) the atmosphere directly. In this instance, the blind flange on the latter exhaust route will be removed (see Figure 3.3).

A conservative effluent channel setpoint has been established for Vent Stack 3A. The monitor setpoint should be reduced proportionately to the estimated fraction of the main condenser effluent flowing directly to the atmosphere.

Table 3.1-1
GASEOUS SOURCE TERMS^(a, b)

	Plant Vent Ventilation Flow via Stack 1		Condenser Vacuum Pump Ventilation Flow via Stack 3A		WPB Ventilation Flow via Stack 5		WPB Ventilation Flow ^(c) via Stack 5A		Containment Purge or Pressure Relief via Stack 1		WGDT Release via Stack 5	
Nuclide	Ci ($\mu\text{Ci/cc}$)	% Rel. Mix	Ci ($\mu\text{Ci/cc}$)	% Rel. Mix	Ci ($\mu\text{Ci/cc}$)	% Rel. Mix	Ci ($\mu\text{Ci/cc}$)	% Rel. Mix	Ci ($\mu\text{Ci/cc}$)	% Rel. Mix	Ci ($\mu\text{Ci/cc}$)	% Rel. Mix
Kr-85m	4.86E-10	6.52	4.70E-9	9.52	0	0	1.96E-9	6.52	1.01E-7	3.79	0	0
Kr-85	0	0	0	0	1.60E-7	97.05	0	0	3.95E-8	1.49	2.22E-5	100.00
Kr-87	4.86E-10	6.52	4.70E-9	9.52	0	0	1.96E-9	6.52	3.59E-8	1.35	0	0
Kr-88	9.71E-10	13.04	7.04E-9	14.29	0	0	3.91E-9	13.04	1.29E-7	4.87	0	0
Xe-131m	3.24E-10	4.35	0	0	4.86E-9	2.95	1.30E-9	4.35	2.16E-7	8.12	0	0
Xe-133m	0	0	0	0	0	0	0	0	5.57E-8	2.10	0	0
Xe-133	1.78E-09	23.91	1.17E-8	23.81	0	0	7.17E-9	23.91	1.31E-6	49.39	0	0
Xe-135m	4.86E-10	6.52	2.35E-9	4.76	0	0	1.96E-9	6.52	7.19E-9	0.27	0	0
Xe-135	2.43E-9	32.61	1.64E-8	33.33	0	0	9.78E-9	32.61	7.55E-7	28.42	0	0
Xe-138	4.86E-10	6.52	2.35E-9	4.76	0	0	1.96E-9	6.52	5.39E-9	0.20	0	0

(a) Source terms are from SHNPP FSAR Table 11.3.3-1 and not actual releases. Values apply only to routine releases and not emergency situations.

(b) $(\mu\text{Ci/cc}) = \frac{(\text{Ci/yr})(\text{yr}/5.256\text{E}5\text{min})(1\text{E}6\mu\text{Ci/Ci})(\text{ft}^3/28320\text{cc})}{(\text{Flow Rate} \text{ ft}^3/\text{min})^{(d)}}$

(c) Source term for this effluent stream not presented with FSAR. RAB mix assumed.

(d) Maximum Effluent Design Flow Rates:

- Plant Vent Ventilation via Stack 1 = 415,000 acfm
- Condenser Vacuum Pump Ventilation via Stack 3A = 28,620 acfm
- WPB Ventilation via Stack 5 = 232,500 acfm
- WPB Ventilation via Stack 5A = 103,050 acfm
- Containment Purge or Pressure Relief via Stack 1 = 37,000 acfm
- WGDT Release via Stack 5 = 15 acfm

TABLE 3.1-2

Deleted

TABLE 3.1-3

GASEOUS MONITOR PARAMETERS

	PVS-1	TBVS-3A	WPBVS-5	WPBVS-5A
Maximum effluent design flow rate, (acfm)	415,000	28,620	232,500	103,050
Flow Allocation Factor [f _{alloc}]	0.532	0.037	0.298	0.132

3.2 Post Release Compliance with 10CFR20-Based ODCM Operational Requirement 3.11.2

3.2.1 Noble Gases

The gaseous effluent monitors' setpoints are utilized to show prerelease compliance with ODCM Operational Requirement 3.11.2.1. However, because they may be based upon a conservative (GALE code) mix of radionuclides, when using Table 3.1-1, the possibility exists that the setpoints could be exceeded and yet 10CFR20-based limits may actually be met. Therefore, the following methodology has been provided in the event that if the high alarm setpoints are exceeded, a determination may be made as to whether the actual releases have exceeded the dose rate limits of ODCM Operational Requirement 3.11.2.1.

The dose rate in unrestricted areas resulting from noble gas effluents is limited to 500 mrem/year to the total body and 3000 mrem/year to the skin. Based upon NUREG-0133, the following equations are used to show compliance:

$$\sum_i K_i \overline{(X/Q)}_v \dot{Q}_{i,v} \leq 500 \text{ mrem/yr} \quad (3.2-1)$$

$$\sum_i (L_i + 1.1M_i) \overline{(X/Q)}_v \dot{Q}_{i,v} \leq 3000 \text{ mrem/yr} \quad (3.2-2)$$

where:

$\overline{(X/Q)}_v$	=	The highest calculated annual average relative concentration for long-term vent stack releases for areas at or beyond the exclusion boundary sec/m^3 .
	=	$1.8\text{E-}05 \text{ sec/m}^3$ (Site Boundary SW) from Table A1 through A4, Appendix A
K_i	=	The total body dose factor due to gamma emissions for noble gas radionuclide "i," mrem/year per $\mu\text{Ci/m}^3$. Table 3.2-3.
L_i	=	The skin dose factor due to beta emissions for noble gas radionuclide "i," mrem/year per $\mu\text{Ci/m}^3$. Table 3.2-3.
M_i	=	The air dose factor due to gamma emissions for noble gas radionuclide "i," mrad/year per $\mu\text{Ci/m}^3$. Table 3.2-3
1.1	=	The ratio of the tissue to air absorption coefficients over the energy range of the photon of interest. Converts mrad to mrem (Reference NUREG-0133).
$\dot{Q}_{i,v}$	=	The release rate of radionuclide "i" in gaseous effluents from all plant vent stacks ($\mu\text{Ci/sec}$).

The determination of the controlling location for implementation of dose rate limits for noble gas exposure is a function of the historical annual average meteorology.

The radionuclide mix is based on the sampling and analysis required by ODCM Operational Requirement 4.11.2.1.2. If the analysis is < LLD, then the GALE code, historical data for the mix, or a Xe-133 / Kr-85 LLD mix for that analysis will be used to demonstrate compliance.

The release rate is derived from either the actual flow rate or the default flow rate and the known or assumed mix.

3.2.1 Noble Gases (continued)

$$\text{Release Rate } (\mu\text{Ci/sec}) = \text{Flow (cc/sec)} * \text{Concentration } (\mu\text{Ci/cc})$$

The noble gas radionuclide mix was based upon source terms calculated using the NRC GALE Code and presented in the SHNPP FSAR Table 11.3.3-1. They are reproduced in Table 3.2-1 as a function of release point.

The X/Q value utilized in the equations is the highest long-term annual average relative concentration $(X/Q)_v$ in the unrestricted area for the period 2010 - 2014. Long-term annual average $(X/Q)_v$ values at other special locations identified by the Land Use Census (see Operational Requirement 3.12.2) are presented in Appendix A. A description of their derivation is also provided in Appendix A.

To select the limiting location for ground-level releases, long-term annual average $(X/Q)_v$ values were calculated assuming no decay, undepleted transport to the exclusion boundary. These values are given in Table A1 through A4, Appendix A. The maximum exclusion boundary $(X/Q)_v$ for ground-level releases occurs in the SW sector. Therefore, the limiting location for implementation of the dose rate limits for noble gases is considered to be the exclusion boundary (1.33 miles) in the SW sector.

Values for K_i , L_i , and M_i which are to be used by SHNPP in Equations 3.2-1 and 3.2-2 to show compliance with ODCM Operational Requirement 3.11.2 are presented in Table 3.2-3. These values were taken from Table B-1 of NRC Regulatory Guide 1.109, Revision 1. The values have been multiplied by $1.0\text{E}+06$ to convert mrad/pCi to mrad/ μCi for use in Equations 3.2-1 and 3.2-2.

3.2.2 Radioiodines and Particulates

The basis for ODCM Operational Requirement 3/4.11.2.1 states that the dose rate to the thyroid of a child in an unrestricted area resulting from the inhalation of radioiodine's, tritium, and particulates with half-lives ≥ 8 days is limited to 1500 mrem/yr to any organ. Based upon NUREG-0133, the following is used to show compliance:

$$\sum_i P_{i-I} [(\overline{X/Q})_v \dot{Q}_{i-v}] \leq 1500 \text{ mrem / yr} \quad (3.2-3)$$

where:

P_{i-I} = The dose parameter for radionuclides other than noble gases for the inhalation pathway, mrem/yr per $\mu\text{Ci}/\text{m}^3$, from Table 3.2-4.

In the calculation to show compliance with ODCM Operational Requirement 3.11.2.1.b, only the inhalation pathway is considered.

The radionuclide mix is based on the sampling and analysis required by ODCM Operational Requirement 4.11.2.1.2. If the analysis is $< \text{LLD}$, then no activity is assumed to have been released during the sampling period. The release rate is derived from the flow (actual or default) and the mix.

Release Rate ($\mu\text{Ci}/\text{sec}$) = Flow (cc/sec) * Concentration ($\mu\text{Ci}/\text{cc}$)

The determination of the controlling exclusion boundary location was based upon the highest exclusion boundary $(X/Q)_v$ value. Values for P_{i-I} in Eq. 3.2-3 were calculated for a child for various radionuclides for the inhalation pathway using the methodology of NUREG-0133. The P_{i-I} values are presented in Table 3.2-4. A description of the methodology used in calculating the P_i values is presented in Appendix B.

The $(\overline{X/Q})_v$ value utilized in Equation 3.2-3 is obtained from the tables presented in Appendix A. A description of the derivation of the X/Q values is provided in Appendix A.

Table 3.2-1

Releases from the Shearon Harris Nuclear Power Plant (a)
Normal Operation (Curies/year)

Waste Processing Bldg Exhaust and/or Waste Gas Decay Tanks (b) via VENT STACK 5			Waste Processing Bldg Exhaust via VENT STACK 5A RAB/FHB and Containment Exhaust via VENT STACK 1		Condenser Vacuum Pump and Turbine Building Exhaust via VENT STACK 3A		
<u>NOBLE GASES</u>	<u>SHUTDOWN</u>	<u>NORMAL OPERATIONS</u>	<u>CONTAINMENT</u>	<u>RAB/FHB</u>	<u>TURBINE</u>	<u>STACK 3A</u>	<u>TOTAL</u>
Kr-85m	0	0	5.6E+01	3.E+00	0	2.0E+00	6.1E+01
Kr-85	5.0E+00	5.6E+02	2.2E+01	0	0	0	5.9E+02
Kr-87	0	0	2.0E+01	3.0E+00	0	2.0E+00	2.5E+01
Kr-88	0	0	7.2E+01	6.0E+00	0	3.0E+00	8.1E+01
Xe-131m	0	1.7E+01	1.2E+02	2.0E+00	0	0	1.4E+02
Xe-133m	0	0	3.1E+01	0	0	0	3.10E+01
Xe-133	0	0	7.3E+02	1.1E+01	0	5.0E+00	7.5E+02
Xe-135m	0	0	4.0E+00	3.0E+00	0	1.0E+00	8.0E+00
Xe-135	0	0	4.2E+02	1.5E+01	0	7.0E+00	4.4E+02
Xe-138	0	0	3.0E+00	3.0E+00	0	1.0E+00	7.0E+00
Ar-41	---	---	---	---	---	---	3.4E+01

(a) Adapted from SHNPP FSAR Table 11.3.3-1 and do not reflect actual release data.
These values are only for routine releases and not for a complete inventory of gases in an emergency.

(b) Waste Gas Decay Tank releases assumed to be after a 90-day decay period.

TABLE 3.2-3

DOSE FACTORS FOR NOBLE GASES *

Radionuclide	Total Body Dose Factor K_i (mrem/yr per $\mu\text{Ci}/\text{m}^3$)	Skin Dose Factor L_i (mrem/yr per $\mu\text{Ci}/\text{m}^3$)	Gamma Air Dose Factor M_i (mrad/yr per $\mu\text{Ci}/\text{m}^3$)	Beta Air Dose Factor N_i (mrad/yr per $\mu\text{Ci}/\text{m}^3$)
Ar-41	8.840E+03	2.690E+03	9.300E+03	3.280E+03
Kr-83M	7.560E-02	0.000E+00	1.930E+01	2.880E+02
Kr-85M	1.170E+03	1.460E+03	1.230E+03	1.970E+03
Kr-85	1.610E+01	1.340E+03	1.720E+01	1.950E+03
Kr-87	5.920E+03	9.730E+03	6.170E+03	1.030E+04
Kr-88	1.470E+04	2.370E+03	1.520E+04	2.930E+03
Kr-89	1.660E+04	1.010E+04	1.730E+04	1.060E+04
Xe-127	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Xe-131M	9.150E+01	4.760E+02	1.560E+02	1.110E+03
Xe-133M	2.510E+02	9.940E+02	3.270E+02	1.480E+03
Xe-133	2.940E+02	3.060E+02	3.530E+02	1.050E+03
Xe-135M	3.120E+03	7.110E+02	3.360E+03	7.390E+02
Xe-135	1.810E+03	1.860E+03	1.920E+03	2.460E+03
Xe-137	1.420E+03	1.220E+04	1.510E+03	1.270E+04
Xe-138	8.830E+03	4.130E+03	9.210E+03	4.750E+03

*The listed dose factors are for radionuclides that may be detected in gaseous effluents.

TABLE 3.2-4
P_i VALUES (INHALATION) FOR A CHILD

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	Gi-LLi
H-3	0.00E+00	1.12E+03	1.12E+03	1.12E+03	1.12E+03	1.12E+03	1.12E+03
P-32	2.60E+06	1.14E+05	9.86E+04	0.00E+00	0.00E+00	0.00E+00	4.21E+04
Cr-51	0.00E+00	0.00E+00	1.54E+02	8.53E+01	2.43E+01	1.70E+04	1.08E+03
Mn-54	0.00E+00	4.29E+04	9.50E+03	0.00E+00	1.00E+04	1.57E+06	2.29E+04
Fe-59	2.07E+04	3.34E+04	1.67E+04	0.00E+00	0.00E+00	1.27E+06	7.06E+04
Co-58	0.00E+00	1.77E+03	3.16E+03	0.00E+00	0.00E+00	1.10E+06	3.43E+04
Co-60	0.00E+00	1.31E+04	2.26E+04	0.00E+00	0.00E+00	7.06E+06	9.61E+04
Zn-65	4.25E+04	1.13E+05	7.02E+04	0.00E+00	7.13E+04	9.94E+05	1.63E+04
Rb-86	0.00E+00	1.98E+05	1.14E+05	0.00E+00	0.00E+00	0.00E+00	7.98E+03
Rb-88	0.00E+00	8.36E+02	5.45E+02	0.00E+00	0.00E+00	0.00E+00	2.56E+01
Rb-89	0.00E+00	5.13E+02	4.31E+02	0.00E+00	0.00E+00	0.00E+00	2.81E+00
Sr-89	5.99E+05	0.00E+00	1.72E+04	0.00E+00	0.00E+00	2.15E+06	1.67E+05
Sr-90	1.01E+08	0.00E+00	6.43E+06	0.00E+00	0.00E+00	1.47E+07	3.43E+05
Y-91	9.13E+05	0.00E+00	2.43E+04	0.00E+00	0.00E+00	2.62E+06	1.84E+05
Zr-95	1.90E+05	4.17E+04	3.69E+04	0.00E+00	5.95E+04	2.23E+06	6.10E+04
Zr-97	2.79E+02	4.04E+01	2.38E+01	0.00E+00	5.78E+01	1.68E+05	5.22E+05
Nb-95	2.35E+04	9.16E+03	6.54E+03	0.00E+00	8.61E+03	6.13E+05	3.69E+04
Nb-97	6.38E-01	1.14E-01	5.36E-02	0.00E+00	1.27E-01	5.08E+03	4.14E+04
Mo-99	0.00E+00	2.56E+02	6.33E+01	0.00E+00	5.83E+02	2.01E+05	1.88E+05
Tc-99M	2.65E-03	5.18E-03	8.58E-02	0.00E+00	7.54E-02	1.41E+03	7.15E+03
Ru-103	2.79E+03	0.00E+00	1.07E+03	0.00E+00	7.02E+03	6.61E+05	4.47E+04
Ru-106	1.36E+05	0.00E+00	1.69E+04	0.00E+00	1.84E+05	1.43E+07	4.29E+05
Ag-110M	1.68E+04	1.14E+04	9.13E+03	0.00E+00	2.12E+04	5.47E+06	1.00E+05
Sn-113	9.00E+03	2.91E+02	9.83E+03	1.19E+02	2.02E+02	3.40E+05	7.45E+03
Sb-124	5.73E+04	7.40E+02	2.00E+04	1.26E+02	0.00E+00	3.24E+06	1.64E+05
Sb-125	9.84E+04	7.59E+02	2.07E+04	9.10E+01	0.00E+00	2.32E+06	4.03E+04
Te-127m	2.48E+04	8.53E+03	3.01E+03	6.06E+03	6.35E+04	1.48E+06	7.13E+04
Te-127	4.12E+00	1.41E+00	9.08E-01	2.92E+00	1.05E+01	1.49E+04	8.36E+04
Te-129M	1.92E+04	6.84E+03	3.04E+03	6.32E+03	5.02E+04	1.76E+06	1.81E+05
Te-129	1.45E-01	5.20E-02	3.54E-02	1.06E-01	3.82E-01	4.36E+03	3.79E+04
Te-131M	2.00E+02	8.80E+01	7.54E+01	1.45E+02	5.94E+02	3.06E+05	4.58E+05
Te-131	3.23E-02	1.25E-02	9.79E-03	2.52E-02	8.75E-02	3.05E+03	1.98E+03
Te-132	7.15E+02	4.05E+02	3.92E+02	4.72E+02	2.63E+03	5.61E+05	2.05E+05
I-131	4.80E+04	4.80E+04	2.72E+04	1.62E+07	7.87E+04	0.00E+00	2.84E+03
I-132	2.11E+03	4.06E+03	1.87E+03	1.93E+05	6.24E+03	0.00E+00	3.20E+03
I-133	1.66E+04	2.03E+04	7.68E+03	3.84E+06	3.37E+04	0.00E+00	5.47E+03
I-134	1.74E+03	3.21E+03	1.48E+03	7.54E+04	4.91E+03	0.00E+00	1.42E+03
I-135	4.91E+03	8.72E+03	4.14E+03	7.91E+05	1.34E+04	0.00E+00	4.43E+03
Cs-134	6.50E+05	1.01E+06	2.24E+05	0.00E+00	3.30E+05	1.21E+05	3.84E+03
Cs-136	6.50E+04	1.71E+05	1.16E+05	0.00E+00	9.53E+04	1.45E+04	4.17E+03
Cs-137	9.05E+05	8.24E+05	1.28E+05	0.00E+00	2.82E+05	1.04E+05	3.61E+03
Ba-140	7.39E+04	6.47E+01	4.32E+03	0.00E+00	2.11E+01	1.74E+06	1.02E+05
Ce-141	3.92E+04	1.95E+04	2.89E+03	0.00E+00	8.53E+03	5.43E+05	5.65E+04
Ce-144	6.76E+06	2.11E+06	3.61E+05	0.00E+00	1.17E+06	1.19E+07	3.88E+05
Hf-181	8.44E+04	3.28E+02	8.50E+03	2.76E+02	2.64E+02	7.95E+05	5.31E+04
Np-239	6.93E+02	4.97E+01	3.49E+01	0.00E+00	1.45E+02	8.64E+04	9.52E+04

3.3 COMPLIANCE WITH 10CFR50

The calculations described in Section 3.2 will be used to ensure compliance with the limits in 10 CFR 50 Appendix I for each release. Summation of doses for all releases for the quarter and year are compared to the limits in 10CFR50 Appendix I to ensure compliance.

With the exception of Carbon-14, the SHNPP ODCM calculates the dose to a single maximum (ALARA) individual. The ALARA individual is an individual that "lives" at the site boundary in the sector that has the most limiting long-term average X/Q value. The Carbon-14 dose is based upon the dose to a child who resides at the location with the most limiting X/Q for a garden.

3.3.1 Noble Gases

1. Cumulation of Doses

Based upon NUREG-0133, the air dose in the unrestricted area due to noble gases released in gaseous effluents can be determined by the following equations:

$$D_{\gamma} = 3.17 \text{ E} - 08 \sum_i M_i \left[\overline{(X / Q)}_v \tilde{Q}_{i_v} + \overline{(X / q)}_v \tilde{q}_{i_v} \right] \quad (3.3-1)$$

$$D_{\beta} = 3.17 \text{ E} - 08 \sum_i N_i \left[\overline{(X / Q)}_v \tilde{Q}_{i_v} + \overline{(X / q)}_v \tilde{q}_{i_v} \right] \quad (3.3-2)$$

where:

D_{γ} = The air dose from gamma radiation, mrad.

D_{β} = The air dose from beta radiation, mrad.

3.17 E-08 = The inverse of the number of seconds in a year (sec/year)⁻¹.

M_i = The air dose factor due to gamma emissions for each identified noble gas radionuclide (mrad/yr/ $\mu\text{Ci}/\text{m}^3$). A unit conversion constant of 1.1 mrad/mrem converts air dose to skin dose. Table 3.2-3.

N_i = The air dose factor due to beta emissions for each identified noble gas radionuclide "i," mrad/year per $\mu\text{Ci}/\text{m}^3$. Table 3.2-3.

$\overline{X/Q}_v$ = The relative concentration for areas at or beyond the exclusion boundary for long-term ground-level vent stack releases (≥ 500 hours/year), sec/m^3 . See Section 3.0 concerning ground-level releases at Shearon Harris Nuclear Plant or use $1.8\text{E}-05 \text{ sec}/\text{m}^3$ from Table A1 through A4, Appendix A as the most limiting X/Q_v .

$\overline{X/q}_v$ = The relative concentration for areas at or beyond the exclusion boundary for short-term ground-level vent stack releases (≤ 500 hours/year), sec/m^3 . See Section 3.0 concerning ground-level releases at Shearon Harris Nuclear Plant or use $1.8\text{E}-05 \text{ sec}/\text{m}^3$ from Table A1 through A4, Appendix A as the most limiting X/Q_v .

$\tilde{Q}_{i_v}$ = The total release of noble gas radionuclide "i" in gaseous effluents for long term releases (>500 hrs/yr) from all vent stacks (μCi).

$\tilde{q}_{i_v}$ = The total release of radionuclide "i" in gaseous releases for short-term releases (≤ 500 hours/year) from all vent stacks, (μCi).

3.3.1 Noble Gases (continued)

To show compliance with 10CFR50, Expressions 3.3-1 and 3.3-2 are evaluated at the controlling location where the air doses are at a maximum.

At SHNPP the limiting location is the exclusion boundary at 1.33 miles (~2.14 kilometers) in the SW sector based upon the tables presented in Appendix A (see Section 3.2.1 earlier). For this document, long-term annual average X/Q_v values can be used in lieu of short-term values. See Section 3.0 concerning ground-level releases at Shearon Harris Nuclear Plant.

The determination of the limiting location for implementation of 10CFR50 is a function of parameters such as radionuclide mix and meteorology. To select the limiting location, the highest annual average X/Q_v value for ground-level releases is controlling. The only source of short-term releases from the plant vent are containment purges, containment pressure relief, and waste gas decay tank release. Determination of source terms is described in 3.3.1.2.

Values for M_i and N_i , which are utilized in the calculation of the gamma air and beta air doses in Equation 3.3-1 to show compliance with 10CFR50, are presented in Table 3.2-3. These values originate from Table B-1 of the NRC Regulatory Guide 1.109, Revision 1. The values have been multiplied by $1.0E+06$ to convert from mrad/pCi to mrad/ μ Ci.

The following relationships should hold for SHNPP to show compliance with ODCM Operational Requirement 3.11.2.2.

For the calendar quarter:

$$D_\gamma \leq 5 \text{ mrad} \quad (3.3-3)$$

$$D_\beta \leq 10 \text{ mrad} \quad (3.3-4)$$

For the calendar year:

$$D_\gamma \leq 10 \text{ mrad} \quad (3.3-5)$$

$$D_\beta \leq 20 \text{ mrad} \quad (3.3-6)$$

The quarterly limits given above represent one-half of the annual design objectives of Section II.B.1 of Appendix I of 10CFR50. If any of the limits of Equations 3.3-3 through 3.3-6 are exceeded, a Special Report pursuant to Technical Specification 6.9.2 must be filed with the NRC. This report complies with Section IV.A of Appendix I of 10CFR50.

3.3.1 Noble Gases (continued)

2. Source Term Determination

Containment Batch Purge

A purge of containment may be started as a Batch purge and continued as a normal purge. The containment Batch Purge volume is considered to be two air containment volumes (RCB vol = 2.26E+06 ft³). The containment air is sampled and analyzed for noble gases and tritium prior to release. Stack 1 has a continuous particulate filter and iodine cartridge sampler that is analyzed weekly (minimum) and used for total particulate and iodine effluent accountability for continuous releases. The noble gases and tritium analysis are used for containment effluent accountability as follows;

$$q_i = C_i \bullet v_b \quad (3.3-7)$$

Where;

q_i = Activity of nuclide "i" released (μ Ci).

C_i = Concentration of radionuclide "i" (μ Ci/cc)

v_b = Containment purge volume (cc).

Waste Gas Decay Tank Batch Releases

Waste Gas Decay Tanks (WGDT) are sampled and analyzed for tritium and noble gases prior to each release. Stack 5 has a continuous particulate filter and iodine cartridge sampler that is analyzed weekly (minimum) and used for total particulate and iodine effluent accountability for continuous releases. The activity (μ Ci) for nuclide "i" for Waste Gas Decay Tank effluent accountability is calculated as follows;

$$q_i = \frac{(C_i \bullet \Delta P_t \bullet 600 \bullet 28316.85 \bullet 273)}{(14.7 \bullet 283)} \quad (3.3-7a)$$

Where;

q_i = Activity of nuclide "i" released (μ Ci).

C_i = Concentration of nuclide "i" (μ Ci/cc).

ΔP_t = Change in pressure (psia) of the WGDT
(psia = psig + 14.7)

600 = WGDT volume, (ft³).

28316.85 = Conversion factor for converting from ft³ to cc.

273 = Standard Temperature for 0°C (°K).

14.7 = Sample pressure at time of measurement, (psia).

283 = WGDT Temperature, °k (see Note below)

NOTE: The FSAR assumes WGDT temperature to be in the 50-140 °F range. Since there is no indicator for the actual WGDT temperature, 50°F (10°C) is conservatively assumed as an acceptable substitute.

3.3.1 Noble Gases (continued)

Containment Pressure Releases

Containment Pressure Releases (ILRT) are calculated using the same methodology as Waste Gas Decay Tank Batch Releases. Containment Pressure Releases are released via Stack 1 and pressurization piping. The volume to use is 2.26E+06 ft³.

Continuous Releases

Each of the four effluent stacks at the HNP have noble gas monitors. Using the net concentration (μCi/cc) from these monitors times the volume released (determined from the flow monitors) the total activity (μCi) of noble gases released are calculated as follows:

$$Q_x = C_x \cdot V_x \quad (3.3-8)$$

Where;

Q_x = Total activity (μCi) released from Stack "x".

C_x = Net concentration (μCi/cc) from Stack "x" noble gas monitor.

V_x = Volume (cc) released from Stack "x" using the flow monitor and, if out of service use the compensatory measurements for volume determination.

The activity (μCi) released for radionuclide "i" equals the radionuclide "i" fraction of the radionuclide mix times the total activity released from Stack "x".

$$Q_i = Q_x \cdot S_i \quad (3.3-8a)$$

Where;

$$S_i = \frac{C_i}{\sum C_i} \quad (3.3-8b)$$

and;

S_i = The radionuclide "i" fraction of the radionuclide mix

C_i = The concentration of nuclide "i" in the grab sample (μCi/cc).

$\sum C_i$ = Total activity in grab sample (μCi/cc).

The radionuclide mix is based on the sampling and analysis required by ODCM Operational Requirement 4.11.2.2.1. If the grab sample activity is < LLD, then a mix based on historical data or a mix based on the Xe-133 / Kr-85 LLD mix of that sample may be used.

When a monitor is out of service, the results of the compensatory sampling for each nuclide times the volume released for that time interval will be used for effluent accountability. During this situation if the sample shows no detectable activity, then there is no activity released.

3.3.1 Noble Gases (continued)

Corrections for Double Accounting

For the two stacks that may have batch releases during the same time interval as continuous releases, the above calculations are corrected for double accounting as follows;

$$Q_{ic} = Q_i - q_i \quad (3.3-9)$$

Where;

Q_{ic} = Total corrected activity of nuclide "i" (μCi) from Stack "x" when batch releases are being made during that time period.

For short term (batch) releases, the effluent stream is sampled and analyzed. The results of the sampling and analysis is used as the source term for the batch release. Release rate is derived from the source term and the release flow rate.

3. Projection of Doses

Doses resulting from the release of gaseous effluents will be projected once every 31 days (monthly). The doses will be projected utilizing Equations 3.3-1 and 3.3-2, and projected using the following expression:

$$D_{pt} = (D_{\tau} \cdot p) + D_{at} \quad (3.3-10)$$

where:

D_{pt}	=	the 31-Day Projected Dose by organ τ
D_{τ}	=	sum of all open and closed release points from the start of the quarter to the end of the release in mrem per organ τ .
p	=	the Projection Factor which is the result of 31 divided by the number of days from start of the quarter to the end of the release.
D_{at}	=	Additional Anticipated Dose for liquid releases by organ τ and quarter of release.

NOTE: The 31-Day Projected Dose values appear on the Standard Permit Reports. The 31-day dose projections include any additional dose.

Where possible, expected operational evolutions (i.e., outages, increased power levels, major planned batch gas releases, etc.) should be accounted for in the dose projections. This may be accomplished by using the source-term data from similar historical operating experiences where practical, and adding the dose as Additional Anticipated Dose.

To show compliance with ODCM Operational Requirement 3.11.2.4, the projected month's dose should be compared as in the following:

$$D_{\gamma} \leq 0.2 \text{ mrad to air for gamma radiation} \quad (3.3-11)$$

and

$$D_{\beta} \leq 0.4 \text{ mrad to air for beta radiation} \quad (3.3-12)$$

If the projections exceed either Equations 3.3-11 or 3.3-12, then the appropriate portions of the gaseous radwaste treatment system shall be used to reduce releases of radioactivity.

3.3.2 Radioiodine and Particulates

1. Cumulation of Doses

Section II.C of Appendix I of 10CFR50 limits the release of radioiodine's and radioactive material in particulate form from a reactor such that the estimated dose or dose commitment to an individual in an unrestricted area from all pathways of exposure is not in excess of 15 mrem to any organ. Based upon NUREG-0133, the dose to an organ of an individual from radioiodine's and particulates with half-lives greater than 8 days in gaseous effluents released to unrestricted areas can be determined by the following equation:

$$D_r = 3.17E - 08 \sum_i (R_{i_I}) [(\overline{X/Q})_v \tilde{Q}_{i_v} + (\overline{X/q})_v \tilde{q}_{i_v}] + \\ (R_{i_M} + R_{i_V} + R_{i_G} + R_{i_B}) [(\overline{D/Q})_v \tilde{Q}_{i_v} + (\overline{D/q})_v \tilde{q}_{i_v}] + \\ (R_{T_M} + R_{T_I} + R_{T_V} + R_{T_B}) [(\overline{X/Q})_v \tilde{Q}_{T_v} + (\overline{X/q})_v \tilde{q}_{T_v}]$$

where:

D_τ	=	Dose to any organ τ from tritium, radioiodine's, and particulates, mrem.
$\overline{(D/Q)}_v$	=	The highest long-term (> 500 hr/yr) annual average relative deposition: 9.0E-09 m ⁻² for the food and ground plane pathways at the controlling location which is the exclusion boundary in the SW sector (from Table A1 through A4, Appendix A, for ground-level vent stack releases).
$\overline{(D/q)}_v$	=	The relative deposition factor for short term, ground-level vent releases ($\leq$ 500 hrs/yr), in m ⁻² . See Section 3.0 concerning ground-level releases at Shearon Harris Nuclear Plant if using "real" meteorology or use 9.0E-09 m ⁻² from Table A1 through A4, Appendix A, for the food and ground plane pathways at the controlling location.
R_{i_M}	=	Dose factor for an organ for radionuclide "i" for either the cow milk or goat milk pathway, mrem/yr per μ Ci/sec per m ⁻² .
R_{i_G}	=	Dose factor for an organ for radionuclide "i" for the ground plane exposure pathway, mrem/yr per μ Ci/sec per m ⁻² .
R_{i_I}	=	Dose factor for an organ for radionuclide "i" for the inhalation pathway, mrem/yr per μ Ci/m ³ .
R_{i_V}	=	Dose factor for an organ for radionuclide "i" for the vegetable pathway, mrem/yr per μ Ci/sec per m ⁻² .
R_{i_B}	=	Dose factor for an organ for radionuclide "i" for the meat pathway, mrem/yr per μ Ci/sec per m ⁻² .
R_{T_M}	=	Dose factor for an organ for tritium for the milk pathway mrem/yr per μ Ci/m ³ .
R_{T_V}	=	Dose factor for an organ for tritium for the vegetable pathway, mrem/yr per μ Ci/m ³ .
R_{T_I}	=	Dose factor for an organ for tritium for the inhalation pathway, mrem/yr per μ Ci/m ³ .

3.3.2 Radioiodine and Particulates (continued)

R_{TB}	=	Dose factor for an organ for tritium for the meat pathway, mrem/yr per $\mu\text{Ci}/\text{m}^3$.
$\tilde{Q}_{TV}$	=	Release of tritium in gaseous effluents for long-term vent stack releases (> 500 hrs/yr), μCi .
$\tilde{q}_{TV}$	=	Release of tritium in gaseous effluents for short-term vent stack releases ($\leq$ 500 hrs/yr), μCi .

To show compliance with 10CFR50, Equation 3.3-13 is evaluated for a hypothetical individual at the limiting location. At SHNPP the SW sector has the highest X/Q_v and the SW and SSW sectors have the highest annual average D/Q_v values. This assures that the actual exposure of a member of the public will not be substantially underestimated. The critical receptor is a child.

Appropriate X/Q_v and D/Q_v values from tables in Appendix A are used. For this document, long-term annual average X/Q_v and D/Q_v values may be used in lieu of short-term values (see Section 3.0 concerning ground-level releases at Shearon Harris Nuclear Plant).

The determination of a limiting location for implementation of 10CFR50 for radioiodine's and particulates is a function of:

1. Isotopic mix
2. Meteorology
3. Exposure pathway
4. Receptor's age

In the determination of the limiting location, the radionuclide mix of radioiodine's and particulates is based on the sampling and analysis required by ODCM Operational Requirement 4.11.2.1.2. If the analysis is < LLD, then no activity is assumed to have been released during the sampling period. The release rate is derived from the flow (actual or default) and the isotopic mix.

In the determination of the limiting sector, all age groups and all of the exposure pathways are evaluated using the highest XOQDOQ values in Appendix A at the site boundary. These include beef and vegetable ingestion, inhalation, and ground plane exposure.

SHNPP ODCM Operational Requirement 3.12.2 requires that a land-use census survey be conducted on an annual basis. Thus, depending on the results of the survey, a new limiting location could result.

To avoid possible annual revisions to the ODCM software which evaluates effluent releases for compliance with 10CFR50, the limiting sector location has been fixed at the exclusion boundary in the SW sector. (Appendix A). With all of the exposure pathways identified in the Land Use Census (ODCM Operational Requirement 3.12.2). This approach avoids a substantial underestimate of the dose to a real member of the public.

Long-term X/Q_v and D/Q_v values for ground-level releases are provided in tables in Appendix A. They may be utilized if an additional special location arises different from those presented in the special locations of the Land Use Census (ODCM Operational Requirement 3.12.2). A description of the derivation of the various X/Q and D/Q values is presented in Appendix A.

3.3.2 Radioiodine and Particulates (continued)

Tables 3.3-1 through 3.3-19 present R_i values for the total body, GI-tract, bone, liver, kidney, thyroid, and lung organs for the ground plane, inhalation, cow milk, goat milk, vegetable, and meat ingestion pathways for the infant, child, teen, and adult age groups as appropriate to the pathways. These values were calculated using the methodology described in NUREG-0133 assuming a grazing period of eight months. A description of the methodology is presented in Appendix B.

The following relationship should hold for SHNPP to show compliance with SHNPP ODCM Operational Requirement 3.11.2.3.

For the calendar quarter:

$$D_t \leq 7.5 \text{ mrem} \quad (3.3-14)$$

For the calendar year:

$$D_t \leq 15 \text{ mrem} \quad (3.3-15)$$

The quarterly limits given above represent one-half the annual design objectives of Section II.C of Appendix I of 10CFR50. If any of the limits of Equations 3.3-14 or 3.3-15 are exceeded, a Special Report pursuant to Technical Specification 6.9.2 must be filed with the NRC. This report complies with Section IV.A of Appendix I of 10CFR50.

3.3.2 Radioiodine and Particulates (continued)

2. Projection of Doses

Doses resulting from release of radioiodine's and particulates will be projected once every 31 days (monthly). The doses will be projected utilizing Equation 3.3-13, and projected using the following expression:

$$D_{pt} = (D_{\tau} \cdot p) + D_{at} \quad (3.3-16)$$

where:

D_{pt}	=	the 31 Day Projected Dose by organ τ
D_{τ}	=	sum of all open and closed release points from the start of the quarter to the end of the release in mrem per organ τ .
p	=	the Projection Factor which is the result of 31 divided by the number of days from start of the quarter to the end of the release.
D_{at}	=	Additional Anticipated Dose for gaseous releases by organ τ and quarter of release.

NOTE: The 31-Day Projected Dose values appear on the Standard Permit Reports. The 31-day dose projections include any additional dose.

When possible, expected operational evolutions (i.e., outages, increased power levels, major planned batch gas releases, etc.) should be accounted for in the dose projections. This may be accomplished by using the source-term data from similar historical operating experiences where practical and adding the dose as Additional Anticipated Dose.

To show compliance with ODCM Operational Requirement 3.11.2.4, the projected month's dose should be compared as in the following:

$$D \leq 0.3 \text{ mrem to any organ} \quad (3.3-17)$$

If the projections exceed Expression 3.3-14, then the appropriate portions of the gaseous radwaste treatment system shall be used to reduce releases of radioactivity.

3.3.2 Carbon 14

Carbon-14 may become a principal radionuclide for the gaseous effluent pathway. It is produced by several nuclear reactions. In a nuclear reactor the most dominate mechanism is the reaction of O-17 in the fuel or water with a neutron to produce C-14 and an alpha particle. C-14 releases in PWRs occur primarily as a mix of organic carbon and carbon dioxide released from the waste gas system. Because the dose contribution of C-14 from liquid radioactive waste is much less than that contributed by gaseous radioactive waste, evaluation of C-14 in liquid waste is not required. The dose rate and subsequent dose to an individual from C-14 intake depends upon the specific activity of the food from each source and the amount of the ingested C-14 which is retained over the period under consideration.

The quantity of C-14 discharged can be estimated by sample measurements or by use of a normalized C-14 source term and scaling factors based upon power generation. NUREG-0017 Rev 1 "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Pressurized Reactors" gives a C-14 source term based on measurements at 10 operating power plants. The C-14 source term recommended by NUREG-0017 (FSAR 11.1.5) is 7.3 curies/year for an 80% capacity factory or 292 Effective Full Power Days. It is not necessary to calculate uncertainties for C-14 or to include C-14 uncertainty in any calculation of overall uncertainty.

In the determination of the limiting sector, all age groups and all of the exposure pathways are evaluated using the highest XOQDOQ values in Appendix A at the site boundary. These include milk, meat and vegetable ingestion, and inhalation. Inorganic atmosphere Carbon Dioxide (CO₂)

3.3.2 Carbon 14 (continue)

and Methane (CO) is incorporated in cellular material by the photosynthetic actions of green plants. Plants and grasses, from which most food stuff is derived, equilibrate with the C-14 CO₂ of the air. Due to the Primary Water System reducing environment, only 30% of the C-14 is released in the inorganic form.

Reg Guide 1.21, Rev 2 states that for PWR C-14 is released primarily through the waste gas system. IAEA Technical Reports Series No. 421 states that 70% of C-14 gaseous effluent from PWRs can be assumed to be from batch releases (WGDTs) and 30% from continuous stack releases. To address intermittent releases, a photosynthesis factor (p factor) is used as the ratio of the total release time (for C-14 atmospheric releases) to the total time which photosynthesis occurs (taken to be 4460 hours/year or 1115 hours/quarter).

SHNPP ODCM Operational Requirement 3.12.2 requires that a land-use census survey be conducted on an annual basis. Thus, depending on the results of the survey, a new limiting location could result.

Regulatory Guide 1.109 provides the detailed implementation guidance to show compliance with Appendix I of 10 CFR 50 limits.

1. Dose from Inhalation of Carbon-14 in Air

The average airborne concentration of C-14 at the location with respect to the release point may be determined as:

$$X_c = 3.17 \times 10^4 Q_c \left(\frac{x}{Q} \right) \quad (3.3-18)$$

X_c = the average ground-level concentration of C-14 in air, in pCi/m³

Q_c = is the release rate of C-14 to the atmosphere, in Ci/yr, this can be determined by:

(1) using actual sample data obtained during the reporting period

(2) estimation by correcting the FSAR 11.1.5 annual C-14 curies released for actual capacity factor using the number of effective full power days (EFPD) for the reporting period

$$Q_c = \frac{7.3 \times \text{EFPD}}{292} \quad (3.3-19)$$

X/Q = annual average atmosphere dispersion factor, in sec/m³ for ground level release with no decay, Table A1 through A4, Appendix A

3.17×10^4 = is the number of pCi/Ci divided by the number of sec/yr

The dose associated with inhalation for C-14, to organ (j) to an age group (a), is then:

$$D_{ja}^A = (U_a^i)(DFA_{ja})(X_c) \quad (3.3-20)$$

D_{ja}^A = the dose from inhalation to an organ (j) of an age group (a) from C-14 in mrem

X_c = the average ground-level concentration of C-14 in air, in pCi/m³

U_a^i = Inhalation rate for age group (a), Table 3.3-20, in m³/yr

DFA_{ja} = Dose factor for an organ from carbon-14 for the inhalation pathway to an organ (j) of an age group (a), mrem/pCi Table 3.3-21

3.3.2 Carbon 14 (continue)

2. Concentration of Airborne Carbon-14 in vegetation

The concentration of Carbon-14 in vegetation at location with respect to the release point may be determined as:

$$C_{14}^V = (3.17 \times 10^7)(p)(Q_{14})\left(\frac{X}{Q}\right)\left(\frac{0.11}{0.16}\right) \quad (3.3-21)$$

C_{14}^V = The concentration of C-14 in vegetation in pCi/kg

p = the fractional equilibrium fraction, dimensionless

$$= \frac{(0.70)(\text{WGDT Release Hr})}{L} + \frac{(0.30)(\text{Continuous Release Hrs})}{L}$$

L = hours photosynthesis occurs
L = 1115 hours/qtr or 4460 hours/yr

Q_{14} = release rate of C-14 from a PWR, assume 30% of C-14 release rate in lieu of site-specific data, in Ci

$$= 0.30 \times Q_C$$

X/Q = annual average atmosphere dispersion factor, in sec/m³ for ground level release with no decay, Table A1 through A4, Appendix A

$$3.17 \text{ E}+07 = (10^{12} \text{ pCi/Ci})(10^3 \text{ g/kg}) / (3.15\text{E}+07 \text{ sec/yr})$$

0.11 = fraction of total plant mass that is natural carbon, dimensionless

0.16 = concentration of natural carbon in the atmosphere, in g/m³

3. Concentration of Airborne Carbon-14 in Milk

The concentration of Carbon-14 in milk is dependent on the amount of contamination level of the feed consumed by the animal.

$$C_{14}^M = (F_m)(C_{14}^V)(Q_f) \quad (3.3-22)$$

C_{14}^M = The concentration of C-14 in milk, pCi/L

F_m = average fraction of the animal's daily intake of C-14 that appears in each liter of milk, in days/liter

$$= \text{Cow or cattle} = 0.012 \text{ days/liter, goat} = 0.10 \text{ days/liter}$$

C_{14}^V = The concentration of C-14 in animal's feed, in pCi/kg

Q_f = amount of feed consumed by the animal per day, in kg/day

$$= \text{Cow or cattle} = 50 \text{ kg, goat} = 6 \text{ kg}$$

3.3.2 Carbon 14 (continue)

4. Concentration of Airborne Carbon-14 in Meat

$$C_{14}^B = (F_F)(C_{14}^V)(Q_f) \quad (3.3-23)$$

C_{14}^B = The concentration of C-14 in meat, pCi/kg

F_F = average fraction of the animal's daily intake of C-14 that appears in each kilogram of flesh, in days/kg

= 0.031

C_{14}^V = The concentration of C-14 in animal's feed, in pCi/kg

Q_f = amount of feed consumed by the animal per day, in kg/day

= Cow or cattle = 50 kg, goat = 6 kg

5. Dose from Atmospherically Released Carbon-14 in Foods

$$D_{ja}^D = DFI_{ja} [U_a^V f_g C_{14}^V + U_a^M C_{14}^M + U_a^B C_{14}^B + U_a^L f_l C_{14}^V] \quad (3.3-24)$$

D_{ja}^D = the dose to organ (j) of an individual in age group (a) from the dietary intake of atmospherically released Carbon-14, in mrem

DFI_{ja} = the dose conversion factor for the ingestion of Carbon-14, organ (j), and age group (a), in mrem/pCi Table 3.3-22

U_a^V = ingestion rate of produce (non-leafy vegetables, fruit, grains), in kg/yr, Table 3.3-20

U_a^M = ingestion rate of milk, in l/yr, Table 3.3-20

U_a^B = ingestion rate of meat and poultry in kg/yr, Table 3.3-20

U_a^L = ingestion rate of leafy vegetables, in kg/yr, Table 3.3-20

f_g = fraction of produce ingested grow in the garden of interest

= 0.76, in lieu of site-specific data

f_l = fraction of leafy vegetables in the garden of interest

= 1.0, in lieu of site-specific data

C_{14}^V = The concentration of C-14 in vegetation, in pCi/kg

C_{14}^M = The concentration of C-14 in milk, pCi/kg

C_{14}^B = The concentration of C-14 in meat, pCi/kg

TABLE 3.3-1
R VALUES FOR THE SHEARON HARRIS NUCLEAR POWER PLANT*

PATHWAY = Ground

AGE GROUP = ALL

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	Gi-LLi
Na-24	1.71E+07	1.71E+07	1.71E+07	1.71E+07	1.71E+07	1.71E+07	1.71E+07
Cr-51	4.66E+06	4.66E+06	4.66E+06	4.66E+06	4.66E+06	4.66E+06	4.66E+06
Mn-54	1.34E+09	1.34E+09	1.34E+09	1.34E+09	1.34E+09	1.34E+09	1.34E+09
Mn-56	1.29E+06	1.29E+06	1.29E+06	1.29E+06	1.29E+06	1.29E+06	1.29E+06
Fe-59	2.75E+08	2.75E+08	2.75E+08	2.75E+08	2.75E+08	2.75E+08	2.75E+08
Co-57	1.88E+08	1.88E+08	1.88E+08	1.88E+08	1.88E+08	1.88E+08	1.88E+08
Co-58	3.79E+08	3.79E+08	3.79E+08	3.79E+08	3.79E+08	3.79E+08	3.79E+08
Co-60	2.15E+10	2.15E+10	2.15E+10	2.15E+10	2.15E+10	2.15E+10	2.15E+10
Ni-65	4.24E+05	4.24E+05	4.24E+05	4.24E+05	4.24E+05	4.24E+05	4.24E+05
Cu-64	8.67E+05	8.67E+05	8.67E+05	8.67E+05	8.67E+05	8.67E+05	8.67E+05
Zn-65	7.49E+08	7.49E+08	7.49E+08	7.49E+08	7.49E+08	7.49E+08	7.49E+08
Zn-69M	3.44E+06	3.44E+06	3.44E+06	3.44E+06	3.44E+06	3.44E+06	3.44E+06
Br-82	5.11E+07	5.11E+07	5.11E+07	5.11E+07	5.11E+07	5.11E+07	5.11E+07
Br-83	6.94E+03	6.94E+03	6.94E+03	6.94E+03	6.94E+03	6.94E+03	6.94E+03
Br-84	2.89E+05	2.89E+05	2.89E+05	2.89E+05	2.89E+05	2.89E+05	2.89E+05
Rb-86	8.99E+06	8.99E+06	8.99E+06	8.99E+06	8.99E+06	8.99E+06	8.99E+06
Rb-88	4.72E+04	4.72E+04	4.72E+04	4.72E+04	4.72E+04	4.72E+04	4.72E+04
Rb-89	1.75E+05	1.75E+05	1.75E+05	1.75E+05	1.75E+05	1.75E+05	1.75E+05
Sr-89	2.23E+04	2.23E+04	2.23E+04	2.23E+04	2.23E+04	2.23E+04	2.23E+04
Sr-91	3.07E+06	3.07E+06	3.07E+06	3.07E+06	3.07E+06	3.07E+06	3.07E+06
Sr-92	1.11E+06	1.11E+06	1.11E+06	1.11E+06	1.11E+06	1.11E+06	1.11E+06
Y-90	6.42E+03	6.42E+03	6.42E+03	6.42E+03	6.42E+03	6.42E+03	6.42E+03
Y-91M	1.43E+05	1.43E+05	1.43E+05	1.43E+05	1.43E+05	1.43E+05	1.43E+05
Y-91	1.08E+06	1.08E+06	1.08E+06	1.08E+06	1.08E+06	1.08E+06	1.08E+06
Y-92	2.57E+05	2.57E+05	2.57E+05	2.57E+05	2.57E+05	2.57E+05	2.57E+05
Y-93	2.62E+05	2.62E+05	2.62E+05	2.62E+05	2.62E+05	2.62E+05	2.62E+05
Zr-95	2.49E+08	2.49E+08	2.49E+08	2.49E+08	2.49E+08	2.49E+08	2.49E+08
Zr-97	4.21E+06	4.21E+06	4.21E+06	4.21E+06	4.21E+06	4.21E+06	4.21E+06
Nb-95	1.36E+08	1.36E+08	1.36E+08	1.36E+08	1.36E+08	1.36E+08	1.36E+08
Nb-97	4.43E+07	4.43E+07	4.43E+07	4.43E+07	4.43E+07	4.43E+07	4.43E+07
Mo-99	5.71E+06	5.71E+06	5.71E+06	5.71E+06	5.71E+06	5.71E+06	5.71E+06
Tc-99M	2.63E+05	2.63E+05	2.63E+05	2.63E+05	2.63E+05	2.63E+05	2.63E+05

*R Values in units of mrem/yr per $\mu\text{Ci}/\text{m}^3$ for inhalation and tritium and in units of mrem/yr per $\mu\text{Ci}/\text{sec}$ per m^2 for all others.

TABLE 3.3-1 (Continue)
R VALUES FOR THE SHEARON HARRIS NUCLEAR POWER PLANT*

PATHWAY = Ground

AGE GROUP = ALL

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	Gi-LLi
Tc-101	2.91E+04	2.91E+04	2.91E+04	2.91E+04	2.91E+04	2.91E+04	2.91E+04
Ru-103	1.09E+08	1.09E+08	1.09E+08	1.09E+08	1.09E+08	1.09E+08	1.09E+08
Ru-105	9.08E+05	9.08E+05	9.08E+05	9.08E+05	9.08E+05	9.08E+05	9.08E+05
Ru-106	4.19E+08	4.19E+08	4.19E+08	4.19E+08	4.19E+08	4.19E+08	4.19E+08
Ag-110M	3.48E+09	3.48E+09	3.48E+09	3.48E+09	3.48E+09	3.48E+09	3.48E+09
Sn-113	1.22E+07	6.21E+06	1.44E+07	1.33E+07	1.00E+07	8.14E+06	6.28E+06
Sb-124	8.99E+08	7.76E+08	8.76E+08	1.01E+09	8.17E+08	8.23E+08	7.53E+08
Sb-125	2.34E+09	2.34E+09	2.34E+09	2.34E+09	2.34E+09	2.34E+09	2.34E+09
Te-125M	1.55E+06	1.55E+06	1.55E+06	1.55E+06	1.55E+06	1.55E+06	1.55E+06
Te-127m	9.15E+04	9.15E+04	9.15E+04	9.15E+04	9.15E+04	9.15E+04	9.15E+04
Te-127	4.25E+03	4.25E+03	4.25E+03	4.25E+03	4.25E+03	4.25E+03	4.25E+03
Te-129M	2.00E+07	2.00E+07	2.00E+07	2.00E+07	2.00E+07	2.00E+07	2.00E+07
Te-129	3.75E+04	3.75E+04	3.75E+04	3.75E+04	3.75E+04	3.75E+04	3.75E+04
Te-131M	1.15E+07	1.15E+07	1.15E+07	1.15E+07	1.15E+07	1.15E+07	1.15E+07
Te-131	4.17E+04	4.17E+04	4.17E+04	4.17E+04	4.17E+04	4.17E+04	4.17E+04
Te-132	6.05E+06	6.05E+06	6.05E+06	6.05E+06	6.05E+06	6.05E+06	6.05E+06
I-130	7.88E+06	7.88E+06	7.88E+06	7.88E+06	7.88E+06	7.88E+06	7.88E+06
I-131	1.72E+07	1.72E+07	1.72E+07	1.72E+07	1.72E+07	1.72E+07	1.72E+07
I-132	1.24E+06	1.24E+06	1.24E+06	1.24E+06	1.24E+06	1.24E+06	1.24E+06
I-133	2.47E+06	2.47E+06	2.47E+06	2.47E+06	2.47E+06	2.47E+06	2.47E+06
I-134	6.38E+05	6.38E+05	6.38E+05	6.38E+05	6.38E+05	6.38E+05	6.38E+05
I-135	2.56E+06	2.56E+06	2.56E+06	2.56E+06	2.56E+06	2.56E+06	2.56E+06
Cs-134	6.82E+09	6.82E+09	6.82E+09	6.82E+09	6.82E+09	6.82E+09	6.82E+09
Cs-136	1.49E+08	1.49E+08	1.49E+08	1.49E+08	1.49E+08	1.49E+08	1.49E+08
Cs-137	1.03E+10	1.03E+10	1.03E+10	1.03E+10	1.03E+10	1.03E+10	1.03E+10
Cs-138	5.13E+05	5.13E+05	5.13E+05	5.13E+05	5.13E+05	5.13E+05	5.13E+05
Ba-139	1.51E+05	1.51E+05	1.51E+05	1.51E+05	1.51E+05	1.51E+05	1.51E+05
Ba-140	2.05E+07	2.05E+07	2.05E+07	2.05E+07	2.05E+07	2.05E+07	2.05E+07
Ba-141	5.97E+04	5.97E+04	5.97E+04	5.97E+04	5.97E+04	5.97E+04	5.97E+04
Ba-142	6.41E+04	6.41E+04	6.41E+04	6.41E+04	6.41E+04	6.41E+04	6.41E+04
La-140	2.74E+07	2.74E+07	2.74E+07	2.74E+07	2.74E+07	2.74E+07	2.74E+07
La-142	1.09E+06	1.09E+06	1.09E+06	1.09E+06	1.09E+06	1.09E+06	1.09E+06
Ce-141	1.36E+07	1.36E+07	1.36E+07	1.36E+07	1.36E+07	1.36E+07	1.36E+07
Ce-143	3.30E+06	3.30E+06	3.30E+06	3.30E+06	3.30E+06	3.30E+06	3.30E+06
Ce-144	6.95E+07	6.95E+07	6.95E+07	6.95E+07	6.95E+07	6.95E+07	6.95E+07
Pr-144	2.62E+03	2.62E+03	2.62E+03	2.62E+03	2.62E+03	2.62E+03	2.62E+03
Nd-147	8.40E+06	8.40E+06	8.40E+06	8.40E+06	8.40E+06	8.40E+06	8.40E+06
Hf-181	2.30E+08	1.70E+08	1.97E+08	2.33E+08	1.77E+08	1.82E+08	1.63E+08
W-187	3.36E+06	3.36E+06	3.36E+06	3.36E+06	3.36E+06	3.36E+06	3.36E+06
Np-239	2.44E+06	2.44E+06	2.44E+06	2.44E+06	2.44E+06	2.44E+06	2.44E+06

*R Values in units of mrem/yr per $\mu\text{Ci}/\text{m}^3$ for inhalation and tritium and in units of mrem/yr per $\mu\text{Ci}/\text{sec}$ per m^2 for all others.

TABLE 3.3-2
R VALUES FOR THE SHEARON HARRIS NUCLEAR POWER PLANT*

PATHWAY = Vegetation

AGE GROUP = Adult

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	Gi-LLi
H-3	0.00E+00	2.28E+03	2.28E+03	2.28E+03	2.28E+03	2.28E+03	2.28E+03
Na-24	6.83E+05	6.83E+05	6.83E+05	6.83E+05	6.83E+05	6.83E+05	6.83E+05
P-32	1.53E+09	9.51E+07	5.91E+07	0.00E+00	0.00E+00	0.00E+00	1.72E+08
Cr-51	0.00E+00	0.00E+00	4.60E+04	2.75E+04	1.01E+04	6.10E+04	1.16E+07
Mn-54	0.00E+00	3.05E+08	5.83E+07	0.00E+00	9.09E+07	0.00E+00	9.36E+08
Mn-56	0.00E+00	3.98E+01	7.06E+00	0.00E+00	5.05E+01	0.00E+00	1.27E+03
Fe-55	2.00E+08	1.38E+08	3.22E+07	0.00E+00	0.00E+00	7.70E+07	7.91E+07
Fe-59	1.24E+08	2.93E+08	1.12E+08	0.00E+00	0.00E+00	8.17E+07	9.75E+08
Co-57	0.00E+00	1.13E+07	1.88E+07	0.00E+00	0.00E+00	0.00E+00	2.86E+08
Co-58	0.00E+00	2.99E+07	6.71E+07	0.00E+00	0.00E+00	0.00E+00	6.07E+08
Co-60	0.00E+00	1.66E+08	3.67E+08	0.00E+00	0.00E+00	0.00E+00	3.12E+09
Ni-63	1.20E+10	8.31E+08	4.02E+08	0.00E+00	0.00E+00	0.00E+00	1.73E+08
Ni-65	1.50E+02	1.95E+01	8.90E+00	0.00E+00	0.00E+00	0.00E+00	4.95E+02
Cu-64	0.00E+00	2.34E+04	1.10E+04	0.00E+00	5.89E+04	0.00E+00	1.99E+06
Zn-65	4.01E+08	1.28E+09	5.77E+08	0.00E+00	8.54E+08	0.00E+00	8.04E+08
Zn-69M	5.73E+04	1.38E+05	1.26E+04	0.00E+00	8.32E+04	0.00E+00	8.39E+06
Zn-69	1.29E-05	2.47E-05	1.72E-06	0.00E+00	1.61E-05	0.00E+00	3.72E-06
Br-82	0.00E+00	0.00E+00	3.90E+06	0.00E+00	0.00E+00	0.00E+00	4.47E+06
Br-83	0.00E+00	0.00E+00	7.57E+00	0.00E+00	0.00E+00	0.00E+00	1.09E+01
Br-84	0.00E+00	0.00E+00	5.51E-11	0.00E+00	0.00E+00	0.00E+00	4.32E-16
Rb-86	0.00E+00	2.21E+08	1.03E+08	0.00E+00	0.00E+00	0.00E+00	4.36E+07
Rb-88	0.00E+00	6.73E-22	3.57E-22	0.00E+00	0.00E+00	0.00E+00	9.30E-33
Rb-89	0.00E+00	6.19E-26	4.35E-26	0.00E+00	0.00E+00	0.00E+00	3.59E-39
Sr-89	1.00E+10	0.00E+00	2.87E+08	0.00E+00	0.00E+00	0.00E+00	1.60E+09
Sr-90	6.70E+11	0.00E+00	1.64E+11	0.00E+00	0.00E+00	0.00E+00	1.93E+10
Sr-91	7.70E+05	0.00E+00	3.11E+04	0.00E+00	0.00E+00	0.00E+00	3.67E+06
Sr-92	1.07E+03	0.00E+00	4.64E+01	0.00E+00	0.00E+00	0.00E+00	2.13E+04
Y-90	3.43E+04	0.00E+00	9.19E+02	0.00E+00	0.00E+00	0.00E+00	3.63E+08
Y-91M	1.20E-08	0.00E+00	4.66E-10	0.00E+00	0.00E+00	0.00E+00	3.53E-08
Y-91	5.01E+06	0.00E+00	1.34E+05	0.00E+00	0.00E+00	0.00E+00	2.76E+09
Y-92	2.25E+00	0.00E+00	6.59E-02	0.00E+00	0.00E+00	0.00E+00	3.95E+04
Y-93	4.29E+02	0.00E+00	1.18E+01	0.00E+00	0.00E+00	0.00E+00	1.36E+07
Zr-95	1.16E+06	3.71E+05	2.51E+05	0.00E+00	5.82E+05	0.00E+00	1.17E+09
Zr-97	8.50E+02	1.72E+02	7.84E+01	0.00E+00	2.59E+02	0.00E+00	5.31E+07
Nb-95	1.40E+05	7.79E+04	4.19E+04	0.00E+00	7.70E+04	0.00E+00	4.73E+08
Nb-97	5.13E-06	1.30E-06	4.74E-07	0.00E+00	1.51E-06	0.00E+00	4.79E-03
Mo-99	0.00E+00	1.59E+07	3.02E+06	0.00E+00	3.60E+07	0.00E+00	3.68E+07
Tc-99M	7.81E+00	2.21E+01	2.81E+02	0.00E+00	3.35E+02	1.08E+01	1.31E+04

*R Values in units of mrem/yr per $\mu\text{Ci}/\text{m}^3$ for inhalation and tritium and in units of mrem/yr per $\mu\text{Ci}/\text{sec}$ per m^2 for all others.

TABLE 3.3-2 (continue)
R VALUES FOR THE SHEARON HARRIS NUCLEAR POWER PLANT*

PATHWAY = Vegetation

AGE GROUP = Adult

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLi
Tc-101	1.51E-30	2.18E-30	2.14E-29	0.00E+00	3.93E-29	1.11E-30	0.00E+00
Ru-103	4.74E+06	0.00E+00	2.04E+06	0.00E+00	1.81E+07	0.00E+00	5.53E+08
Ru-105	1.34E+02	0.00E+00	5.28E+01	0.00E+00	1.73E+03	0.00E+00	8.18E+04
Ru-106	1.94E+08	0.00E+00	2.46E+07	0.00E+00	3.75E+08	0.00E+00	1.26E+10
Ag-110M	1.13E+07	1.05E+07	6.23E+06	0.00E+00	2.06E+07	0.00E+00	4.28E+09
Sn-113	1.44E+07	5.66E+05	1.36E+07	1.96E+05	4.09E+05	0.00E+00	2.52E+08
Sb-124	1.01E+08	1.92E+06	4.02E+07	2.46E+05	0.00E+00	7.90E+07	2.88E+09
Sb-125	1.34E+08	1.50E+06	3.20E+07	1.37E+05	0.00E+00	1.04E+08	1.48E+09
Te-125M	1.21E+08	4.38E+07	1.62E+07	3.64E+07	4.92E+08	0.00E+00	4.83E+08
Te-127m	5.02E+08	1.80E+08	6.12E+07	1.28E+08	2.04E+09	0.00E+00	1.68E+09
Te-127	1.46E+04	5.25E+03	3.16E+03	1.08E+04	5.95E+04	0.00E+00	1.15E+06
Te-129M	2.98E+08	1.11E+08	4.71E+07	1.02E+08	1.24E+09	0.00E+00	1.50E+09
Te-129	1.85E-03	6.96E-04	4.51E-04	1.42E-03	7.78E-03	0.00E+00	1.40E-03
Te-131M	2.38E+06	1.16E+06	9.71E+05	1.84E+06	1.18E+07	0.00E+00	1.16E+08
Te-131	3.24E-15	1.35E-15	1.02E-15	2.66E-15	1.42E-14	0.00E+00	4.58E-16
Te-132	1.14E+07	7.36E+06	6.91E+06	8.13E+06	7.09E+07	0.00E+00	3.48E+08
I-130	1.96E+05	5.78E+05	2.28E+05	4.90E+07	9.02E+05	0.00E+00	4.98E+05
I-131	8.07E+07	1.15E+08	6.61E+07	3.78E+10	1.98E+08	0.00E+00	3.04E+07
I-132	5.57E+01	1.49E+02	5.21E+01	5.21E+03	2.37E+02	0.00E+00	2.80E+01
I-133	2.11E+06	3.67E+06	1.12E+06	5.39E+08	6.40E+06	0.00E+00	3.30E+06
I-134	4.49E-05	1.22E-04	4.36E-05	2.11E-03	1.94E-04	0.00E+00	1.06E-07
I-135	4.05E+04	1.06E+05	3.91E+04	7.00E+06	1.70E+05	0.00E+00	1.20E+05
Cs-134	4.54E+09	1.08E+10	8.83E+09	0.00E+00	3.49E+09	1.16E+09	1.89E+08
Cs-136	4.19E+07	1.66E+08	1.19E+08	0.00E+00	9.21E+07	1.26E+07	1.88E+07
Cs-137	6.63E+09	9.07E+09	5.94E+09	0.00E+00	3.08E+09	1.02E+09	1.76E+08
Cs-138	8.62E-11	1.70E-10	8.43E-11	0.00E+00	1.25E-10	1.24E-11	7.26E-16
Ba-139	6.87E-02	4.89E-05	2.01E-03	0.00E+00	4.57E-05	2.78E-05	1.22E-01
Ba-140	1.28E+08	1.61E+05	8.40E+06	0.00E+00	5.47E+04	9.22E+04	2.64E+08
Ba-141	2.49E-21	1.88E-24	8.40E-23	0.00E+00	1.75E-24	1.07E-24	1.17E-30
La-140	5.06E+03	2.55E+03	6.73E+02	0.00E+00	0.00E+00	0.00E+00	1.87E+08
La-142	4.89E-04	2.22E-04	5.54E-05	0.00E+00	0.00E+00	0.00E+00	1.62E+00
Ce-141	1.93E+05	1.31E+05	1.48E+04	0.00E+00	6.07E+04	0.00E+00	4.99E+08
Ce-143	2.55E+03	1.89E+06	2.09E+02	0.00E+00	8.30E+02	0.00E+00	7.05E+07
Ce-144	3.15E+07	1.32E+07	1.69E+06	0.00E+00	7.80E+06	0.00E+00	1.06E+10
Pr-143	6.23E+04	2.50E+04	3.09E+03	0.00E+00	1.44E+04	0.00E+00	2.73E+08
Pr-144	6.43E-26	2.67E-26	3.27E-27	0.00E+00	1.50E-26	0.00E+00	9.24E-33
Nd-147	3.33E+04	3.85E+04	2.30E+03	0.00E+00	2.25E+04	0.00E+00	1.85E+08
Hf-181	9.51E+06	5.36E+04	1.07E+06	3.41E+04	4.48E+04	0.00E+00	7.06E+08
W-187	9.69E+04	8.10E+04	2.83E+04	0.00E+00	0.00E+00	0.00E+00	2.65E+07
Np-239	3.67E+03	3.61E+02	1.99E+02	0.00E+00	1.13E+03	0.00E+00	7.40E+07

*R Values in units of mrem/yr per $\mu\text{Ci}/\text{m}^3$ for inhalation and tritium and in units of mrem/yr per $\mu\text{Ci}/\text{sec}$ per m^2 for all others.

TABLE 3.3-3
R VALUES FOR THE SHEARON HARRIS NUCLEAR POWER PLANT*

PATHWAY = Vegetation

AGE GROUP = Teen

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	Gi-LLi
H-3	0.00E+00	2.61E+03	2.61E+03	2.61E+03	2.61E+03	2.61E+03	2.61E+03
Na-24	6.07E+05	6.07E+05	6.07E+05	6.07E+05	6.07E+05	6.07E+05	6.07E+05
P-32	1.75E+09	1.09E+08	6.80E+07	0.00E+00	0.00E+00	0.00E+00	1.47E+08
Cr-51	0.00E+00	0.00E+00	6.11E+04	3.39E+04	1.34E+04	8.72E+04	1.03E+07
Mn-54	0.00E+00	4.43E+08	8.79E+07	0.00E+00	1.32E+08	0.00E+00	9.09E+08
Mn-56	0.00E+00	3.59E+01	6.38E+00	0.00E+00	4.54E+01	0.00E+00	2.36E+03
Fe-55	3.10E+08	2.20E+08	5.13E+07	0.00E+00	0.00E+00	1.40E+08	9.53E+07
Fe-59	1.77E+08	4.14E+08	1.60E+08	0.00E+00	0.00E+00	1.30E+08	9.78E+08
Co-57	0.00E+00	1.72E+07	2.89E+07	0.00E+00	0.00E+00	0.00E+00	3.21E+08
Co-58	0.00E+00	4.25E+07	9.79E+07	0.00E+00	0.00E+00	0.00E+00	5.85E+08
Co-60	0.00E+00	2.47E+08	5.57E+08	0.00E+00	0.00E+00	0.00E+00	3.22E+09
Ni-63	1.85E+10	1.31E+09	6.28E+08	0.00E+00	0.00E+00	0.00E+00	2.08E+08
Ni-65	1.40E+02	1.79E+01	8.14E+00	0.00E+00	0.00E+00	0.00E+00	9.68E+02
Cu-64	0.00E+00	2.12E+04	9.95E+03	0.00E+00	5.35E+04	0.00E+00	1.64E+06
Zn-65	5.36E+08	1.86E+09	8.68E+08	0.00E+00	1.19E+09	0.00E+00	7.88E+08
Zn-69M	5.31E+04	1.25E+05	1.15E+04	0.00E+00	7.61E+04	0.00E+00	6.88E+06
Zn-69	1.21E-05	2.31E-05	1.61E-06	0.00E+00	1.51E-05	0.00E+00	4.25E-05
Br-82	0.00E+00	0.00E+00	3.44E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-83	0.00E+00	0.00E+00	7.10E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	5.01E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	2.76E+08	1.30E+08	0.00E+00	0.00E+00	0.00E+00	4.09E+07
Rb-88	0.00E+00	6.22E-22	3.32E-22	0.00E+00	0.00E+00	0.00E+00	5.33E-29
Rb-89	0.00E+00	5.57E-26	3.94E-26	0.00E+00	0.00E+00	0.00E+00	8.54E-35
Sr-89	1.52E+10	0.00E+00	4.36E+08	0.00E+00	0.00E+00	0.00E+00	1.81E+09
Sr-90	8.32E+11	0.00E+00	2.05E+11	0.00E+00	0.00E+00	0.00E+00	2.33E+10
Sr-91	7.19E+05	0.00E+00	2.86E+04	0.00E+00	0.00E+00	0.00E+00	3.26E+06
Sr-92	9.99E+02	0.00E+00	4.26E+01	0.00E+00	0.00E+00	0.00E+00	2.54E+04
Y-90	3.20E+04	0.00E+00	8.63E+02	0.00E+00	0.00E+00	0.00E+00	2.64E+08
Y-91M	1.12E-08	0.00E+00	4.28E-10	0.00E+00	0.00E+00	0.00E+00	5.29E-07
Y-91	7.68E+06	0.00E+00	2.06E+05	0.00E+00	0.00E+00	0.00E+00	3.15E+09
Y-92	2.12E+00	0.00E+00	6.12E-02	0.00E+00	0.00E+00	0.00E+00	5.81E+04
Y-93	4.02E+02	0.00E+00	1.10E+01	0.00E+00	0.00E+00	0.00E+00	1.23E+07
Zr-95	1.69E+06	5.35E+05	3.68E+05	0.00E+00	7.86E+05	0.00E+00	1.23E+09
Zr-97	7.87E+02	1.56E+02	7.17E+01	0.00E+00	2.36E+02	0.00E+00	4.22E+07
Nb-95	1.89E+05	1.05E+05	5.77E+04	0.00E+00	1.02E+05	0.00E+00	4.48E+08
Nb-97	4.76E-06	1.18E-06	4.31E-07	0.00E+00	1.38E-06	0.00E+00	2.82E-02
Mo-99	0.00E+00	1.46E+07	2.78E+06	0.00E+00	3.34E+07	0.00E+00	2.61E+07
Tc-99M	6.89E+00	1.92E+01	2.49E+02	0.00E+00	2.86E+02	1.07E+01	1.26E+04

*R Values in units of mrem/yr per $\mu\text{Ci}/\text{m}^3$ for inhalation and tritium and in units of mrem/yr per $\mu\text{Ci}/\text{sec}$ per m^2 for all others.

TABLE 3.3-3 (continue)
R VALUES FOR THE SHEARON HARRIS NUCLEAR POWER PLANT*

PATHWAY = Vegetation

AGE GROUP = Teen

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	Gi-LLi
Tc-101	1.41E-30	2.00E-30	1.97E-29	0.00E+00	3.62E-29	1.22E-30	3.42E-37
Ru-103	6.78E+06	0.00E+00	2.90E+06	0.00E+00	2.39E+07	0.00E+00	5.66E+08
Ru-105	1.24E+02	0.00E+00	4.82E+01	0.00E+00	1.57E+03	0.00E+00	1.00E+05
Ru-106	3.12E+08	0.00E+00	3.93E+07	0.00E+00	6.02E+08	0.00E+00	1.50E+10
Ag-110M	1.63E+07	1.54E+07	9.39E+06	0.00E+00	2.95E+07	0.00E+00	4.34E+09
Sn-113	1.91E+07	8.03E+05	2.02E+07	2.63E+05	5.65E+05	0.00E+00	2.29E+08
Sb-124	1.51E+08	2.78E+06	5.89E+07	3.43E+05	0.00E+00	1.32E+08	3.04E+09
Sb-125	2.11E+08	2.30E+06	4.92E+07	2.01E+05	0.00E+00	1.85E+08	1.64E+09
Te-125M	1.86E+08	6.69E+07	2.48E+07	5.19E+07	0.00E+00	0.00E+00	5.48E+08
Te-127m	7.93E+08	2.81E+08	9.44E+07	1.89E+08	3.22E+09	0.00E+00	1.98E+09
Te-127	1.38E+04	4.88E+03	2.96E+03	9.50E+03	5.58E+04	0.00E+00	1.06E+06
Te-129M	4.29E+08	1.59E+08	6.79E+07	1.38E+08	1.77E+09	0.00E+00	1.61E+09
Te-129	1.73E-03	6.46E-04	4.22E-04	1.24E-03	7.28E-03	0.00E+00	9.48E-03
Te-131M	2.20E+06	1.06E+06	8.82E+05	1.59E+06	1.10E+07	0.00E+00	8.48E+07
Te-131	3.01E-15	1.24E-15	9.40E-16	2.32E-15	1.32E-14	0.00E+00	2.47E-16
Te-132	1.03E+07	6.55E+06	6.17E+06	6.91E+06	6.29E+07	0.00E+00	2.08E+08
I-130	1.75E+05	5.07E+05	2.02E+05	4.13E+07	7.81E+05	0.00E+00	3.90E+05
I-131	7.68E+07	1.07E+08	5.77E+07	3.14E+10	1.85E+08	0.00E+00	2.13E+07
I-132	5.02E+01	1.31E+02	4.72E+01	4.43E+03	2.07E+02	0.00E+00	5.72E+01
I-133	1.96E+06	3.32E+06	1.01E+06	4.64E+08	5.83E+06	0.00E+00	2.51E+06
I-134	4.06E-05	1.08E-04	3.86E-05	1.79E-03	1.70E-04	0.00E+00	1.42E-06
I-135	3.66E+04	9.42E+04	3.49E+04	6.06E+06	1.49E+05	0.00E+00	1.04E+05
Cs-134	6.90E+09	1.62E+10	7.54E+09	0.00E+00	5.16E+09	1.97E+09	2.02E+08
Cs-136	4.28E+07	1.68E+08	1.13E+08	0.00E+00	9.16E+07	1.44E+07	1.35E+07
Cs-137	1.06E+10	1.41E+10	4.90E+09	0.00E+00	4.78E+09	1.86E+09	2.00E+08
Cs-138	7.95E-11	1.53E-10	7.63E-11	0.00E+00	1.13E-10	1.31E-11	6.93E-14
Ba-139	6.46E-02	4.54E-05	1.88E-03	0.00E+00	4.28E-05	3.13E-05	5.76E-01
Ba-140	1.38E+08	1.69E+05	8.88E+06	0.00E+00	5.72E+04	1.14E+05	2.12E+08
Ba-141	2.33E-21	1.74E-24	7.77E-23	0.00E+00	1.61E-24	1.19E-24	4.96E-27
La-140	4.62E+03	2.27E+03	6.04E+02	0.00E+00	0.00E+00	0.00E+00	1.30E+08
La-142	4.49E-04	1.99E-04	4.97E-05	0.00E+00	0.00E+00	0.00E+00	6.07E+00
Ce-141	2.77E+05	1.85E+05	2.12E+04	0.00E+00	8.70E+04	0.00E+00	5.29E+08
Ce-143	2.38E+03	1.73E+06	1.94E+02	0.00E+00	7.78E+02	0.00E+00	5.21E+07
Ce-144	5.04E+07	2.09E+07	2.71E+06	0.00E+00	1.25E+07	0.00E+00	1.27E+10
Pr-143	6.97E+04	2.78E+04	3.47E+03	0.00E+00	1.62E+04	0.00E+00	2.29E+08
Pr-144	6.02E-26	2.47E-26	3.05E-27	0.00E+00	1.41E-26	0.00E+00	6.64E-29
Nd-147	3.62E+04	3.94E+04	2.36E+03	0.00E+00	2.31E+04	0.00E+00	1.42E+08
Hf-181	1.38E+07	7.58E+04	1.54E+06	4.63E+04	6.32E+04	0.00E+00	6.90E+08
W-187	9.02E+04	7.35E+04	2.58E+04	0.00E+00	0.00E+00	0.00E+00	1.99E+07
Np-239	3.56E+03	3.36E+02	1.87E+02	0.00E+00	1.05E+03	0.00E+00	5.40E+07

*R Values in units of mrem/yr per $\mu\text{Ci}/\text{m}^3$ for inhalation and tritium and in units of mrem/yr per $\mu\text{Ci}/\text{sec}$ per m^2 for all others.

TABLE 3.3-4
R VALUES FOR THE SHEARON HARRIS NUCLEAR POWER PLANT*

PATHWAY = Vegetation

AGE GROUP = Child

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	Gi-LLi
H-3	0.00E+00	4.04E+03	4.04E+03	4.04E+03	4.04E+03	4.04E+03	4.04E+03
Na-24	9.47E+05	9.47E+05	9.47E+05	9.47E+05	9.47E+05	9.47E+05	9.47E+05
P-32	3.67E+09	1.72E+08	1.42E+08	0.00E+00	0.00E+00	0.00E+00	1.01E+08
Cr-51	0.00E+00	0.00E+00	1.16E+05	6.44E+04	1.76E+04	1.18E+05	6.15E+06
Mn-54	0.00E+00	6.49E+08	1.73E+08	0.00E+00	1.82E+08	0.00E+00	5.44E+08
Mn-56	0.00E+00	4.70E+01	1.06E+01	0.00E+00	5.68E+01	0.00E+00	6.81E+03
Fe-55	7.63E+08	4.05E+08	1.25E+08	0.00E+00	0.00E+00	2.29E+08	7.50E+07
Fe-59	3.93E+08	6.36E+08	3.17E+08	0.00E+00	0.00E+00	1.84E+08	6.62E+08
Co-57	0.00E+00	2.88E+07	5.83E+07	0.00E+00	0.00E+00	0.00E+00	2.36E+08
Co-58	0.00E+00	6.27E+07	1.92E+08	0.00E+00	0.00E+00	0.00E+00	3.66E+08
Co-60	0.00E+00	3.76E+08	1.11E+09	0.00E+00	0.00E+00	0.00E+00	2.08E+09
Ni-63	4.55E+10	2.44E+09	1.55E+09	0.00E+00	0.00E+00	0.00E+00	1.64E+08
Ni-65	2.56E+02	2.41E+01	1.41E+01	0.00E+00	0.00E+00	0.00E+00	2.96E+03
Cu-64	0.00E+00	2.79E+04	1.69E+04	0.00E+00	6.74E+04	0.00E+00	1.31E+06
Zn-65	1.03E+09	2.74E+09	1.70E+09	0.00E+00	1.73E+09	0.00E+00	4.81E+08
Zn-69M	9.72E+04	1.66E+05	1.96E+04	0.00E+00	9.63E+04	0.00E+00	5.39E+06
Zn-69	2.23E-05	3.23E-05	2.98E-06	0.00E+00	1.96E-05	0.00E+00	2.04E-03
Br-82	0.00E+00	0.00E+00	5.29E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-83	0.00E+00	0.00E+00	1.31E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	8.50E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	4.56E+08	2.81E+08	0.00E+00	0.00E+00	0.00E+00	2.94E+07
Rb-88	0.00E+00	8.59E-22	5.97E-22	0.00E+00	0.00E+00	0.00E+00	4.21E-23
Rb-89	0.00E+00	7.33E-26	6.52E-26	0.00E+00	0.00E+00	0.00E+00	6.39E-28
Sr-89	3.62E+10	0.00E+00	1.03E+09	0.00E+00	0.00E+00	0.00E+00	1.40E+09
Sr-90	1.38E+12	0.00E+00	3.49E+11	0.00E+00	0.00E+00	0.00E+00	1.86E+10
Sr-91	1.32E+06	0.00E+00	5.00E+04	0.00E+00	0.00E+00	0.00E+00	2.92E+06
Sr-92	1.83E+03	0.00E+00	7.34E+01	0.00E+00	0.00E+00	0.00E+00	3.47E+04
Y-90	5.95E+04	0.00E+00	1.59E+03	0.00E+00	0.00E+00	0.00E+00	1.69E+08
Y-91M	2.05E-08	0.00E+00	7.48E-10	0.00E+00	0.00E+00	0.00E+00	4.02E-05
Y-91	1.83E+07	0.00E+00	4.89E+05	0.00E+00	0.00E+00	0.00E+00	2.44E+09
Y-92	3.90E+00	0.00E+00	1.12E-01	0.00E+00	0.00E+00	0.00E+00	1.13E+05
Y-93	7.41E+02	0.00E+00	2.03E+01	0.00E+00	0.00E+00	0.00E+00	1.10E+07
Zr-95	3.80E+06	8.35E+05	7.44E+05	0.00E+00	1.20E+06	0.00E+00	8.71E+08
Zr-97	1.44E+03	2.08E+02	1.23E+02	0.00E+00	2.98E+02	0.00E+00	3.15E+07
Nb-95	4.04E+05	1.57E+05	1.12E+05	0.00E+00	1.48E+05	0.00E+00	2.91E+08
Nb-97	8.67E-06	1.57E-06	7.31E-07	0.00E+00	1.74E-06	0.00E+00	4.83E-01
Mo-99	0.00E+00	1.99E+07	4.92E+06	0.00E+00	4.25E+07	0.00E+00	1.65E+07
Tc-99M	1.19E+01	2.32E+01	3.85E+02	0.00E+00	3.38E+02	1.18E+01	1.32E+04

*R Values in units of mrem/yr per $\mu\text{Ci}/\text{m}^3$ for inhalation and tritium and in units of mrem/yr per $\mu\text{Ci}/\text{sec}$ per m^2 for all others.

TABLE 3.3-4 (continue)
R VALUES FOR THE SHEARON HARRIS NUCLEAR POWER PLANT*

PATHWAY = Vegetation

AGE GROUP = Child

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	Gi-LLi
Tc-101	2.59E-30	2.71E-30	3.44E-29	0.00E+00	4.62E-29	1.43E-30	8.62E-30
Ru-103	1.52E+07	0.00E+00	5.86E+06	0.00E+00	3.84E+07	0.00E+00	3.94E+08
Ru-105	2.28E+02	0.00E+00	8.26E+01	0.00E+00	2.00E+03	0.00E+00	1.49E+05
Ru-106	7.52E+08	0.00E+00	9.38E+07	0.00E+00	1.02E+09	0.00E+00	1.17E+10
Ag-110M	3.46E+07	2.34E+07	1.87E+07	0.00E+00	4.35E+07	0.00E+00	2.78E+09
Sn-113	3.64E+07	1.18E+06	3.97E+07	4.82E+05	8.09E+05	0.00E+00	1.45E+08
Sb-124	3.44E+08	4.47E+06	1.21E+08	7.61E+05	0.00E+00	1.91E+08	2.16E+09
Sb-125	4.91E+08	3.79E+06	1.03E+08	4.55E+05	0.00E+00	2.74E+08	1.17E+09
Te-125M	4.39E+08	1.19E+08	5.85E+07	1.23E+08	0.00E+00	0.00E+00	4.24E+08
Te-127m	1.90E+09	5.12E+08	2.26E+08	4.55E+08	5.42E+09	0.00E+00	1.54E+09
Te-127	2.54E+04	6.85E+03	5.45E+03	1.76E+04	7.23E+04	0.00E+00	9.93E+05
Te-129M	9.98E+08	2.79E+08	1.55E+08	3.22E+08	2.93E+09	0.00E+00	1.22E+09
Te-129	3.21E-03	8.96E-04	7.62E-04	2.29E-03	9.39E-03	0.00E+00	2.00E-01
Te-131M	4.03E+06	1.39E+06	1.48E+06	2.86E+06	1.35E+07	0.00E+00	5.65E+07
Te-131	5.54E-15	1.69E-15	1.65E-15	4.24E-15	1.68E-14	0.00E+00	2.91E-14
Te-132	1.85E+07	8.20E+06	9.91E+06	1.19E+07	7.62E+07	0.00E+00	8.26E+07
I-130	3.08E+05	6.21E+05	3.20E+05	6.85E+07	9.29E+05	0.00E+00	2.91E+05
I-131	1.43E+08	1.44E+08	8.16E+07	4.75E+10	2.36E+08	0.00E+00	1.23E+07
I-132	8.91E+01	1.64E+02	7.53E+01	7.60E+03	2.51E+02	0.00E+00	1.93E+02
I-133	3.57E+06	4.42E+06	1.67E+06	8.21E+08	7.36E+06	0.00E+00	1.78E+06
I-134	7.21E-05	1.34E-04	6.16E-05	3.08E-03	2.05E-04	0.00E+00	8.88E-05
I-135	6.50E+04	1.17E+05	5.54E+04	1.04E+07	1.79E+05	0.00E+00	8.92E+04
Cs-134	1.56E+10	2.56E+10	5.40E+09	0.00E+00	7.93E+09	2.84E+09	1.38E+08
Cs-136	8.04E+07	2.21E+08	1.43E+08	0.00E+00	1.18E+08	1.76E+07	7.77E+06
Cs-137	2.49E+10	2.39E+10	3.52E+09	0.00E+00	7.78E+09	2.80E+09	1.50E+08
Cs-138	1.45E-10	2.01E-10	1.27E-10	0.00E+00	1.41E-10	1.52E-11	9.26E-11
Ba-139	1.19E-01	6.36E-05	3.45E-03	0.00E+00	5.55E-05	3.74E-05	6.87E+00
Ba-140	2.76E+08	2.42E+05	1.61E+07	0.00E+00	7.87E+04	1.44E+05	1.40E+08
Ba-141	4.29E-21	2.40E-24	1.40E-22	0.00E+00	2.08E-24	1.41E-23	2.45E-21
La-140	8.30E+03	2.90E+03	9.78E+02	0.00E+00	0.00E+00	0.00E+00	8.08E+07
La-142	8.14E-04	2.59E-04	8.12E-05	0.00E+00	0.00E+00	0.00E+00	5.14E+01
Ce-141	6.42E+05	3.20E+05	4.75E+04	0.00E+00	1.40E+05	0.00E+00	3.99E+08
Ce-143	4.39E+03	2.38E+06	3.45E+02	0.00E+00	9.98E+02	0.00E+00	3.48E+07
Ce-144	1.22E+08	3.81E+07	6.49E+06	0.00E+00	2.11E+07	0.00E+00	9.94E+09
Pr-143	1.45E+05	4.35E+04	7.18E+03	0.00E+00	2.35E+04	0.00E+00	1.56E+08
Pr-144	1.12E-25	3.46E-26	5.63E-27	0.00E+00	1.83E-26	0.00E+00	7.45E-23
Nd-147	7.15E+04	5.79E+04	4.48E+03	0.00E+00	3.18E+04	0.00E+00	9.17E+07
Hf-181	3.13E+07	1.22E+05	3.15E+06	1.03E+05	9.78E+04	0.00E+00	5.17E+08
W-187	1.64E+05	9.71E+04	4.36E+04	0.00E+00	0.00E+00	0.00E+00	1.36E+07
Np-239	6.58E+03	4.72E+02	3.32E+02	0.00E+00	1.37E+03	0.00E+00	3.49E+07

*R Values in units of mrem/yr per $\mu\text{Ci}/\text{m}^3$ for inhalation and tritium and in units of mrem/yr per $\mu\text{Ci}/\text{sec}$ per m^2 for all others.

TABLE 3.3-5
R VALUES FOR THE SHEARON HARRIS NUCLEAR POWER PLANT*

PATHWAY = Meat

AGE GROUP = Adult

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	Gi-LLi
H-3	0.00E+00	3.27E+02	3.27E+02	3.27E+02	3.27E+02	3.27E+02	3.27E+02
P-32	3.05E+09	1.89E+08	1.18E+08	0.00E+00	0.00E+00	0.00E+00	3.43E+08
Cr-51	0.00E+00	0.00E+00	4.27E+03	2.56E+03	9.42E+02	5.67E+03	1.08E+06
Mn-54	0.00E+00	5.57E+06	1.06E+06	0.00E+00	1.66E+06	0.00E+00	1.71E+07
Fe-55	1.83E+08	1.26E+08	2.95E+07	0.00E+00	0.00E+00	7.05E+07	7.25E+07
Fe-59	1.59E+08	3.74E+08	1.43E+08	0.00E+00	0.00E+00	1.04E+08	1.25E+09
Co-57	0.00E+00	3.48E+06	5.79E+06	0.00E+00	0.00E+00	0.00E+00	8.84E+07
Co-58	0.00E+00	1.08E+07	2.43E+07	0.00E+00	0.00E+00	0.00E+00	2.20E+08
Co-60	0.00E+00	4.66E+07	1.03E+08	0.00E+00	0.00E+00	0.00E+00	8.76E+08
Ni-63	1.32E+10	9.13E+08	4.42E+08	0.00E+00	0.00E+00	0.00E+00	1.91E+08
Zn-65	2.49E+08	7.91E+08	3.58E+08	0.00E+00	5.29E+08	0.00E+00	4.98E+08
Br-82	0.00E+00	0.00E+00	1.38E-32	0.00E+00	0.00E+00	0.00E+00	1.58E-32
Rb-86	0.00E+00	3.04E+08	1.42E+08	0.00E+00	0.00E+00	0.00E+00	6.00E+07
Sr-89	1.82E+08	0.00E+00	5.23E+06	0.00E+00	0.00E+00	0.00E+00	2.92E+07
Sr-90	8.22E+09	0.00E+00	2.02E+09	0.00E+00	0.00E+00	0.00E+00	2.38E+08
Y-90	1.06E-17	0.00E+00	2.83E-19	0.00E+00	0.00E+00	0.00E+00	1.12E-13
Y-91	6.75E+05	0.00E+00	1.80E+04	0.00E+00	0.00E+00	0.00E+00	3.71E+08
Zr-95	1.12E+06	3.59E+05	2.43E+05	0.00E+00	5.64E+05	0.00E+00	1.14E+09
Nb-95	1.38E+06	7.66E+05	4.12E+05	0.00E+00	7.58E+05	0.00E+00	4.65E+09
Nb-97	8.25E-08	2.09E-08	7.62E-09	0.00E+00	2.43E-08	0.00E+00	7.70E-05
Mo-99	0.00E+00	4.67E-15	8.89E-16	0.00E+00	1.06E-14	0.00E+00	1.08E-14
Ru-103	6.32E+07	0.00E+00	2.72E+07	0.00E+00	2.41E+08	0.00E+00	7.38E+09
Ru-106	1.73E+09	0.00E+00	2.19E+08	0.00E+00	3.35E+09	0.00E+00	1.12E+11
Ag-110M	4.27E+06	3.95E+06	2.34E+06	0.00E+00	7.76E+06	0.00E+00	1.61E+09
Sn-113	2.97E+07	1.15E+06	2.80E+07	4.03E+05	8.40E+05	0.00E+00	5.19E+08
Sb-124	1.19E+07	2.25E+05	4.72E+06	2.88E+04	0.00E+00	9.27E+06	3.38E+08
Te-125M	2.43E+08	8.79E+07	3.25E+07	7.30E+07	9.87E+08	0.00E+00	9.69E+08
Te-127m	8.22E+08	2.94E+08	1.00E+08	2.10E+08	3.34E+09	0.00E+00	2.76E+09
Te-129M	7.40E+08	2.76E+08	1.17E+08	2.54E+08	3.09E+09	0.00E+00	3.73E+09
Te-132	4.41E-10	2.85E-10	2.68E-10	3.15E-10	2.75E-09	0.00E+00	1.35E-08
I-131	7.04E+06	1.01E+07	5.77E+06	3.30E+09	1.73E+07	0.00E+00	2.66E+06
I-133	2.85E-01	4.96E-01	1.51E-01	7.29E+01	8.66E-01	0.00E+00	4.46E-01
I-135	6.28E-17	1.64E-16	6.07E-17	1.08E-14	2.64E-16	0.00E+00	1.86E-16
Cs-134	4.01E+08	9.55E+08	7.81E+08	0.00E+00	3.09E+08	1.03E+08	1.67E+07
Cs-136	7.53E+06	2.97E+07	2.14E+07	0.00E+00	1.65E+07	2.27E+06	3.33E+06
Cs-137	5.57E+08	7.61E+08	4.99E+08	0.00E+00	2.58E+08	8.59E+07	1.47E+07
Ba-140	1.83E+07	2.30E+04	1.20E+06	0.00E+00	7.82E+03	1.32E+04	3.77E+07
La-140	7.57E-33	3.82E-33	1.01E-33	0.00E+00	0.00E+00	0.00E+00	2.80E-28
Ce-141	8.42E+03	5.69E+03	6.46E+02	0.00E+00	2.65E+03	0.00E+00	2.18E+07
Ce-144	8.75E+05	3.66E+05	4.70E+04	0.00E+00	2.17E+05	0.00E+00	2.96E+08
Pr-143	1.33E+04	5.34E+03	6.60E+02	0.00E+00	3.08E+03	0.00E+00	5.83E+07
Nd-147	4.57E+03	5.29E+03	3.16E+02	0.00E+00	3.09E+03	0.00E+00	2.54E+07
Hf-181	1.34E+07	7.57E+04	1.52E+06	4.81E+04	6.33E+04	0.00E+00	9.97E+08
Np-239	5.63E-23	5.53E-24	3.05E-24	0.00E+00	1.73E-23	0.00E+00	1.14E-18

*R Values in units of mrem/yr per $\mu\text{Ci}/\text{m}^3$ for inhalation and tritium and in units of mrem/yr per $\mu\text{Ci}/\text{sec}$ per m^2 for all others.

TABLE 3.3-6
R VALUES FOR THE SHEARON HARRIS NUCLEAR POWER PLANT*

PATHWAY = Meat

AGE GROUP = Teen

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	Gi-LLi
H-3	0.00E+00	1.95E+02	1.95E+02	1.95E+02	1.95E+02	1.95E+02	1.95E+02
P-32	2.58E+09	1.60E+08	9.98E+07	0.00E+00	0.00E+00	0.00E+00	2.16E+08
Cr-51	0.00E+00	0.00E+00	3.42E+03	1.90E+03	7.49E+02	4.88E+03	5.75E+05
Mn-54	0.00E+00	4.25E+06	8.43E+05	0.00E+00	1.27E+06	0.00E+00	8.72E+06
Fe-55	1.49E+08	1.05E+08	2.46E+07	0.00E+00	0.00E+00	6.68E+07	4.56E+07
Fe-59	1.27E+08	2.97E+08	1.15E+08	0.00E+00	0.00E+00	9.36E+07	7.02E+08
Co-57	0.00E+00	2.80E+06	4.69E+06	0.00E+00	0.00E+00	0.00E+00	5.22E+07
Co-58	0.00E+00	8.36E+06	1.93E+07	0.00E+00	0.00E+00	0.00E+00	1.15E+08
Co-60	0.00E+00	3.62E+07	8.15E+07	0.00E+00	0.00E+00	0.00E+00	4.71E+08
Ni-63	1.06E+10	7.49E+08	3.59E+08	0.00E+00	0.00E+00	0.00E+00	1.19E+08
Zn-65	1.75E+08	6.07E+08	2.83E+08	0.00E+00	3.89E+08	0.00E+00	2.57E+08
Br-82	0.00E+00	0.00E+00	1.10E-32	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	2.54E+08	1.19E+08	0.00E+00	0.00E+00	0.00E+00	3.76E+07
Sr-89	1.54E+08	0.00E+00	4.40E+06	0.00E+00	0.00E+00	0.00E+00	1.83E+07
Sr-90	5.32E+09	0.00E+00	1.31E+09	0.00E+00	0.00E+00	0.00E+00	1.49E+08
Y-90	8.89E-18	0.00E+00	2.39E-19	0.00E+00	0.00E+00	0.00E+00	7.33E-14
Y-91	5.68E+05	0.00E+00	1.52E+04	0.00E+00	0.00E+00	0.00E+00	2.33E+08
Zr-95	8.97E+05	2.83E+05	1.95E+05	0.00E+00	4.16E+05	0.00E+00	6.53E+08
Nb-95	1.08E+06	5.97E+05	3.29E+05	0.00E+00	5.79E+05	0.00E+00	2.55E+09
Nb-97	6.83E-08	1.71E-08	6.24E-09	0.00E+00	2.00E-08	0.00E+00	4.08E-04
Mo-99	0.00E+00	3.86E-15	7.37E-16	0.00E+00	8.84E-15	0.00E+00	6.92E-15
Ru-103	5.15E+07	0.00E+00	2.20E+07	0.00E+00	1.82E+08	0.00E+00	4.30E+09
Ru-106	1.46E+09	0.00E+00	1.84E+08	0.00E+00	2.81E+09	0.00E+00	7.00E+10
Ag-110M	3.23E+06	3.06E+06	1.86E+06	0.00E+00	5.83E+06	0.00E+00	8.59E+08
Sn-113	2.09E+07	8.80E+05	2.22E+07	2.88E+05	6.19E+05	0.00E+00	2.51E+08
Sb-124	9.73E+06	1.79E+05	3.80E+06	2.21E+04	0.00E+00	8.50E+06	1.96E+08
Te-125M	2.05E+08	7.39E+07	2.74E+07	5.73E+07	0.00E+00	0.00E+00	6.05E+08
Te-127m	6.94E+08	2.46E+08	8.25E+07	1.65E+08	2.81E+09	0.00E+00	1.73E+09
Te-129M	6.20E+08	2.30E+08	9.81E+07	2.00E+08	2.59E+09	0.00E+00	2.33E+09
Te-132	3.61E-10	2.28E-10	2.15E-10	2.41E-10	2.19E-09	0.00E+00	7.23E-09
I-131	5.85E+06	8.20E+06	4.40E+06	2.39E+09	1.41E+07	0.00E+00	1.62E+06
I-133	2.39E-01	4.05E-01	1.23E-01	5.65E+01	7.10E-01	0.00E+00	3.06E-01
I-135	5.11E-17	1.32E-16	4.88E-17	8.46E-15	2.08E-16	0.00E+00	1.46E-16
Cs-134	3.19E+08	7.51E+08	3.48E+08	0.00E+00	2.39E+08	9.11E+07	9.34E+06
Cs-136	5.87E+06	2.31E+07	1.55E+07	0.00E+00	1.26E+07	1.98E+06	1.86E+06
Cs-137	4.62E+08	6.15E+08	2.14E+08	0.00E+00	2.09E+08	8.13E+07	8.75E+06
Ba-140	1.51E+07	1.86E+04	9.76E+05	0.00E+00	6.29E+03	1.25E+04	2.34E+07
La-140	6.23E-33	3.06E-33	8.14E-34	0.00E+00	0.00E+00	0.00E+00	1.76E-28
Ce-141	7.07E+03	4.72E+03	5.42E+02	0.00E+00	2.22E+03	0.00E+00	1.35E+07
Ce-144	7.37E+05	3.05E+05	3.96E+04	0.00E+00	1.82E+05	0.00E+00	1.85E+08
Pr-143	1.12E+04	4.47E+03	5.58E+02	0.00E+00	2.60E+03	0.00E+00	3.69E+07
Nd-147	4.03E+03	4.38E+03	2.63E+02	0.00E+00	2.57E+03	0.00E+00	1.58E+07
Hf-181	1.10E+07	6.05E+04	1.22E+06	3.69E+04	5.04E+04	0.00E+00	5.50E+08
Np-239	4.92E-23	4.64E-24	2.58E-24	0.00E+00	1.46E-23	0.00E+00	7.46E-19

*R Values in units of mrem/yr per $\mu\text{Ci}/\text{m}^3$ for inhalation and tritium and in units of mrem/yr per $\mu\text{Ci}/\text{sec}$ per m^2 for all others.

TABLE 3.3-7
R VALUES FOR THE SHEARON HARRIS NUCLEAR POWER PLANT*

PATHWAY = Meat

AGE GROUP = Child

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	Gi-LLi
H-3	0.00E+00	2.36E+02	2.36E+02	2.36E+02	2.36E+02	2.36E+02	2.36E+02
P-32	4.86E+09	2.27E+08	1.87E+08	0.00E+00	0.00E+00	0.00E+00	1.34E+08
Cr-51	0.00E+00	0.00E+00	5.33E+03	2.96E+03	8.09E+02	5.40E+03	2.83E+05
Mn-54	0.00E+00	4.86E+06	1.30E+06	0.00E+00	1.36E+06	0.00E+00	4.08E+06
Fe-55	2.85E+08	1.51E+08	4.69E+07	0.00E+00	0.00E+00	8.56E+07	2.80E+07
Fe-59	2.25E+08	3.65E+08	1.82E+08	0.00E+00	0.00E+00	1.06E+08	3.80E+08
Co-57	0.00E+00	3.66E+06	7.41E+06	0.00E+00	0.00E+00	0.00E+00	3.00E+07
Co-58	0.00E+00	9.76E+06	2.99E+07	0.00E+00	0.00E+00	0.00E+00	5.70E+07
Co-60	0.00E+00	4.30E+07	1.27E+08	0.00E+00	0.00E+00	0.00E+00	2.38E+08
Ni-63	2.03E+10	1.09E+09	6.91E+08	0.00E+00	0.00E+00	0.00E+00	7.33E+07
Zn-65	2.62E+08	6.99E+08	4.35E+08	0.00E+00	4.40E+08	0.00E+00	1.23E+08
Br-82	0.00E+00	0.00E+00	1.72E-32	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	3.60E+08	2.21E+08	0.00E+00	0.00E+00	0.00E+00	2.32E+07
Sr-89	2.91E+08	0.00E+00	8.31E+06	0.00E+00	0.00E+00	0.00E+00	1.13E+07
Sr-90	6.87E+09	0.00E+00	1.74E+09	0.00E+00	0.00E+00	0.00E+00	9.26E+07
Y-90	1.68E-17	0.00E+00	4.50E-19	0.00E+00	0.00E+00	0.00E+00	4.79E-14
Y-91	1.07E+06	0.00E+00	2.87E+04	0.00E+00	0.00E+00	0.00E+00	1.43E+08
Zr-95	1.59E+06	3.50E+05	3.12E+05	0.00E+00	5.01E+05	0.00E+00	3.65E+08
Nb-95	1.86E+06	7.23E+05	5.17E+05	0.00E+00	6.80E+05	0.00E+00	1.34E+09
Nb-97	1.28E-07	2.31E-08	1.08E-08	0.00E+00	2.56E-08	0.00E+00	7.13E-03
Mo-99	0.00E+00	5.38E-15	1.33E-15	0.00E+00	1.15E-14	0.00E+00	4.45E-15
Ru-103	9.31E+07	0.00E+00	3.58E+07	0.00E+00	2.34E+08	0.00E+00	2.41E+09
Ru-106	2.75E+09	0.00E+00	3.43E+08	0.00E+00	3.71E+09	0.00E+00	4.27E+10
Ag-110M	5.36E+06	3.62E+06	2.89E+06	0.00E+00	6.74E+06	0.00E+00	4.30E+08
Sn-113	3.14E+07	1.01E+06	3.42E+07	4.15E+05	6.97E+05	0.00E+00	1.25E+08
Sb-124	1.76E+07	2.28E+05	6.17E+06	3.88E+04	0.00E+00	9.77E+06	1.10E+08
Te-125M	3.85E+08	1.04E+08	5.13E+07	1.08E+08	0.00E+00	0.00E+00	3.71E+08
Te-127m	1.31E+09	3.52E+08	1.55E+08	3.13E+08	3.73E+09	0.00E+00	1.06E+09
Te-129M	1.17E+09	3.26E+08	1.81E+08	3.77E+08	3.43E+09	0.00E+00	1.42E+09
Te-132	6.58E-10	2.91E-10	3.52E-10	4.24E-10	2.70E-09	0.00E+00	2.93E-09
I-131	1.09E+07	1.09E+07	6.20E+06	3.61E+09	1.79E+07	0.00E+00	9.72E+05
I-133	4.43E-01	5.48E-01	2.07E-01	1.02E+02	9.13E-01	0.00E+00	2.21E-01
I-135	9.25E-17	1.66E-16	7.87E-17	1.47E-14	2.55E-16	0.00E+00	1.27E-16
Cs-134	5.63E+08	9.23E+08	1.95E+08	0.00E+00	2.86E+08	1.03E+08	4.93E+06
Cs-136	1.01E+07	2.78E+07	1.80E+07	0.00E+00	1.48E+07	2.21E+06	9.78E+05
Cs-137	8.51E+08	8.15E+08	1.20E+08	0.00E+00	2.65E+08	9.55E+07	5.10E+06
Ba-140	2.80E+07	2.45E+04	1.63E+06	0.00E+00	7.97E+03	1.46E+04	1.42E+07
La-140	1.14E-32	3.98E-33	1.34E-33	0.00E+00	0.00E+00	0.00E+00	1.11E-28
Ce-141	1.33E+04	6.64E+03	9.86E+02	0.00E+00	2.91E+03	0.00E+00	8.28E+06
Ce-144	1.39E+06	4.36E+05	7.42E+04	0.00E+00	2.41E+05	0.00E+00	1.14E+08
Pr-143	2.12E+04	6.37E+03	1.05E+03	0.00E+00	3.45E+03	0.00E+00	2.29E+07
Nd-147	7.56E+03	6.12E+03	4.74E+02	0.00E+00	3.36E+03	0.00E+00	9.70E+06
Hf-181	2.00E+07	7.79E+04	2.02E+06	6.56E+04	6.26E+04	0.00E+00	3.31E+08
Np-239	9.26E-23	6.65E-24	4.67E-24	0.00E+00	1.92E-23	0.00E+00	4.92E-19

*R Values in units of mrem/yr per $\mu\text{Ci}/\text{m}^3$ for inhalation and tritium and in units of mrem/yr per $\mu\text{Ci}/\text{sec}$ per m^2 for all others.

TABLE 3.3-8
R VALUES FOR THE SHEARON HARRIS NUCLEAR POWER PLANT*

PATHWAY = Cow Milk

AGE GROUP = Adult

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	Gi-LLi
H-3	0.00E+00	7.69E+02	7.69E+02	7.69E+02	7.69E+02	7.69E+02	7.69E+02
P-32	1.12E+10	6.95E+08	4.32E+08	0.00E+00	0.00E+00	0.00E+00	1.26E+09
Cr-51	0.00E+00	0.00E+00	1.73E+04	1.04E+04	3.82E+03	2.30E+04	4.36E+06
Mn-54	0.00E+00	5.11E+06	9.76E+05	0.00E+00	1.52E+06	0.00E+00	1.57E+07
Fe-55	1.57E+07	1.08E+07	2.52E+06	0.00E+00	0.00E+00	6.04E+06	6.21E+06
Fe-59	1.77E+07	4.17E+07	1.60E+07	0.00E+00	0.00E+00	1.17E+07	1.39E+08
Co-57	0.00E+00	7.91E+05	1.32E+06	0.00E+00	0.00E+00	0.00E+00	2.01E+07
Co-58	0.00E+00	2.80E+06	6.28E+06	0.00E+00	0.00E+00	0.00E+00	5.68E+07
Co-60	0.00E+00	1.02E+07	2.24E+07	0.00E+00	0.00E+00	0.00E+00	1.91E+08
Ni-63	4.70E+09	3.25E+08	1.57E+08	0.00E+00	0.00E+00	0.00E+00	6.79E+07
Zn-65	9.59E+08	3.05E+09	1.38E+09	0.00E+00	2.04E+09	0.00E+00	1.92E+09
Br-82	0.00E+00	0.00E+00	2.09E-29	0.00E+00	0.00E+00	0.00E+00	2.39E-29
Rb-86	0.00E+00	1.62E+09	7.54E+08	0.00E+00	0.00E+00	0.00E+00	3.19E+08
Sr-89	8.70E+08	0.00E+00	2.50E+07	0.00E+00	0.00E+00	0.00E+00	1.40E+08
Sr-90	3.09E+10	0.00E+00	7.59E+09	0.00E+00	0.00E+00	0.00E+00	8.94E+08
Y-90	1.44E-18	0.00E+00	3.86E-20	0.00E+00	0.00E+00	0.00E+00	1.53E-14
Y-91	5.11E+03	0.00E+00	1.37E+02	0.00E+00	0.00E+00	0.00E+00	2.81E+06
Zr-95	5.62E+02	1.80E+02	1.22E+02	0.00E+00	2.83E+02	0.00E+00	5.71E+05
Nb-95	4.95E+04	2.75E+04	1.48E+04	0.00E+00	2.72E+04	0.00E+00	1.67E+08
Nb-97	1.09E-08	2.75E-09	1.00E-09	0.00E+00	3.21E-09	0.00E+00	1.01E-05
Mo-99	0.00E+00	1.83E-12	3.49E-13	0.00E+00	4.15E-12	0.00E+00	4.25E-12
Ru-103	6.11E+02	0.00E+00	2.63E+02	0.00E+00	2.33E+03	0.00E+00	7.14E+04
Ru-106	1.26E+04	0.00E+00	1.60E+03	0.00E+00	2.44E+04	0.00E+00	8.17E+05
Ag-110M	3.71E+07	3.44E+07	2.04E+07	0.00E+00	6.76E+07	0.00E+00	1.40E+10
Sn-113	1.40E+06	5.41E+04	1.32E+06	1.90E+04	3.95E+04	0.00E+00	2.44E+07
Sb-124	1.55E+07	2.92E+05	6.14E+06	3.75E+04	0.00E+00	1.20E+07	4.39E+08
Sb-125	1.30E+07	1.45E+05	3.09E+06	1.32E+04	0.00E+00	1.00E+07	1.43E+08
Te-125M	1.10E+07	3.99E+06	1.48E+06	3.31E+06	4.48E+07	0.00E+00	4.40E+07
Te-127m	3.37E+07	1.21E+07	4.11E+06	8.62E+06	1.37E+08	0.00E+00	1.13E+08
Te-129M	3.91E+07	1.46E+07	6.19E+06	1.34E+07	1.63E+08	0.00E+00	1.97E+08
Te-132	2.06E-10	1.33E-10	1.25E-10	1.47E-10	1.28E-09	0.00E+00	6.29E-09
I-131	1.94E+08	2.77E+08	1.59E+08	9.09E+10	4.76E+08	0.00E+00	7.32E+07
I-132	1.10E+01	2.93E+01	1.03E+01	1.03E+01	4.67E+01	0.00E+00	5.51E-02
I-133	2.64E+06	4.59E+06	1.40E+06	6.75E+08	8.01E+06	0.00E+00	4.13E+06
I-135	9.34E+03	2.45E+04	9.03E+03	1.61E+06	3.92E+04	0.00E+00	2.76E+04

*R Values in units of mrem/yr per $\mu\text{Ci}/\text{m}^3$ for inhalation and tritium and in units of mrem/yr per $\mu\text{Ci}/\text{sec}$ per m^2 for all others.

TABLE 3.3-8 (continue)
R VALUES FOR THE SHEARON HARRIS NUCLEAR POWER PLANT*

PATHWAY = Cow Milk

AGE GROUP = Adult

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLi
Cs-134	3.45E+09	3.21E+09	6.71E+09	0.00E+00	2.66E+09	8.82E+08	1.44E+08
Cs-136	1.66E+08	6.57E+08	4.73E+08	0.00E+00	3.65E+08	5.01E+07	7.46E+07
Cs-137	4.71E+09	6.44E+09	4.22E+09	0.00E+00	2.19E+09	7.27E+08	1.25E+08
Ba-140	1.71E+07	2.15E+04	1.12E+06	0.00E+00	7.32E+03	1.23E+04	3.53E+07
La-140	7.56E-32	3.81E-32	1.01E-32	0.00E+00	0.00E+00	0.00E+00	2.80E-27
Ce-141	2.91E+03	1.97E+03	2.23E+02	0.00E+00	9.14E+02	0.00E+00	7.52E+06
Ce-144	2.15E+05	8.97E+04	1.15E+04	0.00E+00	5.32E+04	0.00E+00	7.26E+07
Pr-143	1.00E+02	4.02E+01	4.97E+00	0.00E+00	2.32E+01	0.00E+00	4.39E+05
Nd-147	6.08E+01	7.02E+01	4.20E+00	0.00E+00	4.10E+01	0.00E+00	3.37E+05
Hf-181	5.91E+03	3.33E+01	6.68E+02	2.12E+01	2.79E+01	0.00E+00	4.38E+05
Np-239	1.34E-22	1.32E-23	7.28E-24	0.00E+00	4.12E-23	0.00E+00	2.71E-18

*R Values in units of mrem/yr per $\mu\text{Ci}/\text{m}^3$ for inhalation and tritium and in units of mrem/yr per $\mu\text{Ci}/\text{sec}$ per m^2 for all others.

TABLE 3.3-9
R VALUES FOR THE SHEARON HARRIS NUCLEAR POWER PLANT*

PATHWAY = Cow Milk

AGE GROUP = Teen

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	Gi-LLi
H-3	0.00E+00	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03
P-32	2.06E+10	1.28E+09	8.00E+08	0.00E+00	0.00E+00	0.00E+00	1.73E+09
Cr-51	0.00E+00	0.00E+00	3.02E+04	1.68E+04	6.63E+03	4.32E+04	5.08E+06
Mn-54	0.00E+00	8.52E+06	1.69E+06	0.00E+00	2.54E+06	0.00E+00	1.75E+07
Fe-55	2.78E+07	1.97E+07	4.59E+06	0.00E+00	0.00E+00	1.25E+07	8.53E+06
Fe-59	3.10E+07	7.23E+07	2.79E+07	0.00E+00	0.00E+00	2.28E+07	1.71E+08
Co-57	0.00E+00	1.39E+06	2.33E+06	0.00E+00	0.00E+00	0.00E+00	2.59E+07
Co-58	0.00E+00	4.72E+06	1.09E+07	0.00E+00	0.00E+00	0.00E+00	6.50E+07
Co-60	0.00E+00	1.72E+07	3.88E+07	0.00E+00	0.00E+00	0.00E+00	2.25E+08
Ni-63	8.25E+09	5.83E+08	2.80E+08	0.00E+00	0.00E+00	0.00E+00	9.27E+07
Zn-65	1.47E+09	5.11E+09	2.38E+09	0.00E+00	3.27E+09	0.00E+00	2.16E+09
Br-82	0.00E+00	0.00E+00	3.62E-29	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	2.95E+09	1.39E+09	0.00E+00	0.00E+00	0.00E+00	4.37E+08
Sr-89	1.60E+09	0.00E+00	4.59E+07	0.00E+00	0.00E+00	0.00E+00	1.91E+08
Sr-90	4.37E+10	0.00E+00	1.08E+10	0.00E+00	0.00E+00	0.00E+00	1.23E+09
Y-90	2.64E-18	0.00E+00	7.12E-20	0.00E+00	0.00E+00	0.00E+00	2.18E-14
Y-91	9.40E+03	0.00E+00	2.52E+02	0.00E+00	0.00E+00	0.00E+00	3.85E+06
Zr-95	9.83E+02	3.10E+02	2.13E+02	0.00E+00	4.56E+02	0.00E+00	7.16E+05
Nb-95	8.45E+04	4.68E+04	2.58E+04	0.00E+00	4.54E+04	0.00E+00	2.00E+08
Nb-97	1.97E-08	4.92E-09	1.80E-09	0.00E+00	5.75E-09	0.00E+00	1.17E-04
Mo-99	0.00E+00	3.31E-12	6.31E-13	0.00E+00	7.57E-12	0.00E+00	5.92E-12
Ru-103	1.09E+03	0.00E+00	4.65E+02	0.00E+00	3.83E+03	0.00E+00	9.08E+04
Ru-106	2.32E+04	0.00E+00	2.93E+03	0.00E+00	4.48E+04	0.00E+00	1.11E+06
Ag-110M	6.14E+07	5.81E+07	3.53E+07	0.00E+00	1.11E+08	0.00E+00	1.63E+10
Sn-113	2.15E+06	9.06E+04	2.28E+06	2.97E+04	6.37E+04	0.00E+00	2.58E+07
Sb-124	2.76E+07	5.08E+05	1.08E+07	6.26E+04	0.00E+00	2.41E+07	5.56E+08
Sb-125	2.32E+07	2.53E+05	5.42E+06	2.22E+04	0.00E+00	2.04E+07	1.80E+08
Te-125M	2.03E+07	7.32E+06	2.72E+06	5.68E+06	0.00E+00	0.00E+00	5.99E+07
Te-127m	6.22E+07	2.21E+07	7.39E+06	1.48E+07	2.52E+08	0.00E+00	1.55E+08
Te-129M	7.15E+07	2.65E+07	1.13E+07	2.31E+07	2.99E+08	0.00E+00	2.69E+08
Te-132	3.68E-10	2.33E-10	2.19E-10	2.45E-10	2.23E-09	0.00E+00	7.37E-09
I-131	3.52E+08	4.93E+08	2.65E+08	1.44E+11	8.48E+08	0.00E+00	9.75E+07
I-132	1.94E+01	5.09E+01	1.83E+01	1.71E+01	8.02E+01	0.00E+00	2.22E+01
I-133	4.82E+06	8.18E+06	2.49E+06	1.14E+09	1.43E+07	0.00E+00	6.19E+06
I-135	1.66E+04	4.27E+04	1.58E+04	2.75E+06	6.75E+04	0.00E+00	4.74E+04

*R Values in units of mrem/yr per $\mu\text{Ci}/\text{m}^3$ for inhalation and tritium and in units of mrem/yr per $\mu\text{Ci}/\text{sec}$ per m^2 for all others.

TABLE 3.3-9 (continue)
R VALUES FOR THE SHEARON HARRIS NUCLEAR POWER PLANT*

PATHWAY = Cow Milk

AGE GROUP = Teen

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	Gi-LLi
Cs-134	5.99E+09	1.41E+10	6.54E+09	0.00E+00	4.48E+09	1.71E+09	1.75E+08
Cs-136	2.83E+08	1.11E+09	7.48E+08	0.00E+00	6.07E+08	9.56E+07	8.97E+07
Cs-137	8.54E+09	1.14E+10	3.96E+09	0.00E+00	3.87E+09	1.50E+09	1.62E+08
Ba-140	3.09E+07	3.79E+04	1.99E+06	0.00E+00	1.28E+04	2.55E+04	4.77E+07
La-140	1.36E-31	6.68E-32	1.78E-32	0.00E+00	0.00E+00	0.00E+00	3.83E-27
Ce-141	5.33E+03	3.56E+03	4.09E+02	0.00E+00	1.68E+03	0.00E+00	1.02E+07
Ce-144	3.95E+05	1.63E+05	2.12E+04	0.00E+00	9.76E+04	0.00E+00	9.93E+07
Pr-143	1.84E+02	7.36E+01	9.17E+00	0.00E+00	4.28E+01	0.00E+00	6.06E+05
Nd-147	1.17E+02	1.27E+02	7.61E+00	0.00E+00	7.47E+01	0.00E+00	4.59E+05
Hf-181	1.06E+04	5.82E+01	1.18E+03	3.55E+01	4.84E+01	0.00E+00	5.28E+05
Np-239	2.56E-22	2.42E-23	1.34E-23	0.00E+00	7.59E-23	0.00E+00	3.89E-18

*R Values in units of mrem/yr per $\mu\text{Ci}/\text{m}^3$ for inhalation and tritium and in units of mrem/yr per $\mu\text{Ci}/\text{sec}$ per m^2 for all others.

TABLE 3.3-10
R VALUES FOR THE SHEARON HARRIS NUCLEAR POWER PLANT*

PATHWAY = Cow Milk

AGE GROUP = Child

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	Gi-LLi
H-3	0.00E+00	1.58E+03	1.58E+03	1.58E+03	1.58E+03	1.58E+03	1.58E+03
P-32	5.09E+10	2.38E+09	1.96E+09	0.00E+00	0.00E+00	0.00E+00	1.41E+09
Cr-51	0.00E+00	0.00E+00	6.17E+04	3.42E+04	9.36E+03	6.25E+04	3.27E+06
Mn-54	0.00E+00	1.27E+07	3.39E+06	0.00E+00	3.57E+06	0.00E+00	1.07E+07
Fe-55	6.97E+07	3.70E+07	1.15E+07	0.00E+00	0.00E+00	2.09E+07	6.85E+06
Fe-59	7.18E+07	1.16E+08	5.79E+07	0.00E+00	0.00E+00	3.37E+07	1.21E+08
Co-57	0.00E+00	2.37E+06	4.80E+06	0.00E+00	0.00E+00	0.00E+00	1.94E+07
Co-58	0.00E+00	7.21E+06	2.21E+07	0.00E+00	0.00E+00	0.00E+00	4.20E+07
Co-60	0.00E+00	2.68E+07	7.90E+07	0.00E+00	0.00E+00	0.00E+00	1.48E+08
Ni-63	2.07E+10	1.11E+09	7.04E+08	0.00E+00	0.00E+00	0.00E+00	7.46E+07
Zn-65	2.89E+09	7.70E+09	4.79E+09	0.00E+00	4.85E+09	0.00E+00	1.35E+09
Br-82	0.00E+00	0.00E+00	7.42E-29	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	5.47E+09	3.36E+09	0.00E+00	0.00E+00	0.00E+00	3.52E+08
Sr-89	3.97E+09	0.00E+00	1.13E+08	0.00E+00	0.00E+00	0.00E+00	1.54E+08
Sr-90	7.38E+10	0.00E+00	1.87E+10	0.00E+00	0.00E+00	0.00E+00	9.95E+08
Y-90	6.54E-18	0.00E+00	1.75E-19	0.00E+00	0.00E+00	0.00E+00	1.86E-14
Y-91	2.32E+04	0.00E+00	6.21E+02	0.00E+00	0.00E+00	0.00E+00	3.09E+06
Zr-95	2.28E+03	5.02E+02	4.47E+02	0.00E+00	7.18E+02	0.00E+00	5.23E+05
Nb-95	1.91E+05	7.42E+04	5.31E+04	0.00E+00	6.98E+04	0.00E+00	1.37E+08
Nb-97	4.81E-08	8.70E-09	4.06E-09	0.00E+00	9.65E-09	0.00E+00	2.68E-03
Mo-99	0.00E+00	6.02E-12	1.49E-12	0.00E+00	1.29E-11	0.00E+00	4.98E-12
Ru-103	2.57E+03	0.00E+00	9.88E+02	0.00E+00	6.47E+03	0.00E+00	6.65E+04
Ru-106	5.72E+04	0.00E+00	7.14E+03	0.00E+00	7.72E+04	0.00E+00	8.90E+05
Ag-110M	1.33E+08	9.00E+07	7.19E+07	0.00E+00	1.68E+08	0.00E+00	1.07E+10
Sn-113	4.22E+05	1.36E+04	4.61E+05	5.58E+03	9.37E+03	0.00E+00	1.69E+06
Sb-124	6.53E+07	8.47E+05	2.29E+07	1.44E+05	0.00E+00	3.62E+07	4.09E+08
Sb-125	5.52E+07	4.26E+05	1.16E+07	5.11E+04	0.00E+00	3.08E+07	1.32E+08
Te-125M	4.99E+07	1.35E+07	6.65E+06	1.40E+07	0.00E+00	0.00E+00	4.81E+07
Te-127m	1.53E+08	4.13E+07	1.82E+07	3.66E+07	4.37E+08	0.00E+00	1.24E+08
Te-129M	1.76E+08	4.92E+07	2.74E+07	5.68E+07	5.18E+08	0.00E+00	2.15E+08
Te-132	8.78E-10	3.88E-10	4.69E-10	5.66E-10	3.61E-09	0.00E+00	3.91E-09
I-131	8.54E+08	8.59E+08	4.88E+08	2.84E+11	1.41E+09	0.00E+00	7.64E+07
I-132	4.60E+01	8.45E+01	3.89E+01	3.92E+01	1.29E+00	0.00E+00	9.95E+01
I-133	1.17E+07	1.45E+07	5.48E+06	2.69E+09	2.41E+07	0.00E+00	5.84E+06
I-135	3.93E+04	7.07E+04	3.35E+04	6.26E+06	1.08E+05	0.00E+00	5.39E+04

*R Values in units of mrem/yr per $\mu\text{Ci}/\text{m}^3$ for inhalation and tritium and in units of mrem/yr per $\mu\text{Ci}/\text{sec}$ per m^2 for all others.

TABLE 3.3-10 (continue)
R VALUES FOR THE SHEARON HARRIS NUCLEAR POWER PLANT*

PATHWAY = Cow Milk

AGE GROUP = Child

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	Gi-LLi
Cs-134	1.38E+10	2.27E+10	4.78E+09	0.00E+00	7.03E+09	2.52E+09	1.22E+08
Cs-136	6.39E+08	1.76E+09	1.14E+09	0.00E+00	9.36E+08	1.40E+08	6.17E+07
Cs-137	2.06E+10	1.97E+10	2.91E+09	0.00E+00	6.42E+09	2.31E+09	1.23E+08
Ba-140	7.47E+07	6.54E+04	4.36E+06	0.00E+00	2.13E+04	3.90E+04	3.78E+07
La-140	3.25E-31	1.14E-31	3.83E-32	0.00E+00	0.00E+00	0.00E+00	3.17E-27
Ce-141	1.31E+04	6.55E+03	9.73E+02	0.00E+00	2.87E+03	0.00E+00	8.17E+06
Ce-144	9.74E+05	3.05E+05	5.20E+04	0.00E+00	1.69E+05	0.00E+00	7.96E+07
Pr-143	4.56E+02	1.37E+02	2.26E+01	0.00E+00	7.42E+01	0.00E+00	4.92E+05
Nd-147	2.87E+02	2.32E+02	1.80E+01	0.00E+00	1.27E+02	0.00E+00	3.68E+05
Hf-181	2.51E+04	9.79E+01	2.53E+03	8.24E+01	7.86E+01	0.00E+00	4.16E+05
Np-239	6.31E-22	4.53E-23	3.18E-23	0.00E+00	1.31E-22	0.00E+00	3.35E-18

*R Values in units of mrem/yr per $\mu\text{Ci}/\text{m}^3$ for inhalation and tritium and in units of mrem/yr per $\mu\text{Ci}/\text{sec}$ per m^{-2} for all others.

TABLE 3.3-11
R VALUES FOR THE SHEARON HARRIS NUCLEAR POWER PLANT*

PATHWAY = Cow Milk

AGE GROUP = Infant

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	Gi-LLi
H-3	0.00E+00	2.40E+03	2.40E+03	2.40E+03	2.40E+03	2.40E+03	2.40E+03
P-32	1.05E+11	6.17E+09	4.06E+09	0.00E+00	0.00E+00	0.00E+00	1.42E+09
Cr-51	0.00E+00	0.00E+00	9.77E+04	6.38E+04	1.39E+04	1.24E+05	2.85E+06
Mn-54	0.00E+00	2.37E+07	5.37E+06	0.00E+00	5.25E+06	0.00E+00	8.71E+06
Fe-55	8.43E+07	5.45E+07	1.46E+07	0.00E+00	0.00E+00	2.66E+07	6.91E+06
Fe-59	1.34E+08	2.34E+08	9.23E+07	0.00E+00	0.00E+00	6.92E+07	1.12E+08
Co-57	0.00E+00	5.53E+06	9.00E+06	0.00E+00	0.00E+00	0.00E+00	1.89E+07
Co-58	0.00E+00	1.44E+07	3.60E+07	0.00E+00	0.00E+00	0.00E+00	3.59E+07
Co-60	0.00E+00	5.47E+07	1.29E+08	0.00E+00	0.00E+00	0.00E+00	1.30E+08
Ni-63	2.44E+10	1.51E+09	8.46E+08	0.00E+00	0.00E+00	0.00E+00	7.50E+07
Zn-65	3.88E+09	1.33E+10	6.14E+09	0.00E+00	6.45E+09	0.00E+00	1.12E+10
Br-82	0.00E+00	0.00E+00	1.25E-28	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.39E+10	6.86E+09	0.00E+00	0.00E+00	0.00E+00	3.55E+08
Sr-89	7.55E+09	0.00E+00	2.17E+08	0.00E+00	0.00E+00	0.00E+00	1.55E+08
Sr-90	8.04E+10	0.00E+00	2.05E+10	0.00E+00	0.00E+00	0.00E+00	1.00E+09
Y-90	1.38E-17	0.00E+00	3.71E-19	0.00E+00	0.00E+00	0.00E+00	1.91E-14
Y-91	4.36E+04	0.00E+00	1.17E+03	0.00E+00	0.00E+00	0.00E+00	3.12E+06
Zr-95	4.05E+03	9.88E+02	7.01E+02	0.00E+00	1.06E+03	0.00E+00	4.92E+05
Nb-95	3.56E+05	1.47E+05	8.48E+04	0.00E+00	1.05E+05	0.00E+00	1.24E+08
Nb-97	1.02E-07	2.17E-08	7.83E-09	0.00E+00	1.70E-08	0.00E+00	6.85E-03
Mo-99	0.00E+00	1.54E-11	3.00E-12	0.00E+00	2.30E-11	0.00E+00	5.07E-12
Ru-103	5.21E+03	0.00E+00	1.74E+03	0.00E+00	1.08E+04	0.00E+00	6.33E+04
Ru-106	1.18E+05	0.00E+00	1.47E+04	0.00E+00	1.39E+05	0.00E+00	8.95E+05
Ag-110M	2.46E+08	1.80E+08	1.19E+08	0.00E+00	2.57E+08	0.00E+00	9.32E+09
Sn-113	6.45E+06	2.45E+05	6.65E+06	9.34E+04	1.31E+05	0.00E+00	1.37E+07
Sb-124	1.26E+08	1.85E+06	3.90E+07	3.34E+05	0.00E+00	7.88E+07	3.88E+08
Sb-125	9.49E+07	9.18E+05	1.95E+07	1.19E+05	0.00E+00	5.95E+07	1.26E+08
Te-125M	1.02E+08	3.41E+07	1.38E+07	3.43E+07	0.00E+00	0.00E+00	4.86E+07
Te-127m	3.10E+08	1.03E+08	3.75E+07	8.96E+07	7.64E+08	0.00E+00	1.25E+08
Te-129M	3.62E+08	1.24E+08	5.57E+07	1.39E+08	9.05E+08	0.00E+00	2.16E+08
Te-132	1.81E-09	8.95E-10	8.35E-10	1.32E-09	5.60E-09	0.00E+00	3.31E-09
I-131	1.78E+09	2.10E+09	9.23E+08	6.90E+11	2.45E+09	0.00E+00	7.49E+07
I-132	9.55E+01	1.94E+00	6.90E+01	9.09E+01	2.16E+00	0.00E+00	1.57E+00
I-133	2.47E+07	3.60E+07	1.05E+07	6.55E+09	4.23E+07	0.00E+00	6.09E+06
I-135	8.17E+04	1.63E+05	5.93E+04	1.46E+07	1.81E+05	0.00E+00	5.88E+04

*R Values in units of mrem/yr per $\mu\text{Ci}/\text{m}^3$ for inhalation and tritium and in units of mrem/yr per $\mu\text{Ci}/\text{sec}$ per m^2 for all others.

TABLE 3.3-11 (continue)
R VALUES FOR THE SHEARON HARRIS NUCLEAR POWER PLANT*

PATHWAY = Cow Milk

AGE GROUP = Infant

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	Gi-LLi
Cs-134	2.23E+10	4.15E+10	4.19E+09	0.00E+00	1.07E+10	4.38E+09	1.13E+08
Cs-136	1.25E+09	3.67E+09	1.37E+09	0.00E+00	1.46E+09	2.99E+08	5.58E+07
Cs-137	3.28E+10	3.84E+10	2.72E+09	0.00E+00	1.03E+10	4.18E+09	1.20E+08
Ba-140	1.54E+08	1.54E+05	7.91E+06	0.00E+00	3.65E+04	9.43E+04	3.77E+07
La-140	6.80E-31	2.68E-31	6.89E-32	0.00E+00	0.00E+00	0.00E+00	3.15E-27
Ce-141	2.60E+04	1.59E+04	1.87E+03	0.00E+00	4.90E+03	0.00E+00	8.21E+06
Ce-144	1.40E+06	5.71E+05	7.82E+04	0.00E+00	2.31E+05	0.00E+00	8.01E+07
Pr-143	9.44E+02	3.53E+02	4.68E+01	0.00E+00	1.31E+02	0.00E+00	4.98E+05
Nd-147	5.69E+02	5.84E+02	3.58E+01	0.00E+00	2.25E+02	0.00E+00	3.70E+05
Hf-181	4.78E+04	2.26E+02	4.23E+03	1.91E+02	1.32E+02	0.00E+00	3.93E+05
Np-239	1.33E-21	1.19E-22	6.74E-23	0.00E+00	2.38E-22	0.00E+00	3.45E-18

*R Values in units of mrem/yr per $\mu\text{Ci}/\text{m}^3$ for inhalation and tritium and in units of mrem/yr per $\mu\text{Ci}/\text{sec}$ per m^2 for all others.

TABLE 3.3-12
R VALUES FOR THE SHEARON HARRIS NUCLEAR POWER PLANT*

PATHWAY = Goat Milk

AGE GROUP = Adult

Nuclide	T. Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
H-3	1.57E+03	1.57E+03	0.00E+01	1.57E+03	1.57E+03	1.57E+03	1.57E+03	1.57E+03
P-32	5.19E+08	1.51E+09	1.34E+10	8.34E+08	0.00E+01	0.00E+01	0.00E+01	0.00E+01
Cr-51	2.08E+03	5.23E+05	0.00E+01	0.00E+01	4.58E+02	1.24E+03	2.76E+03	0.00E+01
Mn-54	1.17E+05	1.88E+06	0.00E+01	6.14E+05	1.83E+05	0.00E+01	0.00E+01	0.00E+01
Fe-59	2.08E+05	1.81E+06	2.31E+05	5.42E+05	0.00E+01	0.00E+01	1.51E+05	0.00E+01
Co-58	7.54E+05	6.82E+06	0.00E+01	3.36E+05	0.00E+01	0.00E+01	0.00E+01	0.00E+01
Co-60	2.69E+06	2.29E+07	0.00E+01	1.22E+06	0.00E+01	0.00E+01	0.00E+01	0.00E+01
Zn-65	1.65E+08	2.31E+08	1.15E+08	3.66E+08	2.45E+08	0.00E+01	0.00E+01	0.00E+01
Rb-86	9.05E+07	3.83E+07	0.00E+01	1.94E+08	0.00E+01	0.00E+01	0.00E+01	0.00E+01
Sr-89	5.24E+07	2.93E+08	1.83E+09	0.00E+01	0.00E+01	0.00E+01	0.00E+01	0.00E+01
Sr-90	1.59E+10	1.88E+09	6.49E+10	0.00E+01	0.00E+01	0.00E+01	0.00E+01	0.00E+01
Y-91	1.64E+01	3.37E+05	6.13E+02	0.00E+01	0.00E+01	0.00E+01	0.00E+01	0.00E+01
Zr-95	1.46E+01	6.85E+04	6.74E+01	2.16E+01	3.39E+01	0.00E+01	0.00E+01	0.00E+01
Nb-95	1.78E+03	2.01E+07	5.94E+03	3.31E+03	3.27E+03	0.00E+01	0.00E+01	0.00E+01
Ru-103	3.16E+01	8.56E+03	7.33E+01	0.00E+01	2.80E+02	0.00E+01	0.00E+01	0.00E+01
Ru-106	1.92E+02	9.81E+04	1.52E+03	0.00E+01	2.93E+03	0.00E+01	0.00E+01	0.00E+01
Aq-110M	2.45E+06	1.68E+09	4.46E+06	4.12E+06	8.11E+06	0.00E+01	0.00E+01	0.00E+01
Sn-113	1.32E+05	2.44E+06	1.40E+05	5.41E+03	3.96E+03	1.90E+03	0.00E+01	0.00E+01
Sb-124	7.36E+05	5.27E+07	1.86E+06	3.51E+04	0.00E+01	4.50E+03	1.44E+06	0.00E+01
Te-127M	4.93E+05	1.36E+07	4.05E+06	1.45E+06	1.64E+07	1.03E+06	0.00E+01	0.00E+01
Te-129M	7.43E+05	2.36E+07	4.69E+06	1.75E+06	1.96E+07	1.61E+06	0.00E+01	0.00E+01
I-131	1.91E+08	8.78E+07	2.33E+08	3.33E+08	5.71E+08	1.09E+11	0.00E+01	0.00E+01
I-132	1.23E+01	6.61E-02	1.32E+01	3.52E+01	5.61E+01	1.23E+01	0.00E+01	0.00E+01
I-133	1.68E+06	4.95E+06	3.17E+06	5.51E+06	9.61E+06	8.10E+08	0.00E+01	0.00E+01
I-135	1.08E+04	3.32E+04	1.12E+04	2.94E+04	4.71E+04	1.94E+06	0.00E+01	0.00E+01
Cs-134	2.01E+10	4.31E+08	1.03E+10	2.46E+10	7.97E+09	0.00E+01	2.65E+09	0.00E+01
Cs-136	1.42E+09	2.24E+08	4.99E+08	1.97E+09	1.10E+09	0.00E+01	1.50E+08	0.00E+01
Cs-137	1.27E+10	3.74E+08	1.41E+10	1.93E+10	6.56E+09	0.00E+01	2.18E+09	0.00E+01
Ba-140	1.35E+05	4.23E+06	2.06E+06	2.58E+03	8.78E+02	0.00E+01	1.48E+03	0.00E+01
Ce-141	2.68E+01	9.03E+05	3.49E+02	2.36E+02	1.10E+02	0.00E+01	0.00E+01	0.00E+01
Ce-144	1.38E+03	8.71E+06	2.58E+04	1.08E+04	6.39E+03	0.00E+01	0.00E+01	0.00E+01
Hf-181	8.02E+01	5.26E+04	7.09E+02	3.99E+00	3.34E+00	2.54E+00	0.00E+01	0.00E+01

*R Values in units of mrem/yr per $\mu\text{Ci}/\text{m}^3$ for inhalation and tritium and in units of mrem/yr per $\mu\text{Ci}/\text{sec}$ per m^2 for all others.

TABLE 3.3-13
R VALUES FOR THE SHEARON HARRIS NUCLEAR POWER PLANT*

PATHWAY = Goat Milk

AGE GROUP = Teen

Nuclide	T. Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
H-3	2.04E+03	2.04E+03	0.00E+01	2.04E+03	2.04E+03	2.04E+03	2.04E+03	2.04E+03
P-32	9.60E+08	2.08E+09	2.48E+10	1.53E+09	0.00E+01	0.00E+01	0.00E+01	0.00E+01
Cr-51	3.63E+03	6.10E+05	0.00E+01	0.00E+01	7.95E+02	2.02E+03	5.18E+03	0.00E+01
Mn-54	2.03E+05	2.10E+06	0.00E+01	1.02E+06	3.05E+05	0.00E+01	0.00E+01	0.00E+01
Fe-59	3.63E+05	2.22E+06	4.03E+05	9.40E+05	0.00E+01	0.00E+01	2.96E+05	0.00E+01
Co-58	1.30E+06	7.80E+06	0.00E+01	5.66E+05	0.00E+01	0.00E+01	0.00E+01	0.00E+01
Co-60	4.66E+06	2.69E+07	0.00E+01	2.07E+06	0.00E+01	0.00E+01	0.00E+01	0.00E+01
Zn-65	2.86E+08	2.60E+08	1.77E+08	6.13E+08	3.93E+08	0.00E+01	0.00E+01	0.00E+01
Rb-86	1.66E+08	5.24E+07	0.00E+01	3.54E+08	0.00E+01	0.00E+01	0.00E+01	0.00E+01
Sr-89	9.65E+07	4.01E+08	3.37E+09	0.00E+01	0.00E+01	0.00E+01	0.00E+01	0.00E+01
Sr-90	2.27E+10	2.58E+09	9.18E+10	0.00E+01	0.00E+01	0.00E+01	0.00E+01	0.00E+01
Y-91	3.02E+01	4.62E+05	1.13E+03	0.00E+01	0.00E+01	0.00E+01	0.00E+01	0.00E+01
Zr-95	2.56E+01	8.59E+04	1.18E+02	3.72E+01	5.47E+01	0.00E+01	0.00E+01	0.00E+01
Nb-95	3.09E+03	2.40E+07	1.01E+04	5.62E+03	5.45E+03	0.00E+01	0.00E+01	0.00E+01
Ru-103	5.58E+01	1.09E+04	1.30E+02	0.00E+01	4.60E+02	0.00E+01	0.00E+01	0.00E+01
Ru-106	3.51E+02	1.34E+05	2.79E+03	0.00E+01	5.38E+03	0.00E+01	0.00E+01	0.00E+01
Aq-110M	4.24E+06	1.96E+09	7.37E+06	6.97E+06	1.33E+07	0.00E+01	0.00E+01	0.00E+01
Sn-113	2.28E+05	2.58E+06	2.15E+05	9.06E+03	6.37E+03	2.97E+03	0.00E+01	0.00E+01
Sb-124	1.29E+06	6.67E+07	3.31E+06	6.10E+04	0.00E+01	7.51E+03	2.89E+06	0.00E+01
Te-127M	8.87E+05	1.86E+07	7.46E+06	2.65E+06	3.02E+07	1.77E+06	0.00E+01	0.00E+01
Te-129M	1.36E+06	3.22E+07	8.58E+06	3.19E+06	3.59E+07	2.77E+06	0.00E+01	0.00E+01
I-131	3.18E+08	1.17E+08	4.22E+08	5.91E+08	1.02E+09	1.73E+11	0.00E+01	0.00E+01
I-132	2.19E+01	2.66E+01	2.33E+01	6.11E+01	9.62E+01	2.06E+01	0.00E+01	0.00E+01
I-133	2.99E+06	7.43E+06	5.79E+06	9.81E+06	1.72E+07	1.37E+09	0.00E+01	0.00E+01
I-135	1.90E+04	5.63E+04	1.99E+04	5.13E+04	8.10E+04	3.30E+06	0.00E+01	0.00E+01
Cs-134	1.96E+10	5.26E+08	1.80E+10	4.23E+10	1.34E+10	0.00E+01	5.13E+09	0.00E+01
Cs-136	2.25E+09	2.69E+07	8.50E+08	3.34E+09	1.82E+09	0.00E+01	2.87E+08	0.00E+01
Cs-137	1.19E+10	4.85E+08	2.56E+10	3.41E+10	1.16E+10	0.00E+01	4.51E+09	0.00E+01
Ba-140	2.39E+05	5.72E+06	3.71E+06	4.55E+03	1.54E+03	0.00E+01	3.06E+03	0.00E+01
Ce-141	4.91E+01	1.22E+06	6.40E+02	4.27E+02	2.01E+02	0.00E+01	0.00E+01	0.00E+01
Ce-144	2.55E+03	1.19E+07	4.74E+04	1.96E+04	1.17E+04	0.00E+01	0.00E+01	0.00E+01
Hf-181	1.41E+02	6.34E+04	1.27E+03	6.97E+00	5.80E+00	4.26E+00	0.00E+01	0.00E+01

*R Values in units of mrem/yr per $\mu\text{Ci}/\text{m}^3$ for inhalation and tritium and in units of mrem/yr per $\mu\text{Ci}/\text{sec}$ per m^2 for all others.

TABLE 3.3-14
R VALUES FOR THE SHEARON HARRIS NUCLEAR POWER PLANT*

PATHWAY = Goat Milk

AGE GROUP = Child

Nuclide	T. Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
H-3	3.23E+03	3.23E+03	0.00E+01	3.23E+03	3.23E+03	3.23E+03	3.23E+03	3.23E+03
P-32	2.35E+09	1.69E+09	6.11E+10	2.86E+09	0.00E+01	0.00E+01	0.00E+01	0.00E+01
Cr-51	7.40E+03	3.93E+05	0.00E+01	0.00E+01	1.12E+03	4.11E+03	7.50E+03	0.00E+01
Mn-54	4.07E+05	1.28E+06	0.00E+01	1.53E+06	4.29E+05	0.00E+01	0.00E+01	0.00E+01
Fe-59	7.52E+05	1.57E+06	9.34E+05	1.51E+06	0.00E+01	0.00E+01	4.38E+05	0.00E+01
Co-58	2.65E+06	5.05E+06	0.00E+01	8.65E+05	0.00E+01	0.00E+01	0.00E+01	0.00E+01
Co-60	9.48E+06	1.78E+07	0.00E+01	3.21E+06	0.00E+01	0.00E+01	0.00E+01	0.00E+01
Zn-65	5.74E+08	1.62E+08	3.47E+08	9.24E+08	5.82E+08	0.00E+01	0.00E+01	0.00E+01
Rb-86	4.04E+08	4.22E+07	0.00E+01	6.57E+08	0.00E+01	0.00E+01	0.00E+01	0.00E+01
Sr-89	2.38E+08	3.23E+08	8.34E+09	0.00E+01	0.00E+01	0.00E+01	0.00E+01	0.00E+01
Sr-90	3.93E+10	2.09E+09	1.55E+11	0.00E+01	0.00E+01	0.00E+01	0.00E+01	0.00E+01
Y-91	7.45E+01	3.71E+05	2.79E+03	0.00E+01	0.00E+01	0.00E+01	0.00E+01	0.00E+01
Zr-95	5.36E+01	6.28E+04	2.74E+02	6.02E+01	8.62E+01	0.00E+01	0.00E+01	0.00E+01
Nb-95	6.37E+03	1.65E+07	2.29E+04	8.91E+03	8.37E+03	0.00E+01	0.00E+01	0.00E+01
Ru-103	1.19E+02	7.98E+03	3.09E+02	0.00E+01	7.77E+02	0.00E+01	0.00E+01	0.00E+01
Ru-106	8.56E+02	1.07E+05	6.86E+03	0.00E+01	9.27E+03	0.00E+01	0.00E+01	0.00E+01
Aq-110M	8.63E+06	1.28E+09	1.60E+07	1.08E+07	2.01E+07	0.00E+01	0.00E+01	0.00E+01
Sn-113	4.61E+05	1.69E+06	4.22E+05	1.36E+04	9.38E+03	5.59E+03	0.00E+01	0.00E+01
Sb-124	2.75E+06	4.91E+07	7.84E+06	1.02E+05	0.00E+01	1.73E+04	4.35E+06	0.00E+01
Te-127M	2.18E+06	1.49E+07	1.84E+07	4.95E+06	5.24E+07	4.40E+06	0.00E+01	0.00E+01
Te-129M	3.28E+06	2.58E+07	2.12E+07	5.91E+06	6.21E+07	6.82E+06	0.00E+01	0.00E+01
I-131	5.85E+08	9.17E+07	1.02E+09	1.03E+09	1.69E+09	3.41E+11	0.00E+01	0.00E+01
I-132	4.67E+01	1.19E+00	5.52E+01	1.01E+00	1.55E+00	4.71E+01	0.00E+01	0.00E+01
I-133	6.58E+06	7.00E+06	1.41E+07	1.74E+07	2.90E+07	3.23E+09	0.00E+01	0.00E+01
I-135	4.01E+04	6.47E+04	4.72E+04	8.49E+04	1.30E+05	7.52E+06	0.00E+01	0.00E+01
Cs-134	1.43E+10	3.67E+08	4.14E+10	6.80E+10	2.11E+10	0.00E+01	7.56E+09	0.00E+01
Cs-136	3.41E+09	1.85E+08	1.92E+09	5.27E+09	2.81E+09	0.00E+01	4.19E+08	0.00E+01
Cs-137	8.72E+09	3.70E+08	6.17E+10	5.91E+10	1.93E+10	0.00E+01	6.93E+09	0.00E+01
Ba-140	5.23E+05	4.54E+05	8.96E+06	7.85E+03	2.56E+03	0.00E+01	4.68E+03	0.00E+01
Ce-141	1.17E+02	9.81E+05	1.53E+03	7.36E+02	3.45E+02	0.00E+01	0.00E+01	0.00E+01
Ce-144	6.24E+03	9.55E+06	1.17E+05	3.66E+04	2.03E+04	0.00E+01	0.00E+01	0.00E+01
Hf-181	3.04E+02	4.99E+04	3.02E+03	1.17E+01	9.43E+00	9.88E+00	0.00E+01	0.00E+01

*R Values in units of mrem/yr per $\mu\text{Ci}/\text{m}^3$ for inhalation and tritium and in units of mrem/yr per $\mu\text{Ci}/\text{sec}$ per m^2 for all others.

TABLE 3.3-15
R VALUES FOR THE SHEARON HARRIS NUCLEAR POWER PLANT*

PATHWAY = Goat Milk

AGE GROUP = Infant

Nuclide	T. Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
H-3	4.90E+03	4.90E+03	0.00E+01	4.90E+03	4.90E+03	4.90E+03	4.90E+03	4.90E+03
P-32	4.88E+09	1.70E+09	1.26E+11	7.40E+09	0.00E+01	0.00E+01	0.00E+01	0.00E+01
Cr-51	1.17E+04	3.42E+05	0.00E+01	0.00E+01	1.67E+03	7.65E+03	1.49E+04	0.00E+01
Mn-54	6.45E+05	1.04E+06	0.00E+01	2.84E+06	6.30E+05	0.00E+01	0.00E+01	0.00E+01
Fe-59	1.20E+06	1.45E+06	1.74E+06	3.04E+06	0.00E+01	0.00E+01	9.00E+05	0.00E+01
Co-58	4.31E+06	4.31E+06	0.00E+01	1.73E+06	0.00E+01	0.00E+01	0.00E+01	0.00E+01
Co-60	1.55E+07	1.56E+07	0.00E+01	6.56E+06	0.00E+01	0.00E+01	0.00E+01	0.00E+01
Zn-65	7.36E+08	1.35E+09	4.66E+08	1.60E+09	7.74E+08	0.00E+01	0.00E+01	0.00E+01
Rb-86	8.23E+08	4.26E+07	0.00E+01	1.67E+09	0.00E+01	0.00E+01	0.00E+01	0.00E+01
Sr-89	4.55E+08	3.26E+08	1.59E+10	0.00E+01	0.00E+01	0.00E+01	0.00E+01	0.00E+01
Sr-90	4.30E+10	2.11E+09	1.69E+11	0.00E+01	0.00E+01	0.00E+01	0.00E+01	0.00E+01
Y-91	1.39E+02	3.75E+05	5.23E+03	0.00E+01	0.00E+01	0.00E+01	0.00E+01	0.00E+01
Zr-95	8.41E+01	5.90E+04	4.85E+02	1.19E+02	1.28E+02	0.00E+01	0.00E+01	0.00E+01
Nb-95	1.02E+04	1.48E+07	4.27E+04	1.76E+04	1.26E+04	0.00E+01	0.00E+01	0.00E+01
Ru-103	2.09E+02	7.60E+03	6.25E+02	0.00E+01	1.30E+03	0.00E+01	0.00E+01	0.00E+01
Ru-106	1.77E+03	1.07E+05	1.41E+04	0.00E+01	1.67E+04	0.00E+01	0.00E+01	0.00E+01
Aq-110M	1.43E+07	1.12E+09	2.95E+07	2.16E+07	3.08E+07	0.00E+01	0.00E+01	0.00E+01
Sn-113	6.66E+05	1.37E+06	6.46E+05	2.45E+04	1.32E+04	9.34E+03	0.00E+01	0.00E+01
Sb-124	4.68E+06	4.66E+07	1.51E+07	2.22E+05	0.00E+01	4.01E+04	9.46E+06	0.00E+01
Te-127M	4.51E+06	1.50E+07	3.72E+07	1.23E+07	9.16E+07	1.08E+07	0.00E+01	0.00E+01
Te-129M	6.69E+06	2.59E+07	4.34E+07	1.49E+07	1.09E+08	1.67E+07	0.00E+01	0.00E+01
I-131	1.11E+09	8.99E+07	2.14E+09	2.52E+09	2.94E+09	8.28E+11	0.00E+01	0.00E+01
I-132	8.28E+01	1.88E+00	1.15E+00	2.33E+00	2.59E+00	1.09E+02	0.00E+01	0.00E+01
I-133	1.27E+07	7.31E+06	2.97E+07	4.32E+07	5.08E+07	7.86E+09	0.00E+01	0.00E+01
I-135	7.11E+04	7.06E+04	9.81E+04	1.95E+05	2.17E+05	1.75E+07	0.00E+01	0.00E+01
Cs-134	1.26E+10	3.38E+08	6.68E+10	1.25E+11	3.21E+10	0.00E+01	1.31E+10	0.00E+01
Cs-136	4.11E+09	1.67E+08	3.75E+09	1.10E+10	4.39E+09	0.00E+01	8.98E+08	0.00E+01
Cs-137	8.17E+09	3.61E+08	9.85E+10	1.15E+11	3.10E+10	0.00E+01	1.25E+10	0.00E+01
Ba-140	9.50E+05	4.53E+06	1.84E+07	1.84E+04	4.38E+03	0.00E+01	1.13E+04	0.00E+01
Ce-141	2.24E+02	9.85E+05	3.13E+03	1.91E+03	5.88E+02	0.00E+01	0.00E+01	0.00E+01
Ce-144	9.39E+03	9.61E+06	1.67E+05	6.86E+04	2.77E+04	0.00E+01	0.00E+01	0.00E+01
Hf-181	5.08E+02	4.72E+04	5.74E+03	2.71E+01	1.58E+01	2.30E+01	0.00E+01	0.00E+01

*R Values in units of mrem/yr per $\mu\text{Ci}/\text{m}^3$ for inhalation and tritium and in units of mrem/yr per $\mu\text{Ci}/\text{sec}$ per m^2 for all others.

TABLE 3.3-16
R VALUES FOR THE SHEARON HARRIS NUCLEAR POWER PLANT*

PATHWAY = Inhalation

AGE GROUP = Adult

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	Gi-LLi
H-3	0.00E+00	1.26E+03	1.26E+03	1.26E+03	1.26E+03	1.26E+03	1.26E+03
C-14	1.82E+04	3.41E+03	3.41E+03	3.41E+03	3.41E+03	3.41E+03	3.41E+03
Na-24	1.04E+04	1.04E+04	1.04E+04	1.04E+04	1.04E+04	1.04E+04	1.04E+04
P-32	1.32E+06	7.70E+04	5.00E+04	0.00E+00	0.00E+00	0.00E+00	8.63E+04
Cr-51	0.00E+00	0.00E+00	9.99E+01	5.94E+01	2.28E+01	1.44E+04	3.32E+03
Mn-54	0.00E+00	3.95E+04	6.29E+03	0.00E+00	9.83E+03	1.40E+06	7.72E+04
Mn-56	0.00E+00	1.26E+00	1.85E-01	0.00E+00	1.32E+00	9.56E+03	2.05E+04
Fe-55	2.49E+04	1.72E+04	3.99E+03	0.00E+00	0.00E+00	7.30E+04	6.11E+03
Fe-59	1.17E+04	2.77E+04	1.05E+04	0.00E+00	0.00E+00	1.01E+06	1.88E+05
Co-57	0.00E+00	7.01E+02	6.80E+02	0.00E+00	0.00E+00	3.74E+05	3.18E+04
Co-58	0.00E+00	1.58E+03	2.07E+03	0.00E+00	0.00E+00	9.27E+05	1.06E+05
Co-60	0.00E+00	1.15E+04	1.48E+04	0.00E+00	0.00E+00	5.96E+06	2.84E+05
Ni-63	4.37E+05	3.18E+04	1.47E+04	0.00E+00	0.00E+00	1.81E+05	1.35E+04
Ni-65	1.56E+00	2.12E-01	9.23E-02	0.00E+00	0.00E+00	5.67E+03	1.25E+04
Cu-64	0.00E+00	1.48E+00	6.23E-01	0.00E+00	4.68E+00	6.87E+03	4.96E+04
Zn-65	3.24E+04	1.03E+05	4.65E+04	0.00E+00	6.89E+04	8.63E+05	5.34E+04
Zn-69M	8.26E+00	1.98E+01	1.81E+00	0.00E+00	1.20E+01	1.93E+04	1.39E+05
Zn-69	3.43E-02	6.59E-02	4.58E-03	0.00E+00	4.27E-02	9.32E+02	1.65E+01
Br-82	0.00E+00	0.00E+00	1.37E+04	0.00E+00	0.00E+00	0.00E+00	1.05E+04
Br-83	0.00E+00	0.00E+00	2.44E+02	0.00E+00	0.00E+00	0.00E+00	2.35E+02
Br-84	0.00E+00	0.00E+00	3.17E+02	0.00E+00	0.00E+00	0.00E+00	1.66E-03
Br-85	0.00E+00	0.00E+00	1.30E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.35E+05	5.89E+04	0.00E+00	0.00E+00	0.00E+00	1.66E+04
Rb-88	0.00E+00	3.92E+02	1.95E+02	0.00E+00	0.00E+00	0.00E+00	3.39E-09
Rb-89	0.00E+00	2.59E+02	1.72E+02	0.00E+00	0.00E+00	0.00E+00	9.40E-12
Sr-89	3.04E+05	0.00E+00	8.71E+03	0.00E+00	0.00E+00	1.40E+06	3.49E+05
Sr-90	9.91E+07	0.00E+00	6.09E+06	0.00E+00	0.00E+00	9.59E+06	7.21E+05
Sr-91	6.27E+01	0.00E+00	2.54E+00	0.00E+00	0.00E+00	3.69E+04	1.94E+05
Sr-92	6.83E+00	0.00E+00	2.95E-01	0.00E+00	0.00E+00	1.67E+04	4.36E+04
Y-90	2.11E+03	0.00E+00	5.68E+01	0.00E+00	0.00E+00	1.72E+05	5.12E+05
Y-91M	2.64E-01	0.00E+00	1.03E-02	0.00E+00	0.00E+00	1.94E+03	1.34E+00
Y-91	4.62E+05	0.00E+00	1.24E+04	0.00E+00	0.00E+00	1.70E+06	3.84E+05
Y-92	1.04E+01	0.00E+00	3.05E-01	0.00E+00	0.00E+00	1.59E+04	7.44E+04
Y-93	9.56E+01	0.00E+00	2.64E+00	0.00E+00	0.00E+00	4.91E+04	4.27E+05
Zr-95	1.07E+05	3.44E+04	2.32E+04	0.00E+00	5.41E+04	1.77E+06	1.50E+05
Zr-97	9.80E+01	1.98E+01	9.15E+00	0.00E+00	3.01E+01	7.97E+04	5.30E+05
Nb-95	1.41E+04	7.80E+03	4.20E+03	0.00E+00	7.72E+03	5.04E+05	1.04E+05
Nb-97	2.25E-01	5.69E-02	2.07E-02	0.00E+00	6.63E-02	2.43E+03	2.45E+02
Mo-99	0.00E+00	1.22E+02	2.32E+01	0.00E+00	2.95E+02	9.23E+04	2.51E+05
Tc-99M	1.04E-03	2.95E-03	3.75E-02	0.00E+00	4.47E-02	7.74E+02	4.21E+03

*R Values in units of mrem/yr per $\mu\text{Ci}/\text{m}^3$ for inhalation and tritium and in units of mrem/yr per $\mu\text{Ci}/\text{sec}$ per m^2 for all others.

Shearon Harris Nuclear Power Plant
Offsite Dose Calculation Manual (ODCM)

Revision 30

TABLE 3.3-16 (continue)
R VALUES FOR THE SHEARON HARRIS NUCLEAR POWER PLANT*

PATHWAY = Inhalation

AGE GROUP = Adult

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLi
Tc-101	4.23E-05	6.09E-05	5.98E-04	0.00E+00	1.09E-03	4.04E+02	1.10E-11
Ru-103	1.53E+03	0.00E+00	6.57E+02	0.00E+00	5.82E+03	5.04E+05	1.10E+05
Ru-105	8.00E-01	0.00E+00	3.15E-01	0.00E+00	1.03E+00	1.11E+04	4.88E+04
Ru-106	6.90E+04	0.00E+00	8.71E+03	0.00E+00	1.33E+05	9.35E+06	9.11E+05
Ag-110M	1.08E+04	9.99E+03	5.94E+03	0.00E+00	1.97E+04	4.63E+06	3.02E+05
Sn-113	6.86E+03	2.69E+02	6.48E+03	9.33E+01	1.97E+02	2.99E+05	2.48E+04
Sb-124	3.12E+04	5.88E+02	1.24E+04	7.55E+01	0.00E+00	2.48E+06	4.06E+05
Sb-125	5.40E+04	6.03E+02	1.28E+04	5.47E+01	0.00E+00	1.77E+06	1.02E+05
Te-125M	3.46E+03	1.60E+03	4.73E+02	1.06E+03	1.26E+04	3.18E+05	7.15E+04
Te-127m	1.26E+04	5.76E+03	1.57E+03	3.28E+03	4.57E+04	9.59E+05	1.49E+05
Te-127	1.42E+00	6.50E-01	3.13E-01	1.07E+00	5.16E+00	6.59E+03	5.81E+04
Te-129M	9.75E+03	4.67E+03	1.58E+03	3.44E+03	3.65E+04	1.16E+06	3.83E+05
Te-129	5.04E-02	2.42E-02	1.26E-02	3.94E-02	1.90E-01	1.96E+03	1.59E+02
Te-131M	7.08E+01	4.41E+01	2.94E+01	5.57E+01	3.13E+02	1.47E+05	5.63E+05
Te-131	1.13E-02	6.03E-03	3.64E-03	9.48E-03	4.42E-02	1.41E+03	1.86E+01
Te-132	2.63E+02	2.18E+02	1.64E+02	1.92E+02	1.47E+03	2.92E+05	5.16E+05
I-130	4.63E+03	1.36E+04	5.35E+03	1.15E+06	2.11E+04	0.00E+00	7.78E+03
I-131	2.52E+04	3.57E+04	2.05E+04	1.19E+07	6.12E+04	0.00E+00	6.27E+03
I-132	1.16E+03	3.25E+03	1.16E+03	1.14E+05	5.18E+03	0.00E+00	4.06E+02
I-133	8.63E+03	1.48E+04	4.51E+03	2.15E+06	2.58E+04	0.00E+00	8.87E+03
I-134	6.52E+02	1.75E+03	6.23E+02	3.02E+04	2.79E+03	0.00E+00	1.02E+00
I-135	2.68E+03	6.97E+03	2.56E+03	4.47E+05	1.11E+04	0.00E+00	5.24E+03
Cs-134	3.72E+05	8.47E+05	7.27E+05	0.00E+00	2.87E+05	9.75E+04	1.04E+04
Cs-136	3.90E+04	1.46E+05	1.10E+05	0.00E+00	8.55E+04	1.20E+04	1.17E+04
Cs-137	4.78E+05	6.20E+05	4.27E+05	0.00E+00	2.22E+05	7.51E+04	8.39E+03
Cs-138	3.35E+02	6.29E+02	3.28E+02	0.00E+00	4.86E+02	4.92E+01	1.89E-03
Ba-139	9.48E-01	6.74E-04	2.77E-02	0.00E+00	6.30E-04	3.81E+03	9.07E+02
Ba-140	3.90E+04	4.90E+01	2.56E+03	0.00E+00	1.67E+01	1.27E+06	2.18E+05
Ba-141	1.01E-01	7.62E-05	3.40E-03	0.00E+00	7.09E-05	1.96E+03	1.17E-07
Ba-142	2.66E-02	2.74E-05	1.68E-03	0.00E+00	2.32E-05	1.21E+03	1.59E-16
La-140	3.48E+02	1.76E+02	4.64E+01	0.00E+00	0.00E+00	1.38E+05	4.64E+05
La-142	6.92E-01	3.14E-01	7.82E-02	0.00E+00	0.00E+00	6.41E+03	2.14E+03
Ce-141	1.99E+04	1.35E+04	1.53E+03	0.00E+00	6.25E+03	3.61E+05	1.20E+05
Ce-143	1.89E+02	1.39E+02	1.55E+01	0.00E+00	6.16E+01	8.08E+04	2.29E+05
Ce-144	3.43E+06	1.43E+06	1.84E+05	0.00E+00	8.47E+05	7.76E+06	8.15E+05
Pr-143	9.48E+03	3.80E+03	4.70E+02	0.00E+00	2.19E+03	2.84E+05	2.03E+05
Pr-144	3.05E-02	1.26E-02	1.55E-03	0.00E+00	7.14E-03	1.03E+03	2.18E-08
Nd-147	5.34E+03	6.17E+03	3.69E+02	0.00E+00	3.60E+03	2.24E+05	1.75E+05
Hf-181	4.56E+04	2.57E+02	5.16E+03	1.63E+02	2.15E+02	5.99E+05	1.29E+05
W-187	8.59E+00	7.17E+00	2.51E+00	0.00E+00	0.00E+00	2.94E+04	1.57E+05
Np-239	2.32E+02	2.28E+01	1.26E+01	0.00E+00	7.09E+01	3.81E+04	1.21E+05

*R Values in units of mrem/yr per $\mu\text{Ci}/\text{m}^3$ for inhalation and tritium and in units of mrem/yr per $\mu\text{Ci}/\text{sec}$ per m^2 for all others.

TABLE 3.3-17
R VALUES FOR THE SHEARON HARRIS NUCLEAR POWER PLANT*

PATHWAY = Inhalation

AGE GROUP = Teen

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLi
H-3	0.00E+00	1.27E+03	1.27E+03	1.27E+03	1.27E+03	1.27E+03	1.27E+03
C-14	2.60E+04	4.87E+03	4.87E+03	4.87E+03	4.87E+03	4.87E+03	4.87E+03
Na-24	1.38E+04	1.38E+04	1.38E+04	1.38E+04	1.38E+04	1.38E+04	1.38E+04
P-32	1.89E+06	1.09E+05	7.15E+04	0.00E+00	0.00E+00	0.00E+00	9.27E+04
Cr-51	0.00E+00	0.00E+00	1.35E+02	7.49E+01	3.07E+01	2.09E+04	3.00E+03
Mn-54	0.00E+00	5.10E+04	8.39E+03	0.00E+00	1.27E+04	1.98E+06	6.67E+04
Mn-56	0.00E+00	1.70E+00	2.52E-01	0.00E+00	1.79E+00	1.52E+04	5.74E+04
Fe-55	3.34E+04	2.38E+04	5.54E+03	0.00E+00	0.00E+00	1.24E+05	6.39E+03
Fe-59	1.59E+04	3.69E+04	1.43E+04	0.00E+00	0.00E+00	1.53E+06	1.78E+05
Co-57	0.00E+00	9.44E+02	9.20E+02	0.00E+00	0.00E+00	5.86E+05	3.14E+04
Co-58	0.00E+00	2.07E+03	2.77E+03	0.00E+00	0.00E+00	1.34E+06	9.51E+04
Co-60	0.00E+00	1.51E+04	1.98E+04	0.00E+00	0.00E+00	8.71E+06	2.59E+05
Ni-63	5.80E+05	4.34E+04	1.98E+04	0.00E+00	0.00E+00	3.07E+05	1.42E+04
Ni-65	2.18E+00	2.93E-01	1.27E-01	0.00E+00	0.00E+00	9.36E+03	3.67E+04
Cu-64	0.00E+00	2.03E+00	8.48E-01	0.00E+00	6.41E+00	1.11E+04	6.14E+04
Zn-65	3.85E+04	1.33E+05	6.23E+04	0.00E+00	8.63E+04	1.24E+06	4.66E+04
Zn-69M	1.15E+01	2.71E+01	2.49E+00	0.00E+00	1.65E+01	3.14E+04	1.71E+05
Zn-69	4.83E-02	9.20E-02	6.46E-03	0.00E+00	6.02E-02	1.58E+03	2.85E+02
Br-82	0.00E+00	0.00E+00	1.82E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-83	0.00E+00	0.00E+00	3.44E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	4.33E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	1.83E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.90E+05	8.39E+04	0.00E+00	0.00E+00	0.00E+00	1.77E+04
Rb-88	0.00E+00	5.46E+02	2.72E+02	0.00E+00	0.00E+00	0.00E+00	2.92E-05
Rb-89	0.00E+00	3.52E+02	2.33E+02	0.00E+00	0.00E+00	0.00E+00	3.38E-07
Sr-89	4.34E+05	0.00E+00	1.25E+04	0.00E+00	0.00E+00	2.41E+06	3.71E+05
Sr-90	1.08E+08	0.00E+00	6.67E+06	0.00E+00	0.00E+00	1.65E+07	7.64E+05
Sr-91	8.80E+01	0.00E+00	3.51E+00	0.00E+00	0.00E+00	6.07E+04	2.59E+05
Sr-92	9.52E+00	0.00E+00	4.06E-01	0.00E+00	0.00E+00	2.74E+04	1.19E+05
Y-90	2.98E+03	0.00E+00	8.00E+01	0.00E+00	0.00E+00	2.93E+05	5.59E+05
Y-91M	3.70E-01	0.00E+00	1.42E-02	0.00E+00	0.00E+00	3.20E+03	3.02E+01
Y-91	6.60E+05	0.00E+00	1.77E+04	0.00E+00	0.00E+00	2.93E+06	4.08E+05
Y-92	1.47E+01	0.00E+00	4.29E-01	0.00E+00	0.00E+00	2.68E+04	1.65E+05
Y-93	1.35E+02	0.00E+00	3.72E+00	0.00E+00	0.00E+00	8.32E+04	5.79E+05
Zr-95	1.45E+05	4.58E+04	3.15E+04	0.00E+00	6.73E+04	2.68E+06	1.49E+05
Zr-97	1.38E+02	2.72E+01	1.26E+01	0.00E+00	4.12E+01	1.30E+05	6.30E+05
Nb-95	1.85E+04	1.03E+04	5.66E+03	0.00E+00	9.99E+03	7.50E+05	9.67E+04
Nb-97	3.14E-01	7.78E-02	2.84E-02	0.00E+00	9.12E-02	3.93E+03	2.17E+03
Mo-99	0.00E+00	1.69E+02	3.22E+01	0.00E+00	4.11E+02	1.54E+05	2.69E+05
Tc-99M	1.38E-03	3.86E-03	4.99E-02	0.00E+00	5.76E-02	1.15E+03	6.13E+03

*R Values in units of mrem/yr per $\mu\text{Ci}/\text{m}^3$ for inhalation and tritium and in units of mrem/yr per $\mu\text{Ci}/\text{sec}$ per m^2 for all others.

Shearon Harris Nuclear Power Plant
Offsite Dose Calculation Manual (ODCM)

Revision 30

TABLE 3.3-17 (continue)
R VALUES FOR THE SHEARON HARRIS NUCLEAR POWER PLANT*

PATHWAY = Inhalation

AGE GROUP = Teen

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLi
Tc-101	5.92E-05	8.40E-05	8.24E-04	0.00E+00	1.52E-03	6.67E+02	8.72E-07
Ru-103	2.10E+03	0.00E+00	8.95E+02	0.00E+00	7.42E+03	7.82E+05	1.09E+05
Ru-105	1.12E+00	0.00E+00	4.34E-01	0.00E+00	1.41E+00	1.82E+04	9.04E+04
Ru-106	9.83E+04	0.00E+00	1.24E+04	0.00E+00	1.90E+05	1.61E+07	9.59E+05
Ag-110M	1.38E+04	1.31E+04	7.98E+03	0.00E+00	2.50E+04	6.74E+06	2.72E+05
Sn-113	8.19E+03	3.44E+02	8.68E+03	1.13E+02	2.45E+02	4.27E+05	2.03E+04
Sb-124	4.30E+04	7.94E+02	1.68E+04	9.76E+01	0.00E+00	3.85E+06	3.98E+05
Sb-125	7.38E+04	8.08E+02	1.72E+04	7.04E+01	0.00E+00	2.74E+06	9.92E+04
Te-125M	4.88E+03	2.24E+03	6.67E+02	1.40E+03	0.00E+00	5.36E+05	7.50E+04
Te-127m	1.80E+04	8.15E+03	2.18E+03	4.38E+03	6.53E+04	1.65E+06	1.59E+05
Te-127	2.01E+00	9.12E-01	4.42E-01	1.42E+00	7.28E+00	1.12E+04	8.08E+04
Te-129M	1.39E+04	6.57E+03	2.24E+03	4.57E+03	5.18E+04	1.97E+06	4.04E+05
Te-129	7.10E-02	3.38E-02	1.76E-02	5.18E-02	2.66E-01	3.30E+03	1.62E+03
Te-131M	9.84E+01	6.01E+01	4.02E+01	7.25E+01	4.39E+02	2.38E+05	6.21E+05
Te-131	1.58E-02	8.32E-03	5.04E-03	1.24E-02	6.18E-02	2.34E+03	1.51E+01
Te-132	3.60E+02	2.90E+02	2.19E+02	2.46E+02	1.95E+03	4.49E+05	4.63E+05
I-130	6.24E+03	1.79E+04	7.17E+03	1.49E+06	2.75E+04	0.00E+00	9.12E+03
I-131	3.54E+04	4.90E+04	2.64E+04	1.46E+07	8.39E+04	0.00E+00	6.48E+03
I-132	1.59E+03	4.37E+03	1.57E+03	1.51E+05	6.91E+03	0.00E+00	1.27E+03
I-133	1.21E+04	2.05E+04	6.21E+03	2.92E+06	3.59E+04	0.00E+00	1.03E+04
I-134	8.88E+02	2.32E+03	8.40E+02	3.95E+04	3.66E+03	0.00E+00	2.04E+01
I-135	3.69E+03	9.43E+03	3.48E+03	6.20E+05	1.49E+04	0.00E+00	6.94E+03
Cs-134	5.02E+05	1.13E+06	5.48E+05	0.00E+00	3.75E+05	1.46E+05	9.75E+03
Cs-136	5.14E+04	1.93E+05	1.37E+05	0.00E+00	1.10E+05	1.77E+04	1.09E+04
Cs-137	6.69E+05	8.47E+05	3.11E+05	0.00E+00	3.04E+05	1.21E+05	8.48E+03
Cs-138	4.66E+02	8.56E+02	4.46E+02	0.00E+00	6.62E+02	7.87E+01	2.70E-01
Ba-139	1.34E+00	9.44E-04	3.90E-02	0.00E+00	8.88E-04	6.46E+03	6.45E+03
Ba-140	5.46E+04	6.69E+01	3.51E+03	0.00E+00	2.28E+01	2.03E+06	2.28E+05
Ba-141	1.42E-01	1.06E-04	4.74E-03	0.00E+00	9.84E-05	3.29E+03	7.46E-04
Ba-142	3.70E-02	3.70E-05	2.27E-03	0.00E+00	3.14E-05	1.91E+03	4.79E-10
La-140	4.79E+02	2.36E+02	6.26E+01	0.00E+00	0.00E+00	2.14E+05	4.87E+05
La-142	9.60E-01	4.25E-01	1.06E-01	0.00E+00	0.00E+00	1.02E+04	1.20E+04
Ce-141	2.84E+04	1.89E+04	2.16E+03	0.00E+00	8.87E+03	6.13E+05	1.26E+05
Ce-143	2.66E+02	1.94E+02	2.16E+01	0.00E+00	8.64E+01	1.30E+05	2.55E+05
Ce-144	4.88E+06	2.02E+06	2.62E+05	0.00E+00	1.21E+06	1.33E+07	8.63E+05
Pr-143	1.34E+04	5.31E+03	6.62E+02	0.00E+00	3.09E+03	4.83E+05	2.14E+05
Pr-144	4.30E-02	1.76E-02	2.18E-03	0.00E+00	1.01E-02	1.75E+03	2.35E-04
Nd-147	7.86E+03	8.56E+03	5.13E+02	0.00E+00	5.02E+03	3.72E+05	1.82E+05
Hf-181	6.32E+04	3.48E+02	7.04E+03	2.12E+02	2.90E+02	9.39E+05	1.20E+05
W-187	1.20E+01	9.76E+00	3.43E+00	0.00E+00	0.00E+00	4.74E+04	1.77E+05
Np-239	3.38E+02	3.19E+01	1.77E+01	0.00E+00	1.00E+02	6.49E+04	1.32E+05

*R Values in units of mrem/yr per $\mu\text{Ci}/\text{m}^3$ for inhalation and tritium and in units of mrem/yr per $\mu\text{Ci}/\text{sec}$ per m^2 for all others.

TABLE 3.3-18
R VALUES FOR THE SHEARON HARRIS NUCLEAR POWER PLANT*

PATHWAY = Inhalation

AGE GROUP = Child

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	Gi-LLi
H-3	0.00E+00	1.12E+03	1.12E+03	1.12E+03	1.12E+03	1.12E+03	1.12E+03
C-14	3.59E+04	6.73E+03	6.73E+03	6.73E+03	6.73E+03	6.73E+03	6.73E+03
Na-24	2.39E+04	2.39E+04	2.39E+04	2.39E+04	2.39E+04	2.39E+04	2.39E+04
P-32	2.60E+06	1.14E+05	9.86E+04	0.00E+00	0.00E+00	0.00E+00	4.21E+04
Cr-51	0.00E+00	0.00E+00	1.54E+02	8.53E+01	2.43E+01	1.70E+04	1.08E+03
Mn-54	0.00E+00	4.29E+04	9.50E+03	0.00E+00	1.00E+04	1.57E+06	2.29E+04
Mn-56	0.00E+00	2.46E+00	4.64E-01	0.00E+00	2.49E+00	1.95E+04	1.83E+05
Fe-55	4.74E+04	2.52E+04	7.77E+03	0.00E+00	0.00E+00	1.11E+05	2.87E+03
Fe-59	2.07E+04	3.34E+04	1.67E+04	0.00E+00	0.00E+00	1.27E+06	7.06E+04
Co-57	0.00E+00	9.03E+02	1.07E+03	0.00E+00	0.00E+00	5.07E+05	1.32E+04
Co-58	0.00E+00	1.77E+03	3.16E+03	0.00E+00	0.00E+00	1.10E+06	3.43E+04
Co-60	0.00E+00	1.31E+04	2.26E+04	0.00E+00	0.00E+00	7.06E+06	9.61E+04
Ni-63	8.21E+05	4.63E+04	2.80E+04	0.00E+00	0.00E+00	2.75E+05	6.33E+03
Ni-65	4.44E+00	4.39E-01	2.44E-01	0.00E+00	0.00E+00	1.22E+04	1.25E+05
Cu-64	0.00E+00	2.96E+00	1.60E+00	0.00E+00	8.97E+00	1.42E+04	5.46E+04
Zn-65	4.25E+04	1.13E+05	7.02E+04	0.00E+00	7.13E+04	9.94E+05	1.63E+04
Zn-69M	2.34E+01	4.00E+01	4.72E+00	0.00E+00	2.32E+01	4.05E+04	1.49E+05
Zn-69	9.96E-02	1.44E-01	1.33E-02	0.00E+00	8.69E-02	2.11E+03	1.51E+04
Br-82	0.00E+00	0.00E+00	3.11E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-83	0.00E+00	0.00E+00	7.04E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	8.14E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	3.76E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.98E+05	1.14E+05	0.00E+00	0.00E+00	0.00E+00	7.98E+03
Rb-88	0.00E+00	8.36E+02	5.45E+02	0.00E+00	0.00E+00	0.00E+00	2.56E+01
Rb-89	0.00E+00	5.13E+02	4.31E+02	0.00E+00	0.00E+00	0.00E+00	2.81E+00
Sr-89	5.99E+05	0.00E+00	1.72E+04	0.00E+00	0.00E+00	2.15E+06	1.67E+05
Sr-90	1.01E+08	0.00E+00	6.43E+06	0.00E+00	0.00E+00	1.47E+07	3.43E+05
Sr-91	1.80E+02	0.00E+00	6.82E+00	0.00E+00	0.00E+00	7.92E+04	2.59E+05
Sr-92	1.95E+01	0.00E+00	7.81E-01	0.00E+00	0.00E+00	3.57E+04	3.60E+05
Y-90	6.11E+03	0.00E+00	1.64E+02	0.00E+00	0.00E+00	3.89E+05	3.98E+05
Y-91M	7.54E-01	0.00E+00	2.74E-02	0.00E+00	0.00E+00	4.18E+03	2.55E+03
Y-91	9.13E+05	0.00E+00	2.43E+04	0.00E+00	0.00E+00	2.62E+06	1.84E+05
Y-92	3.03E+01	0.00E+00	8.64E-01	0.00E+00	0.00E+00	3.55E+04	3.55E+05
Y-93	2.77E+02	0.00E+00	7.59E+00	0.00E+00	0.00E+00	1.11E+05	5.78E+05
Zr-95	1.90E+05	4.17E+04	3.69E+04	0.00E+00	5.95E+04	2.23E+06	6.10E+04
Zr-97	2.79E+02	4.04E+01	2.38E+01	0.00E+00	5.78E+01	1.68E+05	5.22E+05
Nb-95	2.35E+04	9.16E+03	6.54E+03	0.00E+00	8.61E+03	6.13E+05	3.69E+04
Nb-97	6.38E-01	1.14E-01	5.36E-02	0.00E+00	1.27E-01	5.08E+03	4.14E+04
Mo-99	0.00E+00	2.56E+02	6.33E+01	0.00E+00	5.83E+02	2.01E+05	1.88E+05
Tc-99M	2.65E-03	5.18E-03	8.58E-02	0.00E+00	7.54E-02	1.41E+03	7.15E+03

*R Values in units of mrem/yr per $\mu\text{Ci}/\text{m}^3$ for inhalation and tritium and in units of mrem/yr per $\mu\text{Ci}/\text{sec}$ per m^2 for all others.

Shearon Harris Nuclear Power Plant
Offsite Dose Calculation Manual (ODCM)

Revision 30

TABLE 3.3-18 (continue)
R VALUES FOR THE SHEARON HARRIS NUCLEAR POWER PLANT*

PATHWAY = Inhalation

AGE GROUP = Child

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLi
Tc-101	1.20E-04	1.27E-04	1.60E-03	0.00E+00	2.16E-03	8.69E+02	2.43E+01
Ru-103	2.79E+03	0.00E+00	1.07E+03	0.00E+00	7.02E+03	6.61E+05	4.47E+04
Ru-105	2.27E+00	0.00E+00	8.25E-01	0.00E+00	2.00E+00	2.37E+04	1.48E+05
Ru-106	1.36E+05	0.00E+00	1.69E+04	0.00E+00	1.84E+05	1.43E+07	4.29E+05
Ag-110M	1.68E+04	1.14E+04	9.13E+03	0.00E+00	2.12E+04	5.47E+06	1.00E+05
Sn-113	9.00E+03	2.91E+02	9.83E+03	1.19E+02	2.02E+02	3.40E+05	7.45E+03
Sb-124	5.73E+04	7.40E+02	2.00E+04	1.26E+02	0.00E+00	3.24E+06	1.64E+05
Sb-125	9.84E+04	7.59E+02	2.07E+04	9.10E+01	0.00E+00	2.32E+06	4.03E+04
Te-125M	6.73E+03	2.33E+03	9.14E+02	1.92E+03	0.00E+00	4.77E+05	3.38E+04
Te-127m	2.48E+04	8.53E+03	3.01E+03	6.06E+03	6.35E+04	1.48E+06	7.13E+04
Te-127	4.12E+00	1.41E+00	9.08E-01	2.92E+00	1.05E+01	1.49E+04	8.36E+04
Te-129M	1.92E+04	6.84E+03	3.04E+03	6.32E+03	5.02E+04	1.76E+06	1.81E+05
Te-129	1.45E-01	5.20E-02	3.54E-02	1.06E-01	3.82E-01	4.36E+03	3.79E+04
Te-131M	2.00E+02	8.80E+01	7.54E+01	1.45E+02	5.94E+02	3.06E+05	4.58E+05
Te-131	3.23E-02	1.25E-02	9.79E-03	2.52E-02	8.75E-02	3.05E+03	1.98E+03
Te-132	7.15E+02	4.05E+02	3.92E+02	4.72E+02	2.63E+03	5.61E+05	2.05E+05
I-130	1.22E+04	2.44E+04	1.25E+04	2.74E+06	3.64E+04	0.00E+00	7.59E+03
I-131	4.80E+04	4.80E+04	2.72E+04	1.62E+07	7.87E+04	0.00E+00	2.84E+03
I-132	2.11E+03	4.06E+03	1.87E+03	1.93E+05	6.24E+03	0.00E+00	3.20E+03
I-133	1.66E+04	2.03E+04	7.68E+03	3.84E+06	3.37E+04	0.00E+00	5.47E+03
I-134	1.74E+03	3.21E+03	1.48E+03	7.54E+04	4.91E+03	0.00E+00	1.42E+03
I-135	4.91E+03	8.72E+03	4.14E+03	7.91E+05	1.34E+04	0.00E+00	4.43E+03
Cs-134	6.50E+05	1.01E+06	2.24E+05	0.00E+00	3.30E+05	1.21E+05	3.84E+03
Cs-136	6.50E+04	1.71E+05	1.16E+05	0.00E+00	9.53E+04	1.45E+04	4.17E+03
Cs-137	9.05E+05	8.24E+05	1.28E+05	0.00E+00	2.82E+05	1.04E+05	3.61E+03
Cs-138	9.41E+02	1.25E+03	8.25E+02	0.00E+00	9.24E+02	1.01E+02	4.01E+02
Ba-139	2.74E+00	1.46E-03	7.98E-02	0.00E+00	1.28E-03	8.58E+03	8.58E+04
Ba-140	7.39E+04	6.47E+01	4.32E+03	0.00E+00	2.11E+01	1.74E+06	1.02E+05
Ba-141	2.91E-01	1.62E-04	9.46E-03	0.00E+00	1.41E-04	4.34E+03	4.09E+02
Ba-142	7.43E-02	5.35E-05	4.15E-03	0.00E+00	4.33E-05	2.44E+03	4.08E+00
La-140	9.57E+02	3.34E+02	1.12E+02	0.00E+00	0.00E+00	2.72E+05	3.36E+05
La-142	1.93E+00	6.11E-01	1.92E-01	0.00E+00	0.00E+00	1.29E+04	1.13E+05
Ce-141	3.92E+04	1.95E+04	2.89E+03	0.00E+00	8.53E+03	5.43E+05	5.65E+04
Ce-143	5.44E+02	2.95E+02	4.27E+01	0.00E+00	1.24E+02	1.72E+05	1.89E+05
Ce-144	6.76E+06	2.11E+06	3.61E+05	0.00E+00	1.17E+06	1.19E+07	3.88E+05
Pr-143	1.85E+04	5.55E+03	9.14E+02	0.00E+00	3.00E+03	4.33E+05	9.73E+04
Pr-144	8.86E-02	2.74E-02	4.46E-03	0.00E+00	1.45E-02	2.33E+03	2.93E+02
Nd-147	1.08E+04	8.73E+03	6.81E+02	0.00E+00	4.81E+03	3.28E+05	8.21E+04
Hf-181	8.44E+04	3.28E+02	8.50E+03	2.76E+02	2.64E+02	7.95E+05	5.31E+04
W-187	2.43E+01	1.44E+01	6.44E+00	0.00E+00	0.00E+00	6.11E+04	1.35E+05
Np-239	6.93E+02	4.97E+01	3.49E+01	0.00E+00	1.45E+02	8.64E+04	9.52E+04

*R Values in units of mrem/yr per $\mu\text{Ci}/\text{m}^3$ for inhalation and tritium and in units of mrem/yr per $\mu\text{Ci}/\text{sec}$ per m^2 for all others.

TABLE 3.3-19
R VALUES FOR THE SHEARON HARRIS NUCLEAR POWER PLANT*

PATHWAY = Inhalation

AGE GROUP = Infant

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	Gi-LLi
H-3	0.00E+00	6.46E+02	6.46E+02	6.46E+02	6.46E+02	6.46E+02	6.46E+02
C-14	2.65E+04	5.31E+03	5.31E+03	5.31E+03	5.31E+03	5.31E+03	5.31E+03
Na-24	1.06E+04	1.06E+04	1.06E+04	1.06E+04	1.06E+04	1.06E+04	1.06E+04
P-32	2.03E+06	1.12E+05	7.73E+04	0.00E+00	0.00E+00	0.00E+00	1.61E+04
Cr-51	0.00E+00	0.00E+00	8.93E+01	5.75E+01	1.32E+01	1.28E+04	3.56E+02
Mn-54	0.00E+00	2.53E+04	4.98E+03	0.00E+00	4.98E+03	9.98E+05	7.05E+03
Mn-56	0.00E+00	1.54E+00	2.21E-01	0.00E+00	1.10E+00	1.25E+04	7.17E+04
Fe-55	1.97E+04	1.17E+04	3.33E+03	0.00E+00	0.00E+00	8.69E+04	1.09E+03
Fe-59	1.35E+04	2.35E+04	9.46E+03	0.00E+00	0.00E+00	1.01E+06	2.47E+04
Co-57	0.00E+00	6.51E+02	6.41E+02	0.00E+00	0.00E+00	3.79E+05	4.86E+03
Co-58	0.00E+00	1.22E+03	1.82E+03	0.00E+00	0.00E+00	7.76E+05	1.11E+04
Co-60	0.00E+00	8.01E+03	1.18E+04	0.00E+00	0.00E+00	4.50E+06	3.19E+04
Ni-63	3.39E+05	2.04E+04	1.16E+04	0.00E+00	0.00E+00	2.09E+05	2.42E+03
Ni-65	2.39E+00	2.84E-01	1.23E-01	0.00E+00	0.00E+00	8.12E+03	5.01E+04
Cu-64	0.00E+00	1.88E+00	7.74E-01	0.00E+00	3.98E+00	9.30E+03	1.50E+04
Zn-65	1.93E+04	6.25E+04	3.10E+04	0.00E+00	3.24E+04	6.46E+05	5.13E+04
Zn-69M	1.26E+01	2.58E+01	2.34E+00	0.00E+00	1.04E+01	2.67E+04	4.09E+04
Zn-69	5.39E-02	9.67E-02	7.18E-03	0.00E+00	4.02E-02	1.47E+03	1.32E+04
Br-82	0.00E+00	0.00E+00	1.33E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-83	0.00E+00	0.00E+00	3.81E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	4.00E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	2.04E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.90E+05	8.81E+04	0.00E+00	0.00E+00	0.00E+00	3.03E+03
Rb-88	0.00E+00	5.57E+02	2.87E+02	0.00E+00	0.00E+00	0.00E+00	3.39E+02
Rb-89	0.00E+00	3.21E+02	2.06E+02	0.00E+00	0.00E+00	0.00E+00	6.82E+01
Sr-89	3.97E+05	0.00E+00	1.14E+04	0.00E+00	0.00E+00	2.03E+06	6.39E+04
Sr-90	4.08E+07	0.00E+00	2.59E+06	0.00E+00	0.00E+00	1.12E+07	1.31E+05
Sr-91	9.56E+01	0.00E+00	3.46E+00	0.00E+00	0.00E+00	5.26E+04	7.34E+04
Sr-92	1.05E+01	0.00E+00	3.91E-01	0.00E+00	0.00E+00	2.38E+04	1.40E+05
Y-90	3.29E+03	0.00E+00	8.82E+01	0.00E+00	0.00E+00	2.69E+05	1.04E+05
Y-91M	4.07E-01	0.00E+00	1.39E-02	0.00E+00	0.00E+00	2.79E+03	2.35E+03
Y-91	5.87E+05	0.00E+00	1.57E+04	0.00E+00	0.00E+00	2.45E+06	7.02E+04
Y-92	1.64E+01	0.00E+00	4.61E-01	0.00E+00	0.00E+00	2.45E+04	1.27E+05
Y-93	1.50E+02	0.00E+00	4.07E+00	0.00E+00	0.00E+00	7.64E+04	1.67E+05
Zr-95	1.15E+05	2.78E+04	2.03E+04	0.00E+00	3.10E+04	1.75E+06	2.17E+04
Zr-97	1.50E+02	2.56E+01	1.17E+01	0.00E+00	2.59E+01	1.10E+05	1.40E+05
Nb-95	1.57E+04	6.42E+03	3.77E+03	0.00E+00	4.71E+03	4.78E+05	1.27E+04
Nb-97	3.42E-01	7.29E-02	2.63E-02	0.00E+00	5.70E-02	3.32E+03	2.69E+04
Mo-99	0.00E+00	1.65E+02	3.23E+01	0.00E+00	2.65E+02	1.35E+05	4.87E+04
Tc-99M	1.40E-03	2.88E-03	3.72E-02	0.00E+00	3.11E-02	8.11E+02	2.03E+03

*R Values in units of mrem/yr per $\mu\text{Ci}/\text{m}^3$ for inhalation and tritium and in units of mrem/yr per $\mu\text{Ci}/\text{sec}$ per m^2 for all others.

TABLE 3.3-19 (continue)
R VALUES FOR THE SHEARON HARRIS NUCLEAR POWER PLANT*

PATHWAY = Inhal

AGE GROUP = Infant

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	Gi-LLi
Tc-101	6.51E-05	8.23E-05	8.12E-04	0.00E+00	9.79E-04	5.84E+02	8.44E+02
Ru-103	2.01E+03	0.00E+00	6.78E+02	0.00E+00	4.24E+03	5.51E+05	1.61E+04
Ru-105	1.22E+00	0.00E+00	4.10E-01	0.00E+00	8.99E-01	1.57E+04	4.84E+04
Ru-106	8.67E+04	0.00E+00	1.09E+04	0.00E+00	1.06E+05	1.15E+07	1.64E+05
Ag-110M	9.97E+03	7.21E+03	4.99E+03	0.00E+00	1.09E+04	3.66E+06	3.30E+04
Sn-113	4.67E+03	1.74E+02	4.89E+03	6.73E+01	9.94E+01	2.30E+05	2.29E+03
Sb-124	3.79E+04	5.56E+02	1.20E+04	1.00E+02	0.00E+00	2.64E+06	5.91E+04
Sb-125	5.17E+04	4.77E+02	1.09E+04	6.23E+01	0.00E+00	1.64E+06	1.47E+04
Te-125M	4.76E+03	1.99E+03	6.58E+02	1.62E+03	0.00E+00	4.47E+05	1.29E+04
Te-127m	1.66E+04	6.89E+03	2.07E+03	4.86E+03	3.75E+04	1.31E+06	2.73E+04
Te-127	2.23E+00	9.53E-01	4.89E-01	1.85E+00	4.86E+00	1.03E+04	2.44E+04
Te-129M	1.41E+04	6.08E+03	2.22E+03	5.47E+03	3.17E+04	1.68E+06	6.89E+04
Te-129	7.88E-02	3.47E-02	1.88E-02	6.75E-02	1.75E-01	3.00E+03	2.63E+04
Te-131M	1.07E+02	5.50E+01	3.63E+01	8.93E+01	2.65E+02	1.99E+05	1.19E+05
Te-131	1.74E-02	8.22E-03	5.00E-03	1.58E-02	3.99E-02	2.06E+03	8.22E+03
Te-132	3.72E+02	2.37E+02	1.76E+02	2.79E+02	1.03E+03	3.40E+05	4.41E+04
I-130	6.36E+03	1.39E+04	5.57E+03	1.60E+06	1.53E+04	0.00E+00	1.99E+03
I-131	3.79E+04	4.43E+04	1.96E+04	1.48E+07	5.17E+04	0.00E+00	1.06E+03
I-132	1.69E+03	3.54E+03	1.26E+03	1.69E+05	3.94E+03	0.00E+00	1.90E+03
I-133	1.32E+04	1.92E+04	5.59E+03	3.55E+06	2.24E+04	0.00E+00	2.15E+03
I-134	9.21E+02	1.88E+03	6.65E+02	4.45E+04	2.09E+03	0.00E+00	1.29E+03
I-135	3.86E+03	7.59E+03	2.77E+03	6.95E+05	8.46E+03	0.00E+00	1.83E+03
Cs-134	3.96E+05	7.02E+05	7.44E+04	0.00E+00	1.90E+05	7.95E+04	1.33E+03
Cs-136	4.82E+04	1.34E+05	5.28E+04	0.00E+00	5.63E+04	1.17E+04	1.43E+03
Cs-137	5.48E+05	6.11E+05	4.54E+04	0.00E+00	1.72E+05	7.12E+04	1.33E+03
Cs-138	5.05E+02	7.81E+02	3.98E+02	0.00E+00	4.10E+02	6.54E+01	8.76E+02
Ba-139	1.48E+00	9.84E-04	4.30E-02	0.00E+00	5.92E-04	5.95E+03	5.10E+04
Ba-140	5.59E+04	5.59E+01	2.89E+03	0.00E+00	1.34E+01	1.59E+06	3.83E+04
Ba-141	1.57E-01	1.08E-04	4.97E-03	0.00E+00	6.50E-05	2.97E+03	4.75E+03
Ba-142	3.98E-02	3.30E-05	1.96E-03	0.00E+00	1.90E-05	1.55E+03	6.93E+02
La-140	5.05E+02	2.00E+02	5.15E+01	0.00E+00	0.00E+00	1.68E+05	8.48E+04
La-142	1.03E+00	3.77E-01	9.04E-02	0.00E+00	0.00E+00	8.22E+03	5.95E+04
Ce-141	2.77E+04	1.66E+04	1.99E+03	0.00E+00	5.24E+03	5.16E+05	2.15E+04
Ce-143	2.93E+02	1.93E+02	2.21E+01	0.00E+00	5.64E+01	1.16E+05	4.97E+04
Ce-144	3.19E+06	1.21E+06	1.76E+05	0.00E+00	5.37E+05	9.83E+06	1.48E+05
Pr-143	1.40E+04	5.24E+03	6.99E+02	0.00E+00	1.97E+03	4.33E+05	3.72E+04
Pr-144	4.79E-02	1.85E-02	2.41E-03	0.00E+00	6.72E-03	1.61E+03	4.28E+03
Nd-147	7.94E+03	8.13E+03	5.00E+02	0.00E+00	3.15E+03	3.22E+05	3.12E+04
Hf-181	5.65E+04	2.66E+02	5.05E+03	2.25E+02	1.59E+02	6.73E+05	1.90E+04
W-187	1.30E+01	9.02E+00	3.12E+00	0.00E+00	0.00E+00	3.96E+04	3.56E+04
Np-239	3.71E+02	3.32E+01	1.88E+01	0.00E+00	6.62E+01	5.95E+04	2.49E+04

*R Values in units of mrem/yr per $\mu\text{Ci}/\text{m}^3$ for inhalation and tritium and in units of mrem/yr per $\mu\text{Ci}/\text{sec}$ per m^2 for all others.

Table 3.3-20

Recommended Values for U_{ap} to be used for the Maximum Exposed Individual
in Lieu of Site-Specific Data (Table E-5 Regulatory Guide 1.109 Rev 1)

Pathway	Infant	Child	Teen	Adult
Fruits, vegetables & grain (kg/yr) ¹	-	520	630	520
Leafy Vegetables (kg/yr)	-	26	42	64
Milk (L/yr)	330	330	400	310
Meat & poultry (kg/yr)	-	41	65	110
Inhalation (m ³ /yr)	1400	3700	8000	8000

Note 1 – Consists of the following (on a mass basis): 22% fruit, 54% vegetables (including leafy vegetables), and 24% grain

Table 3.3-21

Inhalation Dose Factors from Carbon-14 for organ to an individual from
Tables E-7 to E-10 Regulatory Guide 1.109 Rev 1
(mrem/pCi inhaled)

Individual	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
Infant	1.89E-05	3.79E-06	3.79E-06	3.79E-06	3.79E-06	3.79E-06	3.79E-06
Child	9.70E-06	1.82E-06	1.82E-06	1.82E-06	1.82E-06	1.82E-06	1.82E-06
Teen	3.25E-06	6.09E-07	6.09E-07	6.09E-07	6.09E-07	6.09E-07	6.09E-07
Adult	2.27E-06	4.26E-07	4.26E-07	4.26E-07	4.26E-07	4.26E-07	4.26E-07

Table 3.3-22

Ingestion Dose Factors from Carbon-14 for organ to an individual from
Tables E-11 to E-14 Regulatory Guide 1.109 Rev 1
(mrem/pCi ingested)

Individual	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
Infant	2.37E-05	5.06E-06	5.06E-06	5.06E-06	5.06E-06	5.06E-06	5.06E-06
Child	1.21E-05	2.42E-06	2.42E-06	2.42E-06	2.42E-06	2.42E-06	2.42E-06
Teen	4.06E-06	8.12E-07	8.12E-07	8.12E-07	8.12E-07	8.12E-07	8.12E-07
Adult	2.84E-06	5.68E-07	5.68E-07	5.68E-07	5.68E-07	5.68E-07	5.68E-07

Figure 3.1

SHNPP Gaseous Waste Streams

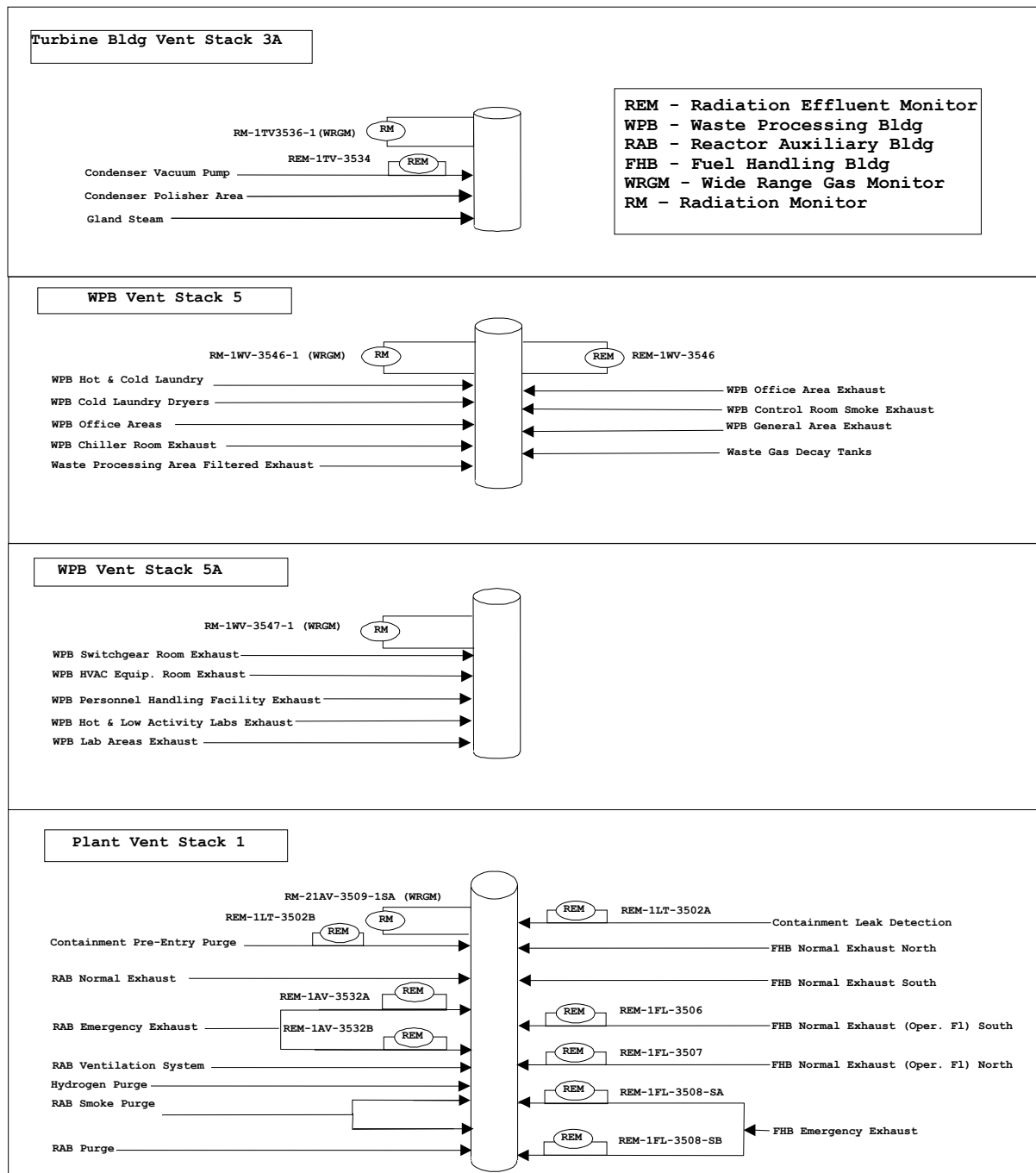


Figure 3.2

Schematic of Airborne Effluent Release Points

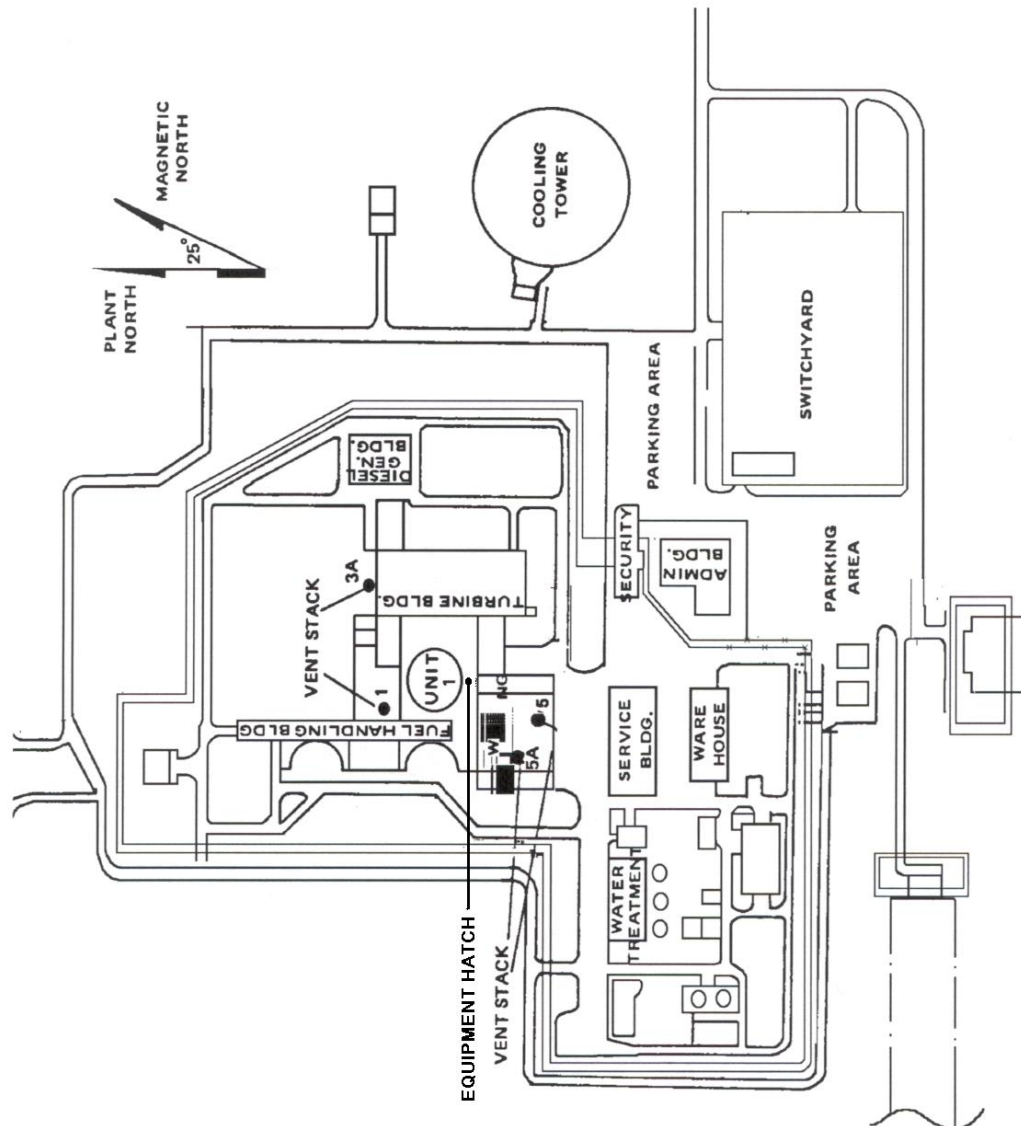
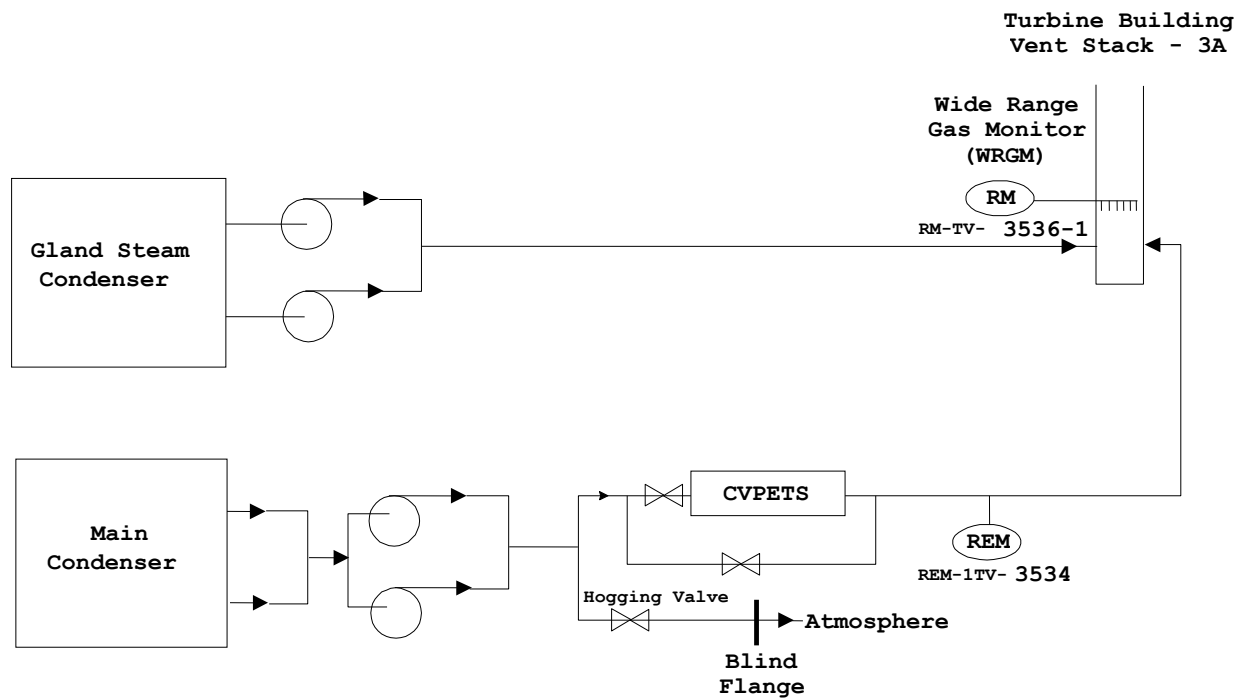


Figure 3.3

SHNPP Condenser Off-Gas System



4.0 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

The purpose of the radiological monitoring program is to measure radioactivity in the environment, to determine whether measured radioactivity is the result of operation of the Shearon Harris Nuclear Power Plant, and to assess the potential dose to the offsite population based on the cumulative measurements of radioactivity of plant origin. The program provides representative measurements of radioactivity in the highest potential exposure pathways and verification of the accuracy of the effluent monitoring program and modeling of environmental exposure pathways (i.e., air, surface water, groundwater.)

Table 4.1 contains the sample point description, sampling and collection frequency, analysis type, and frequency for various exposure pathways in the vicinity of the SHNPP for the radiological monitoring program.

Figure 4.1-1 shows the exclusion boundary surrounding SHNPP. Figures 4.1-2, 4.1-3, and 4.1-4 show the locations of the various sampling points and TLD locations.

TABLE 4.1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample:		Airborne Particulates and Radioiodine
Sampling and Collection Frequency:		Continuous operating sampler with sample collection as required by dust loading but at least once per 7 days.
Analysis Frequency and Required Analysis:		Weekly Gross Beta ² Weekly I-131 (charcoal canisters) Quarterly Gamma Isotopic ^{4,5} (Composited by location)
Sample Point ID No.	Sample Point, Description ¹ , Distance, and Direction	
2	1.4 mi. S on SR 1134 from SR 1011 intersection. NNE sector, 1.4 mi. from site.	
4	New Hill (Population Center) 0.7 mi. N on SR 1127 from intersection with US 1. NNE sector, 3.1 mi. from site.	
5	Pittsboro (Control Station) ³ WNW sector from site, 13.3 mi. from site	
26	Harris Lake Spillway S sector, 4.7 mi. from site	
63	SHNPP site. SW sector, 0.6 mi. from site.	
90	SHNPP site. SSW sector, 0.5 mi. from site.	
91	HE&EC, Sewage Treatment Facility ENE Sector, 1.6 mi. from site.	

TABLE 4.1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample:		Direct Radiation (TLD)
Sampling and Collection Frequency:		Continuous measurement with an integrated readout at least once per quarter.
Analysis Frequency and Required Analysis:		Quarterly Gamma Dose
Sample Point ID No.	Sample Point, Description ¹ , Distance, and Direction	
1	0.1 mi. S on SR 1134 from SR 1011 intersection. N sector, 2.6 mi. from site.	
2	1.4 mi. S on SR 1134 from SR 1011 intersection. NNE sector, 1.4 mi. from site.	
3	HE&EC Visitor Center (Population Center) ENE sector, 1.9 mi. from site.	
4	New Hill (Population Center) 0.7 mi. N on SR 1127 from intersection with US 1 NNE sector, 3.1 mi. from site.	
5	Pittsboro (Control Station) ³ WNW sector from site, 13.3 mi. from site	
6	Intersection of SR 1134 & SR 1135. ENE sector, 0.8 mi. from site.	
7	Extension of SR 1134. E sector 0.7 mi. from site.	
8	Dead end of road. Extension of SR 1134. ESE sector, 0.6 mi. from site.	
9	1 mi. S on SR 1130 from intersection of SR 1127, 1115, and 1130. SE sector, 2.2 mi. from site.	
10	SR 1130 S of intersection of SR 1127, 1115, and 1130. SSE sector, 2.2 mi. from site.	
11	SHNPP site. S sector, 0.6 mi. from site	
12	SHNPP site. SSW sector, 0.9 mi. from site.	
13	SHNPP site. WSW sector 0.7 mi. from site.	
14	SHNPP site. Access road to aux. reservoir. W sector, 1.5 mi. from site.	

TABLE 4.1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample:		Direct Radiation (TLD)
Sampling and Collection Frequency:		Continuous measurement with an integrated readout at least once per quarter.
Analysis Frequency and Required Analysis:		Quarterly Gamma Dose
Sample Point ID No.	Sample Point, Description ¹ , Distance, and Direction	
15	SR 1911. W sector, 2.0 mi. from site.	
19	Cross Country Lane and Humie Olive Rd NNE sector 5.0 mi from site.	
20	US 1 at intersection SR 1149. NE sector 4.5 mi. from site.	
21	1.2 mi. W on SR 1152 from intersection SR 1153. ENE sector, 4.8 mi. from site.	
22	Formerly Ragan's Dairy on SR 1115. E sector, 4.3 mi. from site.	
23	Intersection of SR 1127 and SR 1116. ESE sector, 4.8 mi. from site.	
24	Sweet Springs Church on SR 1116. SE sector 4.0 mi. from site.	
25	0.2 mi. W on SR 1402 from intersection of SR 1400 SSE sector, 4.7 mi. from site	
26	Harris Lake Spillway S sector, 4.7 mi. from site	
27	NC 42 at Buckhorn United Methodist Church SSW sector, 4.8 mi. from site.	
28	0.6 mi. on SR 1924 from intersection of SR 1916. SW sector, 4.8 mi. from site.	
29	Parking lot on SR 1916. WSW sector, 5.7 mi. from site.	

TABLE 4.1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample:		Direct Radiation (TLD)
Sampling and Collection Frequency:		Continuous measurement with an integrated readout at least once per quarter.
Analysis Frequency and Required Analysis:		Quarterly Gamma Dose
Sample Point ID No.	Sample Point, Description ¹ , Distance, and Direction	
31	Intersection of SR 1908, 1909, 1910. WNW sector, 4.7 mi. from site.	
32	Jordan Lake (Population Center) SR 1008. NNW sector 6.4 mi. from site.	
33	SR 1142. 1.7 mi. from intersection of SR 1141. NNW sector, 4.5 mi. from site.	
48	SR 1142. 1.5 mi. from intersection of SR 1141. N sector, 4.5 mi. from site.	
49	SR 1127. 0.3 mi. S from intersection with US 1. NE sector, 2.5 mi. from site.	
50	Holleman Crossroad (Population Center) SR 1127 W from intersection SR 1115 and 1130. ESE sector, 2.6 mi. from site.	
56	SR 1912 at intersection of SR 1912 and SR 1924. WSW sector, 3.0 mi. from site.	
63	SHNPP Site. SW sector, 0.6 mi. from site.	
93	SR 1911. WNW sector, 2.2 mi. from site.	
94	Old US HWY 1 NW sector, 2.0 mi. from site	
95	Bonsal Rd NNW sector, 2.0 mi. from site	

TABLE 4.1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample:		Direct Radiation (TLD)
Sampling and Collection Frequency:		Continuous measurement with an integrated readout at least once per quarter.
Analysis Frequency and Required Analysis:		Quarterly Gamma Dose
98	Holly Springs School Complex (Population Center) E sector, 5.9 mi. from site	
99	Friendship High School (Population Center) NNE sector, 5.5 mi. from site	
130	Old US HWY 1 W sector, 3.9 mi. from site	
153	Beaver Creek Road NW sector, 4.5 mi from site	

Exposure Pathway and/or Sample:		Waterborne, Surface Water
Sampling and Collection Frequency:		Composite sample ⁵ collected over a monthly period.
Analysis Frequency and Required Analysis:		Monthly Gamma Isotopic ⁴ Quarterly Tritium ²⁰
Sample Point ID No.	Sample Point, Description ¹ , Distance, and Direction	
26	Harris Lake Spillway S sector, 4.7 mi. from site	
40	NE Harnett Metro Water Treatment Plant Intake Building Duncan Street, Lillington, N.C. SSE sector, 17.2 mi. from site.	
43	Sanford Water Treatment Plant (Control Station) ³ Poplar Springs Church Road, Sanford, NC SW sector, 8.5 miles from site	

TABLE 4.1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample:		Waterborne, Groundwater
Sampling and Collection Frequency:		Grab sample collected quarterly
Analysis Frequency and Required Analysis:		Quarterly Gamma Isotopic ⁴ Quarterly Tritium
Sample Point ID No.	Sample Point, Description ¹ , Distance, and Direction	
57	SHNPP Site (LP-13) N. side of Aux Res Intake canal SSW sector, 0.4 mi. from site.	
59	SHNPP Site (W-13) N. side of Old Construction Road. NNE sector, 0.5 mi. from site	
60	SHNPP Site (W-9A) W. bank of Harris Lake SE of Cooling Tower. ESE sector, 0.5 mi. from site	
68	SHNPP Site (LP-6) N. of old Steam Generator Storage Building W sector, 0.2 mi. from site	
69	SHNPP Site (LP-7) S. side of Warehouse 9. NNE sector, 0.2 mi. from site	
70	SHNPP Site (LP-9) N. side of Plant Entrance Road. E sector, 0.4 mi. from site	
71	SHNPP Site (LP-16) S. of Switch Yard SE sector, 0.3 mi. from site	
72	SHNPP Site (MWA-12) N. of Cooling Tower Makeup Water Intake Structures. SE sector, 0.2 mi. from site	
73	SHNPP Site N. of Emergency Service Water Screening Structure. S sector, 0.2 mi. from site	
74	SHNPP Site N. of helicopter landing pad. SSE sector, 0.2 mi. from site	

TABLE 4.1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample:		Waterborne, Groundwater
Sampling and Collection Frequency:		Grab sample collected quarterly
Analysis Frequency and Required Analysis:		Quarterly Gamma Isotopic ⁴ Quarterly Tritium
Sample Point ID No.	Sample Point, Description ¹ , Distance, and Direction	
75	SHNPP Site W. of Security Building Entrance ESE sector, 0.1 mi. from site	
77	SHNPP Site (BD-MW1) Along the Cooling Tower Blowdown Line S sector, 0.4 mi. from site	
78	SHNPP Site (BD-MW2) Along the Cooling Tower Blowdown Line S sector, 0.5 mi. from site	
79	SHNPP Site (BD-MW3) Along the Cooling Tower Blowdown Line S sector, 0.5 mi. from site	
80	SHNPP Site (BD-MW5) Along the Cooling Tower Blowdown Line S sector, 0.6 mi. from site	
81	SHNPP Site (BD-MW7) Along the Cooling Tower Blowdown Line S sector, 0.6 mi. from site	
82	SHNPP Site (BD-MW8) Along the Cooling Tower Blowdown Line S sector, 0.6 mi. from site	
83	SHNPP Site (BD-MW16) Along the Cooling Tower Blowdown Line SSW sector, 1.6 mi. from site	
84	SHNPP Site (MW-14) N. of Emergency Service Water Screening Structure. SSW sector, 0.2 mi. from site	
85	SHNPP Site (MW-13) W. of site near Settling Basin SSW sector, 0.2 mi. from site	
86	SHNPP Site (MW-12) W. of site near Old Reactor Head Storage Building SW sector, 0.2 mi. from site	

TABLE 4.1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample:		Waterborne, Drinking Water
Sampling and Collection Frequency:		Composite sample ⁵ collected over a two-week period if I-131 analysis is performed; monthly composite otherwise.
Analysis Frequency and Required Analysis:		I-131 on each composite when the dose⁶ calculated for the consumption of the water is greater than 1 mrem per yr. Monthly Gross Beta Monthly Gamma Isotopic⁴ Quarterly Tritium²⁰
Sample Point ID No.	Sample Point, Description ¹ , Distance, and Direction	
38	Deleted	
40	Deleted	
46	NE Harnett Metro Water Treatment Plant Intake Building Duncan Street, Lillington, N.C. SSE sector, 17.2 mi. from site.	
51	SHNPP Water Treatment Building On Site	
58	Sanford Water Treatment Plant (Control Station) ³ Poplar Springs Church Road, Sanford, NC SW sector, 8.5 miles from site	

TABLE 4.1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample:		Waterborne, Sediment from Shoreline
Sampling and Collection Frequency:		Shoreline Sediment sample collected semiannually.
Analysis Frequency and Required Analysis:		Each Sample Gamma Isotopic ⁴
Sample Point ID No.	Sample Point, Description ¹ , Distance, and Direction	
26	Harris Lake Spillway S sector, 4.6 mi. from site	
41	Shoreline of Mixing Zone of Cooling Tower Blowdown Line S sector, 3.8 miles from site.	

TABLE 4.1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample:		Waterborne, Bottom Sediment
Sampling and Collection Frequency:		Bottom Sediment sample collected semiannually.
Analysis Frequency and Required Analysis:		Each Sample Gamma Isotopic ⁴
Sample Point ID No.	Sample Point, Description ¹ , Distance, and Direction	
52	Harris Lake in the vicinity of the mixing zone of the cooling tower S sector, 3.8 miles from site.	

TABLE 4.1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample:		Ingestion – Milk ^{8, 17}
Sampling and Collection Frequency:		Grab samples semi-monthly when animals are on pasture; monthly at other times. ^{9, 19}
Analysis Frequency and Required Analysis:		Each Sample I-131 Each Sample Gamma Isotopic ⁴
Sample Point ID No.	Sample Point, Description ¹ , Distance, and Direction	
300	Deleted	
102	Goat Farm, W sector, 2.8 miles from site.	

TABLE 4.1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample:		Ingestion - Fish
Sampling and Collection Frequency:		One sample of each of the following semiannually: 1. Catfish (bottom feeders) 2. Sunfish & Largemouth Bass (free swimmers)
Analysis Frequency and Required Analysis:		Each sample - Gamma Isotopic ⁴ on edible portion for each
Sample Point ID No.	Sample Point, Description ¹ , Distance, and Direction	
44	Site varies within the Harris Lake.	
45	Site varies above Buckhorn Dam on Cape Fear River (Control Station) ³	

TABLE 4.1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample:		Ingestion – Food Products ^{7,10,18}
Sampling and Collection Frequency:		Samples of 3 different kinds of broadleaf vegetation monthly during the growing season ¹⁶
Analysis Frequency and Required Analysis:		Each sample - Gamma Isotopic⁴ on edible portion for each One sample of each principle class of food products from any area that is irrigated by water which liquid plant wastes have been discharged¹⁸
Sample Point ID No.	Sample Point, Description ¹ , Distance, and Direction	
5	Deleted	
97	Deleted	

TABLE 4.1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample:		Aquatic Vegetation
Sampling and Collection Frequency:		Annually
Analysis Frequency and Required Analysis:		Each sample - Gamma Isotopic ⁴
Sample Point ID No.	Sample Point, Description ¹ , Distance, and Direction	
26	Harris Lake Spillway S sector, 4.7 mi. from site	
41	Shoreline of Mixing Zone of Cooling Tower Blowdown Line S sector, 3.8 miles from site.	
61	Harris Lake East of New Hill- Holleman Rd (Control Location) E sector, 2.5 mi. from site	

Exposure Pathway and/or Sample:		Broadleaf Vegetation ⁸
Sampling and Collection Frequency:		Monthly ^{15, 19}
Analysis Frequency and Required Analysis:		Each sample - Gamma Isotopic ⁴
Sample Point ID No.	Sample Point, Description ¹ , Distance, and Direction	
5	Pittsboro (Control Station) ³ WNW sector, 13.3 mi. from site	
12	SHNPP Site SSW sector, 0.9 mi. from site	
63	SHNPP Site SW sector, 0.6 mi from site	

NOTES TO TABLE 4.1

SHNPP Radiological Environmental Monitoring Program

1. Sample locations are shown on Figures 4.1-2 and 4.1-3 and 4.1-4. Tables 4.2 and 4.3 lists the sample locations and frequencies.
2. Particulate samples will be analyzed for gross beta radioactivity 24 hours or more following filter change to allow for radon and thorium daughter decay. If gross beta activity is greater than ten times the yearly mean of the control sample station activity, a gamma isotopic analysis will be performed on the individual samples.
3. Control sample stations (or background stations) are located in areas that are unaffected by plant operations. All other sample stations that have the potential to be affected by radioactive emissions from plant operations are considered indicator stations.
4. Gamma isotopic analysis means the identification and quantification of gamma-emitting radionuclides that may be attributable to effluents from plant operations.
5. Composite samples will be collected with equipment which is capable of collecting an aliquot at time intervals which are very short (e.g., every 2 hours) relative to the compositing period (e.g., monthly).
6. The dose will be calculated for the maximum organ and age group, using the methodology contained in ODCM Equation 2.3-1.
7. Based on historical meteorology (1976-1987), food product Locations 54 and 55 were added in the summer of 1988 as the off-site locations with the highest predicted D/Q values. Food product locations 43 and 46 were deleted after the 1988 growing season.
8. If milk animals are not present or unavailable for sampling at indicator locations per page 4-11, sampling of Broadleaf Vegetation per page 4-13 can be substituted.
9. When no milk animals are available at indicator locations, milk sampling of the control location can be reduced to once per month to maintain historical data. As of Revision 30 of this ODCM, there are no identified control milk locations.
10. Sample Locations 54, 55, 62, 64 were deleted from food product sampling in Revision 18 as crops are not irrigated with water in which plant wastes have been discharged or crops are no longer being grown at a location. Sample Location 5 was deleted in Revision 26. The owner of this control location no longer gardens in sufficient quantity provide three different kinds of broadleaf vegetation. The control location 97 added in Revision 25 was deleted in Revision 29 as it does not satisfy the food crop requirement. Currently there are no food product locations irrigated by water containing plant discharges.
11. Sample Location 58 was deleted from groundwater monitoring in Revision 18 since being shown to have direct communication with lake/surface water. Sample Locations 68 through 72 were added to the groundwater monitoring in Revision 19 based on evaluation of data from bedrock wells.
12. Location 39 was deleted from the groundwater monitoring in Revision 20 based on evaluation of data from bedrock wells.
13. Sample Locations 65 & 66 deleted Broadleaf Vegetation samples and added Broadleaf Vegetation to Sample Locations 12 and 63 in Revision 20 based on new meteorology data.
14. Location 57 was removed from the groundwater monitoring in Revision 19 but was reinstated in Revision 21 after new site hydrogeology study. In Revision 21, Sample Locations 73 through 76 were added to the groundwater monitoring in Revision 21 in order to provide a more complete picture of the site's hydrology. Sample Location 76 was removed from the groundwater monitoring in Revision 26 because within the protected area it is not used as a source of drinking water or irrigation.
15. Broadleaf vegetation refers to any natural vegetation, plants, shrubs, or trees that have wide, flat leaves or leaves with veins which branch from a main vein.
16. Attention shall be paid to including samples of tuberous and root food products.
17. Goat milk is seasonally available. Typically, goats' lactate during the spring, summer, and early fall (April through October).
18. One sample of each principle class of food products from any area that is irrigated by water which liquid plant wastes have been discharged. As of Revision 30 of this ODCM, there are no known irrigated gardens.
19. Due to not having a control milk location, broadleaf vegetation sampling will be performed monthly.
20. Monthly Tritium analysis is performed at Surface Water location 26 and Drinking Water location 51.

TABLE 4.2

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SAMPLING LOCATIONS

Site#	Type	Location Distance and Sector*	AC & AP	SW	DW	SS	SB	AV	Fish (FI)	Milk (Mk)	BLV	GW
2	I	1.4 miles NNE	W/Q									
4	I	3.1 miles NNE	W/Q									
5	C	13.3 miles WNW - Pittsboro	W/Q								M	
12	I	0.9 miles SSW									M	
26	I	4.7 miles S	W/Q	M		SA ^(b)		A				
40	I	17.2 miles SSE – Lillington		M/Q								
41	I	3.8 miles S				SA		A				
43	C	8.5 miles SW		M/Q								
44	I	Site varies in Harris Lake							SA			
45	C	Site varies in Cape Fear River above Buckhorn Dam							SA			
46	I	17.2 miles SSE – Lillington			M/Q							
51	I	Water Treatment Building (On Site)			M							
52	I	3.8 miles S					SA					
57	I	0.4 miles SSW										Q
58	C	8.5 miles SW			M/Q							
59	I	0.5 miles NNE										Q
60	I	0.5 miles ESE										Q
61	C	2.5 miles E						A				
63	I	0.6 miles SW	W/Q								M	
68	I	0.2 miles W										Q
69	I	0.2 miles NNE										Q
70	I	0.4 miles E										Q
71	I	0.3 miles SE										Q
72	I	0.2 miles SE										Q
73	I	0.2 miles S										Q
74	I	0.2 miles SSE										Q
75	I	0.1 miles ESE										Q
77	I	0.4 miles S										Q
78	I	0.5 miles S										Q
79	I	0.5 miles S										Q
80	I	0.6 miles S										Q
81	I	0.6 miles S										Q
82	I	0.6 miles S										Q
83	I	1.6 miles SSW										Q
84	I	0.2 miles SSW										Q
85	I	0.2 miles SSW										Q
86	I	0.2 miles SW										Q
90	I	0.5 miles SSW	W/Q									
91	I	1.6 miles ENE	W/Q									
102	I	2.8 miles W								SM ^(a)		

(a) When goats are lactating

(b) 4.6 miles from site

* GPS data reflect approximate accuracy to within 2-5 meters. GPS field measurements were taken as close as possible to the item of interest.

W	Weekly	SM	Semimonthly	AC	Air Cartridge	SB	Sediment Bottom
BW	BiWeekly	Q	Quarterly	AP	Air Particulate	AV	Aquatic Vegetation
M	Monthly	SA	Semiannually	SW	Surface Water	MK	Milk
A	Annual	FI	Fish	DW	Drinking Water	BLV	Broadleaf Vegetation
C	Control	I	Indicator	SS	Sediment Shoreline	GW	Ground Water

Shearon Harris Nuclear Power Plant
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TABLE 4.3
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SAMPLING LOCATIONS
(TLD Sites)

Site #	Measure Type	Location*	Distance (miles)	Sector	Site #	Measure Type	Location*	Distance (miles)	Sector
1	IR	0.1 mi. S on SR 1134 from SR 1011 intersection	2.6	N	25	OR	0.2 mi. W on SR 1402 from intersection of SR 1400	4.7	SSE
2	IR	1.4 mi. S on SR 1134 from SR 1011 intersection	1.4	NNE	26	OR	Harris Lake Spillway	4.7	S
3	SI	HE&EC Visitor Center (Population Center)	1.9	ENE	27	OR	NC 42 at Buckhorn United Methodist Church	4.8	SSW
4	SI	New Hill (Population Center) 0.7 mi. N on SR 1127 from intersection with US 1	3.1	NNE	28	OR	0.6 mi. on SR 1924 from intersection of SR 1916	4.8	SW
5	C	Pittsboro (Control Station)	13.3	WNW	29	OR	Parking lot on SR 1916	5.7	WSW
6	IR	Intersection of SR 1134 & SR 1135	0.8	ENE	31	OR	Intersection of SR 1908, 1909, 1910	4.7	WNW
7	IR	Extension of SR 1134	0.7	E	32	SI	Jordan Lake (Population Center) SR 1008	6.4	NNW
8	IR	Dead end of road, Extension of SR 1134	0.6	ESE	33	OR	SR 1142, 1.7 mi. from intersection of SR 1141	4.5	NNW
9	IR	1 mi. S on SR 1130 from intersection of SR 1127, 1115, and 1130	2.2	SE	48	OR	SR 1142, 1.5 mi. from intersection of SR 1141	4.5	N
10	IR	SR 1130 S of intersection of SR 1127, 1115, and 1130	2.2	SSE	49	IR	SR 1127, 0.3 mi. S from intersection with US 1	2.5	NE
11	IR	SHNPP site	0.6	S	50	SI	Holleman Crossroad (Population Center) SR 1127 W from intersection SR 1115 and 1130	2.6	ESE
12	IR	SHNPP site	0.9	SSW	56	IR	SR 1912 at intersection of SR 1912 and SR 1924	3.0	WSW
13	IR	SHNPP site	0.7	WSW	63	IR	SHNPP Site	0.6	SW
14	IR	SHNPP site. Access road to aux. reservoir	1.5	W	93	IR	SR 1911	2.2	WNW
15	IR	SR 1911	2.0	W	94	IR	Old US HWY 1	2.0	NW
19	OR	Cross Country Lane and Humie Olive Rd	5.0	NNE	95	IR	Bonsal Road	2.0	NNW
20	OR	US 1 at intersection SR 1149	4.5	NE	98	SI	Holly Springs School Complex (Population Center)	5.9	E
21	OR	1.2 mi. W on SR 1152 from intersection SR 1153	4.8	ENE	99	SI	Friendship High School (Population Center)	5.5	NNE
22	OR	Formerly Ragan's Dairy on SR 1115	4.3	E	130	OR	Old US HWY 1	3.9	W
23	OR	Intersection of SR 1127 and SR 1116	4.8	ESE	153	OR	Beaver Creek Road	4.5	NW
24	OR	Sweet Springs Church on SR 1116	4.0	SE					

* GPS data reflect approximate accuracy to within 2-5 meters. GPS field measurements were taken as close as possible to the item of interest.

IR	Inner Ring	OR	Outer Ring
C	Control	SI	Special Interest/ Population Center

Figure 4.1-1
Map of the Site Boundary

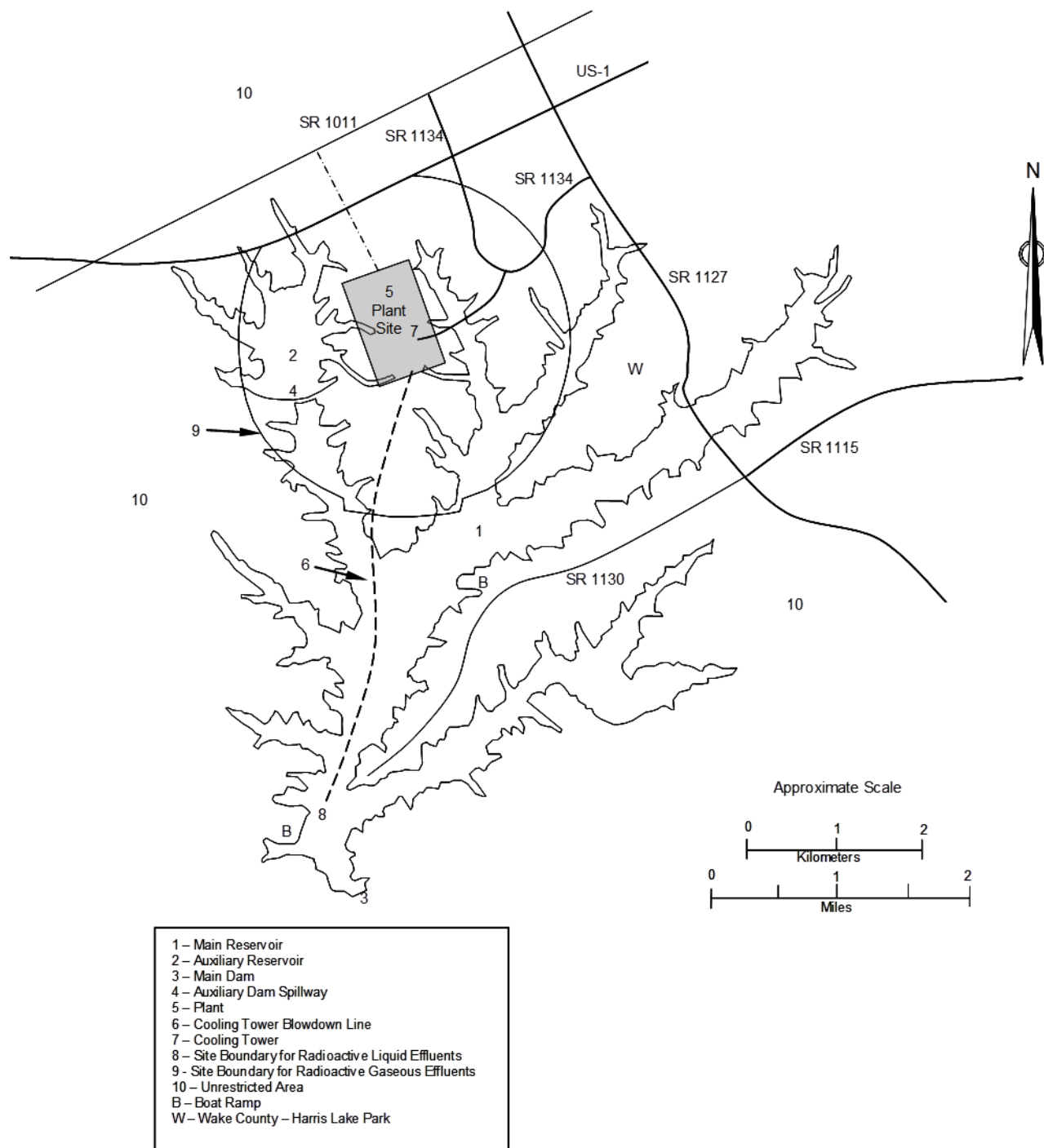


Figure 4.1-2
Environmental Radiological Sampling Points
(One Mile Radius)

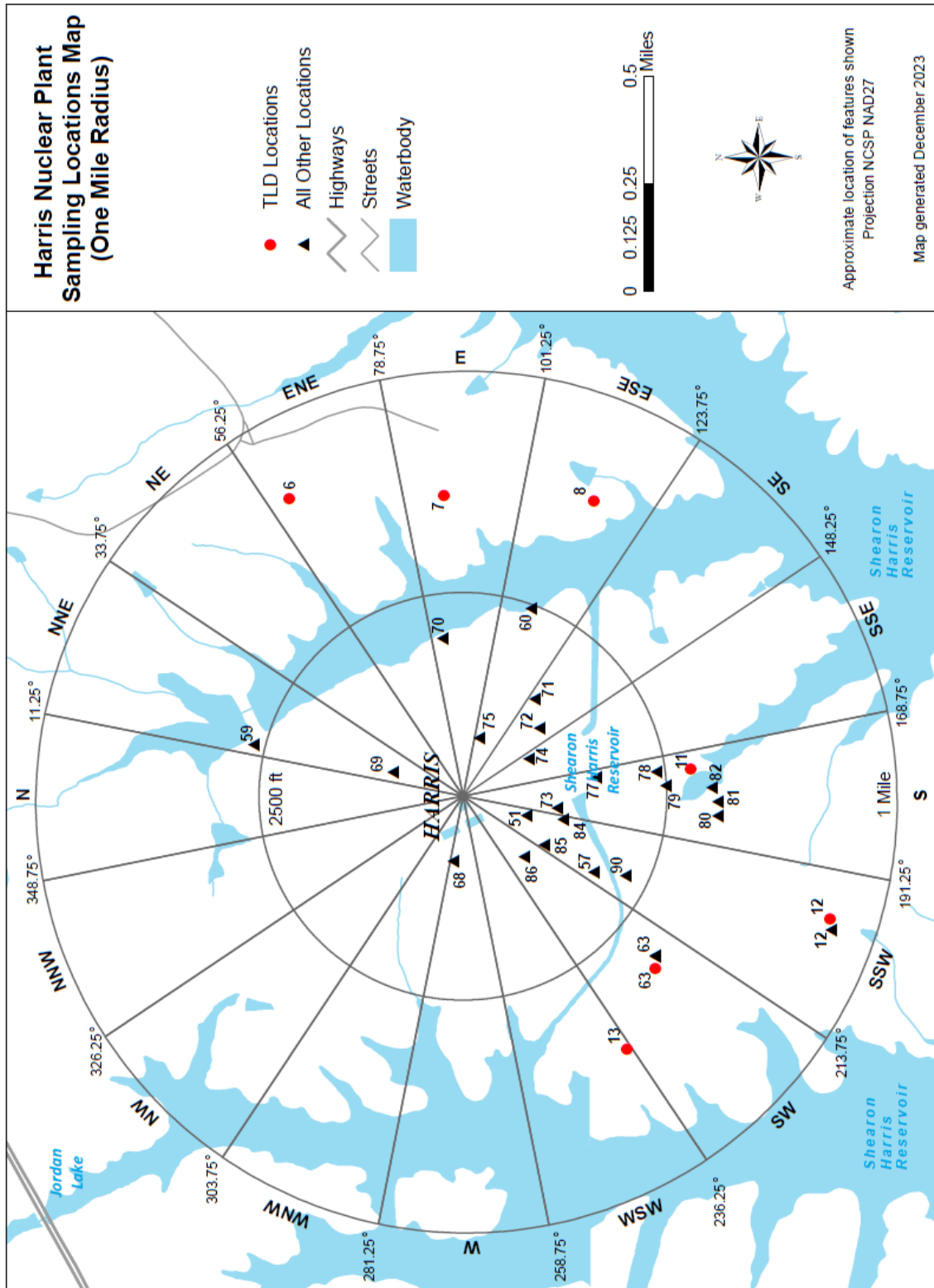


Figure 4.1-3
Environmental Radiological Sampling Points
(10-mile Radius)

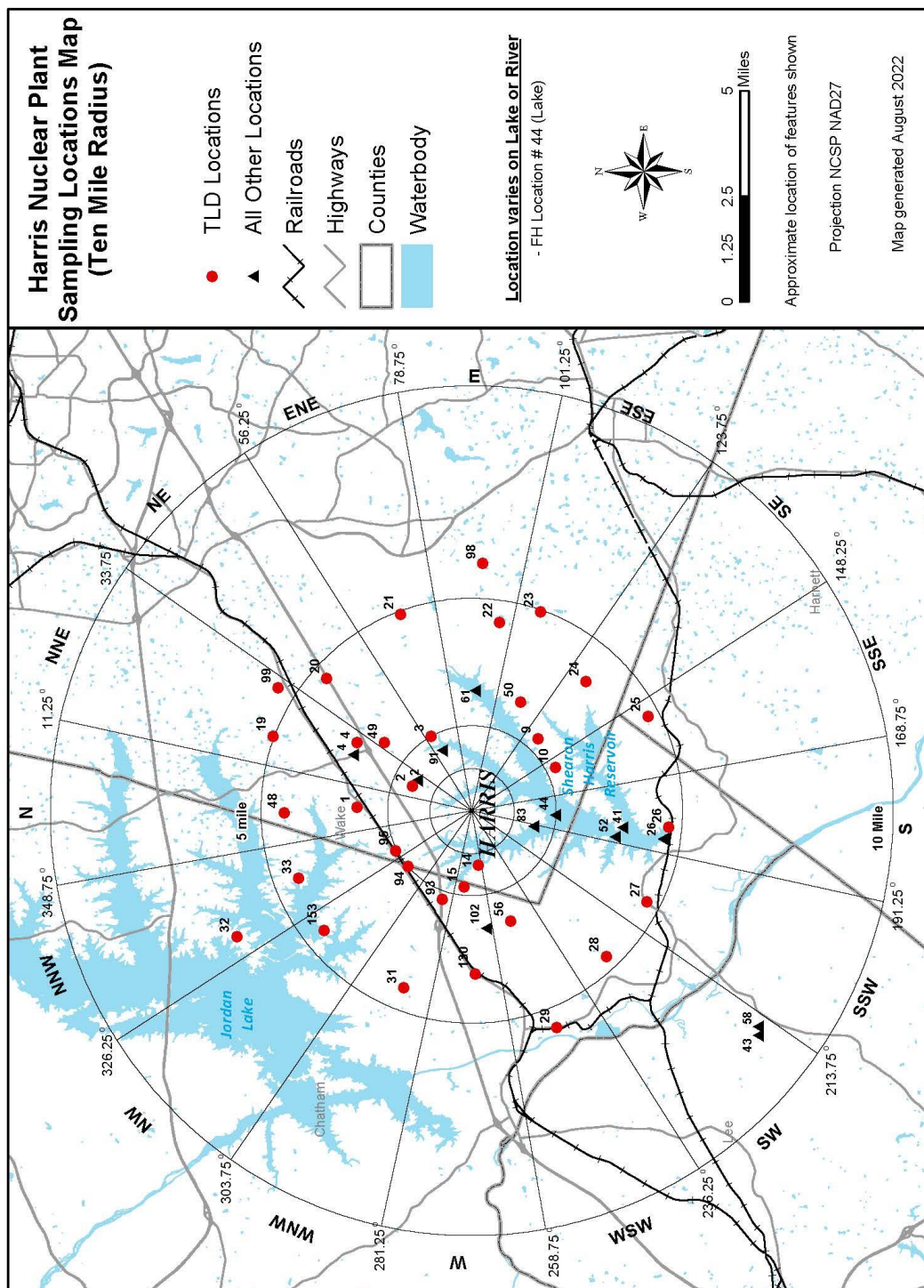
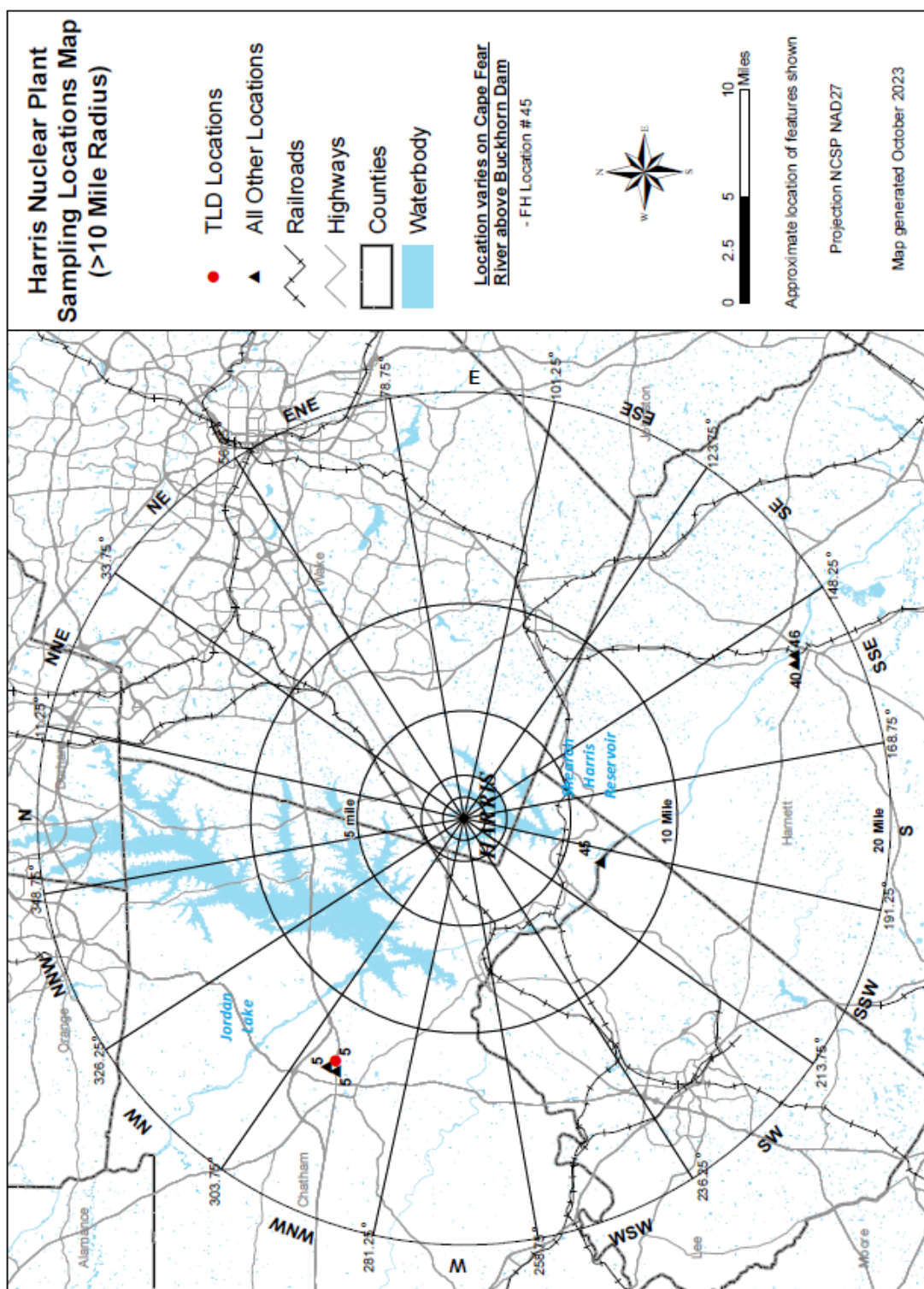


Figure 4.1-4
Environmental Radiological Sampling Points
(>10-mile Radius)



5.0 INTERLABORATORY COMPARISON STUDIES

The objective of this program is to evaluate the total laboratory analysis process by comparing results for an equivalent sample with those obtained by an independent laboratory or laboratories.

Environmental samples from the SHNPP environs are to be analyzed by a qualified laboratory. These laboratories will participate at least annually in a nationally recognized interlaboratory comparison study. The results of the laboratories' performances in the study will be included in the Annual Radiological Environmental Operating Report (see SHNPP ODCM Operational Requirement 4.12.3).

Radiochemical analyses of composite samples required by ODCM Operational Requirements Tables 4.11-1 and 4.11-2 will be performed by a qualified laboratory. The qualified radiochemistry laboratory will participate annually in a corporate interlaboratory comparison study or an equivalent study.

The qualified laboratory results shall be compared to the criteria established in the NRC Inspection Manual (Procedure 84525) for Quality Assurance and Confirmatory Measurements for In-Plant Radiochemical Analysis. The referenced criteria are as follows:

- a) Divide each standard result by its associated uncertainty to obtain resolution (the uncertainty is defined as the relative standard deviation, one sigma of the standard result as calculated from counting statistics).
- b) Divide each laboratory result by the corresponding standard result to obtain the ratio (laboratory result/standard).
- c) The laboratory measurement is in agreement if the value of the ratio falls within the limits shown below for the corresponding resolution:

<u>Resolution</u>	<u>Ratio</u>
<4	0.4 – 2.5
4 - 7	0.5 - 2.0
8 - 15	0.6 - 1.66
16 - 50	0.75 - 1.33
51 -200	0.80 - 1.25
>200	0.85 - 1.28

If the qualified laboratory results lay outside the ratio criteria, an evaluation will be performed to identify any recommended remedial actions to reduce anomalous errors. Complete documentation of the evaluation will be available to HNP and will be provided to the NRC upon request.

6.0 TOTAL DOSE (COMPLIANCE WITH 40 CFR 190) for ODCM OR 3.11.4

Compliance with 40 CFR 190 as prescribed in ODCM Operational Requirement 3.11.4 must be demonstrated only when one or more of ODCM Operational Requirements 3.11.1.2a, 3.11.1.2b, 3.11.2.2a, 3.11.2.2b, 3.11.2.3a, or 3.11.2.3b is exceeded by a factor of two. Once this occurs, the company has 30 days to submit this report in accordance with Technical Specification 6.9.2.

ODCM Operational Requirement 3.11.4 requires that the annual dose or dose commitment to a member of the public from uranium fuel cycle sources be limited to 25 mrem for the whole body and any organ except the thyroid which is limited to 75 mrem. In addition, assessment of radiation doses to the likely most exposed member of the public from primary effluent pathways, direct radiation, and any other nearby uranium fuel cycle sources are to be included.

The dose estimates from the gas and liquid effluent pathways to the likely most exposed member of the public can be obtained by using the Regulatory Guide 1.109 and WASH 1258-based NRC codes LADTAP II and GASPAR. This will allow the use of current annual average meteorology X/Q and D/Q values derived from the NRC XOQDOQ (NUREG/CR-2919) Code that is appropriate for the specific location of the receptor and the applicable exposure pathways.

Radiation exposures of members of the public from direct radiation sources (the reactor unit and other primary system components, radwaste, radioactivity in auxiliary systems such as storage tanks, transportation of radioactive material, etc.) will be determined from TLD measurements. Quarterly TLD measurements at locations within three miles of the plant center (inner ring) will be compared with the four-year, pre-operational TLD measurements using methods contained in NBS Handbook 91, "Experimental Statistics," to determine any significant contribution from direct radiation associated with plant operation.

If there is a significant direct radiation component at the TLD location in the sector containing the likely most exposed member of the public, then this dose will be added to the doses from effluent pathways derived from LADTAP II and GASPAR.

6.1 Total Dose (COMPLIANCE WITH 40 CFR 190) for ODCM OR F.2

To demonstrate compliance with ODCM Operational Requirement F.2, the ODCM dose equations for noble gases, iodine's, particulates, and tritium are used. They provide conservative dose estimates. The X/Q and D/Q values are based on historical data for the exclusion boundary distances. The liquid dose estimates also use the ODCM equations for dose determination which are added together for demonstration of compliance with 40 CFR 190.

7.0 LICENSEE-INITIATED CHANGES TO THE ODCM

Changes to the ODCM:

- a. Shall be documented, and records of reviews performed shall be retained as required by Technical Specification 6.14. This documentation shall contain:
 - 1) Sufficient information to support the change together with the appropriate analyses or evaluations justifying the change(s) and
 - 2) A determination that the change will maintain the level of radioactive effluent control required by 10 CFR 20.1302, 40 CFR 190, 10 CFR 50.36a, and Appendix I to 10 CFR Part 50 and not adversely impact the accuracy or reliability of effluent, dose, or setpoint calculations.
- b. Shall become effective after review and acceptance by the ORC and the approval of the Plant General Manager.
- c. Shall be submitted to the Commission in the form of a complete, legible copy of the entire ODCM as a part of or concurrent with the Annual Radioactive Effluent Release Report for the period of the report in which any change to the ODCM was made. Each change shall be identified by markings in the margin of the affected pages, clearly indicating the areas of the page that was changed, and shall indicate the date (e.g., month/year) the change was implemented.

A.0 Appendix A

Duke Energy has performed the assessment of the transport and dispersion of the effluent in the atmosphere as outlined in Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants, NUREG 0133 (USNRC, 1978). The methodology for this assessment was based on guidelines presented in Regulatory Guide 1.111, Revision 1 (USNRC, 1977). The results of the assessment were to provide the relative deposition flux and relative concentrations (undepleted and depleted) based on numerical models acceptable for use in Appendix I evaluations.

Regulatory Guide 1.111 presented three acceptable diffusion models for use in estimating deposition flux and concentrations. These are:

1. Particle-in-cell model (a variable trajectory model based on the gradient-transport theory),
2. Puff-advection model (a variable trajectory model based on the statistical approach to diffusion), and
3. The constant mean wind direction model referred to here as the straight-line trajectory Gaussian diffusion model (the most widely used model based on a statistical approach). It was resolved that for operational efficiency, the straight-line method described in XOQDOQ Computer Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations, NUREG/CRG-2919 (USNRC, September 1982) would be used for generating the required analysis of Appendix I to provide a more realistic accounting of the variability of wind around the plant site, standard open-terrain recirculation factors were used.

A five-year record of meteorological data was used from the on-site meteorological program at the Shearon Harris Nuclear Power Plant. This data consisted of all collected parameters from the 12.5-meter level for years 2010-2014. The description of the model used, and computations are presented in NUREG/CRC-2919. The following tables provide the meteorological dispersion factors (i.e., concentration (X/Q) and deposition (D/Q) values) utilized to show compliance with ODCM Operational Requirement 3/4.11.2 for noble gases, radioiodine's, and particulates.

A.1 Changes to X/Q and D/Q modeling

Along with updating the ODCM with X/Q and D/Q values using 2010-2014 meteorological data, there were some changes to the XOQDOQ modeling setup based on interpretations of Regulatory Guide 1.111 and NUREG/CRC-2919. The most notable of these changes was to increase the number of wind speed classes from 7 to 13, concentrating more classes for lower wind speeds.

Wind speed classes:

Previous:

- 1) Calm
- 2) 0.45-0.75 mph
- 3) 0.75-3.50 mph
- 4) 3.50-7.50 mph
- 5) 7.50-12.50 mph
- 6) 12.50-18.50 mph
- 7) 18.50-25.00 mph
- 8) 25.00 + mph

Current:

- 1) Calm
- 2) 0.45-0.75 m/s
- 3) 0.75-1.00 m/s
- 4) 1.00-1.25 m/s
- 5) 1.25-1.50 m/s
- 6) 1.50-2.00 m/s
- 7) 2.00-3.00 m/s
- 8) 3.00-4.00 m/s
- 9) 4.00-5.00 m/s
- 10) 5.00-6.00 m/s
- 11) 6.00-8.00 m/s
- 12) 8.00-10.00 m/s
- 13) 10.00+ m/s

Tables A-1 through A-4

Relative undepleted concentration, relative depleted concentration, and relative deposition flux estimates for the ground level releases for special receptors for long-term releases.

Tables A-5 through A-12

Relative undepleted concentration, relative depleted concentration, and relative deposition flux estimates for the ground level releases for standard and segmented distance locations for long-term releases.

Table A-13

SHNPP on-site Joint Wind Frequency Distributions for years 2010-2014.

Table A-14

The NRC XOQDOQ program input is presented. XOQDOQ was obtained and installed on Duke Energy's computer system. This model is part of the NRC's NRCDose program, version 2.3.20. The program was run with appropriate physical plant data and included special receptor locations noted by the annual land use census. The open-terrain recirculation factors were applied within the model.

Tables A-1 through A-4
X/Q and D/Q Values for Routine Ground Level Releases (Special Receptor Locations)

Model: XOQDOQ – SHNP 10-meter Meteorological Data, 2010-2014

Corrected using Standard Open-Terrain factors

Type of Receptor	Direction From Site	Distance (miles)	<u>TABLE A-1</u>	<u>TABLE A-2</u>	<u>TABLE A-3</u>	<u>TABLE A-4</u>
			X/Q	X/Q	X/Q	D/Q
			sec m ⁻³	sec m ⁻³	sec m ⁻³	1/m ²
			No Decay Undepleted	2.3 Day Decay Undepleted	8 Day Decay Depleted	
SITE BOUNDARY	S	1.36	9.4E-06	9.1E-06	8.0E-06	7.7E-09
SITE BOUNDARY	SSW	1.33	1.0E-05	1.0E-05	8.7E-06	9.0E-09
SITE BOUNDARY	SW	1.33	1.8E-05	1.7E-05	1.5E-05	9.0E-09
SITE BOUNDARY	WSW	1.33	1.1E-05	1.1E-05	9.5E-06	6.1E-09
SITE BOUNDARY	W	1.33	5.3E-06	5.1E-06	4.5E-06	3.2E-09
SITE BOUNDARY	WNW	1.33	2.6E-06	2.6E-06	2.3E-06	2.4E-09
SITE BOUNDARY	NW	1.26	3.6E-06	3.5E-06	3.1E-06	3.3E-09
SITE BOUNDARY	NNW	1.26	3.5E-06	3.4E-06	3.0E-06	4.2E-09
SITE BOUNDARY	N	1.32	3.8E-06	3.7E-06	3.3E-06	5.9E-09
SITE BOUNDARY	NNE	1.33	5.1E-06	5.0E-06	4.3E-06	8.3E-09
SITE BOUNDARY	NE	1.33	5.6E-06	5.4E-06	4.7E-06	7.5E-09
SITE BOUNDARY	ENE	1.33	5.4E-06	5.3E-06	4.6E-06	7.2E-09
SITE BOUNDARY	E	1.33	4.5E-06	4.4E-06	3.9E-06	4.6E-09
SITE BOUNDARY	ESE	1.33	3.4E-06	3.3E-06	2.9E-06	4.3E-09
SITE BOUNDARY	SE	1.33	4.0E-06	3.9E-06	3.4E-06	4.9E-09
SITE BOUNDARY	SSE	1.33	5.8E-06	5.7E-06	5.0E-06	5.7E-09
RESIDENT	SSW	3.82	1.4E-06	1.3E-06	1.0E-06	7.3E-10
RESIDENT	SW	2.76	4.4E-06	4.1E-06	3.4E-06	1.5E-09
RESIDENT	WSW	4.29	1.3E-06	1.1E-06	9.4E-07	3.8E-10
RESIDENT	W	2.75	1.3E-06	1.2E-06	1.0E-06	5.6E-10
RESIDENT	WNW	2.13	1.0E-06	9.7E-07	8.2E-07	7.5E-10
RESIDENT	NW	2.24	1.1E-06	1.0E-06	8.8E-07	8.0E-10
RESIDENT	NNW	1.55	2.2E-06	2.2E-06	1.9E-06	2.5E-09
RESIDENT	N	2.21	1.3E-06	1.3E-06	1.1E-06	1.7E-09
RESIDENT	NNE	1.81	2.6E-06	2.6E-06	2.2E-06	3.9E-09
RESIDENT	NE	2.43	1.6E-06	1.6E-06	1.3E-06	1.7E-09
RESIDENT	ENE	1.78	3.0E-06	2.9E-06	2.5E-06	3.5E-09
RESIDENT	E	1.98	2.0E-06	1.9E-06	1.6E-06	1.7E-09
RESIDENT	ESE	2.73	8.1E-07	7.7E-07	6.4E-07	7.6E-10
RESIDENT	SE	4.11	4.6E-07	4.2E-07	3.4E-07	3.4E-10
RESIDENT	SSE	4.26	6.4E-07	5.9E-07	4.8E-07	3.6E-10

Tables A-1 through A-4
X/Q and D/Q Values for Routine Ground Level Releases (Special Receptor Locations)

Model: XOQDOQ – SHNP 10-meter Meteorological Data, 2010-2014

Corrected using Standard Open-Terrain factors

Type of Receptor	Direction From Site	Distance (miles)	<u>TABLE A-1</u>	<u>TABLE A-2</u>	<u>TABLE A-3</u>	<u>TABLE A-4</u>
			X/Q	X/Q	X/Q	D/Q
			sec m ⁻³	sec m ⁻³	sec m ⁻³	1/m ²
			No Decay Undepleted	2.3 Day Decay Undepleted	8 Day Decay Depleted	
GARDEN	SSW	4.20	1.2E-06	1.1E-06	8.8E-07	5.9E-10
GARDEN	SW	2.80	4.2E-06	4.0E-06	3.3E-06	1.5E-09
GARDEN	WSW	4.29	1.3E-06	1.1E-06	9.4E-07	3.8E-10
GARDEN	W	3.73	7.4E-07	6.8E-07	5.6E-07	2.8E-10
GARDEN	WNW	3.39	4.2E-07	3.9E-07	3.2E-07	2.5E-10
GARDEN	NW	3.17	5.7E-07	5.3E-07	4.4E-07	3.6E-10
GARDEN	NNW	1.82	1.6E-06	1.5E-06	1.3E-06	1.7E-09
GARDEN	N	2.21	1.3E-06	1.3E-06	1.1E-06	1.7E-09
GARDEN	NNE	1.91	2.4E-06	2.3E-06	2.0E-06	3.4E-09
GARDEN	NE	3.22	9.7E-07	9.1E-07	7.5E-07	9.0E-10
GARDEN	ENE	2.06	2.2E-06	2.1E-06	1.8E-06	2.5E-09
GARDEN	ESE	4.76	3.0E-07	2.8E-07	2.2E-07	2.2E-10
GARDEN	SE	4.11	4.6E-07	4.2E-07	3.4E-07	3.4E-10
GARDEN	SSE	4.26	6.4E-07	5.9E-07	4.8E-07	3.6E-10
MEAT ANIMAL	SSW	3.93	1.3E-06	1.2E-06	9.9E-07	6.9E-10
MEAT ANIMAL	SW	2.80	4.2E-06	4.0E-06	3.3E-06	1.5E-09
MEAT ANIMAL	WSW	4.29	1.3E-06	1.1E-06	9.4E-07	3.8E-10
MEAT ANIMAL	W	3.26	9.4E-07	8.7E-07	7.2E-07	3.8E-10
MEAT ANIMAL	WNW	2.13	1.0E-06	9.7E-07	8.2E-07	7.5E-10
MEAT ANIMAL	NW	2.24	1.1E-06	1.0E-06	8.8E-07	8.0E-10
MEAT ANIMAL	NNW	1.82	1.6E-06	1.5E-06	1.3E-06	1.7E-09
MEAT ANIMAL	N	2.21	1.3E-06	1.3E-06	1.1E-06	1.7E-09
MEAT ANIMAL	NNE	1.91	2.4E-06	2.3E-06	2.0E-06	3.4E-09
MEAT ANIMAL	NE	3.22	9.7E-07	9.1E-07	7.5E-07	9.0E-10
MEAT ANIMAL	ENE	2.01	2.3E-06	2.2E-06	1.9E-06	2.6E-09
MEAT ANIMAL	ESE	2.74	8.1E-07	7.7E-07	6.4E-07	7.6E-10
MEAT ANIMAL	SE	4.11	4.6E-07	4.2E-07	3.4E-07	3.4E-10
MEAT ANIMAL	SSE	4.57	5.7E-07	5.2E-07	4.2E-07	3.1E-10

Table A-5

Undepleted, no decay, X/Q values for Ground Level Routine Release at standard distances in sec m⁻³

Annual Average X/Q		Distance in miles from the site									
Sector	0.25	0.5	0.75	1	1.5	2	2.5	3	3.5	4	4.5
S	2.611E-04	7.818E-05	3.882E-05	1.920E-05	7.644E-06	4.346E-06	2.856E-06	2.050E-06	1.563E-06	1.243E-06	1.021E-06
SSW	2.698E-04	8.112E-05	4.041E-05	1.998E-05	7.945E-06	4.509E-06	2.959E-06	2.122E-06	1.616E-06	1.284E-06	1.054E-06
SW	4.894E-04	1.442E-04	7.057E-05	3.460E-05	1.372E-05	7.874E-06	5.207E-06	3.758E-06	2.876E-06	2.295E-06	1.890E-06
WSW	3.013E-04	8.921E-05	4.401E-05	2.172E-05	8.656E-06	4.945E-06	3.260E-06	2.347E-06	1.792E-06	1.428E-06	1.174E-06
W	1.375E-04	4.124E-05	2.060E-05	1.021E-05	4.072E-06	2.311E-06	1.517E-06	1.088E-06	8.284E-07	6.584E-07	5.403E-07
WNW	6.379E-05	1.967E-05	1.009E-05	5.083E-06	2.043E-06	1.142E-06	7.407E-07	5.265E-07	3.979E-07	3.142E-07	2.564E-07
NW	7.673E-05	2.375E-05	1.221E-05	6.115E-06	2.443E-06	1.366E-06	8.861E-07	6.299E-07	4.762E-07	3.761E-07	3.070E-07
NNW	7.313E-05	2.287E-05	1.182E-05	5.951E-06	2.383E-06	1.326E-06	8.572E-07	6.076E-07	4.581E-07	3.611E-07	2.942E-07
N	8.759E-05	2.771E-05	1.446E-05	7.266E-06	2.897E-06	1.604E-06	1.033E-06	7.301E-07	5.493E-07	4.322E-07	3.515E-07
NNE	1.163E-04	3.682E-05	1.924E-05	9.723E-06	3.897E-06	2.156E-06	1.388E-06	9.805E-07	7.373E-07	5.797E-07	4.713E-07
NE	1.350E-04	4.174E-05	2.136E-05	1.073E-05	4.295E-06	2.402E-06	1.558E-06	1.108E-06	8.374E-07	6.614E-07	5.399E-07
ENE	1.342E-04	4.128E-05	2.100E-05	1.050E-05	4.189E-06	2.346E-06	1.524E-06	1.085E-06	8.210E-07	6.490E-07	5.302E-07
E	1.133E-04	3.465E-05	1.757E-05	8.770E-06	3.502E-06	1.969E-06	1.282E-06	9.145E-07	6.932E-07	5.488E-07	4.488E-07
ESE	8.409E-05	2.601E-05	1.329E-05	6.638E-06	2.646E-06	1.480E-06	9.609E-07	6.834E-07	5.168E-07	4.084E-07	3.334E-07
SE	9.933E-05	3.054E-05	1.549E-05	7.730E-06	3.082E-06	1.729E-06	1.124E-06	8.009E-07	6.064E-07	4.797E-07	3.921E-07
SSE	1.492E-04	4.526E-05	2.272E-05	1.130E-05	4.507E-06	2.545E-06	1.664E-06	1.190E-06	9.038E-07	7.168E-07	5.872E-07
Annual Average X/Q		Distance in miles from the site									
Sector	5	7.5	10	15	20	25	30	35	40	45	50
S	8.590E-07	4.697E-07	3.175E-07	1.928E-07	1.357E-07	1.035E-07	8.298E-08	6.890E-08	5.868E-08	5.095E-08	4.491E-08
SSW	8.867E-07	4.840E-07	3.268E-07	1.982E-07	1.394E-07	1.062E-07	8.514E-08	7.067E-08	6.016E-08	5.222E-08	4.602E-08
SW	1.595E-06	8.806E-07	5.990E-07	3.667E-07	2.595E-07	1.987E-07	1.598E-07	1.331E-07	1.136E-07	9.879E-08	8.722E-08
WSW	9.896E-07	5.437E-07	3.686E-07	2.247E-07	1.586E-07	1.211E-07	9.731E-08	8.089E-08	6.896E-08	5.993E-08	5.286E-08
W	4.546E-07	2.481E-07	1.675E-07	1.015E-07	7.135E-08	5.436E-08	4.357E-08	3.615E-08	3.077E-08	2.671E-08	2.353E-08
WNW	2.146E-07	1.150E-07	7.670E-08	4.573E-08	3.179E-08	2.402E-08	1.912E-08	1.578E-08	1.337E-08	1.155E-08	1.014E-08
NW	2.571E-07	1.379E-07	9.202E-08	5.493E-08	3.822E-08	2.889E-08	2.302E-08	1.900E-08	1.611E-08	1.393E-08	1.223E-08
NNW	2.459E-07	1.311E-07	8.712E-08	5.170E-08	3.583E-08	2.701E-08	2.146E-08	1.768E-08	1.496E-08	1.292E-08	1.133E-08
N	2.934E-07	1.556E-07	1.031E-07	6.090E-08	4.209E-08	3.166E-08	2.512E-08	2.067E-08	1.747E-08	1.507E-08	1.321E-08
NNE	3.932E-07	2.082E-07	1.376E-07	8.114E-08	5.598E-08	4.204E-08	3.332E-08	2.739E-08	2.313E-08	1.993E-08	1.745E-08
NE	4.520E-07	2.424E-07	1.617E-07	9.652E-08	6.714E-08	5.075E-08	4.042E-08	3.337E-08	2.828E-08	2.445E-08	2.147E-08
ENE	4.443E-07	2.389E-07	1.598E-07	9.564E-08	6.669E-08	5.051E-08	4.029E-08	3.330E-08	2.825E-08	2.445E-08	2.149E-08
E	3.764E-07	2.032E-07	1.362E-07	8.178E-08	5.713E-08	4.333E-08	3.460E-08	2.863E-08	2.430E-08	2.105E-08	1.851E-08
ESE	2.793E-07	1.500E-07	1.002E-07	5.987E-08	4.170E-08	3.156E-08	2.516E-08	2.078E-08	1.762E-08	1.525E-08	1.340E-08
SE	3.286E-07	1.770E-07	1.185E-07	7.102E-08	4.957E-08	3.756E-08	2.998E-08	2.479E-08	2.104E-08	1.821E-08	1.601E-08
SSE	4.932E-07	2.676E-07	1.800E-07	1.086E-07	7.609E-08	5.783E-08	4.627E-08	3.834E-08	3.259E-08	2.825E-08	2.487E-08

Table A-6

Undepleted, no decay, X/Q values for Ground Level Routine Release at standard distances in sec m^{-3}

Annual Average X/Q	Segment Boundaries (miles from site)									
Sector	0.5-1.0	1.0-2.0	2.0-3.0	3.0-4.0	4.0-5.0	5.0-10.0	10.0-20.0	20.0-30.0	30.0-40.0	40.0-50.0
S	3.884E-05	8.746E-06	2.931E-06	1.580E-06	1.027E-06	4.885E-07	1.951E-07	1.039E-07	6.903E-08	5.100E-08
SSW	4.038E-05	9.092E-06	3.037E-06	1.634E-06	1.060E-06	5.036E-07	2.006E-07	1.066E-07	7.080E-08	5.228E-08
SW	7.093E-05	1.576E-05	5.339E-06	2.907E-06	1.901E-06	9.143E-07	3.707E-07	1.994E-07	1.333E-07	9.888E-08
WSW	4.415E-05	9.911E-06	3.344E-06	1.812E-06	1.181E-06	5.650E-07	2.273E-07	1.216E-07	8.104E-08	5.999E-08
W	2.057E-05	4.654E-06	1.557E-06	8.378E-07	5.436E-07	2.581E-07	1.028E-07	5.457E-08	3.622E-08	2.673E-08
WNW	9.993E-06	2.318E-06	7.620E-07	4.027E-07	2.581E-07	1.201E-07	4.642E-08	2.413E-08	1.582E-08	1.157E-08
NW	1.207E-05	2.780E-06	9.115E-07	4.820E-07	3.090E-07	1.440E-07	5.575E-08	2.903E-08	1.905E-08	1.395E-08
NNW	1.167E-05	2.706E-06	8.824E-07	4.639E-07	2.962E-07	1.371E-07	5.252E-08	2.714E-08	1.773E-08	1.294E-08
N	1.421E-05	3.293E-06	1.064E-06	5.563E-07	3.539E-07	1.629E-07	6.191E-08	3.182E-08	2.072E-08	1.509E-08
NNE	1.892E-05	4.418E-06	1.430E-06	7.467E-07	4.745E-07	2.179E-07	8.251E-08	4.227E-08	2.746E-08	1.996E-08
NE	2.116E-05	4.883E-06	1.603E-06	8.476E-07	5.433E-07	2.531E-07	9.796E-08	5.099E-08	3.345E-08	2.448E-08
ENE	2.084E-05	4.772E-06	1.568E-06	8.309E-07	5.336E-07	2.494E-07	9.703E-08	5.074E-08	3.338E-08	2.448E-08
E	1.745E-05	3.991E-06	1.318E-06	7.014E-07	4.516E-07	2.119E-07	8.292E-08	4.352E-08	2.869E-08	2.107E-08
ESE	1.316E-05	3.015E-06	9.884E-07	5.231E-07	3.356E-07	1.566E-07	6.075E-08	3.170E-08	2.083E-08	1.527E-08
SE	1.539E-05	3.513E-06	1.156E-06	6.137E-07	3.945E-07	1.847E-07	7.203E-08	3.773E-08	2.484E-08	1.824E-08
SSE	2.265E-05	5.145E-06	1.709E-06	9.143E-07	5.908E-07	2.788E-07	1.100E-07	5.807E-08	3.841E-08	2.829E-08

Table A-7

Undepleted, 2.26 Day Decay, X/Q values for Ground Level Routine Release at standard distances in sec m⁻³

Annual Average X/Q		Distance in miles from the site									
Sector	0.25	0.5	0.75	1	1.5	2	2.5	3	3.5	4	4.5
S	2.596E-04	7.730E-05	3.818E-05	1.878E-05	7.397E-06	4.158E-06	2.701E-06	1.917E-06	1.444E-06	1.136E-06	9.217E-07
SSW	2.683E-04	8.021E-05	3.975E-05	1.954E-05	7.687E-06	4.312E-06	2.797E-06	1.983E-06	1.493E-06	1.173E-06	9.512E-07
SW	4.863E-04	1.424E-04	6.927E-05	3.375E-05	1.323E-05	7.493E-06	4.893E-06	3.487E-06	2.635E-06	2.077E-06	1.689E-06
WSW	2.994E-04	8.813E-05	4.322E-05	2.121E-05	8.351E-06	4.712E-06	3.069E-06	2.182E-06	1.646E-06	1.295E-06	1.052E-06
W	1.367E-04	4.075E-05	2.025E-05	9.980E-06	3.933E-06	2.206E-06	1.430E-06	1.014E-06	7.628E-07	5.990E-07	4.857E-07
WNW	6.345E-05	1.947E-05	9.932E-06	4.981E-06	1.981E-06	1.096E-06	7.033E-07	4.945E-07	3.697E-07	2.888E-07	2.332E-07
NW	7.631E-05	2.351E-05	1.202E-05	5.991E-06	2.369E-06	1.310E-06	8.412E-07	5.916E-07	4.424E-07	3.457E-07	2.791E-07
NNW	7.276E-05	2.265E-05	1.165E-05	5.840E-06	2.317E-06	1.276E-06	8.167E-07	5.731E-07	4.277E-07	3.337E-07	2.691E-07
N	8.719E-05	2.747E-05	1.428E-05	7.142E-06	2.823E-06	1.548E-06	9.882E-07	6.920E-07	5.157E-07	4.019E-07	3.239E-07
NNE	1.158E-04	3.651E-05	1.900E-05	9.562E-06	3.800E-06	2.084E-06	1.330E-06	9.307E-07	6.935E-07	5.403E-07	4.353E-07
NE	1.343E-04	4.133E-05	2.106E-05	1.053E-05	4.175E-06	2.311E-06	1.485E-06	1.045E-06	7.817E-07	6.112E-07	4.938E-07
ENE	1.335E-04	4.087E-05	2.070E-05	1.030E-05	4.069E-06	2.256E-06	1.450E-06	1.022E-06	7.650E-07	5.985E-07	4.838E-07
E	1.127E-04	3.429E-05	1.730E-05	8.590E-06	3.395E-06	1.888E-06	1.216E-06	8.581E-07	6.433E-07	5.037E-07	4.074E-07
ESE	8.366E-05	2.576E-05	1.309E-05	6.510E-06	2.570E-06	1.423E-06	9.143E-07	6.435E-07	4.816E-07	3.766E-07	3.043E-07
SE	9.880E-05	3.022E-05	1.526E-05	7.576E-06	2.990E-06	1.659E-06	1.068E-06	7.525E-07	5.636E-07	4.410E-07	3.566E-07
SSE	1.483E-04	4.477E-05	2.236E-05	1.106E-05	4.367E-06	2.439E-06	1.577E-06	1.115E-06	8.375E-07	6.568E-07	5.320E-07

Annual Average X/Q		Distance in miles from the site									
Sector	5	7.5	10	15	20	25	30	35	40	45	50
S	7.669E-07	3.957E-07	2.525E-07	1.367E-07	8.591E-08	5.860E-08	4.213E-08	3.142E-08	2.409E-08	1.887E-08	1.505E-08
SSW	7.909E-07	4.072E-07	2.593E-07	1.400E-07	8.780E-08	5.976E-08	4.287E-08	3.190E-08	2.441E-08	1.908E-08	1.518E-08
SW	1.407E-06	7.292E-07	4.657E-07	2.514E-07	1.571E-07	1.063E-07	7.569E-08	5.585E-08	4.232E-08	3.274E-08	2.575E-08
WSW	8.760E-07	4.525E-07	2.885E-07	1.557E-07	9.735E-08	6.600E-08	4.712E-08	3.487E-08	2.652E-08	2.059E-08	1.627E-08
W	4.037E-07	2.074E-07	1.319E-07	7.092E-08	4.429E-08	3.002E-08	2.145E-08	1.589E-08	1.210E-08	9.412E-09	7.449E-09
WNW	1.931E-07	9.804E-08	6.195E-08	3.319E-08	2.077E-08	1.416E-08	1.019E-08	7.616E-09	5.860E-09	4.611E-09	3.694E-09
NW	2.312E-07	1.175E-07	7.425E-08	3.980E-08	2.491E-08	1.697E-08	1.220E-08	9.119E-09	7.011E-09	5.512E-09	4.414E-09
NNW	2.227E-07	1.128E-07	7.119E-08	3.816E-08	2.393E-08	1.635E-08	1.180E-08	8.859E-09	6.844E-09	5.408E-09	4.353E-09
N	2.678E-07	1.355E-07	8.556E-08	4.604E-08	2.903E-08	1.997E-08	1.452E-08	1.099E-08	8.556E-09	6.819E-09	5.537E-09
NNE	3.599E-07	1.820E-07	1.149E-07	6.190E-08	3.909E-08	2.694E-08	1.964E-08	1.489E-08	1.163E-08	9.296E-09	7.571E-09
NE	4.093E-07	2.085E-07	1.322E-07	7.131E-08	4.491E-08	3.081E-08	2.232E-08	1.681E-08	1.302E-08	1.032E-08	8.336E-09
ENE	4.011E-07	2.046E-07	1.298E-07	6.998E-08	4.403E-08	3.015E-08	2.180E-08	1.637E-08	1.265E-08	9.996E-09	8.045E-09
E	3.380E-07	1.726E-07	1.095E-07	5.893E-08	3.696E-08	2.521E-08	1.815E-08	1.356E-08	1.043E-08	8.198E-09	6.562E-09
ESE	2.522E-07	1.285E-07	8.141E-08	4.384E-08	2.756E-08	1.886E-08	1.362E-08	1.023E-08	7.898E-09	6.238E-09	5.018E-09
SE	2.956E-07	1.508E-07	9.558E-08	5.142E-08	3.226E-08	2.201E-08	1.586E-08	1.186E-08	9.130E-09	7.185E-09	5.758E-09
SSE	4.419E-07	2.266E-07	1.441E-07	7.774E-08	4.879E-08	3.328E-08	2.394E-08	1.788E-08	1.373E-08	1.078E-08	8.614E-09

Table A-8

Undepleted, 2.26 Day Decay, X/Q values for Ground Level Routine Release at standard distances in sec m⁻³

Sector	Segment Boundaries (miles from site)									
	0.5-1.0	1.0-2.0	2.0-3.0	3.0-4.0	4.0-5.0	5.0-10.0	10.0-20.0	20.0-30.0	30.0-40.0	40.0-50.0
S	3.825E-05	8.487E-06	2.776E-06	1.462E-06	9.277E-07	4.145E-07	1.399E-07	5.930E-08	3.169E-08	1.900E-08
SSW	3.976E-05	8.822E-06	2.876E-06	1.511E-06	9.574E-07	4.267E-07	1.433E-07	6.048E-08	3.218E-08	1.921E-08
SW	6.973E-05	1.524E-05	5.024E-06	2.666E-06	1.699E-06	7.627E-07	2.571E-07	1.076E-07	5.637E-08	3.299E-08
WSW	4.342E-05	9.591E-06	3.152E-06	1.666E-06	1.059E-06	4.737E-07	1.593E-07	6.680E-08	3.519E-08	2.075E-08
W	2.024E-05	4.509E-06	1.471E-06	7.721E-07	4.889E-07	2.174E-07	7.263E-08	3.040E-08	1.603E-08	9.481E-09
WNW	9.851E-06	2.254E-06	7.244E-07	3.745E-07	2.348E-07	1.031E-07	3.406E-08	1.433E-08	7.682E-09	4.641E-09
NW	1.189E-05	2.704E-06	8.665E-07	4.482E-07	2.811E-07	1.235E-07	4.083E-08	1.718E-08	9.197E-09	5.550E-09
NNW	1.151E-05	2.637E-06	8.418E-07	4.334E-07	2.711E-07	1.187E-07	3.918E-08	1.655E-08	8.933E-09	5.443E-09
N	1.404E-05	3.216E-06	1.019E-06	5.227E-07	3.262E-07	1.427E-07	4.726E-08	2.021E-08	1.107E-08	6.859E-09
NNE	1.869E-05	4.318E-06	1.371E-06	7.029E-07	4.385E-07	1.917E-07	6.355E-08	2.726E-08	1.501E-08	9.349E-09
NE	2.088E-05	4.758E-06	1.529E-06	7.919E-07	4.973E-07	2.192E-07	7.311E-08	3.117E-08	1.694E-08	1.039E-08
ENE	2.056E-05	4.647E-06	1.494E-06	7.749E-07	4.871E-07	2.150E-07	7.174E-08	3.051E-08	1.650E-08	1.006E-08
E	1.720E-05	3.880E-06	1.252E-06	6.515E-07	4.102E-07	1.813E-07	6.041E-08	2.552E-08	1.368E-08	8.253E-09
ESE	1.298E-05	2.936E-06	9.416E-07	4.878E-07	3.064E-07	1.350E-07	4.496E-08	1.909E-08	1.031E-08	6.278E-09
SE	1.517E-05	3.418E-06	1.099E-06	5.709E-07	3.590E-07	1.584E-07	5.271E-08	2.228E-08	1.196E-08	7.233E-09
SSE	2.232E-05	4.998E-06	1.622E-06	8.479E-07	5.356E-07	2.378E-07	7.962E-08	3.368E-08	1.803E-08	1.085E-08

Table A-9

Depleted, 8 Day Decay, X/Q values for Ground Level Routine Release at standard distances in sec m⁻³

Annual Average X/Q		Distance in miles from the site									
Sector	0.25	0.5	0.75	1	1.5	2	2.5	3	3.5	4	4.5
S	2.467E-04	7.116E-05	3.443E-05	1.670E-05	6.431E-06	3.554E-06	2.277E-06	1.598E-06	1.192E-06	9.299E-07	7.496E-07
SSW	2.550E-04	7.384E-05	3.584E-05	1.738E-05	6.685E-06	3.687E-06	2.359E-06	1.653E-06	1.233E-06	9.608E-07	7.740E-07
SW	4.624E-04	1.312E-04	6.256E-05	3.007E-05	1.153E-05	6.429E-06	4.144E-06	2.922E-06	2.189E-06	1.713E-06	1.384E-06
WSW	2.847E-04	8.119E-05	3.902E-05	1.889E-05	7.277E-06	4.039E-06	2.596E-06	1.826E-06	1.365E-06	1.066E-06	8.606E-07
W	1.299E-04	3.753E-05	1.827E-05	8.882E-06	3.425E-06	1.889E-06	1.208E-06	8.470E-07	6.315E-07	4.921E-07	3.964E-07
WNW	6.028E-05	1.791E-05	8.949E-06	4.424E-06	1.720E-06	9.346E-07	5.913E-07	4.108E-07	3.040E-07	2.355E-07	1.887E-07
NW	7.250E-05	2.163E-05	1.083E-05	5.322E-06	2.057E-06	1.118E-06	7.072E-07	4.915E-07	3.639E-07	2.819E-07	2.259E-07
NNW	6.911E-05	2.083E-05	1.049E-05	5.182E-06	2.008E-06	1.086E-06	6.849E-07	4.746E-07	3.506E-07	2.710E-07	2.169E-07
N	8.279E-05	2.524E-05	1.284E-05	6.329E-06	2.442E-06	1.315E-06	8.263E-07	5.712E-07	4.210E-07	3.249E-07	2.596E-07
NNE	1.099E-04	3.354E-05	1.708E-05	8.471E-06	3.286E-06	1.768E-06	1.111E-06	7.673E-07	5.653E-07	4.362E-07	3.483E-07
NE	1.276E-04	3.801E-05	1.896E-05	9.339E-06	3.619E-06	1.967E-06	1.245E-06	8.654E-07	6.407E-07	4.964E-07	3.979E-07
ENE	1.268E-04	3.759E-05	1.864E-05	9.138E-06	3.528E-06	1.921E-06	1.217E-06	8.472E-07	6.279E-07	4.869E-07	3.905E-07
E	1.071E-04	3.155E-05	1.559E-05	7.632E-06	2.948E-06	1.611E-06	1.023E-06	7.134E-07	5.295E-07	4.111E-07	3.301E-07
ESE	7.947E-05	2.369E-05	1.179E-05	5.778E-06	2.229E-06	1.212E-06	7.674E-07	5.336E-07	3.952E-07	3.063E-07	2.456E-07
SE	9.387E-05	2.780E-05	1.375E-05	6.728E-06	2.595E-06	1.415E-06	8.975E-07	6.250E-07	4.635E-07	3.595E-07	2.885E-07
SSE	1.410E-04	4.120E-05	2.016E-05	9.832E-06	3.794E-06	2.082E-06	1.327E-06	9.278E-07	6.901E-07	5.368E-07	4.317E-07

Annual Average X/Q		Distance in miles from the site									
Sector	5	7.5	10	15	20	25	30	35	40	45	50
S	6.200E-07	3.153E-07	1.998E-07	1.086E-07	6.939E-08	4.848E-08	3.584E-08	2.755E-08	2.180E-08	1.763E-08	1.451E-08
SSW	6.398E-07	3.248E-07	2.055E-07	1.115E-07	7.118E-08	4.968E-08	3.670E-08	2.819E-08	2.229E-08	1.801E-08	1.481E-08
SW	1.148E-06	5.884E-07	3.746E-07	2.047E-07	1.312E-07	9.180E-08	6.790E-08	5.220E-08	4.128E-08	3.336E-08	2.742E-08
WSW	7.126E-07	3.638E-07	2.309E-07	1.258E-07	8.047E-08	5.623E-08	4.156E-08	3.193E-08	2.525E-08	2.040E-08	1.677E-08
W	3.276E-07	1.662E-07	1.051E-07	5.695E-08	3.631E-08	2.532E-08	1.868E-08	1.434E-08	1.132E-08	9.143E-09	7.511E-09
WNW	1.552E-07	7.746E-08	4.846E-08	2.592E-08	1.640E-08	1.137E-08	8.364E-09	6.404E-09	5.051E-09	4.075E-09	3.347E-09
NW	1.859E-07	9.285E-08	5.813E-08	3.112E-08	1.970E-08	1.367E-08	1.005E-08	7.700E-09	6.073E-09	4.900E-09	4.025E-09
NNW	1.782E-07	8.852E-08	5.522E-08	2.943E-08	1.858E-08	1.288E-08	9.462E-09	7.241E-09	5.710E-09	4.606E-09	3.784E-09
N	2.131E-07	1.054E-07	6.561E-08	3.489E-08	2.202E-08	1.526E-08	1.122E-08	8.594E-09	6.784E-09	5.480E-09	4.508E-09
NNE	2.858E-07	1.412E-07	8.776E-08	4.660E-08	2.938E-08	2.035E-08	1.495E-08	1.145E-08	9.040E-09	7.303E-09	6.008E-09
NE	3.275E-07	1.637E-07	1.025E-07	5.495E-08	3.483E-08	2.421E-08	1.783E-08	1.368E-08	1.080E-08	8.731E-09	7.183E-09
ENE	3.216E-07	1.611E-07	1.011E-07	5.431E-08	3.448E-08	2.399E-08	1.768E-08	1.357E-08	1.072E-08	8.662E-09	7.125E-09
E	2.721E-07	1.367E-07	8.595E-08	4.625E-08	2.939E-08	2.045E-08	1.507E-08	1.156E-08	9.128E-09	7.372E-09	6.061E-09
ESE	2.022E-07	1.011E-07	6.340E-08	3.401E-08	2.157E-08	1.499E-08	1.105E-08	8.470E-09	6.690E-09	5.405E-09	4.445E-09
SE	2.377E-07	1.192E-07	7.483E-08	4.022E-08	2.553E-08	1.775E-08	1.308E-08	1.003E-08	7.921E-09	6.397E-09	5.259E-09
SSE	3.563E-07	1.799E-07	1.135E-07	6.131E-08	3.904E-08	2.721E-08	2.008E-08	1.541E-08	1.218E-08	9.844E-09	8.096E-09

Table A-10

Depleted, 8 Day Decay, X/Q values for Ground Level Routine Release at standard distances in sec m⁻³

Sector	Segment Boundaries (miles from site)									
	0.5-1.0	1.0-2.0	2.0-3.0	3.0-4.0	4.0-5.0	5.0-10.0	10.0-20.0	20.0-30.0	30.0-40.0	40.0-50.0
S	3.471E-05	7.435E-06	2.346E-06	1.208E-06	7.550E-07	3.316E-07	1.114E-07	4.900E-08	2.773E-08	1.771E-08
SSW	3.608E-05	7.729E-06	2.431E-06	1.249E-06	7.796E-07	3.418E-07	1.145E-07	5.022E-08	2.837E-08	1.809E-08
SW	6.337E-05	1.339E-05	4.265E-06	2.217E-06	1.394E-06	6.176E-07	2.098E-07	9.276E-08	5.253E-08	3.351E-08
WSW	3.944E-05	8.418E-06	2.673E-06	1.383E-06	8.667E-07	3.822E-07	1.290E-07	5.683E-08	3.214E-08	2.049E-08
W	1.838E-05	3.955E-06	1.245E-06	6.399E-07	3.992E-07	1.749E-07	5.847E-08	2.560E-08	1.443E-08	9.185E-09
WNW	8.930E-06	1.972E-06	6.106E-07	3.084E-07	1.902E-07	8.186E-08	2.670E-08	1.151E-08	6.448E-09	4.094E-09
NW	1.078E-05	2.365E-06	7.304E-07	3.691E-07	2.277E-07	9.810E-08	3.204E-08	1.383E-08	7.753E-09	4.923E-09
NNW	1.043E-05	2.304E-06	7.078E-07	3.557E-07	2.186E-07	9.365E-08	3.034E-08	1.303E-08	7.292E-09	4.628E-09
N	1.270E-05	2.805E-06	8.545E-07	4.273E-07	2.617E-07	1.116E-07	3.600E-08	1.545E-08	8.654E-09	5.506E-09
NNE	1.691E-05	3.764E-06	1.149E-06	5.738E-07	3.512E-07	1.496E-07	4.810E-08	2.060E-08	1.153E-08	7.338E-09
NE	1.892E-05	4.156E-06	1.286E-06	6.499E-07	4.010E-07	1.729E-07	5.658E-08	2.449E-08	1.377E-08	8.772E-09
ENE	1.863E-05	4.061E-06	1.257E-06	6.368E-07	3.936E-07	1.701E-07	5.590E-08	2.426E-08	1.366E-08	8.702E-09
E	1.560E-05	3.395E-06	1.056E-06	5.369E-07	3.326E-07	1.442E-07	4.758E-08	2.068E-08	1.164E-08	7.407E-09
ESE	1.176E-05	2.566E-06	7.925E-07	4.009E-07	2.475E-07	1.068E-07	3.501E-08	1.517E-08	8.528E-09	5.430E-09
SE	1.375E-05	2.989E-06	9.265E-07	4.700E-07	2.907E-07	1.258E-07	4.138E-08	1.796E-08	1.010E-08	6.427E-09
SSE	2.024E-05	4.375E-06	1.369E-06	6.996E-07	4.349E-07	1.896E-07	6.300E-08	2.751E-08	1.552E-08	9.890E-09

Table A-11

Deposition values (D/Q) for Ground Level Routine Release at standard distances in per m²

Sector	Distance in miles from the site										
	0.25	0.5	0.75	1	1.5	2	2.5	3	3.5	4	4.5
S	2.043E-07	6.909E-08	3.547E-08	1.687E-08	6.058E-09	3.004E-09	1.769E-09	1.158E-09	8.150E-10	6.040E-10	4.655E-10
SSW	2.243E-07	7.584E-08	3.894E-08	1.851E-08	6.649E-09	3.298E-09	1.942E-09	1.271E-09	8.946E-10	6.630E-10	5.109E-10
SW	2.249E-07	7.606E-08	3.905E-08	1.857E-08	6.669E-09	3.307E-09	1.947E-09	1.275E-09	8.973E-10	6.650E-10	5.124E-10
WSW	1.520E-07	5.141E-08	2.640E-08	1.255E-08	4.508E-09	2.235E-09	1.316E-09	8.619E-10	6.065E-10	4.494E-10	3.464E-10
W	8.074E-08	2.730E-08	1.402E-08	6.665E-09	2.394E-09	1.187E-09	6.990E-10	4.577E-10	3.221E-10	2.387E-10	1.839E-10
WNW	5.925E-08	2.003E-08	1.029E-08	4.890E-09	1.757E-09	8.712E-10	5.130E-10	3.359E-10	2.363E-10	1.752E-10	1.350E-10
NW	7.104E-08	2.402E-08	1.233E-08	5.864E-09	2.106E-09	1.045E-09	6.151E-10	4.027E-10	2.834E-10	2.100E-10	1.618E-10
NNW	9.208E-08	3.114E-08	1.599E-08	7.601E-09	2.730E-09	1.354E-09	7.973E-10	5.220E-10	3.673E-10	2.722E-10	2.098E-10
N	1.450E-07	4.905E-08	2.518E-08	1.197E-08	4.300E-09	2.133E-09	1.256E-09	8.223E-10	5.786E-10	4.288E-10	3.304E-10
NNE	2.084E-07	7.048E-08	3.619E-08	1.720E-08	6.180E-09	3.065E-09	1.805E-09	1.182E-09	8.315E-10	6.162E-10	4.749E-10
NE	1.864E-07	6.302E-08	3.236E-08	1.538E-08	5.526E-09	2.740E-09	1.614E-09	1.057E-09	7.434E-10	5.509E-10	4.246E-10
ENE	1.809E-07	6.118E-08	3.141E-08	1.493E-08	5.364E-09	2.660E-09	1.566E-09	1.026E-09	7.217E-10	5.348E-10	4.121E-10
E	1.151E-07	3.892E-08	1.999E-08	9.501E-09	3.413E-09	1.693E-09	9.966E-10	6.526E-10	4.592E-10	3.403E-10	2.622E-10
ESE	1.081E-07	3.655E-08	1.877E-08	8.922E-09	3.205E-09	1.589E-09	9.358E-10	6.128E-10	4.312E-10	3.195E-10	2.462E-10
SE	1.221E-07	4.129E-08	2.120E-08	1.008E-08	3.620E-09	1.795E-09	1.057E-09	6.922E-10	4.871E-10	3.610E-10	2.782E-10
SSE	1.413E-07	4.778E-08	2.453E-08	1.166E-08	4.189E-09	2.078E-09	1.223E-09	8.010E-10	5.636E-10	4.177E-10	3.219E-10
Sector	Distance in miles from the site										
	5	7.5	10	15	20	25	30	35	40	45	50
S	3.698E-10	1.643E-10	9.951E-11	5.030E-11	3.044E-11	2.041E-11	1.463E-11	1.098E-11	8.539E-12	6.821E-12	5.567E-12
SSW	4.059E-10	1.803E-10	1.092E-10	5.521E-11	3.341E-11	2.240E-11	1.605E-11	1.205E-11	9.373E-12	7.487E-12	6.111E-12
SW	4.071E-10	1.809E-10	1.096E-10	5.537E-11	3.351E-11	2.247E-11	1.610E-11	1.209E-11	9.401E-12	7.509E-12	6.129E-12
WSW	2.752E-10	1.222E-10	7.404E-11	3.743E-11	2.265E-11	1.519E-11	1.088E-11	8.172E-12	6.354E-12	5.075E-12	4.143E-12
W	1.461E-10	6.492E-11	3.932E-11	1.988E-11	1.203E-11	8.066E-12	5.779E-12	4.340E-12	3.374E-12	2.695E-12	2.200E-12
WNW	1.072E-10	4.763E-11	2.886E-11	1.458E-11	8.827E-12	5.919E-12	4.241E-12	3.185E-12	2.476E-12	1.978E-12	1.614E-12
NW	1.286E-10	5.712E-11	3.460E-11	1.749E-11	1.058E-11	7.097E-12	5.085E-12	3.818E-12	2.969E-12	2.372E-12	1.936E-12
NNW	1.667E-10	7.404E-11	4.485E-11	2.267E-11	1.372E-11	9.199E-12	6.592E-12	4.950E-12	3.848E-12	3.074E-12	2.509E-12
N	2.625E-10	1.166E-10	7.064E-11	3.570E-11	2.161E-11	1.449E-11	1.038E-11	7.796E-12	6.062E-12	4.842E-12	3.952E-12
NNE	3.772E-10	1.676E-10	1.015E-10	5.131E-11	3.106E-11	2.082E-11	1.492E-11	1.120E-11	8.711E-12	6.958E-12	5.680E-12
NE	3.373E-10	1.498E-10	9.076E-11	4.588E-11	2.777E-11	1.862E-11	1.334E-11	1.002E-11	7.788E-12	6.221E-12	5.078E-12
ENE	3.274E-10	1.455E-10	8.811E-11	4.453E-11	2.695E-11	1.807E-11	1.295E-11	9.724E-12	7.561E-12	6.039E-12	4.930E-12
E	2.083E-10	9.255E-11	5.606E-11	2.834E-11	1.715E-11	1.150E-11	8.240E-12	6.187E-12	4.811E-12	3.843E-12	3.137E-12
ESE	1.956E-10	8.691E-11	5.264E-11	2.661E-11	1.610E-11	1.080E-11	7.737E-12	5.810E-12	4.517E-12	3.608E-12	2.945E-12
SE	2.210E-10	9.817E-11	5.947E-11	3.006E-11	1.819E-11	1.220E-11	8.740E-12	6.563E-12	5.103E-12	4.076E-12	3.327E-12
SSE	2.557E-10	1.136E-10	6.882E-11	3.478E-11	2.105E-11	1.412E-11	1.011E-11	7.595E-12	5.905E-12	4.717E-12	3.850E-12

Table A-12

Deposition values (D/Q) for Ground Level Routine Release at standard distances in per m²

Sector	Segment Boundaries (miles from site)									
	0.5-1.0	1.0-2.0	2.0-3.0	3.0-4.0	4.0-5.0	5.0-10.0	10.0-20.0	20.0-30.0	30.0-40.0	40.0-50.0
S	3.467E-08	7.102E-09	1.854E-09	8.327E-10	4.711E-10	1.812E-10	5.241E-11	2.077E-11	1.109E-11	6.866E-12
SSW	3.806E-08	7.796E-09	2.035E-09	9.140E-10	5.171E-10	1.988E-10	5.753E-11	2.280E-11	1.218E-11	7.536E-12
SW	3.817E-08	7.819E-09	2.041E-09	9.168E-10	5.186E-10	1.994E-10	5.770E-11	2.287E-11	1.221E-11	7.559E-12
WSW	2.580E-08	5.285E-09	1.380E-09	6.196E-10	3.505E-10	1.348E-10	3.900E-11	1.546E-11	8.254E-12	5.109E-12
W	1.370E-08	2.807E-09	7.327E-10	3.291E-10	1.862E-10	7.159E-11	2.071E-11	8.208E-12	4.383E-12	2.713E-12
WNW	1.005E-08	2.059E-09	5.376E-10	2.415E-10	1.366E-10	5.253E-11	1.520E-11	6.023E-12	3.216E-12	1.991E-12
NW	1.206E-08	2.469E-09	6.447E-10	2.895E-10	1.638E-10	6.299E-11	1.822E-11	7.222E-12	3.857E-12	2.387E-12
NNW	1.563E-08	3.201E-09	8.356E-10	3.753E-10	2.123E-10	8.165E-11	2.362E-11	9.362E-12	4.999E-12	3.094E-12
N	2.461E-08	5.042E-09	1.316E-09	5.911E-10	3.344E-10	1.286E-10	3.720E-11	1.475E-11	7.874E-12	4.874E-12
NNE	3.537E-08	7.245E-09	1.891E-09	8.495E-10	4.806E-10	1.848E-10	5.346E-11	2.119E-11	1.132E-11	7.004E-12
NE	3.163E-08	6.478E-09	1.691E-09	7.595E-10	4.297E-10	1.652E-10	4.780E-11	1.895E-11	1.012E-11	6.262E-12
ENE	3.070E-08	6.289E-09	1.642E-09	7.373E-10	4.171E-10	1.604E-10	4.640E-11	1.839E-11	9.822E-12	6.079E-12
E	1.953E-08	4.001E-09	1.045E-09	4.691E-10	2.654E-10	1.021E-10	2.953E-11	1.170E-11	6.249E-12	3.868E-12
ESE	1.834E-08	3.757E-09	9.809E-10	4.405E-10	2.492E-10	9.584E-11	2.773E-11	1.099E-11	5.868E-12	3.632E-12
SE	2.072E-08	4.244E-09	1.108E-09	4.976E-10	2.815E-10	1.083E-10	3.132E-11	1.241E-11	6.629E-12	4.103E-12
SSE	2.398E-08	4.912E-09	1.282E-09	5.759E-10	3.258E-10	1.253E-10	3.624E-11	1.436E-11	7.671E-12	4.748E-12

Table A-13

Joint Wind Frequency Distribution by Pasquill Stability Classes at SHNP (2010-2014 meteorological data, 12.5-meter level)

Stability Class A																	
Umax	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0.45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0.002	0	0	0.002
1	0	0	0	0.002	0.005	0	0	0	0	0	0	0	0	0	0	0	0.007
1.25	0.002	0	0.005	0.002	0	0.002	0	0	0	0.002	0.002	0	0	0.002	0	0	0.018
1.5	0	0	0.005	0.002	0	0	0.005	0.002	0	0.002	0.002	0	0.005	0	0.005	0	0.028
2	0.002	0	0	0.009	0	0.002	0	0.007	0.002	0	0.005	0.009	0.005	0.002	0.002	0.002	0.048
3	0	0.014	0.028	0.035	0.012	0.002	0	0.007	0.007	0.012	0.012	0.025	0.012	0.005	0.005	0.002	0.175
4	0.005	0.018	0.023	0.018	0.002	0	0.002	0.012	0.023	0.009	0.007	0.037	0.016	0.002	0.009	0.002	0.186
5	0.002	0.014	0.007	0.002	0.005	0	0	0	0.007	0.007	0.012	0.007	0.002	0.002	0.005	0.002	0.074
6	0	0.002	0	0	0	0	0	0	0	0	0.005	0.007	0.002	0	0.002	0.002	0.021
8	0	0	0	0	0	0	0	0	0	0	0.002	0.002	0	0	0	0	0.005
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0.01	0.05	0.07	0.07	0.02	0.01	0.01	0.03	0.04	0.03	0.05	0.09	0.04	0.02	0.03	0.01	0.56
Stability Class B																	
Umax	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0.45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.75	0	0	0	0.002	0.002	0.002	0.002	0	0	0	0	0	0	0	0	0	0.009
1	0	0	0	0	0	0	0	0	0	0.002	0.002	0.002	0	0.002	0	0.005	0.014
1.25	0.002	0	0.002	0.002	0.002	0	0	0	0	0	0.002	0.005	0	0	0.005	0.005	0.025
1.5	0.002	0.005	0.009	0.009	0.005	0.002	0.002	0.005	0	0	0.002	0.005	0.005	0.005	0.002	0.002	0.06
2	0.007	0.012	0.023	0.03	0.021	0.018	0.005	0.012	0.018	0.014	0.007	0.016	0.012	0.007	0.009	0.007	0.216
3	0.044	0.071	0.134	0.076	0.025	0.007	0.018	0.032	0.046	0.044	0.035	0.076	0.028	0.028	0.028	0.016	0.707
4	0.005	0.067	0.041	0.032	0.005	0.009	0.005	0.009	0.085	0.067	0.062	0.104	0.023	0.021	0.023	0.016	0.573
5	0.009	0.018	0.012	0.009	0	0.002	0	0	0.021	0.016	0.032	0.032	0.016	0.007	0.012	0.012	0.198
6	0.009	0.002	0.002	0.002	0	0	0	0	0.005	0.005	0.023	0.007	0.005	0.016	0.005	0.005	0.085
8	0	0	0.002	0	0	0	0	0	0	0	0.002	0.002	0.002	0.002	0.002	0	0.014
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0.08	0.17	0.23	0.16	0.06	0.04	0.03	0.06	0.17	0.15	0.17	0.25	0.09	0.09	0.09	0.07	1.9

Table A-13 (continue)

Joint Wind Frequency Distribution by Pasquill Stability Classes at SHNP (2010-2014 meteorological data, 12.5-meter level)

Stability Class C																	
Umax	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0.45	0.003	0.001	0	0	0	0.001	0.002	0	0.001	0.001	0.001	0.001	0.002	0	0.004	0	0.016
0.75	0.007	0.002	0	0	0	0.002	0.005	0	0.002	0.002	0.002	0.002	0.005	0	0.009	0	0.039
1	0.007	0.005	0.007	0.002	0.007	0.007	0.005	0.009	0.005	0.007	0.005	0.007	0.005	0.014	0.005	0.002	0.097
1.25	0.012	0.012	0.014	0.007	0.012	0.018	0.009	0.007	0.016	0.009	0.007	0.014	0.014	0.005	0.002	0	0.157
1.5	0.023	0.018	0.037	0.032	0.012	0.018	0.018	0.005	0.03	0.016	0.009	0.023	0.016	0.03	0.016	0.023	0.327
2	0.046	0.051	0.064	0.099	0.039	0.032	0.039	0.037	0.048	0.046	0.055	0.069	0.062	0.037	0.067	0.053	0.845
3	0.087	0.26	0.191	0.157	0.074	0.053	0.048	0.113	0.219	0.175	0.11	0.322	0.129	0.099	0.145	0.127	2.309
4	0.085	0.127	0.087	0.03	0.005	0.012	0.009	0.023	0.124	0.131	0.127	0.292	0.099	0.11	0.124	0.09	1.476
5	0.028	0.039	0.014	0	0	0	0	0.002	0.023	0.062	0.046	0.062	0.023	0.032	0.046	0.039	0.417
6	0.002	0.014	0.005	0	0	0	0	0.002	0	0.012	0.018	0.005	0.007	0.012	0.009	0.002	0.087
8	0	0	0	0	0	0	0	0	0	0	0.002	0	0.002	0.007	0.005	0	0.016
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0.3	0.53	0.42	0.33	0.15	0.14	0.14	0.2	0.47	0.46	0.38	0.8	0.36	0.35	0.43	0.34	5.78
Stability Class D																	
Umax	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0.45	0.038	0.063	0.082	0.058	0.042	0.034	0.047	0.041	0.047	0.08	0.055	0.041	0.054	0.051	0.042	0.055	0.831
0.75	0.067	0.11	0.143	0.101	0.074	0.06	0.083	0.071	0.083	0.14	0.097	0.071	0.094	0.09	0.074	0.097	1.455
1	0.207	0.226	0.237	0.198	0.152	0.11	0.129	0.12	0.117	0.161	0.122	0.129	0.127	0.12	0.099	0.154	2.408
1.25	0.23	0.216	0.207	0.138	0.122	0.092	0.115	0.163	0.173	0.157	0.163	0.159	0.108	0.122	0.127	0.163	2.456
1.5	0.311	0.279	0.272	0.193	0.122	0.157	0.143	0.182	0.209	0.292	0.274	0.244	0.189	0.175	0.182	0.258	3.481
2	0.693	0.799	0.571	0.405	0.251	0.244	0.304	0.389	0.504	0.661	0.573	0.615	0.329	0.237	0.352	0.456	7.382
3	1.462	1.563	0.882	0.433	0.26	0.209	0.343	0.64	1.091	1.16	1.128	1.186	0.61	0.453	0.829	0.937	13.186
4	0.605	0.734	0.401	0.166	0.023	0.078	0.076	0.189	0.467	0.737	0.757	0.702	0.371	0.465	0.603	0.506	6.881
5	0.163	0.209	0.087	0.018	0.012	0.007	0.005	0.044	0.115	0.421	0.357	0.299	0.15	0.336	0.311	0.134	2.668
6	0.028	0.067	0.021	0.002	0	0.002	0	0.023	0.048	0.182	0.152	0.113	0.055	0.147	0.076	0.023	0.939
8	0.005	0.009	0	0	0	0	0	0.009	0.03	0.06	0.064	0.035	0.018	0.064	0.021	0.012	0.327
10	0	0	0	0	0	0	0	0	0	0	0	0.002	0	0.012	0	0	0.014
13.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	3.81	4.28	2.9	1.71	1.06	0.99	1.24	1.87	2.89	4.05	3.74	3.6	2.1	2.27	2.71	2.79	42.03

Table A-13 (continue)

Joint Wind Frequency Distribution by Pasquill Stability Classes at SHNP (2010-2014 meteorological data, 12.5-meter level)

Stability Class E																		TOTAL	
Umax	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW			
0.45	0.164	0.207	0.302	0.249	0.169	0.103	0.149	0.106	0.169	0.166	0.156	0.156	0.136	0.108	0.116	0.128	2.585		
0.75	0.15	0.189	0.276	0.228	0.154	0.094	0.136	0.097	0.154	0.152	0.143	0.143	0.124	0.099	0.106	0.117	2.362		
1	0.205	0.239	0.244	0.209	0.145	0.129	0.161	0.184	0.198	0.182	0.182	0.166	0.198	0.161	0.122	0.134	2.859		
1.25	0.221	0.258	0.18	0.173	0.136	0.099	0.113	0.154	0.12	0.228	0.154	0.198	0.177	0.124	0.106	0.127	2.567		
1.5	0.32	0.304	0.203	0.237	0.136	0.11	0.203	0.182	0.2	0.306	0.256	0.256	0.138	0.124	0.12	0.173	3.266		
2	0.472	0.467	0.237	0.163	0.15	0.157	0.168	0.315	0.479	0.559	0.474	0.387	0.239	0.196	0.219	0.279	4.961		
3	0.336	0.419	0.244	0.145	0.076	0.076	0.048	0.161	0.472	1.054	0.741	0.35	0.228	0.246	0.232	0.348	5.177		
4	0.046	0.053	0.046	0.021	0.007	0.009	0.012	0.009	0.134	0.447	0.193	0.078	0.046	0.081	0.062	0.11	1.354		
5	0.005	0.014	0.002	0	0	0.002	0.002	0	0.016	0.081	0.069	0.023	0.021	0.016	0.012	0.007	0.269		
6	0.005	0.005	0	0	0	0	0	0	0.005	0.028	0.009	0.012	0	0.002	0.005	0	0.069		
8	0.007	0	0	0	0	0	0	0	0	0.007	0.005	0	0	0	0	0.002	0.021		
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
13.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
TOTAL	1.93	2.15	1.73	1.43	0.97	0.78	0.99	1.21	1.95	3.21	2.38	1.77	1.31	1.16	1.1	1.42	25.49		

Stability Class F																		TOTAL	
Umax	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW			
0.45	0.281	0.286	0.44	0.367	0.168	0.132	0.095	0.127	0.091	0.195	0.227	0.181	0.159	0.095	0.136	0.2	3.179		
0.75	0.143	0.145	0.223	0.186	0.085	0.067	0.048	0.064	0.046	0.099	0.115	0.092	0.081	0.048	0.069	0.101	1.614		
1	0.173	0.122	0.152	0.152	0.062	0.074	0.058	0.039	0.083	0.076	0.099	0.11	0.074	0.092	0.071	0.11	1.547		
1.25	0.11	0.087	0.048	0.101	0.053	0.023	0.046	0.03	0.051	0.081	0.06	0.078	0.064	0.055	0.053	0.081	1.022		
1.5	0.154	0.094	0.03	0.048	0.025	0.014	0.039	0.044	0.055	0.069	0.078	0.101	0.058	0.058	0.062	0.058	0.988		
2	0.12	0.074	0.039	0.03	0.014	0.009	0.012	0.025	0.051	0.131	0.069	0.074	0.032	0.023	0.025	0.051	0.778		
3	0.018	0.021	0.005	0.007	0.005	0	0.005	0.002	0.018	0.037	0.025	0.028	0.012	0.009	0.002	0.007	0.2		
4	0	0.002	0	0	0	0	0	0	0	0	0	0.002	0.002	0.005	0	0.005	0.016		
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
13.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
TOTAL	1	0.83	0.94	0.89	0.41	0.32	0.3	0.33	0.39	0.69	0.67	0.67	0.48	0.39	0.42	0.61	9.34		

Table A-13 (continue)

Joint Wind Frequency Distribution by Pasquill Stability Classes at SHNP (2010-2014 meteorological data, 12.5-meter level)

Stability Class G																	
Umax	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0.45	1.23	1.266	2.698	1.504	0.633	0.191	0.263	0.215	0.239	0.275	0.43	0.478	0.43	0.298	0.37	0.621	11.139
0.75	0.237	0.244	0.52	0.29	0.122	0.037	0.051	0.041	0.046	0.053	0.083	0.092	0.083	0.058	0.071	0.12	2.148
1	0.092	0.085	0.136	0.134	0.037	0.037	0.016	0.012	0.028	0.046	0.058	0.041	0.035	0.032	0.035	0.048	0.87
1.25	0.041	0.039	0.048	0.03	0.009	0.007	0.016	0.007	0.018	0.018	0.044	0.018	0.021	0.009	0.007	0.03	0.364
1.5	0.044	0.016	0.016	0.009	0.007	0	0.005	0.005	0.009	0.009	0.025	0.016	0.009	0.005	0.007	0.025	0.207
2	0.048	0.018	0.009	0.002	0.007	0.002	0.005	0.002	0.009	0.007	0.012	0.002	0.005	0	0.005	0.012	0.145
3	0.002	0.002	0	0.002	0	0	0	0	0.005	0.002	0	0	0	0	0	0	0.014
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	1.69	1.67	3.43	1.97	0.81	0.27	0.35	0.28	0.35	0.41	0.65	0.65	0.58	0.4	0.49	0.86	14.89

TOTAL HOURS CONSIDERED: 43441 hours from January 2010 to December 2014

WIND MEASURED AT 12.5-METERS

OVERALL WIND DIRECTION FREQUENCY

DIRECTION:	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
FREQUENCY (%):	8.8	9.7	9.7	6.6	3.5	2.6	3.1	4.0	6.3	9.0	8.0	7.8	5.0	4.7	5.3	6.1

WIND SPEED CLASS DETAILS

MAX WIND SPEED (UMAX) (M/S):	.450	.750	1.000	1.250	1.500	2.000	3.000	4.000	5.000	6.000	8.000	10.000	13.900
AVE WIND SPEED (M/S):	.225	.600	.875	1.125	1.375	1.750	2.500	3.500	4.500	5.500	7.000	9.000	11.950
WIND SPEED FREQUENCY (%):	17.75	7.63	7.80	6.61	8.36	14.38	21.77	10.49	3.63	1.20	.38	.01	.00

Table A-14
Shearon Harris Plant Site XOQDOQ Model Input Information for Continuous Ground Level Releases

Card Type	Columns	Variable Name	Format	Description	Value used in XOQDOQ
Card Type 1 is an array (KOPT) of options, such that 1 = DO, 0 = BYPASS. These options remain in effect for all release points run. Thus, all release points must have the same assumptions.					
1	1	KOPT (1)	I1	Option to distribute calms as the first wind-speed class (if calms are already distributed by direction in Card Type 6, KOPT (1) = 0, and Card Type 5 is blank). If KOPT (1) = 1, the calm values of Card Type 5 are distributed by direction in the same proportion as the direction frequency of wind-speed class two.	1
1	2	KOPT (2)	I1	Option to input joint frequency distribution data as percent frequency.	0
1	3	KOPT (3)	I1	Option to compute a sector spread for comparison with centerline value in purge calculation (Normally = 1).	0
1	4	KOPT (4)	I1	Option to plot short-term X/Q values versus probability of occurrence (Normally = 0).	0
1	5	KOPT (5)	I1	Option to use cubic spline in lieu of least square function for fitting intermittent release distribution (Normally = 1).	0
1	6	KOPT (6)	I1	Option to punch radial segment X/Q and D/Q values (Normally = 1).	1
1	7	KOPT (7)	I1	Option to punch output of X/Q and D/Q values of the points of interest (Normally = 1).	1
1	8	KOPT (8)	I1	Option to correct X/Q and D/Q values for open terrain recirculation.	1
1	9	KOPT (9)	I1	Option to correct X/Q and D/Q values using site specific terrain recirculation data.	0

Table A-14
Shearon Harris Plant Site XOQDOQ Model Input Information for Continuous Ground Level Releases

Card Type	Columns	Variable Name	Format	Description	Value used in XOQDOQ
1	10	KOPT (10)	I1	Option to use desert sigma curves (Normally = 0)	0
1	11	KOPT (11)	I1	Option to calculate annual X/Q with 30-degree sectors for North, East, South and West and 20-degree sectors for all others. (Normally = 0, and the code will use 22-1/2-degree sectors)	0
2	1 - 80	TITLM	20A4	The main title printed at the beginning of the output.	N/A
3	1 - 5	NVEL	I5	The number of velocity categories (maximum of 14).	13
3	6 - 10	NSTA	I5	The number of stability categories (maximum of 7) (1 always equals Pasquill stability class A, 2 = B, ..., 7 = G).	7
3	11 - 15	NDIS	I5	The number of distances with terrain data for each sector. The number of distances must be the same for each sector (Card Type 10) (maximum of 10).	0
3	16 - 20	INC	I5	The increment in percent for which plotted results are printed out (Normally = 15).	15
3	21 - 25	NPTYPE	I5	The number of titles of receptor types (cow, garden, etc.) (Card Type 13) (maximum of eight)	4
3	26 - 30	NEXIT	I5	The number of release exit points (maximum of five).	1
3	31 - 35	NCOR	I5	The number of distances of site-specific correction factors for recirculation (maximum of 10).	0
4	1 - 5	PLEV	F5.0	The height (in meters, above ground level) of the measured wind presented in the joint frequency data (Card Type 7). (For elevated/ground-level mixed release, use the lower-level winds).	12.5

Table A-14
Shearon Harris Plant Site XOQDOQ Model Input Information for Continuous Ground Level Releases

Card Type	Columns	Variable Name	Format	Description	Value used in XOQDOQ
4	6 - 20	DECAYS(I) I = 1,3	3F5.0	For each I: The half-life (days) used in the X/Q calculations: if DECAYS > 100, no decay will occur; if DECAYS < 0, depletion factor will be used in the X/Q calculations; if DECAYS = 0, X/Q will not be calculated. (Normally, DECAYS (1) = 101, (2) = 2.26, (3) = -8.00.)	101.00 2.26 -8.00
4	21 - 25	PLGRAD	F5.0	Plant grade elevation (feet above sea level). If PLGRAD = 0.0, DIST and HT data Card Type 10 and 11 must be in meters. If PLGRAD < 0.0, DIST in miles and HT data in feet above plant grade. If PLGRAD > 0.0 above DIST in miles and HT data in feet above sea level.	0
5	1 - 35	CALM(I) I = 1, NSTA	7F5.0	The number of hours, or percent, of calm for each stability category; if KOPT (1) = 0, insert blank card. (Note: I = 1 is stability class A, 2 = B, ..., 7 = G).	Determined by onsite MET Data
6	1 - 80	FREQ (K, I, J) K = 1,16 I = 1, NVEL (if KOPT (1) = 0) I = 2, NVEL (if KOPT (1) = 1) J = 1, NSTA		The joint frequency distribution in hours (or percent). The values for 16 (K) sectors are read on each card for each combination of wind-speed class (I) and stability class (J). The loop to read these value cycles first on direction continuing in a clockwise fashion), then on wind class and finally on stability class.	JFD
7	1 - 5	UCOR	F5.0	A correction factor applied to wind-speed classes. If UCOR < 0: no corrections will be made. If UCOR > 100: the wind-speed classes will be converted from miles/hour to meters/second.	-1

Table A-14
Shearon Harris Plant Site Input Information for Continuous Ground Level Releases

Card Type	Columns	Variable Name	Format	Description	Value used in XOQDOQ
7	6 - 75	UMAX (I)	14F5.0	The maximum wind speed in each wind-speed class, in either miles/hour or meters/second. (If given in miles/hour, set UCOR > 100.)	See Table A-13 (UMAX)
Card Types 8 and 9 are read in for each correction factor and distance given, I = 1, NCOR					
8	1 - 80	VRDIST (K, I) K = 1,16	16F5.0	The distance in meters at which correction factors are given. These values are read in beginning with south and proceeding in a clockwise direction (maximum of 10).	SKIP
9	1 - 80	VRCD (K, I) K = 1,16	16F5.0	Correction factor to be applied to X/Q and D/Q values corresponds to distances specified in VRDIST.	SKIP
Card Types 8 and 9 are repeated for the remaining distances and correction factors.					
Card Types 10 and 11 are read in for each terrain distance and height given, I = 1, NDIS					
10	1 - 80	DIST (K, I) K = 1,16	16F5.0	The distance in meters at which terrain heights are given. These values are read in beginning with south and proceeding in a clockwise direction (maximum of ten distances).	SKIP
11	1 - 80	HT (K, I) K = 1,16	16F5.0	The terrain heights (in meters, above plant grade level) corresponding to the distances specified in the DIST array (Card Type 10). These values are read in the same order as the DIST array. For a given direction and distance, the terrain height should be the highest elevation between the source and that distance anywhere within the direction sector.	SKIP
Card Types 10 and 11 are repeated for the remaining distances and heights.					

Table A-14
Shearon Harris Plant Site Input Information for Continuous Ground Level Releases

Card Type	Columns	Variable Name	Format	Description	Value used in XOQDOQ
12	1 - 25	NPOINT (I) I = 1, NPTYPE	5I5	The number (maximum of 30) of receptor locations for a particular receptor type (such as the number of cows, gardens, or site boundaries).	16,15,14,14
Card Types 13 and 14 are read in for each receptor type, thus I = 1, NPTYPE					
13	1 - 16	TITLPT (I, J)	4A4	The title (cows, gardens, etc.) of the receptor type for the receptor locations (Card Type 14) (a maximum of 16 spaces).	Site Boundary = 16 Nearest Resident = 15 Garden = 14 Meat Animal = 14
14	1 - 80	KDIR (I, N) PTDIST (I, N) N = 1, NPOINT (I)	8(I5, F5.0)	The receptor direction and distance. KDIR is the direction of interest, such that 1 = South, 2 = SSW....., 16 = SSE, PTDIST is the distance, in meters, to the receptor location.	See Table A-1
Card Types 13 and 14 are repeated for the remaining receptor types (See annual Land Use Census).					
Card Types 15, 16 and 17 are read in for each plant release point, thus I = 1, NEXIT.					
15	1 - 80	TITLE (I, J)	20A4	The title for the release points whose characteristics are described on Card Types 16 and 17.	Turbine Building
16	1 - 5	EXIT (I)	F5.0	The vent average velocity (meters/second). (Note: if a 100% ground-level release is assumed, set EXIT = 0, DIAMTR = 0, and SLEV = 10 meters).	0
16	6 - 10	DIAMTR	F5.0	The vent inside diameter (meters).	0
16	11 - 15	HSTACK (I)	F5.0	The height of the vent release point (meters, plant grade level). If release is 100% elevated, input negative of height.	0.0
16	16 - 20	HBLDG (I)	F5.0	The height of the vent's building (meters, above plant grade level).	55.0

Table A-14

Card Type	Columns	Variable Name	Format	Description	Value used in XOQDOQ
16	21 - 25	CRSEC (I)	F5.0	The minimum cross-sectional area for the vent's building (square meters).	2161.0
16	26 - 30	SLEV (I)	F5.0	The wind height used for the vent elevated release (meters, above plant grade level).	12.5
16	31 - 35	HEATR (I)	F5.0	The vent heat emission rate (cal/sec) (Normally = 0).	0.0
17	1	RLSID (I)	A1	A one letter identification for the release point.	G
17	2 - 5	IPURGE (I)	I4	IPURGE = 1, 2 or 3 if the vent has intermittent releases. The 1, 2, or 3 corresponds to DECAYS(1), DECAYS(2), or DECAYS(3) (Card Type 4), respectively, whichever is used as the base for intermittent release calculations (normally no decay/no deplete X/Q, such that IPURGE(I) = 1; if a vent has no intermittent releases, IPURGE = 0.	0
17	6 - 10	NPURGE (I)	I5	The number of intermittent releases per year for this release point.	0
17	11 - 15	NPRGHR (I)	I5	The average number of hours per intermittent release.	0
Card Types 15, 16, and 17 are repeated for the remaining release points.					
Card Types 1 - 17 may be repeated for the next case.					

B.0 APPENDIX B

DOSE PARAMETERS FOR RADIOIODINES, PARTICULATES, AND TRITIUM

This appendix contains the methodology which was used to calculate the dose parameters for radioiodine's, particulates, and tritium to show compliance with ODCM Operational Requirement 3.11.2.1.b and Appendix I of 10CFR50 for gaseous effluents. These dose parameters, P_i and R_i , were calculated using the methodology outlined in NUREG 0133 along with Regulatory Guide 1.109, Revision 1. The following sections provide the specific methodology which was utilized in calculating the P_i and R_i values for the various exposure pathways (Tables 3.2-4 and 3.3-1 through 3.3-19, respectively).

B.1 Calculation of P_i

The dose parameter, P_i , contained in the radioiodine and particulates portion of Section 3.2 includes only the inhalation pathway transport parameter of the "i" radionuclide, the receptor's usage of the pathway media, and the dosimetry of the exposure. Inhalation rates and the internal dosimetry are functions of the receptor's age; however, under the exposure conditions for ODCM Operational Requirement 3.11.2.1b, the child is considered to receive the highest dose. The following sections provide in detail the methodology which was used in calculating the P_i values for inclusion into this ODCM.

The age group considered is the child because the bases for the ODCM Operational Requirement 3.11.2.1.b is to restrict the dose to the child's thyroid via inhalation to ≤ 1500 mrem/yr. The child's breathing rate is taken as $3700 \text{ m}^3/\text{yr}$ from Table E-5 of Regulatory Guide 1.109, Revision 1. The inhalation dose factors for the child, DFA_i , are presented in Table E-9 of Regulatory Guide 1.109 in units of mrem/pCi.

The dose factor from the inhalation pathway is calculated by

$$P_{ii} = K'(\text{BR}) \text{DFA}_i \quad (\text{B.1-1})$$

where:

P_{ii} = Dose factor for radionuclide "i" for the inhalation pathway, mrem/yr per $\mu\text{Ci}/\text{m}^3$, per organ of interest

K' = A constant of unit conversion;

= $10^6 \text{ pCi}/\mu\text{Ci}$;

BR = The breathing rate of the children's age group, m^3/yr ;

DFA_i = The organ inhalation dose factor for the children's age group for radionuclide "i," mrem/pCi.

The incorporation of breathing rate of a child ($3700 \text{ m}^3/\text{yr}$) and the unit conversion factor results in the following equation:

$$P_{ii} = 3.7 \text{ E}+09 \text{ DFA}_i \quad (\text{B.1-2})$$

B.2 Calculation of R_i

The basis for ODCM Operational Requirement 3.11.2.3 states that conformance with the guidance in Appendix I should 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. Underestimation of the dose can be avoided by assigning a theoretical individual to the exclusion boundary in the sector with the highest X/Q and D/Q values and employing all of the likely exposure pathways, e.g., inhalation, cow milk, meat, vegetation, and ground plane. R_i values have been calculated for the adult, teen, child, and infant age groups for the inhalation, ground plane, cow milk, goat milk, vegetable, and beef ingestion pathways. The methodology which was utilized to calculate these values is presented below.

B.2.1 Inhalation Pathway

The dose factor from the inhalation pathway is calculated by:

$$R_{i_i} = K' (BR)_a (DFA_i)_a \quad (B.2-1)$$

where:

$$\begin{aligned} R_{i_i} &= \text{Dose factor for each identified radionuclide "i" of the organ of interest, mrem/yr per } \mu\text{Ci/m}^3; \\ K' &= \text{A constant of unit conversion;} \\ &= 10^6 \text{ pCi}/\mu\text{Ci}; \\ (BR)_a &= \text{Breathing rate of the receptor of age group "a," m}^3/\text{yr}; \\ (DFA_i)_a &= \text{Organ inhalation dose factor for radionuclide "i" for the receptor of age group "a", mrem/pCi.} \end{aligned}$$

The breathing rates $(BR)_a$ for the various age groups are tabulated below, as given in Table E-5 of Regulatory Guide 1.109, Revision 1.

<u>Age Group (a)</u>	<u>Breathing Rate (m³/yr)</u>
Infant	1400
Child	3700
Teen	8000
Adult	8000

Inhalation dose factors $(DFA_i)_a$ for the various age groups are given in Tables E-7 through E-10 of Regulatory Guide 1.109, Revision 1.

B.2.2 Ground Plane Pathway

The ground plane pathway dose factor is calculated by:

$$R_{iG} = I_i K' K'' (SF) DFG_i (1 - e^{-\lambda_i t}) / \lambda_i \quad (B.2-2)$$

where:

R_{iG} = Dose factor for the ground plane pathway for each identified radionuclide "i" for the organ of interest, mrem/yr per $\mu\text{Ci/sec per m}^2$;

K' = A constant of unit conversion;

= $10^6 \text{ pCi}/\mu\text{Ci}$;

K'' = A constant of unit conversion;

= 8760 hr/year;

SF = The shielding factor (dimensionless);
(A shielding factor of 0.7 is suggested in Table E-15 of Regulatory Guide 1.109, Revision 1.)

DFG_i = The ground plane dose conversion factor for radionuclide "i," mrem/hr per pCi/m^2 ;
(A tabulation of DFG_i values is presented in Table E-6 of Regulatory Guide 1.109, Revision 1.)

λ_i = The radiological decay constant for radionuclide "i," sec^{-1} ;

t = The exposure time, sec;

= $4.73 \text{ E}+08 \text{ sec}$ (15 years);

I_i = Factor to account for fractional deposition of radionuclide "i."

For radionuclides other than iodine, the factor I_i is equal to one. For radioiodine's, the value of I_i may vary. However, a value of 1.0 was used in calculating the R values in Table 3.3-2. (Reference NUREG 0133)

B.2.3 Grass Cow or Goat Milk Pathway

The dose factor for the cow milk or goat milk pathway for each radionuclide for each organ is calculated by:

$$R_{iM} = I_i K' Q_F U_{ap} F_m (DFL_i)_a e^{-\lambda_i t_f} (f_{ps} \left(\frac{r(1 - e^{-\lambda_{E_i} t_e})}{Y_p \lambda_{E_i}} + \frac{B_{iv}(1 - e^{-\lambda_i t_b})}{P \lambda_i} \right) + (1 - f_{ps}) \left(\frac{r(1 - e^{-\lambda_{E_i} t_e})}{Y_s \lambda_{E_i}} + \frac{B_{iv}(1 - e^{-\lambda_i t_b})}{P \lambda_i} \right) e^{-\lambda_i t_h}) \quad (B.2-3)$$

where:

- R_{iM} = Dose factor for the cow milk or goat milk pathway, for each identified radionuclide "i" for the organ of interest, mrem/yr per $\mu\text{Ci/sec per m}^2$;
- K' = A constant of unit conversion;
- = $10^6 \text{ pCi}/\mu\text{Ci}$;
- Q_F = The cow's or goat's feed consumption rate, kg/day (wet weight);
- U_{ap} = The receptor's milk consumption rate for age group "a," liters/yr;
- Y_p = The agricultural productivity by unit area of pasture feed grass, kg/m²;
- Y_s = The agricultural productivity by unit area of stored feed, kg/m²;
- F_m = The stable element transfer coefficients, pCi/liter per pCi/day;
- r = Fraction of deposited activity retained on cow's feed grass;
- $(DFL_i)_a$ = The organ ingestion dose for radionuclide "i" for the receptor in age group "a," mrem/pCi;

B.2.3 Grass Cow or Goat Milk Pathway (continued)

$$\lambda_{E_T} = \lambda_i + \lambda_w;$$

λ_i = The radiological decay constant for radionuclide "i," sec⁻¹;

λ_w = The decay constant for removal of activity on leaf and plant surfaces by weathering, sec⁻¹;
= 5.73 E-07 sec⁻¹ (14-day half-life);

t_e = Period of pasture grass and crop exposure during the growing season, sec;

t_f = The transport time from feed to cow or goat, to milk, to receptor, sec;

t_h = The transport time from pasture to cow or goat, to milk to receptor, sec;

t_b = Period of time that sediment is exposed to gaseous effluents, sec;

B_{iv} = Concentration factor for uptake of radionuclide "i" from the soil by the edible parts of crops, pCi/Kg (wet weight) per pCi/Kg (dry soil)

P = Effective surface density for soil, Kg (dry soil)/m²;

f_p = Fraction of the year that the cow or goat is on pasture; (dimensionless).

f_s = Fraction of the cow feed that is pasture grass while the cow is on pasture; (dimensionless).

t_e = Period of pasture grass and crop exposure during the growing season, sec;

I_i = Factor to account for fractional deposition of radionuclide "i."

For radionuclides other than iodine, the factor I_i is equal to one. For radioiodine's, the value of I_i may vary. However, a value of 1.0 was used in calculating the R values in Tables 3.3-8 through 3.3-15. (Reference NUREG 0133)

Milk cattle and goats are considered to be fed from two potential sources, pasture grass and stored feeds. Following the development in Regulatory Guide 1.109, Revision 1, the value of f_s was considered unity in lieu of site-specific information. The value of f_p was 0.667 based upon an 8-month grazing period.

Table B-1 contains the appropriate parameter values and their source in Regulatory Guide 1.109, Revision

B.2.3 Grass Cow or Goat Milk Pathway (continued)

The concentration of tritium in milk is based on the airborne concentration rather than the deposition. Therefore, the R_i is based on X/Q :

$$R_{T_M} = K'K''F_mQ_FU_{ap}(DFL_i)_a 0.75(0.5/H) \quad (B.2-4)$$

where:

$$R_{T_M} = \text{Dose factor for the cow or goat milk pathway for tritium for the organ of interest, mrem/yr per } \mu\text{Ci/m}^3;$$

$$K'' = \text{A constant of unit conversion;} \\ = 10^3 \text{ gm/kg;}$$

$$H = \text{Absolute humidity of the atmosphere, gm/m}^3; \text{ A value of } H = 8 \text{ grams/ meter}^3, \text{ was used in lieu of site-specific information.}$$

$$0.75 = \text{The fraction of total feed that is water;}$$

$$0.5 = \text{The ratio of the specific activity of the feed grass water to the atmospheric water.}$$

and other parameters and values as previously defined.

B.2.4 Grass-Cow-Meat Pathway

The integrated concentration in meat follows in a similar manner to the development for the milk pathway; therefore:

$$R_{iB} = I_i K' Q_F U_{ap} F_f (DFL_i)_a e^{-\lambda_i t_s} \left(\frac{r(1 - e^{-\lambda_{E_i} t_e})}{Y_p \lambda_{E_i}} + \frac{B_{iv} (1 - e^{-\lambda_i t_b})}{P \lambda_i} \right) + (1 - \frac{f}{p} \frac{f}{s}) \left(\frac{r(1 - e^{-\lambda_{E_i} t_e})}{Y_s \lambda_{E_i}} + \frac{B_{iv} (1 - e^{-\lambda_i t_b})}{P \lambda_i} \right) e^{-\lambda_i t_h} \quad (B.2.5)$$

where:

- R_{iB} = Dose factor for the meat ingestion pathway for radionuclide "i" for any organ of interest, mrem/yr per $\mu\text{Ci/sec}$ per m^{-2} ;
- F_f = The stable element transfer coefficients, pCi/Kg per pCi/day ;
- U_{ap} = The receptor's meat consumption rate for age group "a," kg/yr ;
- t_s = Transport time from slaughter to consumption, sec;
- t_h = Transport time from harvest to animal consumption, sec;
- t_e = Period of pasture grass and crop exposure during the growing season, sec;
- I_i = Factor to account for fractional deposition of radionuclide "i."

For radionuclides other than iodine, I_i is equal to one. For radioiodine's, the value of I_i may vary. However, a value of 1.0 was used in calculating the R values in Tables 3.3-5 through 3.3-7.

All other terms remain the same as defined in Equation B.2-3. Table B-2 contains the values which were used in calculating R_i for the meat pathway.

The concentration of tritium in meat is based on its airborne concentration rather than the deposition. Therefore, the R_i is based on X/Q .

$$R_{TB} = K' K'' F_f Q_F U_{ap} (DFL_i)_a 0.75 (0.5/H) \quad (B.2-6)$$

where:

- R_{TB} = Dose factor for the meat ingestion pathway for tritium for any organ of interest, mrem/yr per $\mu\text{Ci/m}^3$.

All other terms are defined in Equations B.2-4 and B.2-5.

B.2.5 Vegetation Pathway

The integrated concentration in vegetation consumed by man follows the expression developed in the derivation of the milk factor. Man is considered to consume two types of vegetation (fresh and stored) that differ only in the time period between harvest and consumption; therefore:

$$R_{iv} = I_i K' (DFL_i)_a (U_{aL}^L e^{-\lambda_i t_L} \left(\frac{r(1 - e^{-\lambda_{E_i} t_e})}{Y_v \lambda_{E_i}} + \frac{B_{iv} (1 - e^{-\lambda_i t_b})}{P \lambda_i} \right) + U_{ag}^S e^{-\lambda_i t_h} \left(\frac{r(1 - e^{-\lambda_{E_i} t_e})}{Y_v \lambda_{E_i}} + \frac{B_{iv} (1 - e^{-\lambda_i t_b})}{P \lambda_i} \right)) \quad (B.2-7)$$

where:

- R_{iv} = Dose factor for vegetable pathway for radionuclide "i" for the organ of interest, mrem/yr per $\mu\text{Ci/sec per m}^{-2}$;
- K' = A constant of unit conversion;
= $10^6 \text{pCi}/\mu\text{Ci}$;
- U_a^L = The consumption rate of fresh leafy vegetation by the receptor in age group "a," kg/yr;
- U_a^S = The consumption rate of stored vegetation by the receptor in age group "a," kg/yr;
- f_L = The fraction of the annual intake of fresh leafy vegetation grown locally;
= 1.0
- f_g = The fraction of annual intake of stored vegetation grown locally;
= 0.76
- t_L = The average time between harvest of leafy vegetation and its consumption, sec;
- t_h = The average time between harvest of stored vegetation and its consumption, sec;
- Y_v = The vegetation a real density, kg/m^2 ;
- t_e = Period of leafy vegetable exposure during growing season, sec;
- I_i = Factor to account for fractional deposition of radionuclide "i."

All other factors as previously defined.

B.2.5 Vegetation Pathway (continued)

For radionuclides other than iodine, the factor I_i is equal to one. For radioiodine's, the value of I_i may vary. However, a value of 1.0 was used in Tables 3.3-2 through 3.3-4.

Table B-3 presents the appropriate parameter values and their source in Regulatory Guide 1.109, Revision 1.

In lieu of site-specific data default values for f_L and f_g , 1.0 and 0.76, respectively, were used in the calculations on R_i . These values were obtained from Table E-15 of Regulatory Guide 1.109, Revision 1.

The concentration of tritium in vegetation is based on the airborne concentration rather than the deposition. Therefore, the R_i is based on X/Q :

$$R_{T_V} = K'K''' \left[U_{a f_L}^L + U_{a f_g}^S \right] (DF L_i)_a \left[0.75 (0.5 / H) \right] \quad (B.2.8)$$

where:

R_{T_V} = Dose factor for the vegetable pathway for tritium for any organ of interest, mrem/yr per $\mu\text{Ci}/\text{m}^3$.

All other terms remain the same as those in Equations B.2-4 and B.2-7.

TABLE B-1
Parameters For Cow and Goat Milk Pathways

Parameter	Value	Reference (Reg. Guide 1.109, Rev. 1)
Q_F (kg/day)	50 (cow) 6 (goat)	Table E-3 Table E-3
Y_p (kg/M ²)	0.7	Table E-15
t_f (seconds)	1.73 E+05 (2 days)	Table E-15
r	1.0 (radioiodine's) 0.2 (particulates)	Table E-15 Table E-15
$(DFL_i)_a$ (mrem/pCi)	Each radionuclide	Table E-11 to E-14
F_m (pCi/liter per pCi/day)	Each stable element	Table E-1 (cow) Table E-2 (goat)
T_b (seconds)	4.75 E+08 (15 yr)	Table E-15
Y_s (kr/m ²)	2.0	Table E-15
t_h (seconds)	7.78 E+06 (90 days)	Table E-15
U_{ap} (liters/yr)	330 infant 330 child 400 teen 310 adult	Table E-5 Table E-5 Table E-5 Table E-5
t_e (seconds)	2.59 E+06 (pasture) 5.18 E+06 (stored feed)	Table E-15
B_{iv} (pCi/kg [wet weight] per pCi/kg [dry soil])	Each stable element	Table E-1
P (kg dry soil/m ²)	240	Table E-15

TABLE B-2

Parameters For the Meat Pathway

Parameter	Value	Reference (Reg. Guide 1.109, Rev. 1)
r	1.0 (radioiodine's) 0.2 (particulates)	Table E-15 Table E-15
F_f (pCi/ke per (pCi/Day)	Each stable element	Table E-1
U_{ap} (kg/yr)	0 infant 41 child 65 teen 110 adult	Table E-5 Table E-5 Table E-5 Table E-5
$(DFL_a)_{I_a}$ (mrem/pCi)	Each radionuclide	Tables E-11 to E-14
Y_p (kg/m ²)	0.7	Table E-15
Y_s (kr/m ²)	2.0	Table E-15
T_b (seconds)	4.73 E+08 (15 yr)	Table E-15
T_s (seconds)	1.73 E+06 (20 days)	Table E-15
t_h (seconds)	7.78 E+06 (90 days)	Table E-15
t_e (seconds)	2.59 E+06 (pasture) 5.18 E+06 (stored feed)	Table E-15
Q_F (kg/day)	50	Table E-3
B_{iv} (pCi/kg [wet weight] per pCi/kg [dry soil])	Each stable element	Table E-1
P (kg dry soil/m ²)	240	Table E-15

TABLE B-3

Parameters for The Vegetable Pathway

Parameter	Value	Reference (Reg. Guide 1.109, Rev. 1)
r (dimensionless)	1.0 (radioiodine's) 0.2 (particulates)	Table E-1 Table E-1
$(DFL_i)_a$ (mrem/pCi)	Each radionuclide	Tables E-11 to E-14
Q_F (kg/day)	50 (cow) 6 (goat)	Table E-3 Table E-3
U_a^L (kg/yr) - Infant - Child - Teen - Adult	0 26 42 64	Table E-5 Table E-5 Table E-5 Table E-5
U_a^S (kr/hr) - Infant - Child - Teen - Adult	0 520 630 520	Table E-5 Table E-5 Table E-5 Table E-5
T_L (seconds)	8.6 E+04 (1 day)	Table E-15
t_h (seconds)	5.18 E+06 (60 day)	Table E-15
Y_v (kg/m ²)	2.0	Table E-15
t_e (seconds)	5.18 E+06 (60 day)	Table E-15
t_b (seconds)	4.73 E+08 (15 yr)	Table E-15
P (kg dry soil/m ²)	240	Table E-15
B_{iv} (pCi/kg [wet weight] per pCi/kg [dry soil])	Each stable element	Table E-1

C.0 APPENDIX C

RADIOACTIVE LIQUID AND GASEOUS EFFLUENT MONITORING INSTRUMENTATION NUMBERS

		Monitor Identification
I.	<u>Liquid Effluent Monitoring Instruments</u>	
A.	Treated Laundry and Hot Shower Tank.....	REM-1WL-3540
B.	Waste Monitor Tank	REM-21WL-3541
C.	Waste Evaporator Condensate Tank.....	REM-21WL-3541
D.	Secondary Waste Sample Tank	REM-21WS-3542
E.	NSW Returns to Circulating Water System from Waste Processing Building	REM-1SW-3500A
	from Reactor Auxiliary Building	REM-1SW-3500B
F.	Outdoor Tank Area Drain Transfer Pump Monitor	REM-1MD-3530
G.	Turbine Building Floor Drains Effluent	REM-1MD-3528
II.	<u>Gaseous Effluent Monitoring Instruments</u>	
A.	Plant Vent Stack 1	* RM-21AV-3509-1SA
B.	Turbine Building Vent Stack 3A	* RM-1TV-3536-1
C.	Waste Processing Building Vent Stack 5	REM-1WV-3546
		* RM-1WV-3546-1
D.	Waste Processing Building Vent Stack 5A	* RM-1WV-3547-1
*	Wide-Range Gas Monitor (WRGM)	

D.0 APPENDIX D

PROGRAMMATIC CONTROLS

The surveillance and operational requirements pertaining to the ODCM Operational Requirements are detailed in Sections:

- D.1 - Instrumentation
- D.2 - Radioactive Effluents
- D.3 - Radiological Environmental Monitoring

D.1 INSTRUMENTATION

3/4.3.3 MONITORING INSTRUMENTATION

3/4.3.3.10 Radioactive Liquid Effluent Monitoring Instrumentation

OPERATIONAL REQUIREMENT

- 3.3.3.10 The radioactive liquid effluent monitoring instrumentation channels shown in Table 3.3-12 shall be OPERABLE with their Alarm/Trip Setpoints set to ensure that the limits of Operational Requirement 3.11.1.1 are not exceeded. The Alarm/Trip Setpoints of these channels shall be determined and adjusted in accordance with the methodology and parameters in the OFFSITE DOSE CALCULATION MANUAL (ODCM).

APPLICABILITY: At all times.

ACTION:

- a. With a radioactive liquid effluent monitoring instrumentation channel Alarm/Trip Setpoint less conservative than required by the above Operational Requirement, immediately (1) suspend the release of radioactive liquid effluents monitored by the affected channel or (2) declare the channel inoperable and take ACTION as directed by b. below.
- b. With less than the minimum number of radioactive liquid effluent monitoring instrumentation channels OPERABLE, take the ACTION shown in Table 3.3-12. Exert best effort to restore to the minimum number of radioactive liquid effluent channels within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report pursuant to ODCM, Appendix F, Section F.2 why this inoperability was not corrected in a timely manner.

SURVEILLANCE REQUIREMENTS

- 4.3.3.10 Each radioactive liquid effluent monitoring instrumentation channel shall be demonstrated OPERABLE by performance of the CHANNEL CHECK, SOURCE CHECK, CHANNEL CALIBRATION, and DIGITAL CHANNEL OPERATIONAL TEST at the frequencies shown in Table 4.3-8.

Each Surveillance Requirement shall be performed within the specified surveillance interval with a maximum allowable extension not to exceed 25% of the specified surveillance interval.

TABLE 3.3-12

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENT		MINIMUM CHANNELS OPERABLE	ACTION
1.	Radioactivity Monitors Providing Alarm and Automatic Termination of Release		
a.	Liquid Radwaste Effluent Lines		
1)	Treated Laundry and Hot Shower Tanks Discharge Monitor	1	35
2)	Waste Monitor Tanks and Waste Evaporator Condensate Tanks Discharge Monitor	1	35
3)	Secondary Waste Sample Tank Discharge Monitor	1	35, 36*
b.	Turbine Building Floor Drains Effluent Line	1	36
2.	Radioactivity Monitor Providing Alarm and Automatic Stop Signal to Discharge Pump		
a.	Outdoor Tank Area Drain Transfer Pump Monitor	1	37
3.	Radioactivity Monitors Providing Alarm but Not Providing Automatic Termination of Release		
a.	Normal Service Water System Return from Waste Processing Building to the Circulating Water System	1	39
b.	Normal Service Water System Return from the Reactor Auxiliary Building to the Circulating Water System	1	39
4.	Flow Rate Measurement Devices		
a.	Liquid Radwaste Effluent Lines		
1)	Treated Laundry and Hot Shower Tanks Discharge	1	38
2)	Waste Monitor Tanks and Waste Evaporator Condensate Tanks Discharge	1	38
3)	Secondary Waste Sample Tank	1	38
b.	Cooling Tower Blowdown	1	38

* When the Secondary Waste System is in the continuous release mode and releases are occurring, Action 36 shall be taken when the monitor is inoperable. In the batch release mode, Action 35 is applicable.

TABLE 3.3-12 (Continued)

ACTION STATEMENTS

- ACTION 35 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided that prior to initiating a release:
- At least two independent samples are analyzed in accordance with Operational Requirement 4.11.1.1.1, and
 - At least two technically qualified members of the facility staff independently verify the release rate calculations and discharge line valving.
- Otherwise, suspend release of radioactive effluents via this pathway.
- ACTION 36 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided grab samples are analyzed for radioactivity at a lower limit of detection of no more than $1\text{E-}07$ $\mu\text{Ci/ml}$:
- At least once per 12 hours when the specific activity of the secondary coolant is greater than 0.01 $\mu\text{Ci/gram DOSE EQUIVALENT I-131}$ or,
 - At least once per 24 hours when the specific activity of the secondary coolant is less than or equal to 0.01 $\mu\text{Ci/gram DOSE EQUIVALENT I-131}$.
- ACTION 37 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided that, at least once per 12 hours, grab samples are collected and analyzed for radioactivity at a lower limit of detection of no more than $1\text{E-}07$ $\mu\text{Ci/ml}$.
- ACTION 38 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided the flow rate is estimated at least once per 4 hours during actual releases. Pump performance curves generated in place may be used to estimate flow.
- ACTION 39 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided the weekly Cooling Tower Blowdown weir surveillance is performed as required by Operational Requirement 4.11.1.1.1. Otherwise, follow the ACTION specified in ACTION 37 above.

TABLE 4.3-8

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION
SURVEILLANCE REQUIREMENTS*

INSTRUMENT	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	DIGITAL CHANNEL OPERATIONAL TEST
1. Radioactivity Monitors Providing Alarm and Automatic Termination of Release				
a. Liquid Radwaste Effluent Lines				
1) Treated Laundry and Hot Shower Tanks Discharge Monitor	D	P	R (3)	Q (1)
2) Waste Monitor Tanks and Waste Evaporator Condensate Tanks Discharge Monitor	D	P	R (3)	Q (1)
3) Secondary Waste Sample Tank Discharge Monitor	D	P, M (5)	R (3)	Q (1)
b. Turbine Building Floor Drains Effluent Line	D	M	R (3)	Q (1)
2. Radioactivity Monitor Providing Alarm and Automatic Stop Signal to Discharge Pump				
a. Outdoor Tank Area Drain Transfer Pump Monitor	D	M	R (3)	Q (1)
3. Radioactivity Monitors Providing Alarm but Not Providing Automatic Termination of Release				
a. Normal Service Water System Return from Waste Processing Building to the Circulating Water System	D	M	R (3)	Q (2)
b. Normal Service Water System Return from the Reactor Auxiliary Building to the Circulating Water System	D	M	R (3)	Q (2)
4. Flow Rate Measurement Devices				
a. Liquid Radwaste Effluent Lines				
1) Treated Laundry and Hot Shower Tanks Discharge	D (4)	N.A.	R	N.A.
2) Waste Monitor Tanks and Waste Evaporator Condensate Tanks Discharge	D (4)	N.A.	R	N.A.
3) Secondary Waste Sample Tank Pump Monitor	D (4)	N.A.	R	N.A.
b. Cooling Tower Blowdown	D (4)	N.A.	R	N.A.

* See Table G-1 for explanation of frequency notation

TABLE 4.3-8 (Continued)

TABLE NOTATIONS

- (1) The DIGITAL CHANNEL OPERATIONAL TEST shall also demonstrate automatic isolation of this pathway (or, for the Outdoor Tank Area Drains Monitor, automatic stop signal to the discharge pump) and control room alarm annunciation* occur if any of the following conditions exists (liquid activity channel only):
 - a. Instrument indicates measured levels above the Alarm/Trip Setpoint,
 - b. Circuit failure (monitor loss of communications (alarm only), detector loss of counts (Alarm only) and monitor loss of power),
 - c. Detector check source test failure (alarm only),
 - d. Detector channel out of service (alarm only),
 - e. Monitor loss of sample flow (alarm only). (Not applicable for Turbine Building Drain Rad Monitor)
- (2) The DIGITAL CHANNEL OPERATIONAL TEST shall also demonstrate that control room alarm annunciation* occurs if any of the following conditions exists (liquid activity channel only):
 - a. Instrument indicates measured levels above the Alarm Setpoint,
 - b. Circuit failure (monitor loss of communications, detector loss of counts, and monitor loss of power),
 - c. Detector check source test failure,
 - d. Detector channel out of service,
 - e. Monitor loss of sample flow.
- (3) The initial CHANNEL CALIBRATION shall be performed using one or more of the reference standards certified by the National Bureau of Standards (NBS) or using standards that have been obtained from suppliers that participate in measurement assurance activities with NBS. 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.
- (4) CHANNEL CHECK shall consist of verifying indication of flow during periods of release. CHANNEL CHECK shall be made at least once per 24 hours on days on which continuous, periodic, or batch releases are made.
- (5) When the Secondary Waste System is being used in the batch release mode, the source check shall be prior to release. When the system is being used in the continuous release mode, the source check shall be monthly.

*Control Room Alarm Annunciation shall consist of a change in state of the tested channel on the RM-11 terminal (i.e., a change in color) or a highlighted message on the DICSP Workstation Channel.

3/4.3.3 MONITORING INSTRUMENTATION

3/4.3.3.11 Radioactive Gaseous Effluent Monitoring Instrumentation

OPERATIONAL REQUIREMENT

- 3.3.3.11 The radioactive gaseous effluent monitoring instrumentation channels shown in Table 3.3-13 shall be OPERABLE with their Alarm/Trip Setpoints set to ensure that the limits of Operational Requirements 3.11.2.1 are not exceeded. The Alarm/Trip Setpoints of these channels meeting Operational Requirement 3.11.2.1 shall be determined and adjusted in accordance with the methodology and parameters in the ODCM.

APPLICABILITY: As shown in Table 3.3-13

ACTION:

- a. With a radioactive gaseous effluent monitoring instrumentation channel Alarm/Trip Setpoint less conservative than required by the above Operational Requirement, immediately (1) suspend the release of radioactive gaseous effluents monitored by the affected channel or (2) declare the channel inoperable and take ACTION as directed by b. below.
- b. With the number of OPERABLE radioactive gaseous effluent monitoring instrumentation channels less than the Minimum Channels OPERABLE, take the ACTION shown in Table 3.3-13. Exert best efforts to return the instrument to OPERABLE status within 30 days. If unsuccessful, explain in the next Annual Radioactive Effluent Release Report pursuant to ODCM, Appendix F, Section F.2 why this inoperability was not corrected in a timely manner.

SURVEILLANCE REQUIREMENTS

- 4.3.3.11 Each radioactive gaseous effluent monitoring instrumentation channel shall be demonstrated OPERABLE by performance of the CHANNEL CHECK, SOURCE CHECK, CHANNEL CALIBRATION and a DIGITAL CHANNEL OPERATIONAL TEST or an ANALOG CHANNEL OPERATIONAL TEST at the frequencies shown in Table 4.3-9.

Each Surveillance Requirement shall be performed within the specified surveillance interval with a maximum allowable extension not to exceed 25% of the specified surveillance interval.

TABLE 3.3-13
RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENT	MIN. CHANNELS OPERABLE	APPLICABILITY	ACTION
1. GASEOUS WASTE PROCESSING SYSTEM - HYDROGEN AND OXYGEN ANALYZERS			
Specification is not used in ODCM			
2. TURBINE BUILDING VENT STACK			
a. Noble Gas Activity Monitor	1	*	47
b. Iodine Sampler	1	*	49
c. Particulate Sampler	1	*	49
d. Flow Rate Monitor	1	*	46
e. Sampler Flow Rate Monitor	1	*	46
3. PLANT VENT STACK			
a. Noble Gas Activity Monitor	1	*	47
b. Iodine Sampler	1	*	49
c. Particulate Sampler	1	*	49
d. Flow Rate Monitor	1	*	46
e. Sampler Flow Rate Monitor	1	*	46
4. WASTE PROCESSING BUILDING VENT STACK 5			
a.1 Noble Gas Activity Monitor (PIG)	1	*	45, 51
a.2 Noble Gas Activity Monitor (WRGM)	1	MODES 1, 2, 3	52
b. Iodine Sampler	1	*	49
c. Particulate Sampler	1	*	49
d. Flow Rate Monitor	1	*	46
e. Sampler Flow Rate Monitor	1	*	46
5. WASTE PROCESSING BUILDING STACK 5A			
a. Noble Gas Activity Monitor	1	*	47
b. Iodine Sampler	1	*	49
c. Particulate Sampler	1	*	49
d. Flow Rate Monitor	1	*	46
e. Sampler Flow Rate Monitor	1	*	46

TABLE NOTATIONS

* At all times.

TABLE 3.3-13 (Continued)

ACTION STATEMENTS

- ACTION 45 - With the number channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, the contents of the waste gas decay tank(s) may be released to the environment provided that prior to initiating the release:
- a. At least two independent samples of the tank's contents are analyzed, and
 - b. At least two technically qualified members of the facility staff independently verify the release rate calculations and discharge valve lineup.
- Otherwise, suspend release of radioactive effluents via this pathway.
- ACTION 46 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided the flow rate is estimated at least once per 4 hours.
- ACTION 47 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided grab samples are taken at least once per 12 hours and these samples are analyzed for radioactivity within 24 hours.
- ACTION 48 - Not Used in the ODCM.
- ACTION 49 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via the affected pathway may continue provided samples are continuously collected with auxiliary sampling equipment as required in Table 4.11-2.
- ACTION 50 - Not used in the ODCM.
- ACTION 51 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement for both the PIG and WRGM, effluent releases via this pathway may continue provided grab samples are taken at least once per 12 hours and these samples are analyzed for radioactivity within 24 hours.
- ACTION 52 - With the number of OPERABLE accident monitoring instrumentation channels for the radiation monitor(s) less than the Minimum Channels OPERABLE requirements of Technical Specification Table 3.3-10, initiate the preplanned alternate method of monitoring the appropriate parameter(s) within 72 hours, and either restore the inoperable channel(s) to OPERABLE status within 14 days or prepare and submit a Special Report to the Commission, pursuant to Technical Specification 6.9.2, within the next 14 days that provides actions taken, cause of the inoperability, and the plans and schedule for restoring the channel(s) to OPERABLE status.

TABLE 4.3-9

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION
SURVEILLANCE REQUIREMENTS**

INSTRUMENT	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	DIGITAL CHANNEL OPERATIONAL TEST	MODES FOR WHICH SURVEILLANCE IS REQUIRED
1. GASEOUS WASTE PROCESSING SYSTEM - HYDROGEN AND OXYGEN ANALYZERS					
Not Used in the ODCM.					
2. TURBINE BUILDING VENT STACK					
a. Noble Gas Activity	D	M	R (3)	Q (2)	*
b. Iodine Sampler	N.A.	N.A.	N.A.	N.A.	*
c. Particulate Sampler	N.A.	N.A.	N.A.	N.A.	*
d. Flow Rate Monitor	D	N.A.	R	Q	*
e. Sampler Flow Rate Monitor	D	N.A.	R	Q	*
3. PLANT VENT STACK					
a. Noble Gas Activity Monitor	D	M	R (3)	Q (2)	*
b. Iodine Sampler	N.A.	N.A.	N.A.	N.A.	*
c. Particulate Sampler	N.A.	N.A.	N.A.	N.A.	*
d. Flow Rate Monitor	D	N.A.	R	Q	*
e. Sampler Flow Rate Monitor	D	N.A.	R	Q	*
4. WASTE PROCESSING BUILDING VENT STACK 5					
a.1 Noble Gas Activity Monitor (PIG)	D	M	R (3)	Q (1)	*
a.2 Noble Gas Activity Monitor (WRGM)	D	M	R (3)	Q (2)	*
b. Iodine Sampler	N.A.	N.A.	N.A.	N.A.	*
c. Particulate Sampler	N.A.	N.A.	N.A.	N.A.	*
d. Flow Rate Monitor	D	N.A.	R	Q	*
e. Sampler Flow Rate Monitor	D	N.A.	R	Q	*
5. WASTE PROCESSING BUILDING VENT STACK 5A					
a. Noble Gas Activity Monitor	D	M	R (3)	Q (2)	*
b. Iodine Sampler	N.A.	N.A.	N.A.	N.A.	*
c. Particulate Sampler	N.A.	N.A.	N.A.	N.A.	*
d. Flow Rate Monitor	D	N.A.	R	Q	*
e. Sampler Flow Rate Monitor	D	N.A.	R	Q	*

* At all times.

** See Table G-1 for explanation of frequency notation

ABLE 4.3-9 (Continued)

TABLE NOTATIONS

- (1) The DIGITAL CHANNEL OPERATIONAL TEST shall also demonstrate that automatic isolation of this pathway and control room annunciation* occur if any of the following conditions exists (gas activity and gas effluent channels only):
 - a. Instrument indicates measured levels above the Alarm/Trip Setpoint,
 - b. Circuit failure (monitor loss of communications - (alarm only), detector loss of counts (alarm only) and monitor loss of power),
 - c. Detector check source test failure (gas activity channel only), (alarm only),
 - d. Detector channel out of service (alarm only),
 - e. Monitor loss of sample flow (alarm only).
- (2) The DIGITAL CHANNEL OPERATIONAL TEST shall also demonstrate that control room alarm annunciation* occurs if any of the following conditions exists (gas activity and gas effluent channels only):
 - a. Instrument indicates measured levels above the Alarm Setpoint,
 - b. Circuit failure (monitor loss of communications (alarm only), detector loss of counts, and monitor loss of power),
 - c. Detector check source test failure (gas activity channel only),
 - d. Detector channel out of service,
 - e. Monitor loss of sample flow.
- (3) The initial CHANNEL CALIBRATION shall be performed using one or more of the reference standards certified by the National Bureau of Standards (NBS) or using standards that have been obtained from suppliers that participate in measurement assurance activities with NBS. 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.
- (4) Not used in the ODCM.
- (5) Not used in the ODCM.

*Control Room Alarm Annunciation shall consist of a change in state of the tested channel on the RM-11 terminal (i.e., a change in color) or a highlighted message on the DICSP Workstation Channel.

D.2 RADIOACTIVE EFFLUENTS

3/4.11.1 LIQUID EFFLUENTS

3/4.11.1.1 Concentration

OPERATIONAL REQUIREMENT

- 3.11.1.1 The concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS (see Technical Specification Figure 5.1-3) shall be limited to 10 times the concentrations specified in 10 CFR Part 20.1001 - 20.2401, 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 2E-04 $\mu\text{Ci/ml}$ total activity.

APPLICABILITY: At all times.

ACTION:

- a. With the concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS exceeding the above limits, immediately restore the concentration to within the above limits.

SURVEILLANCE REQUIREMENTS

- 4.11.1.1.1 Radioactive liquid wastes shall be sampled and analyzed according to the sampling and analysis program of Table 4.11-1.

- 4.11.1.1.2 The results of the radioactivity analyses shall be used in accordance with the methodology and parameters in the ODCM to assure that the concentrations at the point of release are maintained within the limits of Operational Requirement 3.11.1.1.

Each Surveillance Requirement shall be performed within the specified surveillance interval with a maximum allowable extension not to exceed 25% of the specified surveillance interval.

TABLE 4.11-1

RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM*

LIQUID RELEASE TYPE		SAMPLING FREQUENCY	MINIMUM ANALYSIS FREQUENCY	TYPES OF ACTIVITY ANALYSIS	LOWER LIMIT OF DETECTION (LLD) ⁽¹⁾ (μCi/ml)
1. Batch Waste Release Tanks ⁽²⁾					
a.	Waste Monitor Tanks	P Each Batch	P Each Batch	Principal Gamma Emitters ⁽³⁾	5E-07
				I-131	1E-06
b.	Waste Evaporator Condensate Tanks	P One Batch/M	M	Dissolved and Entrained Gases (Gamma Emitters)	1E-05
c.	Secondary Waste Sample Tank ⁽⁸⁾	P Each Batch	M Composite ⁽⁴⁾	H-3	1E-05
				Gross Alpha	1E-07
d.	Treated Laundry and Hot Shower Tanks	P Each Batch	Q Composite ⁽⁴⁾	Sr-89, Sr-90	5E-08
				Fe-55	1E-06
2. Continuous Releases ⁽⁵⁾⁽⁷⁾					
a.	Cooling Tower Weir	Continuous ⁽⁶⁾	W Composite ⁽⁶⁾⁽⁷⁾	Principal Gamma Emitters ⁽³⁾	5E-07
b.	Secondary Waste Sample Tank ⁽⁸⁾	M ⁽⁷⁾ Grab Sample	M ⁽⁷⁾	Dissolved and Entrained Gases (Gamma Emitters)	1E-05
				I-131	1E-06
		Continuous ⁽⁶⁾	M Composite ⁽⁶⁾⁽⁷⁾	H-3	1E-05
				Gross Alpha	1E-07
		Continuous ⁽⁶⁾	Q Composite ⁽⁶⁾⁽⁷⁾	Sr-89, Sr-90	5E-08
				Fe-55	1E-06

* See Table G-1 for explanation of frequency notation

TABLE 4.11-1 (Continued)

TABLE NOTATIONS

- (1) The LLD is defined, for purposes of these Operational Requirements, 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:

$$LLD = \frac{4.66 \cdot S_b}{E \cdot V \cdot (2.22E + 06) \cdot Y \cdot e^{-\lambda \Delta t}}$$

Where:

- LLD = the "a priori" lower limit of detection (μCi per unit mass or volume),
- S_b = the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (counts per minute),
- E = the counting efficiency (counts per disintegration),
- V = the sample size (units of mass or volume),
- $2.22E+06$ = the number of disintegrations per minute per μCi ,
- Y = the fractional radiochemical yield, when applicable,
- λ = the radioactive decay constant for the particular radionuclide (sec^{-1}), and
- Δt = the elapsed time between the midpoint of sample collection and the time of counting (sec).

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

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

- (2) A batch release is the discharge of liquid wastes of a discrete volume. Prior to sampling for analyses, each batch shall be isolated, and then thoroughly mixed by a method described in the ODCM to assure representative sampling.

TABLE 4.11-1 (Continued)

TABLE NOTATIONS (Continued)

- (3) The principal gamma emitters for which the LLD Operational Requirement applies include the following radionuclides: Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, and Ce-141. Ce-144 shall also be measured but with a LLD of 5E-06. This list does not mean that only these nuclides are to be considered. Other gamma peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Annual Radioactive Effluent Release Report pursuant to ODCM, Appendix F, Section F.2 in the format outlined in Regulatory Guide 1.21, Appendix B, Revision 1, June 1974.
- (4) 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 that is representative of the liquids released.
- (5) A continuous release is the discharge of liquid wastes of a non-discrete volume, e.g., from a volume of a system that has an input flow during the continuous release.
- (6) To be representative of the quantities and concentrations of radioactive materials in liquid effluents, samples shall be collected continuously in proportion to the rate of flow of the effluent stream. Prior to analyses, all samples taken for the composite shall be thoroughly mixed in order for the composite sample to be representative of the effluent release.
- (7) These points monitor potential release pathways only and not actual release pathways. The potential contamination points are in the Normal Service Water (NSW) and Secondary Waste (SW) Systems. Action under this Operational Requirement is as follows:
 - a) If the applicable (NSW or SW) monitors in Table 3.3-12 are OPERABLE and not in alarm, then no analysis under this Operational Requirement is required but weekly composites will be collected.
 - b) If the applicable monitor is out of service, then the weekly analysis for principal gamma emitters will be performed.
 - c) If the applicable monitor is in alarm or if the principal gamma emitter analysis indicates the presence of radioactivity as defined in the ODCM, then all other analyses of this Operational Requirement shall be performed at the indicated frequency as long as the initiating conditions exist.
- (8) The Secondary Waste System releases can be either batch or continuous. The type of sample required is determined by the mode of operation being used.

3/4.11.1 LIQUID EFFLUENTS

3/4.11.1.2 Dose

OPERATIONAL REQUIREMENT

- 3.11.1.2 The dose or dose commitment to a MEMBER OF THE PUBLIC from radioactive materials in liquid effluents released to UNRESTRICTED AREAS (see Technical Specification Figure 5.1-3) shall be limited:
- a. During any calendar quarter to less than or equal to 1.5 mrem to the whole body and to less than or equal to 5 mrem to any organ, and
 - b. During any calendar year to less than or equal to 3 mrem to the whole body and to less than or equal to 10 mrem to any organ.

APPLICABILITY: At all times.

ACTION:

- a. With the calculated dose from the release of radioactive materials in liquid effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days, pursuant to Technical Specification 6.9.2, a Special Report that identifies the cause(s) for exceeding the limit(s) and defines the corrective actions that have been taken to reduce the releases and the proposed corrective actions to be taken to assure that subsequent releases will be in compliance with the above limits.

SURVEILLANCE REQUIREMENTS

- 4.11.1.2 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 in the ODCM at least once per 31 days.

Each Surveillance Requirement shall be performed within the specified surveillance interval with a maximum allowable extension not to exceed 25% of the specified surveillance interval.

3/4.11.1 LIQUID EFFLUENTS

3/4.11.1.3 Liquid Radwaste Treatment System

OPERATIONAL REQUIREMENT

- 3.11.1.3 The Liquid Radwaste Treatment System shall be OPERABLE and appropriate portions of the system shall be used to reduce releases of radioactivity when the projected doses, due to the liquid effluent, to UNRESTRICTED AREAS (see Technical Specification Figure 5.1-3) would exceed 0.06 mrem to the whole body or 0.2 mrem to any organ in a 31-day period.

APPLICABILITY: At all times.

ACTION:

- a. With radioactive liquid waste being discharged without treatment and in excess of the above limits and any portion of the Liquid Radwaste Treatment System not in operation, prepare and submit to the Commission within 30 days, pursuant to Technical Specification 6.9.2, a Special Report that includes the following information:
1. Explanation of why liquid radwaste was being discharged without treatment, identification of any inoperable equipment or subsystems, and the reason for the inoperability,
 2. Action(s) taken to restore the inoperable equipment to OPERABLE status, and
 3. Summary description of action(s) taken to prevent a recurrence.

SURVEILLANCE REQUIREMENTS

- 4.11.1.3.1 Doses due to liquid releases to UNRESTRICTED AREAS shall be projected at least once per 31 days in accordance with the methodology and parameters in the ODCM when Liquid Radwaste Treatment Systems are not being fully utilized.

- 4.11.1.3.2 The installed Liquid Radwaste Treatment System shall be considered OPERABLE by meeting Operational Requirements 3.11.1.1 and 3.11.1.2.

Each Surveillance Requirement shall be performed within the specified surveillance interval with a maximum allowable extension not to exceed 25% of the specified surveillance interval.

3/4.11.2 GASEOUS EFFLUENTS

3/4.11.2.1 Dose Rate

OPERATIONAL REQUIREMENT

- 3.11.2.1 The dose rate due to radioactive materials released in gaseous effluents from the site to areas at and beyond the SITE BOUNDARY (see Technical Specification Figure 5.1-1) shall be limited to the following:
- a. For noble gases: Less than or equal to 500 mrem/yr to the whole body and less than or equal to 3000 mrem/yr to the skin, and
 - b. For Iodine-131, for Iodine-133, for tritium, and for all radionuclides in particulate form with half-lives greater than 8 days: Less than or equal to 1500 mrem/yr to any organ.

APPLICABILITY: At all times.

ACTION:

- a. With the dose rate(s) exceeding the above limits, immediately restore the release rate to within the above limit(s).

SURVEILLANCE REQUIREMENTS

- 4.11.2.1.1 The dose rate due to noble gases in gaseous effluents shall be determined to be within the above limits in accordance with the methodology and parameters in the ODCM.
- 4.11.2.1.2 The dose rate due to Iodine-131, Iodine-133, tritium, and all radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents shall be determined to be within the above limits in accordance with the methodology and parameters in the ODCM by obtaining representative samples and performing analyses in accordance with the sampling and analysis program specified in Table 4.11-2.

Each Surveillance Requirement shall be performed within the specified surveillance interval with a maximum allowable extension not to exceed 25% of the specified surveillance interval.

TABLE 4.11-2
RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM*

GASEOUS RELEASE TYPE	SAMPLING FREQUENCY	MINIMUM ANALYSIS FREQUENCY	TYPE OF ACTIVITY ANALYSIS	LOWER LIMIT OF DETECTION (LLD) ⁽¹⁾ (μ Ci/ml)
1. Waste Gas Storage Tank	P Each Tank Grab Sample	P Each Tank	Principal Gamma Emitters ^(2a)	1E-04
2. Containment Purge or Vent ⁽¹⁰⁾	P Each PURGE ⁽³⁾	P Each PURGE ⁽³⁾	Principal Gamma Emitters ^(2a)	1E-04
	Grab Sample	M	H-3 (oxide)	1E-06
3. a. Plant Vent Stack	M ^{(3), (4), (5)} Grab Sample	M	Principal Gamma Emitters ^(2a)	1E-04
			H-3 (oxide)	1E-06
b. Turbine Bldg Vent Stack, Waste Proc. Bldg. Vent Stacks 5 & 5A	M Grab Sample	M	Principal Gamma Emitters ^(2a)	1E-04
4. All Release Types as listed in 1., 2., and 3. above ^{(8), (9), (10)}	Continuous ⁽⁶⁾	W ⁽⁷⁾ Charcoal Sample	I-131 ^(2b)	1E-12
			I-133 ^(2b)	1E-10
	Continuous ⁽⁶⁾	W ^(7,12) Particulate Sample	Principal Gamma Emitters ^(2c)	1E-11
	Continuous ⁽⁶⁾	M Composite Particulate Sample	Gross Alpha	1E-11
	Continuous ⁽⁶⁾	Q Composite Particulate Sample	Sr-89, Sr-90	1E-11
5. Equipment Hatch during Refueling	Continuous	D Charcoal Sample	I-131 ^(2b)	1E-11
			I-133 ^(2b)	1E-09
	Continuous	D ⁽¹¹⁾ Particulate Sample	Principal Gamma Emitters	1E-10

* See Table G-1 for explanation of frequency notation

TABLE 4.11-2 (Continued)

TABLE NOTATIONS

- (1) The LLD is defined, for purposes of these Operational Requirements, 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:

$$LLD = \frac{4.66 \cdot S_b}{E \cdot V \cdot (2.22E + 06) \cdot Y \cdot e^{-\lambda \Delta t}}$$

Where:

- LLD = the "a priori" lower limit of detection (μCi per unit mass or volume),
- S_b = the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (counts per minute),
- E = the counting efficiency (counts per disintegration),
- V = the sample size (units of mass or volume),
- 2.22E+06 = the number of disintegrations per minute per μCi,
- Y = the fractional radiochemical yield, when applicable,
- λ = the radioactive decay constant for the particular radionuclide (sec⁻¹), and
- Δt = the elapsed time between the midpoint of sample collection and the time of counting (sec).

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

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

TABLE 4.11-2 (Continued)

TABLE NOTATIONS (Continued)

- (2a) The principal gamma emitters for which the LLD Operational Requirement applies include the following radionuclides: Kr-87, Kr-88, Xe-133, Xe-133m, Xe-135, and Xe-138 in noble gas releases. This list does not mean that only these nuclides are to be considered. Other noble gas gamma peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Annual Radioactive Effluent Release Report pursuant to ODCM, Appendix F, Section F.2 in the format outlined in Regulatory Guide 1.21, Appendix B, Revision 1, June 1974.
- (2b) The principal gamma emitters for which the LLD Operational Requirement applies include I-131 and I-133 in iodine (charcoal cartridge) samples. This list does not mean that only these nuclides are to be considered. Other iodine gamma peaks that are identifiable, together with I-131 and I-133 nuclides, shall also be analyzed and reported in the Annual Radioactive Effluent Release Report pursuant to ODCM, Appendix F, Section F.2 in the format outlined in Regulatory Guide 1.21, Appendix B, Revision 1, June 1974.
- (2c) The principal gamma emitters for which the LLD Operational Requirement applies include the following radionuclides: Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, I-131, Cs-134, Cs-137, Ce-141, and Ce-144 in particulate releases. This list does not mean that only these nuclides are to be considered. Other particulate gamma peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Annual Radioactive Effluent Release Report pursuant to ODCM, Appendix F, Section F.2 in the format outlined in Regulatory Guide 1.21, Appendix B, Revision 1, June 1974.
- (3) Sampling and analysis shall also be performed following shutdown, startup, or a THERMAL POWER change exceeding 15% of RATED THERMAL POWER within a 1-hour period.
- (4) Tritium grab samples shall be taken at least once per 24 hours when the refueling canal is flooded.
- (5) Tritium grab samples shall be taken at least once per 7 days from the ventilation exhaust from the spent fuel pool area, whenever spent fuel is in the spent fuel pool.
- (6) 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 Operational Requirements 3.11.2.1, 3.11.2.2, and 3.11.2.3.
- (7) 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 shall also be performed at least once per 24 hours for at least 7 days following each shutdown, startup, or THERMAL POWER change exceeding 15% of RATED THERMAL POWER within a 1-hour period and analyses shall be completed within 48 hours of changing. When samples collected for 24 hours are analyzed, the corresponding LLDs may be increased by a factor of 10. This requirement does not apply if: (1) analysis shows that the DOSE EQUIVALENT I-131 concentration in the reactor 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.
- (8) Continuous sampling of Waste Gas Decay Tank (WGDT) releases can be met using the continuous samplers on Wide Range Gas Monitor RM-*1WV-3546-1 on Waste Processing Building Vent Stack 5.
- (9) Continuous sampling of containment atmosphere for (1) Venting, (2) Normal Purge, and (3) Pre-entry purge operations, required by Operational Requirement 4.11.2.1.2, can be met using the continuous samplers on Wide Range Gas Monitor RM-01AV-3509-1SA on Plant Vent Stack 1

TABLE 4.11-2 (Continued)

TABLE NOTATIONS (Continued)

- (10) The requirement to sample the containment atmosphere prior to release for normal and pre-entry containment purge operations (that is, to "permit" the release per the ODCM) is required on initial system startup, and prior to system restart following any system shutdown due to radiological changes in the containment (e.g., valid high alarms on leak detection or containment area monitors). System shutdown occurring on changes in containment pressure, equipment malfunctions, operational convenience, sampling, and so forth, do not require new samples or release permits.
- (11) The composite of all filters collected when releases were being made through the equipment hatch are to be analyzed for gross alpha, strontium-89, and strontium 90 at the end of the outage.
- (12) If isokinetic skid for Plant Vent Stack 1 is INOPERABLE particulate sampling for effluent accountability is to be installed on 286' of the fuel handling building. ANSI 13.1, 1969 defines the conditions for obtaining a representative particulate sample.

3/4.11.2 GASEOUS EFFLUENTS

3/4.11.2.2 Dose - Noble Gases

OPERATIONAL REQUIREMENT

- 3.11.2.2 The air dose due to noble gases released in gaseous effluents to areas at and beyond the SITE BOUNDARY (see Technical Specification Figure 5.1-3) shall be limited to the following:
- a. During any calendar quarter: Less than or equal to 5 mrad for gamma radiation and less than or equal to 10 mrad for beta radiation, and
 - b. During any calendar year: Less than or equal to 10 mrad for gamma radiation and less than or equal to 20 mrad for beta radiation.

APPLICABILITY: At all times.

ACTION:

- a. With the calculated air dose from radioactive noble gases in gaseous effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days, pursuant to Technical Specification 6.9.2, a Special Report that identifies the cause(s) for exceeding the limit(s) and defines the corrective actions that have been taken to reduce the releases and the proposed corrective actions to be taken to assure that subsequent releases will be in compliance with the above limits.

SURVEILLANCE REQUIREMENTS

- 4.11.2.2 Cumulative dose contributions for the current calendar quarter and current calendar year for noble gases shall be determined in accordance with the methodology and parameters in the ODCM at least once per 31 days.

Each Surveillance Requirement shall be performed within the specified surveillance interval with a maximum allowable extension not to exceed 25% of the specified surveillance interval.

3/4.11.2 GASEOUS EFFLUENTS

3/4.11.2.3 Dose - Iodine-131, Iodine-133, Tritium, and Radioactive Material in Particulate Form

OPERATIONAL REQUIREMENT

3.11.2.3 The dose to a MEMBER OF THE PUBLIC from Iodine-131, Iodine-133, tritium, and all radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents released to areas at and beyond the SITE BOUNDARY (see Technical Specification Figure 5.1-3) shall be limited to the following:

- a. During any calendar quarter: Less than or equal to 7.5 mrem to any organ, and
- b. During any calendar year: Less than or equal to 15 mrem to any organ.

APPLICABILITY: At all times.

ACTION:

- a. With 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 exceeding any of the above limits, prepare and submit to the Commission within 30 days, pursuant to Technical Specification 6.9.2, a Special Report that identifies the cause(s) for exceeding the limit(s) and defines the corrective actions that have been taken to reduce the releases and the proposed corrective actions to be taken to assure that subsequent releases will be in compliance with the above limits.

SURVEILLANCE REQUIREMENTS

4.11.2.3 Cumulative dose contributions for the current calendar quarter and current calendar year for Iodine-131, Iodine-133, tritium, and radionuclides in particulate form with half-lives greater than 8 days shall be determined in accordance with the methodology and parameters in the ODCM at least once per 31 days.

Each Surveillance Requirement shall be performed within the specified surveillance interval with a maximum allowable extension not to exceed 25% of the specified surveillance interval.

3/4.11.2 GASEOUS EFFLUENTS

3/4.11.2.4 Gaseous Radwaste Treatment System

OPERATIONAL REQUIREMENT

- 3.11.2.4 The VENTILATION EXHAUST TREATMENT SYSTEM and the GASEOUS RADWASTE TREATMENT SYSTEM shall be OPERABLE and appropriate portions of these systems shall be used to reduce releases of radioactivity when the projected doses in 31 days due to gaseous effluent releases to areas at and beyond the SITE BOUNDARY (see Technical Specification Figure 5.1-3) would exceed:
- 0.2 mrad to air from gamma radiation, or
 - 0.4 mrad to air from beta radiation, or
 - 0.3 mrem to any organ of a MEMBER OF THE PUBLIC.

APPLICABILITY: At all times.

ACTION:

- With radioactive gaseous waste being discharged without treatment and in excess of the above limits, prepare and submit to the Commission within 30 days, pursuant to Technical Specification 6.9.2, a Special Report that includes the following information:
 - Identification of any inoperable equipment or subsystems, and the reason for the inoperability,
 - Action(s) taken to restore the inoperable equipment to OPERABLE status, and
 - Summary description of action(s) taken to prevent a recurrence.

SURVEILLANCE REQUIREMENTS

- 4.11.2.4.1 Doses due to gaseous releases to areas at and beyond the SITE BOUNDARY shall be projected at least once per 31 days in accordance with the methodology and parameters in the ODCM when the GASEOUS RADWASTE TREATMENT SYSTEM is not being fully utilized.
- 4.11.2.4.2 The installed VENTILATION EXHAUST TREATMENT SYSTEM and GASEOUS RADWASTE TREATMENT SYSTEM shall be considered OPERABLE by meeting Operational Requirements 3.11.2.1 and 3.11.2.2 or 3.11.2.3.
- Each Surveillance Requirement shall be performed within the specified surveillance interval with a maximum allowable extension not to exceed 25% of the specified surveillance interval.

3/4.11.4 TOTAL DOSE

OPERATIONAL REQUIREMENT

- 3.11.4 The annual (calendar year) dose or dose commitment to any MEMBER OF THE PUBLIC due to releases of radioactivity and to radiation from uranium fuel cycle sources shall be limited to less than or equal to 25 mremS to the whole body or any organ, except the thyroid, which shall be limited to less than or equal to 75 mremS.

APPLICABILITY: At all times.

ACTION:

- a. With the calculated doses from the release of radioactive materials in liquid or gaseous effluents exceeding twice the limits of Operational Requirement 3.11.1.2a., 3.11.1.2b., 3.11.2.2a., 3.11.2.2b., 3.11.2.3a., or 3.11.2.3b., calculations shall be made including direct radiation contributions from the units and from outside storage tanks to determine whether the above limits of Operational Requirement 3.11.4 have been exceeded. If such is the case, prepare and submit to the Commission within 30 days, pursuant to Technical Specification 6.9.2, a Special Report that defines the corrective action to be taken to reduce subsequent releases to prevent recurrence of exceeding the above limits and includes the schedule for achieving conformance with the above limits. This Special Report, as defined in 10 CFR 20.405(c), shall 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. It shall also describe levels of radiation and concentrations of radioactive material involved, and the cause of the exposure levels or concentrations. If the estimated dose(s) exceeds the above limits, and if the release condition resulting in violation of 40 CFR Part 190 has not already been corrected, the Special Report shall include a request for a variance in accordance with the provisions of 40 CFR Part 190. Submittal of the report is considered a timely request, and a variance is granted until staff action on the request is complete.

SURVEILLANCE REQUIREMENTS

- 4.11.4.1 Cumulative dose contributions from liquid and gaseous effluents shall be determined in accordance with Operational Requirements 4.11.1.2, 4.11.2.2, and 4.11.2.3, and in accordance with the methodology and parameters in the ODCM.
- 4.11.4.2 Cumulative dose contributions from direct radiation from the units and from radwaste storage tanks shall be determined in accordance with the methodology and parameters in the ODCM. This requirement is applicable only under conditions set forth in ACTION a. of Operational Requirement 3.11.4.

Each Surveillance Requirement shall be performed within the specified surveillance interval with a maximum allowable extension not to exceed 25% of the specified surveillance interval.

D.3 RADIOLOGICAL ENVIRONMENTAL MONITORING

3/4.12.1 MONITORING PROGRAM

OPERATIONAL REQUIREMENT

3.12.1 The Radiological Environment Monitoring Program shall be conducted as specified in Table 3.12-1.

APPLICABILITY: At all times.

ACTION:

- a. With the Radiological Environment Monitoring Program not being conducted as specified in Table 3.12-1, prepare, and submit to the Commission, in the Annual Radiological Environmental Operating Report required by ODCM, Appendix F, Section F.1, a description of the reasons for not conducting the program as required and the plans for preventing a recurrence.
- b. With the level of radioactivity as the result of plant effluents in an environmental sampling medium at a specified location exceeding the reporting levels of Table 3.12-2 when averaged over any calendar quarter, prepare and submit to the Commission within 30 days, pursuant to Technical Specification 6.9.2, a Special Report that identifies the cause(s) for exceeding the limit(s) and defines the corrective actions to be taken to reduce radioactive effluents so that the potential annual dose* to a MEMBER OF THE PUBLIC is less than the calendar year limits of Operational Requirements 3.11.1.2, 3.11.2.2, or 3.11.2.3. When more than one of the radionuclides in Table 3.12-2 are detected in the sampling medium, this report shall be submitted if:

$$\frac{\text{concentration}(1)}{\text{reporting level}(1)} + \frac{\text{concentration}(2)}{\text{reporting level}(2)} + \dots \geq 1.0$$

When radionuclides other than those in Table 3.12-2 are detected and are the result of plant effluents, this report shall be submitted if the potential annual dose* to a MEMBER OF THE PUBLIC from all radionuclides is equal to or greater than the calendar year limits of Operational Requirement 3.11.1.2, 3.11.2.2, or 3.11.2.3. This report is not required if the measured level of radioactivity was not the result of plant effluents; however, in such an event, the condition shall be reported and described in the Annual Radiological Environmental Operating Report required by ODCM, Appendix F, Section F.1.

*The methodology and parameters used to estimate the potential annual dose to a MEMBER OF THE PUBLIC shall be indicated in this report.

3/4.12.1 MONITORING PROGRAM

OPERATIONAL REQUIREMENT

ACTION (Continued):

- c. With milk or fresh leafy vegetation samples unavailable from one or more of the sample locations required by Table 3.12-1, identify specific locations for obtaining replacement samples and add them within 30 days to the Radiological Environmental Monitoring Program given in the ODCM. The specific locations from which samples were unavailable may then be deleted from the monitoring program. Pursuant to ODCM, Appendix F, Section F.2, submit in the next Annual Radioactive Effluent Release Report documentation for a change in the ODCM including a revised figure(s) and table for the ODCM reflecting the new location(s) with supporting information identifying the cause of the unavailability of samples and justifying the selection of the new location(s) for obtaining samples.
- d. If any sample result for onsite groundwater, that is or may be used as a source of drinking water, exceeds the reporting criteria of ODCM Table 3.12-2, then submit a special 30 day written report to the NRC. Additionally, a copy of this report shall be forwarded to designated state/local offices listed below in Action e.
- e. If any offsite groundwater, offsite surface water, onsite groundwater monitoring well, or onsite surface water that is hydrologically connected to groundwater exceed the reporting criteria of ODCM Table 3.12-2, then make informal notification to the designated state/local offices listed below by the end of the next business day. Special Ground Water Protection Reports listed in this section are not required for subsequent sample results that are from the same plume and have already been reported in accordance with this section. The Designated State offices for notification are as follows: 1) North Carolina Department of Environmental and Natural Resources, Radiation Protection Section and 2) North Carolina Department of Environmental and Natural Resources, Division of Water Quality.

SURVEILLANCE REQUIREMENTS

- 4.12.1 The radiological environmental monitoring samples shall be collected pursuant to Table 3.12-1 from the specific locations given in the table and figure(s) in the ODCM and shall be analyzed pursuant to the requirements of Table 3.12-1 and the detection capabilities required by Table 4.12-1.

Each Surveillance Requirement shall be performed within the specified surveillance interval with a maximum allowable extension not to exceed 25% of the specified surveillance interval.

TABLE 3.12-1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

<u>EXPOSURE PATHWAY AND/OR SAMPLE</u>	<u>NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS ⁽¹⁾</u>	<u>SAMPLING AND COLLECTION FREQUENCY</u>	<u>TYPE AND FREQUENCY OF ANALYSIS</u>
1. Direct Radiation ⁽²⁾	Forty routine monitoring stations either with two or more dosimeters or with one instrument for measuring and recording dose rate continuously, placed as follows: An inner ring of stations, one in each meteorological sector in the general area of the SITE BOUNDARY; An outer ring of stations, one in each meteorological sector in the 6 to 8 km range from the site; and The balance of the stations to be placed in special interest areas such as population centers, nearby residences, schools, and in one or two areas to serve as control stations.	Quarterly.	Gamma dose quarterly.

TABLE 3.12-1 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS ⁽¹⁾	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
2. Airborne Radioiodine and Particulates	Samples from five locations: Three samples from close to the three SITE BOUNDARY locations, in different sectors, of the highest calculated annual average ground-level D/Q; One sample from the vicinity of a community having the highest calculated annual average ground-level D/Q; and One sample from a control location, as for example 15 to 30 km distant and in the least prevalent wind direction.	Continuous sampler operation with sample collection weekly, or more frequently if required by dust loading.	<u>Radioiodine Cannister:</u> I-131 analysis weekly. <u>Particulate Sampler:</u> Gross beta radioactivity analysis following filter change;⁽³⁾ and gamma isotopic analysis ⁽⁴⁾ of composite (by location) quarterly.
3. Waterborne a. Surface ⁽⁵⁾	One sample upstream. One sample downstream.	Composite sample over 1-month period ⁽⁶⁾ .	Gamma isotopic analysis ⁽⁴⁾ monthly. Composite for tritium analysis quarterly.
b. Ground	Samples from one or two sources only if likely to be affected ⁽⁷⁾ .	Quarterly.	Gamma isotopic ⁽⁴⁾ and tritium analysis quarterly.

TABLE 3.12-1 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

<u>EXPOSURE PATHWAY AND/OR SAMPLE</u>	<u>NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS ⁽¹⁾</u>	<u>SAMPLING AND COLLECTION FREQUENCY</u>	<u>TYPE AND FREQUENCY OF ANALYSIS</u>
3. Waterborne (Continued) c. Drinking	One sample in the vicinity of the nearest downstream municipal water supply intake from the Cape Fear River. One sample from a control location.	Composite sample over 2-week period ⁽⁶⁾ when I-131 analysis is performed; monthly composite otherwise.	I-131 analysis on each composite when the dose calculated for the consumption of the water is greater than 1 mrem per year. ⁽⁸⁾ Composite for gross beta and gamma isotopic analyses ⁽⁴⁾ monthly. Composite for tritium analysis quarterly.
d. Sediment from Shoreline	One sample in the vicinity of the cooling tower blowdown discharge in an area with existing or potential recreational value.	Semiannually.	Gamma isotopic analysis ⁽⁴⁾ semiannually.
4. Ingestion a. Milk	Samples from milking animals in three locations within 5 km distance having the highest dose potential. If there are none, then one sample from milking animals in each of three areas between 5 to 8 km distant where doses are calculated to be greater than 1 mrem per yr. ⁽⁸⁾ One sample from milking animals at a control location 15 to 30 km distant and in the least prevalent wind direction.	Semimonthly when animals are on pasture; monthly at other times. When no milk animals are available at indicator locations, milk sampling of the control location can be reduced to once per month to maintain historical data. If no control location is available, monthly sampling of broad leaf vegetation can be substituted.	Gamma isotopic ⁽⁴⁾ and I-131 analysis semimonthly when animals are on pasture; monthly at other times.

TABLE 3.12-1 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

<u>EXPOSURE PATHWAY AND/OR SAMPLE</u>	<u>NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS ⁽¹⁾</u>	<u>SAMPLING AND COLLECTION FREQUENCY</u>	<u>TYPE AND FREQUENCY OF ANALYSIS</u>
4. Ingestion (Continued) b. Fish and Invertebrates	One sample of Sunfish, Catfish, and Large-Mouth Bass species in vicinity of plant discharge area. One sample of same species in areas not influenced by plant discharge.	Sample in season, or semiannually if they are not seasonal.	Gamma isotopic Analysis ⁽⁴⁾ on edible portions.
c. Food Products	One sample of each principle class of food products from any area that is irrigated by water which liquid plant wastes have been discharged	At time of harvest ⁽⁹⁾	Gamma isotopic analysis ⁽⁴⁾ on edible portions.
	Samples of three different kinds of broad leaf vegetation grown nearest each of two different locations of highest predicted annual average ground level D/Q if milk sampling is not performed. One sample of each of the similar broad leaf vegetation grown 15 to 30 km distant in the least prevalent wind direction if milk sampling is not performed.	Monthly	Gamma isotopic ⁽⁴⁾ and I-131 analysis.

TABLE 3.12-1 (Continued)

TABLE NOTATIONS

- (1) 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 3.12-1 in a table 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 circumstances such as hazardous conditions, seasonal unavailability, and malfunction of automatic sampling equipment. If specimens are unobtainable due to sampling equipment malfunction, effort shall be made to complete corrective action prior to the end of the next sampling period. All deviations from the sampling schedule shall be documented in the Annual Radiological Environmental Operating Report pursuant to Specification 6.9.1.3. 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. Pursuant to ODCM, Appendix F, Section F.2, submit in the next Annual Radioactive Effluent Release Report documentation for a change in the ODCM including a revised figure(s) and table for the ODCM reflecting the new location(s) with supporting information identifying the cause of the unavailability of samples for that pathway and justifying the selection of the new location(s) for obtaining samples.
- (2) 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 (TLD) is considered to be one phosphor; two or more phosphors in a packet are considered as two or more dosimeters. Film badges shall not be used as dosimeters for measuring direct radiation. (The 40 stations are not an absolute number. The number of direct radiation monitoring stations may be reduced according to geographical limitations; e.g., at an ocean site, some sectors will be over water so that the number of dosimeters may be reduced accordingly. The frequency of analysis or readout for TLD systems will depend upon the characteristics of the specific system used and should be selected to obtain optimum dose information within minimal fading.)
- (3) Airborne particulate sample filters shall be analyzed for gross beta radioactivity 24 hours or more after sampling to allow for radon and thoron daughter decay. If gross beta activity in air particulate samples is greater than 10 times the yearly mean of control samples, gamma isotopic analysis shall be performed on the individual samples.
- (4) Gamma isotopic analysis means the identification and quantification of gamma-emitting radionuclides that may be attributable to the effluents from the facility.
- (5) The "upstream sample" shall be taken at a distance beyond significant influence of the discharge. The "downstream" sample shall be taken in an area beyond but near the mixing zone. "Upstream" samples in an estuary must be taken far enough upstream to be beyond the plant influence. Salt water shall be sampled only when the receiving water is utilized for recreational activities.
- (6) A composite sample is one in which the quantity (aliquot) of liquid sampled is proportional to the quantity of flowing liquid and in which the method of sampling employed results in a specimen that is representative of the liquid flow. In this program composite sample aliquots shall be collected at time intervals that are very short (e.g., hourly) relative to the compositing period (e.g., monthly) in order to assure obtaining a representative sample.
- (7) Groundwater samples shall be taken when this source is tapped for drinking or irrigation purposes in areas where the hydraulic gradient or recharge properties are suitable for contamination. None of the previously identified locations have been used for drinking water since pre-operational days of Harris Nuclear Project nor have these wells ever been used for irrigation purposes. These wells were abandoned for drinking water purposes prior to plant operations. Since that time, these wells have been used to monitor the hydraulic gradient or gradient properties for the Harris Site and for the operational Radiological Environmental Monitoring program.

TABLE 3.12-1 (Continued)

TABLE NOTATIONS (Continued)

- (8) The dose shall be calculated for the maximum organ and age group, using the methodology and parameters in the ODCM.
- (9) If harvest occurs more than once per year, sampling shall be performed during each discrete harvest. If harvest occurs continuously, sampling shall be monthly. As of Revision 30 of this ODCM, there are no identified irrigated gardens.

TABLE 3.12-2

REPORTING LEVELS FOR RADIOACTIVITY CONCENTRATIONS IN ENVIRONMENTAL SAMPLES

ANALYSIS	WATER (pCi/l)	AIRBORNE PARTICULATE OR GASES (pCi/m ³)	FISH (pCi/kg, wet)	MILK (pCi/l)	FOOD PRODUCTS (pCi/kg, wet)
H-3	20,000*				
Mn-54	1,000		30,000		
Fe-59	400		10,000		
Co-58	1,000		30,000		
Co-60	300		10,000		
Zn-65	300		20,000		
Zr-Nb-95	400				
I-131	2**	0.9		3	100
Cs-134	30	10	1,000	60	1,000
Cs-137	50	20	2,000	70	2,000
Ba-La-140	200			300	

*For drinking water samples. This is 40 CFR Part 141 value. If no drinking water pathway exists, a value of 30,000 pCi/l may be used.

**If no drinking water pathway exists, a value of 20 pCi/l may be used.

TABLE 4.12-1

DETECTION CAPABILITIES FOR ENVIRONMENTAL SAMPLE ANALYSIS ⁽¹⁾

LOWER LIMIT OF DETECTION (LLD) ⁽²⁾

ANALYSIS	WATER (pCi/l)	AIRBORNE PARTICULATE OR GASES (pCi/m ³)	FISH (pCi/kg, wet)	MILK (pCi/l)	FOOD PRODUCTS (pCi/kg, wet)	SEDIMENT (pCi/kg, dry)
Gross Beta	4	0.01				
H-3	2000*					
Mn-54	15		130			
Fe-59	30		260			
Co-58, 60	15		130			
Zn-65	30		260			
Zr-Nb-95	15					
I-131	1**	0.07		1	60	
Cs-134	15	0.05	130	15	60	150
Cs-137	18	0.06	150	18	80	180
Ba-La-140	15***			15***		

*If no drinking water pathway exists, a value of 3000 pCi/l may be used.

**If no drinking water pathway exists, a value of 15 pCi/l may be used.

***The specific LLD applies to the daughter nuclide of an equilibrium mixture of the parent and daughter nuclides. Per the Branch Technical Position, value of 60 pCi/L may be used for Ba-140 and 15 pCi/L may be used for La-140.

TABLE 4.12-1 (Continued)

TABLE NOTATIONS

- (1) This list does not mean that only these nuclides are to be considered. Other peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Annual Radiological Environmental Operating Report pursuant to ODCM, Appendix F, Section F.1.
- (2) The LLD is defined, for purposes of these Operational Requirements, 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:

$$LLD = \frac{4.66 \cdot S_b}{E \cdot V \cdot (2.22E + 06) \cdot Y \cdot e^{-\lambda \Delta t}}$$

Where:

LLD	=	the "a priori" lower limit of detection (μCi per unit mass or volume),
S _b	=	the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (counts per minute),
E	=	the counting efficiency (counts per disintegration),
V	=	the sample size (units of mass or volume),
2.22E+06	=	the number of disintegrations per minute per μCi,
Y	=	the fractional radiochemical yield, when applicable,
λ	=	the radioactive decay constant for the particular radionuclide (sec ⁻¹), and
Δt	=	the elapsed time between the midpoint of sample collection and the time of counting (sec).

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

It should be recognized that the LLD is defined as an a priori (before the fact) limit representing the capability of a measurement system and not as an a posteriori (after the fact) limit for a particular measurement. Analyses shall be performed in such a manner that the stated LLDs will be achieved under routine conditions. Occasionally background fluctuations, unavoidable small sample sizes, the presence of interfering nuclides, or other uncontrollable circumstances may render these LLDs unachievable. In such cases, the contributing factors shall be identified and described in the Annual Radiological Environmental Operating Report pursuant to ODCM, Appendix F, Section F.1.

3/4.12.2 LAND USE CENSUS

OPERATIONAL REQUIREMENT

- 3.12.2 A Land Use Census shall be conducted and shall identify within a distance of 8 km (5 miles) the location in each of the 16 meteorological sectors of the nearest milk animal, the nearest residence, and the nearest garden* of greater than 50 m² (500 ft²) producing broad leaf vegetation.

APPLICABILITY: At all times.

ACTION:

- a. With a Land Use Census identifying a location(s) that yields a calculated dose or dose commitment greater than the values currently being calculated in Operational Requirement 4.11.2.3, pursuant to ODCM, Appendix F, Section F.2, identify the new location(s) in the next Annual Radioactive Effluent Release Report.
- b. With a Land Use Census identifying a location(s) that yields a calculated dose or dose commitment (via the same exposure pathway) 20% greater than at a location from which samples are currently being obtained in accordance with Operational Requirement 3.12.1, add the new location(s) within 30 days to the Radiological Environmental Monitoring Program given in the ODCM. The sampling location(s), excluding the control station location, having the lowest calculated dose or dose commitment(s), via the same exposure pathway, may be deleted from this monitoring program after October 31 of the year in which this Land Use Census was conducted. Pursuant to ODCM, Appendix F, Section F.2, submit in the next Annual Radioactive Effluent Release Report documentation for a change in the ODCM including a revised figure(s) and table(s) for the ODCM reflecting the new location(s) with information supporting the change in sampling locations.

SURVEILLANCE REQUIREMENTS

- 4.12.2 The Land Use Census shall be conducted during the growing season at least once per 12 months using that information that will provide the best results, such as by a door-to-door survey, 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 ODCM, Appendix F, Section F.1.

Each Surveillance Requirement shall be performed within the specified surveillance interval with a maximum allowable extension not to exceed 25% of the specified surveillance interval.

*Broad leaf vegetation sampling of at least three different kinds of vegetation may be performed at the SITE BOUNDARY in each of two different direction sectors with the highest predicted D/Qs in lieu of the garden census. Operational Requirements for broad leaf vegetation sampling in Table 3.12-1, Part 4.c., shall be followed, including analysis of control samples.

3/4.12.3 INTERLABORATORY COMPARISON PROGRAM

OPERATIONAL REQUIREMENT

- 3.12.3 Analyses shall be performed on all radioactive materials, supplied as part of an Interlaboratory Comparison Program, that correspond to samples required by Table 3.12-1.

APPLICABILITY: At all times.

ACTION:

- a. With analyses not being performed as required above, report the corrective actions taken to prevent a recurrence to the Commission in the Annual Radiological Environmental Operating Report pursuant to ODCM, Appendix F, Section F.1.

SURVEILLANCE REQUIREMENTS

- 4.12.3 The Interlaboratory Comparison Program shall be described in the ODCM. A summary of the results obtained as part of the above required Interlaboratory Comparison Program shall be included in the Annual Radiological Environmental Operating Report pursuant to ODCM, Appendix F, Section F.1.

Each Surveillance Requirement shall be performed within the specified surveillance interval with a maximum allowable extension not to exceed 25% of the specified surveillance interval.

E.0 APPENDIX E

PROGRAMMATIC CONTROL BASES

The Bases for the ODCM Operational Requirements are detailed in Sections:

- E.1 - Instrumentation
- E.2 - Radioactive Effluents
- E.3 - Radiological Environmental Monitoring

E.1 INSTRUMENTATION BASES

3/4.3.3 MONITORING INSTRUMENTATION

3/4.3.3.10 Radioactive Liquid Effluent Monitoring Instrumentation

The radioactive liquid effluent 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 Set Points for these instruments shall be calculated and adjusted in accordance with the methodology and parameters in the ODCM to ensure that the alarm/trip will occur prior to exceeding the limits of 10 CFR Part 20. The OPERABILITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10 CFR Part 50.

3/4.3.3.11 Radioactive Gaseous Effluent Monitoring Instrumentation

The radioactive gaseous effluent instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in gaseous effluents during actual or potential releases of gaseous effluents. The Alarm/Trip Set Points for these instruments shall be calculated and adjusted in accordance with the methodology and parameters in the ODCM to ensure that the alarm/trip will occur prior to exceeding the limits of 10 CFR Part 20. The OPERABILITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10 CFR Part 50. The sensitivity of any noble gas activity monitors used to show compliance with the gaseous effluent release requirements of Operational Requirement 3.11.2.2 shall be such that concentrations as low as $1\text{E-}06 \text{ } \mu\text{Ci/ml}$ are measurable.

E.2 RADIOACTIVE EFFLUENTS BASES

3/4.11.1 LIQUID EFFLUENTS

3/4.11.1.1 Concentration

This Operational Requirement is provided to ensure that the concentration of radioactive materials released in liquid waste effluents to UNRESTRICTED AREAS will be less than the concentration levels specified in 10 CFR Part 20, Appendix B, Table 2, Column 2. This limitation provides additional 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 Part 50, to a MEMBER OF THE PUBLIC, and (2) the limits of 10 CFR Part 20.106(e) to the population. The concentration limit for dissolved or entrained noble gases is based upon the assumption that Xe-135 is the controlling radioisotope and its MPC in air (submersion) was converted to an equivalent concentration in water using the methods described in International Commission on Radiological Protection (ICRP) Publication 2.

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 HASL Procedures Manual, HASL-300 (revised annually), Currie, L. A., "Limits for Qualitative Detection and Quantitative Determination - Application to Radiochemistry," Anal. Chem. **40**, 586-93 (1968), and Hartwell, J. K., "Detection Limits for Radioanalytical Counting Techniques," Atlantic Richfield Hanford Company Report ARH-SA-215 (June 1975).

3/4.11.1.2 Dose

This Operational Requirement is provided to implement the requirements of Sections II.A, III.A, and IV.A of Appendix I, 10 CFR Part 50. The Operational Requirement implements the guides set forth in Section II.A 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 liquid effluents to UNRESTRICTED AREAS will be kept "as low as is reasonably achievable". The dose calculation methodology and parameters 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.

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 Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I," April 1977.

3/4.11.1.3 Liquid Radwaste Treatment System

The OPERABILITY of the Liquid Radwaste Treatment System ensures that this system will be available for use whenever liquid effluents require treatment prior to release to the environment. The requirement 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 Operational Requirement implements the requirements of 10 CFR 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 limits 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.

E.2 RADIOACTIVE EFFLUENTS BASES (continue)

3/4.11.2 GASEOUS EFFLUENTS

3/4.11.2.1 Dose Rate

This Operational Requirement is provided to ensure that the dose at any time at and beyond the SITE BOUNDARY from gaseous effluents from all units on the site will be within the annual dose limits of 10 CFR Part 20 to UNRESTRICTED AREAS. The annual dose limits are the doses associated with the concentrations of 10 CFR Part 20, Appendix B, Table II, Column I. These limits provide 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 within or outside the SITE BOUNDARY, to annual average concentrations exceeding the limits specified in Appendix B, Table II of 10 CFR Part 20 [10 CFR Part 20.106(b)]. 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 any increase in the atmospheric diffusion factor above that for the SITE BOUNDARY. 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 gamma and beta 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 whole 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.

The required detection capabilities for radioactive material 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 HASL Procedures Manual, HASL-300, Currie, L. A., "Limits for Qualitative Detection and Quantitative Determination - Application to Radiochemistry," Anal. Chem. **40**, 586-93 (1968), and Hartwell, J. K., "Detection Limits for Radioanalytical Counting Techniques," Atlantic Richfield Hanford Company Report ARH-SA-215 (June 1975).

3/4.11.2.2 Dose - Noble Gases

This Operational Requirement is provided to implement the requirements of Section II.B, III.A, and IV.A of Appendix I, 10 CFR Part 50. The Operational Requirement implements the guides set forth in Section I.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 calculation methodology and parameters 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 Dose to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision I, 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.

E.2 RADIOACTIVE EFFLUENTS BASES (continue)

3/4.11.2 GASEOUS EFFLUENTS

3/4.11.2.3 Dose - Iodine-131, Iodine-133, Tritium, and Radioactive Material in Particulate Form

This Operational Requirement is provided to implement the requirements of Sections II.C, III.A, and IV.A of Appendix I, 10 CFR Part 50. The Operational Requirements 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 methodology and parameters 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 Operational Requirements for Iodine-131, Iodine-133, tritium, and radionuclides in particulate form with half-lives greater than 8 days are dependent upon the existing radionuclide pathways to man in the areas at and beyond the SITE BOUNDARY. The pathways that were examined in the development of the 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 of the ground with subsequent exposure of man.

3/4.11.2.4 Gaseous Radwaste Treatment System

The OPERABILITY of the WASTE GAS HOLDUP SYSTEM and the VENTILATION EXHAUST TREATMENT SYSTEM ensure that the systems will be available for use whenever gaseous effluents require treatment prior to release to the environment. The requirement that the appropriate portions of these systems 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 Operational Requirement implements the requirements of 10 CFR 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 systems were specified as a suitable fraction of the dose design objectives set forth in Sections II.B and II.C of Appendix I, 10 CFR Part 50, for gaseous effluents.

3/4.11.3 SOLID RADIOACTIVE WASTES

This specification implements the requirements of 10 CFR 50.36a, 10 CFR 61, and General Design Criterion 60 of Appendix A to 10 CFR Part 50. The process parameters included in establishing the PROCESS CONTROL PROGRAM may include, but are not limited to, waste type, waste pH, waste/liquid/SOLIDIFICATION agent/catalyst ratios, waste oil content, waste principal chemical constituents, and mixing and curing times.

E.2 RADIOACTIVE EFFLUENTS BASES (continued)

3/4.11.4 TOTAL DOSE

This Operational Requirement is provided to meet the dose limitations of 40 CFR Part 190 that have been incorporated into 10 CFR Part 20 by 46 FR 18525. The Operational Requirement requires the preparation and submittal of a Special Report whenever the calculated doses due to releases of radioactivity and to radiation from uranium fuel cycle sources exceed 25 mremS to the whole body or any organ, except the thyroid, which shall be limited to less than or equal to 75 mremS. For sites containing 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 Part 190 if the individual reactors remain within twice the dose design objectives of Appendix I, and if direct radiation doses from the units and from outside storage tanks are kept small. The Special Report will 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 Part 190 limits. For the purposes of the Special 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 dose contributions from other nuclear fuel cycle facilities at the same site or within a radius of 8 km must be considered. If the dose to any MEMBER OF THE PUBLIC is estimated to exceed the requirements of 40 CFR Part 190, the Special Report with a request for a variance (provided the release conditions resulting in violation of 40 CFR Part 190 have not already been corrected), in accordance with the provisions of 40 CFR 190.11 and 10 CFR 20.2203, is considered to be a timely request and fulfills the requirements of 40 CFR Part 190 until NRC staff action is completed. The variance only relates to the limits of 40 CFR Part 190 and does not apply in any way to the other requirements for dose limitation of 10 CFR Part 20, as addressed in Operational Requirements 3.11.1.1 and 3.11.2.1. 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.

E.3 RADIOLOGICAL ENVIRONMENTAL MONITORING BASES

3/4.12.1 MONITORING PROGRAM

The Radiological Environmental Monitoring Program required by this Operational Requirement provides representative measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides that lead to the highest potential radiation exposure of MEMBERS OF THE PUBLIC resulting from the plant 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 the modeling of the environmental exposure pathways. Guidance for this monitoring program is provided by the Radiological Assessment Branch Technical Position on Environmental Monitoring, Revision 1, November 1979. The initially specified monitoring program will be effective for at least the first 3 years of commercial operation. Following this period, program changes may be initiated based on operational experience.

The required detection capabilities for environmental sample analyses are tabulated in terms of the lower limits of detection (LLDs). The LLDs required by Table 4.12-1 are considered optimum 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 measurement system and not as an a posteriori (after the fact) limit for a particular measurement.

Detailed discussion of the LLD, and other detection limits, can be found in HASL Procedures Manual, HASL-300, Currie, L. A., "Limits for Qualitative Detection and Quantitative Determination - Application to Radiochemistry," Anal. Chem. 40, 586-93 (1968), and Hartwell, J. K., "Detection Limits for Radioanalytical Counting Techniques" Atlantic Richfield Hanford Company Report ARH-SA-215 (June 1975).

3/4.12.2 LAND USE CENSUS

This Operational Requirement 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 this census. The best information from the door-to-door survey, from aerial survey, or from consulting with local agricultural authorities shall be used. This census satisfies the requirements of Section IV.B.3 of Appendix I to 10 CFR Part 50. Restricting the census to gardens of greater than 50 m² provides assurance that significant exposure pathways via leafy vegetables will be identified and monitored since a garden of this size is the minimum required to produce the quantity (26 kg/year) of leafy vegetables assumed in Regulatory Guide 1.109 for consumption by a child. To determine this minimum garden size, the following assumptions were made: (1) 20% of the garden was used for growing broad leaf vegetation (i.e., similar to lettuce and cabbage), and (2) a vegetation yield of 2 kg/m².

3/4.12.3 INTERLABORATORY COMPARISON PROGRAM

The requirement for participation in an approved Interlaboratory Comparison Program is provided to ensure that independent checks on the precision and accuracy of the measurements of radioactive materials 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.

F.0 APPENDIX F

ADMINISTRATIVE CONTROLS

The Reporting Requirements pertaining to the ODCM Operational Requirements are detailed in Sections:

- F.1 - Annual Radiological Environmental Operating Report
- F.2 - Annual Radioactive Effluent Release Report
- F.3 - Major changes to the Radwaste Treatment System (liquid and gaseous)

F.1 Annual Radiological Environmental Operating Report
(Formerly part of Specification 6.9.1.3)

Routine Annual Radiological Environmental Operating Reports, covering the operation of the unit during the previous calendar year, shall be submitted prior to May 1 of each year. The initial report shall be submitted prior to May 1 of the year following initial criticality.

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, with operational controls, as appropriate, and with 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 the Land Use Census required by Operational Requirement 3.12.2.

The Annual Radiological Environmental Operating Reports shall include the results of analysis of all radiological environmental samples and of all environmental radiation measurements taken during the period pursuant to the locations specified in the table and figures in the OFFSITE DOSE CALCULATION MANUAL, as well as summarized and tabulated results of these analyses and measurements in the format of the table in the Radiological Assessment Branch Technical Position, Revision 1, November 1979. In the event that some individual 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: a summary description of the Radiological Environmental Monitoring Program; at least two legible maps* covering all sampling locations keyed to a table giving distances and directions from the centerline of the reactor; the results of licensee participation in the Interlaboratory Comparison Program and the corrective action taken if the specified program is not being performed as required by Operational Requirement 3.12.3; reasons for not conducting the Radiological Environmental Monitoring Program as required by Operational Requirement 3.12.1, and discussion of all deviations from the sampling schedule of Table 3.12-1; discussion of environmental sample measurements that exceed the reporting levels of Table 3.12-2 but are not the result of plant effluents, pursuant to ACTION b. of Operational Requirement 3.12.1; and discussion of all analyses in which the LLD required by Table 4.12-1 was not achievable.

* One map shall cover stations near the EXCLUSION AREA BOUNDARY; a second shall include the more distant station.

F.2 Annual Radioactive Effluent Release Report
(Formerly part of Specification 6.9.1.4)

Routine Annual Radioactive Effluent Release Report covering the operation of the unit during the previous 12 months of operation shall be submitted by May 1 of each year. The period of the first report shall begin with the date of initial criticality.

The Annual Radioactive Effluent Release Report shall include a summary of the quantities of radioactive liquid and gaseous effluents 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.

The Annual 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 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. For the assessment of radiation doses, approximate and conservative methods are acceptable. The assessment of radiation doses shall be performed in accordance with the methodology and parameters in the Offsite Dose Calculation Manual (ODCM).

The Annual 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."

The Annual Radioactive Effluent Release Report shall also include the dose contribution from return/re-use of previously radioactive effluents (tritium from the lake) at the end of each year. If the dose from the particular pathway is greater than 10 percent of the total dose from all pathways from plant releases (liquid, gaseous, iodine's particulates > 8-day half-life's & tritium from gaseous releases) the dose from the return of previously discharged effluents is to be reported. The total body, each organ, and each age group if applicable the dose should be calculated at the end of year unless it is known to be less than 10 percent of all doses.

The Annual 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 Annual Radioactive Effluent Release Report shall include any changes made during the reporting period to the ODCM, pursuant to Technical Specification 6.14, as well as any major change to Liquid and Gaseous Radwaste Treatment Systems pursuant to ODCM, Appendix F, Section F.3. It shall also include a listing of new locations for dose calculations and/or environmental monitoring identified by the Land Use Census pursuant to Operational Requirement 3.12.2.

The Annual 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 Operational Requirement 3.3.3.10 or 3.3.3.11, respectively; and a description of the events leading to liquid holdup tanks or gas storage tanks exceeding the limits of Technical Specifications or PLP-114.

The Annual Radioactive Effluent Release Report shall include any dose calculations that were performed as a result of a spill or leak from the site that occurred during the reporting period. The Annual Radioactive Effluent Release Report shall include a summary of any on-site spills and leaks that occurred during the reporting period that are communicated IAW the NEI Voluntary Groundwater Initiative.

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

F.3 Major Changes to Liquid and Gaseous Radwaste Treatment Systems*
(Formerly part of Specification 6.15)

Licensee-initiated major changes to the Radwaste Treatment Systems (liquid and gaseous):

- a. Shall be reported to the Commission in the Annual Radioactive Effluent Release Report for the period in which the evaluation was reviewed by the ORC. The discussion of each change shall contain:
 - 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 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 a MEMBER 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 to the actual releases for the period prior to when the change is to be made.
 - 7. An estimate of the exposure to plant operating personnel as a result of the change.
 - 8. Documentation of the fact that the change was reviewed and found acceptable by the ORC.
- b. Shall become effective upon review and acceptance by the ORC.

* Licensees may choose to submit the information called for in the Operational Requirement as part of the annual FSAR update

G.0 APPENDIX G

DEFINITIONS

The defined terms of this section appear in capitalized type and are applicable throughout the ODCM Operational Requirements.

ACTION

ACTION shall be that part of an ODCM Operational Requirement which prescribes remedial measures required under designated conditions.

ANALOG CHANNEL OPERATIONAL TEST

An ANALOG CHANNEL OPERATIONAL TEST shall be the injection of a simulated signal into the channel as close to the sensor as practicable to verify OPERABILITY of alarm, interlock and/or trip functions. The ANALOG CHANNEL OPERATIONAL TEST shall include adjustments, as necessary, of the alarm, interlock and/or Trip Setpoints such that the Setpoints are within the required range and accuracy.

CHANNEL CALIBRATION

A CHANNEL CALIBRATION shall be the adjustment, as necessary, of the channel such that it responds within the required range and accuracy to known values of input. The CHANNEL CALIBRATION shall encompass the entire channel including the sensors and alarm, interlock and/or trip functions and may be performed by any series of sequential, overlapping, or total channel steps such that the entire channel is calibrated.

CHANNEL CHECK

A CHANNEL CHECK shall be the qualitative assessment of channel behavior during operation by observation. This determination shall include, where possible, comparison of the channel indication and/or status with other indications and/or status derived from independent instrument channels measuring the same parameter.

DIGITAL CHANNEL OPERATIONAL TEST

A DIGITAL CHANNEL OPERATIONAL TEST shall consist of exercising the digital computer hardware using data base manipulation to verify OPERABILITY of alarm and/or trip functions.

DOSE EQUIVALENT I-131

DOSE EQUIVALENT I-131 shall be that concentration of I-131 ($\mu\text{Ci}/\text{gram}$) which alone would produce the same thyroid dose as the quantity and isotopic mixture of I-131, I-132, I-133, I-134, and I-135 actually present. The thyroid dose conversion factors used for this calculation shall be those listed in ICRP-30, "Limits for Intakes of Radionuclides by Workers."

EXCLUSION AREA BOUNDARY

The EXCLUSION AREA BOUNDARY shall be that line beyond which the land is not controlled by the licensee to limit access.

FREQUENCY NOTATION

The FREQUENCY NOTATION specified for the performance of Operational Requirements shall correspond to the intervals defined in Table G-1.

GASEOUS RADWASTE TREATMENT SYSTEM

A GASEOUS RADWASTE TREATMENT SYSTEM is any system designed and installed to reduce radioactive gaseous effluents by collecting primary coolant system off-gases from the primary system and providing for delay or holdup for the purpose of reducing the total radioactivity prior to release to the environment.

DEFINITIONS (continued)

LIQUID WASTE PROCESSING SYSTEM

A LIQUID WASTE PROCESSING SYSTEM provides for the collection, storing, processing, and controlled release of radioactive and potentially radioactive liquids. The system is considered fully utilized when the Modular Fluidized Transfer Demineralization System (MFTDS) is used for the purpose of reducing the total radioactivity prior to release to the environment. Some of the original processing equipment and evaporators have been removed from service but descriptions are still maintained to allow for future reactivation.

MEMBER(S) OF THE PUBLIC

MEMBER(S) OF THE PUBLIC shall include all persons who are not occupationally associated with the plant. This category does not include employees of the licensee, its contractors, or vendors. Also excluded from this category are persons who enter the site to service equipment or to make deliveries. This category does include persons who use portions of the site for recreational, occupational, or other purposes not associated with the plant.

OFFSITE DOSE CALCULATION MANUAL

The OFFSITE DOSE CALCULATION MANUAL (ODCM) shall contain the methodology and parameters used in the calculation of offsite doses due to 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.

OPERABLE - OPERABILITY

A system, subsystem, train, component or device shall be OPERABLE or have OPERABILITY when it is capable of performing its specified function(s), and when all necessary attendant instrumentation, controls, electrical power, cooling or seal water, lubrication or other auxiliary equipment that are required for the system, subsystem, train, component, or device to perform its function(s) are also capable of performing their related support function(s).

OPERATIONAL MODE - MODE

An OPERATIONAL MODE (i.e., MODE) shall correspond to any one inclusive combination of core reactivity condition, power level, and average reactor coolant temperature specified in Table G-2.

PROCESS CONTROL PROGRAM

The PROCESS CONTROL PROGRAM (PCP) shall contain the current formulas, sampling, analyses, tests, 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 10 CFR Parts 20, 61, and 71 and Federal and State regulations, burial ground requirements, and other requirements governing the disposal of radioactive waste.

PURGE - PURGING

PURGE or PURGING shall be any controlled process of discharging air or gas from a confinement to maintain temperature, pressure, humidity, concentration or other operating condition, in such a manner that replacement air or gas is required to purify the confinement.

DEFINITIONS (continued)

RELEASE

A RELEASE shall be the discharge of radioactive effluent from the facility in gaseous, particulate or liquid media. Releases can be further categorized for evaluation purposes:

ABNORMAL/UNPLANNED DISCHARGE – Unplanned or uncontrolled emission of licensed radioactive effluent to the unrestricted area. Release may be batch or continuous discharges. Examples: unintentional discharge of a waste gas decay tank, failure of radiation monitor to terminate a release.

ABNORMAL/UNPLANNED RELEASE – Unplanned or uncontrolled release of licensed radioactive material from the plant within the site boundary.

CONTROLLED RELEASE/DISCHARGE – A pre-planned release which can be controlled through component manipulation to assure the discharge was properly accounted, within ODCM limits, and had a pre-planned method of termination or altering the flow rate.

ELEVATED RELEASE – A gaseous effluent release made from a height that is more than twice the height of adjacent solid structures

GROUND-LEVEL RELEASE – A gaseous release made from a height that is at, or less than, the height of adjacent solid structures.

MONITORED RELEASE – A RELEASE which is monitored through installed or portable samplers.

NON-ROUTINE, PLANNED RELEASE/DISCHARGE – An effluent release from a release point that is not defined in the ODCM but that has been planned, monitored, and discharged in accordance with 10 CFR 20.2001.

UNCONTROLLED RELEASE/DISCHARGE – An effluent release that does not meet the definition of a controlled release

SITE BOUNDARY

For these Operational Requirements, the SITE BOUNDARY shall be identical to the EXCLUSION AREA BOUNDARY defined above.

SOLIDIFICATION

SOLIDIFICATION shall be the conversion of wet wastes into a form that meets shipping and burial ground requirements.

SOURCE CHECK

A SOURCE CHECK shall be the qualitative assessment of channel response when the channel sensor is exposed to a source of increased radioactivity.

UNRESTRICTED AREA

An UNRESTRICTED AREA shall be any area at or beyond the SITE BOUNDARY access to which is not controlled by the licensee for 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.

DEFINITIONS (continued)

VENTILATION EXHAUST TREATMENT SYSTEM

A VENTILATION EXHAUST TREATMENT SYSTEM shall be 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 iodine's 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 Features Atmospheric Cleanup Systems are not considered to be VENTILATION EXHAUST TREATMENT SYSTEM components.

VENTING

VENTING shall be the controlled process of discharging air or gas from a confinement to maintain temperature, pressure, humidity, concentration, or other operating condition, in such a manner that replacement air or gas is not provided or required during VENTING. Vent, used in system names, does not imply a VENTING process.

TABLE G-1
FREQUENCY NOTATION

NOTATION	FREQUENCY*
S	At least once per 12 hours.
D	At least once per 24 hours.
W	At least once per 7 days.
M	At least once per 31 days.
Q	At least once per 92 days.
SA	At least once per 184 days.
R	At least once per 18 months.
S/U	Prior to each reactor startup.
N.A.	Not applicable.
P	Completed prior to each release.

* Each Surveillance Requirement shall be performed within the specified surveillance interval with a maximum allowable extension not to exceed 25% of the specified surveillance interval.

TABLE G-2
OPERATIONAL MODES

Mode	Reactivity Condition	K _{eff}	% RATED THERMAL POWER*	AVERAGE COOLANT TEMPERATURE
1	Power Operations	≥ 0.99	$> 5\%$	$\geq 350^{\circ}\text{F}$
2	Startup	≥ 0.99	$\leq 5\%$	$\geq 350^{\circ}\text{F}$
3	Hot Standby	< 0.99	0	$\geq 350^{\circ}\text{F}$
4	Hot Shutdown	< 0.99	0	$350^{\circ}\text{F} > T_{\text{avg}} > 200^{\circ}\text{F}$
5	Cold Shutdown	< 0.99	0	$\leq 200^{\circ}\text{F}$
6	Refueling **	< 0.95	0	$\leq 140^{\circ}\text{F}$

* Excluding decay heat.

** Fuel in the reactor vessel with the vessel head closure bolts less than fully tensioned or with the head removed.

Attachment 10
Summary of Changes to the Process Control Program

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

ATTACHMENT 10

Summary of Changes to the Process Control Program

This attachment includes a summary of changes to the PCP.

Attachment 10
Summary of Changes to the Process Control Program

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

In 2022, the Shearon Harris Nuclear Power Plant Process control Program Document, PLP-300 was superseded and implemented into AD-CP-ALL-0030, Process Control Program- PCP Review and Revision. No revisions to AD-CP-ALL-0030 were made in 2024. The most recent revision is Revision 0. The site specific Process Control Program Implementation Procedure (HPP-830) was not revised in 2024, current revision is revision 6 and was issued 1/14/2019.

Attachment 11
Summary of Major Modifications to the Radioactive Waste Treatment Systems

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

ATTACHMENT 11

Summary of Major Modifications to the Radioactive Waste Treatment Systems

This attachment includes a description of major modifications to the radioactive waste treatment systems that are anticipated to affect effluent releases.

Attachment 11
Summary of Major Modifications to the Radioactive Waste Treatment Systems

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

No major modifications to Shearon Harris Nuclear Power Plant liquid or solid waste treatment systems in 2024.

Attachment 12
Errata to a Previous Year's ARERR

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

ATTACHMENT 12

Errata to a Previous Year's ARERR

This attachment includes any amended pages from a previous year's ARERR.

Attachment 12
Errata to a Previous Year's ARERR

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

Several errors were discovered in the 2022 and 2023 ARERR. Below are the corrected pages from each report with the corrections highlighted in yellow.

2022 ARERR Corrections: NCR 02535406

- In addition to the corrections displayed below, pages 29-30 were incorrectly numbered and the report contained two pages of each. The second page 29 also had the wrong year listed, the correct year should have been 2022.

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3.0 EXECUTIVE SUMMARY

Shearon Harris Nuclear Power Plant Unit 1 (HNPP) Radiological Effluent Control (REC) Program was established to limit the quantities of radioactive material that may be released based on calculated radiation doses or dose rates. Dose to Members of the Public due to radioactive materials released from the plant is limited by Appendix I of 10 CFR 50 and by 40 CFR 190. Operational doses to the public during 2022 were calculated to be very small compared to the limits required by regulation and compared to other sources of radiation dose and pose no health hazard. These doses are summarized and compared to the regulatory limits in Section 3.1, Comparison to Regulatory Limits, below.

The Annual Radioactive Effluent Release Report (ARERR) is published per HNPP Technical Specification 6.9.1.4 and ODCM Section F.2. and provides data related to plant operation, including: quantities of radioactive materials released in liquid and gaseous effluents; radiation doses to members of the public; solid radioactive waste shipped offsite for disposal; and other information as required by site licensing documents. If a revision to the ODCM has occurred during the report period, it is included pursuant to HNPP Technical Specification 6.14.

In 2022 the Land Use Census dose assessments due to radioactive gaseous effluents showed that the critical receptor for Shearon Harris Nuclear Power Plant Unit 1 was the Child, due to the pathways of Inhalation, Ground Plane, Vegetation and Milk at location 2.14 km in the South West sector. The maximum Annual Organ Dose calculated for this receptor was 7.75E-01 mrem, to the Thyroid. This annual dose is a small fraction (5.17E+00 %) of the 10 CFR 50, Appendix I guideline of 15 mrem to the Maximum Organ per reactor unit.

Solid radioactive waste shipped offsite for disposal included 3.81E-01 Curies and 217.86 m³, shipped in 4 shipments.

In addition to monitoring radioactive effluents, HNPP has a Radiological Environmental Monitoring Program (REMP) that monitors for buildup of radioactivity in the offsite environment. Data from the REMP is published in the Annual Radiological Environmental Operating Report (AREOR).

Attachment 12 Errata to a Previous Year's ARERR

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

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3.1 Comparison to Regulatory Limits

During 2022 all solid, liquid, and gaseous radioactive effluents from Shearon Harris Nuclear Power Plant Unit 1 were well below regulatory limits, as summarized in Table 1 and Table 2.

Total dose from liquid and gaseous effluents from Shearon Harris Nuclear Power Plant and the additional pathways mentioned above is conservatively estimated to be less than 2 mrem/yr for total body and organ. It is recognized summing dose for different organs and age groups is not entirely accurate. However, the sum of the organ and age specific doses will always be less than the sum of the maximums of each. Therefore, summing the maximum values of each provides the most conservative value to ensure compliance with 40 CFR 190. The dose from all pathways related to operation of Shearon Harris Nuclear Power Plant meets the 40 CFR Part 190 requirements of an annual dose commitment to any member of the general public of less than 25 mrem total body or any organ and 75 mrem to the thyroid.

Table 1, Shearon Harris Nuclear Power Plant Unit 1 Dose Summary¹

		Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual
Liquid Effluent Dose Limit, ⁽¹⁾ Total Body	Limit	1.5 mrem	1.5 mrem	1.5 mrem	1.5 mrem	3 mrem
	Total Body Dose	8.76E-03	3.42E-02	5.29E-02	7.07E-02	1.67E-01
	% of Limit	5.84E-01	2.28E+00	3.53E+00	4.71E+00	5.55E+00
Liquid Effluent Dose Limit, Any Organ	Limit	5 mrem	5 mrem	5 mrem	5 mrem	10 mrem
	Max Organ Dose ⁽¹⁾	1.76E-02	3.45E-02	6.66E-02	7.46E-02	1.93E-01
	% of Limit	3.52E-01	6.90E-01	1.33E+00	1.49E+00	1.93E+00
Gaseous Effluent Dose Limit, ⁽²⁾ Gamma Air (Noble Gas)	Limit	5 mrad	5 mrad	5 mrad	5 mrad	10 mrad
	Gamma Air Dose ⁽²⁾	5.74E-06	0.00E+00	0.00E+00	4.09E-05	4.66E-05
	% of Limit	1.15E-04	0.00E+00	0.00E+00	8.17E-04	4.66E-04
Gaseous Effluent Dose Limit, Beta Air (Noble Gas)	Limit	10 mrad	10 mrad	10 mrad	10 mrad	20 mrad
	Beta Air Dose ⁽²⁾	1.70E-05	0.00E+00	0.00E+00	1.44E-05	3.14E-05
	% of Limit	1.70E-04	0.00E+00	0.00E+00	1.44E-04	1.57E-04
Gaseous Effluent Organ Dose Limit ⁽³⁾ (Iodine, Tritium, Particulates with > 8-day half-life)	Limit	7.5 mrem	7.5 mrem	7.5 mrem	7.5 mrem	15 mrem
	Max Organ Dose ⁽³⁾	1.02E-01	1.97E-01	2.99E-01	1.78E-01	7.75E-01
	% of Limit	1.35E+00	2.62E+00	3.99E+00	2.38E+00	5.17E+00

(1) Critical Age ADULT, Critical Organ GI-LI

(2) Receptor Location 2.14 km SW

(3) Receptor Location 2.14 km SW, Critical Age Child, Critical Organ Thyroid

¹ Table 1 demonstrates compliance with 10 CFR Part 50, App. I Limits.

Attachment 12
Errata to a Previous Year's ARERR

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

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Table 2, Total Annual Offsite-Dose Comparison to 40 CFR 190 Limits for HNPP²

A. Gaseous Effluent Dose		E. Harris Lake Evaporation H-3 Dose	
1. Location	2.14 km SW	1. Location	6.65 km SSW
2. Critical Age	CHILD	2. Critical Age	CHILD
3. Critical Organ	Thyroid	3. Critical Organ	N/A
4. Organ Dose (mrem)	7.75E-01	4. Organ Dose (mrem)	-
5. Total Body Dose (mrem)	7.75E-01	5. Total Body Dose (mrem)	2.71E-02
B. Liquid Effluent Dose		F. Drinking Water H-3 Dose	
1. Location	2.19 km S	1. Location	Harris Plant
2. Critical Age	ADULT	3. Critical Age	ADULT
3. Critical Organ	GI-LLI	3. Critical Organ	N/A
4. Organ Dose (mrem)	1.93E-01	4. Organ Dose (mrem)	-
5. Total Body Dose (mrem)	1.67E-01	5. Total Body Dose (mrem)	4.10E-02
C. Carbon-14 Dose		G. H-3 in Fish from Harris Lake	
1. Location	2.76km SW	1. Location	Harris Lake
2. Critical Age	ADULT	2. Critical Age	ADULT
3. Critical Organ	BONE	3. Critical Organ	N/A
4. Organ Dose (mrem)	2.01E-01	4. Organ Dose (mrem)	-
5. Total Body Dose (mrem)	3.99E-02	5. Total Body Dose (mrem)	7.14E-03
D. Cooling Tower Plume H-3 Dose			
1. Location	2.91 km NNE		
2. Critical Age	CHILD		
3. Critical Organ	N/A		
4. Organ Dose (mrem)	-		
5. Total Body Dose (mrem)	1.69E-03		

² Table 2 is a summation of Units to show compliance with 40 CFR Part 190 Limits.

Attachment 12 Errata to a Previous Year's ARERR

Shearon Harris Nuclear Power Plant Unit 1
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6.0 SUPPLEMENTAL INFORMATION

6.1 Gaseous Batch Releases

6.1.1 HNPP Unit 1

	Jan - Jun	Jul - Dec	Total	
Number of batch releases	7	15	22	
Total time period for a batch release	1.82E+03	1.91E+04	2.09E+4	minutes
Maximum time period for a batch release	1.06E+03	3.95E+03	3.95E+03	minutes
Average time period for a batch release	2.60E+02	1.27E+03	9.51E+02	minutes
Minimum time period for a batch release	1.00E+00	9.00E+00	1.00E+01	minutes

6.2 Liquid Batch Releases

6.2.1 HNPP Units 1

	Jan - Jun	Jul - Dec	Total	
Number of batch releases	13	24	37	
Total time period for a batch release	1.04E+04	1.93E+04	2.97E+04	minutes
Maximum time period for a batch release	9.10E+02	1.19E+03	1.19E+03	minutes
Average time period for a batch release	8.02E+02	8.05E+02	18.03E+02	minutes
Minimum time period for a batch release	7.46E+02	4.86E+02	4.86E+02	minutes
Average total flow during period of release	9.93E+03	9.09E+03	9.39E+03	gpm

6.3 Abnormal Releases

6.3.1 Gaseous Abnormal Releases

Number of releases	1	
Total activity released	2.82E-04	Ci

6.3.2 Liquid Abnormal Releases

Number of releases	0	
Total activity released	0	Ci

Attachment 12 Errata to a Previous Year's ARERR

Shearon Harris Nuclear Power Plant Unit 1
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6.11 Maximum Permissible Effluent Concentrations

1. Gaseous Effluents - Information found in Offsite Dose Calculation Manual
2. Liquid Effluents - Information found in 10 CFR Part 20, Appendix B, Table 2, Column 2

6.12 Average Energy

Not Applicable to HNPP.

6.13 Dose from Returned/Re-used of Previously Discharge Plant Effluents

6.13.1 Cooling Tower Plume

Tritium in Cooling Tower plume creates an exposure pathway to a member of the public. Murray and Trettle, Inc. was contracted to perform an evaluation of the dose to a member of the public from exposure to tritium in the Cooling Tower plume. Results of the plume exposure are contained in report "Impact of Tritium Release from the Cooling Tower at the Harris Nuclear Plant for 2022". Using the methodology described in ODCM 2.3.2, the following is a summary of tritium activity released through the Cooling Tower plume and resulting dose for 2022.

	Units	Qtr. 1	Qtr. 2	Qtr. 3	Qtr. 4	Yearly Total
1. H-3 Activity Released	Ci	1.22E+01	1.19E+01	2.05E+01	1.30E+01	5.75E+01
2. H-3 Dose	mrem	3.58E-04	3.52E-04	6.03E-04	3.82E-04	1.69E-03
Receptor Location 2.91 km NNE						
Critical Age CHILD						
Critical Organ N/A*						

6.13.2 Harris Lake Evaporation

Evaporation of water containing tritium in Harris Lake creates an exposure pathway to a member of the public. Murray and Trettle, Inc. was contracted to perform an evaluation of the dose to a member of the public from evaporation of tritium in Harris Lake. Results of the evaluation are contained in report "Impact of Tritium Release from the Water Reservoir (Lake Harris) at the Harris Nuclear Plant for 2022". Using the methodology described in ODCM 2.3.3, the following is a summary of tritium activity released through evaporation and resulting dose for 2022.

* The dose factor for H-3 is the same for all organs and Total Body (except for Bone), which is 0.00E+00.

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	Units	Qtr. 1	Qtr. 2	Qtr. 3	Qtr. 4	Yearly Total
1. H-3 Activity Released	Ci	9.99E+00	1.974E+01	2.07E+01	1.40E+01	6.452E+01
2. H-3 Dose	mrem	1.06E-02	2.11E-02	2.19E-02	1.48E-02	6.84E-02
Receptor Location 6.65 km SSW						
Critical Age CHILD						
Critical Organ N/A **						

6.13.3 Drinking Water at Harris Plant and the Harris Energy and Environmental(HE&EC) Training Centers

Concentrations of radionuclides used in this specific drinking water pathway are determined by averaging the monthly concentrations detected in environmental location (REMP) DW-51. In 2022, no plant related gamma emitting radionuclides were detected. Tritium was detected each month, as expected. Using the methodology described in ODCM 2.3.1, the following is a summary of average concentration consumed and resulting dose for 2022.

	Units	Yearly Total
1. Avg. H-3 Concentration	Ci	1.50E+03
2. H-3 Dose	mrem	4.10E-02
Critical Age ADULT		
Critical Organ N/A *		

6.13.4 Tritium in Fish from Harris Lake

Concentrations of radionuclides used in this specific fish consumption pathway are determined by averaging the monthly concentrations detected in environmental location (REMP) SW-26. In 2022, no plant related gamma emitting radionuclides were detected. Tritium was detected each month, as expected. Since tritium is consistently detected in Harris Lake REMP samples, tritium concentration in the fish is assumed to be in equilibrium with Harris Lake. Using the methodology and data described in NRC Regulatory Guide 1.109, Rev.1, October 1977, Equation A-1, Table E-5, and Table E-11, the following is a summary of average concentration consumed and resulting dose for 2022.

	Units	Yearly Total
1. Avg. H-3 Concentration	Ci	3.60+03
2. H-3 Dose	mrem	7.14E-03
Critical Age ADULT		
Critical Organ N/A *		

* The dose factor for H-3 is the same for all organs and Total Body (except for Bone), which is 0.00E+00).

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Errata to a Previous Year's ARERR

Shearon Harris Nuclear Power Plant Unit 1
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6.17 Carbon-14

Carbon-14 (C-14) is a naturally occurring radionuclide with a 5730-year half-life. Nuclear weapons testing in the 1950s and 1960s significantly increased the amount of C-14 in the atmosphere. Nuclear power plants also produce C-14, but the amount is infinitesimal compared to what has been distributed in the environment due to weapons testing and what is produced by natural cosmic ray interactions.

The Shearon Harris Nuclear Power Plant 2022 ARERR contains estimates of C-14 radioactivity released in 2022 and estimates of public dose resulting from the C-14 effluent. The concentration and offsite dose from C-14 has been estimated by using a calculation approach, assuming typical or maximum values for the various calculation parameters. Because the dose contribution of C-14 from liquid radioactive waste is much less than that contributed by gaseous radioactive waste, evaluation of C-14 in liquid radioactive waste is not required (Ref. Reg. Guide 1.21, Rev. 2).

The quantity of gaseous C-14 released to the environment can be estimated by use of a C-14 source term scaling factor based on power generation (Ref. Reg. Guide 1.21, Rev. 2). The Shearon Harris Nuclear Power Plant UFSAR Section 11.1.5 states the expected C-14 generation to be 7.3 Curies assuming 292 effective full power days (EFPD) in a calendar year. For the Shearon Harris Nuclear Power Plant 2022 ARERR, a source term scaling factor using actual EFPD of 300.69 days is assumed. Using the source term scaling factor from Shearon Harris Nuclear Power Plant in 2022 results in a site total C-14 gaseous release estimate to the environment of 7.52 Curies. Due to the reducing environment of a Pressured Water Reactor, only 30% of the C-14 is assumed to be released in the Carbon Dioxide (CO₂) form. Dose is not expected from other forms (methane, etc.). 70% of the C-14 gaseous effluent is assumed to be from batch releases and the remaining 30% is assumed to be from continuous releases through the plant vent (ref. IAEA Technical Reports Series no. 421, "Management of Waste Containing Tritium and Carbon-14", 2004).

The resultant offsite doses were based upon this source term and the dose calculations described in NRC Regulatory Guide 1.109, Revision 1, and the Shearon Harris Nuclear Power Plant ODCM. The estimated C-14 dose impact on the maximum organ dose from airborne effluents released from Shearon Harris Nuclear Power Plant in 2022 is well below the 10CFR 50, Appendix I, ALARA design objective (i.e., 15 mrem/yr. per unit). The Harris Nuclear Plant Land Use Census did not provide sufficient detail for ages groups at the residences. Therefore, a Child was assumed to be at each residence for the C-14 dose calculation. The receptor location of 2.76 km SW and the Critical Age of a Child was the most restrictive receptor and age group out of the sixteen sectors.

Attachment 12 Errata to a Previous Year's ARERR

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Table 4, Production of Carbon 14 and Calculated Maximum Dose

	Units	1 st Qtr	2 nd Qtr	3 rd Qtr	4 th Qtr	Year
EFPD	Days	89.80	89.30	87.80	33.79	300.69
C-14 Activity Released	Ci	2.25E+00	2.23E+00	2.20E+00	8.45E-01	7.52E+00
C-14 Total Body Dose	mrem	1.23E-02	1.17E-02	1.15E-02	4.39E-03	3.99E-02
C-14 Organ Dose	mrem	6.17E-02	5.88E-02	5.79E-02	2.21E-02	2.01E-01

6.18 Errata/Corrections to Previous ARERRs

Attachment 4, Corrected Data from Previous ARERR contains amended pages to the SHNPP 2020-2021 ARERR. Amended pages are identified with 'Amendment#' on page. Specific changes are identified with change bars in right margin. A copy of the original submittal will appear before the amendment page.

Reasoning:

The Annual Radioactive Effluent Release Report (ARERR) that was submitted to the NRC in 2020 and 2021 included some calculation errors when determining averages for Summary of Gaseous and Liquid Effluents. Instead of adding up each quarters value and dividing by 4, in cases where the value equaled zero the quarter was not used for the average calculation. For example in 2021 the average diluted concentration for Dissolved & Entrained Gases was as follows: (Qtr 1-Zero), (Qtr 2-4.99E-11), (Qtr 3-Zero), (Qtr 4-Zero). The average value for the year was listed on the report as 4.99E-11 and should have been 1.25E-11

Attachment 12 Errata to a Previous Year's ARERR

Shearon Harris Nuclear Power Plant Unit 1
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Attachment 1, ARERR Release Summary Tables (RG-1.21 Tables)

1.0 GASEOUS EFFLUENTS

Table 6, Gaseous Effluents Summation of All Releases from HNPP Unit 1

A. Fission & Activation Gases	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Yearly Total
1. Total Release	Ci	2.81E-02	0.00E+00	0.00E+00	7.70E-03	3.58E-02
2. Average release rate for the period	μCi/sec	3.62E-03	0.00E+00	0.00E+00	9.68E-04	1.15E-03
B. Iodine						
1. Total Iodine – 131	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Average release rate for the period	μCi/sec	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C. Particulates						
1. Particulates with half-lives > 8 days	Ci	0.00E+00	0.00E+00	0.00E+00	1.37E-05	1.37E-05
2. Average release rate for the period	μCi/sec	0.00E+00	0.00E+00	0.00E+00	1.72E-06	4.30E-7
D. Tritium						
1. Total Release	Ci	2.55E+01	4.94E+01	7.51E+01	4.47E+01	1.95E+02
2. Average release rate for the period	μCi/sec	3.28E+00	6.29E+00	9.44E+00	5.63E+00	6.16E+00
E. Gross Alpha						
1. Total Release	Ci	0.00+00	0.00+00	0.00+00	0.00+00	0.00E+00
2. Average release rate for the period	μCi/sec	0.00+00	0.00+00	0.00+00	0.00+00	0.00E+00

% of limit is on Table 1, Shearon Harris Nuclear Power Plant Unit 1 Dose Summary

Attachment 12 Errata to a Previous Year's ARERR

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

2023 ARERR Corrections: NCR 02521171

- In addition to the corrections displayed below, Attachment 8, pages 1 and 2 displayed the incorrect date range, the correct date range should have been 1/1/2023-12/31/2023.

Attachment 1 Summary of Gaseous and Liquid Effluents

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2023 - 12/31/2023

Liquid Effluents - Batch Mode

	<u>Units</u>	<u>Qtr 1</u>	<u>Qtr 2</u>	<u>Qtr 3</u>	<u>Qtr 4</u>	<u>Year</u>
A. Fission and Activation Products						
Mn-54	Ci	7.95E-06	1.34E-05	9.96E-06	0.00E+00	3.13E-05
Fe-55	Ci	2.40E-04	4.61E-05	2.40E-04	6.25E-05	5.89E-04
Co-58	Ci	1.07E-04	6.89E-05	4.47E-05	0.00E+00	2.21E-04
Co-60	Ci	7.90E-05	1.06E-04	2.50E-04	4.96E-05	4.85E-04
Ni-63	Ci	8.75E-05	1.28E-04	1.38E-04	3.23E-05	3.86E-04
Sb-124	Ci	1.23E-05	0.00E+00	0.00E+00	0.00E+00	1.23E-05
Sb-125	Ci	8.90E-05	6.08E-06	1.67E-04	7.27E-05	3.35E-04
Cs-137	Ci	6.73E-05	0.00E+00	0.00E+00	8.04E-06	7.53E-05
Total for Period	Ci	6.90E-04	3.68E-04	8.50E-04	2.25E-04	2.13E-03
B. Tritium						
H-3	Ci	1.07E+01	1.10E+02	1.11E+02	4.96E+01	2.81E+02
C. Dissolved & Entrained Gases						
None	Ci	-	-	-	-	-
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Gross Alpha						
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Attachment 12 Errata to a Previous Year's ARERR

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

Attachment 6 Assessment of Radiation Dose from Radioactive Effluents to Members of the Public

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2023 - 12/31/2023

40 CFR Part 190 Uranium Fuel Cycle Dose Calculation Results

In accordance with the requirements of 40 CFR Part 190, the annual dose commitment to any member of the general public shall be calculated to assure that doses are limited to 25 millirems to the total body or any organ with the exception of the thyroid which is limited to 75 millirems. The fuel cycle dose assessment for Shearon Harris Nuclear Power Plant includes liquid and gaseous effluent dose contributions from the plant. Direct and air-scatter dose from the reactor building and other onsite structures does not contribute measurable dose to the maximum exposed individual based on review of the 2023 environmental TLD data. No other uranium fuel cycle facility contributes significantly to the maximum exposed individual. Included below is an estimate of the dose contributed by Carbon-14 (Ref. Attachment 2, Supplemental Information, of this report for further information). Also included is dose from H-3 in the Shearon Harris Nuclear Power Plant Cooling Tower plume, evaporation of H-3 in Harris Lake, H-3 in on-site drinking water, and H-3 in fish from Harris Lake. The combined dose to a maximum exposed individual from effluent releases, combined with the additional dose pathways, is below 40 CFR Part 190 limits as shown by the following summary.

Note: The 40 CFR Part 190 effluent dose analysis to the maximum exposed individual from liquid and gas releases does not include the dose from noble gases (i.e., total body and skin) due to the low significance compared to other dose pathways.

40 CFR Part 190 Effluent Dose Summary			
A. Gaseous Effluent Dose		E. Harris Lake Evaporation H-3 Dose	
1. Location	2.14 km SW	1. Location	4.16 mi SSW
2. Critical Age	CHILD	2. Critical Age	CHILD
3. Critical Organ	LIVER	3. Critical Organ	N/A
4. Organ Dose (mREM)	8.22E-01	4. Organ Dose (mREM)	6.61E-02
5. Total Body Dose (mREM)	8.22E-01	5. Total Body Dose (mREM)	6.61E-02
B. Liquid Effluent Dose		F. Drinking Water H-3 Dose	
1. Location	2.19 km S	1. Location	On Site
2. Critical Age	ADULT	2. Critical Age	ADULT
3. Critical Organ	LIVER	3. Critical Organ	N/A
4. Organ Dose (mREM)	1.22E-01	4. Organ Dose (mREM)	7.83E-02
5. Total Body Dose (mREM)	1.15E-01	5. Total Body Dose (mREM)	7.83E-02
C. Carbon-14 Dose		G. H-3 in Fish from Harris Lake	
1. Location	2.76 mi SW	1. Location	Harris Lake
2. Critical Age	CHILD	2. Critical Age	ADULT
3. Critical Organ	BONE	3. Critical Organ	N/A
4. Organ Dose (mREM)	5.34E-01	4. Organ Dose (mREM)	7.87E-03
5. Total Body Dose (mREM)	1.06E-01	5. Total Body Dose (mREM)	7.87E-03
D. Cooling Tower Plume H-3 Dose			
1. Location	1.81 mi NNE		
2. Critical Age	CHILD		
3. Critical Organ	N/A		
4. Organ Dose (mREM)	4.16E-03		
5. Total Body Dose (mREM)	4.16E-03		

Attachment 12

Errata to a Previous Year's ARERR

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2024 - 12/31/2024

Attachment 6

Assessment of Radiation Dose from Radioactive Effluents to Members of the Public

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2023 - 12/31/2023

Dose contributions from Carbon-14 in gaseous effluents have been determined from ODCM 3.3.2, Carbon-14. The maximum dose rate to the nearest real individual from the release of Carbon-14 in batch and continuous gaseous effluents is conservatively calculated to be $5.34\text{E-}01$ mrem/yr based on $9.12\text{E+}00$ Curies released in 2023 (Ref. Attachment 2, Supplemental Information, of this report).

Dose contributions from Tritium in the Shearon Harris Nuclear Power Plant Cooling Tower plume have been determined from ODCM 2.3, Doses from Return/Re-use of Previously Discharged Radioactive Effluents. The maximum dose rate to the nearest real individual from the release of Tritium the plume is conservatively calculated to be $4.16\text{E-}03$ mrem/yr based on $1.13\text{E+}02$ Curies released in 2023 (Ref. Attachment 2, Supplemental Information, of this report).

Dose contributions from evaporation of Tritium Harris Lake have been determined from ODCM 2.3, Doses from Return/Re-use of Previously Discharged Radioactive Effluents. The maximum dose rate to the nearest real individual from evaporation of Tritium in Harris Lake is conservatively calculated to be $6.61\text{E-}02$ mrem/yr based on $7.18\text{E+}01$ Curies released in 2023 (Ref. Attachment 2, Supplemental Information, of this report).

Dose contributions from Tritium in drinking water at the HE&EC Training Centers and Harris Nuclear Plant have been determined from 2.3, Doses from Return/Re-use of Previously Discharged Radioactive Effluents. The maximum dose rate to the nearest real individual from consuming the drinking water is conservatively calculated to be less than $7.83\text{E-}02$ mrem/yr based on an average concentration of $2.86\text{E+}03$ pCi/L consumed in 2023 (Ref. Attachment 2, Supplemental Information, of this report).

Dose contributions from Tritium in fish in Harris Lake have been determined using NRC Regulatory Guide 1.109, Rev.1, October 1977, Equation A-1, and data from REMP location SW-26. This information was previously included in the Shearon Harris Nuclear Power Plant AREOR. DRR 2008147 was written to include the fish dose calculation methodology in ODCM revision 26, and report in the ARERR. The maximum dose rate to the nearest real individual from consuming the fish in Harris Lake is conservatively calculated to be $7.87\text{E-}03$ mrem/yr based on an average concentration of $3.97\text{E+}03$ pCi/L consumed in 2023 (Ref. Attachment 2, Supplemental Information, of this report).

Total dose from liquid and gaseous effluents from Shearon Harris Nuclear Power Plant and the additional pathways mentioned above is conservatively estimated to be less than 2 mrem/yr for total body and organ. It is recognized summing dose for different organs and age groups is not entirely accurate. However, the sum of the organ and age specific doses will always be less than the sum of the maximums of each. Therefore, summing the maximum values of each provides the most conservative value to ensure compliance with 40 CFR 190. The dose from all pathways related to operation of Shearon Harris Nuclear Power Plant meets the 40 CFR Part 190 requirements of an annual dose commitment to any member of the general public of less than 25 mrem total body or any organ and 75 mrem to the thyroid.

Enclosure 4
RA-25-0095

ENCLOSURE 4: MNS Annual Radioactive Effluent Release Report



McGuire Nuclear Station Units 1 and 2

Annual Radioactive Effluent Release Report

January 1, 2024 through December 31, 2024

Dockets 50-369 and 50-370



Introduction

The Annual Radioactive Effluent Release Report is pursuant to McGuire Nuclear Station Technical Specification 5.6.3 and Selected Licensee Commitment 16.11.17. The below listed attachments to this report provide the required information. In addition, the ODCM is included pursuant to McGuire Nuclear Station Technical Specification 5.5.1.

Attachment 1	Summary of Gaseous and Liquid Effluents
Attachment 2	Supplemental Information
Attachment 3	Solid Radioactive Waste Disposal
Attachment 4	Meteorological Data
Attachment 5	Unplanned Offsite Releases
Attachment 6	Assessment of Radiation Dose from Radioactive Effluents to Members of the Public
Attachment 7	Information to Support the NEI Ground Water Protection Initiative
Attachment 8	Inoperable Equipment
Attachment 9	Summary of Changes to the Offsite Dose Calculation Manual
Attachment 10	Summary of Changes to the Process Control Program
Attachment 11	Summary of Major Modifications to the Radioactive Waste Treatment Systems
Attachment 12	Errata to a Previous Year's ARERR

Attachment 1
Summary of Gaseous and Liquid Effluents

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024- 12/31/2024

ATTACHMENT 1

Summary of Gaseous and Liquid Effluents

This attachment includes a summary of the quantities of radioactive liquid and gaseous effluents as outlined in Regulatory Guide 1.21, Appendix B.

Attachment 1

Summary of Gaseous and Liquid Effluents

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024- 12/31/2024

Gaseous Effluents - Summation of All Releases

	<u>Units</u>	<u>Qtr 1</u>	<u>Qtr 2</u>	<u>Qtr 3</u>	<u>Qtr 4</u>	<u>Year</u>
A. Fission and Activation Gases						
1. Total Release	Ci	7.32E-01	7.83E-01	7.27E-01	7.03E-01	2.94E+00
2. Avg. Release Rate	µCi/sec	9.31E-02	9.96E-02	9.15E-02	8.84E-02	9.31E-02
B. Iodine-131						
1. Total Release	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2. Avg. Release Rate	µCi/sec	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C. Particulates Half-Life ≥ 8 days						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Release Rate	µCi/sec	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Tritium						
1. Total Release	Ci	1.06E+01	1.43E+01	3.07E+01	2.85E+01	8.40E+01
2. Avg. Release Rate	µCi/sec	1.34E+00	1.82E+00	3.87E+00	3.58E+00	2.66E+00
E. Carbon-14						
1. Total Release	Ci	5.56E+00	5.50E+00	4.81E+00	5.59E+00	2.15E+01
2. Avg. Release Rate	µCi/sec	7.07E-01	7.00E-01	6.05E-01	7.04E-01	6.79E-01
F. Gross Alpha						
1. Total Release	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2. Avg. Release Rate	µCi/sec	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Attachment 1

Summary of Gaseous and Liquid Effluents

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024- 12/31/2024

Gaseous Effluents - Elevated Releases - Continuous Mode *

	<u>Units</u>	<u>Qtr 1</u>	<u>Qtr 2</u>	<u>Qtr 3</u>	<u>Qtr 4</u>	<u>Year</u>
A. Fission and Activation Gases						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	-	-	-	-	-
B. Iodines						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	-	-	-	-	-
C. Particulates Half-Life ≥ 8 days						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	-	-	-	-	-
D. Tritium						
N/A	Ci	-	-	-	-	-
E. Carbon-14						
N/A	Ci	-	-	-	-	-
F. Gross Alpha						
Total for Period	Ci	-	-	-	-	-

* McGuire Nuclear Station Units 1 and 2 do not have elevated releases.

Attachment 1

Summary of Gaseous and Liquid Effluents

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024- 12/31/2024

Gaseous Effluents - Elevated Releases - Batch Mode *

	<u>Units</u>	<u>Qtr 1</u>	<u>Qtr 2</u>	<u>Qtr 3</u>	<u>Qtr 4</u>	<u>Year</u>
A. Fission and Activation Gases						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	-	-	-	-	-
B. Iodines						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	-	-	-	-	-
C. Particulates Half-Life ≥ 8 days						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	-	-	-	-	-
D. Tritium						
N/A	Ci	-	-	-	-	-
E. Carbon-14						
N/A	Ci	-	-	-	-	-
F. Gross Alpha						
Total for Period	Ci	-	-	-	-	-

* McGuire Nuclear Station Units 1 and 2 do not have elevated releases.

Attachment 1 Summary of Gaseous and Liquid Effluents

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024- 12/31/2024

Gaseous Effluents - Ground Releases - Continuous Mode

	<u>Units</u>	<u>Qtr 1</u>	<u>Qtr 2</u>	<u>Qtr 3</u>	<u>Qtr 4</u>	<u>Year</u>
A. Fission and Activation Gases						
None	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total for Period	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
B. Iodines						
None	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total for Period	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C. Particulates Half-Life ≥ 8 days						
None	Ci	-	-	-	-	-
Total for Period	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
D. Tritium						
H-3	Ci	1.04E+01	1.42E+01	3.04E+01	2.82E+01	8.32E+01
E. Carbon-14 *						
C-14	Ci	1.67E+00	1.65E+00	1.44E+00	1.68E+00	6.44E+00
F. Gross Alpha						
Total for Period	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

* 30% of total C-14 released is assumed to be in continuous mode. See Attachment 2, Supplemental Information, of this report.

Attachment 1 Summary of Gaseous and Liquid Effluents

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024- 12/31/2024

Gaseous Effluents - Ground Releases - Batch Mode

	<u>Units</u>	<u>Qtr 1</u>	<u>Qtr 2</u>	<u>Qtr 3</u>	<u>Qtr 4</u>	<u>Year</u>
A. Fission and Activation Gases						
AR-41	Ci	6.88E-01	7.33E-01	6.67E-01	6.68E-01	2.76E+00
XE-133	Ci	4.46E-02	4.50E-02	5.56E-02	3.35E-02	1.79E-01
XE-135	Ci	0.00E+00	4.81E-03	3.96E-03	1.80E-03	1.06E-02
Total for Period	Ci	7.32E-01	7.83E-01	7.27E-01	7.03E-01	2.94E+00
B. Iodines						
None	Ci	-	-	-	-	-
Total for Period	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C. Particulates Half-Life ≥ 8 days						
Total for Period	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
D. Tritium						
H-3	Ci	1.33E-01	1.23E-01	3.58E-01	2.58E-01	8.72E-01
E. Carbon-14*						
C-14	Ci	3.89E+00	3.85E+00	3.37E+00	3.91E+00	1.50E+01
F. Gross Alpha						
Total for Period	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
G. Other						
Total for Period	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

* 70% of total C-14 released is assumed to be in batch mode. See Attachment 2, Supplemental Information, of this report.

Attachment 1

Summary of Gaseous and Liquid Effluents

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024- 12/31/2024

Gaseous Effluents - Mixed-Mode Releases - Continuous Mode *

	<u>Units</u>	<u>Qtr 1</u>	<u>Qtr 2</u>	<u>Qtr 3</u>	<u>Qtr 4</u>	<u>Year</u>
A. Fission and Activation Gases						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	-	-	-	-	-
B. Iodines						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	-	-	-	-	-
C. Particulates Half-Life ≥ 8 days						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	-	-	-	-	-
D. Tritium						
N/A	Ci	-	-	-	-	-
E. Carbon-14						
N/A	Ci	-	-	-	-	-
F. Gross Alpha						
Total for Period	Ci	-	-	-	-	-

* McGuire Nuclear Station Units 1 and 2 do not have mixed-mode releases.

Attachment 1

Summary of Gaseous and Liquid Effluents

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024- 12/31/2024

Gaseous Effluents - Mixed-Mode Releases - Batch Mode *

	<u>Units</u>	<u>Qtr 1</u>	<u>Qtr 2</u>	<u>Qtr 3</u>	<u>Qtr 4</u>	<u>Year</u>
A. Fission and Activation Gases						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	-	-	-	-	-
B. Iodines						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	-	-	-	-	-
C. Particulates Half-Life ≥ 8 days						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	-	-	-	-	-
D. Tritium						
N/A	Ci	-	-	-	-	-
E. Carbon-14						
N/A	Ci	-	-	-	-	-
F. Gross Alpha						
Total for Period	Ci	-	-	-	-	-

* McGuire Nuclear Station Units 1 and 2 do not have mixed-mode releases.

Attachment 1

Summary of Gaseous and Liquid Effluents

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024- 12/31/2024

Liquid Effluents - Summation of All Releases

	<u>Units</u>	<u>Qtr 1</u>	<u>Qtr 2</u>	<u>Qtr 3</u>	<u>Qtr 4</u>	<u>Year</u>
A. Fission and Activation Products *						
1. Total Release	Ci	4.85E-03	5.94E-03	1.20E-02	2.07E-02	4.35E-02
2. Avg. Diluted Conc.	µCi/ml	5.70E-12	6.08E-12	1.18E-11	2.12E-11	1.14E-11
3. Batch Releases	µCi/ml	5.70E-12	6.08E-12	1.18E-11	2.12E-11	1.14E-11
B. Tritium						
1. Total Release	Ci	2.66E+02	3.57E+02	4.14E+02	2.20E+02	1.26E+03
2. Avg. Diluted Conc.	µCi/ml	3.13E-07	3.66E-07	4.11E-07	2.26E-07	3.30E-07
3. Batch Releases	µCi/ml	3.12E-07	3.65E-07	4.05E-07	2.25E-07	3.28E-07
C. Dissolved & Entrained Gases						
1. Total Release	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2. Avg. Diluted Conc.	µCi/ml	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
3. Batch Releases	µCi/ml	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
D. Gross Alpha						
1. Total Release	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2. Avg. Diluted Conc.	µCi/ml	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
3. Batch Releases	µCi/ml	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
E. Volume of Liquid Waste						
1. Continuous Releases	liters	6.60E+07	5.47E+07	7.50E+07	6.42E+07	2.60E+08
2. Batch Releases	liters	8.85E+05	1.18E+06	1.48E+06	6.84E+05	4.23E+06
F. Volume of Dilution Water						
1. Continuous Releases	liters	8.51E+10	9.76E+10	1.02E+11	9.77E+10	3.82E+11
2. Batch Releases	liters	8.51E+11	9.76E+11	1.02E+12	9.77E+11	3.82E+12

* Excludes tritium, dissolved and entrained noble gases, and gross alpha.

Attachment 1

Summary of Gaseous and Liquid Effluents

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024- 12/31/2024

Liquid Effluents - Continuous Mode

	<u>Units</u>	<u>Qtr 1</u>	<u>Qtr 2</u>	<u>Qtr 3</u>	<u>Qtr 4</u>	<u>Year</u>
A. Fission and Activation Products						
None	Ci	-	-	-	-	-
Total for Period	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
B. Tritium						
H-3	Ci	4.80E-02	5.88E-02	5.80E-01	1.68E-01	8.55E-01
C. Dissolved & Entrained Gases						
None	Ci	-	-	-	-	-
Total for Period	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
D. Gross Alpha						
Total for Period	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Attachment 1

Summary of Gaseous and Liquid Effluents

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024- 12/31/2024

Liquid Effluents - Batch Mode

	<u>Units</u>	<u>Qtr 1</u>	<u>Qtr 2</u>	<u>Qtr 3</u>	<u>Qtr 4</u>	<u>Year</u>
A. Fission and Activation Products						
Ag-108m	Ci	1.87E-06	0.00E+00	0.00E+00	0.00E+00	1.87E-06
Br-82	Ci	8.21E-07	0.00E+00	0.00E+00	0.00E+00	8.21E-07
Co-58	Ci	2.31E-04	1.37E-04	4.06E-04	2.80E-03	3.58E-03
Co-60	Ci	1.13E-03	7.87E-04	3.35E-03	1.14E-02	1.66E-02
Cs-134	Ci	1.38E-06	0.00E+00	0.00E+00	0.00E+00	1.38E-06
Cs-137	Ci	1.42E-04	2.11E-04	4.64E-04	3.84E-04	1.20E-03
Fe-55	Ci	3.73E-04	1.36E-04	7.49E-04	7.97E-04	2.06E-03
Mn-54	Ci	8.92E-06	1.35E-05	6.13E-05	3.27E-04	4.10E-04
Mo-99	Ci	0.00E+00	0.00E+00	2.73E-05	0.00E+00	2.73E-05
Nb-95	Ci	0.00E+00	0.00E+00	1.31E-05	1.28E-06	1.44E-05
Ni-63	Ci	6.69E-04	7.71E-04	2.13E-03	2.78E-03	6.34E-03
Sb-124	Ci	4.04E-05	9.41E-05	0.00E+00	8.87E-06	1.43E-04
Sb-125	Ci	2.26E-03	3.79E-03	4.83E-03	2.24E-03	1.31E-02
Total for Period	Ci	4.85E-03	5.94E-03	1.20E-02	2.07E-02	4.35E-02
B. Tritium						
H-3	Ci	2.66E+02	3.57E+02	4.13E+02	2.19E+02	1.25E+03
C. Dissolved & Entrained Gases						
None	Ci	-	-	-	-	-
Total for Period	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
D. Gross Alpha						
Total for Period	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Attachment 2
Supplemental Information

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024 - 12/31/2024

ATTACHMENT 2

Supplemental Information

This attachment includes supplemental information to the gaseous and liquid effluents report.

Attachment 2 Supplemental Information

McGuire Nuclear Station Units 1 & 2 Period 1/1/2024 - 12/31/2024

I. Regulatory Limits - Per Unit

A. Noble Gases - Air Dose

1. Calendar Quarter Gamma Dose	= 5	mRAD
2. Calendar Quarter Beta Dose	= 10	mRAD
3. Calendar Year Gamma Dose	= 10	mRAD
4. Calendar Year Beta Dose	= 20	mRAD

B. Liquid Effluents - Dose

1. Calendar Quarter Total Body Dose	= 1.5	mREM
2. Calendar Quarter Organ Dose	= 5	mREM
3. Calendar Year Total Body Dose	= 3	mREM
4. Calendar Year Organ Dose	= 10	mREM

C. Gaseous Effluents - Iodine-131 & 133, Tritium, and Particulates with Half-lives > 8 days

1. Calendar Quarter Organ Dose	= 7.5	mREM
2. Calendar Year Organ Dose	= 15	mREM

II. Maximum Permissible Effluent Concentrations

A. Gaseous Effluents

1. Information found in Offsite Dose Calculation Manual

B. Liquid Effluents

1. Information found in 10 CFR Part 20, Appendix B, Table 2, Column 2

III. Average Energy

(not applicable)

IV. Measurements and Approximations of Total Radioactivity

Analyses of specific radionuclides in selected or composited samples as described in the Selected Licensee Commitments are used to determine the radionuclide composition of the effluent. A summary description of the method used for estimating overall errors associated with radioactivity measurements is provided as part of this attachment.

V. Batch Releases

A. Liquid Effluents

1. Total Number of Batch Releases	=	217
2. Total Time (min) for Batch Releases	=	1.50E+05
3. Maximum Time (min) for a Batch Release	=	4.16E+04
4. Average Time (min) for Batch Releases	=	6.90E+02
5. Minimum Time (min) for a Batch Release	=	2.10E+01
6. Average Dilution Water Flow During Release (lpm)	=	1.92E+06

B. Gaseous Effluents

1. Total Number of Batch Releases	=	28
2. Total Time (min) for Batch Releases	=	1.05E+06
3. Maximum Time (min) for a Batch Release	=	4.52E+04
4. Average Time (min) for Batch Releases	=	3.74E+04
5. Minimum Time (min) for a Batch Release	=	5.24E+02

VI. Abnormal Releases

See Attachment 5, Unplanned Offsite Releases.

Attachment 2 Supplemental Information

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024 - 12/31/2024

Carbon-14

Carbon-14 (C-14), with a half-life of 5730 years, is a naturally occurring isotope of carbon produced by cosmic ray interactions in the atmosphere. Nuclear weapons testing in the 1950s and 1960s significantly increased the amount of C-14 in the atmosphere. C-14 is also produced in commercial nuclear reactors, but the amounts produced are much less than those produced naturally or from weapons testing.

In Regulatory Guide 1.21, Revision 2, "Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste", the NRC recommends U.S. nuclear power plants evaluate whether C-14 is a "principal radionuclide", and if so, report the amount of C-14 released. Improvements over the years in effluent management practices and fuel performance have resulted in a decrease in gaseous radionuclide (non-C-14) concentrations, and a change in the distribution of gaseous radionuclides released to the environment. As a result, many sites show C-14 has become a "principal radionuclide" for the gaseous effluent pathway, as defined in Regulatory Guide 1.21, Rev. 2. McGuire Nuclear Station 2024 ARERR contains estimates of C-14 radioactivity released in 2024, and estimates of public dose resulting from the C-14 effluent.

Because the dose contribution of C-14 from liquid radioactive waste is much less than that contributed by gaseous radioactive waste, evaluation of C-14 in liquid radioactive waste is not required (Ref. Reg. Guide 1.21, Rev. 2). The quantity of gaseous C-14 released to the environment can be estimated by use of a C-14 source term scaling factor based on power generation (Ref. Reg. Guide 1.21, Rev. 2). Many documents provide information related to the magnitude of C-14 in typical effluents from commercial nuclear power plants. Those documents suggest that nominal annual releases of C-14 in gaseous effluents are approximately 5 to 7.3 curies from PWRs (Ref. Reg. Guide 1.21, Rev. 2). A more recent study recommends a higher C-14 gaseous source term scaling factor of approximately 9.0 to 9.8 Ci/GWe-yr for a PWR (Westinghouse) (Ref. EPRI 1021106). For the McGuire Nuclear Station 2024 ARERR a source term scaling factor of 9.4 Ci/GWe-yr is assumed. Using a source term scaling factor of 9.4 Ci/GWe-yr and actual electric generation (MWe-hrs) from McGuire Nuclear Station in 2024 results in a site total C-14 gaseous release estimate to the environment of 2.101+01 Curies. 70% of the C-14 gaseous effluent is assumed to be from batch releases and 30% of C-14 gaseous effluent is assumed to be from continuous releases through the unit vents (ref. IAEA Technical Reports Series no. 421, "Management of Waste Containing Tritium and Carbon-14", 2004; EPRI 1021106).

C-14 releases in PWRs occur primarily as a mix of organic carbon and carbon dioxide released from the waste gas system. Since the PWR operates with a reducing chemistry, most, if not all, of the C-14 species initially produced are organic (e.g., methane). As a general rule, C-14 in the primary coolant is essentially all organic with a large fraction as a gaseous species. Any time the RCS liquid or gas is exposed to an oxidizing environment (e.g. during shutdown or refueling), a slow transformation from an organic to an inorganic chemical form can occur. Various studies documenting measured C-14 releases from PWRs suggest a range of 70% to 95% organic with an average of 80% organic with the remainder being CO₂ (Ref. EPRI TR-105715). For the McGuire Nuclear Station 2024 ARERR a value of 80% organic C-14 is assumed.

Public dose estimates from airborne C-14 are performed using dose models in NUREG-0133 and Regulatory Guide 1.109. The dose models and assumptions used are documented in the McGuire ODCM. The estimated C-14 dose impact on the maximum organ dose from airborne effluents released from McGuire Nuclear Station in 2024 is well below the 10CFR50, Appendix I, ALARA design objective (i.e., 15 mrem/yr per unit).

Attachment 2 Supplemental Information

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024 - 12/31/2024

Overall Estimate of Error for Effluent Radioactivity Release Reported

The estimated percentage of overall error for both Liquid and Gaseous effluent release data at McGuire Nuclear Station has been determined to be $\pm 30.3\%$. This value was derived by taking the square root of the sum of the squares of the following discrete individual estimates of error:

1. Flow Rate Determining Devices	=	$\pm 20\%$
2. Counting Statistical Error	=	$\pm 20\%$
3. Calibration Error	=	$\pm 10\%$
4. Calibration Source Error	=	$\pm 2.5\%$
5. Sample Preparation Error	=	$\pm 3\%$

Attachment 2 Supplemental Information

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024 - 12/31/2024

Summary of Changes in Land Use Census Affecting Effluent Dose Calculations

The 2024 Land Use Census was performed May 28 – June 3, 2024, and the results were certified and made available for use on July 23, 2024. The following are changes to residences, gardens, and milk animals from the previous year.

Residences

No changes were identified during the 2024 Land Use Census.

Gardens

The non-irrigated garden in the N sector (2.64 mi) was not present and no replacement non-irrigated garden was located in the N sector within 5 mi.

The non-irrigated garden in the NNE sector (1.40 mi) was not present and was replaced with a garden at 4.25 mi.

The non-irrigated garden in the E sector (2.11 mi) was not present and was replaced with a garden at 3.06 mi.

The non-irrigated garden in the SE sector (1.20 mi) was not present and was replaced with a garden at 3.86 mi.

The non-irrigated garden in the S sector (1.85 mi) was not present and was replaced with a garden at 3.13 mi.

The non-irrigated garden in the SSW sector (2.79 mi) was not present and was replaced with a garden at 3.15 mi.

The non-irrigated garden in the WSW sector (1.10 mi) was not present and was replaced with a garden at 1.32 mi.

The non-irrigated garden in the NW sector (1.68 mi) was not present and was replaced with a garden at 1.82 mi.

Milk Animals

No changes to nearest milk animal in each sector.

Environmental Monitoring Locations

Sample location 155 Food Products, Island Forest Drive (4.87 mi NNE) was removed from MNS REMP.

-MNS Crop location 155, an irrigated garden from Lake Norman ceased operation 6MAY2024.

Residence where crops were being cultivated was sold. The new owner will not have crops.

A new garden irrigated by Lake Norman was not located. Searches for a garden irrigated by Lake Norman will occur annually with the performance of the Land Use Census.

Sample location 142 C Milk, Lowman Farms-Cows (12.2 mi NNW) was removed from MNS REMP.

-MNS Milk Dairy – Cow, control location, ceased operation 20MAY2024.

A new Milk Dairy was not located. Searches for a Milk Dairy will occur annually with the performance of the Land Use Census.

Sample location 121 Guardhouse Airborne Radioiodine and Particulate removed from MNS REMP. Sample is supplemental and not SLC required.

Sample location 194 East Lincoln Count Water Supply Drinking Water removed from MNS REMP. Sample is supplemental and not SLC required.

Attachment 3
Solid Radioactive Waste Disposal

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024 - 12/31/2024

ATTACHMENT 3

Solid Radioactive Waste Disposal

This attachment includes a summary of the solid waste shipped off-site for burial and/or disposal, including:

- Container volume
- Total Curie content
- Principal Radionuclides
- Source/Type of waste
- Solidification agent or absorbent
- Type of shipping container
- Number of shipments
- Other relevant information as necessary

Attachment 3 Solid Radioactive Waste Disposal

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024 - 12/31/2024

Type of Waste Shipped	Number of Shipments	Number of Containers	Waste Class	Container Type	Burial Volume (m ³)	Total Activity (Curies)
1. <u>Waste from Liquid Systems</u>						
a. Dewatered Powdex Resin (brokered)	None					
b. Dewatered Powdex Resin	None					
c. Dewatered Bead Resin (brokered)	None					
d. Dewatered Bead Resin	None					
e. Dewatered Radwaste System Resin	None					
f. Dewatered Primary Bead Resins (brokered)	5	5	B	B	14.2	773
g. Dewatered Mechanical Filter Media	None					
h. Dewatered Mechanical Filter Media (brokered)	None					
i. Solidified Waste	None					
2. <u>Dry Solid Waste</u>						
a. Dry Active Waste (compacted)	None					
b. Dry Active Waste (non-compacted)	None					
c. Dry Active Waste (brokered / compacted)	None					
d. Dry Active Waste (brokered / non-compacted)	13	60	A	DBP	577	1.1
e. Sealed Sources / Smoke Detectors	None					
f. Sealed Sources	None					
g. Irradiated Components	None					
3. <u>Total Waste</u>	18	65			592	774

Attachment 3 Solid Radioactive Waste Disposal

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024 - 12/31/2024

Type of Waste Shipped	Radionuclide	% Abundance
1. <u>Waste from Liquid Systems</u>		
a. Dewatered Powdex Resin (brokered)	No shipments in 2024	
b. Dewatered Powdex Resin	No shipments in 2024	
c. Dewatered Bead Resin (brokered)	No shipments in 2024	
d. Dewatered Bead Resin	No shipments in 2024	
e. Dewatered Radwaste System Resin (brokered)	No shipments in 2024	
f. Dewatered Primary Bead Resins (brokered)	No shipments in 2024	
g. Dewatered Mechanical Filter Media	No shipments in 2024	
h. Dewatered Mechanical Filter Media (brokered)	No shipments in 2024	
i. Solidified Waste	No shipments in 2024	
2. <u>Dry Solid Waste</u>		
a. Dry Active Waste (compacted)	Compaction no longer	performed on site
b. Dry Active Waste (non-compacted)	No shipments in 2024	
c. Dry Active Waste (brokered / compacted)		
a. RSR#MNS24-0001	Radionuclide	% Abundance
	Cr-51	32.18%
	Mn-54	2.46%
	Fe-55	17.16%
	Fe-59	0.69%
	Co-57	0.06%
	Co-58	14.84%
	Co-60	11.36%
	Ni-63	1.94%
	Zn-65	0.72%
	Zr-95	5.91%
	Nb-95	11.81%
	Sn-113	0.11%
	Sb-124	0.30%
	Sb-125	0.46%

Attachment 3 Solid Radioactive Waste Disposal

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024 - 12/31/2024

b.	RSR#MNS24-0002	Radionuclide	% Abundance
		Cr-51	11.08%
		Mn-54	3.85%
		Fe-55	29.86%
		Fe-59	0.41%
		Co-57	0.09%
		Co-58	13.38%
		Co-60	20.24%
		Ni-63	3.55%
		Zn-65	1.08%
		Zr-95	4.94%
		Nb-95	10.35%
		Sn-113	0.13%
		Sb-124	0.24%
		Sb-125	0.8%

c.	RSR#MNS24-0003	Radionuclide	% Abundance
		Cr-51	15.88%
		Mn-54	3.43%
		Fe-55	25.15%
		Fe-59	0.54%
		Co-57	0.08%
		Co-58	15.27%
		Co-60	16.83%
		Ni-63	2.91%
		Zn-65	0.98%
		Zr-95	5.8%
		Nb-95	12.03%
		Sn-113	0.13%
		Sb-124	0.28%
		Sb-125	0.67%

d.	RSR#MNS24-0005	Radionuclide	% Abundance
		Cr-51	23.01%
		Mn-54	3.81%
		Fe-55	7.7%
		Fe-59	0.67%
		Co-57	0.1%
		Co-58	17.85%
		Co-60	23.43%
		Ni-63	1.2%
		Zn-65	0.78%
		Zr-95	6.68%
		Nb-95	13.92%
		Sn-113	0.23%
		Sb-124	0.12%
		Sb-125	0.51%

Attachment 3 Solid Radioactive Waste Disposal

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024 - 12/31/2024

e.	RSR#MNS24-0006	Radionuclide	% Abundance
		Cr-51	30.5%
		Mn-54	2.51%
		Fe-55	17.27%
		Fe-59	0.7%
		Co-57	0.06%
		Co-58	15.49%
		Co-60	11.38%
		Ni-63	1.94%
		Zn-65	0.74%
		Zr-95	6.15%
		Nb-95	12.36%
		Sn-113	0.12%
		Sb-124	0.31%
		Sb-125	0.46%

f.	RSR#MNS24-0007	Radionuclide	% Abundance
		C-14	0.34%
		Mn-54	0.24%
		Fe-55	11.13%
		Co-60	8.95%
		Ni-59	0.58%
		Ni-63	78.1%
		Zn-65	0.08%
		Sr-90	0.02%
		Sb-125	0.23%
		Cs-137	0.32%

g.	RSR#MNS24-0008	Radionuclide	% Abundance
		C-14	0.34%
		Mn-54	0.23%
		Fe-55	11.05%
		Co-60	8.92%
		Ni-59	0.58%
		Ni-63	78.22%
		Zn-65	0.08%
		Sr-90	0.02%
		Sb-125	0.23%
		Cs-137	0.32%

Attachment 3 Solid Radioactive Waste Disposal

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024 - 12/31/2024

h.	RSR#MNS24-0009	Radionuclide	% Abundance
		C-14	0.34%
		Mn-54	0.23%
		Fe-55	10.96%
		Co-60	8.9%
		Ni-59	0.58%
		Ni-63	78.35%
		Zn-65	0.08%
		Sr-90	0.02%
		Sb-125	0.23%
		Cs-137	0.32%

i.	RSR#MNS24-0010	Radionuclide	% Abundance
		Cr-51	11.57%
		Mn-54	3.78%
		Fe-55	28.8%
		Fe-59	0.44%
		Co-57	0.09%
		Co-58	14.03%
		Co-60	19.44%
		Ni-63	3.4%
		Zn-65	1.07%
		Zr-95	5.21%
		Nb-95	10.91%
		Sn-113	0.13%
		Sb-124	0.25%
		Sb-125	0.77%
		Cs-137	0.1%

j.	RSR#MNS24-0011	Radionuclide	% Abundance
		Cr-51	10.75%
		Mn-54	3.8%
		Fe-55	28.86%
		Fe-59	0.45%
		Co-57	0.09%
		Co-58	14.34%
		Co-60	19.46%
		Ni-63	3.39%
		Zn-65	1.08%
		Zr-95	5.33%
		Nb-95	11.17%
		Sn-113	0.14%
		Sb-124	0.26%
		Sb-125	0.77%
		Cs-137	0.1%

Attachment 3 Solid Radioactive Waste Disposal

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024 - 12/31/2024

k.	RSR#MNS24-0012	Radionuclide	% Abundance
		Cr-51	27.79%
		Mn-54	2.67%
		Fe-55	18.58%
		Fe-59	0.68%
		Co-57	0.06%
		Co-58	15.54%
		Co-60	12.28%
		Ni-63	2.1%
		Zn-65	0.78%
		Zr-95	6.13%
		Nb-95	12.39%
		Sn-113	0.12%
		Sb-124	0.31%
		Sb-125	0.5%
		Cs-137	0.06%

l.	RSR#MNS24-0014	Radionuclide	% Abundance
		Cr-51	37.78%
		Mn-54	2.12%
		Fe-55	14.22%
		Fe-59	0.74%
		Co-57	0.05%
		Co-58	14.84%
		Co-60	9.32%
		Ni-63	1.58%
		Zn-65	0.63%
		Zr-95	6%
		Nb-95	11.86%
		Sn-113	0.1%
		Sb-124	0.31%
		Sb-125	0.38%
		Cs-137	0.05%

m.	RSR#MNS24-0015	Radionuclide	% Abundance
		Cr-51	40.83%
		Mn-54	1.97%
		Fe-55	13.05%
		Fe-59	0.75%
		Co-57	0.05%
		Co-58	14.5%
		Co-60	8.54%
		Ni-63	1.44%
		Zn-65	0.59%
		Zr-95	5.9%
		Nb-95	11.59%
		Sn-113	0.1%
		Sb-124	0.3%
		Sb-125	0.35%
		Cs-137	0.04%

Attachment 3 Solid Radioactive Waste Disposal

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024 - 12/31/2024

n.	RSR#MNS24-0016	Radionuclide	% Abundance
		C-14	0.35%
		Mn-54	0.18%
		Fe-55	10.32%
		Co-60	8.68%
		Ni-59	0.59%
		Ni-63	79.27%
		Zn-65	0.06%
		Sr-90	0.02%
		Sb-125	0.22%
		Cs-137	0.32%

o.	RSR#MNS24-0018	Radionuclide	% Abundance
		C-14	0.35%
		Mn-54	0.18%
		Fe-55	10.23%
		Co-60	8.65%
		Ni-59	0.59%
		Ni-63	79.39%
		Zn-65	0.06%
		Sr-90	0.02%
		Sb-125	0.21%
		Cs-137	0.32%

p.	RSR#MNS24-0019	Radionuclide	% Abundance
		Cr-51	40.47%
		Mn-54	1.99%
		Fe-55	13.18%
		Fe-59	0.75%
		Co-57	0.05%
		Co-58	14.54%
		Co-60	8.62%
		Ni-63	1.46%
		Zn-65	0.59%
		Zr-95	5.91%
		Nb-95	11.62%
		Sn-113	0.1%
		Sb-124	0.3%
		Sb-125	0.35%
		Cs-137	0.04%

Attachment 3 Solid Radioactive Waste Disposal

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024 - 12/31/2024

q. RSR#MNS24-0020	Radionuclide	% Abundance
	Cr-51	40.47%
	Mn-54	1.99%
	Fe-55	13.18%
	Fe-59	0.75%
	Co-57	0.05%
	Co-58	14.54%
	Co-60	8.62%
	Ni-63	1.46%
	Zn-65	0.59%
	Zr-95	5.91%
	Nb-95	11.62%
	Sn-113	0.1%
	Sb-124	0.3%
	Sb-125	0.35%
	Cs-137	0.04%

r. RSR#MNS24-0021	Radionuclide	% Abundance
	Cr-51	22.01%
	Mn-54	3.05%
	Fe-55	21.93%
	Fe-59	0.6%
	Co-57	0.07%
	Co-58	15.26%
	Co-60	14.61%
	Ni-63	2.52%
	Zn-65	0.88%
	Zr-95	5.9%
	Nb-95	12.08%
	Sn-113	0.13%
	Sb-124	0.29%
	Sb-125	0.59%
	Cs-137	0.08%

d. Sealed Sources / Smoke Detectors	No shipments in 2024
e. Sealed Sources	No shipments in 2024
f. Irradiated Components	No shipments in 2024

Attachment 4
Meteorological Data

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024 - 12/31/2024

ATTACHMENT 4

Meteorological Data

This attachment includes a summary of meteorological joint frequency distributions of wind speed, wind direction, and atmospheric stability (hours of occurrence) at the lower level.

Attachment 4 Meteorological Data

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024 - 12/31/2024

Lower Level

Stability Class	Wind Speed (m/s)	Hours of Occurrence															
		Sector															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
A	0.46-0.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.76-1.00	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1.01-1.25	8	5	0	0	0	0	0	0	0	0	0	0	0	0	0	2
	1.26-1.50	34	6	1	1	0	0	0	0	0	0	0	2	1	0	3	7
	1.51-2.00	41	30	11	3	1	1	0	0	2	0	1	0	1	1	1	13
	2.01-3.00	16	26	9	4	5	1	1	0	2	2	4	4	3	1	3	5
	3.01-4.00	12	2	3	1	1	1	0	0	0	1	5	1	2	0	2	1
	4.01-5.00	8	1	1	0	0	0	0	0	0	0	0	0	1	5	1	5
	5.01-6.00	1	2	0	0	0	0	0	0	0	0	1	0	0	0	0	5
	6.01-8.00	4	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5
	8.01-10.00	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10.01-max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B	0.46-0.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.76-1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1.01-1.25	9	1	0	0	0	0	0	0	0	0	0	0	0	0	2	1
	1.26-1.50	15	4	3	0	1	0	0	0	1	0	1	2	1	2	1	11
	1.51-2.00	12	12	5	9	3	0	2	0	1	1	1	2	5	1	0	9
	2.01-3.00	9	19	7	13	2	2	0	1	2	4	13	12	8	4	1	5
	3.01-4.00	12	8	7	9	2	1	0	0	1	5	3	3	8	2	1	5
	4.01-5.00	7	4	6	3	3	0	0	0	0	2	2	2	2	2	1	4
	5.01-6.00	6	2	0	0	0	0	0	0	0	0	3	2	3	0	2	4
	6.01-8.00	15	3	0	0	0	0	0	0	0	0	2	0	0	0	0	4
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10.01-max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment 4 Meteorological Data

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024 - 12/31/2024

Stability Class	Wind Speed (m/s)	Hours of Occurrence															
		Sector															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
C	0.46-0.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.76-1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	1.01-1.25	7	3	0	0	0	0	0	0	0	0	0	0	1	3	1	5
	1.26-1.50	9	11	2	2	0	0	0	0	1	0	0	0	1	1	0	8
	1.51-2.00	9	10	7	9	3	2	0	1	2	2	8	7	2	2	1	5
	2.01-3.00	13	15	13	28	14	3	4	4	7	10	16	25	7	4	5	3
	3.01-4.00	5	8	17	12	1	4	2	1	2	6	17	5	5	7	5	2
	4.01-5.00	10	11	5	2	3	2	0	0	0	1	10	6	6	0	8	8
	5.01-6.00	13	5	1	0	0	0	1	0	0	0	5	3	5	2	3	9
	6.01-8.00	8	3	0	0	0	0	0	0	0	0	5	3	3	2	7	8
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	1	0	0	1	4	3
	10.01-max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
D	0.46-0.75	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1
	0.76-1.00	11	4	2	1	1	0	2	0	4	2	1	2	4	1	4	9
	1.01-1.25	24	13	8	5	3	2	1	5	6	2	3	3	8	8	12	15
	1.26-1.50	19	17	17	11	9	5	8	17	19	10	9	8	17	7	3	17
	1.51-2.00	26	37	56	45	30	19	31	36	41	24	45	51	20	18	17	19
	2.01-3.00	32	67	189	114	117	94	70	20	39	94	181	102	28	16	22	33
	3.01-4.00	24	70	232	101	60	49	27	6	3	83	208	32	19	25	42	21
	4.01-5.00	16	45	109	32	5	10	5	1	1	28	96	23	7	11	22	14
	5.01-6.00	13	7	14	0	0	2	0	1	0	1	43	11	7	7	21	21
	6.01-8.00	3	9	3	0	0	1	0	2	2	3	36	17	5	6	20	18
	8.01-10.00	0	2	0	0	0	3	1	0	0	0	1	2	0	3	5	3
	10.01-max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0

Attachment 4 Meteorological Data

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024 - 12/31/2024

Stability Class	Wind Speed (m/s)	Hours of Occurrence															
		Sector															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
E	0.46-0.75	0	0	0	2	3	2	3	1	1	6	2	0	1	3	1	0
	0.76-1.00	4	3	6	0	3	2	5	9	12	8	10	5	10	8	0	1
	1.01-1.25	8	5	7	3	4	2	6	14	14	17	15	15	9	1	13	5
	1.26-1.50	5	1	4	6	5	11	8	25	19	19	15	17	15	10	4	4
	1.51-2.00	12	5	5	2	3	20	42	33	57	51	51	44	16	7	5	1
	2.01-3.00	3	0	3	7	18	14	79	10	27	89	133	39	16	10	9	5
	3.01-4.00	1	0	1	0	5	1	11	3	2	28	61	15	2	5	5	2
	4.01-5.00	2	0	0	0	0	0	4	0	0	0	9	0	1	2	2	0
	5.01-6.00	0	0	0	0	0	1	0	0	0	0	2	0	0	0	1	0
	6.01-8.00	1	0	2	0	0	1	1	1	0	1	1	0	0	0	0	1
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	10.01-max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F	0.46-0.75	0	0	0	1	1	0	1	1	1	8	7	3	3	3	3	1
	0.76-1.00	0	3	0	0	0	1	2	3	13	17	17	12	10	10	3	2
	1.01-1.25	3	1	1	2	0	3	2	4	18	20	13	10	9	6	2	0
	1.26-1.50	2	0	1	0	0	1	1	3	19	19	15	15	7	0	3	0
	1.51-2.00	0	0	0	0	0	0	2	5	28	32	19	9	3	0	0	0
	2.01-3.00	0	0	1	0	0	0	0	0	2	9	34	8	6	0	0	0
	3.01-4.00	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0
	4.01-5.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	5.01-6.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	6.01-8.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10.01-max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment 4 Meteorological Data

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024 - 12/31/2024

Stability Class	Wind Speed (m/s)	Hours of Occurrence															
		Sector															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
G	0.46-0.75	1	0	0	0	0	1	1	1	1	16	17	4	1	4	0	1
	0.76-1.00	0	0	1	0	0	1	1	1	8	35	37	18	4	3	2	0
	1.01-1.25	0	0	0	0	0	0	0	0	3	18	17	3	1	0	0	0
	1.26-1.50	0	0	0	0	0	0	0	1	8	15	5	2	0	0	0	0
	1.51-2.00	0	0	0	0	0	0	0	0	2	7	0	2	0	0	0	0
	2.01-3.00	0	0	0	0	0	0	0	0	1	0	3	2	1	0	0	0
	3.01-4.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	4.01-5.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	5.01-6.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	6.01-8.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10.01-max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment 5
Unplanned Offsite Releases

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024 - 12/31/2024

ATTACHMENT 5

Unplanned Offsite Releases

This attachment includes a summary of the unplanned offsite releases of gaseous and liquid radioactive effluents.

Attachment 5
Unplanned Offsite Releases

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024 - 12/31/2024

McGuire Nuclear Station experienced no unplanned offsite releases in 2024.

Attachment 6
Assessment of Radiation Dose from Radioactive Effluents to Members of the Public

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024 - 12/31/2024

ATTACHMENT 6

Assessment of Radiation Dose from Radioactive Effluents to Members of the Public

(includes fuel cycle dose calculation results)

This attachment includes an assessment of radiation doses to the maximum exposed member of the public due to radioactive liquid and gaseous effluents released from the site for each calendar quarter for the calendar year of the report as well as the total dose for the calendar year.

This attachment also includes an assessment of radiation doses to the maximum exposed member of the public from all uranium fuel cycle sources within 8 km of the site for the calendar year of this report to show conformance with 40 CFR Part 190.

Methods for calculating the dose contribution from liquid and gaseous effluents are given in the Offsite Dose Calculation Manual (ODCM).

Attachment 6

Assessment of Radiation Dose from Radioactive Effluents to Members of the Public

McGuire Nuclear Station Units 1 & 2 Period 1/1/2024 - 12/31/2024

Gaseous Effluents Dose Summary

	<u>Units</u>	<u>Qtr 1</u>	<u>Qtr 2</u>	<u>Qtr 3</u>	<u>Qtr 4</u>	<u>Year</u>
A. Noble Gases						
1. Maximum Gamma Air	mRAD	6.00E-03	6.40E-03	5.83E-03	5.82E-03	2.41E-02
(a) Limit	mRAD	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
(b) % of Limit		6.00E-02	6.40E-02	5.83E-02	5.82E-02	1.20E-01
2. Maximum Beta Air	mRAD	2.15E-03	2.30E-03	2.11E-03	2.09E-03	8.65E-03
(a) Limit	mRAD	2.00E+01	2.00E+01	2.00E+01	2.00E+01	4.00E+01
(b) % of Limit		1.08E-02	1.15E-02	1.06E-02	1.04E-02	2.16E-02

Receptor Location **0.5 miles ENE**

B. Iodine, H-3, & Particulates						
1. Maximum Organ Dose	mREM	8.51E-01	8.43E-01	7.37E-01	8.57E-01	3.29E+00
(a) Limit	mREM	1.50E+01	1.50E+01	1.50E+01	1.50E+01	3.00E+01
(b) % of Limit		5.67E+00	5.62E+00	4.91E+00	5.71E+00	1.10E+01

Receptor Location **1.0 miles NNE**

Critical Age **CHILD**

Critical Organ **BONE**

Attachment 6

Assessment of Radiation Dose from Radioactive Effluents to Members of the Public

McGuire Nuclear Station Units 1 & 2 Period 1/1/2024 - 12/31/2024

Liquid Effluents Dose Summary

	<u>Units</u>	<u>Qtr 1</u>	<u>Qtr 2</u>	<u>Qtr 3</u>	<u>Qtr 4</u>	<u>Year</u>
A. Batch Mode						
1. Maximum Organ Dose	mREM	3.34E-02	3.91E-02	4.49E-02	2.58E-02	1.44E-01
(a) Limit	mREM	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
(b) % of Limit		3.34E-01	3.91E-01	4.49E-01	2.58E-01	7.20E-01
(c) Critical Age		Child	Child	Child	Child	Child
(d) Critical Organ		Liver	Liver	Liver	Liver	Liver
2. Maximum Total Body Dose	mREM	3.28E-02	3.83E-02	4.32E-02	2.43E-02	1.39E-01
(a) Limit	mREM	3.00E+00	3.00E+00	3.00E+00	3.00E+00	6.00E+00
(b) % of Limit		1.09E+00	1.28E+00	1.44E+00	8.11E-01	2.32E+00
(c) Critical Age		Child	Child	Child	Child	Child
B. Continuous Mode						
1. Maximum Organ Dose	mREM	5.89E-05	6.28E-05	6.00E-04	1.81E-04	9.38E-04
(a) Limit	mREM	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
(b) % of Limit		5.89E-04	6.28E-04	6.00E-03	1.81E-03	4.69E-03
(c) Critical Age		Child	Child	Child	Child	Child
(d) Critical Organ		Liver	Liver	Liver	Liver	Liver
2. Maximum Total Body Dose	mREM	5.89E-05	6.28E-05	6.00E-04	1.81E-04	9.38E-04
(a) Limit	mREM	3.00E+00	3.00E+00	3.00E+00	3.00E+00	6.00E+00
(b) % of Limit		1.96E-03	2.09E-03	2.00E-02	6.04E-03	1.56E-02
(c) Critical Age		Child	Child	Child	Child	Child

Attachment 6

Assessment of Radiation Dose from Radioactive Effluents to Members of the Public

McGuire Nuclear Station Units 1 & 2 Period 1/1/2024 - 12/31/2024

40 CFR Part 190 Uranium Fuel Cycle Dose Calculation Results

In accordance with the requirements of 40 CFR Part 190, the annual dose commitment to any member of the general public shall be calculated to assure that doses are limited to 25 millirems to the total body or any organ with the exception of the thyroid which is limited to 75 millirems. The fuel cycle dose assessment for McGuire Nuclear Station includes liquid and gaseous effluent dose contributions from McGuire Nuclear Station and direct and air-scatter dose from the onsite ISFSI. No other uranium fuel cycle facility contributes significantly to the maximum exposed individual. Included in the gaseous effluent dose calculations is an estimate of the dose contributed by Carbon-14 (Ref. Attachment 2, Supplemental Information, of this report for further information). The combined dose to a maximum exposed individual from effluent releases and direct and air-scatter dose from the ISFSI is below 40 CFR Part 190 limits as shown by the following summary.

Note: The 40 CFR Part 190 effluent dose analysis to the maximum exposed individual from liquid and gas releases includes the dose from noble gases (i.e., total body and skin).

40 CFR Part 190 Effluent Dose Summary

A. Maximum Organ Dose (other than TB)	3.298E+00
1. Location	1.0 miles NNE
2. Critical Age	Child
3. Critical Organ	Bone
4. Gas Contribution %	9.968E+01
5. Liquid Contribution %	3.200E-01
B. Maximum Total Body Dose	1.067 E+00
1. Location	1.0 miles NNE
2. Critical Age	Child
3. Gas non-NG Contribution %	8.556E+01
4. Gas Contribution %	1.387E+00
5. Liquid Contribution %	1.305E+01

Direct and air-scatter radiation dose contributions from the onsite ISFSI have been determined from the 10 CFR 72.212 Evaluation Report, MAGNASTOR®, Revision 14.

The attached excerpt from the 10 CFR 72.212 Evaluation Report, MAGNASTOR®, Revision 14 is provided to document the method used to calculate the dose from ISFSI as less than 7 mrem/yr to the nearest real individual.

Total dose from liquid and gaseous effluents from McGuire Nuclear Station and direct and air-scatter dose from the onsite ISFSI is conservatively estimated to be less than 9 mrem/yr to the nearest real individual. This meets the 40 CFR Part 190 requirements of an annual dose commitment to any member of the general public of less than 25 mrem total body or any organ and 75 mrem to the thyroid.

Attachment 6
Assessment of Radiation Dose from Radioactive Effluents to Members of the Public

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024 - 12/31/2024

10 CFR 72.212 Evaluation Report, MAGNASTOR®, Revision 14

6.0 10 CFR 72.212(b)(5)(iii) - Radioactive Materials in Effluents and Direct Radiation

6.1 Purpose

10 CFR 72.212(b)(5)(iii) requires the general licensee to perform written evaluations, before use and before applying the changes authorized by an amended CoC to a cask loaded under the initial CoC or an earlier amended CoC, that establish that the requirements of 10 CFR 72.104 have been met. A copy of this record shall be retained until spent fuel is no longer stored under the general license issued under 10 CFR 72.210.

10 CFR 72.104 provides the regulatory criteria for radioactive materials in effluents and direct radiation from an independent spent fuel storage installation (ISFSI) during normal operation and anticipated occurrences. Specifically, 10 CFR 72.104(a) limits the annual dose equivalent to any real individual who is located beyond the controlled area to 25 mrem to the whole body, 75 mrem to the thyroid, and 25 mrem to any other critical organ. This dose equivalent must include contributions from (1) planned discharges of radioactive materials (radon and its decay products excepted) to the general environment, (2) direct radiation from ISFSI operations, and (3) any other radiation from uranium fuel cycle operations within the region. In addition, 10 CFR 72.104(b) requires that operational restrictions be established to meet as low as is reasonably achievable (ALARA) objectives for radioactive materials in effluents and direct radiation levels associated with ISFSI operations. Also, 10 CFR 72.104(c) requires that operational limits be established for radioactive materials in effluents and direct radiation levels associated with ISFSI operations to meet the above-mentioned dose limits.

Section 6.2 provides the written evaluation required by 10 CFR 72.212(b)(5)(iii), demonstrating Duke Energy's compliance with the requirements of 10 CFR 72.104 for the MNS ISFSI.

Attachment 6

Assessment of Radiation Dose from Radioactive Effluents to Members of the Public

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024 - 12/31/2024

6.2 Evaluation

This evaluation addresses the radiological dose rate from a composite population of all MNS ISFSI cask types.

6.2.1 §72.104(a) – Dose Limits

Duke Energy Engineering Instruction MCEI-0400-241 determined that the distance from the nearest residence to the ISFSI is 0.65 miles (1046 meters). Hence, it is conservative to assume that the closest real individual is at least 700 meters from the ISFSI.

Enercon determined the annual total dose (gamma plus neutron) at a distance of 700 meters from all currently loaded casks (10 TN-32A casks and 28 NAC-UMS® casks) to be approximately 1.62 mrem. The evaluation was based on actual cask average burn-up (as loaded) and considering cooling time on the storage pads as of September 1, 2010. The distance at which this dose is calculated (700 meters) is conservative compared to the distance to the closest real individual.

NAC International determined the annual total dose (gamma plus neutron) at a distance of 700 meters from a 2x6 array of MAGNASTOR® casks to be approximately 1.01 mrem (3.03 mrem for three arrays). The evaluation was conservatively based on full cask loads of 37 fuel assemblies at the maximum allowable heat load of 35.5 kW. The distance at which this dose is calculated (700 meters) is conservative compared to the distance to the closest real individual.

NAC International determined the annual total dose (gamma plus neutron) at a distance of 700 meters from a 1x6 array of MAGNASTOR® casks to be approximately 0.91 mrem. The evaluation was conservatively based on full cask loads of 37 fuel assemblies at the maximum allowable heat load of 35.5 kW. The distance at which this dose is calculated (700 meters) is conservative compared to the distance to the closest real individual.

NAC International determined the annual total dose (gamma plus neutron) at a distance of 700 meters from a 3x7 array of MAGNASTOR® casks to be approximately 1.35 mrem. The evaluation was conservatively based on full cask loads of 37 fuel assemblies at the maximum allowable heat load of 35.5 kW. The distance at which this dose is calculated (700 meters) is conservative compared to the distance to the closest real individual.

The total calculated annual public dose from liquid and gaseous effluent pathways averaged over a ten-year period is less than 4 mrem. No other uranium fuel cycle facility contributes significantly to the dose received by the closest real individual.

Based on the above, the calculated annual dose to the closest real individual due to the ISFSI, which is comprised of the currently existing ten TN-32A casks and 28 NAC-UMS® casks, and up to three 2x6 arrays, one 1x6 array, and one 3x7 array of MAGNASTOR® casks (*see Note below*), is determined to be less than 7 mrem, and the estimated annual dose due to McGuire power generation is less than 4 mrem. Hence, the total annual dose to the closest real individual (less than 11 mrem) is within the 10 CFR 72.104(a) limit.

Attachment 6
Assessment of Radiation Dose from Radioactive Effluents to Members of the Public

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024 - 12/31/2024

Note: As stated above, up to three 2x6 arrays, one 1x6 array, and one 3x7 array of MAGNASTOR® casks are assumed in this evaluation. The first eight MAGNASTOR® casks are placed on a concrete pad currently containing four NAC-UMS® casks. This will conservatively count as one 2x6 array. Additional MAGNASTOR® casks will be placed on their own concrete pads in two additional 2x6 arrays, one 1x6 array, and one 3x7 array. Hence, this §72.104(a) evaluation bounds up to 59 MAGNASTOR® casks, arranged as described.

Attachment 7
Information to Support the NEI Ground Water Protection Initiative

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024 - 12/31/2024

ATTACHMENT 7

Information to Support the NEI Ground Water Protection Initiative

This attachment includes a summary of voluntary reports made in accordance with the NEI Ground Water Protection Initiative and a summary of ground water well sample data.

Attachment 7
Information to Support the NEI Ground Water Protection Initiative

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024 - 12/31/2024

Duke Energy implemented a Ground Water Protection program in 2007. This initiative was developed to ensure timely and effective management of situations involving inadvertent releases of licensed material to ground water. As part of this program, McGuire Nuclear Station monitored 99 wells, 4 surface water points, and 1 Leachate Pond.

Wells are typically sampled quarterly or semi-annually. Ground water samples are regularly analyzed for tritium and gamma emitters, with select wells being analyzed for difficult-to-detect radionuclides. No gamma or difficult-to-detect radionuclides, other than naturally occurring radionuclides, were identified in well samples during 2024. Results from sampling during 2024 confirmed existing knowledge of tritium concentrations in site ground water.

Results from sampling during 2024 are shown in the table below.

No events meeting the criteria for voluntary notification per NEI 07-07, Industry Ground Water Protection Initiative, occurred at McGuire Nuclear Station in 2024.

Attachment 7
Information to Support the NEI Ground Water Protection Initiative

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024 - 12/31/2024

Key to below table.

NS	-	Not scheduled to be sampled, not sampled due to insufficient volume in well, or well inaccessible during outage.
pCi/l	-	picocuries per liter.
< MDA	-	less than minimum detectable activity, typically 250 pCi/l.
20,000 pCi/l	-	the Environmental Protection Agency drinking water standard for tritium. This standard applies only to water used for drinking.
1,000,000 pCi/l	-	the 10 CFR Part 20, Appendix B, Table 2, Column 2, Effluent Concentration Limit for tritium.

Attachment 7
Information to Support the NEI Ground Water Protection Initiative

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024 - 12/31/2024

Well Name	Location / Description	Tritium Concentration (pCi/l)				# of Samples
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	
M-100R	MNS GWPI / M-100R / SE of WC	NS	<MDA	NS	<MDA	2
M-101	MNS GWPI / M-101 / SE of WC	NS	<MDA	NS	<MDA	2
M-102	MNS GWPI / M-102 / SW of WC	4.25E+0	6.03E+0	4.68E+0	4.60E+0	4
M-103	MNS GWPI / M-103 / S of WC	3.45E+0	3.70E+0	5.46E+0	4.42E+0	4
M-103R	MNS GWPI / M-103R / S of WC	NS	5.78E+0	NS	5.06E+0	2
M-104DR	MNS GWPI / M-104DR / W of WC	NS	4.07E+0	NS	3.92E+0	2
M-104R	MNS GWPI / M-104R / W of WC	5.51E+0	7.80E+0	6.92E+0	4.50E+0	4
M-105	MNS GWPI / M-105 / Landfarm	NS	3.28E+0	NS	2.22E+0	2
M-20	MNS GWPI / M-20 / S of Hwy. 73	NS	3.84E+0	NS	4.16E+0	2
M-20R	MNS GWPI / M-20R / S of Hwy. 73	NS	NS	NS	2.13E+0	1
M-21	MNS GWPI / M-21 / S of Hwy. 73	NS	<MDA	NS	<MDA	2
M-22	MNS GWPI / M-22 / S of Hwy. 73	NS	<MDA	NS	<MDA	2
M-22R	MNS GWPI / M-22R / S of Hwy. 73	NS	NS	NS	<MDA	1
M-23	MNS GWPI / M-23 / S of Acs. Rd.	NS	NS	NS	<MDA	1
M-31	MNS GWPI / M-31 / Access road	NS	NS	NS	<MDA	1
M-32	MNS GWPI / M-32 / Main entrance	NS	<MDA	NS	<MDA	2
M-33	MNS GWPI / M-33 / by softball field / HWY 73	NS	NS	NS	<MDA	1
M-34DR	MNS GWPI / M-34DR / Access road	NS	NS	NS	<MDA	1
M-34R	MNS GWPI / M-34R / Access road	NS	NS	NS	<MDA	1
M-42	MNS GWPI / M-42 / U-2 Rx. Bldg.	3.16E+0	4.37E+0	4.07E+0	4.47E+0	4
M-48DR	MNS GWPI / M-48DR / U-2 SFP	NS	<MDA	NS	<MDA	2
M-48R	MNS GWPI / M-48R / U-2 SFP	NS	6.75E+0	NS	4.64E+0	2
M-53	MNS GWPI / M-53 / N of plant	NS	6.37E+0	NS	6.82E+0	2
M-55	MNS GWPI / M-55 / NAB	NS	<MDA	NS	<MDA	2
M-59	MNS GWPI / M-59 / U-2 Doghouse	9.91E+0	6.11E+0	8.49E+0	7.11E+0	4
M-60	MNS GWPI / M-60 / MOC Parking	NS	NS	NS	<MDA	1
M-62	MNS GWPI / M-62 / S of RWF	<MDA	<MDA	2.44E+0	1.98E+0	4
M-64	MNS GWPI / M-64 / Rdwst. Bldg.	NS	<MDA	NS	<MDA	2
M-66	MNS GWPI / M-66 / S of SSF	6.21E+0	5.63E+0	6.28E+0	5.95E+0	4
M-66R	MNS GWPI / M-66R / S of SSF	NS	<MDA	NS	<MDA	2
M-68	MNS GWPI / M-68 / U-1 RMWST	2.76E+0	4.09E+0	4.66E+0	3.79E+0	4
M-70	MNS GWPI / M-70 / U-1 SFP	2.30E+0	2.80E+0	3.11E+0	<MDA	4
M-70DR	MNS GWPI / M-70DR / U-1 SFP	NS	<MDA	NS	7.92E+0	2
M-70R	MNS GWPI / M-70R / U-1 SFP	NS	5.71E+0	NS	3.72E+0	2
M-72	MNS GWPI / M-72 / Rdwst. Trench	3.41E+0	4.56E+0	4.91E+0	3.66E+0	4
M-76	MNS GWPI / M-76 / W of U-1 SFP	2.67E+0	4.08E+0	3.67E+0	2.32E+0	4
M-82	MNS GWPI / M-82 / River	NS	NS	NS	4.62E+0	1
M-84	MNS GWPI / M-84 / River	NS	NS	NS	6.09E+0	1
M-84R	MNS GWPI / M-84R / River	NS	NS	NS	4.63E+0	1
M-85	MNS GWPI / M-85 / River	NS	NS	NS	3.00E+0	1
M-87	MNS GWPI / M-87 / Landfarm	NS	NS	NS	3.54E+0	1
M-89	MNS GWPI / M-89 / Landfarm	NS	NS	NS	4.45E+0	1

Attachment 7
Information to Support the NEI Ground Water Protection Initiative

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024 - 12/31/2024

Well Name	Location / Description	Tritium Concentration (pCi/l)				# of Samples
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	
M-90	MNS GWPI / M-90 / Landfarm	NS	NS	NS	2.76E+02	1
M-91	MNS GWPI / M-91 / E of WC	NS	2.64E+02	NS	2.46E+02	2
M-91R	MNS GWPI / M-91R / E of WC	NS	NS	NS	2.82E+02	1
M-92	MNS GWPI / M-92 / N of WC Ponds	NS	1.88E+0	NS	2.83E+0	2
M-92R	MNS GWPI / M-92R / N of WC Ponds	NS	NS	NS	<MDA	1
M-93	MNS GWPI / M-93 / N of IHUP	NS	3.67E+0	NS	2.51E+0	2
M-93R	MNS GWPI / M-93R / N of IHUP	NS	NS	NS	2.51E+0	1
M-94	MNS GWPI / M-94 / SE of IHUP	NS	<MDA	NS	<MDA	2
M-95	MNS GWPI / M-95 / Lower Parking	NS	1.89E+0	NS	<MDA	2
M-95R	MNS GWPI / M-95R / Lower Parking	NS	NS	NS	<MDA	1
M-96	MNS GWPI / M-96 / West Parking	NS	<MDA	NS	<MDA	2
M-96R	MNS GWPI / M-96R / West Parking	NS	NS	NS	<MDA	1
M-97	MNS GWPI / M-97 / East Parking	NS	<MDA	NS	<MDA	2
M-98	MNS GWPI / M-98 / S of Amin. Bldg.	NS	<MDA	NS	<MDA	2
M-98R	MNS GWPI / M-98R / S of Amin. Bldg.	NS	NS	NS	<MDA	1
MNS_LEACHP	MNS Landfill 2 / Leachate Pond	NS	5.63E+0	NS	5.32E+0	2
MNS_MW-1	MNS Landfarm 2 / MW-1	NS	NS	NS	<MDA	1
MNS_MW-10A	MNS Landfill 2 / MW-10A	NS	<MDA	NS	<MDA	2
MNS_MW-1A	MNS Landfarm 2 / MW-1A	NS	NS	NS	<MDA	1
MNS_MW-2	MNS Landfarm 2 / MW-2	NS	NS	NS	<MDA	1
MNS_MW-2A	MNS Landfarm 2 / MW-2A	NS	NS	NS	<MDA	1
MNS_MW-3	MNS Landfarm 2 / MW-3	NS	NS	NS	<MDA	1
MNS_MW-3A	MNS Landfarm 2 / MW-3A	NS	NS	NS	<MDA	1
MNS_MW-4A	MNS Landfarm 2 / MW-4A	NS	NS	NS	<MDA	1
MNS_MW-4R	MNS Landfarm 2 / MW-4R	NS	NS	NS	<MDA	1
MNS_MW-5A	MNS Landfill 2 / MW-5A	NS	<MDA	NS	<MDA	2
MNS_MW-5R	MNS Landfill 2 / MW-5R	NS	<MDA	NS	<MDA	2
MNS_MW-6	MNS Landfill 2 / MW-6	NS	<MDA	NS	<MDA	2
MNS_MW-6A	MNS Landfill 2 / MW-6A	NS	<MDA	NS	<MDA	2
MNS_MW-7A	MNS Landfill 2 / MW-7A	NS	<MDA	NS	<MDA	2
MNS_MW-7R	MNS Landfill 2 / MW-7R	NS	<MDA	NS	<MDA	2
MNS_MW-8	MNS Landfill 2 / MW-8	NS	<MDA	NS	<MDA	2
MNS_MW-8A	MNS Landfill 2 / MW-8A	NS	<MDA	NS	<MDA	2
MNS_MW-9	MNS Landfill 2 / MW-9	NS	<MDA	NS	<MDA	2
MNS_MW-9A	MNS Landfill 2 / MW-9A	NS	<MDA	NS	<MDA	2
MNS_SW-1	MNS Landfill 2 / SW-1	NS	<MDA	NS	<MDA	2
MNS_SW-2	MNS Landfill 2 / SW-2	NS	<MDA	NS	<MDA	2
MS-1	MNS GWPI / MS-1 / Surface Water	NS	<MDA	NS	<MDA	2
MS-2	MNS GWPI / MS-2 / Surface Water	NS	3.56E+0	NS	2.70E+0	2
MS-3	MNS GWPI / MS-3 / Surface Water	NS	2.55E+0	NS	3.97E+0	2

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024 - 12/31/2024

[illegible]

Attachment 8
Inoperable Equipment

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024 - 12/31/2024

ATTACHMENT 8

Inoperable Equipment

This attachment includes an explanation of inoperable instruments related to effluent monitoring in excess of allowed time defined by licensing bases and an explanation of unprotected permanent or temporary outside liquid storage tanks exceeding 10 Curies total activity (excluding tritium and dissolved or entrained noble gases).

Attachment 8 Inoperable Equipment

McGuire Nuclear Station Units 1 & 2 Period 1/1/2024 - 12/31/2024

McGuire Nuclear Station experienced one instance of inoperable equipment relevant to effluent monitoring in excess of SLC limits during 2024. Details are described below.

McGuire Nuclear Station does not have unprotected permanent or temporary outside liquid storage tanks, therefore none exceeded 10 Curies total activity (excluding tritium and dissolved or entrained noble gases) during 2024.

SLC # from Table 16.11.2-1	Title	Completion Time	Determination and Data Reviewed
4.d	2WPFT5120	30 Days	For 2WPFT5120, out of service time for 2024 is 365 days (1/1/2024 to 1/1/2025*) LCOTR A-2-22-01213

For 2024, 2WPFT5120 was non-functional from 1/1/2024 to 1/1/2025*. During alignment for 2WPLP5120 calibration, 2WPFT5120 failed the acceptance criteria.

*2WPFT5120 remained non-functional through the end of the year 2024. Additional non-functional time will be accounted for in the 2025 ARERR.

- WO 20498458-01
- WO 20498458-02

Attachment 9
Summary of Changes to the Offsite Dose Calculation Manual

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024 - 12/31/2024

ATTACHMENT 9

Summary of Changes to the Offsite Dose Calculation Manual

This attachment includes a summary of changes to the ODCM and Radiological Effluent Controls.

Attachment 9

Summary of Changes to the Offsite Dose Calculation Manual

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024 - 12/31/2024

Offsite Dose Calculation Manual

The McGuire ODCM was revised in 2024. The most recent revision is 63 and is provided with the 2024 ARERR.

DRR 02482354:

Location Description Changes

Location 128 description updated to remove the word "Bridge" in Table 6.0-1 of the MNS Off-Site Dose Calculation Manual. The water sampler at REMP Surface Water Location 128 was moved from the MNS Discharge Canal Bridge to another location along the Discharge Canal.

DRR 02518756:

Removed sample location 155 Food Products, Island Forest Drive (4.87 mi NNE)

-MNS Crop location 155, an irrigated garden from Lake Norman ceased operation 6MAY2024. Residence where crops were being cultivated was sold. The new owner will not have crops.

A new garden irrigated by Lake Norman was not located. Searches for a garden irrigated by Lake Norman will occur annually with the performance of the Land Use Census.

Removed sample location 142 C Milk, Lowman Farms-Cows (12.2 mi NNW)

-MNS Milk Dairy – Cow, control location, ceased operation 20MAY2024.

A new Milk Dairy was not located. Searches for a Milk Dairy will occur annually with the performance of the Land Use Census.

DRR 02519501:

Appendix I Ri Child Goat Cow Meat page numbers changed to Page 1,2,3.

Airborne Radioiodine and Particulate sample point 121 Guardhouse removed from MNS REMP. Sample point is supplemental and not SLC required.

Drinking Water sample point 194 East Lincoln County Water Supply removed from MNS REMP. Sample point is supplemental and not SLC required.

Radiological Effluent Controls (SLC 16.11)

The McGuire Nuclear Station Radiological Effluent Controls are contained in SLC 16.11 and are included in this section. SLC 16.11 was not revised in 2024.



Facility Code :	MC		
Applicable Facilities :			
Document Number :	ODCM McGuire		
Document Revision Number :	063		
Document EC Number :			
Change Reason :			
Document Title :	Offsite Dose Calculation Manual - McGuire		
Bridges, Madison B Approver 6/24/2024			
Notes :			

McGuire Nuclear Station Units 1 and 2



ODCM

Offsite Dose
Calculation Manual



McGuire Nuclear Station
Units 1 and 2

**OFFSITE DOSE CALCULATION MANUAL
(ODCM)**

Revision 63

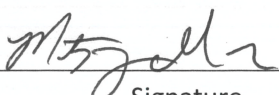
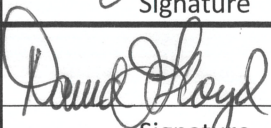
Prepared By: Madison Bridges MNS Lead Scientist, Station Sciences	 Signature	<u>6-24-24</u> Date
Reviewed By: Montgomery Green MNS Radiation Protection Superintendent	 Signature	<u>6/24/24</u> Date
Approved By: David Lloyd MNS Station Sciences Manager	 Signature	<u>6/24/24</u> Date



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Offsite Dose Calculation Manual (ODCM)

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EXECUTIVE SUMMARY

The McGuire Nuclear Station (MNS) Offsite Dose Calculation Manual (ODCM) provides the methodology and parameters to be used in the calculation of offsite doses due to normal operation radioactive liquid and gaseous effluents to assure compliance with the dose limitations of the Selected Licensee Commitments (SLCs, UFSAR Chapter 16) and Technical Specifications (TSs). These dose limitations assure that:

- (1) the concentration of radioactive liquid effluents released from the site to the unrestricted area will be limited to 10 times the effluent concentration (EC) levels of 10CFR20, Appendix B, Table 2, and $2.0E-04$ $\mu\text{Ci/ml}$ for dissolved and entrained noble gases (TS 5.5.5(a)(2), SLC 16.11.1);
- (2) the exposures to any individual member of the public from radioactive liquid effluents will not result in doses greater than the ALARA design objectives of 10CFR50, Appendix I or the 10CFR20 limits (TS 5.5.5(a)(4), SLC 16.11.3);
- (3) the dose rate at any time at the site boundary from radioactive gaseous effluents will be limited to: for noble gases; less than or equal to 500 mrem/yr to the whole body, and less than or equal to 3000 mrem/yr to the skin; and for iodine-131 and iodine-133, for tritium, and for all radioactive materials in particulate form with half-lives greater than 8 days; less than or equal to 1500 mrem/yr to any organ (TS 5.5.5(a)(7), SLC 16.11.6);
- (4) the exposure to any individual member of the public from radioactive gaseous effluents will not result in doses greater than the ALARA design objectives of 10CFR50, Appendix I or the 10CFR20 limits (TS 5.5.5(a) (8 and 9), SLCs 16.11.8 and 16.11.9); and
- (5) the dose to any individual member of the public from the nuclear fuel cycle will not exceed the limits of 40CFR190 (TS 5.5.5(a)(10), SLC 16.11.12).



The methodology and parameters used to assure compliance with the dose limitations described above shall be used to prepare the radioactive liquid and gaseous effluent reports required by the SLCs and Technical Specifications. Dose calculations that demonstrate compliance with 40CFR190 will be considered to

demonstrate compliance with the 10CFR20 0.1-rem annual dose limit. The ODCM also provides the methodology and parameters to be used in the calculation of radioactive liquid and gaseous effluent monitoring instrumentation alarm/trip setpoints to assure compliance with the concentration and dose rate limitations of the SLCs and Technical Specifications. Software implementing NUREG-0133 methodology is used for the calculation of offsite doses, but the ODCM also provides a method for the calculation of offsite doses when the software is not available.

The ODCM has been prepared as generically as possible in order to minimize the need for revisions. Any changes to the methodology and parameters to be used in this ODCM shall be reviewed by knowledgeable individual(s), and approved by the Station Manager or Radiation Protection Manager prior to implementation. Changes to the ODCM shall be submitted to the Nuclear Regulatory Commission in accordance with the SLCs and Technical Specifications.

The ODCM does not replace any station implementing procedures. Programmatic controls for radioactive effluents and radiological environmental monitoring are contained in the Administrative Controls chapter of the Technical Specifications. Procedural details for radioactive effluents and radiological environmental monitoring consisting of licensee commitments, applicability, remedial actions, surveillance requirements, and the bases for these requirements are contained in Section 16.11 of the SLCs.

1.0 RADWASTE SYSTEMS

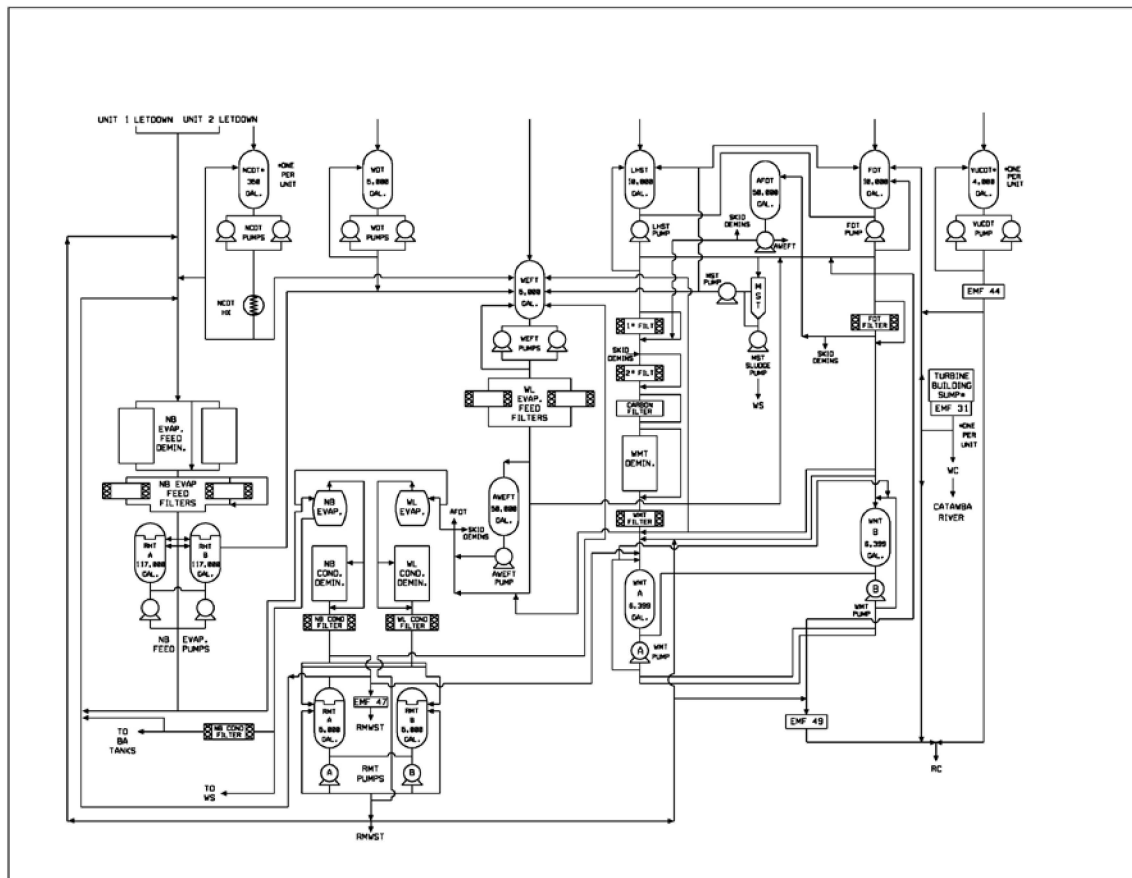
1.0.1 LIQUID RADWASTE PROCESSING

The liquid radwaste system at McGuire Nuclear Station is used to collect and treat liquid chemical and radiochemical byproducts of unit operation. The system produces effluents that can be reused in the plant or discharged to the environment. The means of treatment vary with waste type and desired product in the various systems:

- (A) Filtration - Waste sources are filtered during processing. In some cases, such as the Floor Drain Tank (FDT) subsystem of the Liquid Waste System (WL), filtration may be the only treatment required.
- (B) Adsorption - Adsorption of halides and organic chemicals by activated charcoal (carbon filter) may be used in treating waste in the Laundry and Hot Shower Tank (LHST). The carbon filter is designed to remove organophosphates and free chlorine. Activated charcoal need not be used when these chemicals are not present (e.g., phosphate detergents are not used at the station). Ion exchange resin or other media may be used in the carbon filter vessel as desired.
- (C) Ion Exchange - Ion exchange is used to remove radioactive cations from solution, as in the case of the FDT waste after removal of organics by carbon filtration (adsorption). Ion exchange can also be used in removing both cations (cobalt, manganese) and anions (chloride, fluoride) from evaporator distillates in order to purify the distillates for reuse as makeup water. Distillate from the Boron Recycle Evaporator in the Boron Recycle System (NB) can be treated by this method.
- (D) Gas Stripping - Removal of gaseous radioactive fission products is accomplished in the NB Evaporator.
- (E) Distillation - Production of pure water from the waste by boiling it away from the contaminated solution which it was originally contained is accomplished by the NB evaporator. Proper control of the process will yield water that can be reused for makeup. Polishing of this product can be achieved by ion exchange as pointed out above.
- (F) Concentration - In the NB Evaporator, dissolved chemicals are concentrated in the lower shell as water is boiled away. The dilute boron is normally concentrated to 4% so that it may be reused for makeup to the reactor coolant system.

Figure 1.0-1 is a schematic representation of the liquid radwaste system at McGuire.

Figure 1.0-1 McGuire Nuclear Station Liquid Radwaste System



1.0.2 GASEOUS RADWASTE PROCESSING

The Gaseous Waste System (WG) for McGuire is designed with the capability of processing the fission product gases from contaminated reactor coolant fluids resulting from operation. The design basis for the WG shown schematically in Figure 1.0-2 is the retention, through the plant lifetime, of all the gaseous fission products to be discharged from the reactor coolant system to the Chemical and Volume Control System (NV) and other plant systems to eliminate the need for intentional discharge of radioactive gases from the waste gas holdup tanks. Actual system operation is aimed at maximizing storage time for decay prior to infrequent releases. Unavoidable sources of low level radioactive gaseous discharge to the environment will be from periodic purging operations of the containment, and through the secondary system air ejector. With respect to the former, the potential fission product gas is expected to arise from non-recyclable reactor coolant leakage. With respect to the air ejector, the potential source of fission product gas will be from leakage of the reactor coolant to the secondary system through defects in steam generator tubes. The gaseous waste disposal system includes two waste gas compressors, two catalytic hydrogen recombiners, six gas decay storage tanks for use during normal power generation, and two gas decay storage tanks for use during shutdown and startup operations.

1.0.2.1 GAS COLLECTION SYSTEM

The gas collection system combines the waste hydrogen and fission gases from the volume control tanks, the boron recycle and liquid waste gas stripper evaporators, and other sources produced during normal operation or the gas collected during the shutdown degasification (high percentage of hydrogen), and cycles it through the catalytic recombiners to convert hydrogen to water. After the water vapor is removed, the resulting gas stream is transferred from the recombiner into the waste gas decay tanks (WGDTs), where the accumulated activity may be contained in six approximately equal parts. From the decay tanks, the gas flows back to the compressor suction to complete the loop circuit.

1.0.2.2 CONTAINMENT AND AUXILIARY BUILDING VENTILATION

Non-recyclable reactor coolant leakage occurring either inside the containment or inside the auxiliary building will generate gaseous activity. Gases resulting from leakage inside the containment atmosphere will be circulated through a charcoal adsorber and a particulate filter prior to release to the atmosphere.

Gases resulting from leakage inside the auxiliary building are released, without further decay, to the atmosphere. The ventilation exhaust from potentially contaminated areas in the auxiliary building is passed through charcoal adsorbers and particulate filters to reduce releases to the atmosphere upon a radiation monitor alarm.

1.0.2.3 SECONDARY SYSTEMS

The gases removed from the secondary system by the air ejectors are discharged to the unit vent. If the secondary system contains activity, the steam generator blowdown may be either discharged directly to the condenser cooling water system or through demineralizers to reduce activity levels.

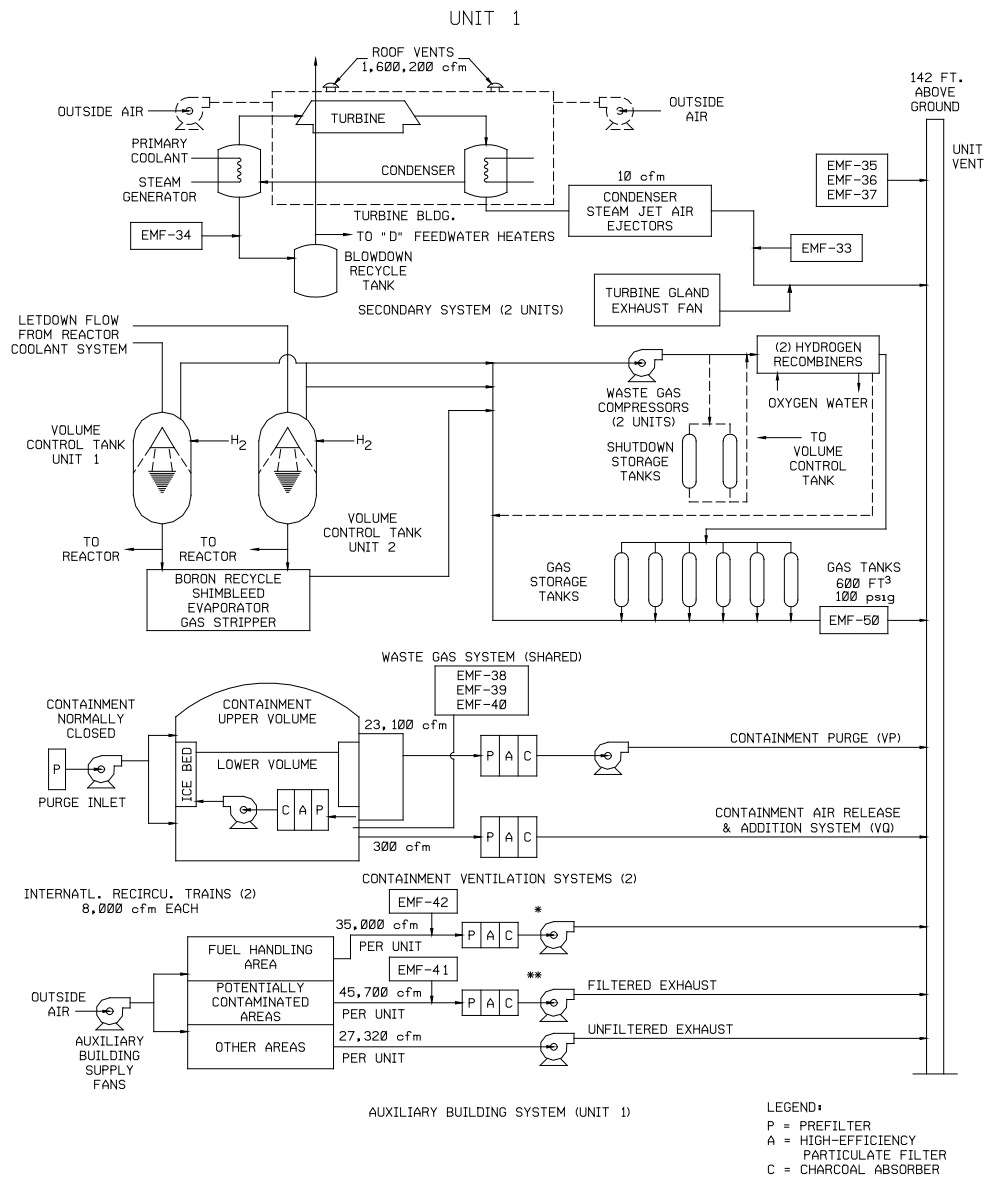
Gland leak-off steam, which represents a minor source of activity, is routed to the gland condenser. The non-condensable gases are exhausted to the unit vent; the condensables are condensed and drained to the condensate storage tank.

Some low radioactivity secondary system steam releases can occur at the site such as from infrequent lifts or testing of the main steam power operated relief valves (PORVs) and the code safety main steam relief valves. Radioactivity released from secondary system steam releases is documented and included in the site effluent release total.

Figure 1.0-2 is a schematic representation of the gaseous radwaste system at McGuire.

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Figure 1.0-2 McGuire Nuclear Station Gaseous Radwaste System
Page 1 of 2

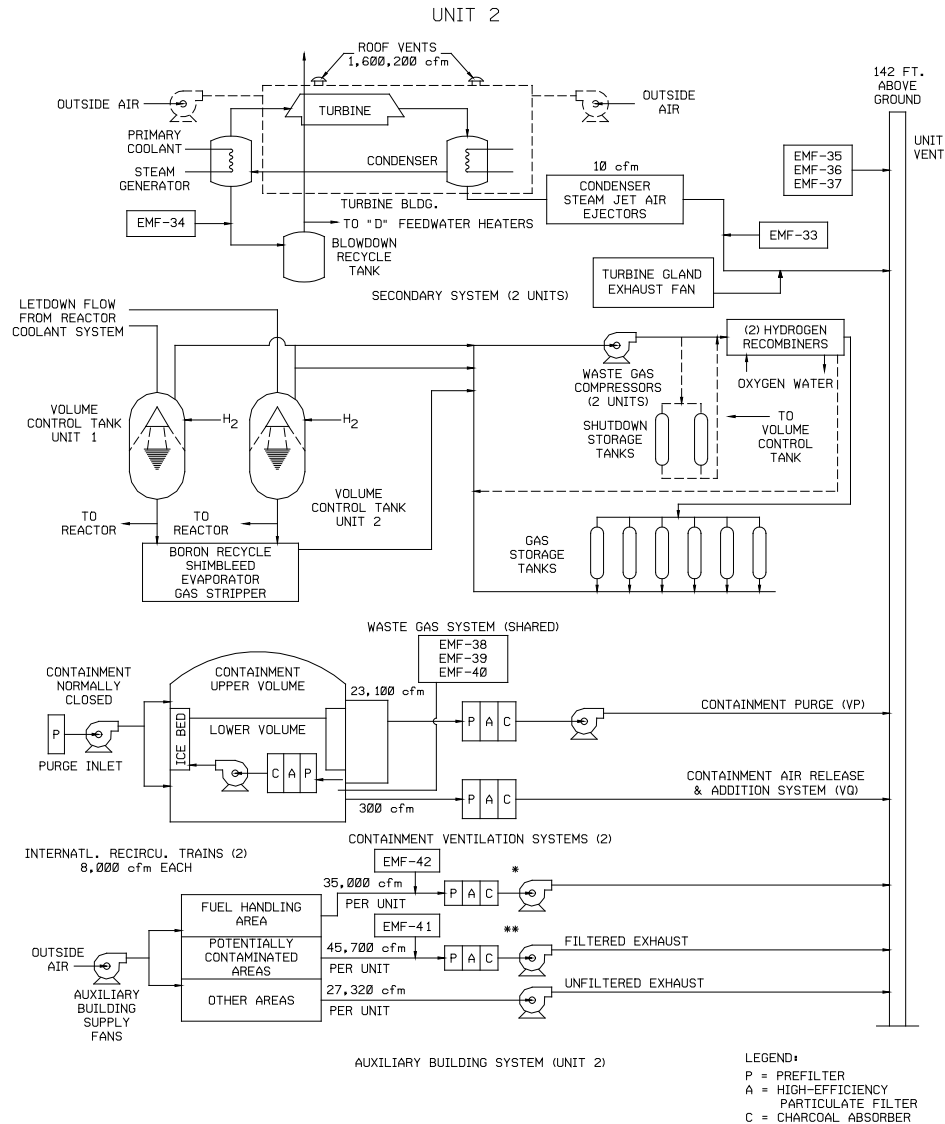


* FUEL HANDLING AREA IS NORMALLY UNFILTERED. UPON A RADIATION ALARM BY EMF-42, THE EXHAUST WILL BE DIVERTED TO THE FILTER MODE.

** POTENTIALLY CONTAMINATED AREAS OF THE AUXILIARY BUILDING ARE NORMALLY UNFILTERED. UPON A RADIATION ALARM BY EMF-41, THE EXHAUST WILL BE DIVERTED TO THE FILTERED MODE.

McGuire Nuclear Station
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Figure 1.0-2 McGuire Nuclear Station Gaseous Radwaste System
Page 2 of 2



*FUEL HANDLING AREA IS NORMALLY UNFILTERED. UPON A RADIATION ALARM BY EMF-42, THE EXHAUST WILL BE DIVERTED TO THE FILTER MODE.

**POTENTIALLY CONTAMINATED AREAS OF THE AUXILIARY BUILDING ARE NORMALLY UNFILTERED. UPON A RADIATION ALARM BY EMF-41, THE EXHAUST WILL BE DIVERTED TO THE FILTERED MODE.

2.0 RELEASE RATE CALCULATIONS

2.0.1 LIQUID RELEASE RATE LIMIT CALCULATIONS

There are two liquid radwaste discharge points to the environment at McGuire; (1) the Condenser Cooling Water System (RC) discharge point to Lake Norman, and (2) the Conventional Waste Water System (WC) and Waste Water Collection Basin (WWCB) discharge point to the Catawba River downstream of Cowan's Ford Dam (See Figure 2.0-1).

2.0.1.1 RC DISCHARGE RELEASE RATE LIMIT CALCULATION

Liquid releases to Lake Norman through the RC pathway normally contain the radioactive releases from the site including effluents from the waste monitor tanks and containment ventilation unit condensate drain tanks. The RC discharge point can also contain Turbine Building Sump (TBS) releases, however TBS effluent is normally released through WC. Condenser unwatering (WU) is normally released to the WWCB discharge point. Each unit has four RC pumps that pump 2.5E5 gpm each and provide dilution for releases. Each release path has a radiation monitor (EMF) that is used to monitor the liquid effluent (See Figure 2.0-2).

To comply with Technical Specifications and Selected Licensee Commitments, and to assure that the concentration of radioactive liquid effluents released from the site to the unrestricted area is limited to 10 times the effluent concentrations (ECs) of 10CFR20, Appendix B, Table 2, Column 2, and 2.0E-04 $\mu\text{Ci/ml}$ for dissolved and entrained noble gases, the following release rate limit calculation shall be performed for liquid releases to Lake Norman via the RC discharge point:

$$f \leq (F \div (DF - 1)) \quad \text{Condition: } DF > 1.0 \quad \text{Equation 2.1}$$

where:

f = the undiluted effluent flow, in gpm.

F = the dilution flow available depending on the number (1-8) of RC pumps in service, in gpm.
= (2.50E+05 gpm/pump) $\times$ (# of RC pumps in service)

DF = required dilution factor to be applied to the undiluted effluent flow, unitless.

$$DF = \sigma \times \sum_i \frac{C_i}{(10 \times EC_i)} \quad \text{Equation 2.2}$$

Note:

If $DF \leq 1.0$ then no dilution is required and the release rate is unrestricted.

If $DF > 1.0$ then dilution flow is required and the allowable release rate is calculated using Equation 2.1. Equation 2.1 is used only when $DF > 1.0$.

σ = the recirculation factor at equilibrium at the RC discharge location, (dimensionless).
The recirculation factor accounts for the fraction of discharged water reused by the station. Equation reference: McGuire Final Environmental Statement, (10/1972)

$$\sigma = 1 + \frac{Q_{df}}{Q_{cf}} = 1 + \frac{3740}{2976} = 2.26$$

where:

Q_{df} = annual average RC dilution flow (3740 cfs). (1990-1994 average flow)

Q_{cf} = annual average flow past Cowans Ford Dam (2970 cfs). (1990-1994 average flow)

C_i = the concentration of radionuclide, 'i', in the undiluted liquid effluent, in $\mu\text{Ci/ml}$.

EC_i = the concentration of radionuclide, 'i', from 10CFR20, Appendix B, Table 2, Column 2, in $\mu\text{Ci/ml}$. Note: if radionuclide, 'i', is a dissolved noble gas, then $EC_i = 2.00\text{E-}05 \mu\text{Ci/ml}$.

2.0.1.2 WC AND WWCB DISCHARGE

Liquid releases to the Catawba River through the WC and WWCB discharge pathways normally contain measurable activity above background. The WC/WWCB effluent typically accounts for <1% of the station total liquid activity released. Although designed for continuous discharge, inputs to WC, primarily from the Unit 1 and Unit 2 turbine building sumps, are normally held up in one of two WC Settling Ponds, and then released as a batch. There is a composite sampler at the discharge to the river. An EMF monitors the TBS and Condenser Drain (WU) output (See Figure 2.0-3). It is assumed that no activity is present in the TBS/WU effluent until indicated by radiation monitoring measurements. If an EMF alarms, the TBS/WU pumps are secured. At this time the discharge may be routed to the floor drain tank for processing or routed directly to the condenser cooling water (RC) flow rather than to WC.

Releases going directly to the WWCB are in continuous release. Some activity is planned for release through this pathway during condenser draining; therefore, grab samples are collected and retained for composite generation. Similar to WC, the only radiation monitoring is on the TBS/WU output (see Figure 2.0-3).

WZ (groundwater) Sump C discharges to the Standby Nuclear Service Water Pond (SNSWP). To account for WZ activity discharged into the SNSWP a composite sampler is installed in WZ Sump C (see Figure 2.0-3).

Figure 2.0-1 Liquid Radwaste Discharge Locations

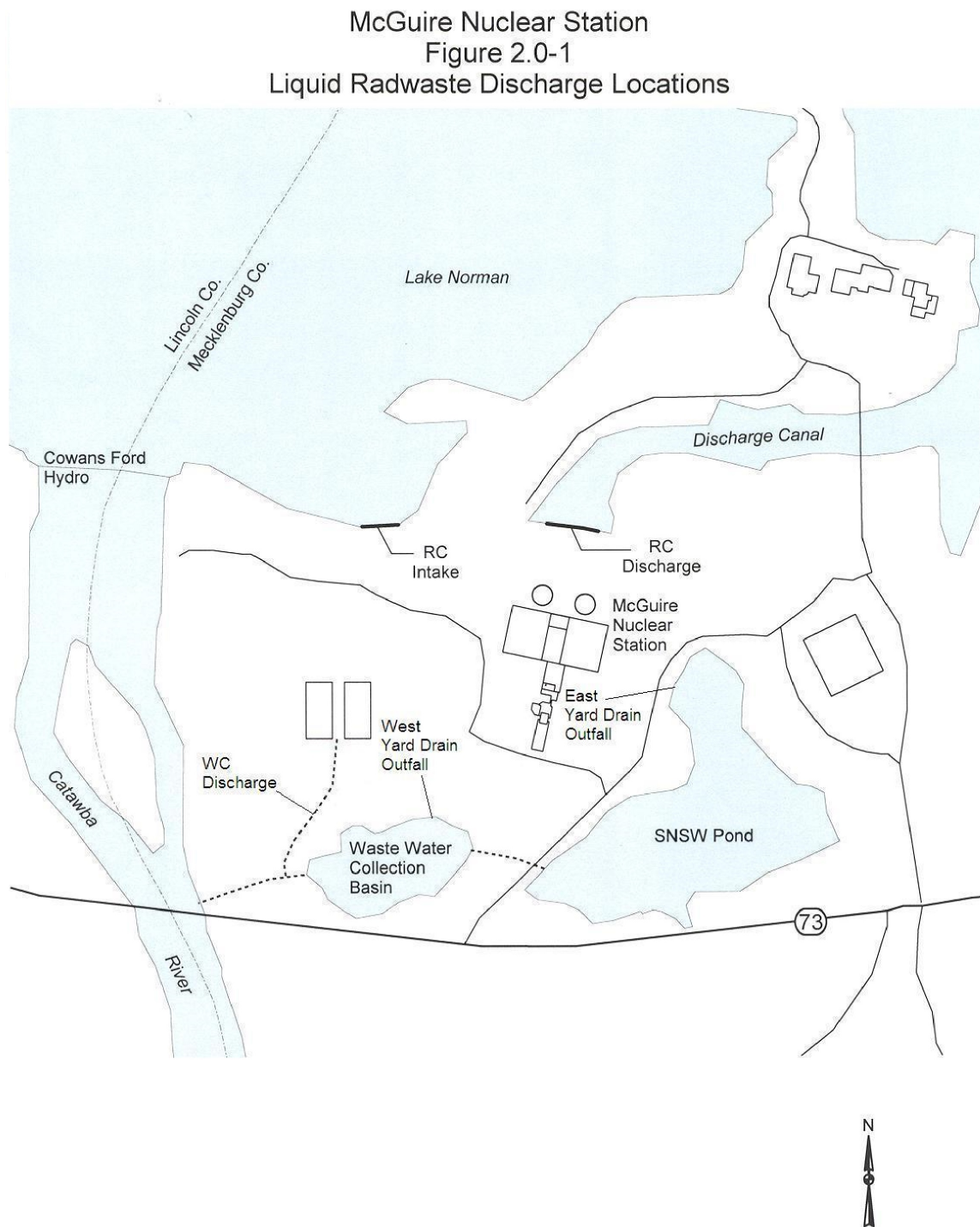


Figure 2.0-2 RC Discharge to Lake Norman

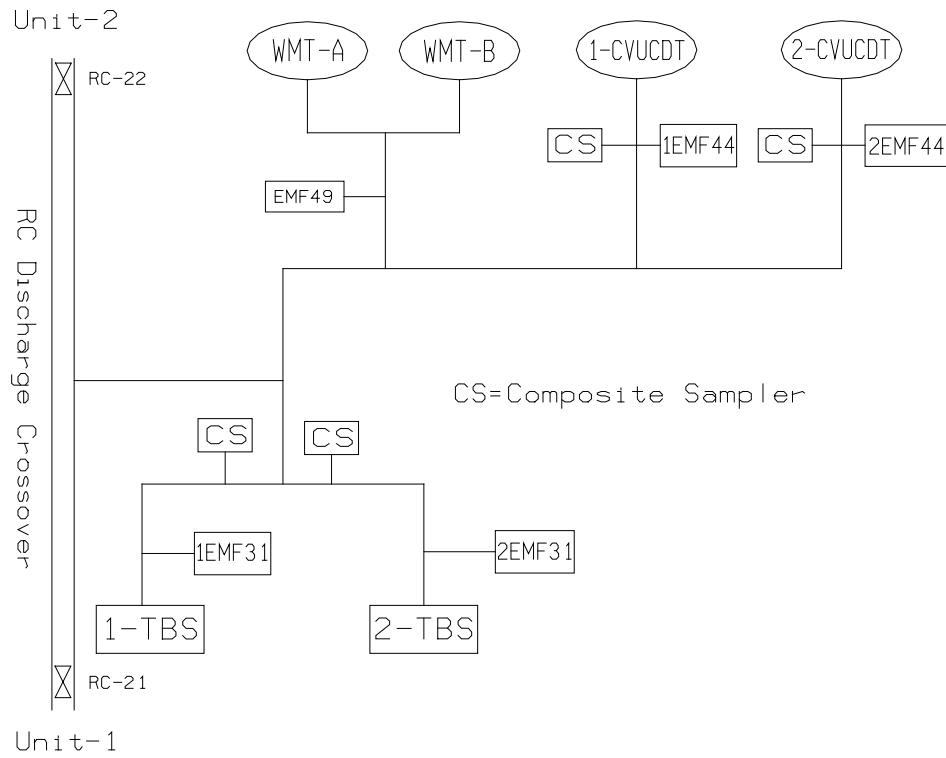
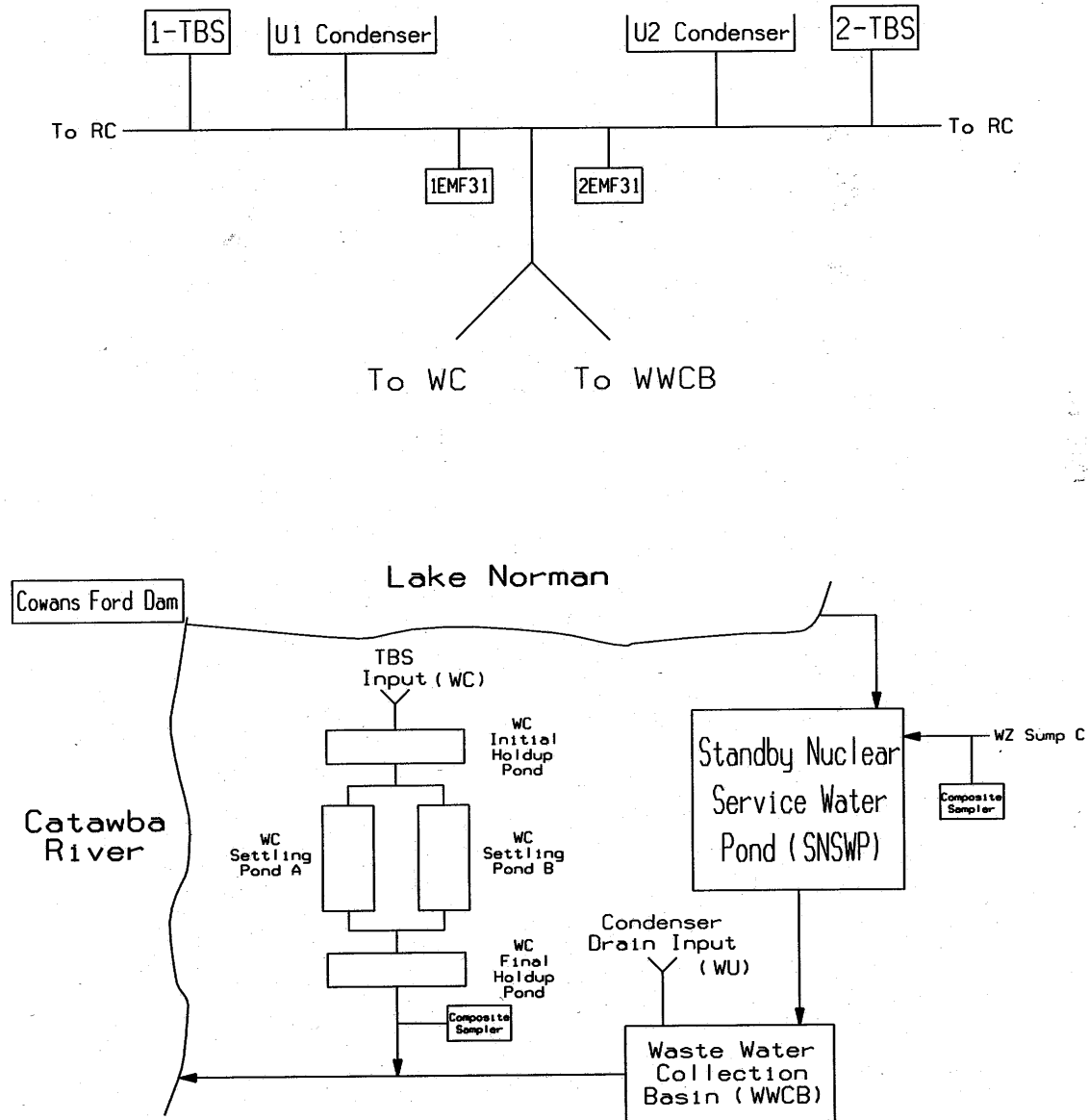


Figure 2.0-3 WC and WWCB Discharge to the Catawba River



2.0.2 GASEOUS RELEASE RATE LIMIT CALCULATIONS

The two unit vents are the primary gaseous radioactive release points at McGuire. The unit vents are the release points for waste gas decay tanks, containment building purges, auxiliary building ventilation, and the condenser air ejector (see Figure 2.0-4). Each unit vent contains multi-range radiation monitors (EMFs) and flow rate measuring instrumentation.

There are three other separate gaseous effluent release points at McGuire; the Waste Management Facility, Waste Handling Area and Unit 2 Staging Building. These three release points contribute a small percentage of the total site gaseous effluent. Each release point has an EMF, composite sampler, and flow totalizer (see Figure 2.0-5).

2.0.2.1 UNIT VENT DISCHARGE RELEASE RATE LIMIT CALCULATION

In order to comply with Technical Specifications and Selected Licensee Commitments and to assure that the dose rate, at any time, at or beyond the site boundary due to radioactive materials released in gaseous effluents from the site is limited to: ≤ 500 mrem/yr to the total body, and ≤ 3000 mrem/yr to the skin for the noble gases, and is limited to ≤ 1500 mrem/yr to any organ for radioiodine and for radioactive materials in particulate form, and radionuclides other than noble gases with half lives greater than 8 days, the following release rate and radiation monitor setpoint calculations shall be performed for releases from the waste gas decay tanks and the containment building. The release rate calculations when solved for the flow rate, 'f', are the release rates for noble gases and for radioiodines, particulates and other radionuclides with half-lives greater than 8 days. The most conservative release rate calculated shall control the flow rate. The following equations are based on the site dose rate limits. For simultaneous releases a multiple release calculation is performed to ensure that the site dose rate limits are not exceeded.

a. Noble Gases

Total Body:

$$\sum_i \left(K_i \times \frac{\chi}{Q} \times Q_i \right) < 500 \text{ mrem/yr} \quad \text{Equation 2.3}$$

Skin:

$$\sum_i \left((L_i + 1.1M_i) \times \frac{\chi}{Q} \times Q_i \right) < 3000 \text{ mrem/yr} \quad \text{Equation 2.4}$$

b. Radioiodines, Particulates, and Others

Inhalation, Ingestion and Ground Organ Pathways:

$$\sum_p \sum_i (P_{opi} \times W \times Q_i \times E_i) < 1500 \text{ mrem/yr}$$

To include both the food and ground organ dose and the inhalation organ dose the equation can be expanded to:

$$\sum_p \sum_i \{ (P_{opi})_{food/gr} \times W_{D/Q} + (P_{opi})_{inhal} \times W_{\chi/Q} \} \times Q_i \times E_i < 1500 \text{ mrem/yr}$$

Equation 2.5

where:

K_i = the total body dose factor due to gamma emissions for each identified noble gas radionuclide, 'i', in mrem/yr per $\mu\text{Ci}/\text{m}^3$ (See Appendix A).

L_i = the skin dose factor due to beta emissions for each identified noble gas radionuclide, 'i', in mrem/yr per $\mu\text{Ci}/\text{m}^3$ (See Appendix A).

M_i = the air dose factor due to gamma emissions for each identified noble gas radionuclide, 'i', in mrad/yr per $\mu\text{Ci}/\text{m}^3$ (See Appendix A).

1.1 = ratio to convert dose (mrad) to dose equivalent (mrem).

P_{opi} = the dose parameter for radionuclides other than noble gases for the inhalation pathway, in mrem/yr per $\mu\text{Ci}/\text{m}^3$ and for the food and ground plane pathways in ($\text{m}^2 \times (\text{mrem/yr per } \mu\text{Ci/sec})$) for organ, 'o', and radionuclide, 'i', (See Appendix B for the pathway specific dose commitment factors). Note: NUREG-1301, page 75, specifies use of the Child age group, Inhalation pathway, for the P_{opi} values.

χ/Q = the highest calculated annual average dispersion parameter for any area at or beyond the site boundary in sec/m^3 . For McGuire this value is $7.611\text{E-}5 \text{ sec}/\text{m}^3$. The location is the NNE sector at 0.5 mile. The boundary for establishing gaseous effluent release limits is the Exclusion Area Boundary (EAB). As shown in McGuire UFSAR Figure 2-5, the EAB is defined as a 2500 foot (~0.5 mile) radius from the station center.

W = the highest calculated annual average dispersion or deposition parameter for estimating the maximum dose rate to an individual from the total inhalation, food, and ground plane pathways:

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$W_{\chi/Q}$ = 7.611E-5 sec/m³, for the inhalation pathway and the airborne H-3 food pathway. The location is the NNE sector at 0.5 mile.

$W_{D/Q}$ = 1.403E-7 m⁻², for the food and ground plane pathways. The location is the NNE sector at 0.5 mile.

E_i = the filter removal factor for radionuclide, 'i', e.g., for 99% removal $E_i = 0.01$. For VQ and VP releases $E_i = 0.1$ for iodine, 0.01 for particulates. There is no filtration for WGD releases.

Q_i = the release rate of radionuclide, 'i', in gaseous effluent from all release points at the site, in $\mu\text{Ci/sec}$.

$$Q_i = k_1 C_i f \div k_2 = 472 \times C_i f \quad \text{Equation 2.6}$$

where:

C_i = the concentration of radionuclide, 'i', in undiluted gaseous effluent, in $\mu\text{Ci/ml}$.

f = the undiluted effluent flow, in ft³/min.

k_1 = conversion factor, 2.83E+04 cc/ft³.

k_2 = conversion factor, 60 sec/min.

Substituting the expression for Q_i in Equation 2.6 into Equations 2.3, 2.4, and 2.5, and solving for the flow rate, ' f ', in each equation gives:

Noble Gases - Total Body Maximum Release Rate:

$$f_{tb} < \frac{500}{472 \times \chi/Q \times \sum_i (K_i \times C_i)}$$

Noble Gases - Skin Maximum Release Rate:

$$f_{sk} < \frac{3000}{472 \times \chi/Q \times \sum_i [(L_i + 1.1M_i) \times C_i]}$$

Radioiodines, Particulates, and Others - Organ Maximum Release Rate:

$$f_{or} < \frac{1500}{472 \times \sum_p \sum_i \{ (P_{opi})_{\text{food/gr}} \times W_{D/Q} + (P_{opi})_{\text{inhal}} \times W_{\chi/Q} \} \times E_i \times C_i}$$

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f_{ib} , f_{sk} , and f_{or} , are calculated for each batch prior to release. The most limiting gaseous release rate is used to assure that no instantaneous dose rate limit is exceeded.

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Figure 2.0-4 Unit Vent Release Points

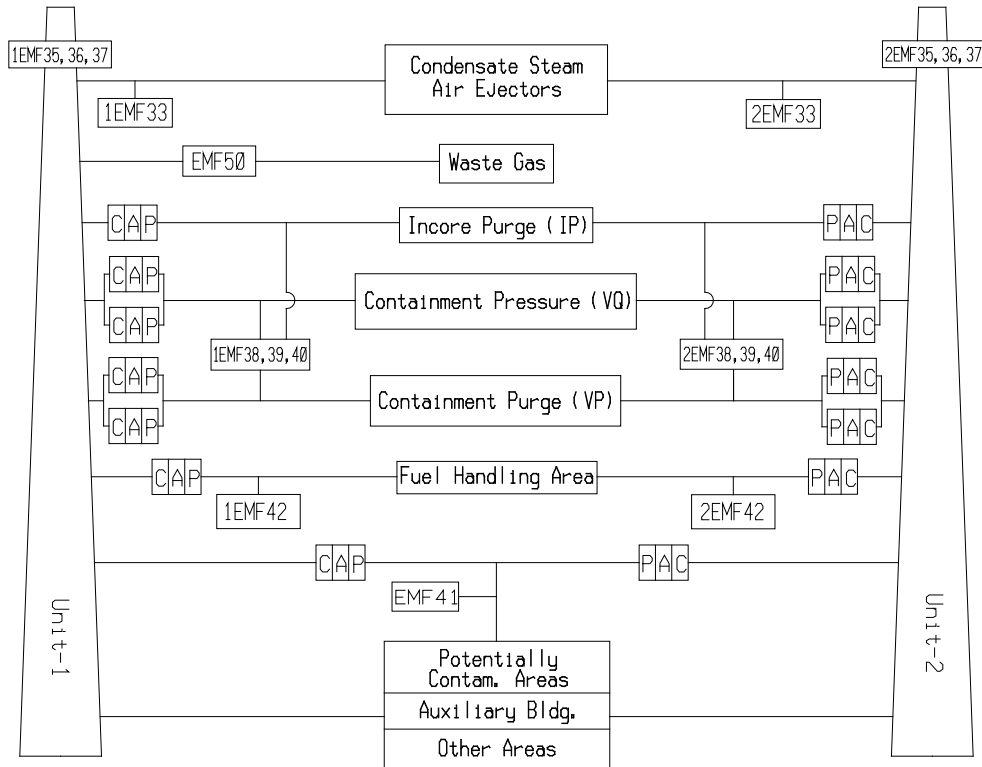
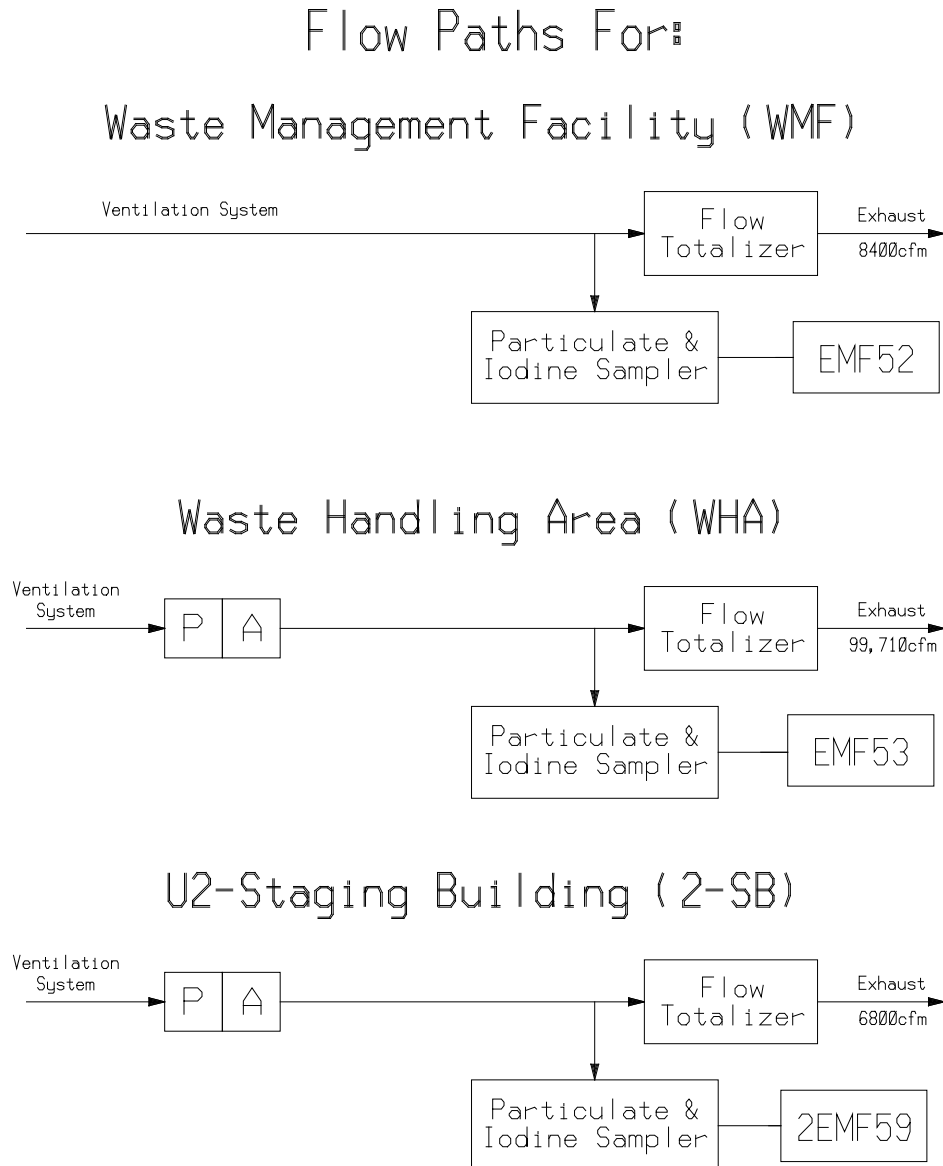


Figure 2.0-5 WMF, WHA, 2-SB Release Points



Derivations of Iodine, Particulate, and H-3 Dose Commitment Factors (P_{opi})

Inhalation Pathway - Child Age Group

$$P_{opi} = K'(BR)(DFA_{oi})$$

Formula: from NUREG-0133, page 25.

Where:

P_{opi}	Dose commitment factor for Child age group, organ o, nuclide i, for the inhalation pathway (mrem/yr per $\mu\text{Ci}/\text{m}^3$). (See Appendix B for the pathway specific dose commitment factors).
K'	Units conversion factor $\text{pCi}/\mu\text{Ci}$ (10^6).
BR	Breathing rate for the Child age group (m^3/yr , from Regulatory Guide 1.109): Child – 3700
DFA_{oi}	Organ inhalation dose conversion factor for Child age group, organ o, nuclide i, (mrem/pCi), from Table E-9 of Regulatory Guide 1.109.

3.0 SETPOINT CALCULATIONS

3.0.1 LIQUID RADIATION MONITOR SETPOINT CALCULATIONS

Once the liquid release rate parameters have been established radiation monitor setpoints shall be calculated to assure that the concentration of radioactive liquid effluents released from the site to the unrestricted area is limited to ten times the effluent concentrations (ECs) of 10CFR20, Appendix B, Table 2, Column 2, and 2.0E-04 $\mu\text{Ci/ml}$ for dissolved and entrained noble gases. By substituting the dilution factor (DF) from Equation 2.2 into Equation 2.1, solving for the undiluted liquid effluent concentration, C_i , and accounting for the monitor background reading, the liquid radiation monitor setpoint can be readily obtained by multiplying C_i by the radiation monitor correlation factor, CF_i , as follows:

$$C_i \leq \frac{(F + f) \times (10 \times EC_i)}{\sigma \times f} \quad \text{Equation 3.1}$$

$$SP \leq \sum_i (C_i \times CF_i) + bkg \quad \text{Equation 3.2}$$

where:

C_i = the maximum allowable concentration of radionuclide, 'i', in the undiluted liquid effluent, in $\mu\text{Ci/ml}$.

SP = radiation monitor setpoint, in cpm.

CF_i = radiation monitor correlation factor for radionuclide, 'i', in cpm/ $\mu\text{Ci/ml}$. These correlation factors are controlled by station procedures.

bkg = background reading for the radiation monitor, in cpm.

All other parameters were previously defined.

Using conservative or "worst-case" parameters in Equation 3.1 and Equation 3.2 can provide a liquid radiation monitor setpoint that does not need to be revised for every release if activity is low enough to allow for this type of operation such as with continuous releases from the WC release point. However, for batch releases, e.g., waste monitor tanks, through the RC discharge the radiation monitor setpoint is calculated based on actual expected activity in the release. In general, liquid radiation monitors are calibrated to Cs-137, and their setpoints are calculated as follows:

$$C_{Cs-137} = \sum_i (C_i \times Eq_i)$$

$$Expected\ cpm = (C_{Cs-137} \times CF_{Cs-137}) + bkg \quad \text{Equation 3.3}$$

"Trip" setpoints are set based on a multiplier factor above the "expected" cpm calculated in Equation 3.3.

where:

C_{Cs-137} = Cs-137 equivalent concentration, in $\mu\text{Ci/ml}$.

Eq_i = Cs-137 equivalence factor for each isotope, excluding tritium, to that of Cs-137 due to different gamma energies and abundance. This factor includes a 4-hour decay time due to the average time between sample and release. (See Table 3.0-1).

All other parameters were previously defined.

3.0.1.1 WASTE MONITOR TANK SETPOINTS (EMF 49)

As shown on Figure 2.0-2, EMF 49 is the controlling radiation monitor for Waste Monitor Tank (WMT) releases. EMF 49 setpoints are based on actual tank activity, and are calculated as follows:

$$Expected\ cpm = (C_{Cs-137} \times CF_{Cs-137}) + bkg$$

$$Trip\ 1\ setpoint = (C_{Cs-137} \times CF_{Cs-137} \times 1.5) + bkg$$

When $Cs-137$ equivalent concentration $\leq 1.43\text{E-}05\ \mu\text{Ci/ml}$:

$$Trip\ 2\ setpoint = (C_{Cs-137} \times CF_{Cs-137} \times 2.0) + bkg \text{ or } 3 \times bkg, \text{ whichever is higher.}$$

If the Cs-137 equivalent concentration is $\leq 1.43\text{E-}05\ \mu\text{Ci/ml}$, then $1.43\text{E-}05$ is used in the Trip 1 and Trip 2 setpoint calculations. This is an indication of a low activity tank, and normal EMF fluctuation may cause Trip 2 alarms and release termination.

When $Cs-137$ equivalent concentration $> 1.43\text{E-}05\ \mu\text{Ci/ml}$:

$$Trip\ 2\ setpoint = (C_{Cs-137} \times CF_{Cs-137} \times 2.0) + bkg$$

where:

C_{Cs-137} = Cs-137 equivalent concentration, in $\mu\text{Ci/ml}$.

CF_{Cs-137} = EMF 49 Cs-137 correlation factor, 3.42E+08 cpm/μCi/ml.

bkg = Background reading from EMF 49 after flushed from previous releases.

3.0.1.2 CONTAINMENT VENTILATION UNIT CONDENSATE DRAIN TANK SETPOINTS (EMF 44)

As shown on Figure 2.0-2, EMF 44 is the controlling radiation monitor for Containment Ventilation Unit Condensate Drain Tank (CVUCDT) releases. EMF 44 setpoints are based on actual tank activity, and are calculated as follows:

Expected cpm = $C_{Cs-137} \times CF_{Cs-137}$ **or** bkg , whichever is higher.

Trip 1 setpoint = any value between *Expected cpm* and *Trip 2*. Normally $2 \times \text{Expected cpm}$

Trip 2 setpoint = The lesser of $3 \times \text{Expected cpm}$ **or** $5.00E+06 \text{ cpm} \times \#RC \text{ pumps}$

where:

C_{Cs-137} = Cs-137 equivalent concentration, in μCi/ml.

CF_{Cs-137} = EMF 44 Cs-137 correlation factor, 3.42E+08 cpm/μCi/ml.

bkg = Background reading from EMF 44.

$\#RC \text{ pumps}$ = The least number of available RC pumps that will produce a setpoint greater than *Expected cpm*.

$5.00E+06$ = Derived as follows from Equation 3.1:

$$C \leq \frac{(F+f) \times (10 \times EC)}{\sigma \times f}$$

Given the following for each parameter:

C = The gross activity in the undiluted effluent, μCi/ml.

f = Tank flow which varies from 0-60 gpm, assumed to be 60 gpm.

$EC = 9.00E-07 \text{ μCi/ml}$, from 10CFR20, the EC for Cs-134 which is the smallest EC value for any detectable radionuclide that is not known to be absent from the mixture.

σ = Recirculation factor, previously defined as 2.26 (see Section 2, Page 2).

F = Dilution flow available: # of RC pumps $\times$ 2.50E+05 gpm/pump. Minimum dilution of one pump is used.

Substituting results in $C \leq 1.66\text{E-}02 \mu\text{Ci/ml}$. Next multiply by the EMF 44 correlation factor of $3.42\text{E+}08 \text{ cpm}/\mu\text{Ci/ml}$: $1.66\text{E-}02 \times 3.42\text{E+}08 = 5.68\text{E+}06 \text{ cpm}$. Value is rounded down to $5.00\text{E+}06 \text{ cpm}$ for added conservatism.

3.0.1.3 TURBINE BUILDING SUMP TO RC SETPOINTS (EMF 31)

As shown on Figure 2.0-2, EMF 31 is the controlling radiation monitor for releases from the Turbine Building Sump (TBS) to the condenser cooling water system (RC). EMF 31 setpoints are based on actual sump activity, and are calculated as follows:

Expected cpm = $C_{Cs-137} \times CF_{Cs-137}$ **or** *bkg*, whichever is higher.

Trip 1 setpoint = any value between *Expected cpm* and *Trip 2*. Normally $2 \times \text{Expected cpm}$

Trip 2 setpoint = the lesser of $3 \times \text{Expected cpm}$ **or** $2.10\text{E+}05 \text{ cpm} \times \text{\#RC pumps}$

where:

C_{Cs-137} = Cs-137 equivalent concentration, in $\mu\text{Ci/ml}$.

CF_{Cs-137} = EMF 31 Cs-137 correlation factor, $3.02\text{E+}08$ (1EMF31) or $3.06\text{E+}08$ (2EMF31)

bkg = Background reading from EMF 31.

\#RC pumps = The least number of available RC pumps that will produce a setpoint greater than *Expected cpm*.

$2.10\text{E+}05$ = Derived as follows from Equation 3.1:

$$C \leq \frac{(F+f) \times (10 \times EC)}{\sigma \times f}$$

Given the following for each parameter:

C = The gross activity in the undiluted effluent, $\mu\text{Ci/ml}$.

f = Sump flow which varies from 0-1340 gpm, assumed to be 1340 gpm.

$EC = 9.00E-07$ $\mu\text{Ci/ml}$, from 10CFR20, the EC for Cs-134 which is the smallest EC value for any detectable radionuclide that is not known to be absent from the mixture.

σ = Recirculation factor at the RC discharge point, = 2.26.

F = Dilution flow available: # of RC pumps $\times$ $2.50E+05$ gpm/pump. Minimum dilution of one pump is used.

Substituting the values yields $C \leq 7.47E-04$ $\mu\text{Ci/ml}$. Next multiply by the EMF 31 correlation factor of $3.02E+08$ (1EMF31) or $3.06E+08$ (2EMF31) cpm/ $\mu\text{Ci/ml}$: $7.47E-04 \times 3.02E+08$ (1EMF31) or $3.06E+08$ (2EMF31) (1EMF31) or $3.06E+08$ (2EMF31) = $2.26E+05$ cpm. Value is rounded down to $2.10E+05$ cpm for added conservatism.

3.0.1.4 TURBINE BUILDING SUMP TO WC SETPOINTS (EMF 31)

As shown on Figure 2.0-3, EMF 31 is the controlling radiation monitor for releases from the Turbine Building Sump (TBS) to WC. EMF 31 setpoints are based on actual sump activity, and are calculated as follows:

Expected cpm = $C_{Cs-137} \times CF_{Cs-137}$ **or** *bkg*, whichever is higher.

Trip 1 setpoint = any value between *Expected cpm* and *Trip 2*. Normally $2 \times$ *Expected cpm*

Trip 2 setpoint = the lesser of $3 \times$ *Expected cpm* **or** $8.46E+03$ cpm

where:

C_{Cs-137} = Cs-137 equivalent concentration, in $\mu\text{Ci/ml}$.

CF_{Cs-137} = EMF 31 Cs-137 correlation factor, $3.02E+08$ (1EMF31) or $3.06E+08$ (2EMF31) cpm/ $\mu\text{Ci/ml}$.

bkg = Background reading from EMF 31.

$8.46E+03$ = Derived as follows from Equation 3.1:

$$C \leq \frac{(F \times 0.1 + f) \times (10 \times EC)}{\sigma \times f}$$

Given the following for each parameter:

C = The gross activity in the undiluted effluent, $\mu\text{Ci/ml}$.

f = Sump flow which varies from 0-6700 gpm, assumed to be 6700 gpm.

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$EC = 9.00E-07$ $\mu\text{Ci/ml}$, from 10CFR20, the EC for Cs-134 which is the smallest EC value for any detectable radionuclide that is not known to be absent from the mixture.

σ = Recirculation factor at point where WC enters the Catawba River downstream of Cowans Ford Dam = 1.26.

F = Dilution flow available: Cowans Ford flow may vary from 80 to 50,000 cfs, but is conservatively estimated at 436 cfs ($1.96E5$ gpm), the historic minimum dilution flow available.

0.1 = Only 10% of Cowans Ford flow is assumed for dilution credit to account for incomplete mixing of the WC effluent downstream of Cowans Ford Dam.

Substituting the values yields $C \leq 2.80E-05$ $\mu\text{Ci/ml}$. Next multiply by the EMF 31 correlation factor of $3.02E+08$ (1EMF31) or $3.06E+08$ (2EMF31) cpm/ $\mu\text{Ci/ml}$: $2.80E-05 \times 3.02E+08$ (1EMF31) or $3.06E+08$ (2EMF31) = $8.46E+03$ cpm. Value is rounded down to $8.00E+03$ cpm for added conservatism.

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Table 3.0-1 Cs-137 Equivalents

Isotope	Equivalence Factor	Isotope	Equivalence Factor	Isotope	Equivalence Factor
Be-7	0.1282	Mo-99	0.3135	La-141	0.0132
F-18	0.5238	Tc-99m	0.5788	La-142	0.2785
Na-24	1.3013	Tc-101	0.00	Ce-141	0.4966
Cl-38	0.0068	Ru-103	1.1798	Ce-143	0.7066
K-40	0.0913	Ru-105	0.8673	Ce-144	0.1321
Cr-51	0.1207	Ru-106	0.4097	I-130	3.1610
Mn-54	1.0871	Ag-108m	3.2676	I-131	1.2074
Mn-56	0.4826	Ag-110m	3.5043	I-132	1.0137
Fe-59	0.9915	Cd-115	0.4739	I-133	1.0971
Co-57	0.8892	Cd-115m	0.0228	I-134	0.1396
Co-58	1.4883	In-115m	0.3048	I-135	0.8432
Co-60	1.8564	Sb-122	0.8691	Ar-41	0.1987
Cu-64	0.3577	Sb-124	2.0195	Kr-85	0.0054
Ni-65	0.1389	Sb-125	1.0467	Kr-85m	0.5240
Zn-65	0.5278	Sb-126	5.0018	Kr-87	0.1020
Zn-69m	0.9788	Sn-113	0.8413	Kr-88	0.4607
Se-75	1.9710	Sn-123	0.0062	Kr-89	0.00
Br-80m	0.0821	Sn-126	0.1747	Xe-131m	0.0211
Br-82	3.3664	Te-125m	0.0023	Xe-133	0.0520
Br-83	0.0054	Te-127	0.0116	Xe-133m	0.1176
Br-84	0.0056	Te-127m	0.0005	Xe-135	0.8334
Br-85	0.00	Te-129	0.0122	Xe-135m	0.00
Rb-86	0.0873	Te-129m	0.0526	Xe-137	0.00
Rb-88	0.00	Te-131	0.0016	Xe-138	0.00
Rb-89	0.00	Te-131m	1.9281	Nd-147	0.3706
Sr-89	0.0002	Te-132	1.0302	Hf-181	1.7053
Sr-91	0.6398	Te-134	0.0402	W-187	0.8499
Sr-92	0.3415	Cs-134	2.5843	Tl-208	0.00
Y-91	0.0028	Cs-136	3.1799	Bi-212	0.0140
Y-91m	0.0403	Cs-137	1.00	Bi-214	0.0003
Y-92	0.1281	Cs-138	0.0110	Pb-212	0.4507
Y-93	0.1009	Ba-133	1.2331	Pb-214	0.0018
Zr-95	1.1163	Ba-139	0.0255	Ra-226	0.0386
Zr-97	1.1163	Ba-140	0.5022	Ac-228	0.8370
Nb-95	1.1114	Ba-141	0.0002	Th-228	0.0090
Nb-95m	0.2929	Ba-142	0.00	Np-239	0.8989
Nb-97	0.1164	La-140	2.0586		

3.0.2 Gaseous Radiation Monitor Setpoint Calculations

In general, gaseous radiation monitors (EMFs) are calibrated to Xe-133, and for continuous release points, e.g., the two unit vents, are preset at a maximum value based on the 500 mrem/year total body gaseous release rate limit according to the following methodology. Note: when applied to the individual release points the 500 mrem/year site dose rate value is apportioned 40% to each unit vent, 7% to the Waste Handling Area, and 6.5% each to the Waste Management Facility and Unit 2 Staging Building.

$$K_{Xe-133} \times \chi / Q \times Q_{Xe-133} < 500 \text{ mrem/yr}$$

Solve for Q_{Xe-133} :

$$Q_{Xe-133} < \frac{500}{K_{Xe-133} \times \chi / Q} \quad \text{Equation 3.4}$$

From Equation 2.6:

$$Q_{Xe-133} = 472 \times C_{Xe-133} \times f \quad \text{Equation 3.5}$$

Substitute Equation 3.5 into Equation 3.4:

$$472 \times C_{Xe-133} \times f < \frac{500}{K_{Xe-133} \times \chi / Q}$$

Solve for C_{Xe-133} :

$$C_{Xe-133} < \frac{500}{472 \times f \times K_{Xe-133} \times \chi / Q}$$

$$SP = (C_{Xe-133} \times CF) + bkg \quad \text{Equation 3.6}$$

where:

K_{Xe-133} = 294, the total body dose factor due to gamma emissions for Xe-133, in mrem/year per $\mu\text{Ci}/\text{m}^3$ (See Appendix A).

χ/Q = the highest calculated annual average dispersion parameter for any area at or beyond the site boundary in sec/m^3 . For McGuire this value is $7.611\text{E}-5 \text{ sec}/\text{m}^3$. The location is the NNE sector at 0.5 mile.

Q_{Xe-133} = Xe-133 equivalent release rate limit for the noble gas total body dose pathway, in $\mu\text{Ci}/\text{sec}$.

- 472 = Conversion factor, (cc/ft³)/(sec/min).
- C_{Xe-133} = the maximum allowable Xe-133 equivalent concentration in the gaseous effluent, in $\mu\text{Ci/cc}$.
- f = the gaseous effluent flow from the tank, building, or vent, in ft³/min.
- SP = radiation monitor setpoint, in cpm.
- CF = the Xe-133 equivalent monitor correlation factor, in cpm/ $\mu\text{Ci/cc}$. The correlation factors are controlled by station procedures.
- bkg = the radiation monitor background reading, in cpm.

Equation 3.6 provides the methodology to calculate the maximum setpoint for continuous releases. However, most gaseous releases at McGuire are batch releases, e.g., Containment Purge (VP), in which the radiation monitor setpoint is calculated based on actual activity expected in the release. For batch releases with a low activity release rate, e.g., Containment Air Release and Addition (VQ), the expected monitor response is essentially no greater than the existing reading, and the trip setpoints are based on multiples of the existing cpm or a maximum based on flow rate. For batch releases where the effluent can contain activity significantly above background, e.g., Waste Gas Decay Tank (WGDT), the following setpoint methodology is used:

$$C_{Xe-133} = \sum (C_i \times Eq_i)$$

$$\text{Expected Cpm} = (C_{Xe-133} \times CF_{Xe-133}) + bkg \quad \text{Equation 3.7}$$

"Trip" setpoints are set based on a multiplier factor above the "expected" cpm calculated in Equation 3.7.

where:

C_{Xe-133} = Xe-133 equivalent concentration, in $\mu\text{Ci/ml}$.

Eq_i = Xe-133 equivalence factor for each isotope, excluding tritium, to that of Xe-133 due to different beta energies and abundance. (See Table 3.0-2).

All other parameters were previously defined.

3.0.2.1 CONTAINMENT AIR RELEASE AND ADDITION (VO) SETPOINTS (EMF 39)

As shown on Figure 2.0-4 and Figure 2.0-5, EMF 39 is the controlling radiation monitor for VQ releases from Containment to the Unit Vent. EMF 39 setpoints for VQ releases are calculated as follows:

Expected cpm = background = current reading

Trip 1 setpoint = any number between Expected cpm and Trip 2, normally $2 \times \text{Expected cpm}$

Trip 2 setpoint = $3 \times \text{Expected cpm}$ or $2.9\text{E}+04$ cpm (setpoint at VP maximum flow rate), whichever is largest, not to exceed $2.2\text{E}+06$ cpm. $2.2\text{E}+06$ cpm derived as follows:

From Equation 3.6

$$SP = (C_{Xe-133} \times CF) + bkg$$

where for a single unit vent release point:

$$C_{Xe-133} < \frac{200}{472 \times f \times K_{Xe-133} \times \chi/Q}$$

Substituting 300 cfm for the VQ flow rate (system max), 294 mrem/yr/ $\mu\text{Ci}/\text{m}^3$ for the total body Xe-133 dose factor (See Appendix A), and the values for all the other previously defined parameters:

$$C_{Xe-133} < \frac{200}{472 \times 300 \times 294 \times 7.611\text{E}-05}$$

$$C_{Xe-133} < 6.3\text{E}-02 \text{ } \mu\text{Ci}/\text{ml}$$

Substituting $3.54\text{E}+07$ cpm/ $\mu\text{Ci}/\text{ml}$ for the EMF 39 monitor correlation factor and given that background is negligible compared to the maximum Trip 2 setpoint yields:

$$SP = 6.3\text{E}-02 \times 3.54\text{E}+07 \cong 2.2\text{E}+06 \text{ cpm}$$

3.0.2.2 CONTAINMENT PURGE (VP) AND INCORE PURGE (IP) SETPOINTS (EMF 39, EMF 36)

As shown on Figure 2.0-4 and Figure 2.0-5, EMF 39 is the controlling radiation monitor for VP and IP releases from Containment to the Unit Vent.

For VP and IP low activity releases (i.e. $\text{Expected cpm} \leq 1.0\text{E}+04$ cpm) only EMF 39 setpoints are calculated. EMF 39 setpoints for VP and IP low activity releases are calculated as follows:

Expected cpm = background = current reading

Trip 1 setpoint = any number between Expected cpm and Trip 2, normally $2 \times \text{Expected cpm}$

Trip 2 setpoint = $2.9E+04$ cpm, derived as follows:

From Equation 3.6

$$SP = (C_{Xe-133} \times CF) + bkg$$

where for a single unit vent release point:

$$C_{Xe-133} < \frac{200}{472 \times f \times K_{Xe-133} \times \chi/Q}$$

Substituting $2.31E+04$ cfm for the VP flow rate, 294 mrem/yr/ $\mu\text{Ci}/\text{m}^3$ for the total body Xe-133 dose factor (See Appendix A), and the values for all the other previously defined parameters:

$$C_{Xe-133} < \frac{200}{472 \times 2.31E+04 \times 294 \times 7.611E-05}$$

$$C_{Xe-133} < 8.20E-04 \mu\text{Ci}/\text{ml}$$

Substituting $3.54E+07$ cpm/ $\mu\text{Ci}/\text{ml}$ for the EMF 39 monitor correlation factor and given that background is negligible compared to the maximum Trip 2 setpoint yields:

$$SP = 8.20E-04 \times 3.54E+07 \cong 2.9E+04 \text{ cpm}$$

Note: The flow rate used for VP is $2.31E+04$ cfm, but the same setpoint would be used for IP. The IP flow rate is 800 cfm, therefore the $2.9E+04$ cpm setpoint is conservative for IP.

For VP and IP high activity releases (i.e. Expected cpm $> 1.0E+04$ cpm) it may be necessary to give the "affected" unit (the unit making the VP or IP release) a greater allowable release rate than the 200 mrem/yr default value. For the VP and IP high activity cases, in addition to EMF 39 setpoints, the EMF 36 Trip 2 setpoint is calculated as follows:

$$EMF\ 36\ Expected\ CPM = \frac{VP \times EMF\ 39\ cpm \times 0.75}{(VP * + UV)}$$

where:

$EMF\ 39\ cpm$ = EMF 39 present or expected reading.

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0.75 = approximate value of EMF 36 correlation factor (2.60E+07)/EMF 39 correlation factor (3.54E+07).

UV = Unit Vent flow rate (cfm).

VP = VP calculated flow rate (cfm):

$$VP \text{ Flow Rate} = \frac{2.31E+04 \text{ cfm} \times 1.45E+04 \text{ cpm} \times M}{\text{Desired EMF 39 Trip 2 minus bkg (normally } 2.90E+04 \text{ cpm)}}$$

where:

2.31E+04 cfm = Full VP flow rate.

1.45E+04 cpm = cpm related to 100 mrem at full VP flow rate.

M = Multiplication factor for dose assignment to the affected unit vent. *M* can be ≥ 2 (= 200 mrem/yr), but, if > 2 , both unit vents together must be ≤ 4 (=400 mrem/yr). Note that increasing the Multiplication Factor is in effect giving the "affected" unit more of the station release rate limit, and decreasing the release rate limit for the "unaffected" unit.

*VP** indicates that VP flow is not used in the denominator if VP is already running.

$$\text{AFFECTED EMF 36 Trip 2} = \frac{M}{2} \times 4.10E+03 \text{ cpm}$$

where:

4.10E+03 cpm = Normal EMF 36 Trip 2 setpoint (derived below)

UNAFFECTED EMF 36 Trip 2 = 8.20E+03 cpm - AFFECTED EMF 36 Trip 2

where:

8.20E+03 cpm = Total cpm allowed for both unit vents ($2 \times 4.10E+03$).

4.10E+03 cpm is derived as follows:

From Equation 3.6

$$SP = (C_{Xe-133} \times CF) + bkg$$

where for a single unit vent release point:

$$C_{Xe-133} < \frac{200}{472 \times f \times K_{Xe-133} \times \chi/Q}$$

Substituting 1.20E+05 cfm for the UV flow rate, 294 mrem/yr/μCi/m³ for the total body Xe-133 dose factor (See Appendix A), and the values for all the other previously defined parameters:

$$C_{Xe-133} < \frac{200}{472 \times 1.20E+05 \times 294 \times 7.611E-05}$$

$$C_{Xe-133} < 1.58E-04 \text{ } \mu\text{Ci/ml}$$

Substituting 2.60E+07 cpm/μCi/ml for the EMF 36 monitor correlation factor and given that background is negligible compared to the maximum Trip 2 setpoint yields:

$$SP = 1.58E-04 \times 2.60E+07 = 4.10E+03 \text{ cpm}$$

3.0.2.3 WASTE GAS DECAY TANK (WGDT) SETPOINTS (EMF 50, EMF 36)

As shown on Figure 2.0-4 and Figure 2.0-5, EMF 50 (when operable) and EMF 36 (when EMF 50 is not operable) are the controlling radiation monitors for WGDT releases to the Unit Vent.

EMF 50 setpoints are based on actual tank activity, and are calculated as follows:

$$\text{Expected cpm} = (C_{Xe-133} \times CF_{Xe-133}) + bkg$$

$$\text{Trip 1 setpoint} = (C_{Xe-133} \times CF_{Xe-133} \times 1.5) + bkg$$

$$\text{Trip 2 setpoint} = (C_{Xe-133} \times CF_{Xe-133} \times 3.0) + bkg$$

where:

C_{Xe-133} = Xe-133 equivalent concentration, in μCi/ml.

CF_{Xe-133} = EMF 50 Xe-133 correlation factor, 1.75E+06 cpm/μCi/ml.

bkg = Background reading from EMF 50.

If the Xe-133 equivalent concentration is $\leq 5.71E-05$ μCi/ml, then 5.71E-05 is used in the Trip 1 and Trip 2 setpoint calculations. This is an indication of a low activity tank, and normal EMF fluctuation may cause Trip 2 alarms and release termination.

The unit vent gas radiation monitor, EMF 36, is used as the controlling monitor for WGDТ releases if EMF 50 is inoperable. In the rare occurrence that EMF 36 must be used as the controlling monitor for WGDТ releases only the "expected" cpm is calculated, and the EMF counts are monitored manually during the WGDТ release. The EMF 36 expected counts from WGDТ activity is calculated as follows:

$$Expected\ cpm = \frac{40\ cfm \times C_{Xe-133} \times CF_{Xe-133}}{F_{UV}} + bkg$$

where:

C_{Xe-133} = Xe-133 equivalent concentration, in $\mu Ci/ml$.

CF_{Xe-133} = EMF 36 Xe-133 correlation factor, $2.60E+07$ cpm/ $\mu Ci/ml$.

bkg = Background reading from EMF 36.

$40\ cfm$ = Maximum Waste Gas flow rate.

F_{UV} = Current Unit Vent (U1) flow rate.

Table 3.0-2

Xe-133 Equivalents

Isotope	EMF 36/39 Equivalence Factors	EMF 50 Equivalence Factors
Kr-83m	0	0
Kr-85m	2.48	7.60
Kr-85	2.56	7.24
Kr-87	2.93	8.73
Kr-88	2.78	8.20
Kr-89	2.93	8.73
Kr-90	2.93	8.73
Xe-131m	1.69	3.10
Xe-133m	1.99	4.50
Xe-133	1.00	1.00
Xe-135m	0.83	1.44
Xe-135	2.63	7.60
Xe-137	2.93	8.73
Xe-138	2.93	8.73
Ar-41	2.82	8.40
C-11	2.70	8.20

4.0 EFFLUENT DOSE MODELS

The effluent dose models used to show compliance with 10CFR50, Appendix I ALARA design objectives, 40CFR190 fuel cycle dose limits, and the dose values given in station SLCs are based on the methodology given in NUREG-0133 and Regulatory Guide 1.109. Dose contributions to the maximum individual shall be calculated at least every 31 days, quarterly, and annually using software which implements the ODCM methodology. The software is designed to automate many of the tasks required in the administration of effluent releases at McGuire and performs normal operation effluent dose assessment using NUREG-0133 and Regulatory Guide 1.109 methodology.

Station long-term historical and dose projection calculations are performed periodically to determine the station's status with respect to meeting annual ALARA goals specified in the McGuire SLCs. Such calculations are used to verify that adequate margin remains during a report period to allow normal station and radwaste system operation, including anticipated operational occurrences, for the remainder of the report period without exceeding applicable goals. Station 31-day dose projections that are used to assess the need to reduce effluent releases with the Gaseous Waste (WG) or Liquid Waste (WL) systems as required in the McGuire SLCs are estimated by the previous month's calculated dose results.

Fuel cycle dose calculations shall be performed annually or as required by special reports. Dose contributions shall be calculated using the software implementing the ODCM methodology.

4.0.1 LIQUID EFFLUENT DOSE MODEL FOR THE MAXIMUM EXPOSED INDIVIDUAL

Of the possible exposure pathways in the aquatic environment, only three contribute significantly to the total dose; these pathways are ingestion of potable water and aquatic foods, and direct exposure from radioactivity deposited on the shoreline. The dose contribution from these pathways for measured quantities of radioactive materials identified in liquid effluents released to unrestricted areas shall be calculated for the maximum exposed individual in each age group using the methodology provided in this section.

There are two liquid discharge points to the environment at McGuire; (1) the RC discharge point to Lake Norman, and (2) the WC and WWCB discharge point to the Catawba River downstream of Cowan's Ford Dam (See Figure 2.0-1). Liquid dose calculations for the maximum exposed individual are performed and documented in the ARERR for both locations using the applicable activity release and dilution data for each liquid effluent release point. The primary liquid effluent discharge point for McGuire is through RC to Lake Norman. In general, only low activity tritium releases (<1% station total) occur through the WC and WWCB discharge point to the Catawba River. Dose calculations are performed for each of the two liquid discharge points for dose reporting purposes. The highest calculated dose from the two dose calculations is used to define the maximum individual dose from liquid releases at McGuire.

Liquid Dose Calculations

Liquid permit Dose_{oa} is initially calculated using dilution flow based on number of RC pumps running. Liquid permit Dose_{oa} values are updated, typically for the ARERR, using actual monthly, quarterly, and annual RC average dilution flow. For individual liquid permits, Dose_{oa} is determined using C_i, Δt, and F_n during the period of release. Liquid 31-day dose projections to show compliance with SLC limits are performed for each liquid permit and determined by summing individual liquid permit Dose_{oa} values for the previous 31 days. Quarterly and Annual doses to show compliance with SLC limits are performed for each liquid permit and determined by summing individual liquid permit Dose_{oa} values for the applicable quarter and year-to-date.

The following equation is used for calculating liquid dose to the maximum exposed individual from each of the two liquid effluent release points:

$$Dose_{oa} = \sum_p \sum_i (A_{oapi} \times C_i) \times \Delta t \times F_n \qquad F_n = \frac{f}{f + F} \times \sigma$$

Formula: adapted from NUREG-0133, pages 15-17.		
Where:		
Dose _{oa}	The cumulative dose commitment for organ o and age group a, from the liquid effluent for the total time period, Δt. (mrem)	
A _{oapi}	Dose commitment factor for organ o, age group a, pathway p, and nuclide i (mrem/hr per μCi/ml). (See Appendices C through F for age group and pathway specific dose commitment factors).	
C _i	The average concentration of nuclide i, in undiluted liquid effluent during the time period, Δt. (μCi/ml)	
Δt	The length of time over which C _i and F _n are averaged for all liquid releases. (hr)	
F _n	The near field average dilution factor for C _i during the period of interest, Δt. Includes the recirculation factor. (dimensionless)	
f	Average liquid radwaste flow during the period of interest, Δt. (gpm)	
F	Average dilution flow during the period of interest, Δt. (gpm)	
	RC primary discharge location:	2.50E+05 gpm × # RC pumps running
	RC average dilution flow	
	WC discharge location: 10% of Cowans Ford Dam average dilution flow	
σ	Recirculation factor*. (dimensionless)	
	Lake Norman (RC) = 2.26 for fish, shoreline; = 1.26 for potable water	
	Catawba River (WC and WWCB) = 1.26 for fish, potable water, shoreline	

* The recirculation factor accounts for the fraction of discharged water reused by the station. The recirculation factors are based on methodology given in the McGuire Final Environmental Statement (10/1972), and historic annual average values based on 1990-1994 data. These values can be modified to account for deviations from average in a particular year for use in calculating maximum individual dose. A recirculation factor of 4.0 is currently being used for all pathways in the liquid dose calculation model for added conservatism.

Derivation of Liquid Dose Commitment Factors (A_{oapi})

Potable Water

$$A_{oapi} = 1.14 \times 10^5 \times \frac{U_{aw}}{D_w} \times D_{aoi} \times e^{-\lambda_i t_p}$$

Formula: from NUREG-0133, page 16, and Regulatory Guide 1.109, pg. 1.109-12.
Where:

A_{oapi}	Dose commitment factor for organ o, age group a, pathway p, and nuclide i, (mrem/hr per $\mu\text{Ci/ml}$). (See Appendices C through F for age group and pathway specific dose commitment factors).
1.14×10^5	Units conversion factor (pCi-yr-ml)/($\mu\text{Ci-hr-l}$).
U_{aw}	Water consumption rate in liters per year for age group a. From Table E-5, Regulatory Guide 1.109. Adult – 730 Teen – 510 Child – 510 Infant – 330
D_w	Dilution factor from the near field area to the potable water intake; =1.0 for McGuire.
D_{aoi}	Dose factor for age group a, organ o, nuclide i, in mrem/pCi. From tables E-11 through E-14 of Regulatory Guide 1.109.
λ_i	Decay constant for nuclide i, in sec^{-1} .
t_p	Environmental transit time from release to receptor. Default = $4.32\text{E}+04$ sec (12 hours). From Regulatory Guide 1.109, Table E-15.

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Aquatic Foods

$$A_{oapi} = 1.14 \times 10^5 \times U_{af} \times BF_i \times D_{aoi} \times e^{-\lambda_i t_p}$$

**Formula: from NUREG-0133, page 16, and Regulatory Guide 1.109, pg. 1.109-12.
Where:**

A_{oapi}	Dose commitment factor for organ o, age group a, pathway p, and nuclide i, (mrem/hr per $\mu\text{Ci/ml}$). (See Appendices C through F for age group and pathway specific dose commitment factors).
1.14×10^5	Units conversion factor (pCi-yr-ml)/($\mu\text{Ci-hr-l}$).
U_{af}	Fish consumption rate for age group a (kg/yr). From Table E-5, Regulatory Guide 1.109. Adult – 21 Teen – 16 Child – 6.9 Infant – 0
BF_i	Bioaccumulation factor for nuclide i, in fish, in units of (pCi/kg per pCi/liter). From Table A-1 of Regulatory Guide 1.109.
D_{aoi}	Dose factor for age group a, organ o, nuclide i, in mrem/pCi . From tables E-11 through E-14 of Regulatory Guide 1.109.
λ_i	Decay constant for nuclide i, in sec^{-1} .
t_p	Environmental transit time from release to receptor. Default = $8.64\text{E}+04$ sec (1 day). From Regulatory Guide 1.109, Table E-15.

Shoreline Sediment

$$A_{oapi} = 1.14 \times 10^5 \times 100 \times DFG_{oi} \times w \times U_{as} \times T_i^{\frac{1}{2}} \times e^{-\lambda_i t_p} \times (1 - e^{-\lambda_i t_b})$$

Formula: adapted from Regulatory Guide 1.109, page 1.109-14.

Where:

A_{oapi}	Dose commitment factor for organ o, age group a, pathway p, and nuclide i, (mrem/hr per $\mu\text{Ci/ml}$). (See Appendices C through F for age group and pathway specific dose commitment factors).
1.14×10^5	Units conversion factor (pCi-yr-ml)/($\mu\text{Ci-hr-l}$).
100	Proportionality constant used in the sediment radioactivity model, ($\text{liters}/(\text{m}^2\text{-day})$).
DFG_{oi}	Ground plane dose conversion factor for organ o, nuclide i (mrem/hr per pCi/m^2), from Table E-6 of Regulatory Guide 1.109.
w	Shoreline width factor. For McGuire = 0.3, from Table A-2, Regulatory Guide 1.109.
U_{as}	Shoreline exposure rate for age group a (hr/yr), From Table E-5, Regulatory Guide 1.109. Adult – 12 Teen – 67 Child – 14 Infant – 0
$T_i^{1/2}$	Nuclide half life for nuclide i, in days.
λ_i	Nuclide decay constant for nuclide i.
t_p	Average transit time to point of exposure (0 hours).
t_b	Sediment exposure time (15 years). Page 1.109-14.

4.0.2 GASEOUS EFFLUENT DOSE MODEL FOR THE MAXIMUM EXPOSED INDIVIDUAL

The dose contributions from measured quantities of radioactive materials identified in gaseous effluent released to unrestricted areas shall be calculated for the maximum gamma and beta air dose from noble gases, and for the maximum exposed individual from radioiodines, particulates, and others using the following equations:

Gaseous Dose Calculations

Noble Gas Dose Calculations

Gamma Air Dose

$$Dose_{\gamma} = 3.17 \times 10^{-8} \times \chi / Q \times \sum_i (M_i \times Q_i)$$

Formula: adapted from NUREG-0133, page 28.

Where:

$Dose_{\gamma}$	Gamma air dose for the time period of interest (mrad).
3.17×10^{-8}	Inverse number of seconds in year (year/seconds).
M_i	Gamma air dose factor due to gamma emissions for nuclide i (mrad/yr per $\mu\text{Ci}/\text{m}^3$). (See Appendix A).
χ/Q	The highest calculated annual average relative concentration for any area at or beyond the site boundary (sec/m^3). (See Table 6.0-8).
Q_i	Activity for nuclide i released during the time period of interest (μCi).

Beta Air Dose

$$Dose_{\beta} = 3.17 \times 10^{-8} \times \chi / Q \times \sum_i (N_i \times Q_i)$$

Formula: adapted from NUREG-0133, page 28.

Where:

$Dose_{\beta}$	Beta air dose for the time period of interest (mrad).
3.17×10^{-8}	Inverse number of seconds in year (year/seconds).
N_i	Beta air dose factor due to beta emissions for nuclide i (mrad/yr per $\mu\text{Ci}/\text{m}^3$). (See Appendix A).
χ/Q	The highest calculated annual average relative concentration for any area at or beyond the site boundary (sec/m^3). (See Table 6.0-8).
Q_i	Activity for nuclide i released during the time period of interest (μCi).

Iodine, Particulates, and H-3 Dose Organ Dose Calculation

$$Dose_{oa} = 3.17 \times 10^{-8} \times W \times \sum_p \sum_i (R_{oapi} \times Q_i)$$

Formula: adapted from NUREG-0133, pages 29 & 30.		
Where:		
Dose _{oa}	The cumulative dose commitment to the total body or any organ o, for an individual of age group a (mrem).	
3.17×10 ⁻⁸	Inverse number of seconds in year (year/seconds).	
R _{oapi}	Dose commitment factor for organ o, age group a, pathway p, and nuclide i. The units are based on whether a dispersion or deposition factor is used. When a χ/Q is used the units are mrem/yr per $\mu\text{Ci}/\text{m}^3$. When a D/Q is used the units are (m ² · mrem/yr) per $\mu\text{Ci}/\text{sec}$. (See Appendices G through J for age group and pathway specific dose commitment factors).	
W*	Dispersion (χ/Q) or deposition factor (D/Q). The factor used is based upon the pathway. Note: χ/Q is always used for tritium and C-14.	
	Pathway	Factor Used
	Ground Plane Deposition	D/Q (m ⁻²)
	Inhalation	χ/Q (sec/m ³)
	Vegetation	D/Q (m ⁻²)
	Grass/Cow/Milk	D/Q (m ⁻²)
	Grass/Goat/Milk	D/Q (m ⁻²)
	Grass/Cow/Meat	D/Q (m ⁻²)
	Grass/Goat/Meat	D/Q (m ⁻²)
Q _i **	Activity for nuclide i, released during the time period of interest (μCi).	

* Maximum individual organ dose is determined by calculating the organ dose at each of the χ/Q and D/Q locations shown in Table 6.0-8 and Table 6.0-9 (144 locations), and then choosing the maximum dose. Dose is calculated only for pathways (e.g., garden, milk animal, etc.) that actually exist at each location as determined by the land use census. The boundary for establishing gaseous effluent release limits is the Exclusion Area Boundary (EAB). As shown in McGuire UFSAR Figure 2-5, the EAB is defined as a 2500 foot (~0.5 mile) radius from the station center.

** C-14 airborne activity released to the environment is estimated based on actual power generation as discussed in Regulatory Guide 1.21, Revision 2. A value of 9.4 Ci/GWe-yr is used along with actual power generation to estimate C-14 activity released to the environment via gaseous effluents from McGuire. 9.4 Ci/GWe-yr is based on information from "Estimation of Carbon-14 in Nuclear Power Plant Gaseous Effluents", EPRI, Palo Alto, CA: 2010. 1021106.

Derivations of Iodine, Particulate, and H-3 Dose Commitment Factors (R_{oapi})

Ground Plane Deposition Pathway

$$R_{oapi} = K'K''(SF)DFG_{oi} \left[\frac{(1 - e^{-\lambda_i t})}{\lambda_i} \right]$$

Formula: from NUREG-0133, page 32.

Where:

R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for ground plane deposition pathway ($m^2 \cdot mrem/yr$ per $\mu Ci/sec$). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor $pCi/\mu Ci$ (10^6).
K''	Units conversion factor 8760 hr/year.
SF	Shielding factor (dimensionless) (0.7 , from Regulatory Guide 1.109).
DFG_{oi}	Ground plane dose conversion factor for organ o, nuclide i ($mrem/hr$ per pCi/m^2), from Table E-6 of Regulatory Guide 1.109.
λ_i	Nuclide decay constant for nuclide i (sec^{-1}).
t	Exposure time, 4.73×10^8 seconds (15 years).

Inhalation Pathway

$$R_{oapi} = K'(BR_a)(DFA_{oi})_a$$

Formula: from NUREG-0133, page 31.

Where:

R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for inhalation pathway ($mrem/yr$ per $\mu Ci/m^3$). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor $pCi/\mu Ci$ (10^6).
BR_a	Breathing rate for age group a (m^3/yr), from Regulatory Guide 1.109: Adult – 8000 Teen – 8000 Child – 3700 Infant – 1400
$(DFA_{oi})_a$	Organ inhalation factor dose conversion factor for organ o, nuclide i, age group a ($mrem/pCi$), from Tables E-7 through E-10 of Regulatory Guide 1.109.

Vegetation

$$R_{oapi} = K' \left[\frac{(r)}{Y_v(\lambda_i + \lambda_w)} \right] \times (DFL_{oi})_a \times \left[U_a^L f_L e^{-\lambda_i t_L} + U_a^S f_g e^{-\lambda_i t_h} \right]$$

Formula: from NUREG-0133, page 35. Where:

R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for vegetation pathway ($m^2 \cdot mrem/yr$ per $\mu Ci/sec$). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor $pCi/\mu Ci$ (10^6).
r	Fraction of deposited activity retained on vegetation, from Regulatory Guide 1.109. 1.0 for radioiodine. 0.2 for particulates.
Y_v	Vegetation areal density (kg/m^2) (2.0, from Regulatory Guide 1.109).
λ_i	Nuclide decay constant for nuclide i (sec^{-1}).
λ_w	Decay constant for removal of activity on leaf and plant surfaces by weathering ($5.73 \times 10^{-7} sec^{-1}$, from NUREG-0133).
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Reg. Guide 1.109 ($mrem/pCi$).
U_a^L	Consumption rate of fresh leafy vegetation for age group a (kg/yr) (from Regulatory Guide 1.109). Adult – 64 Teen – 42 Child – 26 Infant – 0
f_L	Fraction of annual intake of fresh leafy vegetation grown locally (1.0, from NUREG-0133).
t_L	Average time between harvest of leafy vegetation and consumption (8.6×10^4 seconds, (1 day), from Regulatory Guide 1.109).
U_a^S	Consumption rate of stored vegetation for age group a (kg/yr) (from Regulatory Guide 1.109). Adult – 520 Teen – 630 Child – 520 Infant – 0
f_g	Fraction of annual intake of stored vegetation (0.76, from Regulatory Guide 1.109).
t_h	Average time between harvest of stored vegetation and consumption (5.18×10^6 seconds, (60 days), from Regulatory Guide 1.109).

Vegetation – Tritium

$$R_{oapi} = K' K''' [U_a^L f_L + U_a^S f_g] (DFL_{oi})_a [0.75(0.5 / H)]$$

Formula: from NUREG-0133, page 36.

Where:

R_{oapi}	Dose commitment factor for organ o, age group a, for vegetation pathway and tritium (mrem/yr per $\mu\text{Ci}/\text{m}^3$). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor $\text{pCi}/\mu\text{Ci}$ (10^6).
K'''	Units conversion factor gm/kg (10^3).
U_a^L	Consumption rate of fresh leafy vegetation for age group a (kg/yr) (from Regulatory Guide 1.109). Adult – 64 Teen – 42 Child – 26 Infant – 0
f_L	Fraction of annual intake of fresh leafy vegetation grown locally (1.0, from NUREG-0133).
U_a^S	Consumption rate of stored vegetation for age group a (kg/yr) (from Regulatory Guide 1.109). Adult – 520 Teen – 630 Child – 520 Infant – 0
f_g	Fraction of annual intake of stored vegetation (0.76, from Regulatory Guide 1.109).
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Regulatory Guide 1.109 (mrem/pCi).
0.75	Fraction of total feed that is water. (From NUREG-0133).
0.5	Ratio of specific activity of feed grass water to atmospheric water. (From NUREG-0133).
H	Absolute humidity of the atmosphere ($8 \text{ gm}/\text{m}^3$, from Regulatory Guide 1.109).

Vegetation – Carbon-14

$$R_{oapi} = K'K'''[U_a^L f_L + U_a^S f_g](DFL_{oi})_a[0.11/0.16](p)(f_i)$$

Formula: from NUREG-0133, page 36 and Regulatory Guide 1.109, page 26.

Where:

R_{oapi}	Dose commitment factor for organ o, age group a, for vegetation pathway and carbon-14 (mrem/yr per $\mu\text{Ci}/\text{m}^3$). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor $\text{pCi}/\mu\text{Ci}$ (10^6).
K'''	Units conversion factor gm/kg (10^3).
U_a^L	Consumption rate of fresh leafy vegetation for age group a (kg/yr) (from Regulatory Guide 1.109). Adult – 64 Teen – 42 Child – 26 Infant – 0
f_L	Fraction of annual intake of fresh leafy vegetation grown locally (1.0, from NUREG-0133).
U_a^S	Consumption rate of stored vegetation for age group a (kg/yr) (from Regulatory Guide 1.109). Adult – 520 Teen – 630 Child – 520 Infant – 0
f_g	Fraction of annual intake of stored vegetation (0.76, from Regulatory Guide 1.109).
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Regulatory Guide 1.109 (mrem/pCi).
0.11	Fraction of total plant mass that is natural carbon.
0.16	Concentration of natural carbon in the atmosphere (gm/m^3).
p	Ratio of the total annual C-14 release time to the total annual time during which photosynthesis occurs. This value is assumed to be 0.31, based on 70% of C-14 releases being from WGDTs, and 30% of C-14 releases being continuous from the unit vents (ref. IAEA Technical Reports Series no. 421, "Management of Waste Containing Tritium and Carbon-14", 2004; EPRI TR-1024827, "Carbon-14 Dose Calculation Methods at Nuclear Power Plants", 2012, Section 3.2.5).
f_i	The fraction of C-14 assumed to be in inorganic form (e.g., CO_2). Assumed to be 20%. Reference EPRI TR-105715, "Characterization of Carbon-14 Generated by the Nuclear Power Industry", Table 5-1.

Grass/Cow/Milk

$$R_{oapi} = K' \frac{Q_F (U_{ap})}{\lambda_i + \lambda_w} F_{mi}(r) (DFL_{oi})_a \left[\frac{f_p f_s}{Y_p} + \frac{(1 - f_p f_s) e^{-\lambda_i t_h}}{Y_s} \right] e^{-\lambda_i t_f}$$

Formula: from NUREG-0133, pages 32 & 33. Where:

R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for grass/cow/milk pathway ($m^2 \cdot mrem/yr$ per $\mu Ci/sec$). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor $pCi/\mu Ci$ (10^6).
Q_F	Cow consumption rate (50 kg/day, from Regulatory Guide 1.109)
U_{ap}	Consumption rate of cow milk for age group a (liters/yr, from Regulatory Guide 1.109). Adult – 310 Teen – 400 Child – 330 Infant – 330
r	Fraction of deposited activity retained on cow's feed grass, (from Regulatory Guide 1.109). 1.0 for radioiodine. 0.2 for particulates.
Y_p	Agricultural productivity by unit area of pasture feed grass ($0.7 kg/m^2$, from Regulatory Guide 1.109).
Y_s	Agricultural productivity by unit area of stored feed ($2.0 kg/m^2$, from Regulatory Guide 1.109).
λ_i	Nuclide decay constant for nuclide i (sec^{-1}).
λ_w	Decay constant for removal of activity on leaf and plant surfaces by weathering ($5.73 \times 10^{-7} sec^{-1}$, from NUREG-0133).
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Regulatory Guide 1.109 ($mrem/pCi$).
F_{mi}	Stable element transfer coefficient for nuclide i, in days/liter, from Table E-1 of Regulatory Guide 1.109 for cow milk.
f_p	Fraction of year that the cow is on pasture (1.0, from RG 1.109).
f_s	Fraction of the cow feed that is pasture grass while the cow is on pasture (1.0, from Regulatory Guide 1.109).
t_f	Transport time for pasture to cow, to milk, to receptor ($1.73E+05$ seconds, from Regulatory Guide 1.109).
t_h	Transport time from pasture, to harvest, to cow, to milk, to receptor ($7.78E+06$ seconds, from Regulatory Guide 1.109).

Grass/Cow/Milk – Tritium

$$R_{oapi} = K' K''' F_{mi} Q_f U_{ap} (DFL_{io})_a [0.75(0.5 / H)]$$

Formula: from NUREG-0133, page 34.

Where:

R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for grass/cow/milk pathway (mrem/yr per $\mu\text{Ci}/\text{m}^3$). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor $\text{pCi}/\mu\text{Ci}$ (10^6).
K'''	Units conversion factor gm/kg (10^3).
Q_F	Cow consumption rate (50 kg/day, from Regulatory Guide 1.109).
U_{ap}	Consumption rate of cow milk for age group a (liters/yr, from Regulatory Guide 1.109). Adult – 310 Teen – 400 Child – 330 Infant – 330
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Regulatory Guide 1.109 (mrem/pCi).
F_{mi}	Stable element transfer coefficient for nuclide i, in days/liter, from Table E-1 of Regulatory Guide 1.109 for cow milk.
0.75	Fraction of total feed that is water (from NUREG-0133).
0.5	Ratio of specific activity of feed grass water to atmospheric water (from NUREG-0133).
H	Absolute humidity of the atmosphere ($8 \text{ gm}/\text{m}^3$, from Regulatory Guide 1.109).

Grass/Cow/Milk – Carbon-14

$$R_{oapi} = K' K'' F_{mi} Q_F U_{ap} (DFL_{oi})_a [0.11/0.16](p)(f_I)$$

Formula: from NUREG-0133, page 34 and Regulatory Guide 1.109, page 26.

Where:

R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for grass/cow/meat pathway (mrem/yr per $\mu\text{Ci}/\text{m}^3$). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor pCi/ μCi (10^6).
K''	Units conversion factor gm/kg (10^3).
F_{mi}	Stable element transfer coefficient for nuclide i, in days/liter, from Table E-1 of Regulatory Guide 1.109 for cow milk.
Q_F	Cow consumption rate (50 kg/day, from Regulatory Guide 1.109).
U_{ap}	Consumption rate of cow milk for age group a (liters/yr) (from Regulatory Guide 1.109). Adult – 310 Teen – 400 Child – 330 Infant – 330
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Regulatory Guide 1.109 (mrem/pCi).
0.11	Fraction of total plant mass that is natural carbon.
0.16	Concentration of natural carbon in the atmosphere (gm/m^3).
p	Ratio of the total annual C-14 release time to the total annual time during which photosynthesis occurs. This value is assumed to be 0.31, based on 70% of C-14 releases being from WGDTs, and 30% of C-14 releases being continuous from the unit vents (ref. IAEA Technical Reports Series no. 421, "Management of Waste Containing Tritium and Carbon-14", 2004; EPRI TR-1024827, "Carbon-14 Dose Calculation Methods at Nuclear Power Plants", 2012, Section 3.2.5).
f_I	The fraction of C-14 assumed to be in inorganic form (e.g., CO_2). Assumed to be 20%. Reference EPRI TR-105715, "Characterization of Carbon-14 Generated by the Nuclear Power Industry", Table 5-1.

Grass/Goat/Milk

$$R_{oapi} = K' \frac{Q_F (U_{ap})}{\lambda_i + \lambda_w} F_{mi}(r) (DFL_{oi})_a \left[\frac{f_p f_s}{Y_p} + \frac{(1 - f_p f_s) e^{-\lambda_i t_h}}{Y_s} \right] e^{-\lambda_i t_f}$$

Formula: from NUREG-0133, pages 32 & 33. Where:

R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for grass/goat/milk pathway ($m^2 \cdot mrem/yr$ per $\mu Ci/sec$). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor $pCi/\mu Ci$ (10^6).
Q_F	Goat consumption rate (6 kg/day, from Regulatory Guide 1.109).
U_{ap}	Consumption rate of goat milk for age group a (liters/yr, from Regulatory Guide 1.109). Adult – 310 Teen – 400 Child – 330 Infant – 330
r	Fraction of deposited activity retained on goat's feed grass, from Regulatory Guide 1.109. 1.0 for radioiodine. 0.2 for particulates.
Y_p	Agricultural productivity by unit area of pasture feed grass ($0.7 kg/m^2$, from Regulatory Guide 1.109).
Y_s	Agricultural productivity by unit area of stored feed ($2.0 kg/m^2$, from Regulatory Guide 1.109).
λ_i	Nuclide decay constant for nuclide i (sec^{-1}).
λ_w	Decay constant for removal of activity on leaf and plant surfaces by weathering ($5.73 \times 10^{-7} sec^{-1}$, from NUREG-0133).
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Regulatory Guide 1.109 ($mrem/pCi$).
F_{mi}	Stable element transfer coefficient for nuclide i, in days/liter, from Table E-2 of Regulatory Guide 1.109 for goat milk.
f_p	Fraction of year that the goat is on pasture (1.0, from RG 1.109).
f_s	Fraction of the goat feed that is pasture grass while the goat is on pasture (1.0, from Regulatory Guide 1.109).
t_f	Transport time for pasture to goat, to milk, to receptor ($1.73E+05$ seconds, from Regulatory Guide 1.109).
t_h	Transport time from pasture, to harvest, to goat, to milk, to receptor ($7.78E+06$ seconds, from Regulatory Guide 1.109).

Grass/Goat/Milk – Tritium

$$R_{oapi} = K' K''' F_{mi} Q_f U_{ap} (DFL_{oi})_a [0.75(0.5 / H)]$$

Formula: from NUREG-0133, page 34.

Where:

R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for grass/goat/milk pathway (mrem/yr per $\mu\text{Ci}/\text{m}^3$). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor $\text{pCi}/\mu\text{Ci}$ (10^6).
K'''	Units conversion factor gm/kg (10^3).
Q_F	Goat consumption rate (6 kg/day, from Regulatory Guide 1.109).
U_{ap}	Consumption rate of goat milk for age group a (liters/yr, from Regulatory Guide 1.109). Adult – 310 Teen – 400 Child – 330 Infant – 330
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Regulatory Guide 1.109 (mrem/pCi).
F_{mi}	Stable element transfer coefficient for nuclide i, in days/liter, from Table E-2 of Regulatory Guide 1.109 for goat milk.
0.75	Fraction of total feed that is water (from NUREG-0133).
0.5	Ratio of specific activity of feed grass water to atmospheric water (from NUREG-0133).
H	Absolute humidity of the atmosphere ($8 \text{ gm}/\text{m}^3$, from Regulatory Guide 1.109).

Grass/Goat/Milk – Carbon-14

$$R_{oapi} = K'K''' F_{mi} Q_F U_{ap} (DFL_{oi})_a [0.11/0.16](p)(f_I)$$

Formula: from NUREG-0133, page 34 and Regulatory Guide 1.109, page 26.

Where:

R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for grass/cow/meat pathway (mrem/yr per $\mu\text{Ci}/\text{m}^3$). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor $\text{pCi}/\mu\text{Ci}$ (10^6).
K'''	Units conversion factor gm/kg (10^3).
F_{mi}	Stable element transfer coefficient for nuclide i, in days/liter, from Table E-2 of Regulatory Guide 1.109 for goat milk (0.10).
Q_F	Goat consumption rate (6 kg/day, from Regulatory Guide 1.109).
U_{ap}	Consumption rate of goat milk for age group a (liters/yr) (from Regulatory Guide 1.109). Adult – 310 Teen – 400 Child – 330 Infant – 330
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Regulatory Guide 1.109 (mrem/pCi).
0.11	Fraction of total plant mass that is natural carbon.
0.16	Concentration of natural carbon in the atmosphere (gm/m^3).
p	Ratio of the total annual C-14 release time to the total annual time during which photosynthesis occurs. This value is assumed to be 0.31, based on 70% of C-14 releases being from WGDTs, and 30% of C-14 releases being continuous from the unit vents (ref. IAEA Technical Reports Series no. 421, "Management of Waste Containing Tritium and Carbon-14", 2004; EPRI TR-1024827, "Carbon-14 Dose Calculation Methods at Nuclear Power Plants", 2012, Section 3.2.5).
f_I	The fraction of C-14 assumed to be in inorganic form (e.g., CO_2). Assumed to be 20%. Reference EPRI TR-105715, "Characterization of Carbon-14 Generated by the Nuclear Power Industry", Table 5-1.

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Grass/Cow/Meat

$$R_{oapi} = K' \frac{Q_F (U_{ap})}{\lambda_i + \lambda_w} F_{fi}(r) (DFL_i)_a \left[\frac{f_p f_s}{Y_p} + \frac{(1 - f_p f_s) e^{-\lambda_i t_h}}{Y_s} \right] e^{-\lambda_i t_f}$$

Formula: from NUREG-0133, pages 34 & 35. Where:

R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for grass/cow/meat pathway ($m^2 \cdot mrem/yr$ per $\mu Ci/sec$). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor $pCi/\mu Ci$ (10^6).
Q_F	Cow consumption rate (50 kg/day, from Regulatory Guide 1.109).
U_{ap}	Consumption rate of cow meat for age group a (kg/yr, from Regulatory Guide 1.109). Adult – 110 Teen – 65 Child – 41 Infant – 0
r	Fraction of deposited activity retained on cow's feed grass (from Regulatory Guide 1.109). 1.0 for radioiodine. 0.2 for particulates.
Y_p	Agricultural productivity by unit area of pasture feed grass ($0.7 kg/m^2$, from Regulatory Guide 1.109).
Y_s	Agricultural productivity by unit area of stored feed ($2.0 kg/m^2$, from Regulatory Guide 1.109).
λ_i	Nuclide decay constant for nuclide i (sec^{-1}).
λ_w	Decay constant for removal of activity on leaf and plant surfaces by weathering ($5.73 \times 10^{-7} sec^{-1}$, from NUREG-0133).
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Regulatory Guide 1.109 ($mrem/pCi$).
F_{fi}	Stable element transfer coefficient for nuclide i, in days/kg, from Table E-1 of Regulatory Guide 1.109 for cow meat.
f_p	Fraction of year that the cow is on pasture (1.0, from RG 1.109).
f_s	Fraction of the cow feed that is pasture grass while the cow is on pasture (1.0, from Regulatory Guide 1.109).
t_f	Transport time from pasture to receptor ($1.73E+06$ seconds, from Regulatory Guide 1.109).
t_h	Transport time from crop field to receptor ($7.78E+06$ seconds, from Regulatory Guide 1.109).

Grass/Cow/Meat – Tritium

$$R_{oapi} = K' K''' F_{fi} Q_F U_{ap} (DFL_{oi})_a [0.75(0.5 / H)]$$

Formula: from NUREG-0133, page 35.

Where:

R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for grass/cow/meat pathway (mrem/yr per $\mu\text{Ci}/\text{m}^3$). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor $\text{pCi}/\mu\text{Ci}$ (10^6).
K'''	Units conversion factor gm/kg (10^3).
Q_F	Cow consumption rate (50 kg/day, from Regulatory Guide 1.109).
U_{ap}	Consumption rate of cow meat for age group a (kg/yr, from Regulatory Guide 1.109). Adult – 110 Teen – 65 Child – 41 Infant – 0
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Regulatory Guide 1.109 (mrem/pCi).
F_{fi}	Stable element transfer coefficient for nuclide i, in days/liter, from Table E-1 of Regulatory Guide 1.109 for cow meat.
0.75	Fraction of total feed that is water (from NUREG-0133).
0.5	Ratio of specific activity of feed grass water to atmospheric water (from NUREG-0133).
H	Absolute humidity of the atmosphere ($8 \text{ gm}/\text{m}^3$, from Regulatory Guide 1.109).

Grass/Cow/Meat – Carbon-14

$$R_{oapi} = K'K''' F_{fi} Q_F U_{ap} (DFL_{oi})_a [0.11/0.16](p)(f_I)$$

Formula: from NUREG-0133, page 35 and Regulatory Guide 1.109, page 26.

Where:

R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for grass/cow/meat pathway (mrem/yr per $\mu\text{Ci}/\text{m}^3$). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor $\text{pCi}/\mu\text{Ci}$ (10^6).
K'''	Units conversion factor gm/kg (10^3).
F_{fi}	Stable element transfer coefficient for nuclide i, in days/liter, from Table E-1 of Regulatory Guide 1.109 for cow meat.
Q_F	Cow consumption rate (50 kg/day, from Regulatory Guide 1.109).
U_{ap}	Consumption rate of cow meat for age group a (kg/yr) (from Regulatory Guide 1.109). Adult – 110 Teen – 65 Child – 41 Infant – 0
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Regulatory Guide 1.109 (mrem/pCi).
0.11	Fraction of total plant mass that is natural carbon.
0.16	Concentration of natural carbon in the atmosphere (gm/m^3).
p	Ratio of the total annual C-14 release time to the total annual time during which photosynthesis occurs. This value is assumed to be 0.31, based on 70% of C-14 releases being from WGDTs, and 30% of C-14 releases being continuous from the unit vents (ref. IAEA Technical Reports Series no. 421, "Management of Waste Containing Tritium and Carbon-14", 2004; EPRI TR-1024827, "Carbon-14 Dose Calculation Methods at Nuclear Power Plants", 2012, Section 3.2.5).
f_I	The fraction of C-14 assumed to be in inorganic form (e.g., CO_2). Assumed to be 20%. Reference EPRI TR-105715, "Characterization of Carbon-14 Generated by the Nuclear Power Industry", Table 5-1.

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Grass/Goat/Meat

$$R_{oapi} = K' \frac{Q_F (U_{ap})}{\lambda_i + \lambda_w} F_{fi}(r) (DFL_i)_a \left[\frac{f_p f_s}{Y_p} + \frac{(1 - f_p f_s) e^{-\lambda_i t_h}}{Y_s} \right] e^{-\lambda_i t_f}$$

Formula: from NUREG-0133, pages 34 & 35. Where:

R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for grass/goat/meat pathway ($m^2 \cdot mrem/yr$ per $\mu Ci/sec$). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor $pCi/\mu Ci$ (10^6).
Q_F	Goat consumption rate (6 kg/day, from Regulatory Guide 1.109).
U_{ap}	Consumption rate of goat meat for age group a (kg/yr, from Regulatory Guide 1.109). Adult – 110 Teen – 65 Child – 41 Infant – 0
r	Fraction of deposited activity retained on goat's feed grass (from Regulatory Guide 1.109). 1.0 for radioiodine. 0.2 for particulates.
Y_p	Agricultural productivity by unit area of pasture feed grass ($0.7 kg/m^2$, from Regulatory Guide 1.109).
Y_s	Agricultural productivity by unit area of stored feed ($2.0 kg/m^2$, from Regulatory Guide 1.109).
λ_i	Nuclide decay constant for nuclide i (sec^{-1}).
λ_w	Decay constant for removal of activity on leaf and plant surfaces by weathering ($5.73 \times 10^{-7} sec^{-1}$, from NUREG-0133).
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Regulatory Guide 1.109 ($mrem/pCi$).
F_{fi}	Stable element transfer coefficient for nuclide i, in days/kg, from Table E-1 of Regulatory Guide 1.109 for cow meat.
f_p	Fraction of year that the goat is on pasture (1.0, from RG 1.109).
f_s	Fraction of the goat feed that is pasture grass while the cow is on pasture (1.0, from Regulatory Guide 1.109).
t_f	Transport time from pasture to receptor ($1.73E+06$ seconds, from Regulatory Guide 1.109).
t_h	Transport time from crop field to receptor ($7.78E+06$ seconds, from Regulatory Guide 1.109).

Grass/Goat/Meat – Tritium

$$R_{oapi} = K' K''' F_{fi} Q_F U_{ap} (DFL_{oi})_a [0.75(0.5 / H)]$$

Formula: from NUREG-0133, page 35.

Where:

R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for grass/goat/meat pathway (mrem/yr per $\mu\text{Ci}/\text{m}^3$). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor $\text{pCi}/\mu\text{Ci}$ (10^6).
K'''	Units conversion factor gm/kg (10^3).
Q_F	Goat consumption rate (6 kg/day, from Regulatory Guide 1.109).
U_{ap}	Consumption rate of goat meat for age group a (kg/yr, from Regulatory Guide 1.109). Adult – 110 Teen – 65 Child – 41 Infant – 0
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Regulatory Guide 1.109 (mrem/pCi).
F_{fi}	Stable element transfer coefficient for nuclide i, in days/liter, from Table E-1 of Regulatory Guide 1.109 for cow meat.
0.75	Fraction of total feed that is water (from NUREG-0133).
0.5	Ratio of specific activity of feed grass water to atmospheric water (from NUREG-0133).
H	Absolute humidity of the atmosphere ($8 \text{ gm}/\text{m}^3$, from Regulatory Guide 1.109).

Grass/Goat/Meat – Carbon-14

$$R_{oapi} = K'K''' F_{fi} Q_F U_{ap} (DFL_{oi})_a [0.11/0.16](p)(f_I)$$

Formula: from NUREG-0133, page 35 and Regulatory Guide 1.109, page 26.

Where:

R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for grass/goat/meat pathway (mrem/yr per $\mu\text{Ci}/\text{m}^3$). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor $\text{pCi}/\mu\text{Ci}$ (10^6).
K'''	Units conversion factor gm/kg (10^3).
F_{fi}	Stable element transfer coefficient for nuclide i, in days/liter, from Table E-1 of Regulatory Guide 1.109 for cow meat.
Q_F	Goat consumption rate (6 kg/day, from Regulatory Guide 1.109).
U_{ap}	Consumption rate of goat meat for age group a (kg/yr) (from Regulatory Guide 1.109). Adult – 110 Teen – 65 Child – 41 Infant – 0
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Regulatory Guide 1.109 (mrem/pCi).
0.11	Fraction of total plant mass that is natural carbon.
0.16	Concentration of natural carbon in the atmosphere (gm/m^3).
p	Ratio of the total annual C-14 release time to the total annual time during which photosynthesis occurs. This value is assumed to be 0.31, based on 70% of C-14 releases being from WGDTs, and 30% of C-14 releases being continuous from the unit vents (ref. IAEA Technical Reports Series no. 421, "Management of Waste Containing Tritium and Carbon-14", 2004; EPRI TR-1024827, "Carbon-14 Dose Calculation Methods at Nuclear Power Plants", 2012, Section 3.2.5).
f_I	The fraction of C-14 assumed to be in inorganic form (e.g., CO_2). Assumed to be 20%. Reference EPRI TR-105715, "Characterization of Carbon-14 Generated by the Nuclear Power Industry", Table 5-1.

4.0.3 DIRECT RADIATION

Direct radiation is that radiation from confined sources, and does not include any external component from radioactive effluents. The point kernel method has been used to calculate offsite dose rates from radioactive materials stored in the refueling water storage tanks, reactor makeup water storage tanks, and temporary onsite radwaste storage tanks. Dose calculations using this method performed for McGuire Nuclear Station indicate direct radiation doses are much less than 0.01 mrem/yr and, therefore, make a negligible contribution to individual dose. Likewise, direct and air-scatter radiation dose contributions from the onsite Independent Spent Fuel Storage Installation (ISFSI) at McGuire have been calculated and documented in the McGuire 10CFR72.212 evaluation report. The results of the calculation demonstrate that the annual dose to any "real individual" beyond the controlled area boundary is below the 10CFR72.104(a) and 40CFR190.10(a) limit of 25 mrem from direct and skyshine radiation, and all other fuel cycle sources (e.g., effluent). Direct radiation doses will not be calculated routinely.

4.0.4 EFFLUENT APPORTIONMENT

For the McGuire Nuclear Station the effluent releases are apportioned equally to each unit for each site as recommended by Section 3.1 of NUREG-0133, because the shared radwaste treatment systems at each site make it impractical to accurately ascribe releases to a specific reactor unit. For Annual Radiological Effluent Release Report purposes effluent releases are summed for each unit, and the maximum individual dose to the public is reported as a site total.

5.0 FUEL CYCLE CALCULATIONS

In accordance with the requirements of 40CFR190, the annual dose commitment to any member of the general public shall be calculated to assure that doses are limited to 25 millirems to the total body or any organ with the exception of the thyroid which is limited to 75 millirems. In accordance with the requirements of the Selected Licensee Commitments, the annual dose commitment shall also be calculated any time twice the specified quarterly dose limit of the Selected Licensee Commitments is exceeded; these annual dose commitments may not just be calculated for the calendar year.

The "Uranium fuel cycle" is defined in 40CFR Part 190.02(b) as:

"Uranium fuel cycle means the operations of milling of uranium ore, chemical conversion of uranium, isotopic enrichment of uranium, fabrication of uranium fuel, generation of electricity by a light-water-cooled nuclear power plant using uranium fuel, and reprocessing of spent uranium fuel, to the extent that these directly support the production of electrical power for public use utilizing nuclear energy, but excludes mining operations, operations at waste disposal sites, transportation of any radioactive material in support of these operations, and the reuse of recovered non-uranium special nuclear and by-product materials from the cycle."

Based on this definition of the fuel cycle and the information in 10CFR51, Table S-3, and Wash-1248, the radiological impact of the following operations has been assessed for McGuire Nuclear Station:

5.0.1 MILLING

No milling operations occur within fifty miles of the McGuire Nuclear Station.

5.0.2 CONVERSION

No uranium hexafluoride production occurs within fifty miles of the McGuire Nuclear Station.

5.0.3 ENRICHMENT

No uranium enrichment operations occur within fifty miles of the McGuire Nuclear Station.

5.0.4 FUEL FABRICATION

No fuel fabrication operations occur within fifty miles of the McGuire Nuclear Station.

5.0.5 NUCLEAR POWER PRODUCTION

The production of electricity for public use using light-water-cooled nuclear power stations results in increments of dose to individuals within fifty miles of any station due to liquid and gaseous effluent releases and direct radiation or skyshine. The increments of dose resulting from liquid and gaseous effluent releases will be calculated using the software implementing the ODCM methodology. The dose from direct radiation, skyshine, and radiation from the station storage facilities has been estimated using conservative assumptions (see Section 4.0.3).

In certain situations more than one nuclear power station site may contribute to the doses to be considered in making fuel cycle dose assessments in accordance with 40CFR190. However, since the McGuire and Catawba nuclear stations are located approximately 30 miles apart the relative dose contribution from each site to the other is insignificant, and can be ignored in assessing compliance with 40CFR190.

5.0.6 FUEL REPROCESSING

No fuel reprocessing operations occur within fifty miles of the McGuire Nuclear Station.

5.0.7 40CFR190 TOTAL DOSE DETERMINATION

To summarize, only dose increments from nuclear power production operations (Section 5.0.5) need be considered in calculations to demonstrate compliance with the requirements of 40CFR190. The fuel cycle dose assessments for McGuire Nuclear Station only include liquid and gaseous dose contributions from McGuire and dose from McGuire's ISFSI since no other uranium fuel cycle facility contributes significantly to McGuire's maximum exposed individual. For this dose assessment, the total body and maximum organ dose contributions to the maximum exposed individual from McGuire's liquid and gaseous effluents are estimated using the following calculations:

$$D_{wb}(T) = D_{wb}(l) + D_{wb}(g)$$

$$D_{mo}(T) = D_{mo}(l) + D_{mo}(g)$$

where:

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

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

6.0 ENVIRONMENTAL LOCATIONS

6.0.1 SITE DESCRIPTION AND SAMPLE LOCATIONS

McGuire Nuclear Station is located geographically near the center of a highly industrialized region of the Carolinas. The land is predominantly rural non-farm with a small amount of land being used to support beef cattle and farming. Recreation in the area is confined mostly to the lake and shores of Lake Norman and Mountain Island reservoir. The McGuire site is in northwestern Mecklenburg County, North Carolina, 17 miles north-northwest of Charlotte, North Carolina. The site is bounded to the west by the Catawba River channel and to the north by 32,510 acre Lake Norman. Lake Norman is impounded by Duke Energy's Cowans Ford Dam Hydroelectric Station, which is located immediately west of the site and on the Catawba River channel. The tailwater of Cowans Ford Dam is the upper limit of Mountain Island Reservoir. Mountain Island Dam is located 15 miles downstream from the site. Lookout Shoals Hydroelectric Station is at the upper reaches of Lake Norman. Marshall Steam Station is located on the western shore of Lake Norman, approximately 16 miles upstream from the site. The site exclusion radius is 2500 feet.

Table 6.0-1 and Table 6.0-2 define the sampling and TLD locations for the McGuire Radiological Monitoring Program. Figure 6.0-1 and Figure 6.0-2 illustrate these locations as compared to McGuire Nuclear Station.

6.0.2 LAND USE CENSUS DATA

The Annual Land Use Census, required by Selected Licensee Commitments, is performed to ensure that changes in the use of areas at or beyond the site boundary are identified, and that modifications to the Radiological Environmental Monitoring Program are made if required by changes in land use. This census satisfies the requirements of Section IV.B.3 of Appendix I to 10CFR50. The land use census identifies nearest pathways to the exclusion area boundary (EAB, ~ 0.5 mile) for each of the 16 meteorological sectors. Global Positioning System field measurements are taken as close as possible to the item of interest and are accurate to within 2-5 meters. Locations beyond the nearest pathway for each sector are assumed to contain that pathway for dose calculation purposes. For the 4.5-5.0 mile sector all pathways, i.e., residence, garden, milk animal (goat), and meat animal (cow), are assumed to exist for dose calculation purposes. Results are maintained on file and data reviewed in accordance with procedure AD-CP-ALL-0014, Land Use Census Evaluation.

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TABLE 6.0-1

**MCGUIRE RADIOLOGICAL MONITORING PROGRAM
SAMPLING LOCATIONS**

Table 6.0-1 Codes			
W	Weekly	SM	Semimonthly
BW	BiWeekly	Q	Quarterly
M	Monthly	SA	Semiannually
C	Control		

Site #	Location Description	Air Rad. & Part.	Surface Water	Drinking Water	Shoreline Sediment	Food Products	Fish	Milk	Broad Leaf Veg.
101	North Mecklenburg Water Treatment Facility (3.31 mi E)			M					
102 C	Amity Church Road (9.89 mi WNW)	W							M (a)
106	Maintenance Training Facility (0.47 mi E)	W							
119	Mt. Holly Municipal Water Supply (7.40 mi SSW)			M					
120	HP Boathouse - Site Boundary (0.46 mi NNE)	W							M (a)
125	Settling Ponds - Site Boundary (0.38 mi SW)	W							M (a)
128	Discharge Canal (0.45 mi NE)		M						
129	Discharge Canal Entrance to Lake Norman (0.51 mi ENE)				SA		SA		
130	Hwy 73 Bridge Downstream (0.52 mi SW)				SA				
131	Cowans Ford Dam (0.64 mi WNW)		M						
132	Charlotte Municipal Water Supply (11.1 mi SSE)			M					
133	Cornelius (6.23 mi ENE)	W							
135 C	Plant Marshall Intake Canal (11.9 mi N)		M						
136 C	Mooresville Municipal Water Supply (12.7 mi NNE)			M					
137 C	Pinnacle Access Area (12.0 mi N)				SA		SA		
193	Site Boundary (0.19 mi N)								M (a)
195	Fishing Access Road (0.19 mi N)	W							

(a) When Available

* GPS data reflect approximate accuracy to within 2-5 meters. GPS field measurements were taken as close as possible to the item of interest.

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TABLE 6.0-2

**MCGUIRE RADIOLOGICAL MONITORING PROGRAM
SAMPLING LOCATIONS
(TLD SITES)**

Site #	Location	Distance	Sector	Site #	Location	Distance	Sector
143	SITE BOUNDARY	0.27 miles	NW	164	HAMBRIGHT & BEATTIES FORD ROAD	4.64 miles	SSE
144	SITE BOUNDARY	0.46 miles	NNE	165	ARTHER AUTEN ROAD	4.57 miles	S
145	SITE BOUNDARY	0.47 miles	NE	166	NECK ROAD REFUGE BOUNDARY	4.44 miles	SSW
146	SITE BOUNDARY	0.42 miles	ENE	167	LUCIA RIVERBEND HWY/ OLD FIREHOUSE	4.87 miles	SW
147	SITE BOUNDARY	0.44 miles	E	168	OLD PLANK ROAD BRIDGE	4.60 miles	WSW
148	SITE BOUNDARY	0.46 miles	ESE	169	GLOVER LANE	4.03 miles	W
149	SITE BOUNDARY	0.50 miles	SE	170	LITTLE EGYPT ROAD	4.32 miles	WNW
151	SITE BOUNDARY	0.37 miles	S	171	OLD HWY 16	3.95 miles	NW
152	SITE BOUNDARY	0.44 miles	SSW	172	LAKESHORE SOUTH RD & ISLAND VIEW COURT	4.69 miles	NNW
153	SITE BOUNDARY	0.47 miles	SW	173 SI	KEISTLER STORE / GLENWOOD ROAD	8.39 miles	NNW
154	SITE BOUNDARY	0.45 miles	W	174 SI	EAST LINCOLN JR. HIGH SCHOOL	8.85 miles	WNW
156	SITE BOUNDARY	0.44 miles	WNW	175 C	BOGER CITY	15.5 miles	WNW
189	SITE BOUNDARY	0.43 miles	SSE	177 SI	BELMARROW ROAD / COULWOOD COMMUNITY	8.77 miles	S
190	SITE BOUNDARY	0.37 miles	WSW	178 SI	APPRX. 0.25 MI NORTH OF LAKEVIEW RD/ DAVID COX RD ON HWY 115	9.36 miles	SE
157	THE POINTE/MOORESVILLE	4.69 miles	N	180 SI	MOORESVILLE WATER TREATMENT FACILITY	12.7 miles	NNE
158	BETHEL CHURCH ROAD	4.33 miles	NNE	181 SI	OLD DAVIDSON WATER TREATMENT FACILITY	7.02 miles	NE
159	HENDERSON ROAD	4.77 miles	NE	182 SI	CORNELIUS / AIR SITE # 133	6.23 miles	ENE
160	INTERSECTION OF HWY 21 & WESTMORELAND RD	4.89 miles	ENE	186 SI	MCGUIRE FISHING ACCESS ROAD ON PENINSULA	0.24 miles	NNW
161	SAM FURR ROAD & HWY 21	4.70 miles	E	187 SI	ENERGY EXPLORIUM / AIR SITE # 195	0.19 miles	N
162	RANSON ROAD	4.53 miles	ESE	191 SI	PENINSULA DEVELOPMENT / JOHN CONNOR ROAD	2.84 miles	NNE
163	MCCOY ROAD	4.94 miles	SE				

C = Control
SI = Special Interest

* GPS data reflect approximate accuracy to within 2-5 meters. GPS field measurements were taken as close as possible to the item of interest.

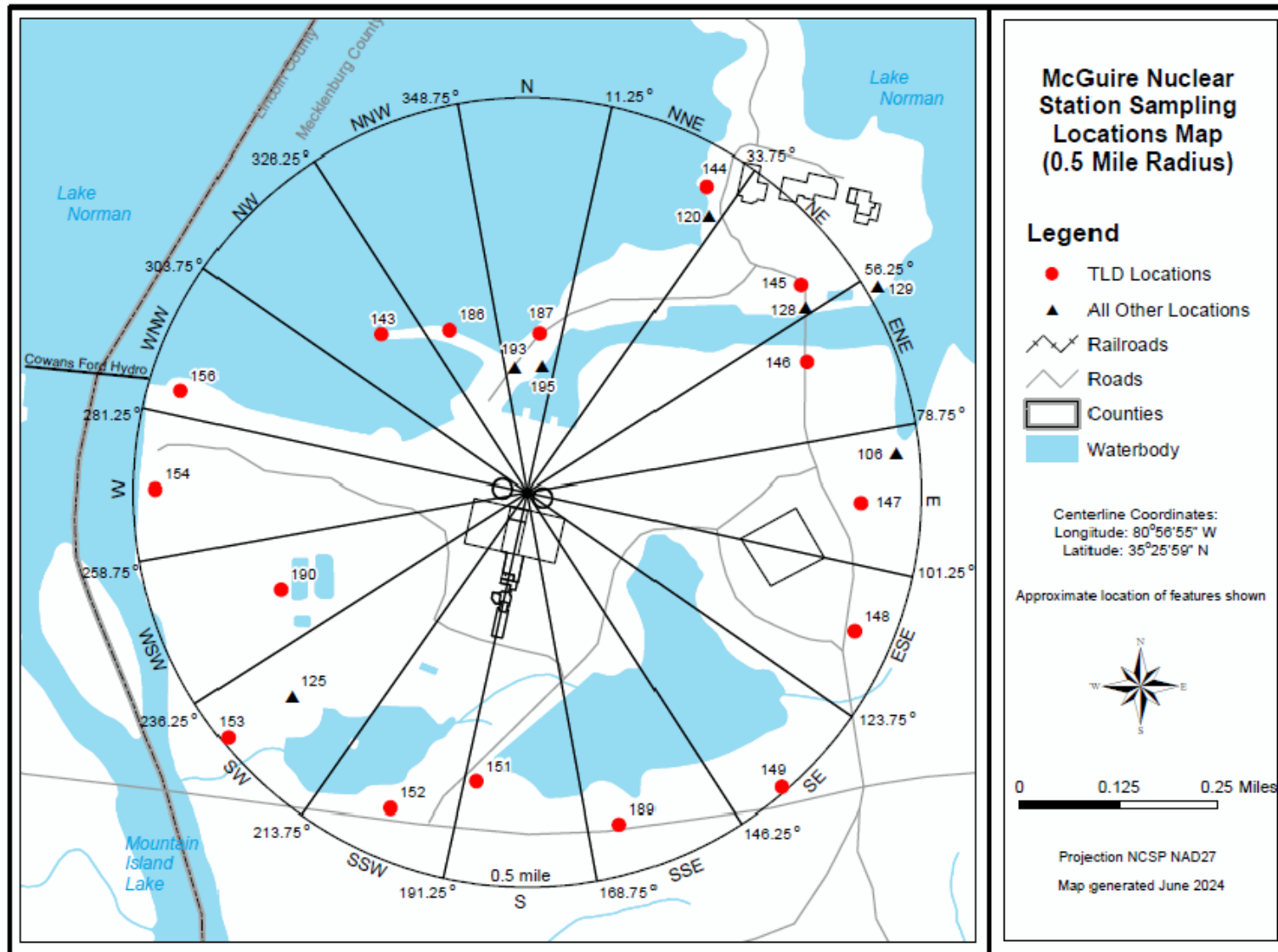
TABLE 6.0-3

Land Use Census Results

Deleted in ODCM Revision 58.

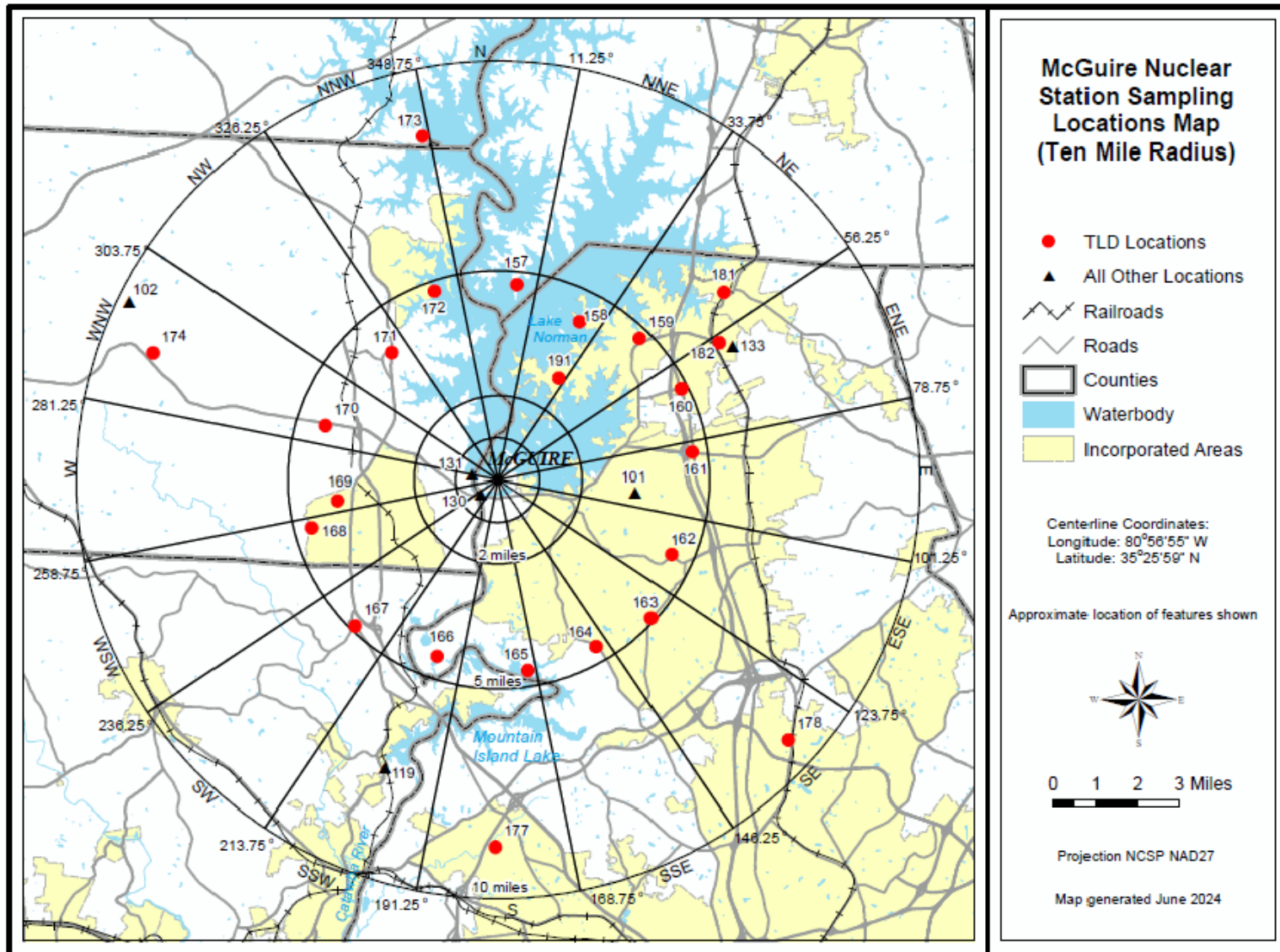
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Figure 6.0-1 Sampling Locations Map (Site Boundary)



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Figure 6.0-2 Sampling Locations Map (Ten Mile Radius)



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Figure 6.0-3 Sampling Locations Map (>Ten Mile Radius)

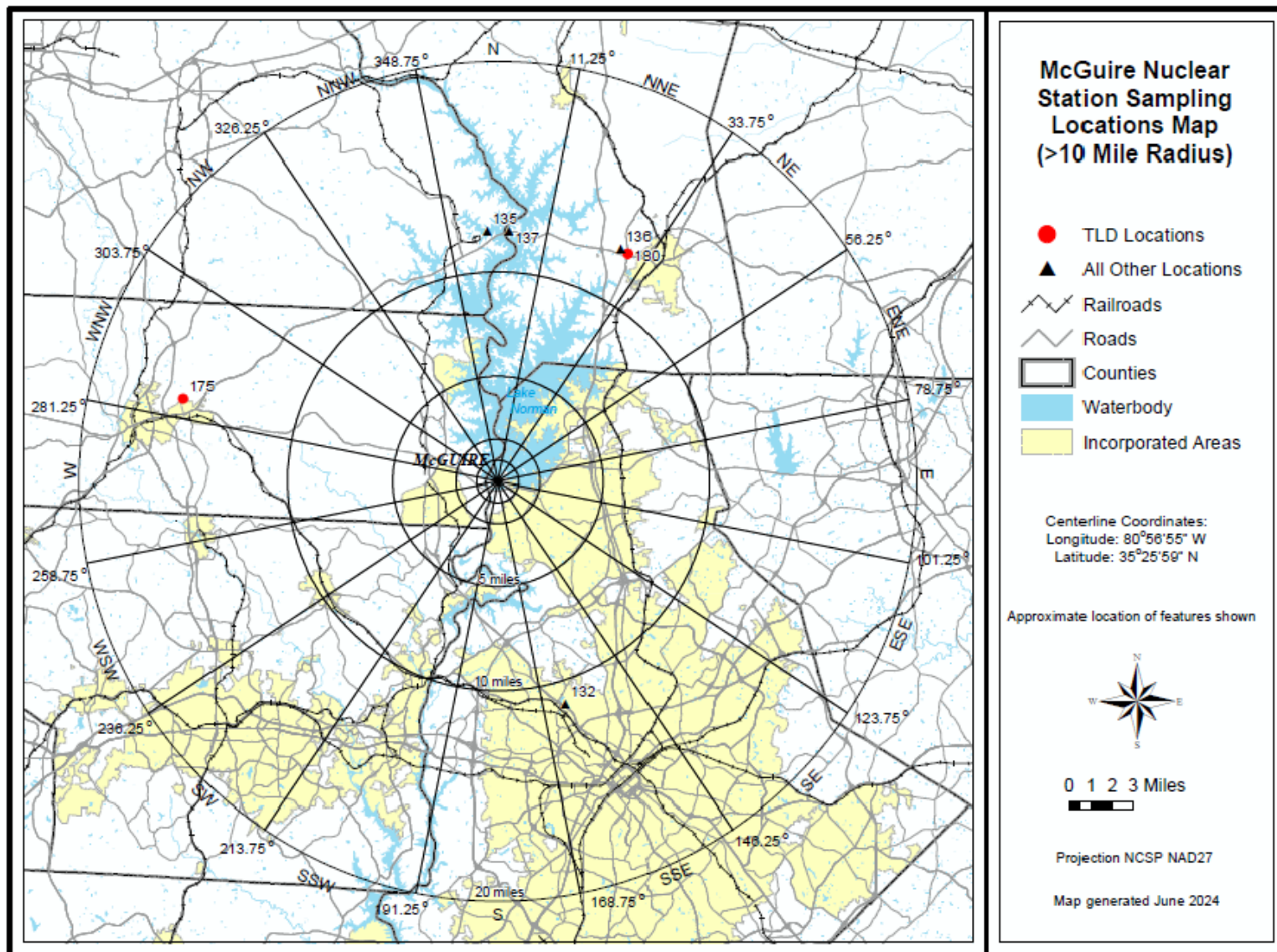


Figure 6.0-4 Land Use Census Map

Deleted in ODCM Revision 58.

6.0.3 MCGUIRE METEOROLOGY: RELATIVE AIR CONCENTRATIONS AND DEPOSITION

Calculations of annually averaged air concentrations and deposition values from routine releases provide the air dispersion and deposition factors needed for dose assessment. The methodology is based upon Regulatory Guide 1.111, as implemented by the NRC's computer model "XOQDOQ: Computer Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations," NUREG/CR-2919, PNL-4380, September 1982.

Five years of hourly meteorological data from the onsite instruments are processed into a representative joint frequency distribution of winds and atmospheric stability for input into the XOQDOQ model (Version 2.0). Thus, the air dispersion and deposition factors (χ/Q and D/Q) output by the model are based on a five-year climatology for the site.

6.0.3.1 XOQDOQ METHODOLOGY AND ASSUMPTIONS

A continuous, routine release (non-purge) is simulated from each unit vent. The release type is treated as "ground-level" in the model, for which surrounding terrain elevations are not input. The locale does consist of gently rolling terrain, so the default open terrain recirculation factor is applied in XOQDOQ [$KOPT(8)=1$]. This correction factor is recommended in RG 1.111 to adjust the straight-line airflow of the model for spatial and temporal variations that are produced by large scale weather patterns, or other non-linear flow conditions at local and regional scales.

In order for XOQDOQ to treat the plume as a ground-level release, the exit velocity and the inside diameter of the unit vent must be input as zero. The heat emission rate of each vent is also assumed to be zero, as recommended by the model. The height of the vent (40.2 m) above plant grade elevation (760 ft msl) is then used to determine the plume centerline height. Using the building height (43.1 m) and minimum cross-sectional area of the containment building (1616 m²), XOQDOQ applies a building wake correction to the relative air concentrations from the ground level release.

Calculations of relative air concentrations and deposition are made for grid receptor distances per sector. The "no decay" assumption is used in the XOQDOQ model.

6.0.3.2 METEOROLOGICAL DATA

Five years (1988-1992) of hourly, onsite meteorological data are used to produce the joint frequency distributions of wind speed and direction per stability class. The 10 m level winds are used. It is these joint frequency distributions which are input to the XOQDOQ model. Hours of calm winds are distributed by direction with the same frequency as the lowest "noncalm" wind speed class [$KOPT(1)=1$]. Thus, wind speed classes are established so that the lowest wind speed class is the starting threshold of the anemometer (i.e. the "calm" wind speed class). The largest wind speed class has the upper bound of

(5 m/s + max hourly wind speed). Stability classes (A-G) are based on the vertical temperature gradient, measured by the hourly averaged delta-T variable.

6.0.3.3 ANNUAL XOODOO COMPARISON TO THE ODCM

Each year, the prevailing winds and stability class frequencies for MNS are compared to the 5-year period (1988-1992) upon which the χ/Q and D/Q calculations have been made. The 5-year climatology is summarized in Table 6.0-4 and Table 6.0-5 below. Since the comparison is being made to a 5-year climatology, significant differences should not occur in the meteorological variables of concern (i.e. winds and delta-T). The meteorological comparison serves to verify this assumption.

Table 6.0-4

MNS Atmospheric Stability Frequency (1988-1992)

	A	B	C	D	E	F	G
Frequency (%)	13.8	4.7	6.1	33.8	19.3	8.0	14.3

Table 6.0-5

MNS Frequency of Wind Direction (From) and Speed (1988-1992)

Sector	Wind Direction Frequency (%)	Wind Speed Class (m/s)	Wind Speed Frequency (%)
N	5.6	CALM	1.3
NNE	8.8	0.45 - 0.74 m/s	4.3
NE	11.0	0.75 - 0.99 m/s	7.3
ENE	5.8	1.00 - 1.24 m/s	5.8
E	1.6	1.25 - 1.49 m/s	6.7
ESE	1.5	1.50 - 1.99 m/s	12.9
SE	2.3	2.00 - 2.99 m/s	23.5
SSE	3.2	3.00 - 3.99 m/s	17.0
S	13.2	4.00 - 4.99 m/s	10.8
SSW	17.9	5.00 - 5.99 m/s	5.6
SW	9.0	6.00 - 7.99 m/s	3.8
WSW	5.0	8.00 - 9.99 m/s	0.6
W	3.9	> 9.99 m/s	0.4
WNW	4.2		
NW	3.5		
NNW	3.5		

The joint frequency distributions of wind speed and direction versus atmospheric stability class are also determined from the annual data to provide input to the XOQDOQ model. Modeled χ/Q and D/Q values for the 0.5 mile Exclusion Area Boundary at MNS are compared to the maximum of the (1988-1992) χ/Q and D/Q values from all sectors. If the newly calculated annual dispersion and deposition values do not result in a significant increase in the calculated offsite dose relative to the 10CFR50, Appendix I dose objectives then the 5-year χ/Q and D/Q values used in the Annual Radiological Effluent Release Report (ARERR) are not revised. An increase in calculated offsite dose that is greater than five percent of the 10CFR50, Appendix I dose objectives would be considered significant enough to warrant a change in the χ/Q and D/Q values used in the ARERR. If an increasing trend in the annual χ/Q and D/Q values compared to the 5-year values is noted then a revised set of 5-year χ/Q and D/Q values will be generated. These limiting values are listed in Table 6.0-6. The entire χ/Q and D/Q list based on directional sector and distance is given in Table 6.0-8 and 6.0-9.

Table 6.0-6
MNS Limiting χ/Q and D/Q Values (1988-1992)

	$(\chi/Q, \text{s/m}^3)$ $(D/Q, \text{1/m}^2)$	Distance	Sector
Maximum χ/Q	7.611E-5	0.5 mile EAB	NNE
Maximum D/Q	1.403E-7	0.5 mile EAB	NNE

Note:

The McGuire 40 m tall meteorological tower was replaced with a new 60 m meteorological tower in August 1998 and relocated on site. The 60 m tower became operational at hour 0000 on September 1, 1998. Determination of atmospheric stability prior to this time uses the 30 m separation criteria shown in Table 6.0-7, while data after this time uses the 50 m separation criteria.

Table 6.0-7
MNS Delta-T Ranges per Vertical Separation Distances

Stability Class	30 m separation Delta-T (between 40m-10m levels)	50 m separation Delta-T (between 60m-10m levels) Starting at hour 0000 on SEPT 1, 1998.
A	$dT < -0.57$	$dT < -0.95$
B	$-0.57 < dT < -0.51$	$-0.95 < dT < -0.85$
C	$-0.51 < dT < -0.45$	$-0.85 < dT < -0.75$
D	$-0.45 < dT < -0.15$	$-0.75 < dT < -0.25$
E	$-0.15 < dT < 0.45$	$-0.25 < dT < 0.75$
F	$0.45 < dT < 1.2$	$0.75 < dT < 2.00$
G	$1.2 < dT$	$2.00 < dT$

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Comparison of concurrent data from both the 40 m and 60 m McGuire meteorological towers was made for a limited period of simultaneous operation (August 19 to September 10, 1998) prior to termination of the historical 40 m tower. Results were documented in the Corrective Action Program (NCR 01697913 or PIP M-98-1240).

The analysis indicated the 40m tower was subject to microscale terrain related impacts due to its location below the dam elevation, near plant buildings. The current 60 m tower location north McGuire has an open exposure and is more representative of regional meteorological conditions.

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Table 6.0-8

McGuire χ/Q Average Values (1988-1992)
(sec/m³)

Sector	0.5-1.0*	1.0-1.5	1.5-2.0	2.0-2.5	2.5-3.0	3.0-3.5	3.5-4.0	4.0-4.5	4.5-5.0
N	4.795E-05	1.220E-05	5.144E-06	2.879E-06	1.871E-06	1.333E-06	1.009E-06	7.985E-07	6.529E-07
NNE	7.611E-05	1.910E-05	8.103E-06	4.553E-06	2.968E-06	2.118E-06	1.607E-06	1.274E-06	1.043E-06
NE	5.330E-05	1.329E-05	5.662E-06	3.191E-06	2.084E-06	1.490E-06	1.132E-06	8.978E-07	7.357E-07
ENE	2.950E-05	7.487E-06	3.166E-06	1.776E-06	1.155E-06	8.237E-07	6.243E-07	4.943E-07	4.044E-07
E	1.742E-05	4.506E-06	1.884E-06	1.049E-06	6.787E-07	4.818E-07	3.638E-07	2.872E-07	2.344E-07
ESE	1.206E-05	3.143E-06	1.303E-06	7.209E-07	4.646E-07	3.288E-07	2.476E-07	1.951E-07	1.589E-07
SE	7.697E-06	2.011E-06	8.234E-07	4.521E-07	2.897E-07	2.040E-07	1.531E-07	1.202E-07	9.763E-08
SSE	6.179E-06	1.613E-06	6.504E-07	3.533E-07	2.246E-07	1.572E-07	1.173E-07	9.173E-08	7.421E-08
S	6.262E-06	1.581E-06	6.263E-07	3.363E-07	2.120E-07	1.475E-07	1.095E-07	8.525E-08	6.872E-08
SSW	7.346E-06	1.836E-06	7.234E-07	3.872E-07	2.435E-07	1.690E-07	1.253E-07	9.745E-08	7.847E-08
SW	8.606E-06	2.206E-06	8.483E-07	4.456E-07	2.759E-07	1.890E-07	1.386E-07	1.066E-07	8.508E-08
WSW	6.424E-06	1.671E-06	6.526E-07	3.466E-07	2.165E-07	1.493E-07	1.101E-07	8.519E-08	6.829E-08
W	3.523E-06	9.147E-07	3.697E-07	2.012E-07	1.281E-07	8.973E-08	6.705E-08	5.245E-08	4.247E-08
WNW	4.063E-06	1.071E-06	4.351E-07	2.376E-07	1.516E-07	1.064E-07	7.963E-08	6.238E-08	5.056E-08
NW	5.543E-06	1.448E-06	5.898E-07	3.226E-07	2.061E-07	1.448E-07	1.085E-07	8.504E-08	6.898E-08
NNW	1.053E-05	2.735E-06	1.131E-06	6.250E-07	4.024E-07	2.845E-07	2.141E-07	1.686E-07	1.372E-07

* Units are in miles from the station. Each χ/Q value is calculated at the closest location for the sector, e.g., 4.795E-05 sec/m³ is the χ/Q value at 0.5 miles (N) from the station. The boundary for establishing gaseous effluent release limits is the Exclusion Area Boundary (EAB). As shown in McGuire UFSAR Figure 2-5, the EAB is defined as a 2500 foot (~0.5 mile) radius from the station center.

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Table 6.0-9

**McGuire D/Q Average Values (1988-1992)
(m⁻²)**

Sector	0.5-1.0*	1.0-1.5	1.5-2.0	2.0-2.5	2.5-3.0	3.0-3.5	3.5-4.0	4.0-4.5	4.5-5.0
N	1.031E-07	2.516E-08	9.037E-09	4.482E-09	2.639E-09	1.728E-09	1.216E-09	9.011E-10	6.944E-10
NNE	1.403E-07	3.424E-08	1.230E-08	6.100E-09	3.592E-09	2.352E-09	1.655E-09	1.226E-09	9.451E-10
NE	7.027E-08	1.715E-08	6.161E-09	3.055E-09	1.799E-09	1.178E-09	8.289E-10	6.143E-10	4.734E-10
ENE	3.893E-08	9.504E-09	3.414E-09	1.693E-09	9.969E-10	6.527E-10	4.593E-10	3.404E-10	2.623E-10
E	3.024E-08	7.381E-09	2.651E-09	1.315E-09	7.742E-10	5.069E-10	3.567E-10	2.643E-10	2.037E-10
ESE	3.299E-08	8.052E-09	2.892E-09	1.434E-09	8.445E-10	5.530E-10	3.891E-10	2.884E-10	2.222E-10
SE	2.733E-08	6.673E-09	2.397E-09	1.189E-09	6.999E-10	4.583E-10	3.225E-10	2.390E-10	1.842E-10
SSE	2.765E-08	6.749E-09	2.424E-09	1.202E-09	7.079E-10	4.635E-10	3.262E-10	2.417E-10	1.863E-10
S	4.360E-08	1.064E-08	3.823E-09	1.896E-09	1.116E-09	7.309E-10	5.143E-10	3.811E-10	2.937E-10
SSW	6.929E-08	1.691E-08	6.075E-09	3.013E-09	1.774E-09	1.162E-09	8.174E-10	6.058E-10	4.668E-10
SW	8.605E-08	2.100E-08	7.545E-09	3.742E-09	2.203E-09	1.443E-09	1.015E-09	7.523E-10	5.797E-10
WSW	4.562E-08	1.114E-08	4.000E-09	1.984E-09	1.168E-09	7.648E-10	5.382E-10	3.988E-10	3.073E-10
W	1.268E-08	3.094E-09	1.112E-09	5.512E-10	3.246E-10	2.125E-10	1.495E-10	1.108E-10	8.541E-11
WNW	1.213E-08	2.962E-09	1.064E-09	5.276E-10	3.107E-10	2.034E-10	1.431E-10	1.061E-10	8.175E-11
NW	1.785E-08	4.358E-09	1.565E-09	7.763E-10	4.571E-10	2.993E-10	2.106E-10	1.561E-10	1.203E-10
NNW	2.520E-08	6.152E-09	2.210E-09	1.096E-09	6.453E-10	4.225E-10	2.973E-10	2.203E-10	1.698E-10

* Units are in miles from the station. Each D/Q value is calculated at the closest location for the sector, e.g., 1.031E-07 m⁻² is the D/Q value at 0.5 miles (N) from the station. The boundary for establishing gaseous effluent release limits is the Exclusion Area Boundary (EAB). As shown in McGuire UFSAR Figure 2-5, the EAB is defined as a 2500 foot (~0.5 mile) radius from the station center.

7.0 LICENSEE INITIATED CHANGES

All ODCM changes are reviewed by knowledgeable individual(s), and approved by either the Station Manager or Radiation Protection Manager. The changes below do not adversely impact the accuracy or reliability of effluent, dose, or setpoint calculations.

ODCM Revision 63 - Implementation Date: 6/24/2024

ODCM Revision 63 was approved by the Radiation Protection Manager. Changes driven by Document Revision Requests (DRR) are noted with DRR number.

Section 6 - Page 3

Airborne Radioiodine and Particulate sample point 121-Guardhouse removed from the MNS REMP Program. Sample point is supplemental and not SLC required. Change made per DRR 02519501

Section 6 - Page 3

Drinking Water sample point 194-East Lincoln County Water Supply removed from the MNS REMP Program. Sample point is supplemental and not SLC required. Change made per DRR 02519501

Appendix I Ri Child GoatCow Meat

Corrected page numbering. Change made per DRR 02519501

APPENDIX A

Dose Factors for Exposure to a Semi-Infinite Cloud of Noble Gases*

Nuclide	K_i Total Body mrem/yr $\mu\text{Ci}/\text{m}^3$	L_i Skin mrem/yr $\mu\text{Ci}/\text{m}^3$	M_i Gamma Air mrad/yr $\mu\text{Ci}/\text{m}^3$	N_i Beta Air mrad/yr $\mu\text{Ci}/\text{m}^3$
AR-41	8.840E+03	2.690E+03	9.300E+03	3.280E+03
KR-83M	7.560E-02	0.000E+00	1.930E+01	2.880E+02
KR-85M	1.170E+03	1.460E+03	1.230E+03	1.970E+03
KR-85	1.610E+01	1.340E+03	1.720E+01	1.950E+03
KR-87	5.920E+03	9.730E+03	6.170E+03	1.030E+04
KR-88	1.470E+04	2.370E+03	1.520E+04	2.930E+03
KR-89	1.660E+04	1.010E+04	1.730E+04	1.060E+04
KR-90	1.560E+04	7.290E+03	1.630E+04	7.830E+03
XE-131M	9.150E+01	4.760E+02	1.560E+02	1.110E+03
XE-133M	2.510E+02	9.940E+02	3.270E+02	1.480E+03
XE-133	2.940E+02	3.060E+02	3.530E+02	1.050E+03
XE-135M	3.120E+03	7.110E+02	3.360E+03	7.390E+02
XE-135	1.810E+03	1.860E+03	1.920E+03	2.460E+03
XE-137	1.420E+03	1.220E+04	1.510E+03	1.270E+04
XE-138	8.830E+03	4.130E+03	9.210E+03	4.750E+03

* Reference Regulatory Guide 1.109, Table B-1

APPENDIX B

P_i Dose Factors for use in the Gaseous Release Rate Limit Calculations

Agegroup:	CHILD	Pathway:	Inhalation (INHL)			Units:	mrem/yr / $\mu\text{Ci}/\text{m}^3$	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
H-3	0.000E+00	1.120E+03	1.120E+03	1.120E+03	1.120E+03	1.120E+03	0.000E+00	1.120E+03
C-14	3.590E+04	6.730E+03	6.730E+03	6.730E+03	6.730E+03	6.730E+03	0.000E+00	6.730E+03
NA-24	1.610E+04	1.610E+04	1.610E+04	1.610E+04	1.610E+04	1.610E+04	0.000E+00	1.610E+04
P-32	2.600E+06	1.140E+05	0.000E+00	0.000E+00	0.000E+00	4.220E+04	0.000E+00	9.880E+04
CR-51	0.000E+00	0.000E+00	8.550E+01	2.430E+01	1.700E+04	1.080E+03	0.000E+00	1.540E+02
MN-54	0.000E+00	4.290E+04	0.000E+00	1.000E+04	1.580E+06	2.290E+04	0.000E+00	9.510E+03
MN-56	0.000E+00	1.660E+00	0.000E+00	1.670E+00	1.310E+04	1.230E+05	0.000E+00	3.120E-01
FE-55	4.740E+04	2.520E+04	0.000E+00	0.000E+00	1.110E+05	2.870E+03	0.000E+00	7.770E+03
FE-59	2.070E+04	3.340E+04	0.000E+00	0.000E+00	1.270E+06	7.070E+04	0.000E+00	1.670E+04
CO-58	0.000E+00	1.770E+03	0.000E+00	0.000E+00	1.110E+06	3.440E+04	0.000E+00	3.160E+03
CO-60	0.000E+00	1.310E+04	0.000E+00	0.000E+00	7.070E+06	9.620E+04	0.000E+00	2.260E+04
NI-63	8.210E+05	4.620E+04	0.000E+00	0.000E+00	2.750E+05	6.330E+03	0.000E+00	2.800E+04
NI-65	2.990E+00	2.960E-01	0.000E+00	0.000E+00	8.180E+03	8.400E+04	0.000E+00	1.640E-01
CU-64	0.000E+00	1.990E+00	0.000E+00	6.030E+00	9.580E+03	3.670E+04	0.000E+00	1.070E+00
ZN-65	4.260E+04	1.130E+05	0.000E+00	7.140E+04	9.950E+05	1.630E+04	0.000E+00	7.030E+04
ZN-69	6.700E-02	9.660E-02	0.000E+00	5.850E-02	1.420E+03	1.020E+04	0.000E+00	8.920E-03
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.740E+02
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.480E+02
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.530E+01
RB-86	0.000E+00	1.980E+05	0.000E+00	0.000E+00	0.000E+00	7.990E+03	0.000E+00	1.140E+05
RB-88	0.000E+00	5.620E+02	0.000E+00	0.000E+00	0.000E+00	1.720E+01	0.000E+00	3.660E+02
RB-89	0.000E+00	3.450E+02	0.000E+00	0.000E+00	0.000E+00	1.890E+00	0.000E+00	2.900E+02
SR-89	5.990E+05	0.000E+00	0.000E+00	0.000E+00	2.160E+06	1.670E+05	0.000E+00	1.720E+04
SR-90	1.010E+08	0.000E+00	0.000E+00	0.000E+00	1.480E+07	3.430E+05	0.000E+00	6.440E+06
SR-91	1.210E+02	0.000E+00	0.000E+00	0.000E+00	5.330E+04	1.740E+05	0.000E+00	4.590E+00

APPENDIX B

P_i Dose Factors for use in the Gaseous Release Rate Limit Calculations

Agegroup:	CHILD	Pathway:	Inhalation (INHL)			Units:	mrem/yr / $\mu\text{Ci}/\text{m}^3$	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-92	1.310E+01	0.000E+00	0.000E+00	0.000E+00	2.400E+04	2.420E+05	0.000E+00	5.250E-01
Y-90	4.110E+03	0.000E+00	0.000E+00	0.000E+00	2.620E+05	2.680E+05	0.000E+00	1.110E+02
Y-91	9.140E+05	0.000E+00	0.000E+00	0.000E+00	2.630E+06	1.840E+05	0.000E+00	2.440E+04
Y-91M	5.070E-01	0.000E+00	0.000E+00	0.000E+00	2.810E+03	1.720E+03	0.000E+00	1.840E-02
Y-92	2.030E+01	0.000E+00	0.000E+00	0.000E+00	2.390E+04	2.390E+05	0.000E+00	5.810E-01
Y-93	1.860E+02	0.000E+00	0.000E+00	0.000E+00	7.440E+04	3.880E+05	0.000E+00	5.110E+00
ZR-95	1.900E+05	4.180E+04	0.000E+00	5.960E+04	2.230E+06	6.110E+04	0.000E+00	3.700E+04
ZR-97	1.880E+02	2.720E+01	0.000E+00	3.880E+01	1.130E+05	3.510E+05	0.000E+00	1.600E+01
NB-95	2.350E+04	9.180E+03	0.000E+00	8.620E+03	6.140E+05	3.700E+04	0.000E+00	6.550E+03
MO-99	0.000E+00	1.720E+02	0.000E+00	3.920E+02	1.350E+05	1.270E+05	0.000E+00	4.260E+01
TC-99M	1.780E-03	3.480E-03	0.000E+00	5.070E-02	9.510E+02	4.810E+03	0.000E+00	5.770E-02
TC-101	8.100E-05	8.510E-05	0.000E+00	1.450E-03	5.850E+02	1.630E+01	0.000E+00	1.080E-03
RU-103	2.790E+03	0.000E+00	0.000E+00	7.030E+03	6.620E+05	4.480E+04	0.000E+00	1.070E+03
RU-105	1.530E+00	0.000E+00	0.000E+00	1.340E+00	1.590E+04	9.950E+04	0.000E+00	5.550E-01
RU-106	1.360E+05	0.000E+00	0.000E+00	1.840E+05	1.430E+07	4.290E+05	0.000E+00	1.690E+04
AG-110M	1.690E+04	1.140E+04	0.000E+00	2.120E+04	5.480E+06	1.000E+05	0.000E+00	9.140E+03
TE-125M	6.730E+03	2.330E+03	1.920E+03	0.000E+00	4.770E+05	3.380E+04	0.000E+00	9.140E+02
TE-127	2.770E+00	9.510E-01	1.960E+00	7.070E+00	1.000E+04	5.620E+04	0.000E+00	6.100E-01
TE-127M	2.490E+04	8.550E+03	6.070E+03	6.360E+04	1.480E+06	7.140E+04	0.000E+00	3.020E+03
TE-129	9.770E-02	3.500E-02	7.140E-02	2.570E-01	2.930E+03	2.550E+04	0.000E+00	2.380E-02
TE-129M	1.920E+04	6.840E+03	6.330E+03	5.030E+04	1.760E+06	1.820E+05	0.000E+00	3.040E+03
TE-131	2.170E-02	8.440E-03	1.700E-02	5.880E-02	2.050E+03	1.330E+03	0.000E+00	6.590E-03
TE-131M	1.340E+02	5.920E+01	9.770E+01	4.000E+02	2.060E+05	3.080E+05	0.000E+00	5.070E+01
TE-132	4.810E+02	2.720E+02	3.170E+02	1.770E+03	3.770E+05	1.380E+05	0.000E+00	2.630E+02
I-130	8.180E+03	1.640E+04	1.850E+06	2.450E+04	0.000E+00	5.110E+03	0.000E+00	8.440E+03

APPENDIX B

P_i Dose Factors for use in the Gaseous Release Rate Limit Calculations

Agegroup:	CHILD	Pathway:	Inhalation (INHL)			Units:	mrem/yr / $\mu\text{Ci}/\text{m}^3$	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
I-131	4.810E+04	4.810E+04	1.620E+07	7.880E+04	0.000E+00	2.840E+03	0.000E+00	2.730E+04
I-132	2.120E+03	4.070E+03	1.940E+05	6.250E+03	0.000E+00	3.200E+03	0.000E+00	1.880E+03
I-133	1.660E+04	2.030E+04	3.850E+06	3.380E+04	0.000E+00	5.480E+03	0.000E+00	7.700E+03
I-134	1.170E+03	2.160E+03	5.070E+04	3.300E+03	0.000E+00	9.550E+02	0.000E+00	9.950E+02
I-135	4.920E+03	8.730E+03	7.920E+05	1.340E+04	0.000E+00	4.440E+03	0.000E+00	4.140E+03
CS-134	6.510E+05	1.010E+06	0.000E+00	3.300E+05	1.210E+05	3.850E+03	0.000E+00	2.250E+05
CS-136	6.510E+04	1.710E+05	0.000E+00	9.550E+04	1.450E+04	4.180E+03	0.000E+00	1.160E+05
CS-137	9.060E+05	8.250E+05	0.000E+00	2.820E+05	1.040E+05	3.620E+03	0.000E+00	1.280E+05
CS-138	6.330E+02	8.400E+02	0.000E+00	6.220E+02	6.810E+01	2.700E+02	0.000E+00	5.550E+02
BA-139	1.840E+00	9.840E-04	0.000E+00	8.620E-04	5.770E+03	5.770E+04	0.000E+00	5.360E-02
BA-140	7.400E+04	6.480E+01	0.000E+00	2.110E+01	1.740E+06	1.020E+05	0.000E+00	4.330E+03
BA-141	1.960E-01	1.090E-04	0.000E+00	9.470E-05	2.920E+03	2.750E+02	0.000E+00	6.360E-03
BA-142	5.000E-02	3.600E-05	0.000E+00	2.910E-05	1.640E+03	2.740E+00	0.000E+00	2.790E-03
LA-140	6.440E+02	2.250E+02	0.000E+00	0.000E+00	1.830E+05	2.260E+05	0.000E+00	7.550E+01
LA-142	1.300E+00	4.110E-01	0.000E+00	0.000E+00	8.700E+03	7.580E+04	0.000E+00	1.290E-01
CE-141	3.920E+04	1.950E+04	0.000E+00	8.550E+03	5.440E+05	5.660E+04	0.000E+00	2.900E+03
CE-143	3.660E+02	1.990E+02	0.000E+00	8.360E+01	1.150E+05	1.270E+05	0.000E+00	2.870E+01
CE-144	6.770E+06	2.120E+06	0.000E+00	1.170E+06	1.200E+07	3.880E+05	0.000E+00	3.610E+05
PR-143	1.850E+04	5.550E+03	0.000E+00	3.000E+03	4.330E+05	9.730E+04	0.000E+00	9.140E+02
PR-144	5.960E-02	1.850E-02	0.000E+00	9.770E-03	1.570E+03	1.970E+02	0.000E+00	3.000E-03
ND-147	1.080E+04	8.730E+03	0.000E+00	4.810E+03	3.280E+05	8.210E+04	0.000E+00	6.810E+02
W-187	1.630E+01	9.660E+00	0.000E+00	0.000E+00	4.110E+04	9.100E+04	0.000E+00	4.330E+00
NP-239	4.660E+02	3.340E+01	0.000E+00	9.730E+01	5.810E+04	6.400E+04	0.000E+00	2.350E+01

APPENDIX C

A_i Adult Dose Factors for use in the Liquid Dose Calculations

Age group:	ADULT	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / μ Ci/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
H-3	0.000E+00	8.740E+00	8.740E+00	8.740E+00	8.740E+00	8.740E+00	0.000E+00	8.740E+00
C-14	2.360E+02	4.730E+01	4.730E+01	4.730E+01	4.730E+01	4.730E+01	0.000E+00	4.730E+01
NA-24	8.140E+01	8.140E+01	8.140E+01	8.140E+01	8.140E+01	8.140E+01	0.000E+00	8.140E+01
P-32	1.570E+04	9.750E+02	0.000E+00	0.000E+00	0.000E+00	1.760E+03	0.000E+00	6.060E+02
CR-51	0.000E+00	0.000E+00	1.310E-01	4.820E-02	2.900E-01	5.500E+01	0.000E+00	2.190E-01
MN-54	0.000E+00	3.800E+02	0.000E+00	1.130E+02	0.000E+00	1.160E+03	0.000E+00	7.250E+01
MN-56	0.000E+00	3.800E-01	0.000E+00	4.820E-01	0.000E+00	1.210E+01	0.000E+00	6.740E-02
FE-55	2.290E+02	1.580E+02	0.000E+00	0.000E+00	8.820E+01	9.070E+01	0.000E+00	3.690E+01
FE-59	3.580E+02	8.420E+02	0.000E+00	0.000E+00	2.350E+02	2.810E+03	0.000E+00	3.230E+02
CO-58	0.000E+00	6.170E+01	0.000E+00	0.000E+00	0.000E+00	1.250E+03	0.000E+00	1.380E+02
CO-60	0.000E+00	1.780E+02	0.000E+00	0.000E+00	0.000E+00	3.340E+03	0.000E+00	3.930E+02
NI-63	1.080E+04	7.500E+02	0.000E+00	0.000E+00	0.000E+00	1.560E+02	0.000E+00	3.630E+02
NI-65	1.620E+00	2.100E-01	0.000E+00	0.000E+00	0.000E+00	5.340E+00	0.000E+00	9.600E-02
CU-64	0.000E+00	3.590E+00	0.000E+00	9.060E+00	0.000E+00	3.060E+02	0.000E+00	1.690E+00
ZN-65	4.020E+02	1.280E+03	0.000E+00	8.560E+02	0.000E+00	8.060E+02	0.000E+00	5.780E+02
ZN-69	1.070E-04	2.050E-04	0.000E+00	1.330E-04	0.000E+00	3.080E-05	0.000E+00	1.430E-05
SE-75	1.038E+02	3.991E+01	3.991E+01	7.983E+00	9.579E+01	1.118E+02	0.000E+00	7.983E+02
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.480E-01	0.000E+00	1.030E-01
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.270E-12	0.000E+00	6.710E-07
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.380E-77
RB-86	0.000E+00	1.720E+03	0.000E+00	0.000E+00	0.000E+00	3.400E+02	0.000E+00	8.030E+02
RB-88	0.000E+00	3.360E-12	0.000E+00	0.000E+00	0.000E+00	4.640E-23	0.000E+00	1.780E-12
RB-89	0.000E+00	3.090E-14	0.000E+00	0.000E+00	0.000E+00	1.790E-27	0.000E+00	2.170E-14
SR-89	2.550E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.080E+03	0.000E+00	7.310E+02
SR-90	6.310E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.820E+04	0.000E+00	1.550E+05

APPENDIX C

A_i Adult Dose Factors for use in the Liquid Dose Calculations

Age group:	ADULT	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / μ Ci/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-91	1.960E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.350E+02	0.000E+00	7.930E+00
SR-92	8.290E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.640E+02	0.000E+00	3.590E-01
Y-90	7.030E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.460E+03	0.000E+00	1.890E-02
Y-91	1.170E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.420E+03	0.000E+00	3.120E-01
Y-91M	3.360E-07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.860E-07	0.000E+00	1.300E-08
Y-92	6.710E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.170E+02	0.000E+00	1.960E-04
Y-93	9.770E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.100E+03	0.000E+00	2.700E-03
ZR-95	2.520E+00	8.070E-01	0.000E+00	1.270E+00	0.000E+00	2.560E+03	0.000E+00	5.460E-01
ZR-97	8.540E-02	1.720E-02	0.000E+00	2.600E-02	0.000E+00	5.340E+03	0.000E+00	7.880E-03
NB-95	5.130E-01	2.850E-01	0.000E+00	2.820E-01	0.000E+00	1.730E+03	0.000E+00	1.530E-01
MO-99	0.000E+00	3.160E+02	0.000E+00	7.160E+02	0.000E+00	7.330E+02	0.000E+00	6.020E+01
TC-99M	5.160E-03	1.460E-02	0.000E+00	2.210E-01	7.140E-03	8.630E+00	0.000E+00	1.860E-01
TC-101	1.130E-17	1.630E-17	0.000E+00	2.930E-16	8.320E-18	4.890E-29	0.000E+00	1.600E-16
RU-103	1.530E+01	0.000E+00	0.000E+00	5.820E+01	0.000E+00	1.780E+03	0.000E+00	6.570E+00
RU-105	1.970E-01	0.000E+00	0.000E+00	2.540E+00	0.000E+00	1.200E+02	0.000E+00	7.760E-02
RU-106	2.290E+02	0.000E+00	0.000E+00	4.410E+02	0.000E+00	1.480E+04	0.000E+00	2.890E+01
AG-108M	9.207E+01	3.541E+01	3.541E+01	7.082E+00	8.498E+01	9.915E+01	0.000E+00	7.082E+02
AG-110M	1.330E+01	1.230E+01	0.000E+00	2.420E+01	0.000E+00	5.020E+03	0.000E+00	7.300E+00
SN-113	2.913E+01	1.121E+01	1.121E+01	2.241E+00	2.689E+01	3.137E+01	0.000E+00	2.241E+02
SN-117M	2.771E+01	1.066E+01	1.066E+01	2.131E+00	2.557E+01	2.984E+01	0.000E+00	2.131E+02
SB-124	2.317E+02	4.377E+00	5.618E-01	0.000E+00	1.804E+02	6.578E+03	0.000E+00	9.184E+01
SB-125	1.489E+02	1.664E+00	1.514E-01	0.000E+00	1.148E+02	1.639E+03	0.000E+00	3.544E+01
SB-126	9.307E+01	1.894E+00	5.697E-01	0.000E+00	5.705E+01	7.607E+03	0.000E+00	3.358E+01
TE-123M	5.588E+01	2.149E+01	2.149E+01	4.298E+00	5.158E+01	6.018E+01	0.000E+00	4.298E+02
TE-125M	2.220E+02	8.030E+01	6.670E+01	9.020E+02	0.000E+00	8.850E+02	0.000E+00	2.970E+01

APPENDIX C

A_i Adult Dose Factors for use in the Liquid Dose Calculations

Age group:	ADULT	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / μ Ci/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
TE-127	3.780E+00	1.360E+00	2.800E+00	1.540E+01	0.000E+00	2.980E+02	0.000E+00	8.170E-01
TE-127M	5.620E+02	2.010E+02	1.440E+02	2.280E+03	0.000E+00	1.880E+03	0.000E+00	6.840E+01
TE-129	1.920E-03	7.230E-04	1.480E-03	8.080E-03	0.000E+00	1.450E-03	0.000E+00	4.690E-04
TE-129M	9.470E+02	3.530E+02	3.250E+02	3.950E+03	0.000E+00	4.770E+03	0.000E+00	1.500E+02
TE-131	3.520E-09	1.470E-09	2.900E-09	1.540E-08	0.000E+00	4.990E-10	0.000E+00	1.110E-09
TE-131M	1.090E+02	5.340E+01	8.450E+01	5.400E+02	0.000E+00	5.300E+03	0.000E+00	4.450E+01
TE-132	1.880E+02	1.220E+02	1.350E+02	1.170E+03	0.000E+00	5.770E+03	0.000E+00	1.140E+02
I-130	3.210E+01	9.460E+01	8.020E+03	1.480E+02	0.000E+00	8.140E+01	0.000E+00	3.730E+01
I-131	3.320E+02	4.740E+02	1.550E+05	8.130E+02	0.000E+00	1.250E+02	0.000E+00	2.720E+02
I-132	4.540E-01	1.220E+00	4.250E+01	1.940E+00	0.000E+00	2.280E-01	0.000E+00	4.250E-01
I-133	7.920E+01	1.380E+02	2.020E+04	2.400E+02	0.000E+00	1.240E+02	0.000E+00	4.200E+01
I-134	6.580E-04	1.790E-03	3.100E-02	2.840E-03	0.000E+00	1.560E-06	0.000E+00	6.390E-04
I-135	1.050E+01	2.750E+01	1.810E+03	4.400E+01	0.000E+00	3.100E+01	0.000E+00	1.010E+01
CS-134	5.170E+03	1.230E+04	0.000E+00	3.980E+03	1.320E+03	2.150E+02	0.000E+00	1.010E+04
CS-136	5.280E+02	2.080E+03	0.000E+00	1.160E+03	1.590E+02	2.370E+02	0.000E+00	1.500E+03
CS-137	6.630E+03	9.070E+03	0.000E+00	3.080E+03	1.020E+03	1.760E+02	0.000E+00	5.940E+03
CS-138	8.450E-07	1.670E-06	0.000E+00	1.230E-06	1.210E-07	7.120E-12	0.000E+00	8.260E-07
BA-133	6.004E+01	2.309E+01	2.309E+01	4.618E+00	5.542E+01	6.466E+01	0.000E+00	4.618E+02
BA-139	1.990E-02	1.420E-05	0.000E+00	1.330E-05	8.050E-06	3.530E-02	0.000E+00	5.830E-04
BA-140	1.640E+03	2.070E+00	0.000E+00	7.020E-01	1.180E+00	3.390E+03	0.000E+00	1.080E+02
BA-141	5.440E-12	4.120E-15	0.000E+00	3.830E-15	2.340E-15	2.570E-21	0.000E+00	1.840E-13
BA-142	6.290E-21	6.470E-24	0.000E+00	5.460E-24	3.660E-24	8.860E-39	0.000E+00	3.960E-22
LA-140	1.690E-01	8.530E-02	0.000E+00	0.000E+00	0.000E+00	6.260E+03	0.000E+00	2.250E-02
LA-142	5.720E-05	2.600E-05	0.000E+00	0.000E+00	0.000E+00	1.900E-01	0.000E+00	6.480E-06
CE-141	7.710E-01	5.210E-01	0.000E+00	2.420E-01	0.000E+00	1.990E+03	0.000E+00	5.910E-02

APPENDIX C

A_i Adult Dose Factors for use in the Liquid Dose Calculations

Age group:	ADULT	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / μ Ci/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
CE-143	1.070E-01	7.890E+01	0.000E+00	3.470E-02	0.000E+00	2.950E+03	0.000E+00	8.730E-03
CE-144	4.060E+01	1.700E+01	0.000E+00	1.010E+01	0.000E+00	1.370E+04	0.000E+00	2.180E+00
PR-143	7.460E-01	2.990E-01	0.000E+00	1.730E-01	0.000E+00	3.270E+03	0.000E+00	3.700E-02
PR-144	7.350E-16	3.050E-16	0.000E+00	1.720E-16	0.000E+00	1.060E-22	0.000E+00	3.730E-17
ND-147	5.070E-01	5.860E-01	0.000E+00	3.430E-01	0.000E+00	2.810E+03	0.000E+00	3.510E-02
EU-152	1.623E+01	3.695E+00	0.000E+00	2.288E+01	0.000E+00	2.130E+03	0.000E+00	3.245E+00
W-187	6.050E+00	5.050E+00	0.000E+00	0.000E+00	0.000E+00	1.660E+03	0.000E+00	1.770E+00
NP-239	8.550E-02	8.400E-03	0.000E+00	2.620E-02	0.000E+00	1.720E+03	0.000E+00	4.630E-03

APPENDIX C

A_i Adult Dose Factors for use in the Liquid Dose Calculations

Age group:	ADULT	Pathway:	Fresh Water Fish - Sport (FFSP)			Units:	mrem/hr / μ Ci/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
H-3	0.000E+00	2.260E-01	2.260E-01	2.260E-01	2.260E-01	2.260E-01	0.000E+00	2.260E-01
C-14	3.130E+04	6.260E+03	6.260E+03	6.260E+03	6.260E+03	6.260E+03	0.000E+00	6.260E+03
NA-24	1.350E+02	1.350E+02	1.350E+02	1.350E+02	1.350E+02	1.350E+02	0.000E+00	1.350E+02
P-32	1.320E+06	8.210E+04	0.000E+00	0.000E+00	0.000E+00	1.480E+05	0.000E+00	5.100E+04
CR-51	0.000E+00	0.000E+00	7.420E-01	2.740E-01	1.650E+00	3.120E+02	0.000E+00	1.240E+00
MN-54	0.000E+00	4.370E+03	0.000E+00	1.300E+03	0.000E+00	1.340E+04	0.000E+00	8.330E+02
MN-56	0.000E+00	1.730E-01	0.000E+00	2.200E-01	0.000E+00	5.530E+00	0.000E+00	3.070E-02
FE-55	6.580E+02	4.550E+02	0.000E+00	0.000E+00	2.540E+02	2.610E+02	0.000E+00	1.060E+02
FE-59	1.020E+03	2.400E+03	0.000E+00	0.000E+00	6.720E+02	8.010E+03	0.000E+00	9.220E+02
CO-58	0.000E+00	8.830E+01	0.000E+00	0.000E+00	0.000E+00	1.790E+03	0.000E+00	1.980E+02
CO-60	0.000E+00	2.560E+02	0.000E+00	0.000E+00	0.000E+00	4.810E+03	0.000E+00	5.650E+02
NI-63	3.110E+04	2.160E+03	0.000E+00	0.000E+00	0.000E+00	4.500E+02	0.000E+00	1.040E+03
NI-65	1.720E-01	2.230E-02	0.000E+00	0.000E+00	0.000E+00	5.660E-01	0.000E+00	1.020E-02
CU-64	0.000E+00	2.680E+00	0.000E+00	6.760E+00	0.000E+00	2.290E+02	0.000E+00	1.260E+00
ZN-65	2.310E+04	7.350E+04	0.000E+00	4.920E+04	0.000E+00	4.630E+04	0.000E+00	3.320E+04
ZN-69	7.730E-07	1.480E-06	0.000E+00	9.610E-07	0.000E+00	2.220E-07	0.000E+00	1.030E-07
SE-75	5.953E+02	2.290E+02	2.290E+02	4.579E+01	5.495E+02	6.411E+02	0.000E+00	4.579E+03
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.500E-02	0.000E+00	3.820E-02
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.850E-18	0.000E+00	1.250E-12
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	9.730E+04	0.000E+00	0.000E+00	0.000E+00	1.920E+04	0.000E+00	4.530E+04
RB-88	0.000E+00	1.290E-22	0.000E+00	0.000E+00	0.000E+00	1.780E-33	0.000E+00	6.830E-23
RB-89	0.000E+00	1.640E-26	0.000E+00	0.000E+00	0.000E+00	9.560E-40	0.000E+00	1.160E-26
SR-89	2.180E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.500E+03	0.000E+00	6.260E+02
SR-90	5.440E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.570E+04	0.000E+00	1.340E+05

APPENDIX C

A_i Adult Dose Factors for use in the Liquid Dose Calculations

Age group:	ADULT	Pathway:	Fresh Water Fish - Sport (FFSP)			Units:	mrem/hr / μ Ci/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-91	7.050E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.360E+02	0.000E+00	2.850E+00
SR-92	3.320E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.570E+00	0.000E+00	1.430E-02
Y-90	4.440E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.710E+03	0.000E+00	1.190E-02
Y-91	8.340E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.590E+03	0.000E+00	2.230E-01
Y-91M	1.070E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.150E-11	0.000E+00	4.150E-13
Y-92	4.600E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.060E+00	0.000E+00	1.340E-05
Y-93	3.080E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.770E+02	0.000E+00	8.500E-04
ZR-95	2.380E-01	7.620E-02	0.000E+00	1.200E-01	0.000E+00	2.410E+02	0.000E+00	5.160E-02
ZR-97	4.960E-03	1.000E-03	0.000E+00	1.510E-03	0.000E+00	3.100E+02	0.000E+00	4.570E-04
NB-95	4.380E+02	2.440E+02	0.000E+00	2.410E+02	0.000E+00	1.480E+06	0.000E+00	1.310E+02
MO-99	0.000E+00	8.020E+01	0.000E+00	1.820E+02	0.000E+00	1.860E+02	0.000E+00	1.530E+01
TC-99M	5.590E-04	1.580E-03	0.000E+00	2.400E-02	7.740E-04	9.340E-01	0.000E+00	2.010E-02
TC-101	2.610E-33	3.760E-33	0.000E+00	6.770E-32	1.920E-33	1.130E-44	0.000E+00	3.690E-32
RU-103	4.350E+00	0.000E+00	0.000E+00	1.660E+01	0.000E+00	5.080E+02	0.000E+00	1.870E+00
RU-105	8.670E-03	0.000E+00	0.000E+00	1.120E-01	0.000E+00	5.300E+00	0.000E+00	3.420E-03
RU-106	6.570E+01	0.000E+00	0.000E+00	1.270E+02	0.000E+00	4.250E+03	0.000E+00	8.320E+00
AG-108M	2.648E+01	1.019E+01	1.019E+01	2.037E+00	2.445E+01	2.852E+01	0.000E+00	2.037E+02
AG-110M	8.790E-01	8.130E-01	0.000E+00	1.600E+00	0.000E+00	3.320E+02	0.000E+00	4.830E-01
SN-113	2.507E+03	9.641E+02	9.641E+02	1.928E+02	2.314E+03	2.699E+03	0.000E+00	1.928E+04
SN-117M	2.331E+03	8.965E+02	8.965E+02	1.793E+02	2.152E+03	2.510E+03	0.000E+00	1.793E+04
SB-124	6.626E+02	1.252E+01	1.607E+00	0.000E+00	5.159E+02	1.881E+04	0.000E+00	2.627E+02
SB-125	4.282E+02	4.785E+00	4.354E-01	0.000E+00	3.301E+02	4.713E+03	0.000E+00	1.019E+02
SB-126	2.603E+02	5.297E+00	1.594E+00	0.000E+00	1.596E+02	2.128E+04	0.000E+00	9.395E+01
TE-123M	6.411E+02	2.466E+02	2.466E+02	4.932E+01	5.918E+02	6.904E+02	0.000E+00	4.932E+03
TE-125M	2.540E+03	9.190E+02	7.630E+02	1.030E+04	0.000E+00	1.010E+04	0.000E+00	3.400E+02

APPENDIX C

A_i Adult Dose Factors for use in the Liquid Dose Calculations

Age group:	ADULT	Pathway:	Fresh Water Fish - Sport (FFSP)			Units:	mrem/hr / μ Ci/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
TE-127	1.790E+01	6.440E+00	1.330E+01	7.300E+01	0.000E+00	1.410E+03	0.000E+00	3.880E+00
TE-127M	6.440E+03	2.300E+03	1.650E+03	2.620E+04	0.000E+00	2.160E+04	0.000E+00	7.850E+02
TE-129	1.630E-05	6.120E-06	1.250E-05	6.850E-05	0.000E+00	1.230E-05	0.000E+00	3.970E-06
TE-129M	1.080E+04	4.020E+03	3.710E+03	4.500E+04	0.000E+00	5.430E+04	0.000E+00	1.710E+03
TE-131	8.710E-17	3.640E-17	7.160E-17	3.820E-16	0.000E+00	1.230E-17	0.000E+00	2.750E-17
TE-131M	9.510E+02	4.650E+02	7.370E+02	4.710E+03	0.000E+00	4.620E+04	0.000E+00	3.880E+02
TE-132	1.950E+03	1.260E+03	1.390E+03	1.210E+04	0.000E+00	5.960E+04	0.000E+00	1.180E+03
I-130	7.050E+00	2.080E+01	1.760E+03	3.250E+01	0.000E+00	1.790E+01	0.000E+00	8.210E+00
I-131	1.370E+02	1.960E+02	6.420E+04	3.360E+02	0.000E+00	5.170E+01	0.000E+00	1.120E+02
I-132	5.270E-03	1.410E-02	4.940E-01	2.250E-02	0.000E+00	2.650E-03	0.000E+00	4.940E-03
I-133	2.290E+01	3.990E+01	5.860E+03	6.950E+01	0.000E+00	3.580E+01	0.000E+00	1.210E+01
I-134	2.120E-08	5.750E-08	9.960E-07	9.140E-08	0.000E+00	5.010E-11	0.000E+00	2.060E-08
I-135	1.290E+00	3.370E+00	2.220E+02	5.410E+00	0.000E+00	3.810E+00	0.000E+00	1.240E+00
CS-134	2.980E+05	7.080E+05	0.000E+00	2.290E+05	7.610E+04	1.240E+04	0.000E+00	5.790E+05
CS-136	2.960E+04	1.170E+05	0.000E+00	6.500E+04	8.900E+03	1.330E+04	0.000E+00	8.400E+04
CS-137	3.820E+05	5.220E+05	0.000E+00	1.770E+05	5.890E+04	1.010E+04	0.000E+00	3.420E+05
CS-138	8.940E-12	1.770E-11	0.000E+00	1.300E-11	1.280E-12	7.530E-17	0.000E+00	8.750E-12
BA-133	6.908E+00	2.657E+00	2.657E+00	5.314E-01	6.376E+00	7.439E+00	0.000E+00	5.314E+01
BA-139	5.650E-06	4.030E-09	0.000E+00	3.760E-09	2.280E-09	1.000E-05	0.000E+00	1.660E-07
BA-140	1.840E+02	2.310E-01	0.000E+00	7.860E-02	1.320E-01	3.790E+02	0.000E+00	1.210E+01
BA-141	8.700E-25	6.580E-28	0.000E+00	6.120E-28	3.730E-28	4.100E-34	0.000E+00	2.940E-26
BA-142	2.570E-42	2.640E-45	0.000E+00	2.230E-45	1.490E-45	3.620E-60	0.000E+00	1.610E-43
LA-140	9.900E-02	4.990E-02	0.000E+00	0.000E+00	0.000E+00	3.660E+03	0.000E+00	1.320E-02
LA-142	2.210E-07	1.000E-07	0.000E+00	0.000E+00	0.000E+00	7.330E-04	0.000E+00	2.500E-08
CE-141	2.190E-02	1.480E-02	0.000E+00	6.890E-03	0.000E+00	5.670E+01	0.000E+00	1.680E-03

APPENDIX C

A_i Adult Dose Factors for use in the Liquid Dose Calculations

Age group:	ADULT	Pathway:	Fresh Water Fish - Sport (FFSP)			Units:	mrem/hr / μ Ci/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
CE-143	2.380E-03	1.760E+00	0.000E+00	7.760E-04	0.000E+00	6.590E+01	0.000E+00	1.950E-04
CE-144	1.170E+00	4.870E-01	0.000E+00	2.890E-01	0.000E+00	3.940E+02	0.000E+00	6.260E-02
PR-143	5.230E-01	2.100E-01	0.000E+00	1.210E-01	0.000E+00	2.290E+03	0.000E+00	2.590E-02
PR-144	1.550E-28	6.440E-29	0.000E+00	3.630E-29	0.000E+00	2.230E-35	0.000E+00	7.880E-30
ND-147	3.530E-01	4.080E-01	0.000E+00	2.390E-01	0.000E+00	1.960E+03	0.000E+00	2.440E-02
EU-152	2.334E+01	5.314E+00	0.000E+00	3.291E+01	0.000E+00	3.064E+03	0.000E+00	4.668E+00
W-187	1.470E+02	1.230E+02	0.000E+00	0.000E+00	0.000E+00	4.030E+04	0.000E+00	4.300E+01
NP-239	2.120E-02	2.090E-03	0.000E+00	6.510E-03	0.000E+00	4.280E+02	0.000E+00	1.150E-03

APPENDIX C

A_i Adult Dose Factors for use in the Liquid Dose Calculations

Age group:	ADULT	Pathway:	Shoreline Sediment (SHDp)			Units:	mrem/hr / μ Ci/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
H-3	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C-14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NA-24	6.410E-01	6.410E-01	6.410E-01	6.410E-01	6.410E-01	6.410E-01	7.440E-01	6.410E-01
P-32	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CR-51	2.500E-01	2.500E-01	2.500E-01	2.500E-01	2.500E-01	2.500E-01	2.960E-01	2.500E-01
MN-54	7.440E+01	7.440E+01	7.440E+01	7.440E+01	7.440E+01	7.440E+01	8.720E+01	7.440E+01
MN-56	4.840E-02	4.840E-02	4.840E-02	4.840E-02	4.840E-02	4.840E-02	5.720E-02	4.840E-02
FE-55	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
FE-59	1.460E+01	1.460E+01	1.460E+01	1.460E+01	1.460E+01	1.460E+01	1.720E+01	1.460E+01
CO-58	2.030E+01	2.030E+01	2.030E+01	2.030E+01	2.030E+01	2.030E+01	2.380E+01	2.030E+01
CO-60	1.150E+03	1.150E+03	1.150E+03	1.150E+03	1.150E+03	1.150E+03	1.360E+03	1.150E+03
NI-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NI-65	1.590E-02	1.590E-02	1.590E-02	1.590E-02	1.590E-02	1.590E-02	1.850E-02	1.590E-02
CU-64	3.260E-02	3.260E-02	3.260E-02	3.260E-02	3.260E-02	3.260E-02	3.690E-02	3.260E-02
ZN-65	4.010E+01	4.010E+01	4.010E+01	4.010E+01	4.010E+01	4.010E+01	4.610E+01	4.010E+01
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE-75	2.425E+02	2.425E+02	2.425E+02	2.425E+02	2.425E+02	2.425E+02	2.838E+02	2.425E+02
BR-83	2.620E-04	2.620E-04	2.620E-04	2.620E-04	2.620E-04	2.620E-04	3.800E-04	2.620E-04
BR-84	1.090E-02	1.090E-02	1.090E-02	1.090E-02	1.090E-02	1.090E-02	1.270E-02	1.090E-02
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	4.820E-01	4.820E-01	4.820E-01	4.820E-01	4.820E-01	4.820E-01	5.510E-01	4.820E-01
RB-88	1.780E-03	1.780E-03	1.780E-03	1.780E-03	1.780E-03	1.780E-03	2.030E-03	1.780E-03
RB-89	6.600E-03	6.600E-03	6.600E-03	6.600E-03	6.600E-03	6.600E-03	7.920E-03	6.600E-03
SR-89	1.160E-03	1.160E-03	1.160E-03	1.160E-03	1.160E-03	1.160E-03	1.350E-03	1.160E-03
SR-90	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

APPENDIX C

A_i Adult Dose Factors for use in the Liquid Dose Calculations

Age group:	ADULT	Pathway:	Shoreline Sediment (SHDp)			Units:	mrem/hr / μ Ci/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-91	1.150E-01	1.150E-01	1.150E-01	1.150E-01	1.150E-01	1.150E-01	1.350E-01	1.150E-01
SR-92	4.170E-02	4.170E-02	4.170E-02	4.170E-02	4.170E-02	4.170E-02	4.630E-02	4.170E-02
Y-90	2.410E-04	2.410E-04	2.410E-04	2.410E-04	2.410E-04	2.410E-04	2.850E-04	2.410E-04
Y-91	5.760E-02	5.760E-02	5.760E-02	5.760E-02	5.760E-02	5.760E-02	6.480E-02	5.760E-02
Y-91M	5.380E-03	5.380E-03	5.380E-03	5.380E-03	5.380E-03	5.380E-03	6.230E-03	5.380E-03
Y-92	9.680E-03	9.680E-03	9.680E-03	9.680E-03	9.680E-03	9.680E-03	1.150E-02	9.680E-03
Y-93	9.840E-03	9.840E-03	9.840E-03	9.840E-03	9.840E-03	9.840E-03	1.350E-02	9.840E-03
ZR-95	1.310E+01	1.310E+01	1.310E+01	1.310E+01	1.310E+01	1.310E+01	1.520E+01	1.310E+01
ZR-97	1.590E-01	1.590E-01	1.590E-01	1.590E-01	1.590E-01	1.590E-01	1.850E-01	1.590E-01
NB-95	7.340E+00	7.340E+00	7.340E+00	7.340E+00	7.340E+00	7.340E+00	8.630E+00	7.340E+00
MO-99	2.140E-01	2.140E-01	2.140E-01	2.140E-01	2.140E-01	2.140E-01	2.480E-01	2.140E-01
TC-99M	9.880E-03	9.880E-03	9.880E-03	9.880E-03	9.880E-03	9.880E-03	1.130E-02	9.880E-03
TC-101	1.090E-03	1.090E-03	1.090E-03	1.090E-03	1.090E-03	1.090E-03	1.210E-03	1.090E-03
RU-103	5.810E+00	5.810E+00	5.810E+00	5.810E+00	5.810E+00	5.810E+00	6.780E+00	5.810E+00
RU-105	3.420E-02	3.420E-02	3.420E-02	3.420E-02	3.420E-02	3.420E-02	3.870E-02	3.420E-02
RU-106	2.270E+01	2.270E+01	2.270E+01	2.270E+01	2.270E+01	2.270E+01	2.720E+01	2.270E+01
AG-108M	2.768E+04	2.768E+04	2.768E+04	2.768E+04	2.768E+04	2.768E+04	3.239E+04	2.768E+04
AG-110M	1.850E+02	1.850E+02	1.850E+02	1.850E+02	1.850E+02	1.850E+02	2.150E+02	1.850E+02
SN-113	8.011E+00	8.011E+00	8.011E+00	8.011E+00	8.011E+00	8.011E+00	9.372E+00	8.011E+00
SN-117M	1.119E+01	1.119E+01	1.119E+01	1.119E+01	1.119E+01	1.119E+01	1.310E+01	1.119E+01
SB-124	3.211E+01	3.211E+01	3.211E+01	3.211E+01	3.211E+01	3.211E+01	3.705E+01	3.211E+01
SB-125	1.252E+02	1.252E+02	1.252E+02	1.252E+02	1.252E+02	1.252E+02	1.414E+02	1.252E+02
SB-126	4.529E+00	4.529E+00	4.529E+00	4.529E+00	4.529E+00	4.529E+00	5.089E+00	4.529E+00
TE-123M	9.088E+01	9.088E+01	9.088E+01	9.088E+01	9.088E+01	9.088E+01	1.063E+02	9.088E+01
TE-125M	8.330E-02	8.330E-02	8.330E-02	8.330E-02	8.330E-02	8.330E-02	1.140E-01	8.330E-02

APPENDIX C

A_i Adult Dose Factors for use in the Liquid Dose Calculations

Age group:	ADULT	Pathway:	Shoreline Sediment (SHDp)			Units:	mrem/hr / μ Ci/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
TE-127	1.600E-04	1.600E-04	1.600E-04	1.600E-04	1.600E-04	1.600E-04	1.760E-04	1.600E-04
TE-127M	4.920E-03	4.920E-03	4.920E-03	4.920E-03	4.920E-03	4.920E-03	5.810E-03	4.920E-03
TE-129	1.410E-03	1.410E-03	1.410E-03	1.410E-03	1.410E-03	1.410E-03	1.670E-03	1.410E-03
TE-129M	1.060E+00	1.060E+00	1.060E+00	1.060E+00	1.060E+00	1.060E+00	1.240E+00	1.060E+00
TE-131	1.570E-03	1.570E-03	1.570E-03	1.570E-03	1.570E-03	1.570E-03	1.850E+00	1.570E-03
TE-131M	4.310E-01	4.310E-01	4.310E-01	4.310E-01	4.310E-01	4.310E-01	5.080E-01	4.310E-01
TE-132	2.270E-01	2.270E-01	2.270E-01	2.270E-01	2.270E-01	2.270E-01	2.670E-01	2.270E-01
I-130	2.960E-01	2.960E-01	2.960E-01	2.960E-01	2.960E-01	2.960E-01	3.590E-01	2.960E-01
I-131	9.240E-01	9.240E-01	9.240E-01	9.240E-01	9.240E-01	9.240E-01	1.120E+00	9.240E-01
I-132	6.680E-02	6.680E-02	6.680E-02	6.680E-02	6.680E-02	6.680E-02	7.860E-02	6.680E-02
I-133	1.320E-01	1.320E-01	1.320E-01	1.320E-01	1.320E-01	1.320E-01	1.600E-01	1.320E-01
I-134	2.400E-02	2.400E-02	2.400E-02	2.400E-02	2.400E-02	2.400E-02	2.850E-02	2.400E-02
I-135	1.360E-01	1.360E-01	1.360E-01	1.360E-01	1.360E-01	1.360E-01	1.580E-01	1.360E-01
CS-134	3.680E+02	3.680E+02	3.680E+02	3.680E+02	3.680E+02	3.680E+02	4.300E+02	3.680E+02
CS-136	8.100E+00	8.100E+00	8.100E+00	8.100E+00	8.100E+00	8.100E+00	9.180E+00	8.100E+00
CS-137	5.520E+02	5.520E+02	5.520E+02	5.520E+02	5.520E+02	5.520E+02	6.440E+02	5.520E+02
CS-138	1.930E-02	1.930E-02	1.930E-02	1.930E-02	1.930E-02	1.930E-02	2.200E-02	1.930E-02
BA-133	4.732E+03	4.732E+03	4.732E+03	4.732E+03	4.732E+03	4.732E+03	5.536E+03	4.732E+03
BA-139	5.680E-03	5.680E-03	5.680E-03	5.680E-03	5.680E-03	5.680E-03	6.390E-03	5.680E-03
BA-140	1.100E+00	1.100E+00	1.100E+00	1.100E+00	1.100E+00	1.100E+00	1.260E+00	1.100E+00
BA-141	2.240E-03	2.240E-03	2.240E-03	2.240E-03	2.240E-03	2.240E-03	2.550E-03	2.240E-03
BA-142	2.410E-03	2.410E-03	2.410E-03	2.410E-03	2.410E-03	2.410E-03	2.740E-03	2.410E-03
LA-140	1.030E+00	1.030E+00	1.030E+00	1.030E+00	1.030E+00	1.030E+00	1.170E+00	1.030E+00
LA-142	4.080E-02	4.080E-02	4.080E-02	4.080E-02	4.080E-02	4.080E-02	4.890E-02	4.080E-02
CE-141	7.330E-01	7.330E-01	7.330E-01	7.330E-01	7.330E-01	7.330E-01	8.270E-01	7.330E-01

APPENDIX C

A_i Adult Dose Factors for use in the Liquid Dose Calculations

Age group:	ADULT	Pathway:	Shoreline Sediment (SHDp)			Units:	mrem/hr / μ Ci/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
CE-143	1.240E-01	1.240E-01	1.240E-01	1.240E-01	1.240E-01	1.240E-01	1.410E-01	1.240E-01
CE-144	3.730E+00	3.730E+00	3.730E+00	3.730E+00	3.730E+00	3.730E+00	4.320E+00	3.730E+00
PR-143	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR-144	9.850E-05	9.850E-05	9.850E-05	9.850E-05	9.850E-05	9.850E-05	1.130E-04	9.850E-05
ND-147	4.510E-01	4.510E-01	4.510E-01	4.510E-01	4.510E-01	4.510E-01	5.410E-01	4.510E-01
EU-152	7.976E+02	7.976E+02	7.976E+02	7.976E+02	7.976E+02	7.976E+02	9.231E+02	7.976E+02
W-187	1.260E-01	1.260E-01	1.260E-01	1.260E-01	1.260E-01	1.260E-01	1.470E-01	1.260E-01
NP-239	9.180E-02	9.180E-02	9.180E-02	9.180E-02	9.180E-02	9.180E-02	1.060E-01	9.180E-02

APPENDIX D

A_i Teen Factors for use in the Liquid Dose Calculations

Age group:	TEEN	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / μ Ci/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
H-3	0.000E+00	6.160E+00	6.160E+00	6.160E+00	6.160E+00	6.160E+00	0.000E+00	6.160E+00
C-14	2.360E+02	4.720E+01	4.720E+01	4.720E+01	4.720E+01	4.720E+01	0.000E+00	4.720E+01
NA-24	7.690E+01	7.690E+01	7.690E+01	7.690E+01	7.690E+01	7.690E+01	0.000E+00	7.690E+01
P-32	1.570E+04	9.700E+02	0.000E+00	0.000E+00	0.000E+00	1.320E+03	0.000E+00	6.070E+02
CR-51	0.000E+00	0.000E+00	1.150E-01	4.530E-02	2.950E-01	3.470E+01	0.000E+00	2.070E-01
MN-54	0.000E+00	3.430E+02	0.000E+00	1.020E+02	0.000E+00	7.030E+02	0.000E+00	6.790E+01
MN-56	0.000E+00	3.640E-01	0.000E+00	4.610E-01	0.000E+00	2.400E+01	0.000E+00	6.480E-02
FE-55	2.200E+02	1.560E+02	0.000E+00	0.000E+00	9.880E+01	6.740E+01	0.000E+00	3.630E+01
FE-59	3.390E+02	7.900E+02	0.000E+00	0.000E+00	2.490E+02	1.870E+03	0.000E+00	3.050E+02
CO-58	0.000E+00	5.620E+01	0.000E+00	0.000E+00	0.000E+00	7.750E+02	0.000E+00	1.300E+02
CO-60	0.000E+00	1.630E+02	0.000E+00	0.000E+00	0.000E+00	2.130E+03	0.000E+00	3.680E+02
NI-63	1.030E+04	7.270E+02	0.000E+00	0.000E+00	0.000E+00	1.160E+02	0.000E+00	3.490E+02
NI-65	1.610E+00	2.050E-01	0.000E+00	0.000E+00	0.000E+00	1.110E+01	0.000E+00	9.350E-02
CU-64	0.000E+00	3.470E+00	0.000E+00	8.770E+00	0.000E+00	2.690E+02	0.000E+00	1.630E+00
ZN-65	3.340E+02	1.160E+03	0.000E+00	7.430E+02	0.000E+00	4.920E+02	0.000E+00	5.420E+02
ZN-69	1.070E-04	2.040E-04	0.000E+00	1.330E-04	0.000E+00	3.760E-04	0.000E+00	1.430E-05
SE-75	8.644E+01	3.325E+01	3.325E+01	6.649E+00	7.979E+01	9.309E+01	0.000E+00	6.649E+02
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.030E-01
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.500E-07
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.360E-77
RB-86	0.000E+00	1.700E+03	0.000E+00	0.000E+00	0.000E+00	2.520E+02	0.000E+00	7.990E+02
RB-88	0.000E+00	3.300E-12	0.000E+00	0.000E+00	0.000E+00	2.830E-19	0.000E+00	1.760E-12
RB-89	0.000E+00	2.960E-14	0.000E+00	0.000E+00	0.000E+00	4.540E-23	0.000E+00	2.090E-14
SR-89	2.540E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.030E+03	0.000E+00	7.280E+02
SR-90	4.830E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.350E+04	0.000E+00	1.190E+05

APPENDIX D

A_i Teen Factors for use in the Liquid Dose Calculations

Age group:	TEEN	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / μ Ci/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-91	1.950E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.850E+02	0.000E+00	7.760E+00
SR-92	8.220E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.090E+02	0.000E+00	3.500E-01
Y-90	7.000E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.770E+03	0.000E+00	1.880E-02
Y-91	1.160E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.760E+03	0.000E+00	3.120E-01
Y-91M	3.330E-07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.570E-05	0.000E+00	1.270E-08
Y-92	6.710E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.840E+02	0.000E+00	1.940E-04
Y-93	9.760E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.980E+03	0.000E+00	2.670E-03
ZR-95	2.380E+00	7.520E-01	0.000E+00	1.100E+00	0.000E+00	1.730E+03	0.000E+00	5.170E-01
ZR-97	8.420E-02	1.670E-02	0.000E+00	2.530E-02	0.000E+00	4.510E+03	0.000E+00	7.670E-03
NB-95	4.730E-01	2.630E-01	0.000E+00	2.540E-01	0.000E+00	1.120E+03	0.000E+00	1.440E-01
MO-99	0.000E+00	3.090E+02	0.000E+00	7.070E+02	0.000E+00	5.530E+02	0.000E+00	5.890E+01
TC-99M	4.840E-03	1.350E-02	0.000E+00	2.010E-01	7.500E-03	8.870E+00	0.000E+00	1.750E-01
TC-101	1.120E-17	1.590E-17	0.000E+00	2.880E-16	9.700E-18	2.720E-24	0.000E+00	1.560E-16
RU-103	1.470E+01	0.000E+00	0.000E+00	5.180E+01	0.000E+00	1.230E+03	0.000E+00	6.280E+00
RU-105	1.940E-01	0.000E+00	0.000E+00	2.450E+00	0.000E+00	1.570E+02	0.000E+00	7.540E-02
RU-106	2.280E+02	0.000E+00	0.000E+00	4.390E+02	0.000E+00	1.090E+04	0.000E+00	2.870E+01
AG-108M	7.830E+01	3.012E+01	3.012E+01	6.023E+00	7.228E+01	8.433E+01	0.000E+00	6.023E+02
AG-110M	1.190E+01	1.130E+01	0.000E+00	2.150E+01	0.000E+00	3.160E+03	0.000E+00	6.850E+00
SN-113	2.565E+01	9.866E+00	9.866E+00	1.973E+00	2.368E+01	2.762E+01	0.000E+00	1.973E+02
SN-117M	2.399E+01	9.227E+00	9.227E+00	1.845E+00	2.215E+01	2.584E+01	0.000E+00	1.845E+02
SB-124	2.237E+02	4.122E+00	5.075E-01	0.000E+00	1.954E+02	4.509E+03	0.000E+00	8.729E+01
SB-125	1.441E+02	1.575E+00	1.377E-01	0.000E+00	1.267E+02	1.122E+03	0.000E+00	3.371E+01
SB-126	8.989E+01	1.837E+00	5.083E-01	0.000E+00	6.445E+01	5.320E+03	0.000E+00	3.228E+01
TE-123M	4.740E+01	1.823E+01	1.823E+01	3.646E+00	4.376E+01	5.105E+01	0.000E+00	3.646E+02
TE-125M	2.210E+02	7.980E+01	6.180E+01	0.000E+00	0.000E+00	6.530E+02	0.000E+00	2.960E+01

APPENDIX D

A_i Teen Factors for use in the Liquid Dose Calculations

Age group:	TEEN	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / μ Ci/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
TE-127	3.790E+00	1.340E+00	2.610E+00	1.530E+01	0.000E+00	2.930E+02	0.000E+00	8.150E-01
TE-127M	5.600E+02	1.990E+02	1.330E+02	2.270E+03	0.000E+00	1.400E+03	0.000E+00	6.660E+01
TE-129	1.920E-03	7.150E-04	1.370E-03	8.040E-03	0.000E+00	1.050E-02	0.000E+00	4.660E-04
TE-129M	9.380E+02	3.480E+02	3.030E+02	3.920E+03	0.000E+00	3.520E+03	0.000E+00	1.480E+02
TE-131	3.490E-09	1.440E-09	2.690E-09	1.520E-08	0.000E+00	2.860E-10	0.000E+00	1.090E-09
TE-131M	1.080E+02	5.150E+01	7.750E+01	5.380E+02	0.000E+00	4.140E+03	0.000E+00	4.300E+01
TE-132	1.820E+02	1.150E+02	1.220E+02	1.110E+03	0.000E+00	3.660E+03	0.000E+00	1.090E+02
I-130	3.050E+01	8.830E+01	7.200E+03	1.360E+02	0.000E+00	6.790E+01	0.000E+00	3.530E+01
I-131	3.260E+02	4.560E+02	1.330E+05	7.850E+02	0.000E+00	9.020E+01	0.000E+00	2.450E+02
I-132	4.360E-01	1.140E+00	3.850E+01	1.800E+00	0.000E+00	4.970E-01	0.000E+00	4.100E-01
I-133	7.830E+01	1.330E+02	1.860E+04	2.330E+02	0.000E+00	1.010E+02	0.000E+00	4.050E+01
I-134	6.330E-04	1.680E-03	2.800E-02	2.640E-03	0.000E+00	2.210E-05	0.000E+00	6.020E-04
I-135	1.010E+01	2.600E+01	1.670E+03	4.100E+01	0.000E+00	2.880E+01	0.000E+00	9.630E+00
CS-134	4.860E+03	1.140E+04	0.000E+00	3.640E+03	1.390E+03	1.420E+02	0.000E+00	5.310E+03
CS-136	4.860E+02	1.910E+03	0.000E+00	1.040E+03	1.640E+02	1.540E+02	0.000E+00	1.290E+03
CS-137	6.510E+03	8.660E+03	0.000E+00	2.950E+03	1.150E+03	1.230E+02	0.000E+00	3.020E+03
CS-138	8.300E-07	1.590E-06	0.000E+00	1.180E-06	1.370E-07	7.230E-10	0.000E+00	7.970E-07
BA-133	2.041E+02	7.851E+01	7.851E+01	1.570E+01	1.884E+02	2.198E+02	0.000E+00	1.570E+03
BA-139	1.990E-02	1.400E-05	0.000E+00	1.320E-05	9.670E-06	1.780E-01	0.000E+00	5.810E-04
BA-140	1.610E+03	1.970E+00	0.000E+00	6.680E-01	1.320E+00	2.480E+03	0.000E+00	1.040E+02
BA-141	5.420E-12	4.050E-15	0.000E+00	3.760E-15	2.770E-15	1.150E-17	0.000E+00	1.810E-13
BA-142	6.170E-21	6.170E-24	0.000E+00	5.220E-24	4.100E-24	1.890E-32	0.000E+00	3.800E-22
LA-140	1.650E-01	8.090E-02	0.000E+00	0.000E+00	0.000E+00	4.640E+03	0.000E+00	2.150E-02
LA-142	5.590E-05	2.480E-05	0.000E+00	0.000E+00	0.000E+00	7.550E-01	0.000E+00	6.180E-06
CE-141	7.650E-01	5.110E-01	0.000E+00	2.400E-01	0.000E+00	1.460E+03	0.000E+00	5.870E-02

APPENDIX D

A_i Teen Factors for use in the Liquid Dose Calculations

Age group:	TEEN	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / μ Ci/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
CE-143	1.060E-01	7.730E+01	0.000E+00	3.460E-02	0.000E+00	2.320E+03	0.000E+00	8.630E-03
CE-144	4.040E+01	1.670E+01	0.000E+00	9.990E+00	0.000E+00	1.020E+04	0.000E+00	2.170E+00
PR-143	7.420E-01	2.960E-01	0.000E+00	1.720E-01	0.000E+00	2.440E+03	0.000E+00	3.700E-02
PR-144	7.330E-16	3.000E-16	0.000E+00	1.720E-16	0.000E+00	8.080E-19	0.000E+00	3.720E-17
ND-147	5.280E-01	5.750E-01	0.000E+00	3.370E-01	0.000E+00	2.070E+03	0.000E+00	3.440E-02
EU-152	1.424E+01	3.430E+00	0.000E+00	1.593E+01	0.000E+00	1.262E+03	0.000E+00	3.023E+00
W-187	5.990E+00	4.880E+00	0.000E+00	0.000E+00	0.000E+00	1.320E+03	0.000E+00	1.710E+00
NP-239	8.830E-02	8.330E-03	0.000E+00	2.610E-02	0.000E+00	1.340E+03	0.000E+00	4.630E-03

APPENDIX D

A_i Teen Dose Factors for use in the Liquid Dose Calculations

Age group:	TEEN	Pathway:	Fresh Water Fish - Sport (FFSP)			Units:	mrem/hr / μ Ci/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
H-3	0.000E+00	1.740E-01	1.740E-01	1.740E-01	1.740E-01	1.740E-01	0.000E+00	1.740E-01
C-14	3.410E+04	6.810E+03	6.810E+03	6.810E+03	6.810E+03	6.810E+03	0.000E+00	6.810E+03
NA-24	1.390E+02	1.390E+02	1.390E+02	1.390E+02	1.390E+02	1.390E+02	0.000E+00	1.390E+02
P-32	1.440E+06	8.910E+04	0.000E+00	0.000E+00	0.000E+00	1.210E+05	0.000E+00	5.580E+04
CR-51	0.000E+00	0.000E+00	7.120E-01	2.810E-01	1.830E+00	2.150E+02	0.000E+00	1.280E+00
MN-54	0.000E+00	4.300E+03	0.000E+00	1.280E+03	0.000E+00	8.810E+03	0.000E+00	8.520E+02
MN-56	0.000E+00	1.810E-01	0.000E+00	2.300E-01	0.000E+00	1.190E+01	0.000E+00	3.230E-02
FE-55	6.890E+02	4.880E+02	0.000E+00	0.000E+00	3.100E+02	2.110E+02	0.000E+00	1.140E+02
FE-59	1.050E+03	2.460E+03	0.000E+00	0.000E+00	7.760E+02	5.820E+03	0.000E+00	9.500E+02
CO-58	0.000E+00	8.780E+01	0.000E+00	0.000E+00	0.000E+00	1.210E+03	0.000E+00	2.020E+02
CO-60	0.000E+00	2.560E+02	0.000E+00	0.000E+00	0.000E+00	3.340E+03	0.000E+00	5.770E+02
NI-63	3.230E+04	2.280E+03	0.000E+00	0.000E+00	0.000E+00	3.630E+02	0.000E+00	1.090E+03
NI-65	1.860E-01	2.370E-02	0.000E+00	0.000E+00	0.000E+00	1.290E+00	0.000E+00	1.080E-02
CU-64	0.000E+00	2.820E+00	0.000E+00	7.140E+00	0.000E+00	2.190E+02	0.000E+00	1.330E+00
ZN-65	2.100E+04	7.280E+04	0.000E+00	4.660E+04	0.000E+00	3.080E+04	0.000E+00	3.390E+04
ZN-69	8.410E-07	1.600E-06	0.000E+00	1.050E-06	0.000E+00	2.950E-06	0.000E+00	1.120E-07
SE-75	5.408E+02	2.080E+02	2.080E+02	4.160E+01	4.992E+02	5.824E+02	0.000E+00	4.160E+03
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.160E-02
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.320E-12
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	1.050E+05	0.000E+00	0.000E+00	0.000E+00	1.550E+04	0.000E+00	4.920E+04
RB-88	0.000E+00	1.380E-22	0.000E+00	0.000E+00	0.000E+00	1.180E-29	0.000E+00	7.360E-23
RB-89	0.000E+00	1.720E-26	0.000E+00	0.000E+00	0.000E+00	2.630E-35	0.000E+00	1.220E-26
SR-89	2.370E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.830E+03	0.000E+00	6.800E+02
SR-90	4.540E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.270E+04	0.000E+00	1.120E+05

APPENDIX D

A_i Teen Dose Factors for use in the Liquid Dose Calculations

Age group:	TEEN	Pathway:	Fresh Water Fish - Sport (FFSP)			Units:	mrem/hr / μ Ci/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-91	7.640E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.470E+02	0.000E+00	3.040E+00
SR-92	3.590E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.130E+00	0.000E+00	1.530E-02
Y-90	4.820E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.980E+03	0.000E+00	1.300E-02
Y-91	9.060E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.710E+03	0.000E+00	2.430E-01
Y-91M	1.160E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.470E-10	0.000E+00	4.430E-13
Y-92	5.020E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.380E+01	0.000E+00	1.450E-05
Y-93	3.350E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.020E+03	0.000E+00	9.190E-04
ZR-95	2.450E-01	7.740E-02	0.000E+00	1.140E-01	0.000E+00	1.790E+02	0.000E+00	5.320E-02
ZR-97	5.330E-03	1.050E-03	0.000E+00	1.600E-03	0.000E+00	2.850E+02	0.000E+00	4.860E-04
NB-95	4.410E+02	2.450E+02	0.000E+00	2.370E+02	0.000E+00	1.050E+06	0.000E+00	1.350E+02
MO-99	0.000E+00	8.550E+01	0.000E+00	1.960E+02	0.000E+00	1.530E+02	0.000E+00	1.630E+01
TC-99M	5.720E-04	1.600E-03	0.000E+00	2.380E-02	8.860E-04	1.050E+00	0.000E+00	2.070E-02
TC-101	2.820E-33	4.010E-33	0.000E+00	7.240E-32	2.440E-33	6.840E-40	0.000E+00	3.930E-32
RU-103	4.570E+00	0.000E+00	0.000E+00	1.610E+01	0.000E+00	3.820E+02	0.000E+00	1.950E+00
RU-105	9.350E-03	0.000E+00	0.000E+00	1.180E-01	0.000E+00	7.550E+00	0.000E+00	3.630E-03
RU-106	7.140E+01	0.000E+00	0.000E+00	1.380E+02	0.000E+00	3.420E+03	0.000E+00	8.990E+00
AG-108M	2.457E+01	9.448E+00	9.448E+00	1.890E+00	2.268E+01	2.645E+01	0.000E+00	1.890E+02
AG-110M	8.580E-01	8.120E-01	0.000E+00	1.550E+00	0.000E+00	2.280E+02	0.000E+00	4.940E-01
SN-113	2.407E+03	9.257E+02	9.257E+02	1.851E+02	2.222E+03	2.592E+03	0.000E+00	1.851E+04
SN-117M	2.201E+03	8.466E+02	8.466E+02	1.693E+02	2.032E+03	2.371E+03	0.000E+00	1.693E+04
SB-124	6.978E+02	1.286E+01	1.583E+00	0.000E+00	6.095E+02	1.406E+04	0.000E+00	2.723E+02
SB-125	4.520E+02	4.940E+00	4.320E-01	0.000E+00	3.974E+02	3.518E+03	0.000E+00	1.057E+02
SB-126	2.742E+02	5.606E+00	1.551E+00	0.000E+00	1.966E+02	1.623E+04	0.000E+00	9.849E+01
TE-123M	5.931E+02	2.281E+02	2.281E+02	4.563E+01	5.475E+02	6.388E+02	0.000E+00	4.563E+03
TE-125M	2.760E+03	9.950E+02	7.710E+02	0.000E+00	0.000E+00	8.150E+03	0.000E+00	3.690E+02

APPENDIX D

A_i Teen Dose Factors for use in the Liquid Dose Calculations

Age group:	TEEN	Pathway:	Fresh Water Fish - Sport (FFSP)			Units:	mrem/hr / μ Ci/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
TE-127	1.960E+01	6.950E+00	1.350E+01	7.940E+01	0.000E+00	1.510E+03	0.000E+00	4.220E+00
TE-127M	7.010E+03	2.490E+03	1.670E+03	2.840E+04	0.000E+00	1.750E+04	0.000E+00	8.340E+02
TE-129	1.770E-05	6.600E-06	1.260E-05	7.430E-05	0.000E+00	9.680E-05	0.000E+00	4.310E-06
TE-129M	1.160E+04	4.320E+03	3.760E+03	4.870E+04	0.000E+00	4.370E+04	0.000E+00	1.840E+03
TE-131	9.400E-17	3.870E-17	7.240E-17	4.110E-16	0.000E+00	7.710E-18	0.000E+00	2.940E-17
TE-131M	1.020E+03	4.900E+02	7.370E+02	5.110E+03	0.000E+00	3.930E+04	0.000E+00	4.090E+02
TE-132	2.060E+03	1.300E+03	1.370E+03	1.250E+04	0.000E+00	4.130E+04	0.000E+00	1.230E+03
I-130	7.320E+00	2.120E+01	1.730E+03	3.260E+01	0.000E+00	1.630E+01	0.000E+00	8.460E+00
I-131	1.470E+02	2.060E+02	6.000E+04	3.540E+02	0.000E+00	4.070E+01	0.000E+00	1.100E+02
I-132	5.520E-03	1.440E-02	4.870E-01	2.280E-02	0.000E+00	6.290E-03	0.000E+00	5.180E-03
I-133	2.470E+01	4.190E+01	5.850E+03	7.350E+01	0.000E+00	3.170E+01	0.000E+00	1.280E+01
I-134	2.220E-08	5.890E-08	9.810E-07	9.280E-08	0.000E+00	7.760E-10	0.000E+00	2.110E-08
I-135	1.350E+00	3.480E+00	2.240E+02	5.490E+00	0.000E+00	3.850E+00	0.000E+00	1.290E+00
CS-134	3.050E+05	7.180E+05	0.000E+00	2.280E+05	8.710E+04	8.930E+03	0.000E+00	3.330E+05
CS-136	2.970E+04	1.170E+05	0.000E+00	6.370E+04	1.000E+04	9.410E+03	0.000E+00	7.860E+04
CS-137	4.090E+05	5.440E+05	0.000E+00	1.850E+05	7.190E+04	7.730E+03	0.000E+00	1.890E+05
CS-138	9.580E-12	1.840E-11	0.000E+00	1.360E-11	1.580E-12	8.340E-15	0.000E+00	9.190E-12
BA-133	2.561E+01	9.851E+00	9.851E+00	1.970E+00	2.364E+01	2.758E+01	0.000E+00	1.970E+02
BA-139	6.170E-06	4.340E-09	0.000E+00	4.090E-09	2.990E-09	5.510E-05	0.000E+00	1.800E-07
BA-140	1.960E+02	2.410E-01	0.000E+00	8.160E-02	1.620E-01	3.030E+02	0.000E+00	1.260E+01
BA-141	9.450E-25	7.050E-28	0.000E+00	6.550E-28	4.830E-28	2.010E-30	0.000E+00	3.150E-26
BA-142	2.750E-42	2.750E-45	0.000E+00	2.320E-45	1.830E-45	8.430E-54	0.000E+00	1.690E-43
LA-140	1.050E-01	5.160E-02	0.000E+00	0.000E+00	0.000E+00	2.960E+03	0.000E+00	1.370E-02
LA-142	2.350E-07	1.040E-07	0.000E+00	0.000E+00	0.000E+00	3.180E-03	0.000E+00	2.600E-08
CE-141	2.370E-02	1.590E-02	0.000E+00	7.460E-03	0.000E+00	4.540E+01	0.000E+00	1.820E-03

APPENDIX D

A_i Teen Dose Factors for use in the Liquid Dose Calculations

Age group:	TEEN	Pathway:	Fresh Water Fish - Sport (FFSP)			Units:	mrem/hr / μ Ci/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
CE-143	2.590E-03	1.880E+00	0.000E+00	8.450E-04	0.000E+00	5.660E+01	0.000E+00	2.100E-04
CE-144	1.270E+00	5.240E-01	0.000E+00	3.130E-01	0.000E+00	3.180E+02	0.000E+00	6.810E-02
PR-143	5.680E-01	2.270E-01	0.000E+00	1.320E-01	0.000E+00	1.870E+03	0.000E+00	2.830E-02
PR-144	1.690E-28	6.900E-29	0.000E+00	3.960E-29	0.000E+00	1.860E-31	0.000E+00	8.550E-30
ND-147	4.020E-01	4.370E-01	0.000E+00	2.560E-01	0.000E+00	1.580E+03	0.000E+00	2.620E-02
EU-152	2.234E+01	5.380E+00	0.000E+00	2.499E+01	0.000E+00	1.979E+03	0.000E+00	4.742E+00
W-187	1.590E+02	1.300E+02	0.000E+00	0.000E+00	0.000E+00	3.510E+04	0.000E+00	4.540E+01
NP-239	2.390E-02	2.260E-03	0.000E+00	7.080E-03	0.000E+00	3.630E+02	0.000E+00	1.250E-03

APPENDIX D

A_i Teen Dose Factors for use in the Liquid Dose Calculations

Age group:	TEEN	Pathway:	Shoreline Sediment (SHDp)			Units:	mrem/hr / μ Ci/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
H-3	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C-14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NA-24	3.580E+00	3.580E+00	3.580E+00	3.580E+00	3.580E+00	3.580E+00	4.150E+00	3.580E+00
P-32	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CR-51	1.400E+00	1.400E+00	1.400E+00	1.400E+00	1.400E+00	1.400E+00	1.650E+00	1.400E+00
MN-54	4.150E+02	4.150E+02	4.150E+02	4.150E+02	4.150E+02	4.150E+02	4.870E+02	4.150E+02
MN-56	2.700E-01	2.700E-01	2.700E-01	2.700E-01	2.700E-01	2.700E-01	3.200E-01	2.700E-01
FE-55	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
FE-59	8.180E+01	8.180E+01	8.180E+01	8.180E+01	8.180E+01	8.180E+01	9.610E+01	8.180E+01
CO-58	1.140E+02	1.140E+02	1.140E+02	1.140E+02	1.140E+02	1.140E+02	1.330E+02	1.140E+02
CO-60	6.440E+03	6.440E+03	6.440E+03	6.440E+03	6.440E+03	6.440E+03	7.580E+03	6.440E+03
NI-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NI-65	8.900E-02	8.900E-02	8.900E-02	8.900E-02	8.900E-02	8.900E-02	1.030E-01	8.900E-02
CU-64	1.820E-01	1.820E-01	1.820E-01	1.820E-01	1.820E-01	1.820E-01	2.060E-01	1.820E-01
ZN-65	2.240E+02	2.240E+02	2.240E+02	2.240E+02	2.240E+02	2.240E+02	2.580E+02	2.240E+02
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE-75	1.354E+03	1.354E+03	1.354E+03	1.354E+03	1.354E+03	1.354E+03	1.584E+03	1.354E+03
BR-83	1.460E-03	1.460E-03	1.460E-03	1.460E-03	1.460E-03	1.460E-03	2.120E-03	1.460E-03
BR-84	6.070E-02	6.070E-02	6.070E-02	6.070E-02	6.070E-02	6.070E-02	7.080E-02	6.070E-02
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	2.690E+00	2.690E+00	2.690E+00	2.690E+00	2.690E+00	2.690E+00	3.080E+00	2.690E+00
RB-88	9.910E-03	9.910E-03	9.910E-03	9.910E-03	9.910E-03	9.910E-03	1.130E-02	9.910E-03
RB-89	3.680E-02	3.680E-02	3.680E-02	3.680E-02	3.680E-02	3.680E-02	4.420E-02	3.680E-02
SR-89	6.490E-03	6.490E-03	6.490E-03	6.490E-03	6.490E-03	6.490E-03	7.530E-03	6.490E-03
SR-90	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

APPENDIX D

A_i Teen Dose Factors for use in the Liquid Dose Calculations

Age group:	TEEN	Pathway:	Shoreline Sediment (SHDp)			Units:	mrem/hr / μ Ci/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-91	6.440E-01	6.440E-01	6.440E-01	6.440E-01	6.440E-01	6.440E-01	7.530E-01	6.440E-01
SR-92	2.330E-01	2.330E-01	2.330E-01	2.330E-01	2.330E-01	2.330E-01	2.590E-01	2.330E-01
Y-90	1.350E-03	1.350E-03	1.350E-03	1.350E-03	1.350E-03	1.350E-03	1.590E-03	1.350E-03
Y-91	3.220E-01	3.220E-01	3.220E-01	3.220E-01	3.220E-01	3.220E-01	3.620E-01	3.220E-01
Y-91M	3.010E-02	3.010E-02	3.010E-02	3.010E-02	3.010E-02	3.010E-02	3.480E-02	3.010E-02
Y-92	5.410E-02	5.410E-02	5.410E-02	5.410E-02	5.410E-02	5.410E-02	6.420E-02	5.410E-02
Y-93	5.500E-02	5.500E-02	5.500E-02	5.500E-02	5.500E-02	5.500E-02	7.520E-02	5.500E-02
ZR-95	7.330E+01	7.330E+01	7.330E+01	7.330E+01	7.330E+01	7.330E+01	8.510E+01	7.330E+01
ZR-97	8.870E-01	8.870E-01	8.870E-01	8.870E-01	8.870E-01	8.870E-01	1.030E+00	8.870E-01
NB-95	4.100E+01	4.100E+01	4.100E+01	4.100E+01	4.100E+01	4.100E+01	4.820E+01	4.100E+01
MO-99	1.200E+00	1.200E+00	1.200E+00	1.200E+00	1.200E+00	1.200E+00	1.390E+00	1.200E+00
TC-99M	5.520E-02	5.520E-02	5.520E-02	5.520E-02	5.520E-02	5.520E-02	6.320E-02	5.520E-02
TC-101	6.100E-03	6.100E-03	6.100E-03	6.100E-03	6.100E-03	6.100E-03	6.780E-03	6.100E-03
RU-103	3.250E+01	3.250E+01	3.250E+01	3.250E+01	3.250E+01	3.250E+01	3.790E+01	3.250E+01
RU-105	1.910E-01	1.910E-01	1.910E-01	1.910E-01	1.910E-01	1.910E-01	2.160E-01	1.910E-01
RU-106	1.270E+02	1.270E+02	1.270E+02	1.270E+02	1.270E+02	1.270E+02	1.520E+02	1.270E+02
AG-108M	1.546E+05	1.546E+05	1.546E+05	1.546E+05	1.546E+05	1.546E+05	1.808E+05	1.546E+05
AG-110M	1.030E+03	1.030E+03	1.030E+03	1.030E+03	1.030E+03	1.030E+03	1.200E+03	1.030E+03
SN-113	4.473E+01	4.473E+01	4.473E+01	4.473E+01	4.473E+01	4.473E+01	5.233E+01	4.473E+01
SN-117M	6.250E+01	6.250E+01	6.250E+01	6.250E+01	6.250E+01	6.250E+01	7.313E+01	6.250E+01
SB-124	1.793E+02	1.793E+02	1.793E+02	1.793E+02	1.793E+02	1.793E+02	2.069E+02	1.793E+02
SB-125	6.992E+02	6.992E+02	6.992E+02	6.992E+02	6.992E+02	6.992E+02	7.894E+02	6.992E+02
SB-126	2.529E+01	2.529E+01	2.529E+01	2.529E+01	2.529E+01	2.529E+01	2.841E+01	2.529E+01
TE-123M	5.074E+02	5.074E+02	5.074E+02	5.074E+02	5.074E+02	5.074E+02	5.937E+02	5.074E+02
TE-125M	4.650E-01	4.650E-01	4.650E-01	4.650E-01	4.650E-01	4.650E-01	6.380E-01	4.650E-01

APPENDIX D

A_i Teen Dose Factors for use in the Liquid Dose Calculations

Age group:	TEEN	Pathway:	Shoreline Sediment (SHDp)			Units:	mrem/hr / μ Ci/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
TE-127	8.920E-04	8.920E-04	8.920E-04	8.920E-04	8.920E-04	8.920E-04	9.820E-04	8.920E-04
TE-127M	2.750E-02	2.750E-02	2.750E-02	2.750E-02	2.750E-02	2.750E-02	3.250E-02	2.750E-02
TE-129	7.860E-03	7.860E-03	7.860E-03	7.860E-03	7.860E-03	7.860E-03	9.300E-03	7.860E-03
TE-129M	5.930E+00	5.930E+00	5.930E+00	5.930E+00	5.930E+00	5.930E+00	6.930E+00	5.930E+00
TE-131	8.750E-03	8.750E-03	8.750E-03	8.750E-03	8.750E-03	8.750E-03	1.030E+01	8.750E-03
TE-131M	2.410E+00	2.410E+00	2.410E+00	2.410E+00	2.410E+00	2.410E+00	2.840E+00	2.410E+00
TE-132	1.270E+00	1.270E+00	1.270E+00	1.270E+00	1.270E+00	1.270E+00	1.490E+00	1.270E+00
I-130	1.650E+00	1.650E+00	1.650E+00	1.650E+00	1.650E+00	1.650E+00	2.010E+00	1.650E+00
I-131	5.160E+00	5.160E+00	5.160E+00	5.160E+00	5.160E+00	5.160E+00	6.260E+00	5.160E+00
I-132	3.730E-01	3.730E-01	3.730E-01	3.730E-01	3.730E-01	3.730E-01	4.390E-01	3.730E-01
I-133	7.350E-01	7.350E-01	7.350E-01	7.350E-01	7.350E-01	7.350E-01	8.930E-01	7.350E-01
I-134	1.340E-01	1.340E-01	1.340E-01	1.340E-01	1.340E-01	1.340E-01	1.590E-01	1.340E-01
I-135	7.570E-01	7.570E-01	7.570E-01	7.570E-01	7.570E-01	7.570E-01	8.830E-01	7.570E-01
CS-134	2.060E+03	2.060E+03	2.060E+03	2.060E+03	2.060E+03	2.060E+03	2.400E+03	2.060E+03
CS-136	4.520E+01	4.520E+01	4.520E+01	4.520E+01	4.520E+01	4.520E+01	5.130E+01	4.520E+01
CS-137	3.080E+03	3.080E+03	3.080E+03	3.080E+03	3.080E+03	3.080E+03	3.590E+03	3.080E+03
CS-138	1.080E-01	1.080E-01	1.080E-01	1.080E-01	1.080E-01	1.080E-01	1.230E-01	1.080E-01
BA-133	2.642E+04	2.642E+04	2.642E+04	2.642E+04	2.642E+04	2.642E+04	3.091E+04	2.642E+04
BA-139	3.170E-02	3.170E-02	3.170E-02	3.170E-02	3.170E-02	3.170E-02	3.570E-02	3.170E-02
BA-140	6.150E+00	6.150E+00	6.150E+00	6.150E+00	6.150E+00	6.150E+00	7.030E+00	6.150E+00
BA-141	1.250E-02	1.250E-02	1.250E-02	1.250E-02	1.250E-02	1.250E-02	1.420E-02	1.250E-02
BA-142	1.340E-02	1.340E-02	1.340E-02	1.340E-02	1.340E-02	1.340E-02	1.530E-02	1.340E-02
LA-140	5.760E+00	5.760E+00	5.760E+00	5.760E+00	5.760E+00	5.760E+00	6.530E+00	5.760E+00
LA-142	2.280E-01	2.280E-01	2.280E-01	2.280E-01	2.280E-01	2.280E-01	2.730E-01	2.280E-01
CE-141	4.090E+00	4.090E+00	4.090E+00	4.090E+00	4.090E+00	4.090E+00	4.620E+00	4.090E+00

APPENDIX D

A_i Teen Dose Factors for use in the Liquid Dose Calculations

Age group:	TEEN	Pathway:	Shoreline Sediment (SHDp)			Units:	mrem/hr / μ Ci/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
CE-143	6.930E-01	6.930E-01	6.930E-01	6.930E-01	6.930E-01	6.930E-01	7.870E-01	6.930E-01
CE-144	2.080E+01	2.080E+01	2.080E+01	2.080E+01	2.080E+01	2.080E+01	2.410E+01	2.080E+01
PR-143	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR-144	5.500E-04	5.500E-04	5.500E-04	5.500E-04	5.500E-04	5.500E-04	6.320E-04	5.500E-04
ND-147	2.520E+00	2.520E+00	2.520E+00	2.520E+00	2.520E+00	2.520E+00	3.020E+00	2.520E+00
EU-152	4.453E+03	4.453E+03	4.453E+03	4.453E+03	4.453E+03	4.453E+03	5.154E+03	4.453E+03
W-187	7.050E-01	7.050E-01	7.050E-01	7.050E-01	7.050E-01	7.050E-01	8.190E-01	7.050E-01
NP-239	5.130E-01	5.130E-01	5.130E-01	5.130E-01	5.130E-01	5.130E-01	5.930E-01	5.130E-01

APPENDIX E

A_i Child Dose Factors for use in the Liquid Dose Calculations

Age group:	CHILD	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / μ Ci/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
H-3	0.000E+00	1.180E+01	1.180E+01	1.180E+01	1.180E+01	1.180E+01	0.000E+00	1.180E+01
C-14	7.030E+02	1.410E+02	1.410E+02	1.410E+02	1.410E+02	1.410E+02	0.000E+00	1.410E+02
NA-24	1.940E+02	1.940E+02	1.940E+02	1.940E+02	1.940E+02	1.940E+02	0.000E+00	1.940E+02
P-32	4.680E+04	2.190E+03	0.000E+00	0.000E+00	0.000E+00	1.290E+03	0.000E+00	1.800E+03
CR-51	0.000E+00	0.000E+00	2.840E-01	7.750E-02	5.180E-01	2.710E+01	0.000E+00	5.110E-01
MN-54	0.000E+00	6.210E+02	0.000E+00	1.740E+02	0.000E+00	5.220E+02	0.000E+00	1.660E+02
MN-56	0.000E+00	7.700E-01	0.000E+00	9.320E-01	0.000E+00	1.120E+02	0.000E+00	1.740E-01
FE-55	6.680E+02	3.550E+02	0.000E+00	0.000E+00	2.010E+02	6.570E+01	0.000E+00	1.100E+02
FE-59	9.520E+02	1.540E+03	0.000E+00	0.000E+00	4.470E+02	1.600E+03	0.000E+00	7.670E+02
CO-58	0.000E+00	1.040E+02	0.000E+00	0.000E+00	0.000E+00	6.070E+02	0.000E+00	3.190E+02
CO-60	0.000E+00	3.080E+02	0.000E+00	0.000E+00	0.000E+00	1.700E+03	0.000E+00	9.070E+02
NI-63	3.130E+04	1.670E+03	0.000E+00	0.000E+00	0.000E+00	1.130E+02	0.000E+00	1.060E+03
NI-65	4.760E+00	4.480E-01	0.000E+00	0.000E+00	0.000E+00	5.490E+01	0.000E+00	2.610E-01
CU-64	0.000E+00	7.390E+00	0.000E+00	1.780E+01	0.000E+00	3.470E+02	0.000E+00	4.460E+00
ZN-65	7.950E+02	2.120E+03	0.000E+00	1.340E+03	0.000E+00	3.720E+02	0.000E+00	1.320E+03
ZN-69	3.190E-04	4.610E-04	0.000E+00	2.800E-04	0.000E+00	2.900E-02	0.000E+00	4.260E-05
SE-75	2.314E+02	8.902E+01	8.902E+01	1.780E+01	2.136E+02	2.492E+02	0.000E+00	1.780E+03
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.060E-01
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.780E-06
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.300E-76
RB-86	0.000E+00	3.820E+03	0.000E+00	0.000E+00	0.000E+00	2.460E+02	0.000E+00	2.350E+03
RB-88	0.000E+00	7.360E-12	0.000E+00	0.000E+00	0.000E+00	3.610E-13	0.000E+00	5.110E-12
RB-89	0.000E+00	6.300E-14	0.000E+00	0.000E+00	0.000E+00	5.490E-16	0.000E+00	5.600E-14
SR-89	7.620E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.950E+03	0.000E+00	2.180E+03
SR-90	9.880E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.330E+04	0.000E+00	2.510E+05

APPENDIX E

A_i Child Dose Factors for use in the Liquid Dose Calculations

Age group:	CHILD	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / μ Ci/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-91	5.810E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.280E+03	0.000E+00	2.190E+01
SR-92	2.430E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.610E+02	0.000E+00	9.760E-01
Y-90	2.100E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.980E+03	0.000E+00	5.620E-02
Y-91	3.480E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.640E+03	0.000E+00	9.310E-01
Y-91M	9.860E-07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.930E-03	0.000E+00	3.590E-08
Y-92	2.000E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.770E+02	0.000E+00	5.710E-04
Y-93	2.900E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.330E+03	0.000E+00	7.970E-03
ZR-95	6.710E+00	1.470E+00	0.000E+00	2.110E+00	0.000E+00	1.540E+03	0.000E+00	1.310E+00
ZR-97	2.480E-01	3.590E-02	0.000E+00	5.150E-02	0.000E+00	5.440E+03	0.000E+00	2.120E-02
NB-95	1.300E+00	5.040E-01	0.000E+00	4.740E-01	0.000E+00	9.330E+02	0.000E+00	3.600E-01
MO-99	0.000E+00	6.820E+02	0.000E+00	1.460E+03	0.000E+00	5.640E+02	0.000E+00	1.690E+02
TC-99M	1.350E-02	2.640E-02	0.000E+00	3.840E-01	1.340E-02	1.500E+01	0.000E+00	4.380E-01
TC-101	3.330E-17	3.480E-17	0.000E+00	5.940E-16	1.840E-17	1.110E-16	0.000E+00	4.410E-16
RU-103	4.210E+01	0.000E+00	0.000E+00	1.060E+02	0.000E+00	1.090E+03	0.000E+00	1.620E+01
RU-105	5.750E-01	0.000E+00	0.000E+00	5.060E+00	0.000E+00	3.750E+02	0.000E+00	2.090E-01
RU-106	6.800E+02	0.000E+00	0.000E+00	9.180E+02	0.000E+00	1.060E+04	0.000E+00	8.480E+01
AG-108M	1.818E+02	6.991E+01	6.991E+01	1.398E+01	1.678E+02	1.958E+02	0.000E+00	1.398E+03
AG-110M	3.130E+01	2.110E+01	0.000E+00	3.940E+01	0.000E+00	2.510E+03	0.000E+00	1.690E+01
SN-113	7.249E+01	2.788E+01	2.788E+01	5.576E+00	6.692E+01	7.807E+01	0.000E+00	5.576E+02
SN-117M	6.816E+01	2.621E+01	2.621E+01	5.243E+00	6.291E+01	7.340E+01	0.000E+00	5.243E+02
SB-124	6.416E+02	8.324E+00	1.416E+00	0.000E+00	3.561E+02	4.012E+03	0.000E+00	2.249E+02
SB-125	4.161E+02	3.208E+00	3.853E-01	0.000E+00	2.319E+02	9.939E+02	0.000E+00	8.718E+01
SB-126	2.488E+02	3.805E+00	1.459E+00	0.000E+00	1.187E+02	5.015E+03	0.000E+00	8.933E+01
TE-123M	1.366E+02	5.255E+01	5.255E+01	1.051E+01	1.261E+02	1.471E+02	0.000E+00	1.051E+03
TE-125M	6.590E+02	1.790E+02	1.850E+02	0.000E+00	0.000E+00	6.360E+02	0.000E+00	8.780E+01

APPENDIX E

A_i Child Dose Factors for use in the Liquid Dose Calculations

Age group:	CHILD	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / μ Ci/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
TE-127	1.130E+01	3.050E+00	7.820E+00	3.210E+01	0.000E+00	4.410E+02	0.000E+00	2.420E+00
TE-127M	1.670E+03	4.510E+02	4.000E+02	4.780E+03	0.000E+00	1.360E+03	0.000E+00	1.990E+02
TE-129	5.730E-03	1.600E-03	4.090E-03	1.680E-02	0.000E+00	3.570E-01	0.000E+00	1.360E-03
TE-129M	2.800E+03	7.830E+02	9.030E+02	8.230E+03	0.000E+00	3.420E+03	0.000E+00	4.350E+02
TE-131	1.040E-08	3.160E-09	7.930E-09	3.140E-08	0.000E+00	5.450E-08	0.000E+00	3.090E-09
TE-131M	3.170E+02	1.100E+02	2.260E+02	1.060E+03	0.000E+00	4.450E+03	0.000E+00	1.170E+02
TE-132	5.280E+02	2.340E+02	3.400E+02	2.170E+03	0.000E+00	2.350E+03	0.000E+00	2.820E+02
I-130	8.650E+01	1.750E+02	1.930E+04	2.610E+02	0.000E+00	8.180E+01	0.000E+00	9.010E+01
I-131	9.580E+02	9.630E+02	3.190E+05	1.580E+03	0.000E+00	8.580E+01	0.000E+00	5.470E+02
I-132	1.250E+00	2.300E+00	1.070E+02	3.520E+00	0.000E+00	2.710E+00	0.000E+00	1.060E+00
I-133	2.310E+02	2.850E+02	5.300E+04	4.750E+02	0.000E+00	1.150E+02	0.000E+00	1.080E+02
I-134	1.820E-03	3.370E-03	7.760E-02	5.160E-03	0.000E+00	2.240E-03	0.000E+00	1.550E-03
I-135	2.890E+01	5.210E+01	4.610E+03	7.990E+01	0.000E+00	3.970E+01	0.000E+00	2.460E+01
CS-134	1.360E+04	2.230E+04	0.000E+00	6.920E+03	2.480E+03	1.200E+02	0.000E+00	4.710E+03
CS-136	1.330E+03	3.660E+03	0.000E+00	1.950E+03	2.910E+02	1.290E+02	0.000E+00	2.370E+03
CS-137	1.900E+04	1.820E+04	0.000E+00	5.930E+03	2.130E+03	1.140E+02	0.000E+00	2.690E+03
CS-138	2.440E-06	3.390E-06	0.000E+00	2.380E-06	2.570E-07	1.560E-06	0.000E+00	2.150E-06
BA-133	1.091E+02	4.194E+01	4.194E+01	8.389E+00	1.007E+02	1.174E+02	0.000E+00	8.389E+02
BA-139	5.940E-02	3.170E-05	0.000E+00	2.770E-05	1.860E-05	3.430E+00	0.000E+00	1.720E-03
BA-140	4.700E+03	4.120E+00	0.000E+00	1.340E+00	2.460E+00	2.380E+03	0.000E+00	2.740E+02
BA-141	1.620E-11	9.050E-15	0.000E+00	7.830E-15	5.310E-14	9.210E-12	0.000E+00	5.260E-13
BA-142	1.800E-20	1.300E-23	0.000E+00	1.050E-23	7.630E-24	2.350E-22	0.000E+00	1.010E-21
LA-140	4.780E-01	1.670E-01	0.000E+00	0.000E+00	0.000E+00	4.650E+03	0.000E+00	5.630E-02
LA-142	1.640E-04	5.210E-05	0.000E+00	0.000E+00	0.000E+00	1.030E+01	0.000E+00	1.630E-05
CE-141	2.280E+00	1.140E+00	0.000E+00	4.990E-01	0.000E+00	1.420E+03	0.000E+00	1.690E-01

APPENDIX E

A_i Child Dose Factors for use in the Liquid Dose Calculations

Age group:	CHILD	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / μ Ci/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
CE-143	3.160E-01	1.710E+02	0.000E+00	7.180E-02	0.000E+00	2.510E+03	0.000E+00	2.480E-02
CE-144	1.210E+02	3.790E+01	0.000E+00	2.100E+01	0.000E+00	9.870E+03	0.000E+00	6.450E+00
PR-143	2.230E+00	6.690E-01	0.000E+00	3.620E-01	0.000E+00	2.400E+03	0.000E+00	1.110E-01
PR-144	2.200E-15	6.800E-16	0.000E+00	3.600E-16	0.000E+00	1.460E-12	0.000E+00	1.110E-16
ND-147	1.570E+00	1.270E+00	0.000E+00	6.990E-01	0.000E+00	2.020E+03	0.000E+00	9.860E-02
EU-152	3.575E+01	6.511E+00	0.000E+00	2.750E+01	0.000E+00	1.070E+03	0.000E+00	7.732E+00
W-187	1.760E+01	1.040E+01	0.000E+00	0.000E+00	0.000E+00	1.460E+03	0.000E+00	4.680E+00
NP-239	2.630E-01	1.890E-02	0.000E+00	5.470E-02	0.000E+00	1.400E+03	0.000E+00	1.330E-02

APPENDIX E

A_i Child Dose Factors for use in the Liquid Dose Calculations

Age group:	CHILD	Pathway:	Fresh Water Fish - Sport (FFSP)			Units:	mrem/hr / μ Ci/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
H-3	0.000E+00	1.440E-01	1.440E-01	1.440E-01	1.440E-01	1.440E-01	0.000E+00	1.440E-01
C-14	4.380E+04	8.760E+03	8.760E+03	8.760E+03	8.760E+03	8.760E+03	0.000E+00	8.760E+03
NA-24	1.510E+02	1.510E+02	1.510E+02	1.510E+02	1.510E+02	1.510E+02	0.000E+00	1.510E+02
P-32	1.850E+06	8.680E+04	0.000E+00	0.000E+00	0.000E+00	5.130E+04	0.000E+00	7.150E+04
CR-51	0.000E+00	0.000E+00	7.580E-01	2.070E-01	1.380E+00	7.240E+01	0.000E+00	1.370E+00
MN-54	0.000E+00	3.360E+03	0.000E+00	9.420E+02	0.000E+00	2.820E+03	0.000E+00	8.950E+02
MN-56	0.000E+00	1.650E-01	0.000E+00	2.000E-01	0.000E+00	2.400E+01	0.000E+00	3.730E-02
FE-55	9.040E+02	4.790E+02	0.000E+00	0.000E+00	2.710E+02	8.880E+01	0.000E+00	1.490E+02
FE-59	1.280E+03	2.070E+03	0.000E+00	0.000E+00	5.990E+02	2.150E+03	0.000E+00	1.030E+03
CO-58	0.000E+00	7.010E+01	0.000E+00	0.000E+00	0.000E+00	4.090E+02	0.000E+00	2.150E+02
CO-60	0.000E+00	2.080E+02	0.000E+00	0.000E+00	0.000E+00	1.150E+03	0.000E+00	6.130E+02
NI-63	4.230E+04	2.270E+03	0.000E+00	0.000E+00	0.000E+00	1.530E+02	0.000E+00	1.440E+03
NI-65	2.370E-01	2.230E-02	0.000E+00	0.000E+00	0.000E+00	2.740E+00	0.000E+00	1.300E-02
CU-64	0.000E+00	2.590E+00	0.000E+00	6.260E+00	0.000E+00	1.220E+02	0.000E+00	1.570E+00
ZN-65	2.150E+04	5.730E+04	0.000E+00	3.610E+04	0.000E+00	1.010E+04	0.000E+00	3.560E+04
ZN-69	1.080E-06	1.560E-06	0.000E+00	9.470E-07	0.000E+00	9.840E-05	0.000E+00	1.440E-07
SE-75	6.244E+02	2.402E+02	2.402E+02	4.803E+01	5.764E+02	6.725E+02	0.000E+00	4.803E+03
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.340E-02
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.570E-12
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	1.020E+05	0.000E+00	0.000E+00	0.000E+00	6.530E+03	0.000E+00	6.250E+04
RB-88	0.000E+00	1.330E-22	0.000E+00	0.000E+00	0.000E+00	6.510E-24	0.000E+00	9.220E-23
RB-89	0.000E+00	1.580E-26	0.000E+00	0.000E+00	0.000E+00	1.370E-28	0.000E+00	1.400E-26
SR-89	3.070E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.190E+03	0.000E+00	8.780E+02
SR-90	4.010E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.400E+03	0.000E+00	1.020E+05

APPENDIX E

A_i Child Dose Factors for use in the Liquid Dose Calculations

Age group:	CHILD	Pathway:	Fresh Water Fish - Sport (FFSP)			Units:	mrem/hr / μ Ci/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-91	9.800E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.160E+02	0.000E+00	3.700E+00
SR-92	4.580E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.670E+00	0.000E+00	1.840E-02
Y-90	6.240E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.780E+03	0.000E+00	1.670E-02
Y-91	1.170E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.560E+03	0.000E+00	3.130E-01
Y-91M	1.480E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.900E-08	0.000E+00	5.390E-13
Y-92	6.440E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.860E+01	0.000E+00	1.840E-05
Y-93	4.300E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.420E+02	0.000E+00	1.180E-03
ZR-95	2.980E-01	6.550E-02	0.000E+00	9.370E-02	0.000E+00	6.830E+01	0.000E+00	5.830E-02
ZR-97	6.780E-03	9.790E-04	0.000E+00	1.410E-03	0.000E+00	1.480E+02	0.000E+00	5.780E-04
NB-95	5.210E+02	2.030E+02	0.000E+00	1.900E+02	0.000E+00	3.750E+05	0.000E+00	1.450E+02
MO-99	0.000E+00	8.130E+01	0.000E+00	1.740E+02	0.000E+00	6.720E+01	0.000E+00	2.010E+01
TC-99M	6.860E-04	1.350E-03	0.000E+00	1.950E-02	6.830E-04	7.650E-01	0.000E+00	2.230E-02
TC-101	3.610E-33	3.780E-33	0.000E+00	6.440E-32	2.000E-33	1.200E-32	0.000E+00	4.790E-32
RU-103	5.650E+00	0.000E+00	0.000E+00	1.420E+01	0.000E+00	1.460E+02	0.000E+00	2.170E+00
RU-105	1.190E-02	0.000E+00	0.000E+00	1.050E-01	0.000E+00	7.790E+00	0.000E+00	4.330E-03
RU-106	9.190E+01	0.000E+00	0.000E+00	1.240E+02	0.000E+00	1.430E+03	0.000E+00	1.150E+01
AG-108M	2.459E+01	9.459E+00	9.459E+00	1.892E+00	2.270E+01	2.648E+01	0.000E+00	1.892E+02
AG-110M	9.720E-01	6.570E-01	0.000E+00	1.220E+00	0.000E+00	7.810E+01	0.000E+00	5.250E-01
SN-113	2.933E+03	1.128E+03	1.128E+03	2.256E+02	2.708E+03	3.159E+03	0.000E+00	2.256E+04
SN-117M	2.697E+03	1.037E+03	1.037E+03	2.074E+02	2.489E+03	2.904E+03	0.000E+00	2.074E+04
SB-124	8.631E+02	1.120E+01	1.905E+00	0.000E+00	4.790E+02	5.396E+03	0.000E+00	3.025E+02
SB-125	5.628E+02	4.339E+00	5.212E-01	0.000E+00	3.136E+02	1.344E+03	0.000E+00	1.179E+02
SB-126	3.273E+02	5.006E+00	1.919E+00	0.000E+00	1.562E+02	6.598E+03	0.000E+00	1.175E+02
TE-123M	7.373E+02	2.836E+02	2.836E+02	5.671E+01	6.806E+02	7.940E+02	0.000E+00	5.671E+03
TE-125M	3.540E+03	9.610E+02	9.950E+02	0.000E+00	0.000E+00	3.420E+03	0.000E+00	4.730E+02

APPENDIX E

A_i Child Dose Factors for use in the Liquid Dose Calculations

Age group:	CHILD	Pathway:	Fresh Water Fish - Sport (FFSP)			Units:	mrem/hr / μ Ci/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
TE-127	2.520E+01	6.800E+00	1.750E+01	7.170E+01	0.000E+00	9.850E+02	0.000E+00	5.410E+00
TE-127M	9.040E+03	2.430E+03	2.160E+03	2.580E+04	0.000E+00	7.320E+03	0.000E+00	1.070E+03
TE-129	2.280E-05	6.370E-06	1.630E-05	6.680E-05	0.000E+00	1.420E-03	0.000E+00	5.420E-06
TE-129M	1.500E+04	4.190E+03	4.840E+03	4.410E+04	0.000E+00	1.830E+04	0.000E+00	2.330E+03
TE-131	1.210E-16	3.680E-17	9.220E-17	3.650E-16	0.000E+00	6.330E-16	0.000E+00	3.590E-17
TE-131M	1.300E+03	4.500E+02	9.250E+02	4.350E+03	0.000E+00	1.820E+04	0.000E+00	4.790E+02
TE-132	2.570E+03	1.140E+03	1.650E+03	1.050E+04	0.000E+00	1.140E+04	0.000E+00	1.370E+03
I-130	8.950E+00	1.810E+01	1.990E+03	2.700E+01	0.000E+00	8.460E+00	0.000E+00	9.320E+00
I-131	1.860E+02	1.870E+02	6.190E+04	3.070E+02	0.000E+00	1.670E+01	0.000E+00	1.060E+02
I-132	6.830E-03	1.250E-02	5.820E-01	1.920E-02	0.000E+00	1.480E-02	0.000E+00	5.770E-03
I-133	3.140E+01	3.880E+01	7.210E+03	6.470E+01	0.000E+00	1.560E+01	0.000E+00	1.470E+01
I-134	2.750E-08	5.100E-08	1.170E-06	7.800E-08	0.000E+00	3.380E-08	0.000E+00	2.350E-08
I-135	1.670E+00	3.010E+00	2.660E+02	4.610E+00	0.000E+00	2.290E+00	0.000E+00	1.420E+00
CS-134	3.680E+05	6.040E+05	0.000E+00	1.870E+05	6.710E+04	3.250E+03	0.000E+00	1.270E+05
CS-136	3.510E+04	9.640E+04	0.000E+00	5.130E+04	7.660E+03	3.390E+03	0.000E+00	6.240E+04
CS-137	5.140E+05	4.920E+05	0.000E+00	1.600E+05	5.770E+04	3.080E+03	0.000E+00	7.270E+04
CS-138	1.210E-11	1.690E-11	0.000E+00	1.190E-11	1.280E-12	7.770E-12	0.000E+00	1.070E-11
BA-133								
BA-139	7.930E-06	4.230E-09	0.000E+00	3.700E-09	2.490E-09	4.580E-04	0.000E+00	2.300E-07
BA-140	2.480E+02	2.170E-01	0.000E+00	7.060E-02	1.290E-01	1.250E+02	0.000E+00	1.450E+01
BA-141	1.210E-24	6.800E-28	0.000E+00	5.880E-28	3.990E-27	6.920E-25	0.000E+00	3.950E-26
BA-142	3.460E-42	2.490E-45	0.000E+00	2.020E-45	1.470E-45	4.510E-44	0.000E+00	1.930E-43
LA-140	1.310E-01	4.590E-02	0.000E+00	0.000E+00	0.000E+00	1.280E+03	0.000E+00	1.550E-02
LA-142	2.970E-07	9.470E-08	0.000E+00	0.000E+00	0.000E+00	1.880E-02	0.000E+00	2.960E-08
CE-141	3.060E-02	1.520E-02	0.000E+00	6.680E-03	0.000E+00	1.900E+01	0.000E+00	2.260E-03

APPENDIX E

A_i Child Dose Factors for use in the Liquid Dose Calculations

Age group:	CHILD	Pathway:	Fresh Water Fish - Sport (FFSP)			Units:	mrem/hr / μ Ci/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
CE-143	3.320E-03	1.800E+00	0.000E+00	7.550E-04	0.000E+00	2.640E+01	0.000E+00	2.610E-04
CE-144	1.630E+00	5.120E-01	0.000E+00	2.830E-01	0.000E+00	1.330E+02	0.000E+00	8.710E-02
PR-143	7.340E-01	2.200E-01	0.000E+00	1.190E-01	0.000E+00	7.920E+02	0.000E+00	3.640E-02
PR-144	2.180E-28	6.750E-29	0.000E+00	3.570E-29	0.000E+00	1.450E-25	0.000E+00	1.100E-29
ND-147	5.150E-01	4.170E-01	0.000E+00	2.290E-01	0.000E+00	6.610E+02	0.000E+00	3.230E-02
EU-152	2.418E+01	4.404E+00	0.000E+00	1.860E+01	0.000E+00	7.236E+02	0.000E+00	5.230E+00
W-187	2.010E+02	1.190E+02	0.000E+00	0.000E+00	0.000E+00	1.680E+04	0.000E+00	5.350E+01
NP-239	3.080E-02	2.210E-03	0.000E+00	6.390E-03	0.000E+00	1.630E+02	0.000E+00	1.550E-03

APPENDIX E

A_i Child Dose Factors for use in the Liquid Dose Calculations

Age group:	CHILD	Pathway:	Shoreline Sediment (SHDp)			Units:	mrem/hr / μ Ci/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
H-3	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C-14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NA-24	7.480E-01	7.480E-01	7.480E-01	7.480E-01	7.480E-01	7.480E-01	8.680E-01	7.480E-01
P-32	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CR-51	2.920E-01	2.920E-01	2.920E-01	2.920E-01	2.920E-01	2.920E-01	3.450E-01	2.920E-01
MN-54	8.680E+01	8.680E+01	8.680E+01	8.680E+01	8.680E+01	8.680E+01	1.020E+02	8.680E+01
MN-56	5.650E-02	5.650E-02	5.650E-02	5.650E-02	5.650E-02	5.650E-02	6.680E-02	5.650E-02
FE-55	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
FE-59	1.710E+01	1.710E+01	1.710E+01	1.710E+01	1.710E+01	1.710E+01	2.010E+01	1.710E+01
CO-58	2.370E+01	2.370E+01	2.370E+01	2.370E+01	2.370E+01	2.370E+01	2.780E+01	2.370E+01
CO-60	1.350E+03	1.350E+03	1.350E+03	1.350E+03	1.350E+03	1.350E+03	1.580E+03	1.350E+03
NI-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NI-65	1.860E-02	1.860E-02	1.860E-02	1.860E-02	1.860E-02	1.860E-02	2.160E-02	1.860E-02
CU-64	3.800E-02	3.800E-02	3.800E-02	3.800E-02	3.800E-02	3.800E-02	4.310E-02	3.800E-02
ZN-65	4.680E+01	4.680E+01	4.680E+01	4.680E+01	4.680E+01	4.680E+01	5.380E+01	4.680E+01
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE-75	2.830E+02	2.830E+02	2.830E+02	2.830E+02	2.830E+02	2.830E+02	3.311E+02	2.830E+02
BR-83	3.050E-04	3.050E-04	3.050E-04	3.050E-04	3.050E-04	3.050E-04	4.430E-04	3.050E-04
BR-84	1.270E-02	1.270E-02	1.270E-02	1.270E-02	1.270E-02	1.270E-02	1.480E-02	1.270E-02
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	5.630E-01	5.630E-01	5.630E-01	5.630E-01	5.630E-01	5.630E-01	6.430E-01	5.630E-01
RB-88	2.070E-03	2.070E-03	2.070E-03	2.070E-03	2.070E-03	2.070E-03	2.370E-03	2.070E-03
RB-89	7.700E-03	7.700E-03	7.700E-03	7.700E-03	7.700E-03	7.700E-03	9.240E-03	7.700E-03
SR-89	1.360E-03	1.360E-03	1.360E-03	1.360E-03	1.360E-03	1.360E-03	1.570E-03	1.360E-03
SR-90	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

APPENDIX E

A_i Child Dose Factors for use in the Liquid Dose Calculations

Age group:	CHILD	Pathway:	Shoreline Sediment (SHDp)			Units:	mrem/hr / μ Ci/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-91	1.350E-01	1.350E-01	1.350E-01	1.350E-01	1.350E-01	1.350E-01	1.570E-01	1.350E-01
SR-92	4.860E-02	4.860E-02	4.860E-02	4.860E-02	4.860E-02	4.860E-02	5.410E-02	4.860E-02
Y-90	2.810E-04	2.810E-04	2.810E-04	2.810E-04	2.810E-04	2.810E-04	3.320E-04	2.810E-04
Y-91	6.720E-02	6.720E-02	6.720E-02	6.720E-02	6.720E-02	6.720E-02	7.560E-02	6.720E-02
Y-91M	6.280E-03	6.280E-03	6.280E-03	6.280E-03	6.280E-03	6.280E-03	7.270E-03	6.280E-03
Y-92	1.130E-02	1.130E-02	1.130E-02	1.130E-02	1.130E-02	1.130E-02	1.340E-02	1.130E-02
Y-93	1.150E-02	1.150E-02	1.150E-02	1.150E-02	1.150E-02	1.150E-02	1.570E-02	1.150E-02
ZR-95	1.530E+01	1.530E+01	1.530E+01	1.530E+01	1.530E+01	1.530E+01	1.780E+01	1.530E+01
ZR-97	1.850E-01	1.850E-01	1.850E-01	1.850E-01	1.850E-01	1.850E-01	2.160E-01	1.850E-01
NB-95	8.560E+00	8.560E+00	8.560E+00	8.560E+00	8.560E+00	8.560E+00	1.010E+01	8.560E+00
MO-99	2.500E-01	2.500E-01	2.500E-01	2.500E-01	2.500E-01	2.500E-01	2.900E-01	2.500E-01
TC-99M	1.150E-02	1.150E-02	1.150E-02	1.150E-02	1.150E-02	1.150E-02	1.320E-02	1.150E-02
TC-101	1.270E-03	1.270E-03	1.270E-03	1.270E-03	1.270E-03	1.270E-03	1.420E-03	1.270E-03
RU-103	6.780E+00	6.780E+00	6.780E+00	6.780E+00	6.780E+00	6.780E+00	7.910E+00	6.780E+00
RU-105	3.990E-02	3.990E-02	3.990E-02	3.990E-02	3.990E-02	3.990E-02	4.520E-02	3.990E-02
RU-106	2.640E+01	2.640E+01	2.640E+01	2.640E+01	2.640E+01	2.640E+01	3.170E+01	2.640E+01
AG-108M	3.230E+04	3.230E+04	3.230E+04	3.230E+04	3.230E+04	3.230E+04	3.779E+04	3.230E+04
AG-110M	2.150E+02	2.150E+02	2.150E+02	2.150E+02	2.150E+02	2.150E+02	2.510E+02	2.150E+02
SN-113	9.346E+00	9.346E+00	9.346E+00	9.346E+00	9.346E+00	9.346E+00	1.093E+01	9.346E+00
SN-117M	1.306E+01	1.306E+01	1.306E+01	1.306E+01	1.306E+01	1.306E+01	1.528E+01	1.306E+01
SB-124	3.746E+01	3.746E+01	3.746E+01	3.746E+01	3.746E+01	3.746E+01	4.322E+01	3.746E+01
SB-125	1.461E+02	1.461E+02	1.461E+02	1.461E+02	1.461E+02	1.461E+02	1.650E+02	1.461E+02
SB-126	5.284E+00	5.284E+00	5.284E+00	5.284E+00	5.284E+00	5.284E+00	5.937E+00	5.284E+00
TE-123M	1.060E+02	1.060E+02	1.060E+02	1.060E+02	1.060E+02	1.060E+02	1.241E+02	1.060E+02
TE-125M	9.720E-02	9.720E-02	9.720E-02	9.720E-02	9.720E-02	9.720E-02	1.330E-01	9.720E-02

APPENDIX E

A_i Child Dose Factors for use in the Liquid Dose Calculations

Age group:	CHILD	Pathway:	Shoreline Sediment (SHDp)			Units:	mrem/hr / μ Ci/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
TE-127	1.860E-04	1.860E-04	1.860E-04	1.860E-04	1.860E-04	1.860E-04	2.050E-04	1.860E-04
TE-127M	5.740E-03	5.740E-03	5.740E-03	5.740E-03	5.740E-03	5.740E-03	6.780E-03	5.740E-03
TE-129	1.640E-03	1.640E-03	1.640E-03	1.640E-03	1.640E-03	1.640E-03	1.940E-03	1.640E-03
TE-129M	1.240E+00	1.240E+00	1.240E+00	1.240E+00	1.240E+00	1.240E+00	1.450E+00	1.240E+00
TE-131	1.830E-03	1.830E-03	1.830E-03	1.830E-03	1.830E-03	1.830E-03	2.160E+00	1.830E-03
TE-131M	5.030E-01	5.030E-01	5.030E-01	5.030E-01	5.030E-01	5.030E-01	5.920E-01	5.030E-01
TE-132	2.650E-01	2.650E-01	2.650E-01	2.650E-01	2.650E-01	2.650E-01	3.120E-01	2.650E-01
I-130	3.450E-01	3.450E-01	3.450E-01	3.450E-01	3.450E-01	3.450E-01	4.190E-01	3.450E-01
I-131	1.080E+00	1.080E+00	1.080E+00	1.080E+00	1.080E+00	1.080E+00	1.310E+00	1.080E+00
I-132	7.800E-02	7.800E-02	7.800E-02	7.800E-02	7.800E-02	7.800E-02	9.180E-02	7.800E-02
I-133	1.540E-01	1.540E-01	1.540E-01	1.540E-01	1.540E-01	1.540E-01	1.870E-01	1.540E-01
I-134	2.800E-02	2.800E-02	2.800E-02	2.800E-02	2.800E-02	2.800E-02	3.320E-02	2.800E-02
I-135	1.580E-01	1.580E-01	1.580E-01	1.580E-01	1.580E-01	1.580E-01	1.850E-01	1.580E-01
CS-134	4.300E+02	4.300E+02	4.300E+02	4.300E+02	4.300E+02	4.300E+02	5.010E+02	4.300E+02
CS-136	9.450E+00	9.450E+00	9.450E+00	9.450E+00	9.450E+00	9.450E+00	1.070E+01	9.450E+00
CS-137	6.440E+02	6.440E+02	6.440E+02	6.440E+02	6.440E+02	6.440E+02	7.510E+02	6.440E+02
CS-138	2.250E-02	2.250E-02	2.250E-02	2.250E-02	2.250E-02	2.250E-02	2.570E-02	2.250E-02
BA-133	5.521E+03	5.521E+03	5.521E+03	5.521E+03	5.521E+03	5.521E+03	6.459E+03	5.521E+03
BA-139	6.630E-03	6.630E-03	6.630E-03	6.630E-03	6.630E-03	6.630E-03	7.460E-03	6.630E-03
BA-140	1.290E+00	1.290E+00	1.290E+00	1.290E+00	1.290E+00	1.290E+00	1.470E+00	1.290E+00
BA-141	2.610E-03	2.610E-03	2.610E-03	2.610E-03	2.610E-03	2.610E-03	2.980E-03	2.610E-03
BA-142	2.810E-03	2.810E-03	2.810E-03	2.810E-03	2.810E-03	2.810E-03	3.200E-03	2.810E-03
LA-140	1.200E+00	1.200E+00	1.200E+00	1.200E+00	1.200E+00	1.200E+00	1.360E+00	1.200E+00
LA-142	4.760E-02	4.760E-02	4.760E-02	4.760E-02	4.760E-02	4.760E-02	5.710E-02	4.760E-02
CE-141	8.560E-01	8.560E-01	8.560E-01	8.560E-01	8.560E-01	8.560E-01	9.650E-01	8.560E-01

APPENDIX E

A_i Child Dose Factors for use in the Liquid Dose Calculations

Age group:	CHILD	Pathway:	Shoreline Sediment (SHDp)			Units:	mrem/hr / μ Ci/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
CE-143	1.450E-01	1.450E-01	1.450E-01	1.450E-01	1.450E-01	1.450E-01	1.650E-01	1.450E-01
CE-144	4.350E+00	4.350E+00	4.350E+00	4.350E+00	4.350E+00	4.350E+00	5.040E+00	4.350E+00
PR-143	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR-144	1.150E-04	1.150E-04	1.150E-04	1.150E-04	1.150E-04	1.150E-04	1.320E-04	1.150E-04
ND-147	5.260E-01	5.260E-01	5.260E-01	5.260E-01	5.260E-01	5.260E-01	6.310E-01	5.260E-01
EU-152	9.305E+02	9.305E+02	9.305E+02	9.305E+02	9.305E+02	9.305E+02	1.077E+03	9.305E+02
W-187	1.470E-01	1.470E-01	1.470E-01	1.470E-01	1.470E-01	1.470E-01	1.710E-01	1.470E-01
NP-239	1.070E-01	1.070E-01	1.070E-01	1.070E-01	1.070E-01	1.070E-01	1.240E-01	1.070E-01

APPENDIX F

A_i Infant Dose Factors for use in the Liquid Dose Calculations

Age group:	INFANT	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / μ Ci/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
H-3	0.000E+00	1.160E+01	1.160E+01	1.160E+01	1.160E+01	1.160E+01	0.000E+00	1.160E+01
C-14	8.920E+02	1.900E+02	1.900E+02	1.900E+02	1.900E+02	1.900E+02	0.000E+00	1.900E+02
NA-24	2.190E+02	2.190E+02	2.190E+02	2.190E+02	2.190E+02	2.190E+02	0.000E+00	2.190E+02
P-32	6.240E+04	3.670E+03	0.000E+00	0.000E+00	0.000E+00	8.450E+02	0.000E+00	2.420E+03
CR-51	0.000E+00	0.000E+00	3.420E-01	7.470E-02	6.650E-01	1.530E+01	0.000E+00	5.240E-01
MN-54	0.000E+00	7.480E+02	0.000E+00	1.660E+02	0.000E+00	2.750E+02	0.000E+00	1.690E+02
MN-56	0.000E+00	1.220E+00	0.000E+00	1.050E+00	0.000E+00	1.110E+02	0.000E+00	2.100E-01
FE-55	5.230E+02	3.380E+02	0.000E+00	0.000E+00	1.650E+02	4.290E+01	0.000E+00	9.030E+01
FE-59	1.150E+03	2.010E+03	0.000E+00	0.000E+00	5.940E+02	9.590E+02	0.000E+00	7.910E+02
CO-58	0.000E+00	1.350E+02	0.000E+00	0.000E+00	0.000E+00	3.360E+02	0.000E+00	3.360E+02
CO-60	0.000E+00	4.060E+02	0.000E+00	0.000E+00	0.000E+00	9.670E+02	0.000E+00	9.590E+02
NI-63	2.390E+04	1.470E+03	0.000E+00	0.000E+00	0.000E+00	7.340E+01	0.000E+00	8.280E+02
NI-65	6.520E+00	7.380E-01	0.000E+00	0.000E+00	0.000E+00	5.620E+01	0.000E+00	3.360E-01
CU-64	0.000E+00	1.190E+01	0.000E+00	2.010E+01	0.000E+00	2.440E+02	0.000E+00	5.500E+00
ZN-65	6.910E+02	2.370E+03	0.000E+00	1.150E+03	0.000E+00	2.000E+03	0.000E+00	1.090E+03
ZN-69	4.390E-04	7.910E-04	0.000E+00	3.290E-04	0.000E+00	6.450E-02	0.000E+00	5.890E-05
SE-75	3.609E+02	1.388E+02	1.388E+02	2.776E+01	3.331E+02	3.886E+02	0.000E+00	2.776E+03
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.200E-01
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.220E-06
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.800E-76
RB-86	0.000E+00	6.280E+03	0.000E+00	0.000E+00	0.000E+00	1.610E+02	0.000E+00	3.100E+03
RB-88	0.000E+00	1.250E-11	0.000E+00	0.000E+00	0.000E+00	1.220E-11	0.000E+00	6.840E-12
RB-89	0.000E+00	9.960E-14	0.000E+00	0.000E+00	0.000E+00	3.390E-14	0.000E+00	6.860E-14
SR-89	9.380E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.930E+03	0.000E+00	2.690E+03
SR-90	6.960E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.690E+03	0.000E+00	1.770E+05

APPENDIX F

A_i Infant Dose Factors for use in the Liquid Dose Calculations

Age group:	INFANT	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / μ Ci/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-91	7.830E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.270E+02	0.000E+00	2.830E+01
SR-92	3.350E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.610E+02	0.000E+00	1.240E+00
Y-90	2.870E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.970E+03	0.000E+00	7.700E-02
Y-91	4.230E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.030E+03	0.000E+00	1.130E+00
Y-91M	1.350E-06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.510E-03	0.000E+00	4.610E-08
Y-92	2.740E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.240E+02	0.000E+00	7.710E-04
Y-93	4.010E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.170E+03	0.000E+00	1.090E-02
ZR-95	7.710E+00	1.880E+00	0.000E+00	2.020E+00	0.000E+00	9.350E+02	0.000E+00	1.330E+00
ZR-97	3.400E-01	5.840E-02	0.000E+00	5.890E-02	0.000E+00	3.720E+03	0.000E+00	2.670E-02
NB-95	1.560E+00	6.440E-01	0.000E+00	4.620E-01	0.000E+00	5.440E+02	0.000E+00	3.720E-01
MO-99	0.000E+00	1.130E+03	0.000E+00	1.680E+03	0.000E+00	3.710E+02	0.000E+00	2.200E+02
TC-99M	1.810E-02	3.740E-02	0.000E+00	4.020E-01	1.950E-02	1.090E+01	0.000E+00	4.820E-01
TC-101	4.570E-17	5.750E-17	0.000E+00	6.840E-16	3.140E-17	9.780E-15	0.000E+00	5.690E-16
RU-103	5.520E+01	0.000E+00	0.000E+00	1.150E+02	0.000E+00	6.710E+02	0.000E+00	1.850E+01
RU-105	7.850E-01	0.000E+00	0.000E+00	5.770E+00	0.000E+00	3.120E+02	0.000E+00	2.640E-01
RU-106	9.060E+02	0.000E+00	0.000E+00	1.070E+03	0.000E+00	6.880E+03	0.000E+00	1.130E+02
AG-108M	3.800E+02	1.462E+02	1.462E+02	2.923E+01	3.508E+02	4.092E+02	0.000E+00	2.923E+03
AG-110M	3.740E+01	2.730E+01	0.000E+00	3.910E+01	0.000E+00	1.420E+03	0.000E+00	1.810E+01
SN-113	1.407E+02	5.412E+01	5.412E+01	1.082E+01	1.299E+02	1.515E+02	0.000E+00	1.082E+03
SN-117M	1.358E+02	5.224E+01	5.224E+01	1.045E+01	1.254E+02	1.463E+02	0.000E+00	1.045E+03
SB-124	8.004E+02	1.178E+01	2.125E+00	0.000E+00	5.012E+02	2.469E+03	0.000E+00	2.480E+02
SB-125	4.626E+02	4.475E+00	5.791E-01	0.000E+00	2.903E+02	6.168E+02	0.000E+00	9.515E+01
SB-126	2.949E+02	5.780E+00	2.264E+00	0.000E+00	1.855E+02	3.055E+03	0.000E+00	1.065E+02
TE-123M	3.428E+02	1.319E+02	1.319E+02	2.637E+01	3.164E+02	3.692E+02	0.000E+00	2.637E+03
TE-125M	8.710E+02	2.910E+02	2.930E+02	0.000E+00	0.000E+00	4.150E+02	0.000E+00	1.180E+02

APPENDIX F

A_i Infant Dose Factors for use in the Liquid Dose Calculations

Age group:	INFANT	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / μ Ci/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
TE-127	1.550E+01	5.200E+00	1.260E+01	3.790E+01	0.000E+00	3.260E+02	0.000E+00	3.340E+00
TE-127M	2.190E+03	7.280E+02	6.340E+02	5.400E+03	0.000E+00	8.850E+02	0.000E+00	2.660E+02
TE-129	7.860E-03	2.710E-03	6.590E-03	1.960E-02	0.000E+00	6.280E-01	0.000E+00	1.840E-03
TE-129M	3.720E+03	1.280E+03	1.430E+03	9.310E+03	0.000E+00	2.220E+03	0.000E+00	5.730E+02
TE-131	1.420E-08	5.250E-09	1.270E-08	3.640E-08	0.000E+00	5.750E-07	0.000E+00	3.990E-09
TE-131M	4.330E+02	1.740E+02	3.540E+02	1.200E+03	0.000E+00	2.940E+03	0.000E+00	1.440E+02
TE-132	7.030E+02	3.480E+02	5.140E+02	2.180E+03	0.000E+00	1.290E+03	0.000E+00	3.250E+02
I-130	1.150E+02	2.530E+02	2.840E+04	2.780E+02	0.000E+00	5.430E+01	0.000E+00	1.020E+02
I-131	1.290E+03	1.520E+03	5.010E+05	1.780E+03	0.000E+00	5.440E+01	0.000E+00	6.700E+02
I-132	1.680E+00	3.410E+00	1.600E+02	3.800E+00	0.000E+00	2.760E+00	0.000E+00	1.210E+00
I-133	3.150E+02	4.590E+02	8.350E+04	5.400E+02	0.000E+00	7.770E+01	0.000E+00	1.340E+02
I-134	2.440E-03	4.990E-03	1.160E-01	5.580E-03	0.000E+00	5.160E-03	0.000E+00	1.780E-03
I-135	3.900E+01	7.750E+01	6.950E+03	8.640E+01	0.000E+00	2.800E+01	0.000E+00	2.830E+01
CS-134	1.420E+04	2.640E+04	0.000E+00	6.810E+03	2.790E+03	7.180E+01	0.000E+00	2.670E+03
CS-136	1.680E+03	4.950E+03	0.000E+00	1.970E+03	4.030E+02	7.510E+01	0.000E+00	1.850E+03
CS-137	1.960E+04	2.300E+04	0.000E+00	6.170E+03	2.500E+03	7.190E+01	0.000E+00	1.630E+03
CS-138	3.330E-06	5.410E-06	0.000E+00	2.700E-06	4.210E-07	8.650E-06	0.000E+00	2.620E-06
BA-133	3.981E+02	1.531E+02	1.531E+02	3.062E+01	3.674E+02	4.287E+02	0.000E+00	3.062E+03
BA-139	8.180E-02	5.420E-05	0.000E+00	3.260E-05	3.290E-05	5.180E+00	0.000E+00	2.370E-03
BA-140	6.260E+03	6.260E+00	0.000E+00	1.490E+00	3.840E+00	1.540E+03	0.000E+00	3.230E+02
BA-141	2.220E-11	1.520E-14	0.000E+00	9.140E-15	9.250E-15	2.710E-10	0.000E+00	7.000E-13
BA-142	2.460E-20	2.040E-23	0.000E+00	1.180E-23	1.240E-23	1.010E-19	0.000E+00	1.210E-21
LA-140	6.460E-01	2.550E-01	0.000E+00	0.000E+00	0.000E+00	2.990E+03	0.000E+00	6.550E-02
LA-142	2.220E-04	8.160E-05	0.000E+00	0.000E+00	0.000E+00	1.390E+01	0.000E+00	1.950E-05
CE-141	2.930E+00	1.790E+00	0.000E+00	5.510E-01	0.000E+00	9.230E+02	0.000E+00	2.100E-01

APPENDIX F

A_i Infant Dose Factors for use in the Liquid Dose Calculations

Age group:	INFANT	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / μ Ci/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
CE-143	4.330E-01	2.870E+02	0.000E+00	8.360E-02	0.000E+00	1.670E+03	0.000E+00	3.270E-02
CE-144	1.120E+02	4.580E+01	0.000E+00	1.850E+01	0.000E+00	6.430E+03	0.000E+00	6.270E+00
PR-143	2.980E+00	1.110E+00	0.000E+00	4.140E-01	0.000E+00	1.570E+03	0.000E+00	1.480E-01
PR-144	3.020E-15	1.170E-15	0.000E+00	4.240E-16	0.000E+00	5.440E-11	0.000E+00	1.520E-16
ND-147	2.020E+00	2.070E+00	0.000E+00	7.980E-01	0.000E+00	1.310E+03	0.000E+00	1.270E-01
EU-152	2.535E+01	6.734E+00	0.000E+00	1.888E+01	0.000E+00	5.981E+02	0.000E+00	5.680E+00
W-187	2.400E+01	1.670E+01	0.000E+00	0.000E+00	0.000E+00	9.790E+02	0.000E+00	5.760E+00
NP-239	3.600E-01	3.220E-02	0.000E+00	6.430E-02	0.000E+00	9.320E+02	0.000E+00	1.820E-02

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Grs/Cow/Milk (CMILK)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
H-3	0.000E+00	7.630E+02	7.630E+02	7.630E+02	7.630E+02	7.630E+02	0.000E+00	7.630E+02
C-14	2.250E+04	4.500E+03	4.500E+03	4.500E+03	4.500E+03	4.500E+03	0.000E+00	4.500E+03
NA-24	2.440E+06	2.440E+06	2.440E+06	2.440E+06	2.440E+06	2.440E+06	0.000E+00	2.440E+06
P-32	1.710E+10	1.060E+09	0.000E+00	0.000E+00	0.000E+00	1.920E+09	0.000E+00	6.610E+08
CR-51	0.000E+00	0.000E+00	1.710E+04	6.300E+03	3.790E+04	7.190E+06	0.000E+00	2.860E+04
MN-54	0.000E+00	8.410E+06	0.000E+00	2.500E+06	0.000E+00	2.580E+07	0.000E+00	1.610E+06
MN-56	0.000E+00	4.090E-03	0.000E+00	5.190E-03	0.000E+00	1.310E-01	0.000E+00	7.260E-04
FE-55	2.510E+07	1.740E+07	0.000E+00	0.000E+00	9.680E+06	9.950E+06	0.000E+00	4.050E+06
FE-59	2.970E+07	6.980E+07	0.000E+00	0.000E+00	1.950E+07	2.330E+08	0.000E+00	2.680E+07
CO-58	0.000E+00	4.710E+06	0.000E+00	0.000E+00	0.000E+00	9.550E+07	0.000E+00	1.060E+07
CO-60	0.000E+00	1.640E+07	0.000E+00	0.000E+00	0.000E+00	3.080E+08	0.000E+00	3.620E+07
NI-63	6.730E+09	4.660E+08	0.000E+00	0.000E+00	0.000E+00	9.730E+07	0.000E+00	2.260E+08
NI-65	3.700E-01	4.810E-02	0.000E+00	0.000E+00	0.000E+00	1.220E+00	0.000E+00	2.190E-02
CU-64	0.000E+00	2.380E+04	0.000E+00	6.010E+04	0.000E+00	2.030E+06	0.000E+00	1.120E+04
ZN-65	1.370E+09	4.370E+09	0.000E+00	2.920E+09	0.000E+00	2.750E+09	0.000E+00	1.970E+09
ZN-69	2.090E-12	4.000E-12	0.000E+00	2.600E-12	0.000E+00	6.010E-13	0.000E+00	2.780E-13
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.400E-01	0.000E+00	9.720E-02
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.260E-28	0.000E+00	1.610E-23
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	2.590E+09	0.000E+00	0.000E+00	0.000E+00	5.120E+08	0.000E+00	1.210E+09
RB-88	0.000E+00	2.140E-45	0.000E+00	0.000E+00	0.000E+00	2.960E-56	0.000E+00	1.140E-45
RB-89	0.000E+00	4.330E-53	0.000E+00	0.000E+00	0.000E+00	2.510E-66	0.000E+00	3.040E-53
SR-89	1.450E+09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.330E+08	0.000E+00	4.160E+07
SR-90	4.680E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.350E+09	0.000E+00	1.150E+10
SR-91	2.890E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.380E+05	0.000E+00	1.170E+03

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Grs/Cow/Milk (CMILK)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-92	4.880E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.680E+00	0.000E+00	2.110E-02
Y-90	7.080E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.510E+05	0.000E+00	1.900E+00
Y-91	8.590E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.730E+06	0.000E+00	2.300E+02
Y-91M	5.980E-20	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.760E-19	0.000E+00	2.320E-21
Y-92	5.580E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.770E-01	0.000E+00	1.630E-06
Y-93	2.230E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.090E+03	0.000E+00	6.170E-03
ZR-95	9.430E+02	3.030E+02	0.000E+00	4.750E+02	0.000E+00	9.590E+05	0.000E+00	2.050E+02
ZR-97	4.330E-01	8.740E-02	0.000E+00	1.320E-01	0.000E+00	2.710E+04	0.000E+00	4.000E-02
NB-95	8.260E+04	4.590E+04	0.000E+00	4.540E+04	0.000E+00	2.790E+08	0.000E+00	2.470E+04
MO-99	0.000E+00	2.480E+07	0.000E+00	5.610E+07	0.000E+00	5.740E+07	0.000E+00	4.710E+06
TC-99M	3.320E+00	9.380E+00	0.000E+00	1.420E+02	4.600E+00	5.550E+03	0.000E+00	1.200E+02
TC-101	2.590E-60	3.740E-60	0.000E+00	6.730E-59	1.910E-60	1.120E-71	0.000E+00	3.670E-59
RU-103	1.020E+03	0.000E+00	0.000E+00	3.890E+03	0.000E+00	1.190E+05	0.000E+00	4.390E+02
RU-105	8.570E-04	0.000E+00	0.000E+00	1.110E-02	0.000E+00	5.240E-01	0.000E+00	3.380E-04
RU-106	2.040E+04	0.000E+00	0.000E+00	3.940E+04	0.000E+00	1.320E+06	0.000E+00	2.580E+03
AG-110M	5.820E+07	5.390E+07	0.000E+00	1.060E+08	0.000E+00	2.200E+10	0.000E+00	3.200E+07
TE-125M	1.630E+07	5.900E+06	4.900E+06	6.630E+07	0.000E+00	6.500E+07	0.000E+00	2.180E+06
TE-127	6.530E+02	2.340E+02	4.840E+02	2.660E+03	0.000E+00	5.150E+04	0.000E+00	1.410E+02
TE-127M	4.580E+07	1.640E+07	1.170E+07	1.860E+08	0.000E+00	1.540E+08	0.000E+00	5.580E+06
TE-129	2.830E-10	1.060E-10	2.170E-10	1.190E-09	0.000E+00	2.130E-10	0.000E+00	6.880E-11
TE-129M	6.020E+07	2.250E+07	2.070E+07	2.510E+08	0.000E+00	3.030E+08	0.000E+00	9.530E+06
TE-131	3.600E-33	1.500E-33	2.960E-33	1.580E-32	0.000E+00	5.100E-34	0.000E+00	1.140E-33
TE-131M	3.610E+05	1.770E+05	2.800E+05	1.790E+06	0.000E+00	1.750E+07	0.000E+00	1.470E+05
TE-132	2.400E+06	1.550E+06	1.720E+06	1.500E+07	0.000E+00	7.350E+07	0.000E+00	1.460E+06
I-130	4.200E+05	1.240E+06	1.050E+08	1.930E+06	0.000E+00	1.070E+06	0.000E+00	4.890E+05

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Grs/Cow/Milk (CMILK)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
I-131	2.960E+08	4.230E+08	1.390E+11	7.260E+08	0.000E+00	1.120E+08	0.000E+00	2.430E+08
I-132	1.640E-01	4.390E-01	1.540E+01	7.000E-01	0.000E+00	8.250E-02	0.000E+00	1.540E-01
I-133	3.870E+06	6.730E+06	9.890E+08	1.170E+07	0.000E+00	6.050E+06	0.000E+00	2.050E+06
I-134	2.020E-12	5.480E-12	9.490E-11	8.710E-12	0.000E+00	4.770E-15	0.000E+00	1.960E-12
I-135	1.280E+04	3.360E+04	2.220E+06	5.390E+04	0.000E+00	3.800E+04	0.000E+00	1.240E+04
CS-134	5.650E+09	1.350E+10	0.000E+00	4.350E+09	1.450E+09	2.350E+08	0.000E+00	1.100E+10
CS-136	2.630E+08	1.040E+09	0.000E+00	5.780E+08	7.930E+07	1.180E+08	0.000E+00	7.480E+08
CS-137	7.380E+09	1.010E+10	0.000E+00	3.430E+09	1.140E+09	1.950E+08	0.000E+00	6.610E+09
CS-138	9.050E-24	1.790E-23	0.000E+00	1.310E-23	1.300E-24	7.620E-29	0.000E+00	8.850E-24
BA-139	4.420E-08	3.150E-11	0.000E+00	2.940E-11	1.790E-11	7.830E-08	0.000E+00	1.290E-09
BA-140	2.690E+07	3.380E+04	0.000E+00	1.150E+04	1.930E+04	5.530E+07	0.000E+00	1.760E+06
BA-141	4.090E-46	3.090E-49	0.000E+00	2.880E-49	1.760E-49	1.930E-55	0.000E+00	1.380E-47
BA-142	2.640E-80	2.720E-83	0.000E+00	2.300E-83	1.540E-83	3.720E-98	0.000E+00	1.660E-81
LA-140	4.510E+00	2.270E+00	0.000E+00	0.000E+00	0.000E+00	1.670E+05	0.000E+00	6.010E-01
LA-142	1.860E-11	8.460E-12	0.000E+00	0.000E+00	0.000E+00	6.170E-08	0.000E+00	2.110E-12
CE-141	4.840E+03	3.280E+03	0.000E+00	1.520E+03	0.000E+00	1.250E+07	0.000E+00	3.720E+02
CE-143	4.160E+01	3.070E+04	0.000E+00	1.350E+01	0.000E+00	1.150E+06	0.000E+00	3.400E+00
CE-144	3.580E+05	1.500E+05	0.000E+00	8.870E+04	0.000E+00	1.210E+08	0.000E+00	1.920E+04
PR-143	1.580E+02	6.330E+01	0.000E+00	3.660E+01	0.000E+00	6.920E+05	0.000E+00	7.830E+00
PR-144	5.870E-54	2.440E-54	0.000E+00	1.380E-54	0.000E+00	8.450E-61	0.000E+00	2.990E-55
ND-147	9.420E+01	1.090E+02	0.000E+00	6.360E+01	0.000E+00	5.220E+05	0.000E+00	6.510E+00
W-187	6.510E+03	5.450E+03	0.000E+00	0.000E+00	0.000E+00	1.780E+06	0.000E+00	1.900E+03
NP-239	3.670E+00	3.610E-01	0.000E+00	1.130E+00	0.000E+00	7.410E+04	0.000E+00	1.990E-01

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Grs/Goat/Milk (GMILK)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
H-3	0.000E+00	1.560E+03	1.560E+03	1.560E+03	1.560E+03	1.560E+03	0.000E+00	1.560E+03
C-14	2.250E+04	4.500E+03	4.500E+03	4.500E+03	4.500E+03	4.500E+03	0.000E+00	4.500E+03
NA-24	2.930E+05	2.930E+05	2.930E+05	2.930E+05	2.930E+05	2.930E+05	0.000E+00	2.930E+05
P-32	2.050E+10	1.280E+09	0.000E+00	0.000E+00	0.000E+00	2.310E+09	0.000E+00	7.930E+08
CR-51	0.000E+00	0.000E+00	2.050E+03	7.550E+02	4.550E+03	8.620E+05	0.000E+00	3.430E+03
MN-54	0.000E+00	1.010E+06	0.000E+00	3.000E+05	0.000E+00	3.090E+06	0.000E+00	1.930E+05
MN-56	0.000E+00	4.910E-04	0.000E+00	6.230E-04	0.000E+00	1.570E-02	0.000E+00	8.710E-05
FE-55	3.260E+05	2.260E+05	0.000E+00	0.000E+00	1.260E+05	1.290E+05	0.000E+00	5.260E+04
FE-59	3.860E+05	9.070E+05	0.000E+00	0.000E+00	2.540E+05	3.020E+06	0.000E+00	3.480E+05
CO-58	0.000E+00	5.660E+05	0.000E+00	0.000E+00	0.000E+00	1.150E+07	0.000E+00	1.270E+06
CO-60	0.000E+00	1.970E+06	0.000E+00	0.000E+00	0.000E+00	3.700E+07	0.000E+00	4.340E+06
NI-63	8.070E+08	5.600E+07	0.000E+00	0.000E+00	0.000E+00	1.170E+07	0.000E+00	2.710E+07
NI-65	4.440E-02	5.770E-03	0.000E+00	0.000E+00	0.000E+00	1.460E-01	0.000E+00	2.630E-03
CU-64	0.000E+00	2.660E+03	0.000E+00	6.700E+03	0.000E+00	2.260E+05	0.000E+00	1.250E+03
ZN-65	1.650E+08	5.240E+08	0.000E+00	3.500E+08	0.000E+00	3.300E+08	0.000E+00	2.370E+08
ZN-69	2.510E-13	4.800E-13	0.000E+00	3.120E-13	0.000E+00	7.210E-14	0.000E+00	3.340E-14
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.680E-02	0.000E+00	1.170E-02
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.520E-29	0.000E+00	1.930E-24
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	3.110E+08	0.000E+00	0.000E+00	0.000E+00	6.140E+07	0.000E+00	1.450E+08
RB-88	0.000E+00	2.570E-46	0.000E+00	0.000E+00	0.000E+00	3.550E-57	0.000E+00	1.360E-46
RB-89	0.000E+00	5.190E-54	0.000E+00	0.000E+00	0.000E+00	3.020E-67	0.000E+00	3.650E-54
SR-89	3.050E+09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.890E+08	0.000E+00	8.750E+07
SR-90	9.830E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.840E+09	0.000E+00	2.410E+10
SR-91	6.070E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.890E+05	0.000E+00	2.450E+03

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Grs/Goat/Milk (GMILK)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-92	1.030E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.030E+01	0.000E+00	4.440E-02
Y-90	8.500E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.010E+04	0.000E+00	2.280E-01
Y-91	1.030E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.670E+05	0.000E+00	2.760E+01
Y-91M	7.170E-21	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.110E-20	0.000E+00	2.780E-22
Y-92	6.690E-06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.170E-01	0.000E+00	1.960E-07
Y-93	2.680E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.500E+02	0.000E+00	7.400E-04
ZR-95	1.130E+02	3.630E+01	0.000E+00	5.700E+01	0.000E+00	1.150E+05	0.000E+00	2.460E+01
ZR-97	5.200E-02	1.050E-02	0.000E+00	1.580E-02	0.000E+00	3.250E+03	0.000E+00	4.800E-03
NB-95	9.910E+03	5.510E+03	0.000E+00	5.450E+03	0.000E+00	3.340E+07	0.000E+00	2.960E+03
MO-99	0.000E+00	2.970E+06	0.000E+00	6.730E+06	0.000E+00	6.890E+06	0.000E+00	5.660E+05
TC-99M	3.980E-01	1.130E+00	0.000E+00	1.710E+01	5.520E-01	6.660E+02	0.000E+00	1.430E+01
TC-101	3.110E-61	4.490E-61	0.000E+00	8.080E-60	2.290E-61	1.350E-72	0.000E+00	4.400E-60
RU-103	1.220E+02	0.000E+00	0.000E+00	4.660E+02	0.000E+00	1.430E+04	0.000E+00	5.260E+01
RU-105	1.030E-04	0.000E+00	0.000E+00	1.330E-03	0.000E+00	6.290E-02	0.000E+00	4.060E-05
RU-106	2.450E+03	0.000E+00	0.000E+00	4.730E+03	0.000E+00	1.580E+05	0.000E+00	3.100E+02
AG-110M	6.990E+06	6.460E+06	0.000E+00	1.270E+07	0.000E+00	2.640E+09	0.000E+00	3.840E+06
TE-125M	1.950E+06	7.080E+05	5.880E+05	7.950E+06	0.000E+00	7.800E+06	0.000E+00	2.620E+05
TE-127	7.830E+01	2.810E+01	5.800E+01	3.190E+02	0.000E+00	6.180E+03	0.000E+00	1.700E+01
TE-127M	5.490E+06	1.960E+06	1.400E+06	2.230E+07	0.000E+00	1.840E+07	0.000E+00	6.690E+05
TE-129	3.390E-11	1.270E-11	2.600E-11	1.430E-10	0.000E+00	2.560E-11	0.000E+00	8.260E-12
TE-129M	7.220E+06	2.690E+06	2.480E+06	3.020E+07	0.000E+00	3.640E+07	0.000E+00	1.140E+06
TE-131	4.320E-34	1.810E-34	3.550E-34	1.890E-33	0.000E+00	6.120E-35	0.000E+00	1.360E-34
TE-131M	4.330E+04	2.120E+04	3.360E+04	2.150E+05	0.000E+00	2.100E+06	0.000E+00	1.770E+04
TE-132	2.880E+05	1.860E+05	2.060E+05	1.800E+06	0.000E+00	8.820E+06	0.000E+00	1.750E+05
I-130	5.040E+05	1.490E+06	1.260E+08	2.320E+06	0.000E+00	1.280E+06	0.000E+00	5.870E+05

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Grs/Goat/Milk (GMILK)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
I-131	3.550E+08	5.080E+08	1.670E+11	8.710E+08	0.000E+00	1.340E+08	0.000E+00	2.910E+08
I-132	1.970E-01	5.270E-01	1.840E+01	8.400E-01	0.000E+00	9.900E-02	0.000E+00	1.840E-01
I-133	4.640E+06	8.080E+06	1.190E+09	1.410E+07	0.000E+00	7.260E+06	0.000E+00	2.460E+06
I-134	2.420E-12	6.570E-12	1.140E-10	1.050E-11	0.000E+00	5.730E-15	0.000E+00	2.350E-12
I-135	1.540E+04	4.030E+04	2.660E+06	6.470E+04	0.000E+00	4.560E+04	0.000E+00	1.490E+04
CS-134	1.700E+10	4.040E+10	0.000E+00	1.310E+10	4.340E+09	7.060E+08	0.000E+00	3.300E+10
CS-136	7.900E+08	3.120E+09	0.000E+00	1.730E+09	2.380E+08	3.540E+08	0.000E+00	2.240E+09
CS-137	2.210E+10	3.030E+10	0.000E+00	1.030E+10	3.420E+09	5.860E+08	0.000E+00	1.980E+10
CS-138	2.710E-23	5.360E-23	0.000E+00	3.940E-23	3.890E-24	2.290E-28	0.000E+00	2.650E-23
BA-139	5.300E-09	3.780E-12	0.000E+00	3.530E-12	2.140E-12	9.400E-09	0.000E+00	1.550E-10
BA-140	3.230E+06	4.050E+03	0.000E+00	1.380E+03	2.320E+03	6.640E+06	0.000E+00	2.110E+05
BA-141	4.910E-47	3.710E-50	0.000E+00	3.450E-50	2.110E-50	2.310E-56	0.000E+00	1.660E-48
BA-142	3.170E-81	3.260E-84	0.000E+00	2.750E-84	1.850E-84	0.000E+00	0.000E+00	2.000E-82
LA-140	5.410E-01	2.730E-01	0.000E+00	0.000E+00	0.000E+00	2.000E+04	0.000E+00	7.210E-02
LA-142	2.230E-12	1.010E-12	0.000E+00	0.000E+00	0.000E+00	7.410E-09	0.000E+00	2.530E-13
CE-141	5.810E+02	3.930E+02	0.000E+00	1.830E+02	0.000E+00	1.500E+06	0.000E+00	4.460E+01
CE-143	4.990E+00	3.690E+03	0.000E+00	1.620E+00	0.000E+00	1.380E+05	0.000E+00	4.080E-01
CE-144	4.290E+04	1.790E+04	0.000E+00	1.060E+04	0.000E+00	1.450E+07	0.000E+00	2.300E+03
PR-143	1.890E+01	7.600E+00	0.000E+00	4.390E+00	0.000E+00	8.300E+04	0.000E+00	9.390E-01
PR-144	7.050E-55	2.930E-55	0.000E+00	1.650E-55	0.000E+00	1.010E-61	0.000E+00	3.580E-56
ND-147	1.130E+01	1.310E+01	0.000E+00	7.630E+00	0.000E+00	6.270E+04	0.000E+00	7.810E-01
W-187	7.820E+02	6.530E+02	0.000E+00	0.000E+00	0.000E+00	2.140E+05	0.000E+00	2.280E+02
NP-239	4.410E-01	4.330E-02	0.000E+00	1.350E-01	0.000E+00	8.890E+03	0.000E+00	2.390E-02

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Age group:	ADULT	Pathway:	Grs/Cow/Meat (CMEAT)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
H-3	0.000E+00	3.250E+02	3.250E+02	3.250E+02	3.250E+02	3.250E+02	0.000E+00	3.250E+02
C-14	2.060E+04	4.130E+03	4.130E+03	4.130E+03	4.130E+03	4.130E+03	0.000E+00	4.130E+03
NA-24	1.360E-03	1.360E-03	1.360E-03	1.360E-03	1.360E-03	1.360E-03	0.000E+00	1.360E-03
P-32	4.660E+09	2.900E+08	0.000E+00	0.000E+00	0.000E+00	5.240E+08	0.000E+00	1.800E+08
CR-51	0.000E+00	0.000E+00	4.210E+03	1.550E+03	9.350E+03	1.770E+06	0.000E+00	7.050E+03
MN-54	0.000E+00	9.180E+06	0.000E+00	2.730E+06	0.000E+00	2.810E+07	0.000E+00	1.750E+06
MN-56	0.000E+00	1.320E-53	0.000E+00	1.680E-53	0.000E+00	4.220E-52	0.000E+00	2.350E-54
FE-55	2.930E+08	2.030E+08	0.000E+00	0.000E+00	1.130E+08	1.160E+08	0.000E+00	4.720E+07
FE-59	2.660E+08	6.240E+08	0.000E+00	0.000E+00	1.740E+08	2.080E+09	0.000E+00	2.390E+08
CO-58	0.000E+00	1.820E+07	0.000E+00	0.000E+00	0.000E+00	3.690E+08	0.000E+00	4.090E+07
CO-60	0.000E+00	7.520E+07	0.000E+00	0.000E+00	0.000E+00	1.410E+09	0.000E+00	1.660E+08
NI-63	1.890E+10	1.310E+09	0.000E+00	0.000E+00	0.000E+00	2.730E+08	0.000E+00	6.330E+08
NI-65	2.250E-52	2.920E-53	0.000E+00	0.000E+00	0.000E+00	7.400E-52	0.000E+00	1.330E-53
CU-64	0.000E+00	2.710E-07	0.000E+00	6.830E-07	0.000E+00	2.310E-05	0.000E+00	1.270E-07
ZN-65	3.560E+08	1.130E+09	0.000E+00	7.570E+08	0.000E+00	7.130E+08	0.000E+00	5.120E+08
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.650E-57	0.000E+00	6.000E-57
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	4.870E+08	0.000E+00	0.000E+00	0.000E+00	9.600E+07	0.000E+00	2.270E+08
RB-88	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-89	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-89	3.020E+08	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.840E+07	0.000E+00	8.660E+06
SR-90	1.240E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.590E+08	0.000E+00	3.050E+09
SR-91	1.520E-10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.240E-10	0.000E+00	6.140E-12

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Age group:	ADULT	Pathway:	Grs/Cow/Meat (CMEAT)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-92	1.180E-49	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.340E-48	0.000E+00	5.100E-51
Y-90	1.080E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.140E+06	0.000E+00	2.890E+00
Y-91	1.130E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.230E+08	0.000E+00	3.030E+04
Y-91M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y-92	1.520E-39	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.660E-35	0.000E+00	4.430E-41
Y-93	4.690E-12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.490E-07	0.000E+00	1.300E-13
ZR-95	1.870E+06	6.010E+05	0.000E+00	9.420E+05	0.000E+00	1.900E+09	0.000E+00	4.070E+05
ZR-97	2.070E-05	4.170E-06	0.000E+00	6.300E-06	0.000E+00	1.290E+00	0.000E+00	1.910E-06
NB-95	2.300E+06	1.280E+06	0.000E+00	1.260E+06	0.000E+00	7.760E+09	0.000E+00	6.870E+05
MO-99	0.000E+00	1.000E+05	0.000E+00	2.260E+05	0.000E+00	2.320E+05	0.000E+00	1.900E+04
TC-99M	4.450E-21	1.260E-20	0.000E+00	1.910E-19	6.150E-21	7.430E-18	0.000E+00	1.600E-19
TC-101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-103	1.050E+08	0.000E+00	0.000E+00	4.010E+08	0.000E+00	1.230E+10	0.000E+00	4.530E+07
RU-105	5.780E-28	0.000E+00	0.000E+00	7.460E-27	0.000E+00	3.530E-25	0.000E+00	2.280E-28
RU-106	2.800E+09	0.000E+00	0.000E+00	5.400E+09	0.000E+00	1.810E+11	0.000E+00	3.540E+08
AG-110M	6.680E+06	6.180E+06	0.000E+00	1.220E+07	0.000E+00	2.520E+09	0.000E+00	3.670E+06
TE-125M	3.590E+08	1.300E+08	1.080E+08	1.460E+09	0.000E+00	1.430E+09	0.000E+00	4.810E+07
TE-127	2.120E-10	7.610E-11	1.570E-10	8.640E-10	0.000E+00	1.670E-08	0.000E+00	4.590E-11
TE-127M	1.120E+09	3.990E+08	2.850E+08	4.530E+09	0.000E+00	3.740E+09	0.000E+00	1.360E+08
TE-129	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-129M	1.130E+09	4.230E+08	3.900E+08	4.730E+09	0.000E+00	5.710E+09	0.000E+00	1.790E+08
TE-131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-131M	4.510E+02	2.210E+02	3.490E+02	2.230E+03	0.000E+00	2.190E+04	0.000E+00	1.840E+02
TE-132	1.420E+06	9.180E+05	1.010E+06	8.840E+06	0.000E+00	4.340E+07	0.000E+00	8.620E+05
I-130	2.110E-06	6.220E-06	5.270E-04	9.700E-06	0.000E+00	5.350E-06	0.000E+00	2.450E-06

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Age group:	ADULT	Pathway:	Grs/Cow/Meat (CMEAT)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
I-131	1.070E+07	1.540E+07	5.030E+09	2.630E+07	0.000E+00	4.050E+06	0.000E+00	8.800E+06
I-132	6.970E-59	1.860E-58	6.530E-57	2.970E-58	0.000E+00	3.500E-59	0.000E+00	6.530E-59
I-133	3.650E-01	6.350E-01	9.340E+01	1.110E+00	0.000E+00	5.710E-01	0.000E+00	1.940E-01
I-134	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-135	4.420E-17	1.160E-16	7.640E-15	1.860E-16	0.000E+00	1.310E-16	0.000E+00	4.270E-17
CS-134	6.580E+08	1.560E+09	0.000E+00	5.060E+08	1.680E+08	2.740E+07	0.000E+00	1.280E+09
CS-136	1.210E+07	4.760E+07	0.000E+00	2.650E+07	3.630E+06	5.410E+06	0.000E+00	3.420E+07
CS-137	8.720E+08	1.190E+09	0.000E+00	4.050E+08	1.350E+08	2.310E+07	0.000E+00	7.810E+08
CS-138	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-139	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-140	2.870E+07	3.610E+04	0.000E+00	1.230E+04	2.070E+04	5.920E+07	0.000E+00	1.880E+06
BA-141	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA-140	3.710E-02	1.870E-02	0.000E+00	0.000E+00	0.000E+00	1.370E+03	0.000E+00	4.940E-03
LA-142	3.470E-92	1.580E-92	0.000E+00	0.000E+00	0.000E+00	1.150E-88	0.000E+00	3.940E-93
CE-141	1.400E+04	9.500E+03	0.000E+00	4.410E+03	0.000E+00	3.630E+07	0.000E+00	1.080E+03
CE-143	2.010E-02	1.480E+01	0.000E+00	6.530E-03	0.000E+00	5.550E+02	0.000E+00	1.640E-03
CE-144	1.460E+06	6.090E+05	0.000E+00	3.610E+05	0.000E+00	4.930E+08	0.000E+00	7.830E+04
PR-143	2.100E+04	8.410E+03	0.000E+00	4.850E+03	0.000E+00	9.180E+07	0.000E+00	1.040E+03
PR-144	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND-147	7.070E+03	8.170E+03	0.000E+00	4.780E+03	0.000E+00	3.920E+07	0.000E+00	4.890E+02
W-187	2.070E-02	1.730E-02	0.000E+00	0.000E+00	0.000E+00	5.660E+00	0.000E+00	6.040E-03
NP-239	2.590E-01	2.550E-02	0.000E+00	7.950E-02	0.000E+00	5.230E+03	0.000E+00	1.400E-02

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Age group:	ADULT	Pathway:	Grs/Goat/Meat (GMEAT)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
H-3	0.000E+00	3.900E+01	3.900E+01	3.900E+01	3.900E+01	3.900E+01	0.000E+00	3.900E+01
C-14	2.472E+03	4.956E+02	4.956E+02	4.956E+02	4.956E+02	4.956E+02	0.000E+00	4.956E+02
NA-24	1.632E-04	1.632E-04	1.632E-04	1.632E-04	1.632E-04	1.632E-04	0.000E+00	1.632E-04
P-32	5.592E+08	3.480E+07	0.000E+00	0.000E+00	0.000E+00	6.288E+07	0.000E+00	2.160E+07
CR-51	0.000E+00	0.000E+00	5.052E+02	1.860E+02	1.122E+03	2.124E+05	0.000E+00	8.460E+02
MN-54	0.000E+00	1.102E+06	0.000E+00	3.276E+05	0.000E+00	3.372E+06	0.000E+00	2.100E+05
MN-56	0.000E+00	1.584E-54	0.000E+00	2.016E-54	0.000E+00	5.064E-53	0.000E+00	2.820E-55
FE-55	3.516E+07	2.436E+07	0.000E+00	0.000E+00	1.356E+07	1.392E+07	0.000E+00	5.664E+06
FE-59	3.192E+07	7.488E+07	0.000E+00	0.000E+00	2.088E+07	2.496E+08	0.000E+00	2.868E+07
CO-58	0.000E+00	2.184E+06	0.000E+00	0.000E+00	0.000E+00	4.428E+07	0.000E+00	4.908E+06
CO-60	0.000E+00	9.024E+06	0.000E+00	0.000E+00	0.000E+00	1.692E+08	0.000E+00	1.992E+07
NI-63	2.268E+09	1.572E+08	0.000E+00	0.000E+00	0.000E+00	3.276E+07	0.000E+00	7.596E+07
NI-65	2.700E-53	3.504E-54	0.000E+00	0.000E+00	0.000E+00	8.880E-53	0.000E+00	1.596E-54
CU-64	0.000E+00	3.252E-08	0.000E+00	8.196E-08	0.000E+00	2.772E-06	0.000E+00	1.524E-08
ZN-65	4.272E+07	1.356E+08	0.000E+00	9.084E+07	0.000E+00	8.556E+07	0.000E+00	6.144E+07
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.038E-57	0.000E+00	7.200E-58
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	5.844E+07	0.000E+00	0.000E+00	0.000E+00	1.152E+07	0.000E+00	2.724E+07
RB-88	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-89	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-89	3.624E+07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.808E+06	0.000E+00	1.039E+06
SR-90	1.488E+09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.308E+07	0.000E+00	3.660E+08
SR-91	1.824E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.688E-11	0.000E+00	7.368E-13

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Age group:	ADULT	Pathway:	Grs/Goat/Meat (GMEAT)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-92	1.416E-50	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.808E-49	0.000E+00	6.120E-52
Y-90	1.296E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.368E+05	0.000E+00	3.468E-01
Y-91	1.356E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.476E+07	0.000E+00	3.636E+03
Y-91M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y-92	1.824E-40	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.192E-36	0.000E+00	5.316E-42
Y-93	5.628E-13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.788E-08	0.000E+00	1.560E-14
ZR-95	2.244E+05	7.212E+04	0.000E+00	1.130E+05	0.000E+00	2.280E+08	0.000E+00	4.884E+04
ZR-97	2.484E-06	5.004E-07	0.000E+00	7.560E-07	0.000E+00	1.548E-01	0.000E+00	2.292E-07
NB-95	2.760E+05	1.536E+05	0.000E+00	1.512E+05	0.000E+00	9.312E+08	0.000E+00	8.244E+04
MO-99	0.000E+00	1.200E+04	0.000E+00	2.712E+04	0.000E+00	2.784E+04	0.000E+00	2.280E+03
TC-99M	5.340E-22	1.512E-21	0.000E+00	2.292E-20	7.380E-22	8.916E-19	0.000E+00	1.920E-20
TC-101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-103	1.260E+07	0.000E+00	0.000E+00	4.812E+07	0.000E+00	1.476E+09	0.000E+00	5.436E+06
RU-105	6.936E-29	0.000E+00	0.000E+00	8.952E-28	0.000E+00	4.236E-26	0.000E+00	2.736E-29
RU-106	3.360E+08	0.000E+00	0.000E+00	6.480E+08	0.000E+00	2.172E+10	0.000E+00	4.248E+07
AG-110M	8.016E+05	7.416E+05	0.000E+00	1.464E+06	0.000E+00	3.024E+08	0.000E+00	4.404E+05
TE-125M	4.308E+07	1.560E+07	1.296E+07	1.752E+08	0.000E+00	1.716E+08	0.000E+00	5.772E+06
TE-127	2.544E-11	9.132E-12	1.884E-11	1.037E-10	0.000E+00	2.004E-09	0.000E+00	5.508E-12
TE-127M	1.344E+08	4.788E+07	3.420E+07	5.436E+08	0.000E+00	4.488E+08	0.000E+00	1.632E+07
TE-129	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-129M	1.356E+08	5.076E+07	4.680E+07	5.676E+08	0.000E+00	6.852E+08	0.000E+00	2.148E+07
TE-131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-131M	5.412E+01	2.652E+01	4.188E+01	2.676E+02	0.000E+00	2.628E+03	0.000E+00	2.208E+01
TE-132	1.704E+05	1.102E+05	1.212E+05	1.061E+06	0.000E+00	5.208E+06	0.000E+00	1.034E+05
I-130	2.532E-07	7.464E-07	6.324E-05	1.164E-06	0.000E+00	6.420E-07	0.000E+00	2.940E-07

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Age group:	ADULT	Pathway:	Grs/Goat/Meat (GMEAT)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
I-131	1.284E+06	1.848E+06	6.036E+08	3.156E+06	0.000E+00	4.860E+05	0.000E+00	1.056E+06
I-132	8.364E-60	2.232E-59	7.836E-58	3.564E-59	0.000E+00	4.200E-60	0.000E+00	7.836E-60
I-133	4.380E-02	7.620E-02	1.121E+01	1.332E-01	0.000E+00	6.852E-02	0.000E+00	2.328E-02
I-134	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-135	5.304E-18	1.392E-17	9.168E-16	2.232E-17	0.000E+00	1.572E-17	0.000E+00	5.124E-18
CS-134	7.896E+07	1.872E+08	0.000E+00	6.072E+07	2.016E+07	3.288E+06	0.000E+00	1.536E+08
CS-136	1.452E+06	5.712E+06	0.000E+00	3.180E+06	4.356E+05	6.492E+05	0.000E+00	4.104E+06
CS-137	1.046E+08	1.428E+08	0.000E+00	4.860E+07	1.620E+07	2.772E+06	0.000E+00	9.372E+07
CS-138	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-139	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-140	3.444E+06	4.332E+03	0.000E+00	1.476E+03	2.484E+03	7.104E+06	0.000E+00	2.256E+05
BA-141	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA-140	4.452E-03	2.244E-03	0.000E+00	0.000E+00	0.000E+00	1.644E+02	0.000E+00	5.928E-04
LA-142	4.164E-93	1.896E-93	0.000E+00	0.000E+00	0.000E+00	1.380E-89	0.000E+00	4.728E-94
CE-141	1.680E+03	1.140E+03	0.000E+00	5.292E+02	0.000E+00	4.356E+06	0.000E+00	1.296E+02
CE-143	2.412E-03	1.776E+00	0.000E+00	7.836E-04	0.000E+00	6.660E+01	0.000E+00	1.968E-04
CE-144	1.752E+05	7.308E+04	0.000E+00	4.332E+04	0.000E+00	5.916E+07	0.000E+00	9.396E+03
PR-143	2.520E+03	1.009E+03	0.000E+00	5.820E+02	0.000E+00	1.102E+07	0.000E+00	1.248E+02
PR-144	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND-147	8.484E+02	9.804E+02	0.000E+00	5.736E+02	0.000E+00	4.704E+06	0.000E+00	5.868E+01
W-187	2.484E-03	2.076E-03	0.000E+00	0.000E+00	0.000E+00	6.792E-01	0.000E+00	7.248E-04
NP-239	3.108E-02	3.060E-03	0.000E+00	9.540E-03	0.000E+00	6.276E+02	0.000E+00	1.680E-03

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Vegetation (VEG)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
H-3	0.000E+00	2.260E+03	2.260E+03	2.260E+03	2.260E+03	2.260E+03	0.000E+00	2.260E+03
C-14	5.560E+04	1.110E+04	1.110E+04	1.110E+04	1.110E+04	1.110E+04	0.000E+00	1.110E+04
NA-24	2.690E+05	2.690E+05	2.690E+05	2.690E+05	2.690E+05	2.690E+05	0.000E+00	2.690E+05
P-32	1.400E+09	8.730E+07	0.000E+00	0.000E+00	0.000E+00	1.580E+08	0.000E+00	5.430E+07
CR-51	0.000E+00	0.000E+00	2.780E+04	1.020E+04	6.160E+04	1.170E+07	0.000E+00	4.640E+04
MN-54	0.000E+00	3.130E+08	0.000E+00	9.310E+07	0.000E+00	9.590E+08	0.000E+00	5.970E+07
MN-56	0.000E+00	1.580E+01	0.000E+00	2.000E+01	0.000E+00	5.040E+02	0.000E+00	2.800E+00
FE-55	2.100E+08	1.450E+08	0.000E+00	0.000E+00	8.080E+07	8.310E+07	0.000E+00	3.380E+07
FE-59	1.260E+08	2.960E+08	0.000E+00	0.000E+00	8.280E+07	9.880E+08	0.000E+00	1.140E+08
CO-58	0.000E+00	3.070E+07	0.000E+00	0.000E+00	0.000E+00	6.230E+08	0.000E+00	6.890E+07
CO-60	0.000E+00	1.670E+08	0.000E+00	0.000E+00	0.000E+00	3.140E+09	0.000E+00	3.690E+08
NI-63	1.040E+10	7.210E+08	0.000E+00	0.000E+00	0.000E+00	1.500E+08	0.000E+00	3.490E+08
NI-65	6.150E+01	7.990E+00	0.000E+00	0.000E+00	0.000E+00	2.030E+02	0.000E+00	3.640E+00
CU-64	0.000E+00	9.200E+03	0.000E+00	2.320E+04	0.000E+00	7.840E+05	0.000E+00	4.320E+03
ZN-65	3.170E+08	1.010E+09	0.000E+00	6.750E+08	0.000E+00	6.360E+08	0.000E+00	4.560E+08
ZN-69	5.490E-06	1.050E-05	0.000E+00	6.830E-06	0.000E+00	1.580E-06	0.000E+00	7.310E-07
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.470E+00	0.000E+00	3.110E+00
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.940E-16	0.000E+00	2.480E-11
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	2.190E+08	0.000E+00	0.000E+00	0.000E+00	4.330E+07	0.000E+00	1.020E+08
RB-88	0.000E+00	3.430E-22	0.000E+00	0.000E+00	0.000E+00	4.740E-33	0.000E+00	1.820E-22
RB-89	0.000E+00	3.890E-26	0.000E+00	0.000E+00	0.000E+00	2.260E-39	0.000E+00	2.730E-26
SR-89	9.970E+09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.600E+09	0.000E+00	2.860E+08
SR-90	6.050E+11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.750E+10	0.000E+00	1.480E+11
SR-91	3.050E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.450E+06	0.000E+00	1.230E+04

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Vegetation (VEG)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-92	4.270E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.450E+03	0.000E+00	1.850E+01
Y-90	1.330E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.410E+08	0.000E+00	3.570E+02
Y-91	5.110E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.810E+09	0.000E+00	1.370E+05
Y-91M	5.220E-09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.530E-08	0.000E+00	2.020E-10
Y-92	9.150E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.600E+04	0.000E+00	2.680E-02
Y-93	1.700E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.380E+06	0.000E+00	4.680E+00
ZR-95	1.170E+06	3.770E+05	0.000E+00	5.910E+05	0.000E+00	1.190E+09	0.000E+00	2.550E+05
ZR-97	3.370E+02	6.810E+01	0.000E+00	1.030E+02	0.000E+00	2.110E+07	0.000E+00	3.110E+01
NB-95	1.420E+05	7.920E+04	0.000E+00	7.830E+04	0.000E+00	4.810E+08	0.000E+00	4.260E+04
MO-99	0.000E+00	6.150E+06	0.000E+00	1.390E+07	0.000E+00	1.430E+07	0.000E+00	1.170E+06
TC-99M	3.100E+00	8.770E+00	0.000E+00	1.330E+02	4.300E+00	5.190E+03	0.000E+00	1.120E+02
TC-101	8.220E-31	1.180E-30	0.000E+00	2.130E-29	6.050E-31	3.560E-42	0.000E+00	1.160E-29
RU-103	4.770E+06	0.000E+00	0.000E+00	1.820E+07	0.000E+00	5.570E+08	0.000E+00	2.060E+06
RU-105	5.390E+01	0.000E+00	0.000E+00	6.960E+02	0.000E+00	3.290E+04	0.000E+00	2.130E+01
RU-106	1.930E+08	0.000E+00	0.000E+00	3.720E+08	0.000E+00	1.250E+10	0.000E+00	2.440E+07
AG-110M	1.050E+07	9.750E+06	0.000E+00	1.920E+07	0.000E+00	3.980E+09	0.000E+00	5.790E+06
TE-125M	9.660E+07	3.500E+07	2.900E+07	3.930E+08	0.000E+00	3.860E+08	0.000E+00	1.290E+07
TE-127	5.660E+03	2.030E+03	4.190E+03	2.310E+04	0.000E+00	4.470E+05	0.000E+00	1.220E+03
TE-127M	3.490E+08	1.250E+08	8.920E+07	1.420E+09	0.000E+00	1.170E+09	0.000E+00	4.260E+07
TE-129	7.630E-04	2.870E-04	5.850E-04	3.210E-03	0.000E+00	5.760E-04	0.000E+00	1.860E-04
TE-129M	2.510E+08	9.380E+07	8.630E+07	1.050E+09	0.000E+00	1.270E+09	0.000E+00	3.980E+07
TE-131	1.500E-15	6.270E-16	1.230E-15	6.570E-15	0.000E+00	2.130E-16	0.000E+00	4.740E-16
TE-131M	9.120E+05	4.460E+05	7.060E+05	4.520E+06	0.000E+00	4.430E+07	0.000E+00	3.720E+05
TE-132	4.300E+06	2.780E+06	3.070E+06	2.680E+07	0.000E+00	1.320E+08	0.000E+00	2.610E+06
I-130	3.920E+05	1.160E+06	9.810E+07	1.810E+06	0.000E+00	9.960E+05	0.000E+00	4.570E+05

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Vegetation (VEG)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
I-131	8.080E+07	1.160E+08	3.790E+10	1.980E+08	0.000E+00	3.050E+07	0.000E+00	6.620E+07
I-132	5.760E+01	1.540E+02	5.390E+03	2.450E+02	0.000E+00	2.890E+01	0.000E+00	5.390E+01
I-133	2.090E+06	3.630E+06	5.330E+08	6.330E+06	0.000E+00	3.260E+06	0.000E+00	1.110E+06
I-134	9.650E-05	2.620E-04	4.540E-03	4.170E-04	0.000E+00	2.290E-07	0.000E+00	9.380E-05
I-135	3.900E+04	1.020E+05	6.730E+06	1.640E+05	0.000E+00	1.150E+05	0.000E+00	3.770E+04
CS-134	4.670E+09	1.110E+10	0.000E+00	3.590E+09	1.190E+09	1.940E+08	0.000E+00	9.080E+09
CS-136	4.270E+07	1.680E+08	0.000E+00	9.380E+07	1.290E+07	1.910E+07	0.000E+00	1.210E+08
CS-137	6.360E+09	8.700E+09	0.000E+00	2.950E+09	9.810E+08	1.680E+08	0.000E+00	5.700E+09
CS-138	3.920E-11	7.730E-11	0.000E+00	5.680E-11	5.610E-12	3.300E-16	0.000E+00	3.830E-11
BA-139	2.860E-02	2.030E-05	0.000E+00	1.900E-05	1.150E-05	5.060E-02	0.000E+00	8.360E-04
BA-140	1.280E+08	1.610E+05	0.000E+00	5.490E+04	9.240E+04	2.650E+08	0.000E+00	8.420E+06
BA-141	1.150E-21	8.700E-25	0.000E+00	8.090E-25	4.940E-25	5.430E-31	0.000E+00	3.890E-23
BA-142	5.960E-39	6.120E-42	0.000E+00	5.170E-42	3.470E-42	8.390E-57	0.000E+00	3.750E-40
LA-140	1.980E+03	9.970E+02	0.000E+00	0.000E+00	0.000E+00	7.320E+07	0.000E+00	2.630E+02
LA-142	2.020E-04	9.190E-05	0.000E+00	0.000E+00	0.000E+00	6.710E-01	0.000E+00	2.290E-05
CE-141	1.970E+05	1.330E+05	0.000E+00	6.190E+04	0.000E+00	5.100E+08	0.000E+00	1.510E+04
CE-143	9.980E+02	7.380E+05	0.000E+00	3.250E+02	0.000E+00	2.760E+07	0.000E+00	8.160E+01
CE-144	3.290E+07	1.380E+07	0.000E+00	8.160E+06	0.000E+00	1.110E+10	0.000E+00	1.770E+06
PR-143	6.260E+04	2.510E+04	0.000E+00	1.450E+04	0.000E+00	2.740E+08	0.000E+00	3.100E+03
PR-144	3.090E-26	1.280E-26	0.000E+00	7.230E-27	0.000E+00	4.440E-33	0.000E+00	1.570E-27
ND-147	3.330E+04	3.850E+04	0.000E+00	2.250E+04	0.000E+00	1.850E+08	0.000E+00	2.310E+03
W-187	3.800E+04	3.180E+04	0.000E+00	0.000E+00	0.000E+00	1.040E+07	0.000E+00	1.110E+04
NP-239	1.430E+03	1.400E+02	0.000E+00	4.380E+02	0.000E+00	2.880E+07	0.000E+00	7.740E+01

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Inhalation (INHL)			Units:	mrem/yr / $\mu\text{Ci}/\text{m}^3$	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
H-3	0.000E+00	1.260E+03	1.260E+03	1.260E+03	1.260E+03	1.260E+03	0.000E+00	1.260E+03
C-14	1.820E+04	3.410E+03	3.410E+03	3.410E+03	3.410E+03	3.410E+03	0.000E+00	3.410E+03
NA-24	1.020E+04	1.020E+04	1.020E+04	1.020E+04	1.020E+04	1.020E+04	0.000E+00	1.020E+04
P-32	1.320E+06	7.710E+04	0.000E+00	0.000E+00	0.000E+00	8.640E+04	0.000E+00	5.010E+04
CR-51	0.000E+00	0.000E+00	5.950E+01	2.280E+01	1.440E+04	3.320E+03	0.000E+00	1.000E+02
MN-54	0.000E+00	3.960E+04	0.000E+00	9.840E+03	1.400E+06	7.740E+04	0.000E+00	6.300E+03
MN-56	0.000E+00	1.240E+00	0.000E+00	1.300E+00	9.440E+03	2.020E+04	0.000E+00	1.830E-01
FE-55	2.460E+04	1.700E+04	0.000E+00	0.000E+00	7.210E+04	6.030E+03	0.000E+00	3.940E+03
FE-59	1.180E+04	2.780E+04	0.000E+00	0.000E+00	1.020E+06	1.880E+05	0.000E+00	1.060E+04
CO-58	0.000E+00	1.580E+03	0.000E+00	0.000E+00	9.280E+05	1.060E+05	0.000E+00	2.070E+03
CO-60	0.000E+00	1.150E+04	0.000E+00	0.000E+00	5.970E+06	2.850E+05	0.000E+00	1.480E+04
NI-63	4.320E+05	3.140E+04	0.000E+00	0.000E+00	1.780E+05	1.340E+04	0.000E+00	1.450E+04
NI-65	1.540E+00	2.100E-01	0.000E+00	0.000E+00	5.600E+03	1.230E+04	0.000E+00	9.120E-02
CU-64	0.000E+00	1.460E+00	0.000E+00	4.620E+00	6.780E+03	4.900E+04	0.000E+00	6.150E-01
ZN-65	3.240E+04	1.030E+05	0.000E+00	6.900E+04	8.640E+05	5.340E+04	0.000E+00	4.660E+04
ZN-69	3.380E-02	6.510E-02	0.000E+00	4.220E-02	9.200E+02	1.630E+01	0.000E+00	4.520E-03
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.320E+02	0.000E+00	2.410E+02
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.640E-03	0.000E+00	3.130E+02
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.280E+01
RB-86	0.000E+00	1.350E+05	0.000E+00	0.000E+00	0.000E+00	1.660E+04	0.000E+00	5.900E+04
RB-88	0.000E+00	3.870E+02	0.000E+00	0.000E+00	0.000E+00	3.340E-09	0.000E+00	1.930E+02
RB-89	0.000E+00	2.560E+02	0.000E+00	0.000E+00	0.000E+00	9.280E-12	0.000E+00	1.700E+02
SR-89	3.040E+05	0.000E+00	0.000E+00	0.000E+00	1.400E+06	3.500E+05	0.000E+00	8.720E+03
SR-90	9.920E+07	0.000E+00	0.000E+00	0.000E+00	9.600E+06	7.220E+05	0.000E+00	6.100E+06
SR-91	6.190E+01	0.000E+00	0.000E+00	0.000E+00	3.650E+04	1.910E+05	0.000E+00	2.500E+00

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Inhalation (INHL)			Units:	mrem/yr / $\mu\text{Ci}/\text{m}^3$	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-92	6.740E+00	0.000E+00	0.000E+00	0.000E+00	1.650E+04	4.300E+04	0.000E+00	2.910E-01
Y-90	2.090E+03	0.000E+00	0.000E+00	0.000E+00	1.700E+05	5.060E+05	0.000E+00	5.610E+01
Y-91	4.620E+05	0.000E+00	0.000E+00	0.000E+00	1.700E+06	3.850E+05	0.000E+00	1.240E+04
Y-91M	2.610E-01	0.000E+00	0.000E+00	0.000E+00	1.920E+03	1.330E+00	0.000E+00	1.020E-02
Y-92	1.030E+01	0.000E+00	0.000E+00	0.000E+00	1.570E+04	7.350E+04	0.000E+00	3.020E-01
Y-93	9.440E+01	0.000E+00	0.000E+00	0.000E+00	4.850E+04	4.220E+05	0.000E+00	2.610E+00
ZR-95	1.070E+05	3.440E+04	0.000E+00	5.420E+04	1.770E+06	1.500E+05	0.000E+00	2.330E+04
ZR-97	9.680E+01	1.960E+01	0.000E+00	2.970E+01	7.870E+04	5.230E+05	0.000E+00	9.040E+00
NB-95	1.410E+04	7.820E+03	0.000E+00	7.740E+03	5.050E+05	1.040E+05	0.000E+00	4.210E+03
MO-99	0.000E+00	1.210E+02	0.000E+00	2.910E+02	9.120E+04	2.480E+05	0.000E+00	2.300E+01
TC-99M	1.030E-03	2.910E-03	0.000E+00	4.420E-02	7.640E+02	4.160E+03	0.000E+00	3.700E-02
TC-101	4.180E-05	6.020E-05	0.000E+00	1.080E-03	3.990E+02	1.090E-11	0.000E+00	5.900E-04
RU-103	1.530E+03	0.000E+00	0.000E+00	5.830E+03	5.050E+05	1.100E+05	0.000E+00	6.580E+02
RU-105	7.900E-01	0.000E+00	0.000E+00	1.020E+00	1.100E+04	4.820E+04	0.000E+00	3.110E-01
RU-106	6.910E+04	0.000E+00	0.000E+00	1.340E+05	9.360E+06	9.120E+05	0.000E+00	8.720E+03
AG-110M	1.080E+04	1.000E+04	0.000E+00	1.970E+04	4.630E+06	3.020E+05	0.000E+00	5.940E+03
TE-125M	3.420E+03	1.580E+03	1.050E+03	1.240E+04	3.140E+05	7.060E+04	0.000E+00	4.670E+02
TE-127	1.400E+00	6.420E-01	1.060E+00	5.100E+00	6.510E+03	5.740E+04	0.000E+00	3.100E-01
TE-127M	1.260E+04	5.770E+03	3.290E+03	4.580E+04	9.600E+05	1.500E+05	0.000E+00	1.570E+03
TE-129	4.980E-02	2.390E-02	3.900E-02	1.870E-01	1.940E+03	1.570E+02	0.000E+00	1.240E-02
TE-129M	9.760E+03	4.670E+03	3.440E+03	3.660E+04	1.160E+06	3.830E+05	0.000E+00	1.580E+03
TE-131	1.110E-02	5.950E-03	9.360E-03	4.370E-02	1.390E+03	1.840E+01	0.000E+00	3.590E-03
TE-131M	6.990E+01	4.360E+01	5.500E+01	3.090E+02	1.460E+05	5.560E+05	0.000E+00	2.900E+01
TE-132	2.600E+02	2.150E+02	1.900E+02	1.460E+03	2.880E+05	5.100E+05	0.000E+00	1.620E+02
I-130	4.580E+03	1.340E+04	1.140E+06	2.090E+04	0.000E+00	7.690E+03	0.000E+00	5.280E+03

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Inhalation (INHL)			Units:	mrem/yr / $\mu\text{Ci}/\text{m}^3$	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
I-131	2.520E+04	3.580E+04	1.190E+07	6.130E+04	0.000E+00	6.280E+03	0.000E+00	2.050E+04
I-132	1.160E+03	3.260E+03	1.140E+05	5.180E+03	0.000E+00	4.060E+02	0.000E+00	1.160E+03
I-133	8.640E+03	1.480E+04	2.150E+06	2.580E+04	0.000E+00	8.880E+03	0.000E+00	4.520E+03
I-134	6.440E+02	1.730E+03	2.980E+04	2.750E+03	0.000E+00	1.010E+00	0.000E+00	6.150E+02
I-135	2.680E+03	6.980E+03	4.480E+05	1.110E+04	0.000E+00	5.250E+03	0.000E+00	2.570E+03
CS-134	3.730E+05	8.480E+05	0.000E+00	2.870E+05	9.760E+04	1.040E+04	0.000E+00	7.280E+05
CS-136	3.900E+04	1.460E+05	0.000E+00	8.560E+04	1.200E+04	1.170E+04	0.000E+00	1.100E+05
CS-137	4.780E+05	6.210E+05	0.000E+00	2.220E+05	7.520E+04	8.400E+03	0.000E+00	4.280E+05
CS-138	3.310E+02	6.210E+02	0.000E+00	4.800E+02	4.860E+01	1.860E-03	0.000E+00	3.240E+02
BA-139	9.360E-01	6.660E-04	0.000E+00	6.220E-04	3.760E+03	8.960E+02	0.000E+00	2.740E-02
BA-140	3.900E+04	4.900E+01	0.000E+00	1.670E+01	1.270E+06	2.180E+05	0.000E+00	2.570E+03
BA-141	1.000E-01	7.530E-05	0.000E+00	7.000E-05	1.940E+03	1.160E-07	0.000E+00	3.360E-03
BA-142	2.630E-02	2.700E-05	0.000E+00	2.290E-05	1.190E+03	1.570E-16	0.000E+00	1.660E-03
LA-140	3.440E+02	1.740E+02	0.000E+00	0.000E+00	1.360E+05	4.580E+05	0.000E+00	4.580E+01
LA-142	6.830E-01	3.100E-01	0.000E+00	0.000E+00	6.330E+03	2.110E+03	0.000E+00	7.720E-02
CE-141	1.990E+04	1.350E+04	0.000E+00	6.260E+03	3.620E+05	1.200E+05	0.000E+00	1.530E+03
CE-143	1.860E+02	1.380E+02	0.000E+00	6.080E+01	7.980E+04	2.260E+05	0.000E+00	1.530E+01
CE-144	3.430E+06	1.430E+06	0.000E+00	8.480E+05	7.780E+06	8.160E+05	0.000E+00	1.840E+05
PR-143	9.360E+03	3.750E+03	0.000E+00	2.160E+03	2.810E+05	2.000E+05	0.000E+00	4.640E+02
PR-144	3.010E-02	1.250E-02	0.000E+00	7.050E-03	1.020E+03	2.150E-08	0.000E+00	1.530E-03
ND-147	5.270E+03	6.100E+03	0.000E+00	3.560E+03	2.210E+05	1.730E+05	0.000E+00	3.650E+02
W-187	8.480E+00	7.080E+00	0.000E+00	0.000E+00	2.900E+04	1.550E+05	0.000E+00	2.480E+00
NP-239	2.300E+02	2.260E+01	0.000E+00	7.000E+01	3.760E+04	1.190E+05	0.000E+00	1.240E+01

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Ground Plane Deposition (GPD)			Units:	m ² ·mrem/yr / μCi/sec	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
H-3	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C-14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NA-24	1.190E+07	1.190E+07	1.190E+07	1.190E+07	1.190E+07	1.190E+07	1.390E+07	1.190E+07
P-32	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CR-51	4.660E+06	4.660E+06	4.660E+06	4.660E+06	4.660E+06	4.660E+06	5.510E+06	4.660E+06
MN-54	1.390E+09	1.390E+09	1.390E+09	1.390E+09	1.390E+09	1.390E+09	1.630E+09	1.390E+09
MN-56	9.020E+05	9.020E+05	9.020E+05	9.020E+05	9.020E+05	9.020E+05	1.070E+06	9.020E+05
FE-55	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
FE-59	2.730E+08	2.730E+08	2.730E+08	2.730E+08	2.730E+08	2.730E+08	3.210E+08	2.730E+08
CO-58	3.790E+08	3.790E+08	3.790E+08	3.790E+08	3.790E+08	3.790E+08	4.440E+08	3.790E+08
CO-60	2.150E+10	2.150E+10	2.150E+10	2.150E+10	2.150E+10	2.150E+10	2.530E+10	2.150E+10
NI-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NI-65	2.970E+05	2.970E+05	2.970E+05	2.970E+05	2.970E+05	2.970E+05	3.450E+05	2.970E+05
CU-64	6.070E+05	6.070E+05	6.070E+05	6.070E+05	6.070E+05	6.070E+05	6.880E+05	6.070E+05
ZN-65	7.470E+08	7.470E+08	7.470E+08	7.470E+08	7.470E+08	7.470E+08	8.590E+08	7.470E+08
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	4.870E+03	4.870E+03	4.870E+03	4.870E+03	4.870E+03	4.870E+03	7.080E+03	4.870E+03
BR-84	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.360E+05	2.030E+05
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	8.990E+06	8.990E+06	8.990E+06	8.990E+06	8.990E+06	8.990E+06	1.030E+07	8.990E+06
RB-88	3.310E+04	3.310E+04	3.310E+04	3.310E+04	3.310E+04	3.310E+04	3.780E+04	3.310E+04
RB-89	1.230E+05	1.230E+05	1.230E+05	1.230E+05	1.230E+05	1.230E+05	1.480E+05	1.230E+05
SR-89	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.510E+04	2.160E+04
SR-90	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-91	2.150E+06	2.150E+06	2.150E+06	2.150E+06	2.150E+06	2.150E+06	2.510E+06	2.150E+06

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Ground Plane Deposition (GPD)			Units:	m ² ·mrem/yr / μCi/sec	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-92	7.770E+05	7.770E+05	7.770E+05	7.770E+05	7.770E+05	7.770E+05	8.630E+05	7.770E+05
Y-90	4.490E+03	4.490E+03	4.490E+03	4.490E+03	4.490E+03	4.490E+03	5.310E+03	4.490E+03
Y-91	1.070E+06	1.070E+06	1.070E+06	1.070E+06	1.070E+06	1.070E+06	1.210E+06	1.070E+06
Y-91M	1.000E+05	1.000E+05	1.000E+05	1.000E+05	1.000E+05	1.000E+05	1.160E+05	1.000E+05
Y-92	1.800E+05	1.800E+05	1.800E+05	1.800E+05	1.800E+05	1.800E+05	2.140E+05	1.800E+05
Y-93	1.830E+05	1.830E+05	1.830E+05	1.830E+05	1.830E+05	1.830E+05	2.510E+05	1.830E+05
ZR-95	2.450E+08	2.450E+08	2.450E+08	2.450E+08	2.450E+08	2.450E+08	2.840E+08	2.450E+08
ZR-97	2.960E+06	2.960E+06	2.960E+06	2.960E+06	2.960E+06	2.960E+06	3.440E+06	2.960E+06
NB-95	1.370E+08	1.370E+08	1.370E+08	1.370E+08	1.370E+08	1.370E+08	1.610E+08	1.370E+08
MO-99	3.990E+06	3.990E+06	3.990E+06	3.990E+06	3.990E+06	3.990E+06	4.630E+06	3.990E+06
TC-99M	1.840E+05	1.840E+05	1.840E+05	1.840E+05	1.840E+05	1.840E+05	2.110E+05	1.840E+05
TC-101	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.260E+04	2.040E+04
RU-103	1.080E+08	1.080E+08	1.080E+08	1.080E+08	1.080E+08	1.080E+08	1.260E+08	1.080E+08
RU-105	6.360E+05	6.360E+05	6.360E+05	6.360E+05	6.360E+05	6.360E+05	7.210E+05	6.360E+05
RU-106	4.220E+08	4.220E+08	4.220E+08	4.220E+08	4.220E+08	4.220E+08	5.070E+08	4.220E+08
AG-110M	3.440E+09	3.440E+09	3.440E+09	3.440E+09	3.440E+09	3.440E+09	4.010E+09	3.440E+09
TE-125M	1.550E+06	1.550E+06	1.550E+06	1.550E+06	1.550E+06	1.550E+06	2.130E+06	1.550E+06
TE-127	2.980E+03	2.980E+03	2.980E+03	2.980E+03	2.980E+03	2.980E+03	3.280E+03	2.980E+03
TE-127M	9.160E+04	9.160E+04	9.160E+04	9.160E+04	9.160E+04	9.160E+04	1.080E+05	9.160E+04
TE-129	2.620E+04	2.620E+04	2.620E+04	2.620E+04	2.620E+04	2.620E+04	3.100E+04	2.620E+04
TE-129M	1.980E+07	1.980E+07	1.980E+07	1.980E+07	1.980E+07	1.980E+07	2.310E+07	1.980E+07
TE-131	2.920E+04	2.920E+04	2.920E+04	2.920E+04	2.920E+04	2.920E+04	3.450E+07	2.920E+04
TE-131M	8.030E+06	8.030E+06	8.030E+06	8.030E+06	8.030E+06	8.030E+06	9.460E+06	8.030E+06
TE-132	4.230E+06	4.230E+06	4.230E+06	4.230E+06	4.230E+06	4.230E+06	4.980E+06	4.230E+06
I-130	5.510E+06	5.510E+06	5.510E+06	5.510E+06	5.510E+06	5.510E+06	6.690E+06	5.510E+06

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Ground Plane Deposition (GPD)			Units:	m ² ·mrem/yr / μCi/sec	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
I-131	1.720E+07	1.720E+07	1.720E+07	1.720E+07	1.720E+07	1.720E+07	2.090E+07	1.720E+07
I-132	1.250E+06	1.250E+06	1.250E+06	1.250E+06	1.250E+06	1.250E+06	1.470E+06	1.250E+06
I-133	2.450E+06	2.450E+06	2.450E+06	2.450E+06	2.450E+06	2.450E+06	2.980E+06	2.450E+06
I-134	4.470E+05	4.470E+05	4.470E+05	4.470E+05	4.470E+05	4.470E+05	5.300E+05	4.470E+05
I-135	2.530E+06	2.530E+06	2.530E+06	2.530E+06	2.530E+06	2.530E+06	2.950E+06	2.530E+06
CS-134	6.860E+09	6.860E+09	6.860E+09	6.860E+09	6.860E+09	6.860E+09	8.000E+09	6.860E+09
CS-136	1.510E+08	1.510E+08	1.510E+08	1.510E+08	1.510E+08	1.510E+08	1.710E+08	1.510E+08
CS-137	1.030E+10	1.030E+10	1.030E+10	1.030E+10	1.030E+10	1.030E+10	1.200E+10	1.030E+10
CS-138	3.590E+05	3.590E+05	3.590E+05	3.590E+05	3.590E+05	3.590E+05	4.100E+05	3.590E+05
BA-139	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.190E+05	1.060E+05
BA-140	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.350E+07	2.050E+07
BA-141	4.170E+04	4.170E+04	4.170E+04	4.170E+04	4.170E+04	4.170E+04	4.750E+04	4.170E+04
BA-142	4.490E+04	4.490E+04	4.490E+04	4.490E+04	4.490E+04	4.490E+04	5.110E+04	4.490E+04
LA-140	1.920E+07	1.920E+07	1.920E+07	1.920E+07	1.920E+07	1.920E+07	2.180E+07	1.920E+07
LA-142	7.600E+05	7.600E+05	7.600E+05	7.600E+05	7.600E+05	7.600E+05	9.120E+05	7.600E+05
CE-141	1.370E+07	1.370E+07	1.370E+07	1.370E+07	1.370E+07	1.370E+07	1.540E+07	1.370E+07
CE-143	2.310E+06	2.310E+06	2.310E+06	2.310E+06	2.310E+06	2.310E+06	2.630E+06	2.310E+06
CE-144	6.950E+07	6.950E+07	6.950E+07	6.950E+07	6.950E+07	6.950E+07	8.040E+07	6.950E+07
PR-143	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR-144	1.830E+03	1.830E+03	1.830E+03	1.830E+03	1.830E+03	1.830E+03	2.110E+03	1.830E+03
ND-147	8.390E+06	8.390E+06	8.390E+06	8.390E+06	8.390E+06	8.390E+06	1.010E+07	8.390E+06
W-187	2.350E+06	2.350E+06	2.350E+06	2.350E+06	2.350E+06	2.350E+06	2.730E+06	2.350E+06
NP-239	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.980E+06	1.710E+06

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Grs/Cow/Milk (CMILK)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
H-3	0.000E+00	9.940E+02	9.940E+02	9.940E+02	9.940E+02	9.940E+02	0.000E+00	9.940E+02
C-14	4.150E+04	8.310E+03	8.310E+03	8.310E+03	8.310E+03	8.310E+03	0.000E+00	8.310E+03
NA-24	4.260E+06	4.260E+06	4.260E+06	4.260E+06	4.260E+06	4.260E+06	0.000E+00	4.260E+06
P-32	3.150E+10	1.950E+09	0.000E+00	0.000E+00	0.000E+00	2.650E+09	0.000E+00	1.220E+09
CR-51	0.000E+00	0.000E+00	2.770E+04	1.090E+04	7.130E+04	8.390E+06	0.000E+00	4.990E+04
MN-54	0.000E+00	1.400E+07	0.000E+00	4.180E+06	0.000E+00	2.870E+07	0.000E+00	2.780E+06
MN-56	0.000E+00	7.250E-03	0.000E+00	9.180E-03	0.000E+00	4.770E-01	0.000E+00	1.290E-03
FE-55	4.450E+07	3.160E+07	0.000E+00	0.000E+00	2.000E+07	1.370E+07	0.000E+00	7.360E+06
FE-59	5.180E+07	1.210E+08	0.000E+00	0.000E+00	3.810E+07	2.860E+08	0.000E+00	4.670E+07
CO-58	0.000E+00	7.940E+06	0.000E+00	0.000E+00	0.000E+00	1.090E+08	0.000E+00	1.830E+07
CO-60	0.000E+00	2.780E+07	0.000E+00	0.000E+00	0.000E+00	3.620E+08	0.000E+00	6.260E+07
NI-63	1.180E+10	8.350E+08	0.000E+00	0.000E+00	0.000E+00	1.330E+08	0.000E+00	4.010E+08
NI-65	6.770E-01	8.650E-02	0.000E+00	0.000E+00	0.000E+00	4.690E+00	0.000E+00	3.940E-02
CU-64	0.000E+00	4.250E+04	0.000E+00	1.070E+05	0.000E+00	3.290E+06	0.000E+00	2.000E+04
ZN-65	2.110E+09	7.320E+09	0.000E+00	4.680E+09	0.000E+00	3.100E+09	0.000E+00	3.410E+09
ZN-69	3.850E-12	7.330E-12	0.000E+00	4.790E-12	0.000E+00	1.350E-11	0.000E+00	5.130E-13
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.790E-01
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.880E-23
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	4.730E+09	0.000E+00	0.000E+00	0.000E+00	7.000E+08	0.000E+00	2.220E+09
RB-88	0.000E+00	3.890E-45	0.000E+00	0.000E+00	0.000E+00	3.330E-52	0.000E+00	2.070E-45
RB-89	0.000E+00	7.660E-53	0.000E+00	0.000E+00	0.000E+00	1.170E-61	0.000E+00	5.420E-53
SR-89	2.670E+09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.190E+08	0.000E+00	7.660E+07
SR-90	6.610E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.860E+09	0.000E+00	1.630E+10
SR-91	5.310E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.410E+05	0.000E+00	2.110E+03

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Grs/Cow/Milk (CMILK)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-92	8.940E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.280E+01	0.000E+00	3.810E-02
Y-90	1.300E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.070E+06	0.000E+00	3.510E+00
Y-91	1.580E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.480E+06	0.000E+00	4.240E+02
Y-91M	1.090E-19	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.170E-18	0.000E+00	4.180E-21
Y-92	1.030E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.830E+00	0.000E+00	2.980E-06
Y-93	4.120E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.260E+04	0.000E+00	1.130E-02
ZR-95	1.650E+03	5.200E+02	0.000E+00	7.650E+02	0.000E+00	1.200E+06	0.000E+00	3.580E+02
ZR-97	7.880E-01	1.560E-01	0.000E+00	2.370E-01	0.000E+00	4.220E+04	0.000E+00	7.190E-02
NB-95	1.410E+05	7.810E+04	0.000E+00	7.570E+04	0.000E+00	3.340E+08	0.000E+00	4.300E+04
MO-99	0.000E+00	4.470E+07	0.000E+00	1.020E+08	0.000E+00	8.010E+07	0.000E+00	8.530E+06
TC-99M	5.760E+00	1.610E+01	0.000E+00	2.390E+02	8.920E+00	1.050E+04	0.000E+00	2.080E+02
TC-101	4.740E-60	6.750E-60	0.000E+00	1.220E-58	4.110E-60	1.150E-66	0.000E+00	6.630E-59
RU-103	1.810E+03	0.000E+00	0.000E+00	6.380E+03	0.000E+00	1.510E+05	0.000E+00	7.740E+02
RU-105	1.560E-03	0.000E+00	0.000E+00	1.970E-02	0.000E+00	1.260E+00	0.000E+00	6.070E-04
RU-106	3.750E+04	0.000E+00	0.000E+00	7.240E+04	0.000E+00	1.800E+06	0.000E+00	4.730E+03
AG-110M	9.630E+07	9.110E+07	0.000E+00	1.740E+08	0.000E+00	2.560E+10	0.000E+00	5.540E+07
TE-125M	3.000E+07	1.080E+07	8.390E+06	0.000E+00	0.000E+00	8.860E+07	0.000E+00	4.020E+06
TE-127	1.210E+03	4.290E+02	8.350E+02	4.900E+03	0.000E+00	9.340E+04	0.000E+00	2.600E+02
TE-127M	8.440E+07	2.990E+07	2.010E+07	3.420E+08	0.000E+00	2.100E+08	0.000E+00	1.000E+07
TE-129	5.200E-10	1.940E-10	3.720E-10	2.180E-09	0.000E+00	2.840E-09	0.000E+00	1.270E-10
TE-129M	1.100E+08	4.090E+07	3.550E+07	4.610E+08	0.000E+00	4.130E+08	0.000E+00	1.740E+07
TE-131	6.580E-33	2.710E-33	5.070E-33	2.880E-32	0.000E+00	5.400E-34	0.000E+00	2.060E-33
TE-131M	6.570E+05	3.150E+05	4.740E+05	3.290E+06	0.000E+00	2.530E+07	0.000E+00	2.630E+05
TE-132	4.290E+06	2.720E+06	2.870E+06	2.610E+07	0.000E+00	8.610E+07	0.000E+00	2.560E+06
I-130	7.380E+05	2.140E+06	1.740E+08	3.290E+06	0.000E+00	1.640E+06	0.000E+00	8.530E+05

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Grs/Cow/Milk (CMILK)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
I-131	5.370E+08	7.520E+08	2.190E+11	1.290E+09	0.000E+00	1.490E+08	0.000E+00	4.040E+08
I-132	2.910E-01	7.620E-01	2.570E+01	1.200E+00	0.000E+00	3.320E-01	0.000E+00	2.740E-01
I-133	7.070E+06	1.200E+07	1.670E+09	2.100E+07	0.000E+00	9.070E+06	0.000E+00	3.660E+06
I-134	3.580E-12	9.500E-12	1.580E-10	1.500E-11	0.000E+00	1.250E-13	0.000E+00	3.410E-12
I-135	2.280E+04	5.870E+04	3.780E+06	9.270E+04	0.000E+00	6.510E+04	0.000E+00	2.180E+04
CS-134	9.820E+09	2.310E+10	0.000E+00	7.340E+09	2.800E+09	2.870E+08	0.000E+00	1.070E+10
CS-136	4.480E+08	1.760E+09	0.000E+00	9.600E+08	1.510E+08	1.420E+08	0.000E+00	1.180E+09
CS-137	1.340E+10	1.780E+10	0.000E+00	6.060E+09	2.350E+09	2.530E+08	0.000E+00	6.200E+09
CS-138	1.640E-23	3.150E-23	0.000E+00	2.330E-23	2.710E-24	1.430E-26	0.000E+00	1.580E-23
BA-139	8.170E-08	5.750E-11	0.000E+00	5.420E-11	3.960E-11	7.290E-07	0.000E+00	2.380E-09
BA-140	4.850E+07	5.950E+04	0.000E+00	2.020E+04	4.000E+04	7.480E+07	0.000E+00	3.130E+06
BA-141	7.520E-46	5.620E-49	0.000E+00	5.210E-49	3.850E-49	1.600E-51	0.000E+00	2.510E-47
BA-142	4.790E-80	4.790E-83	0.000E+00	4.050E-83	3.190E-83	1.470E-91	0.000E+00	2.950E-81
LA-140	8.100E+00	3.980E+00	0.000E+00	0.000E+00	0.000E+00	2.290E+05	0.000E+00	1.060E+00
LA-142	3.360E-11	1.490E-11	0.000E+00	0.000E+00	0.000E+00	4.540E-07	0.000E+00	3.710E-12
CE-141	8.880E+03	5.930E+03	0.000E+00	2.790E+03	0.000E+00	1.700E+07	0.000E+00	6.810E+02
CE-143	7.640E+01	5.560E+04	0.000E+00	2.490E+01	0.000E+00	1.670E+06	0.000E+00	6.210E+00
CE-144	6.580E+05	2.720E+05	0.000E+00	1.630E+05	0.000E+00	1.660E+08	0.000E+00	3.540E+04
PR-143	2.900E+02	1.160E+02	0.000E+00	6.730E+01	0.000E+00	9.540E+05	0.000E+00	1.440E+01
PR-144	1.080E-53	4.430E-54	0.000E+00	2.540E-54	0.000E+00	1.190E-56	0.000E+00	5.490E-55
ND-147	1.810E+02	1.970E+02	0.000E+00	1.160E+02	0.000E+00	7.110E+05	0.000E+00	1.180E+01
W-187	1.190E+04	9.710E+03	0.000E+00	0.000E+00	0.000E+00	2.630E+06	0.000E+00	3.400E+03
NP-239	7.010E+00	6.610E-01	0.000E+00	2.070E+00	0.000E+00	1.060E+05	0.000E+00	3.670E-01

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Grs/Goat/Milk (GMILK)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
H-3	0.000E+00	2.030E+03	2.030E+03	2.030E+03	2.030E+03	2.030E+03	0.000E+00	2.030E+03
C-14	4.150E+04	8.310E+03	8.310E+03	8.310E+03	8.310E+03	8.310E+03	0.000E+00	8.310E+03
NA-24	5.110E+05	5.110E+05	5.110E+05	5.110E+05	5.110E+05	5.110E+05	0.000E+00	5.110E+05
P-32	3.780E+10	2.340E+09	0.000E+00	0.000E+00	0.000E+00	3.180E+09	0.000E+00	1.470E+09
CR-51	0.000E+00	0.000E+00	3.330E+03	1.310E+03	8.550E+03	1.010E+06	0.000E+00	5.990E+03
MN-54	0.000E+00	1.680E+06	0.000E+00	5.020E+05	0.000E+00	3.450E+06	0.000E+00	3.340E+05
MN-56	0.000E+00	8.700E-04	0.000E+00	1.100E-03	0.000E+00	5.730E-02	0.000E+00	1.550E-04
FE-55	5.790E+05	4.110E+05	0.000E+00	0.000E+00	2.600E+05	1.780E+05	0.000E+00	9.570E+04
FE-59	6.740E+05	1.570E+06	0.000E+00	0.000E+00	4.960E+05	3.720E+06	0.000E+00	6.070E+05
CO-58	0.000E+00	9.520E+05	0.000E+00	0.000E+00	0.000E+00	1.310E+07	0.000E+00	2.190E+06
CO-60	0.000E+00	3.340E+06	0.000E+00	0.000E+00	0.000E+00	4.350E+07	0.000E+00	7.520E+06
NI-63	1.420E+09	1.000E+08	0.000E+00	0.000E+00	0.000E+00	1.590E+07	0.000E+00	4.810E+07
NI-65	8.120E-02	1.040E-02	0.000E+00	0.000E+00	0.000E+00	5.630E-01	0.000E+00	4.730E-03
CU-64	0.000E+00	4.730E+03	0.000E+00	1.200E+04	0.000E+00	3.670E+05	0.000E+00	2.230E+03
ZN-65	2.530E+08	8.780E+08	0.000E+00	5.620E+08	0.000E+00	3.720E+08	0.000E+00	4.100E+08
ZN-69	4.620E-13	8.800E-13	0.000E+00	5.750E-13	0.000E+00	1.620E-12	0.000E+00	6.160E-14
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.150E-02
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.450E-24
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	5.670E+08	0.000E+00	0.000E+00	0.000E+00	8.400E+07	0.000E+00	2.670E+08
RB-88	0.000E+00	4.670E-46	0.000E+00	0.000E+00	0.000E+00	4.000E-53	0.000E+00	2.490E-46
RB-89	0.000E+00	9.190E-54	0.000E+00	0.000E+00	0.000E+00	1.410E-62	0.000E+00	6.500E-54
SR-89	5.620E+09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.690E+08	0.000E+00	1.610E+08
SR-90	1.390E+11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.900E+09	0.000E+00	3.430E+10
SR-91	1.120E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.060E+05	0.000E+00	4.440E+03

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Grs/Goat/Milk (GMILK)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-92	1.880E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.780E+01	0.000E+00	8.000E-02
Y-90	1.560E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.290E+05	0.000E+00	4.210E-01
Y-91	1.900E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.770E+05	0.000E+00	5.080E+01
Y-91M	1.310E-20	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.200E-19	0.000E+00	5.020E-22
Y-92	1.240E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.390E-01	0.000E+00	3.580E-07
Y-93	4.940E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.510E+03	0.000E+00	1.360E-03
ZR-95	1.980E+02	6.250E+01	0.000E+00	9.180E+01	0.000E+00	1.440E+05	0.000E+00	4.300E+01
ZR-97	9.460E-02	1.870E-02	0.000E+00	2.840E-02	0.000E+00	5.070E+03	0.000E+00	8.620E-03
NB-95	1.690E+04	9.370E+03	0.000E+00	9.080E+03	0.000E+00	4.010E+07	0.000E+00	5.160E+03
MO-99	0.000E+00	5.370E+06	0.000E+00	1.230E+07	0.000E+00	9.610E+06	0.000E+00	1.020E+06
TC-99M	6.910E-01	1.930E+00	0.000E+00	2.870E+01	1.070E+00	1.270E+03	0.000E+00	2.500E+01
TC-101	5.690E-61	8.100E-61	0.000E+00	1.460E-59	4.930E-61	1.380E-67	0.000E+00	7.950E-60
RU-103	2.170E+02	0.000E+00	0.000E+00	7.660E+02	0.000E+00	1.810E+04	0.000E+00	9.290E+01
RU-105	1.880E-04	0.000E+00	0.000E+00	2.370E-03	0.000E+00	1.520E-01	0.000E+00	7.290E-05
RU-106	4.500E+03	0.000E+00	0.000E+00	8.680E+03	0.000E+00	2.160E+05	0.000E+00	5.670E+02
AG-110M	1.160E+07	1.090E+07	0.000E+00	2.080E+07	0.000E+00	3.070E+09	0.000E+00	6.650E+06
TE-125M	3.600E+06	1.300E+06	1.010E+06	0.000E+00	0.000E+00	1.060E+07	0.000E+00	4.820E+05
TE-127	1.450E+02	5.150E+01	1.000E+02	5.880E+02	0.000E+00	1.120E+04	0.000E+00	3.120E+01
TE-127M	1.010E+07	3.590E+06	2.410E+06	4.100E+07	0.000E+00	2.520E+07	0.000E+00	1.200E+06
TE-129	6.240E-11	2.330E-11	4.460E-11	2.620E-10	0.000E+00	3.410E-10	0.000E+00	1.520E-11
TE-129M	1.320E+07	4.900E+06	4.260E+06	5.530E+07	0.000E+00	4.960E+07	0.000E+00	2.090E+06
TE-131	7.900E-34	3.260E-34	6.090E-34	3.450E-33	0.000E+00	6.480E-35	0.000E+00	2.470E-34
TE-131M	7.880E+04	3.780E+04	5.690E+04	3.940E+05	0.000E+00	3.030E+06	0.000E+00	3.150E+04
TE-132	5.150E+05	3.260E+05	3.440E+05	3.130E+06	0.000E+00	1.030E+07	0.000E+00	3.070E+05
I-130	8.860E+05	2.560E+06	2.090E+08	3.950E+06	0.000E+00	1.970E+06	0.000E+00	1.020E+06

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Grs/Goat/Milk (GMILK)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
I-131	6.450E+08	9.030E+08	2.630E+11	1.550E+09	0.000E+00	1.790E+08	0.000E+00	4.850E+08
I-132	3.500E-01	9.150E-01	3.080E+01	1.440E+00	0.000E+00	3.980E-01	0.000E+00	3.280E-01
I-133	8.480E+06	1.440E+07	2.010E+09	2.520E+07	0.000E+00	1.090E+07	0.000E+00	4.390E+06
I-134	4.300E-12	1.140E-11	1.900E-10	1.800E-11	0.000E+00	1.500E-13	0.000E+00	4.090E-12
I-135	2.740E+04	7.040E+04	4.530E+06	1.110E+05	0.000E+00	7.810E+04	0.000E+00	2.610E+04
CS-134	2.940E+10	6.930E+10	0.000E+00	2.200E+10	8.410E+09	8.620E+08	0.000E+00	3.220E+10
CS-136	1.340E+09	5.290E+09	0.000E+00	2.880E+09	4.540E+08	4.260E+08	0.000E+00	3.550E+09
CS-137	4.020E+10	5.340E+10	0.000E+00	1.820E+10	7.060E+09	7.600E+08	0.000E+00	1.860E+10
CS-138	4.920E-23	9.450E-23	0.000E+00	6.980E-23	8.120E-24	4.290E-26	0.000E+00	4.730E-23
BA-139	9.800E-09	6.900E-12	0.000E+00	6.500E-12	4.750E-12	8.750E-08	0.000E+00	2.860E-10
BA-140	5.820E+06	7.130E+03	0.000E+00	2.420E+03	4.800E+03	8.980E+06	0.000E+00	3.750E+05
BA-141	9.030E-47	6.740E-50	0.000E+00	6.260E-50	4.610E-50	1.920E-52	0.000E+00	3.010E-48
BA-142	5.750E-81	5.750E-84	0.000E+00	4.860E-84	3.820E-84	1.760E-92	0.000E+00	3.540E-82
LA-140	9.720E-01	4.780E-01	0.000E+00	0.000E+00	0.000E+00	2.740E+04	0.000E+00	1.270E-01
LA-142	4.030E-12	1.790E-12	0.000E+00	0.000E+00	0.000E+00	5.440E-08	0.000E+00	4.450E-13
CE-141	1.070E+03	7.120E+02	0.000E+00	3.350E+02	0.000E+00	2.040E+06	0.000E+00	8.170E+01
CE-143	9.170E+00	6.670E+03	0.000E+00	2.990E+00	0.000E+00	2.000E+05	0.000E+00	7.450E-01
CE-144	7.900E+04	3.270E+04	0.000E+00	1.950E+04	0.000E+00	1.990E+07	0.000E+00	4.240E+03
PR-143	3.480E+01	1.390E+01	0.000E+00	8.080E+00	0.000E+00	1.150E+05	0.000E+00	1.730E+00
PR-144	1.300E-54	5.320E-55	0.000E+00	3.050E-55	0.000E+00	1.430E-57	0.000E+00	6.590E-56
ND-147	2.170E+01	2.360E+01	0.000E+00	1.390E+01	0.000E+00	8.530E+04	0.000E+00	1.420E+00
W-187	1.430E+03	1.170E+03	0.000E+00	0.000E+00	0.000E+00	3.150E+05	0.000E+00	4.080E+02
NP-239	8.410E-01	7.930E-02	0.000E+00	2.490E-01	0.000E+00	1.280E+04	0.000E+00	4.410E-02

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Age group:	TEEN	Pathway:	Grs/Cow/Meat (CMEAT)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
H-3	0.000E+00	1.940E+02	1.940E+02	1.940E+02	1.940E+02	1.940E+02	0.000E+00	1.940E+02
C-14	1.740E+04	3.490E+03	3.490E+03	3.490E+03	3.490E+03	3.490E+03	0.000E+00	3.490E+03
NA-24	1.080E-03	1.080E-03	1.080E-03	1.080E-03	1.080E-03	1.080E-03	0.000E+00	1.080E-03
P-32	3.930E+09	2.440E+08	0.000E+00	0.000E+00	0.000E+00	3.310E+08	0.000E+00	1.530E+08
CR-51	0.000E+00	0.000E+00	3.130E+03	1.240E+03	8.050E+03	9.470E+05	0.000E+00	5.640E+03
MN-54	0.000E+00	7.000E+06	0.000E+00	2.090E+06	0.000E+00	1.440E+07	0.000E+00	1.390E+06
MN-56	0.000E+00	1.070E-53	0.000E+00	1.360E-53	0.000E+00	7.070E-52	0.000E+00	1.910E-54
FE-55	2.380E+08	1.690E+08	0.000E+00	0.000E+00	1.070E+08	7.310E+07	0.000E+00	3.940E+07
FE-59	2.120E+08	4.950E+08	0.000E+00	0.000E+00	1.560E+08	1.170E+09	0.000E+00	1.910E+08
CO-58	0.000E+00	1.410E+07	0.000E+00	0.000E+00	0.000E+00	1.940E+08	0.000E+00	3.240E+07
CO-60	0.000E+00	5.830E+07	0.000E+00	0.000E+00	0.000E+00	7.600E+08	0.000E+00	1.310E+08
NI-63	1.520E+10	1.070E+09	0.000E+00	0.000E+00	0.000E+00	1.710E+08	0.000E+00	5.150E+08
NI-65	1.880E-52	2.410E-53	0.000E+00	0.000E+00	0.000E+00	1.300E-51	0.000E+00	1.100E-53
CU-64	0.000E+00	2.210E-07	0.000E+00	5.600E-07	0.000E+00	1.720E-05	0.000E+00	1.040E-07
ZN-65	2.500E+08	8.690E+08	0.000E+00	5.560E+08	0.000E+00	3.680E+08	0.000E+00	4.050E+08
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.070E-57
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	4.070E+08	0.000E+00	0.000E+00	0.000E+00	6.020E+07	0.000E+00	1.910E+08
RB-88	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-89	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-89	2.550E+08	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.030E+07	0.000E+00	7.290E+06
SR-90	8.050E+09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.260E+08	0.000E+00	1.990E+09
SR-91	1.280E-10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.800E-10	0.000E+00	5.090E-12

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Age group:	TEEN	Pathway:	Grs/Cow/Meat (CMEAT)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-92	9.880E-50	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.520E-48	0.000E+00	4.210E-51
Y-90	9.060E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.470E+05	0.000E+00	2.440E+00
Y-91	9.540E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.910E+08	0.000E+00	2.560E+04
Y-91M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y-92	1.280E-39	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.520E-35	0.000E+00	3.710E-41
Y-93	3.960E-12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.210E-07	0.000E+00	1.090E-13
ZR-95	1.500E+06	4.730E+05	0.000E+00	6.950E+05	0.000E+00	1.090E+09	0.000E+00	3.250E+05
ZR-97	1.720E-05	3.410E-06	0.000E+00	5.170E-06	0.000E+00	9.230E-01	0.000E+00	1.570E-06
NB-95	1.790E+06	9.950E+05	0.000E+00	9.650E+05	0.000E+00	4.260E+09	0.000E+00	5.480E+05
MO-99	0.000E+00	8.270E+04	0.000E+00	1.890E+05	0.000E+00	1.480E+05	0.000E+00	1.580E+04
TC-99M	3.530E-21	9.850E-21	0.000E+00	1.470E-19	5.470E-21	6.470E-18	0.000E+00	1.280E-19
TC-101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-103	8.570E+07	0.000E+00	0.000E+00	3.020E+08	0.000E+00	7.160E+09	0.000E+00	3.660E+07
RU-105	4.830E-28	0.000E+00	0.000E+00	6.090E-27	0.000E+00	3.900E-25	0.000E+00	1.880E-28
RU-106	2.360E+09	0.000E+00	0.000E+00	4.550E+09	0.000E+00	1.130E+11	0.000E+00	2.970E+08
AG-110M	5.060E+06	4.790E+06	0.000E+00	9.130E+06	0.000E+00	1.340E+09	0.000E+00	2.910E+06
TE-125M	3.030E+08	1.090E+08	8.470E+07	0.000E+00	0.000E+00	8.940E+08	0.000E+00	4.050E+07
TE-127	1.800E-10	6.380E-11	1.240E-10	7.290E-10	0.000E+00	1.390E-08	0.000E+00	3.870E-11
TE-127M	9.410E+08	3.340E+08	2.240E+08	3.820E+09	0.000E+00	2.350E+09	0.000E+00	1.120E+08
TE-129	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-129M	9.500E+08	3.530E+08	3.070E+08	3.970E+09	0.000E+00	3.570E+09	0.000E+00	1.500E+08
TE-131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-131M	3.760E+02	1.800E+02	2.710E+02	1.880E+03	0.000E+00	1.450E+04	0.000E+00	1.500E+02
TE-132	1.160E+06	7.360E+05	7.750E+05	7.060E+06	0.000E+00	2.330E+07	0.000E+00	6.920E+05
I-130	1.700E-06	4.910E-06	4.000E-04	7.560E-06	0.000E+00	3.770E-06	0.000E+00	1.960E-06

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Age group:	TEEN	Pathway:	Grs/Cow/Meat (CMEAT)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
I-131	8.920E+06	1.250E+07	3.650E+09	2.150E+07	0.000E+00	2.470E+06	0.000E+00	6.710E+06
I-132	5.660E-59	1.480E-58	4.990E-57	2.330E-58	0.000E+00	6.450E-59	0.000E+00	5.320E-59
I-133	3.050E-01	5.180E-01	7.230E+01	9.090E-01	0.000E+00	3.920E-01	0.000E+00	1.580E-01
I-134	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-135	3.600E-17	9.260E-17	5.960E-15	1.460E-16	0.000E+00	1.030E-16	0.000E+00	3.430E-17
CS-134	5.230E+08	1.230E+09	0.000E+00	3.910E+08	1.490E+08	1.530E+07	0.000E+00	5.710E+08
CS-136	9.400E+06	3.700E+07	0.000E+00	2.010E+07	3.170E+06	2.980E+06	0.000E+00	2.480E+07
CS-137	7.240E+08	9.630E+08	0.000E+00	3.280E+08	1.270E+08	1.370E+07	0.000E+00	3.360E+08
CS-138	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-139	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-140	2.380E+07	2.910E+04	0.000E+00	9.870E+03	1.960E+04	3.660E+07	0.000E+00	1.530E+06
BA-141	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA-140	3.050E-02	1.500E-02	0.000E+00	0.000E+00	0.000E+00	8.610E+02	0.000E+00	3.990E-03
LA-142	2.870E-92	1.280E-92	0.000E+00	0.000E+00	0.000E+00	3.880E-88	0.000E+00	3.180E-93
CE-141	1.180E+04	7.870E+03	0.000E+00	3.710E+03	0.000E+00	2.250E+07	0.000E+00	9.040E+02
CE-143	1.690E-02	1.230E+01	0.000E+00	5.510E-03	0.000E+00	3.690E+02	0.000E+00	1.370E-03
CE-144	1.230E+06	5.080E+05	0.000E+00	3.040E+05	0.000E+00	3.090E+08	0.000E+00	6.600E+04
PR-143	1.760E+04	7.040E+03	0.000E+00	4.090E+03	0.000E+00	5.800E+07	0.000E+00	8.780E+02
PR-144	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND-147	6.230E+03	6.770E+03	0.000E+00	3.980E+03	0.000E+00	2.440E+07	0.000E+00	4.060E+02
W-187	1.730E-02	1.410E-02	0.000E+00	0.000E+00	0.000E+00	3.820E+00	0.000E+00	4.940E-03
NP-239	2.260E-01	2.140E-02	0.000E+00	6.700E-02	0.000E+00	3.440E+03	0.000E+00	1.190E-02

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Age group:	TEEN	Pathway:	Grs/Goat/Meat (GMEAT)			Units:	m ² ·mrem/yr / μ Ci/sec; mrem/yr / μ Ci/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
H-3	0.000E+00	2.328E+01	2.328E+01	2.328E+01	2.328E+01	2.328E+01	0.000E+00	2.328E+01
C-14	2.088E+03	4.188E+02	4.188E+02	4.188E+02	4.188E+02	4.188E+02	0.000E+00	4.188E+02
NA-24	1.296E-04	1.296E-04	1.296E-04	1.296E-04	1.296E-04	1.296E-04	0.000E+00	1.296E-04
P-32	4.716E+08	2.928E+07	0.000E+00	0.000E+00	0.000E+00	3.972E+07	0.000E+00	1.836E+07
CR-51	0.000E+00	0.000E+00	3.756E+02	1.488E+02	9.660E+02	1.136E+05	0.000E+00	6.768E+02
MN-54	0.000E+00	8.400E+05	0.000E+00	2.508E+05	0.000E+00	1.728E+06	0.000E+00	1.668E+05
MN-56	0.000E+00	1.284E-54	0.000E+00	1.632E-54	0.000E+00	8.484E-53	0.000E+00	2.292E-55
FE-55	2.856E+07	2.028E+07	0.000E+00	0.000E+00	1.284E+07	8.772E+06	0.000E+00	4.728E+06
FE-59	2.544E+07	5.940E+07	0.000E+00	0.000E+00	1.872E+07	1.404E+08	0.000E+00	2.292E+07
CO-58	0.000E+00	1.692E+06	0.000E+00	0.000E+00	0.000E+00	2.328E+07	0.000E+00	3.888E+06
CO-60	0.000E+00	6.996E+06	0.000E+00	0.000E+00	0.000E+00	9.120E+07	0.000E+00	1.572E+07
NI-63	1.824E+09	1.284E+08	0.000E+00	0.000E+00	0.000E+00	2.052E+07	0.000E+00	6.180E+07
NI-65	2.256E-53	2.892E-54	0.000E+00	0.000E+00	0.000E+00	1.560E-52	0.000E+00	1.320E-54
CU-64	0.000E+00	2.652E-08	0.000E+00	6.720E-08	0.000E+00	2.064E-06	0.000E+00	1.248E-08
ZN-65	3.000E+07	1.043E+08	0.000E+00	6.672E+07	0.000E+00	4.416E+07	0.000E+00	4.860E+07
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.084E-58
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	4.884E+07	0.000E+00	0.000E+00	0.000E+00	7.224E+06	0.000E+00	2.292E+07
RB-88	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-89	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-89	3.060E+07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.636E+06	0.000E+00	8.748E+05
SR-90	9.660E+08	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.712E+07	0.000E+00	2.388E+08
SR-91	1.536E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.960E-11	0.000E+00	6.108E-13

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Age group:	TEEN	Pathway:	Grs/Goat/Meat (GMEAT)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-92	1.186E-50	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.024E-49	0.000E+00	5.052E-52
Y-90	1.087E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.964E+04	0.000E+00	2.928E-01
Y-91	1.145E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.692E+07	0.000E+00	3.072E+03
Y-91M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y-92	1.536E-40	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.224E-36	0.000E+00	4.452E-42
Y-93	4.752E-13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.452E-08	0.000E+00	1.308E-14
ZR-95	1.800E+05	5.676E+04	0.000E+00	8.340E+04	0.000E+00	1.308E+08	0.000E+00	3.900E+04
ZR-97	2.064E-06	4.092E-07	0.000E+00	6.204E-07	0.000E+00	1.108E-01	0.000E+00	1.884E-07
NB-95	2.148E+05	1.194E+05	0.000E+00	1.158E+05	0.000E+00	5.112E+08	0.000E+00	6.576E+04
MO-99	0.000E+00	9.924E+03	0.000E+00	2.268E+04	0.000E+00	1.776E+04	0.000E+00	1.896E+03
TC-99M	4.236E-22	1.182E-21	0.000E+00	1.764E-20	6.564E-22	7.764E-19	0.000E+00	1.536E-20
TC-101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-103	1.028E+07	0.000E+00	0.000E+00	3.624E+07	0.000E+00	8.592E+08	0.000E+00	4.392E+06
RU-105	5.796E-29	0.000E+00	0.000E+00	7.308E-28	0.000E+00	4.680E-26	0.000E+00	2.256E-29
RU-106	2.832E+08	0.000E+00	0.000E+00	5.460E+08	0.000E+00	1.356E+10	0.000E+00	3.564E+07
AG-110M	6.072E+05	5.748E+05	0.000E+00	1.096E+06	0.000E+00	1.608E+08	0.000E+00	3.492E+05
TE-125M	3.636E+07	1.308E+07	1.016E+07	0.000E+00	0.000E+00	1.073E+08	0.000E+00	4.860E+06
TE-127	2.160E-11	7.656E-12	1.488E-11	8.748E-11	0.000E+00	1.668E-09	0.000E+00	4.644E-12
TE-127M	1.129E+08	4.008E+07	2.688E+07	4.584E+08	0.000E+00	2.820E+08	0.000E+00	1.344E+07
TE-129	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-129M	1.140E+08	4.236E+07	3.684E+07	4.764E+08	0.000E+00	4.284E+08	0.000E+00	1.800E+07
TE-131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-131M	4.512E+01	2.160E+01	3.252E+01	2.256E+02	0.000E+00	1.740E+03	0.000E+00	1.800E+01
TE-132	1.392E+05	8.832E+04	9.300E+04	8.472E+05	0.000E+00	2.796E+06	0.000E+00	8.304E+04
I-130	2.040E-07	5.892E-07	4.800E-05	9.072E-07	0.000E+00	4.524E-07	0.000E+00	2.352E-07

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Age group:	TEEN	Pathway:	Grs/Goat/Meat (GMEAT)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
I-131	1.070E+06	1.500E+06	4.380E+08	2.580E+06	0.000E+00	2.964E+05	0.000E+00	8.052E+05
I-132	6.792E-60	1.776E-59	5.988E-58	2.796E-59	0.000E+00	7.740E-60	0.000E+00	6.384E-60
I-133	3.660E-02	6.216E-02	8.676E+00	1.091E-01	0.000E+00	4.704E-02	0.000E+00	1.896E-02
I-134	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-135	4.320E-18	1.111E-17	7.152E-16	1.752E-17	0.000E+00	1.236E-17	0.000E+00	4.116E-18
CS-134	6.276E+07	1.476E+08	0.000E+00	4.692E+07	1.788E+07	1.836E+06	0.000E+00	6.852E+07
CS-136	1.128E+06	4.440E+06	0.000E+00	2.412E+06	3.804E+05	3.576E+05	0.000E+00	2.976E+06
CS-137	8.688E+07	1.156E+08	0.000E+00	3.936E+07	1.524E+07	1.644E+06	0.000E+00	4.032E+07
CS-138	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-139	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-140	2.856E+06	3.492E+03	0.000E+00	1.184E+03	2.352E+03	4.392E+06	0.000E+00	1.836E+05
BA-141	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA-140	3.660E-03	1.800E-03	0.000E+00	0.000E+00	0.000E+00	1.033E+02	0.000E+00	4.788E-04
LA-142	3.444E-93	1.536E-93	0.000E+00	0.000E+00	0.000E+00	4.656E-89	0.000E+00	3.816E-94
CE-141	1.416E+03	9.444E+02	0.000E+00	4.452E+02	0.000E+00	2.700E+06	0.000E+00	1.085E+02
CE-143	2.028E-03	1.476E+00	0.000E+00	6.612E-04	0.000E+00	4.428E+01	0.000E+00	1.644E-04
CE-144	1.476E+05	6.096E+04	0.000E+00	3.648E+04	0.000E+00	3.708E+07	0.000E+00	7.920E+03
PR-143	2.112E+03	8.448E+02	0.000E+00	4.908E+02	0.000E+00	6.960E+06	0.000E+00	1.054E+02
PR-144	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND-147	7.476E+02	8.124E+02	0.000E+00	4.776E+02	0.000E+00	2.928E+06	0.000E+00	4.872E+01
W-187	2.076E-03	1.692E-03	0.000E+00	0.000E+00	0.000E+00	4.584E-01	0.000E+00	5.928E-04
NP-239	2.712E-02	2.568E-03	0.000E+00	8.040E-03	0.000E+00	4.128E+02	0.000E+00	1.428E-03

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Vegetation (VEG)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
H-3	0.000E+00	2.590E+03	2.590E+03	2.590E+03	2.590E+03	2.590E+03	0.000E+00	2.590E+03
C-14	9.010E+04	1.800E+04	1.800E+04	1.800E+04	1.800E+04	1.800E+04	0.000E+00	1.800E+04
NA-24	2.390E+05	2.390E+05	2.390E+05	2.390E+05	2.390E+05	2.390E+05	0.000E+00	2.390E+05
P-32	1.610E+09	9.970E+07	0.000E+00	0.000E+00	0.000E+00	1.350E+08	0.000E+00	6.240E+07
CR-51	0.000E+00	0.000E+00	3.430E+04	1.350E+04	8.810E+04	1.040E+07	0.000E+00	6.170E+04
MN-54	0.000E+00	4.540E+08	0.000E+00	1.360E+08	0.000E+00	9.320E+08	0.000E+00	9.010E+07
MN-56	0.000E+00	1.420E+01	0.000E+00	1.800E+01	0.000E+00	9.360E+02	0.000E+00	2.530E+00
FE-55	3.260E+08	2.310E+08	0.000E+00	0.000E+00	1.470E+08	1.000E+08	0.000E+00	5.390E+07
FE-59	1.790E+08	4.190E+08	0.000E+00	0.000E+00	1.320E+08	9.900E+08	0.000E+00	1.620E+08
CO-58	0.000E+00	4.360E+07	0.000E+00	0.000E+00	0.000E+00	6.010E+08	0.000E+00	1.000E+08
CO-60	0.000E+00	2.490E+08	0.000E+00	0.000E+00	0.000E+00	3.240E+09	0.000E+00	5.600E+08
NI-63	1.610E+10	1.130E+09	0.000E+00	0.000E+00	0.000E+00	1.810E+08	0.000E+00	5.450E+08
NI-65	5.720E+01	7.310E+00	0.000E+00	0.000E+00	0.000E+00	3.970E+02	0.000E+00	3.330E+00
CU-64	0.000E+00	8.340E+03	0.000E+00	2.110E+04	0.000E+00	6.470E+05	0.000E+00	3.920E+03
ZN-65	4.240E+08	1.470E+09	0.000E+00	9.420E+08	0.000E+00	6.230E+08	0.000E+00	6.870E+08
ZN-69	5.140E-06	9.800E-06	0.000E+00	6.400E-06	0.000E+00	1.810E-05	0.000E+00	6.860E-07
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.910E+00
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.250E-11
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	2.740E+08	0.000E+00	0.000E+00	0.000E+00	4.050E+07	0.000E+00	1.290E+08
RB-88	0.000E+00	3.170E-22	0.000E+00	0.000E+00	0.000E+00	2.720E-29	0.000E+00	1.690E-22
RB-89	0.000E+00	3.500E-26	0.000E+00	0.000E+00	0.000E+00	5.360E-35	0.000E+00	2.470E-26
SR-89	1.510E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.800E+09	0.000E+00	4.340E+08
SR-90	7.510E+11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.110E+10	0.000E+00	1.850E+11
SR-91	2.850E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.290E+06	0.000E+00	1.130E+04

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Vegetation (VEG)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-92	3.970E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.010E+04	0.000E+00	1.690E+01
Y-90	1.240E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.020E+08	0.000E+00	3.350E+02
Y-91	7.840E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.210E+09	0.000E+00	2.100E+05
Y-91M	4.860E-09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.290E-07	0.000E+00	1.860E-10
Y-92	8.600E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.360E+04	0.000E+00	2.490E-02
Y-93	1.590E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.860E+06	0.000E+00	4.360E+00
ZR-95	1.720E+06	5.430E+05	0.000E+00	7.980E+05	0.000E+00	1.250E+09	0.000E+00	3.730E+05
ZR-97	3.120E+02	6.180E+01	0.000E+00	9.370E+01	0.000E+00	1.670E+07	0.000E+00	2.850E+01
NB-95	1.920E+05	1.070E+05	0.000E+00	1.030E+05	0.000E+00	4.560E+08	0.000E+00	5.870E+04
MO-99	0.000E+00	5.650E+06	0.000E+00	1.290E+07	0.000E+00	1.010E+07	0.000E+00	1.080E+06
TC-99M	2.740E+00	7.630E+00	0.000E+00	1.140E+02	4.240E+00	5.010E+03	0.000E+00	9.890E+01
TC-101	7.640E-31	1.090E-30	0.000E+00	1.970E-29	6.620E-31	1.860E-37	0.000E+00	1.070E-29
RU-103	6.820E+06	0.000E+00	0.000E+00	2.400E+07	0.000E+00	5.700E+08	0.000E+00	2.920E+06
RU-105	5.000E+01	0.000E+00	0.000E+00	6.310E+02	0.000E+00	4.040E+04	0.000E+00	1.940E+01
RU-106	3.100E+08	0.000E+00	0.000E+00	5.970E+08	0.000E+00	1.480E+10	0.000E+00	3.900E+07
AG-110M	1.520E+07	1.430E+07	0.000E+00	2.740E+07	0.000E+00	4.030E+09	0.000E+00	8.720E+06
TE-125M	1.480E+08	5.340E+07	4.140E+07	0.000E+00	0.000E+00	4.370E+08	0.000E+00	1.980E+07
TE-127	5.330E+03	1.890E+03	3.680E+03	2.160E+04	0.000E+00	4.120E+05	0.000E+00	1.150E+03
TE-127M	5.510E+08	1.960E+08	1.310E+08	2.240E+09	0.000E+00	1.370E+09	0.000E+00	6.560E+07
TE-129	7.140E-04	2.660E-04	5.100E-04	3.000E-03	0.000E+00	3.910E-03	0.000E+00	1.740E-04
TE-129M	3.620E+08	1.340E+08	1.170E+08	1.510E+09	0.000E+00	1.360E+09	0.000E+00	5.730E+07
TE-131	1.390E-15	5.750E-16	1.070E-15	6.100E-15	0.000E+00	1.140E-16	0.000E+00	4.360E-16
TE-131M	8.440E+05	4.050E+05	6.090E+05	4.220E+06	0.000E+00	3.250E+07	0.000E+00	3.380E+05
TE-132	3.910E+06	2.470E+06	2.610E+06	2.370E+07	0.000E+00	7.840E+07	0.000E+00	2.330E+06
I-130	3.510E+05	1.010E+06	8.280E+07	1.560E+06	0.000E+00	7.800E+05	0.000E+00	4.050E+05

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Vegetation (VEG)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
I-131	7.690E+07	1.080E+08	3.140E+10	1.850E+08	0.000E+00	2.130E+07	0.000E+00	5.780E+07
I-132	5.190E+01	1.360E+02	4.580E+03	2.140E+02	0.000E+00	5.920E+01	0.000E+00	4.880E+01
I-133	1.940E+06	3.290E+06	4.590E+08	5.760E+06	0.000E+00	2.490E+06	0.000E+00	1.000E+06
I-134	8.720E-05	2.310E-04	3.850E-03	3.640E-04	0.000E+00	3.050E-06	0.000E+00	8.310E-05
I-135	3.520E+04	9.070E+04	5.830E+06	1.430E+05	0.000E+00	1.000E+05	0.000E+00	3.360E+04
CS-134	7.100E+09	1.670E+10	0.000E+00	5.310E+09	2.030E+09	2.080E+08	0.000E+00	7.750E+09
CS-136	4.370E+07	1.720E+08	0.000E+00	9.370E+07	1.480E+07	1.380E+07	0.000E+00	1.160E+08
CS-137	1.010E+10	1.350E+10	0.000E+00	4.590E+09	1.780E+09	1.920E+08	0.000E+00	4.690E+09
CS-138	3.610E-11	6.940E-11	0.000E+00	5.120E-11	5.960E-12	3.150E-14	0.000E+00	3.470E-11
BA-139	2.690E-02	1.890E-05	0.000E+00	1.780E-05	1.300E-05	2.400E-01	0.000E+00	7.830E-04
BA-140	1.380E+08	1.690E+05	0.000E+00	5.740E+04	1.140E+05	2.130E+08	0.000E+00	8.900E+06
BA-141	1.080E-21	8.040E-25	0.000E+00	7.460E-25	5.500E-25	2.290E-27	0.000E+00	3.590E-23
BA-142	5.490E-39	5.490E-42	0.000E+00	4.640E-42	3.650E-42	1.680E-50	0.000E+00	3.380E-40
LA-140	1.810E+03	8.880E+02	0.000E+00	0.000E+00	0.000E+00	5.100E+07	0.000E+00	2.360E+02
LA-142	1.850E-04	8.240E-05	0.000E+00	0.000E+00	0.000E+00	2.510E+00	0.000E+00	2.050E-05
CE-141	2.830E+05	1.890E+05	0.000E+00	8.890E+04	0.000E+00	5.400E+08	0.000E+00	2.170E+04
CE-143	9.330E+02	6.790E+05	0.000E+00	3.040E+02	0.000E+00	2.040E+07	0.000E+00	7.580E+01
CE-144	5.270E+07	2.180E+07	0.000E+00	1.300E+07	0.000E+00	1.330E+10	0.000E+00	2.830E+06
PR-143	7.000E+04	2.800E+04	0.000E+00	1.630E+04	0.000E+00	2.300E+08	0.000E+00	3.490E+03
PR-144	2.900E-26	1.190E-26	0.000E+00	6.800E-27	0.000E+00	3.190E-29	0.000E+00	1.470E-27
ND-147	3.620E+04	3.940E+04	0.000E+00	2.310E+04	0.000E+00	1.420E+08	0.000E+00	2.360E+03
W-187	3.540E+04	2.880E+04	0.000E+00	0.000E+00	0.000E+00	7.800E+06	0.000E+00	1.010E+04
NP-239	1.390E+03	1.310E+02	0.000E+00	4.100E+02	0.000E+00	2.100E+07	0.000E+00	7.260E+01

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Inhalation (INHL)			Units:	mrem/yr / $\mu\text{Ci}/\text{m}^3$	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
H-3	0.000E+00	1.270E+03	1.270E+03	1.270E+03	1.270E+03	1.270E+03	0.000E+00	1.270E+03
C-14	2.600E+04	4.870E+03	4.870E+03	4.870E+03	4.870E+03	4.870E+03	0.000E+00	4.870E+03
NA-24	1.380E+04	1.380E+04	1.380E+04	1.380E+04	1.380E+04	1.380E+04	0.000E+00	1.380E+04
P-32	1.890E+06	1.100E+05	0.000E+00	0.000E+00	0.000E+00	9.280E+04	0.000E+00	7.160E+04
CR-51	0.000E+00	0.000E+00	7.500E+01	3.070E+01	2.100E+04	3.000E+03	0.000E+00	1.350E+02
MN-54	0.000E+00	5.110E+04	0.000E+00	1.270E+04	1.980E+06	6.680E+04	0.000E+00	8.400E+03
MN-56	0.000E+00	1.700E+00	0.000E+00	1.790E+00	1.520E+04	5.740E+04	0.000E+00	2.520E-01
FE-55	3.340E+04	2.380E+04	0.000E+00	0.000E+00	1.240E+05	6.390E+03	0.000E+00	5.540E+03
FE-59	1.590E+04	3.700E+04	0.000E+00	0.000E+00	1.530E+06	1.780E+05	0.000E+00	1.430E+04
CO-58	0.000E+00	2.070E+03	0.000E+00	0.000E+00	1.340E+06	9.520E+04	0.000E+00	2.780E+03
CO-60	0.000E+00	1.510E+04	0.000E+00	0.000E+00	8.720E+06	2.590E+05	0.000E+00	1.980E+04
NI-63	5.800E+05	4.340E+04	0.000E+00	0.000E+00	3.070E+05	1.420E+04	0.000E+00	1.980E+04
NI-65	2.180E+00	2.930E-01	0.000E+00	0.000E+00	9.360E+03	3.670E+04	0.000E+00	1.270E-01
CU-64	0.000E+00	2.030E+00	0.000E+00	6.410E+00	1.110E+04	6.140E+04	0.000E+00	8.480E-01
ZN-65	3.860E+04	1.340E+05	0.000E+00	8.640E+04	1.240E+06	4.660E+04	0.000E+00	6.240E+04
ZN-69	4.830E-02	9.200E-02	0.000E+00	6.020E-02	1.580E+03	2.850E+02	0.000E+00	6.460E-03
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.440E+02
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.330E+02
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.830E+01
RB-86	0.000E+00	1.900E+05	0.000E+00	0.000E+00	0.000E+00	1.770E+04	0.000E+00	8.400E+04
RB-88	0.000E+00	5.460E+02	0.000E+00	0.000E+00	0.000E+00	2.920E-05	0.000E+00	2.720E+02
RB-89	0.000E+00	3.520E+02	0.000E+00	0.000E+00	0.000E+00	3.380E-07	0.000E+00	2.330E+02
SR-89	4.340E+05	0.000E+00	0.000E+00	0.000E+00	2.420E+06	3.710E+05	0.000E+00	1.250E+04
SR-90	1.080E+08	0.000E+00	0.000E+00	0.000E+00	1.650E+07	7.650E+05	0.000E+00	6.680E+06
SR-91	8.800E+01	0.000E+00	0.000E+00	0.000E+00	6.070E+04	2.590E+05	0.000E+00	3.510E+00

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Inhalation (INHL)			Units:	mrem/yr / $\mu\text{Ci}/\text{m}^3$	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-92	9.520E+00	0.000E+00	0.000E+00	0.000E+00	2.740E+04	1.190E+05	0.000E+00	4.060E-01
Y-90	2.980E+03	0.000E+00	0.000E+00	0.000E+00	2.930E+05	5.590E+05	0.000E+00	8.000E+01
Y-91	6.610E+05	0.000E+00	0.000E+00	0.000E+00	2.940E+06	4.090E+05	0.000E+00	1.770E+04
Y-91M	3.700E-01	0.000E+00	0.000E+00	0.000E+00	3.200E+03	3.020E+01	0.000E+00	1.420E-02
Y-92	1.470E+01	0.000E+00	0.000E+00	0.000E+00	2.680E+04	1.650E+05	0.000E+00	4.290E-01
Y-93	1.350E+02	0.000E+00	0.000E+00	0.000E+00	8.320E+04	5.790E+05	0.000E+00	3.720E+00
ZR-95	1.460E+05	4.580E+04	0.000E+00	6.740E+04	2.690E+06	1.490E+05	0.000E+00	3.150E+04
ZR-97	1.380E+02	2.720E+01	0.000E+00	4.120E+01	1.300E+05	6.300E+05	0.000E+00	1.260E+01
NB-95	1.860E+04	1.030E+04	0.000E+00	1.000E+04	7.510E+05	9.680E+04	0.000E+00	5.660E+03
MO-99	0.000E+00	1.690E+02	0.000E+00	4.110E+02	1.540E+05	2.690E+05	0.000E+00	3.220E+01
TC-99M	1.380E-03	3.860E-03	0.000E+00	5.760E-02	1.150E+03	6.130E+03	0.000E+00	4.990E-02
TC-101	5.920E-05	8.400E-05	0.000E+00	1.520E-03	6.670E+02	8.720E-07	0.000E+00	8.240E-04
RU-103	2.100E+03	0.000E+00	0.000E+00	7.430E+03	7.830E+05	1.090E+05	0.000E+00	8.960E+02
RU-105	1.120E+00	0.000E+00	0.000E+00	1.410E+00	1.820E+04	9.040E+04	0.000E+00	4.340E-01
RU-106	9.840E+04	0.000E+00	0.000E+00	1.900E+05	1.610E+07	9.600E+05	0.000E+00	1.240E+04
AG-110M	1.380E+04	1.310E+04	0.000E+00	2.500E+04	6.750E+06	2.730E+05	0.000E+00	7.990E+03
TE-125M	4.880E+03	2.240E+03	1.400E+03	0.000E+00	5.360E+05	7.500E+04	0.000E+00	6.670E+02
TE-127	2.010E+00	9.120E-01	1.420E+00	7.280E+00	1.120E+04	8.080E+04	0.000E+00	4.420E-01
TE-127M	1.800E+04	8.160E+03	4.380E+03	6.540E+04	1.660E+06	1.590E+05	0.000E+00	2.180E+03
TE-129	7.100E-02	3.380E-02	5.180E-02	2.660E-01	3.300E+03	1.620E+03	0.000E+00	1.760E-02
TE-129M	1.390E+04	6.580E+03	4.580E+03	5.190E+04	1.980E+06	4.050E+05	0.000E+00	2.250E+03
TE-131	1.580E-02	8.320E-03	1.240E-02	6.180E-02	2.340E+03	1.510E+01	0.000E+00	5.040E-03
TE-131M	9.840E+01	6.010E+01	7.250E+01	4.390E+02	2.380E+05	6.210E+05	0.000E+00	4.020E+01
TE-132	3.600E+02	2.900E+02	2.460E+02	1.950E+03	4.490E+05	4.630E+05	0.000E+00	2.190E+02
I-130	6.240E+03	1.790E+04	1.490E+06	2.750E+04	0.000E+00	9.120E+03	0.000E+00	7.170E+03

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Inhalation (INHL)			Units:	mrem/yr / $\mu\text{Ci}/\text{m}^3$	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
I-131	3.540E+04	4.910E+04	1.460E+07	8.400E+04	0.000E+00	6.490E+03	0.000E+00	2.640E+04
I-132	1.590E+03	4.380E+03	1.510E+05	6.920E+03	0.000E+00	1.270E+03	0.000E+00	1.580E+03
I-133	1.220E+04	2.050E+04	2.920E+06	3.590E+04	0.000E+00	1.030E+04	0.000E+00	6.220E+03
I-134	8.880E+02	2.320E+03	3.950E+04	3.660E+03	0.000E+00	2.040E+01	0.000E+00	8.400E+02
I-135	3.700E+03	9.440E+03	6.210E+05	1.490E+04	0.000E+00	6.950E+03	0.000E+00	3.490E+03
CS-134	5.020E+05	1.130E+06	0.000E+00	3.750E+05	1.460E+05	9.760E+03	0.000E+00	5.490E+05
CS-136	5.150E+04	1.940E+05	0.000E+00	1.100E+05	1.780E+04	1.090E+04	0.000E+00	1.370E+05
CS-137	6.700E+05	8.480E+05	0.000E+00	3.040E+05	1.210E+05	8.480E+03	0.000E+00	3.110E+05
CS-138	4.660E+02	8.560E+02	0.000E+00	6.620E+02	7.870E+01	2.700E-01	0.000E+00	4.460E+02
BA-139	1.340E+00	9.440E-04	0.000E+00	8.880E-04	6.460E+03	6.450E+03	0.000E+00	3.900E-02
BA-140	5.470E+04	6.700E+01	0.000E+00	2.280E+01	2.030E+06	2.290E+05	0.000E+00	3.520E+03
BA-141	1.420E-01	1.060E-04	0.000E+00	9.840E-05	3.290E+03	7.460E-04	0.000E+00	4.740E-03
BA-142	3.700E-02	3.700E-05	0.000E+00	3.140E-05	1.910E+03	4.790E-10	0.000E+00	2.270E-03
LA-140	4.790E+02	2.360E+02	0.000E+00	0.000E+00	2.140E+05	4.870E+05	0.000E+00	6.260E+01
LA-142	9.600E-01	4.250E-01	0.000E+00	0.000E+00	1.020E+04	1.200E+04	0.000E+00	1.060E-01
CE-141	2.840E+04	1.900E+04	0.000E+00	8.880E+03	6.140E+05	1.260E+05	0.000E+00	2.170E+03
CE-143	2.660E+02	1.940E+02	0.000E+00	8.640E+01	1.300E+05	2.550E+05	0.000E+00	2.160E+01
CE-144	4.890E+06	2.020E+06	0.000E+00	1.210E+06	1.340E+07	8.640E+05	0.000E+00	2.620E+05
PR-143	1.340E+04	5.310E+03	0.000E+00	3.090E+03	4.830E+05	2.140E+05	0.000E+00	6.620E+02
PR-144	4.300E-02	1.760E-02	0.000E+00	1.010E-02	1.750E+03	2.350E-04	0.000E+00	2.180E-03
ND-147	7.860E+03	8.560E+03	0.000E+00	5.020E+03	3.720E+05	1.820E+05	0.000E+00	5.130E+02
W-187	1.200E+01	9.760E+00	0.000E+00	0.000E+00	4.740E+04	1.770E+05	0.000E+00	3.430E+00
NP-239	3.380E+02	3.190E+01	0.000E+00	1.000E+02	6.490E+04	1.320E+05	0.000E+00	1.770E+01

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Ground Plane Deposition (GPD)			Units:	m ² ·mrem/yr / μCi/sec	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
H-3	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C-14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NA-24	1.190E+07	1.190E+07	1.190E+07	1.190E+07	1.190E+07	1.190E+07	1.390E+07	1.190E+07
P-32	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CR-51	4.660E+06	4.660E+06	4.660E+06	4.660E+06	4.660E+06	4.660E+06	5.510E+06	4.660E+06
MN-54	1.390E+09	1.390E+09	1.390E+09	1.390E+09	1.390E+09	1.390E+09	1.630E+09	1.390E+09
MN-56	9.020E+05	9.020E+05	9.020E+05	9.020E+05	9.020E+05	9.020E+05	1.070E+06	9.020E+05
FE-55	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
FE-59	2.730E+08	2.730E+08	2.730E+08	2.730E+08	2.730E+08	2.730E+08	3.210E+08	2.730E+08
CO-58	3.790E+08	3.790E+08	3.790E+08	3.790E+08	3.790E+08	3.790E+08	4.440E+08	3.790E+08
CO-60	2.150E+10	2.150E+10	2.150E+10	2.150E+10	2.150E+10	2.150E+10	2.530E+10	2.150E+10
NI-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NI-65	2.970E+05	2.970E+05	2.970E+05	2.970E+05	2.970E+05	2.970E+05	3.450E+05	2.970E+05
CU-64	6.070E+05	6.070E+05	6.070E+05	6.070E+05	6.070E+05	6.070E+05	6.880E+05	6.070E+05
ZN-65	7.470E+08	7.470E+08	7.470E+08	7.470E+08	7.470E+08	7.470E+08	8.590E+08	7.470E+08
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	4.870E+03	4.870E+03	4.870E+03	4.870E+03	4.870E+03	4.870E+03	7.080E+03	4.870E+03
BR-84	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.360E+05	2.030E+05
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	8.990E+06	8.990E+06	8.990E+06	8.990E+06	8.990E+06	8.990E+06	1.030E+07	8.990E+06
RB-88	3.310E+04	3.310E+04	3.310E+04	3.310E+04	3.310E+04	3.310E+04	3.780E+04	3.310E+04
RB-89	1.230E+05	1.230E+05	1.230E+05	1.230E+05	1.230E+05	1.230E+05	1.480E+05	1.230E+05
SR-89	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.510E+04	2.160E+04
SR-90	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-91	2.150E+06	2.150E+06	2.150E+06	2.150E+06	2.150E+06	2.150E+06	2.510E+06	2.150E+06

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Ground Plane Deposition (GPD)			Units:	m ² ·mrem/yr / μCi/sec	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-92	7.770E+05	7.770E+05	7.770E+05	7.770E+05	7.770E+05	7.770E+05	8.630E+05	7.770E+05
Y-90	4.490E+03	4.490E+03	4.490E+03	4.490E+03	4.490E+03	4.490E+03	5.310E+03	4.490E+03
Y-91	1.070E+06	1.070E+06	1.070E+06	1.070E+06	1.070E+06	1.070E+06	1.210E+06	1.070E+06
Y-91M	1.000E+05	1.000E+05	1.000E+05	1.000E+05	1.000E+05	1.000E+05	1.160E+05	1.000E+05
Y-92	1.800E+05	1.800E+05	1.800E+05	1.800E+05	1.800E+05	1.800E+05	2.140E+05	1.800E+05
Y-93	1.830E+05	1.830E+05	1.830E+05	1.830E+05	1.830E+05	1.830E+05	2.510E+05	1.830E+05
ZR-95	2.450E+08	2.450E+08	2.450E+08	2.450E+08	2.450E+08	2.450E+08	2.840E+08	2.450E+08
ZR-97	2.960E+06	2.960E+06	2.960E+06	2.960E+06	2.960E+06	2.960E+06	3.440E+06	2.960E+06
NB-95	1.370E+08	1.370E+08	1.370E+08	1.370E+08	1.370E+08	1.370E+08	1.610E+08	1.370E+08
MO-99	3.990E+06	3.990E+06	3.990E+06	3.990E+06	3.990E+06	3.990E+06	4.630E+06	3.990E+06
TC-99M	1.840E+05	1.840E+05	1.840E+05	1.840E+05	1.840E+05	1.840E+05	2.110E+05	1.840E+05
TC-101	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.260E+04	2.040E+04
RU-103	1.080E+08	1.080E+08	1.080E+08	1.080E+08	1.080E+08	1.080E+08	1.260E+08	1.080E+08
RU-105	6.360E+05	6.360E+05	6.360E+05	6.360E+05	6.360E+05	6.360E+05	7.210E+05	6.360E+05
RU-106	4.220E+08	4.220E+08	4.220E+08	4.220E+08	4.220E+08	4.220E+08	5.070E+08	4.220E+08
AG-110M	3.440E+09	3.440E+09	3.440E+09	3.440E+09	3.440E+09	3.440E+09	4.010E+09	3.440E+09
TE-125M	1.550E+06	1.550E+06	1.550E+06	1.550E+06	1.550E+06	1.550E+06	2.130E+06	1.550E+06
TE-127	2.980E+03	2.980E+03	2.980E+03	2.980E+03	2.980E+03	2.980E+03	3.280E+03	2.980E+03
TE-127M	9.160E+04	9.160E+04	9.160E+04	9.160E+04	9.160E+04	9.160E+04	1.080E+05	9.160E+04
TE-129	2.620E+04	2.620E+04	2.620E+04	2.620E+04	2.620E+04	2.620E+04	3.100E+04	2.620E+04
TE-129M	1.980E+07	1.980E+07	1.980E+07	1.980E+07	1.980E+07	1.980E+07	2.310E+07	1.980E+07
TE-131	2.920E+04	2.920E+04	2.920E+04	2.920E+04	2.920E+04	2.920E+04	3.450E+07	2.920E+04
TE-131M	8.030E+06	8.030E+06	8.030E+06	8.030E+06	8.030E+06	8.030E+06	9.460E+06	8.030E+06
TE-132	4.230E+06	4.230E+06	4.230E+06	4.230E+06	4.230E+06	4.230E+06	4.980E+06	4.230E+06
I-130	5.510E+06	5.510E+06	5.510E+06	5.510E+06	5.510E+06	5.510E+06	6.690E+06	5.510E+06

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Ground Plane Deposition (GPD)			Units:	m ² ·mrem/yr / μCi/sec	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
I-131	1.720E+07	1.720E+07	1.720E+07	1.720E+07	1.720E+07	1.720E+07	2.090E+07	1.720E+07
I-132	1.250E+06	1.250E+06	1.250E+06	1.250E+06	1.250E+06	1.250E+06	1.470E+06	1.250E+06
I-133	2.450E+06	2.450E+06	2.450E+06	2.450E+06	2.450E+06	2.450E+06	2.980E+06	2.450E+06
I-134	4.470E+05	4.470E+05	4.470E+05	4.470E+05	4.470E+05	4.470E+05	5.300E+05	4.470E+05
I-135	2.530E+06	2.530E+06	2.530E+06	2.530E+06	2.530E+06	2.530E+06	2.950E+06	2.530E+06
CS-134	6.860E+09	6.860E+09	6.860E+09	6.860E+09	6.860E+09	6.860E+09	8.000E+09	6.860E+09
CS-136	1.510E+08	1.510E+08	1.510E+08	1.510E+08	1.510E+08	1.510E+08	1.710E+08	1.510E+08
CS-137	1.030E+10	1.030E+10	1.030E+10	1.030E+10	1.030E+10	1.030E+10	1.200E+10	1.030E+10
CS-138	3.590E+05	3.590E+05	3.590E+05	3.590E+05	3.590E+05	3.590E+05	4.100E+05	3.590E+05
BA-139	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.190E+05	1.060E+05
BA-140	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.350E+07	2.050E+07
BA-141	4.170E+04	4.170E+04	4.170E+04	4.170E+04	4.170E+04	4.170E+04	4.750E+04	4.170E+04
BA-142	4.490E+04	4.490E+04	4.490E+04	4.490E+04	4.490E+04	4.490E+04	5.110E+04	4.490E+04
LA-140	1.920E+07	1.920E+07	1.920E+07	1.920E+07	1.920E+07	1.920E+07	2.180E+07	1.920E+07
LA-142	7.600E+05	7.600E+05	7.600E+05	7.600E+05	7.600E+05	7.600E+05	9.120E+05	7.600E+05
CE-141	1.370E+07	1.370E+07	1.370E+07	1.370E+07	1.370E+07	1.370E+07	1.540E+07	1.370E+07
CE-143	2.310E+06	2.310E+06	2.310E+06	2.310E+06	2.310E+06	2.310E+06	2.630E+06	2.310E+06
CE-144	6.950E+07	6.950E+07	6.950E+07	6.950E+07	6.950E+07	6.950E+07	8.040E+07	6.950E+07
PR-143	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR-144	1.830E+03	1.830E+03	1.830E+03	1.830E+03	1.830E+03	1.830E+03	2.110E+03	1.830E+03
ND-147	8.390E+06	8.390E+06	8.390E+06	8.390E+06	8.390E+06	8.390E+06	1.010E+07	8.390E+06
W-187	2.350E+06	2.350E+06	2.350E+06	2.350E+06	2.350E+06	2.350E+06	2.730E+06	2.350E+06
NP-239	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.980E+06	1.710E+06

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Grs/Cow/Milk (CMILK)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
H-3	0.000E+00	1.570E+03	1.570E+03	1.570E+03	1.570E+03	1.570E+03	0.000E+00	1.570E+03
C-14	1.020E+05	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.040E+04	0.000E+00	2.040E+04
NA-24	8.850E+06	8.850E+06	8.850E+06	8.850E+06	8.850E+06	8.850E+06	0.000E+00	8.850E+06
P-32	7.780E+10	3.640E+09	0.000E+00	0.000E+00	0.000E+00	2.150E+09	0.000E+00	3.000E+09
CR-51	0.000E+00	0.000E+00	5.650E+04	1.540E+04	1.030E+05	5.400E+06	0.000E+00	1.020E+05
MN-54	0.000E+00	2.100E+07	0.000E+00	5.880E+06	0.000E+00	1.760E+07	0.000E+00	5.590E+06
MN-56	0.000E+00	1.260E-02	0.000E+00	1.530E-02	0.000E+00	1.830E+00	0.000E+00	2.860E-03
FE-55	1.120E+08	5.930E+07	0.000E+00	0.000E+00	3.350E+07	1.100E+07	0.000E+00	1.840E+07
FE-59	1.200E+08	1.950E+08	0.000E+00	0.000E+00	5.640E+07	2.030E+08	0.000E+00	9.690E+07
CO-58	0.000E+00	1.210E+07	0.000E+00	0.000E+00	0.000E+00	7.070E+07	0.000E+00	3.710E+07
CO-60	0.000E+00	4.320E+07	0.000E+00	0.000E+00	0.000E+00	2.390E+08	0.000E+00	1.270E+08
NI-63	2.960E+10	1.590E+09	0.000E+00	0.000E+00	0.000E+00	1.070E+08	0.000E+00	1.010E+09
NI-65	1.660E+00	1.560E-01	0.000E+00	0.000E+00	0.000E+00	1.910E+01	0.000E+00	9.100E-02
CU-64	0.000E+00	7.460E+04	0.000E+00	1.800E+05	0.000E+00	3.500E+06	0.000E+00	4.510E+04
ZN-65	4.130E+09	1.100E+10	0.000E+00	6.940E+09	0.000E+00	1.930E+09	0.000E+00	6.850E+09
ZN-69	9.460E-12	1.370E-11	0.000E+00	8.300E-12	0.000E+00	8.620E-10	0.000E+00	1.260E-12
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.400E-01
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.510E-23
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	8.770E+09	0.000E+00	0.000E+00	0.000E+00	5.640E+08	0.000E+00	5.390E+09
RB-88	0.000E+00	7.160E-45	0.000E+00	0.000E+00	0.000E+00	3.510E-46	0.000E+00	4.970E-45
RB-89	0.000E+00	1.340E-52	0.000E+00	0.000E+00	0.000E+00	1.170E-54	0.000E+00	1.190E-52
SR-89	6.620E+09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.560E+08	0.000E+00	1.890E+08
SR-90	1.120E+11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.510E+09	0.000E+00	2.830E+10
SR-91	1.300E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.880E+05	0.000E+00	4.920E+03

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Grs/Cow/Milk (CMILK)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-92	2.180E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.130E+01	0.000E+00	8.750E-02
Y-90	3.220E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.170E+05	0.000E+00	8.620E+00
Y-91	3.900E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.200E+06	0.000E+00	1.040E+03
Y-91M	2.670E-19	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.240E-16	0.000E+00	9.730E-21
Y-92	2.530E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.310E+00	0.000E+00	7.240E-06
Y-93	1.010E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.510E+04	0.000E+00	2.780E-02
ZR-95	3.830E+03	8.420E+02	0.000E+00	1.210E+03	0.000E+00	8.790E+05	0.000E+00	7.500E+02
ZR-97	1.920E+00	2.770E-01	0.000E+00	3.980E-01	0.000E+00	4.200E+04	0.000E+00	1.640E-01
NB-95	3.180E+05	1.240E+05	0.000E+00	1.160E+05	0.000E+00	2.290E+08	0.000E+00	8.840E+04
MO-99	0.000E+00	8.140E+07	0.000E+00	1.740E+08	0.000E+00	6.730E+07	0.000E+00	2.010E+07
TC-99M	1.320E+01	2.590E+01	0.000E+00	3.760E+02	1.320E+01	1.470E+04	0.000E+00	4.290E+02
TC-101	1.160E-59	1.220E-59	0.000E+00	2.080E-58	6.440E-60	3.870E-59	0.000E+00	1.540E-58
RU-103	4.280E+03	0.000E+00	0.000E+00	1.080E+04	0.000E+00	1.110E+05	0.000E+00	1.650E+03
RU-105	3.820E-03	0.000E+00	0.000E+00	3.360E-02	0.000E+00	2.490E+00	0.000E+00	1.390E-03
RU-106	9.240E+04	0.000E+00	0.000E+00	1.250E+05	0.000E+00	1.440E+06	0.000E+00	1.150E+04
AG-110M	2.090E+08	1.410E+08	0.000E+00	2.630E+08	0.000E+00	1.680E+10	0.000E+00	1.130E+08
TE-125M	7.380E+07	2.000E+07	2.070E+07	0.000E+00	0.000E+00	7.120E+07	0.000E+00	9.840E+06
TE-127	2.980E+03	8.020E+02	2.060E+03	8.470E+03	0.000E+00	1.160E+05	0.000E+00	6.380E+02
TE-127M	2.080E+08	5.600E+07	4.970E+07	5.930E+08	0.000E+00	1.680E+08	0.000E+00	2.470E+07
TE-129	1.280E-09	3.580E-10	9.160E-10	3.750E-09	0.000E+00	7.990E-08	0.000E+00	3.050E-10
TE-129M	2.710E+08	7.580E+07	8.750E+07	7.970E+08	0.000E+00	3.310E+08	0.000E+00	4.210E+07
TE-131	1.620E-32	4.920E-33	1.240E-32	4.890E-32	0.000E+00	8.490E-32	0.000E+00	4.810E-33
TE-131M	1.600E+06	5.530E+05	1.140E+06	5.350E+06	0.000E+00	2.240E+07	0.000E+00	5.890E+05
TE-132	1.020E+07	4.530E+06	6.600E+06	4.210E+07	0.000E+00	4.570E+07	0.000E+00	5.480E+06
I-130	1.730E+06	3.490E+06	3.840E+08	5.220E+06	0.000E+00	1.630E+06	0.000E+00	1.800E+06

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Grs/Cow/Milk (CMILK)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
I-131	1.300E+09	1.310E+09	4.330E+11	2.150E+09	0.000E+00	1.170E+08	0.000E+00	7.450E+08
I-132	6.890E-01	1.270E+00	5.870E+01	1.940E+00	0.000E+00	1.490E+00	0.000E+00	5.820E-01
I-133	1.720E+07	2.120E+07	3.940E+09	3.540E+07	0.000E+00	8.560E+06	0.000E+00	8.030E+06
I-134	8.480E-12	1.570E-11	3.620E-10	2.410E-11	0.000E+00	1.040E-11	0.000E+00	7.250E-12
I-135	5.400E+04	9.720E+04	8.610E+06	1.490E+05	0.000E+00	7.400E+04	0.000E+00	4.600E+04
CS-134	2.260E+10	3.720E+10	0.000E+00	1.150E+10	4.130E+09	2.000E+08	0.000E+00	7.840E+09
CS-136	1.010E+09	2.780E+09	0.000E+00	1.480E+09	2.210E+08	9.770E+07	0.000E+00	1.800E+09
CS-137	3.220E+10	3.090E+10	0.000E+00	1.010E+10	3.620E+09	1.930E+08	0.000E+00	4.550E+09
CS-138	3.980E-23	5.530E-23	0.000E+00	3.890E-23	4.190E-24	2.550E-23	0.000E+00	3.510E-23
BA-139	2.010E-07	1.070E-10	0.000E+00	9.360E-11	6.300E-11	1.160E-05	0.000E+00	5.820E-09
BA-140	1.170E+08	1.030E+05	0.000E+00	3.340E+04	6.120E+04	5.930E+07	0.000E+00	6.840E+06
BA-141	1.850E-45	1.040E-48	0.000E+00	8.960E-49	6.090E-48	1.050E-45	0.000E+00	6.020E-47
BA-142	1.150E-79	8.310E-83	0.000E+00	6.720E-83	4.890E-83	1.510E-81	0.000E+00	6.450E-81
LA-140	1.940E+01	6.780E+00	0.000E+00	0.000E+00	0.000E+00	1.890E+05	0.000E+00	2.290E+00
LA-142	8.100E-11	2.580E-11	0.000E+00	0.000E+00	0.000E+00	5.120E-06	0.000E+00	8.090E-12
CE-141	2.190E+04	1.090E+04	0.000E+00	4.780E+03	0.000E+00	1.360E+07	0.000E+00	1.620E+03
CE-143	1.870E+02	1.020E+05	0.000E+00	4.260E+01	0.000E+00	1.490E+06	0.000E+00	1.470E+01
CE-144	1.620E+06	5.090E+05	0.000E+00	2.820E+05	0.000E+00	1.330E+08	0.000E+00	8.660E+04
PR-143	7.180E+02	2.160E+02	0.000E+00	1.170E+02	0.000E+00	7.750E+05	0.000E+00	3.560E+01
PR-144	2.680E-53	8.290E-54	0.000E+00	4.380E-54	0.000E+00	1.780E-50	0.000E+00	1.350E-54
ND-147	4.450E+02	3.600E+02	0.000E+00	1.980E+02	0.000E+00	5.700E+05	0.000E+00	2.790E+01
W-187	2.890E+04	1.710E+04	0.000E+00	0.000E+00	0.000E+00	2.400E+06	0.000E+00	7.670E+03
NP-239	1.720E+01	1.240E+00	0.000E+00	3.580E+00	0.000E+00	9.170E+04	0.000E+00	8.710E-01

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Grs/Goat/Milk (GMILK)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
H-3	0.000E+00	3.200E+03	3.200E+03	3.200E+03	3.200E+03	3.200E+03	0.000E+00	3.200E+03
C-14	1.020E+05	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.040E+04	0.000E+00	2.040E+04
NA-24	1.060E+06	1.060E+06	1.060E+06	1.060E+06	1.060E+06	1.060E+06	0.000E+00	1.060E+06
P-32	9.330E+10	4.370E+09	0.000E+00	0.000E+00	0.000E+00	2.580E+09	0.000E+00	3.600E+09
CR-51	0.000E+00	0.000E+00	6.780E+03	1.850E+03	1.240E+04	6.480E+05	0.000E+00	1.220E+04
MN-54	0.000E+00	2.520E+06	0.000E+00	7.060E+05	0.000E+00	2.110E+06	0.000E+00	6.700E+05
MN-56	0.000E+00	1.520E-03	0.000E+00	1.840E-03	0.000E+00	2.200E-01	0.000E+00	3.430E-04
FE-55	1.450E+06	7.710E+05	0.000E+00	0.000E+00	4.360E+05	1.430E+05	0.000E+00	2.390E+05
FE-59	1.560E+06	2.530E+06	0.000E+00	0.000E+00	7.330E+05	2.630E+06	0.000E+00	1.260E+06
CO-58	0.000E+00	1.450E+06	0.000E+00	0.000E+00	0.000E+00	8.490E+06	0.000E+00	4.450E+06
CO-60	0.000E+00	5.180E+06	0.000E+00	0.000E+00	0.000E+00	2.870E+07	0.000E+00	1.530E+07
NI-63	3.560E+09	1.900E+08	0.000E+00	0.000E+00	0.000E+00	1.280E+07	0.000E+00	1.210E+08
NI-65	1.990E-01	1.870E-02	0.000E+00	0.000E+00	0.000E+00	2.290E+00	0.000E+00	1.090E-02
CU-64	0.000E+00	8.320E+03	0.000E+00	2.010E+04	0.000E+00	3.900E+05	0.000E+00	5.020E+03
ZN-65	4.960E+08	1.320E+09	0.000E+00	8.330E+08	0.000E+00	2.320E+08	0.000E+00	8.220E+08
ZN-69	1.140E-12	1.640E-12	0.000E+00	9.960E-13	0.000E+00	1.030E-10	0.000E+00	1.520E-13
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.280E-02
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.820E-24
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	1.050E+09	0.000E+00	0.000E+00	0.000E+00	6.770E+07	0.000E+00	6.470E+08
RB-88	0.000E+00	8.590E-46	0.000E+00	0.000E+00	0.000E+00	4.210E-47	0.000E+00	5.970E-46
RB-89	0.000E+00	1.610E-53	0.000E+00	0.000E+00	0.000E+00	1.410E-55	0.000E+00	1.430E-53
SR-89	1.390E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.380E+08	0.000E+00	3.970E+08
SR-90	2.350E+11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.160E+09	0.000E+00	5.950E+10
SR-91	2.740E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.040E+05	0.000E+00	1.030E+04

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHIL	Pathway:	Grs/Goat/Milk (GMILK)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-92	4.580E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.680E+01	0.000E+00	1.840E-01
Y-90	3.870E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.100E+05	0.000E+00	1.030E+00
Y-91	4.680E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.240E+05	0.000E+00	1.250E+02
Y-91M	3.210E-20	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.280E-17	0.000E+00	1.170E-21
Y-92	3.040E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.770E-01	0.000E+00	8.690E-07
Y-93	1.210E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.810E+03	0.000E+00	3.330E-03
ZR-95	4.600E+02	1.010E+02	0.000E+00	1.450E+02	0.000E+00	1.050E+05	0.000E+00	9.000E+01
ZR-97	2.300E-01	3.330E-02	0.000E+00	4.780E-02	0.000E+00	5.040E+03	0.000E+00	1.960E-02
NB-95	3.810E+04	1.490E+04	0.000E+00	1.400E+04	0.000E+00	2.750E+07	0.000E+00	1.060E+04
MO-99	0.000E+00	9.760E+06	0.000E+00	2.090E+07	0.000E+00	8.080E+06	0.000E+00	2.420E+06
TC-99M	1.590E+00	3.110E+00	0.000E+00	4.520E+01	1.580E+00	1.770E+03	0.000E+00	5.150E+01
TC-101	1.400E-60	1.460E-60	0.000E+00	2.490E-59	7.720E-61	4.640E-60	0.000E+00	1.850E-59
RU-103	5.140E+02	0.000E+00	0.000E+00	1.290E+03	0.000E+00	1.330E+04	0.000E+00	1.980E+02
RU-105	4.580E-04	0.000E+00	0.000E+00	4.030E-03	0.000E+00	2.990E-01	0.000E+00	1.660E-04
RU-106	1.110E+04	0.000E+00	0.000E+00	1.500E+04	0.000E+00	1.720E+05	0.000E+00	1.380E+03
AG-110M	2.510E+07	1.690E+07	0.000E+00	3.150E+07	0.000E+00	2.010E+09	0.000E+00	1.350E+07
TE-125M	8.850E+06	2.400E+06	2.480E+06	0.000E+00	0.000E+00	8.540E+06	0.000E+00	1.180E+06
TE-127	3.570E+02	9.630E+01	2.470E+02	1.020E+03	0.000E+00	1.390E+04	0.000E+00	7.660E+01
TE-127M	2.500E+07	6.720E+06	5.970E+06	7.120E+07	0.000E+00	2.020E+07	0.000E+00	2.960E+06
TE-129	1.540E-10	4.300E-11	1.100E-10	4.510E-10	0.000E+00	9.590E-09	0.000E+00	3.660E-11
TE-129M	3.260E+07	9.090E+06	1.050E+07	9.560E+07	0.000E+00	3.970E+07	0.000E+00	5.060E+06
TE-131	1.940E-33	5.910E-34	1.480E-33	5.860E-33	0.000E+00	1.020E-32	0.000E+00	5.770E-34
TE-131M	1.920E+05	6.640E+04	1.360E+05	6.420E+05	0.000E+00	2.690E+06	0.000E+00	7.060E+04
TE-132	1.230E+06	5.440E+05	7.920E+05	5.050E+06	0.000E+00	5.480E+06	0.000E+00	6.570E+05
I-130	2.070E+06	4.190E+06	4.610E+08	6.260E+06	0.000E+00	1.960E+06	0.000E+00	2.160E+06

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Grs/Goat/Milk (GMILK)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
I-131	1.560E+09	1.570E+09	5.200E+11	2.580E+09	0.000E+00	1.400E+08	0.000E+00	8.940E+08
I-132	8.270E-01	1.520E+00	7.050E+01	2.330E+00	0.000E+00	1.790E+00	0.000E+00	6.990E-01
I-133	2.060E+07	2.550E+07	4.730E+09	4.250E+07	0.000E+00	1.030E+07	0.000E+00	9.640E+06
I-134	1.020E-11	1.890E-11	4.350E-10	2.890E-11	0.000E+00	1.250E-11	0.000E+00	8.700E-12
I-135	6.480E+04	1.170E+05	1.030E+07	1.790E+05	0.000E+00	8.880E+04	0.000E+00	5.520E+04
CS-134	6.790E+10	1.110E+11	0.000E+00	3.450E+10	1.240E+10	6.010E+08	0.000E+00	2.350E+10
CS-136	3.030E+09	8.340E+09	0.000E+00	4.440E+09	6.630E+08	2.930E+08	0.000E+00	5.400E+09
CS-137	9.670E+10	9.260E+10	0.000E+00	3.020E+10	1.090E+10	5.800E+08	0.000E+00	1.370E+10
CS-138	1.190E-22	1.660E-22	0.000E+00	1.170E-22	1.260E-23	7.640E-23	0.000E+00	1.050E-22
BA-139	2.410E-08	1.290E-11	0.000E+00	1.120E-11	7.560E-12	1.390E-06	0.000E+00	6.980E-10
BA-140	1.410E+07	1.230E+04	0.000E+00	4.010E+03	7.340E+03	7.120E+06	0.000E+00	8.200E+05
BA-141	2.220E-46	1.240E-49	0.000E+00	1.080E-49	7.300E-49	1.270E-46	0.000E+00	7.230E-48
BA-142	1.390E-80	9.970E-84	0.000E+00	8.070E-84	5.870E-84	1.810E-82	0.000E+00	7.740E-82
LA-140	2.330E+00	8.140E-01	0.000E+00	0.000E+00	0.000E+00	2.270E+04	0.000E+00	2.740E-01
LA-142	9.730E-12	3.100E-12	0.000E+00	0.000E+00	0.000E+00	6.140E-07	0.000E+00	9.710E-13
CE-141	2.620E+03	1.310E+03	0.000E+00	5.740E+02	0.000E+00	1.630E+06	0.000E+00	1.940E+02
CE-143	2.250E+01	1.220E+04	0.000E+00	5.120E+00	0.000E+00	1.790E+05	0.000E+00	1.770E+00
CE-144	1.950E+05	6.110E+04	0.000E+00	3.380E+04	0.000E+00	1.590E+07	0.000E+00	1.040E+04
PR-143	8.620E+01	2.590E+01	0.000E+00	1.400E+01	0.000E+00	9.300E+04	0.000E+00	4.280E+00
PR-144	3.220E-54	9.950E-55	0.000E+00	5.260E-55	0.000E+00	2.140E-51	0.000E+00	1.620E-55
ND-147	5.330E+01	4.320E+01	0.000E+00	2.370E+01	0.000E+00	6.850E+04	0.000E+00	3.350E+00
W-187	3.470E+03	2.050E+03	0.000E+00	0.000E+00	0.000E+00	2.880E+05	0.000E+00	9.210E+02
NP-239	2.070E+00	1.490E-01	0.000E+00	4.300E-01	0.000E+00	1.100E+04	0.000E+00	1.040E-01

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Grs/Cow/Meat (CMEAT)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
H-3	0.000E+00	2.340E+02	2.340E+02	2.340E+02	2.340E+02	2.340E+02	0.000E+00	2.340E+02
C-14	3.280E+04	6.560E+03	6.560E+03	6.560E+03	6.560E+03	6.560E+03	0.000E+00	6.560E+03
NA-24	1.720E-03	1.720E-03	1.720E-03	1.720E-03	1.720E-03	1.720E-03	0.000E+00	1.720E-03
P-32	7.420E+09	3.470E+08	0.000E+00	0.000E+00	0.000E+00	2.050E+08	0.000E+00	2.860E+08
CR-51	0.000E+00	0.000E+00	4.880E+03	1.330E+03	8.910E+03	4.660E+05	0.000E+00	8.790E+03
MN-54	0.000E+00	8.010E+06	0.000E+00	2.250E+06	0.000E+00	6.720E+06	0.000E+00	2.130E+06
MN-56	0.000E+00	1.430E-53	0.000E+00	1.730E-53	0.000E+00	2.070E-51	0.000E+00	3.230E-54
FE-55	4.570E+08	2.420E+08	0.000E+00	0.000E+00	1.370E+08	4.490E+07	0.000E+00	7.510E+07
FE-59	3.760E+08	6.090E+08	0.000E+00	0.000E+00	1.770E+08	6.340E+08	0.000E+00	3.030E+08
CO-58	0.000E+00	1.640E+07	0.000E+00	0.000E+00	0.000E+00	9.580E+07	0.000E+00	5.020E+07
CO-60	0.000E+00	6.930E+07	0.000E+00	0.000E+00	0.000E+00	3.840E+08	0.000E+00	2.040E+08
NI-63	2.910E+10	1.560E+09	0.000E+00	0.000E+00	0.000E+00	1.050E+08	0.000E+00	9.910E+08
NI-65	3.520E-52	3.310E-53	0.000E+00	0.000E+00	0.000E+00	4.060E-51	0.000E+00	1.930E-53
CU-64	0.000E+00	2.970E-07	0.000E+00	7.180E-07	0.000E+00	1.390E-05	0.000E+00	1.800E-07
ZN-65	3.750E+08	1.000E+09	0.000E+00	6.300E+08	0.000E+00	1.760E+08	0.000E+00	6.220E+08
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.520E-57
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	5.770E+08	0.000E+00	0.000E+00	0.000E+00	3.710E+07	0.000E+00	3.550E+08
RB-88	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-89	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-89	4.820E+08	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.870E+07	0.000E+00	1.380E+07
SR-90	1.040E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.400E+08	0.000E+00	2.640E+09
SR-91	2.400E-10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.300E-10	0.000E+00	9.050E-12

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Grs/Cow/Meat (CMEAT)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-92	1.850E-49	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.490E-48	0.000E+00	7.400E-51
Y-90	1.710E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.880E+05	0.000E+00	4.590E+00
Y-91	1.800E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.400E+08	0.000E+00	4.820E+04
Y-91M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y-92	2.410E-39	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.960E-35	0.000E+00	6.890E-41
Y-93	7.440E-12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.110E-07	0.000E+00	2.040E-13
ZR-95	2.660E+06	5.850E+05	0.000E+00	8.380E+05	0.000E+00	6.110E+08	0.000E+00	5.210E+05
ZR-97	3.200E-05	4.630E-06	0.000E+00	6.650E-06	0.000E+00	7.010E-01	0.000E+00	2.730E-06
NB-95	3.100E+06	1.210E+06	0.000E+00	1.130E+06	0.000E+00	2.230E+09	0.000E+00	8.620E+05
MO-99	0.000E+00	1.150E+05	0.000E+00	2.460E+05	0.000E+00	9.510E+04	0.000E+00	2.840E+04
TC-99M	6.190E-21	1.210E-20	0.000E+00	1.760E-19	6.160E-21	6.910E-18	0.000E+00	2.010E-19
TC-101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-103	1.550E+08	0.000E+00	0.000E+00	3.900E+08	0.000E+00	4.010E+09	0.000E+00	5.960E+07
RU-105	9.020E-28	0.000E+00	0.000E+00	7.930E-27	0.000E+00	5.890E-25	0.000E+00	3.270E-28
RU-106	4.440E+09	0.000E+00	0.000E+00	5.990E+09	0.000E+00	6.900E+10	0.000E+00	5.540E+08
AG-110M	8.390E+06	5.670E+06	0.000E+00	1.060E+07	0.000E+00	6.740E+08	0.000E+00	4.530E+06
TE-125M	5.690E+08	1.540E+08	1.600E+08	0.000E+00	0.000E+00	5.490E+08	0.000E+00	7.590E+07
TE-127	3.380E-10	9.120E-11	2.340E-10	9.630E-10	0.000E+00	1.320E-08	0.000E+00	7.260E-11
TE-127M	1.770E+09	4.780E+08	4.240E+08	5.060E+09	0.000E+00	1.440E+09	0.000E+00	2.110E+08
TE-129	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-129M	1.790E+09	5.000E+08	5.770E+08	5.260E+09	0.000E+00	2.180E+09	0.000E+00	2.780E+08
TE-131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-131M	7.000E+02	2.420E+02	4.980E+02	2.340E+03	0.000E+00	9.820E+03	0.000E+00	2.580E+02
TE-132	2.120E+06	9.380E+05	1.370E+06	8.710E+06	0.000E+00	9.450E+06	0.000E+00	1.130E+06
I-130	3.030E-06	6.130E-06	6.750E-04	9.160E-06	0.000E+00	2.870E-06	0.000E+00	3.160E-06

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Grs/Cow/Meat (CMEAT)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
I-131	1.650E+07	1.660E+07	5.500E+09	2.730E+07	0.000E+00	1.480E+06	0.000E+00	9.460E+06
I-132	1.020E-58	1.880E-58	8.730E-57	2.880E-58	0.000E+00	2.210E-58	0.000E+00	8.650E-59
I-133	5.670E-01	7.020E-01	1.300E+02	1.170E+00	0.000E+00	2.830E-01	0.000E+00	2.660E-01
I-134	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-135	6.510E-17	1.170E-16	1.040E-14	1.800E-16	0.000E+00	8.930E-17	0.000E+00	5.550E-17
CS-134	9.220E+08	1.510E+09	0.000E+00	4.690E+08	1.680E+08	8.160E+06	0.000E+00	3.190E+08
CS-136	1.620E+07	4.460E+07	0.000E+00	2.370E+07	3.540E+06	1.570E+06	0.000E+00	2.880E+07
CS-137	1.330E+09	1.280E+09	0.000E+00	4.160E+08	1.500E+08	7.990E+06	0.000E+00	1.880E+08
CS-138	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-139	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-140	4.380E+07	3.840E+04	0.000E+00	1.250E+04	2.290E+04	2.220E+07	0.000E+00	2.560E+06
BA-141	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA-140	5.590E-02	1.950E-02	0.000E+00	0.000E+00	0.000E+00	5.440E+02	0.000E+00	6.580E-03
LA-142	5.300E-92	1.690E-92	0.000E+00	0.000E+00	0.000E+00	3.350E-87	0.000E+00	5.290E-93
CE-141	2.220E+04	1.110E+04	0.000E+00	4.850E+03	0.000E+00	1.380E+07	0.000E+00	1.640E+03
CE-143	3.170E-02	1.720E+01	0.000E+00	7.210E-03	0.000E+00	2.520E+02	0.000E+00	2.490E-03
CE-144	2.320E+06	7.260E+05	0.000E+00	4.020E+05	0.000E+00	1.890E+08	0.000E+00	1.240E+05
PR-143	3.340E+04	1.000E+04	0.000E+00	5.430E+03	0.000E+00	3.600E+07	0.000E+00	1.660E+03
PR-144	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND-147	1.170E+04	9.470E+03	0.000E+00	5.190E+03	0.000E+00	1.500E+07	0.000E+00	7.330E+02
W-187	3.210E-02	1.900E-02	0.000E+00	0.000E+00	0.000E+00	2.670E+00	0.000E+00	8.530E-03
NP-239	4.260E-01	3.060E-02	0.000E+00	8.850E-02	0.000E+00	2.260E+03	0.000E+00	2.150E-02

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Grs/Goat/Meat (GMEAT)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
H-3	0.000E+00	2.808E+01	2.808E+01	2.808E+01	2.808E+01	2.808E+01	0.000E+00	2.808E+01
C-14	3.936E+03	7.872E+02	7.872E+02	7.872E+02	7.872E+02	7.872E+02	0.000E+00	7.872E+02
NA-24	2.064E-04	2.064E-04	2.064E-04	2.064E-04	2.064E-04	2.064E-04	0.000E+00	2.064E-04
P-32	8.904E+08	4.164E+07	0.000E+00	0.000E+00	0.000E+00	2.460E+07	0.000E+00	3.432E+07
CR-51	0.000E+00	0.000E+00	5.856E+02	1.596E+02	1.069E+03	5.592E+04	0.000E+00	1.055E+03
MN-54	0.000E+00	9.612E+05	0.000E+00	2.700E+05	0.000E+00	8.064E+05	0.000E+00	2.556E+05
MN-56	0.000E+00	1.716E-54	0.000E+00	2.076E-54	0.000E+00	2.484E-52	0.000E+00	3.876E-55
FE-55	5.484E+07	2.904E+07	0.000E+00	0.000E+00	1.644E+07	5.388E+06	0.000E+00	9.012E+06
FE-59	4.512E+07	7.308E+07	0.000E+00	0.000E+00	2.124E+07	7.608E+07	0.000E+00	3.636E+07
CO-58	0.000E+00	1.968E+06	0.000E+00	0.000E+00	0.000E+00	1.150E+07	0.000E+00	6.024E+06
CO-60	0.000E+00	8.316E+06	0.000E+00	0.000E+00	0.000E+00	4.608E+07	0.000E+00	2.448E+07
NI-63	3.492E+09	1.872E+08	0.000E+00	0.000E+00	0.000E+00	1.260E+07	0.000E+00	1.189E+08
NI-65	4.224E-53	3.972E-54	0.000E+00	0.000E+00	0.000E+00	4.872E-52	0.000E+00	2.316E-54
CU-64	0.000E+00	3.564E-08	0.000E+00	8.616E-08	0.000E+00	1.668E-06	0.000E+00	2.160E-08
ZN-65	4.500E+07	1.200E+08	0.000E+00	7.560E+07	0.000E+00	2.112E+07	0.000E+00	7.464E+07
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.142E-57
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	6.924E+07	0.000E+00	0.000E+00	0.000E+00	4.452E+06	0.000E+00	4.260E+07
RB-88	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-89	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-89	5.784E+07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.244E+06	0.000E+00	1.656E+06
SR-90	1.248E+09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.680E+07	0.000E+00	3.168E+08
SR-91	2.880E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.360E-11	0.000E+00	1.086E-12

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHIL	Pathway:	Grs/Goat/Meat (GMEAT)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-92	2.220E-50	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.188E-49	0.000E+00	8.880E-52
Y-90	2.052E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.856E+04	0.000E+00	5.508E-01
Y-91	2.160E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.880E+07	0.000E+00	5.784E+03
Y-91M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y-92	2.892E-40	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.352E-36	0.000E+00	8.268E-42
Y-93	8.928E-13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.332E-08	0.000E+00	2.448E-14
ZR-95	3.192E+05	7.020E+04	0.000E+00	1.006E+05	0.000E+00	7.332E+07	0.000E+00	6.252E+04
ZR-97	3.840E-06	5.556E-07	0.000E+00	7.980E-07	0.000E+00	8.412E-02	0.000E+00	3.276E-07
NB-95	3.720E+05	1.452E+05	0.000E+00	1.356E+05	0.000E+00	2.676E+08	0.000E+00	1.034E+05
MO-99	0.000E+00	1.380E+04	0.000E+00	2.952E+04	0.000E+00	1.141E+04	0.000E+00	3.408E+03
TC-99M	7.428E-22	1.452E-21	0.000E+00	2.112E-20	7.392E-22	8.292E-19	0.000E+00	2.412E-20
TC-101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-103	1.860E+07	0.000E+00	0.000E+00	4.680E+07	0.000E+00	4.812E+08	0.000E+00	7.152E+06
RU-105	1.082E-28	0.000E+00	0.000E+00	9.516E-28	0.000E+00	7.068E-26	0.000E+00	3.924E-29
RU-106	5.328E+08	0.000E+00	0.000E+00	7.188E+08	0.000E+00	8.280E+09	0.000E+00	6.648E+07
AG-110M	1.007E+06	6.804E+05	0.000E+00	1.272E+06	0.000E+00	8.088E+07	0.000E+00	5.436E+05
TE-125M	6.828E+07	1.848E+07	1.920E+07	0.000E+00	0.000E+00	6.588E+07	0.000E+00	9.108E+06
TE-127	4.056E-11	1.094E-11	2.808E-11	1.156E-10	0.000E+00	1.584E-09	0.000E+00	8.712E-12
TE-127M	2.124E+08	5.736E+07	5.088E+07	6.072E+08	0.000E+00	1.728E+08	0.000E+00	2.532E+07
TE-129	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-129M	2.148E+08	6.000E+07	6.924E+07	6.312E+08	0.000E+00	2.616E+08	0.000E+00	3.336E+07
TE-131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-131M	8.400E+01	2.904E+01	5.976E+01	2.808E+02	0.000E+00	1.178E+03	0.000E+00	3.096E+01
TE-132	2.544E+05	1.126E+05	1.644E+05	1.045E+06	0.000E+00	1.134E+06	0.000E+00	1.356E+05
I-130	3.636E-07	7.356E-07	8.100E-05	1.099E-06	0.000E+00	3.444E-07	0.000E+00	3.792E-07

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Grs/Goat/Meat (GMEAT)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
I-131	1.980E+06	1.992E+06	6.600E+08	3.276E+06	0.000E+00	1.776E+05	0.000E+00	1.135E+06
I-132	1.224E-59	2.256E-59	1.048E-57	3.456E-59	0.000E+00	2.652E-59	0.000E+00	1.038E-59
I-133	6.804E-02	8.424E-02	1.560E+01	1.404E-01	0.000E+00	3.396E-02	0.000E+00	3.192E-02
I-134	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-135	7.812E-18	1.404E-17	1.248E-15	2.160E-17	0.000E+00	1.072E-17	0.000E+00	6.660E-18
CS-134	1.106E+08	1.812E+08	0.000E+00	5.628E+07	2.016E+07	9.792E+05	0.000E+00	3.828E+07
CS-136	1.944E+06	5.352E+06	0.000E+00	2.844E+06	4.248E+05	1.884E+05	0.000E+00	3.456E+06
CS-137	1.596E+08	1.536E+08	0.000E+00	4.992E+07	1.800E+07	9.588E+05	0.000E+00	2.256E+07
CS-138	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-139	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-140	5.256E+06	4.608E+03	0.000E+00	1.500E+03	2.748E+03	2.664E+06	0.000E+00	3.072E+05
BA-141	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA-140	6.708E-03	2.340E-03	0.000E+00	0.000E+00	0.000E+00	6.528E+01	0.000E+00	7.896E-04
LA-142	6.360E-93	2.028E-93	0.000E+00	0.000E+00	0.000E+00	4.020E-88	0.000E+00	6.348E-94
CE-141	2.664E+03	1.332E+03	0.000E+00	5.820E+02	0.000E+00	1.656E+06	0.000E+00	1.968E+02
CE-143	3.804E-03	2.064E+00	0.000E+00	8.652E-04	0.000E+00	3.024E+01	0.000E+00	2.988E-04
CE-144	2.784E+05	8.712E+04	0.000E+00	4.824E+04	0.000E+00	2.268E+07	0.000E+00	1.488E+04
PR-143	4.008E+03	1.200E+03	0.000E+00	6.516E+02	0.000E+00	4.320E+06	0.000E+00	1.992E+02
PR-144	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND-147	1.404E+03	1.136E+03	0.000E+00	6.228E+02	0.000E+00	1.800E+06	0.000E+00	8.796E+01
W-187	3.852E-03	2.280E-03	0.000E+00	0.000E+00	0.000E+00	3.204E-01	0.000E+00	1.024E-03
NP-239	5.112E-02	3.672E-03	0.000E+00	1.062E-02	0.000E+00	2.712E+02	0.000E+00	2.580E-03

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Vegetation (VEG)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
H-3	0.000E+00	4.010E+03	4.010E+03	4.010E+03	4.010E+03	4.010E+03	0.000E+00	4.010E+03
C-14	2.170E+05	4.340E+04	4.340E+04	4.340E+04	4.340E+04	4.340E+04	0.000E+00	4.340E+04
NA-24	3.730E+05	3.730E+05	3.730E+05	3.730E+05	3.730E+05	3.730E+05	0.000E+00	3.730E+05
P-32	3.370E+09	1.580E+08	0.000E+00	0.000E+00	0.000E+00	9.310E+07	0.000E+00	1.300E+08
CR-51	0.000E+00	0.000E+00	6.500E+04	1.780E+04	1.190E+05	6.210E+06	0.000E+00	1.170E+05
MN-54	0.000E+00	6.650E+08	0.000E+00	1.860E+08	0.000E+00	5.580E+08	0.000E+00	1.770E+08
MN-56	0.000E+00	1.860E+01	0.000E+00	2.250E+01	0.000E+00	2.700E+03	0.000E+00	4.200E+00
FE-55	8.010E+08	4.250E+08	0.000E+00	0.000E+00	2.400E+08	7.870E+07	0.000E+00	1.320E+08
FE-59	3.980E+08	6.430E+08	0.000E+00	0.000E+00	1.860E+08	6.700E+08	0.000E+00	3.200E+08
CO-58	0.000E+00	6.440E+07	0.000E+00	0.000E+00	0.000E+00	3.760E+08	0.000E+00	1.970E+08
CO-60	0.000E+00	3.780E+08	0.000E+00	0.000E+00	0.000E+00	2.100E+09	0.000E+00	1.120E+09
NI-63	3.950E+10	2.110E+09	0.000E+00	0.000E+00	0.000E+00	1.420E+08	0.000E+00	1.340E+09
NI-65	1.050E+02	9.890E+00	0.000E+00	0.000E+00	0.000E+00	1.210E+03	0.000E+00	5.770E+00
CU-64	0.000E+00	1.100E+04	0.000E+00	2.660E+04	0.000E+00	5.160E+05	0.000E+00	6.640E+03
ZN-65	8.130E+08	2.160E+09	0.000E+00	1.360E+09	0.000E+00	3.800E+08	0.000E+00	1.350E+09
ZN-69	9.490E-06	1.370E-05	0.000E+00	8.320E-06	0.000E+00	8.640E-04	0.000E+00	1.270E-06
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.370E+00
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.820E-11
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	4.520E+08	0.000E+00	0.000E+00	0.000E+00	2.910E+07	0.000E+00	2.780E+08
RB-88	0.000E+00	4.380E-22	0.000E+00	0.000E+00	0.000E+00	2.150E-23	0.000E+00	3.040E-22
RB-89	0.000E+00	4.610E-26	0.000E+00	0.000E+00	0.000E+00	4.020E-28	0.000E+00	4.090E-26
SR-89	3.600E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.390E+09	0.000E+00	1.030E+09
SR-90	1.240E+12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.670E+10	0.000E+00	3.150E+11
SR-91	5.240E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.160E+06	0.000E+00	1.980E+04

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Vegetation (VEG)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-92	7.280E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.380E+04	0.000E+00	2.920E+01
Y-90	2.310E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.570E+07	0.000E+00	6.180E+02
Y-91	1.860E+07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.480E+09	0.000E+00	4.990E+05
Y-91M	8.910E-09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.740E-05	0.000E+00	3.240E-10
Y-92	1.580E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.580E+04	0.000E+00	4.530E-02
Y-93	2.930E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.370E+06	0.000E+00	8.040E+00
ZR-95	3.860E+06	8.480E+05	0.000E+00	1.210E+06	0.000E+00	8.850E+08	0.000E+00	7.550E+05
ZR-97	5.700E+02	8.240E+01	0.000E+00	1.180E+02	0.000E+00	1.250E+07	0.000E+00	4.860E+01
NB-95	4.110E+05	1.600E+05	0.000E+00	1.500E+05	0.000E+00	2.960E+08	0.000E+00	1.140E+05
MO-99	0.000E+00	7.710E+06	0.000E+00	1.650E+07	0.000E+00	6.380E+06	0.000E+00	1.910E+06
TC-99M	4.710E+00	9.230E+00	0.000E+00	1.340E+02	4.690E+00	5.260E+03	0.000E+00	1.530E+02
TC-101	1.410E-30	1.470E-30	0.000E+00	2.510E-29	7.780E-31	4.680E-30	0.000E+00	1.870E-29
RU-103	1.530E+07	0.000E+00	0.000E+00	3.860E+07	0.000E+00	3.970E+08	0.000E+00	5.900E+06
RU-105	9.160E+01	0.000E+00	0.000E+00	8.050E+02	0.000E+00	5.980E+04	0.000E+00	3.320E+01
RU-106	7.450E+08	0.000E+00	0.000E+00	1.010E+09	0.000E+00	1.160E+10	0.000E+00	9.300E+07
AG-110M	3.210E+07	2.170E+07	0.000E+00	4.040E+07	0.000E+00	2.580E+09	0.000E+00	1.730E+07
TE-125M	3.510E+08	9.500E+07	9.840E+07	0.000E+00	0.000E+00	3.380E+08	0.000E+00	4.670E+07
TE-127	9.850E+03	2.650E+03	6.810E+03	2.800E+04	0.000E+00	3.850E+05	0.000E+00	2.110E+03
TE-127M	1.320E+09	3.560E+08	3.160E+08	3.770E+09	0.000E+00	1.070E+09	0.000E+00	1.570E+08
TE-129	1.320E-03	3.690E-04	9.430E-04	3.870E-03	0.000E+00	8.230E-02	0.000E+00	3.140E-04
TE-129M	8.410E+08	2.350E+08	2.710E+08	2.470E+09	0.000E+00	1.030E+09	0.000E+00	1.310E+08
TE-131	2.570E-15	7.830E-16	1.960E-15	7.770E-15	0.000E+00	1.350E-14	0.000E+00	7.640E-16
TE-131M	1.540E+06	5.330E+05	1.100E+06	5.160E+06	0.000E+00	2.160E+07	0.000E+00	5.680E+05
TE-132	7.000E+06	3.100E+06	4.510E+06	2.880E+07	0.000E+00	3.120E+07	0.000E+00	3.740E+06
I-130	6.160E+05	1.240E+06	1.370E+08	1.860E+06	0.000E+00	5.820E+05	0.000E+00	6.410E+05

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Vegetation (VEG)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
I-131	1.430E+08	1.440E+08	4.750E+10	2.360E+08	0.000E+00	1.280E+07	0.000E+00	8.170E+07
I-132	9.220E+01	1.690E+02	7.860E+03	2.590E+02	0.000E+00	1.990E+02	0.000E+00	7.790E+01
I-133	3.530E+06	4.370E+06	8.110E+08	7.280E+06	0.000E+00	1.760E+06	0.000E+00	1.650E+06
I-134	1.550E-04	2.880E-04	6.620E-03	4.400E-04	0.000E+00	1.910E-04	0.000E+00	1.320E-04
I-135	6.260E+04	1.130E+05	9.970E+06	1.730E+05	0.000E+00	8.580E+04	0.000E+00	5.330E+04
CS-134	1.600E+10	2.630E+10	0.000E+00	8.150E+09	2.930E+09	1.420E+08	0.000E+00	5.550E+09
CS-136	8.240E+07	2.270E+08	0.000E+00	1.210E+08	1.800E+07	7.960E+06	0.000E+00	1.470E+08
CS-137	2.390E+10	2.290E+10	0.000E+00	7.460E+09	2.680E+09	1.430E+08	0.000E+00	3.380E+09
CS-138	6.570E-11	9.130E-11	0.000E+00	6.430E-11	6.920E-12	4.210E-11	0.000E+00	5.790E-11
BA-139	4.950E-02	2.640E-05	0.000E+00	2.310E-05	1.560E-05	2.860E+00	0.000E+00	1.440E-03
BA-140	2.770E+08	2.420E+05	0.000E+00	7.890E+04	1.450E+05	1.400E+08	0.000E+00	1.610E+07
BA-141	1.990E-21	1.110E-24	0.000E+00	9.620E-25	6.530E-24	1.130E-21	0.000E+00	6.460E-23
BA-142	9.930E-39	7.150E-42	0.000E+00	5.780E-42	4.200E-42	1.300E-40	0.000E+00	5.540E-40
LA-140	3.250E+03	1.130E+03	0.000E+00	0.000E+00	0.000E+00	3.160E+07	0.000E+00	3.820E+02
LA-142	3.360E-04	1.070E-04	0.000E+00	0.000E+00	0.000E+00	2.120E+01	0.000E+00	3.350E-05
CE-141	6.560E+05	3.270E+05	0.000E+00	1.430E+05	0.000E+00	4.080E+08	0.000E+00	4.860E+04
CE-143	1.720E+03	9.310E+05	0.000E+00	3.910E+02	0.000E+00	1.360E+07	0.000E+00	1.350E+02
CE-144	1.270E+08	3.980E+07	0.000E+00	2.210E+07	0.000E+00	1.040E+10	0.000E+00	6.780E+06
PR-143	1.460E+05	4.370E+04	0.000E+00	2.370E+04	0.000E+00	1.570E+08	0.000E+00	7.230E+03
PR-144	5.380E-26	1.660E-26	0.000E+00	8.800E-27	0.000E+00	3.580E-23	0.000E+00	2.710E-27
ND-147	7.150E+04	5.790E+04	0.000E+00	3.180E+04	0.000E+00	9.170E+07	0.000E+00	4.480E+03
W-187	6.430E+04	3.810E+04	0.000E+00	0.000E+00	0.000E+00	5.350E+06	0.000E+00	1.710E+04
NP-239	2.560E+03	1.840E+02	0.000E+00	5.310E+02	0.000E+00	1.360E+07	0.000E+00	1.290E+02

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Inhalation (INHL)			Units:	mrem/yr / $\mu\text{Ci}/\text{m}^3$	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
H-3	0.000E+00	1.120E+03	1.120E+03	1.120E+03	1.120E+03	1.120E+03	0.000E+00	1.120E+03
C-14	3.590E+04	6.730E+03	6.730E+03	6.730E+03	6.730E+03	6.730E+03	0.000E+00	6.730E+03
NA-24	1.610E+04	1.610E+04	1.610E+04	1.610E+04	1.610E+04	1.610E+04	0.000E+00	1.610E+04
P-32	2.600E+06	1.140E+05	0.000E+00	0.000E+00	0.000E+00	4.220E+04	0.000E+00	9.880E+04
CR-51	0.000E+00	0.000E+00	8.550E+01	2.430E+01	1.700E+04	1.080E+03	0.000E+00	1.540E+02
MN-54	0.000E+00	4.290E+04	0.000E+00	1.000E+04	1.580E+06	2.290E+04	0.000E+00	9.510E+03
MN-56	0.000E+00	1.660E+00	0.000E+00	1.670E+00	1.310E+04	1.230E+05	0.000E+00	3.120E-01
FE-55	4.740E+04	2.520E+04	0.000E+00	0.000E+00	1.110E+05	2.870E+03	0.000E+00	7.770E+03
FE-59	2.070E+04	3.340E+04	0.000E+00	0.000E+00	1.270E+06	7.070E+04	0.000E+00	1.670E+04
CO-58	0.000E+00	1.770E+03	0.000E+00	0.000E+00	1.110E+06	3.440E+04	0.000E+00	3.160E+03
CO-60	0.000E+00	1.310E+04	0.000E+00	0.000E+00	7.070E+06	9.620E+04	0.000E+00	2.260E+04
NI-63	8.210E+05	4.620E+04	0.000E+00	0.000E+00	2.750E+05	6.330E+03	0.000E+00	2.800E+04
NI-65	2.990E+00	2.960E-01	0.000E+00	0.000E+00	8.180E+03	8.400E+04	0.000E+00	1.640E-01
CU-64	0.000E+00	1.990E+00	0.000E+00	6.030E+00	9.580E+03	3.670E+04	0.000E+00	1.070E+00
ZN-65	4.260E+04	1.130E+05	0.000E+00	7.140E+04	9.950E+05	1.630E+04	0.000E+00	7.030E+04
ZN-69	6.700E-02	9.660E-02	0.000E+00	5.850E-02	1.420E+03	1.020E+04	0.000E+00	8.920E-03
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.740E+02
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.480E+02
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.530E+01
RB-86	0.000E+00	1.980E+05	0.000E+00	0.000E+00	0.000E+00	7.990E+03	0.000E+00	1.140E+05
RB-88	0.000E+00	5.620E+02	0.000E+00	0.000E+00	0.000E+00	1.720E+01	0.000E+00	3.660E+02
RB-89	0.000E+00	3.450E+02	0.000E+00	0.000E+00	0.000E+00	1.890E+00	0.000E+00	2.900E+02
SR-89	5.990E+05	0.000E+00	0.000E+00	0.000E+00	2.160E+06	1.670E+05	0.000E+00	1.720E+04
SR-90	1.010E+08	0.000E+00	0.000E+00	0.000E+00	1.480E+07	3.430E+05	0.000E+00	6.440E+06
SR-91	1.210E+02	0.000E+00	0.000E+00	0.000E+00	5.330E+04	1.740E+05	0.000E+00	4.590E+00

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Inhalation (INHL)			Units:	mrem/yr / $\mu\text{Ci}/\text{m}^3$	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-92	1.310E+01	0.000E+00	0.000E+00	0.000E+00	2.400E+04	2.420E+05	0.000E+00	5.250E-01
Y-90	4.110E+03	0.000E+00	0.000E+00	0.000E+00	2.620E+05	2.680E+05	0.000E+00	1.110E+02
Y-91	9.140E+05	0.000E+00	0.000E+00	0.000E+00	2.630E+06	1.840E+05	0.000E+00	2.440E+04
Y-91M	5.070E-01	0.000E+00	0.000E+00	0.000E+00	2.810E+03	1.720E+03	0.000E+00	1.840E-02
Y-92	2.030E+01	0.000E+00	0.000E+00	0.000E+00	2.390E+04	2.390E+05	0.000E+00	5.810E-01
Y-93	1.860E+02	0.000E+00	0.000E+00	0.000E+00	7.440E+04	3.880E+05	0.000E+00	5.110E+00
ZR-95	1.900E+05	4.180E+04	0.000E+00	5.960E+04	2.230E+06	6.110E+04	0.000E+00	3.700E+04
ZR-97	1.880E+02	2.720E+01	0.000E+00	3.880E+01	1.130E+05	3.510E+05	0.000E+00	1.600E+01
NB-95	2.350E+04	9.180E+03	0.000E+00	8.620E+03	6.140E+05	3.700E+04	0.000E+00	6.550E+03
MO-99	0.000E+00	1.720E+02	0.000E+00	3.920E+02	1.350E+05	1.270E+05	0.000E+00	4.260E+01
TC-99M	1.780E-03	3.480E-03	0.000E+00	5.070E-02	9.510E+02	4.810E+03	0.000E+00	5.770E-02
TC-101	8.100E-05	8.510E-05	0.000E+00	1.450E-03	5.850E+02	1.630E+01	0.000E+00	1.080E-03
RU-103	2.790E+03	0.000E+00	0.000E+00	7.030E+03	6.620E+05	4.480E+04	0.000E+00	1.070E+03
RU-105	1.530E+00	0.000E+00	0.000E+00	1.340E+00	1.590E+04	9.950E+04	0.000E+00	5.550E-01
RU-106	1.360E+05	0.000E+00	0.000E+00	1.840E+05	1.430E+07	4.290E+05	0.000E+00	1.690E+04
AG-110M	1.690E+04	1.140E+04	0.000E+00	2.120E+04	5.480E+06	1.000E+05	0.000E+00	9.140E+03
TE-125M	6.730E+03	2.330E+03	1.920E+03	0.000E+00	4.770E+05	3.380E+04	0.000E+00	9.140E+02
TE-127	2.770E+00	9.510E-01	1.960E+00	7.070E+00	1.000E+04	5.620E+04	0.000E+00	6.100E-01
TE-127M	2.490E+04	8.550E+03	6.070E+03	6.360E+04	1.480E+06	7.140E+04	0.000E+00	3.020E+03
TE-129	9.770E-02	3.500E-02	7.140E-02	2.570E-01	2.930E+03	2.550E+04	0.000E+00	2.380E-02
TE-129M	1.920E+04	6.840E+03	6.330E+03	5.030E+04	1.760E+06	1.820E+05	0.000E+00	3.040E+03
TE-131	2.170E-02	8.440E-03	1.700E-02	5.880E-02	2.050E+03	1.330E+03	0.000E+00	6.590E-03
TE-131M	1.340E+02	5.920E+01	9.770E+01	4.000E+02	2.060E+05	3.080E+05	0.000E+00	5.070E+01
TE-132	4.810E+02	2.720E+02	3.170E+02	1.770E+03	3.770E+05	1.380E+05	0.000E+00	2.630E+02
I-130	8.180E+03	1.640E+04	1.850E+06	2.450E+04	0.000E+00	5.110E+03	0.000E+00	8.440E+03

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Inhalation (INHL)			Units:	mrem/yr / $\mu\text{Ci}/\text{m}^3$	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
I-131	4.810E+04	4.810E+04	1.620E+07	7.880E+04	0.000E+00	2.840E+03	0.000E+00	2.730E+04
I-132	2.120E+03	4.070E+03	1.940E+05	6.250E+03	0.000E+00	3.200E+03	0.000E+00	1.880E+03
I-133	1.660E+04	2.030E+04	3.850E+06	3.380E+04	0.000E+00	5.480E+03	0.000E+00	7.700E+03
I-134	1.170E+03	2.160E+03	5.070E+04	3.300E+03	0.000E+00	9.550E+02	0.000E+00	9.950E+02
I-135	4.920E+03	8.730E+03	7.920E+05	1.340E+04	0.000E+00	4.440E+03	0.000E+00	4.140E+03
CS-134	6.510E+05	1.010E+06	0.000E+00	3.300E+05	1.210E+05	3.850E+03	0.000E+00	2.250E+05
CS-136	6.510E+04	1.710E+05	0.000E+00	9.550E+04	1.450E+04	4.180E+03	0.000E+00	1.160E+05
CS-137	9.060E+05	8.250E+05	0.000E+00	2.820E+05	1.040E+05	3.620E+03	0.000E+00	1.280E+05
CS-138	6.330E+02	8.400E+02	0.000E+00	6.220E+02	6.810E+01	2.700E+02	0.000E+00	5.550E+02
BA-139	1.840E+00	9.840E-04	0.000E+00	8.620E-04	5.770E+03	5.770E+04	0.000E+00	5.360E-02
BA-140	7.400E+04	6.480E+01	0.000E+00	2.110E+01	1.740E+06	1.020E+05	0.000E+00	4.330E+03
BA-141	1.960E-01	1.090E-04	0.000E+00	9.470E-05	2.920E+03	2.750E+02	0.000E+00	6.360E-03
BA-142	5.000E-02	3.600E-05	0.000E+00	2.910E-05	1.640E+03	2.740E+00	0.000E+00	2.790E-03
LA-140	6.440E+02	2.250E+02	0.000E+00	0.000E+00	1.830E+05	2.260E+05	0.000E+00	7.550E+01
LA-142	1.300E+00	4.110E-01	0.000E+00	0.000E+00	8.700E+03	7.580E+04	0.000E+00	1.290E-01
CE-141	3.920E+04	1.950E+04	0.000E+00	8.550E+03	5.440E+05	5.660E+04	0.000E+00	2.900E+03
CE-143	3.660E+02	1.990E+02	0.000E+00	8.360E+01	1.150E+05	1.270E+05	0.000E+00	2.870E+01
CE-144	6.770E+06	2.120E+06	0.000E+00	1.170E+06	1.200E+07	3.880E+05	0.000E+00	3.610E+05
PR-143	1.850E+04	5.550E+03	0.000E+00	3.000E+03	4.330E+05	9.730E+04	0.000E+00	9.140E+02
PR-144	5.960E-02	1.850E-02	0.000E+00	9.770E-03	1.570E+03	1.970E+02	0.000E+00	3.000E-03
ND-147	1.080E+04	8.730E+03	0.000E+00	4.810E+03	3.280E+05	8.210E+04	0.000E+00	6.810E+02
W-187	1.630E+01	9.660E+00	0.000E+00	0.000E+00	4.110E+04	9.100E+04	0.000E+00	4.330E+00
NP-239	4.660E+02	3.340E+01	0.000E+00	9.730E+01	5.810E+04	6.400E+04	0.000E+00	2.350E+01

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Ground Plane Deposition (GPD)			Units:	m ² ·mrem/yr / μCi/sec	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
H-3	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C-14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NA-24	1.190E+07	1.190E+07	1.190E+07	1.190E+07	1.190E+07	1.190E+07	1.390E+07	1.190E+07
P-32	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CR-51	4.660E+06	4.660E+06	4.660E+06	4.660E+06	4.660E+06	4.660E+06	5.510E+06	4.660E+06
MN-54	1.390E+09	1.390E+09	1.390E+09	1.390E+09	1.390E+09	1.390E+09	1.630E+09	1.390E+09
MN-56	9.020E+05	9.020E+05	9.020E+05	9.020E+05	9.020E+05	9.020E+05	1.070E+06	9.020E+05
FE-55	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
FE-59	2.730E+08	2.730E+08	2.730E+08	2.730E+08	2.730E+08	2.730E+08	3.210E+08	2.730E+08
CO-58	3.790E+08	3.790E+08	3.790E+08	3.790E+08	3.790E+08	3.790E+08	4.440E+08	3.790E+08
CO-60	2.150E+10	2.150E+10	2.150E+10	2.150E+10	2.150E+10	2.150E+10	2.530E+10	2.150E+10
NI-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NI-65	2.970E+05	2.970E+05	2.970E+05	2.970E+05	2.970E+05	2.970E+05	3.450E+05	2.970E+05
CU-64	6.070E+05	6.070E+05	6.070E+05	6.070E+05	6.070E+05	6.070E+05	6.880E+05	6.070E+05
ZN-65	7.470E+08	7.470E+08	7.470E+08	7.470E+08	7.470E+08	7.470E+08	8.590E+08	7.470E+08
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	4.870E+03	4.870E+03	4.870E+03	4.870E+03	4.870E+03	4.870E+03	7.080E+03	4.870E+03
BR-84	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.360E+05	2.030E+05
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	8.990E+06	8.990E+06	8.990E+06	8.990E+06	8.990E+06	8.990E+06	1.030E+07	8.990E+06
RB-88	3.310E+04	3.310E+04	3.310E+04	3.310E+04	3.310E+04	3.310E+04	3.780E+04	3.310E+04
RB-89	1.230E+05	1.230E+05	1.230E+05	1.230E+05	1.230E+05	1.230E+05	1.480E+05	1.230E+05
SR-89	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.510E+04	2.160E+04
SR-90	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-91	2.150E+06	2.150E+06	2.150E+06	2.150E+06	2.150E+06	2.150E+06	2.510E+06	2.150E+06

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Ground Plane Deposition (GPD)			Units:	m ² ·mrem/yr / μCi/sec	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-92	7.770E+05	7.770E+05	7.770E+05	7.770E+05	7.770E+05	7.770E+05	8.630E+05	7.770E+05
Y-90	4.490E+03	4.490E+03	4.490E+03	4.490E+03	4.490E+03	4.490E+03	5.310E+03	4.490E+03
Y-91	1.070E+06	1.070E+06	1.070E+06	1.070E+06	1.070E+06	1.070E+06	1.210E+06	1.070E+06
Y-91M	1.000E+05	1.000E+05	1.000E+05	1.000E+05	1.000E+05	1.000E+05	1.160E+05	1.000E+05
Y-92	1.800E+05	1.800E+05	1.800E+05	1.800E+05	1.800E+05	1.800E+05	2.140E+05	1.800E+05
Y-93	1.830E+05	1.830E+05	1.830E+05	1.830E+05	1.830E+05	1.830E+05	2.510E+05	1.830E+05
ZR-95	2.450E+08	2.450E+08	2.450E+08	2.450E+08	2.450E+08	2.450E+08	2.840E+08	2.450E+08
ZR-97	2.960E+06	2.960E+06	2.960E+06	2.960E+06	2.960E+06	2.960E+06	3.440E+06	2.960E+06
NB-95	1.370E+08	1.370E+08	1.370E+08	1.370E+08	1.370E+08	1.370E+08	1.610E+08	1.370E+08
MO-99	3.990E+06	3.990E+06	3.990E+06	3.990E+06	3.990E+06	3.990E+06	4.630E+06	3.990E+06
TC-99M	1.840E+05	1.840E+05	1.840E+05	1.840E+05	1.840E+05	1.840E+05	2.110E+05	1.840E+05
TC-101	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.260E+04	2.040E+04
RU-103	1.080E+08	1.080E+08	1.080E+08	1.080E+08	1.080E+08	1.080E+08	1.260E+08	1.080E+08
RU-105	6.360E+05	6.360E+05	6.360E+05	6.360E+05	6.360E+05	6.360E+05	7.210E+05	6.360E+05
RU-106	4.220E+08	4.220E+08	4.220E+08	4.220E+08	4.220E+08	4.220E+08	5.070E+08	4.220E+08
AG-110M	3.440E+09	3.440E+09	3.440E+09	3.440E+09	3.440E+09	3.440E+09	4.010E+09	3.440E+09
TE-125M	1.550E+06	1.550E+06	1.550E+06	1.550E+06	1.550E+06	1.550E+06	2.130E+06	1.550E+06
TE-127	2.980E+03	2.980E+03	2.980E+03	2.980E+03	2.980E+03	2.980E+03	3.280E+03	2.980E+03
TE-127M	9.160E+04	9.160E+04	9.160E+04	9.160E+04	9.160E+04	9.160E+04	1.080E+05	9.160E+04
TE-129	2.620E+04	2.620E+04	2.620E+04	2.620E+04	2.620E+04	2.620E+04	3.100E+04	2.620E+04
TE-129M	1.980E+07	1.980E+07	1.980E+07	1.980E+07	1.980E+07	1.980E+07	2.310E+07	1.980E+07
TE-131	2.920E+04	2.920E+04	2.920E+04	2.920E+04	2.920E+04	2.920E+04	3.450E+07	2.920E+04
TE-131M	8.030E+06	8.030E+06	8.030E+06	8.030E+06	8.030E+06	8.030E+06	9.460E+06	8.030E+06
TE-132	4.230E+06	4.230E+06	4.230E+06	4.230E+06	4.230E+06	4.230E+06	4.980E+06	4.230E+06
I-130	5.510E+06	5.510E+06	5.510E+06	5.510E+06	5.510E+06	5.510E+06	6.690E+06	5.510E+06

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Ground Plane Deposition (GPD)			Units:	m ² ·mrem/yr / μCi/sec	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
I-131	1.720E+07	1.720E+07	1.720E+07	1.720E+07	1.720E+07	1.720E+07	2.090E+07	1.720E+07
I-132	1.250E+06	1.250E+06	1.250E+06	1.250E+06	1.250E+06	1.250E+06	1.470E+06	1.250E+06
I-133	2.450E+06	2.450E+06	2.450E+06	2.450E+06	2.450E+06	2.450E+06	2.980E+06	2.450E+06
I-134	4.470E+05	4.470E+05	4.470E+05	4.470E+05	4.470E+05	4.470E+05	5.300E+05	4.470E+05
I-135	2.530E+06	2.530E+06	2.530E+06	2.530E+06	2.530E+06	2.530E+06	2.950E+06	2.530E+06
CS-134	6.860E+09	6.860E+09	6.860E+09	6.860E+09	6.860E+09	6.860E+09	8.000E+09	6.860E+09
CS-136	1.510E+08	1.510E+08	1.510E+08	1.510E+08	1.510E+08	1.510E+08	1.710E+08	1.510E+08
CS-137	1.030E+10	1.030E+10	1.030E+10	1.030E+10	1.030E+10	1.030E+10	1.200E+10	1.030E+10
CS-138	3.590E+05	3.590E+05	3.590E+05	3.590E+05	3.590E+05	3.590E+05	4.100E+05	3.590E+05
BA-139	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.190E+05	1.060E+05
BA-140	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.350E+07	2.050E+07
BA-141	4.170E+04	4.170E+04	4.170E+04	4.170E+04	4.170E+04	4.170E+04	4.750E+04	4.170E+04
BA-142	4.490E+04	4.490E+04	4.490E+04	4.490E+04	4.490E+04	4.490E+04	5.110E+04	4.490E+04
LA-140	1.920E+07	1.920E+07	1.920E+07	1.920E+07	1.920E+07	1.920E+07	2.180E+07	1.920E+07
LA-142	7.600E+05	7.600E+05	7.600E+05	7.600E+05	7.600E+05	7.600E+05	9.120E+05	7.600E+05
CE-141	1.370E+07	1.370E+07	1.370E+07	1.370E+07	1.370E+07	1.370E+07	1.540E+07	1.370E+07
CE-143	2.310E+06	2.310E+06	2.310E+06	2.310E+06	2.310E+06	2.310E+06	2.630E+06	2.310E+06
CE-144	6.950E+07	6.950E+07	6.950E+07	6.950E+07	6.950E+07	6.950E+07	8.040E+07	6.950E+07
PR-143	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR-144	1.830E+03	1.830E+03	1.830E+03	1.830E+03	1.830E+03	1.830E+03	2.110E+03	1.830E+03
ND-147	8.390E+06	8.390E+06	8.390E+06	8.390E+06	8.390E+06	8.390E+06	1.010E+07	8.390E+06
W-187	2.350E+06	2.350E+06	2.350E+06	2.350E+06	2.350E+06	2.350E+06	2.730E+06	2.350E+06
NP-239	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.980E+06	1.710E+06

APPENDIX J

R_i Infant Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	INFANT	Pathway:	Grs/Cow/Milk (CMILK)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
H-3	0.000E+00	2.380E+03	2.380E+03	2.380E+03	2.380E+03	2.380E+03	0.000E+00	2.380E+03
C-14	2.000E+05	4.270E+04	4.270E+04	4.270E+04	4.270E+04	4.270E+04	0.000E+00	4.270E+04
NA-24	1.540E+07	1.540E+07	1.540E+07	1.540E+07	1.540E+07	1.540E+07	0.000E+00	1.540E+07
P-32	1.600E+11	9.430E+09	0.000E+00	0.000E+00	0.000E+00	2.170E+09	0.000E+00	6.210E+09
CR-51	0.000E+00	0.000E+00	1.050E+05	2.300E+04	2.050E+05	4.700E+06	0.000E+00	1.610E+05
MN-54	0.000E+00	3.900E+07	0.000E+00	8.640E+06	0.000E+00	1.430E+07	0.000E+00	8.840E+06
MN-56	0.000E+00	3.100E-02	0.000E+00	2.660E-02	0.000E+00	2.810E+00	0.000E+00	5.340E-03
FE-55	1.350E+08	8.730E+07	0.000E+00	0.000E+00	4.270E+07	1.110E+07	0.000E+00	2.330E+07
FE-59	2.240E+08	3.920E+08	0.000E+00	0.000E+00	1.160E+08	1.870E+08	0.000E+00	1.540E+08
CO-58	0.000E+00	2.420E+07	0.000E+00	0.000E+00	0.000E+00	6.040E+07	0.000E+00	6.050E+07
CO-60	0.000E+00	8.820E+07	0.000E+00	0.000E+00	0.000E+00	2.100E+08	0.000E+00	2.080E+08
NI-63	3.490E+10	2.160E+09	0.000E+00	0.000E+00	0.000E+00	1.070E+08	0.000E+00	1.210E+09
NI-65	3.510E+00	3.970E-01	0.000E+00	0.000E+00	0.000E+00	3.020E+01	0.000E+00	1.800E-01
CU-64	0.000E+00	1.850E+05	0.000E+00	3.140E+05	0.000E+00	3.810E+06	0.000E+00	8.590E+04
ZN-65	5.550E+09	1.900E+10	0.000E+00	9.230E+09	0.000E+00	1.610E+10	0.000E+00	8.780E+09
ZN-69	2.020E-11	3.630E-11	0.000E+00	1.510E-11	0.000E+00	2.960E-09	0.000E+00	2.700E-12
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.340E-01
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.260E-22
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	2.230E+10	0.000E+00	0.000E+00	0.000E+00	5.690E+08	0.000E+00	1.100E+10
RB-88	0.000E+00	1.880E-44	0.000E+00	0.000E+00	0.000E+00	1.830E-44	0.000E+00	1.030E-44
RB-89	0.000E+00	3.290E-52	0.000E+00	0.000E+00	0.000E+00	1.120E-52	0.000E+00	2.260E-52
SR-89	1.260E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.590E+08	0.000E+00	3.610E+08
SR-90	1.220E+11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.520E+09	0.000E+00	3.100E+10
SR-91	2.720E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.220E+05	0.000E+00	9.830E+03

APPENDIX J

R_i Infant Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	INFANT	Pathway:	Grs/Cow/Milk (CMILK)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-92	4.640E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.000E+01	0.000E+00	1.720E-01
Y-90	6.810E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.410E+05	0.000E+00	1.830E+01
Y-91	7.330E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.250E+06	0.000E+00	1.950E+03
Y-91M	5.670E-19	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.890E-15	0.000E+00	1.930E-20
Y-92	5.380E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.030E+01	0.000E+00	1.510E-05
Y-93	2.160E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.700E+04	0.000E+00	5.870E-02
ZR-95	6.800E+03	1.660E+03	0.000E+00	1.790E+03	0.000E+00	8.260E+05	0.000E+00	1.180E+03
ZR-97	4.060E+00	6.970E-01	0.000E+00	7.030E-01	0.000E+00	4.450E+04	0.000E+00	3.180E-01
NB-95	5.930E+05	2.440E+05	0.000E+00	1.750E+05	0.000E+00	2.060E+08	0.000E+00	1.410E+05
MO-99	0.000E+00	2.080E+08	0.000E+00	3.110E+08	0.000E+00	6.850E+07	0.000E+00	4.060E+07
TC-99M	2.750E+01	5.670E+01	0.000E+00	6.100E+02	2.960E+01	1.650E+04	0.000E+00	7.300E+02
TC-101	2.470E-59	3.110E-59	0.000E+00	3.700E-58	1.700E-59	5.280E-57	0.000E+00	3.080E-58
RU-103	8.670E+03	0.000E+00	0.000E+00	1.800E+04	0.000E+00	1.050E+05	0.000E+00	2.900E+03
RU-105	8.050E-03	0.000E+00	0.000E+00	5.920E-02	0.000E+00	3.200E+00	0.000E+00	2.710E-03
RU-106	1.900E+05	0.000E+00	0.000E+00	2.250E+05	0.000E+00	1.440E+06	0.000E+00	2.380E+04
AG-110M	3.860E+08	2.820E+08	0.000E+00	4.030E+08	0.000E+00	1.460E+10	0.000E+00	1.860E+08
TE-125M	1.510E+08	5.040E+07	5.070E+07	0.000E+00	0.000E+00	7.180E+07	0.000E+00	2.040E+07
TE-127	6.320E+03	2.120E+03	5.140E+03	1.540E+04	0.000E+00	1.330E+05	0.000E+00	1.360E+03
TE-127M	4.210E+08	1.400E+08	1.220E+08	1.040E+09	0.000E+00	1.700E+08	0.000E+00	5.100E+07
TE-129	2.720E-09	9.380E-10	2.280E-09	6.770E-09	0.000E+00	2.170E-07	0.000E+00	6.350E-10
TE-129M	5.570E+08	1.910E+08	2.140E+08	1.390E+09	0.000E+00	3.330E+08	0.000E+00	8.580E+07
TE-131	3.430E-32	1.270E-32	3.060E-32	8.760E-32	0.000E+00	1.380E-30	0.000E+00	9.610E-33
TE-131M	3.380E+06	1.360E+06	2.750E+06	9.350E+06	0.000E+00	2.290E+07	0.000E+00	1.120E+06
TE-132	2.110E+07	1.040E+07	1.540E+07	6.530E+07	0.000E+00	3.870E+07	0.000E+00	9.750E+06
I-130	3.550E+06	7.810E+06	8.750E+08	8.580E+06	0.000E+00	1.670E+06	0.000E+00	3.130E+06

APPENDIX J

R_i Infant Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	INFANT	Pathway:	Grs/Cow/Milk (CMILK)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
I-131	2.720E+09	3.200E+09	1.050E+12	3.740E+09	0.000E+00	1.140E+08	0.000E+00	1.410E+09
I-132	1.430E+00	2.900E+00	1.360E+02	3.240E+00	0.000E+00	2.350E+00	0.000E+00	1.030E+00
I-133	3.630E+07	5.280E+07	9.600E+09	6.210E+07	0.000E+00	8.930E+06	0.000E+00	1.550E+07
I-134	1.760E-11	3.600E-11	8.400E-10	4.030E-11	0.000E+00	3.720E-11	0.000E+00	1.280E-11
I-135	1.120E+05	2.230E+05	2.000E+07	2.490E+05	0.000E+00	8.080E+04	0.000E+00	8.140E+04
CS-134	3.650E+10	6.800E+10	0.000E+00	1.750E+10	7.180E+09	1.850E+08	0.000E+00	6.870E+09
CS-136	1.980E+09	5.810E+09	0.000E+00	2.320E+09	4.740E+08	8.820E+07	0.000E+00	2.170E+09
CS-137	5.150E+10	6.020E+10	0.000E+00	1.620E+10	6.550E+09	1.880E+08	0.000E+00	4.270E+09
CS-138	8.390E-23	1.360E-22	0.000E+00	6.800E-23	1.060E-23	2.180E-22	0.000E+00	6.610E-23
BA-139	4.270E-07	2.830E-10	0.000E+00	1.700E-10	1.720E-10	2.710E-05	0.000E+00	1.240E-08
BA-140	2.410E+08	2.410E+05	0.000E+00	5.720E+04	1.480E+05	5.920E+07	0.000E+00	1.240E+07
BA-141	3.930E-45	2.690E-48	0.000E+00	1.620E-48	1.640E-48	4.800E-44	0.000E+00	1.240E-46
BA-142	2.430E-79	2.020E-82	0.000E+00	1.160E-82	1.220E-82	1.000E-78	0.000E+00	1.200E-80
LA-140	4.050E+01	1.600E+01	0.000E+00	0.000E+00	0.000E+00	1.880E+05	0.000E+00	4.110E+00
LA-142	1.700E-10	6.250E-11	0.000E+00	0.000E+00	0.000E+00	1.060E-05	0.000E+00	1.500E-11
CE-141	4.340E+04	2.640E+04	0.000E+00	8.150E+03	0.000E+00	1.370E+07	0.000E+00	3.110E+03
CE-143	3.970E+02	2.630E+05	0.000E+00	7.670E+01	0.000E+00	1.540E+06	0.000E+00	3.000E+01
CE-144	2.330E+06	9.520E+05	0.000E+00	3.850E+05	0.000E+00	1.330E+08	0.000E+00	1.300E+05
PR-143	1.490E+03	5.550E+02	0.000E+00	2.060E+02	0.000E+00	7.840E+05	0.000E+00	7.360E+01
PR-144	5.690E-53	2.200E-53	0.000E+00	7.980E-54	0.000E+00	1.020E-48	0.000E+00	2.870E-54
ND-147	8.810E+02	9.050E+02	0.000E+00	3.490E+02	0.000E+00	5.740E+05	0.000E+00	5.550E+01
W-187	6.080E+04	4.230E+04	0.000E+00	0.000E+00	0.000E+00	2.480E+06	0.000E+00	1.460E+04
NP-239	3.650E+01	3.260E+00	0.000E+00	6.510E+00	0.000E+00	9.430E+04	0.000E+00	1.840E+00

APPENDIX J

R_i Infant Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	INFANT	Pathway:	Grs/Goat/Milk (GMILK)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
H-3	0.000E+00	4.860E+03	4.860E+03	4.860E+03	4.860E+03	4.860E+03	0.000E+00	4.860E+03
C-14	2.000E+05	4.270E+04	4.270E+04	4.270E+04	4.270E+04	4.270E+04	0.000E+00	4.270E+04
NA-24	1.850E+06	1.850E+06	1.850E+06	1.850E+06	1.850E+06	1.850E+06	0.000E+00	1.850E+06
P-32	1.920E+11	1.130E+10	0.000E+00	0.000E+00	0.000E+00	2.600E+09	0.000E+00	7.460E+09
CR-51	0.000E+00	0.000E+00	1.260E+04	2.760E+03	2.460E+04	5.640E+05	0.000E+00	1.940E+04
MN-54	0.000E+00	4.680E+06	0.000E+00	1.040E+06	0.000E+00	1.720E+06	0.000E+00	1.060E+06
MN-56	0.000E+00	3.720E-03	0.000E+00	3.190E-03	0.000E+00	3.380E-01	0.000E+00	6.410E-04
FE-55	1.760E+06	1.130E+06	0.000E+00	0.000E+00	5.550E+05	1.440E+05	0.000E+00	3.030E+05
FE-59	2.920E+06	5.100E+06	0.000E+00	0.000E+00	1.510E+06	2.430E+06	0.000E+00	2.010E+06
CO-58	0.000E+00	2.910E+06	0.000E+00	0.000E+00	0.000E+00	7.250E+06	0.000E+00	7.260E+06
CO-60	0.000E+00	1.060E+07	0.000E+00	0.000E+00	0.000E+00	2.520E+07	0.000E+00	2.500E+07
NI-63	4.190E+09	2.590E+08	0.000E+00	0.000E+00	0.000E+00	1.290E+07	0.000E+00	1.450E+08
NI-65	4.210E-01	4.760E-02	0.000E+00	0.000E+00	0.000E+00	3.620E+00	0.000E+00	2.170E-02
CU-64	0.000E+00	2.070E+04	0.000E+00	3.500E+04	0.000E+00	4.240E+05	0.000E+00	9.570E+03
ZN-65	6.660E+08	2.280E+09	0.000E+00	1.110E+09	0.000E+00	1.930E+09	0.000E+00	1.050E+09
ZN-69	2.420E-12	4.360E-12	0.000E+00	1.810E-12	0.000E+00	3.550E-10	0.000E+00	3.240E-13
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.120E-01
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.510E-23
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	2.670E+09	0.000E+00	0.000E+00	0.000E+00	6.830E+07	0.000E+00	1.320E+09
RB-88	0.000E+00	2.250E-45	0.000E+00	0.000E+00	0.000E+00	2.190E-45	0.000E+00	1.230E-45
RB-89	0.000E+00	3.940E-53	0.000E+00	0.000E+00	0.000E+00	1.340E-53	0.000E+00	2.720E-53
SR-89	2.640E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.430E+08	0.000E+00	7.580E+08
SR-90	2.550E+11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.190E+09	0.000E+00	6.500E+10
SR-91	5.700E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.750E+05	0.000E+00	2.060E+04

APPENDIX J

R_i Infant Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	INFANT	Pathway:	Grs/Goat/Milk (GMILK)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-92	9.750E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.050E+02	0.000E+00	3.620E-01
Y-90	8.170E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.130E+05	0.000E+00	2.190E+00
Y-91	8.790E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.300E+05	0.000E+00	2.340E+02
Y-91M	6.810E-20	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.270E-16	0.000E+00	2.320E-21
Y-92	6.450E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.230E+00	0.000E+00	1.810E-06
Y-93	2.590E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.040E+03	0.000E+00	7.050E-03
ZR-95	8.170E+02	1.990E+02	0.000E+00	2.140E+02	0.000E+00	9.910E+04	0.000E+00	1.410E+02
ZR-97	4.870E-01	8.360E-02	0.000E+00	8.430E-02	0.000E+00	5.340E+03	0.000E+00	3.820E-02
NB-95	7.120E+04	2.930E+04	0.000E+00	2.100E+04	0.000E+00	2.480E+07	0.000E+00	1.700E+04
MO-99	0.000E+00	2.500E+07	0.000E+00	3.730E+07	0.000E+00	8.220E+06	0.000E+00	4.870E+06
TC-99M	3.300E+00	6.800E+00	0.000E+00	7.320E+01	3.550E+00	1.970E+03	0.000E+00	8.760E+01
TC-101	2.960E-60	3.730E-60	0.000E+00	4.440E-59	2.030E-60	6.340E-58	0.000E+00	3.690E-59
RU-103	1.040E+03	0.000E+00	0.000E+00	2.170E+03	0.000E+00	1.270E+04	0.000E+00	3.480E+02
RU-105	9.660E-04	0.000E+00	0.000E+00	7.110E-03	0.000E+00	3.840E-01	0.000E+00	3.250E-04
RU-106	2.280E+04	0.000E+00	0.000E+00	2.700E+04	0.000E+00	1.730E+05	0.000E+00	2.850E+03
AG-110M	4.630E+07	3.380E+07	0.000E+00	4.830E+07	0.000E+00	1.750E+09	0.000E+00	2.240E+07
TE-125M	1.810E+07	6.050E+06	6.090E+06	0.000E+00	0.000E+00	8.620E+06	0.000E+00	2.450E+06
TE-127	7.580E+02	2.540E+02	6.170E+02	1.850E+03	0.000E+00	1.590E+04	0.000E+00	1.630E+02
TE-127M	5.050E+07	1.680E+07	1.460E+07	1.240E+08	0.000E+00	2.040E+07	0.000E+00	6.120E+06
TE-129	3.260E-10	1.130E-10	2.740E-10	8.130E-10	0.000E+00	2.610E-08	0.000E+00	7.620E-11
TE-129M	6.690E+07	2.290E+07	2.570E+07	1.670E+08	0.000E+00	3.990E+07	0.000E+00	1.030E+07
TE-131	4.110E-33	1.520E-33	3.670E-33	1.050E-32	0.000E+00	1.660E-31	0.000E+00	1.150E-33
TE-131M	4.050E+05	1.630E+05	3.310E+05	1.120E+06	0.000E+00	2.750E+06	0.000E+00	1.350E+05
TE-132	2.530E+06	1.250E+06	1.850E+06	7.840E+06	0.000E+00	4.640E+06	0.000E+00	1.170E+06
I-130	4.260E+06	9.370E+06	1.050E+09	1.030E+07	0.000E+00	2.010E+06	0.000E+00	3.760E+06

APPENDIX J

R_i Infant Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	INFANT	Pathway:	Grs/Goat/Milk (GMILK)			Units:	m ² ·mrem/yr / μCi/sec; mrem/yr / μCi/m ³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
I-131	3.260E+09	3.850E+09	1.260E+12	4.490E+09	0.000E+00	1.370E+08	0.000E+00	1.690E+09
I-132	1.720E+00	3.480E+00	1.630E+02	3.890E+00	0.000E+00	2.820E+00	0.000E+00	1.240E+00
I-133	4.350E+07	6.340E+07	1.150E+10	7.450E+07	0.000E+00	1.070E+07	0.000E+00	1.860E+07
I-134	2.110E-11	4.320E-11	1.010E-09	4.830E-11	0.000E+00	4.470E-11	0.000E+00	1.540E-11
I-135	1.350E+05	2.680E+05	2.400E+07	2.990E+05	0.000E+00	9.700E+04	0.000E+00	9.770E+04
CS-134	1.090E+11	2.040E+11	0.000E+00	5.250E+10	2.150E+10	5.540E+08	0.000E+00	2.060E+10
CS-136	5.930E+09	1.740E+10	0.000E+00	6.950E+09	1.420E+09	2.650E+08	0.000E+00	6.510E+09
CS-137	1.540E+11	1.810E+11	0.000E+00	4.850E+10	1.960E+10	5.650E+08	0.000E+00	1.280E+10
CS-138	2.520E-22	4.090E-22	0.000E+00	2.040E-22	3.190E-23	6.540E-22	0.000E+00	1.980E-22
BA-139	5.130E-08	3.400E-11	0.000E+00	2.040E-11	2.060E-11	3.250E-06	0.000E+00	1.480E-09
BA-140	2.890E+07	2.890E+04	0.000E+00	6.870E+03	1.780E+04	7.100E+06	0.000E+00	1.490E+06
BA-141	4.720E-46	3.230E-49	0.000E+00	1.940E-49	1.960E-49	5.760E-45	0.000E+00	1.490E-47
BA-142	2.920E-80	2.430E-83	0.000E+00	1.400E-83	1.470E-83	1.200E-79	0.000E+00	1.440E-81
LA-140	4.860E+00	1.920E+00	0.000E+00	0.000E+00	0.000E+00	2.250E+04	0.000E+00	4.930E-01
LA-142	2.040E-11	7.500E-12	0.000E+00	0.000E+00	0.000E+00	1.270E-06	0.000E+00	1.790E-12
CE-141	5.200E+03	3.170E+03	0.000E+00	9.790E+02	0.000E+00	1.640E+06	0.000E+00	3.740E+02
CE-143	4.760E+01	3.160E+04	0.000E+00	9.200E+00	0.000E+00	1.840E+05	0.000E+00	3.600E+00
CE-144	2.790E+05	1.140E+05	0.000E+00	4.620E+04	0.000E+00	1.600E+07	0.000E+00	1.560E+04
PR-143	1.780E+02	6.670E+01	0.000E+00	2.480E+01	0.000E+00	9.410E+04	0.000E+00	8.840E+00
PR-144	6.830E-54	2.640E-54	0.000E+00	9.570E-55	0.000E+00	1.230E-49	0.000E+00	3.440E-55
ND-147	1.060E+02	1.090E+02	0.000E+00	4.190E+01	0.000E+00	6.880E+04	0.000E+00	6.650E+00
W-187	7.300E+03	5.070E+03	0.000E+00	0.000E+00	0.000E+00	2.980E+05	0.000E+00	1.750E+03
NP-239	4.380E+00	3.910E-01	0.000E+00	7.810E-01	0.000E+00	1.130E+04	0.000E+00	2.210E-01

APPENDIX J

R_i Infant Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	INFANT	Pathway:	Inhalation (INHL)			Units:	mrem/yr / $\mu\text{Ci}/\text{m}^3$	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
H-3	0.000E+00	6.470E+02	6.470E+02	6.470E+02	6.470E+02	6.470E+02	0.000E+00	6.470E+02
C-14	2.650E+04	5.310E+03	5.310E+03	5.310E+03	5.310E+03	5.310E+03	0.000E+00	5.310E+03
NA-24	1.060E+04	1.060E+04	1.060E+04	1.060E+04	1.060E+04	1.060E+04	0.000E+00	1.060E+04
P-32	2.030E+06	1.120E+05	0.000E+00	0.000E+00	0.000E+00	1.610E+04	0.000E+00	7.740E+04
CR-51	0.000E+00	0.000E+00	5.750E+01	1.320E+01	1.280E+04	3.570E+02	0.000E+00	8.950E+01
MN-54	0.000E+00	2.530E+04	0.000E+00	4.980E+03	1.000E+06	7.060E+03	0.000E+00	4.980E+03
MN-56	0.000E+00	1.540E+00	0.000E+00	1.100E+00	1.250E+04	7.170E+04	0.000E+00	2.210E-01
FE-55	1.970E+04	1.170E+04	0.000E+00	0.000E+00	8.690E+04	1.090E+03	0.000E+00	3.330E+03
FE-59	1.360E+04	2.350E+04	0.000E+00	0.000E+00	1.010E+06	2.480E+04	0.000E+00	9.480E+03
CO-58	0.000E+00	1.220E+03	0.000E+00	0.000E+00	7.770E+05	1.110E+04	0.000E+00	1.820E+03
CO-60	0.000E+00	8.020E+03	0.000E+00	0.000E+00	4.510E+06	3.190E+04	0.000E+00	1.180E+04
NI-63	3.390E+05	2.040E+04	0.000E+00	0.000E+00	2.090E+05	2.420E+03	0.000E+00	1.160E+04
NI-65	2.390E+00	2.840E-01	0.000E+00	0.000E+00	8.120E+03	5.010E+04	0.000E+00	1.230E-01
CU-64	0.000E+00	1.880E+00	0.000E+00	3.980E+00	9.300E+03	1.500E+04	0.000E+00	7.740E-01
ZN-65	1.930E+04	6.260E+04	0.000E+00	3.250E+04	6.470E+05	5.140E+04	0.000E+00	3.110E+04
ZN-69	5.390E-02	9.670E-02	0.000E+00	4.020E-02	1.470E+03	1.320E+04	0.000E+00	7.180E-03
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.810E+02
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.000E+02
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.040E+01
RB-86	0.000E+00	1.900E+05	0.000E+00	0.000E+00	0.000E+00	3.040E+03	0.000E+00	8.820E+04
RB-88	0.000E+00	5.570E+02	0.000E+00	0.000E+00	0.000E+00	3.390E+02	0.000E+00	2.870E+02
RB-89	0.000E+00	3.210E+02	0.000E+00	0.000E+00	0.000E+00	6.820E+01	0.000E+00	2.060E+02
SR-89	3.980E+05	0.000E+00	0.000E+00	0.000E+00	2.030E+06	6.400E+04	0.000E+00	1.140E+04
SR-90	4.090E+07	0.000E+00	0.000E+00	0.000E+00	1.120E+07	1.310E+05	0.000E+00	2.590E+06
SR-91	9.560E+01	0.000E+00	0.000E+00	0.000E+00	5.260E+04	7.340E+04	0.000E+00	3.460E+00

APPENDIX J

R_i Infant Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	INFANT	Pathway:	Inhalation (INHL)			Units:	mrem/yr / $\mu\text{Ci}/\text{m}^3$	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-92	1.050E+01	0.000E+00	0.000E+00	0.000E+00	2.380E+04	1.400E+05	0.000E+00	3.910E-01
Y-90	3.290E+03	0.000E+00	0.000E+00	0.000E+00	2.690E+05	1.040E+05	0.000E+00	8.820E+01
Y-91	5.880E+05	0.000E+00	0.000E+00	0.000E+00	2.450E+06	7.030E+04	0.000E+00	1.570E+04
Y-91M	4.070E-01	0.000E+00	0.000E+00	0.000E+00	2.790E+03	2.350E+03	0.000E+00	1.390E-02
Y-92	1.640E+01	0.000E+00	0.000E+00	0.000E+00	2.450E+04	1.270E+05	0.000E+00	4.610E-01
Y-93	1.500E+02	0.000E+00	0.000E+00	0.000E+00	7.640E+04	1.670E+05	0.000E+00	4.070E+00
ZR-95	1.150E+05	2.790E+04	0.000E+00	3.110E+04	1.750E+06	2.170E+04	0.000E+00	2.030E+04
ZR-97	1.500E+02	2.560E+01	0.000E+00	2.590E+01	1.100E+05	1.400E+05	0.000E+00	1.170E+01
NB-95	1.570E+04	6.430E+03	0.000E+00	4.720E+03	4.790E+05	1.270E+04	0.000E+00	3.780E+03
MO-99	0.000E+00	1.650E+02	0.000E+00	2.650E+02	1.350E+05	4.870E+04	0.000E+00	3.230E+01
TC-99M	1.400E-03	2.880E-03	0.000E+00	3.110E-02	8.110E+02	2.030E+03	0.000E+00	3.720E-02
TC-101	6.510E-05	8.230E-05	0.000E+00	9.790E-04	5.840E+02	8.440E+02	0.000E+00	8.120E-04
RU-103	2.020E+03	0.000E+00	0.000E+00	4.240E+03	5.520E+05	1.610E+04	0.000E+00	6.790E+02
RU-105	1.220E+00	0.000E+00	0.000E+00	8.990E-01	1.570E+04	4.840E+04	0.000E+00	4.100E-01
RU-106	8.680E+04	0.000E+00	0.000E+00	1.070E+05	1.160E+07	1.640E+05	0.000E+00	1.090E+04
AG-110M	9.980E+03	7.220E+03	0.000E+00	1.090E+04	3.670E+06	3.300E+04	0.000E+00	5.000E+03
TE-125M	4.760E+03	1.990E+03	1.620E+03	0.000E+00	4.470E+05	1.290E+04	0.000E+00	6.580E+02
TE-127	2.230E+00	9.530E-01	1.850E+00	4.860E+00	1.030E+04	2.440E+04	0.000E+00	4.890E-01
TE-127M	1.670E+04	6.900E+03	4.870E+03	3.750E+04	1.310E+06	2.730E+04	0.000E+00	2.070E+03
TE-129	7.880E-02	3.470E-02	6.750E-02	1.750E-01	3.000E+03	2.630E+04	0.000E+00	1.880E-02
TE-129M	1.410E+04	6.090E+03	5.470E+03	3.180E+04	1.680E+06	6.900E+04	0.000E+00	2.230E+03
TE-131	1.740E-02	8.220E-03	1.580E-02	3.990E-02	2.060E+03	8.220E+03	0.000E+00	5.000E-03
TE-131M	1.070E+02	5.500E+01	8.930E+01	2.650E+02	1.990E+05	1.190E+05	0.000E+00	3.630E+01
TE-132	3.720E+02	2.370E+02	2.790E+02	1.030E+03	3.400E+05	4.410E+04	0.000E+00	1.760E+02
I-130	6.360E+03	1.390E+04	1.600E+06	1.530E+04	0.000E+00	1.990E+03	0.000E+00	5.570E+03

APPENDIX J

R_i Infant Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	INFANT	Pathway:	Inhalation (INHL)			Units:	mrem/yr / $\mu\text{Ci}/\text{m}^3$	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
I-131	3.790E+04	4.440E+04	1.480E+07	5.180E+04	0.000E+00	1.060E+03	0.000E+00	1.960E+04
I-132	1.690E+03	3.540E+03	1.690E+05	3.950E+03	0.000E+00	1.900E+03	0.000E+00	1.260E+03
I-133	1.320E+04	1.920E+04	3.560E+06	2.240E+04	0.000E+00	2.160E+03	0.000E+00	5.600E+03
I-134	9.210E+02	1.880E+03	4.450E+04	2.090E+03	0.000E+00	1.290E+03	0.000E+00	6.650E+02
I-135	3.860E+03	7.600E+03	6.960E+05	8.470E+03	0.000E+00	1.830E+03	0.000E+00	2.770E+03
CS-134	3.960E+05	7.030E+05	0.000E+00	1.900E+05	7.970E+04	1.330E+03	0.000E+00	7.450E+04
CS-136	4.830E+04	1.350E+05	0.000E+00	5.640E+04	1.180E+04	1.430E+03	0.000E+00	5.290E+04
CS-137	5.490E+05	6.120E+05	0.000E+00	1.720E+05	7.130E+04	1.330E+03	0.000E+00	4.550E+04
CS-138	5.050E+02	7.810E+02	0.000E+00	4.100E+02	6.540E+01	8.760E+02	0.000E+00	3.980E+02
BA-139	1.480E+00	9.840E-04	0.000E+00	5.920E-04	5.950E+03	5.100E+04	0.000E+00	4.300E-02
BA-140	5.600E+04	5.600E+01	0.000E+00	1.340E+01	1.600E+06	3.840E+04	0.000E+00	2.900E+03
BA-141	1.570E-01	1.080E-04	0.000E+00	6.500E-05	2.970E+03	4.750E+03	0.000E+00	4.970E-03
BA-142	3.980E-02	3.300E-05	0.000E+00	1.900E-05	1.550E+03	6.930E+02	0.000E+00	1.960E-03
LA-140	5.050E+02	2.000E+02	0.000E+00	0.000E+00	1.680E+05	8.480E+04	0.000E+00	5.150E+01
LA-142	1.030E+00	3.770E-01	0.000E+00	0.000E+00	8.220E+03	5.950E+04	0.000E+00	9.040E-02
CE-141	2.770E+04	1.670E+04	0.000E+00	5.250E+03	5.170E+05	2.160E+04	0.000E+00	1.990E+03
CE-143	2.930E+02	1.930E+02	0.000E+00	5.640E+01	1.160E+05	4.970E+04	0.000E+00	2.210E+01
CE-144	3.190E+06	1.210E+06	0.000E+00	5.380E+05	9.840E+06	1.480E+05	0.000E+00	1.760E+05
PR-143	1.400E+04	5.240E+03	0.000E+00	1.970E+03	4.330E+05	3.720E+04	0.000E+00	6.990E+02
PR-144	4.790E-02	1.850E-02	0.000E+00	6.720E-03	1.610E+03	4.280E+03	0.000E+00	2.410E-03
ND-147	7.940E+03	8.130E+03	0.000E+00	3.150E+03	3.220E+05	3.120E+04	0.000E+00	5.000E+02
W-187	1.300E+01	9.020E+00	0.000E+00	0.000E+00	3.960E+04	3.560E+04	0.000E+00	3.120E+00
NP-239	3.710E+02	3.320E+01	0.000E+00	6.620E+01	5.950E+04	2.490E+04	0.000E+00	1.880E+01

APPENDIX J

R_i Infant Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	INFANT	Pathway:	Ground Plane Deposition (GPD)			Units:	m ² ·mrem/yr / μCi/sec	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
H-3	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C-14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NA-24	1.190E+07	1.190E+07	1.190E+07	1.190E+07	1.190E+07	1.190E+07	1.390E+07	1.190E+07
P-32	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CR-51	4.660E+06	4.660E+06	4.660E+06	4.660E+06	4.660E+06	4.660E+06	5.510E+06	4.660E+06
MN-54	1.390E+09	1.390E+09	1.390E+09	1.390E+09	1.390E+09	1.390E+09	1.630E+09	1.390E+09
MN-56	9.020E+05	9.020E+05	9.020E+05	9.020E+05	9.020E+05	9.020E+05	1.070E+06	9.020E+05
FE-55	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
FE-59	2.730E+08	2.730E+08	2.730E+08	2.730E+08	2.730E+08	2.730E+08	3.210E+08	2.730E+08
CO-58	3.790E+08	3.790E+08	3.790E+08	3.790E+08	3.790E+08	3.790E+08	4.440E+08	3.790E+08
CO-60	2.150E+10	2.150E+10	2.150E+10	2.150E+10	2.150E+10	2.150E+10	2.530E+10	2.150E+10
NI-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NI-65	2.970E+05	2.970E+05	2.970E+05	2.970E+05	2.970E+05	2.970E+05	3.450E+05	2.970E+05
CU-64	6.070E+05	6.070E+05	6.070E+05	6.070E+05	6.070E+05	6.070E+05	6.880E+05	6.070E+05
ZN-65	7.470E+08	7.470E+08	7.470E+08	7.470E+08	7.470E+08	7.470E+08	8.590E+08	7.470E+08
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	4.870E+03	4.870E+03	4.870E+03	4.870E+03	4.870E+03	4.870E+03	7.080E+03	4.870E+03
BR-84	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.360E+05	2.030E+05
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	8.990E+06	8.990E+06	8.990E+06	8.990E+06	8.990E+06	8.990E+06	1.030E+07	8.990E+06
RB-88	3.310E+04	3.310E+04	3.310E+04	3.310E+04	3.310E+04	3.310E+04	3.780E+04	3.310E+04
RB-89	1.230E+05	1.230E+05	1.230E+05	1.230E+05	1.230E+05	1.230E+05	1.480E+05	1.230E+05
SR-89	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.510E+04	2.160E+04
SR-90	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-91	2.150E+06	2.150E+06	2.150E+06	2.150E+06	2.150E+06	2.150E+06	2.510E+06	2.150E+06

APPENDIX J

R_i Infant Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	INFANT	Pathway:	Ground Plane Deposition (GPD)			Units:	m ² ·mrem/yr / μCi/sec	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-92	7.770E+05	7.770E+05	7.770E+05	7.770E+05	7.770E+05	7.770E+05	8.630E+05	7.770E+05
Y-90	4.490E+03	4.490E+03	4.490E+03	4.490E+03	4.490E+03	4.490E+03	5.310E+03	4.490E+03
Y-91	1.070E+06	1.070E+06	1.070E+06	1.070E+06	1.070E+06	1.070E+06	1.210E+06	1.070E+06
Y-91M	1.000E+05	1.000E+05	1.000E+05	1.000E+05	1.000E+05	1.000E+05	1.160E+05	1.000E+05
Y-92	1.800E+05	1.800E+05	1.800E+05	1.800E+05	1.800E+05	1.800E+05	2.140E+05	1.800E+05
Y-93	1.830E+05	1.830E+05	1.830E+05	1.830E+05	1.830E+05	1.830E+05	2.510E+05	1.830E+05
ZR-95	2.450E+08	2.450E+08	2.450E+08	2.450E+08	2.450E+08	2.450E+08	2.840E+08	2.450E+08
ZR-97	2.960E+06	2.960E+06	2.960E+06	2.960E+06	2.960E+06	2.960E+06	3.440E+06	2.960E+06
NB-95	1.370E+08	1.370E+08	1.370E+08	1.370E+08	1.370E+08	1.370E+08	1.610E+08	1.370E+08
MO-99	3.990E+06	3.990E+06	3.990E+06	3.990E+06	3.990E+06	3.990E+06	4.630E+06	3.990E+06
TC-99M	1.840E+05	1.840E+05	1.840E+05	1.840E+05	1.840E+05	1.840E+05	2.110E+05	1.840E+05
TC-101	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.260E+04	2.040E+04
RU-103	1.080E+08	1.080E+08	1.080E+08	1.080E+08	1.080E+08	1.080E+08	1.260E+08	1.080E+08
RU-105	6.360E+05	6.360E+05	6.360E+05	6.360E+05	6.360E+05	6.360E+05	7.210E+05	6.360E+05
RU-106	4.220E+08	4.220E+08	4.220E+08	4.220E+08	4.220E+08	4.220E+08	5.070E+08	4.220E+08
AG-110M	3.440E+09	3.440E+09	3.440E+09	3.440E+09	3.440E+09	3.440E+09	4.010E+09	3.440E+09
TE-125M	1.550E+06	1.550E+06	1.550E+06	1.550E+06	1.550E+06	1.550E+06	2.130E+06	1.550E+06
TE-127	2.980E+03	2.980E+03	2.980E+03	2.980E+03	2.980E+03	2.980E+03	3.280E+03	2.980E+03
TE-127M	9.160E+04	9.160E+04	9.160E+04	9.160E+04	9.160E+04	9.160E+04	1.080E+05	9.160E+04
TE-129	2.620E+04	2.620E+04	2.620E+04	2.620E+04	2.620E+04	2.620E+04	3.100E+04	2.620E+04
TE-129M	1.980E+07	1.980E+07	1.980E+07	1.980E+07	1.980E+07	1.980E+07	2.310E+07	1.980E+07
TE-131	2.920E+04	2.920E+04	2.920E+04	2.920E+04	2.920E+04	2.920E+04	3.450E+07	2.920E+04
TE-131M	8.030E+06	8.030E+06	8.030E+06	8.030E+06	8.030E+06	8.030E+06	9.460E+06	8.030E+06
TE-132	4.230E+06	4.230E+06	4.230E+06	4.230E+06	4.230E+06	4.230E+06	4.980E+06	4.230E+06
I-130	5.510E+06	5.510E+06	5.510E+06	5.510E+06	5.510E+06	5.510E+06	6.690E+06	5.510E+06

APPENDIX J

R_i Infant Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	INFANT	Pathway:	Ground Plane Deposition (GPD)			Units:	m ² ·mrem/yr / μCi/sec	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
I-131	1.720E+07	1.720E+07	1.720E+07	1.720E+07	1.720E+07	1.720E+07	2.090E+07	1.720E+07
I-132	1.250E+06	1.250E+06	1.250E+06	1.250E+06	1.250E+06	1.250E+06	1.470E+06	1.250E+06
I-133	2.450E+06	2.450E+06	2.450E+06	2.450E+06	2.450E+06	2.450E+06	2.980E+06	2.450E+06
I-134	4.470E+05	4.470E+05	4.470E+05	4.470E+05	4.470E+05	4.470E+05	5.300E+05	4.470E+05
I-135	2.530E+06	2.530E+06	2.530E+06	2.530E+06	2.530E+06	2.530E+06	2.950E+06	2.530E+06
CS-134	6.860E+09	6.860E+09	6.860E+09	6.860E+09	6.860E+09	6.860E+09	8.000E+09	6.860E+09
CS-136	1.510E+08	1.510E+08	1.510E+08	1.510E+08	1.510E+08	1.510E+08	1.710E+08	1.510E+08
CS-137	1.030E+10	1.030E+10	1.030E+10	1.030E+10	1.030E+10	1.030E+10	1.200E+10	1.030E+10
CS-138	3.590E+05	3.590E+05	3.590E+05	3.590E+05	3.590E+05	3.590E+05	4.100E+05	3.590E+05
BA-139	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.190E+05	1.060E+05
BA-140	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.350E+07	2.050E+07
BA-141	4.170E+04	4.170E+04	4.170E+04	4.170E+04	4.170E+04	4.170E+04	4.750E+04	4.170E+04
BA-142	4.490E+04	4.490E+04	4.490E+04	4.490E+04	4.490E+04	4.490E+04	5.110E+04	4.490E+04
LA-140	1.920E+07	1.920E+07	1.920E+07	1.920E+07	1.920E+07	1.920E+07	2.180E+07	1.920E+07
LA-142	7.600E+05	7.600E+05	7.600E+05	7.600E+05	7.600E+05	7.600E+05	9.120E+05	7.600E+05
CE-141	1.370E+07	1.370E+07	1.370E+07	1.370E+07	1.370E+07	1.370E+07	1.540E+07	1.370E+07
CE-143	2.310E+06	2.310E+06	2.310E+06	2.310E+06	2.310E+06	2.310E+06	2.630E+06	2.310E+06
CE-144	6.950E+07	6.950E+07	6.950E+07	6.950E+07	6.950E+07	6.950E+07	8.040E+07	6.950E+07
PR-143	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR-144	1.830E+03	1.830E+03	1.830E+03	1.830E+03	1.830E+03	1.830E+03	2.110E+03	1.830E+03
ND-147	8.390E+06	8.390E+06	8.390E+06	8.390E+06	8.390E+06	8.390E+06	1.010E+07	8.390E+06
W-187	2.350E+06	2.350E+06	2.350E+06	2.350E+06	2.350E+06	2.350E+06	2.730E+06	2.350E+06
NP-239	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.980E+06	1.710E+06

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.1 Liquid Effluents – Concentration

- COMMITMENT** The concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS (see Figure 16.11.1-1) shall be limited:
- a. For radionuclides other than dissolved or entrained noble gases, 10 times the effluent concentrations specified in 10 CFR Part 20, Appendix B, Table 2, Column 2, and
 - b. For dissolved or entrained noble gases, the concentration shall be limited to 2×10^{-4} microCurie/ml total activity.

APPLICABILITY At all times.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS not within limits.	A.1 Restore the concentration to within limits.	Immediately

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11.1.1 -----NOTE----- The results of the radioactivity analyses shall be used in accordance with the methodology and parameters in the ODCM to assure that the concentrations at the point of release are maintained within the limits. ----- Sample and analyze radioactive liquid wastes according to Table 16.11.1-1.	According to Table 16.11.1-1

TABLE 16.11.1-1
(Page 1 of 3)

RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

LIQUID RELEASE TYPE	SAMPLING FREQUENCY	MINIMUM ANALYSIS FREQUENCY	TYPE OF ACTIVITY ANALYSIS	LOWER LIMIT OF DETECTION (LLD) microCi/ml ⁽¹⁾
1. Batch Waste Release Tanks (WMT and RMT) ⁽⁴⁾	P Each Batch	P Each Batch	Principal Gamma Emitters ⁽⁶⁾	5×10^{-7}
			I-131	1×10^{-6}
	P One Batch/M	M	Dissolved and Entrained Gases (Gamma emitters) ⁽⁷⁾	1×10^{-5}
	P Each Batch	M Composite ⁽²⁾	H-3	1×10^{-5}
			Gross Alpha	1×10^{-7}
	P Each Batch	Q Composite ⁽²⁾	Sr-89, Sr-90	5×10^{-8}
2. Continuous Releases (VUCDT discharge, CWWTS outlet and Turbine Building Sump to RC) ⁽⁵⁾	Continuous ⁽³⁾	W Composite ⁽³⁾	Principal Gamma Emitters ⁽⁶⁾	5×10^{-7}
			I-131	1×10^{-6}
	M Grab Sample	M	Dissolved and Entrained Gases (Gamma emitters) ⁽⁷⁾	1×10^{-5}
	Continuous ⁽³⁾	M Composite ⁽³⁾	H-3	1×10^{-5}
			Gross Alpha	1×10^{-7}
	Continuous ⁽³⁾	Q Composite ⁽³⁾	Sr-89, Sr-90	5×10^{-8}

TABLE 16.11.1-1
(Page 2 of 3)

NOTES:

- (1) The LLD is defined, for purposes of these commitments, 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):

$$LLD = \frac{(2.71/T) + 4.65S_b}{E \cdot V \cdot 2.22 \times 10^6 \cdot Y \cdot \exp(-\lambda\Delta t)}$$

Where:

LLD is the "a priori" lower limit of detection as defined above (as microCurie per unit mass or volume),

S_b is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute),

E is the counting efficiency (as counts per disintegration),

V is the sample size (in units of mass or volume),

2.22×10^6 is the number of disintegrations per minute per microCurie,

Y is the fractional radiochemical yield (when applicable),

λ is the radioactive decay constant for the particular radionuclide,

Δt is the elapsed time between midpoint of sample collection and time of counting (for plant effluents, not environmental samples), and

T is the background and sample counting time in minutes.

Typical values of E, V, Y and Δt shall 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 an a posteriori (after the fact) limit for a particular measurement.

- (2) 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.

TABLE 16.11.1-1
(Page 3 of 3)

- (3) To be representative of the quantities and concentrations of radioactive materials in liquid effluents, samples shall be collected continuously or intermittently in proportion to the rate of flow of the effluent stream. Prior to analyses, all samples taken for the composite shall be thoroughly mixed in order for the composite sample to be representative of the effluent release.
- (4) A batch release is the discharge of liquid wastes of a discrete volume. Prior to sampling for analyses, each batch shall be isolated and thoroughly mixed to assure representative sampling.
- (5) A continuous release is the discharge of liquid wastes of a nondiscrete volume; e.g., from a volume of system that has an input flow during the continuous release.
- (6) 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, and Ce-141. The LLD for Ce-144 is 5×10^{-6} microCi/ml. 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 be identified and reported in the Annual Radioactive Effluent Release Report.
- (7) The principal gas gamma emitters for which the LLD specification applies are Xe-133 and Xe-135. These are the reference nuclides in Regulatory Guide 1.21.

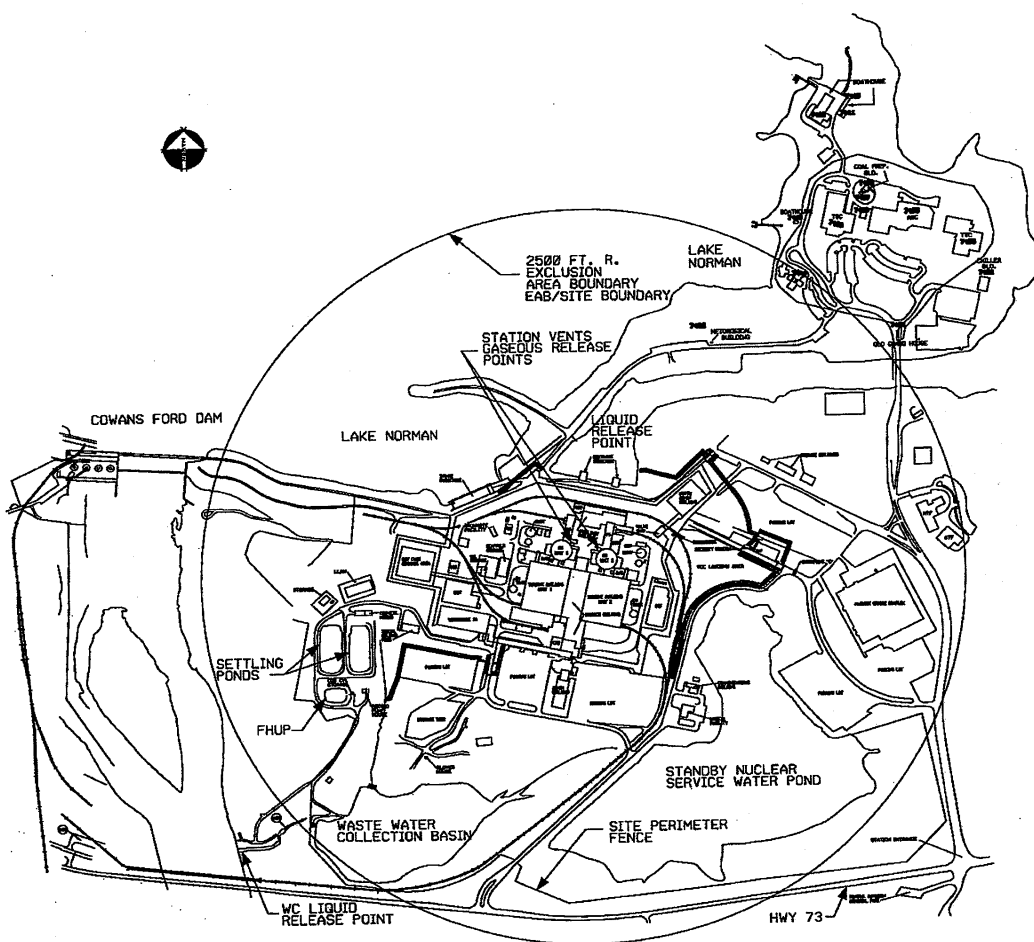


FIGURE 16.11.1-1 SITE BOUNDARY / EXCLUSION AREA BOUNDARY

BASES

This commitment is provided to ensure that the concentration of radioactive materials released in liquid waste effluents to UNRESTRICTED AREAS will be less than 10 times the effluent concentration levels specified in 10 CFR Part 20, Appendix B, Table 2, Column 2. This limitation provides additional 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 Part 50, to a MEMBER OF THE PUBLIC, and (2) the limits of 10 CFR Part 20.1301 to the population. The concentration limit for dissolved or entrained noble gases is based upon the assumption that Xe-135 is the controlling radioisotope and its EC in air (submersion) was converted to an equivalent concentration in water using the methods described in International Commission on Radiological Protection (ICRP) Publication 2. This commitment applies to the release of liquid effluents from all reactors at the site.

The basic requirements for the Selected Licensee Commitments concerning effluents from nuclear power reactors are stated in 10CFR50.36a. These requirements indicate that compliance with effluent Selected Licensee Commitments will keep average annual releases of radioactive material in effluents to small percentages of the limits specified in the old 10CFR20.106 (new 10CFR20.1301). These requirements further indicate that operational flexibility is allowed, compatible with considerations of health and safety, which may temporarily result in releases higher than such small percentages, but still within the limits specified in the old 10CFR20.106 which references Appendix B, Table II concentrations (MPCs). These referenced concentrations are specific values which relate to an annual dose of 500 mrem. It is further indicated in 10CFR50.36a that when using operational flexibility, best efforts shall be exerted to keep levels of radioactive materials in effluents as low as is reasonably achievable (ALARA) as set forth in 10CFR50, Appendix I.

As stated in the Introduction to Appendix B of the new 10CFR20, the effluent concentration (EC) limits given in Appendix B, Table 2, Column 2, are based on an annual dose of 50 mrem. Since a release concentration corresponding to a limiting dose rate of 500 mrem/year has been acceptable as a SLC limit for liquid effluents, which applies at all times as an assurance that the limits of 10CFR50, Appendix I are not likely to be exceeded, it should not be necessary to reduce this limit by a factor of 10.

Operational history at Catawba/McGuire/Oconee has demonstrated that the use of the concentration values associated with the old 10CFR20.106 as SLC limits has resulted in calculated maximum individual doses to members of the public that are small percentages of the limits of 10CFR50, Appendix I. Therefore, the use of concentration values which correspond to an annual dose of 500 mrem should not have a negative impact on the ability to continue to operate within the limits of 10CFR50 Appendix I and 40CFR190.

Having sufficient operational flexibility is especially important in establishing a basis for effluent monitor setpoint calculations. As discussed above, the concentrations stated in the new 10CFR20, Appendix B, Table 2, Column 2, relate to a dose of 50 mrem in a year. When applied on an instantaneous basis, this corresponds to a dose rate of 50 mrem/year. This low value is impractical upon which to base effluent monitor setpoint calculations for many liquid effluent release situations when monitor background, monitor sensitivity, and monitor performance must be taken into account.

BASES (continued)

Therefore, to accommodate operational flexibility needed for effluent releases, the limits associated with SLC 16.11.1 are based on ten times the concentrations stated in the new 10CFR20, Appendix B, Table 2, Column 2 to apply at all times. The multiplier of ten is proposed because the annual dose of 500 mrem, upon which the concentrations in the old 10CFR20, Appendix B, Table II, Column 2 are based, is a factor of ten higher than the annual dose of 50 mrem, upon which the concentrations in the new 10CFR20, Appendix B, Table 2, Column 2, are based. Compliance with the limits of the new 10CFR20.1301 will be demonstrated by operating within the limits of 10CFR50, Appendix I and 40CFR190.

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 HASL Procedures Manual, HASL-300 (revised annually), Currie, L. A., "Limits for Qualitative Detection and Quantitative Determination - Application to Radiochemistry," Anal. Chem. **40**, 586-93 (1968), and Hartwell, J. K., "Detection Limits for Radioanalytical Counting Techniques," Atlantic Richfield Hanford Company Report ARH-SA-215 (June 1975).

REFERENCES

1. McGuire Nuclear Station Offsite Dose Calculation Manual (ODCM)
2. International Commission on Radiological Protection (ICRP) Publication 2

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.2 Radioactive Liquid Effluent Monitoring Instrumentation

COMMITMENT The radioactive liquid effluent monitoring instrumentation channels shown in Table 16.11.2-1 shall be FUNCTIONAL with their Alarm/Trip Setpoints set to ensure that the limits of SLC 16.11.1 are not exceeded.

AND

The Alarm/Trip Setpoints of these channels shall be determined and adjusted in accordance with the methodology and parameters in the OFFSITE DOSE CALCULATION MANUAL (ODCM).

APPLICABILITY As shown in Table 16.11.2-1.

REMEDIAL ACTIONS

-----NOTE-----
Separate Condition entry is allowed for each Function.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or more radioactive liquid effluent monitoring channels Alarm/Trip setpoint less conservative than required.	A.1 Suspend the release of radioactive liquid effluents monitored by the affected channel.	Immediately
	<u>OR</u>	
	A.2 Declare the channel non-functional.	Immediately
	<u>OR</u>	
	A.3 Adjust setpoint to within limit.	Immediately
B. One or more radioactive liquid effluent monitoring instrument channels non-functional.	B.1 Enter the Remedial Action specified in Table 16.11.2-1 for the channel(s).	Immediately

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
C. One channel non-functional.	C.1.1 Analyze two independent samples per TR 16.11.1.1.	Prior to initiating a release
	<u>AND</u>	
	C.1.2 Perform independent verification of the discharge line valving.	Prior to initiating a release
	<u>AND</u>	
	C.1.3.1 Perform independent verification of manual portion of the computer input for the release rate calculations performed by computer.	Prior to initiating a release
	<u>OR</u>	
	C.1.3.2 Perform independent verification of entire release rate calculations for calculations performed manually.	Prior to initiating a release
	<u>AND</u>	
	C.1.4 Restore channel to FUNCTIONAL status.	14 days
	<u>OR</u>	
	C.2 Suspend the release of radioactive effluents via this pathway.	Immediately

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
D. One or more channels non-functional.	D.1 Obtain grab samples from the effluent pathway. <u>AND</u> D.2 Perform an analysis of grab samples for radioactivity. <u>AND</u> D.3 Restore the channel to FUNCTIONAL status.	Once per 12 hours during releases. To meet LLD requirements per Table 16.11.1-1. 30 days
E. One or more flow rate measurement channels non-functional.	E.1 -----NOTE----- Pump performance curves generated in place may be used to estimate flow. ----- Estimate the flow rate of the release. <u>AND</u> E.2 Restore the channel to FUNCTIONAL status.	Once per 4 hours during releases 30 days
F. RC minimum flow interlock non-functional.	F.1 Verify that the number of pumps providing dilution is greater than or equal to the number of pumps required. <u>AND</u> F.2 Restore the channel to FUNCTIONAL status.	Once per 4 hours during releases 30 days

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
G. Required Action and associated Completion Time of Condition C, D, E or F not met.	G.1 Explain why the non-functionality was not corrected within the specified Completion Time in the Annual Radioactive Effluent Release Report.	In the next scheduled Annual Radioactive Effluent Release Report

TESTING REQUIREMENTS

-----NOTE-----
Refer to Table 16.11.2-1 to determine which TRs apply for each Radioactive Liquid Effluent Monitoring channel.

TEST	FREQUENCY
TR 16.11.2.1 Perform CHANNEL CHECK.	24 hours
TR 16.11.2.2 -----NOTE----- The CHANNEL CHECK shall consist of verifying indication of flow. ----- Perform CHANNEL CHECK.	Every 24 hours during periods of release
TR 16.11.2.3 Perform SOURCE CHECK.	Prior to each release
TR 16.11.2.4 Perform SOURCE CHECK.	31 days
TR 16.11.2.5 Perform CHANNEL OPERATIONAL TEST.	9 months
TR 16.11.2.6 Perform a CHANNEL CALIBRATION.	18 months

(continued)

TESTING REQUIREMENTS (continued)

TEST	FREQUENCY
TR 16.11.2.7 -----NOTE----- The initial CHANNEL CALIBRATION shall be performed using standards certified by the National Institute of Standards and Technology (NIST) or using standards 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.	24 months
TR 16.11.2.8 -----NOTES----- 1. For Instrument 1, the COT shall also demonstrate that automatic isolation of the pathway occurs if the instrument indicates measured levels above the Alarm/Trip Setpoint. 2. For Instruments 1 and 2, the COT shall also demonstrate that control room alarm annunciation occurs if the instrument indicates measured levels above the Alarm/Trip Setpoint; circuit failure and, a downscale failure. ----- Perform a CHANNEL OPERATIONAL TEST	12 months

TABLE 16.11.2-1

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENT	MINIMUM CHANNELS FUNCTIONAL	REMEDIAL ACTION	APPLICABILITY	TESTING REQUIREMENTS
1. Radioactivity Monitors Providing Alarm And Automatic Termination of Release				
a. Waste Liquid Effluent Line (EMF-49, low range)	1 per station	A, C, G	During liquid effluent releases	TR 16.11.2.1 TR 16.11.2.3 TR 16.11.2.8 TR 16.11.2.7
b. EMF-49 Minimum Flow Device (2)	1 per station	C, G	During liquid effluent releases	TR 16.11.2.8 TR 16.11.2.7
c. Containment Ventilation Unit Condensate Line (EMF-44, low range)	1	A, D, G	At all times	TR 16.11.2.1 TR 16.11.2.4 TR 16.11.2.8 TR 16.11.2.7
d. EMF-44 Minimum Flow Device (2)	1	D, G	At all times	TR 16.11.2.8 TR 16.11.2.7
2. Radioactivity Monitors Providing Alarm But Not Automatic Termination of Release				
a. Conventional Waste Water Treatment Line or Turbine Building Sump to RC (EMF- 31)	1	A, D, G	At all times	TR 16.11.2.1 TR 16.11.2.4 TR 16.11.2.8 TR 16.11.2.7
b. EMF-31 Minimum Flow Device (2)	1	D, G	At all times	TR 16.11.2.8 TR 16.11.2.7
3. Continuous Composite Samplers				
a. Containment Ventilation Unit Condensate Line	1	D, G	At all times	TR 16.11.2.2 TR 16.11.2.5 TR 16.11.2.6
b. Conventional Waste Water Treatment Line	1 per station	D, G	At all times	TR 16.11.2.2 TR 16.11.2.5 TR 16.11.2.6
c. Turbine Building Sump to RC	1	D, G	At all times	TR 16.11.2.2 TR 16.11.2.6

(Continued)

4. Flow Rate Measurement Devices				
a. Waste Liquid Effluent Line	1 per station	E, G	During liquid effluent releases	TR 16.11.2.2 TR 16.11.2.5 TR 16.11.2.6
b. Containment Ventilation Unit Condensate Line	1	E, G	At all times	TR 16.11.2.2 TR 16.11.2.5 TR 16.11.2.6
c. Conventional Waste Water Treatment Line	1 per station	E, G	At all times	TR 16.11.2.2 TR 16.11.2.5 TR 16.11.2.6
d. Turbine Building Sump to RC	1	E, G	At all times	TR 16.11.2.2 TR 16.11.2.6
5. RC Minimum Flow Interlock (1)	1 per station	F, G	At all times	TR 16.11.2.5

NOTES:

1. Minimum flow dilution is assured by an interlock which terminates waste liquid release if the number of RC pumps running falls below the number of pumps required for dilution. The required number of RC pumps for dilution is determined per station procedures.
2. Radioactivity Monitor (EMF) shall not be declared functional unless both the EMF and the associated EMF's Minimum Flow Device are rendered functional.

BASES

The radioactive liquid effluent 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 minimum flow devices for EMFs listed in Table 16.11.2-1 are required to provide assurance of representative sampling during actual or potential releases of liquid effluents. An interlock between the EMF's minimum flow device and its associated flow rate measurement device disables the remove alarm during non-release timeframes for the purpose of the control room black board annunciator criteria that disable expected alarms. An EMF flow rate measurement device measures total flow of the effluent while the EMF minimum flow device measures the sample flow rate through the EMF. The Alarm/Trip Setpoints of these instruments shall be calculated and adjusted in accordance with the methodology and parameters in the ODCM to ensure that the Alarm/Trip will occur prior to exceeding the limits stated in SLC 16.11.1. 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. The Turbine Building Sump to RC Discharge Flow Measurement and Sampler Devices are for monitoring only and do not alarm or have any controls that require a COT.

REFERENCES

1. McGuire Nuclear Station Offsite Dose Calculation Manual (ODCM)
2. 10 CFR Part 50, Appendix A

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.3 Dose - Liquid Effluents

COMMITMENT The dose or dose commitment to a MEMBER OF THE PUBLIC from radioactive materials in liquid effluents released from each unit to UNRESTRICTED AREAS (see Figure 16.11.1-1) shall be limited:

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

APPLICABILITY At all times.

REMEDIAL ACTIONS

NOTES

Enter applicable Conditions and Required Actions of SLC 16.11.12, "Total Dose," when the limits of this SLC are exceeded by twice the specified limit.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Calculated dose from release of radioactive materials in liquid effluents exceeding above limits.	-----NOTE----- The Special Report shall include the results of radiological analyses of the drinking water source, and the radiological impact on finished drinking water supplies with regard to the requirements of 40 CFR 141, Safe Drinking Water Act, as applicable. ----- A.1 Prepare and submit a Special Report to the NRC which identifies the causes for exceeding the limits, corrective actions taken to reduce releases, and actions taken to ensure that subsequent releases are within limits.	30 days

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11.3.1 Determine cumulative dose contributions from liquid effluents for current calendar quarter and current calendar year in accordance with the methodology and parameters in the ODCM.	31 days

BASES

This commitment is provided to implement the requirements of Sections II.A, III.A and IV.A of Appendix I, 10 CFR Part 50. The commitment implements the guides set forth in Section II.A of Appendix I. The REMEDIAL 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 liquid effluents to UNRESTRICTED AREAS will be kept "as low as is reasonably achievable." Also, for fresh water sites with drinking water supplies that 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 Part 141. These requirements are applicable only if the drinking water supply is taken from the river 3 miles downstream of the plant discharge.

The dose calculation methodology and parameters 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. 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 Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I," April 1977.

This commitment applies to the release of liquid effluents from each unit at the site. For units with shared Radwaste Treatment Systems, the liquid effluents from the shared system are to be proportioned among the units sharing that system in accordance with the guidance given in NUREG-0133, Chapter 3.1.

REFERENCES

1. McGuire Nuclear Station, Off site Dose Calculation Manual
2. 40 CFR Part 141, Safe Drinking Water Act
3. 10 CFR Part 50, Appendix I
4. 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.
5. Regulatory Guide 1.113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I," April 1977.

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.4 Liquid Radwaste Treatment System

COMMITMENT The Liquid Radwaste Treatment System shall be FUNCTIONAL and appropriate portions of the system shall be used to reduce releases of radioactivity when the projected doses due to the liquid effluent from each unit to UNRESTRICTED AREAS (see Figure 16.11.1-1) would exceed 0.06 mrem to the total body or 0.2 mrem to any organ in a 31 day period.

APPLICABILITY At all times.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Radioactive liquid waste being discharged without treatment and in excess of above limits. <u>AND</u> Any portion of Liquid Radwaste Treatment System not in operation.	A.1 Prepare and submit a Special Report to the NRC which identifies the reasons liquid radwaste was discharged without treatment, identification of non-functional equipment and reasons for non-functionality, corrective actions taken to restore the equipment to FUNCTIONAL status, and actions taken to prevent recurrence.	30 days

TESTING REQUIREMENTS

NOTE

The Liquid Radwaste Treatment System shall be demonstrated FUNCTIONAL by meeting SLC 16.11.1 and 16.11.3.

TEST	FREQUENCY
TR 16.11.4.1 Project liquid release doses from each unit to UNRESTRICTED AREAS, in accordance with the methodology and parameters in the ODCM, when water systems are being released without being processed by its radwaste treatment system.	31 days

BASES

The requirement 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 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 objective given in Section II.D of Appendix I to 10 CFR Part 50. The specified limits 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.

This commitment applies to the release of liquid effluents from each reactor at the site. For units with shared Radwaste Treatment Systems, the liquid effluents from the shared system are to be proportioned among the units sharing that system in accordance with the guidance given in NUREG-0133, Chapter 3.1.

REFERENCES

1. McGuire Nuclear Station, Off site Dose Calculation Manual
2. 10 CFR Part 50
3. 10 CFR Part 50, Appendix I

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.5 Chemical Treatment Ponds

COMMITMENT The quantity of radioactive material contained in each chemical treatment pond shall be limited by the following expression (excluding tritium and dissolved or entrained noble gases):

$$\frac{264}{V} \cdot \sum_j \frac{A_j}{(C_j \times 10)} < 1.0$$

Where:

A_j = pond inventory limit for single radionuclide "j", in Curies

C_j = 10 CFR 20, Appendix B, Table 2, Column 2, concentration for single radionuclide "j", microCuries/ml;

V = design volume of liquid and slurry in the pond, in gallons; and

264 = conversion unit, microCuries/Curie per milliliter/gallon.

APPLICABILITY At all times.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Quantity of radioactive material in any of the chemical treatment ponds exceeding above limit.	A.1 Suspend all additions of radioactive material to the pond.	Immediately
	<u>AND</u> A.2 Initiate corrective action to reduce the pond contents to within limits.	Immediately

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11.5.1 Verify quantity of radioactive material in each batch of slurry (powdex resin) to be transferred to chemical treatment ponds is within limits by analyzing a representative sample of the slurry. Each batch to be transferred to the chemical treatment ponds is limited by: $\sum_j \frac{Q_j}{(C_j \times 10)} < 6.0 \times 10^5 \frac{pCi / gm}{\mu Ci / ml}$	Prior to each transfer

BASES

The inventory limits of the chemical treatment ponds (CTP) are based on limiting the consequences of an uncontrolled release of the pond inventory. The expression in SLC 16.11.5 assumes the pond inventory is uniformly mixed, that the pond is located in an uncontrolled area as defined in 10 CFR Part 20, and that the concentration limit in Note 4 to Appendix B of 10 CFR Part 20 applies.

The batch limits of slurry to the chemical treatment ponds assure that radioactive material in the slurry transferred to the CTP are "as low as is reasonably achievable" in accordance with 10 CFR Part 50.36a. The expression in SLC 16.11.5 assures no batch of slurry will be transferred to the CTP unless the sum-of the ratios of the activity of the radionuclides to their respective concentration limitation is less than the ratio of the 10 CFR Part 50, Appendix I, Section II.A, total body dose level to the instantaneous whole body dose rate limitation, or that:

$$\sum_j \frac{c_j}{(C_j \times 10)} < \frac{3 \text{ mrem} / \text{yr}}{500 \text{ mrem} / \text{yr}} = 0.006$$

Where:

c_j = Radioactive slurry concentration for radionuclide "j" entering the UNRESTRICTED AREA chemical treatment ponds, in microCuries/milliliter; and

C_j = 10 CFR 20, Appendix B, Table 2, Column 2, concentration for single radionuclide "j", in microCuries/milliliter.

BASES (continued)

For the design of filter/demineralizers using powder resin, the slurry wash volume and the weight of resin used per batch is fixed by the cell surface area, and the slurry volume to resin weight ratio is constant at 100 ml/gram of wet, drained resin with a moisture content of approximately 55 to 60% (bulk density of about 58 pounds per cubic feet). Therefore,

$$\sum_j \frac{c_j}{(C_j \times 10)} = \sum_j \frac{Q_j}{(C_j \times 10) (10^2 \text{ ml / gm}) (10^6 \text{ pCi / } \mu\text{Ci})} < 0.006, \text{ and}$$

$$\sum_j \frac{Q_j}{(C_j \times 10)} < 6.0 \times 10^5 \frac{\text{pCi / gm}}{\mu\text{Ci / ml}}$$

Where:

Q_j = concentration of radioactive materials in wet, drained slurry (powdex resin) for radionuclide "j", excluding tritium, dissolved or entrained noble gases, and radionuclides with less than an 8-day half-life. The analysis shall include at least Ce-144, Cs-134, Cs-137, Co-58 and Co-60, in picoCuries/gram. Estimates of the Sr-89 and Sr-90 batch concentration shall be included based on the most recent monthly composite analysis (within 3 months); and

C_j = 10 CFR 20, Appendix B, Table 2, Column 2, concentration for single radionuclide "j", in microCuries/milliliter.

The batch limits provide assurance that activity input to the chemical treatment ponds will be minimized, and a means of identifying radioactive material in the inventory limitation of SLC 16.11.5.

The basic requirements for the Selected Licensee Commitments concerning effluents from nuclear power reactors are stated in 10CFR50.36a. These requirements indicate that compliance with effluent Selected Licensee Commitments will keep average annual releases of radioactive material in effluents to small percentages of the limits specified in the old 10CFR20.106 (new 10CFR20.1301). These requirements further indicate that operational flexibility is allowed, compatible with considerations of health and safety, which may temporarily result in releases higher than such small percentages, but still within the limits specified in the old 10CFR20.106 which references Appendix B, Table II concentrations- (MPCs). These referenced concentrations are specific values which relate to an annual dose of 500 mrem. It is further indicated in 10CFR50.36a that when using operational flexibility, best efforts shall be exerted to keep levels of radioactive materials in effluents as low as is reasonably achievable (ALARA) as set forth in 10CFR50, Appendix I.

BASES (continued)

As stated in the Introduction to Appendix B of the new 10CFR20, the effluent concentration (EC) limits given in Appendix B, Table 2, Column 2, are based on an annual dose of 50 mrem. Since a release concentration corresponding to a limiting dose rate of 500 mrem/year has been acceptable as a SLC limit for liquid effluents, which applies at all times as an assurance that the limits of 10CFR50, Appendix I are not likely to be exceeded, it should not be necessary to reduce this limit by a factor of 10.

Operational history at Catawba/McGuire/Oconee has demonstrated that the use of the concentration values associated with the old 10CFR20.106 as SLC limits has resulted in calculated maximum individual doses to members of the public that are small percentages of the limits of 10CFR50, Appendix I. Therefore, the use of concentration values which correspond to an annual dose of 500 mrem should not have a negative impact on the ability to continue to operate within the limits of 10CFR50, Appendix I and 40CFR190.

Having sufficient operational flexibility is especially important in establishing a basis for effluent monitor setpoint calculations. As discussed above, the concentrations stated in the new 10CFR20, Appendix B, Table 2, Column 2, relate to a dose of 50 mrem in a year. When applied on an instantaneous basis, this corresponds to a dose rate of 50 mrem/year. This low value is impractical upon which to base effluent monitor setpoint calculations for many liquid effluent release situations when monitor background, monitor sensitivity, and monitor performance must be taken into account.

Therefore, to accommodate operational flexibility needed for effluent releases, the limits associated with SLC 16.11.1 are based on ten times the concentrations stated in the new 10CFR20, Appendix B, Table 2, Column 2 to apply at all times. The multiplier of ten is proposed because the annual dose of 500 mrem, upon which the concentrations in the old 10CFR20, Appendix B, Table II, Column 2 are based, is a factor of ten higher than the annual dose of 50 mrem, upon which the concentrations in the new 10CFR20, Appendix B, Table 2, Column 2, are based. Compliance with the limits of the new 10CFR20.1301 will be demonstrated by operating within the limits of 10CFR50, Appendix I and 40CFR190.

REFERENCES

1. McGuire Nuclear Station, Off site Dose Calculation Manual
2. 10 CFR 20, Appendix B
3. 10 CFR 50, Appendix I, Section II.A
4. 10 CFR 20
5. 10 CFR 50.36a

16.11 RADIOLOGICAL EFFLUENT CONTROL

16.11.6 Dose Rate - Gaseous Effluents

COMMITMENT The dose rate due to radioactive materials released in gaseous effluents from the site to areas at and beyond the SITE BOUNDARY (see Figure 16.11.1-1) shall be limited to the following:

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

APPLICABILITY At all times.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Dose rate not within limit.	A.1 Restore the release rate to within limits.	Immediately

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11.6.1 Verify dose rates due to noble gases in gaseous effluents are within limits in accordance with the methodology and parameters in the ODCM.	In accordance with the ODCM
TR 16.11.6.2 Verify dose rates due to radioactive materials, other than noble gases, in gaseous effluents are within limits in accordance with the methodology and parameters in the ODCM by obtaining representative samples and performing analyses in accordance with Table 16.11.6-1.	In accordance with Table 16.11.6-1

TABLE 16.11.6-1
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RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM

Gaseous Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) ⁽¹⁾ (μCi/ml)
1. Waste Gas Storage Tanks	P Each Tank Grab Sample	P Each Tank	Principal Gas Gamma Emitters ⁽⁶⁾	1x10 ⁻⁴
2. Containment Purge	P Each PURGE Grab Sample	P Each PURGE	Principal Gas Gamma Emitters ⁽⁶⁾	1x10 ⁻⁴
		M	H-3	1x10 ⁻⁶
3. Unit Vent	W ⁽²⁾ Grab Sample	W	Principal Gas Gamma Emitters ⁽⁶⁾	1x10 ⁻⁴
			H-3	1x10 ⁻⁶
4.a. Radwaste Facility Vent	W Grab Sample	W	Principal Gas Gamma Emitters ⁽⁶⁾	1x10 ⁻⁴
b. Waste Handling Building			H-3	1x10 ⁻⁶
c. Equipment Staging Building				
5. Unit Vents	Continuous ⁽⁶⁾	W ⁽⁸⁾ Charcoal Sample	I-131	1x10 ⁻¹²
			I-133	1x10 ⁻¹⁰
	Continuous ⁽⁶⁾	W ⁽⁸⁾ Particulate Sample	Principal Gamma Emitters ⁽⁶⁾ (I-131, Others)	1x10 ⁻¹¹
	Continuous ⁽⁶⁾	M Composite Particulate Sample	Gross Alpha ⁽⁷⁾	1x10 ⁻¹¹
	Continuous ⁽⁶⁾	Q Composite Particulate Sample	Sr-89, Sr-90	1x10 ⁻¹¹

TABLE 16.11.6-1
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RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM

Gaseous Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) ⁽¹⁾ ($\mu\text{Ci/ml}$)
6. All Release Types as listed in 4 above.	Continuous ⁽⁶⁾	W ⁽⁸⁾ Charcoal Sample	I-131	1×10^{-12}
			I-133	1×10^{-10}
	Continuous ⁽⁶⁾	W ⁽⁸⁾ Particulate Sample	Principal Gamma Emitters ⁽⁶⁾ (I-131, Others)	1×10^{-11}
	Continuous ⁽⁶⁾	M Composite Particulate Sample	Gross Alpha ⁽⁷⁾	1×10^{-11}
	Continuous ⁽⁶⁾	Q Composite Particulate Sample	Sr-89, Sr-90	1×10^{-11}

TABLE 16.11.6-1
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NOTES:

1. The LLD is defined, for purposes of these commitments, 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):

$$LLD = \frac{(2.71/T) + 4.65S_b}{E \cdot V \cdot 2.22 \times 10^6 \cdot Y \cdot \exp(-\lambda\Delta t)}$$

Where:

LLD = the "a priori" lower limit of detection as defined above (as microCurie per unit mass or volume);

S_b = the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute);

E = the counting efficiency (as counts per disintegration);

V = the sample size (in units of mass or volume);

2.22×10^6 = the number of disintegrations per minute per microCurie;

Y = the fractional radiochemical yield (when applicable);

λ = the radioactive decay constant for the particular radionuclide;

Δt = the elapsed time between midpoint of sample collection and time of counting (for plant effluents, not environmental samples); and

T = The background and sample counting time in minutes.

Typical values of E , V , Y and Δt shall 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 an "a posteriori" (after the fact) limit for a particular measurement.

TABLE 16.11.6-1
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NOTES:

2. Tritium grab samples shall be taken at least once per 24 hours when the refueling canal is flooded.
3. Not used.
4. Not used.
5. The ratio of the sample flow volume to the sampled stream flow volume shall be known for the time period covered by each dose or dose rate calculation made in accordance with SLCs 16.11.6, 16.11.8 and 16.11.9.
6. The principal gamma emitters for which the LLD specification applies include the following radionuclides: Kr-87, Kr-88, Xe-133, Xe-133m, Xe-135, and Xe-138 in noble gas releases and Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, I-131, Cs-134, Cs-137, and Ce-141 in iodine and particulate releases. The LLD for Ce-144 is 5×10^{-9} microCi/ml. This list does not mean that only these nuclides are to be considered. Other gamma peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Annual Radioactive Effluent Release Report.
7. The composite filter(s) will be analyzed for alpha activity by analyzing the filter media used during the collection period.
8. Samples shall be changed at least once per 7 days and analyses shall be completed to meet LLD after changing, or after removal from sampler. If the particulate and charcoal sample frequency is changed to a 24 hour frequency the corresponding LLDs may be increased by a factor of 10 (i.e., LLD for I-131 from 1×10^{-12} to 1×10^{-11} microCi/ml).

BASES

Specific release rate limits restrict, at all times, the corresponding gamma and beta 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 whole body, and 3000 mrem/year to the skin from noble gases, and 1500 mrem/year to any organ from Iodine 131, Iodine 133, tritium, and all radionuclides in particulate form with half-lives greater than eight days. This commitment applies to the release of gaseous effluents from all reactors at the site. The Exclusion Area Boundary (Site Boundary) is set as the boundary for gaseous effluent release limits. The Exclusion Area Boundary (EAB) is formed by a 2500 ft radius centered on the Reactor Buildings' centerlines as shown on Figure 16.11.1-1.

The basic requirements for the Selected Licensee Commitments concerning effluents from nuclear power reactors are stated in 10CFR50.36a. These requirements indicate that compliance with effluent Selected Licensee Commitments will keep average annual releases of radioactive material in effluents to small percentages of the limits specified in the old 10CFR20.106 (new 10CFR20.1301). These requirements further indicate that operational flexibility is allowed, compatible with considerations of health and safety, which may temporarily result in releases higher than such small percentages, but still within the limits specified in the old 10CFR20.106 which references Appendix B, Table II concentrations (MPCs). These referenced concentrations are specific values which relate to an annual dose of 500 mrem. It is further indicated in 10CFR50.36a that when using operational flexibility, best efforts shall be exerted to keep levels of radioactive materials in effluents as low as is reasonably achievable (ALARA) as set forth in 10CFR50, Appendix I.

As stated in the Introduction to Appendix B of the new 10CFR20, the effluent concentration (EC) limits given in Appendix B, Table 2, Column 1, are based on an annual dose of 50 mrem for isotopes for which inhalation or ingestion is limiting or 100 mrem for isotopes for which submersion (noble gases) is limiting. Since release concentrations corresponding to limiting dose rates of less than or equal to 500 mrem/year to the whole body, 3000 mrem/year to the skin from noble gases, and 1500 mrem/year to any organ from Iodine 131, Iodine 133, tritium and for all radionuclides in particulate form with half-lives greater than eight days at the site boundary has been acceptable as a SLC limit for gaseous effluents to assure that the limits of 10CFR50, Appendix I and 40CFR190 are not likely to be exceeded, it should not be necessary to restrict the operational flexibility by incorporating the EC value for isotopes based on ingestion/inhalation (50 mrem/year) or for isotopes with the EC based on submersion (100 mrem/year).

Having sufficient operational flexibility is especially important in establishing a basis for effluent monitor setpoint calculations. As discussed above, the concentrations stated in the new 10CFR20, Appendix B, Table 2, Column 1, relate to a dose of 50 or 100 mrem in a year. When applied on an instantaneous basis, this corresponds to a dose rate of either 50 or 100 mrem/year. These low values are impractical upon which to base effluent monitor setpoint calculations for many effluent release situations when monitor background, monitor sensitivity, and monitor performance must be taken into account. Therefore, to accommodate operational flexibility needed for effluent releases, the limits associated with SLC 16.11.6 will be maintained at the current dose rate limit for noble gases of 500 mrem/year to the whole body and 3000 mrem/year to the skin, for Iodine 131, Iodine 133, tritium and all radionuclides in particulate form with half-lives greater than eight days an instantaneous dose rate limit of 1500 mrem/year to any organ.

BASES (continued)

Compliance with the limits of the new 10CFR20.1301 will be demonstrated by operating within the limits of 10CFR50, Appendix I and 40CFR190. Operational history at Catawba/McGuire/Oconee has demonstrated that the use of the dose rate values listed above (i.e. 500 mrem/year, 3000 mrem/year and 1500 mrem/year) as SLC limits has resulted in calculated maximum individual doses to members of the public that are small percentages of the limits of 10CFR50, Appendix I and 40CFR190.

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 HASL Procedures Manual, HASL-300 (revised annually), Currie, L.A., "Limits for Qualitative Detection and Quantitative Determination - Application to Radiochemistry," Anal. Chem. **40**, 586-93 (1968), and Hartwell, J. K. "Detection Limits for Radioanalytical Counting Techniques," Atlantic Richfield Hanford Company Report ARH-SA-215 (June 1975).

REFERENCES

1. McGuire Nuclear Station, Off site Dose Calculation Manual
2. 10 CFR Part 20, Appendix B
3. 10 CFR Part 20
4. 10 CFR Part 50

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.7 Radioactive Gaseous Effluent Monitoring Instrumentation

COMMITMENT The radioactive gaseous effluent monitoring instrumentation channels shown in Table 16.11.7-1 shall be FUNCTIONAL with Alarm/Trip Setpoints set to ensure that the limits of SLC 16.11.6 are not exceeded.

AND

The Alarm/Trip setpoints shall be determined and adjusted in accordance with the methodology and parameters in the ODCM.

-----NOTE-----
Brief periods of routine sampling (not to exceed 15 minutes) do not make the instrumentation non-functional.

APPLICABILITY As shown in Table 16.11.7-1.

REMEDIAL ACTIONS

-----NOTE-----
Separate Condition entry is allowed for each Function.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or more radioactive gaseous effluent monitoring channels Alarm/Trip setpoint less conservative than required.	A.1 Suspend the release of radioactive gaseous effluents monitored by the affected channel.	Immediately
	<u>OR</u>	
	A.2 Declare the channel non-functional.	Immediately
	<u>OR</u>	
	A.3 Adjust setpoint to within limit.	Immediately

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
B. One or more radioactive gaseous effluent monitoring instrument channels non-functional.	B.1 Enter the Remedial Action specified in Table 16.11.7-1 for the channel(s).	Immediately
C. One channel non-functional.	C.1.1 Analyze two independent samples of the tank contents. <u>AND</u> C.1.2 Perform independent verification of the discharge valve lineup. <u>AND</u> C.1.3.1 Perform independent verification of manual portion of the computer input for the release rate calculations performed by computer. <u>OR</u> C.1.3.2 Perform independent verification of entire release rate calculations for calculations performed manually. <u>AND</u> C.1.4 Restore channel to FUNCTIONAL status. <u>OR</u> C.2 Suspend the release of radioactive effluents via this pathway.	Prior to initiating a release Prior to initiating a release Prior to initiating a release Prior to initiating a release 14 days Immediately

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
D. One or more flow rate measurement channels non-functional.	D.1 Estimate the flow rate of the release. <u>AND</u> D.2 Restore the channel to FUNCTIONAL status.	Once per 4 hours during releases 30 days
E. One or more noble gas activity monitor channels non-functional.	E.1 Obtain grab samples from the effluent pathway. <u>AND</u> E.2 Perform an analysis of grab samples for radioactivity. <u>AND</u> E.3 Restore the channel to FUNCTIONAL status.	Once per 12 hours during releases To meet LLD requirements per Table 16.11.6-1 30 days
F. Noble gas activity monitor providing automatic termination of release non-functional.	F.1 Suspend PURGING or VENTING of radioactive effluents via this pathway.	Immediately
G. One or more sampler channels non-functional.	G.1 Perform sampling with auxiliary sampling equipment as required by Table 16.11.6-1. <u>AND</u> G.2 Restore the channel to FUNCTIONAL status.	Continuously 30 days

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
H. One or more Sampler Minimum Flow Device Channels non-functional.	H.1 Verify flow through the sampling apparatus.	Once per 4 hours during releases
	<u>AND</u> H.2 Restore the channel to FUNCTIONAL status.	30 days
I. Required Action and associated Completion Time of Condition C, D, E, F, G, or H not met.	I.1 Explain why the non-functionality was not corrected within the specified Completion Time in the Annual Radioactive Effluent Release Report.	In the next scheduled Annual Radioactive Effluent Release Report

TESTING REQUIREMENTS

-----NOTE-----

Refer to Table 16.11.7-1 to determine which TRs apply for each Radioactive Gaseous Effluent Monitoring channel.

TEST	FREQUENCY
TR 16.11.7.1 Perform CHANNEL CHECK.	Prior to each release
TR 16.11.7.2 -----NOTE----- The SOURCE CHECK for these channels shall be the qualitative assessment of channel response when the channel sensor is exposed to a source of increased radioactivity or a simulated source of radioactivity such as a light emitting diode. ----- Perform SOURCE CHECK.	Prior to each release
TR 16.11.7.3 Perform CHANNEL CHECK.	24 hours
TR 16.11.7.4 Perform CHANNEL CHECK.	7 days

(continued)

TESTING REQUIREMENTS (continued)

TEST	FREQUENCY
TR 16.11.7.5 -----NOTE----- The SOURCE CHECK for these channels shall be the qualitative assessment of channel response when the channel sensor is exposed to a source of increased radioactivity or a simulated source of radioactivity such as a light emitting diode. ----- Perform SOURCE CHECK.	31 days
TR 16.11.7.6 -----NOTES----- 1. For noble gas activity monitors providing automatic termination of release, the COT shall also demonstrate that automatic isolation of the pathway occurs if the instrument indicates measured levels above the Alarm/Trip Setpoint. 2. For all noble gas activity monitors, the COT shall also demonstrate that control room alarm annunciation occurs if the instrument indicates measured levels above the Alarm/Trip Setpoint; circuit failure, or a downscale failure. ----- Perform CHANNEL OPERATIONAL TEST.	9 months
TR 16.11.7.7 -----NOTE----- For all noble gas activity monitors, the initial CHANNEL CALIBRATION shall be performed using standards certified by the National Institute of Standards and Technology (NIST) or using standards 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

TR 16.11.7.8 -----NOTE----- 1. For noble gas activity monitors providing automatic termination of release, the COT shall also demonstrate that automatic isolation of the pathway occurs if the instrument indicates measured levels above the Alarm/Trip Setpoint. 2. For all noble gas activity monitors, the COT shall also demonstrate that control room alarm annunciation occurs if the instrument indicates measured levels above the Alarm/Trip Setpoint, circuit failure, or a downscale failure. ----- Perform CHANNEL OPERATIONAL TEST.	92 days

TABLE 16.11.7-1
(Page 1 of 3)

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENTS	MINIMUM CHANNELS FUNCTIONAL	REMEDIAL ACTION	APPLICABILITY	TESTING REQUIREMENTS
1. WASTE GAS HOLDUP SYSTEM				
a. Noble Gas Activity Monitor - Providing Alarm and Automatic Termination of Release (0EMF-50L or 1EMF-36L)	1 per station	A, C, I	During gas effluent releases.	TR 16.11.7.1 TR 16.11.7.2 TR 16.11.7.6 TR 16.11.7.7
b. Effluent System Flow Rate Measuring Device	1 per station	D, I	At all times except when isolation valve is closed & locked.	TR 16.11.7.3 TR 16.11.7.6 TR 16.11.7.7
2. Condenser Evacuation System - Noble Gas Activity Monitor (EMF-33)	1	A, E, I	When air ejectors are operable.	TR 16.11.7.3 TR 16.11.7.5 TR 16.11.7.6 TR 16.11.7.7
3. Vent System				
a. Noble Gas Activity Monitor (Low Range - EMF-36)	1	A, E, I	At all times.	TR 16.11.7.3 TR 16.11.7.5 TR 16.11.7.6 TR 16.11.7.7
b. Iodine Sampler	1	G, I	At all times, except during routine sampling.	TR 16.11.7.4
c. Particulate Sampler (EMF-35)	1	G, I	At all times, except during routine sampling.	TR 16.11.7.4
d. Unit Vent Flow Rate Monitor (Totalizer)	1	D, I	At all times.	TR 16.11.7.3 TR 16.11.7.6 TR 16.11.7.7
e. Iodine Sampler Minimum Flow Device	1	H, I	At all times, except during routine sampling.	TR 16.11.7.3 TR 16.11.7.6 TR 16.11.7.7
f. Particulate Sampler Minimum Flow Device (1)	1	G, I	At all times, except during routine sampling.	TR 16.11.7.3 TR 16.11.7.8 TR 16.11.7.7
4. Containment Purge System - Noble Gas Activity Monitor - Providing Alarm and Automatic Termination of Release (Low Range - EMF-39)	1	A, F, I	Modes 1 through 6, except when isolation valve is closed & locked.	TR 16.11.7.2 TR 16.11.7.3 TR 16.11.7.6 TR 16.11.7.7

(continued)

TABLE 16.11.7-1
(Page 2 of 3)

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENTS	MINIMUM CHANNELS FUNCTIONAL	REMEDIAL ACTION	APPLICABILITY	TESTING REQUIREMENTS
5. Auxiliary Building Ventilation System - Noble Gas Activity Monitor (0EMF-41 or EMF-36L)	1	A, E, I	At all times.	TR 16.11.7.3 TR 16.11.7.5 TR 16.11.7.6 TR 16.11.7.7
6. Fuel Storage Area Ventilation System - Noble Gas Activity Monitor (EMF-42 or EMF-36L)	1	A, E, I	At all times.	TR 16.11.7.3 TR 16.11.7.5 TR 16.11.7.6 TR 16.11.7.7
7. Contaminated Parts Warehouse Ventilation System				
a. Noble Gas Activity Monitor (EMF-53)	1 per station	A, E, I	During gaseous effluent releases.	TR 16.11.7.3 TR 16.11.7.5 TR 16.11.7.6 TR 16.11.7.7
b. Flow Rate Monitor	1 per station	D, I	During gaseous effluent releases.	TR 16.11.7.3 TR 16.11.7.6 TR 16.11.7.7
c. EMF-53 Sampler Minimum Flow Device (1)	1 per station	H, I	During gaseous effluent releases.	TR 16.11.7.3 TR 16.11.7.6 TR 16.11.7.7
8. Radwaste Facility Ventilation System				
a. Noble Gas Activity Monitor (EMF-52)	1 per station	A, E, I	During gaseous effluent releases.	TR 16.11.7.3 TR 16.11.7.5 TR 16.11.7.6 TR 16.11.7.7
b. Flow Rate Monitor	1 per station	D, I	During gaseous effluent releases.	TR 16.11.7.3 TR 16.11.7.6 TR 16.11.7.7
c. EMF-52 Sampler Minimum Flow Device (1)	1 per station	H, I	During gaseous effluent releases.	TR 16.11.7.3 TR 16.11.7.6 TR 16.11.7.7

(continued)

TABLE 16.11.7-1
(Page 3 of 3)

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENTS	MINIMUM CHANNELS FUNCTIONAL	REMEDIAL ACTION	APPLICABILITY	TESTING REQUIREMENTS
9. Equipment Staging Building Ventilation System				
a. Noble Gas Activity Monitor (EMF-59)	1 per station	A, E, I	During gaseous effluent releases.	TR 16.11.7.3 TR 16.11.7.5 TR 16.11.7.6 TR 16.11.7.7
b. Flow Rate Monitor	1 per station	D, I	During gaseous effluent releases.	TR 16.11.7.3 TR 16.11.7.6 TR 16.11.7.7
c. EMF-59 Sampler Minimum Flow Device (1)	1 per station	H, I	During gaseous effluent releases.	TR 16.11.7.3 TR 16.11.7.6 TR 16.11.7.7
10. Containment Air Release and Addition System - Noble Gas Activity Monitor (EMF-39L or EMF-36L)	1	A, E, I	At all times except when isolation valve is closed & locked.	TR 16.11.7.3 TR 16.11.7.5 TR 16.11.7.6 TR 16.11.7.7

NOTES:

1. Radioactivity monitor (EMF) shall not be declared FUNCTIONAL unless both the EMF and the associated EMF's Minimum Flow Device are rendered FUNCTIONAL.

BASES

The radioactive gaseous effluent instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in gaseous effluents during actual or potential releases of gaseous effluents. The instrumentation consists of monitoring and sampling instrumentation. Monitors provide continuous display of process parameters with appropriate alarms and trip setpoints established. Samplers collect a portion of the desired process for subsequent laboratory analysis, and do not have alarm/trip capability. Samplers and the analysis program provide a method to assure that long term effluent release quantities do not exceed the requirements of SLC 16.11.6. Monitors provide assurance that instantaneous effluent releases do not exceed the requirements of SLC 16.11.6. The minimum flow devices for EMFs listed in Table 16.11.7-1 are required to provide assurance of representative sampling during actual or potential releases of gaseous effluents. The flow rate monitor quantifies the total gaseous effluent (both non-radioactive and radioactive) released to the environment. During routine sampling, instrumentation may be turned off for short periods of time (not to exceed 15 minutes) in order to meet analysis requirements of SLC 16.11.6. This is considered to be a normal function of the equipment. The Alarm/Trip Setpoints for these instruments shall be calculated and adjusted in accordance with the methodology and parameters in the ODCM to ensure that the Alarm/Trip will occur prior to exceeding the limits stated in SLC 16.11.6. 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.

REFERENCES

1. McGuire Nuclear Station, Offsite Dose Calculation Manual
2. 10 CFR Part 50, Appendix A

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.8 Noble Gases

COMMITMENT Air dose due to noble gases released in gaseous effluents, from each unit, to areas at and beyond the SITE BOUNDARY (see Figure 16.11.1-1) shall be limited to the following:

- a. During any calendar quarter: Less than or equal to 5 mrad for gamma radiation and less than or equal to 10 mrad for beta radiation, and
- b. During any calendar year: Less than or equal to 10 mrad for gamma radiation and less than or equal to 20 mrad for beta radiation.

APPLICABILITY At all times.

REMEDIAL ACTIONS

NOTES

Enter applicable Conditions and Required Actions of SLC 16.11.12, "Total Dose," when the limits of this SLC are exceeded by twice the specified limit.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Calculated air dose from radioactive noble gases in gaseous effluents exceeding any of above limits.	A.1 Prepare and submit a Special Report to the NRC which identifies the causes for exceeding the limits, corrective actions taken to reduce releases, and actions taken to ensure that subsequent releases are within limits.	30 days

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11.8.1 Determine cumulative dose contributions from noble gases in gaseous effluents for current calendar quarter and current calendar year in accordance with the methodology and parameters in the ODCM.	31 days

BASES

This commitment 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 REMEDIAL 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 TESTING 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 under-estimated.

The dose calculation methodology and parameters 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 commitment applies at all times to the release of gaseous effluents from each reactor at the site. For units with shared Radwaste Treatment Systems, the gaseous effluents from the shared system are to be proportioned among the units sharing that system in accordance with the guidance given in NUREG-0133, Chapter 3.1.

REFERENCES

1. McGuire Nuclear Station, Off site Dose Calculation Manual
2. 10 CFR Part 50, Appendix I

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.9 Dose - Iodine-131 and 133, Tritium and Radioactive Materials in Particulate Form

COMMITMENT The dose to a MEMBER OF THE PUBLIC from Iodine-131 and 133, tritium, and all radioactive materials in particulate form with half-lives greater than 8 days in gaseous effluents released from each unit to areas at and beyond the SITE BOUNDARY (see Figure 16.11.1-1) shall be limited to the following:

- a. During any calendar quarter: less than or equal to 7.5 mrem to any organ, and
- b. During any calendar year: less than or equal to 15 mrem to any organ.

APPLICABILITY At all times.

REMEDIAL ACTIONS

NOTES

Enter applicable Conditions and Required Actions of SLC 16.11.12, "Total Dose," when the limits of this SLC are exceeded by twice the specified limit.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Calculated dose from the release of Iodine 131 and 133, tritium, and radioactive materials in particulate form with half-lives greater than 8 days in gaseous effluents exceeding any of the above limits.	A.1 Prepare and submit a Special Report to the NRC which identifies the causes for exceeding the limits, corrective actions taken to reduce releases, and actions taken to ensure that subsequent releases are within limits.	30 days

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11.9.1 Determine cumulative dose contributions for Iodine 131 and 133, tritium, and radioactive material in particulate form with half lives greater than 8 days in gaseous effluents for current calendar quarter and current calendar year in accordance with the methodology and parameters in the ODCM.	31 days

BASES

This commitment 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 REMEDIAL 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 TESTING 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 methodology and parameters 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 and 133, tritium, and radionuclides in particulate form with half-lives greater than 8 days are dependent upon the existing radionuclide pathways to man, in the areas at and beyond the SITE BOUNDARY. The pathways that 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.

BASES (continued)

This commitment applies at all times to the release of gaseous effluents from each reactor at the site. For units with shared Radwaste Treatment Systems, the gaseous effluents from the shared system are to be proportioned among the units sharing that system in accordance with the guidance given in NUREG 0133, Chapter 3.1.

REFERENCES

1. McGuire Nuclear Station, Off site Dose Calculation Manual
2. 10 CFR Part 50, Appendix I

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.10 Gaseous Radwaste Treatment System

COMMITMENT The VENTILATION EXHAUST TREATMENT and WASTE GAS HOLDUP SYSTEMS shall be FUNCTIONAL and appropriate portions of these systems shall be used to reduce releases of radioactivity when the projected doses in 31 days due to gaseous effluent releases, from each unit, to areas at and beyond the SITE BOUNDARY (see Figure 16.11.1-1) would exceed:

- a. 0.2 mrad to air from gamma radiation, or
- b. 0.4 mrad to air from beta radiation, or
- c. 0.3 mrem to any organ of a MEMBER OF THE PUBLIC.

APPLICABILITY At all times.

REMEDIAL ACTIONS

CONDITION		REQUIRED ACTION	COMPLETION TIME
A.	Radioactive gases being discharged without treatment and in excess of above limits.	A.1 Prepare and submit a Special Report to the NRC which identifies non-functional equipment and reasons for non-functionality, actions taken to restore the equipment to FUNCTIONAL status, and actions taken to prevent recurrence.	30 days

TESTING REQUIREMENTS

-----NOTE-----

The installed Gaseous Radwaste Treatment System shall be demonstrated FUNCTIONAL by meeting SLC 16.11.6, 16.11.8 and 16.11.9.

TEST	FREQUENCY
TR 16.11.10.1 Project gaseous release doses from each unit to areas at and beyond the SITE BOUNDARY, in accordance with the methodology and parameters in the ODCM, when gaseous systems are being released without being processed by its radwaste treatment system.	31 days

BASES

The FUNCTIONALITY of the WASTE GAS HOLDUP SYSTEM and the VENTILATION EXHAUST TREATMENT SYSTEM ensures that the systems will be available for use whenever gaseous effluents require treatment prior to release to the environment. The requirement that the appropriate portions of these systems 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 commitment implements the requirements of 19 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 systems 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 Part 50, for gaseous effluents.

This commitment applies at all times to the release of radioactive materials in gaseous effluents from each unit at the site. For units with shared Radwaste Treatment Systems, the gaseous effluents from the shared system are to be proportioned among the units sharing that system in accordance with NUREG-0133, Chapter 3.1.

REFERENCES

1. McGuire Nuclear Station, Off site Dose Calculation Manual
2. 10 CFR Part 50, Appendix I
3. 10 CFR Part 50

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.11 Solid Radioactive Waste

COMMITMENT	Radioactive wastes shall be processed and packaged to ensure compliance with the applicable requirements of 10 CFR Part 20, 10CFR Part 61, 10 CFR Part 71, and State regulations governing the transportation and disposal of radioactive wastes. The Solid Radwaste System or an approved alternative process shall be used in accordance with a PROCESS CONTROL PROGRAM (PCP) for the solidification of liquid or wet radioactive wastes or the dewatering of wet radioactive wastes to be shipped for direct disposal at a 10CFR61 licensed disposal site. Wastes shipped for off site processing in accordance with the processor's specifications and transportation requirements are not required to be solidified or dewatered to meet disposal requirements. • The PCP describes administrative and operational controls used for the solidification of liquid or wet solid radioactive wastes in order to meet applicable 10CFR61 waste form requirements. • The PCP describes the administrative and operational controls used for the dewatering of wet radioactive wastes to meet 10CFR61 free standing water requirements. • The process parameters used in establishing the PCP shall be based on demonstrated processing of actual or simulated liquid or wet solid wastes and must adequately verify that the final product of solidification or dewatering meets all applicable Federal, State and disposal site requirements.
APPLICABILITY	At all times.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Applicable regulatory requirements for solidified or dewatered wastes are not satisfied.	A.1 Suspend shipments of defectively packaged solid radioactive wastes from the site.	Immediately
	<u>AND</u> A.2 Initiate action to correct the PROCESS CONTROL PROGRAM, procedures, or solid waste equipment as necessary to prevent recurrence.	Prior to next shipment for disposal of solidified or dewatered wastes.
B. A solidification test as described in the PCP fails to verify Solidification.	B.1 Suspend solidification of the batch under test and follow PCP guidance for test failures.	Immediately
	<u>AND</u> B.2 Once a subsequent test verifies Solidification, solidification of the batch may then be resumed as directed by the PCP. The PCP shall be modified as required to assure Solidification of subsequent batches of waste	Prior to next solidification for shipment of waste for disposal at a 10CFR61 disposal site.

(continued)

REMEDIAL ACTIONS (continued)

C. With solidification or dewatering for disposal not performed in accordance with the PROCESS CONTROL PROGRAM.	C.1 Reprocess the waste in accordance with PCP requirements. <u>OR</u> C.2 Follow PCP or procedure guidance for alternative free standing liquid verification to ensure the waste in each container meets disposal requirements and take appropriate administrative action to prevent recurrence.	Prior to shipment for disposal of the inadequately processed waste that requires solidification of dewatering
D. With the solid waste equipment incapable of meeting SLC 16.11.11 or not in service	D.1 Restore the equipment to FUNCTIONAL status or provide for alternative capability to process wastes as necessary to satisfy all applicable disposal requirements	In a time frame that supports the COMMITMENT section of SLC 16.11.11

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11.11.1 The Process Control Program shall be used to verify the Solidification of at least one representative test specimens from at least every tenth batch of each type of radioactive waste to be solidified for disposal at a 10CFR61 disposal site per the COMMITMENT of this SLC.	Every tenth batch of each type of radioactive waste to be solidified.

BASES:

This commitment implements the requirements of 10 CFR Part 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50 and requirements to use a Process Control Program to meet applicable 10CFR61 waste form criteria for solidified and dewatered radioactive wastes.

REFERENCES:

1. 10CFR Part 50, "Domestic Licensing of Production and Utilization Facilities"
2. 10 CFR Part 50, Appendix A
3. 10CFR20, "Standards for Protection Against Radiation"
4. 10CFR61, "Licensing Requirements for Land Disposal of Radioactive Waste"
5. 10CFR71, "Packaging and Transportation of Radioactive Materials"
6. DPCo Process Control Program Manual
7. NRC Generic Letter 84-12, "Compliance With 10 CFR Part 61 And Implementation Of the Radiological Effluent Technical Specifications (Rets) and Attendant Process Control Program (PCP)"
8. NRC Generic Letter 89-01, "Implementation of Programmatic Controls for Radiological Effluent Technical Specifications In the Administrative Controls Section of the Technical Specifications and the Relocation of Procedural Details of Rets to the Offsite Dose Calculation Manual or to the Process Control Program"

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.12 Total Dose

COMMITMENT The annual (calendar year) dose or dose commitment to any MEMBER OF THE PUBLIC, due to releases of radioactivity and radiation, from uranium fuel cycle sources shall be limited to ≤ 25 mrem to the whole body or any organ, except the thyroid, which shall be limited to ≤ 75 mrem.

APPLICABILITY At all times.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Calculated doses from releases exceeding twice the specified limits of SLC 16.11.3, 16.11.8 or 16.11.9.	A.1 Verify, by calculation, the cumulative dose from direct radiation contributions, the ISFSI, outside storage tanks, and radioactivity releases are within the total dose limit.	Immediately
	<u>AND</u> A.2 -----NOTE----- Only required to be performed if the total dose limit is exceeded. ----- Prepare and submit a Special Report to the NRC which identifies corrective actions to be taken to reduce subsequent releases to prevent recurrence and schedule for achieving conformance with specified limits.	30 days

TESTING REQUIREMENTS

NOTE

Cumulative dose contributions from liquid and gaseous effluents shall be determined in accordance with SLC 16.11.3, 16.11.8 and 16.11.9, and in accordance with the methodology and parameters specified in the ODCM.

TEST	FREQUENCY
TR 16.11.12.1 Determine cumulative dose contributions from direct radiation from the units, the ISFSI, and from radwaste storage tanks in accordance with the methodology and parameters specified in the ODCM.	When calculated doses from effluent releases exceeds twice the limits of SLCs 16.11.3, 16.11.8 or 16.11.9

BASES

This commitment is provided to meet the dose limitations of 40 CFR Part 190 that have been incorporated into 10 CFR Part 20 by 46 FR 18525. The specification requires the preparation and submittal of a Special Report whenever the calculated doses from plant generated radioactive effluents and direct radiation exceed 25 mrem to the whole body or any organ, except the thyroid, which shall be limited to less than or equal to 75 mrem. For sites containing 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 Part 190 if the individual reactors remain within twice the dose design objectives of 10 CFR Part 50, Appendix I, and if direct radiation doses from the units and outside storage tanks are kept small.

This Special Report, as defined in 10 CFR Part 20.2203(a)(4), shall 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. It shall also describe levels of radiation and concentrations of radioactive material involved, and the cause of the exposure levels or concentrations. The Special Report will 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 Part 190 limits. For the purposes of the Special 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 dose contributions from other nuclear fuel cycle facilities at the same site or within a radius of 8 km must be considered.

If the dose to any MEMBER OF THE PUBLIC is estimated to exceed the requirements of 40 CFR Part 190, the Special Report with a request for a variance (provided the release conditions resulting in violation of 40 CFR Part 190 have not already been corrected), in

BASES (continued)

accordance with the provisions of 40 CFR Part 190.11 and 10 CFR Part 20.2203(a)(4), is considered to be a timely request and fulfills the requirements of 40 CFR Part 190 and a variance is granted until NRC staff action is completed. The variance only relates to the limits of 40 CFR Part 190, and does not apply in any way to the other requirements for dose limitation of 10 CFR Part 20, as addressed in SLCs 16.11.1 and 16.11.6.

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.

REFERENCES

1. McGuire Nuclear Station, Offsite Dose Calculation Manual
2. 10 CFR Part 20
3. 40 CFR Part 190
4. 10 CFR Part 50, Appendix I

16.11 RADIOLOGICAL EFFLUENT MONITORING

16.11.13 Radiological Environmental Monitoring Program

COMMITMENT The Radiological Environmental Monitoring Program shall be conducted as specified in Table 16.11.13-1.

APPLICABILITY At all times.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Radiological Environmental Monitoring Program not being conducted as specified in Table 16.11.13-1.	A.1 Identify the reasons for not conducting the program as required and the plans for preventing a recurrence in the Annual Radiological Environmental Operating Report.	Within the next scheduled Annual Radiological Environmental Operating Report
B. Radioactivity level of environmental sampling medium at a specified location in excess of reporting limits of Table 16.11.13-2.	B.1 Prepare and submit a Special Report that defines the corrective actions to be taken to reduce radioactive effluents so that the potential annual dose to a MEMBER OF THE PUBLIC is less than the calendar year limits of SLC 16.11.3, 16.11.8, and 16.11.9.	30 days

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
C. Milk or fresh leafy vegetable samples unavailable from one or more required sample locations.	C.1 -----NOTE----- Specific locations from which samples were unavailable may be deleted from the program. ----- Revise the Radiological Environmental Monitoring Program to identify locations for obtaining replacement samples. <u>AND</u> C.2 Identify the cause of the unavailability of samples and identify 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 for the ODCM reflecting the new location(s).	30 days Within the next scheduled Annual Radioactive Effluent Release Report

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11.13.1 -----NOTES----- The maximum values for the lower limits of detection shall be as specified in Table 16.11.13-3. ----- The radiological environmental monitoring samples shall be collected from the locations given in the table and figure in the ODCM and shall be analyzed pursuant to the requirements of Tables 16.11.13-1.	In accordance with Table 16.11.13-1

TABLE 16.11.13-1
(Page 1 of 6)
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS ⁽¹⁾	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
1. Direct Radiation ⁽²⁾	Forty routine monitoring stations either with two or more dosimeters or with one instrument for measuring and recording dose rate continuously, placed as follows: An inner ring of stations, one in each meteorological sector in the general area of the SITE BOUNDARY; An outer ring of stations, one in each meteorological sector in the 6- to 8-km range from the site; and The balance of the stations placed in special interest areas such as population centers, nearby residences, schools, and in one or two areas to serve as control stations.	Quarterly	Gamma dose quarterly.
(continued)			

TABLE 16.11.13-1
(Page 2 of 6)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS ⁽¹⁾	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
2. Airborne Radioiodine and Particulates	Samples from five locations: Three samples from close to the three SITE BOUNDARY locations, in different sectors, of the highest calculated annual average ground level D/Q. One sample from the vicinity of a community having the highest calculated annual average ground level D/Q. One sample from a control location, as for example 15-30 km distant and in the least prevalent wind direction⁽³⁾.	Continuous sampler operation with sample collection weekly, or more frequently if required by dust loading.	<u>Radioiodine Canister:</u> I-131 analysis weekly. <u>Particulate Sampler:</u> Gross beta radioactivity analysis following filter change⁽⁴⁾. Gamma isotopic analysis⁽⁵⁾ of composite (by location quarterly).
3. Waterborne a. Surface ⁽⁶⁾	One sample upstream. One sample downstream.	Composite sample over 1-month period ⁽⁷⁾ .	Gamma isotope analysis ⁽⁵⁾ monthly. Composite for tritium analysis quarterly.
b. Ground	Samples from one or two sources only if likely to be affected ⁽⁸⁾	Quarterly	Gamma isotopic ⁽⁵⁾ and tritium analysis quarterly.
(continued)			

TABLE 16.11.13-1
(Page 3 of 6)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS ⁽¹⁾	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
c. Drinking	One sample of each of one to three of the nearest water supplies that could be affected by its discharge. One sample from a control location.	Composite sample over 2-week period ⁽⁷⁾ when I-131 analysis is performed; monthly composite otherwise.	I-131 analysis on each composite when the dose calculated for the consumption of the water is greater than 1 mrem per year ⁽⁹⁾ . Composite for gross beta and gamma isotopic analyses ⁽⁵⁾ monthly. Composite for tritium analysis quarterly.
d. Sediment from the shoreline	One sample from downstream area with existing or potential recreational value.	Semiannually	Gamma isotopic analysis ⁽⁵⁾ semiannually.
4. Ingestion a. Milk	Samples from milking animals in three locations within 5-km distance having the highest dose potential. If there are none, then one sample from milking animals in each of three areas between 5 to 8 km distant where doses are calculated to be greater than 1 mrem per year ⁽⁹⁾ . One sample from milking animals at a control location 15 to 30 km distant and in the least prevalent wind direction.	Semiannually when animals are on pasture; monthly at other times.	Gamma isotopic ⁽⁵⁾ and I-131 analysis semimonthly when animals are on pasture; monthly at other times.
(continued)			

TABLE 16.11.13-1
(Page 4 of 6)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS ⁽¹⁾	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
b. Fish and Invertebrates	One sample each commercially and recreationally important species in vicinity of plant discharge area.	Sample in season, or semiannually if they are not seasonal	Gamma isotopic analysis ⁽⁶⁾ on edible portions
	One sample of same species in areas not influenced by plant discharge.		
c. Food Products	One sample of each principal class of food products from any area that is irrigated by water in which liquid plant wastes have been discharged.	At time of harvest ⁽¹⁰⁾	Gamma isotopic analyses ⁽⁵⁾ on edible portion.
	Samples of three different kinds of broad leaf vegetation grown nearest each of two different offsite locations of highest predicted annual average ground level D/Q if milk sampling is not performed.	Monthly, when available.	Gamma isotopic ⁽⁵⁾ and I-131 analysis.
	One sample of each of the similar broad leaf vegetation grown 15 to 30 km distant in the least prevalent wind direction if milk sampling is not performed.	Monthly, when available.	Gamma isotopic ⁽⁵⁾ and I-131 analysis.

TABLE 16.11.13-1

(Page 5 of 6)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

NOTES:

1. 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 16.11.13-1 in a table 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 prior to the end of the next sampling period. All 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 practical 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. In lieu of an Licensee Event Report, identify the cause of the unavailability of samples for that pathway and identify the new locations(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 for the ODCM reflecting the new location(s).
2. 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 (TLD) is considered to be one phosphor; two or more phosphors in a packet are considered as two or more dosimeters. Film badges shall not be used as dosimeters for measuring direct radiation. The forty stations is not an absolute number. The number of direct radiation monitoring stations may be reduced according to geographical limitations; e.g., at an ocean site, some sections will be over water so that the number of dosimeters may be reduced accordingly. The frequency of analysis or readout for TLD systems will depend upon the characteristics of the specific system used and should be selected to obtain optimum dose information with minimal fading.
3. The purpose of this sample is to obtain background information. If it is not practical to establish control locations in accordance with the distance and wind direction criteria, other sites that provide valid background data may be substituted.
4. Airborne particulate sample filters shall be analyzed for gross beta radioactivity 24 hours or more after sampling to allow for radon and thoron daughter decay. If gross beta activity in air particulate samples is greater than ten times the yearly mean of control samples, gamma isotopic analysis shall be performed on the individual samples.

TABLE 16.11.13-1

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RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

NOTES (continued):

5. Gamma isotopic analysis means the identification and quantification of gamma-emitting radionuclides that may be attributable to the effluents from the facility.
6. The "upstream sample" shall be taken at a distance beyond significant influence of the discharge. The "downstream" sample shall be taken in an area beyond but near the mixing zone. "Upstream" samples in an estuary must be taken far enough upstream to be beyond the plant influence. Salt water shall be sampled only when the receiving water is utilized for recreational activities.
7. A composite sample is one in which the quantity (aliquot) of liquid sampled is proportional to the quantity of flowing liquid and in which the method of sampling employed results in a specimen that is representative of the liquid flow. In this program composite sample aliquots shall be collected at time intervals that are very short (e.g., hourly) relative to the compositing period (e.g., monthly) in order to assure obtaining a representative sample.
8. Groundwater samples shall be taken when this source is tapped for drinking or irrigation purposes in areas where the hydraulic gradient or recharge properties are suitable for contamination.
9. The dose shall be calculated for the maximum organ and age group, using the methodology and parameters in the ODCM.
10. If harvest occurs more than once a year, sampling shall be performed during each discrete harvest. If harvest occurs continuously, sampling shall be monthly. Attention shall be paid to including samples of tuborous and root food products.

TABLE 16.11.13-2
(Page 1 of 1)

REPORTING LEVELS FOR RADIOACTIVITY CONCENTRATIONS IN ENVIRONMENTAL SAMPLES

ANALYSIS	REPORTING LEVELS				
	WATER (pCi/l)	AIRBOURNE PARTICULATE OR GASES (pCi/m ³)	FISH (pCi/kg, wet)	MILK (pCi/l)	BROAD LEAF VEGETATION (pCi/kg, wet)
H-3	20,000 ⁽¹⁾	N/A	N/A	N/A	N/A
Mn-54	1,000	N/A	30,000	N/A	N/A
Fe-59	400	N/A	10,000	N/A	N/A
Co-58	1,000	N/A	30,000	N/A	N/A
Co-60	300	N/A	10,000	N/A	N/A
Zn-65	300	N/A	20,000	N/A	N/A
Zr-Nb-95	400	N/A	N/A	N/A	N/A
I-131	2	0.9	N/A	3	100
Cs-134	30	10	1,000	60	1,000
Cs-137	50	20	2,000	70	2,000
Ba-La-140	200	N/A	N/A	300	N/A

NOTES:

1. For drinking water samples. This is 40 CFR Part 141 value. If no drinking water pathway exists, a value of 30,000 pCi/l may be used.

TABLE 16.11.13-3
(Page 1 of 3)

MAXIMUM VALUES FOR THE LOWER LIMITS OF DETECTION (LLD) ⁽¹⁾⁽²⁾⁽³⁾

ANALYSIS	WATER (pCi/l)	AIRBORNE PARTICULATE OR GASES (pCi/m ³)	FISH (pCi/kg, wet)	MILK (pCi/l)	BROAD LEAF VEGETATION (pCi/kg, wet)	SEDIMENT (pCi/kg, dry)
Gross Beta	4	0.01	N/A	N/A	N/A	N/A
H-3	2000*	N/A	N/A	N/A	N/A	N/A
Mn-54	15	N/A	130	N/A	N/A	N/A
Fe-59	30	N/A	260	N/A	N/A	N/A
Co-58, 60	15	N/A	130	N/A	N/A	N/A
Zn-65	30	N/A	260	N/A	N/A	N/A
Zr-95	15	N/A	N/A	N/A	N/A	N/A
Nb-95	15	N/A	N/A	N/A	N/A	N/A
I-131	1 ⁽⁴⁾	0.07	N/A	1	60	N/A
Cs-134	15	0.05	130	15	60	150
Cs-137	18	0.06	150	18	80	180
Ba-140	15	N/A	N/A	15	N/A	N/A
La-140	15	N/A	N/A	15	N/A	N/A

* If no drinking water pathway exists, a value of 3000 pCi/l may be used.

TABLE 16.11.13-3
(Page 2 of 3)

MAXIMUM VALUES FOR THE LOWER LIMITS OF DETECTION (LLD)

NOTES:

1. The LLD is defined, for purposes of these commitments, 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 5% probability of falsely concluding that a blank observation represents a "real" signal.

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

$$LLD = \frac{(2.71/T) + 4.65S_b}{E \cdot V \cdot 2.22 \cdot Y \cdot \exp(-\lambda \Delta t)}$$

Where:

LLD is the "a priori" lower limit of detection as defined above (as picoCurie per unit mass or volume),

s_b is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute),

E is the counting efficiency (as counts per disintegration),

V is the sample size (in units of mass or volume),

2.22 is the number of disintegrations per minute per picoCurie,

Y is the fractional radiochemical yield (when applicable),

λ is the radioactive decay constant for the particular radionuclide,

Δt is the elapsed time between sample collection (or end of the sample collection period) and time of counting (for environmental samples, not plant effluent samples), and

T is the background and sample counting time in minutes.

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 an a posteriori (after the fact) limit for a particular measurement. Analyses shall be performed in such a manner that the stated LLDs will be achieved under routine conditions. Occasionally background fluctuations, unavoidable small sample sizes, the presence of interfering nuclides, or other uncontrollable circumstances may render these LLDs unachievable. In such cases, the contributing factors shall be identified and described in the Annual Radiological Environmental Operating Report.

TABLE 16.11.13-3
(Page 3 of 3)

MAXIMUM VALUES FOR THE LOWER LIMITS OF DETECTION (LLD)

NOTES (continued):

2. This list does not mean that only these nuclides are to be considered. Other peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Annual Radiological Environmental Operating Report.
3. Required detection capabilities for thermoluminescent dosimeters used for environmental measurements shall be in accordance with the recommendations of Regulatory Guide 4.13.
4. LLD for drinking water samples. If no drinking water pathway exists, the LLD of gamma isotopic analysis may be used.

BASES

The Radiological Environmental Monitoring Program is established to monitor the radiation and radionuclides in the environs of the plant. The program provides representative measurements of radioactivity in the highest potential exposure pathways, and verification of the accuracy of the effluent monitoring program and modeling of environmental exposure pathways. The program is contained in SLC 16.11.13 – 16.11.16 and conforms to the guidance of Appendix I to 10 CFR Part 50. The program includes the following:

1. Monitoring, sampling, analysis, and reporting of radiation and radionuclides in the environment in accordance with the methodology and parameters in the ODCM,
2. A Land Use Census to ensure that changes in the use of areas at and beyond the SITE BOUNDARY are identified and that modifications to the monitoring program are made if required by the results of this census, and
3. Participation in an Interlaboratory Comparison Program to ensure that independent checks on the precision and accuracy of the measurements of radioactive materials in environmental sample matrices are performed as part of the quality assurance program for environmental monitoring.

The portion of the Radiological Environmental Monitoring Program required by this commitment provides representative measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides that 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 the modeling of the environmental exposure pathways. Guidance for this monitoring program is provided by the Radiological Assessment Branch Technical Position on Environmental Monitoring. The initially specified monitoring program will be effective for at least the first 3 years of commercial operation. Following this period, program changes may be initiated based on operational experience.

The required detection capabilities for environmental sample analyses are tabulated in terms of the lower limits of detection (LLDs). The LLDs required by Table 16.11.13-3 are considered optimum 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 measurement system and not as an a posteriori (after the fact) limit for a particular measurement.

With the level of radioactivity in an environmental sampling medium at a specified location exceeding the reporting levels of Table 16.11.13-3 when averaged over any calendar quarter, in lieu of a Licensee Event Report, prepare and submit to the Commission within 30 days a Special Report that defines the corrective actions to be

BASES (continued)

taken to reduce radioactive effluents so that the potential annual dose to a MEMBER OF THE PUBLIC is less than the calendar year limits of SLCs 16.11.6, 16.11.8, and 16.11.9. When more than one of the radionuclides in Table 16.11.13-2 are detected in the sampling medium, this report shall be submitted if:

$$\frac{\text{concentration (1)}}{\text{limit level (1)}} + \frac{\text{concentration (2)}}{\text{limit level (2)}} + \dots \geq 1.0$$

When radionuclides other than those in Table 16.11.13-2 are detected and are the result of plant effluents, this report shall be submitted if the potential annual dose to a MEMBER OF THE PUBLIC is equal to or greater than the calendar year limits of SLCs 16.11.6, 16.11.8 and 16.11.9. This report is not required if the measured level of radioactivity was not the result of plant effluents; however, in such an event, the condition shall be reported and described in the Annual Radiological Environmental Operating Report. The methodology and parameters used to estimate the potential annual dose to a MEMBER OF THE PUBLIC shall be indicated in this report.

Detailed discussion of the LLD, and other detection limits, can be found in HASL Procedures Manual, HASL-300 (revised annually), Currie, L. A., "Limits for Qualitative Detection and Quantitative Determination - Application to Radiochemistry," Anal. Chem. **40**, 586-93 (1968), and Hartwell, J. K., "Detection Limits for Radioanalytical Counting Techniques," Atlantic Richfield Hanford Company Report ARH-SA-215 (June 1975).

REFERENCES

1. McGuire Nuclear Station, Off site Dose Calculation Manual
2. 10 CFR Part 50, Appendix I

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.14 Land Use Census

COMMITMENT 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:

- a. the nearest milk animal,
- b. the nearest residence, and
- c. the nearest garden of greater than 50 m² (500 ft²) producing broad leaf vegetation.

For elevated releases as defined in Regulatory Guide 1.111, Revision 1, July 1977, the land use census shall identify within a distance of 5 km (3 miles) the location in each of the 16 meteorological sectors of:

- a. all milk animals, and
- b. all gardens of greater than 50 m² producing broad leaf vegetation.

-----NOTE-----
Broad leaf vegetation sampling of three different kinds of vegetation may be performed at the SITE BOUNDARY in each of two different direction sectors with the highest predicted D/Qs in lieu of the garden census. Specifications for broad leaf vegetation sampling in Table 16.11.13-1 4c shall be followed, including analysis of control samples.

APPLICABILITY At all times.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Location(s) identified which yields a calculated dose/dose commitment greater than values currently calculated in SLC 16.11.9.	A.1 Identify the new location in the Annual Radioactive Effluent Release Report.	In next scheduled Annual Radioactive Effluent Release Report

(continued)

B. Location(s) identified which yields a calculated dose or dose commitment (via same exposure pathway) 20% greater than at a location from which samples are currently being obtained in accordance with SLC 16.11.13.	B.1 Add the new location to the Radiological Environmental Monitoring Program.	30 days
	<u>AND</u> B.2 -----NOTES----- If samples cannot be obtained, an explanation of why samples are not obtainable (substitute representative locations if possible) shall be included. ----- Identify the new location(s), revised figures and tables for the ODCM, in the next Annual Radiological Release Report.	In the next scheduled Annual Radiological Release Report

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11.14.1 -----NOTE----- The results of the land use census shall be included in the Annual Radiological Environmental Operating Report. ----- Conduct a land use census during the growing season using the information which will provide the best results such as a door-to-door survey, aerial survey, or consultation with local agricultural authorities.	12 months

BASES

This commitment 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 this census. The best information from the door-to-door survey, from aerial survey, or from consulting with local agricultural authorities shall be used. This census satisfies the requirements of Section IV.B.3 of Appendix I to 10 CFR Part 50. Restricting the census to gardens of greater than 50 m² provides assurance that significant exposure pathways via leafy vegetables will be identified and monitored since a garden of this size is the minimum required to produce the quantity (26 kg/year) of leafy vegetables assumed in Regulatory Guide 1.109 for consumption by a child. To determine this minimum garden size, the following assumptions were made: (1) 20% of the garden was used for growing broad leaf vegetation (i.e., similar to lettuce and cabbage), and (2) a vegetation yield of 2 kg/m².

With a land use census identifying a location(s) which yields a calculated dose or dose commitment (via the same exposure pathway) 20% greater than at a location from which samples are currently being obtained in accordance with SLC 16.11.13, add the new location to the Radiological Environmental Monitoring Program. The sampling location(s), excluding the control station location, having the lowest calculated dose or dose commitment (via the same exposure pathway) may be deleted from this monitoring program after October 31 of the year in which this land use census was conducted.

REFERENCES

1. McGuire Nuclear Station, Off site Dose Calculation Manual
2. 10 CFR Part 50, Appendix I

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.15 Interlaboratory Comparison Program

COMMITMENT Analyses shall be performed on radioactive materials, supplied as part of an Interlaboratory Comparison Program (ICP), that correspond to samples required by SLC 16.11.13.

APPLICABILITY At all times.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Analyses not being performed as required.	A.1 Report corrective actions taken to prevent recurrence in the Annual Radiological Environmental Operating Report.	In next scheduled Annual Radiological Environmental Operating Report

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11.15.1 Report a summary of the results of the Interlaboratory Comparison Program in the Annual Radiological Environmental Operating Report.	12 months

BASES

This requirement for participation in an Interlaboratory Comparison Program is provided to ensure that independent checks on the precision and accuracy of the measurements 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.

The Interlaboratory Comparison Program (ICP) shall be described in the Annual Radiological Environmental Operating Report.

REFERENCES

1. 10 CFR Part 50, Appendix I

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.16 Annual Radiological Environmental Operating Report

COMMITMENT

Routine Annual Radiological Environmental Operating Reports covering the operation of the unit during the previous calendar year shall be submitted by May 15 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 pre-operational studies, with operational controls as appropriate, and with 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 SLC 16.11.14.

The Annual Radiological Environmental Operating Reports shall include the results of analysis of all radiological environmental samples and of all environmental radiation measurements taken during the period pursuant to the locations specified in the Table and Figures in the ODCM, as well as summarized and tabulated results of these analyses and measurements in the format of the table in the Radiological Assessment Branch Technical Position, Revision 1, November 1979. In the event that some individual 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:

- a summary description of the Radiological Environmental Monitoring Program;
- at least two legible maps covering all sampling locations keyed to a table giving distances and directions from the centerline of one reactor (one map shall cover stations near the site boundary; a second shall include the more distant stations);
- the results of licensee participation in the Interlaboratory Comparison Program, required by SLC 16.11.15;
- a discussion of all deviations from the sampling schedule of Table 16.11.13-1; and

COMMITMENT (continued)

- a discussion of all analyses in which the LLD required by Table 16.11.13-3 was not achievable.

A single submittal may be made for a multiple unit station..

APPLICABILITY

At all times.

REMEDIAL ACTIONS

None

TESTING REQUIREMENTS

None

BASES

None

REFERENCES

1. Technical Specification 5.6.2

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.17 Radioactive Effluent Release Reports

COMMITMENT Routine Radioactive Effluent Release Reports covering the operation of the unit during the previous calendar year of operation shall be submitted before May 1 of each year.

The Radioactive Effluent Release Reports 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 provided for the reporting period using Appendix B as guidance.

The Radioactive Effluent Release Report shall include an annual summary of hourly meteorological data collected over the previous calendar 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. A five year average of representative onsite meteorological data shall be used in the gaseous effluent dose pathway calculations. Dispersion factors (X/Qs) and deposition factors (D/Qs) shall be generated using the computer code XOQDOQ (NUREG/CR-2919) which implements NRC Regulatory Guide 1.111. The meteorological conditions concurrent with the time of release shall be reviewed annually to determine if the five-year average values should be revised. 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.

COMMITMENT (continued)

The Radioactive Effluent Release Reports shall include the following information for each type of solid waste shipped offsite or disposed of in the site landfill during the report period:

- a. Total container volume, in cubic meters,
- b. Total Curie quantity (determined by measurement or estimate),
- c. Principal radionuclides (determined by measurement or estimate),
- d. Type of waste (e.g., dewatered spent resin, compacted dry waste, evaporator bottoms),
- e. Number of shipments, and
- f. Solidification agent or absorbent (e.g., cement, or other approved agents (media)).

The Radioactive Effluent Release Reports 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 Reports shall include any changes made during the reporting period to the PROCESS CONTROL PROGRAM (PCP) and to the OFFSITE DOSE CALCULATION MANUAL (ODCM), as well as a listing of new locations for dose calculations and/or environmental monitoring identified by the land use census pursuant to SLC 16.11.14.

The Radioactive Effluent Release Reports shall also identify any licensee initiated major changes to the Radioactive Waste Systems (liquid, gaseous, and solid). Otherwise, this information may be included in the annual UFSAR update. The discussion of each change shall contain:

- a. A summary of the evaluation that led to the determination that the change could be made in accordance with 10 CFR Part 50.59;
- b. Sufficient detailed information to totally support the reason for the change without benefit of additional or supplemental information;
- c. A detailed description of the equipment, components, and processes involved and the interfaces with other plant systems;
- d. 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;

COMMITMENT (continued)

- e. An evaluation of the change, which shows expected maximum exposures to individual in the UNRESTRICTED AREA and to the general population that differ from those previously estimated in the License application and amendments thereto;
- f. 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 prior to when the changes are to be made;
- g. An estimate of the exposure to plant operating personnel as a result of the change; and
- h. Documentation of the fact that the change was reviewed and found acceptable by the Station Manager or the Chemistry Manager.

A single submittal may be made for a multiple unit station. The submittal should combine those sections that are common to all units at the station; however, for units with separate Radwaste Systems, the submittal shall specify the releases of radioactive material from each unit.

APPLICABILITY

At all times

REMEDIAL ACTIONS

None

TESTING REQUIREMENTS

None

BASES

None

REFERENCES

1. Technical Specification 5.6.3

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.18 Liquid Holdup Tanks

COMMITMENT The quantity of radioactive material contained in each unprotected outdoor radwaste tank shall be limited to ≤ 10 Curies, excluding tritium and dissolved or entrained noble gases.

APPLICABILITY At all times.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Quantity of radioactive material in tank not within limit.	A.1 Suspend all additions of radioactive material to the tank.	Immediately
	<u>AND</u>	
	A.2 Reduce the tank contents to within limit.	48 hours
	<u>AND</u>	
	A.3 Describe the events leading to this condition in the next Annual Radioactive Effluent Release Report.	Within the next scheduled Annual Radioactive Effluent Release Report

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11.18.1 Verify the quantity of radioactive material contained in unprotected outdoor radwaste tanks is within limits by analyzing a representative sample of the tank's contents when radioactive materials are being added to the tank.	7 days

BASES

The tanks applicable to this SLC include all those outdoor radwaste tanks that are not surrounded by liners, dikes, or walls capable of holding the tank contents and that do not have tank overflows and surrounding area drains connected to the Liquid Radwaste Treatment System.

Restricting the quantity of radioactive material contained in the specified tanks provides assurance that in the event of an uncontrolled release of the tanks' contents, the resulting concentrations would be less than the limits of 10 CFR Part 20, Appendix B, Table II, Column 2, at the nearest potable water supply and the nearest surface water supply in an UNRESTRICTED AREA.

REFERENCES

None

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.19 Explosive Gas Mixture

COMMITMENT The concentration of oxygen in the WASTE GAS HOLDUP SYSTEM shall be limited to $\leq 2\%$ by volume whenever the hydrogen concentration exceeds 4% by volume.

APPLICABILITY At all times.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Concentration of oxygen in the WASTE GAS HOLDUP SYSTEM $> 2\%$ but $\leq 4\%$ by volume.	A.1 Reduce oxygen concentration to within limits.	48 hours
B. Concentration of oxygen in the WASTE GAS HOLDUP SYSTEM $> 4\%$ and hydrogen concentration $> 4\%$ by volume.	B.1 Suspend all additions of waste gases to the system.	Immediately
	<u>AND</u>	
	B.2 Reduce the concentration of oxygen to $\leq 4\%$ by volume.	Immediately
	<u>AND</u>	
	B.3 Reduce oxygen concentration to within limits.	48 hours

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11.19.1 Verify the concentrations of hydrogen and oxygen in the WASTE GAS HOLDUP SYSTEM is within limits by monitoring waste gases in the WASTE GAS HOLDUP SYSTEM with the hydrogen and oxygen monitors required by SLC 16.7.8.	During WASTE GAS HOLDUP SYSTEM operation

BASES

This specification is provided to ensure that the concentration of potentially explosive gas mixtures contained in the WASTE GAS HOLDUP SYSTEM is maintained below the flammability limits of hydrogen and oxygen. Automatic control features are included in the system to prevent the hydrogen and oxygen concentrations from reaching these flammability limits. These automatic control features include isolation of the source of hydrogen and/or oxygen, automatic diversion to recombiners, or injection of dilutants to reduce the concentration below the flammability limits. Maintaining the concentration of hydrogen and oxygen below their flammability limits provides assurance that the releases of radioactive materials will be controlled in conformance with the requirements of General Design Criterion 60 of Appendix A to 10 CFR Part 50.

REFERENCES

None

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.20 Gas Storage Tanks

COMMITMENT The quantity of radioactivity contained in each gas storage tank shall be limited $\leq$ 49,000 Curies noble gases (considered as Xe-133).

APPLICABILITY At all times.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Quantity of radioactive material in tank not within limit.	A.1 Suspend all additions of radioactive material to the tank.	Immediately
	<u>AND</u> A.2 Reduce the tank contents to within limit.	48 hours

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11.20.1 Verify the quantity of radioactive material contained in each gas storage tank is within limit when radioactive materials are being added to the tank.	24 hours

BASES

This SLC considers postulated radioactive releases due to a waste gas system leak or failure, and limits the quantity of radioactivity in each pressurized gas storage tank in the WASTE GAS HOLDUP SYSTEM to assure that a release would be substantially below the dose guideline values of 10 CFR Part 100 for a postulated event.

Restricting the quantity of radioactivity contained in each gas storage tank provides assurance that in the event of an uncontrolled release of the tank's contents, the resulting total body exposure to a MEMBER OF THE PUBLIC at the nearest exclusion area boundary will not exceed 0.5 rem. This is consistent with Standard Review Plan 11.3, Branch Technical Position ETSB 11-5, "Postulated Radioactive Releases Due to a Waste Gas System Leak or Failure," in NUREG-0800, July 1981.

REFERENCES

None

Attachment 10
Summary of Changes to the Process Control Program

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024 - 12/31/2024

ATTACHMENT 10

Summary of Changes to the Process Control Program

This attachment includes a summary of changes to the PCP.

Attachment 10
Summary of Changes to the Process Control Program

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024 - 12/31/2024

The McGuire Nuclear Station PCP was not revised in 2024. The most recent revision was provided with the McGuire Nuclear Station 2022 ARERR.

Attachment 11
Summary of Major Modifications to the Radioactive Waste Treatment Systems

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024 - 12/31/2024

ATTACHMENT 11

Summary of Major Modifications to the Radioactive Waste Treatment Systems

This attachment includes a description of major modifications to the radioactive waste treatment systems that are anticipated to affect effluent releases.

Attachment 11
Summary of Major Modifications to the Radioactive Waste Treatment Systems

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024 - 12/31/2024

No major modifications to McGuire Nuclear Station liquid, gaseous, solid, or mobile radioactive waste treatment systems occurred in 2024.

Attachment 12
Errata to a Previous Year's ARERR

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024 - 12/31/2024

ATTACHMENT 12

Errata to a Previous Year's ARERR

This attachment includes any amended pages from a previous year's ARERR.

Attachment 12
Errata to a Previous Year's ARERR

McGuire Nuclear Station Units 1 & 2
Period 1/1/2024 - 12/31/2024

There are no changes to a previous year's ARERR.