DUKE ENERGY

Bentley K. Jones
Director, Organizational Effectiveness
Harris Nuclear Plant
5413 Shearon Harris Rd
New Hill, NC 27562-9300

919-362-2305

APR 2 8 2017

Serial: HNP-17-023

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

Shearon Harris Nuclear Power Plant, Unit 1
Docket No. 50-400/Renewed License No. NPF-63

Subject: Annual Radioactive Effluent Release Report

Ladies and Gentlemen:

In accordance with Harris Nuclear Plant Technical Specification 6.9.1.4, Duke Energy Progress, LLC, is providing the enclosed Annual Radioactive Effluent Release Report for 2016.

This submittal contains no regulatory commitments. Should you have any questions regarding this submittal, please contact Jeff Robertson, Manager – Regulatory Affairs, at (919) 362-3137.

Sincerely,

Bentley K. Jones

Enclosure

cc: Mr. D. Retterer, NRC Sr. Resident Inspector, HNP
Ms. M. Barillas, NRC Project Manager, HNP
NRC Regional Administrator, Region II

Bentley K. Jones
Director, Organizational Effectiveness
Harris Nuclear Plant
5413 Shearon Harris Rd
New Hill, NC 27562-9300

919-362-2305

Serial: HNP-17-023

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

Shearon Harris Nuclear Power Plant, Unit 1
Docket No. 50-400/Renewed License No. NPF-63

Subject: Annual Radioactive Effluent Release Report

Ladies and Gentlemen:

In accordance with Harris Nuclear Plant Technical Specification 6.9.1.4, Duke Energy Progress, LLC, is providing the enclosed Annual Radioactive Effluent Release Report for 2016.

This submittal contains no regulatory commitments. Should you have any questions regarding this submittal, please contact Jeff Robertson, Manager – Regulatory Affairs, at (919) 362-3137.

Sincerely,

Bentley K. Jones

Enclosure

cc: Mr. D. Retterer, NRC Sr. Resident Inspector, HNP
Ms. M. Barillas, NRC Project Manager, HNP
NRC Regional Administrator, Region II

Shearon Harris Nuclear Power Plant
Unit 1

Annual Radioactive Effluent Release Report

January 1, 2016 through December 31, 2016

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
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

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 1/1/2016 - 12/31/2016

Gaseous Effluents - Summation of All Releases

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Gases						
1. Total Release	Ci	1.16E-01	8.45E-03	2.11E-02	2.84E-03	1.48E-01
2. Avg. Release Rate	μCi/sec	1.47E-02	1.08E-03	2.65E-03	3.57E-04	4.69E-03
B. Iodine-131						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	1.27E-07	1.27E-07
2. Avg. Release Rate	μCi/sec	0.00E+00	0.00E+00	0.00E+00	1.60E-08	4.02E-09
C. Particulates Half-Life ≥ 8 days						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	2.58E-06	2.58E-06
2. Avg. Release Rate	μCi/sec	0.00E+00	0.00E+00	0.00E+00	3.25E-07	8.16E-08
D. Tritium						
1. Total Release	Ci	2.36E+01	1.87E+01	1.81E+01	2.00E+01	8.04E+01
2. Avg. Release Rate	μCi/sec	3.00E+00	2.38E+00	2.28E+00	2.52E+00	2.54E+00
E. Gross Alpha						
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

Attachment 1
Summary of Gaseous and Liquid Effluents

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2016 - 12/31/2016

Gaseous Effluents - Elevated Releases - Continuous Mode *

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
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 elevated releases.

Attachment 1
Summary of Gaseous and Liquid Effluents

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2016 - 12/31/2016

Gaseous Effluents - Elevated Releases - Batch Mode *

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
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 elevated releases.

Attachment 1
Summary of Gaseous and Liquid Effluents

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2016 - 12/31/2016

Gaseous Effluents - Ground Releases - Continuous Mode

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Gases						
Xe-133	Ci	1.16E-01	6.16E-03	1.32E-03	2.84E-03	1.26E-01
Total for Period	Ci	1.16E-01	6.16E-03	1.32E-03	2.84E-03	1.26E-01
B. Iodines						
None	Ci	-	-	-	-	-
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	-	-	-	-	-
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Tritium						
H-3	Ci	2.36E+01	1.87E+01	1.81E+01	1.95E+01	7.99E+01
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 1/1/2016 - 12/31/2016

Gaseous Effluents - Ground Releases - Batch Mode

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Gases						
Kr-85M	Ci	0.00E+00	0.00E+00	2.26E-06	0.00E+00	2.26E-06
Xe-131M	Ci	0.00E+00	4.20E-06	4.68E-04	0.00E+00	4.72E-04
Xe-133M	Ci	0.00E+00	3.43E-05	5.11E-05	0.00E+00	8.54E-05
Xe-133	Ci	0.00E+00	2.17E-03	1.91E-02	0.00E+00	2.13E-02
Xe-135	Ci	0.00E+00	8.85E-05	9.72E-05	0.00E+00	1.86E-04
Total for Period	Ci	0.00E+00	2.29E-03	1.97E-02	0.00E+00	2.20E-02
B. Iodines						
I-131	Ci	0.00E+00	0.00E+00	0.00E+00	1.27E-07	1.27E-07
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	1.27E-07	1.27E-07
C. Particulates Half-Life ≥ 8 days						
Cr-51	Ci	0.00E+00	0.00E+00	0.00E+00	6.94E-07	6.94E-07
Mn-54	Ci	0.00E+00	0.00E+00	0.00E+00	1.23E-08	1.23E-08
Co-58	Ci	0.00E+00	0.00E+00	0.00E+00	5.51E-07	5.51E-07
Co-60	Ci	0.00E+00	0.00E+00	0.00E+00	5.25E-07	5.25E-07
Zr-95	Ci	0.00E+00	0.00E+00	0.00E+00	3.35E-07	3.35E-07
Nb-95	Ci	0.00E+00	0.00E+00	0.00E+00	4.29E-07	4.29E-07
Sb-125	Ci	0.00E+00	0.00E+00	0.00E+00	3.48E-08	3.48E-08
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	2.58E-06	2.58E-06
D. Tritium						
H-3	Ci	0.00E+00	7.01E-05	7.79E-05	4.50E-01	4.50E-01
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 1/1/2016 - 12/31/2016

Gaseous Effluents - Mixed-Mode Releases - Continuous Mode *

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
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 1/1/2016 - 12/31/2016

Gaseous Effluents - Mixed-Mode Releases - Batch Mode *

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
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 1/1/2016 - 12/31/2016

Liquid Effluents - Summation of All Releases

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Products *						
1. Total Release	Ci	4.84E-04	3.01E-04	1.66E-03	1.73E-02	1.97E-02
2. Avg. Diluted Conc.	µCi/ml	1.03E-10	6.27E-11	3.36E-10	3.56E-09	1.02E-09
B. Tritium						
1. Total Release	Ci	1.17E+01	1.97E+02	4.09E+02	1.59E+02	7.77E+02
2. Avg. Diluted Conc.	µCi/ml	2.49E-06	4.09E-05	8.28E-05	3.26E-05	4.02E-05
C. Dissolved & Entrained Gases						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	2.08E-04	2.08E-04
2. Avg. Diluted Conc.	µCi/ml	0.00E+00	0.00E+00	0.00E+00	4.28E-11	1.08E-11
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	3.16E+05	6.53E+05	1.41E+06	2.33E+06	4.71E+06
2. Continuous Releases	liters	8.33E+06	1.08E+07	1.18E+07	1.01E+07	4.09E+07
F. Volume of Dilution Water						
1. Batch Releases	liters	4.70E+09	4.81E+09	4.94E+09	4.86E+09	1.93E+10
2. Continuous Releases	liters	4.10E+08	4.29E+08	7.06E+08	5.09E+08	2.05E+09

* 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 1/1/2016 - 12/31/2016

Liquid Effluents - Continuous Mode

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Products						
None	Ci	-	-	-	-	-
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
B. Tritium						
H-3	Ci	9.21E-02	9.91E-02	7.97E-02	8.39E-04	2.72E-01
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 1
Summary of Gaseous and Liquid Effluents

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2016 - 12/31/2016

Liquid Effluents - Batch Mode

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Products						
Cr-51	Ci	0.00E+00	0.00E+00	5.31E-05	2.74E-03	2.79E-03
Mn-54	Ci	0.00E+00	0.00E+00	5.48E-05	3.70E-04	4.25E-04
Fe-55	Ci	0.00E+00	0.00E+00	0.00E+00	9.56E-04	9.56E-04
Fe-59	Ci	0.00E+00	0.00E+00	0.00E+00	1.12E-04	1.12E-04
Co-58	Ci	3.56E-05	0.00E+00	6.44E-05	6.16E-03	6.26E-03
Co-60	Ci	1.08E-04	1.07E-04	7.06E-04	2.52E-03	3.44E-03
Ni-63	Ci	2.69E-04	1.94E-04	5.17E-04	2.96E-03	3.94E-03
Zr-95	Ci	1.21E-05	0.00E+00	9.76E-06	4.33E-04	4.55E-04
Nb-95	Ci	1.17E-05	0.00E+00	4.45E-05	5.90E-04	6.46E-04
Sb-124	Ci	0.00E+00	0.00E+00	0.00E+00	1.06E-04	1.06E-04
Sb-125	Ci	4.15E-05	0.00E+00	2.00E-04	3.03E-04	5.45E-04
Cs-137	Ci	6.61E-06	0.00E+00	1.16E-05	3.73E-05	5.55E-05
Ce-143	Ci	0.00E+00	0.00E+00	0.00E+00	4.40E-06	4.40E-06
Total for Period	Ci	4.84E-04	3.01E-04	1.66E-03	1.73E-02	1.97E-02
B. Tritium						
H-3	Ci	1.17E+01	1.97E+02	4.09E+02	1.59E+02	7.77E+02
C. Dissolved & Entrained Gases						
Xe-133	Ci	0.00E+00	0.00E+00	0.00E+00	2.08E-04	2.08E-04
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	2.08E-04	2.08E-04
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

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

Attachment 2
Supplemental Information

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2016 - 12/31/2016

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. Total Number of Batch Releases	=	1.30E+01	5.00E+01
2. Total Time (min) for Batch Releases	=	1.01E+04	3.91E+04
3. Maximum Time (min) for a Batch Release	=	8.79E+02	9.90E+02
4. Average Time (min) for Batch Releases	=	7.75E+02	7.82E+02
5. Minimum Time (min) for a Batch Release	=	5.64E+02	8.20E+01
6. Average Dilution Water Flow During Release (gpm)	=	9.48E+03	9.65E+03

B. Gaseous Effluents		**Jan - Jun**	**Jul - Dec**
1. Total Number of Batch Releases	=	5.00E+00	2.00+01
2. Total Time (min) for Batch Releases	=	3.85E+03	1.56E+04
3. Maximum Time (min) for a Batch Release	=	2.03E+03	3.01E+03
4. Average Time (min) for Batch Releases	=	7.69E+02	7.79E+02
5. Minimum Time (min) for a Batch Release	=	2.03E+02	1.20E+02

VI. Abnormal Releases

See Attachment 5, Unplanned Offsite Releases.

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2016 - 12/31/2016

Carbon-14

The Shearon Harris Nuclear Power Plant 2016 ARERR contains estimates of C-14 radioactivity released in 2016, 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 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 2016 ARERR, a source term scaling factor using actual EFPD of 328.674 days is assumed. Using the source term scaling factor from Shearon Harris Nuclear Power Plant in 2016 results in a site total C-14 gaseous release estimate to the environment of 8.22 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 (CO_2) form. Dose is not expected from other forms (methane, etc). 70% of the C-14 gaseous effluent is assumed to be from batch releases (e.g. WGDTs), 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 2016 is well below the 10CFR50, Appendix I, ALARA design objective (i.e., 15 mrem/yr per unit).

	Units	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Year
1. EFFD	Days	90.366	90.607	91.596	56.105	328.674
2. C-14 Activity Released	Ci	2.26E+00	2.27E+00	2.29E+00	1.40E+00	8.22E+00
3. C-14 Total Body Dose	mREM	1.36E-02	1.54E-02	1.42E-02	8.46E-03	5.17E-02
4. C-14 Organ Dose	mREM	6.85E-02	7.72E-02	7.11E-02	4.26E-02	2.59E-01

Receptor Location ***3.07*** km ***NNE***
Critical Age ***CHILD***
Critical Organ ***BONE***

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 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 2016*". 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 2016.

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
1. H-3 Activity Released	Ci	2.55E+01	1.74E+01	2.52E+01	1.95E+01	8.75E+01
2. H-3 Dose	mREM	1.12E-03	7.61E-04	1.10E-03	8.54E-04	3.84E-03

Receptor Location ***3.07*** km ***NNE***
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 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 2016*". Using the methodology described in ODCM 2.3.3, the following is a summary of tritium activity released through evaporation and resulting dose for 2016.

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
1. H-3 Activity Released	Ci	1.58E+01	2.64E+01	4.37E+01	2.67E+01	1.13E+02
2. H-3 Dose	mREM	1.23E-02	2.05E-02	3.38E-02	2.06E-02	8.72E-02

Receptor Location ***6.70*** km ***SSW***
Critical Age ***CHILD***
Critical Organ ***N/A*** *

Drinking Water for Wake County Fire and 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 2016, 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 2016.

	Units	Year
1. Avg. H-3 Concentration	ρCi/L	4.32E+03
2. H-3 Dose	mREM	1.18E-01

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).*

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 2016, 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 2016.

	Units	Year
1. Avg. H-3 Concentration	ρCi/L	5.76E+03
2. H-3 Dose	mREM	1.14E-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).*

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.

Overall Estimate of Error for Gaseous Effluent Radioactivity Release Reported

The estimated percentage of overall error for Noble Gases in Gaseous effluent release data at Shearon Harris Nuclear Power Plant has been determined to be ± 52.68%. This value was derived by taking the square root of the sum of the squares of the following discrete individual estimates of error:

1. Counting Standard (20000 counts/energy % error) = ± 0.1%
2. Calibration Standard = ± 5.0%
3. Acceptable Counting Statistic for Nuclide ID (R.E.) = ± 25.0%
4. Sample Volume Variability = ± 5.0%
5. Stack Flow Rates (Non-steady Release Rates) = ± 10.0%
6. Rad Monitor Calibration = ± 20.0%
7. Net Activity Determination from Rad Monitors = ± 40.0%

The estimated percentage of overall error for Air Particulates in Gaseous effluent release data at Shearon Harris Nuclear Power Plant has been determined to be ± 33.75%. This value was derived by taking the square root of the sum of the squares of the following discrete individual estimates of error:

1. Counting Standard (20000 counts/energy % error) = ± 0.1%
2. Calibration Standard = ± 5.0%
3. Acceptable Counting Statistic for Nuclide ID (R.E.) = ± 25.0%
4. Sample Flow (Sample Volume) = ± 10.0%
5. Potential Sample Line Losses = ± 8.0%
6. Stack Flow Rates (Non-steady Release Rates) = ± 10.0%
7. Chemical Yield Factors (Sr-89, 90) = ± 15.0%

The estimated percentage of overall error for Iodine on Charcoal Filters in Gaseous effluent release data at Shearon Harris Nuclear Power Plant has been determined to be ± 30.38%. This value was derived by taking the square root of the sum of the squares of the following discrete individual estimates of error:

1. Counting Standard (20000 counts/energy % error) = ± 0.1%
2. Calibration Standard = ± 5.0%
3. Acceptable Counting Statistic for Nuclide ID (R.E.) = ± 25.0%
4. Sample Flow (Sample Volume) = ± 10.0%
5. Potential Sample Line Losses = ± 8.0%
6. Stack Flow Rates (Non-steady Release Rates) = ± 10.0%
7. Collection Efficiency = ± 3.0%

The estimated percentage of overall error for Tritium in Gaseous effluent release data at Shearon Harris Nuclear Power Plant has been determined to be ± 52.20%. This value was derived by taking the square root of the sum of the squares of the following discrete individual estimates of error:

1. Counting Standard (20000 counts/energy % error) = ± 0.1%
2. Calibration Standard = ± 5.0%
3. Acceptable Counting Statistic for Nuclide ID (R.E.) = ± 50.0%
4. Stack Flow Rates (Non-steady Release Rates) = ± 10.0%
5. Collection Efficiency = ± 10.0%

Overall Estimate of Error for Liquid Effluent Radioactivity Release Reported

The estimated percentage of overall error for Fission and Activation Products in Liquid effluent release data at Shearon Harris Nuclear Power Plant has been determined to be ± 32.79%. This value was derived by taking the square root of the sum of the squares of the following discrete individual estimates of error:

1. Counting Standard (20000 counts/energy % error) = ± 0.1%
2. Calibration Standard = ± 5.0%
3. Acceptable Counting Statistic for Nuclide ID (R.E.) = ± 25.0%
4. Sample (sample volume between techs) = ± 5.0%
5. Volume Determinations (Tank Level) = ± 20.0%

The estimated percentage of overall error for Tritium in Liquid effluent release data at Shearon Harris Nuclear Power Plant has been determined to be ± 54.31%. This value was derived by taking the square root of the sum of the squares of the following discrete individual estimates of error:

1. Counting Standard (20000 counts/energy % error) = ± 0.1%
2. Calibration Standard = ± 5.0%
3. Acceptable Counting Statistic for Nuclide ID (R.E.) = ± 50.0%
4. Sample (sample volume between techs) = ± 5.0%
5. Volume Determinations (Tank Level) = ± 20.0%

Overall Estimate of Error for Solid Waste Radioactivity Reported

The estimated percentage of overall error for Solid Waste data at Shearon Harris Nuclear Power Plant has been determined to be ± 96%. This value was derived by taking the square root of the sum of the squares of the following discrete individual estimates of error:

1.	Counting Standard (20000 counts/energy % error)	=	< ± 0.1%
2.	Calibration Standard	=	± 5.0%
3.	Acceptable Counting Statistic for Nuclide ID (R.E.)	=	± 95.0%
4.	Sample Volume Variability	=	± 0.001%
5.	Instrument Errors	=	± 5.0%
6.	Dose Rate Measurement	=	± 10.0%
7.	Geometry	=	± 5.0%
8.	Volume Determinations	=	± 5.0%
9.	RADMAN Database (sample analysis variance)	=	± 0.96%

Attachment 2
Supplemental Information

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2016 - 12/31/2016

Summary of Changes in Land Use Census Affecting Effluent Dose Calculations

The 2016 Land Use Census was performed August 2-4, 2016, and the results were certified and made available for use on October 12, 2016. The following are changes to residences, gardens, and milk animals from the previous year.

Residences

The residence in the E sector at 1.98 miles was replaced by a residence at 1.88 miles.

Gardens

The garden in the NNE sector at 1.91 miles was replaced by a non-irrigated garden at 1.81 miles.
The garden in the NE sector at 3.22 miles was replaced by a non-irrigated garden at 2.92 miles.
The garden in the ESE sector at 4.76 miles was replaced by a non-irrigated garden at 2.75 miles.
The garden in the SSW sector at 4.20 miles was replaced by an irrigated (public utility) garden at 4.13 miles.
The garden in the W sector at 3.73 miles was replaced by an irrigated (well) garden at 2.75 miles.
The garden in the WNW sector at 3.39 miles was no longer present and replaced by an irrigated (well) garden at 4.33 miles.

NOTE: No gardens being irrigated from Harris Lake were identified. All irrigation sources identified were from wells, ponds, public utilities, etc.

Meat Animals

The meat animal in the ESE sector at 2.74 miles was no longer present and replaced by a meat animal at 2.84 miles.
The meat animal in the SSE sector at 4.57 miles was replaced by a meat animal at 4.32 miles.
The meat animal in the W sector at 3.26 miles was replaced by a meat animal at 2.82 miles.
The meat animal in the WNW sector at 2.13 miles was no longer present and replaced by a meat animal at 3.39 miles.

Milk Animals

A new milk animal (goat) was identified in the W sector at 2.82 miles. Owner may participate in REMP when able during breeding months in late-spring and late-fall seasons.
A new milk animal (goat) was identified in the NNW sector at 4.68 miles. Owner does not wish to participate in REMP.

Environmental Monitoring Locations

No other changes to environmental monitoring locations in each sector.

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 1/1/2016 - 12/31/2016

	Type of Waste Shipped	Number of Shipments	Number of Containers	Waste Class	Container Type	Solidification Agent	Burial Volume (m^3)	Total Activity (Curies)
1.	**Waste from Liquid Systems**							
	a. Dewatered Spent Resins (compacted)	4	-	A	NRC Approved	N/A	14.36	6.03E+01
	b. Evaporator Concentrates	0	-	-	-	-	-	-
	c. Dewatered Demineralizers	0	-	-	-	-	-	-
	d. Solidified (cement) Acids, Oils, Sludge	0	-	-	-	-	-	-
2.	**Dry Solid Waste**							
	a. Dry Active Waste (dewatered, compacted)	1	-	B	NRC Approved	N/A	0.027	1.27E-01
	b. Dry Active Waste (dewatered, non-compacted)	7	-	A	NRC Approved	N/A	343.22	8.10E-01
	c. Dry Active Waste (brokered)	0	-	-	-	-	-	-
	d. Irradiated Components (dewatered, non-compacted)	1	-	A	NRC Approved	N/A	0.017	1.03E-01
	e. Other (dewatered, non-compacted)	8	-	A	NRC Approved	N/A	195.95	1.26E-02
3.	**Total Solid Waste**	**21**	**-**				**553.57**	**6.14E+01**

Attachment 3
Solid Radioactive Waste Disposal

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2016 - 12/31/2016

Type of Waste Shipped	Radionuclide	% Abundance
1. Waste from Liquid Systems		
a. Dewatered Spent Resins	Be-7	5.57
	C-14	0.36
	Ce-144	0.06
	Co-57	0.07
	Co-58	1.85
	Co-60	15.69
	Cr-51	0.00
	Cs-137	2.89
	Fe-55	41.70
	Fe-59	0.02
	H-3	0.07
	I-129	0.00
	Mn-54	16.70
	Nb-95	0.23
	Ni-63	16.14
	Sb-125	1.20
	Sn-113	0.06
	Sr-89	0.02
	Sr-90	0.02
	Tc-99	0.01
	Zr-95	0.23
b. Evaporator Concentrates	N/A	N/A
c. Dewatered Demineralizers	N/A	N/A
d. Solidified (cement) Acids, Oils, Sludge	N/A	N/A
2. Dry Solid Waste		
a. Dry Active Waste (dewatered, compacted)	C-14	1.12
	Ce-144	0.04
	Co-57	0.02
	Co-58	0.00
	Co-60	24.40
	Cs-137	0.07
	Fe-55	50.80
	H-3	3.99
	Mn-54	0.94
	Nb-95	0.00
	Ni-63	17.60
	Sb-125	1.03
	Sr-90	0.02
	Zr-95	0.00
	I-129	0.01
	Tc-99	0.03

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2016 - 12/31/2016

b. Dry Active Waste (dewatered, non-compacted)	C-14	0.06
	Ce-144	0.24
	Co-57	0.00
	Co-58	0.65
	Co-60	11.30
	Cr-51	1.31
	Cs-137	0.14
	Fe-55	6.22
	Fe-59	0.00
	H-3	5.67
	I-129	0.01
	Mn-54	0.38
	Nb-95	17.29
	Ni-63	6.32
	Sb-125	1.28
	Sn-113	0.00
	Sr-90	0.07
	Tc-99	0.08
	Zr-95	13.47
	Am-241	0.00
	Cm-243	0.00
	Pu-238	0.00
	Pu-239	0.00
	Pu-241	0.00
	Cs-134	0.00
c. Dry Active Waste (brokered)	N/A	N/A
d. Irradiated Components (dewatered, non-compacted)	C-14	0.03
	Ce-144	0.00
	Co-58	0.03
	Co-60	68.90
	Cr-51	10.49
	Cs-137	0.00
	Fe-55	10.59
	Fe-59	0.21
	H-3	0.00
	I-129	0.00
	Mn-54	0.04
	Nb-95	0.00
	Ni-63	0.31
	Sb-125	0.00
	Sr-90	0.00
	Tc-99	0.00
	Zr-95	0.00
	Ni-59	0.00
	Zn-65	9.40
	Nb-94	0.00
e. Other (dewatered, non-compacted)	C-14	8.26
	Ce-144	0.04
	Co-60	0.02
	Cs-137	0.02
	H-3	47.14
	I-129	11.07
	Tc-99	33.40

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).

Attachment 4
Meteorological Data

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2016 - 12/31/2016

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	1	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	0	0	0	0	0	0	0	0	0	0	0	0
	2.01-3.00	0	1	1	3	2	0	0	0	0	0	0	0	0	0	0	0
	3.01-4.00	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	4.01-5.00	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	5.01-6.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	6.01-8.00	0	0	0	0	0	0	0	0	0	0	0	0	0	3	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	1	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	1	1	1	0	0	0	0	2	0	0	0	0	0	0	1	0
	1.51-2.00	1	3	3	2	2	1	0	1	0	0	0	0	0	0	0	1
	2.01-3.00	0	5	3	5	1	2	0	1	5	0	0	2	2	4	2	1
	3.01-4.00	4	7	9	5	0	1	0	0	5	1	1	1	0	1	3	0
	4.01-5.00	0	1	0	2	0	0	0	0	1	2	3	3	2	4	3	1
	5.01-6.00	0	1	0	0	0	0	0	0	0	2	0	2	0	1	0	0
	6.01-8.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	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 1/1/2016 - 12/31/2016

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	1	0	0	0	0	1	0	1	0	0	1	0	0
	0.76-1.00	3	1	3	1	0	2	0	1	1	0	1	0	0	0	0	1
	1.01-1.25	2	1	2	2	2	2	2	1	1	1	3	0	2	2	1	1
	1.26-1.50	1	3	5	3	3	5	3	4	1	4	1	3	3	1	2	1
	1.51-2.00	3	11	13	6	8	6	6	7	8	6	8	5	6	4	3	3
	2.01-3.00	8	14	14	17	3	4	5	10	29	8	5	19	3	8	19	20
	3.01-4.00	13	16	15	4	2	1	2	1	12	9	6	17	7	12	18	11
	4.01-5.00	0	1	0	0	0	0	0	0	1	5	14	5	4	6	9	6
	5.01-6.00	0	0	0	0	0	0	0	0	0	6	3	2	0	4	3	2
	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	10	10	17	17	9	6	11	5	6	5	10	9	9	13	6	15
	0.76-1.00	11	10	25	14	14	20	12	6	8	16	10	17	16	14	10	16
	1.01-1.25	13	21	21	17	14	14	8	11	12	12	16	20	16	10	12	14
	1.26-1.50	24	22	35	11	16	14	12	17	24	17	17	23	12	15	21	17
	1.51-2.00	64	70	61	55	29	37	22	24	42	59	62	69	38	29	34	44
	2.01-3.00	123	188	79	54	23	24	20	33	76	102	96	137	71	39	62	96
	3.01-4.00	74	76	23	7	0	3	3	15	48	56	52	39	36	31	37	41
	4.01-5.00	15	7	0	0	0	0	0	2	13	26	34	19	7	15	19	20
	5.01-6.00	6	5	0	0	0	0	0	3	4	16	7	7	5	5	5	3
	6.01-8.00	2	7	0	0	0	0	0	0	2	0	2	2	2	1	0	0
	8.01-10.00	0	1	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 1/1/2016 - 12/31/2016

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	14	29	14	11	11	8	12	21	14	22	15	18	12	7	12
	0.76-1.00	20	17	13	14	11	20	6	11	20	15	16	11	14	7	6	13
	1.01-1.25	18	17	17	17	10	8	9	17	12	16	14	15	11	7	9	5
	1.26-1.50	28	23	21	14	9	8	13	20	12	32	12	21	7	13	10	6
	1.51-2.00	40	45	27	15	5	9	3	29	28	43	34	22	16	8	14	14
	2.01-3.00	42	30	18	6	1	2	0	16	50	106	48	15	12	23	21	32
	3.01-4.00	1	3	2	0	1	0	1	0	10	49	17	1	10	5	3	8
	4.01-5.00	0	0	0	0	0	0	0	0	0	7	0	1	0	0	0	0
	5.01-6.00	0	0	0	0	0	0	0	0	0	3	2	1	0	0	0	1
	6.01-8.00	0	0	0	0	0	0	0	0	0	1	2	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	12	17	11	14	3	2	3	4	5	8	13	9	7	3	9	12
	0.76-1.00	11	10	6	8	2	5	2	2	5	5	8	8	4	4	10	12
	1.01-1.25	16	8	8	3	1	1	3	1	2	4	6	8	4	3	6	4
	1.26-1.50	11	5	5	4	0	0	0	3	0	4	8	5	2	4	6	6
	1.51-2.00	14	8	3	2	3	0	1	2	3	13	7	5	2	3	4	2
	2.01-3.00	1	1	0	0	0	0	0	0	1	3	1	0	1	1	0	0
	3.01-4.00	0	0	0	0	0	0	1	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 4
Meteorological Data

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2016 - 12/31/2016

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	18	8	12	10	3	5	2	4	3	2	6	8	5	7	2	14
	0.76-1.00	6	3	4	2	1	0	2	0	4	2	4	3	5	8	5	4
	1.01-1.25	4	1	1	0	0	0	0	0	1	3	1	1	0	0	2	2
	1.26-1.50	3	1	0	0	0	0	0	1	0	1	3	0	1	0	0	0
	1.51-2.00	1	2	0	0	0	0	0	0	1	0	1	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

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 1/1/2016 - 12/31/2016

Shearon Harris Nuclear Power Plant had one (1) unplanned liquid release in 2016.

Shearon Harris Nuclear Power Plant had one (1) unplanned gaseous release in 2016.

Summaries in this attachment include:

- Detailed description of event.
- Total Curies released.
- Anticipated dose consequences.

Attachment 5
Unplanned Offsite Releases

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2016 - 12/31/2016

Gaseous Release- Waste Gas Decay Tank (WGDT) 'D' 5/17/2016: Nuclear Condition Report (NCR) 2030195

After the transfer of "A" WGDT to "D" WGDT Operations noticed that the "D" WGDT had a lowering trend. Waste Gas was secured and the inlet and outlet valves of the "D" WGDT were shut and the pressure stabilized. 347 ft^3 of gas was released from the tank through the monitored released point.

Isotope	Concentration (µCi/cc)	Post Dilution Concentration (µCi/cc)	Activity Released (Ci)
H-3	3.621E-07	4.60E-12	3.56E-06
Xe-133M	3.907E-07	4.97E-12	3.84E-06
Xe-133	2.400E-05	3.05E-10	2.36E-04
Xe-135	1.008E-06	1.28E-11	9.91E-06
		Total	2.53E-04

In order to determine the dose to a member of the public from the release of the "D" waste gas decay tank was calculated using the radiological effluent software (OpenEMS) and compared against 10 CFR Part 50 Appendix I limits. The maximum receptor dose for particulates, iodine, and tritium (PIT) from this release, including cow milk, ground plane, inhalation, meat, and vegetation pathways, was determined to be a child at the site boundary with a limiting organ of liver. The noble gas from all gamma and beta emitter in the air was computed, as well at the annual dose rate to the skin and total body. The result were documented in Gaseous Release Permit G-2016-0083 and listed in the table below.

Name	Dose	Limit	% QTR	% Annual
Total Body (PIT)	1.81E-08	7.5 mrem/qtr 15 mrem/yr	2.41E-07	1.21E-07
Organ (PIT)	1.81E-08	7.5 mrem/qtr 15 mrem/yr	2.41E-07	1.21E-07
Skin Dose Rate (NG)	3.95E-04	3000 mrem/yr	N/A	1.32E-05
Total Body Dose Rate (NG)	1.68E-04	500 mrem/yr	N/A	3.35E-05
Gamma Air Dose	7.55E-08	5 mrad/qtr 10 mrad/yr	1.51E-06	7.55E-07
Beta Air Dose	2.03E-07	10 mrad/qtr 20 mrad/yr	2.03E-06	1.01E-06

In each instance, the dose was < 0.01% of the dose limits and thus did not exceed any of the limits at or near the site boundary. Finally, the cumulative gaseous dose from all release (including all stacks and waste gas decay tank releases) is computed, the cumulative maximum individual organ dose from particulate, iodine, and tritium is 0.71% of the quarterly limits. Thus, the dose calculations from this release were well beneath any regulatory limits.

Attachment 5
Unplanned Offsite Releases

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2016 - 12/31/2016

Liquid Release - Treated Laundry and Hot Shower (TLHS) "B": NCR 2069947

On October 12, 1400 Operations performed a planned, permitted radioactive discharge of the Treated Laundry Hot Shower Tank (TLHS) "B" in accordance to OP-120.10.04. The release was monitored by the TLHS radiation monitor REM-3540. After the release was completed on October 13, 03:23, Operations flushed the discharge, through the monitor, with 2,852 gallons of demin water per OP-120.10.04 Section 7.1. Like the radioactive tank discharge, the flush water flew unimpeded to Harris Lake via the Radwaste Discharge Pipe and Cooling Tower Blowdown Line. After the contamination of the WPB demin water was identified, a sample of the remaining water in the pipe (3DW-169) associated with the flush was analyzed. Note: a sample of the actual flush water was impossible because the water had already entered and mixed with Harris Lake inventory. The sample contained 2.91E-06 uCi/ml tritium and 2.23E-07 uCi/ml Co58. The radiation monitor associated with this flush was reviewed (REM-3540) and no changes were identified during the period of the flush. Since the release was contained within the discharge piping to Harris Lake it did not impact groundwater. The contamination the demin water caused an unplanned radioactive discharge to the public.

Isotope	Concentration (uCi/mL)	Post Dilution Concentration (uCi/mL)	Curies
H-3	2.91E-06	1.07E-08	3.14E-05
Co-58	2.23E-07	8.20E-10	2.41E-06
		Total	3.38E-05

The dose and dose rate to a member of the public from the release of the contaminated flush water was calculated using the radiological effluent software (OpenEMS) and compared against 10 CFR Part 50 Appendix I limits. The maximum receptor was an adult and the dose factors where based upon site specific parameters as defined in the Off Site Dose Calculation Manual Section B. The result were documented in Liquid Release Permit L-2016-0048 and listed in the table below.

Name	Dose	Limit	% QTR	% Annual
Total Body	2.45E-07 mrem	1.5 mrem/qtr 3 mrem/yr	1.63E-05	8.17E-06
Organ (GILLI)	2.12E-06 mrem	5 mrem/qtr 10 mrem/yr	4.23E-05	2.12E-05

In each instance, the dose was <0.01% of the dose limits and thus did not exceed any of the limits at or near the site boundary. Finally, the cumulative liquid dose from all release (including all liquid releases) is computed, the cumulative maximum total body dose is 8.80% of the annual limits. Thus, the dose calculations from this release were well beneath any regulatory limits.

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 1/1/2016 - 12/31/2016

Gaseous Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Noble Gases						
1. Maximum Gamma Air	mRAD	2.97E-05	2.28E-06	5.47E-06	5.72E-07	3.81E-05
(a) Limit	mRAD	5.00E+00	5.00E+00	5.00E+00	5.00E+00	1.00E+01
(b) % of Limit		5.95E-04	4.55E-05	1.09E-04	1.14E-05	3.81E-04
2. Maximum Beta Air	mRAD	8.85E-05	6.58E-06	1.63E-05	1.70E-06	1.13E-04
(a) Limit	mRAD	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
(b) % of Limit		8.85E-04	6.58E-05	1.63E-04	1.70E-05	5.65E-04

Receptor Location ***2.14*** km ***SW***

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
B. Iodine, H-3, & Particulates						
1. Maximum Organ Dose	mREM	1.20E-01	9.52E-02	9.18E-02	7.96E-02	3.87E-01
(a) Limit	mREM	7.50E+00	7.50E+00	7.50E+00	7.50E+00	1.50E+01
(b) % of Limit		1.60E+00	1.27E+00	1.22E+00	1.06E+00	2.58E+00

Receptor Location ***2.14*** km ***SW***
Critical Age ***CHILD***
Critical Organ ***THYROID***

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

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2016 - 12/31/2016

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Batch Mode						
1. Maximum Organ Dose	mREM	4.19E-04	3.91E-03	2.19E-02	9.27E-02	1.19E-01
(a) Limit	mREM	5.00E+00	5.00E+00	5.00E+00	5.00E+00	1.00E+01
(b) % of Limit		8.39E-03	7.81E-02	4.38E-01	1.85E+00	1.19E+00
2. Maximum Total Body Dose	mREM	1.38E-04	3.90E-03	1.87E-02	1.44E-02	3.71E-02
(a) Limit	mREM	1.50E+00	1.50E+00	1.50E+00	1.50E+00	3.00E+00
(b) % of Limit		9.23E-03	2.60E-01	1.24E+00	9.59E-01	1.24E+00

Critical Age ***ADULT***
Critical Organ ***GILLI***

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

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2016 - 12/31/2016

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 2016 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	6.70 km SSW
2. Critical Age	CHILD	2. Critical Age	CHILD
3. Critical Organ	THYROID	3. Critical Organ	N/A
4. Organ Dose (mREM)	3.87E-01	4. Organ Dose (mREM)	8.72E-02
5. Total Body Dose (mREM)	3.87E-01	5. Total Body Dose (mREM)	8.72E-02
B. Liquid Effluent Dose		F. Training Center Drinking Water H-3 Dose	
1. Location	2.19 km S	1. Location	OCA
2. Critical Age	ADULT	2. Critical Age	ADULT
3. Critical Organ	GI-LLI	3. Critical Organ	N/A
4. Organ Dose (mREM)	1.19E-01	4. Organ Dose (mREM)	1.18E-01
5. Total Body Dose (mREM)	3.71E-02	5. Total Body Dose (mREM)	1.18E-01
C. Carbon-14 Dose		G. H-3 in Fish from Harris Lake	
1. Location	3.07 km NNE	1. Location	Lake
2. Critical Age	CHILD	2. Critical Age	ADULT
3. Critical Organ	BONE	3. Critical Organ	N/A
4. Organ Dose (mREM)	2.59E-01	4. Organ Dose (mREM)	1.14E-02
5. Total Body Dose (mREM)	5.17E-02	5. Total Body Dose (mREM)	1.14E-02
D. Cooling Tower Plume H-3 Dose			
1. Location	3.07 km NNE		
2. Critical Age	CHILD		
3. Critical Organ	N/A		
4. Organ Dose (mREM)	3.84E-03		
5. Total Body Dose (mREM)	3.84E-03		

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

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2016 - 12/31/2016

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 less than 2.59E-01 mrem/yr based on 8.22E+00 Curies released in 2016 (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 less than 3.84E-03 mrem/yr based on 8.75E+01 Curies released in 2016 (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 less than 8.72E-02 mrem/yr based on 1.13E+02 Curies released in 2016 (Ref. Attachment 2, Supplemental Information, of this report).

Dose contributions from Tritium in drinking water at the Wake County Fire and HE&EC Training Centers 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 1.18E-01 mrem/yr based on an average concentration of 4.32E+03 ρCi/L consumed in 2016 (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 less than 1.14E-02 mrem/yr based on an average concentration of 5.76E+03 ρCi/L consumed in 2016 (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

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 1/1/2016 - 12/31/2016

Samples were taken at various locations throughout the plant in support of the Groundwater Protection Initiative. Samples included Groundwater Monitoring Wells along the Cooling Tower Blowdown Line, Storm Drains, Vaults and Yard Drains that could potentially affect groundwater. None of the vaults, yard drains, or storm drains indicated plant related gamma emitters or tritium above the investigation limit. HNP Self Assessment (AR-0202000) determined Groundwater Monitoring location #76 did not meet the requirements for waterborne monitoring, so in September 2016 it was removed from the site's Radiological Environmental Monitoring Program (REMP). The well is located within the protected area and is not used as a source of drinking water or irrigation, thus is not a potential dose pathway. In addition, in June 2015 12 new groundwater monitoring wells were installed near the site's Waste Neutralization Basin. These wells are not listed in the ODCM or part of the REMP. The data for these wells are located below. Per NEI 07-07 the results of the Groundwater Monitoring Wells were included in the REMP and are not listed in this report but included in the AREOR.

Results from sampling during 2016 are shown in the table below.

	Tritium Concentration (ρCi/L)				
Well #	**1st Qtr**	**2nd Qtr**	**3rd Qtr**	**4th Qtr**	**# Samples**
GW76	<MDA	4.48E+02	4.29E+02	<MDA	4[1]
HMW1	2.56E+02	2.67E+02	2.52E+02	2.81E+02	4
HMW2	<MDA	<MDA	<MDA	<MDA	4
HMW3	<MDA	<MDA	<MDA	<MDA	4
HMW4D	<MDA	<MDA	<MDA	<MDA	4
HMW4S	<MDA	<MDA	<MDA	<MDA	4
HMW5	<MDA	<MDA	<MDA	<MDA	4
HMW6	<MDA	<MDA	2.72E+02	2.63E+02	4
HMW7	<MDA	<MDA	<MDA	<MDA	4
HMW8	<MDA	<MDA	<MDA	<MDA	4
HMW9	<MDA	<MDA	<MDA	<MDA	4
HMW10	<MDA	<MDA	<MDA	<MDA	4
HMW11	<MDA	<MDA	<MDA	<MDA	4

NOTE: MDA for monitoring wells 185 ρCi/L

[1] GW76 results from 1st to 3rd quarter 2016 are included in the Annual Radiological Environmental Operating Report

Zero (0) events meeting the criteria for voluntary notification per NEI 07-07, Industry Ground Water Protection Initiative, occurred at Shearon Harris Nuclear Power Plant in 2016.

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 1/1/2016 - 12/31/2016

Shearon Harris Nuclear Power Plant did not experience inoperable equipment relevant to effluent monitoring in excess of ODCM limits during 2016.

Shearon Harris Nuclear Power Plant did not experience temporary outside liquid storage tanks exceeding 10 Curies total activity (excluding tritium and dissolved or entrained noble gases) during 2016.

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 1/1/2016 - 12/31/2016

ODCM Revision 26

There are two types of changes to the ODCM; 1) programmatic changes and 2) administrative corrections, changes, and clarifications. Programmatic Changes were as follows:

As part of fleet alignment, the fleet meteorology organization revised site's transportation and deposition model (XOQDOQ) increasing the number of wind classification from 7 to 13, concentrating more classes for the 0.75 - 3.50 mph wind speed. The increase the number of lower wind classifications improves the assessment of dose to show compliance with 10CFRPart20.1302 and 10CFRPart50 Appendix I.

- The revision to the site's transportation and deposition model (XOQDOQ) changed the locations and value for the highest X/Q and D/Q. The site's Radiological Effluent Program and Emergency Plan have been revised to incorporate the update.
- HNP Self Assessment (AR-0202000) evaluated the site's REMP against NUREG-1301 Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Pressurized Water Reactors requirements. The self assessment identified opportunities for improvements in the location of Special Interest (i.e. population center) TLD's. Due to the growth in the area the original location of population center TLD's no longer met the intent of ODCMOR 3/4.12.1. As a result, new TLD's were located near schools and neighborhoods.
- HNP Self Assessment (AR-0202000) determined Groundwater Monitoring location #76 did not meet the requirements for waterborne monitoring. The well is located within the protected area and is not used as a source of drinking water or irrigation, thus is not a potential dose pathway. The well will continue to be sampled as part of the site's Groundwater Protection Program and the results published the Annual Radiological Effluent Release Report.
- The owners of Food Crop #5 and Milk #96 no longer can provide food crop or milk samples. An alternative Food Crop location #96 (included in ODCM Revision 25) provides sufficient quantities of vegetation for Food Crop surveillance. Since, there are no active dairies in the area location #96 has been removed from the REMP. The annual Land Use Census will continue to monitor for new gardens or milk animals.

No changes to plant safety systems or components, FSAR-described evaluation methodologies, or tests/experiments outside the bounds of the FSAR are effected by Rev 26 to the ODCM.

Revision 26 was approved by the Plant Nuclear Safety Committee on 9-23-2016.

A complete list of the changes the ODCM in Revision 26 is below.

Attachment 9
Summary of Changes to the Offsite Dose Calculation Manual

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2016 - 12/31/2016

DRRs 01998214, 01996625, 02008147, 02031405, 02031406

Section	Page	Description
Table of Contents	i	Changed to “ODCM REV. 26 CHANGE SUMMARY”,
Entire Document		The site's FSAR and the fleet now use a common revision number for the ODCM so the List of Effective Pages and revision headings were deleted. (DRR 2031406) The format and font of the entire document was adjusted for uniformity throughout.
ODCM REV 26 CHANGE SUMMARY	v	Changed to reflect Rev. 26 revisions.
2.3	2-16	Added "and the consumption of fish from Harris Lake". This is an additional return/reuse pathway.
2.3.4	2-20	Added dose calculation from the consumption of fish from Harris Lake. The dose assessment is based upon Reg Guide 1.109 (DRR 2008147)
3.0	3-1	Added "Minor release pathways, such as steam leaks, steam dumps, and open penetrations are evaluated for significant of release." (DRR 1998214)
3.1.1	3-2	Equation 3.1-1a and 3.1-1b incorrectly contain a summation sign. The equations are for the individual release rates rather than the sum of all the releases. (DRR 2031405)
3.1.1, 3.1.2 3.2.1, 3.3.1	3-2, 3-7, 3-12, 3-18	Changed X/Q from 2.30E-05 to 1.8E-05 to update to highest X/Q new value (AR 682873)
3.2.1	3-13	Changed X/Q period from 2003 - 2007 to 2010 - 2014 to reflect the new Appendix A update.
3.3.2	3-23	Changed D/Q from 1.00E-08 in SSW sector to 9.0E-09 in SW sector to update to highest D/Q new value (AR 682873)
3.3.2	3-24	Revised sentence "At SHNPP the SW sector has the highest X/Q_v and the SSW sector has the highest annual average D/Q_v values." to "At SHNPP the SW sector has the highest X/Q_v and the SW and SSW sector have the highest annual average D/Q_v values." because both the SW and SSW have the same D/Q = 9.0E-09
3.3.2	3-27 to 3-28	Revised Carbon-14 dose assessment to allow for dose to be calculated either quarterly or annually. Removed the word "annual" from descriptions and terms. Changed the number of hours of photosynthesis per year from 4400 hours to 4460 hours/yr and 1115 hours/quarter. This result is based upon data from the US Naval Observatory for Raleigh, NC.
4.0	4-1	Deleted reference to figures 4.1-4, 4.1-5, and 4.1-6. Those figures were removed from the ODCM in earlier revision.
Table 4.1 - Direct Radiation	4-3	Added distance for location 5 at 13.3 mile (NCR 02047421)

Table 4.1 - Direct Radiation	4-5, 4-6	Deleted TLD locations 67, (HEEC), 34 (Apex), 35 (Holly Springs) and replaced with TLD locations 98 (Holly Springs school complex) and 99 (Friendship High School). Due to the growth in the area, these locations are more centrally located to population. Deleted TLD locations 36 (Sunset Lake) and 37 (Fuquay Varina). These TLD locations are defined as special interest locations due to population centers per ODCMOR 3/4.12.1 and located approximately 10 miles from the plant. Since the inception of the Radiological Environmental Monitoring Program, the regional population has moved closer to the plant and these locations no longer meet the intent of ODCMOR 3/4.12.1 TLD locations #3 and #50 are new special interest locations. (AR 02020000)
Table 4.1 - Surface Water	4-6	Changed required analysis from Monthly Gross Beta and Quarterly Gamma Isotopic to the correct Monthly Gamma Isotopic and Quarterly Tritium per NUREG-1301 Table 3.12-1 Added note "H-3 analysis is normally performed monthly"
Table 4.1 Groundwater Monitoring	4-8	Removed Groundwater location 76 from the Radiological Environmental Monitoring Program. The groundwater at this location does not meet the requirements for waterborne monitoring. Because this well is located within the protected area it is not used as a source of drinking water or irrigation. This well will be sampled per plant procedures and the results published in the Annual Effluent Release Report per ODCM Section F.2. (AR 02020000)
Table 4.1 Ingestion –Milk	4-11	Removed location 96 from Milk. This location is no longer available because the homeowner no longer sells goat milk. According to the homeowner's business website the goat milk is used for the production of soap. (AR 02020000)
Table 4.1 Ingestion – Food Products	4-12	Removed location 5 from Food Crop. This location is no longer available because the homeowner no longer gardens. Added reference to notes 10 and 16. (AR 02020000)
Notes for Table 4.1	4-14	Revised Note 1 to remove reference to figures 4.1-4, 4.1-5, and 4.1-6. Revised Note 10, 11, 12, and 14 to include new information regarding Food Crop location 5 and groundwater monitoring well 76. Revised note 15 to clarify the description of broadleaf vegetation. Added new note 16 "Attention shall be paid to including samples of tuberous and root food products."
Table 4.2 Radiological Environmental Monitoring Program	4-15	Deleted "M" for Site #5 under FP. Deleted Site #76 under GW and #96 under MK.
Table 4.3 Radiological Environmental Monitoring Program (TLD Sites)	4-16	Deleted Site # 34, 35, 36, 37, 67 and added # 98, 99. Identified locations #3 and #50 as special interest. Changed distance of #5 from >12 m. to 13.3 mi. (NCR 02047421)
Figure 4.1-2 Environmental Radiological Sampling Points	4-18	Revised maps to reflect removal of location 76

Attachment 9
Summary of Changes to the Offsite Dose Calculation Manual

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2016 - 12/31/2016

Figure 4.1-3 Environmental Radiological Sampling Points	4-19	Revised maps to reflect removal of location 34, 35, 36, 37, 96 and the addition of locations 98, 99
Appendix A	A1 - A22	revised Appendix A to new XOQDOQ based upon 2010 - 2014 meteorology data. Increased the number of wind classifications from 7 to 13, concentrating more classes for the 0.75-3.50 mph wind speed. This class was split into 5 segments to get more accurate analysis of XOQDOQ. (AR 682873, DRR1996625)
Table 3.12-2 Food Products	D-32	Added additional food product sample requirement from areas irrigated by water which liquid plant wastes have been discharged per NUREG-1301 Table 3.12-1. Note: there are currently no Food Products that are irrigated by plant discharges
Note to Table 3.12-2	D-34	Added note 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." based upon NUREG-1301 Table 3.12-1
Table 4.12-1 Detection Capabilities for Environmental Samples	D-36	Add the note "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."
3 /4.12.3 Interlaboratory Comparison Program	D-39	Deleted "The laboratory used for the Interlaboratory Comparison Program is to participate in the National Institute of Standard and Technology (NIST) program" This is not a recognized program.

SHEARON HARRIS NUCLEAR POWER PLANT
OFF-SITE DOSE CALCULATION MANUAL

(ODCM)

Revision 26

Docket No. STN-50-400

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

Approval by PNSC Chairman ____________________

Approval by General Manager - Harris Plant ____________________

Prepared by Heather Baxter

Reviewed by ____________________

Effective Date 9-23-16

TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES (continued)

NOTE: Tables in Appendix D are named after their respective Operational Requirement.

LIST OF FIGURES

ODCM REV. 26 CHANGE SUMMARY

Revision 26 to the ODCM is as follows:
DRR's 1998214, 1996625, 2008147, 2031405, 2031406

Section	Page	Description
Table of Contents	i	Changed to "ODCM REV. 26 CHANGE SUMMARY",
Entire Document		The site's FSAR and the fleet now use a common revision number for the ODCM so the List of Effective Pages and revision headings were deleted. (DRR 2031406) The format and font of the entire document was adjusted for uniformity throughout.
ODCM REV 26 CHANGE SUMMARY	v	Changed to reflect Rev. 26 revisions.
2.3	2-16	Added "and the consumption of fish from Harris Lake". This is an additional return/reuse pathway.
2.3.4	2-20	Added dose calculation from the consumption of fish from Harris Lake. The dose assessment is based upon Reg Guide 1.109 (DRR 2008147)
3.0	3-1	Added "Minor release pathways, such as steam leaks, steam dumps, and open penetrations are evaluated for significant of release." (DRR 1998214)
3.1.1	3-2	Equation 3.1-1a and 3.1-1b incorrectly contain a summation sign. The equations are for the individual release rates rather than the sum of all the releases. (DRR 2031405)
3.1.1, 3.1.2 3.2.1, 3.3.1	3-2, 3-7, 3-12, 3-18	Changed X/Q from 2.30E-05 to 1.8E-05 to update to highest X/Q new value (AR 682873)
3.2.1	3-13	Changed X/Q period from 2003 - 2007 to 2010 - 2014 to reflect the new Appendix A update.
3.3.2	3-23	Changed D/Q from 1.00E-08 in SSW sector to 9.0E-09 in SW sector to update to highest D/Q new value (AR 682873)
3.3.2	3-24	Revised sentence "At SHNPP the SW sector has the highest X/Q_v and the SSW sector has the highest annual average D/Q_v values." to "At SHNPP the SW sector has the highest X/Q_v and the SW and SSW sector have the highest annual average D/Q_v values." because both the SW and SSW have the same D/Q = 9.0E-09
3.3.2	3-27 to 3-28	Revised Carbon-14 dose assessment to allow for dose to be calculated either quarterly or annually. Removed the word "annual" from descriptions and terms. Changed the number of hours of photosynthesis per year from 4400 hours to 4460 hours/yr and 1115 hours/quarter. This result is based upon data from the US Naval Observatory for Raleigh, NC.
4.0	4-1	Deleted reference to figures 4.1-4, 4.1-5, and 4.1-6. Those figures were removed from the ODCM in earlier revision.
Table 4.1 - Direct Radiation	4-3	Added distance for location 5 at 13.3 mile (NCR 02047421)
Table 4.1 - Direct Radiation	4-5, 4-6	Deleted TLD locations 67, (HEEC), 34 (Apex), 35 (Holly Springs) and replaced with TLD locations 98 (Holly Springs school complex) and 99 (Friendship High School). Due to the growth in the area, these locations are more centrally located to population. Deleted TLD locations 36 (Sunset Lake) and 37 (Fuquay Varina). These TLD locations are defined as special interest locations due to population centers per ODCMOR 3/4.12.1 and located approximately 10 miles from the plant. Since the inception of the Radiological Environmental Monitoring Program, the regional population has moved closer to the plant and these locations no longer meet the intent of ODCMOR 3/4.12.1 TLD locations #3 and #50 are new special interest locations. (AR 02020000)

ODCM REV. 26 CHANGE SUMMARY (continue)

Table 4.1 - Surface Water	4-6	Changed required analysis from Monthly Gross Beta and Quarterly Gamma Isotopic to the correct Monthly Gamma Isotopic and Quarterly Tritium per NUREG-1301 Table 3.12-1 Added note "H-3 analysis is normally performed monthly"
Table 4.1 Groundwater Monitoring	4-8	Removed Groundwater location 76 from the Radiological Environmental Monitoring Program. The groundwater at this location does not meet the requirements for waterborne monitoring. Because this well is located within the protected area it is not used as a source of drinking water or irrigation. This well will be sampled per plant procedures and the results published in the Annual Effluent Release Report per ODCM Section F.2. (AR 02020000)
Table 4.1 Ingestion –Milk	4-11	Removed location 96 from Milk. This location is no longer available because the homeowner no longer sells goat milk. According to the homeowner's business website the goat milk is used for the production of soap. (AR 02020000)
Table 4.1 Ingestion – Food Products	4-12	Removed location 5 from Food Crop. This location is no longer available because the homeowner no longer gardens. Added reference to notes 10 and 16. (AR 02020000)
Notes for Table 4.1	4-14	Revised Note 1 to remove reference to figures 4.1-4, 4.1-5, and 4.1-6. Revised Note 10, 11, 12, and 14 to include new information regarding Food Crop location 5 and groundwater monitoring well 76. Revised note 15 to clarify the description of broadleaf vegetation. Added new note 16 "Attention shall be paid to including samples of tuberous and root food products."
Table 4.2 Radiological Environmental Monitoring Program	4-15	Deleted "M" for Site #5 under FP. Deleted Site #76 under GW and #96 under MK.
Table 4.3 Radiological Environmental Monitoring Program (TLD Sites)	4-16	Deleted Site # 34, 35, 36, 37, 67 and added # 98, 99. Identified locations #3 and #50 as special interest. Changed distance of #5 from >12 m. to 13.3 mi. (NCR 02047421)
Figure 4.1-2 Environmental Radiological Sampling Points	4-18	Revised maps to reflect removal of location 76
Figure 4.1-3 Environmental Radiological Sampling Points	4-19	Revised maps to reflect removal of location 34, 35, 36, 37, 96 and the addition of locations 98, 99
Appendix A	A1 - A22	revised Appendix A to new XOQDOQ based upon 2010 - 2014 meteorology data. Increased the number of wind classifications from 7 to 13, concentrating more classes for the 0.75-3.50 mph wind speed. This class was split into 5 segments to get more accurate analysis of XOQDOQ. (AR 682873, DRR1996625)
Table 3.12-2 Food Products	D-32	Added additional food product sample requirement from areas irrigated by water which liquid plant wastes have been discharged per NUREG-1301 Table 3.12-1. Note: there are currently no Food Products that are irrigated by plant discharges
Note to Table 3.12-2	D-34	Added note 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." based upon NUREG-1301 Table 3.12-1
Table 4.12-1 Detection Capabilities for Environmental Samples	D-36	Add the note "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."
3 /4.12.3 Interlaboratory Comparison Program	D-39	Deleted "The laboratory used for the Interlaboratory Comparison Program is to participate in the National Institute of Standard and Technology (NIST) program" This is not a recognized program.

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 2E-4 µCi/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 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.

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

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, and 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:

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

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.

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

where:

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

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

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

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

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 µCi/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 µCi/ml. If no gamma activity is detectable then an activity of 9E-07 µCi/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 µCi/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

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

R_{wmax} = Liquid effluent tank maximum waste flow rate, as specified in Table 2.1-1. 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 but normally will be 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 $D_{req} \leq 1$, the minimum dilution flow rate is set to 0.0. If $D_{req} > 1$, the minimum dilution flow rate is determined as follows:

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

where

F_{waste} = waste flow anticipated for this release

2.1.1 Batch Releases (continued)

5. 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 µCi/ml.

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 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

$$S_{max}\,(\text{Cs-equiv}) = (S_{adj} \bullet R_{mon}) + B \qquad (2.1\text{-}8)$$

where

S_{adj} = Setpoint adjustment factor.

$$= \frac{\dfrac{f_{alloc} \bullet F_{avail}}{F_{waste}} - D_{req,ng}}{D_{req,g}} \qquad (2.1\text{-}9)$$

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

B = monitor background (µCi/ml)

2.1.1 Batch Releases (continued)

R_{mon} = Σ $slope_i \bullet C_i$

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.

$$S_{alert} = [(S_{max} - B) \bullet F_x] + B \qquad (2.1\text{-}10)$$

where:

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

2.1.1 Batch Releases (continued)

(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:

$$MDC \leq 0.1[(S_{max} - B) \bullet F_x] \quad (2.1\text{-}11)$$

where:

$$MDC = \frac{2\sqrt{\frac{Bkg}{2\tau}}}{E_m} \quad (2.1\text{-}12)$$

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/µCi/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.

6. 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} (μCi/ml).

$$S_{max} = \frac{0.1\ (ECL_{eff} \bullet Sens_{eff}) + Bkg}{E_m} \quad (2.1\text{-}13)$$

where:

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

$Sens_{eff}$ = Σ_g ($Sens_i$ x % abundance) for the SWST nuclide mix, cpm/μCi/ml.

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

$$S_{alert} = [(S_{max} - B) \bullet F_x] + B \quad (2.1\text{-}14)$$

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_{eff}. Therefore, background is acceptable if:

$$MDC \leq \frac{0.01\,(ECL_{eff} \bullet Sens_{eff})}{E_m} \quad (2.1\text{-}15)$$

2.1.3 Other Liquid Releases

1. Outdoor Tank Area Drain Effluent Line

The outdoor tank area drain effluent line routes rain water 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 is 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:

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

where:

$D_{i\tau r}$ = 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.

$A_{i\tau r}$ = 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:

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

and

Rmix = 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 water cross-tie. 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 loses (balance of plant), will be used for effluent accountability. The secondary loss rate will also be used for volume accountability.

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:

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

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 μCi/ml are given in Table 2.2-1.

1.14E+05 = Unit Conversion Factor

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

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};

= $\frac{0.693}{(t½)_i}$

$(t½)_i$ = 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:

$D_{i\tau r} \leq$ 1.5 mrem total body (2.2-5)

$D_{i\tau r} \leq$ 5 mrem any organ (2.2-6)

For the calendar year:

$D_{i\tau r} \leq$ 3 mrem total body (2.2-7)

$D_{i\tau r} \leq$ 10 mrem any organ (2.2-8)

where:

$D_{i\tau r}$ = Cumulative total dose to any organ t 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:

$D_{p\tau} = (D_{\tau} \bullet p) + D_{a\tau}$ (2.2-9)

where:

$D_{p\tau}$ = 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.

$D_{a\tau}$ = 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:

$D_{p\tau} \leq 0.06$ mrem for total body (2.2-10)

and

$D_{p\tau} \leq 0.2$ mrem for any organ (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, iodines 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 –

$R_{apj} = U_{ap} * D_{apj} * C_{ip}$ (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 work days/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:

$$D_{T\tau r} = (3.17E-08) * (R_{TI\tau}) * (X/Q_{Elv}) \sum Q_{VT} \qquad (2.3\text{-}2)$$

where:

$D_{T\tau r}$ = 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_{Ti} = 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/m^3).

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 + U25/10) (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	=	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)

$Q_T = \sum (L_{area} * EV_{ave} * (L_{TConc} * 1E\text{-}09))$ (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 = $Curies/meter^3$

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 are be 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:

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

Where:

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

Q_T = Yearly Tritium Release from Lake Section, (Ci/yr)

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

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

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

$Dose_{a,poi}$ = $(q_{Tsect}) * (DFA)_a * (BR)_a$ (2.3-6)

Where:

$Dose_{a,poi}$ = 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)

$(DFA)_a$ = 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.

$(BR)_a$ = 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 –

$R_{apj} = U_{ap} * D_{apj} * C_{ip} * BF_i$ (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 Capacity (gal)	Radiation Effluent Monitor ID
		Discharge	Recirculation			
SWST	1	100	100	0.2	25,000	REM-3542
WECT	2	35	35	1.0	10,000	REM-3541
WMT[(3)]	2	100	100	0.25	25,000	REM-3542
TL&HS	2	100	100	0.25	25,000	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 are used to batch release secondary waste effluent when activity is suspected in this pathway.

TABLE 2.1-1b

LIQUID EFFLUENT RELEASE TANKS AND PUMPS FOR NORMAL OPERATIONS [(1)]

Tank [(2)]	No. of Tanks	PUMP CAPACITY		Eductor Factor	Tank Capacity @ Overflow Line (gal)	Radiation Effluent Monitor ID
		Recirculation (gpm)	Pressure (psig)			
SWST	1	80	≤ 71	0.2	23,922	REM-3542
WECT	2	35	≤ 110	1.0	9,447	REM-3541
WMT[(3)]	2	80	≤ 101	0.25	23,945	REM-3542
TL&HS	2	80	≤ 91	0.25	25,000	REM-3540

1 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 ± 5%	3,800
2	7,000 ± 5%	6,650
3	11,000 ± 5%	10,450
4	15,000 ± 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/µCi/ml)	Slope	Sensitivity TB Bldg. Drain Only (cpm/µCi/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/μCi/ml)	Slope	Sensitivity TB Bldg. Drain Only (cpm/μCi/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/µCi/ml)	Slope	Sensitivity TB Bldg. Drain Only (cpm/µCi/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.

Sheet 1 of 3

TABLE 2.2-1

$A_{i\tau}$ VALUES FOR THE ADULT FOR THE SHEARON HARRIS NUCLEAR POWER PLANT

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

(mrem/hr per μCi/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
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)

$A_{i\tau}$ VALUES FOR THE ADULT FOR THE SHEARON HARRIS NUCLEAR POWER PLANT
(mrem/hr per μCi/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
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
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)

$A_{i\tau}$ VALUES FOR THE ADULT FOR THE SHEARON HARRIS NUCLEAR POWER PLANT
(mrem/hr per µCi/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

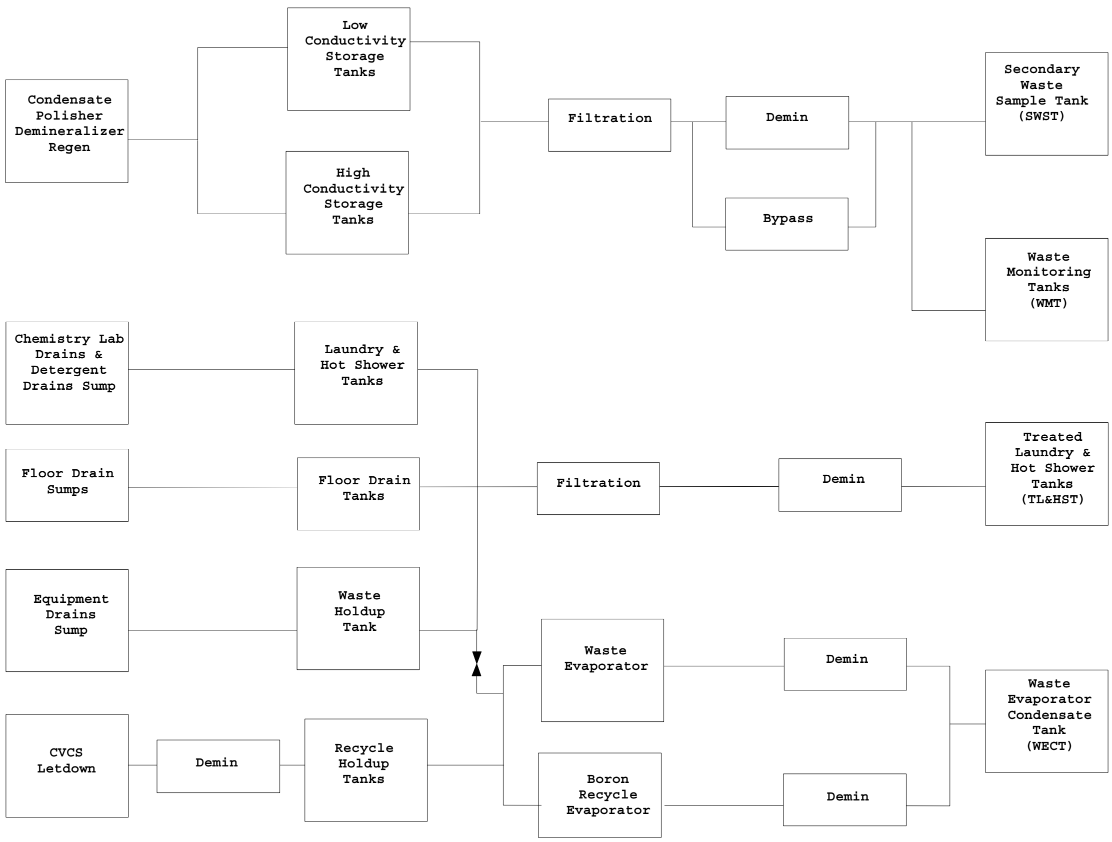


Figure 2.1-2

Liquid Effluent Flow Stream Diagram

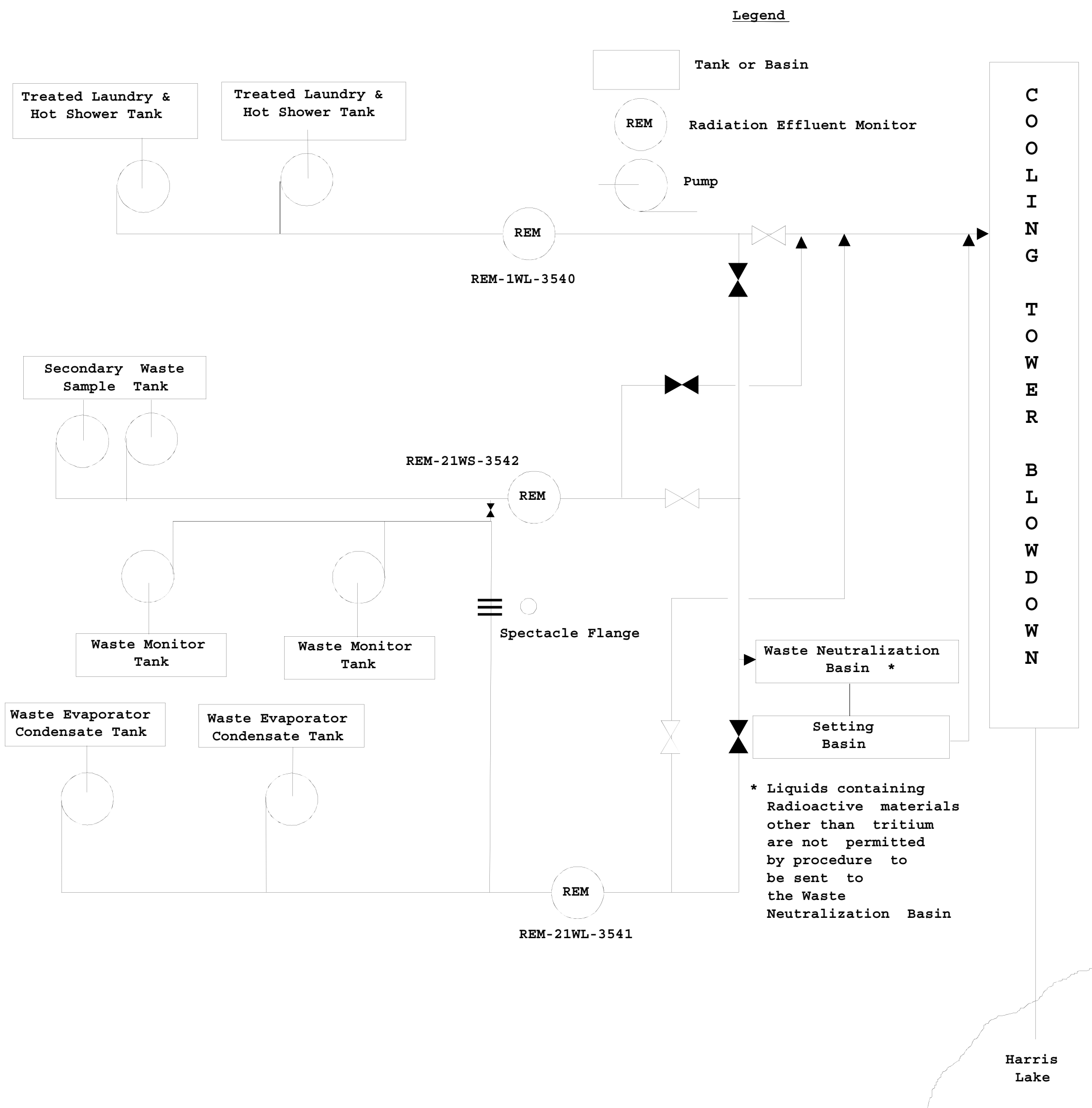
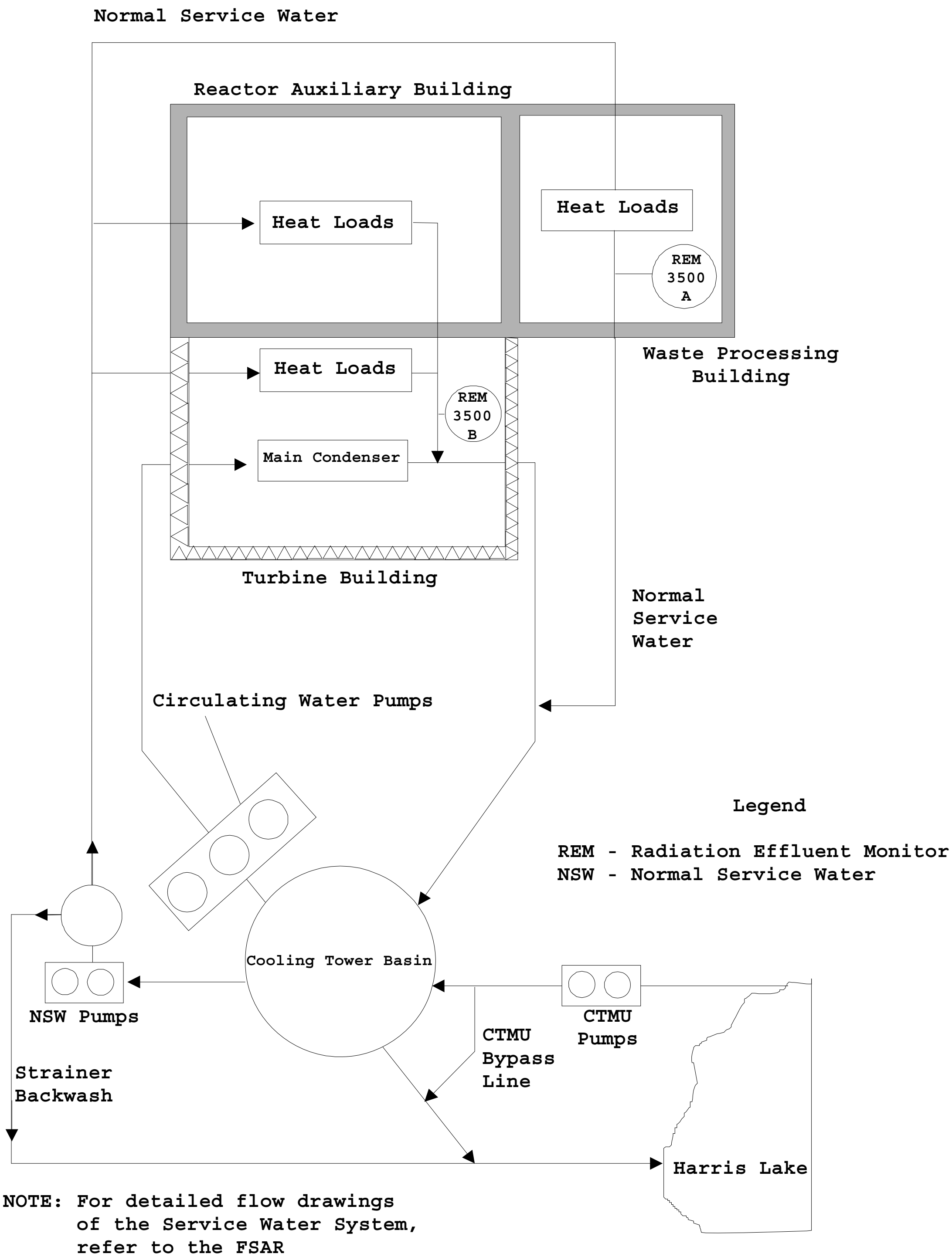


Figure 2.1-3

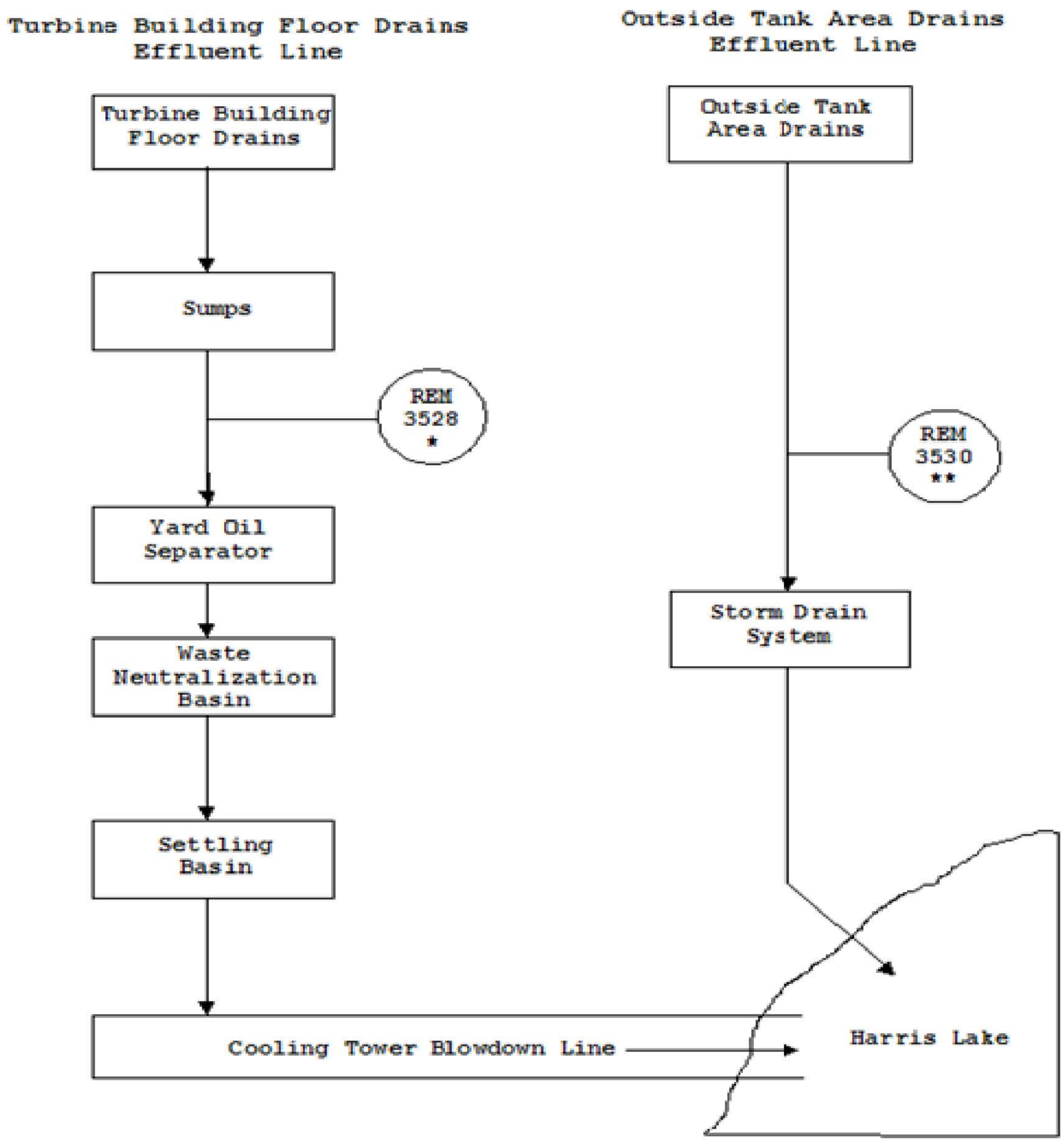
Normal Service Water Flow Diagram



NOTE: For detailed flow drawings of the Service Water System, refer to the FSAR

Figure 2.1-4

Other Liquid Effluent Pathways

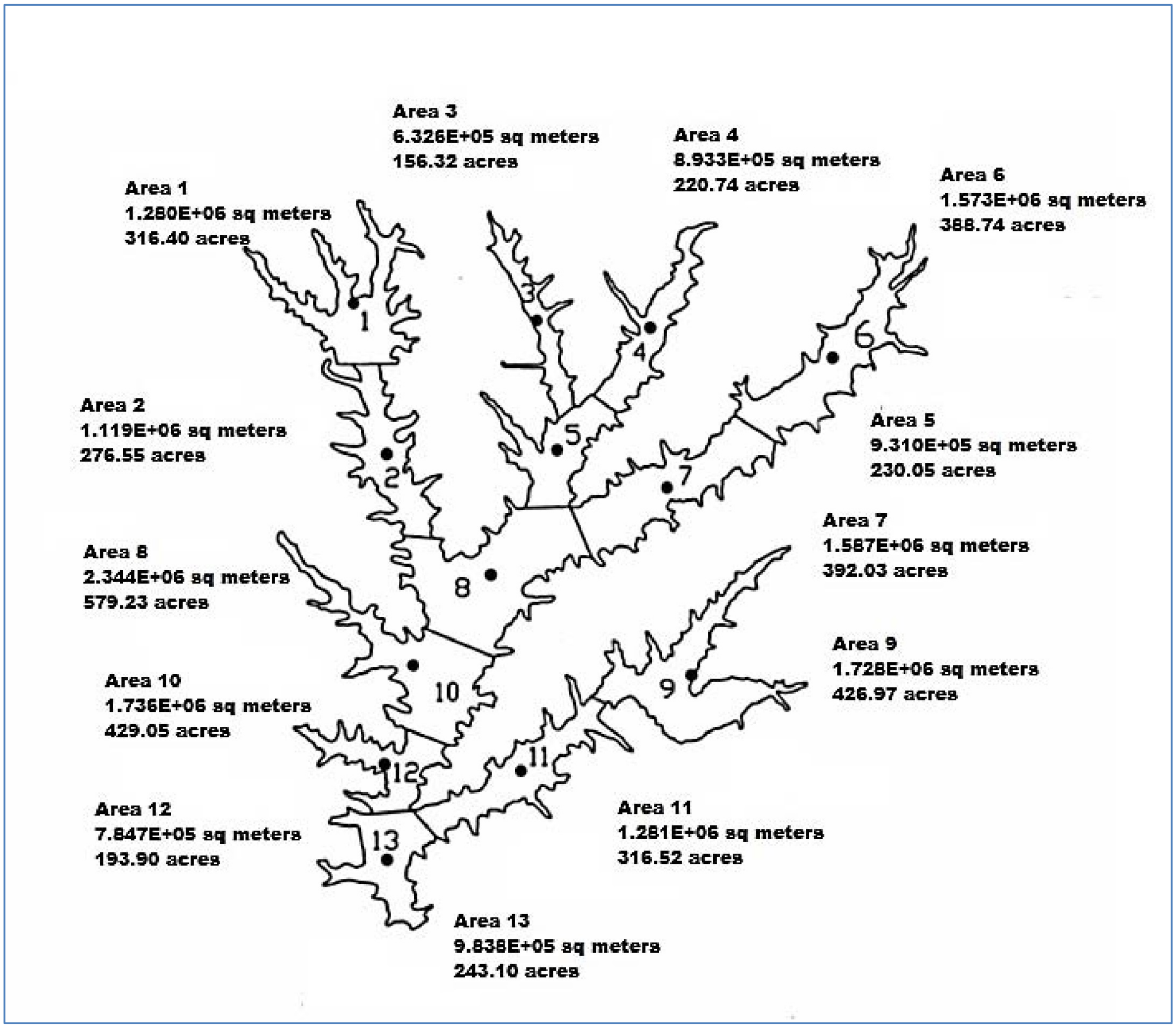


* Turbine Building Floor Drains Effluent can be Diverted to the Secondary Waste Treatment System

** Outside Tank Area Drains Effluent can be Diverted to the Liquid Radwaste Treatment System

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 outages 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 µCi/sec for each nuclide "i". $\dot{Q}_i$ is the release rate of nuclide "i" in gaseous effluent from discharge point "v", in µCi/sec.

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

and

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

where:

v = index over all vent stacks

C_i = concentration of nuclide, in µCi/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.

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

and

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

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 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/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 µCi/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)

= 1.8E-05 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.

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

and

Skin ratio $= \dfrac{3000}{Q_{m\text{-}s}}$ (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 μCi/cc, and RR_{max} the maximum release rate setpoint in μCi/sec for the monitor.

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

and

$RR_{max} = S_{max} \bullet F_v \bullet 28316.852 / 60$ (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

Bkg = Monitor background, in μCi/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 µCi/cc and µCi/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 µCi/cc, and RR_{alert} the gas channel alert alarm release rate setpoint in µCi/sec.

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

and

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

where:

A_f = A value < 1.0 designed to alert the operator that the high alarm setpoint is being approached.

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

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 µCi/sec for each nuclide "i". $\dot{Q}_i$ is the average release rate of nuclide "i" in gaseous effluent from discharge point "v", in µCi/sec. Noble gases may be averaged over a period of 1 hour.

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

and

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

where:

C_i = concentration of nuclide, in µCi/cc

= the measured concentration from a stack effluent sample or pre-release sample. If there is no activity in the sample, then the GALE code activities from Table 3.1-1 will be used.

WGDTs
= (µCi/cc from analysis of WGDT)(6.45 E-05) +
(µCi/cc from analysis/GALE Code of Vent Stack 5)(0.9999)

Containment Normal Purge (Batch)
= (µCi/cc from analysis of Containment)(3.60 E-03) +
(µCi/cc from analysis/GALE Code of PV Stack 1)(0.9964)

Containment Preentry Purge (Batch)
= (µCi/cc from analysis of Containment)(8.19 E-02) +
(µCi/cc from analysis/GALE Code of PV Stack 1)(0.9181)

6.45 E-05 = Dilution factor WGDT = (15 acfm)/(232,500 acfm + 15 acfm)

0.9999 = Dilution factor Vent Stack 5
= 232,500 acfm/(232,500 acfm + 15 acfm)

3.60 E-03 = Dilution factor Normal Purge
= 1500 acfm/(415,000 acfm + 1500 acfm)

0.9964 = Dilution factor PV-1 = 415,000 acfm/(415,000 acfm + 1500 acfm)

8.19 E-02 = Dilution factor Preentry Purge (Batch)
= 37,000 acfm/(415,000 acfm + 37,000 acfm)

0.9181 = Dilution factor PV-1
= 415,000 acfm/(415,000 acfm + 37,000 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 preentry purge + 415,000 acfm from Plan Vent Stack 1

= 15 acfm for Waste Gas Decay Tank pre release 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.

$$= \frac{2.26E+06 \left(\frac{\Delta P_C}{14.7}\right)\left(\frac{273°}{T_C}\right)}{t}$$

for a containment pressure release

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

for a Waste Gas Decay Tank release

where:

2.26E+06 and 600 are the volumes in ft^3 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

ΔP_c,ΔP_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/ft^3

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.

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

and

$Q_{m\text{-}s}$ = $\overline{(X/Q)}[\Sigma_i (L_i + 1.1 M_i)\dot{Q}_i]$ (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/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 µCi/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)

= 1.8E-05 sec/m^3 (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.

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

and

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

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 µCi/cc, and RR_{max} the maximum release rate setpoint in µCi/sec for the monitor.

$$S_{max} = (f_s \bullet f_{alloc} \bullet \text{nratio} \bullet \Sigma C_i) + \text{Bkg} \quad (3.2\text{-}4a)$$

and

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

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

Bkg = Monitor background, in µCi/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 µCi/cc, and RR_{alert} the gas channel alert alarm release rate setpoint in µCi/sec.

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

and

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

where:

A_f = A value < 1.0 designed to alert the operator that the high alarm setpoint is being approached.

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

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 (µCi/cc)	% Rel. Mix	Ci (µCi/cc)	% Rel. Mix	Ci (µCi/cc)	% Rel. Mix	Ci (µCi/cc)	% Rel. Mix	Ci (µCi/cc)	% Rel. Mix	Ci (µCi/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) $(uCi/cc) = \frac{(Ci/yr)(yr/5.256E5min)(1E6\mu Ci/Ci)(ft^3/28320cc)}{(Flow\ Rate\ \_\_\_\_\_\_\ ft^3/min)^{(d)}}$

(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 Postrelease 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:

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

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

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.

= 1.8E-05 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 µCi/m^3. Table 3.2-3.

L_i = The skin dose factor due to beta emissions for noble gas radionuclide "i," mrem/year per µCi/m^3. Table 3.2-3.

M_i = The air dose factor due to gamma emissions for noble gas radionuclide "i," mrad/year per µCi/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).

$\dot{Q}_{iv}$ = The release rate of radionuclide "i" in gaseous effluents from all plant vent stacks (µCi/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)

Release Rate (µCi/sec) = Flow (cc/sec) * Concentration (µCi/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 1.0E+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 radioiodines, 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:

$$\sum_i P_{i_I} \; [\overline{(X/Q)}_V \;\; \dot{Q}_{iv}] \qquad \leq 1500 \text{ mrem / yr} \qquad (3.2\text{-}3)$$

where:

P_{i_I} = The dose parameter for radionuclides other than noble gases for the inhalation pathway, mrem/yr per $\mu Ci/m^3$, 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 < 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 (μCi/sec) = Flow (cc/sec) * Concentration (μCi/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		
NOBLE GASES	SHUTDOWN	NORMAL OPERATIONS	CONTAINMENT	RAB/FHB	TURBINE	STACK 3A	TOTAL
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 $\mu Ci/m^3$)	Skin Dose Factor L_i (mrem/yr per $\mu Ci/m^3$)	Gamma Air Dose Factor M_i (mrad/yr per $\mu Ci/m^3$)	Beta Air Dose Factor N_i (mrad/yr per $\mu Ci/m^3$)
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_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:

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

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

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 $(\text{sec/year})^{-1}$.

M_i = The air dose factor due to gamma emissions for each identified noble gas radionuclide ($\text{mrad/yr}/\mu\text{Ci/m}^3$). 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 $\mu\text{Ci/m}^3$. 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 1.8E-05 sec/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 1.8E-05 sec/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/µCi.

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

For the calendar quarter:

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

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

For the calendar year:

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

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

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 ft^3). 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;

$$q_i = C_i \bullet v_b \qquad (3.3\text{-}7)$$

Where;

q_i = Activity of nuclide "i" released (μCi).

C_i = Concentration of radionuclide "i" (μCi/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 (μCi) for nuclide "i" for Waste Gas Decay Tank effluent accountability is calculated as follows;

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

Where;

q_i = Activity of nuclide "i" released (μCi).

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

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

600 = WGDT volume, (ft^3).

28316.85 = Conversion factor for converting from ft^3 to cc.

273 = Standard Temperature for 0^0C (°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 ft^3.

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:

$$Q_x = C_x \bullet V_x \qquad (3.3\text{-}8)$$

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".

$$Q_i = Q_x \bullet S_i \qquad (3.3\text{-}8a)$$

Where;

$$S_i = \frac{C_i}{\Sigma C_i} \qquad (3.3\text{-}8b)$$

and;

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

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

ΣC_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.

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;

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

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:

$$D_{p\tau} = (D\tau \bullet p) + D_{a\tau} \qquad (3.3\text{-}10)$$

where:

$D_{p\tau}$ = 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.

$D_{a\tau}$ = 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:

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

and

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

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 radioiodines 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 radioiodines and particulates with half-lives greater than 8 days in gaseous effluents released to unrestricted areas can be determined by the following equation:

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

where:

D_τ	=	Dose to any organ τ from tritium, radioiodines, 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 (≤ 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 µCi/sec per m^{-2}.
R_{i_G}	=	Dose factor for an organ for radionuclide "i" for the ground plane exposure pathway, mrem/yr per µCi/sec per m^{-2}.
R_{i_I}	=	Dose factor for an organ for radionuclide "i" for the inhalation pathway, mrem/yr per µCi/m^3.
R_{i_V}	=	Dose factor for an organ for radionuclide "i" for the vegetable pathway, mrem/yr per µCi/sec per m^{-2}.
R_{i_B}	=	Dose factor for an organ for radionuclide "i" for the meat pathway, mrem/yr per µCi/sec per m^{-2}.
R_{T_M}	=	Dose factor for an organ for tritium for the milk pathway mrem/yr per µCi/m^3.
R_{T_V}	=	Dose factor for an organ for tritium for the vegetable pathway, mrem/yr per µCi/m^3.
R_{T_I}	=	Dose factor for an organ for tritium for the inhalation pathway, mrem/yr per µCi/m^3.

3.3.2 Radioiodine and Particulates (continued)

R_{T_B} = Dose factor for an organ for tritium for the meat pathway, mrem/yr per μCi/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 (≤ 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 sector 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 radioiodines 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 radioiodines 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. The age groupings at the various receptor locations are also determined during this survey. Thus, depending on the results of the survey, a new limiting location and receptor age group 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:

$$D_\tau \leq 7.5 \text{ mrem} \qquad (3.3\text{-}14)$$

For the calendar year:

$$D_\tau \leq 15 \text{ mrem} \qquad (3.3\text{-}15)$$

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 radioiodines 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:

$$D_{p\tau} = (D_{\tau} \bullet p) + D_{a\tau} \quad (3.3\text{-}16)$$

where:

$D_{p\tau}$ = 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.

$D_{a\tau}$ = 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:

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

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 (CO_2)

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 are derived, equilibrate with the C-14 CO_2 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. The age groupings at the various receptor locations are also determined during this survey. Thus, depending on the results of the survey, a new limiting location and receptor age group 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:

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

X_C = the average ground-level concentration of C-14 in air, in pCi/m^3

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

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

X/Q = annual average atmosphere dispersion factor, in sec/m^3 for ground level release with no decay, Table A1 through A4, Appendix A

$3.17 \text{ X } 10^4$ = 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:

$$D_{ja}^{A} = \left(U_a^i\right)\left(DFA_{ja}\right)\left(X_C\right) \quad (3.3\text{-}20)$$

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/m^3

U_a^i = Inhalation rate for age group (a), Table 3.3-20, in m^3/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:

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

C_{14}^{V}	=	The concentration of C-14 in vegetation in pCi/kg
p	=	the fractional equilibrium fraction, dimensionless
	=	(0.70)(WGDT Release Hr)/(L) + (0.30)(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 x Q_C
X/Q	=	annual average atmosphere dispersion factor, in sec/m^3 for ground level release with no decay, Table A1 through A4, Appendix A
3.17 E7	=	(10^{12} pCi/Ci)(10^3 g/kg) / (3.15E7 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/m^3

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.

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

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
	=	Cow or cattle = 0.012 days/liter, goat = 0.10 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
	=	Cow or cattle = 50 kg, goat = 6 kg

3.3.2 Carbon 14 (continue)

4. Concentration of Airborne Carbon-14 in Meat

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

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

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

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 $\mu Ci/m^3$ for inhalation and tritium and in units of mrem/yr per $\mu Ci/sec$ 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 $\mu Ci/m^3$ for inhalation and tritium and in units of mrem/yr per $\mu Ci/sec$ 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 μCi/m^3 for inhalation and tritium and in units of mrem/yr per μCi/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 $\mu Ci/m^3$ for inhalation and tritium and in units of mrem/yr per $\mu Ci/sec$ 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 μCi/m^3 for inhalation and tritium and in units of mrem/yr per μCi/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 μCi/m^3 for inhalation and tritium and in units of mrem/yr per μCi/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 μCi/m^3 for inhalation and tritium and in units of mrem/yr per μCi/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 μCi/m^3 for inhalation and tritium and in units of mrem/yr per μCi/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 μCi/m^3 for inhalation and tritium and in units of mrem/yr per μCi/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 μCi/m^3 for inhalation and tritium and in units of mrem/yr per μCi/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 μCi/m^3 for inhalation and tritium and in units of mrem/yr per μCi/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 μCi/m^3 for inhalation and tritium and in units of mrem/yr per μCi/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 $\mu Ci/m^3$ for inhalation and tritium and in units of mrem/yr per $\mu Ci/sec$ 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 $\mu Ci/m^3$ for inhalation and tritium and in units of mrem/yr per $\mu Ci/sec$ 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 μCi/m^3 for inhalation and tritium and in units of mrem/yr per μCi/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 $\mu Ci/m^3$ for inhalation and tritium and in units of mrem/yr per $\mu Ci/sec$ 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 µCi/m^3 for inhalation and tritium and in units of mrem/yr per µCi/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 μCi/m^3 for inhalation and tritium and in units of mrem/yr per μCi/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 $\mu Ci/m^3$ for inhalation and tritium and in units of mrem/yr per $\mu Ci/sec$ 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
Ag-11OM	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 μCi/m^3 for inhalation and tritium and in units of mrem/yr per μCi/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
Ag-11OM	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 μCi/m^3 for inhalation and tritium and in units of mrem/yr per μCi/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
Ag-11OM	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 $\mu Ci/m^3$ for inhalation and tritium and in units of mrem/yr per $\mu Ci/sec$ 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
Ag-11OM	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 μCi/m^3 for inhalation and tritium and in units of mrem/yr per μCi/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 $\mu Ci/m^3$ for inhalation and tritium and in units of mrem/yr per $\mu Ci/sec$ per m^{-2} for all others.

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

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

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 $\mu Ci/m^3$ for inhalation and tritium and in units of mrem/yr per $\mu Ci/sec$ 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 μCi/m^3 for inhalation and tritium and in units of mrem/yr per μCi/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 $\mu Ci/m^3$ for inhalation and tritium and in units of mrem/yr per μCi/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

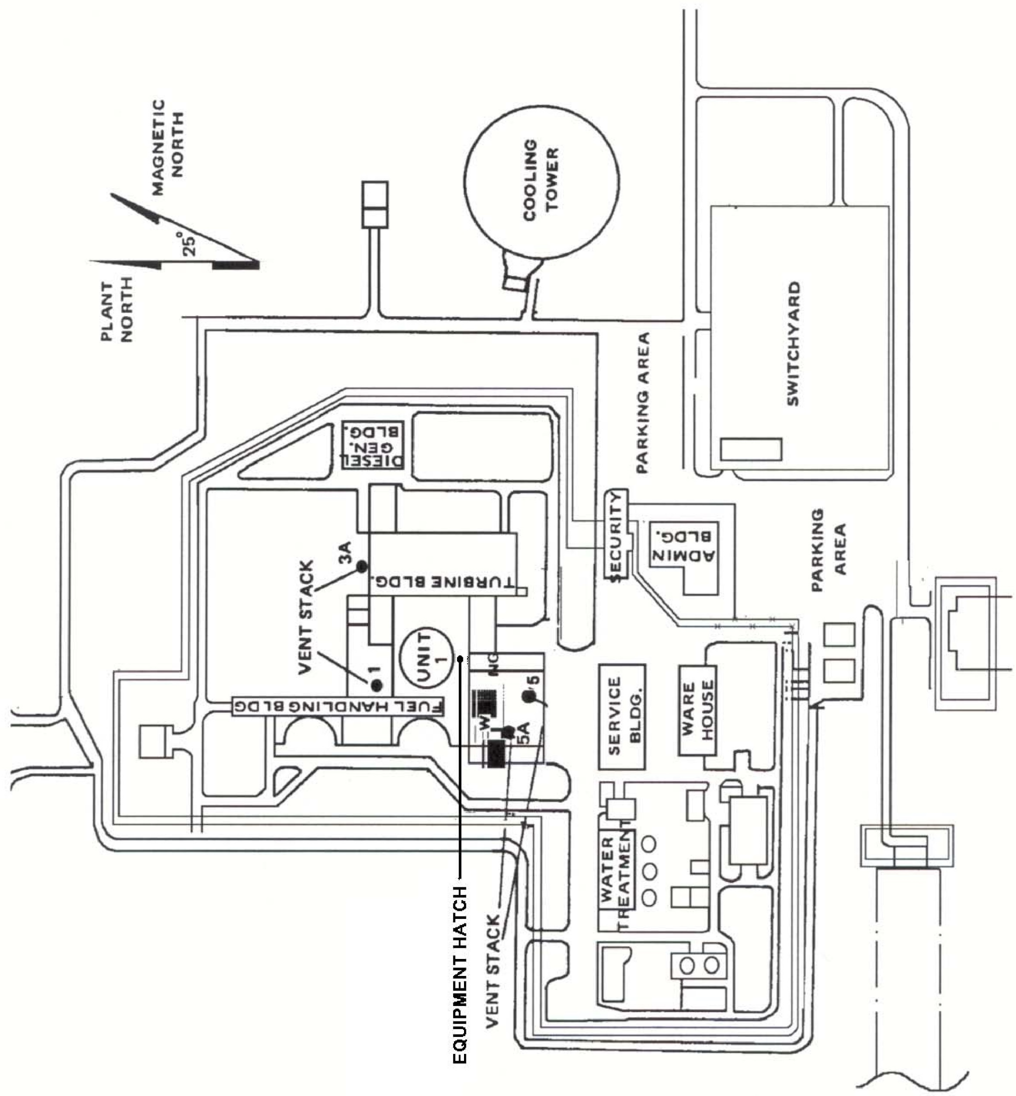
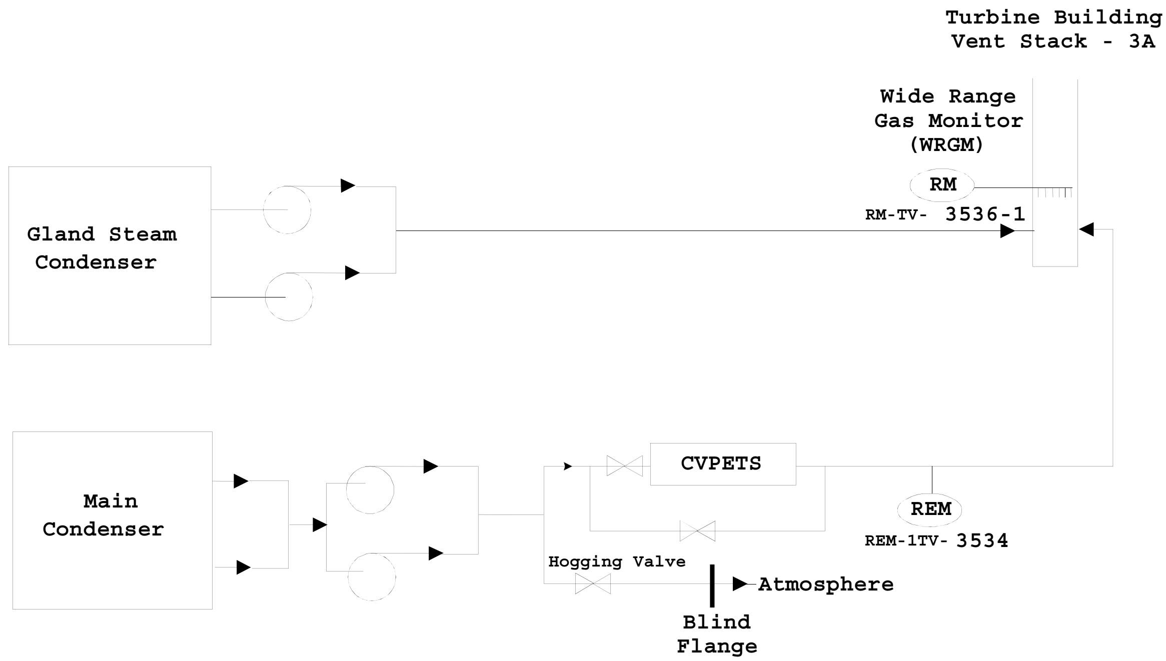


Figure 3.3

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 and 4.1-3 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
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.
4	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, > 12 mi. from site
26	Harris Lake Spillway S sector, 4.7 mi. from site
47	1.3 mi. N on SR 1912 from intersection of NC 42 SSW sector, 3.4 miles 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, >12 mi. (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	0.6 mi. E on SR 1142 from intersection of SR 1141. 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 @ 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 of Arclin, Inc. 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
30	Exit intersection of SR 1972 and US 1. W sector, 5.6 mi. from site.
31	At 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.
34	Deleted
35	Deleted
36	Deleted
37	Deleted
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.
53	SR 1972 N from intersection of SR 1910 and SR 1972. NW sector, 5.8 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.
67	Deleted

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
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
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

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
Sample Point ID No.	Sample Point, Description[1], Distance, and Direction
26	Harris Lake Spillway S sector, 4.7 mi. from site
38	Cape Fear Steam Electric Plant Intake Structure (Control Station)[3] WSW sector, 6.2 miles from site
40	NE Harnett Metro Water Treatment Plant Intake Building Duncan Street, Lillington, N.C. SSE sector, ~17 mi. from site.

NOTE: H-3 analysis is normally performed monthly.

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
76	Deleted
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

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 dose[6] calculated for the consumption of the water is greater than 1 mrem per yr. Monthly Gross Beta Monthly Gamma Isotopic[4] Quarterly Tritium

Sample Point ID No.	Sample Point, Description[1], Distance, and Direction
38	Cape Fear Steam Electric Plant Intake Structure (Control Station)[3] WSW sector, 6.2 miles from site
40	NE Harnett Metro Water Treatment Plant Intake Building Duncan Street, Lillington, N.C. SSE sector, ~17 mi. from site.
51	SHNPP Water Treatment Building On Site

NOTE: H-3 analysis is normally performed monthly.

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]
Sampling and Collection Frequency:	Grab samples semi-monthly when animals are on pasture; monthly at other times.[9]
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
5	Manco's Dairy, Pittsboro (Control Station)[3] WNW sector from site, > 12 mi. from site
96	Deleted

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]
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 Isotopic[4] on edible portion for each

Sample Point ID No.	Sample Point, Description[1], Distance, and Direction
5	Deleted
97	Granite Springs Farm (Control Station)[3] NW sector, 19.1 miles from site

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, during growing season [15]
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] NNW sector, > 12 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. 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 2.2-1.
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 4-14 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.
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 new control location 97 is a commercial operation and satisfies 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 57 was removed from the groundwater monitoring in Revision 19 and Locations 39 deleted the groundwater monitoring in Revision 20 based on evaluation of data from bedrock wells.
13. Sample Locations 65 & 66 deleted Broad Leaf vegetation samples and added Broad Leaf vegetation to Sample Locations 12 and 63 in Revision 20 based on new meteorology data.
14. In Revision 21, Sample Locations 57, 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. Typically leaves are only present during the growing season May through October.
16. Attention shall be paid to including samples of tuberous and root food products.

TABLE 4.2

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SAMPLING LOCATIONS

Site#	Type	Location Description*	AC & AP	SW	DW	SS	SB	AV	FP(a)	Fish (FI)	Milk (Mk)	BLV(b)	GW
1	I	2.6 miles N	W/Q										
2	I	1.4 miles NNE	W/Q										
4	I	3.1 miles NNE	W/Q										
5	C	>12 miles WNW – Pittsboro >12 Miles NNW – Pittsboro (BLV)	W/Q								SM/M	M(b)	
12	I	0.9 miles SSW										M(b)	
26	I	4.7 miles S	W/Q	BW/M		SA		A					
38	C	6.2 miles WSW		BW/M	BW/M								
40	I	17.2 miles SSE -- Lillington		BW/M	BW/M								
41	I	3.8 miles S				SA		A					
44	I	Site varies in Harris Lake								SA			
45	C	Site varies in Cape Fear River above Buckhorn Dam								SA			
47	I	3.4 miles SSW	W/Q										
51	I	Water Treatment Building (On Site)			BW/M								
52	I	3.8 miles S					SA						
57	I	0.4 miles SSW											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(b)	
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
90	I	0.5 miles SSW	W/Q										
91	I	1.6 miles ENE	W/Q										
97	C	19.1 miles NW Granite Springs Farm							M(a)				

(a) When Available, during Harvest/Growing Season
(b) During Growing Season per ODCM – May through October

* 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	FI	Fish
BW	BiWeekly	Q	Quarterly	AP	Air Particulate	AV	Aquatic Vegetation	MK	Milk
M	Monthly	SA	Semiannually	SW	Surface Water	FP	Food Product		
A	Annual			DW	Drinking Water	BLV	Broadleaf Vegetation		
C	Control	I	Indicator	SS	Sediment Shoreline	GW	Ground Water		

TABLE 4.3

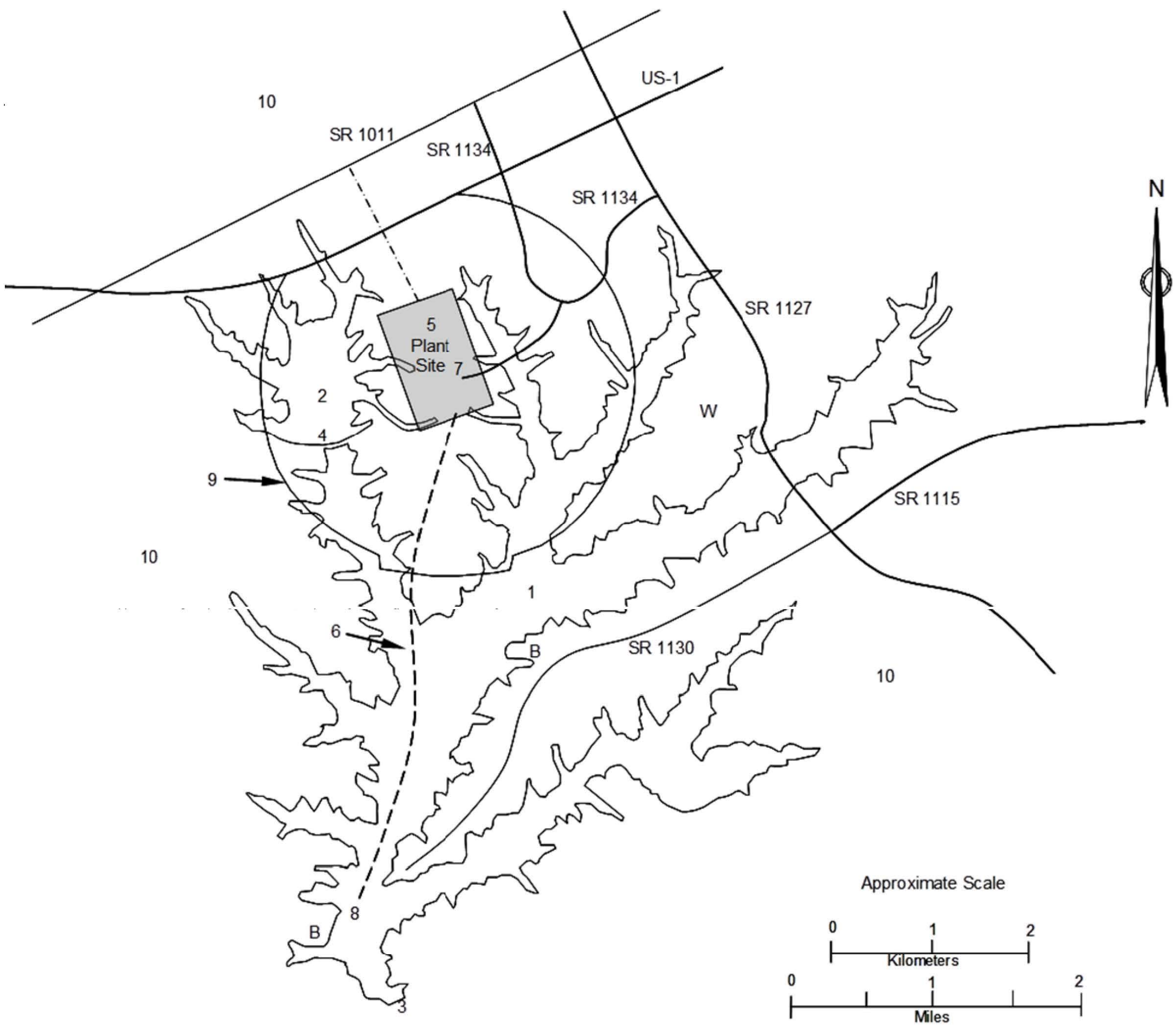
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SAMPLING LOCATIONS
(TLD Sites)

Site #	Measure Type	Location*	Distance (miles)	Sector	Site #	Measure Type	Location*	Distance (miles)	Sector
1	IR		2.6	N	26	OR		4.7	S
2	IR		1.4	NNE	27	OR		4.8	SSW
3	SI	HE&EC Visitor Center (Population Center)	1.9	ENE	28	OR		4.8	SW
4	SI	New Hill (Population Center)	3.1	NNE	29	OR		5.7	WSW
5	C	Pittsboro (Control Station)	13.3	WNW	30	OR		5.6	W
6	IR		0.8	ENE	31	OR		4.7	WNW
7	IR		0.7	E	32	SI	Jordan Lake (Population Center)	6.4	NNW
8	IR		0.6	ESE	33	OR		4.5	NNW
9	IR		2.2	SE	48	OR		4.5	N
10	IR		2.2	SSE	49	IR		2.5	NE
11	IR		0.6	S	50	SI	Holleman Crossroads (Population Center)	2.6	ESE
12	IR		0.9	SSW	53	OR		5.8	NW
13	IR		0.7	WSW	56	IR		3.0	WSW
14	IR		1.5	W	63	IR		0.6	SW
15	IR		2.0	W	93	IR		2.2	WNW
19	OR		5.0	NNE	94	IR		2.0	NW
20	OR		4.5	NE	95	IR		2.0	NNW
21	OR		4.8	ENE	98	SI	Holly Springs School Complex (Population Center)	5.9	E
22	OR		4.3	E	99	SI	Friendship School (Population Center)	5.5	NNE
23	OR		4.8	ESE					
24	OR		4.0	SE					
25	OR		4.7	SSE					

* 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



1 – Main Reservoir
2 – Auxiliary Reservoir
3 – Main Dam
4 – Auxiliary Dam Spillway
5 – Plant
6 – Cooling Tower Blowdown Line
7 – Cooling Tower
8 – Site Boundary for Radioactive Liquid Effluents
9 - Site Boundary for Radioactive Gaseous Effluents
10 – Unrestricted Area
B – Boat Ramp
W – Wake County – Harris Lake Park

Shearon Harris Nuclear Power Plant
Offsite Dose Calculation Manual (ODCM) Revision 26

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

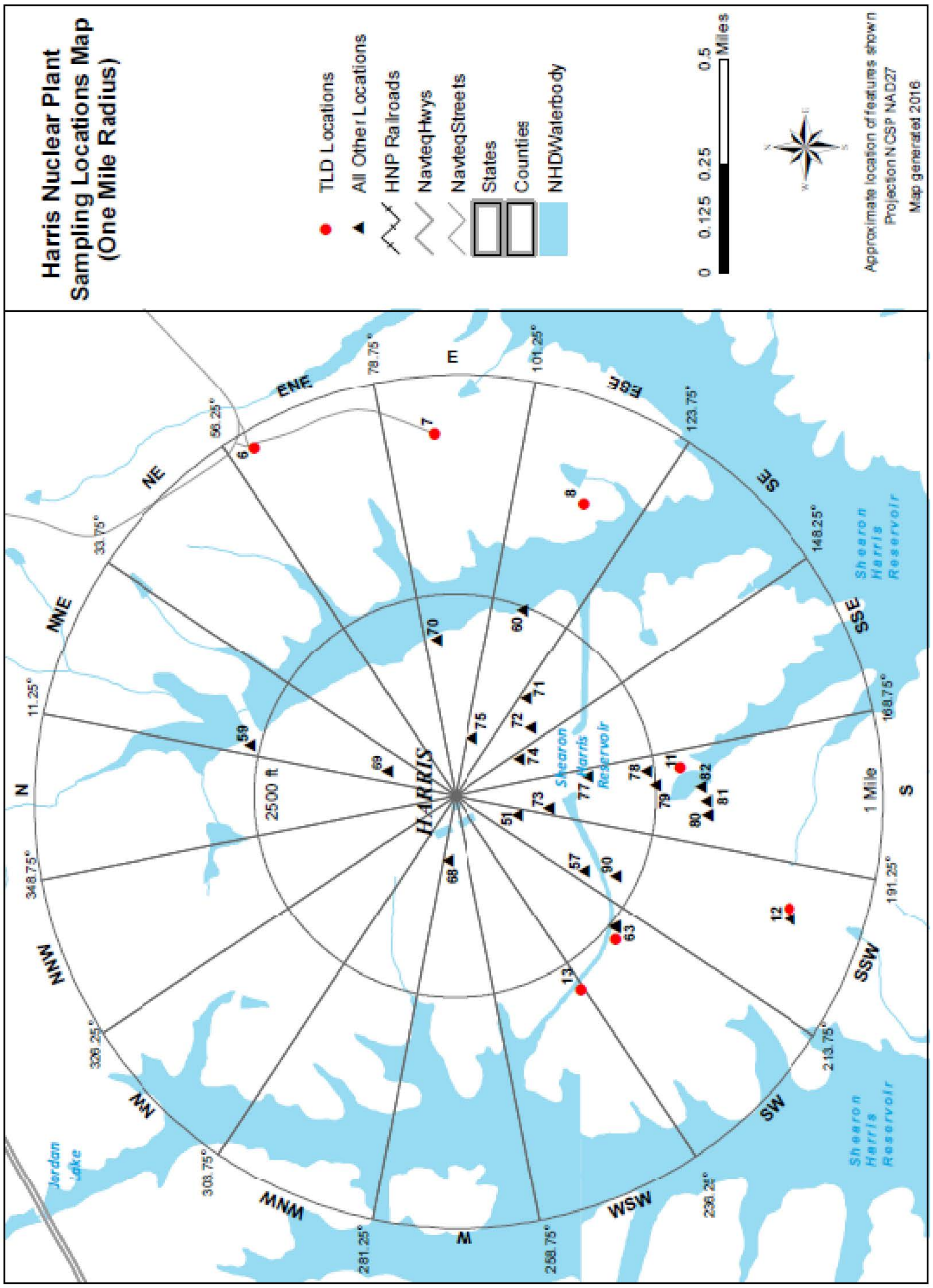
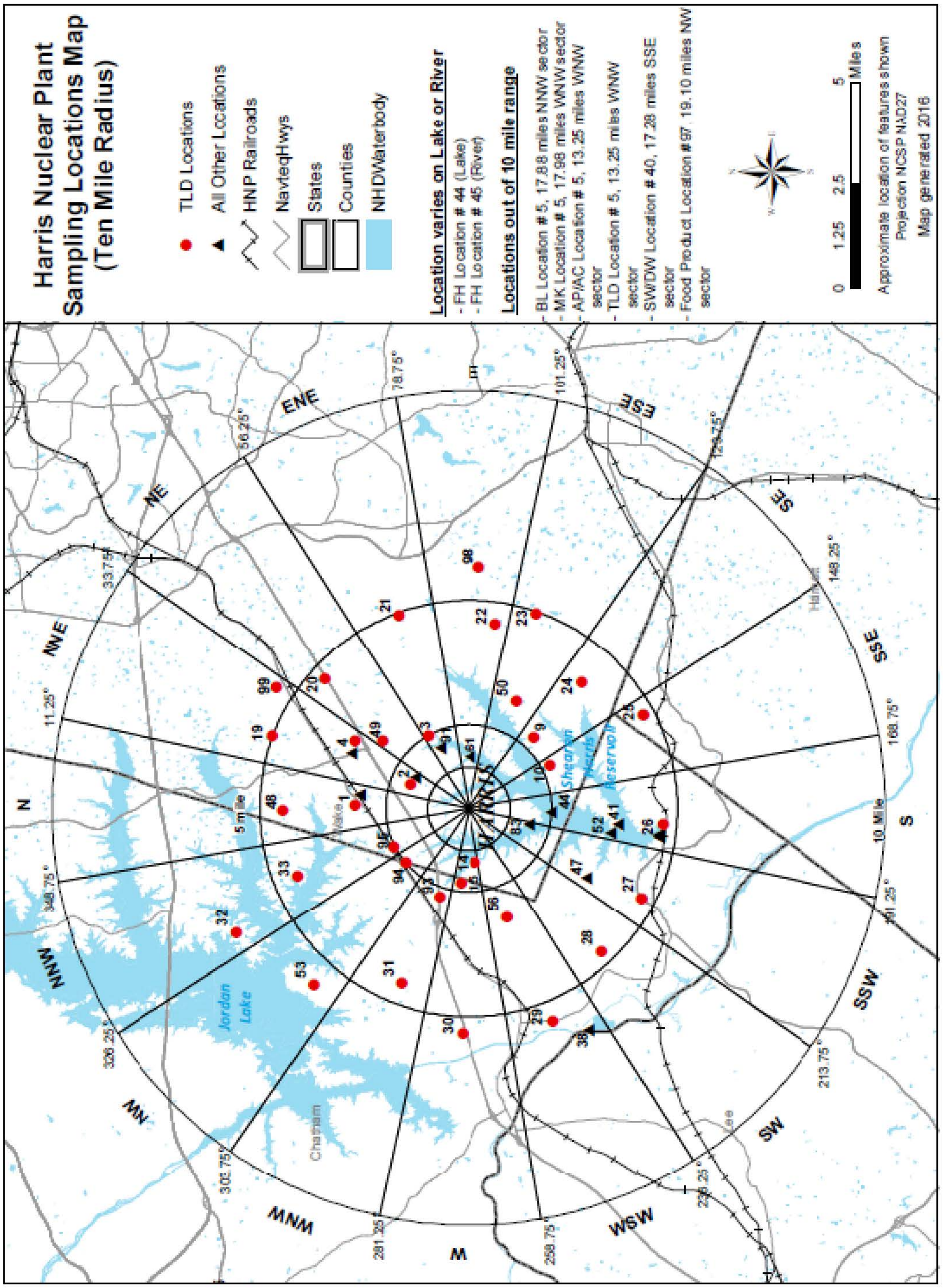


Figure 4.1-3
Environmental Radiological Sampling Points
(10 mile Radius)



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 84750) for Radioactive Waste Treatment, Effluent, and Environmental Monitoring. The referenced criteria is 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:

Resolution	Ratio
<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, iodines, particulates, and tritium are used. They provide conservative dose estimates. The X/Q and D/Q valves 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 PNSC 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 (USRNC,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, radioiodines 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:	**Current:**
1) Calm	1) Calm
2) 0.45-0.75 mph	2) 0.45-0.75 m/s
3) 0.75-3.50 mph	3) 0.75-1.00 m/s
4) 3.50-7.50 mph	4) 1.00-1.25 m/s
5) 7.50-12.50 mph	5) 1.25-1.50 m/s
6) 12.50-18.50 mph	6) 1.50-2.00 m/s
7) 18.50-25.00 mph	7) 2.00-3.00 m/s
8) 25.00 + mph	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 landuse 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)	TABLE A-1 X/Q sec m^{-3} No Decay Undepleted	TABLE A-2 X/Q sec m^{-3} 2.3 Day Decay Undepleted	TABLE A-3 X/Q sec m^{-3} 8 Day Decay Depleted	TABLE A-4 D/Q 1/m^{2}
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)	TABLE A-1 X/Q sec m^{-3} No Decay Undepleted	TABLE A-2 X/Q sec m^{-3} 2.3 Day Decay Undepleted	TABLE A-3 X/Q sec m^{-3} 8 Day Decay Depleted	TABLE A-4 D/Q $1/m^2$
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}

	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	3.825E-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}

	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	3.471E-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 m^2

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	2.043E-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

Distance in miles from the site

Sector	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 m^2

	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	3.467E-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

Umax	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
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

Umax	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
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 point 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 radioiodines, 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 m^3/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

$$P_{i_I} = K'(BR)\,DFA_i \qquad (B.1\text{-}1)$$

where:

P_{i_I} = Dose factor for radionuclide "i" for the inhalation pathway, mrem/yr per µCi/m^3, per organ of interest

K' = A constant of unit conversion;

= 10^6 pCi/µCi;

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 m^3/yr) and the unit conversion factor results in the following equation:

$$P_{i_I} = 3.7\,E{+}09\ DFA_i \qquad (B.1\text{-}2)$$

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:

$$R_{i_I} = K' (BR)_a (DFA_i)_a \qquad \text{(B.2-1)}$$

where:

R_{i_I} = Dose factor for each identified radionuclide "i" of the organ of interest, mrem/yr per µCi/m^3;

K' = A constant of unit conversion;

= 10^6 pCi/µCi;

$(BR)_a$ = Breathing rate of the receptor of age group "a," m^3/yr;

$(DFA_i)_a$ = Organ inhalation dose factor for radionuclide "i" for the receptor of age group "a", mrem/pCi.

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.

Age Group (a)	Breathing Rate (m^3/yr)
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:

$$R_{i_G} = I_i K'K''(SF)DFG_i \left(1 - e^{-\lambda_i t}\right) / \lambda_i \qquad \text{(B.2-2)}$$

where:

R_{i_G} = Dose factor for the ground plane pathway for each identified radionuclide "i" for the organ of interest, mrem/yr per µCi/sec per m^{-2};

K' = A constant of unit conversion;

= 10^6 pCi/µCi;

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 E+08 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 radioiodines, 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:

$$R_{i_M} = I_i K'Q_F \; U_{ap} \; F_m \; (DFL_i)_a e^{-\lambda_i t_f} \left(f_p f_s \left(\frac{r(1 - e^{-\lambda_{E_i} t_e})}{Y_p \lambda_{E_i}} + \frac{B_{iv} (1 - e^{-\lambda_i t_b})}{P\lambda_i} \right) + (1 - f_p f_s) \left(\frac{r(1 - e^{-\lambda_{E_i} t_e})}{Y_s \lambda_{E_i}} + \frac{B_{iv}(1 - e^{-\lambda_i t_b})}{P\lambda_i} \right) e^{-\lambda_i t_h} \right) \quad (B.2\text{-}3)$$

where:

R_{i_M} = Dose factor for the cow milk or goat milk pathway, for each identified radionuclide "i" for the organ of interest, mrem/yr per µCi/sec per m^{-2};

K' = A constant of unit conversion;

= 10^6 pCi/µCi;

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/m^2;

Y_s = The agricultural productivity by unit area of stored feed, kg/m^2;

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)

λ_{E_I} = $\lambda_i + \lambda_w$;

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)/m^2;

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 radioiodines, 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:

$$R_{T_M} = K'K'''F_m Q_F U_{ap} (DFL_i)_a \, 0.75(0.5/H) \quad \text{(B.2-4)}$$

where:

R_{T_M} = Dose factor for the cow or goat milk pathway for tritium for the organ of interest, mrem/yr per $\mu Ci/m^3$;

K''' = A constant of unit conversion;
= 10^3 gm/kg;

H = Absolute humidity of the atmosphere, gm/m^3; A value of H = 8 grams/ $meter^3$, was used in lieu of site-specific information.

0.75 = The fraction of total feed that is water;

0.5 = 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:

$$R_{i_B} = I_i K' Q_F \; U_{ap} \; F_f \; (DFL_i)_a \, e^{-\lambda_i t_s} \left(f_p f_s \left(\frac{r(1 - e^{-\lambda_{E_i} t_e})}{Y_p \lambda_{E_i}} + \frac{B_{iv}(1 - e^{-\lambda_i t_b})}{P\lambda_i} \right) + (1 - f_p f_s) \left(\frac{r(1 - e^{-\lambda_{E_i} t_e})}{Y_s \lambda_{E_i}} + \frac{B_{iv}(1 - e^{-\lambda_i t_b})}{P\lambda_i} \right) e^{-\lambda_i t_h} \right) \quad \text{(B.2.5)}$$

where:

R_{i_B} = Dose factor for the meat ingestion pathway for radionuclide "i" for any organ of interest, mrem/yr per μCi/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 radioiodines, 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.

$$R_{T_B} = K'K''' F_f \, Q_F \, U_{ap} \, (DFL_i)_a \; 0.75 \; (0.5/H) \quad \text{(B.2-6)}$$

where:

R_{T_B} = Dose factor for the meat ingestion pathway for tritium for any organ of interest, mrem/yr per $\mu Ci/m^3$.

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:

$$R_{i_V} = I_i K'(DFL_i)_a \left(U_a^L f_L e^{-\lambda_i t_L} \left(\frac{r(1 - e^{-\lambda_{E_i} t_e})}{Y_v \lambda_{E_i}} + \frac{B_{iv}(1 - e^{-\lambda_i t_b})}{P\lambda_i} \right) + U_a^S f_g e^{-\lambda_i t_h} \left(\frac{r(1 - e^{-\lambda_{E_i} t_e})}{Y_v \lambda_{E_i}} + \frac{B_{iv}(1 - e^{-\lambda_i t_b})}{P\lambda_i} \right) \right) \quad \text{(B.2-7)}$$

where:

R_{i_V} = Dose factor for vegetable pathway for radionuclide "i" for the organ of interest, mrem/yr per µCi/sec per m^{-2};

K' = A constant of unit conversion;

= 10^6pCi/µCi;

U_a^L = The consumption rate of fresh leafy vegetation by the receptor in age group "a," kg/yr;

U^S_a = 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 radioiodines, 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:

$$R_{T_V} = K'K''' \left[U_a^L f_L + U_a^S f_g \right] (DFL_i)_a \left[0.75 \; (0.5 \; / \; H) \right] \qquad \text{(B.2.8)}$$

where:

R_{T_V} = Dose factor for the vegetable pathway for tritium for any organ of interest, mrem/yr per $\mu Ci/m^3$.

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 (radioiodines) 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 (radioiodines) 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
$(DFL_i)_a$ (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 (radioiodines) 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.	Liquid Effluent Monitoring Instruments	
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.	Gaseous Effluent Monitoring Instruments	
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:

a. At least two independent samples are analyzed in accordance with Operational Requirement 4.11.1.1.1, and

b. 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 1E-07 µCi/ml:

a. At least once per 12 hours when the specific activity of the secondary coolant is greater than 0.01 µCi/gram DOSE EQUIVALENT I-131 or,

b. At least once per 24 hours when the specific activity of the secondary coolant is less than or equal to 0.01 µCi/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 1E-07 µCi/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 CALIBRATIO N	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 µCi/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:

$$LLD = \frac{4.66 \bullet s_b}{E \bullet V \bullet (2.22E+06) \bullet Y \bullet e^{-\lambda \Delta t}}$$

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 nondiscrete 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 mrems to the whole body and to less than or equal to 5 mrems to any organ, and

b. During any calendar year to less than or equal to 3 mrems to the whole body and to less than or equal to 10 mrems 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 mrems/yr to the whole body and less than or equal to 3000 mrems/yr to the skin, and

b. For Iodine-131, for Iodine-133, for tritium, and for all radionuclides in particular form with half-lives greater than 8 days: Less than or equal to 1500 mrems/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) (μCi/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:

$$LLD = \frac{4.66 \bullet S_b}{E \bullet V \bullet (2.22E+06) \bullet Y \bullet e^{-\lambda \Delta t}}$$

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 mrads for gamma radiation and less than or equal to 10 mrads for beta radiation, and

b. During any calendar year: Less than or equal to 10 mrads for gamma radiation and less than or equal to 20 mrads 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 mrems to any organ, and

b. During any calendar year: Less than or equal to 15 mrems 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:

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.

ACTION:

a. 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:

1. 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

4.11.2.4.1 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 Environmental 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:

$$\frac{\text{concentration(1)}}{\text{reporting level(1)}}+\frac{\text{concentration(2)}}{\text{reporting level(2)}}+\ldots\geq 1.0$$

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

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 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.	Radioiodine Cannister: I-131 analysis weekly. Particulate Sampler: 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

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS[1]	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
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.	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

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS(1)	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
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 during growing season.	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.

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:

$$LLD = \frac{4.66 \bullet S_b}{E \bullet V \bullet (2.22E + 06) \bullet Y \bullet e^{-\lambda \Delta t}}$$

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 m^2 (500 ft^2) 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 1E-06 μCi/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 mrems/year to the whole body or to less than or equal to 3000 mrems/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 mrems/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 reasonable 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 m^2 provides assurance that significant exposure pathways via leafy vegetables will be identified and monitored since a garden of this size is the minimum required to produce the quantity (26 kg/year) of leafy vegetables assumed in Regulatory Guide 1.109 for consumption by a child. To determine this minimum garden size, the following assumptions were made: (1) 20% of the garden was used for growing broad leaf vegetation (i.e., similar to lettuce and cabbage), and (2) a vegetation yield of 2 kg/m^2.

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, iodines 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 Specification 3.11.1.4 or PLP-114, Attachment 5, respectively.

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 PNSC. 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 PNSC.

b. Shall become effective upon review and acceptance by the PNSC.

---

* 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 (μCi/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 iodines or particulates from the gaseous exhaust stream prior to the release to the environment. Such a system is not considered to have any effect on noble gas effluents. Engineered Safety 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	Keff	% RATED THERMAL POWER*	AVERAGE COOLANT TEMPERATURE
1	Power Operations	≥ 0.99	> 5%	≥ 350°F
2	Startup	≥ 0.99	≤ 5%	≥ 350°F
3	Hot Standby	< 0.99	0	≥ 350°F
4	Hot Shutdown	< 0.99	0	350°F > Tavg > 200°F
5	Cold Shutdown	< 0.99	0	≤ 200°F
6	Refueling **	< 0.95	0	≤ 140°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

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 1/1/2016 - 12/31/2016

The Shearon Harris Nuclear Power Plant PCP Revision 12 was implemented in 2016 and provided in entirety in this section.

PLP-300 (HNP Process Control Program) directs HNP to follow specific vendor procedures to perform dewatering activities. The procedures that are referenced have become obsolete since EnergySolutions buyout of Studsvik. EnergySolutions has developed a dewatering system that is offered in place of the Studsvik system. References to the Studsvik system and its procedures (FP-001, FP-003, & FP-004) will be replaced by the EnergySolutions system and corresponding procedures (CS-OP-PR-008 & CS-OP-PR-010). The purpose, applicability, applicable industrial & radiological requirements, and acceptance criteria remain unchanged. Differences in the two sets of procedures are limited to step by step operating instructions.

No changes to plant safety systems or components, FSAR-described evaluation methodologies, or tests/experiments outside the bounds of the FSAR are effected by Rev 12 to the PCP.

The following is a summary of changes.

- Updated to PAS (procedure automation system) format (format upgrade only) which included the following:
  - Reordered sections
  - Moved old Section 5.1, Management Responsibilities, to new Section 4.0, Responsibilities.
  - Removed abbreviations for "PCP" and "FSAR" previously located in the old Definitions/Abbreviations section.
- Replaced "CP&L" with "Duke Energy" in Section 5.6 Step 1.
- Replaced reference to "FP-003" with "CS-OP-PR-008" and "CS-OP-PR-010" in [7.3.3] and [7.3.4].
- Replaced "Superintendent - RP" with "Manager - RP" in Section 4.2.

Information Use

HARRIS UNIT 1

PLANT PROGRAM

PLP-300

PROCESS CONTROL PROGRAM

REVISION 12

PROCESS CONTROL PROGRAM	PLP-300
	Rev. 12
	Page 2 of 18

REVISION SUMMARY
PRR 1979753 **DESCRIPTION**
The following changes were implemented in this revision to support implementation of the Process Control Program: • Updated to PAS format (format upgrade only) which included the following: ◊ Reordered sections ◊ Moved old Section 5.1, Management Responsibilities, to new Section 4.0, Responsibilities. ◊ Removed abbreviations for "PCP" and "FSAR" previously located in the old Definitions/Abbreviations section. • Replaced "CP&L" with "Duke Energy" in Section 5.6 Step 1. • Replaced reference to "FP-003" with "CS-OP-PR-008" and "CS-OP-PR-010" in [7.3.3] and [7.3.4]. • Replaced "Superintendent - RP" with "Manager - RP" in Section 4.2. Revised by Theresa Tripp.

TABLE OF CONTENTS

SECTION PAGE

ATTACHMENTS

1.0 PURPOSE

1. The purpose of the Process Control Program (PCP) is to establish the management responsibilities and controls used at Harris Nuclear Power Plant (HNP) to provide reasonable assurance of complete dewatering and solidification of various radioactive waste.

2.0 SCOPE

1. This procedure demonstrates compliance with 10CFR20, 10CFR61, Plant Technical Specifications, Federal and State regulation, burial site requirements and other requirements governing the disposal of radioactive waste.

3.0 DEFINITIONS

1. **Batch -** For the purpose of the HNP PCP, a batch is a specific quantity of a particular waste stream which can be isolated from further inputs. This may be the volume in a tank or in a liner.

2. **Dewatering -** The process of removing water from a bed of solid waste. Dewatering processes can also be used to prepare solid waste for shipment without solidification using cement or other chemical agents. Dewatered waste must meet NRC and burial site conditions on maximum drainable liquid content.

3. **High Integrity Containers (HICs) -** Containers certified by the burial state to meet the stability requirements for wastes requiring stability for disposal.

4. **Liner -** A container into which radioactive waste is placed for shipment to the burial site.

5. **Qualified Process Control Program -** A PCP which the testing to meet 10CFR61 requirements is underway or test results have been transmitted to the NRC, or agreement state, for approval.

6. **Scaling Factor -** The ratio of a hard to measure isotope to an isotope that is easily measured through techniques such as gamma-spectral analysis.

7. **Solidification -** The process of converting wet wastes, pretreatment chemicals, cement and the appropriate additives together to produce a free standing solidified form that meets shipping and burial ground requirements.

8. **Solidification Formulation -** The quantities of waste, pretreatment chemicals, cement and additives required to affect solidification. Also referred to as the recipe.

3.0 DEFINITIONS (continued)

9. **Stable Waste -** Wastes that, by virtue of their radionuclide content, have been dewatered in high integrity containers or solidified using a solidification formulation that results in a solidified product that meets the performance requirements of 10CFR61.56, Waste Characteristics.

10. **Unstable Waste -** Wastes that, by virtue of their radionuclide content, have been dewatered in steel liners or solidified to meet the minimum requirements of 10CFR61.56(a).

11. **Waste Classification -** The determination of a waste class as outlined in 10CFR61 by radionuclide isotopic analysis and/or correlation with other measured nuclides.

12. **Waste Streams -** Radioactive wastes are divided into separate waste streams categories based on scaling factors and characteristics of the waste.

4.0 RESPONSIBILITIES

4.1 General Manager - Harris Plant

1. Ensures that radioactive waste is processed and shipped per the appropriate state and federal regulations.

4.2 Manager - RP

1. Assures spent resin, radwaste filters, radwaste sludge, and radwaste evaporator concentrates and other radioactive wastes are processed and packaged per Attachment 1, Solid Radwaste Programmatic Controls, HPP-830, the PCP, and plant procedures.

2. Ensures that radioactive wastes are stored and shipped per plant procedures; and the state, burial site, and federal regulations.

3. Ensures radioactive wastes are sampled and classified per 10CFR61.

4.3 PCP Coordinator

1. Advises plant management on the appropriate technical standards, regulations, and requirements related to solidification and dewatering of radioactive waste.

2. Ensures the vendor's PCP and solidification/dewatering procedures are reviewed and approved as required.

4.3 PCP Coordinator (continued)

3. Retains vendor supplied documentation for NRC inspection and review.

4. Advises plant management on the appropriate technical standards, regulations, and requirements related to storage and shipment of radioactive waste.

5.0 INSTRUCTIONS

5.1 Background Information

1. The installed plant solidification system at HNP failed to meet the requirements of 10CFR61 and has been abandoned. Vendor processes and equipment are used for solidification and dewatering of radioactive waste. Attachment 1, Solid Radwaste Programmatic Controls, requires the Solid Radwaste System to be used per a vendor PCP to meet shipping and transportation requirements and disposal site criteria. It is the objective of the HNP PCP to provide reasonable assurance of meeting the applicable shipping, transportation, and disposal site requirements by:

   - Requiring solidification, dewatering, packaging, waste classification, and transportation to be done per the HNP PCP and approved plant procedures.
   - Defining the various solid radwaste waste streams at HNP.
   - Providing management programmatic controls for vendor solidification and dewatering of these waste streams.
   - Implementing the burial site disposal criteria.
   - Implementing a sampling and waste classification system per 10CFR61.55 and 10CFR20.2006 Appendix F to 20.1001-20.2402.
   - Providing a quality control program required by 10CFR20.2006 Appendix F to 20.1001-20.2402.

5.2 Review, Approval, And Changes

1. The HNP PCP shall be reviewed by the PNSC and approved by the NRC before implementation. Revision 0 of the HNP PCP was submitted to the NRC in September 1985 and approved in the Shearon Harris Safety Evaluation Report, (NUREG-1038) Supplement #3.

5.2 Review, Approval, And Changes (continued)

2. Changes to the PCP shall be reviewed by the PNSC per Technical Specification 6.13. Certain Vendor PCP procedures (referenced in HPP-830) shall be included in the HNP PCP and are subject to the same review by the PNSC as changes to this Program.

5.3 <u>General Requirements</u>

1. All radioactive waste shall be processed, packaged, classified, and shipped to the burial site per the requirements of the HNP PCP.

2. Class A Unstable waste products need only demonstrate that the product is a free standing monolith with **<u>NO</u>** more than 0.5 percent of the waste volume as free liquid. Qualified Individuals shall ensure that Class A Stable, Class B and Class C wastes meet stability requirements of 10CFR61 or be packaged in a High Integrity Container approved by the burial site.

3. Solidification and/or dewatering shall be done by qualified individuals who have completed a solidification and/or dewatering training and qualification program.

4. If solidification does **<u>NOT</u>** meet disposal site and shipping/transportation requirements, the PCP Coordinator/designee shall immediately suspend shipment of inadequately processed waste and correct the PCP, the implementing procedures, and/or the Solid Waste Processing System to prevent recurrence.

5. If solidification is **<u>NOT</u>** performed per the HNP PCP, the PCP Coordinator/designee shall ensure the processed waste in each container is tested to ensure it meets burial site and shipping requirements and take appropriate actions to prevent recurrence.

6. With the installed Solid Waste Processing equipment incapable of meeting requirements of Attachment 1, Solid Radwaste Programmatic Controls, or declared inoperable, the PCP Coordinator/designee shall ensure the equipment is returned to operable status or provide for contract capability to process waste as necessary to satisfy applicable transportation and disposal requirements.

5.4 <u>Implementation</u>

1. The HNP PCP shall be implemented by use of approved plant procedures. These procedures shall provide step-by-step direction for the operation of solidification and dewatering systems and for transportation/disposal of waste at a licensed burial facility. All plant procedures which implement the PCP shall be reviewed and approved per Technical Specification 6.13.

5.5 Waste Streams

1. Radioactive wastes are divided into separate waste stream categories based on scaling factors and characteristics of the waste and/or batch. Waste streams at HNP include, but are **NOT** limited to:

    - Dry Active Waste (DAW)
    - Radwaste Filters
    - Radwaste Resin/Charcoal
    - CVCS Resin/BTRS Resin/Spent Fuel Pool Resin
    - Sludge
    - Evaporator Concentrates
    - Spent Fuel Pool Charcoal
    - Spent Fuel Pool Filters
    - Decontamination Waste
    - Oil

5.6 Vendor Solidification/Dewatering Requirements

1. Before performing solidification/dewatering services at HNP, the vendor shall provide documentation on the following for Duke Energy review, evaluation, and retention:

    a. A qualified PCP or a program approved by the NRC, or agreement state. For each low-level radioactive waste formulation, the PCP (reference HPP-830 for current vendor PCP) should address the boundary conditions for processing the waste to provide reasonable assurance that the final waste form will meet 10CFR61 stability requirements.

    b. Topical Report for Solidification/Dewatering including review and acceptance letter from the NRC, or agreement state.

    c. Copy of the 10CFR61 Testing Program to meet stability requirements including submittal letter or NRC approval letter. This is **NOT** required if the vendor only performs dewatering service or solidification of waste **NOT** requiring stability.

    d. Sketch or drawing of the solidification/dewatering process system.

5.6 Vendor Solidification/Dewatering Requirements (continued)

e. Detailed procedures for operation of the solidification/dewatering equipment and inspection and use of containers.

f. Documentation that the operator has been qualified per the vendor's solidification/dewatering training and qualification program.

g. Identification of solidification agent(s) and formulation used by the process.

h. Copies of the Technical Specification(s) and Material Safety Data Sheets for all chemicals that will be used by the vendor.

i. Certificate of Compliance for any High Integrity Containers and a list of incompatible waste.

2. The vendor is accountable to the PCP Coordinator/designee for the solidification and/or dewatering of liquid waste. The RP unit is responsible for shipping of solidified and dewatered wastes.

3. Solidification and/or dewatering shall be done by qualified individuals who have completed a solidification and/or dewatering training and qualification program. Certification shall be provided by the vendor for vendor operators and shall be on file prior to any solidification/dewatering work performed by the individual.

4. Solidification and/or dewatering shall be done per approved procedures described in HPP-830.

5. As required by Attachment 1, Solid Radwaste Programmatic Controls, a test solidification of at least every tenth batch of each type of wet radioactive waste shall be performed. Test solidification of every batch may be performed if desired.

6. If any test specimen fails to verify solidification, the solidification of the batch under test shall **NOT** be performed until such time as additional test specimens can be obtained, alternative solidification parameters can be determined, and a subsequent test verifies solidification. Solidification of the batch may then be resumed using the alternative solidification parameters.

7. If the initial test specimen from a batch of waste fails to verify solidification, then representative test samples shall be collected from each consecutive batch of the same type of wet waste until at least three consecutive initial test specimens demonstrate solidification.

5.6 Vendor Solidification/Dewatering Requirements (continued)

8. For high activity waste, where handling samples could result in personnel radiation exposures which are inconsistent with ALARA principles, representative non-radioactive samples may be test solidified. These samples shall be as close to the actual waste and chemical properties as possible. For resins, the resin beads shall be depleted prior to test solidification.

9. The quality of the solidified and/or dewatered product shall meet or exceed regulatory requirements and the disposal site criteria prior to release from the HNP site. Copies of the site disposal criteria shall be maintained by the PCP Coordinator/designee. The site disposal criteria requirements are implemented as requirements by reference from this PCP.

5.7 <u>High Integrity Containers</u>

1. With the approval from the land disposal facility, wastes may be disposed of in approved high integrity containers (HICs). Certificate of Compliance from the disposal facility shall be on file prior to use of any high integrity containers.

2. The maximum allowable free liquid in a high integrity container shall be less than one percent of the waste volume.

3. Corrosion and chemical tests should be performed to confirm the suitability of the proposed container. List of prohibited contents should be available. If it is suspected that the waste may contain any of the prohibited chemicals, chemical tests shall be run to verify the absence of the chemical. As a minimum, the waste pH shall be determined to be within the acceptable range for the HIC.

4. Written procedures or documentation for use, inspection and storage of a HIC shall be provided by the manufacturer/supplier.

5. The length of on-site storage of HICs may vary depending on the type of container. Procedures for use and storage of HICs should contain maximum storage times. Photosensitive containers shall be kept out of direct sunlight and away from any other sources of ultraviolet radiation.

6. HICs shall be inspected prior to use.

5.8 Reporting Of Mishaps

1. Any knowledge of misuse or failure of waste forms and containers shall be reported to the NRC's Director of the Division of Low Level Waste Management and Decommissioning and the designated State disposal site regulatory authority within 30 days of the knowledge of the incident. An Condition Report shall be completed and sent to Regulatory Compliance Unit. For any such waste form mishap occurrence, the affected waste form should **NOT** be shipped off-site until approval is obtained from the disposal site regulatory authority. Such mishaps include, but are **NOT** necessarily limited to:

    a. The failure of high integrity containers used to ensure structural stability. Such failure may be evidenced by changed container dimensions, cracking, or injury from mishandling.

    b. The misuse of high integrity containers, as evidenced by a quantity of free liquid greater than or equal to one percent of the waste volume, or an excessive void space within the container.

    c. The production of solidified Class A Stable, Class B, or Class C waste form that has any of the following characteristics:

        (1) Greater than 0.5 percent volume of free liquid.

        (2) Concentrations of radionuclides greater than the concentrations demonstrated to be stable in the waste form in qualification testing accepted by the regulatory agency.

        (3) Greater or lesser amounts of solidification media than were used in qualification testing accepted by the regulatory agency.

        (4) Contains chemical ingredients **NOT** present or accounted for in qualification testing accepted by the regulatory agency.

        (5) Shows instability evidenced by crumbling, cracking, spalling, voids, softening, disintegration, non homogeneity, or change in dimensions.

        (6) Evidences processing phenomena that exceed the limiting processing conditions identified in applicable topical reports or PCPs, such as foaming, excessive temperature, premature or slow hardening, production of volatile material.

5.9 <u>10CFR61 Implementation</u>

Solidified radioactive waste packaged for disposal at a licensed burial facility shall meet the requirements of 10CFR61.

5.9.1 Waste Classification 10CFR61.55

1. Waste is determined to be generally unacceptable for near-surface disposal if it contains any of the radionuclides listed in Table 1 and 2 of 10CFR61.55 in concentrations exceeding the limits established for the radionuclides. Compliance with these limits shall be determined prior to shipment.

2. Waste transported for disposal must be classified as Class A, Class B, or Class C for the purpose of segregation at the disposal site. The waste class is based on the concentration of certain radionuclides in the waste form as given in 10CFR61.55.

3. Waste shall be classified based on isotopic analysis and the use of scaling factors for hard to measure isotopes. Initially, generic scaling factors will be used for waste classification. Each waste stream shall then be sampled after the first three months of commercial operation or prior to the first shipment if generated after the first three months of commercial operation.

4. Confirmatory sampling for Class A waste shall be performed on a bi-annual basis. Class B and Class C wastes shall be sampled for confirmation of scaling factors at least on an annual basis. These frequencies may be extended based on fuel performance factors influencing the affected waste stream. Samples shall **<u>NOT</u>** be required if the waste stream is **<u>NOT</u>** generated during the sampling frequency. These infrequently generated waste stream shall be sampled and the scaling factors updated prior to shipment. In addition, a waste stream shall be sampled if it is determined that a factor of 10 shift in any scaling factor has occurred in that waste stream.

5. If the plant is in an outage period at the same time the sampling period is due, the sampling period may be delayed until after the outage period. Resampling should **<u>NOT</u>** be completed until after two months at full power operation to allow the reactor water chemistry and waste stream characteristics to stabilize.

6. A computerized waste classification and shipping program is normally used to determine waste classification from isotopic analysis and the scaling factors. Manual methods may be used if the computer system is **<u>NOT</u>** available. Waste Classification is controlled by HPS-NGGC-0001.

5.9.2 Radioactive Waste Characteristics 10CFR61.56

1. The eight minimum waste characteristics identified in 10CFR61.56(a) and listed below shall apply to any waste solidified or dewatered at HNP.

   a. Waste must **NOT** be packaged for disposal in cardboard or fiberboard boxes.

   b. Liquid waste must be solidified or packaged in sufficient absorbent material to absorb twice the volume of the liquid.

   c. Solid waste containing liquid shall contain as little free standing and noncorrosive liquid as is reasonably achievable, but in **NO** case shall the liquid exceed 1% of the volume.

   d. Waste must **NOT** be readily capable of detonation or of explosive decomposition or reaction at normal pressures and temperatures, or of explosive reaction with water.

   e. Waste must **NOT** contain, or be capable of generating, quantities of toxic gases, vapors, or fumes harmful to persons transporting, handling, or disposing of the waste.

   f. Waste must **NOT** be pyrophoric. Pyrophoric materials contained in waste shall be treated, prepared, and packaged to be nonflammable.

   g. Waste in a gaseous form must be packaged at a pressure that does **NOT** exceed 1.5 atmospheres at 20°C. Total Activity must **NOT** exceed 100 curies per container.

   h. Waste containing hazardous, biological, pathogenic, or infectious material must be treated to reduce to the maximum extent practicable the potential hazard from the non-radiological materials.

2. Waste stability requirements are assured by the requirement in Section 5.3 for the vendor to provide a copy of the 10CFR61 Testing Program for Waste Stability.

5.9.3 Labeling 10CFR61.57

1. Each package of waste shall be clearly labeled to identify the appropriate waste classification per Section 5.6.1.

5.10 10CFR20.2006 Implementation

Radioactive waste transferred for disposal by Harris Nuclear Plant shall meet the requirements of 10CFR20.2006 and Appendix F to 20.1001-20.2402.

5.10.1 Shipment Manifest

The requirements of 10CFR20.2006 and Appendix F to 20.1001-20.2402 for shipment manifest and record keeping shall be included in HPS-NGGC-0001.

5.10.2 Quality Control Program

1. The quality control program consists of required use of plant procedures which implement the PCP and audits by personnel independent of the activities.

2. The PCP and implementing procedures for processing and packaging radioactive wastes are audited once per 24 months by Nuclear Oversight (NOS) per plant FSAR Section 17.3. These audits shall be reviewed by the Superintendent - RP.

6.0 RECORDS

1. No QA records are generated by this procedure.

7.0 REFERENCES

7.1 Commitments

None

7.2 Procedures

1. HPS-NGGC-0001, Radioactive Material Shipping Procedure

2. HPP-830, Process Control Program Implementation

7.3 Miscellaneous Documents

1. 10CFR20.2006, Transfer for Disposal and Manifests

2. 10CFR61, Licensing Requirements for Land Disposal of Radioactive Waste

3. CS-OP-PR-008, Setup and Operation of EnergySolutions Self-Engaging Dewatering Systems Fillhead

7.3 Miscellaneous Documents (continued)

4. CS-OP-PR-010, Bead Resin/Activated Carbon Dewatering Procedure For EnergySolutions 14-215 Or Smaller Liners, Utilizing EnergySolutions Self-Engaging Dewatering System

5. FO-AD-002, Operating Guidelines For Use Of Polyethylene High Integrity Containers

6. HNP Technical Specification 6.13, Process Control Program

7. Issuance of Final Branch Technical Position on Concentration Averaging and Encapsulation, Revision in Part to Waste Classification Technical Position - January 1995

8. NUREG-0133, Preparation of Radiological Effluent Technical Specification for Nuclear Power Plants

9. NUREG-0472, Radiological Effluent Technical Specification for PWR, July 1979

10. NUREG-1038, Supplement #3, Safety Evaluation Report

11. Technical Position on Waste Form - January 1991

12. USNRC 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

<< Solid Radwaste Programmatic Controls >>

3/4.11.3 SOLID RADIOACTIVE WASTES (historical information removed from Technical Specifications)

OPERATIONAL REQUIREMENT

3.11.3 Radioactive wastes shall be solidified or dewatered per the PROCESS CONTROL PROGRAM to meet shipping and transportation requirements during transit, and disposal site requirements when received at the disposal site.

APPLICABILITY: At all times.

ACTION:

a. With SOLIDIFICATION or dewatering **NOT** meeting disposal site and shipping and transportation requirements, suspend shipment of the inadequately processed wastes and correct the PROCESS CONTROL PROGRAM, the procedures, and/or the Solid Waste System as necessary to prevent recurrence.

b. With SOLIDIFICATION or dewatering **NOT** performed per the PROCESS CONTROL PROGRAM, test the improperly processed waste in each container to ensure that it meets burial ground and shipping requirements and take appropriate administrative action to prevent recurrence.

SURVEILLANCE REQUIREMENTS

4.11.3 SOLIDIFICATION of at least one representative test specimen from at least every tenth batch of each type of wet radioactive wastes (for example, filter sludges, spent resins, evaporator bottoms, boric acid solutions, and sodium sulfate solutions) shall be verified per the PROCESS CONTROL PROGRAM:

a. If any test specimen fails to verify SOLIDIFICATION, the SOLIDIFICATION of the batch under test shall be suspended until such time as additional test specimens can be obtained, alternative SOLIDIFICATION parameters can be determined per the PROCESS CONTROL PROGRAM, and a subsequent test verifies SOLIDIFICATION. SOLIDIFICATION of the batch may then be resumed using the alternative SOLIDIFICATION parameters determined by the PROCESS CONTROL PROGRAM;

<< Solid Radwaste Programmatic Controls >>

b. If the initial test specimen from a batch of waste fails to verify SOLIDIFICATION, the PROCESS CONTROL PROGRAM shall provide for the collection and testing of representative test specimens from each consecutive batch of the same type of wet waste until at least three consecutive initial test specimens demonstrate SOLIDIFICATION. The PROCESS CONTROL PROGRAM shall be modified as required, as provided in Technical Specification 6.13, to assure SOLIDIFICATION of subsequent batches of waste; and

c. With the installed equipment incapable of meeting Effluent Specification 3.11.3 or declared inoperable, restore the equipment to OPERABLE status or provide for contract capability to process wastes as necessary to satisfy all applicable transportation and disposal requirements.

3/4.11.3 SOLID RADIOACTIVE WASTES

BASES

This specification implements the requirements of 10CFR50.36a, 10CFR61, and General Design Criterion 60 of Appendix A to 10CFR50. 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.

ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT

6.9.1.4 Routine Annual Radioactive Effluent Release Reports covering the operation of the unit during the previous year 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 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 summarized on a quarterly basis following the format of Appendix B thereof. For solid wastes, the format for Table 3 in Appendix B shall be supplemented with three additional categories: class of solid wastes (as defined by 10CFR61), type of container (for example, Type A, Type B) and SOLIDIFICATION agent or absorbent (for example, cement).

<< Solid Radwaste Programmatic Controls >>

6.15 MAJOR CHANGES TO SOLID RADWASTE TREATMENT SYSTEMS* (Operational Requirement)

Licensee-initiated major changes to the Solid Radwaste Treatment Systems:

a. Shall be reported to the Commission in the Annual Radioactive Effluent Release Report for the period in which the evaluation was reviewed per Technical Specification 6.9. The discussion of each change shall contain:

   1. A summary of the evaluation that led to the determination that the change could be made per 10CFR50.59;

   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 quantity of solid waste that differ from those previously predicted in the License application and amendments thereto;

   5. A comparison of the predicted releases of radioactive materials, in solid waste, to the actual releases for the period prior to when the change is to be made;

   6. An estimate of the exposure to plant operating personnel as a result of the change; and

   7. Documentation of the fact that the change was reviewed and found acceptable per Technical Specification 6.13.

b. Shall become effective upon review and acceptance per Technical Specification 6.13.

*Licensees may choose to submit the information called for in this Operational Requirement as part of the annual FSAR update.

<u>ATTACHMENT 11</u>

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 1/1/2016 - 12/31/2016

One major modification to Shearon Harris Nuclear Power Plant liquid, gaseous, solid, or mobile radioactive waste treatment systems occurred in 2016.

The Modular Fluidized Transfer Demineralizer System (MFTDS) is a radwaste processing set of equipment on Waste Processing Building Elev 236' that the plant uses to reduce floor drain, equipment drain and laundry/hot shower liquid waste to levels low enough to discharge to the environment. The water may be processed through the MFTDS as many times as necessary to reduce nuclide concentration.

EC 400448 modified the MFTDS equipment by adding a prefilter (F-40) and replacing two existing bag filters (F-50 & F-60) with deep bed granular activated carbon (GAC) filters. Each GAC filter is be mobile and has hose quick-connect fittings compatible with the existing MFTDS hose fittings. Each mobile GAC filter has a mobile shield package to facilitate radwaste shipping for offsite disposal of the spent carbon and recharging with fresh carbon. Stationary radiation shielding was provided to minimize general area dose rates in the MFTDS room. The new prefilter (F-40) was added upstream of the GAC filters due to the sludge heels in the Floor Drain Tanks. The prefilter contains the same type and size bag elements contained in the existing bag filter (F-4) currently used to prefilter the influent to the MFTDS.

Many plants have already switched their radwaste processing systems to use activated carbon. Activated carbon offers the benefit of retaining and stripping several high energy nuclides of electrons which predisposes them for efficient removal in the MFTDS demineralizers. GAC filters have proven to be reliable for removal of dirt, turbidity, oil, color, organics and colloidal particulate (including Co-58, Co-60, Ag-110, and Mn-54) in significantly larger volumes than cartridge filters. This deep bed filtration method increases the life of the downstream media, thus reducing secondary radioactive waste generation and personnel exposure resulting from media replacement.

The change was reviewed and approved by the Plant Nuclear Safety Committee on May 19, 2016.

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 1/1/2016 - 12/31/2016

The following contains amended pages to the Shearon Harris Nuclear Power Plant 2015 ARERR. Amended pages are identified with "Amendment #" on page. Specific changes are identified with change bars in right margin.

The Shearon Harris Nuclear Power Plant 2015 ARERR Amendment #1 requires the following change from Attachment 3 Page 3-2:

Shearon Harris Nuclear Power Plant 2015 ARERR as submitted:

	Type of Waste Shipped	Number of Shipments	Number of Containers	Waste Class	Container Type	Solidification Agent	Burial Volume (m^3)	Total Activity (Curies)
1.	**Waste from Liquid Systems**							
	a. Dewatered Spent Resins (compacted)	2	2	A	NRC Approved	N/A	8.04	2.92E-01
	b. Evaporator Concentrates	0	-	-	-	-	-	-
	c. Dewatered Demineralizers	0	-	-	-	-	-	-
	d. Solidified (cement) Acids, Oils, Sludge	0	-	-	-	-	-	-
2.	**Dry Solid Waste**							
	a. Dry Active Waste (compacted)	0	-	-	-	-	-	-
	b. Dry Active Waste (dewatered, non-compacted)	5	5	A	NRC Approved	N/A	294	6.45E-01
	c. Dry Active Waste (brokered)	0	-	-	-	-	-	-
	d. Irradiated Components (dewatered, non-compacted)	1	1	A	NRC Approved	N/A	294	1.39E-01
3.	**Total Solid Waste**	**8**	**8**				**596.04**	**1.08E+00**

Attachment 12
Errata to a Previous Year's ARERR

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2016 - 12/31/2016

Shearon Harris Nuclear Power Plant 2015 ARERR Amendment #1 as revised:

	Type of Waste Shipped	Number of Shipments	Number of Containers	Waste Class	Container Type	Solidification Agent	Burial Volume (m^3)	Total Activity (Curies)
1.	**Waste from Liquid Systems**							
a.	Dewatered Spent Resins (compacted)	2	2	A	NRC Approved	N/A	8.0	2.92E-01
b.	Evaporator Concentrates	0	-	-	-	-	-	-
c.	Dewatered Demineralizers	0	-	-	-	-	-	-
d.	Solidified (cement) Acids, Oils, Sludge	0	-	-	-	-	-	-
2.	**Dry Solid Waste**							
a.	Dry Active Waste (compacted)	0	-	-	-	-	-	-
b.	Dry Active Waste (dewatered, non-compacted)	5	5	A	NRC Approved	N/A	59.2	6.45E-01
c.	Dry Active Waste (brokered)	0	-	-	-	-	-	-
d.	Irradiated Components (dewatered, non-compacted)	1	1	A	NRC Approved	N/A	3.2	1.39E-01
3.	**Total Solid Waste**	**8**	**8**				**70.5**	**1.08E+00**

Attachment 12
Errata to a Previous Year's ARERR

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2016 - 12/31/2016

Attachment 3
Solid Radioactive Waste Disposal

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2015 - 12/31/2015

	Type of Waste Shipped	Number of Shipments	Number of Containers	Waste Class	Container Type	Solidification Agent	Burial Volume (m^3)	Total Activity (Curies)
1.	**Waste from Liquid Systems**							
	a. Dewatered Spent Resins (compacted)	2	2	A	NRC Approved	N/A	8.0	2.92E-01
	b. Evaporator Concentrates	0	-	-	-	-	-	-
	c. Dewatered Demineralizers	0	-	-	-	-	-	-
	d. Solidified (cement) Acids, Oils, Sludge	0	-	-	-	-	-	-
2.	**Dry Solid Waste**							
	a. Dry Active Waste (compacted)	0	-	-	-	-	-	-
	b. Dry Active Waste (dewatered, non-compacted)	5	5	A	NRC Approved	N/A	59.2	6.45E-01
	c. Dry Active Waste (brokered)	0	-	-	-	-	-	-
	d. Irradiated Components (dewatered, non-compacted)	1	1	A	NRC Approved	N/A	3.2	1.39E-01
3.	**Total Solid Waste**	**8**	**8**				**70.5**	**1.08E+00**

Page 3-2

Shearon Harris Nuclear Plant 2015 ARERR Amendment #1