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Serial: RA-23-0046 10 CFR 50.36a
April 24, 2023

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

Brunswick Steam Electric Plant, Unit Nos. 1 and 2
Renewed Facility Operating License Nos. DPR-71 and DPR-62
Docket Nos. 50-325 and 50-324

Catawba Nuclear Station, Unit Nos. 1 and 2
Renewed Facility Operating License Nos. NPF-35 and NPF-52
Docket Nos. 50-413 and 50-414

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

McGuire Nuclear Station, Unit Nos. 1 and 2
Renewed Facility Operating License Nos. NPF-9 and NPF-17
Docket Nos. 50-369 and 50-370

Oconee Nuclear Station, Unit Nos. 1, 2 and 3
Renewed Facility Operating License Nos. DPR-38, DPR-47 and DPR-55
Docket Nos. 50-269, 50-270 and 50-287

H. B. Robinson Steam Electric Plant, Unit 2
Renewed Facility Operating License No. DPR-23
Docket No. 50-261

SUBJECT: Annual Radioactive Effluent Release Report - 2022

Ladies and Gentlemen:

Duke Energy Carolinas, LLC and Duke Energy Progress, LLC (collectively referred to as Duke Energy), in accordance with 10 CFR 50.36a and Technical Specification (TS) 5.6.3 for Brunswick Steam Electric Plant Units 1 and 2 (BNP), TS 5.6.3 and Selected Licensing Commitment (SLC) 16.11-16 for Catawba Nuclear Station Units 1 and 2 (CNS), TS 6.9.1.4 for Shearon Harris Nuclear Power Plant Unit 1 (HNP), TS 5.6.3 and SLC 16.11.17 for McGuire Nuclear Station Units 1 and 2 (MNS), TS 5.6.3 and SLC 16.11.9 for Oconee Nuclear Station Units 1, 2, and 3 (ONS), and TS 5.6.3 for H. B. Robinson Steam Electric Plant Unit 2 (RNP), is submitting the Annual Radioactive Effluent Release Reports (ARERRs) for the period from January 1, 2022, through December 31, 2022. The ARERRs are provided in Enclosures 1 through 6.

BNP TS 5.5.1, "Offsite Dose Calculation Manual (ODCM)," requires changes to the ODCM be submitted as part of, or concurrent with, the Radioactive Effluent Release Report. The ODCM was not revised during this report period.

CNS TS 5.5.1, "Offsite Dose Calculation Manual (ODCM)," requires changes to the ODCM be submitted as part of, or concurrent with, the Radioactive Effluent Release Report. The ODCM was not revised during this report period.

HNP TS 6.14, "Offsite Dose Calculation Manual (ODCM)," requires changes to the ODCM be submitted as part of, or concurrent with, the Radioactive Effluent Release Report. ODCM Revision 29 was implemented in 2022 and is included with this submittal.

MNS TS 5.5.1, "Offsite Dose Calculation Manual (ODCM)," requires changes to the ODCM be submitted as part of, or concurrent with, the Radioactive Effluent Release Report. ODCM Revision 61 was implemented in 2022 and is included with this submittal.

ONS TS 5.5.1, "Offsite Dose Calculation Manual (ODCM)," requires changes to the ODCM be submitted as part of, or concurrent with, the Radioactive Effluent Release Report. ODCM Revision 61 was implemented in 2022 and is included with this submittal.

RNP TS 5.5.1, "Offsite Dose Calculation Manual (ODCM)," requires changes to the ODCM be submitted as part of, or concurrent with, the Radioactive Effluent Release Report. ODCM Revision 37 was implemented in 2022 and is included with this submittal.

No regulatory commitments are contained in this submittal.

Please refer any questions concerning this letter and its enclosures to Ryan Treadway, Director, Nuclear Fleet Licensing, at (980) 373-5873.

Sincerely,

Cecil Fletcher
General Manager (Acting), Nuclear Regulatory Affairs, Policy & Emergency Preparedness

Enclosures:

1. BNP Annual Radioactive Effluent Release Report
2. CNS Annual Radioactive Effluent Release Report
3. HNP Annual Radioactive Effluent Release Report
4. MNS Annual Radioactive Effluent Release Report
5. ONS Annual Radioactive Effluent Release Report
6. RNP Annual Radioactive Effluent Release Report

cc: (all Enclosures unless specified)

L. Dudes, USNRC, Region II Regional Administrator
N. Jordan, USNRC NRR Project Manager for BNP
S. Williams, USNRC NRR Project Manager for CNS/ONS
M. Mahoney, USNRC NRR Project Manager for HNP/RNP
J. Klos, USNRC NRR Project Manager for MNS
G. Smith, USNRC Senior Resident Inspector for BNP
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P. Boguszewski, USNRC Senior Resident Inspector for HNP
C. Safouri, USNRC Senior Resident Inspector for MNS
J. Nadel, USNRC Senior Resident Inspector for ONS
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Enclosure 1
General Counsel to Chair of NC Utilities Commission (swatson@ncuc.net)

Enclosure 6
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Enclosure 1, 3, and 4
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Enclosures 2, 5, and 6
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ENCLOSURE 1: BNP Annual Radioactive Effluent Release Report

Brunswick Steam Electric Plant
Units 1 and 2

Annual Radioactive Effluent Release Report

January 1, 2022 through December 31, 2022

Dockets 50-325 and 50-324

Introduction

The Annual Radioactive Effluent Release Report is pursuant to Brunswick Steam Electric Plant Technical Specification 5.6.3 and ODCM Specification 7.4.2. The below listed attachments to this report provide the required information. In addition, if a revision to the ODCM has occurred during the report period, it is included pursuant to Brunswick Steam Electric Plant Technical Specification 5.5.1.

Attachment 1	Summary of Gaseous and Liquid Effluents
Attachment 2	Supplemental Information
Attachment 3	Solid Radioactive Waste Disposal
Attachment 4	Meteorological Data
Attachment 5	Unplanned Offsite Releases
Attachment 6	Assessment of Radiation Dose from Radioactive Effluents to Members of the Public
Attachment 7	Information to Support the NEI Ground Water Protection Initiative
Attachment 8	Inoperable Equipment
Attachment 9	Summary of Changes to the Offsite Dose Calculation Manual
Attachment 10	Summary of Changes to the Process Control Program
Attachment 11	Summary of Major Modifications to the Radioactive Waste Treatment Systems
Attachment 12	Errata to a Previous Year's ARERR

ATTACHMENT 1

Summary of Gaseous and Liquid Effluents

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

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2022 - 12/31/2022

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	2.62E+02	3.43E+02	6.76E+02	6.33E+02	1.91E+03
2. Avg. Release Rate	µCi/sec	3.37E+01	4.36E+01	8.50E+01	7.97E+01	6.05E+01
B. Iodine-131						
1. Total Release	Ci	2.16E-02	4.41E-02	2.59E-02	2.73E-02	1.19E-01
2. Avg. Release Rate	µCi/sec	2.77E-03	5.61E-03	3.26E-03	3.44E-03	3.77E-03
C. Particulates Half-Life ≥ 8 days						
1. Total Release	Ci	1.72E-03	1.68E-03	2.59E-03	2.53E-03	8.52E-03
2. Avg. Release Rate	µCi/sec	2.21E-04	2.13E-04	3.26E-04	3.18E-04	2.70E-04
D. Tritium						
1. Total Release	Ci	1.90E+01	1.16E+01	8.65E+00	1.24E+01	5.17E+01
2. Avg. Release Rate	µCi/sec	2.45E+00	1.47E+00	1.09E+00	1.56E+00	1.64E+00
E. Carbon-14						
1. Total Release	Ci	4.43E+00	5.61E+00	5.99E+00	5.93E+00	2.20E+01
2. Avg. Release Rate	µCi/sec	5.70E-01	7.14E-01	7.53E-01	7.46E-01	6.96E-01
F. Gross Alpha						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Attachment 1
Summary of Gaseous and Liquid Effluents

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2022 - 12/31/2022

Gaseous Effluents - Elevated Releases - Continuous Mode

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Gases						
Ar-41	Ci	4.99E-01	1.05E+00	1.11E+00	7.48E-01	3.41E+00
Kr-85m	Ci	3.45E+01	2.59E+01	4.20E+01	4.09E+01	1.43E+02
Kr-85	Ci	0.00E+00	1.64E+01	0.00E+00	0.00E+00	1.64E+01
Kr-87	Ci	4.31E+00	6.05E+00	3.31E+01	1.03E+01	5.38E+01
Kr-88	Ci	3.28E+01	2.36E+01	5.15E+01	2.62E+01	1.34E+02
Xe-133m	Ci	0.00E+00	3.04E-02	3.78E-04	0.00E+00	3.08E-02
Xe-133	Ci	4.07E+01	4.07E+01	6.23E+01	7.37E+01	2.17E+02
Xe-135m	Ci	1.60E+01	2.69E+01	5.34E+01	5.25E+01	1.49E+02
Xe-135	Ci	4.55E+00	1.35E+01	8.83E+01	2.67E+01	1.33E+02
Xe-137	Ci	1.78E+01	6.89E+01	1.47E+02	1.65E+02	3.99E+02
Xe-138	Ci	4.16E+01	6.36E+01	1.22E+02	1.32E+02	3.59E+02
Total for Period	Ci	1.93E+02	2.87E+02	6.01E+02	5.28E+02	1.61E+03
B. Iodines						
I-131	Ci	8.35E-03	2.75E-02	2.39E-02	1.91E-02	7.89E-02
I-133	Ci	2.55E-02	9.56E-02	1.31E-01	1.08E-01	3.60E-01
I-135	Ci	2.66E-02	1.21E-01	1.54E-01	1.29E-01	4.31E-01
Total for Period	Ci	6.05E-02	2.44E-01	3.09E-01	2.56E-01	8.70E-01
C. Particulates Half-Life ≥ 8 days						
Cr-51	Ci	6.26E-06	0.00E+00	0.00E+00	0.00E+00	6.26E-06
Mn-54	Ci	2.25E-06	1.44E-06	0.00E+00	0.00E+00	3.69E-06
Fe-59	Ci	0.00E+00	0.00E+00	3.66E-06	0.00E+00	3.66E-06
Co-58	Ci	2.40E-06	1.09E-05	0.00E+00	0.00E+00	1.33E-05
Co-60	Ci	9.73E-06	8.71E-06	1.40E-06	5.07E-06	2.49E-05
Sr-89	Ci	1.87E-04	3.34E-04	4.79E-04	3.13E-04	1.31E-03
Ag-110m	Ci	0.00E+00	6.81E-07	1.28E-06	2.05E-06	4.01E-06
Cs-137	Ci	3.59E-07	5.96E-07	0.00E+00	0.00E+00	9.55E-07
Ba-140	Ci	1.07E-04	3.13E-04	6.64E-04	3.96E-04	1.48E-03
La-140	CI	1.87E-04	5.67E-04	1.17E-03	7.58E-04	2.68E-03
Total	CI	5.01E-04	1.24E-03	2.32E-03	1.47E-03	5.53E-03
D. Tritium						
H-3	Ci	1.99E+00	3.20E+00	3.48E+00	2.62E+00	1.13E+01
E. Carbon-14						
C-14	Ci	1.77E+00	2.25E+00	2.39E+00	2.37E+00	8.78E+00
F. 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

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2022 - 12/31/2022

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. Carbon-14						
N/A	Ci	-	-	-	-	-
F. Gross Alpha						
Total for Period	Ci	-	-	-	-	-

* Brunswick Steam Electric Plant Units 1 and 2 do not have batch elevated releases.

Attachment 1
Summary of Gaseous and Liquid Effluents

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2022 - 12/31/2022

Gaseous Effluents - Ground Releases - Continuous 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	2.66E-02	0.00E+00	2.66E-02
Kr-87	Ci	0.00E+00	0.00E+00	2.86E-03	0.00E+00	2.86E-03
Kr-88	Ci	9.56E-04	0.00E+00	0.00E+00	0.00E+00	9.56E-04
Xe-133	Ci	4.90E-01	3.33E-02	1.33E-01	1.28E-02	6.69E-01
Xe-135m	Ci	0.00E+00	4.66E-02	2.90E-01	1.20E+00	1.54E+00
Xe-135	Ci	1.55E+01	1.02E+01	5.06E+00	6.67E+00	3.74E+01
Xe-138	Ci	0.00E+00	0.00E+00	0.00E+00	1.28E+00	1.28E+00
Total for Period	Ci	1.60E+01	1.03E+01	5.51E+00	9.17E+00	4.10E+01
B. Iodines						
I-131	Ci	1.08E-02	7.28E-03	1.16E-04	1.21E-03	1.94E-02
I-133	Ci	3.09E-02	2.01E-02	3.23E-04	1.04E-02	6.17E-02
I-135	Ci	3.69E-02	2.60E-02	1.88E-04	1.65E-02	7.96E-02
Total for Period	Ci	7.86E-02	5.34E-02	6.27E-04	2.81E-02	1.61E-01
C. Particulates Half-Life ≥ 8 days						
Cr-51	Ci	1.56E-06	0.00E+00	0.00E+00	0.00E+00	1.56E-06
Mn-54	Ci	0.00E+00	1.02E-07	0.00E+00	0.00E+00	1.02E-07
Co-57	Ci	1.18E-06	0.00E+00	0.00E+00	0.00E+00	1.18E-06
Co-58	Ci	0.00E+00	9.33E-08	0.00E+00	0.00E+00	9.33E-08
Co-60	Ci	1.54E-05	4.29E-06	3.28E-06	5.83E-06	2.88E-05
Sr-89	Ci	1.40E-04	6.70E-06	0.00E+00	1.23E-05	1.59E-04
Ag-110m	Ci	5.90E-06	0.00E+00	0.00E+00	0.00E+00	5.90E-06
Sb-125	Ci	1.48E-06	0.00E+00	0.00E+00	0.00E+00	1.48E-06
Cs-137	Ci	1.86E-07	0.00E+00	0.00E+00	7.43E-09	1.93E-07
Ba-140	Ci	8.97E-05	2.82E-05	0.00E+00	1.24E-04	2.42E-04
La-140	Ci	2.58E-04	5.75E-05	0.00E+00	1.33E-04	4.49E-04
Total for Period	Ci	5.13E-04	9.69E-05	3.28E-06	2.76E-04	8.89E-04
D. Tritium						
H-3	Ci	1.49E+01	4.70E+00	3.15E+00	4.77E+00	2.75E+01
E. Carbon-14						
C-14	Ci	8.87E-01	1.12E+00	1.20E+00	1.19E+00	4.40E+00
F. 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

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2022 - 12/31/2022

Gaseous Effluents - Ground 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. Carbon-14						
N/A	Ci	-	-	-	-	-
F. Gross Alpha						
Total for Period	Ci	-	-	-	-	-

* Brunswick Steam Electric Plant Units 1 and 2 do not have batch ground releases.

Attachment 1
Summary of Gaseous and Liquid Effluents

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2022 - 12/31/2022

Gaseous Effluents - Mixed-Mode Releases - Continuous Mode

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Gases						
Kr-85	Ci	2.69E+01	1.84E+01	5.35E+01	6.52E+01	1.64E+02
Xe-133	Ci	1.05E+00	0.00E+00	6.90E-01	1.00E+01	1.17E+01
Xe-135m	Ci	1.95E+01	2.05E+01	8.68E+00	1.19E+01	6.06E+01
Xe-135	Ci	5.77E+00	6.88E+00	6.25E+00	7.37E+00	2.63E+01
Xe-138	Ci	0.00E+00	0.00E+00	0.00E+00	1.54E+00	1.54E+00
Total for Period	Ci	5.32E+01	4.58E+01	6.91E+01	9.61E+01	2.64E+02
B. Iodines						
I-131	Ci	2.39E-03	9.32E-03	1.90E-03	6.99E-03	2.06E-02
I-133	Ci	1.13E-02	3.09E-02	1.87E-02	6.29E-02	1.24E-01
I-135	Ci	1.63E-02	4.54E-02	3.36E-02	1.09E-01	2.04E-01
Total for Period	Ci	3.00E-02	8.56E-02	5.43E-02	1.79E-01	3.49E-01
C. Particulates Half-Life ≥ 8 days						
Cr-51	Ci	3.10E-05	4.37E-05	0.00E+00	0.00E+00	7.47E-05
Mn-54	Ci	3.36E-05	1.23E-05	5.69E-07	0.00E+00	4.65E-05
Fe-59	Ci	1.94E-06	2.78E-06	0.00E+00	0.00E+00	4.72E-06
Co-58	Ci	3.95E-05	1.90E-05	1.17E-05	0.00E+00	7.02E-05
Co-60	Ci	1.33E-04	8.96E-05	6.64E-05	6.08E-05	3.50E-04
Zn-65	Ci	4.05E-05	0.00E+00	0.00E+00	0.00E+00	4.05E-05
Sr-89	Ci	0.00E+00	0.00E+00	0.00E+00	3.34E-05	3.34E-05
Ag-110m	Ci	9.03E-06	6.47E-06	1.55E-06	1.96E-05	3.67E-05
Cs-134	Ci	0.00E+00	2.21E-06	0.00E+00	0.00E+00	2.21E-06
Cs-137	Ci	0.00E+00	0.00E+00	0.00E+00	3.78E-06	3.78E-06
Ba-140	Ci	1.46E-04	5.32E-05	5.09E-05	1.98E-04	4.48E-04
La-140	Ci	2.72E-04	1.15E-04	1.41E-04	4.66E-04	9.94E-04
Total for Period	Ci	7.06E-04	3.44E-04	2.72E-04	7.81E-04	2.10E-03
Tritium						
D. H-3	Ci	2.17E+00	3.66E+00	2.02E+00	4.99E+00	1.28E+01
Carbon-14						
E. C-14	Ci	1.77E+00	2.25E+00	2.39E+00	2.37E+00	8.78E+00
Gross Alpha						
F. 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

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2022 - 12/31/2022

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. Carbon-14						
N/A	Ci	-	-	-	-	-
F. Gross Alpha						
Total for Period	Ci	-	-	-	-	-

* Brunswick Steam Electric Plant Units 1 and 2 do not have batch mixed-mode releases.

Attachment 1
Summary of Gaseous and Liquid Effluents

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2022 - 12/31/2022

Liquid Effluents - Summation of All Releases - Discharge Canal

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Products *						
1. Total Release	Ci	1.44E-03	6.04E-03	1.68E-02	1.16E-02	3.59E-02
2. Avg. Diluted Conc.	µCi/ml	3.93E-12	1.24E-11	3.21E-11	2.47E-11	1.83E-11
B. Tritium						
1. Total Release	Ci	1.76E+01	9.14E+00	1.16E+01	1.29E+01	5.12E+01
2. Avg. Diluted Conc.	µCi/ml	4.82E-08	1.88E-08	2.22E-08	2.75E-08	2.92E-08
C. Dissolved & Entrained Gases						
1. Total Release	Ci	3.10E-02	1.90E-02	3.93E-02	7.69E-02	1.66E-01
2. Avg. Diluted Conc.	µCi/ml	8.49E-11	3.91E-11	7.48E-11	1.64E-10	9.07E-11
D. Gross Alpha						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
E. Volume of Liquid Waste						
1. Batch Releases	Liters	4.48E+06	3.50E+06	4.10E+06	3.53E+06	1.56E+07
2. Continuous Releases	Liters	1.11E+08	1.09E+08	1.71E+08	1.02E+08	4.93E+08
F. Volume of Dilution Water						
1. All Releases	Liters	3.65E+11	4.87E+11	5.25E+11	4.70E+11	1.85E+12

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

Attachment 1
Summary of Gaseous and Liquid Effluents

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2022 - 12/31/2022

Liquid Effluents - Summation of All Releases - Marsh Area

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Products *						
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
B. Tritium						
1. Total Release	Ci	6.97E-03	0.00E+00	3.66E-03	0.00E+00	1.06E-02
2. Avg. Diluted Conc.	μCi/ml	1.39E-07	0.00E+00	7.14E-08	0.00E+00	5.26E-08
C. Dissolved & Entrained Gases						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Diluted Conc.	μCi/ml	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Gross Alpha						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Diluted Conc.	μCi/ml	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
E. Volume of Liquid Waste						
1. Batch Releases	Liters	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Continuous Releases	Liters	5.02E+07	5.07E+07	5.13E+07	5.13E+07	2.04E+08
F. Volume of Dilution Water						
1. All Releases	Liters	5.02E+07	5.07E+07	5.13E+07	5.13E+07	2.04E+08

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

Attachment 1
Summary of Gaseous and Liquid Effluents

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2022 - 12/31/2022

Liquid Effluents - Continuous Mode - Discharge Canal

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Products						
None	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
B. Tritium						
H-3	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C. Dissolved & Entrained Gases						
None	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Gross Alpha						
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Attachment 1
Summary of Gaseous and Liquid Effluents

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2022 - 12/31/2022

Liquid Effluents - Continuous Mode - Marsh Area

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Products						
None	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
B. Tritium						
H-3	Ci	6.97E-03	0.00E+00	3.66E-03	0.00E+00	1.06E-02
C. Dissolved & Entrained Gases						
None	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Gross Alpha						
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Attachment 1
Summary of Gaseous and Liquid Effluents

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2022 - 12/31/2022

Liquid Effluents - Batch Mode - Discharge Canal

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Products						
Na-24	Ci	0.00E+00	0.00E+00	0.00E+00	2.42E-05	2.42E-05
Mn-54	Ci	0.00E+00	4.69E-06	1.70E-06	6.42E-07	7.03E-06
Co-58	Ci	4.07E-05	2.47E-06	0.00E+00	0.00E+00	4.32E-05
Co-60	Ci	1.82E-04	1.32E-04	5.96E-05	3.48E-05	4.08E-04
Zn-65	Ci	0.00E+00	8.22E-06	0.00E+00	0.00E+00	8.22E-06
Zn-69m	Ci	4.75E-06	0.00E+00	0.00E+00	0.00E+00	4.75E-06
Br-82	Ci	0.00E+00	5.18E-06	1.85E-05	1.35E-05	3.72E-05
Sr-92	Ci	0.00E+00	0.00E+00	0.00E+00	8.55E-06	8.55E-06
Mo-99	Ci	0.00E+00	0.00E+00	0.00E+00	2.76E-05	2.76E-05
Tc-99m	Ci	0.00E+00	0.00E+00	0.00E+00	5.74E-05	5.74E-05
Tc-104	Ci	5.90E-06	0.00E+00	0.00E+00	0.00E+00	5.90E-06
Ru-105	Ci	0.00E+00	1.11E-05	8.75E-06	0.00E+00	1.99E-05
Sb-124	Ci	2.07E-06	1.63E-05	3.92E-06	0.00E+00	2.23E-05
Sb-125	Ci	4.93E-06	1.19E-05	2.67E-05	0.00E+00	4.35E-05
Te-129m	Ci	0.00E+00	0.00E+00	0.00E+00	6.45E-05	6.45E-05
Te-131m	Ci	0.00E+00	0.00E+00	0.00E+00	6.63E-06	6.63E-06
I-131	Ci	8.41E-04	3.05E-03	6.19E-03	5.41E-03	1.55E-02
I-132	Ci	0.00E+00	1.36E-06	7.52E-05	5.22E-06	8.18E-05
I-133	Ci	3.22E-04	2.41E-03	8.84E-03	5.12E-03	1.67E-02
I-135	Ci	2.19E-05	3.70E-04	1.58E-03	7.88E-04	2.76E-03
Cs-137	Ci	9.79E-06	1.16E-05	1.13E-06	1.60E-05	3.85E-05
La-140	Ci	0.00E+00	0.00E+00	0.00E+00	2.30E-06	2.30E-06
W-187	Ci	0.00E+00	0.00E+00	3.14E-05	2.26E-05	5.40E-05
Total for Period	Ci	1.44E-03	6.04E-03	1.68E-02	1.16E-02	3.59E-02
B. Tritium						
H-3	Ci	1.76E+01	9.14E+00	1.16E+01	1.29E+01	5.12E+01
C. Dissolved & Entrained Gases						
Kr-85m	Ci	0.00E+00	0.00E+00	0.00E+00	7.44E-06	7.44E-06
Kr-85	Ci	2.39E-04	0.00E+00	0.00E+00	4.13E-04	6.52E-04
Kr-87	Ci	2.09E-06	0.00E+00	0.00E+00	0.00E+00	2.09E-06
Xe-133m	Ci	0.00E+00	3.05E-05	1.30E-04	4.26E-04	5.87E-04
Xe-133	Ci	7.19E-03	4.14E-03	8.64E-03	1.59E-02	3.59E-02
Xe-135m	Ci	1.30E-05	5.70E-05	4.66E-04	2.34E-04	7.70E-04
Xe-135	Ci	2.36E-02	1.48E-02	3.00E-02	5.98E-02	1.28E-01
Total for Period	Ci	3.10E-02	1.90E-02	3.93E-02	7.69E-02	1.66E-01
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

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2022 - 12/31/2022

Liquid Effluents - Batch Mode - Marsh Area

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Products						
None	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
B. Tritium						
H-3	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C. Dissolved & Entrained Gases						
None	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Gross Alpha						
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

ATTACHMENT 2

Supplemental Information

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

Attachment 2
Supplemental Information

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2022 - 12/31/2022

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	=	129	125
2. Total Time (min) for Batch Releases	=	2.62E+05	2.62E+05
3. Maximum Time (min) for a Batch Release	=	4.34E+04	4.32E+04
4. Average Time (min) for Batch Releases	=	2.03E+03	2.10E+03
5. Minimum Time (min) for a Batch Release	=	1.40E+01	2.00E+00
6. Average Dilution Water Flow During Release (gpm)	=	7.25E+05	8.01E+05

B. Gaseous Effluents		Jan - Jun	Jul - Dec
1. Total Number of Batch Releases	=	N/A	N/A
2. Total Time (min) for Batch Releases	=	N/A	N/A
3. Maximum Time (min) for a Batch Release	=	N/A	N/A
4. Average Time (min) for Batch Releases	=	N/A	N/A
5. Minimum Time (min) for a Batch Release	=	N/A	N/A

VI. Abnormal Releases

See Attachment 5, Unplanned Offsite Releases.

Attachment 2
Supplemental Information

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2022 - 12/31/2022

Carbon-14

In Regulatory Guide 1.21, Revision 2, “Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste”, the NRC recommends U.S. nuclear power plants evaluate whether C-14 is a "principal radionuclide" in gaseous effluents, and if so, report the amount of C-14 released. Improvements over the years in effluent management practices and fuel performance have resulted in a decrease in gaseous radionuclide (non-C-14) concentrations, and a change in the distribution of gaseous radionuclides released to the environment. As a result, many sites show C-14 has become a "principal radionuclide" for the gaseous effluent pathway, as defined in Regulatory Guide 1.21, Rev. 2. Although committed to Regulatory Guide 1.21, Rev. 1, the Brunswick Steam Electric Plant 2022 ARERR contains estimates of C-14 radioactivity released in 2022 and estimates of public dose resulting from the C-14 effluent.

Because the dose contribution of C-14 from liquid radioactive waste is much less than that contributed by gaseous radioactive waste, evaluation of C-14 in liquid radioactive waste is not required (Ref. Reg. Guide 1.21, Rev. 2). The quantity of gaseous C-14 released to the environment can be estimated by use of a C-14 source term scaling factor based on power generation (Ref. Reg. Guide 1.21, Rev. 2). The Brunswick Steam Electric Plant Updated Final Safety Analysis Report (UFSAR) states the C-14 release rate from a BWR is approximately 9.5 Ci/yr per unit assuming 80% plant capacity factor, or 292 Effective Full Power Days (EFPD). Since Brunswick Steam Electric Plant has two reactors, the total release rate would be 19.0 Ci/yr. Using actual EFPD for Unit 1 and Unit 2, the total C-14 release rate was 2.20E+01 Ci/yr.

Public dose estimates from airborne C-14 are performed using dose models in Regulatory Guide 1.109. The dose models and assumptions used are documented in the Brunswick Steam Electric Plant ODCM 3.3.3, Carbon-14. The estimated C-14 dose impact on the maximum organ dose from airborne effluents released from Brunswick Steam Electric Plant in 2022 is well below the 10CFR50, Appendix I, ALARA design objective (i.e., 15 mrem/yr per unit).

Based on the 2022 Land Use Census, the critical receptor is located in the south sector at 1.5 miles with a garden. There are no meat or milk pathways within 5 miles. Regulatory Guide 1.109 methodology was used to determine the dose to this critical receptor. The bone dose for 2022 was 4.24E+00 mrem and the total body dose was 8.47E-01 mrem.

	Units	Year
1. C-14 Activity Released	Ci	2.20E+01
2. C-14 Total Body Dose	mREM	8.47E-01
3. C-14 Organ Dose	mREM	4.24E+00

Receptor Location ***1.0*** miles ***S***
Critical Age ***CHILD***
Critical Organ ***BONE***

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2022 - 12/31/2022

Discussion of liquid release from the BSEP Sewage Treatment Plant

In accordance with the Brunswick Steam Electric Plant (BSEP) National Pollutant Discharge Elimination System (NPDES) Permit Number NC0007064 the decant from the BSEP Sewage Treatment Plant is released to Outfall Number 004. Outfall Number 004 discharges to the discharge canal which is a designated release point. The BSEP sewage decant is monitored continuously with a composite sampler for gamma and tritium analysis. On December 11, 2013 the monthly effluent sample contained tritium, there was no detectable gamma activity. Condition Report (CR) 651320 was generated and daily sampling was initiated for effluent accountability. Inputs to the system were sampled and it was discovered that tritiated groundwater is leaking into the Number 6 lift station. The source of tritium is from pre-existing groundwater contamination in the general area surrounding the Number 6 lift station. Regulatory Affairs confirmed this was not reportable per NEI 07-07 groundwater reporting. The BSEP sewage treatment plant was decommissioned in January 2019 and no further releases from this point occurred.

Discussion of liquid releases from the Storm Drain Collector Basin (SDCB)

During periods of heavy rain, the contents of the SDCB may be released to the discharge canal in accordance with regulatory requirements to protect plant personnel and equipment. The SDCB was released directly to the discharge canal on 27 occasions in 2022 due to heavy rains. Approximately 8.23E+06 gallons containing 0.00E+00 curies of tritium were released. There was no detectable gamma radioactivity.

Discussion of liquid releases from the Storm Drain Stabilization Facility (SDSF)

The SDSF collects rainwater, water from miscellaneous low volume drains on plant site, water from the Groundwater Extraction System, and water from the Unit 1 CST Remediation Facility. Treatment consists of filtration and evaporation. When sufficient water has accumulated in the pond it is released into the intake canal where it is drawn into the plant circulating and service water system and eventually released into the discharge canal. There were 13 SDSF releases in 2022. Approximately 1.22 E+08 gallons containing 5.01E-01 curies of tritium were released from the SDSF. There was no detectable gamma radioactivity.

Discussion of water evaporation from the Storm Drain Stabilization Pond (SDSP)

It was calculated that up to 8.98E+05 cubic feet of water vapor were released via evaporation from the SDSP in 2022. This yields 0.00E+00 curies of tritium released to the atmosphere as a ground release. The nearest resident to the pond is in the northwest sector at approximately 0.3 miles. The maximum exposed individuals at that location received a calculated dose of 0.00E+00 mrem via the inhalation pathway in 2022. Only inhalation dose would be determined because the exposed individuals do not have a garden and do not have any milk or meat animals at this location. The Drainage Holding Facility (DHF) is within the footprint of the SDSP and the DHF sample results are used in this calculation and attributed to the SDSP evaporation.

Discussion of water evaporation from the Storm Drain Stabilization Facility (SDSF)

It was calculated that 6.52E+05 cubic feet of water vapor were released via evaporation from the SDSF in 2022. This yields 8.27E-02 curies of tritium released to the atmosphere as a ground release. The nearest resident to the pond is in the north-northwest sector at approximately 0.5 miles. The maximum exposed individuals at that location received a calculated dose of 5.33E-05 mrem via the inhalation pathway in 2022. Only inhalation dose was determined because the exposed individuals do not have a garden and do not have any milk or meat animals at this location.

Attachment 2
Supplemental Information

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2022 - 12/31/2022

Discussion of liquid releases from the Marsh to Nancy's Creek

Samples are routinely analyzed from the marsh areas that drain into Nancy's Creek during falling tides. The marsh areas are all on company owned property. The marsh land is under the influence of high and low tides and releases to Nancy's Creek, which is offsite. This constitutes a release point for evaluation. The sampling program consists of monthly sampling and analysis at nine locations. All gamma analyses performed in 2022 were less than the Lower Limit of Detection (LLD). Some tritium analyses were greater than the LLD. The average tritium concentration each month, two high tides per day, the area of the marsh at high tide, the days in the month, and a conservative factor of 2 were used to calculate the amount of tritium released each month. In 2022, it was calculated that 5.38E+07 gallons were released to Nancy's Creek containing 1.06E-02 curies of tritium. This yielded a Total Body dose of 1.29E-04 mrem to an adult from eating fish and invertebrate.

Discussion of liquid releases from the Storm Drain Stabilization Pond (SDSP)

The SDSP collects rainwater as its only input source. Treatment from this location consists of sedimentation, evaporation, and transpiration. When sufficient water has accumulated in the pond, it is released into the intake canal where it is drawn into the circulating and service water system and eventually released into the discharge canal. There was 0 SDSP release in 2022. Approximately 0.00E+00 gallons were released in 2022 containing 0.00E+00 curies of tritium. There was no detectable gamma radioactivity.

The focus of the BNP Groundwater Program is to be proactive in fully understanding the actions needed for the management of historical leaks and the prevention and management of potential future leaks and spills. The site has taken important steps to strengthen this program and to manage in a safe and sustainable way. One action is to cap the existing SDSP and construct a new holding facility for stormwater. The SDSP requires retirement / abandonment in support of site legacy radionuclide management. The system no longer receives radionuclide sources because of groundwater liabilities with its unlined original design and has been replaced by the lined SDSF. In addition, the SDSP containment perimeter condition has become degraded by vegetative overgrowth. The consequence of a barrier failure would be potential release of radionuclide contents to the adjacent creek over time.

The risk has been managed by initial pond retirement actions which were completed for vegetation removal and stabilization of the perimeter berm. The risk was eliminated with subsequent pond retirement actions including back grading the pond and culverting runoff toward an engineered breach at site-side waters, removing pond static head at the perimeter. A new Drainage Holding Facility (DHF) has nearly finished construction phase (as of end of December 2022) within the SDSP. The DHF will control aquatic vegetation by use of an aeration system and weighted high-density polyethylene (HDPE) balls. Also, the DHF will be double lined to reduce the potential for any tritium leakage to groundwater. Due to the decision to double line the new DHF pond and delays the newest expected completion date is March 2023. When sufficient water has accumulated in the DHF pond it is released into the intake canal where it is drawn into the plant circulating and service water system and eventually released into the discharge canal. There was 1 test release from the DHF in 2022 during a storm event to the NC coast from Hurricane Ian. Approximately 6.08E+05 gallons were released in 2022 containing 0.00E+00 curies of tritium. There was no detectable gamma radioactivity.

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2022 - 12/31/2022

Overall Estimate of Error for Effluent Radioactivity Release Reported

The estimated percentage of overall error for Gaseous effluent release data at Brunswick Steam Electric Plant is listed below. These values were derived by taking the square root of the sum of the squares of the discrete individual estimates of error.

1. Fission and Activation Gases = ± 25%
2. Particulates and Iodine = ± 25%
3. Tritium = ± 15%

The estimated percentage of overall error for Liquid effluent release data at Brunswick Steam Electric Plant is listed below. These values were derived by taking the square root of the sum of the squares of the discrete individual estimates of error.

1. Fission and Activation Products and Dissolved and Entrained Noble Gases = ± 17%
2. Tritium = ± 23%
3. Gross Alpha = ± 32%

Overall Estimate of Error for Solid Waste Radioactivity Reported

The estimated percentage of overall error for Solid Waste data at Brunswick Steam Electric Plant has been determined to be ± 10%.

Summary of Changes in Land Use Census Affecting Effluent Dose Calculations

The 2022 Land Use Census was initially performed June 6-7, 2022. The Land Use census was reevaluated on October 10-13, 2022 as a result of using a different centerline UFSAR (NCR#02441863). The following are changes to residences, gardens, and milk animals from the previous year.

Residences

- See table 3.9-A

Gardens

- See table 3.9-B.

Milk Animals

No milk animals (cows or goats) were identified in the 5-mile radius in any of the 16 meteorological sectors.

Environmental Monitoring Locations

Based upon the June 6-7, 2022 evaluation, an additional Air Sampler was added to the NNE sector and a broadleaf vegetation sample location was added to the ENE sector.

Based upon the October 10-13, 2022 reevaluation, no sampler was required to the NNE. The newly added NNE sampler was kept in place in the program. The ENE sector broadleaf sample location identified in the June 6-7, 2022 evaluation will be replaced with a different sample location in the ENE sector, however, it is not a required sample location.

Attachment 2
Supplemental Information

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2022 - 12/31/2022

Table 3.9-A

Brunswick Steam Electric Plant

Land Use Census Comparison (2021 – 2022)

Performed - June 6-7, 2022 and October 10-13, 2022

Nearest Pathway (Miles)

SECTOR	RESIDENT		GARDEN		MILK ANIMALS	
	2021	2022	2021	2022	2021	2022
N	0.74	0.87**	---	1.11*	---	---
NNE	0.82	0.91*	0.87	0.99*	---	---
NE	---	---	---	---	---	---
ENE	---	---	---	---	---	---
E	---	---	---	---	---	---
ESE	1.37	1.37	---	1.48	---	---
SE	---	---	---	---	---	---
SSE	2.13	1.22**	---	---	---	---
S	1.12	1.02*	2.28	1.50*	---	---
SSW	1.38	1.25*	1.62	1.48*	---	---
SW	1.09	0.97*	1.09	0.97*	---	---
WSW	1.24	1.27**	1.36	1.27*	---	---
W	0.85	0.84*	1.34	0.85*	---	---
WNW	0.93	0.90*	0.98	---^	---	---
NW	0.82	0.95**	4.86	0.98^	---	---
NNW	0.84	0.86**	0.92	1.02*	---	---

* Represents a change from previous year due to NCR#02441863 (Same location as identified in June 2022, but mileage changed).
** Represents a change from June 2022 due to NCR#02441863 (New closer location identified within the sector).
^ Represents a change from June 2022 due to NCR#02441863 (Closer garden identified OR no garden within the sector due to sector change).
--- Indicates no occurance within 3 or 5 mile radius.
Sector and distance determined by Global Positioning System.

Attachment 2
Supplemental Information

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2022 - 12/31/2022

Table 3.9-B
Brunswick Steam Electric Plant
Garden Census – 2022
Performed - June 6-7, 2022 and October 10-13, 2022

SECTOR	Bearing (degrees)	DISTANCE (miles)		SECTOR	Bearing (degrees)	DISTANCE (miles)
N	177*	1.11*^		SSW	013*	2.12*
NNE	199*	0.99*^		SSW	023	2.22*
NE	---	---		SSW	021*	2.30*
ENE	---	---		SSW	025	2.45*
E	---	---		SSW	014*	2.53*
ESE	299*	1.48^		SSW	016	2.57*
SE	---	---		SSW	019*	2.72*
SSE	---	---		SW	055*	0.97*^
S	002*	1.50*^		SW	053*	2.63*
S	004*	2.17*		SW	037*	2.88*
S	003*	2.21*		WSW	078*	1.27*^
S	354*	2.26*		WSW	076*	3.22*
S	004*	2.33*		W	101*	0.85*^
S	005*	2.48*		W	094*	1.28*
S$	011*	1.95*		W	091*	4.07*
SSW	032	1.48*^		WNW$	---	---
SSW	029	1.72*		NW#	127*	0.98^
SSW	025	1.59*		NNW	168*	1.02*^
SSW	029	2.04*		NNW$	148*	4.93*

Note: Two geographical descriptors (bearing and mileage) are provided due to multiple gardens occurring in one sector and to show the shifts that occurred within the sector due to NCR#02441863. Sector and distance determined by Global Positioning System

--- Indicates no occurance within 3 or 5 mile radius.
^ Indicates nearest garden in sector.
* Represents a change from previous year due to NCR#02441863 (Same garden as identified in June 2022, but mileage/bearing has changed).
\# Represents a change from June 2022 due to NCR#02441863 (Closer garden identified within the sector, this is a previously identified garden has changed sectors).
$ Represents a change from June 2022 due to NCR#02441863 (Sector change, no longer a garden in the sector OR no longer the closest garden in 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

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2022 - 12/31/2022

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. Spent Resins, Filters, Sludges (dewatered)	19	19	A	Type A GDP	N/A	8.65E+1	2.36E+2
b. Spent Resins, Filters, Sludges (dewatered	2	2	B	Type B	N/A	4.53	4.94E+2
c. Solidified (cement) Acids, Oily Water	0	-	-	-	-	-	-
2. Dry Solid Waste							
a. Dry Active Waste (compacted & non-compacted)	30	44	A	Type A GDP	N/A	9.58E+2	3.79
b. Irradiated Components	1	1	C	Type B	N/A	7.54	1.91E+4
c. Other Waste (oil/sludge)	0	-	-		-	-	-
3. Total Solid Waste	**52**		**-**	**-**	**-**	**1.06E+3**	**1.98E+4**

NOTE: *Total Activity determined by estimate. Solid Waste listed above shipped for processing to various waste processing services or directly shipped to licensed disposal facility.*

Attachment 3
Solid Radioactive Waste Disposal

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2022 - 12/31/2022

Type of Waste Shipped	Radionuclide	% Abundance
1. Waste from Liquid Systems		
a. Spent Resins, Filters, Sludges (dewatered)	Fe-55	38.45
	Mn-54	3.74
	Co-60	48.79
	Ni-63	2.23
	Zn-65	2.98
	Cs-137	1.1
	Co-58	1.07
b. Solidified (cement) Acids, Oily Water	N/A	N/A
2. Dry Solid Waste		
a. Dry Active Waste (compacted & non-compacted)	Fe-55	43.31
	Mn-54	5.14
	Co-60	44.7
	Ni-63	1.96
	Cr-51	1.57
	Zn-65	1.09
b. Irradiated Components	Fe-55	57.92
	Co-60	17.85
	Ni-63	3.2
	Mn-54	3.79
	Ta-182	8.1
	Cr-51	1.34
	Hf-181	6.0
	Co-58	1.48
c. Other Waste	N/A	N/A

<u>ATTACHMENT 4</u>

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

Brunswick Nuclear Plant
Period 1/1/2022 - 12/31/2022

Lower Level

Stability Class	Wind Speed (mph)	Hours of Occurrence															
		Sector															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
A	0.75-3.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	3.51-7.50	6	0	0	0	0	1	0	0	0	0	0	0	2	7	6	6
	7.51-12.50	16	2	2	1	9	2	1	0	6	58	85	1	1	3	1	2
	12.51-18.50	0	0	0	5	0	0	0	0	1	19	8	0	0	0	0	0
	18.51-25.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	25+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B	0.75-3.50	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	3.51-7.50	17	17	7	1	3	7	6	4	2	0	8	5	6	6	16	14
	7.51-12.50	14	11	40	22	28	13	5	2	17	54	97	5	0	2	3	5
	12.51-18.50	0	0	7	4	2	0	0	0	3	14	9	1	1	0	0	0
	18.51-25.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	25+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	0.75-3.50	1	1	0	1	0	1	1	2	0	0	0	0	1	1	0	4
	3.51-7.50	20	29	22	7	11	15	15	8	10	11	25	10	10	5	17	11
	7.51-12.50	20	20	68	36	24	13	10	7	28	44	60	6	4	2	12	5
	12.51-18.50	0	5	5	3	1	0	0	0	3	7	6	0	2	0	0	0
	18.51-25.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	25+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D	0.75-3.50	41	20	9	10	9	16	18	6	0	8	18	9	16	17	22	26
	3.51-7.50	191	191	141	100	89	65	55	36	60	163	292	73	36	52	67	84
	7.51-12.50	103	134	163	105	39	10	7	32	56	192	366	21	7	11	19	20
	12.51-18.50	0	28	23	15	3	0	1	2	4	33	51	7	1	1	4	2
	18.51-25.00	0	0	1	0	0	0	2	0	2	4	0	0	0	0	0	0
	25+	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0

Attachment 4
Meteorological Data

Brunswick Nuclear Plant
Period 1/1/2022 - 12/31/2022

Lower Level

Stability Class	Wind Speed (mph)	Hours of Occurrence															
		Sector															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
E	0.75-3.50	100	40	35	27	23	18	26	21	24	26	59	75	72	54	78	70
	3.51-7.50	158	42	34	33	20	30	26	23	34	56	150	36	25	27	26	57
	7.51-12.50	3	5	2	7	5	2	2	5	32	32	28	0	0	0	0	0
	12.51-18.50	0	0	0	0	1	0	1	0	7	9	3	0	0	0	0	0
	18.51-25.00	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
	25+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F	0.75-3.50	112	24	12	2	4	5	11	5	10	14	21	31	41	37	84	141
	3.51-7.50	13	0	4	9	2	0	8	3	1	7	22	2	0	1	2	10
	7.51-12.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	12.51-18.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	18.51-25.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	25+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G	0.75-3.50	32	12	1	3	1	2	1	1	2	4	3	14	32	41	66	98
	3.51-7.50	3	0	0	0	0	0	1	0	0	0	3	0	0	0	0	3
	7.51-12.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	12.51-18.50	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	18.51-25.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	25+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment 4
Meteorological Data

Brunswick Nuclear Plant
Period 1/1/2022 - 12/31/2022

Upper Level

Stability Class	Wind Speed (mph)	Hours of Occurrence															
		Sector															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
A	0.75-3.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	3.51-7.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	7.51-12.50	5	0	0	3	0	1	1	0	1	10	7	0	0	2	6	6
	12.51-18.50	18	0	2	0	7	2	0	0	1	25	90	7	0	6	4	1
	18.51-25.00	4	0	0	5	0	0	0	0	0	10	20	5	0	0	0	0
	25+	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0
B	0.75-3.50	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	3.51-7.50	2	3	0	0	0	2	2	1	2	0	1	0	0	0	1	6
	7.51-12.50	12	18	13	17	18	15	7	8	5	14	16	14	2	9	11	10
	12.51-18.50	9	3	19	26	10	6	0	0	3	27	63	24	3	1	6	4
	18.51-25.00	4	2	10	6	0	0	0	0	2	10	22	6	0	0	0	1
	25+	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0
C	0.75-3.50	1	0	0	1	1	0	0	2	0	0	0	0	0	2	0	0
	3.51-7.50	7	9	4	4	6	7	2	4	6	3	4	2	2	5	5	9
	7.51-12.50	6	21	24	27	28	17	22	11	11	23	24	16	4	7	8	9
	12.51-18.50	12	14	46	26	13	2	0	1	9	20	37	21	3	0	6	4
	18.51-25.00	5	1	11	3	1	0	0	0	2	9	17	4	2	0	5	1
	25+	0	0	3	0	0	0	0	0	0	0	2	0	2	3	1	0
D	0.75-3.50	1	6	3	2	5	0	3	1	0	2	1	3	2	0	3	5
	3.51-7.50	13	41	29	34	33	41	22	23	13	16	15	14	12	9	8	17
	7.51-12.50	48	68	95	82	92	44	31	28	48	77	83	42	20	16	25	31
	12.51-18.50	90	132	196	121	49	14	7	17	36	139	268	149	40	34	41	49
	18.51-25.00	53	45	90	39	7	3	0	4	15	83	192	65	10	15	18	12
	25+	1	0	43	6	2	1	1	5	3	10	40	18	12	4	5	3

Attachment 4
Meteorological Data

Brunswick Nuclear Plant
Period 1/1/2022 - 12/31/2022

Upper Level

Stability Class	Wind Speed (mph)	Hours of Occurrence															
		Sector															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
E	0.75-3.50	0	4	0	0	2	0	0	2	3	2	3	0	0	1	3	1
	3.51-7.50	3	3	14	6	8	9	11	16	14	12	8	6	14	9	9	5
	7.51-12.50	12	21	34	29	30	24	25	22	44	38	49	53	16	14	10	19
	12.51-18.50	42	101	128	47	23	12	18	21	16	32	93	65	54	39	44	45
	18.51-25.00	12	25	8	11	0	3	8	8	23	43	32	21	21	15	9	9
	25+	1	0	2	0	0	5	3	0	18	13	14	2	0	0	0	0
F	0.75-3.50	1	1	2	3	4	1	4	2	2	7	5	0	1	1	2	0
	3.51-7.50	4	3	7	8	15	15	15	13	8	10	3	3	4	3	5	6
	7.51-12.50	9	9	19	25	15	14	9	9	8	11	13	12	12	8	5	9
	12.51-18.50	7	37	62	14	12	2	6	6	5	17	22	20	24	16	6	19
	18.51-25.00	5	8	16	1	2	3	6	6	0	5	12	15	8	3	8	11
	25+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G	0.75-3.50	2	2	0	2	2	2	0	1	3	2	2	3	1	4	2	5
	3.51-7.50	4	4	3	6	4	4	9	18	10	4	11	10	4	4	17	8
	7.51-12.50	8	11	12	16	7	5	11	10	5	7	8	14	10	6	13	10
	12.51-18.50	21	12	28	9	10	8	6	6	3	4	9	7	10	1	3	16
	18.51-25.00	2	0	10	1	0	0	0	1	0	0	0	5	12	4	1	1
	25+	0	0	0	0	0	0	0	0	0	1	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

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2022 - 12/31/2022

Brunswick Steam Electric Plant did not experience any unplanned offsite gaseous or liquid effluent releases in 2022.

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

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2022 - 12/31/2022

Gaseous Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Noble Gases						
1. Maximum Beta Air	mRAD	1.30E-02	1.04E-02	1.35E-02	1.80E-02	5.49E-02
(a) Limit	mRAD	2.00E+01	2.00E+01	2.00E+01	2.00E+01	4.00E+01
(b) % of Limit		6.50E-02	5.21E-02	6.74E-02	9.01E-02	1.37E-01
2. Maximum Gamma Air	mRAD	1.47E-02	1.37E-02	1.56E-02	1.86E-02	6.27E-02
(a) Limit	mRAD	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
(b) % of Limit		1.47E-01	1.37E-01	1.56E-01	1.86E-01	3.13E-01

Receptor Location ***0.7*** miles ***ENE***

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
B. Iodine, H-3, & Particulates						
1. Maximum Organ Dose	mREM	8.67E-01	1.09E+00	1.15E+00	1.14E+00	4.23E+00
(a) Limit	mREM	1.50E+01	1.50E+01	1.50E+01	1.50E+01	3.00E+01
(b) % of Limit		5.78E+00	7.24E+00	7.64E+00	7.57E+00	1.41E+01

Receptor Location ***1.0*** miles ***S***
Critical Age ***Child***
Critical Organ ***Bone***

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

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2022 - 12/31/2022

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Batch & Continuous Mode						
1. Maximum Organ Dose	mREM	7.23E-04	1.89E-03	4.17E-03	3.44E-03	1.02E-02
(a) Limit	mREM	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
(b) % of Limit		7.23E-03	1.89E-02	4.17E-02	3.44E-02	5.11E-02
2. Maximum Total Body Dose	mREM	1.33E-04	5.05E-05	7.06E-05	3.68E-05	2.91E-04
(a) Limit	mREM	3.00E+00	3.00E+00	3.00E+00	3.00E+00	6.00E+00
(b) % of Limit		4.44E-03	1.68E-03	2.35E-03	1.23E-03	4.85E-03

Critical Age ***ADULT***
Critical Organ ***Thyroid***

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

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2022 - 12/31/2022

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 Brunswick Steam Electric Plant includes liquid and gaseous effluent dose contributions from Brunswick Steam Electric Plant and direct and air-scatter dose from the onsite ISFSI and Turbine Buildings. No other uranium fuel cycle facility contributes significantly to the maximum exposed individual. Also included is dose from Carbon-14, evaporation of tritium from both the SDSP and SDSF, and marsh releases containing tritium to Nancy's Creek (Ref. Attachment 2, Supplemental Information, of this report for further information). The combined dose to a maximum exposed individual from effluent releases and direct and air-scatter dose 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		D. SDSP Evaporation H-3 Dose	
1. Location	4.75 mi. NE	1. Location	0.30 mi. NW
2. Critical Age	INFANT	2. Critical Age	TEEN
3. Critical Organ	THYROID	3. Critical Organ	N/A
4. Organ Dose (mREM)	1.18E+00	4. Organ Dose (mREM)	0.00E+00
5. Total Body Dose (mREM)	2.96E-03	5. Total Body Dose (mREM)	0.00E+00
B. Liquid Effluent Dose		E. SDSF Evaporation H-3 Dose	
1. Location	0.10 mi. SW	1. Location	0.50 mi. NNW
2. Critical Age	ADULT	2. Critical Age	TEEN
3. Critical Organ	THYROID	3. Critical Organ	N/A
4. Organ Dose (mREM)	1.02E-02	4. Organ Dose (mREM)	5.33E-05
5. Total Body Dose (mREM)	2.91E-04	5. Total Body Dose (mREM)	5.33E-05
C. Carbon-14 Dose		F. Nancy's Creek Marsh H-3 Dose	
1. Location	1.0 mi. S	1. Location	Nancy's Creek
2. Critical Age	CHILD	2. Critical Age	ADULT
3. Critical Organ	BONE	3. Critical Organ	N/A
4. Organ Dose (mREM)	4.23E+00	4. Organ Dose (mREM)	1.29E-04
5. Total Body Dose (mREM)	8.46E-01	5. Total Body Dose (mREM)	1.29E-04

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

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2022 - 12/31/2022

Direct and air-scatter radiation dose contributions from the onsite ISFSI and Turbine Buildings are shown in plant operating manual 0PLP-36, 10 CFR 72.212 Report, revision 6. The maximum dose rate to the nearest real individual from the ISFSI and Turbine Buildings is conservatively calculated to be less than 14.8 mrem/yr. The below excerpt from plant operating manual 0PLP-36, 10 CFR 72.212 Report, revision 4, Attachment 1, is provided to document the method used to calculate the dose from the onsite ISFSI and Turbine Buildings as less than 14.8 mrem/yr to the nearest real individual.

5.2.2 Dose from Normal Operations and Anticipated Occurrences

5. *The real dose contribution from direct radiation sources during plant operations at BSEP it taken at 14.8 mrem/year.*

Dose contributions from Carbon-14 in gaseous effluents have been determined from ODCM 3.3.3, Carbon-14. The maximum dose rate to the nearest real individual from the release of Carbon-14 in gaseous effluents is conservatively calculated to be less than 4.23E+00 mrem/yr based on 2.20E+01 Curies released in 2022 (Ref. Attachment 2, Supplemental Information, of this report).

Dose contributions from evaporation of the Storm Drain Stabilization Pond (SDSP) have been determined from ODCM 3.3.2, I-131, I-133, Particulates, and Tritium, equation 3.2-19. The maximum dose rate to the nearest real individual from evaporation of tritium in the SDSP is conservatively calculated to be 0.00E+00 mrem/yr based on 0.00E+00 Curies released in 2022 (Ref. Attachment 2, Supplemental Information, of this report).

Dose contributions from evaporation of the Storm Drain Stabilization Facility (SDSF) have been determined from ODCM 3.3.2, I-131, I-133, Particulates, and Tritium, equation 3.2-19. The maximum dose rate to the nearest real individual from evaporation of tritium in the SDSF is conservatively calculated to be less than 5.33E-05 mrem/yr based on 8.27E-02 Curies released in 2022 (Ref. Attachment 2, Supplemental Information, of this report).

Dose contributions from marsh releases to Nancy's Creek from ODCM 2.1.5, Marsh Releases. The maximum dose rate to the nearest real individual from marsh releases to Nancy's Creek is conservatively calculated to be less than 1.29E-04 mrem/yr based on 1.06E-02 Curies released in 2022 (Ref. Attachment 2, Supplemental Information, of this report).

Total dose from liquid and gaseous effluents from Brunswick Steam Electric Plant and the additional pathways mentioned above is conservatively estimated to be less than 22 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 Brunswick Steam Electric 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

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2022 - 12/31/2022

The Brunswick Steam Electric Plant groundwater sampling and analysis program is a significant surveillance program. Wells are installed around the Storm Drain Stabilization Pond (SDSP), in the Protected Area (PA), and throughout the Owner Controlled Area (OCA). The wells listed in the ODCM are collected as part of the Radiological Environmental Monitoring Program (REMP) and reported in the Annual Radiological Environmental Operating Report (AREOR). The monitoring wells not described in the ODCM are listed below. The list consists of shallow wells, intermediate wells, and deep aquifer wells in different locations around the OCA and PA. They are used to evaluate groundwater movement and for remediation of the Unit 1 Condensate Storage Tank (CST) leak and the SDSP.

Unit 1 CST Groundwater Wells - The investigation into groundwater impacts resulting from the December 2010 Unit 1 Condensate Storage Tank line leak resulted in the installation of numerous monitoring/recovery wells. Two of these wells (U1CSTREM-07BCH and U1CSTREM-09BCH) are installed in the Castle Hayne aquifer (greater than 70' below ground surface) to investigate and monitor potential impacts to the aquifer. Nine of these wells (U1CSTREM-05B, U1CSTREM-02B, GWM-17, U1CSTREM-09B, GWM-15, U1CSTREM-21B, U1CSTREM-22B, U1CSTREM-27B, MW-01B) are installed in the dense sand unit (45' - 70' below ground surface) to investigate and monitor impacts to this flow zone comprised of native material beneath the plant excavation backfill. Three of these dense sand wells are currently being used as recovery wells as part of the groundwater remediation effort (GWM-01, GWM-15, GWM-17). Twenty-three of these wells (GWM-01, U1CSTREM-09C, U1CSTREM-10C, U1CSTREM-11C, U1CSTREM-12C, GWM-13, GWM-15, GWM-16, GWM-18, GWM-19, U1CSTREM-21C, U1CSTREM-22B, GWM-11, GWM-22, GWM-21, U1CSTREM-27C, U1CSTREM-28C, GWM-02, GWM-08, GWM-09, U1CSTREM-32C, GWM-10, GWM-12) are installed in the plant excavation backfill (up to 45' below ground surface) to investigate and monitor impacts to this flow zone where the leak occurred. Fifteen of these wells are currently able to be used as recovery wells as part of the groundwater remediation effort.

Monitoring wells are typically sampled on a frequency determined from activity of the wells, risk assessments, and historical trends. This frequency can range from weekly to every two years. Ground water samples are regularly analyzed for tritium. There were no notifications per NEI 07-07, Industry Ground Water Protection Initiative in 2022.

Results from sampling during 2022 are shown in the table below.

Key to below table

NS	-	Not scheduled to be sampled, not sampled due to insufficient volume in well, or well inaccessible during outage.
ρCi/l	-	picocuries per liter.
< LLD	-	less than lower limit of detection, typically 250 ρCi/l.
20,000 ρCi/l	-	the Environmental Protection Agency drinking water standard for tritium. This standard applies only to water used for drinking.
1,000,000 ρCi/l	-	the 10 CFR Part 20, Appendix B, Table 2, Column 2, Effluent Concentration Limit for tritium.

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2022 - 12/31/2022

Brunswick Shallow Wells for Plant Site						
Well Name	Number of Samples in 2022	Number of Positive H-3 Samples in 2022	Average H-3 Activity (pCi/L)	Minimum H-3 Activity (pCi/L)	Maximum H-3 Activity (pCi/L)	Depth of Well (ft)
ESS-2C	4	4	7.51E+02	7.00E+02	7.93E+02	27
ESS-3C	2	2	3.35E+02	2.47E+02	4.22E+02	14
ESS-12C	1	0	<LLD	<LLD	<LLD	15
ESS-13C	3	2	2.50E+02	2.16E+02	2.83E+02	25
ESS-16	1	1	9.55E+02	9.55E+02	9.55E+02	27
ESS-17C	3	3	6.32E+03	5.66E+03	6.67E+03	26
ESS-18C	3	3	2.82E+03	1.35E+03	3.86E+03	20
ESS-19C	2	2	5.79E+04	5.64E+04	5.94E+04	20
ESS-20C	4	4	2.34E+03	1.76E+03	2.70E+03	20
ESS-21C	1	0	<LLD	<LLD	<LLD	20
ESS-22C	1	1	3.54E+03	3.54E+03	3.54E+03	20
ESS-23C	2	2	3.47E+04	3.06E+04	3.88E+04	23
ESS-24C	4	4	4.38E+03	3.01E+03	5.33E+03	18
ESS-25C	1	0	<LLD	<LLD	<LLD	22
ESS-26C	2	2	1.27E+03	9.07E+02	1.63E+03	15
ESS-27C	2	2	5.48E+04	5.16E+04	5.79E+04	16
ESS-28C	2	1	2.03E+02	2.03E+02	2.03E+02	23
ESS-29C	2	0	<LLD	<LLD	<LLD	28
ESS-30C	2	0	<LLD	<LLD	<LLD	15
ESS-31C	2	0	<LLD	<LLD	<LLD	15
ESS-38C	1	0	<LLD	<LLD	<LLD	15
ESS-39C	1	0	<LLD	<LLD	<LLD	20
ESS-40C	1	0	<LLD	<LLD	<LLD	30
ESS-41C	1	0	<LLD	<LLD	<LLD	27
ESS-42C	1	0	<LLD	<LLD	<LLD	30
ESS-44C	1	0	<LLD	<LLD	<LLD	15
ESS-45C	1	0	<LLD	<LLD	<LLD	21
ESS-46C	1	0	<LLD	<LLD	<LLD	18
ESS-48C	1	0	<LLD	<LLD	<LLD	18
ESS-49C	1	0	<LLD	<LLD	<LLD	19
ESS-50C	1	0	<LLD	<LLD	<LLD	22
ESS-51C	1	0	<LLD	<LLD	<LLD	22
ESS-54C	1	0	<LLD	<LLD	<LLD	24
ESS-55C	1	0	<LLD	<LLD	<LLD	38
ESS-56C	1	0	<LLD	<LLD	<LLD	32
ESS-58C	1	0	<LLD	<LLD	<LLD	18
ESS-59C	1	0	<LLD	<LLD	<LLD	18
ESS-60C	1	0	<LLD	<LLD	<LLD	19

Attachment 7
Information to Support the NEI Ground Water Protection Initiative

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2022 - 12/31/2022

Brunswick Shallow Wells for Plant Site						
Well Name	**Number of Samples in 2022**	**Number of Positive H-3 Samples in 2022**	**Average H-3 Activity (pCi/L)**	**Minimum H-3 Activity (pCi/L)**	**Maximum H-3 Activity (pCi/L)**	**Depth of Well (ft)**
ESS-67C	1	0	<LLD	<LLD	<LLD	25
ESS-72C	1	0	<LLD	<LLD	<LLD	18
ESS-201C	3	3	4.67E+02	3.57E+02	6.55E+02	19
ESS-202C	4	4	1.10E+04	8.38E+03	1.30E+04	19
ESS-203C	3	3	7.63E+02	6.78E+02	8.16E+02	19
ESS-STAB	7	7	5.88E+04	3.96E+04	6.69E+04	31
ESS-NC-4A	12	12	1.90E+04	1.58E+04	2.04E+04	17
MW-3	1	1	3.07E+02	3.07E+02	3.07E+02	26
MWPA-100C	1	1	2.30E+02	2.30E+02	2.30E+02	30
MWPA-101C	2	1	2.26E+02	2.26E+02	2.26E+02	29
MWPA-102C	1	1	4.74E+02	4.74E+02	4.74E+02	30
MWPA-103C	1	0	<LLD	<LLD	<LLD	30
MWPA-104C	1	1	9.66E+02	9.66E+02	9.66E+02	29
MWPA-105C	1	1	3.27E+02	3.27E+02	3.27E+02	30
MWPA-106C	1	1	3.90E+02	3.90E+02	3.90E+02	29
MWPA-107C	4	4	3.37E+03	3.05E+03	3.73E+03	29
MWPA-108C	2	0	<LLD	<LLD	<LLD	29
MWPA-109C	2	2	1.15E+03	9.50E+02	1.35E+03	29
MWPA-110C	3	1	3.23E+02	3.23E+02	3.23E+02	29
MWPA-113C	1	1	1.90E+03	1.90E+03	1.90E+03	25
MWPA-114C	4	4	1.20E+03	1.09E+03	1.28E+03	30
MWPA-115C	3	3	2.34E+03	1.54E+03	3.05E+03	34
MWPA-117C	2	2	6.77E+02	6.19E+02	7.35E+02	30
MWPA-118C	1	1	3.39E+02	3.39E+02	3.39E+02	30
GWSP- 1C	1	0	<LLD	<LLD	<LLD	19
ESS-61C	1	0	<LLD	<LLD	<LLD	28
ESS-62C	1	0	<LLD	<LLD	<LLD	20
ESS-63C	1	0	<LLD	<LLD	<LLD	29
ESS-64C	1	0	<LLD	<LLD	<LLD	21
ESS-65C	1	0	<LLD	<LLD	<LLD	15
ESS-66C	1	0	<LLD	<LLD	<LLD	20
ESS-57C	1	0	<LLD	<LLD	<LLD	40
ESS-43C	1	0	<LLD	<LLD	<LLD	17
ESS-32C	1	0	<LLD	<LLD	<LLD	35
ESS-33C	1	0	<LLD	<LLD	<LLD	25
ESS-34C	1	0	<LLD	<LLD	<LLD	22
ESS-35C	1	0	<LLD	<LLD	<LLD	20
ESS-36C	1	0	<LLD	<LLD	<LLD	22

Attachment 7
Information to Support the NEI Ground Water Protection Initiative

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2022 - 12/31/2022

Brunswick Shallow Wells for Plant Site						
Well Name	**Number of Samples in 2022**	**Number of Positive H-3 Samples in 2022**	**Average H-3 Activity (pCi/L)**	**Minimum H-3 Activity (pCi/L)**	**Maximum H-3 Activity (pCi/L)**	**Depth of Well (ft)**
SME-01C	6	0	<LLD	<LLD	<LLD	36

Attachment 7
Information to Support the NEI Ground Water Protection Initiative

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2022 - 12/31/2022

Brunswick Intermediate Wells for Plant Site						
Well Name	**Number of Samples in 2022**	**Number of Positive H-3 Samples in 2022**	**Average H-3 Activity (pCi/L)**	**Minimum H-3 Activity (pCi/L)**	**Maximum H-3 Activity (pCi/L)**	**Depth of Well (ft)**
ESS-3B	1	1	3.99E+02	3.99E+02	3.99E+02	52
ESS-18B	4	4	1.60E+03	1.43E+03	1.73E+03	63
ESS-19B	4	4	6.77E+03	5.31E+03	8.75E+03	42
ESS-20B	2	0	<LLD	<LLD	<LLD	43
ESS-22B	4	4	4.26E+03	4.12E+03	4.52E+03	76
ESS-38B	1	0	<LLD	<LLD	<LLD	55
ESS-39B	1	0	<LLD	<LLD	<LLD	55
ESS-51B	1	0	<LLD	<LLD	<LLD	45
ESS-52B	1	0	<LLD	<LLD	<LLD	51
ESS-53B	1	0	<LLD	<LLD	<LLD	76
MWPA-104B	1	1	1.66E+03	1.66E+03	1.66E+03	59
MWPA-107B	3	3	2.97E+03	2.48E+03	3.37E+03	60
ESS-401-BCH	1	0	<LLD	<LLD	<LLD	85
GWSP-2B	1	1	1.12E+03	1.12E+03	1.12E+03	65
GWSP-4B	1	1	5.97E+02	5.97E+02	5.97E+02	65
SME-01BCH	6	0	<LLD	<LLD	<LLD	100
SME-02B	6	0	<LLD	<LLD	<LLD	66
SME-02BCH	6	0	<LLD	<LLD	<LLD	107
SME-03B	6	0	<LLD	<LLD	<LLD	58
SME-04B	6	0	<LLD	<LLD	<LLD	50

Attachment 7
Information to Support the NEI Ground Water Protection Initiative

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2022 - 12/31/2022

Brunswick Deep Wells for Plant Site						
Well Name	**Number of Samples in 2022**	**Number of Positive H-3 Samples in 2022**	**Average H-3 Activity (pCi/L)**	**Minimum H-3 Activity (pCi/L)**	**Maximum H-3 Activity (pCi/L)**	**Depth of Well (ft)**
ESS-13A	1	0	<LLD	<LLD	<LLD	134
SME-01A	6	0	<LLD	<LLD	<LLD	175
SME-02A	6	0	<LLD	<LLD	<LLD	157
SME-04A	6	0	<LLD	<LLD	<LLD	155
SME-05A	5	0	<LLD	<LLD	<LLD	166

Attachment 7
Information to Support the NEI Ground Water Protection Initiative

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2022 - 12/31/2022

Brunswick Unit 1 CST Groundwater Wells						
Well Name	**Number of Samples in 2022**	**Number of Positive H-3 Samples in 2022**	**Average H-3 Activity (pCi/L)**	**Minimum H-3 Activity (pCi/L)**	**Maximum H-3 Activity (pCi/L)**	**Depth of Well (ft)**
GWM-01	16	16	2.64E+03	1.73E+03	3.91E+03	61
GWM-02	23	23	1.24E+04	3.99E+03	1.92E+04	45
GMW-06	0	-	-	-	-	45
GWM-08	11	11	2.04E+03	4.23E+02	6.46E+03	45
GWM-09	11	10	1.80E+03	7.74E+02	5.69E+03	46
GWM-10	11	11	4.46E+03	1.23E+03	1.26E+04	45
GWM-11	11	11	2.02E+03	1.19E+03	2.40E+03	45
GWM-12	8	8	2.26E+03	3.68E+02	4.84E+03	33
GMW-13	16	16	1.38E+04	9.59E+03	1.83E+04	44
GWM-14	17	16	4.10E+04	1.17E+04	6.84E+04	44
GMW-15	15	14	6.23E+03	2.71E+02	1.78E+04	59
GWM-16	24	24	9.92E+04	6.41E+03	1.50E+05	40
GMW-17	15	15	6.96E+03	5.00E+03	1.38E+04	68
GWM-18	24	24	8.79E+04	1.91E+04	1.50E+05	29
GMW-19	22	21	1.33E+04	1.26E+03	4.37E+04	40
GMW-20	11	11	1.13E+04	8.40E+03	1.58E+04	45
GMW-21	20	20	1.68E+04	5.44E+03	4.07E+04	45
GWM-22	23	23	1.27E+04	4.92E+03	1.61E+04	29
MW-1	9	6	4.89E+02	3.83E+02	6.39E+02	24
MW-1B	9	1	4.58E+02	4.58E+02	4.58E+02	45
U1CSTREM-02B	16	3	3.13E+02	2.84E+02	3.56E+02	68
U1CSTREM-05B	9	3	5.13E+02	4.14E+02	7.02E+02	65
U1CSTREM-07BCH	9	7	4.23E+02	2.51E+02	7.08E+02	85
U1CSTREM-09B	9	9	3.33E+03	1.21E+03	4.94E+03	68
U1CSTREM-09BCH	9	8	2.72E+03	1.39E+03	4.15E+03	85
U1CSTREM-09C	16	16	1.05E+04	4.28E+03	2.93E+04	45
U1CSTREM-10C	9	3	4.38E+02	3.79E+02	4.87E+02	45
U1CSTREM-11C	9	2	3.95E+02	3.68E+02	4.22E+02	40
U1CSTREM-12C	15	12	4.97E+03	2.91E+02	1.89E+04	34
U1CSTREM-21B	9	8	3.96E+03	8.95E+02	4.86E+03	69
U1CSTREM-21C	9	9	4.91E+03	2.79E+03	6.02E+03	45
U1CSTREM-22B	9	4	4.75E+02	3.04E+02	7.28E+02	69
U1CSTREM-27B	9	3	3.77E+02	2.96E+02	4.36E+02	68
U1CSTREM-27C	9	5	6.55E+02	4.61E+02	8.66E+02	45
U1CSTREM-28C	12	10	1.55E+04	2.88E+02	2.83E+04	45
U1CSTREM-32C	9	9	7.05E+02	4.78E+02	8.86E+02	45

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 liquid hold-up tanks exceeding 10 Curies total activity (excluding tritium and dissolved or entrained noble gases).

Attachment 8
Inoperable Equipment

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2022 - 12/31/2022

Brunswick Steam Electric Plant experienced two (2) instances of inoperable equipment relevant to effluent monitoring in excess of ODCM Specification 7.3.0 limits during 2022.

ODCM # From Table 7.3.2-1	Title	Completion Time
5	Main Condenser Off-Gas Treatment System Explosive Gas Monitoring System – Hydrogen Monitor	30 Days

Description:

The 2-OG-AIT-4284 (SJAE Room 2A/2B H2/O2 Analyzer H3B) was out of service greater than 30-days due to component failure. Investigation found that the detector needed a new flow meter. Delays in procurement of flowmeter is the cause of the 30-day exceedance. Once the part was received it was replaced. The monitor was out of service from 5-11-22 to 8-10-22.

The 2-OG-AIT-4324 (SJAE Room 2A/2B H2/O2 Analyzer H3C) was out of service greater than 30-days due to water intrusion. Investigation found that the detector needed new sample flow meter and sample flow columns. Delays in procurement of the needed parts and time for the monitor to dry out lead to its 30-day exceedance. The monitor was out of service from 6-20-22 to 7-26-22.

Brunswick Steam Electric Plant experienced no Liquid Hold-Up Tank exceeding the 10 Curie limit of ODCMS 7.3.6 during 2022.

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

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2022 - 12/31/2022

ODCM Revision 39

The Brunswick Steam Electric Plant ODCM was not revised in 2022. The most recent revision is 39.

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

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2022 - 12/31/2022

No changes were made to the BSEP Process Control Program (PCP) in 2022. The most recent revision is 5.

ATTACHMENT 11

Summary of Major Modifications to the Radioactive Waste Treatment Systems

This attachment includes a description of major modifications to the radioactive waste treatment systems that are anticipated to affect effluent releases.

Attachment 11
Summary of Major Modifications to the Radioactive Waste Treatment Systems

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2022 - 12/31/2022

Summary:

No major modifications to Brunswick Steam Electric Plant liquid, gaseous, solid, or mobile radioactive waste treatment systems occurred in 2022.

<u>ATTACHMENT 12</u>

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

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2022 - 12/31/2022

There are no changes to a previous year's ARERR.

ENCLOSURE 2: CNS Annual Radioactive Effluent Release Report

Catawba Nuclear Station
Units 1 and 2

Annual Radioactive Effluent Release Report

January 1, 2022 through December 31, 2022

Dockets 50-413 and 50-414

Introduction

The Annual Radioactive Effluent Release Report is pursuant to Catawba Nuclear Station Technical Specification 5.6.3 and Selected Licensee Commitment 16.11-16. The below listed attachments to this report provide the required information.

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	Offsite Dose Calculation Manual (ODCM) and Summary of Changes to the ODCM
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

Catawba Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

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	6.35E-01	6.99E-01	7.45E-01	7.13E-01	2.79E+00
2. Avg. Release Rate	μCi/sec	8.17E-02	8.89E-02	9.37E-02	8.96E-02	8.85E-02
B. Iodine-131						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Release Rate	μCi/sec	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C. Particulates Half-Life ≥ 8 days						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Release Rate	μCi/sec	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Tritium						
1. Total Release	Ci	6.23E+01	6.09E+01	5.31E+01	4.09E+01	2.17E+02
2. Avg. Release Rate	μCi/sec	8.01E+00	7.74E+00	6.68E+00	5.14E+00	6.88E+00
E. Carbon-14						
1. Total Release	Ci	5.46E+00	5.29E+00	4.83E+00	4.76E+00	2.03E+01
2. Avg. Release Rate	μCi/sec	7.03E-01	6.73E-01	6.07E-01	5.99E-01	6.45E-01
F. 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

Catawba Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

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. Carbon-14						
N/A	Ci	-	-	-	-	-
F. Gross Alpha						
N/A	Ci	-	-	-	-	-

* Catawba Nuclear Station Units 1 and 2 do not have elevated releases.

Attachment 1
Summary of Gaseous and Liquid Effluents

Catawba Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

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. Carbon-14						
N/A	Ci	-	-	-	-	-
F. Gross Alpha						
N/A	Ci	-	-	-	-	-

* Catawba Nuclear Station Units 1 and 2 do not have elevated releases.

Attachment 1
Summary of Gaseous and Liquid Effluents

Catawba Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

Gaseous Effluents - Ground Releases - Continuous Mode

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Gases						
None	Ci	-	-	-	-	-
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
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	6.22E+01	6.08E+01	5.30E+01	4.08E+01	2.17E+02
E. Carbon-14 *						
C-14	Ci	1.64E+00	1.59E+00	1.45E+00	1.43E+00	6.10E+00
F. Gross Alpha						
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

* 30% of total C-14 released is assumed to be in continuous mode. See Attachment 2, Supplemental Information, of this report.

Attachment 1
Summary of Gaseous and Liquid Effluents

Catawba Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

Gaseous Effluents - Ground Releases - Batch Mode

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Gases						
AR-41	Ci	4.90E-01	5.33E-01	5.58E-01	5.35E-01	2.12E+00
KR-85	Ci	0.00E+00	0.00E+00	1.36E-03	4.54E-04	1.81E-03
XE-133	Ci	1.34E-01	1.54E-01	1.75E-01	1.66E-01	6.29E-01
XE-135	Ci	1.14E-02	1.23E-02	1.03E-02	1.07E-02	4.48E-02
Total for Period	Ci	6.35E-01	6.99E-01	7.45E-01	7.13E-01	2.79E+00
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	6.66E-02	7.69E-02	7.67E-02	9.39E-02	3.14E-01
E. Carbon-14 *						
C-14	Ci	3.82E+00	3.71E+00	3.38E+00	3.33E+00	1.42E+01
F. Gross Alpha						
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

* 70% of total C-14 released is assumed to be in batch mode. See Attachment 2, Supplemental Information, of this report.

Attachment 1
Summary of Gaseous and Liquid Effluents

Catawba Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

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. Carbon-14						
N/A	Ci	-	-	-	-	-
F. Gross Alpha						
N/A	Ci	-	-	-	-	-

* Catawba Nuclear Station Units 1 and 2 do not have mixed-mode releases.

Attachment 1
Summary of Gaseous and Liquid Effluents

Catawba Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

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. Carbon-14						
N/A	Ci	-	-	-	-	-
F. Gross Alpha						
N/A	Ci	-	-	-	-	-

* Catawba Nuclear Station Units 1 and 2 do not have mixed-mode releases.

Attachment 1
Summary of Gaseous and Liquid Effluents

Catawba Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

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	3.46E-03	6.25E-03	8.40E-03	1.69E-02	3.50E-02
2. Avg. Diluted Conc.	µCi/ml	1.09E-10	1.77E-10	2.11E-10	6.28E-10	2.61E-10
3. Batch Releases	µCi/ml	1.09E-10	1.77E-10	2.11E-10	6.28E-10	2.61E-10
B. Tritium						
1. Total Release	Ci	1.60E+02	1.75E+02	8.41E+02	1.76E+02	1.35E+03
2. Avg. Diluted Conc.	µCi/ml	5.04E-06	4.95E-06	3.52E-05	6.54E-06	1.43E-05
3. Batch Releases	µCi/ml	5.04E-06	4.95E-06	1.96E-05	6.54E-06	9.65E-06
C. Dissolved & Entrained Gases						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Diluted Conc.	µCi/ml	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3. Batch Releases	µCi/ml	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Gross Alpha						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Diluted Conc.	µCi/ml	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3. Batch Releases	µCi/ml	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
E. Volume of Liquid Waste						
1. Continuous Releases	liters	0.00E+00	0.00E+00	6.56E+07	0.00E+00	6.56E+07
2. Batch Releases	liters	8.44E+05	1.16E+06	2.26E+06	1.27E+06	5.53E+06
F. Volume of Dilution Water						
1. Continuous Releases	liters	3.18E+09	3.54E+09	3.97E+09	2.69E+09	1.34E+10
2. Batch Releases	liters	3.18E+10	3.54E+10	3.97E+10	2.69E+10	1.34E+11

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

Attachment 1
Summary of Gaseous and Liquid Effluents

Catawba Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

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	0.00E+00	0.00E+00	6.19E+01	0.00E+00	6.19E+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

Catawba Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

Liquid Effluents - Batch Mode

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Products						
Ag-110m	Ci	3.49E-06	0.00E+00	0.00E+00	0.00E+00	3.49E-06
Bi-214	Ci	8.45E-06	7.38E-06	4.98E-05	2.01E-05	8.58E-05
Co-57	Ci	0.00E+00	0.00E+00	9.58E-06	0.00E+00	9.58E-06
Co-58	Ci	8.07E-05	8.26E-05	1.10E-03	3.85E-03	5.11E-03
Co-60	Ci	1.63E-03	3.65E-03	4.65E-03	2.61E-03	1.25E-02
Cr-51	Ci	0.00E+00	0.00E+00	1.76E-04	1.87E-03	2.04E-03
Cs-137	Ci	0.00E+00	0.00E+00	2.69E-05	3.02E-06	2.99E-05
Fe-55	Ci	2.65E-04	2.52E-04	1.04E-03	2.73E-03	4.29E-03
Fe-59	Ci	0.00E+00	0.00E+00	2.86E-05	5.12E-04	5.41E-04
Mn-54	Ci	2.48E-05	1.76E-04	2.20E-04	1.67E-04	5.87E-04
Nb-95	Ci	0.00E+00	0.00E+00	2.66E-05	1.02E-04	1.29E-04
Nb-97	Ci	4.78E-06	0.00E+00	0.00E+00	1.17E-05	1.65E-05
Ni-63	Ci	1.18E-03	1.46E-03	7.89E-04	4.67E-03	8.10E-03
Pb-214	Ci	1.40E-05	5.12E-05	1.16E-04	8.16E-05	2.63E-04
Sb-124	Ci	6.50E-06	0.00E+00	0.00E+00	0.00E+00	6.50E-06
Sb-125	Ci	2.38E-04	5.28E-04	1.53E-04	1.71E-04	1.09E-03
Sr-92	Ci	0.00E+00	0.00E+00	0.00E+00	6.01E-06	6.01E-06
Zn-65	Ci	0.00E+00	3.69E-05	1.49E-05	1.58E-05	6.76E-05
Zr-95	Ci	0.00E+00	0.00E+00	0.00E+00	5.19E-05	5.19E-05
Total for Period	Ci	3.46E-03	6.25E-03	8.40E-03	1.69E-02	3.50E-02
B. Tritium						
H-3	Ci	1.60E+02	1.75E+02	7.79E+02	1.76E+02	1.29E+03
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 2

Supplemental Information

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

Attachment 2
Supplemental Information

Catawba Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

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 $\geq$ 8 days

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

II. Maximum Permissible Effluent Concentrations

A. Gaseous Effluents

1. Information found in Offsite Dose Calculation Manual

B. Liquid Effluents

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

III. Average Energy

(not applicable)

IV. Measurements and Approximations of Total Radioactivity

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

V. Batch Releases

A. Liquid Effluents

1. Total Number of Batch Releases	=	130
2. Total Time (min) for Batch Releases	=	1.03E+04
3. Maximum Time (min) for a Batch Release	=	1.51E+03
4. Average Time (min) for Batch Releases	=	7.92E+01
5. Minimum Time (min) for a Batch Release	=	3.10E+01
6. Average Dilution Water Flow During Release (gpm)	=	6.72E+04

B. Gaseous Effluents

1. Total Number of Batch Releases	=	62
2. Total Time (min) for Batch Releases	=	1.02E+06
3. Maximum Time (min) for a Batch Release	=	4.46E+04
4. Average Time (min) for Batch Releases	=	1.64E+04
5. Minimum Time (min) for a Batch Release	=	1.01E+02

VI. Abnormal Releases

See Attachment 5, Unplanned Offsite Releases.

Carbon-14

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

In Regulatory Guide 1.21, Revision 2, “Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste”, the NRC recommends U.S. nuclear power plants evaluate whether C-14 is a "principal radionuclide", and if so, report the amount of C-14 released. Improvements over the years in effluent management practices and fuel performance have resulted in a decrease in gaseous radionuclide (non-C-14) concentrations, and a change in the distribution of gaseous radionuclides released to the environment. As a result, many sites show C-14 has become a "principal radionuclide" for the gaseous effluent pathway, as defined in Regulatory Guide 1.21, Rev. 2. Catawba Nuclear Station 2022 ARERR contains estimates of C-14 radioactivity released in 2022 and estimates of public dose resulting from the C-14 effluent.

Because the dose contribution of C-14 from liquid radioactive waste is much less than that contributed by gaseous radioactive waste, evaluation of C-14 in liquid radioactive waste is not required (Ref. Reg. Guide 1.21, Rev. 2). The quantity of gaseous C-14 released to the environment can be estimated by use of a C-14 source term scaling factor based on power generation (Ref. Reg. Guide 1.21, Rev. 2). Many documents provide information related to the magnitude of C-14 in typical effluents from commercial nuclear power plants. Those documents suggest that nominal annual releases of C-14 in gaseous effluents are approximately 5 to 7.3 curies from PWRs (Ref. Reg. Guide 1.21, Rev. 2). A more recent study recommends a higher C-14 gaseous source term scaling factor of approximately 9.0 to 9.8 Ci/GWe-yr for a PWR (Westinghouse) (Ref. EPRI 1021106). For the Catawba Nuclear Station 2022 ARERR, a source term scaling factor of 9.4 Ci/GWe-yr is assumed. Using a source term scaling factor of 9.4 Ci/GWe-yr and actual electric generation (MWe-hrs) from Catawba Nuclear Station in 2022 results in a site total C-14 gaseous release estimate to the environment of 2.03E+01 Curies. 70% of the C-14 gaseous effluent is assumed to be from batch releases and 30% of C-14 gaseous effluent is assumed to be from continuous releases through the unit vents (ref. IAEA Technical Reports Series no. 421, "Management of Waste Containing Tritium and Carbon-14", 2004).

C-14 releases in PWRs occur primarily as a mix of organic carbon and carbon dioxide released from the waste gas system. Since the PWR operates with a reducing chemistry, most, if not all, of the C-14 species initially produced are organic (e.g., methane). As a general rule, C-14 in the primary coolant is essentially all organic with a large fraction as a gaseous species. Any time the RCS liquid or gas is exposed to an oxidizing environment (e.g. during shutdown or refueling), a slow transformation from an organic to an inorganic chemical form can occur. Various studies documenting measured C-14 releases from PWRs suggest a range of 70% to 95% organic with an average of 80% organic with the remainder being CO_2 (Ref. EPRI TR-105715). For the Catawba Nuclear Station 2022 ARERR a value of 80% organic C-14 is assumed.

Public dose estimates from airborne C-14 are performed using dose models in NUREG-0133 and Regulatory Guide 1.109. The dose models and assumptions used are documented in the Catawba ODCM. The estimated C-14 dose impact on the maximum organ dose from airborne effluents released from Catawba Nuclear Station in 2022 is well below the 10CFR50, Appendix I, ALARA design objective (i.e., 15 mrem/yr per unit).

Attachment 2
Supplemental Information

Catawba Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

Overall Estimate of Error for Effluent Radioactivity Release Reported

The estimated percentage of overall error for both Liquid and Gaseous effluent release data at Catawba Nuclear Station has been determined to be ± 30.3%. This value was derived by taking the square root of the sum of the squares of the following discrete individual estimates of error:

1. Flow Rate Determining Devices = ± 20%
2. Counting Statistical Error = ± 20%
3. Calibration Error = ± 10%
4. Calibration Source Error = ± 2.5%
5. Sample Preparation Error = ± 3%

Attachment 2
Supplemental Information

Catawba Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

Summary of Changes in Land Use Census Affecting Effluent Dose Calculations

The 2022 Land Use Census was performed June 29 & 30, 2022, and the results were certified and made available for use on August 29, 2022. The following are changes to residences, gardens, and milk animals from the previous year.

Residences

The Residence in the SSE Sector (0.74 miles) was replaced with a residence at 0.80 miles.
The Residence in the SW Sector (0.63 miles) was replaced with a residence at 0.60 miles.

Gardens

The garden in the N sector (1.55 miles) was replaced with a garden at 1.33 miles.
The garden in the ENE sector (2.89 miles) was replaced with a garden at 2.80 miles.
The garden in the ESE sector (3.80 miles) was replaced with a garden at 3.72 miles.
The garden in the S sector (1.87 miles) was replaced with a garden at 1.10 miles.
The garden in the WSW sector (2.60 miles) was replaced with a garden at 2.07 miles.
The garden in the WNW sector (1.31 miles) was replaced with a garden at 1.23 miles.
The garden in the NW sector (1.75 miles) was replaced with a garden at 2.41 miles.

Milk Animals

There were new milk animals identified in the SE sector at 4.89 miles. The owners of the milk animals are not willing to participate in the REMP.

Environmental Monitoring Locations

No changes to environmental monitoring locations in each sector as a result of the census.

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 (specify whether determined by measurement or estimate)
- Principal Radionuclides
- Source and 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

Catawba Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

	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 Secondary Resins	0	-	-	-	-	-	-
	b. Dewatered Primary Resins	6	6	A / B	HIC	NA	27.72	290
	c. Evaporator Concentrates	0	-	-	-	-	-	-
	d. Dewatered Mechanical Filters	1	1	C	HIC	NA	3.41	52.6
	e. Dewatered Demineralizers	0	-	-	-	-	-	-
	f. Solidified (cement) Acids, Oils, Sludge	0	-	-	-	-	-	-
	g. ***Other (add as necessary)***	0	-	-	-	-	-	-
2.	**Dry Solid Waste**							
	a. Dry Active Waste (compacted)	0	-	-	-	-	-	-
	b. Dry Active Waste (non-compacted)	0	-	-	-	-	-	-
	c. Dry Active Waste (brokered)	7	13	A	GDP	NA	107.6	1.17
	d. Irradiated Components	0	-	-	-	-	-	-
	e. ***Other (add as necessary)***	0	-	-	-	-	-	-
3.	**Total Solid Waste**	**14**	**20**				**138.73**	**343.8**

Attachment 3
Solid Radioactive Waste Disposal

Catawba Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

Type of Waste Shipped	Radionuclide	% Abundance
1. Waste from Liquid Systems		
a. Dewatered Secondary Resins	N/A	N/A
b. Dewatered Primary Resins	H-3	0.10%
	Be-7	0.25%
	Mn-54	3.88%
	Co-57	0.16%
	Co-58	1.84%
	Co-60	20.92%
	Zn-65	0.85%
	Nb-95	0.00%
	Sn-113	0.01%
	Sb-125	0.29%
	Cs-134	0.02%
	Cs-137	0.13%
	Ce-144	0.01%
	C-14	0.20%
	Fe-55	23.37%
	Ni-59	0.28%
	Ni-63	47.69%
	Sr-90	0.00%
	Tc-99	0.00%
	Am-241	0.00%
c. Evaporator Concentrates	N/A	N/A
d. Dewatered Mechanical Filters	H-3	0.01%
	Be-7	0.07%
	Cr-51	0.56%
	Mn-54	4.90%
	Co-57	0.09%
	Co-58	8.27%
	Fe-59	0.17%
	Co-60	26.42%
	Zn-65	0.79%
	Nb-94	0.00%
	Nb-95	2.89%
	Zr-95	1.37%
	Sn-113	0.16%
	Sb-124	0.01%
	Sb-125	0.35%
	Cs-137	0.50%
	Hf-181	0.00%
	Ce-144	1.25%
	Pu-238	0.00%
	C-14	0.80%
	Fe-55	26.99%
	Ni-63	24.33%
	Sr-89	0.00%
	Sr-90	0.00%
	Tc-99	0.06%
	Sn-117m	0.00%
	Am-241	0.00%
	Pu-241	0.00%
	Cm-242	0.00%
	Cm-243	0.00%
	Cm-244	0.00%
e. Dewatered Demineralizers	N/A	N/A
f. Solidified (cement) Acids, Oils, Sludge	N/A	N/A
g. ***Other (add as necessary)***	N/A	N/A

Attachment 3
Solid Radioactive Waste Disposal

Catawba Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

2. <u>Dry Solid Waste</u>

a. Dry Active Waste (compacted)	N/A	N/A
b. Dry Active Waste (non-compacted)	N/A	N/A
c. Dry Active Waste (brokered)	H-3	0.11%
	Cr-51	15.16%
	Mn-54	2.20%
	Co-57	0.13%
	Co-58	24.78%
	Fe-59	0.78%
	Co-60	14.41%
	Zn-65	0.56%
	Nb-95	8.68%
	Zr-95	4.98%
	Sn-113	0.42%
	Sb-124	0.06%
	Sb-125	0.39%
	Cs-137	0.07%
	Ce-144	0.23%
	C-14	0.10%
	Fe-55	17.98%
	Ni-59	0.22%
	Ni-63	8.19%
	Sr-89	0.33%
	Sr-90	0.21%
	Tc-99	0.00%
	I-129	0.00%
d. Irradiated Components	N/A	N/A
e. ***Other (add as necessary)***	N/A	N/A

<u>ATTACHMENT 4</u>

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

Catawba Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

Stability Class	Wind Speed (m/s)	Hours of Occurrence															
		Sector															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
A	0.46-0.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.76-1.00	0	0	0	0	0	0	0	0	0	0	1	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	1	0	0	0	0	0	0
	1.51-2.00	1	0	0	0	0	1	1	3	2	3	9	6	3	1	2	2
	2.01-3.00	1	2	1	0	1	2	1	27	22	89	146	46	28	20	3	1
	3.01-4.00	13	7	4	0	0	1	1	7	7	41	55	17	19	10	4	2
	4.01-5.00	19	14	1	0	0	0	0	0	2	5	7	5	3	6	7	3
	5.01-6.00	5	22	0	0	0	0	0	0	0	1	1	0	0	1	2	3
	6.01-8.00	1	7	3	0	0	0	0	0	0	0	0	0	0	0	0	5
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10.01-max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B	0.46-0.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.76-1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1.01-1.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1.26-1.50	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
	1.51-2.00	2	0	0	1	0	1	1	6	5	7	7	4	3	2	1	1
	2.01-3.00	4	4	3	2	0	2	6	27	25	39	32	10	15	13	2	5
	3.01-4.00	18	16	12	0	2	1	2	1	3	10	7	7	3	3	7	4
	4.01-5.00	27	25	5	1	0	0	0	1	1	1	1	1	0	3	3	7
	5.01-6.00	4	13	2	0	0	0	0	0	0	0	1	0	0	3	1	3
	6.01-8.00	0	1	3	1	0	0	0	0	0	0	0	0	0	1	3	1
	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

Catawba Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

Stability Class	Wind Speed (m/s)	Hours of Occurrence															
		Sector															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
C	0.46-0.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.76-1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1.01-1.25	0	0	0	0	0	0	0	0	0	2	1	1	1	0	0	0
	1.26-1.50	1	0	0	0	0	1	1	1	2	1	3	1	1	0	0	2
	1.51-2.00	2	3	1	0	1	0	6	16	11	22	16	7	11	2	3	3
	2.01-3.00	19	13	8	3	4	6	7	28	22	41	26	9	12	7	8	9
	3.01-4.00	41	30	8	1	1	0	1	6	2	5	3	4	4	6	6	5
	4.01-5.00	17	23	20	0	0	0	1	0	0	2	2	0	1	2	2	3
	5.01-6.00	5	12	4	0	0	0	0	0	0	0	0	0	0	2	2	2
	6.01-8.00	0	4	4	0	0	0	0	0	0	0	0	0	0	1	1	2
	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	0	0	0	1	0	1	2	5	1	2	2	1	1	3	1	1
	0.76-1.00	2	0	4	1	0	1	2	7	14	16	12	13	7	3	2	1
	1.01-1.25	4	0	1	0	4	2	7	23	22	28	27	17	20	18	8	5
	1.26-1.50	9	5	4	4	3	4	10	23	48	93	43	23	17	19	13	18
	1.51-2.00	41	20	10	8	6	5	22	53	138	104	76	30	19	34	28	34
	2.01-3.00	177	73	38	27	9	13	19	68	129	94	68	27	17	27	24	73
	3.01-4.00	164	158	90	11	2	1	12	21	30	29	21	14	4	11	18	42
	4.01-5.00	76	129	100	11	1	0	2	7	21	10	3	0	1	8	8	19
	5.01-6.00	26	42	26	3	0	0	3	1	4	1	1	1	0	3	8	5
	6.01-8.00	6	18	6	0	0	0	0	0	1	0	0	0	0	0	4	2
	8.01-10.00	3	3	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

Catawba Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

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	2	0	0	0	0	0	0	2	4	12	6	7	7	4	1	1
	0.76-1.00	1	0	0	0	0	0	1	2	25	57	52	30	24	17	7	5
	1.01-1.25	1	0	0	0	0	3	0	11	54	65	47	33	21	11	12	7
	1.26-1.50	3	3	0	1	1	2	1	22	83	99	40	29	23	25	25	21
	1.51-2.00	23	2	2	2	3	2	9	36	111	54	29	18	20	32	37	68
	2.01-3.00	115	13	12	1	4	2	13	24	58	25	12	11	11	19	37	87
	3.01-4.00	43	7	2	6	2	0	6	5	19	2	6	5	0	0	11	23
	4.01-5.00	5	5	14	1	2	2	2	3	6	1	1	1	0	0	5	1
	5.01-6.00	1	1	2	1	2	0	0	0	0	0	0	2	0	0	0	1
	6.01-8.00	2	0	2	2	0	1	0	0	0	0	0	0	0	0	0	0
	8.01-10.00	6	3	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	0	0	0	0	0	1	0	0	6	5	7	8	5	5	4	1
	0.76-1.00	0	0	0	1	0	1	1	1	11	40	26	15	14	10	7	4
	1.01-1.25	0	0	0	0	0	0	1	3	29	30	15	17	10	7	12	11
	1.26-1.50	3	0	0	0	1	0	0	8	35	23	13	15	14	13	14	31
	1.51-2.00	18	0	0	0	0	0	2	8	11	4	6	8	11	8	13	55
	2.01-3.00	47	2	1	0	0	0	3	8	0	0	1	0	2	3	8	38
	3.01-4.00	3	4	0	0	0	0	1	3	0	0	0	1	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

Catawba Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

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	0	0	0	0	0	0	0	0	0	8	9	16	13	13	6	1
	0.76-1.00	0	0	0	0	0	0	0	3	19	24	26	23	17	13	23	4
	1.01-1.25	1	0	0	0	0	0	0	1	23	27	29	11	9	18	14	22
	1.26-1.50	3	0	0	0	0	0	0	0	14	20	22	8	5	1	19	27
	1.51-2.00	13	0	0	0	0	0	0	2	3	0	10	6	10	1	3	22
	2.01-3.00	12	0	0	0	0	0	0	0	0	0	0	5	5	0	1	9
	3.01-4.00	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	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

Catawba Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

Catawba Nuclear Station had no unplanned liquid releases in 2022.

Catawba Nuclear Station had no unplanned gaseous releases in 2022.

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

Catawba Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

Gaseous Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Noble Gases						
1. Maximum Gamma Air	mRAD	5.15E-03	5.60E-03	5.87E-03	5.63E-03	2.22E-02
(a) Limit	mRAD	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
(b) % of Limit		5.15E-02	5.60E-02	5.87E-02	5.63E-02	1.11E-01
Receptor Location	***0.5*** miles	***NNE***	***NNE***	***NNE***	***NNE***	***NNE***
2. Maximum Beta Air	mRAD	1.98E-03	2.16E-03	2.27E-03	2.18E-03	8.59E-03
(a) Limit	mRAD	2.00E+01	2.00E+01	2.00E+01	2.00E+01	4.00E+01
(b) % of Limit		9.89E-03	1.08E-02	1.14E-02	1.09E-02	2.15E-02
Receptor Location	***0.5*** miles	***NNE***	***NNE***	***NNE***	***NNE***	***NNE***
B. Iodine, H-3, & Particulates						
1. Maximum Organ Dose	mREM	1.28E+00	1.24E+00	1.13E+00	1.12E+00	4.78E+00
(a) Limit	mREM	1.50E+01	1.50E+01	1.50E+01	1.50E+01	3.00E+01
(b) % of Limit		8.55E+00	8.29E+00	7.56E+00	7.45E+00	1.59E+01
Receptor Location	***0.5*** miles	***NE***	***NE***	***NE***	***NE***	***NE***
Critical Age		***CHILD***	***CHILD***	***CHILD***	***CHILD***	***CHILD***
Critical Organ		***BONE***	***BONE***	***BONE***	***BONE***	***BONE***
Critical Pathway		***VEGETA-TION***	***VEGETA-TION***	***VEGETA-TION***	***VEGETA-TION***	***VEGETA-TION***

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

Catawba Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Batch Mode						
1. Maximum Organ Dose	mREM	1.48E-02	1.51E-02	5.87E-02	3.12E-02	1.18E-01
(a) Limit	mREM	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
(b) % of Limit		1.48E-01	1.51E-01	5.87E-01	3.12E-01	5.89E-01
Critical Age		***CHILD***	***CHILD***	***CHILD***	***ADULT***	***CHILD***
Critical Organ		***LIVER***	***LIVER***	***LIVER***	***GI-LLI***	***GI-LLI***
Critical Pathway		***POTABLE WATER***	***POTABLE WATER***	***POTABLE WATER***	***FRESH WATER FISH SPORT***	***POTABLE WATER***
2. Maximum Total Body Dose	mREM	1.48E-02	1.50E-02	5.81E-02	2.04E-02	1.15E-01
(a) Limit	mREM	3.00E+00	3.00E+00	3.00E+00	3.00E+00	6.00E+00
(b) % of Limit		4.93E-01	5.00E-01	1.94E+00	6.80E-01	1.92E+00
Critical Age		***CHILD***	***CHILD***	***CHILD***	***CHILD***	***CHILD***
Critical Pathway		***POTABLE WATER***	***POTABLE WATER***	***POTABLE WATER***	***POTABLE WATER***	***POTABLE WATER***
B. Continuous Mode						
1. Maximum Organ Dose	mREM	0.00E+00	0.00E+00	4.48E-02	0.00E+00	5.34E-02
(a) Limit	mREM	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
(b) % of Limit		0.00E+00	0.00E+00	4.48E-01	0.00E+00	2.67E-01
Critical Age		***N/A***	***N/A***	***CHILD***	***N/A***	***CHILD***
Critical Organ		***N/A***	***N/A***	***LIVER***	***N/A***	***LIVER***
Critical Pathway		***N/A***	***N/A***	***POTABLE WATER***	***N/A***	***POTABLE WATER***
2. Maximum Total Body Dose	mREM	0.00E+00	0.00E+00	4.48E-02	0.00E+00	5.34E-02
(a) Limit	mREM	3.00E+00	3.00E+00	3.00E+00	3.00E+00	6.00E+00
(b) % of Limit		0.00E+00	0.00E+00	1.49E+00	0.00E+00	8.90E-01
Critical Age		***N/A***	***N/A***	***CHILD***	***N/A***	***CHILD***
Critical Pathway		***N/A***	***N/A***	***POTABLE WATER***	***N/A***	***POTABLE WATER***

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

Catawba Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

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 Catawba Nuclear Station includes liquid and gaseous effluent dose contributions from Catawba Nuclear Station and direct and air-scatter dose from the onsite ISFSI. No other uranium fuel cycle facility contributes significantly to the maximum exposed individual. Included in the gaseous effluent dose calculations is an estimate of the dose contributed by Carbon-14 (Ref. Attachment 2, Supplemental Information, of this report for further information). The combined dose to a maximum exposed individual from effluent releases and direct and air-scatter dose from the ISFSI is below 40 CFR Part 190 limits as shown by the following summary.

Note: The 40 CFR Part 190 effluent dose analysis to the maximum exposed individual from liquid and gas releases includes the dose from noble gases (i.e., total body and skin).

40 CFR Part 190 Effluent Dose Summary

A. Maximum Organ Dose (other than TB)	4.803E+00 mrem
1. Location	0.5 miles NE
2. Critical Age	Child
3. Critical Organ	Bone
4. Gas Contribution %	99.444%
5. Liquid Contribution %	0.556%
B. Maximum Total Body Dose	2.113E+00 mrem
1. Location	0.5 miles NE
2. Critical Age	Child
3. Gas non-NG Contribution %	93.728%
4. Gas NG Contribution %	0.833%
5. Liquid Contribution %	5.439%

Direct and air-scatter radiation dose contributions from the onsite ISFSI have been determined from the 10 CFR 72.212 Evaluation Report, MAGNASTOR®, Revision 4.

The attached excerpt from the 10 CFR 72.212 Evaluation Report, MAGNASTOR®, Revision 4 is provided to document the method used to calculate the dose from ISFSI as less than 15.2 mrem/yr to the nearest real individual.

Total dose from liquid and gaseous effluents from Catawba Nuclear Station and direct and air-scatter dose from the onsite ISFSI is estimated to be less than 9 mrem/yr to the nearest real individual. This meets the 40 CFR Part 190 requirements of an annual dose commitment to any member of the general public of less than 25 mrem total body or any organ and 75 mrem to the thyroid.

10 CFR 72.212 Evaluation Report, MAGNASTOR®, Revision 4

6.0 10 CFR 72.212(b)(5)(iii) - Radioactive Materials in Effluents and Direct Radiation

6.1 Purpose

10 CFR 72.212(b)(5)(iii) requires the general licensee to perform written evaluations, before use and before applying the changes authorized by an amended CoC to a cask loaded under the initial CoC or an earlier amended CoC, that establish that the requirements of 10 CFR 72.104 have been met. A copy of this record shall be retained until spent fuel is no longer stored under the general license issued under 10 CFR 72.210.

10 CFR 72.104 provides the regulatory criteria for radioactive materials in effluents and direct radiation from an ISFSI during normal operation and anticipated occurrences. Specifically, 10 CFR 72.104(a) limits the annual dose equivalent to any real individual who is located beyond the controlled area to 25 mrem to the whole body, 75 mrem to the thyroid, and 25 mrem to any other critical organ. This dose equivalent must include contributions from (1) planned discharges of radioactive materials (radon and its decay products excepted) to the general environment, (2) direct radiation from ISFSI operations, and (3) any other radiation from uranium fuel cycle operations within the region. In addition, 10 CFR 72.104(b) requires that operational restrictions be established to meet As Low As is Reasonably Achievable (ALARA) objectives for radioactive materials in effluents and direct radiation levels associated with ISFSI operations. Also, 10 CFR 72.104(c) requires that operational limits be established for radioactive materials in effluents and direct radiation levels associated with ISFSI operations to meet the above-mentioned dose limits.

This section provides the written evaluation required by 10 CFR 72.212(b)(5)(iii), demonstrating Duke Energy's compliance with the requirements of 10 CFR 72.104 for the CNS ISFSI.

6.2 Evaluation

This evaluation addresses the radiological dose rate from a composite population of all CNS ISFSI cask types.

6.2.1 §72.104(a) - Dose Limits

Duke Energy Calculation DPC-1229.00-00-0011, "Distance Measurements from ISFSI to Nearest Residents" determined that the nearest residence to the ISFSI is 0.35 miles (563.27 meters).

Within the quadrant that contains the residences closest to the ISFSI (NE), dose rate data from Revision 1 of calculation CNC1229.00-00-0061, "UMS Cask Array Dose Analysis for Duke Catawba (NAC International Calculation 12418-5004)" show a maximum annual total dose (gamma plus neutron) - at a distance of 535 meters from a 2x12 array of NAC-UMS® casks - to be approximately 3.2 mrem. The as-loaded evaluation was based on full cask loads of 24 fuel assemblies (45 GWd/MTU, 3.1 wt% U 235, and 27.6 years cooling) with burnable poison (BP) non-fuel inserts (28 GWd burnup and 17 years cooling). The cask decay heat load was conservatively assumed to be 20 kW. The distance at which this dose was calculated (535 meters) is conservative compared to the distance to the closest real individual.

Within the quadrant that contains the residences closest to the ISFSI (NE), dose rate data from Revision 2 of calculation CNC1229.00-00-0067, "MAGNASTOR Cask Array Dose Analysis for Duke Catawba (NAC Calculation 12418-5006)" show a maximum annual total dose (gamma plus neutron) - at a distance of 535 meters from both a 2x12 and a 2x6 array of MAGNASTOR® casks - to be approximately 7.0 mrem. The evaluation was conservatively based on full cask loads of 37 bounding fuel assemblies at a decay heat load of 35.5 kW. The distance at which this dose is calculated (535 meters) is conservative compared to the distance to the closest real individual.

The total calculated annual public dose from liquid and gaseous effluent pathways reviewed over the past 10 years is bounded by 5 mrem. No other uranium fuel cycle facility contributes significantly to the dose received by the closest real individual.

Based on the above, the calculated annual dose to the closest real individual due to the ISFSI, which is comprised of the currently existing 24 NAC-UMS® casks (Pad 1), one 2x12 array of MAGNASTOR® casks (Pad 2), and up to one 2x6 array of MAGNASTOR casks (Pad 3) is determined to be less than 10.2 mrem, and the estimated annual dose due to Catawba power generation is less than 5 mrem. Hence, the total annual dose to the closest real individual (less than 15.2 mrem) is within the 10 CFR 72.104(a) limit

The 2022 Land Use Census nearest actual residence is 0.56 miles (901 m NE) from Catawba. The estimated doses for a 2 x 12 array of NAC-UMS casks at 535 m, 2 x 12 array of MAGNASTOR casks at 535 m, and a 2x6 array of MAGNASTOR casks at 550 m can be reasonably approximated as point sources (distance from the ISFSI is much greater than the size of the ISFSI) to determine a dose of 3.596 mrem direct radiation dose at the nearest resident distance of 901 m. Combined with the dose from effluents, maximum organ dose from Catawba is 8.399 mrem and maximum total body dose is 5.709 mrem, which are below the dose limits of 40 CFR 190.

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

Catawba Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

Duke Energy implemented a Ground Water Protection program in 2007. This initiative was developed to ensure timely and effective management of situations involving inadvertent releases of licensed material to ground water. As part of this program, Catawba Nuclear Station monitored 49 wells and 1 outfall from the Conventional Wastewater Treatment Ponds in 2022.

Wells are typically sampled quarterly or semi-annually. Ground water samples are regularly analyzed for tritium and gamma emitters, with select wells being analyzed for difficult-to-detect radionuclides. Results from sampling during 2022 confirmed existing knowledge of tritium concentrations in site ground water.

One well sample identified a non-naturally occurring gamma emitter during 2021. Well LMW-3A (CNS Landfill) was collected 12/20/2021 and submitted to General Engineering Laboratories (GEL) in Charleston, South Carolina for analysis. The sample analysis identified 12.8 ± 1.52 pCi/L (2-sigma error) Cs-137. A reanalysis of the sample was performed on 01/10/2022 with Cs-137 activity of 12.5 ± 2.46 pCi/L. The well was resampled 01/10/2022 and all nuclides were below Minimum Detectable Activity (MDA). Sampling changed to monthly instead of quarterly. Sample collected on 03/01/2022 was also less than MDA for all gamma emitters.

Tritium results from sampling during 2022 are shown in the table below.

No events meeting the criteria for voluntary notification per NEI 07-07, Industry Ground Water Protection Initiative, occurred at Catawba Nuclear Station in 2022.

Key to below table.

NS	-	Not scheduled to be sampled, not sampled due to insufficient volume in well, or well inaccessible during outage.
pCi/l	-	picocuries per liter.
< MDA	-	less than minimum detectable activity, typically 250 ρCi/l.
20,000 pCi/l	-	the Environmental Protection Agency drinking water standard for tritium. This standard applies only to water used for drinking.
1,000,000 pCi/l	-	the 10 CFR Part 20, Appendix B, Table 2, Column 2, Effluent Concentration Limit for tritium.

Attachment 7
Information to Support the NEI Ground Water Protection Initiative

Catawba Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

Well Name	Location / Description	Tritium Concentration (pCi/l) 1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	# of Samples
C-100DR	CNS GWPI / C-100DR / U-1 SFP	2.09E+02	<MDA	<MDA	2.21E+02	4
C-101DR	CNS GWPI / C-101DR / U-1 SFP	2.73E+02	2.54E+02	3.13E+02	3.65E+02	4
C-101R	CNS GWPI / C-101R / U-1 SFP	7.91E+02	3.97E+02	4.77E+02	6.10E+02	4
C-102	CNS GWPI / C-102 / E of U1 SFP O/S protected area	<MDA	NS	<MDA	NS	2
C-103	CNS GWPI / C-103 / E of U1 SFP @ Cooling Towers	<MDA	NS	<MDA	NS	2
C-104	CNS GWPI / C-104 / U-1 RMWST	4.91E+02	3.13E+02	3.85E+02	6.52E+02	4
C-105	CNS GWPI / C-105 / Engr. Bldg.	3.00E+02	3.14E+02	1.75E+03	3.32E+02 2.86E+02	5
C-105R	CNS GWPI / C-105R / Engr. Bldg.	4.31E+02	NS	NS	NS	1
C-106	CNS GWPI / C-106 / W Parking Lot	<MDA	NS	<MDA	NS	2
C-106R	CNS GWPI / C-106R / W Parking Lot	<MDA	NS	<MDA	NS	2
C-107	CNS GWPI / C-107 / MET Tower Hill	5.92E+02	5.61E+02	5.23E+02	4.95E+02	4
C-108	CNS GWPI / C-108 /	7.85E+02	NS	<MDA	NS	2
C-109	CNS GWPI / C-109 /	5.86E+02	NS	2.18E+03	1.85E+03 1.64E+03	4
C-110	CNS GWPI / C-110 /	1.30E+03	1.45E+03	1.15E+03	1.18E+03	4
C-200DR	CNS GWPI / C-200DR / U-2 SFP	4.74E+02	4.34E+02	NS	4.95E+02 4.49E+02	4
C-200R	CNS GWPI / C-200R / U-2 SFP	5.73E+02	5.12E+02	NS	4.98E+02 5.14E+02	4
C-201DR	CNS GWPI / C-201DR / U-2 SFP	5.62E+02	3.63E+02	NS	4.15E+02 4.81E+02	4
C-201R	CNS GWPI / C-201R / U-2 SFP	1.03E+03	1.09E+03	NS	1.97E+03 1.88E+03	4
C-202	CNS GWPI / C-202 / S of RMC Tent	6.52E+02	NS	NS	6.32E+02	2
C-203	CNS GWPI / C-203 / E of RMC Tent @ Cooling Towers	3.30E+02	NS	3.33E+02	NS	2
C-204	CNS GWPI / C-204 / S of RMC Tent	4.46E+02	NS	4.26E+02	NS	2
C-205	CNS GWPI / C-205 / Adm. Parking	<MDA	<MDA	<MDA	<MDA	4
C-205R	CNS GWPI / C-205R / Adm. Parking	<MDA	<MDA	<MDA	<MDA	4
C-206	CNS GWPI / C-206 / W Parking Lot	<MDA	NS	<MDA	NS	2
C-207	CNS GWPI / C-207 / Mon. Tank B	2.07E+02	<MDA	3.17E+02	3.31E+02	4
C-207R	CNS GWPI / C-207R / Mon. Tank B	<MDA	<MDA	<MDA	<MDA	4
C-208	CNS GWPI / C-208 / N of MTB	<MDA	NS	4.50E+02	NS	2
C-209	CNS GWPI / C-209 / MTUville S of light pole 23A	<MDA	2.49E+02	<MDA	<MDA	4
C-210	CNS GWPI / C-210 / N of U2 Mech Equip Bldg	<MDA	NS	3.05E+02	NS	2

Attachment 7
Information to Support the NEI Ground Water Protection Initiative

Catawba Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

Well Name	Location / Description	Tritium Concentration (pCi/l) 1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	# of Samples
C-211	CNS GWPI / C-211 / W of RL Intake O/S Protected Area	9.80E+02	NS	7.52E+02	NS	2
C-212	CNS GWPI / C-212 / Behind Aquatic Center	<MDA	<MDA	<MDA	<MDA	4
C-213	CNS GWPI / C-213 / Mon. Tank B	2.98E+03	3.31E+03	2.30E+03	2.87E+03	4
C-213R	CNS GWPI / C-213R / Mon. Tank B	<MDA	2.51E+02	<MDA	<MDA	4
C-214	CNS GWPI / C-214 / N of U2 TB	5.01E+02	6.80E+02	5.74E+02	7.82E+02	4
C-215	CNS GWPI / C-215 / N of U2 TB	3.60E+02	4.27E+02	3.94E+02	4.39E+02	4
C-217	CNS GWPI / C-217 / N of U2 TB	4.92E+02	NS	4.84E+02	NS	2
C-218	CNS GWPI / C-218 / N of U2 TB	3.72E+02	3.17E+02	3.12E+02	5.50E+02	4
C-220	CNS GWPI / C-220 / N of U2 TB	6.80E+02	7.89E+02	6.71E+02	9.05E+02	4
C-221	CNS GWPI / C-221 / N of U2 TB	3.51E+02	5.04E+02	2.63E+02	4.02E+02	4
LMW-1B	CNS Landfill / LMW-1B / Landfill	NS	2.10E+02	NS	<MDA	2
LMW-2A	CNS Landfill / LMW-2A / Landfill	NS	<MDA	NS	<MDA	2
LMW-3A	CNS Landfill / LMW-3A / Landfill	<MDA <MDA	<MDA <MDA <MDA	NS	<MDA	6
LMW-4	CNS Landfill / LMW-4 / Landfill	NS	2.72E+02	NS	<MDA	2
LMW-5D	CNS Landfill / LMW-5D / Landfill	NS	<MDA	NS	<MDA	2
LMW-5S	CNS Landfill / LMW-5S / Landfill	NS	<MDA	NS	<MDA	2
OUTFALL 017	CNS WC Ponds / OUTFALL-017 / WC Ponds	5.65E+02	2.05E+03	1.54E+03	7.42E+02	4
WCMW-2	CNS WC Ponds / WCMW-2 / WC Ponds	2.30E+03	2.12E+03	3.00E+03	2.85E+03	4
WCMW-3	CNS WC Ponds / WCMW-3 / WC Ponds	1.13E+03	1.25E+03	1.27E+03	1.18E+03	4
WCMW-4	CNS WC Ponds / WCMW-4 / WC Ponds	2.47E+02	3.41E+02	3.20E+02	4.65E+02	4
WCMW-5	CNS WC Ponds / WCMW-5 / WC Ponds	<MDA	<MDA	<MDA	<MDA	4

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

Catawba Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

Catawba Nuclear Station had two instances of any inoperable equipment relevant to effluent monitoring in excess of SLC 16.11 limits during 2022. Details are discussed below.

Catawba Nuclear Station did not experience any temporary unprotected outside liquid storage tanks exceeding 10 Curies total activity (excluding tritium and dissolved or entrained noble gases) during 2022.

SLC # from Table 16.11-2	Title	Completion Time	Determination and Data Reviewed
1.a	RL Min Flow Interlock	30 days	For RL Min Flow Interlock, out of service time for 2022 was 48.97 days (3/1/2022 12:28:00 PM to 4/19/2022 11:41:00 AM) LCOTR A-0-22-00274. NCR's: 02418362, 02422148. WR's: 20529894, 20209952

Description: The Low-Pressure Service Water Minimum Flow Interlock was declared Non-Functional on 03/01/22 at 1228 due to erratic instrumentation with low RL discharge flows to Lake Wylie.

WR 20209952 (0RLP5080 controller in control room indicating erratic flow) was generated on 09/22/2021 due to RL flow controller 0RLP5080 indicating erratic flow, swinging between approximately 50000 gpm and 25000 gpm, with the indicated flow oscillation occurring every few minutes. This WR was closed to WO 20525111 on 3/9/2022 02:50.

WR 20222590 (0RL LP 5080/5930: DISCHARGE FLOW SPIKES AT LOW FLOW LEVEL) was generated on 3/22/2022 11:29 to address this spike in the EL discharge flow at low flow level which brought the Interlock to Non-Functional status. This WR was closed to WO 2059894 on 4/13/2022 13:40.

NCR 02418362 (RL Discharge Header OAC Indication Anomalies) was generated after investigation into the issue for erratic indications it was discovered that the current wiring configuration did not allow for a correct indication for the A & B RL discharge flows on the OAC.

NCR 02422148 (RL Minimum Flow Interlock Non-Functional >30 days,) was generated to explain why the non-functionality was not corrected within the specified completion time. Per SLC 16.11-2 (Radioactive Liquid Effluent Monitoring Instrumentation), Condition G must be entered when the RL Minimum Flow Interlock is Non-Functional for >30 days. As stated in the communication assigned for this report, the item was reviewed during the Operational Focus Meeting each day as an "Action Statement in Effect" assigned to MNT but was not appropriately elevated to an Operational Focus Item (OFI) or Emergent Plant Problem, despite there being subtle signs that the task was not on track to completion. It wasn't until four days remained that we made this an OFI, which was too late to ensure timely resolution.

Attachment 8
Inoperable Equipment

Catawba Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

SLC # from Table 16.11-2	Title	Completion Time	Determination and Data Reviewed
2.a 3.b	0WCME5450 0WCLP5110	30 days	For 0WCME5450 (Discharge flow) and 0WCLP5110 (Discharge sample), out of service time for 2022 was 47.16 days (06/12/2022 00:00:00 to 07/29/2022 03:44:00) LCOTR A-0-22-00733. NCR: 02430755. WO's: 20501064, 20539403.

Description: During performance of WO 20501064: 0WC FT 5110: CHANNEL CAL WC EFFLUENT LINE FLOW LOOP, the indications for 0WCP5110 and 0WCCR5110 did not work, and the acceptance criteria for IP/0/B/3090/006 was not met. WR 20227130 was written for 0WCP5110 and 0WCCR5110 not working. It was found during WO 20539403-01 that 0WCFT5110 would not output more than 6mA with 100% input supplied. and would need to be replaced. WO 20539403-02 states that replacement of 0WCFT5110 was performed on 7/18/22 17:29, allowing for the components to be brought back to operable status on 7/29/22 at 03:44.

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
Offsite Dose Calculation Manual (ODCM) and Summary of Changes to the ODCM

Catawba Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

ODCM Revision 64

ODCM Revision 64 was approved by the Radiation Protection Manager on 12/30/2020. No revisions to the ODCM were approved during 2022.

Radiological Effluent Controls (SLC 16.11)

The Catawba Nuclear Station Radiological Effluent Controls are contained in SLC 16.11 shown in this section.

There were five revisions to the Catawba Nuclear Station Updated Final Safety Analysis Report, Section 16.11, Radiological Controls, in 2022:

- SLC 16.11-2, Radioactive Liquid Effluent Monitoring Instrumentation, Rev. 7, was implemented on 01/27/2022. This revision changes the Frequency for Test TR 16.11-2-6 from 9 months to 18 months.
- SLC 16.11-2, Radioactive Liquid Effluent Monitoring Instrumentation, Rev. 8, was implemented on 05/03/2022. This revision clarifies the applicability of 16.11-2 Conditions A - E. Note 1 has been amended to Table 16.11-2-1, stating, when applicable, that certain conditions are applicable “unless effluent pathway is mechanically isolated such that a release to the environment is not possible.”
- SLC 16.11-2, Radioactive Liquid Effluent Monitoring Instrumentation, Rev. 9, was implemented on 07/07/2022. Note 2 has been amended to Table 16.11-2, which further clarifies the applicability criteria for Conditions D and E. Rev. 9 also amends the Bases section with further clarification regarding Note 1 of Table 16.11-2-1.
- SLC 16.11-7, Radioactive Gaseous Effluent Monitoring Instrumentation, Rev. 13, was implemented on 01/27/2022. This revision changes the Frequency for Test TR 16.11-7-7 from 9 months to 18 months.
- SLC 16.11-7, Radioactive Gaseous Effluent Monitoring Instrumentation, Rev. 14, was implemented on 05/03/2022. Notes 3 and 4 have been amended to Table 16.11-7-1, providing clarification on the applicability of referenced modes. Rev. 14 also amends the Bases section with further clarification regarding Note 3 of Table 16.11-7-1.

As per TS 5.5.5.b, "Licensee initiated changes to the Radiological Effluent Controls of the UFSAR," Catawba is attaching the entire Section 16.11 of the UFSAR and the List of Effective Sections (LOES) which will demonstrate when each section was revised. Revisions 103 - 114 of the LOES are included as they include all changes approved in 2022.

LIST OF EFFECTIVE SECTIONS

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TABLE OF CONTENTS	15	05/10/16
16.1	1	08/27/08
16.2	2	08/21/09
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16.5-1	7	03/30/21
16.5-2	Deleted	
16.5-3	2	09/19/19
16.5-4	1	01/27/22
16.5-5	1	01/28/10
16.5-6	1	08/21/09
16.5-7	2	02/06/15
16.5-8	Deleted	
16.5-9	Deleted	03/02/21
16.5-10	Deleted	
16.6-1	0	10/09/02
16.6-2	Deleted	
16.6-3	2	01/27/22
16.6-4	2	11/21/19
16.6-5	3	07/07/20
16.7-1	1	08/21/09
16.7-2	4	02/03/11
16.7-3	5	11/21/19
16.7-4	2	08/21/09
16.7-5	5	04/20/21

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16.7-6	3	06/10/16
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16.7-8	2	08/21/09
16.7-9	13	09/14/21
16.7-10	10	01/27/22
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16.7-13	3	06/10/16
16.7-14	1	08/21/09
16.7-15	2	01/27/22
16.7-16	0	06/08/09
16.7-17	0	02/10/15
16.7-18	0	05/10/16
16.8-1	8	01/27/22
16.8-2	3	12/18/19
16.8-3	1	10/24/06
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16.9-1	10	01/29/19
16.9-2	6	08/03/17
16.9-3	5	07/03/18
16.9-4	5	09/11/17
16.9-5	11	10/08/19
16.9-6	12	07/03/18

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16.9-7	4	08/21/09
16.9-8	5	08/21/09
16.9-9	3	08/21/09
16.9-10	5	08/21/09
16.9-11	3	08/21/09
16.9-12	3	02/10/15
16.9-13	4	09/27/16
16.9-14	1	09/25/06
16.9-15	2	08/21/09
16.9-16	2	08/21/09
16.9-17	0	10/09/02
16.9-18	Deleted	
16.9-19	3	02/20/12
16.9-20	0	10/09/02
16.9-21	1	10/13/16
16.9-22	1	08/21/09
16.9-23	5	08/03/17
16.9-24	2	10/24/06
16.9-25	2	08/21/09
16.9-26	1	11/15/18
16.10-1	1	08/21/09
16.10-2	1	10/24/06
16.10-3	1	08/21/09
16.10-4	0	08/04/20

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16.11-2	7	01/27/22
16.11-3	0	10/09/02
16.11-4	1	08/21/09
16.11-5	0	10/09/02
16.11-6	3	08/03/15
16.11-7	13	01/27/22
16.11-8	0	10/09/02
16.11-9	0	10/09/02
16.11-10	1	08/21/09
16.11-11	1	03/20/03
16.11-12	0	10/09/02
16.11-13	1	07/27/13
16.11-14	0	10/09/02
16.11-15	0	10/09/02
16.11-16	1	10/24/11
16.11-17	0	10/09/02
16.11-18	1	08/21/09
16.11-19	0	10/09/02
16.11-20	3	11/21/19
16.11-21	0	10/09/02
16.12-1	0	10/09/02
16.13-1	1	08/03/17
16.13-2	Deleted	

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SECTION	REVISION NUMBER	REVISION DATE
16.13-3	Deleted	
16.13-4	4	10/04/21

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16.3	1	08/21/09
16.5-1	7	03/30/21
16.5-2	Deleted	
16.5-3	2	09/19/19
16.5-4	1	01/27/22
16.5-5	1	01/28/10
16.5-6	2	02/16/22
16.5-7	2	02/06/15
16.5-8	Deleted	
16.5-9	Deleted	03/02/21
16.5-10	Deleted	
16.6-1	0	10/09/02
16.6-2	Deleted	
16.6-3	2	01/27/22
16.6-4	2	11/21/19
16.6-5	3	07/07/20
16.7-1	1	08/21/09
16.7-2	4	02/03/11
16.7-3	5	11/21/19
16.7-4	2	08/21/09
16.7-5	5	04/20/21

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16.7-7	1	08/21/09
16.7-8	2	08/21/09
16.7-9	13	09/14/21
16.7-10	10	01/27/22
16.7-11	1	08/21/09
16.7-12	1	08/21/09
16.7-13	3	06/10/16
16.7-14	1	08/21/09
16.7-15	2	01/27/22
16.7-16	0	06/08/09
16.7-17	0	02/10/15
16.7-18	0	05/10/16
16.8-1	8	01/27/22
16.8-2	3	12/18/19
16.8-3	1	10/24/06
16.8-4	2	11/05/07
16.8-5	3	08/21/09
16.9-1	10	01/29/19
16.9-2	6	08/03/17
16.9-3	5	07/03/18
16.9-4	5	09/11/17
16.9-5	11	10/08/19
16.9-6	12	07/03/18

SECTION	REVISION NUMBER	REVISION DATE
16.9-7	4	08/21/09
16.9-8	5	08/21/09
16.9-9	3	08/21/09
16.9-10	5	08/21/09
16.9-11	3	08/21/09
16.9-12	3	02/10/15
16.9-13	4	09/27/16
16.9-14	1	09/25/06
16.9-15	2	08/21/09
16.9-16	2	08/21/09
16.9-17	0	10/09/02
16.9-18	Deleted	
16.9-19	3	02/20/12
16.9-20	0	10/09/02
16.9-21	1	10/13/16
16.9-22	1	08/21/09
16.9-23	5	08/03/17
16.9-24	2	10/24/06
16.9-25	2	08/21/09
16.9-26	1	11/15/18
16.10-1	1	08/21/09
16.10-2	1	10/24/06
16.10-3	1	08/21/09
16.10-4	0	08/04/20

SECTION	REVISION NUMBER	REVISION DATE
16.10-5	1	03/16/21
16.11-1	1	07/27/13
16.11-2	7	01/27/22
16.11-3	0	10/09/02
16.11-4	1	08/21/09
16.11-5	0	10/09/02
16.11-6	3	08/03/15
16.11-7	13	01/27/22
16.11-8	0	10/09/02
16.11-9	0	10/09/02
16.11-10	1	08/21/09
16.11-11	1	03/20/03
16.11-12	0	10/09/02
16.11-13	1	07/27/13
16.11-14	0	10/09/02
16.11-15	0	10/09/02
16.11-16	1	10/24/11
16.11-17	0	10/09/02
16.11-18	1	08/21/09
16.11-19	0	10/09/02
16.11-20	3	11/21/19
16.11-21	0	10/09/02
16.12-1	0	10/09/02
16.13-1	1	08/03/17
16.13-2	Deleted	

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16.5-1	7	03/30/21
16.5-2	Deleted	
16.5-3	2	09/19/19
16.5-4	1	01/27/22
16.5-5	1	01/28/10
16.5-6	2	02/16/22
16.5-7	2	02/06/15
16.5-8	Deleted	
16.5-9	Deleted	03/02/21
16.5-10	Deleted	
16.6-1	0	10/09/02
16.6-2	Deleted	
16.6-3	2	01/27/22
16.6-4	2	11/21/19
16.6-5	3	07/07/20
16.7-1	1	08/21/09
16.7-2	4	02/03/11
16.7-3	5	11/21/19
16.7-4	2	08/21/09
16.7-5	6	03/29/22

LIST OF EFFECTIVE SECTIONS

SECTION	REVISION NUMBER	REVISION DATE
16.7-6	3	06/10/16
16.7-7	1	08/21/09
16.7-8	2	08/21/09
16.7-9	13	09/14/21
16.7-10	10	01/27/22
16.7-11	1	08/21/09
16.7-12	1	08/21/09
16.7-13	3	06/10/16
16.7-14	1	08/21/09
16.7-15	2	01/27/22
16.7-16	0	06/08/09
16.7-17	0	02/10/15
16.7-18	0	05/10/16
16.8-1	8	01/27/22
16.8-2	3	12/18/19
16.8-3	1	10/24/06
16.8-4	2	11/05/07
16.8-5	3	08/21/09
16.9-1	10	01/29/19
16.9-2	6	08/03/17
16.9-3	5	07/03/18
16.9-4	5	09/11/17
16.9-5	11	10/08/19
16.9-6	12	07/03/18

LIST OF EFFECTIVE SECTIONS

SECTION	REVISION NUMBER	REVISION DATE
16.9-7	4	08/21/09
16.9-8	5	08/21/09
16.9-9	3	08/21/09
16.9-10	5	08/21/09
16.9-11	3	08/21/09
16.9-12	3	02/10/15
16.9-13	4	09/27/16
16.9-14	1	09/25/06
16.9-15	2	08/21/09
16.9-16	2	08/21/09
16.9-17	0	10/09/02
16.9-18	Deleted	
16.9-19	3	02/20/12
16.9-20	0	10/09/02
16.9-21	1	10/13/16
16.9-22	1	08/21/09
16.9-23	5	08/03/17
16.9-24	2	10/24/06
16.9-25	2	08/21/09
16.9-26	1	11/15/18
16.10-1	1	08/21/09
16.10-2	1	10/24/06
16.10-3	1	08/21/09
16.10-4	0	08/04/20

SECTION	REVISION NUMBER	REVISION DATE
16.13-3	Deleted	
16.13-4	4	10/04/21

LIST OF EFFECTIVE SECTIONS

SECTION	REVISION NUMBER	REVISION DATE
TABLE OF CONTENTS	15	05/10/16
16.1	1	08/27/08
16.2	2	08/21/09
16.3	1	08/21/09
16.5-1	7	03/30/21
16.5-2	Deleted	
16.5-3	2	09/19/19
16.5-4	1	01/27/22
16.5-5	1	01/28/10
16.5-6	2	02/16/22
16.5-7	2	02/06/15
16.5-8	Deleted	
16.5-9	Deleted	03/02/21
16.5-10	Deleted	
16.6-1	0	10/09/02
16.6-2	Deleted	
16.6-3	2	01/27/22
16.6-4	2	11/21/19
16.6-5	3	07/07/20
16.7-1	1	08/21/09
16.7-2	4	02/03/11
16.7-3	5	11/21/19
16.7-4	2	08/21/09
16.7-5	6	03/29/22

LIST OF EFFECTIVE SECTIONS

SECTION	REVISION NUMBER	REVISION DATE
16.9-7	4	08/21/09
16.9-8	5	08/21/09
16.9-9	3	08/21/09
16.9-10	5	08/21/09
16.9-11	3	08/21/09
16.9-12	3	02/10/15
16.9-13	4	09/27/16
16.9-14	1	09/25/06
16.9-15	2	08/21/09
16.9-16	2	08/21/09
16.9-17	0	10/09/02
16.9-18	Deleted	
16.9-19	3	02/20/12
16.9-20	0	10/09/02
16.9-21	1	10/13/16
16.9-22	1	08/21/09
16.9-23	5	08/03/17
16.9-24	2	10/24/06
16.9-25	2	08/21/09
16.9-26	1	11/15/18
16.10-1	1	08/21/09
16.10-2	1	10/24/06
16.10-3	1	08/21/09
16.10-4	0	08/04/20

LIST OF EFFECTIVE SECTIONS

SECTION	REVISION NUMBER	REVISION DATE
16.13-3	Deleted	
16.13-4	4	10/04/21

LIST OF EFFECTIVE SECTIONS

SECTION	REVISION NUMBER	REVISION DATE
TABLE OF CONTENTS	15	05/10/16
16.1	1	08/27/08
16.2	2	08/21/09
16.3	1	08/21/09
16.5-1	7	03/30/21
16.5-2	Deleted	
16.5-3	2	09/19/19
16.5-4	1	01/27/22
16.5-5	1	01/28/10
16.5-6	2	02/16/22
16.5-7	2	02/06/15
16.5-8	Deleted	
16.5-9	Deleted	03/02/21
16.5-10	Deleted	
16.6-1	0	10/09/02
16.6-2	Deleted	
16.6-3	2	01/27/22
16.6-4	2	11/21/19
16.6-5	3	07/07/20
16.7-1	1	08/21/09
16.7-2	4	02/03/11
16.7-3	5	11/21/19
16.7-4	2	08/21/09
16.7-5	7	06/01/22

LIST OF EFFECTIVE SECTIONS

SECTION	REVISION NUMBER	REVISION DATE
16.7-6	3	06/10/16
16.7-7	1	08/21/09
16.7-8	2	08/21/09
16.7-9	13	09/14/21
16.7-10	10	01/27/22
16.7-11	1	08/21/09
16.7-12	1	08/21/09
16.7-13	3	06/10/16
16.7-14	1	08/21/09
16.7-15	2	01/27/22
16.7-16	0	06/08/09
16.7-17	0	02/10/15
16.7-18	0	05/10/16
16.8-1	8	01/27/22
16.8-2	3	12/18/19
16.8-3	1	10/24/06
16.8-4	2	11/05/07
16.8-5	3	08/21/09
16.9-1	10	01/29/19
16.9-2	6	08/03/17
16.9-3	5	07/03/18
16.9-4	5	09/11/17
16.9-5	11	10/08/19
16.9-6	12	07/03/18

SECTION	REVISION NUMBER	REVISION DATE
16.9-7	4	08/21/09
16.9-8	5	08/21/09
16.9-9	3	08/21/09
16.9-10	5	08/21/09
16.9-11	3	08/21/09
16.9-12	3	02/10/15
16.9-13	4	09/27/16
16.9-14	1	09/25/06
16.9-15	2	08/21/09
16.9-16	2	08/21/09
16.9-17	0	10/09/02
16.9-18	Deleted	
16.9-19	3	02/20/12
16.9-20	0	10/09/02
16.9-21	1	10/13/16
16.9-22	1	08/21/09
16.9-23	5	08/03/17
16.9-24	2	10/24/06
16.9-25	2	08/21/09
16.9-26	1	11/15/18
16.10-1	1	08/21/09
16.10-2	1	10/24/06
16.10-3	1	08/21/09
16.10-4	0	08/04/20

SECTION	REVISION NUMBER	REVISION DATE
16.10-5	1	03/16/21
16.11-1	1	07/27/13
16.11-2	8	05/03/22
16.11-3	0	10/09/02
16.11-4	1	08/21/09
16.11-5	0	10/09/02
16.11-6	3	08/03/15
16.11-7	14	05/03/22
16.11-8	0	10/09/02
16.11-9	0	10/09/02
16.11-10	1	08/21/09
16.11-11	1	03/20/03
16.11-12	0	10/09/02
16.11-13	1	07/27/13
16.11-14	0	10/09/02
16.11-15	0	10/09/02
16.11-16	1	10/24/11
16.11-17	0	10/09/02
16.11-18	1	08/21/09
16.11-19	0	10/09/02
16.11-20	3	11/21/19
16.11-21	0	10/09/02
16.12-1	0	10/09/02
16.13-1	1	08/03/17
16.13-2	Deleted	

LIST OF EFFECTIVE SECTIONS

SECTION	REVISION NUMBER	REVISION DATE
TABLE OF CONTENTS	15	05/10/16
16.1	1	08/27/08
16.2	2	08/21/09
16.3	1	08/21/09
16.5-1	7	03/30/21
16.5-2	Deleted	
16.5-3	2	09/19/19
16.5-4	1	01/27/22
16.5-5	1	01/28/10
16.5-6	2	02/16/22
16.5-7	2	02/06/15
16.5-8	Deleted	
16.5-9	Deleted	03/02/21
16.5-10	Deleted	
16.6-1	0	10/09/02
16.6-2	Deleted	
16.6-3	2	01/27/22
16.6-4	2	11/21/19
16.6-5	3	07/07/20
16.7-1	1	08/21/09
16.7-2	4	02/03/11
16.7-3	5	11/21/19
16.7-4	2	08/21/09
16.7-5	7	06/01/22

SECTION	REVISION NUMBER	REVISION DATE
16.7-6	3	06/10/16
16.7-7	2	06/14/22
16.7-8	2	08/21/09
16.7-9	14	06/14/22
16.7-10	10	01/27/22
16.7-11	1	08/21/09
16.7-12	1	08/21/09
16.7-13	3	06/10/16
16.7-14	1	08/21/09
16.7-15	2	01/27/22
16.7-16	0	06/08/09
16.7-17	0	02/10/15
16.7-18	0	05/10/16
16.8-1	8	01/27/22
16.8-2	3	12/18/19
16.8-3	2	06/14/22
16.8-4	2	11/05/07
16.8-5	3	08/21/09
16.9-1	10	01/29/19
16.9-2	6	08/03/17
16.9-3	5	07/03/18
16.9-4	5	09/11/17
16.9-5	11	10/08/19
16.9-6	12	07/03/18

LIST OF EFFECTIVE SECTIONS

SECTION	REVISION NUMBER	REVISION DATE
16.9-7	4	08/21/09
16.9-8	5	08/21/09
16.9-9	3	08/21/09
16.9-10	5	08/21/09
16.9-11	3	08/21/09
16.9-12	3	02/10/15
16.9-13	4	09/27/16
16.9-14	1	09/25/06
16.9-15	2	08/21/09
16.9-16	2	08/21/09
16.9-17	0	10/09/02
16.9-18	Deleted	
16.9-19	3	02/20/12
16.9-20	0	10/09/02
16.9-21	1	10/13/16
16.9-22	1	08/21/09
16.9-23	5	08/03/17
16.9-24	2	10/24/06
16.9-25	2	08/21/09
16.9-26	1	11/15/18
16.10-1	1	08/21/09
16.10-2	1	10/24/06
16.10-3	1	08/21/09
16.10-4	0	08/04/20

SECTION	REVISION NUMBER	REVISION DATE
16.10-5	1	03/16/21
16.11-1	1	07/27/13
16.11-2	8	05/03/22
16.11-3	0	10/09/02
16.11-4	1	08/21/09
16.11-5	0	10/09/02
16.11-6	3	08/03/15
16.11-7	14	05/03/22
16.11-8	0	10/09/02
16.11-9	0	10/09/02
16.11-10	1	08/21/09
16.11-11	1	03/20/03
16.11-12	0	10/09/02
16.11-13	1	07/27/13
16.11-14	0	10/09/02
16.11-15	0	10/09/02
16.11-16	1	10/24/11
16.11-17	0	10/09/02
16.11-18	1	08/21/09
16.11-19	0	10/09/02
16.11-20	3	11/21/19
16.11-21	0	10/09/02
16.12-1	0	10/09/02
16.13-1	1	08/03/17
16.13-2	Deleted	

LIST OF EFFECTIVE SECTIONS

SECTION	REVISION NUMBER	REVISION DATE
16.13-3	Deleted	
16.13-4	4	10/04/21

LIST OF EFFECTIVE SECTIONS

SECTION	REVISION NUMBER	REVISION DATE
TABLE OF CONTENTS	15	05/10/16
16.1	1	08/27/08
16.2	2	08/21/09
16.3	1	08/21/09
16.5-1	7	03/30/21
16.5-2	Deleted	
16.5-3	2	09/19/19
16.5-4	1	01/27/22
16.5-5	1	01/28/10
16.5-6	2	02/16/22
16.5-7	2	02/06/15
16.5-8	Deleted	
16.5-9	Deleted	03/02/21
16.5-10	Deleted	
16.6-1	0	10/09/02
16.6-2	Deleted	
16.6-3	2	01/27/22
16.6-4	2	11/21/19
16.6-5	3	07/07/20
16.7-1	1	08/21/09
16.7-2	4	02/03/11
16.7-3	5	11/21/19
16.7-4	2	08/21/09
16.7-5	7	06/01/22

LIST OF EFFECTIVE SECTIONS

LIST OF EFFECTIVE SECTIONS

SECTION	REVISION NUMBER	REVISION DATE
16.9-7	4	08/21/09
16.9-8	5	08/21/09
16.9-9	3	08/21/09
16.9-10	5	08/21/09
16.9-11	3	08/21/09
16.9-12	3	02/10/15
16.9-13	4	09/27/16
16.9-14	1	09/25/06
16.9-15	2	08/21/09
16.9-16	2	08/21/09
16.9-17	0	10/09/02
16.9-18	Deleted	
16.9-19	3	02/20/12
16.9-20	0	10/09/02
16.9-21	1	10/13/16
16.9-22	2	06/21/22
16.9-23	5	08/03/17
16.9-24	2	10/24/06
16.9-25	2	08/21/09
16.9-26	1	11/15/18
16.10-1	1	08/21/09
16.10-2	1	10/24/06
16.10-3	1	08/21/09
16.10-4	0	08/04/20

LIST OF EFFECTIVE SECTIONS

SECTION	REVISION NUMBER	REVISION DATE
16.10-5	1	03/16/21
16.11-1	1	07/27/13
16.11-2	8	05/03/22
16.11-3	0	10/09/02
16.11-4	1	08/21/09
16.11-5	0	10/09/02
16.11-6	3	08/03/15
16.11-7	14	05/03/22
16.11-8	0	10/09/02
16.11-9	0	10/09/02
16.11-10	1	08/21/09
16.11-11	1	03/20/03
16.11-12	0	10/09/02
16.11-13	1	07/27/13
16.11-14	0	10/09/02
16.11-15	0	10/09/02
16.11-16	1	10/24/11
16.11-17	0	10/09/02
16.11-18	1	08/21/09
16.11-19	0	10/09/02
16.11-20	3	11/21/19
16.11-21	0	10/09/02
16.12-1	0	10/09/02
16.13-1	1	08/03/17
16.13-2	Deleted	

LIST OF EFFECTIVE SECTIONS

SECTION	REVISION NUMBER	REVISION DATE
16.13-3	Deleted	
16.13-4	4	10/04/21

LIST OF EFFECTIVE SECTIONS

SECTION	REVISION NUMBER	REVISION DATE
TABLE OF CONTENTS	15	05/10/16
16.1	1	08/27/08
16.2	2	08/21/09
16.3	1	08/21/09
16.5-1	7	03/30/21
16.5-2	Deleted	
16.5-3	2	09/19/19
16.5-4	1	01/27/22
16.5-5	1	01/28/10
16.5-6	2	02/16/22
16.5-7	2	02/06/15
16.5-8	Deleted	
16.5-9	Deleted	03/02/21
16.5-10	Deleted	
16.6-1	0	10/09/02
16.6-2	Deleted	
16.6-3	2	01/27/22
16.6-4	2	11/21/19
16.6-5	3	07/07/20
16.7-1	1	08/21/09
16.7-2	4	02/03/11
16.7-3	5	11/21/19
16.7-4	2	08/21/09
16.7-5	7	06/01/22

LIST OF EFFECTIVE SECTIONS

SECTION	REVISION NUMBER	REVISION DATE
16.7-6	3	06/10/16
16.7-7	2	06/14/22
16.7-8	2	08/21/09
16.7-9	14	06/14/22
16.7-10	10	01/27/22
16.7-11	1	08/21/09
16.7-12	1	08/21/09
16.7-13	3	06/10/16
16.7-14	1	08/21/09
16.7-15	2	01/27/22
16.7-16	0	06/08/09
16.7-17	0	02/10/15
16.7-18	0	05/10/16
16.8-1	8	01/27/22
16.8-2	3	12/18/19
16.8-3	2	06/14/22
16.8-4	2	11/05/07
16.8-5	3	08/21/09
16.9-1	10	01/29/19
16.9-2	6	08/03/17
16.9-3	5	07/03/18
16.9-4	5	09/11/17
16.9-5	11	10/08/19
16.9-6	12	07/03/18

LIST OF EFFECTIVE SECTIONS

SECTION	REVISION NUMBER	REVISION DATE
16.9-7	4	08/21/09
16.9-8	5	08/21/09
16.9-9	3	08/21/09
16.9-10	5	08/21/09
16.9-11	3	08/21/09
16.9-12	3	02/10/15
16.9-13	4	09/27/16
16.9-14	1	09/25/06
16.9-15	2	08/21/09
16.9-16	2	08/21/09
16.9-17	0	10/09/02
16.9-18	Deleted	
16.9-19	3	02/20/12
16.9-20	0	10/09/02
16.9-21	1	10/13/16
16.9-22	2	06/21/22
16.9-23	5	08/03/17
16.9-24	2	10/24/06
16.9-25	2	08/21/09
16.9-26	1	11/15/18
16.10-1	1	08/21/09
16.10-2	1	10/24/06
16.10-3	1	08/21/09
16.10-4	0	08/04/20

LIST OF EFFECTIVE SECTIONS

SECTION	REVISION NUMBER	REVISION DATE
16.10-5	1	03/16/21
16.11-1	1	07/27/13
16.11-2	9	07/07/22
16.11-3	0	10/09/02
16.11-4	1	08/21/09
16.11-5	0	10/09/02
16.11-6	3	08/03/15
16.11-7	14	05/03/22
16.11-8	0	10/09/02
16.11-9	0	10/09/02
16.11-10	1	08/21/09
16.11-11	1	03/20/03
16.11-12	0	10/09/02
16.11-13	1	07/27/13
16.11-14	0	10/09/02
16.11-15	0	10/09/02
16.11-16	1	10/24/11
16.11-17	0	10/09/02
16.11-18	1	08/21/09
16.11-19	0	10/09/02
16.11-20	3	11/21/19
16.11-21	0	10/09/02
16.12-1	0	10/09/02
16.13-1	1	08/03/17
16.13-2	Deleted	

LIST OF EFFECTIVE SECTIONS

LIST OF EFFECTIVE SECTIONS

SECTION	REVISION NUMBER	REVISION DATE
TABLE OF CONTENTS	16	08/17/22
16.1	1	08/27/08
16.2	3	08/17/22
16.3	1	08/21/09
16.5-1	7	03/30/21
16.5-2	Deleted	
16.5-3	2	09/19/19
16.5-4	1	01/27/22
16.5-5	1	01/28/10
16.5-6	3	08/17/22
16.5-7	2	02/06/15
16.5-8	Deleted	
16.5-9	Deleted	03/02/21
16.5-10	Deleted	
16.6-1	0	10/09/02
16.6-2	Deleted	
16.6-3	2	01/27/22
16.6-4	3	08/17/22
16.6-5	3	07/07/20
16.7-1	1	08/21/09
16.7-2	4	02/03/11
16.7-3	5	11/21/19
16.7-4	2	08/21/09
16.7-5	7	06/01/22

LIST OF EFFECTIVE SECTIONS

SECTION	REVISION NUMBER	REVISION DATE
16.7-6	3	06/10/16
16.7-7	2	06/14/22
16.7-8	2	08/21/09
16.7-9	15	08/17/22
16.7-10	10	01/27/22
16.7-11	1	08/21/09
16.7-12	1	08/21/09
16.7-13	3	06/10/16
16.7-14	1	08/21/09
16.7-15	2	01/27/22
16.7-16	0	06/08/09
16.7-17	0	02/10/15
16.7-18	0	05/10/16
16.8-1	8	01/27/22
16.8-2	3	12/18/19
16.8-3	2	06/14/22
16.8-4	2	11/05/07
16.8-5	3	08/21/09
16.9-1	10	01/29/19
16.9-2	6	08/03/17
16.9-3	5	07/03/18
16.9-4	5	09/11/17
16.9-5	11	10/08/19
16.9-6	12	07/03/18

SECTION	REVISION NUMBER	REVISION DATE
16.9-7	4	08/21/09
16.9-8	5	08/21/09
16.9-9	3	08/21/09
16.9-10	5	08/21/09
16.9-11	3	08/21/09
16.9-12	3	02/10/15
16.9-13	4	09/27/16
16.9-14	1	09/25/06
16.9-15	2	08/21/09
16.9-16	2	08/21/09
16.9-17	0	10/09/02
16.9-18	Deleted	
16.9-19	3	02/20/12
16.9-20	0	10/09/02
16.9-21	1	10/13/16
16.9-22	3	08/17/22
16.9-23	5	08/03/17
16.9-24	2	10/24/06
16.9-25	2	08/21/09
16.9-26	1	11/15/18
16.10-1	1	08/21/09
16.10-2	1	10/24/06
16.10-3	1	08/21/09
16.10-4	0	08/04/20

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SECTION	REVISION NUMBER	REVISION DATE
16.10-5	1	03/16/21
16.11-1	1	07/27/13
16.11-2	9	07/07/22
16.11-3	0	10/09/02
16.11-4	1	08/21/09
16.11-5	0	10/09/02
16.11-6	3	08/03/15
16.11-7	14	05/03/22
16.11-8	0	10/09/02
16.11-9	0	10/09/02
16.11-10	1	08/21/09
16.11-11	1	03/20/03
16.11-12	0	10/09/02
16.11-13	1	07/27/13
16.11-14	0	10/09/02
16.11-15	0	10/09/02
16.11-16	1	10/24/11
16.11-17	0	10/09/02
16.11-18	1	08/21/09
16.11-19	0	10/09/02
16.11-20	3	11/21/19
16.11-21	0	10/09/02
16.12-1	0	10/09/02
16.13-1	1	08/03/17
16.13-2	Deleted	

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SECTION	REVISION NUMBER	REVISION DATE
TABLE OF CONTENTS	16	08/17/22
16.1	1	08/27/08
16.2	3	08/17/22
16.3	1	08/21/09
16.5-1	7	03/30/21
16.5-2	Deleted	
16.5-3	2	09/19/19
16.5-4	1	01/27/22
16.5-5	1	01/28/10
16.5-6	3	08/17/22
16.5-7	2	02/06/15
16.5-8	Deleted	
16.5-9	Deleted	03/02/21
16.5-10	Deleted	
16.6-1	0	10/09/02
16.6-2	Deleted	
16.6-3	2	01/27/22
16.6-4	3	08/17/22
16.6-5	3	07/07/20
16.7-1	1	08/21/09
16.7-2	4	02/03/11
16.7-3	5	11/21/19
16.7-4	2	08/21/09
16.7-5	7	06/01/22

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SECTION	REVISION NUMBER	REVISION DATE
16.7-6	3	06/10/16
16.7-7	2	06/14/22
16.7-8	2	08/21/09
16.7-9	15	08/17/22
16.7-10	10	01/27/22
16.7-11	1	08/21/09
16.7-12	1	08/21/09
16.7-13	3	06/10/16
16.7-14	1	08/21/09
16.7-15	2	01/27/22
16.7-16	0	06/08/09
16.7-17	0	02/10/15
16.7-18	0	05/10/16
16.8-1	8	01/27/22
16.8-2	3	12/18/19
16.8-3	2	06/14/22
16.8-4	2	11/05/07
16.8-5	3	08/21/09
16.9-1	10	01/29/19
16.9-2	6	08/03/17
16.9-3	5	07/03/18
16.9-4	5	09/11/17
16.9-5	11	10/08/19
16.9-6	12	07/03/18

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16.9-7	4	08/21/09
16.9-8	5	08/21/09
16.9-9	3	08/21/09
16.9-10	5	08/21/09
16.9-11	3	08/21/09
16.9-12	3	02/10/15
16.9-13	4	09/27/16
16.9-14	1	09/25/06
16.9-15	2	08/21/09
16.9-16	2	08/21/09
16.9-17	0	10/09/02
16.9-18	Deleted	
16.9-19	3	02/20/12
16.9-20	0	10/09/02
16.9-21	1	10/13/16
16.9-22	3	08/17/22
16.9-23	5	08/03/17
16.9-24	2	10/24/06
16.9-25	2	08/21/09
16.9-26	1	11/15/18
16.10-1	1	08/21/09
16.10-2	1	10/24/06
16.10-3	1	08/21/09
16.10-4	0	08/04/20

SECTION	REVISION NUMBER	REVISION DATE
16.10-5	2	09/07/22
16.11-1	1	07/27/13
16.11-2	9	07/07/22
16.11-3	0	10/09/02
16.11-4	1	08/21/09
16.11-5	0	10/09/02
16.11-6	3	08/03/15
16.11-7	14	05/03/22
16.11-8	0	10/09/02
16.11-9	0	10/09/02
16.11-10	1	08/21/09
16.11-11	1	03/20/03
16.11-12	0	10/09/02
16.11-13	1	07/27/13
16.11-14	0	10/09/02
16.11-15	0	10/09/02
16.11-16	1	10/24/11
16.11-17	0	10/09/02
16.11-18	1	08/21/09
16.11-19	0	10/09/02
16.11-20	3	11/21/19
16.11-21	0	10/09/02
16.12-1	0	10/09/02
16.13-1	1	08/03/17
16.13-2	Deleted	

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16.1	1	08/27/08
16.2	3	08/17/22
16.3	1	08/21/09
16.5-1	7	03/30/21
16.5-2	Deleted	
16.5-3	2	09/19/19
16.5-4	1	01/27/22
16.5-5	1	01/28/10
16.5-6	3	08/17/22
16.5-7	2	02/06/15
16.5-8	Deleted	
16.5-9	Deleted	03/02/21
16.5-10	Deleted	
16.6-1	0	10/09/02
16.6-2	Deleted	
16.6-3	2	01/27/22
16.6-4	3	08/17/22
16.6-5	3	07/07/20
16.7-1	1	08/21/09
16.7-2	4	02/03/11
16.7-3	5	11/21/19
16.7-4	Deleted	
16.7-5	7	06/01/22

SECTION	REVISION NUMBER	REVISION DATE
16.7-6	3	06/10/16
16.7-7	2	06/14/22
16.7-8	2	08/21/09
16.7-9	15	08/17/22
16.7-10	10	01/27/22
16.7-11	1	08/21/09
16.7-12	1	08/21/09
16.7-13	3	06/10/16
16.7-14	1	08/21/09
16.7-15	2	01/27/22
16.7-16	0	06/08/09
16.7-17	0	02/10/15
16.7-18	0	05/10/16
16.8-1	8	01/27/22
16.8-2	3	12/18/19
16.8-3	2	06/14/22
16.8-4	2	11/05/07
16.8-5	3	08/21/09
16.9-1	10	01/29/19
16.9-2	6	08/03/17
16.9-3	5	07/03/18
16.9-4	5	09/11/17
16.9-5	11	10/08/19
16.9-6	12	07/03/18

SECTION	REVISION NUMBER	REVISION DATE
16.13-3	Deleted	
16.13-4	4	10/04/21

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SECTION	REVISION NUMBER	REVISION DATE
TABLE OF CONTENTS	17	10/20/22
16.1	1	08/27/08
16.2	3	08/17/22
16.3	1	08/21/09
16.5-1	7	03/30/21
16.5-2	Deleted	
16.5-3	2	09/19/19
16.5-4	1	01/27/22
16.5-5	1	01/28/10
16.5-6	3	08/17/22
16.5-7	2	02/06/15
16.5-8	Deleted	
16.5-9	Deleted	03/02/21
16.5-10	Deleted	
16.6-1	0	10/09/02
16.6-2	Deleted	
16.6-3	2	01/27/22
16.6-4	3	08/17/22
16.6-5	3	07/07/20
16.7-1	1	08/21/09
16.7-2	4	02/03/11
16.7-3	5	11/21/19
16.7-4	Deleted	
16.7-5	7	06/01/22

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SECTION	REVISION NUMBER	REVISION DATE
16.7-6	3	06/10/16
16.7-7	2	06/14/22
16.7-8	2	08/21/09
16.7-9	15	08/17/22
16.7-10	10	01/27/22
16.7-11	1	08/21/09
16.7-12	1	08/21/09
16.7-13	3	06/10/16
16.7-14	1	08/21/09
16.7-15	2	01/27/22
16.7-16	0	06/08/09
16.7-17	0	02/10/15
16.7-18	0	05/10/16
16.8-1	8	01/27/22
16.8-2	3	12/18/19
16.8-3	3	11/28/22
16.8-4	2	11/05/07
16.8-5	3	08/21/09
16.9-1	10	01/29/19
16.9-2	6	08/03/17
16.9-3	5	07/03/18
16.9-4	5	09/11/17
16.9-5	11	10/08/19
16.9-6	12	07/03/18

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SECTION	REVISION NUMBER	REVISION DATE
16.9-7	4	08/21/09
16.9-8	5	08/21/09
16.9-9	3	08/21/09
16.9-10	5	08/21/09
16.9-11	3	08/21/09
16.9-12	3	02/10/15
16.9-13	4	09/27/16
16.9-14	1	09/25/06
16.9-15	2	08/21/09
16.9-16	2	08/21/09
16.9-17	0	10/09/02
16.9-18	Deleted	
16.9-19	3	02/20/12
16.9-20	0	10/09/02
16.9-21	1	10/13/16
16.9-22	3	08/17/22
16.9-23	5	08/03/17
16.9-24	2	10/24/06
16.9-25	2	08/21/09
16.9-26	1	11/15/18
16.10-1	1	08/21/09
16.10-2	1	10/24/06
16.10-3	1	08/21/09
16.10-4	0	08/04/20

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SECTION	REVISION NUMBER	REVISION DATE
16.10-5	2	09/07/22
16.11-1	1	07/27/13
16.11-2	9	07/07/22
16.11-3	0	10/09/02
16.11-4	1	08/21/09
16.11-5	0	10/09/02
16.11-6	3	08/03/15
16.11-7	14	05/03/22
16.11-8	0	10/09/02
16.11-9	0	10/09/02
16.11-10	1	08/21/09
16.11-11	1	03/20/03
16.11-12	0	10/09/02
16.11-13	1	07/27/13
16.11-14	0	10/09/02
16.11-15	0	10/09/02
16.11-16	1	10/24/11
16.11-17	0	10/09/02
16.11-18	1	08/21/09
16.11-19	0	10/09/02
16.11-20	3	11/21/19
16.11-21	0	10/09/02
16.12-1	0	10/09/02
16.13-1	1	08/03/17
16.13-2	Deleted	

LIST OF EFFECTIVE SECTIONS

SECTION	REVISION NUMBER	REVISION DATE
16.13-3	Deleted	
16.13-4	4	10/04/21

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

16.11-1 Liquid Effluents

COMMITMENT: The concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS (see Figure 16.11-16-1 in SLC 16.11-16) shall be limited to:

a. For radionuclides other than dissolved or entrained noble gases, 10 times the effluent concentrations specified in 10 CFR Part 20, Appendix B, Table 2, Column 2, and

b. For dissolved or entrained noble gases, the concentration shall be limited to 2×10^{-4} microCurie/ml total activity.

APPLICABILITY: At all times.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS not within limits.	A.1 Restore the concentration to within limits.	Immediately

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11-1-1 --------------------------------NOTE-------------------------------- The results of the radioactivity analyses shall be used in accordance with the methodology and parameters in the ODCM to assure that the concentrations at the point of release are maintained within the limits. -- Sample and analyze radioactive liquid wastes according to Table 16.11-1-1.	According to Table 16.11-1-1

Table 16.11-1-1

Radioactive Liquid Waste Sampling and Analysis Program (page 1 of 3)

LIQUID RELEASE TYPE	SAMPLING FREQUENCY	MINIMUM ANALYSIS FREQUENCY	TYPE OF ACTIVITY ANALYSIS	LOWER LIMIT OF DETECTION (LLD)[1] (µCi/ml)
1. Batch Waste Release Tanks[2] Any tank which discharges liquid wastes by either liquid effluent monitor, EMF-49 or EMF-57	Prior to each release Each Batch	Prior to each release Each Batch	Principal Gamma Emitters[3]	$5x10^{-7}$
			I-131	$1x10^{-6}$
	Prior to each release One Batch/31 days	31 days	Dissolved and Entrained Gases (Gamma Emitters)	$1x10^{-5}$
	Prior to each release Each Batch	31 days Composite[4]	H-3	$1x10^{-5}$
			Gross Alpha	$1x10^{-7}$
	Prior to each release Each Batch	92 days Composite[4]	Sr-89, Sr-90	$5x10^{-8}$
2. Continuous Releases[5] Conventional Waste Water Treatment Line	Continuous[6]	7 days Composite[6]	Principal Gamma Emitters[3]	$5x10^{-7}$
			I-131	$1x10^{-6}$
	31 days Grab Sample	31 days	Dissolved and Entrained Gases (Gamma Emitters)	$1x10^{-5}$
	Continuous[6]	31 days Composite[6]	H-3	$1x10^{-5}$
			Gross Alpha	$1x10^{-7}$
	Continuous[6]	92 days Composite[6]	Sr-89, Sr-90	$5x10^{-8}$

Table 16.11-1-1

Radioactive Liquid Waste Sampling and Analysis Program (page 2 of 3)

NOTES:

(1) The LLD is defined, for purposes of these commitments, as the smallest concentration of radioactive material in a sample that will yield a net count, above system background, that will be detected with 95% probability with only 5% probability of falsely concluding that a blank observation represents a “real” signal.

For a particular measurement system, which may include radiochemical separation:

$$LLD = \frac{(2.71/T) + 4.65 s_b}{E \cdot V \cdot 2.22 \ x \ 10^6 \cdot Y \cdot \exp(-\lambda \Delta t)}$$

Where:

LLD = the “a priori” lower limit of detection (microCurie per unit mass or volume),

s_b = the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (counts per minute),

E = the counting efficiency (counts per disintegration),

V = the sample size (units of mass or volume),

2.22×10^6 = the number of disintegrations per minute per microCurie,

Y = the fractional radiochemical yield, when applicable,

λ = the radioactive decay constant for the particular radionuclide (sec^{-1}),

Δt = the elapsed time between midpoint of sample collection and time of counting (sec), and

T = the sample counting time (min).

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

It should be recognized that the LLD is defined as an <u>a priori</u> (before the fact) limit representing the capability of a measurement system and not as an <u>a posteriori</u> (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 to assure representative sampling.

Table 16.11-1-1

Radioactive Liquid Waste Sampling and Analysis Program (page 3 of 3)

(3) The principal gamma emitters for which the LLD specification applies include the following radionuclides:

Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, and Ce-141. The LLD for Ce-144 is 5×10^{-6} µCi/ml. This list does not mean that only these nuclides are to be considered. Other gamma peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Radioactive Effluent Release Report pursuant to Technical Specification 5.6.3 in the format outlined in Regulatory Guide 1.21, Appendix B, Revision 1, June 1974.

(4) A composite sample is one in which the quantity of liquid sampled is proportional to the quantity of liquid waste discharged and in which the method of sampling employed results in a specimen that is representative of the liquids released.

(5) A continuous release is the discharge of liquid wastes of a non-discrete volume, e.g., from a volume of a system that has an input flow during the continuous release.

(6) To be representative of the quantities and concentrations of radioactive materials in liquid effluents, samples shall be collected continuously in proportion to the rate of flow of the effluent stream. Prior to analyses, all samples taken for the composite shall be thoroughly mixed in order for the composite sample to be representative of the effluent release.

BASES

The basic requirements for SLCs concerning effluents from nuclear power reactors are stated in 10 CFR 50.36a. These requirements indicate that compliance with effluent SLCs will keep average annual releases of radioactive material in effluents to small percentages of the limits specified in the old 10 CFR 20.106 (new 10 CFR 20.1302). These requirements further indicate that operational flexibility is allowed, compatible with considerations of health and safety, which may temporarily result in releases higher than such small percentages, but still within the limits specified in the old 10 CFR 20.106 which references Appendix B, Table II concentrations (MPCs). These referenced concentrations are specific values which relate to an annual dose of 500 mrem. It is further indicated in 10 CFR 50.36a that when using operational flexibility, best efforts shall be exerted to keep levels of radioactive materials in effluents as low as is reasonably achievable (ALARA) as set forth in 10 CFR 50, Appendix I.

As stated in the Introduction to Appendix B of the new 10 CFR 20, the liquid effluent concentration (EC) limits given in Appendix B, Table 2, Column 2, are based on an annual dose of 50 mrem. Since a release concentration corresponding to a limiting dose rate of 500 mrem/year has been acceptable as a SLC limit for liquid effluents, which applies at all times as an assurance that the limits of 10 CFR 50, Appendix I are not likely to be exceeded, it should not be necessary to reduce this limit by a factor of 10.

Operational history at Catawba has demonstrated that the use of the concentration values associated with the old 10 CFR 20.106 as SLC limits has resulted in calculated maximum individual doses to a MEMBER OF THE PUBLIC that are small percentages of the limits of 10 CFR 50, Appendix I. Therefore, the use of concentration values which correspond to an annual dose of 500 mrem (ten times the concentration values stated in the new 10 CFR 20, Appendix B, Table 2, Column 2) should not have a negative impact on the ability to continue to operate within the limits of 10 CFR 50, Appendix I and 40 CFR 190.

Having sufficient operational flexibility is especially important in establishing a basis for effluent monitor setpoint calculations. As discussed above, the concentrations stated in the new 10 CFR 20, Appendix B, Table 2, Column 2, relate to a dose of 50 mrem in a year. When applied on an instantaneous basis, this corresponds to a dose rate of 50 mrem/year. This low value is impractical upon which to base effluent monitor setpoint calculations for many liquid effluent release situations when monitor background, monitor sensitivity, and monitor performance must be taken into account.

Therefore, to accommodate operational flexibility needed for effluent releases, the limits associated with SLC 16.11-1 are based on ten times the concentrations stated in the new 10 CFR 20, Appendix B, Table 2, Column 2, to apply at all times. The multiplier of ten is proposed because the annual dose of 500 mrem, upon which the concentrations in the old 10 CFR 20, Appendix B, Table II, Column 2, are based, is a factor of 10 higher than annual dose of 50 mrem, upon which the concentrations in the new 10 CFR

BASES (continued)

20, Appendix B, Table 2, Column 2, are based. Compliance with the limits of the new 10 CFR 20.1301 will be demonstrated by operating within the limits of 10 CFR 50, Appendix I and 40 CFR 190. 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.

This commitment applies to the release of radioactive materials in liquid effluents from all units at the site.

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," Annal. Chem. 40, 586-93 (1968), and Hartwell, J. K., "Detection Limits for Radioanalytical Counting Techniques," Atlantic Richfield Hanford Company Report ARH-SA-215 (June 1975).

REFERENCES

1. Catawba Offsite Dose Calculation Manual.
2. 10 CFR Part 20, Appendix B.

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

16.11-2 Radioactive Liquid Effluent Monitoring Instrumentation

COMMITMENT The Radioactive Liquid Effluent Monitoring Instrumentation channels shown in Table 16.11-2-1 shall be FUNCTIONAL with their Alarm/Trip Setpoints set to ensure that the limits of SLC 16.11-1 are not exceeded.

AND

The Alarm/Trip Setpoints of these channels shall be determined and adjusted in accordance with the methodology and parameters in the OFFSITE DOSE CALCULATION MANUAL (ODCM).

APPLICABILITY: Conditions A, B, and G are applicable at all times. Conditions C, D, E, and F are applicable at all times, except when the effluent pathway is mechanically isolated; thus a release to the environment is not possible.

REMEDIAL ACTIONS

---NOTE---
Separate Condition entry is allowed for each Function.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or more Radioactive Liquid Effluent Monitoring Instrumentation channel(s) Alarm/Trip Setpoint less conservative than required.	A.1 Suspend the release of radioactive liquid effluents monitored by the affected channel(s).	Immediately
	<u>OR</u>	
	A.2 Declare the channel(s) non-functional.	Immediately
B. One or more Radioactive Liquid Effluent Monitoring Instrumentation channel(s) non-functional.	B.1 Enter the applicable Conditions and Required Actions specified in Table 16.11-2-1 for the channel(s).	Immediately
	<u>AND</u>	
	B.2.1 Restore channel to FUNCTIONAL status.	14 Days (*Note 1)
	<u>OR</u>	
	B.2.2 Restore channel to FUNCTIONAL status.	30 Days (*Note 1)

*Note 1 – Required Action B.2.1 Applies to Instruments 1.a and 1.c ONLY. Required Action B.2.2 Applies to the remainder of required Instruments listed in Table 16.11-2-1.

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
C. One channel non-functional.	C.1.1 Analyze two independent samples per Testing Requirement 16.11-1-1.	Prior to initiating a release
	AND	
	C.1.2 Perform independent verification of the discharge line valving.	Prior to initiating a release
	AND	
	C.1.3.1 Perform independent verification of manual portion of the computer input for release rate calculations performed by computer.	Prior to initiating a release
	OR	
	C.1.3.2 Perform independent verification of entire calculations for release rate calculations performed manually.	Prior to initiating a release
	OR	
	C.2 Suspend release of radioactive effluents via this pathway.	Immediately

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
D. One flow rate measurement device channel non-functional.	D.1 --------------NOTE------------- Pump performance curves generated in place may be used to estimate flow. ----------------------------------- Estimate the flow rate of the release.	 Once per 4 hours during releases
E. One channel non-functional.	E.1 Perform an analysis of grab samples for radioactivity at a lower limit of detection of 10^{-7} microCurie/ml.	Once per 12 hours during releases when secondary specific activity is > 0.01 microCurie/gm DOSE EQUIVALENT I-131 AND Once per 24 hours during releases when secondary specific activity is $\leq$ 0.01 microCurie/gm DOSE EQUIVALENT I-131

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
F. One channel non-functional.	F.1 Collect and analyze grab samples for principal gamma emitters (listed in Table 16.11-1-1, NOTE 3) at a lower limit of detection of no more than $5x10^{-7}$ microCurie/ml.	Once per 12 hours
G. Required Action and associated Completion Time of Condition B not met.	G.1 Explain why the non-functionality was not corrected within the specified Completion Time.	In the next scheduled Radioactive Effluent Release Report pursuant to Technical Specification 5.6.3

TESTING REQUIREMENTS

---NOTE---
Refer to Table 16.11-2-1 to determine which TRs apply for each Radioactive Liquid Effluent Monitoring Instrumentation channel.

TEST		FREQUENCY
TR 16.11-2-1	Perform CHANNEL CHECK.	24 hours
TR 16.11-2-2	--------------------------------NOTE-------------------------------- The CHANNEL CHECK shall consist of verifying indication of flow. -- Perform CHANNEL CHECK.	 24 hours during periods of release
TR 16.11-2-3	Perform SOURCE CHECK.	Prior to each release
TR 16.11-2-4	Perform SOURCE CHECK.	31 days
TR 16.11-2-5	Perform COT.	182 days
TR 16.11-2-6	--------------------------------NOTE-------------------------------- For Instrument 1, the COT shall also demonstrate that automatic isolation of this pathway and control room alarm annunciation (for EMF-57, alarm annunciation is in the Monitor Tank Building control room and on the Monitor Tank Building control panel remote annunciator panel) occur if any of the following conditions exist: a. Instrument indicates measured levels above the Alarm/Trip Setpoint, or b. Circuit failure/instrument downscale failure (alarm only) -- Perform COT.	 9 months

(continued)

TESTING REQUIREMENTS (continued)

TEST		FREQUENCY
TR 16.11-2-7	--------------------------------NOTE-------------------------------- For Instrument 1, 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. --	
	Perform CHANNEL CALIBRATION.	18 months

Table 16.11-2-1

Radioactive Liquid Effluent Monitoring Instrumentation

INSTRUMENT		REQUIRED CHANNELS	CONDITIONS	TESTING REQUIREMENTS
1.	Radioactivity Monitors Providing Alarm and Automatic Termination of Release			
1.a	Waste Liquid Discharge Monitor (EMF-49 – Low Range)	1 per station	A, B, C, G	TR 16.11-2-1 TR 16.11-2-3 TR 16.11-2-6 TR 16.11-2-7
1.b	Turbine Building Sump Monitor (EMF-31)	1	A, B, E, G	TR 16.11-2-1 TR 16.11-2-4 TR 16.11-2-6 TR 16.11-2-7
1.c	Monitor Tank Building Liquid Discharge Monitor (EMF-57 – Low Range)	1 per station	A, B, C, G	TR 16.11-2-1 TR 16.11-2-3 TR 16.11-2-6 TR 16.11-2-7
2.	Continuous Composite Samplers and Sampler Flow Monitor			
2.a	Conventional Waste Water Treatment Line (no alarm/trip function)	1 per station	B, E, G	TR 16.11-2-2 TR 16.11-2-7
3.	Flow Rate Measurement Devices			
3.a	Waste Liquid Effluent Line (no alarm/trip function)	1 per station	B, D, G	TR 16.11-2-2 TR 16.11-2-7
3.b	Conventional Waste Water Treatment Line (no alarm/trip function)	1 per station	B, D, G	TR 16.11-2-2 TR 16.11-2-7
3.c	Low Pressure Service Water Minimum Flow Interlock	1 per station	B, D, G	TR 16.11-2-2 TR 16.11-2-5 TR 16.11-2-7
3.d	Monitor Tank Building Waste Liquid Effluent Line (no alarm/trip function)	1 per station	B, D, G	TR 16.11-2-2 TR 16.11-2-7
4.	Radioactivity Monitors Providing Alarm			
4.a	Service Water Monitor on Containment Spray Heat Exchanger (EMF-45 A & B – Low Range)	1 per heat exchanger	A, B, F, G	TR 16.11-2-1 TR 16.11-2-4 TR 16.11-2-6 TR 16.11-2-7

BASES

The Radioactive Liquid Effluent Monitoring Instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in liquid effluents during actual or potential releases of liquid effluents. The Alarm/Trip Setpoints for these instruments shall be calculated 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 FUNCTIONALITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10 CFR Part 50.

Regarding the COMMITMENT APPLICABILITY, isolation of the effluent pathway is to be by mechanical means (e.g., valve closure). Electrical or pneumatic isolation is not required, unless the isolation is designed to receive an automatic signal to open.

REFERENCES

1. Catawba Offsite Dose Calculation Manual.

2. 10 CFR Part 20.

3. 10 CFR Part 50, Appendix A.

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

16.11-2 Radioactive Liquid Effluent Monitoring Instrumentation

COMMITMENT The Radioactive Liquid Effluent Monitoring Instrumentation channels shown in Table 16.11-2-1 shall be FUNCTIONAL with their Alarm/Trip Setpoints set to ensure that the limits of SLC 16.11-1 are not exceeded.

AND

The Alarm/Trip Setpoints of these channels shall be determined and adjusted in accordance with the methodology and parameters in the OFFSITE DOSE CALCULATION MANUAL (ODCM).

APPLICABILITY: Conditions A, B, and G are applicable at all times. Conditions C, D, E, and F are applicable at all times, except when the effluent pathway is mechanically isolated; thus a release to the environment is not possible.

REMEDIAL ACTIONS

---NOTE---
Separate Condition entry is allowed for each Function.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or more Radioactive Liquid Effluent Monitoring Instrumentation channel(s) Alarm/Trip Setpoint less conservative than required.	A.1 Suspend the release of radioactive liquid effluents monitored by the affected channel(s).	Immediately
	OR	
	A.2 Declare the channel(s) non-functional.	Immediately
B. One or more Radioactive Liquid Effluent Monitoring Instrumentation channel(s) non-functional.	B.1 Enter the applicable Conditions and Required Actions specified in Table 16.11-2-1 for the channel(s).	Immediately
	AND	
	B.2.1 Restore channel to FUNCTIONAL status.	14 Days (*Note 1)
	OR	
	B.2.2 Restore channel to FUNCTIONAL status.	30 Days (*Note 1)

*Note 1 – Required Action B.2.1 Applies to Instruments 1.a and 1.c ONLY. Required Action B.2.2 Applies to the remainder of required Instruments listed in Table 16.11-2-1.

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
C. One channel non-functional.	C.1.1 Analyze two independent samples per Testing Requirement 16.11-1-1.	Prior to initiating a release
	AND	
	C.1.2 Perform independent verification of the discharge line valving.	Prior to initiating a release
	AND	
	C.1.3.1 Perform independent verification of manual portion of the computer input for release rate calculations performed by computer.	Prior to initiating a release
	OR	
	C.1.3.2 Perform independent verification of entire calculations for release rate calculations performed manually.	Prior to initiating a release
	OR	
	C.2 Suspend release of radioactive effluents via this pathway.	Immediately

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
D. One flow rate measurement device channel non-functional.	D.1 --------------NOTE------------- Pump performance curves generated in place may be used to estimate flow. ----------------------------------- Estimate the flow rate of the release.	 Once per 4 hours during releases
E. One channel non-functional.	E.1 Perform an analysis of grab samples for radioactivity at a lower limit of detection of 10^{-7} microCurie/ml.	Once per 12 hours during releases when secondary specific activity is > 0.01 microCurie/gm DOSE EQUIVALENT I-131 <u>AND</u> Once per 24 hours during releases when secondary specific activity is ≤ 0.01 microCurie/gm DOSE EQUIVALENT I-131

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
F. One channel non-functional.	F.1 Collect and analyze grab samples for principal gamma emitters (listed in Table 16.11-1-1, NOTE 3) at a lower limit of detection of no more than 5×10^{-7} microCurie/ml.	Once per 12 hours
G. Required Action and associated Completion Time of Condition B not met.	G.1 Explain why the non-functionality was not corrected within the specified Completion Time.	In the next scheduled Radioactive Effluent Release Report pursuant to Technical Specification 5.6.3

TESTING REQUIREMENTS

---NOTE---
Refer to Table 16.11-2-1 to determine which TRs apply for each Radioactive Liquid Effluent Monitoring Instrumentation channel.

TEST		FREQUENCY
TR 16.11-2-1	Perform CHANNEL CHECK.	24 hours
TR 16.11-2-2	--------------------------------NOTE-------------------------------- The CHANNEL CHECK shall consist of verifying indication of flow. -- Perform CHANNEL CHECK.	24 hours during periods of release
TR 16.11-2-3	Perform SOURCE CHECK.	Prior to each release
TR 16.11-2-4	Perform SOURCE CHECK.	31 days
TR 16.11-2-5	Perform COT.	182 days
TR 16.11-2-6	--------------------------------NOTE-------------------------------- For Instrument 1, the COT shall also demonstrate that automatic isolation of this pathway and control room alarm annunciation (for EMF-57, alarm annunciation is in the Monitor Tank Building control room and on the Monitor Tank Building control panel remote annunciator panel) occur if any of the following conditions exist: a. Instrument indicates measured levels above the Alarm/Trip Setpoint, or b. Circuit failure/instrument downscale failure (alarm only) -- Perform COT.	18 months

(continued)

TESTING REQUIREMENTS (continued)

TEST		FREQUENCY
TR 16.11-2-7	---------------------------------NOTE--------------------------------- For Instrument 1, 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. -- Perform CHANNEL CALIBRATION.	18 months

Table 16.11-2-1

Radioactive Liquid Effluent Monitoring Instrumentation

INSTRUMENT		REQUIRED CHANNELS	CONDITIONS	TESTING REQUIREMENTS
1.	Radioactivity Monitors Providing Alarm and Automatic Termination of Release			
1.a	Waste Liquid Discharge Monitor (EMF-49 – Low Range)	1 per station	A, B, C, G	TR 16.11-2-1 TR 16.11-2-3 TR 16.11-2-6 TR 16.11-2-7
1.b	Turbine Building Sump Monitor (EMF-31)	1	A, B, E, G	TR 16.11-2-1 TR 16.11-2-4 TR 16.11-2-6 TR 16.11-2-7
1.c	Monitor Tank Building Liquid Discharge Monitor (EMF-57 – Low Range)	1 per station	A, B, C, G	TR 16.11-2-1 TR 16.11-2-3 TR 16.11-2-6 TR 16.11-2-7
2.	Continuous Composite Samplers and Sampler Flow Monitor			
2.a	Conventional Waste Water Treatment Line (no alarm/trip function)	1 per station	B, E, G	TR 16.11-2-2 TR 16.11-2-7
3.	Flow Rate Measurement Devices			
3.a	Waste Liquid Effluent Line (no alarm/trip function)	1 per station	B, D, G	TR 16.11-2-2 TR 16.11-2-7
3.b	Conventional Waste Water Treatment Line (no alarm/trip function)	1 per station	B, D, G	TR 16.11-2-2 TR 16.11-2-7
3.c	Low Pressure Service Water Minimum Flow Interlock	1 per station	B, D, G	TR 16.11-2-2 TR 16.11-2-5 TR 16.11-2-7
3.d	Monitor Tank Building Waste Liquid Effluent Line (no alarm/trip function)	1 per station	B, D, G	TR 16.11-2-2 TR 16.11-2-7
4.	Radioactivity Monitors Providing Alarm			
4.a	Service Water Monitor on Containment Spray Heat Exchanger (EMF-45 A & B – Low Range)	1 per heat exchanger	A, B, F, G	TR 16.11-2-1 TR 16.11-2-4 TR 16.11-2-6 TR 16.11-2-7

BASES

The Radioactive Liquid Effluent Monitoring Instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in liquid effluents during actual or potential releases of liquid effluents. The Alarm/Trip Setpoints for these instruments shall be calculated 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 FUNCTIONALITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10 CFR Part 50.

Regarding the COMMITMENT APPLICABILITY, isolation of the effluent pathway is to be by mechanical means (e.g., valve closure). Electrical or pneumatic isolation is not required, unless the isolation is designed to receive an automatic signal to open.

REFERENCES

1. Catawba Offsite Dose Calculation Manual.
2. 10 CFR Part 20.
3. 10 CFR Part 50, Appendix A.

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

16.11-2 Radioactive Liquid Effluent Monitoring Instrumentation

COMMITMENT The Radioactive Liquid Effluent Monitoring Instrumentation channels shown in Table 16.11-2-1 shall be FUNCTIONAL with their Alarm/Trip Setpoints set to ensure that the limits of SLC 16.11-1 are not exceeded.

AND

The Alarm/Trip Setpoints of these channels shall be determined and adjusted in accordance with the methodology and parameters in the OFFSITE DOSE CALCULATION MANUAL (ODCM).

APPLICABILITY: Condition Applicability is as shown in Table 16.11-2-1.

REMEDIAL ACTIONS

---NOTE---
Separate Condition entry is allowed for each Function.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or more Radioactive Liquid Effluent Monitoring Instrumentation channel(s) Alarm/Trip Setpoint less conservative than required.	A.1 Suspend the release of radioactive liquid effluents monitored by the affected channel(s).	Immediately
	OR	
	A.2 Declare the channel(s) non-functional.	Immediately
B. One or more Radioactive Liquid Effluent Monitoring Instrumentation channel(s) non-functional.	B.1 Enter the applicable Conditions and Required Actions specified in Table 16.11-2-1 for the channel(s).	Immediately
	AND	
	B.2.1 Restore channel to FUNCTIONAL status.	14 Days (*Note 1)
	OR	
	B.2.2 Restore channel to FUNCTIONAL status.	30 Days (*Note 1)

*Note 1 – Required Action B.2.1 Applies to Instruments 1.a and 1.c ONLY. Required Action B.2.2 Applies to the remainder of required Instruments listed in Table 16.11-2-1.

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
C. One channel non-functional.	C.1.1 Analyze two independent samples per Testing Requirement 16.11-1-1.	Prior to initiating a release
	AND	
	C.1.2 Perform independent verification of the discharge line valving.	Prior to initiating a release
	AND	
	C.1.3.1 Perform independent verification of manual portion of the computer input for release rate calculations performed by computer.	Prior to initiating a release
	OR	
	C.1.3.2 Perform independent verification of entire calculations for release rate calculations performed manually.	Prior to initiating a release
	OR	
	C.2 Suspend release of radioactive effluents via this pathway.	Immediately

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
D. One flow rate measurement device channel non-functional.	D.1 --------------NOTE------------- Pump performance curves generated in place may be used to estimate flow. ----------------------------------- Estimate the flow rate of the release.	 Once per 4 hours during releases
E. One channel non-functional.	E.1 Perform an analysis of grab samples for radioactivity at a lower limit of detection of 10^{-7} microCurie/ml.	Once per 12 hours during releases when secondary specific activity is > 0.01 microCurie/gm DOSE EQUIVALENT I-131 AND Once per 24 hours during releases when secondary specific activity is $\leq$ 0.01 microCurie/gm DOSE EQUIVALENT I-131

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
F. One channel non-functional.	F.1 Collect and analyze grab samples for principal gamma emitters (listed in Table 16.11-1-1, NOTE 3) at a lower limit of detection of no more than $5x10^{-7}$ microCurie/ml.	Once per 12 hours
G. Required Action and associated Completion Time of Condition B not met.	G.1 Explain why the non-functionality was not corrected within the specified Completion Time.	In the next scheduled Radioactive Effluent Release Report pursuant to Technical Specification 5.6.3

TESTING REQUIREMENTS

---NOTE---
Refer to Table 16.11-2-1 to determine which TRs apply for each Radioactive Liquid Effluent Monitoring Instrumentation channel.

	TEST	FREQUENCY
TR 16.11-2-1	Perform CHANNEL CHECK.	24 hours
TR 16.11-2-2	-------------------------------NOTE------------------------------- The CHANNEL CHECK shall consist of verifying indication of flow. --- Perform CHANNEL CHECK.	 24 hours during periods of release
TR 16.11-2-3	Perform SOURCE CHECK.	Prior to each release
TR 16.11-2-4	Perform SOURCE CHECK.	31 days
TR 16.11-2-5	Perform COT.	182 days
TR 16.11-2-6	-------------------------------NOTE------------------------------- For Instrument 1, the COT shall also demonstrate that automatic isolation of this pathway and control room alarm annunciation (for EMF-57, alarm annunciation is in the Monitor Tank Building control room and on the Monitor Tank Building control panel remote annunciator panel) occur if any of the following conditions exist: a. Instrument indicates measured levels above the Alarm/Trip Setpoint, or b. Circuit failure/instrument downscale failure (alarm only) --- Perform COT.	 18 months

(continued)

TESTING REQUIREMENTS (continued)

	TEST	FREQUENCY
TR 16.11-2-7	---------------------------------NOTE--------------------------------- For Instrument 1, 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. --- Perform CHANNEL CALIBRATION.	18 months

Table 16.11-2-1
Radioactive Liquid Effluent Monitoring Instrumentation

		REQUIRED CHANNELS	CONDITIONS	APPLICABILITY	TESTING REQUIREMENTS
1.	Radioactivity Monitors Providing Alarm and Automatic Termination of Release				
1.a	Waste Liquid Discharge Monitor (EMF-49 – Low Range)	1 per station	A, B, G / C	At all times / (Note 1)	TR 16.11-2-1 TR 16.11-2-3 TR 16.11-2-6 TR 16.11-2-7
1.b	Turbine Building Sump Monitor (EMF-31)	1	A, B, G / E	At all times / (Note 1)	TR 16.11-2-1 TR 16.11-2-4 TR 16.11-2-6 TR 16.11-2-7
1.c	Monitor Tank Building Liquid Discharge Monitor (EMF-57 – Low Range)	1 per station	A, B, G / C	At all times / (Note 1)	TR 16.11-2-1 TR 16.11-2-3 TR 16.11-2-6 TR 16.11-2-7
2.	Continuous Composite Samplers and Sampler Flow Monitor				
2.a	Conventional Waste Water Treatment Line (no alarm/trip function)	1 per station	B, G / E	At all times / (Note 1)	TR 16.11-2-2 TR 16.11-2-7
3.	Flow Rate Measurement Devices				
3.a	Waste Liquid Effluent Line (no alarm/trip function)	1 per station	B, G / D	At all times / (Note 1)	TR 16.11-2-2 TR 16.11-2-7
3.b	Conventional Waste Water Treatment Line (no alarm/trip function)	1 per station	B, G / D	At all times / (Note 1)	TR 16.11-2-2 TR 16.11-2-7
3.c	Low Pressure Service Water Minimum Flow Interlock	1 per station	B, G / D	At all times / (Note 1)	TR 16.11-2-2 TR 16.11-2-5 TR 16.11-2-7
3.d	Monitor Tank Building Waste Liquid Effluent Line (no alarm/trip function)	1 per station	B, G / D	At all times / (Note 1)	TR 16.11-2-2 TR 16.11-2-7
4.	Radioactivity Monitors Providing Alarm				
4.a	Service Water Monitor on Containment Spray Heat Exchanger (EMF-45 A & B – Low Range)	1 per heat exchanger	A, B, G / F	At all times / (Note 1)	TR 16.11-2-1 TR 16.11-2-4 TR 16.11-2-6 TR 16.11-2-7

Note 1: At all times, unless effluent pathway is mechanically isolated such that a release to the environment is not possible.

BASES

The Radioactive Liquid Effluent Monitoring Instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in liquid effluents during actual or potential releases of liquid effluents. The Alarm/Trip Setpoints for these instruments shall be calculated 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 FUNCTIONALITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10 CFR Part 50.

Regarding Note 1 of Table 16.11-2-1, isolation of the effluent pathway is to be by mechanical means (e.g., valve closure). Electrical or pneumatic isolation is not required, unless the isolation is designed to receive an automatic signal to open.

REFERENCES

1. Catawba Offsite Dose Calculation Manual.
2. 10 CFR Part 20.
3. 10 CFR Part 50, Appendix A.

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

16.11-2 Radioactive Liquid Effluent Monitoring Instrumentation

COMMITMENT The Radioactive Liquid Effluent Monitoring Instrumentation channels shown in Table 16.11-2-1 shall be FUNCTIONAL with their Alarm/Trip Setpoints set to ensure that the limits of SLC 16.11-1 are not exceeded.

AND

The Alarm/Trip Setpoints of these channels shall be determined and adjusted in accordance with the methodology and parameters in the OFFSITE DOSE CALCULATION MANUAL (ODCM).

APPLICABILITY: Condition Applicability is as shown in Table 16.11-2-1.

REMEDIAL ACTIONS

---NOTE---
Separate Condition entry is allowed for each Function.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or more Radioactive Liquid Effluent Monitoring Instrumentation channel(s) Alarm/Trip Setpoint less conservative than required.	A.1 Suspend the release of radioactive liquid effluents monitored by the affected channel(s).	Immediately
	<u>OR</u>	
	A.2 Declare the channel(s) non-functional.	Immediately
B. One or more Radioactive Liquid Effluent Monitoring Instrumentation channel(s) non-functional.	B.1 Enter the applicable Conditions and Required Actions specified in Table 16.11-2-1 for the channel(s).	Immediately
	<u>AND</u>	
	B.2.1 Restore channel to FUNCTIONAL status.	14 Days (*Note 1)
	<u>OR</u>	
	B.2.2 Restore channel to FUNCTIONAL status.	30 Days (*Note 1)

*Note 1 – Required Action B.2.1 Applies to Instruments 1.a and 1.c ONLY. Required Action B.2.2 Applies to the remainder of required Instruments listed in Table 16.11-2-1.

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
C. One channel non-functional.	C.1.1 Analyze two independent samples per Testing Requirement 16.11-1-1.	Prior to initiating a release
	AND	
	C.1.2 Perform independent verification of the discharge line valving.	Prior to initiating a release
	AND	
	C.1.3.1 Perform independent verification of manual portion of the computer input for release rate calculations performed by computer.	Prior to initiating a release
	OR	
	C.1.3.2 Perform independent verification of entire calculations for release rate calculations performed manually.	Prior to initiating a release
	OR	
	C.2 Suspend release of radioactive effluents via this pathway.	Immediately

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
D. One flow rate measurement device channel non-functional.	D.1 --------------NOTE------------- Pump performance curves generated in place may be used to estimate flow. ----------------------------------- Estimate the flow rate of the release.	 Once per 4 hours during releases
E. One channel non-functional.	E.1 Perform an analysis of grab samples for radioactivity at a lower limit of detection of 10^{-7} microCurie/ml.	Once per 12 hours during releases when secondary specific activity is > 0.01 microCurie/gm DOSE EQUIVALENT I-131 <u>AND</u> Once per 24 hours during releases when secondary specific activity is $\leq$ 0.01 microCurie/gm DOSE EQUIVALENT I-131

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
F. One channel non-functional.	F.1 Collect and analyze grab samples for principal gamma emitters (listed in Table 16.11-1-1, NOTE 3) at a lower limit of detection of no more than 5×10^{-7} microCurie/ml.	Once per 12 hours
G. Required Action and associated Completion Time of Condition B not met.	G.1 Explain why the non-functionality was not corrected within the specified Completion Time.	In the next scheduled Radioactive Effluent Release Report pursuant to Technical Specification 5.6.3

TESTING REQUIREMENTS

----------NOTE----------
Refer to Table 16.11-2-1 to determine which TRs apply for each Radioactive Liquid Effluent Monitoring Instrumentation channel.

	TEST	FREQUENCY
TR 16.11-2-1	Perform CHANNEL CHECK.	24 hours
TR 16.11-2-2	----------NOTE---------- The CHANNEL CHECK shall consist of verifying indication of flow. -------------------- Perform CHANNEL CHECK.	24 hours during periods of release
TR 16.11-2-3	Perform SOURCE CHECK.	Prior to each release
TR 16.11-2-4	Perform SOURCE CHECK.	31 days
TR 16.11-2-5	Perform COT.	182 days
TR 16.11-2-6	----------NOTE---------- For Instrument 1, the COT shall also demonstrate that automatic isolation of this pathway and control room alarm annunciation (for EMF-57, alarm annunciation is in the Monitor Tank Building control room and on the Monitor Tank Building control panel remote annunciator panel) occur if any of the following conditions exist: a. Instrument indicates measured levels above the Alarm/Trip Setpoint, or b. Circuit failure/instrument downscale failure (alarm only) -------------------- Perform COT.	18 months

(continued)

TESTING REQUIREMENTS (continued)

TEST		FREQUENCY
TR 16.11-2-7	---------------------------------NOTE--------------------------------- For Instrument 1, 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. --	
	Perform CHANNEL CALIBRATION.	18 months

Table 16.11-2-1
Radioactive Liquid Effluent Monitoring Instrumentation

		REQUIRED CHANNELS	CONDITIONS	APPLICABILITY	TESTING REQUIREMENTS
1.	Radioactivity Monitors Providing Alarm and Automatic Termination of Release				
1.a	Waste Liquid Discharge Monitor (EMF-49 – Low Range)	1 per station	A, B, G / C	At all times / (Note 1)	TR 16.11-2-1 TR 16.11-2-3 TR 16.11-2-6 TR 16.11-2-7
1.b	Turbine Building Sump Monitor (EMF-31)	1	A, B, G / E	At all times / (Note 1)	TR 16.11-2-1 TR 16.11-2-4 TR 16.11-2-6 TR 16.11-2-7
1.c	Monitor Tank Building Liquid Discharge Monitor (EMF-57 – Low Range)	1 per station	A, B, G / C	At all times / (Note 1)	TR 16.11-2-1 TR 16.11-2-3 TR 16.11-2-6 TR 16.11-2-7
2.	Continuous Composite Samplers and Sampler Flow Monitor				
2.a	Conventional Waste Water Treatment Line (no alarm/trip function)	1 per station	B, G / E (Note 2)	At all times / (Note 1)	TR 16.11-2-2 TR 16.11-2-7
3.	Flow Rate Measurement Devices				
3.a	Waste Liquid Effluent Line (no alarm/trip function)	1 per station	B, G / D	At all times / (Note 1)	TR 16.11-2-2 TR 16.11-2-7
3.b	Conventional Waste Water Treatment Line (no alarm/trip function)	1 per station	B, G / D (Note 2)	At all times / (Note 1)	TR 16.11-2-2 TR 16.11-2-7
3.c	Low Pressure Service Water Minimum Flow Interlock	1 per station	B, G / D	At all times / (Note 1)	TR 16.11-2-2 TR 16.11-2-5 TR 16.11-2-7
3.d	Monitor Tank Building Waste Liquid Effluent Line (no alarm/trip function)	1 per station	B, G / D	At all times / (Note 1)	TR 16.11-2-2 TR 16.11-2-7
4.	Radioactivity Monitors Providing Alarm				
4.a	Service Water Monitor on Containment Spray Heat Exchanger (EMF-45 A & B – Low Range)	1 per heat exchanger	A, B, G / F	At all times / (Note 1)	TR 16.11-2-1 TR 16.11-2-4 TR 16.11-2-6 TR 16.11-2-7

Note 1: At all times, unless effluent pathway is mechanically isolated such that a release to the environment is not possible.
Note 2: Condition D entry and associated Required Action not required if any flow indication remains available. Condition E entry and associated Required Action not required if the composite sampler remains available.

BASES

The Radioactive Liquid Effluent Monitoring Instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in liquid effluents during actual or potential releases of liquid effluents. The Alarm/Trip Setpoints for these instruments shall be calculated 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 FUNCTIONALITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10 CFR Part 50.

Regarding Note 1 of Table 16.11-2-1, isolation of the effluent pathway is to be by mechanical means (e.g., valve closure). Electrical or pneumatic isolation is not required, unless the isolation is designed to receive an automatic signal to open.

Note 2 allows for the continued use of any installed discharge flow indication on loop 0WCLP5110. This note also allows for use of the composite sampler if available. In some instances, the transmitter and associated components may be declared nonfunctional but still provide accurate flow indication or continue to take composite samples as required.

REFERENCES

1. Catawba Offsite Dose Calculation Manual.
2. 10 CFR Part 20.
3. 10 CFR Part 50, Appendix A.

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

16.11-3 Dose

COMMITMENT The dose or dose commitment to a MEMBER OF THE PUBLIC from radioactive materials in liquid effluents released, from each unit, to UNRESTRICTED AREAS (see Figure 16.11-16-1 in SLC 16.11-16) shall be limited:

a. During any calendar quarter to $\leq$ 1.5 mrem to the whole body and to $\leq$ 5 mrem to any organ, and

b. During any calendar year to $\leq$ 3 mrem to the whole body and to $\leq$ 10 mrem to any organ.

APPLICABILITY: At all times.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Calculated dose from release of radioactive materials in liquid effluents exceeding above limits.	A.1 --------------NOTE------------- If drinking water supply is taken from receiving water body within 3 miles downstream of plant discharge, the Special Report shall also include the results of radiological analyses of the drinking water source and the radiological impact on finished drinking water supplies with regard to 40 CFR 141, Safe Drinking Water Act. ------------------------------------	
	Prepare and submit a Special Report to the NRC which identifies the causes for exceeding the limits, corrective actions taken to reduce releases, and actions taken to ensure that subsequent releases are within limits.	30 days

TESTING REQUIREMENTS

TEST		FREQUENCY
TR 16.11-3-1	Determine cumulative dose contributions from liquid effluents for current calendar quarter and current calendar year in accordance with the methodology and parameters in the ODCM.	31 days

BASES

This SLC is provided to implement the requirements of Sections II.A, III.A and IV.A of Appendix I, 10 CFR Part 50. The COMMITMENT implements the guides set forth in Section II.A of Appendix I. The REMEDIAL ACTION statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in liquid effluents to UNRESTRICTED AREAS will be kept "as low as is reasonably achievable". Also, for fresh water sites with drinking water supplies that can be potentially affected by plant operations, there is reasonable assurance that the operation of the facility will not result in radionuclide concentrations in the finished drinking water that are in excess of the requirements of 40 CFR Part 141. The dose calculation methodology and parameters in the ODCM implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data, such that the actual exposure of a MEMBER OF THE PUBLIC through appropriate pathways is unlikely to be substantially underestimated. The equations specified in the ODCM for calculating the doses due to the actual release rates of radioactive materials in liquid effluents are consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1, October 1977 and Regulatory Guide 1.113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I," April 1977.

This SLC applies to the release of radioactive materials in liquid effluents from each unit at the site. When shared radwaste treatment systems are used by more than one unit on a site, the wastes from all units are mixed for shared treatment; by such mixing, the effluent releases cannot accurately be ascribed to a specific unit. An estimate should be made of the contributions from each unit based on input conditions, e.g., flow rates and radioactivity concentrations, or, if not practicable, the treated effluent releases may be allocated equally to each of the radioactive waste producing units sharing the radwaste treatment system. For determining conformance to COMMITMENTS, these allocations from shared radwaste treatment systems are to be added to the releases specifically attributed to each unit to obtain the total releases per unit.

REFERENCES

1. Catawba Offsite Dose Calculation Manual.
2. 40 CFR Part 141.
3. 10 CFR Part 50, Appendix I.

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

16.11-4 Liquid Radwaste Treatment System

COMMITMENT: The Liquid Radwaste Treatment System shall be FUNCTIONAL and appropriate portions of the system shall be used to reduce releases of radioactivity when the projected doses due to the liquid effluent, from each unit, to UNRESTRICTED AREAS (see Figure 16.11-16-1 in SLC 16.11-16) 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.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Radioactive liquid waste being discharged without treatment and in excess of above limits. AND Any portion of Liquid Radwaste Treatment System not in operation.	A.1 Prepare and submit a Special Report to the NRC which identifies the reasons liquid radwaste was discharged without treatment, identification of non-functional equipment and reasons for non-functionality, corrective actions taken to restore the equipment to FUNCTIONAL status, and actions taken to prevent recurrence.	30 days

TESTING REQUIREMENTS

---NOTE---
The Liquid Radwaste Treatment System shall be demonstrated FUNCTIONAL by meeting SLC 16.11-1 and SLC 16.11-3.

TEST		FREQUENCY
TR 16.11-4-1	Project liquid release doses from each unit to UNRESTRICTED AREAS, in accordance with the methodology and parameters in the ODCM, when the Liquid Radwaste Treatment System is not being fully utilized.	31 days

BASES

The FUNCTIONALITY 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 COMMITMENT implements the requirements of 10 CFR Part 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50, and the design objective given in Section II.D of Appendix I to 10 CFR Part 50. The specified limits governing the use of appropriate portions of the Liquid Radwaste Treatment System were specified as a suitable fraction of the dose design objectives set forth in Section II.A of Appendix I, 10 CFR Part 50, for liquid effluents.

This SLC applies to the release of radioactive materials in liquid effluents from each unit at the site. When shared radwaste treatment systems are used by more than one unit on a site, the wastes from all units are mixed for shared treatment; by such mixing, the effluent releases cannot accurately be ascribed to a specific unit. An estimate should be made of the contributions from each unit based on input conditions, e.g., flow rates and radioactivity concentrations, or, if not practicable, the treated effluent releases may be allocated equally to each of the radioactive waste producing units sharing the radwaste treatment system. For determining conformance to COMMITMENTS, these allocations from shared radwaste treatment systems are to be added to the releases specifically attributed to each unit to obtain the total releases per unit.

REFERENCES

1. Catawba Offsite Dose Calculation Manual.

2. 10 CFR Part 50, Appendix A.

REFERENCES (continued)

3. 10 CFR Part 50, Appendix I.

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

16.11-5 Chemical Treatment Ponds

COMMITMENT

The quantity of radioactive material contained in each Chemical Treatment Pond (CTP) shall be limited by the following expression:

$$\frac{264}{V} \cdot \sum_{j} \frac{A_j}{(C_j \ x\, 10)} < 1.0$$

excluding tritium and dissolved or entrained noble gases,

where:

A_j = CTP inventory limit for single radionuclide “j”, in Curies;

C_j = 10 CFR 20, Appendix B, Table 2, Column 2, concentration for single radionuclide “j”, microCuries/milliliter;

V = design volume of liquid and slurry in the CTP, in gallons; and

264 = conversion unit, microCuries/Curie per milliliter/gallon.

APPLICABILITY: At all times.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Quantity of radioactive material in any CTP exceeding above limit.	A.1 Suspend all additions of radioactive material to the CTP.	Immediately
	<u>AND</u>	
	A.2 Initiate corrective action to reduce the CTP contents to within limits.	Immediately

TESTING REQUIREMENTS

TEST		FREQUENCY
TR 16.11-5-1	Verify that the quantity of radioactive material contained in each batch of resin/water slurry to be transferred to the CTPs is within limits by analyzing a representative sample of the batch to be transferred. Each batch to be transferred to the CTPs shall be limited by: $\sum_j \frac{c_j}{(C_j \, x \, 10)} < 0.006$, where: c_j = radioactive resin/water slurry concentration for radionuclide "j" entering the UNRESTRICTED AREA CTPs, in microCuries/milliliter; and C_j = 10 CFR 20, Appendix B, Table 2, Column 2, concentration for single radionuclide "j", in microCuries/milliliter.	Prior to each transfer

BASES

The inventory limits of the CTPs are based on limiting the consequences of an uncontrolled release of the pond inventory. The expression in this SLC assumes the pond inventory is uniformly mixed, that the pond is located in an uncontrolled area as defined in 10 CFR Part 20, and that the concentration limit in Note 1 to Appendix B of 10 CFR Part 20 applies.

The batch limits of resin/water slurry transferred to the CTP assure that radioactive material transferred to the CTP are "as low as is reasonably achievable" in accordance with 10 CFR 50.36a. The expression in SLC 16.11-5 assures no batch will be transferred to the CTP unless the sum of the ratios of the activity of the radionuclides to their respective concentration limitation is less than the ratio of the 10 CFR Part 50, Appendix I, Section II.A, total body dose level to the instantaneous whole body dose rate limitation, or that:

$$\sum_j \frac{c_j}{(C_j \text{ x } 10)} < \frac{3 \text{ mrem/yr}}{500 \text{ mrem/yr}} = 0.006,$$

where:

BASES (continued)

c_j = radioactive resin/water slurry concentration for radionuclide “j” entering the UNRESTRICTED AREA CTP, in microCuries/milliliter; and,

C_j = 10 CFR Part 20, Appendix B, Table 2, Column 2, concentration for single radionuclide “j”, in microCuries/milliliter.

The filter/demineralizers using powdered resin and the blowdown demineralizer are backwashed or sluiced to a holding tank. The tank will be agitated to obtain a representative sample of the resin inventory in the tank. A known weight of the wet, drained resin (moisture content approximately 55 to 60%, bulk density of about 58 pounds per cubic foot) will then be counted. The concentration of the resin slurry to be pumped to the CTPs will then be determined by the formula:

$$c_j = \frac{Q_j W_R}{V_T},$$

where:

Q_j = concentration of radioactive materials in wet, drained resin for radionuclide “j”, excluding tritium, dissolved or entrained noble gases, and radionuclides with less than an 8-day half-life. The analysis shall include at least Ce-144, Cs-134, Cs-137, Co-58, and Co-60, in microCuries/gram. Estimates of the Sr-89 and Sr-90 batch concentration shall be included based on the most recent monthly composite analysis (within 3 months);

W_R = total weight of resin in the storage tank in grams (determined from chemistry logs procedures); and,

V_T = total volume of resin water mixture in storage tank to be transferred to the CTPs in milliliters.

The batch limits provide assurance that activity input to the CTP will be minimized, and a means of identifying radioactive material in the inventory limitation of this SLC.

REFERENCES

1. Catawba Offsite Dose Calculation Manual.
2. 10 CFR Part 20, Appendix B.
3. 10 CFR Part 50, Appendix I.

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

16.11-6 Gaseous Effluents

COMMITMENT The dose rate due to radioactive materials released in gaseous effluents from the site to areas at and beyond the SITE BOUNDARY (see Figure 16.11-16-1 in SLC 16.11-16) shall be limited to the following:

a. For noble gases: $\leq$ 500 mrem/yr to the whole body and $\leq$ 3000 mrem/yr to the skin; and,

b. For Iodine-131, for Iodine-133, for tritium, and for all radionuclides in particulate form with half-lives > 8 days: $\leq$ 1500 mrem/yr to any organ.

APPLICABILITY: At all times.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Dose rate not within limit.	A.1 Restore the release rate to within limits.	Immediately

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11-6-1 Verify that the dose rate due to noble gases in gaseous effluents is within limits in accordance with the methodology and parameters in the ODCM.	In accordance with the methodology and parameters in the ODCM
TR 16.11-6-2 Verify that the dose rate due to Iodine-131, Iodine-133, tritium, and all radionuclides in particulate form with half-lives > 8 days in gaseous effluents is within limits in accordance with the methodology and parameters in the ODCM by obtaining representative samples and performing analyses according to Table 16.11-6-1.	According to Table 16.11-6-1

Table 16.11-6-1

Radioactive Gaseous Waste Sampling and Analysis Program (page 1 of 4)

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	Prior to each release Each Tank Grab Sample	Prior to each release Each Tank	Principal Gamma Emitters(2)	$1x10^{-4}$
2. Containment Purge	Prior to each release Each PURGE(3) Grab Sample	Prior to each release Each PURGE(3)	Principal Gamma Emitters(2)	$1x10^{-4}$
		31 days	H-3 (oxide)	$1x10^{-6}$
3. Unit Vent	7 days(3)(4) Grab Sample	7 days(3)	Principal Gamma Emitters(2)	$1x10^{-4}$
			H-3 (oxide)	$1x10^{-6}$
4. Containment Air Release and Addition System	24 hours(3)(5) Grab Sample	24 hours(3)(5)	Principal Gamma Emitters(2)	$1x10^{-4}$
		31 days	H-3 (oxide)	$1x10^{-6}$
5. All Release Types as Listed in 3. Above	Continuous(6)	7 days(7) Charcoal Sample	I-131	$1x10^{-12}$
			I-133	$1x10^{-10}$
	Continuous(6)	7 days(7) Particulate Sample	Principal Gamma Emitters(2)	$1x10^{-11}$
	Continuous(6)	31 days Composite Particulate Sample	Gross Alpha(8)	$1x10^{-11}$
	Continuous(6)	92 days Composite Particulate Sample	Sr-89, Sr-90	$1x10^{-11}$

(continued)

Table 16.11-6-1

Radioactive Gaseous Waste Sampling and Analysis Program (page 2 of 4)

GASEOUS RELEASE TYPE	SAMPLING FREQUENCY	MINIMUM ANALYSIS FREQUENCY	TYPE OF ACTIVITY ANALYSIS	LOWER LIMIT OF DETECTION (LLD)(1) (µCi/ml)
6. Waste Monitor Tank Building Ventilation Exhaust	7 days Grab Sample	7 days	Principal Gamma Emitters(2)	$1x10^{-4}$
			H-3 (oxide)	$1x10^{-6}$
	Continuous(6)	7 days(9) Charcoal Sample	I-131	$1x10^{-12}$
			I-133	$1x10^{-10}$
	Continuous(6)	7 days(9) Particulate Sample	Principal Gamma Emitters(2)	$1x10^{-11}$
	Continuous(6)	31 days Composite Particulate Sample	Gross Alpha	$1x10^{-11}$
	Continuous(6)	92 days Composite Particulate Sample	Sr-89, Sr-90	$1x10^{-11}$

Table 16.11-6-1

Radioactive Gaseous Waste Sampling and Analysis Program (page 3 of 4)

NOTES:

(1) The LLD is defined, for purposes of these commitments, as the smallest concentration of radioactive material in a sample that will yield a net count, above system background, that will be detected with 95% probability with only 5% probability of falsely concluding that a blank observation represents a “real” signal.

For a particular measurement system, which may include radiochemical separation:

$$\text{LLD} = \frac{(2.71/T) + 4.65\, s_b}{E \cdot V \cdot 2.22\ x\ 10^6 \cdot Y \cdot \exp(-\lambda \Delta t)}$$

Where:

LLD = the “a priori” lower limit of detection (microCurie per unit mass or volume);

S_b = the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (counts per minute);

E = the counting efficiency (counts per disintegration);

V = the sample size (units of mass or volume);

2.22×10^6 = the number of disintegrations per minute per microCurie;

Y = the fractional radiochemical yield, when applicable;

λ = the radioactive decay constant for the particular radionuclide (sec^{-1});

Δt = the elapsed time between midpoint of sample collection and time of counting (sec); and

T = the sample counting time (min).

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

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

Table 16.11-6-1

Radioactive Gaseous Waste Sampling and Analysis Program (page 4 of 4)

(2) The principal gamma emitters for which the LLD specification applies include the following radionuclides: Kr-87, Kr-88, Xe-133, Xe-133m, Xe-135, and Xe-138 in noble gas releases based on grab samples and Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, I-131, Cs-134, Cs-137, and Ce-141 in Iodine and particulate releases based on continuous samples. The LLD for Ce-144 is $5x10^{-9}$ μCi/ml and is based on continuous samples. 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 Radioactive Effluent Release Report, pursuant to Technical Specification 5.6.3 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 stabilization (power level constant at desired power level) after a THERMAL POWER change exceeding 15% of RATED THERMAL POWER within a 1-hour period, for at least one of the three gaseous release types with this notation.

(4) Tritium grab samples shall be taken at least once per 24 hours when the refueling canal is flooded.

(5) Required sampling and analysis frequency during effluent release via this pathway.

(6) The ratio of the sample flow volume to the sampled stream flow volume shall be known for the time period covered by each dose or dose rate calculation made in accordance with SLCs 16.11-6, 16.11-8, and 16.11-9.

(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) The composite filter(s) will be analyzed for alpha activity by analyzing one filter per week to ensure that at least four filters are analyzed per collection period.

(9) Samples shall be changed at least once per 7 days and analyses shall be completed within 48 hours to meet LLDs after changing, or after removal from sampler. If the particulate and charcoal sample frequency is changed to a 24-hour frequency, the corresponding LLDs may be increased by a factor of 10 (e.g., LLD for I-131 from $1x10^{-12}$ to $1x10^{-11}$ μCi/ml).

BASES

The basic requirements for SLCs concerning effluents from nuclear power reactors are stated in 10 CFR 50.36a. These requirements indicate that compliance with effluent SLCs will keep average annual releases of radioactive material in effluents to small percentages of the limits specified in the old 10 CFR 20.106 (new 10 CFR 20.1301). These requirements further indicate that operational flexibility is allowed, compatible with considerations of health and safety, which may temporarily result in releases higher than such small percentages, but still within the limits specified in the old 10 CFR 20.106 which references Appendix B, Table II concentrations (MPCs). These referenced concentrations are specific values which relate to an annual dose of 500 mrems. It is further indicated in 10 CFR 50.36a that when using operational flexibility, best efforts shall be exerted to keep levels of radioactive materials in effluents as low as is reasonably achievable (ALARA) as set forth in 10 CFR 50, Appendix I.

As stated in the Introduction to Appendix B of the new 10 CFR 20, the gaseous effluent concentration (EC) limits given in Appendix B, Table 2, Column 1, are based on an annual dose of 50 mrems for isotopes for which inhalation or ingestion is limiting or 100 mrems for isotopes for which submersion (noble gases) is limiting. Since release concentrations corresponding to limiting dose rates less than or equal to 500 mrems/year to the whole body, 3000 mrems/year to the skin from noble gases, and 1500 mrems/year to any organ from Iodine-131, Iodine-133, tritium, and all radionuclides in particulate form with half-lives greater than 8 days at the site boundary has been acceptable as a SLC limit for gaseous effluents to assure that the limits of 10 CFR 50, Appendix I and 40 CFR 190 are not likely to be exceeded, it should not be necessary to restrict the operational flexibility by incorporating the dose rate associated with the EC value for isotopes based on inhalation/ingestion (50 mrems/year) or the dose rate associated with the EC value for isotopes based on submersion (100 mrems/year).

Having sufficient operational flexibility is especially important in establishing a basis for effluent monitor setpoint calculations. As discussed above, the concentrations stated in the new 10 CFR 20, Appendix B, Table 2, Column 1, relate to a dose of 50 or 100 mrems in a year. When applied on an instantaneous basis, this corresponds to a dose rate of 50 or 100 mrems/year.

These low values are impractical upon which to base effluent monitor setpoint calculations for many gaseous effluent release situations when monitor background, monitor sensitivity, and monitor performance must be taken into account.

Therefore, to accommodate operational flexibility needed for effluent releases, the limits associated with gaseous release rate SLCs will be maintained at the current instantaneous dose rate limit for noble gases of 500 mrems/year to the whole body and 3000 mrems/year to the skin; and for Iodine-131, for Iodine-133, for tritium, and for all radionuclides in particulate

BASES (continued)

form with half-lives greater than 8 days, an instantaneous dose rate limit of 1500 mrems/year to any organ.

Compliance with the limits of the new 10 CFR 20.1301 will be demonstrated by operating within the limits of 10 CFR 50, Appendix I and 40 CFR 190. Operational history at Catawba has demonstrated that the use of the dose rate values listed above (i.e., 500 mrems/year, 3000 mrems/year, and 1500 mrems/year) as SLC limits has resulted in calculated maximum individual doses to MEMBERS OF THE PUBLIC that are small percentages of the limits of 10 CFR 50, Appendix I and 40 CFR 190.

The specified release rate limits restrict, at all times, the corresponding gamma and beta dose rates above background to a MEMBER OF THE PUBLIC at or beyond the SITE BOUNDARY to less than or equal to 500 mrem/year to the whole body and to less than or equal to 3000 mrem/year to the skin from noble gases, and to less than or equal to 1500 mrem/year to any organ from Iodine-131, Iodine-133, tritium, and all radionuclides in particulate form with half-lives greater than eight days.

This commitment applies to the release of radioactive materials in gaseous effluents from all units at the site.

The required detection capabilities for radioactive material in gaseous waste samples are tabulated in terms of the lower limits of detection (LLDs). Based on NUREG-1301 and Regulatory Guide 1.21, the LLD value of $1x10^{-4}$ µCi/ml for grab samples is only applicable to noble gases grab samples and the LLD values for particulate and iodine radionuclides are applicable to continuous charcoal and particulate samples. The Table 16.11-6-1 Gaseous Release Type Number 5 (All Release Types as Listed in 3. Above) and Type Number 6 (Waste Monitor Tank Building Ventilation Exhaust) LLDs are based on weekly samples per NUREG-1301. There are two isotopes with associated LLDs that do not agree directly with NUREG-1301: Ce-144, LLD of $5x10^{-9}$ µCi/ml, which has historically been applied and achieved for analytical results, and I-133, LLD of $1x10^{-10}$ µCi/ml, which again has been historically listed, as $1x10^{-9}$ µCi/ml, for Radioactive Gaseous Waste Sampling but changed to be in agreement with I-131 for weekly (7-day) samples and is not specified in NUREG-1301. Detailed discussion of the LLD, and other detection limits can be found in HASL Procedures Manual, HASL-300 (revised annually), Currie, L.A., "Limits for Qualitative Detection and Quantitative Determination – Application to Radiochemistry," Anal. Chem. 40, 586-93 (1968), and Hartwell, J.K., "Detection Limits for Radioanalytical Counting Techniques," Atlantic Richfield Hanford Company Report ARH-SA-215 (June 1975).

REFERENCES 1. Catawba Offsite Dose Calculation Manual.

REFERENCES (continued)

2. 10 CFR Part 20, Appendix B.

3. 10 CFR Part 20.

4. 10 CFR Part 50.

5. 40 CFR Part 190.

6. NUREG-1301.

7. Regulatory Guide 1.21.

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

16.11-7 Radioactive Gaseous Effluent Monitoring Instrumentation

COMMITMENT The Radioactive Gaseous Effluent Monitoring Instrumentation channels shown in Table 16.11-7-1 shall be FUNCTIONAL with their Alarm/Trip Setpoints set to ensure that the limits of SLC 16.11-6 are not exceeded.

AND

The Alarm/Trip Setpoints of these channels shall be determined and adjusted in accordance with the methodology and parameters in the OFFSITE DOSE CALCULATION MANUAL (ODCM).

APPLICABILITY: Conditions B and K are applicable at all times. All other Conditions are applicable as shown in Table 16.11-7-1.

REMEDIAL ACTIONS

--NOTE--
Separate Condition entry is allowed for each Function.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or more Radioactive Gaseous Effluent Monitoring Instrumentation channel(s) Alarm/Trip Setpoint less conservative than required.	A.1 Suspend the release of radioactive gaseous effluents monitored by the affected channel(s).	Immediately
	OR	
	A.2 Declare the channel(s) non-functional.	Immediately
B. One or more Radioactive Gaseous Effluent Monitoring Instrumentation channel(s) non-functional.	B.1 Enter the applicable Conditions and Required Actions specified in Table 16.11-7-1 for the channel(s).	Immediately
	AND	
	B.2.1 Restore channel to FUNCTIONAL status.	14 Days (*Note 1)
	OR	
	B.2.2 Restore channel to FUNCTIONAL status.	30 Days (*Note 1)

*Note 1 – Required Action B.2.1 applies to Instrument 1.a ONLY. (continued)
Required Action B.2.2 applies to Instruments 1.b, 2, 3.a, 3.c, 3.d, 3.e, 5, 6.a, and 6.b listed in Table 16.11-7-1.

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
C. One channel non-functional.	C.1 Verify that EMF-36 (Low Range) is FUNCTIONAL.	Prior to initiating a release
	OR	
	C.2.1 Analyze two independent samples of the tank's contents.	Prior to initiating a release
	AND	
	C.2.2 Perform independent verification of the discharge line valving.	Prior to initiating a release
	AND	
	C.2.3.1 Perform independent verification of manual portion of the computer input for release rate calculations performed by computer.	Prior to initiating a release
	OR	
	C.2.3.2 Perform independent verification of entire calculations for release rate calculations performed manually.	Prior to initiating a release
	OR	
	C.3 Suspend release of radioactive effluents via this pathway.	Immediately

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
D. One or more flow rate measurement device channel(s) non-functional.	D.1 Estimate the flow rate of the release.	Once per 4 hours during releases
E. One or more Noble Gas Activity Monitor channel(s) non-functional.	------------------NOTE------------------- **IF** 0EMF41 is NON-FUNCTIONAL **AND** either 1EMF36 **OR** 2EMF36 is NON-FUNCTIONAL, perform SLC 16.7-10, Required Action G.2 ---	
	E.1 Obtain grab samples from effluent pathway.	Once per 12 hours during releases
	AND	
	E.2 Perform an analysis of grab samples for radioactivity.	Within 24 hours of obtaining the sample

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
F. Noble Gas Activity Monitor (EMF-39 – Low Range) providing automatic termination of release via the Containment Purge Exhaust System (CPES) non-functional.	F.1 -------------NOTE-------------- In order to utilize Required Action F.1, the following conditions must be satisfied: 1. The affected unit is in MODES 5 or 6. 2. EMF-36 is FUNCTIONAL and in service for the affected unit. 3. The Reactor Coolant System for the affected unit has been vented. 4. Either the reactor vessel head is in place (bolts are not required), or if it is not in place, the lifting of heavy loads over the reactor vessel and the movement of irradiated fuel assemblies within containment have been suspended. ------------------------------------ Restore the non-functional channel to FUNCTIONAL status.	 12 hours
G. Required Action and associated Completion Time of Condition F not met. <u>OR</u> Required Action F.1 not utilized.	G.1 Suspend PURGING of radioactive effluents via this pathway.	Immediately

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
H. One or more sampler channel(s) non-functional.	H.1 Perform sampling with auxiliary sampling equipment as required by Table 16.11-6-1.	Continuously
I. One Condenser Evacuation System Noble Gas Activity Monitor (EMF-33) channel non-functional.	I.1 --------------NOTE------------- Applicable to effluent releases via the Condenser Steam Air Ejector (ZJ) System. ------------------------------------	
	Obtain grab samples from effluent pathway.	Once per 12 hours during releases
	<u>AND</u>	
	I.2 --------------NOTE------------- Applicable to effluent releases via the Condenser Steam Air Ejector (ZJ) System. ------------------------------------	
	Perform an analysis of grab samples for radioactivity.	Within 24 hours of obtaining the sample
	<u>AND</u>	
		(continued)

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
I. (continued)	I.3 --------------NOTE------------- Applicable to effluent releases via the Steam Generator Blowdown (BB) System atmospheric vent valve (BB-27) in the off-normal mode. ------------------------------------ Perform an analysis of grab samples for radioactivity at a lower limit of detection of 10^{-7} microCurie/ml.	 Once per 12 hours during releases when secondary specific activity is > 0.01 microCurie/gm DOSE EQUIVALENT I-131 AND Once per 24 hours during releases when secondary specific activity is $\leq$ 0.01 microCurie/gm DOSE EQUIVALENT I-131
J. Noble Gas Activity Monitor (EMF-39 – Low Range) providing automatic termination of release via the Containment Air Release and Addition System non-functional.	J.1 Verify that EMF-36 is FUNCTIONAL. OR J.2.1 Analyze two independent samples of the containment atmosphere. AND	Prior to initiating a release Prior to initiating a release (continued)

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
J. (continued)	J.2.2 Perform independent verification of the discharge line valving.	Prior to initiating a release
	AND	
	J.2.3.1 Perform independent verification of manual portion of the computer input for release rate calculations performed by computer.	Prior to initiating a release
	OR	
	J.2.3.2 Perform independent verification of entire calculations for release rate calculations performed manually.	Prior to initiating a release

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
K. Required Action and associated Completion Time of Condition B or F not met.	K.1 Explain why the non-functionality was not corrected within the specified Completion Time.	In the next scheduled Radioactive Effluent Release Report pursuant to Technical Specification 5.6.3

TESTING REQUIREMENTS

---NOTE---
Refer to Table 16.11-7-1 to determine which TRs apply for each Radioactive Gaseous Effluent Monitoring Instrumentation channel.

TEST		FREQUENCY
TR 16.11-7-1	Perform CHANNEL CHECK.	Prior to each release
TR 16.11-7-2	---------------------------------NOTE--------------------------------- For Instruments 1a, 4, and 5, a SOURCE CHECK for these channels shall be the qualitative assessment of channel response when the channel sensor is exposed to a light-emitting diode. --- Perform SOURCE CHECK.	Prior to each release
TR 16.11-7-3	Perform CHANNEL CHECK.	12 hours
TR 16.11-7-4	Perform CHANNEL CHECK.	24 hours
TR 16.11-7-5	Perform CHANNEL CHECK.	7 days

(continued)

TESTING REQUIREMENTS (continued)

	TEST	FREQUENCY
TR 16.11-7-6	--------------------------------NOTE-------------------------------- For Instruments 2 and 3a, a SOURCE CHECK for these channels shall be the qualitative assessment of channel response when the channel sensor is exposed to a light-emitting diode. -- Perform SOURCE CHECK.	31 days
TR 16.11-7-7	--------------------------------NOTE-------------------------------- For Instruments 1a, 3a, 3c, 5, and 6a, the COT shall also demonstrate, as applicable, that automatic isolation of this pathway and control room alarm annunciation (for EMF-58, alarm annunciation is in the Monitor Tank Building control room and on the Monitor Tank Building control panel remote annunciator panel) occur if any of the following conditions exist: a. Instrument indicates measured levels above the Alarm/Trip Setpoint, or b. Circuit failure/instrument downscale failure (alarm only) -- Perform COT.	9 months
TR 16.11-7-8	--------------------------------NOTE-------------------------------- For Instruments 2 and 4, the COT shall also demonstrate that automatic isolation of this pathway and control room alarm annunciation occur if any of the following conditions exist: a. Instrument indicates measured levels above the Alarm/Trip Setpoint, or b. Circuit failure/instrument downscale failure (alarm only) -- Perform COT.	18 months

(continued)

TESTING REQUIREMENTS (continued)

	TEST	FREQUENCY
TR 16.11-7-9	----------NOTE---------- For Instruments 1a, 2, 3a, 3c, 4, 5, and 6a, 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. ----------------------------	
	Perform CHANNEL CALIBRATION.	18 months

Table 16.11-7-1

Radioactive Gaseous Effluent Monitoring Instrumentation (page 1 of 2)

INSTRUMENT		REQUIRED CHANNELS	CONDITIONS	APPLICABLE MODES	TESTING REQUIREMENTS
1.	Waste Gas Holdup System				
1.a	Noble Gas Activity Monitor – Providing Alarm and Automatic Termination of Release (EMF-50 – Low Range)	1 per station	A, B, C, K	At all times except when the isolation valve is closed and locked	TR 16.11-7-1 TR 16.11-7-2 TR 16.11-7-7 TR 16.11-7-9
1.b	Effluent System Flow Rate Measuring Device	1 per station	B, D, K	At all times except when the isolation valve is closed and locked	TR 16.11-7-1 TR 16.11-7-9
2.	Condenser Evacuation System Noble Gas Activity Monitor (EMF-33) (BB-27 is only isolation function required) (Note 1)	1	A, B, I, K	When air ejectors are in operation (Apply Required Action I.3 when air ejectors are not in operation)	TR 16.11-7-3 TR 16.11-7-6 TR 16.11-7-8 TR 16.11-7-9
3.	Vent System				
3.a	Noble Gas Activity Monitor (EMF-36 – Low Range)	1	A, B, E, K	At all times	TR 16.11-7-4 TR 16.11-7-6 TR 16.11-7-7 TR 16.11-7-9
3.b	Deleted.				
3.c	Particulate Sampler (EMF-35)	1	A, B, H, K	At all times (Note 2)	TR 16.11-7-4 TR 16.11-7-6 TR 16.11-7-7 TR 16.11-7-9
3.d	Unit Vent Stack Flow Rate Meter (no alarm/trip function)	1	B, D, K	At all times (Note 2)	TR 16.11-7-4 TR 16.11-7-9
3.e	Unit Vent Radiation Monitor Flow Meter	1	B, E, K	At all times (Note 2)	TR 16.11-7-4 TR 16.11-7-9
4.	Containment Purge System Noble Gas Activity Monitor – Providing Alarm and Automatic Termination of Release (EMF-39 – Low Range)	1	A, F, G, K	5, 6	TR 16.11-7-2 TR 16.11-7-3 TR 16.11-7-8 TR 16.11-7-9

(continued)

Table 16.11-7-1

Radioactive Gaseous Effluent Monitoring Instrumentation (page 2 of 2)

INSTRUMENT	REQUIRED CHANNELS	CONDITIONS	APPLICABLE MODES	TESTING REQUIREMENTS
5. Containment Air Release and Addition System Noble Gas Activity Monitor – Providing Alarm and Automatic Termination of Release (EMF-39 – Low Range)	1	A, B, J, K	1, 2, 3, 4, 5, 6	TR 16.11-7-2 TR 16.11-7-3 TR 16.11-7-7 TR 16.11-7-9
6. Monitor Tank Building HVAC				
6.a Noble Gas Activity Monitor – Providing Alarm (EMF-58 – Low Range)	1 per station	A, B, E, K	At all times (Note 2)	TR 16.11-7-4 TR 16.11-7-6 TR 16.11-7-7 TR 16.11-7-9
6.b Effluent Flow Rate Measuring Device	1 per station	B, D, K	At all times (Note 2)	TR 16.11-7-4 TR 16.11-7-9

Note 1: The setpoint is as required by the primary to secondary leak rate monitoring program.

Note 2: Except when the effluent pathway is mechanically isolated; thus, a release to the environment is not possible.

BASES

The Radioactive Gaseous Effluent Monitoring 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 Setpoints for these instruments shall be calculated 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. Conservative Alarm/Trip Setpoints may be used during a release provided they are less than or equal to the setpoints determined by the methodology and parameters of the ODCM. The FUNCTIONALITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10 CFR Part 50. The sensitivity of any noble gas activity monitor used to show compliance with the gaseous effluent release requirements of SLC 16.11-8 shall be such that concentrations as low as 1×10^{-6} μCi/cc are measurable.

Regarding Note 2 of Table 16.11-7-1, isolation of the effluent pathway is to be by mechanical means (e.g., valve closure). Electrical or pneumatic isolation is not required, unless the isolation is designed to receive an automatic signal to open.

In MODES 5 and 6, initiation of the Containment Purge Exhaust System (CPES) with EMF-39 non-functional is not permissible. The basis for Required Action F.1 is to allow the continued operation of the CPES with EMF-39 initially FUNCTIONAL. Continued operation of the CPES is contingent upon the ability of the affected unit to meet the requirements as noted in Required Action F.1.

TR 16.11-7-7 requires the performance of a COT on the applicable Radioactive Gaseous Effluent Radiation Monitors. The test ensures that a signal from the control room module can generate the appropriate alarm and actuations. The required actuations/isolations for a High Radiation condition (i.e., radiation level above its Trip 2 setpoint) are listed below for each monitor.

0EMF-50 - Waste Gas Discharge Monitor
1WG160 closes when EMF-50 detects radiation level above its setpoint.

1/2EMF-36 - Unit Vent Noble Gas Monitor
The following actuations occur when EMF-36 detects radiation level above its setpoint:

1. Containment Air Release and Addition System fans discharge to unit vent valve VQ10 closes.
2. Auxiliary Building unfiltered ventilation exhaust fans A and B stop.
3. Fuel Handling Ventilation Exhaust System (FHVES) exhaust trains align to the filter units.
4. (For 1EMF-36 only) 1WG160 closes.

1/2EMF-35 - Unit Vent Particulate Monitor (Sampler)
The following actuations occur when EMF-35 detects radiation level above its setpoint:

1. Containment Air Release and Addition System fans discharge to unit vent valve VQ10 closes.
2. Auxiliary Building unfiltered ventilation exhaust fans A and B stop.

BASES (continued)

3. Fuel Handling Ventilation Exhaust System (FHVES) exhaust trains align to the filter units.
4. ((For 1EMF-35 only) 1WG160 closes.

1/2EMF-39 - Containment Noble Gas Monitor
The following actuations occur when EMF-39 detects radiation level above its setpoint:

1. Signals are provided to both trains of the Solid State Protection System (SSPS) to initiate a CPES isolation. This is verified by observing that Relays K615 in the SSPS A output cabinet and the SSPS B output cabinet are latched.
2. EMF-39 isolates the CPES without going through the SSPS by stopping CPES supply fans A and B, CPES exhaust fans A and B, and by closing the appropriate valves and dampers.
3. Containment Evacuation Alarm, unless the source range trip is blocked.

0EMF-58
This monitor provides no control function.

TR 16.11-7-8 requires the performance of a COT on the Condensate Steam Air Ejector Exhaust Monitor, 1/2EMF-33 and Containment Noble Gas Monitor, 1/2EMF-39. The test ensures that a signal from the control room module can generate the appropriate alarm and actuations. The required actuations/isolations for a High Radiation condition (i.e., radiation level above its Trip 2 setpoint) are listed below.

1/2EMF-33 - Condensate Steam Air Ejector Exhaust Monitor
The following actuations occur when EMF-33 detects radiation level above its setpoint:

1. Closure of BB27 is required in order to isolate the Blowdown Tank from the environment. Because of plant limitations/restrictions:
    a. Opening the valve (in order to verify it goes closed on a High Radiation signal) is only possible during outages due to the negative effects on the Blowdown System with the unit at power.
    b. Testing during innages will be by verification of relay contacts opening in the valve circuit.
2. Closure of BB24, BB65, BB69, and BB73 is required to minimize the amount of potentially contaminated material being delivered to the Blowdown Tank.
3. Closure of NM269, NM270, NM271, and NM272 is required to minimize the amount of potentially contaminated material being delivered to the
4. Conventional Sampling System. Closure of NM267 is required to minimize the amount of potentially contaminated material being delivered to the Condensate Storage Tank by isolating flow through EMF-34.
5. Closure of BB48 is required to minimize the amount of potentially contaminated material being delivered from the Blowdown System discharge to the Turbine Building sump.

1/2EMF-39 - Containment Noble Gas Monitor

BASES (continued)

The following actuations occur when EMF-39 detects radiation level above its setpoint:

1. Signals are provided to both trains of the Solid State Protection System (SSPS) to initiate a Containment Air Release and Addition System isolation. This is verified by observing that relays K615 in the SSPS Train A output cabinet and the SSPS Train B output cabinet are latched.
2. Containment Evacuation Alarm, unless the source range trip is blocked.

REFERENCES

1. Catawba Offsite Dose Calculation Manual.

2. 10 CFR Part 20.

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

16.11-7 Radioactive Gaseous Effluent Monitoring Instrumentation

COMMITMENT

The Radioactive Gaseous Effluent Monitoring Instrumentation channels shown in Table 16.11-7-1 shall be FUNCTIONAL with their Alarm/Trip Setpoints set to ensure that the limits of SLC 16.11-6 are not exceeded.

AND

The Alarm/Trip Setpoints of these channels shall be determined and adjusted in accordance with the methodology and parameters in the OFFSITE DOSE CALCULATION MANUAL (ODCM).

APPLICABILITY: Conditions B and K are applicable at all times. All other Conditions are applicable as shown in Table 16.11-7-1.

REMEDIAL ACTIONS

--NOTE--
Separate Condition entry is allowed for each Function.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or more Radioactive Gaseous Effluent Monitoring Instrumentation channel(s) Alarm/Trip Setpoint less conservative than required.	A.1 Suspend the release of radioactive gaseous effluents monitored by the affected channel(s).	Immediately
	OR	
	A.2 Declare the channel(s) non-functional.	Immediately
B. One or more Radioactive Gaseous Effluent Monitoring Instrumentation channel(s) non-functional.	B.1 Enter the applicable Conditions and Required Actions specified in Table 16.11-7-1 for the channel(s).	Immediately
	AND	
	B.2.1 Restore channel to FUNCTIONAL status.	14 Days (*Note 1)
	OR	
	B.2.2 Restore channel to FUNCTIONAL status.	30 Days (*Note 1)

*Note 1 – Required Action B.2.1 applies to Instrument 1.a ONLY. (continued)
Required Action B.2.2 applies to Instruments 1.b, 2, 3.a, 3.c, 3.d, 3.e, 5, 6.a, and 6.b listed in Table 16.11-7-1.

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
C. One channel non-functional.	C.1 Verify that EMF-36 (Low Range) is FUNCTIONAL.	Prior to initiating a release
	<u>OR</u>	
	C.2.1 Analyze two independent samples of the tank's contents.	Prior to initiating a release
	<u>AND</u>	
	C.2.2 Perform independent verification of the discharge line valving.	Prior to initiating a release
	<u>AND</u>	
	C.2.3.1 Perform independent verification of manual portion of the computer input for release rate calculations performed by computer.	Prior to initiating a release
	<u>OR</u>	
	C.2.3.2 Perform independent verification of entire calculations for release rate calculations performed manually.	Prior to initiating a release
	<u>OR</u>	
	C.3 Suspend release of radioactive effluents via this pathway.	Immediately

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
D. One or more flow rate measurement device channel(s) non-functional.	D.1 Estimate the flow rate of the release.	Once per 4 hours during releases
E. One or more Noble Gas Activity Monitor channel(s) non-functional.	------------------NOTE------------------- **<u>IF</u>** 0EMF41 is NON-FUNCTIONAL **<u>AND</u>** either 1EMF36 **<u>OR</u>** 2EMF36 is NON-FUNCTIONAL, perform SLC 16.7-10, Required Action G.2 --	
	E.1 Obtain grab samples from effluent pathway.	Once per 12 hours during releases
	<u>AND</u>	
	E.2 Perform an analysis of grab samples for radioactivity.	Within 24 hours of obtaining the sample

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
F. Noble Gas Activity Monitor (EMF-39 – Low Range) providing automatic termination of release via the Containment Purge Exhaust System (CPES) non-functional.	F.1 -------------NOTE-------------- In order to utilize Required Action F.1, the following conditions must be satisfied: 1. The affected unit is in MODES 5 or 6. 2. EMF-36 is FUNCTIONAL and in service for the affected unit. 3. The Reactor Coolant System for the affected unit has been vented. 4. Either the reactor vessel head is in place (bolts are not required), or if it is not in place, the lifting of heavy loads over the reactor vessel and the movement of irradiated fuel assemblies within containment have been suspended. ------------------------------------ Restore the non-functional channel to FUNCTIONAL status.	12 hours
G. Required Action and associated Completion Time of Condition F not met. <u>OR</u> Required Action F.1 not utilized.	G.1 Suspend PURGING of radioactive effluents via this pathway.	Immediately

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
H. One or more sampler channel(s) non-functional.	H.1 Perform sampling with auxiliary sampling equipment as required by Table 16.11-6-1.	Continuously
I. One Condenser Evacuation System Noble Gas Activity Monitor (EMF-33) channel non-functional.	I.1 --------------NOTE------------- Applicable to effluent releases via the Condenser Steam Air Ejector (ZJ) System. ------------------------------------ Obtain grab samples from effluent pathway.	 Once per 12 hours during releases
	<u>AND</u>	
	I.2 --------------NOTE------------- Applicable to effluent releases via the Condenser Steam Air Ejector (ZJ) System. ------------------------------------ Perform an analysis of grab samples for radioactivity.	 Within 24 hours of obtaining the sample
	<u>AND</u>	
		(continued)

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
I. (continued)	I.3 --------------NOTE------------- Applicable to effluent releases via the Steam Generator Blowdown (BB) System atmospheric vent valve (BB-27) in the off-normal mode. ------------------------------------ Perform an analysis of grab samples for radioactivity at a lower limit of detection of 10^{-7} microCurie/ml.	Once per 12 hours during releases when secondary specific activity is > 0.01 microCurie/gm DOSE EQUIVALENT I-131 AND Once per 24 hours during releases when secondary specific activity is ≤ 0.01 microCurie/gm DOSE EQUIVALENT I-131
J. Noble Gas Activity Monitor (EMF-39 – Low Range) providing automatic termination of release via the Containment Air Release and Addition System non-functional.	J.1 Verify that EMF-36 is FUNCTIONAL. OR J.2.1 Analyze two independent samples of the containment atmosphere. AND	Prior to initiating a release Prior to initiating a release (continued)

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
J. (continued)	J.2.2 Perform independent verification of the discharge line valving.	Prior to initiating a release
	<u>AND</u>	
	J.2.3.1 Perform independent verification of manual portion of the computer input for release rate calculations performed by computer.	Prior to initiating a release
	<u>OR</u>	
	J.2.3.2 Perform independent verification of entire calculations for release rate calculations performed manually.	Prior to initiating a release

(continued)

REMEDIAL ACTIONS (continued)

CONDITION		REQUIRED ACTION		COMPLETION TIME
K.	Required Action and associated Completion Time of Condition B or F not met.	K.1	Explain why the non-functionality was not corrected within the specified Completion Time.	In the next scheduled Radioactive Effluent Release Report pursuant to Technical Specification 5.6.3

TESTING REQUIREMENTS

---NOTE---
Refer to Table 16.11-7-1 to determine which TRs apply for each Radioactive Gaseous Effluent Monitoring Instrumentation channel.

TEST		FREQUENCY
TR 16.11-7-1	Perform CHANNEL CHECK.	Prior to each release
TR 16.11-7-2	--------------------------------NOTE-------------------------------- For Instruments 1a, 4, and 5, a SOURCE CHECK for these channels shall be the qualitative assessment of channel response when the channel sensor is exposed to a light-emitting diode. --- Perform SOURCE CHECK.	Prior to each release
TR 16.11-7-3	Perform CHANNEL CHECK.	12 hours
TR 16.11-7-4	Perform CHANNEL CHECK.	24 hours
TR 16.11-7-5	Perform CHANNEL CHECK.	7 days

(continued)

TESTING REQUIREMENTS (continued)

TEST		FREQUENCY
TR 16.11-7-6	--------------------------------NOTE-------------------------------- For Instruments 2 and 3a, a SOURCE CHECK for these channels shall be the qualitative assessment of channel response when the channel sensor is exposed to a light-emitting diode. --- Perform SOURCE CHECK.	31 days
TR 16.11-7-7	--------------------------------NOTE-------------------------------- For Instruments 1a, 3a, 3c, 5, and 6a, the COT shall also demonstrate, as applicable, that automatic isolation of this pathway and control room alarm annunciation (for EMF-58, alarm annunciation is in the Monitor Tank Building control room and on the Monitor Tank Building control panel remote annunciator panel) occur if any of the following conditions exist: a. Instrument indicates measured levels above the Alarm/Trip Setpoint, or b. Circuit failure/instrument downscale failure (alarm only) --- Perform COT.	18 months
TR 16.11-7-8	--------------------------------NOTE-------------------------------- For Instruments 2 and 4, the COT shall also demonstrate that automatic isolation of this pathway and control room alarm annunciation occur if any of the following conditions exist: a. Instrument indicates measured levels above the Alarm/Trip Setpoint, or b. Circuit failure/instrument downscale failure (alarm only) --- Perform COT.	18 months

(continued)

TESTING REQUIREMENTS (continued)

TEST		FREQUENCY
TR 16.11-7-9	---------------------------------NOTE--------------------------------- For Instruments 1a, 2, 3a, 3c, 4, 5, and 6a, 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. --- Perform CHANNEL CALIBRATION.	18 months

Table 16.11-7-1

Radioactive Gaseous Effluent Monitoring Instrumentation (page 1 of 2)

INSTRUMENT	REQUIRED CHANNELS	CONDITIONS	APPLICABLE MODES	TESTING REQUIREMENTS
1. Waste Gas Holdup System				
1.a Noble Gas Activity Monitor – Providing Alarm and Automatic Termination of Release (EMF-50 – Low Range)	1 per station	A, B, C, K	At all times except when the isolation valve is closed and locked	TR 16.11-7-1 TR 16.11-7-2 TR 16.11-7-7 TR 16.11-7-9
1.b Effluent System Flow Rate Measuring Device	1 per station	B, D, K	At all times except when the isolation valve is closed and locked	TR 16.11-7-1 TR 16.11-7-9
2. Condenser Evacuation System Noble Gas Activity Monitor (EMF-33) (BB-27 is only isolation function required) (Note 1)	1	A, B, I, K	When air ejectors are in operation (Apply Required Action I.3 when air ejectors are not in operation)	TR 16.11-7-3 TR 16.11-7-6 TR 16.11-7-8 TR 16.11-7-9
3. Vent System				
3.a Noble Gas Activity Monitor (EMF-36 – Low Range)	1	A, B, E, K	At all times	TR 16.11-7-4 TR 16.11-7-6 TR 16.11-7-7 TR 16.11-7-9
3.b Deleted.				
3.c Particulate Sampler (EMF-35)	1	A, B, H, K	At all times (Note 2)	TR 16.11-7-4 TR 16.11-7-6 TR 16.11-7-7 TR 16.11-7-9
3.d Unit Vent Stack Flow Rate Meter (no alarm/trip function)	1	B, D, K	At all times (Note 2)	TR 16.11-7-4 TR 16.11-7-9
3.e Unit Vent Radiation Monitor Flow Meter	1	B, E, K	At all times (Note 2)	TR 16.11-7-4 TR 16.11-7-9
4. Containment Purge System Noble Gas Activity Monitor – Providing Alarm and Automatic Termination of Release (EMF-39 – Low Range)	1	A, F, G, K	5, 6	TR 16.11-7-2 TR 16.11-7-3 TR 16.11-7-8 TR 16.11-7-9

(continued)

Table 16.11-7-1

Radioactive Gaseous Effluent Monitoring Instrumentation (page 2 of 2)

INSTRUMENT	REQUIRED CHANNELS	CONDITIONS	APPLICABLE MODES	TESTING REQUIREMENTS
5. Containment Air Release and Addition System Noble Gas Activity Monitor – Providing Alarm and Automatic Termination of Release (EMF-39 – Low Range)	1	A, B, J, K	1, 2, 3, 4, 5, 6	TR 16.11-7-2 TR 16.11-7-3 TR 16.11-7-7 TR 16.11-7-9
6. Monitor Tank Building HVAC				
6.a Noble Gas Activity Monitor – Providing Alarm (EMF-58 – Low Range)	1 per station	A, B, E, K	At all times (Note 2)	TR 16.11-7-4 TR 16.11-7-6 TR 16.11-7-7 TR 16.11-7-9
6.b Effluent Flow Rate Measuring Device	1 per station	B, D, K	At all times (Note 2)	TR 16.11-7-4 TR 16.11-7-9

Note 1: The setpoint is as required by the primary to secondary leak rate monitoring program.

Note 2: Except when the effluent pathway is mechanically isolated; thus, a release to the environment is not possible.

BASES

The Radioactive Gaseous Effluent Monitoring 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 Setpoints for these instruments shall be calculated 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. Conservative Alarm/Trip Setpoints may be used during a release provided they are less than or equal to the setpoints determined by the methodology and parameters of the ODCM. The FUNCTIONALITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10 CFR Part 50. The sensitivity of any noble gas activity monitor used to show compliance with the gaseous effluent release requirements of SLC 16.11-8 shall be such that concentrations as low as 1×10^{-6} µCi/cc are measurable.

Regarding Note 2 of Table 16.11-7-1, isolation of the effluent pathway is to be by mechanical means (e.g., valve closure). Electrical or pneumatic isolation is not required, unless the isolation is designed to receive an automatic signal to open.

In MODES 5 and 6, initiation of the Containment Purge Exhaust System (CPES) with EMF-39 non-functional is not permissible. The basis for Required Action F.1 is to allow the continued operation of the CPES with EMF-39 initially FUNCTIONAL. Continued operation of the CPES is contingent upon the ability of the affected unit to meet the requirements as noted in Required Action F.1.

TR 16.11-7-7 requires the performance of a COT on the applicable Radioactive Gaseous Effluent Radiation Monitors. The test ensures that a signal from the control room module can generate the appropriate alarm and actuations. The required actuations/isolations for a High Radiation condition (i.e., radiation level above its Trip 2 setpoint) are listed below for each monitor.

0EMF-50 - Waste Gas Discharge Monitor
1WG160 closes when EMF-50 detects radiation level above its setpoint.

1/2EMF-36 - Unit Vent Noble Gas Monitor
The following actuations occur when EMF-36 detects radiation level above its setpoint:

1. Containment Air Release and Addition System fans discharge to unit vent valve VQ10 closes.
2. Auxiliary Building unfiltered ventilation exhaust fans A and B stop.
3. Fuel Handling Ventilation Exhaust System (FHVES) exhaust trains align to the filter units.
4. (For 1EMF-36 only) 1WG160 closes.

1/2EMF-35 - Unit Vent Particulate Monitor (Sampler)
The following actuations occur when EMF-35 detects radiation level above its setpoint:

1. Containment Air Release and Addition System fans discharge to unit vent valve VQ10 closes.
2. Auxiliary Building unfiltered ventilation exhaust fans A and B stop.

BASES (continued)

3. Fuel Handling Ventilation Exhaust System (FHVES) exhaust trains align to the filter units.
4. ((For 1EMF-35 only) 1WG160 closes.

1/2EMF-39 - Containment Noble Gas Monitor
The following actuations occur when EMF-39 detects radiation level above its setpoint:

1. Signals are provided to both trains of the Solid State Protection System (SSPS) to initiate a CPES isolation. This is verified by observing that Relays K615 in the SSPS A output cabinet and the SSPS B output cabinet are latched.
2. EMF-39 isolates the CPES without going through the SSPS by stopping CPES supply fans A and B, CPES exhaust fans A and B, and by closing the appropriate valves and dampers.
3. Containment Evacuation Alarm, unless the source range trip is blocked.

0EMF-58
This monitor provides no control function.

TR 16.11-7-8 requires the performance of a COT on the Condensate Steam Air Ejector Exhaust Monitor, 1/2EMF-33 and Containment Noble Gas Monitor, 1/2EMF-39. The test ensures that a signal from the control room module can generate the appropriate alarm and actuations. The required actuations/isolations for a High Radiation condition (i.e., radiation level above its Trip 2 setpoint) are listed below.

1/2EMF-33 - Condensate Steam Air Ejector Exhaust Monitor
The following actuations occur when EMF-33 detects radiation level above its setpoint:

1. Closure of BB27 is required in order to isolate the Blowdown Tank from the environment. Because of plant limitations/restrictions:
   a. Opening the valve (in order to verify it goes closed on a High Radiation signal) is only possible during outages due to the negative effects on the Blowdown System with the unit at power.
   b. Testing during innages will be by verification of relay contacts opening in the valve circuit.
2. Closure of BB24, BB65, BB69, and BB73 is required to minimize the amount of potentially contaminated material being delivered to the Blowdown Tank.
3. Closure of NM269, NM270, NM271, and NM272 is required to minimize the amount of potentially contaminated material being delivered to the
4. Conventional Sampling System. Closure of NM267 is required to minimize the amount of potentially contaminated material being delivered to the Condensate Storage Tank by isolating flow through EMF-34.
5. Closure of BB48 is required to minimize the amount of potentially contaminated material being delivered from the Blowdown System discharge to the Turbine Building sump.

1/2EMF-39 - Containment Noble Gas Monitor

BASES (continued)

The following actuations occur when EMF-39 detects radiation level above its setpoint:

1. Signals are provided to both trains of the Solid State Protection System (SSPS) to initiate a Containment Air Release and Addition System isolation. This is verified by observing that relays K615 in the SSPS Train A output cabinet and the SSPS Train B output cabinet are latched.
2. Containment Evacuation Alarm, unless the source range trip is blocked.

REFERENCES

1. Catawba Offsite Dose Calculation Manual.

2. 10 CFR Part 20.

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

16.11-7 Radioactive Gaseous Effluent Monitoring Instrumentation

COMMITMENT The Radioactive Gaseous Effluent Monitoring Instrumentation channels shown in Table 16.11-7-1 shall be FUNCTIONAL with their Alarm/Trip Setpoints set to ensure that the limits of SLC 16.11-6 are not exceeded.

AND

The Alarm/Trip Setpoints of these channels shall be determined and adjusted in accordance with the methodology and parameters in the OFFSITE DOSE CALCULATION MANUAL (ODCM).

APPLICABILITY: Conditions B and K are applicable at all times. All other Conditions are applicable as shown in Table 16.11-7-1.

REMEDIAL ACTIONS

---NOTE---
Separate Condition entry is allowed for each Function.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or more Radioactive Gaseous Effluent Monitoring Instrumentation channel(s) Alarm/Trip Setpoint less conservative than required.	A.1 Suspend the release of radioactive gaseous effluents monitored by the affected channel(s).	Immediately
	<u>OR</u>	
	A.2 Declare the channel(s) non-functional.	Immediately
B. One or more Radioactive Gaseous Effluent Monitoring Instrumentation channel(s) non-functional.	B.1 Enter the applicable Conditions and Required Actions specified in Table 16.11-7-1 for the channel(s).	Immediately
	<u>AND</u>	
	B.2.1 Restore channel to FUNCTIONAL status.	14 Days (*Note 1)
	<u>OR</u>	
	B.2.2 Restore channel to FUNCTIONAL status.	30 Days (*Note 1)

*Note 1 – Required Action B.2.1 applies to Instrument 1.a ONLY. (continued)
Required Action B.2.2 applies to Instruments 1.b, 2, 3.a, 3.c, 3.d, 3.e, 5, 6.a, and 6.b listed in Table 16.11-7-1.

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
C. One channel non-functional.	C.1 Verify that EMF-36 (Low Range) is FUNCTIONAL.	Prior to initiating a release
	<u>OR</u>	
	C.2.1 Analyze two independent samples of the tank's contents.	Prior to initiating a release
	<u>AND</u>	
	C.2.2 Perform independent verification of the discharge line valving.	Prior to initiating a release
	<u>AND</u>	
	C.2.3.1 Perform independent verification of manual portion of the computer input for release rate calculations performed by computer.	Prior to initiating a release
	<u>OR</u>	
	C.2.3.2 Perform independent verification of entire calculations for release rate calculations performed manually.	Prior to initiating a release
	<u>OR</u>	
	C.3 Suspend release of radioactive effluents via this pathway.	Immediately

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
D. One or more flow rate measurement device channel(s) non-functional.	D.1 Estimate the flow rate of the release.	Once per 4 hours during releases
E. One or more Noble Gas Activity Monitor channel(s) non-functional.	------------------NOTE------------------ **IF** 0EMF41 is NON-FUNCTIONAL **AND** either 1EMF36 **OR** 2EMF36 is NON-FUNCTIONAL, perform SLC 16.7-10, Required Action G.2 --	
	E.1 Obtain grab samples from effluent pathway.	Once per 12 hours during releases
	AND	
	E.2 Perform an analysis of grab samples for radioactivity.	Within 24 hours of obtaining the sample

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
F. Noble Gas Activity Monitor (EMF-39 – Low Range) providing automatic termination of release via the Containment Purge Exhaust System (CPES) non-functional.	F.1 -------------NOTE-------------- In order to utilize Required Action F.1, the following conditions must be satisfied: 1. The affected unit is in MODES 5 or 6. 2. EMF-36 is FUNCTIONAL and in service for the affected unit. 3. The Reactor Coolant System for the affected unit has been vented. 4. Either the reactor vessel head is in place (bolts are not required), or if it is not in place, the lifting of heavy loads over the reactor vessel and the movement of irradiated fuel assemblies within containment have been suspended. ------------------------------------ Restore the non-functional channel to FUNCTIONAL status.	 12 hours
G. Required Action and associated Completion Time of Condition F not met. <u>OR</u> Required Action F.1 not utilized.	G.1 Suspend PURGING of radioactive effluents via this pathway.	Immediately

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
H. One or more sampler channel(s) non-functional.	H.1 Perform sampling with auxiliary sampling equipment as required by Table 16.11-6-1.	Continuously
I. One Condenser Evacuation System Noble Gas Activity Monitor (EMF-33) channel non-functional.	I.1 --------------NOTE------------- Applicable to effluent releases via the Condenser Steam Air Ejector (ZJ) System. ------------------------------------ Obtain grab samples from effluent pathway.	Once per 12 hours during releases
	AND	
	I.2 --------------NOTE------------- Applicable to effluent releases via the Condenser Steam Air Ejector (ZJ) System. ------------------------------------ Perform an analysis of grab samples for radioactivity.	Within 24 hours of obtaining the sample
	AND	
		(continued)

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
I. (continued)	I.3 --------------NOTE------------- Applicable to effluent releases via the Steam Generator Blowdown (BB) System atmospheric vent valve (BB-27) in the off-normal mode. ------------------------------------ Perform an analysis of grab samples for radioactivity at a lower limit of detection of 10^{-7} microCurie/ml.	 Once per 12 hours during releases when secondary specific activity is > 0.01 microCurie/gm DOSE EQUIVALENT I-131 AND Once per 24 hours during releases when secondary specific activity is ≤ 0.01 microCurie/gm DOSE EQUIVALENT I-131
J. Noble Gas Activity Monitor (EMF-39 – Low Range) providing automatic termination of release via the Containment Air Release and Addition System non-functional.	J.1 Verify that EMF-36 is FUNCTIONAL. OR J.2.1 Analyze two independent samples of the containment atmosphere. AND	Prior to initiating a release Prior to initiating a release (continued)

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
J. (continued)	J.2.2 Perform independent verification of the discharge line valving.	Prior to initiating a release
	AND	
	J.2.3.1 Perform independent verification of manual portion of the computer input for release rate calculations performed by computer.	Prior to initiating a release
	OR	
	J.2.3.2 Perform independent verification of entire calculations for release rate calculations performed manually.	Prior to initiating a release

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
K. Required Action and associated Completion Time of Condition B or F not met.	K.1 Explain why the non-functionality was not corrected within the specified Completion Time.	In the next scheduled Radioactive Effluent Release Report pursuant to Technical Specification 5.6.3

TESTING REQUIREMENTS

---NOTE---
Refer to Table 16.11-7-1 to determine which TRs apply for each Radioactive Gaseous Effluent Monitoring Instrumentation channel.

TEST		FREQUENCY
TR 16.11-7-1	Perform CHANNEL CHECK.	Prior to each release
TR 16.11-7-2	-------------------------------NOTE------------------------------- For Instruments 1a, 4, and 5, a SOURCE CHECK for these channels shall be the qualitative assessment of channel response when the channel sensor is exposed to a light-emitting diode. --- Perform SOURCE CHECK.	Prior to each release
TR 16.11-7-3	Perform CHANNEL CHECK.	12 hours
TR 16.11-7-4	Perform CHANNEL CHECK.	24 hours
TR 16.11-7-5	Perform CHANNEL CHECK.	7 days

(continued)

TESTING REQUIREMENTS (continued)

TEST		FREQUENCY
TR 16.11-7-6	--------------------------------NOTE-------------------------------- For Instruments 2 and 3a, a SOURCE CHECK for these channels shall be the qualitative assessment of channel response when the channel sensor is exposed to a light-emitting diode. --- Perform SOURCE CHECK.	31 days
TR 16.11-7-7	--------------------------------NOTE-------------------------------- For Instruments 1a, 3a, 3c, 5, and 6a, the COT shall also demonstrate, as applicable, that automatic isolation of this pathway and control room alarm annunciation (for EMF-58, alarm annunciation is in the Monitor Tank Building control room and on the Monitor Tank Building control panel remote annunciator panel) occur if any of the following conditions exist: a. Instrument indicates measured levels above the Alarm/Trip Setpoint, or b. Circuit failure/instrument downscale failure (alarm only) --- Perform COT.	18 months
TR 16.11-7-8	--------------------------------NOTE-------------------------------- For Instruments 2 and 4, the COT shall also demonstrate that automatic isolation of this pathway and control room alarm annunciation occur if any of the following conditions exist: a. Instrument indicates measured levels above the Alarm/Trip Setpoint, or b. Circuit failure/instrument downscale failure (alarm only) --- Perform COT.	18 months

(continued)

TESTING REQUIREMENTS (continued)

TEST		FREQUENCY
TR 16.11-7-9	---------------------------------NOTE--------------------------------- For Instruments 1a, 2, 3a, 3c, 4, 5, and 6a, 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. --- Perform CHANNEL CALIBRATION.	18 months

Table 16.11-7-1

Radioactive Gaseous Effluent Monitoring Instrumentation (page 1 of 2)

INSTRUMENT	REQUIRED CHANNELS	CONDITIONS	APPLICABLE MODES	TESTING REQUIREMENTS
1. Waste Gas Holdup System				
1.a Noble Gas Activity Monitor – Providing Alarm and Automatic Termination of Release (EMF-50 – Low Range)	1 per station	B, K A, C	At all times (Note 3)	TR 16.11-7-1 TR 16.11-7-2 TR 16.11-7-7 TR 16.11-7-9
1.b Effluent System Flow Rate Measuring Device	1 per station	B, K D	At all times (Note 3)	TR 16.11-7-1 TR 16.11-7-9
2. Condenser Evacuation System Noble Gas Activity Monitor (EMF-33) (BB-27 is only isolation function required) (Note 1)	1	B, K A, I	At all times (Note 4)	TR 16.11-7-3 TR 16.11-7-6 TR 16.11-7-8 TR 16.11-7-9
3. Vent System				
3.a Noble Gas Activity Monitor (EMF-36 – Low Range)	1	A, B, E, K	At all times	TR 16.11-7-4 TR 16.11-7-6 TR 16.11-7-7 TR 16.11-7-9
3.b Deleted.				
3.c Particulate Sampler (EMF-35)	1	B, K A, H	At all times (Note 2)	TR 16.11-7-4 TR 16.11-7-6 TR 16.11-7-7 TR 16.11-7-9
3.d Unit Vent Stack Flow Rate Meter (no alarm/trip function)	1	B, K D	At all times (Note 2)	TR 16.11-7-4 TR 16.11-7-9
3.e Unit Vent Radiation Monitor Flow Meter	1	B, K E	At all times (Note 2)	TR 16.11-7-4 TR 16.11-7-9
4. Containment Purge System Noble Gas Activity Monitor – Providing Alarm and Automatic Termination of Release (EMF-39 – Low Range)	1	A, F, G, K	5, 6	TR 16.11-7-2 TR 16.11-7-3 TR 16.11-7-8 TR 16.11-7-9

(continued)

Table 16.11-7-1

Radioactive Gaseous Effluent Monitoring Instrumentation (page 2 of 2)

INSTRUMENT	REQUIRED CHANNELS	CONDITIONS	APPLICABLE MODES	TESTING REQUIREMENTS
5. Containment Air Release and Addition System Noble Gas Activity Monitor – Providing Alarm and Automatic Termination of Release (EMF-39 – Low Range)	1	B, K A, J	At all times 1, 2, 3, 4, 5, 6	TR 16.11-7-2 TR 16.11-7-3 TR 16.11-7-7 TR 16.11-7-9
6. Monitor Tank Building HVAC				
6.a Noble Gas Activity Monitor – Providing Alarm (EMF-58 – Low Range)	1 per station	B, K A, E	At all times (Note 2)	TR 16.11-7-4 TR 16.11-7-6 TR 16.11-7-7 TR 16.11-7-9
6.b Effluent Flow Rate Measuring Device	1 per station	B, K D	At all times (Note 2)	TR 16.11-7-4 TR 16.11-7-9

Note 1: The setpoint is as required by the primary to secondary leak rate monitoring program.

Note 2: Applicable at all times, unless the effluent pathway is mechanically isolated; thus, a release to the environment is not possible.

Note 3: Applicable at all times, unless the effluent pathway is mechanically isolated; thus, a release to the environment is not possible. Utilization of this note requires the pathway be isolated by locked close valve.

Note 4: When air ejectors are in operation, apply Required Action I.3 when air ejectors are NOT in operation.

BASES

The Radioactive Gaseous Effluent Monitoring 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 Setpoints for these instruments shall be calculated 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. Conservative Alarm/Trip Setpoints may be used during a release provided they are less than or equal to the setpoints determined by the methodology and parameters of the ODCM. The FUNCTIONALITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10 CFR Part 50. The sensitivity of any noble gas activity monitor used to show compliance with the gaseous effluent release requirements of SLC 16.11-8 shall be such that concentrations as low as 1×10^{-6} µCi/cc are measurable.

Regarding Notes 2 and 3 of Table 16.11-7-1, isolation of the effluent pathway is to be by mechanical means (e.g., valve closure). Electrical or pneumatic isolation is not required, unless the isolation is designed to receive an automatic signal to open. For EMF-50 Low Range only, isolation of the effluent pathway is only considered complete if isolated by a locked closed valve.

In MODES 5 and 6, initiation of the Containment Purge Exhaust System (CPES) with EMF-39 non-functional is not permissible. The basis for Required Action F.1 is to allow the continued operation of the CPES with EMF-39 initially FUNCTIONAL. Continued operation of the CPES is contingent upon the ability of the affected unit to meet the requirements as noted in Required Action F.1.

TR 16.11-7-7 requires the performance of a COT on the applicable Radioactive Gaseous Effluent Radiation Monitors. The test ensures that a signal from the control room module can generate the appropriate alarm and actuations. The required actuations/isolations for a High Radiation condition (i.e., radiation level above its Trip 2 setpoint) are listed below for each monitor.

0EMF-50 - Waste Gas Discharge Monitor
1WG160 closes when EMF-50 detects radiation level above its setpoint.

1/2EMF-36 - Unit Vent Noble Gas Monitor
The following actuations occur when EMF-36 detects radiation level above its setpoint:

1. Containment Air Release and Addition System fans discharge to unit vent valve VQ10 closes.
2. Auxiliary Building unfiltered ventilation exhaust fans A and B stop.
3. Fuel Handling Ventilation Exhaust System (FHVES) exhaust trains align to the filter units.
4. (For 1EMF-36 only) 1WG160 closes.

1/2EMF-35 - Unit Vent Particulate Monitor (Sampler)
The following actuations occur when EMF-35 detects radiation level above its setpoint:

1. Containment Air Release and Addition System fans discharge to unit vent valve VQ10 closes.
2. Auxiliary Building unfiltered ventilation exhaust fans A and B stop.

BASES (continued)

3. Fuel Handling Ventilation Exhaust System (FHVES) exhaust trains align to the filter units.
4. ((For 1EMF-35 only) 1WG160 closes.

1/2EMF-39 - Containment Noble Gas Monitor
The following actuations occur when EMF-39 detects radiation level above its setpoint:

1. Signals are provided to both trains of the Solid State Protection System (SSPS) to initiate a CPES isolation. This is verified by observing that Relays K615 in the SSPS A output cabinet and the SSPS B output cabinet are latched.
2. EMF-39 isolates the CPES without going through the SSPS by stopping CPES supply fans A and B, CPES exhaust fans A and B, and by closing the appropriate valves and dampers.
3. Containment Evacuation Alarm, unless the source range trip is blocked.

0EMF-58
This monitor provides no control function.

TR 16.11-7-8 requires the performance of a COT on the Condensate Steam Air Ejector Exhaust Monitor, 1/2EMF-33 and Containment Noble Gas Monitor, 1/2EMF-39. The test ensures that a signal from the control room module can generate the appropriate alarm and actuations. The required actuations/isolations for a High Radiation condition (i.e., radiation level above its Trip 2 setpoint) are listed below.

1/2EMF-33 - Condensate Steam Air Ejector Exhaust Monitor
The following actuations occur when EMF-33 detects radiation level above its setpoint:

1. Closure of BB27 is required in order to isolate the Blowdown Tank from the environment. Because of plant limitations/restrictions:
   a. Opening the valve (in order to verify it goes closed on a High Radiation signal) is only possible during outages due to the negative effects on the Blowdown System with the unit at power.
   b. Testing during innages will be by verification of relay contacts opening in the valve circuit.
2. Closure of BB24, BB65, BB69, and BB73 is required to minimize the amount of potentially contaminated material being delivered to the Blowdown Tank.
3. Closure of NM269, NM270, NM271, and NM272 is required to minimize the amount of potentially contaminated material being delivered to the Conventional Sampling System.
4. Closure of NM267 is required to minimize the amount of potentially contaminated material being delivered to the Condensate Storage Tank by isolating flow through EMF-34.
5. Closure of BB48 is required to minimize the amount of potentially contaminated material being delivered from the Blowdown System discharge to the Turbine Building sump.

BASES (continued)

1/2EMF-39 - Containment Noble Gas Monitor
The following actuations occur when EMF-39 detects radiation level above its setpoint:

1. Signals are provided to both trains of the Solid State Protection System (SSPS) to initiate a Containment Air Release and Addition System isolation. This is verified by observing that relays K615 in the SSPS Train A output cabinet and the SSPS Train B output cabinet are latched.
2. Containment Evacuation Alarm, unless the source range trip is blocked.

REFERENCES

1. Catawba Offsite Dose Calculation Manual.

2. 10 CFR Part 20.

3. AR 02400313, 0EMF-50L Non-Functional.

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

16.11-8 Dose - Noble Gases

COMMITMENT: The air dose due to noble gases released in gaseous effluents, from each unit, to areas at and beyond the SITE BOUNDARY (see Figure 16.11-16-1 in SLC 16.11-16) shall be limited to the following:

a. During any calendar quarter: $\leq$ 5 mrad for gamma radiation and $\leq$ 10 mrad for beta radiation, and

b. During any calendar year: $\leq$ 10 mrad for gamma radiation and $\leq$ 20 mrad for beta radiation.

APPLICABILITY: At all times.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Calculated air dose from radioactive noble gases in gaseous effluents exceeding any of above limits.	A.1 Prepare and submit a Special Report to the NRC which identifies the causes for exceeding the limits, corrective actions taken to reduce releases, and actions taken to ensure that subsequent releases are within limits.	30 days

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11-8-1 Determine cumulative dose contributions from noble gases in gaseous effluents for current calendar quarter and current calendar year in accordance with the methodology and parameters in the ODCM.	31 days

BASES

This SLC is provided to implement the requirements of Sections II.B, III.A and IV.A of Appendix I, 10 CFR Part 50. The COMMITMENT implements the guides set forth in Section II.B of Appendix I. The REMEDIAL ACTION statement provides the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in gaseous effluents to UNRESTRICTED AREAS will be kept "as low as is reasonably achievable”. The TESTING REQUIREMENTS implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data such that the actual exposure of a MEMBER OF THE PUBLIC through appropriate pathways is unlikely to be substantially 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 Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I,” Revision 1, October 1977 and Regulatory Guide 1.111, “Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water Cooled Reactors,” Revision 1, July 1977. The ODCM equations provided for determining the air doses at and beyond the SITE BOUNDARY are based upon the historical average atmospheric conditions.

This commitment applies to the release of radioactive materials in gaseous effluents from each unit at the site. When shared radwaste treatment systems are used by more than one unit on a site, the wastes from all units are mixed for shared treatment; by such mixing, the effluent releases cannot accurately be ascribed to a specific unit. An estimate should be made of the contributions from each unit based on input conditions, e.g., flow rates and radioactivity concentrations, or, if not practicable, the treated effluent releases may be allocated equally to each of the radioactives waste producing units sharing the radwaste treatment system. For determining conformance to COMMITMENTS, these allocations from shared radwaste treatment systems are to be added to the releases specifically attributed to each unit to obtain the total releases per unit.

REFERENCES

1. Catawba Offsite Dose Calculation Manual.
2. 10 CFR Part 50, Appendix I.

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

16.11-9 Dose - Iodine-131, Iodine-133, Tritium, and Radioactive Material in Particulate Form

COMMITMENT The dose to a MEMBER OF THE PUBLIC from Iodine-131, Iodine-133, tritium, and all radionuclides in particulate form with half-lives > 8 days in gaseous effluents released, from each unit, to areas at and beyond the SITE BOUNDARY (see Figure 16.11-16-1 in SLC 16.11-16) shall be limited to the following:

a. During any calendar quarter: $\leq$ 7.5 mrem to any organ, and

b. During any calendar year: $\leq$ 15 mrem to any organ.

APPLICABILITY: At all times.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Calculated dose from the release of Iodine-131, Iodine-133, tritium, and radioactive material in particulate form with half-lives > 8 days in gaseous effluents exceeding any of above limits.	A.1 Prepare and submit a Special Report to the NRC which identifies the causes for exceeding the limits, corrective actions taken to reduce releases, and actions taken to ensure that subsequent releases are within limits.	30 days

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11-9-1 Determine cumulative dose contributions from Iodine-131, Iodine-133, tritium, and radioactive material in particulate form with half-lives > 8 days in gaseous effluents for current calendar quarter and current calendar year in accordance with the methodology and parameters in the ODCM.	31 days

BASES

This SLC is provided to implement the requirements of Sections II.C, III.A and IV.A of Appendix I, 10 CFR Part 50, and are the guides set forth in Section II.C of Appendix I. The REMEDIAL ACTION statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive materials in gaseous effluents to UNRESTRICTED AREAS will be kept "as low as is reasonably achievable". The ODCM calculational methods specified in the TESTING REQUIREMENTS implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data, such that the actual exposure of a MEMBER OF THE PUBLIC through appropriate pathways is unlikely to be substantially underestimated. The ODCM calculational methodology and parameters for calculating the doses due to the actual release rates of the subject materials are consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1, October 1977 and Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," Revision 1, July 1977. These equations also provide for determining the actual doses based upon the historical average atmospheric conditions. The release rate COMMITMENTS 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 on the ground with subsequent exposure of man.

This commitment applies to the release of radioactive materials in gaseous effluents from each unit at the site. When shared radwaste treatment systems are used by more than one unit on a site, the wastes from all units are mixed for shared treatment; by such mixing, the effluent releases cannot accurately be ascribed to a specific unit. An estimate should be made of the contributions from each unit based on input conditions, e.g., flow rates and radioactivity concentrations, or, if not practicable, the treated effluent releases may be allocated equally to each of the radioactive waste producing units sharing the radwaste treatment system. For determining conformance to COMMITMENTS, these allocations from shared radwaste treatment systems are to be added to the releases specifically attributed to each unit to obtain the total releases per unit.

REFERENCES

1. Catawba Offsite Dose Calculation Manual.

2. 10 CFR Part 50, Appendix I.

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

16.11-10 Gaseous Radwaste Treatment System

COMMITMENT The VENTILATION EXHAUST TREATMENT SYSTEM and the WASTE GAS HOLDUP SYSTEM shall be FUNCTIONAL and appropriate portions of these systems shall be used to reduce releases of radioactivity when the projected doses in 31 days due to gaseous effluent releases, from each unit, to areas at and beyond the SITE BOUNDARY (see Figure 16.11-16-1 in SLC 16.11-16) would exceed either:

a. 0.2 mrad to air from gamma radiation, or

b. 0.4 mrad to air from beta radiation, or

c. 0.3 mrem to any organ of a MEMBER OF THE PUBLIC.

APPLICABILITY: At all times.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Radioactive gaseous waste being discharged without treatment and in excess of above limits.	A.1 Prepare and submit a Special Report to the NRC which identifies non-functional equipment and reasons for non-functionality, actions taken to restore the equipment to FUNCTIONAL status, and actions taken to prevent recurrence.	30 days

TESTING REQUIREMENTS

---NOTE---
The installed VENTILATION EXHAUST TREATMENT SYSTEM and WASTE GAS HOLDUP SYSTEM shall be demonstrated FUNCTIONAL by meeting SLC 16.11-6, SLC 16.11-8, and SLC 16.11-9.

TEST		FREQUENCY
TR 16.11-10-1	Project gaseous release doses from each unit to areas at and beyond the SITE BOUNDARY, in accordance with the methodology and parameters in the ODCM, when Gaseous Radwaste Treatment Systems are not being fully utilized.	31 days

BASES

The FUNCTIONALITY of the WASTE GAS HOLDUP SYSTEM and the VENTILATION EXHAUST TREATMENT SYSTEM ensures that the systems will be available for use whenever gaseous effluents require treatment prior to release to the environment. The requirement that the appropriate portions of these systems be used, when specified, provides reasonable assurance that the releases of radioactive materials in gaseous effluents will be kept “as low as is reasonably achievable”. This COMMITMENT implements the requirements of 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.

This SLC applies to the release of radioactive materials in gaseous effluents from each unit at the site. When shared radwaste treatment systems are used by more than one unit on a site, the wastes from all units are mixed for shared treatment; by such mixing, the effluent releases cannot accurately be ascribed to a specific unit. An estimate should be made of the contributions from each unit based on input conditions, e.g., flow rates and radioactivity concentrations, or, if not practicable, the treated effluent releases may be allocated equally to each of the radioactive waste producing units sharing the radwaste treatment system. For determining conformance to COMMITMENTS, these allocations from shared radwaste treatment systems are to be added to the releases specifically attributed to each unit to obtain the total releases per unit.

REFERENCES

1. Catawba Offsite Dose Calculation Manual.
2. 10 CFR Part 50, Appendix I.

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

16.11-11 Solid Radioactive Wastes

COMMITMENT

Radioactive wastes shall be processed and packaged to ensure compliance with the applicable requirements of 10 CFR Part 20, 10 CFR Part 61, 10 CFR Part 71, and state regulations governing the transportation and disposal of radioactive wastes.

The Solid Radwaste System or an approved alternative process shall be used in accordance with the PROCESS CONTROL PROGRAM for the solidification of liquid or wet radioactive wastes or the dewatering of wet radioactive wastes to be shipped for direct disposal at a 10 CFR Part 61 licensed disposal site. Wastes shipped for offsite processing in accordance with the processor's specifications and transportation requirements are not required to be solidified or dewatered to meet disposal requirements.

APPLICABILITY: At all times.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Applicable regulatory requirements for solidified or dewatered wastes not satisfied.	A.1 Suspend shipment of inadequately processed waste.	Immediately
	<u>AND</u>	
	A.2 Take action to correct the PROCESS CONTROL PROGRAM, procedures, or solid waste equipment as necessary to prevent recurrence.	Prior to next shipment for disposal of solidified or dewatered wastes

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
B. Solidification test as described in the PROCESS CONTROL PROGRAM fails to verify solidification.	B.1 Suspend solidification of the batch under test and follow PROCESS CONTROL PROGRAM guidance for test failures.	Immediately
	<u>AND</u>	
	B.2 --------------NOTE------------- Once a subsequent test verifies solidification, solidification of the batch may be resumed as directed by the PROCESS CONTROL PROGRAM. ------------------------------------ Modify the PROCESS CONTROL PROGRAM as required to assure solidification of subsequent batches of waste.	Prior to next solidification for shipment of waste for disposal at a 10 CFR Part 61 disposal site
C. Solidification or dewatering for disposal not performed in accordance with the PROCESS CONTROL PROGRAM.	C.1 Reprocess the waste in accordance with PROCESS CONTROL PROGRAM requirements.	Prior to shipment for disposal of the inadequately processed waste that requires solidification or dewatering
	<u>OR</u>	
	C.2 Follow PROCESS CONTROL PROGRAM or procedure guidance for alternative free-standing liquid verification to ensure the waste in each container meets disposal requirements and take appropriate administrative action to prevent recurrence.	Prior to shipment for disposal of the inadequately processed waste that requires solidification or dewatering

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
D. Solid waste equipment incapable of supporting COMMITMENT.	D.1 Restore the equipment to a status capable of supporting COMMITMENT.	In a time frame supporting COMMITMENT
	<u>OR</u>	
	D.2 Provide for alternative capability to process wastes as necessary to satisfy all applicable transportation and disposal requirements.	In a time frame supporting COMMITMENT

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11-11-1 Verify, using the PROCESS CONTROL PROGRAM, the solidification of at least one representative test specimen from at least every tenth batch of each type of radioactive waste to be solidified for disposal at a 10 CFR Part 61 disposal site.	Every tenth batch of each type of radioactive waste to be solidified

BASES

This SLC implements the requirements of 10 CFR Part 50.36a and General Design Criterion 60 of Appendix A to 10 CFR Part 50 and requirements to use a PROCESS CONTROL PROGRAM to meet applicable 10 CFR Part 61 waste form criteria for solidified and dewatered radioactive wastes.

- The PROCESS CONTROL PROGRAM describes administrative and operational controls used for the solidification of liquid or wet solid radioactive wastes in order to meet applicable 10 CFR Part 61 waste form requirements.
- The PROCESS CONTROL PROGRAM describes the administrative and operational controls used for the dewatering of wet radioactive wastes to meet 10 CFR Part 61 free-standing water requirements.
- The process parameters used in establishing the PROCESS CONTROL PROGRAM shall be based on demonstrated processing of actual or simulated liquid or wet solid wastes and must adequately verify that the final product of solidification or dewatering meets all applicable federal, state, and disposal site requirements.

REFERENCES

1. 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities."

2. 10 CFR Part 50, Appendix A.

3. 10 CFR Part 20, "Standards for Protection Against Radiation."

4. 10 CFR Part 61, "Licensing Requirements for Land Disposal of Radioactive Waste."

5. 10 CFR Part 71, "Packaging and Transportation of Radioactive Materials."

6. PROCESS CONTROL PROGRAM Manual.

7. Generic Letter 84-12, "Compliance with 10 CFR Part 61 and Implementation of the Radiological Effluent Technical Specifications (RETS) and Attendant Process Control Program (PCP)."

8. Generic Letter 89-01, "Implementation of Programmatic Controls for Radiological Effluent Technical Specifications in the Administrative Controls Section of the Technical Specifications and the Relocation of Procedural Details of RETS to the Offsite Dose Calculation Manual or to the Process Control Program."

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

16.11-12 Total Dose

COMMITMENT The annual (calendar year) dose or dose commitment to any MEMBER OF THE PUBLIC due to releases of radioactivity and to radiation from uranium fuel cycle sources shall be limited to ≤ 25 mrem to the whole body or any organ, except the thyroid, which shall be limited to ≤ 75 mrem.

APPLICABILITY: At all times.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Calculated doses from releases exceeding twice the specified limits of SLC 16.11-3, SLC 16.11-8, or SLC 16.11-9.	A.1 Verify, by calculation, that the cumulative dose from direct radiation contributions and outside storage tanks and radioactivity releases are within the total dose limit.	Immediately
	AND	
	A.2 --------------NOTE------------- Only required to be performed if the total dose limit is exceeded. ------------------------------------ Prepare and submit a Special Report to the NRC which identifies corrective actions to be taken to reduce subsequent releases to prevent recurrence and schedule for achieving conformance with specified limits.	30 days

TESTING REQUIREMENTS

---NOTE---
Cumulative dose contributions from liquid and gaseous effluents shall be determined in accordance with SLC 16.11-3, SLC 16.11-8, and SLC 16.11-9, and in accordance with the methodology and parameters specified in the ODCM.

TEST		FREQUENCY
TR 16.11-12-1	Determine cumulative dose contributions from direct radiation from the units and from radwaste storage tanks in accordance with the methodology and parameters specified in the ODCM.	When calculated doses from effluent releases exceed twice the limits of SLC 16.11-3, SLC 16.11-8, or SLC 16.11-9

BASES

This SLC 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 SLC 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 mrem to the whole body or any organ, except the thyroid, which shall be limited to less than or equal to 75 mrem. For sites containing up to four reactors, it is highly unlikely that the resultant dose to a MEMBER OF THE PUBLIC will exceed the dose limits of 40 CFR Part 190 if the individual reactors remain within twice the dose design objectives of Appendix I, and if direct radiation doses from the units and from outside storage tanks are kept small.

This Special Report, as defined in 10 CFR 20.2203(a)(4), shall include an analysis that estimates the radiation exposure (dose) to a MEMBER OF THE PUBLIC from uranium fuel cycle sources, including all effluent pathways and direct radiation, for the calendar year that includes the release(s) covered by this report. It shall also describe levels of radiation and concentrations of radioactive material involved, and the cause of the exposure levels or concentrations. The Special Report will describe a course of action that should result in the limitation of the annual dose to a MEMBER OF THE PUBLIC to within the 40 CFR Part 190 limits. For the purposes of the Special Report, it may be assumed that the dose commitment to the MEMBER OF THE PUBLIC from other uranium fuel cycle sources is negligible, with the exception that dose contributions from other nuclear fuel cycle facilities at the same site or within a radius of 8 km must be considered.

BASES (continued)

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(a)(4), is considered to be a timely request and fulfills the requirements of 40 CFR Part 190 and a variance is granted until NRC staff action is completed. The variance only relates to the limits of 40 CFR Part 190, and does not apply in any way to the other requirements for dose limitation of 10 CFR Part 20, as addressed in SLC 16.11-1 and SLC 16.11-6.

An individual is not considered a MEMBER OF THE PUBLIC during any period in which he/she is engaged in carrying out any operation that is part of the nuclear fuel cycle.

REFERENCES

1. Catawba Offsite Dose Calculation Manual.
2. 10 CFR Part 20.
3. 40 CFR Part 190.

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

16.11-13 Monitoring Program

COMMITMENT The Radiological Environmental Monitoring Program shall be conducted as specified in Table 16.11-13-1.

APPLICABILITY: At all times.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Radiological Environmental Monitoring Program not being conducted as specified in Table 16.11-13-1.	A.1 Identify the reasons for not conducting the program as required and the plans for preventing a recurrence in the Annual Radiological Environmental Operating Report.	In the next scheduled Annual Radiological Environmental Operating Report pursuant to Technical Specification 5.6.2
B. Radioactivity level resulting from plant effluents of environmental sampling medium at a specified location in excess of reporting limits of Table 16.11-13-2 when averaged over any calendar quarter.	B.1 Prepare and submit a Special Report that identifies the cause(s) for exceeding the limits 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 SLC 16.11-3, SLC 16.11-8, and SLC 16.11-9.	30 days

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
C. Milk or fresh leafy vegetation samples unavailable from one or more sample location(s) required by Table 16.11-13-1.	C.1 --------------NOTE------------- Specific location(s) from which samples were unavailable may be deleted from the program. ------------------------------------	
	Revise the Radiological Environmental Monitoring Program to identify location(s) for obtaining replacement samples.	30 days
	AND	
	C.2 Identify the cause of the unavailability of samples and identify and justify new location(s) for obtaining replacement samples in the Annual Radioactive Effluent Release Report and also include in the report a revised figure(s) and table for the ODCM reflecting the new location(s).	In the next scheduled Annual Radioactive Effluent Release Report pursuant to Technical Specification 5.5.1

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11-13-1 --------------------------------NOTE-------------------------------- The maximum values for the lower limits of detection shall be as specified in Table 16.11-13-3. ---	
Collect and analyze radiological environmental monitoring samples pursuant to Table 16.11-13-1 from the specific locations given in the table and figure(s) in the ODCM.	In accordance with Table 16.11-13-1

Table 16.11-13-1

Radiological Environmental Monitoring Program (page 1 of 7)

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

(continued)

Table 16.11-13-1

Radiological Environmental Monitoring Program (page 2 of 7)

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS[1]	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
2. Airborne Radioiodine and Particulates	Samples from five locations. Three samples from close to the three SITE BOUNDARY locations, in different sectors, of the highest calculated annual average ground-level D/Q; One sample from the vicinity of a community having the highest calculated annual average ground-level D/Q; and One sample from a control location, as for example 15 to 30 km distant and in the least prevalent wind direction.	Continuous sampler operation with sample collection weekly, or more frequently if required by dust loading.	<u>Radioiodine Canister</u>: I-131 analysis weekly. <u>Particulate Sampler</u>: Gross beta radioactivity analysis following filter change;[3] and gamma isotopic analysis[4] of composite (by location) quarterly.

(continued)

Table 16.11-13-1

Radiological Environmental Monitoring Program (page 3 of 7)

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS[1]	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
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.
c. Drinking	One sample of each of one to three of the nearest water supplies that could be affected by its discharge. One sample from a control location.	Composite sample over 2-week period [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 from downstream area with existing or potential recreational value.	Semiannually	Gamma isotopic analysis [4] semiannually.

(continued)

Table 16.11-13-1

Radiological Environmental Monitoring Program (page 4 of 7)

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS[1]	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
4. Ingestion			
a. Milk	Samples from milking animals in three locations within 5-km distance having the highest dose potential. If there are none, then one sample from milking animals in each of three areas between 5 to 8 km distant where doses are calculated to be greater than 1 mrem per year[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.	Gamma isotopic[4] and I-131 analysis semi-monthly when animals are on pasture; monthly at other times.
b. Fish and Invertebrates	One sample each of a predatory species, a bottom feeder and a forage species in vicinity of plant discharge area. One sample each of a predatory species, a bottom feeder and a forage 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.

(continued)

Table 16.11-13-1

Radiological Environmental Monitoring Program (page 5 of 7)

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)			
c. Food Products	One sample of each principal class of food products from any area that is irrigated by water in which liquid plant wastes have been discharged.	At time of harvest [9].	Gamma isotopic analyses [4] on edible portion.
	Samples of three different kinds of broad leaf vegetation grown nearest each of two different offsite locations of highest predicted annual average ground level D/Q if milk sampling is not performed.	Monthly, when available.	Gamma isotopic [4] and I-131 analysis.
	One sample of each of the similar broad leaf vegetation grown 15 to 30 km distant in the least prevalent wind direction if milk sampling is not performed.	Monthly, when available.	Gamma isotopic [4] and I-131 analysis.

Table 16.11-13-1

Radiological Environmental Monitoring Program (page 6 of 7)

NOTES:

(1) Specific parameters of distance and direction sector from the centerline of the station, and additional description where pertinent, shall be provided for each and every sample location in Table 16.11-13-1 in a table and figure(s) in the ODCM. Refer to NUREG-0133, “Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants,” October 1978, and to Radiological Assessment Branch Technical Position, Revision 1, November 1979. Deviations are permitted from the required sampling schedule if specimens are unobtainable due to 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 Technical Specification 5.6.2. 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. In lieu of any Licensee Event Report required by 10 CFR 50.73 and pursuant to Technical Specification 5.6.3, identify the cause of the unavailability of samples for that pathway and identify the new location(s) for obtaining replacement samples in the next Radioactive Effluent Release Report and also include in the report a revised figure(s) and table for the ODCM reflecting the new location(s).

(2) One or more instruments, such as a pressurized ion chamber, for measuring and recording dose rate continuously may be used in place of, or in addition to, integrating dosimeters. For the purposes of this table, a thermoluminescent dosimeter (TLD) is considered to be one phosphor; two or more phosphors in a packet are considered as two or more dosimeters. Film badges shall not be used as dosimeters for measuring direct radiation. (The 40 stations is not an absolute number. The number of direct radiation monitoring stations may be reduced according to geographical limitations; e.g., at an ocean site, some 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.

Table 16.11-13-1

Radiological Environmental Monitoring Program (page 7 of 7)

(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 rate at which the liquid sampled is uniform and in which the method of sampling employed results in a specimen that is representative of the time-averaged concentration at the location being sampled. 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.

(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 a year, sampling shall be performed during each discrete harvest. If harvest occurs continuously, sampling shall be monthly. Attention shall be paid to including samples of tuberous and root food products.

Table 16.11-13-2

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[1]				
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	

(1) For drinking water samples. This is 40 CFR Part 141 value. If no drinking water pathway exists, a value of 30,000 pCi/l may be used.

Table 16.11-13-3

Lower Limit of Detection (LLD)[(3)] (page 1 of 3)

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[(5)]					
Mn-54	15		130			
Fe-59	30		260			
Co-58, 60	15		130			
Zn-65	30		260			
Zr-Nb-95	15					
I-131	1[(4)]	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		

Table 16.11-13-3

Lower Limit of Detection (LLD)(3) (page 2 of 3)

NOTES:

(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 Technical Specification 5.6.2.

(2) Required detection capabilities for thermoluminescent dosimeters used for environmental measurements shall be in accordance with the recommendations of Regulatory Guide 4.13.

(3) The LLD is defined, for purposes of these commitments, as the smallest concentrations of radioactive material in a sample that will yield a net count, above system background, that will be detected with 95% probability with only 5% probability of falsely concluding that a blank observation represents a “real” signal.

For a particular measurement system, which may include radiochemical separation:

$$LLD = \frac{(2.71/T) + 4.65 s_b}{E \cdot V \cdot 2.22 \cdot Y \cdot \exp(-\lambda \Delta t)}$$

Where:

LLD = the “a priori” lower limit of detection (picoCuries 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);

2.22 = the number of disintegrations per minute per picoCurie;

Y = the fractional radiochemical yield, when applicable;

λ = the radioactive decay constant for the particular radionuclide (sec^{-1});

Δt = the elapsed time between environmental collection, or end of the sample collection period, and time of counting (sec); and

T = the sample counting time (min).

Table 16.11-13-3

Lower Limit of Detection (LLD)[(3)] (page 3 of 3)

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

It should be recognized that the LLD is defined as an a priori (before the fact) limit representing the capability of a measurement system and not as an a posteriori (after the fact) limit for a particular measurement. 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 Technical Specification 5.6.2.

(4) LLD for drinking water samples. If no drinking water pathway exists, the LLD of gamma isotopic analysis may be used.

(5) If no drinking water pathway exists, a value of 3000 pCi/l may be used.

BASES

The Radiological Environmental Monitoring Program required by this SLC provides representative measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides that lead to the highest potential radiation exposures of MEMBERS OF THE PUBLIC resulting from the 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. The initially specified Monitoring Program will be effective for at least the first 3 years of commercial operation. Following this period, program changes may be initiated based on operational experience.

The required detection capabilities for environmental sample analyses are tabulated in terms of the lower limits of detection (LLDs). The LLDs required by Table 16.11-13-3 are considered optimum for routine environmental measurements in industrial laboratories. It should be recognized that the LLD is defined as an *a priori* (before the fact) limit representing the capability of a measurement system and not as an *a posteriori* (after the fact) limit for a particular measurement.

With the level of radioactivity in an environmental sampling medium at a specified location exceeding the reporting levels of Table 16.11-13-2 when averaged over any calendar quarter, in lieu of a Licensee Event Report, prepare and submit to the Commission within 30 days a Special Report that defines the corrective actions to be taken to reduce radioactive effluents so that the potential annual dose to a MEMBER OF THE PUBLIC is less than the calendar year limits of SLC 16.11-3, SLC 16.11-8, and SLC 16.11-9. When more than one of the radionuclides in Table 16.11-13-2 are detected in the sampling medium, this report shall be submitted if:

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

When radionuclides other than those in Table 16.11-13-2 are detected and are the result of plant effluents, this report shall be submitted if the potential annual dose to a MEMBER OF THE PUBLIC from all radionuclides is equal to or greater than the calendar year limits of SLC 16.11-3, SLC 16.11-8, and SLC 16.11-9. This report is not required if the measured level of radioactivity was not the result of plant effluents; however, in such an event, the condition shall be reported and described in the Annual Radiological Environmental Operating Report required by Technical Specification 5.6.2. The methodology and parameters used to estimate the potential annual dose to a MEMBER OF THE PUBLIC shall be indicated in the 30-day Special Report.

BASES (continued)

Detailed discussion of the LLD, and other detection limits, can be found in HASL Procedures Manual, HASL-300 (revised annually), Currie, L.A., "Limits for Qualitative Detection and Quantitative Determination – Application to Radiochemistry," Anal. Chem. 40, 586-93 (1968), and Hartwell, J.K., "Detection Limits for Radioanalytical Counting Techniques," Atlantic Richfield Hanford Company Report ARH-SA-215 (June 1975).

REFERENCES

1. Catawba Offsite Dose Calculation Manual.

2. 10 CFR Part 50, Appendix I.

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

16.11-14 Land Use Census

COMMITMENT

---NOTE---
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. Requirements for broad leaf vegetation sampling in Table 16.11-13-1 (Item 4c) shall be followed, including analysis of control samples.

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 > 50 m^2 (500 ft^2) producing broad leaf vegetation.

APPLICABILITY: At all times.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Location(s) identified which yield a calculated dose or dose commitment greater than values currently calculated in SLC 16.11-9.	A.1 Identify the new location(s) in the Annual Radioactive Effluent Release Report.	In the next scheduled Annual Radioactive Effluent Release Report pursuant to Technical Specification 5.6.3
B. Location(s) identified which yield a calculated dose or dose commitment (via same exposure pathway) 20% greater than at a location from which samples are currently being obtained in accordance with SLC 16.11-13.	B.1 Add the new location(s) to the Radiological Environmental Monitoring Program. AND	30 days

(continued)

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
B. (continued)	B.2 Identify the new location(s), revised figure(s) and table(s) for the ODCM, and information supporting the change in sampling location(s) in the Annual Radioactive Effluent Release Report.	In the next scheduled Annual Radioactive Effluent Release Report pursuant to Technical Specification 5.5.1

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11-14-1 --------------------------------NOTE-------------------------------- The results of the Land Use Census shall be included in the Annual Radiological Environmental Operating Report pursuant to Technical Specification 5.6.2. -- Conduct a Land Use Census during the growing season using the information which will provide the best results such as a door-to-door survey, aerial survey, or consultation with local agricultural authorities.	12 months

BASES

This SLC 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 given in the ODCM 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 quantify (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.

BASES (continued)

With a Land Use Census identifying a location(s) which yield a calculated dose or dose commitment (via the same exposure pathway) 20% greater than at a location from which samples are currently being obtained in accordance with SLC 16.11-13, add the new location(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, via the same exposure pathway, may be deleted from this monitoring program after October 31 of the year in which this Land Use Census was conducted.

REFERENCES

1. Catawba Offsite Dose Calculation Manual.
2. 10 CFR Part 50, Appendix I.

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

16.11-15 Interlaboratory Comparison Program

COMMITMENT Analyses shall be performed on all radioactive materials, supplied as part of an Interlaboratory Comparison Program, that correspond to samples required by SLC 16.11-13.

APPLICABILITY: At all times.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Analyses not being performed as required.	A.1 Report corrective actions taken to prevent recurrence in the Annual Radiological Environmental Operating Report.	In the next scheduled Annual Radiological Environmental Operating Report pursuant to Technical Specification 5.6.2

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11-15-1 Report a summary of the results of the Interlaboratory Comparison Program in the Annual Radiological Environmental Operating Report.	In the Annual Radiological Environmental Operating Report pursuant to Technical Specification 5.6.2

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

BASES (continued)

The Interlaboratory Comparison Program shall be described in the Annual Radiological Environmental Operating Report.

REFERENCES 1. 10 CFR Part 50, Appendix I.

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

16.11-16 Annual Radiological Environmental Operating Report and Radioactive Effluent Release Report

COMMITMENT Annual Radiological Environmental Operating Report

Routine Annual Radiological Environmental Operating Reports covering the operation of the unit during the previous calendar year shall be submitted prior to May 15 of each year.

The Annual Radiological Environmental Operating Reports shall include summaries, interpretations, and an analysis of trends of the results of the radiological environmental surveillance activities for the report period, including a comparison with 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.

The Annual Radiological Environmental Operating Reports shall include the results of analysis of all radiological environmental samples and of all environmental radiation measurements taken during the period pursuant to the locations specified in the table and figures in the ODCM, as well as summarized and tabulated results of these analyses and measurements in the format of the table in the Radiological Assessment Branch Technical Position, Revision 1, November 1979. In the event that some individual results are not available for inclusion with the report, the report shall be submitted noting and explaining the reasons for the missing results. The missing data shall be submitted as soon as possible in a supplementary report.

The reports shall also include the following: a summary description of the Radiological Environmental Monitoring Program; at least two legible maps (one map shall cover stations near the SITE BOUNDARY, and a second map shall include the more distant stations) covering all sampling locations keyed to a table giving distances and directions from the centerline of one reactor; the results of licensee participation in the Interlaboratory Comparison Program, required by SLC 16.11-15; discussion of all deviations from the sampling schedule of Table 16.11-13-1; and discussion of all analyses in which the LLD required by Table 16.11-13-3 was not achievable.

A single submittal may be made for the station.

(continued)

COMMITMENT (continued)

Radioactive Effluent Release Report

The Radioactive Effluent Release Report covering the operation of the unit during the previous calendar year shall be submitted before May 1 of each year. The Radioactive Effluent Release Reports shall include a summary of the quantities of radioactive liquid and gaseous effluents and solid waste released from the unit.

The Radioactive Effluent Release Report shall include an annual summary of hourly meteorological data collected over the previous year. This annual summary may be either in the form of an hour-by-hour listing on magnetic tape of wind speed, wind direction, atmospheric stability, and precipitation (if measured), or in the form of joint frequency distributions of wind speed, wind direction, and atmospheric stability. (In lieu of submission with the 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.) This same report shall include an assessment of the radiation doses due to the radioactive liquid and gaseous effluents released from the unit or station during the previous calendar year. A five-year average of representative onsite meteorological data shall be used in the gaseous effluent dose pathway calculations. Dispersion factors (X/Qs) and deposition factors (D/Qs) shall be generated using the computer code XOQDOQ (NUREG/CR-2919) which implements NRC Regulatory Guide 1.111. The meteorological conditions concurrent with the time of release shall be reviewed annually to determine if the five-year average values should be revised. The assessment of radiation doses shall be performed in accordance with the methodology and parameters in the ODCM.

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

The Radioactive Effluent Release Reports shall include the following information for each type of solid waste shipped offsite during the report period:

(continued)

COMMITMENT (continued)

a. Total container volume, in cubic meters,

b. Total Curie quantity (determined by measurement or estimate),

c. Principal radionuclides (determined by measurement or estimate),

d. Type of waste (e.g., dewatered spent resin, compacted dry waste, evaporator bottoms),

e. Number of shipments, and

f. Solidification agent or absorbent (e.g., cement or other approved agents (media)).

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

The Radioactive Effluent Release Reports shall include any changes made during the reporting period to the PROCESS CONTROL PROGRAM (PCP) and to the ODCM, as well as a listing of new locations for dose calculations and/or environmental monitoring identified by the Land Use Census pursuant to SLC 16.11-14.

A single submittal may be made for the station. The submittal should combine those sections that are common to both units.

APPLICABILITY: At all times.

REMEDIAL ACTIONS None

TESTING REQUIREMENTS None

BASES None

REFERENCES None

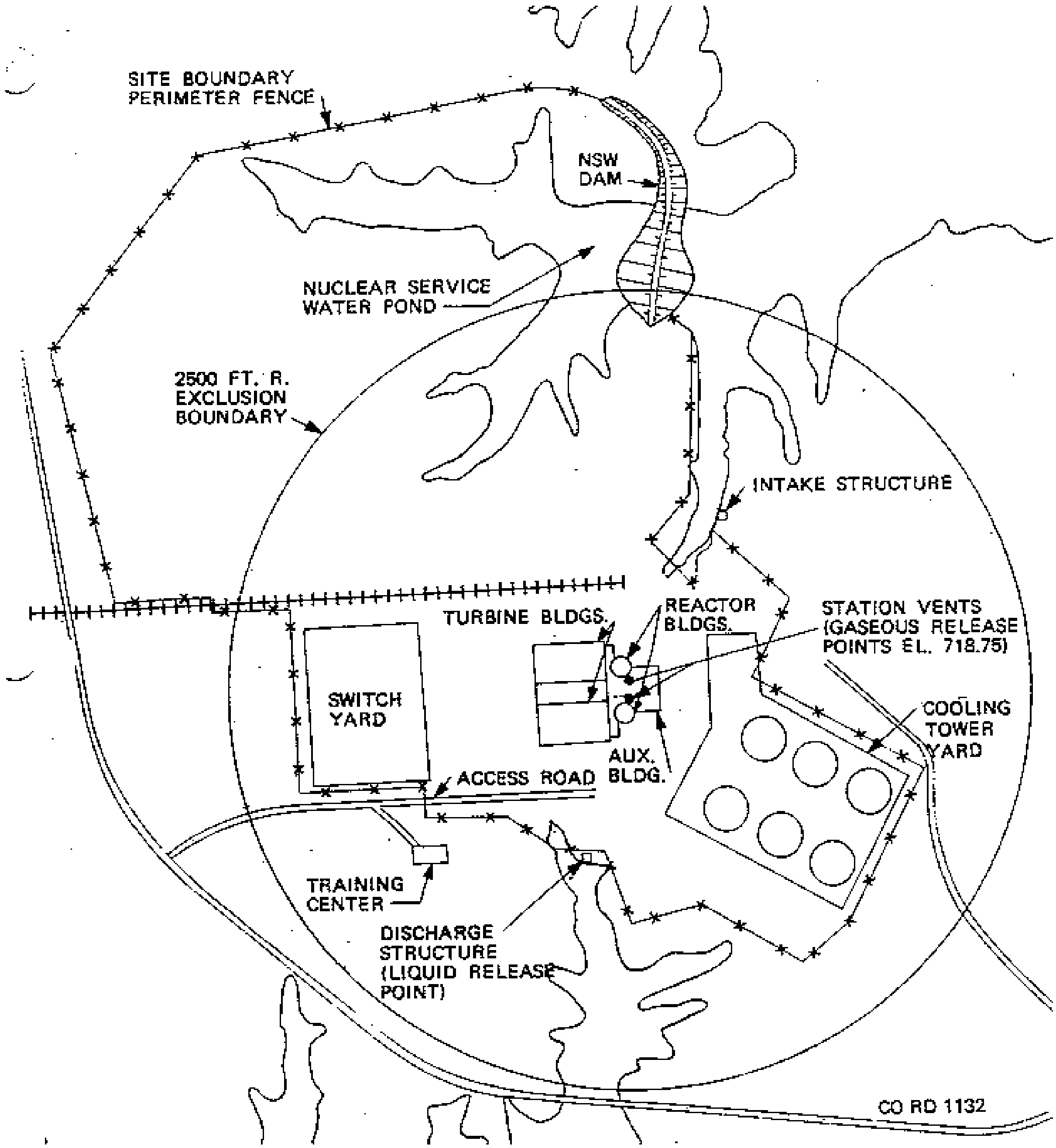

Figure 16.11-16-1

UNRESTRICTED AREA and SITE BOUNDARY for Radioactive Effluents

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

16.11-17 Liquid Holdup Tanks

COMMITMENT The quantity of radioactive material contained in each temporary unprotected outdoor tank shall be limited to $\leq$ 10 Curies, excluding tritium and dissolved or entrained noble gases.

APPLICABILITY: At all times.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Quantity of radioactive material in tank(s) exceeding limit.	A.1 Suspend all additions of radioactive material to the tank(s).	Immediately
	AND	
	A.2 Reduce tank(s) contents to within limit.	48 hours
	AND	
	A.3 Describe the events leading to this condition in the Radioactive Effluent Release Report.	In the next scheduled Radioactive Effluent Release Report pursuant to Technical Specification 5.6.3

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11-17-1 Verify that the quantity of radioactive material contained in each tank is within limits by analyzing a representative sample of the tank(s) contents when radioactive materials are being added to the tank(s).	7 days

BASES

The tanks included in this SLC are all those outdoor radwaste tanks that are not surrounded by liners, dikes, or walls capable of holding the tank contents and that do not have tank overflows and surrounding area drains connected to the liquid radwaste treatment system.

Restricting the quantity of radioactive material contained in the specified tanks provides assurance that in the event of an uncontrolled release of the tank's contents, the resulting concentrations would be less than the limits of 10 CFR Part 20, Appendix B, Table II, Column 2, at the nearest potable water supply and the nearest surface water supply in an UNRESTRICTED AREA.

REFERENCES

1. Letter from NRC to Gary R. Peterson, Duke, Issuance of Improved Technical Specifications Amendments for Catawba, September 30, 1998.

2. Technical Specification 5.5.12, Explosive Gas and Storage Tank Radioactivity Monitoring Program.

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

16.11-18 Explosive Gas Mixture

COMMITMENT The concentration of oxygen in the WASTE GAS HOLDUP SYSTEM shall be limited to $\leq$ 2% by volume whenever the hydrogen concentration is > 4% by volume.

APPLICABILITY: At all times.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Concentration of oxygen in the WASTE GAS HOLDUP SYSTEM > 2% but $\leq$ 4% by volume and hydrogen concentration > 4% by volume.	A.1 Reduce oxygen concentration to within limits.	48 hours
B. Concentration of oxygen in the WASTE GAS HOLDUP SYSTEM > 4% by volume and hydrogen concentration > 4% by volume.	B.1 Suspend all additions of waste gases to the system.	Immediately
	AND	
	B.2 Reduce the concentration of oxygen to $\leq$ 4% by volume.	Immediately
	AND	
	B.3 Reduce oxygen concentration to within limits.	48 hours

TESTING REQUIREMENTS

TEST		FREQUENCY
TR 16.11-18-1	Verify that the concentrations of hydrogen and oxygen in the WASTE GAS HOLDUP SYSTEM are within limits by continuously monitoring the waste gases in the WASTE GAS HOLDUP SYSTEM with the hydrogen and oxygen monitors required FUNCTIONAL by SLC 16.11-20.	During WASTE GAS HOLDUP SYSTEM operation

BASES

This SLC is provided to ensure that the concentration of potentially explosive gas mixtures contained in the WASTE GAS HOLDUP SYSTEM is maintained below the flammability limits of hydrogen and oxygen. Automatic control features are included in the system to prevent the hydrogen and oxygen concentrations from reaching these flammability limits. These automatic control features include isolation of the source of hydrogen and/or oxygen, automatic diversion to recombiners, or injection of dilutants to reduce the concentration below the flammability limits. Maintaining the concentration of hydrogen and oxygen below their flammability limits provides assurance that the releases of radioactive materials will be controlled in conformance with the requirements of General Design Criterion 60 of Appendix A to 10 CFR Part 50.

REFERENCES

1. Letter from NRC to Gary R. Peterson, Duke, Issuance of Improved Technical Specifications Amendments for Catawba, September 30, 1998.

2. Technical Specification 5.5.12, Explosive Gas and Storage Tank Radioactivity Monitoring Program.

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

16.11-19 Gas Storage Tanks

COMMITMENT: The quantity of radioactivity contained in each gas storage tank shall be limited to $\leq$ 97,000 Curies of noble gases (considered as Xe-133 equivalent).

APPLICABILITY: At all times.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Quantity of radioactive material in tank(s) exceeding limit.	A.1 Suspend all additions of radioactive material to the tank(s).	Immediately
	AND	
	A.2 Reduce tank(s) contents to within limit.	48 hours
	AND	
	A.3 Describe the events leading to this condition in the Radioactive Effluent Release Report.	In the next scheduled Radioactive Effluent Release Report pursuant to Technical Specification 5.6.3

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11-19-1 Verify that the quantity of radioactive material contained in each tank is within limits when radioactive materials are being added to the tank(s).	24 hours

BASES

The tanks included in this SLC are those tanks for which the quantity of radioactivity contained is not limited directly or indirectly by another SLC. Restricting the quantity of radioactivity contained in each gas storage tank provides assurance that in the event of an uncontrolled release of the tank's contents, the resulting whole body exposure to a MEMBER OF THE PUBLIC at the nearest SITE BOUNDARY will not exceed 0.5 rem. This is consistent with Standard Review Plan 11.3, Branch Technical Position ETSB 11-5, "Postulated Radioactive Releases Due to a Waste Gas System Leak or Failure," in NUREG-0800, July 1981.

REFERENCES

1. Letter from NRC to Gary R. Peterson, Duke, Issuance of Improved Technical Specifications Amendments for Catawba, September 30, 1998.

2. Technical Specification 5.5.12, Explosive Gas and Storage Tank Radioactivity Monitoring Program.

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

16.11-20 Explosive Gas Monitoring Instrumentation

COMMITMENT The Explosive Gas Monitoring Instrumentation channels shown in Table 16.11-20-1 shall be FUNCTIONAL with their Alarm/Trip Setpoints set to ensure that the limits of SLC 16.11-18 are not exceeded.

APPLICABILITY: During WASTE GAS HOLDUP SYSTEM operation.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or more required Explosive Gas Monitoring Instrumentation channel(s) Alarm/Trip Setpoint less conservative than required.	A.1 Declare the channel(s) non-functional.	Immediately
B. One required hydrogen monitor channel non-functional.	B.1 Suspend oxygen supply to the recombiner.	Immediately
	<u>AND</u>	
	B.2 Restore channel to FUNCTIONAL status.	30 days
C. One required oxygen monitor channel non-functional.	C.1 Obtain and analyze grab samples.	24 hours
	<u>AND</u>	
	C.2 Restore channel to FUNCTIONAL status.	30 days

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
D. Two required oxygen monitor channels non-functional.	D.1 Obtain and analyze grab samples. AND D.2 Restore channels to FUNCTIONAL status.	Once per 4 hours during degassing operations AND Once per 24 hours during other operations 30 days
E. Required Action and associated Completion Time of Condition B, C, or D not met.	E.1 Prepare and submit a Special Report to the NRC to explain why the non-functionality was not corrected within the time specified.	30 days

TESTING REQUIREMENTS

---NOTE---
Refer to Table 16.11-20-1 to determine which TRs apply for each Explosive Gas Monitoring Instrumentation channel.

TEST	FREQUENCY
TR 16.11-20-1 Perform CHANNEL CHECK.	24 hours
TR 16.11-20-2 Perform COT.	31 days

(continued)

TESTING REQUIREMENTS (continued)

TEST	FREQUENCY
TR 16.11-20-3 ---------------------------------NOTE--------------------------------- The CHANNEL CALIBRATION shall include the use of standard gas samples in accordance with the manufacturer's recommendations. In addition, a standard gas sample of nominal four volume percent hydrogen (for the hydrogen monitors), nominal four volume percent oxygen (for the oxygen monitors 0WGMT6540, 0WGMT6560, 0WGMT6160, and 0WGMT6161), and nominal three volume percent oxygen (for the oxygen monitors 0WGMT6550 and 0WGMT6570) with the balance nitrogen, shall be used in the calibration and/or to check linearity of the analyzers. --- Perform CHANNEL CALIBRATION.	92 days

Table 16.11-20-1

Explosive Gas Monitoring Instrumentation

INSTRUMENT		REQUIRED CHANNELS	TESTING REQUIREMENTS
WASTE GAS HOLDUP SYSTEM Explosive Gas Monitoring Instrumentation			
1.	Hydrogen Monitors	1/inservice train per station	TR 16.11-20-1 TR 16.11-20-2 TR 16.11-20-3
2.	Oxygen Monitors	2/inservice train per station	TR 16.11-20-1 TR 16.11-20-2 TR 16.11-20-3

BASES

The Explosive Gas Monitoring Instrumentation is provided for monitoring and controlling the concentrations of potentially explosive gas mixtures in the WASTE GAS HOLDUP SYSTEM.

If an instrument has alarm <u>and</u> trip capability, then <u>both</u> the alarm and the trip setpoints are required to be verified for the instrument to remain FUNCTIONAL. For instruments with alarm-only capability, the alarm setpoint must be verified for the instrument to remain FUNCTIONAL.

0WGMT6540, 0WGMT6550, 0WGMT6560, and 0WGMT6570 provide both an alarm and a trip function. 0WGMT6160 and 0WGMT6161 provide an alarm-only function. The oxygen monitors for waste gas analyzers 0WGMT6550 or 0WGMT6570 can only be credited if oxygen concentration is <3.7% and if NO oxygen sources are present.

REFERENCES

1. Letter from NRC to Gary R. Peterson, Duke, Issuance of Improved Technical Specifications Amendments for Catawba, September 30, 1998.

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

16.11-21 Major Changes to Liquid, Gaseous, and Solid Radwaste Treatment Systems

COMMITMENT

Licensee-initiated major changes to the Radwaste Treatment Systems (liquid, gaseous, and solid):

1. Shall be reported to the NRC in the Radioactive Effluent Release Report for the period in which the evaluation was reviewed by the Station Manager. Licensees may choose to submit the information called for in this SLC as part of the periodic Updated Final Safety Analysis Report update. The discussion of each change shall contain:

   a. A summary of the evaluation that led to the determination that the change could be made in accordance with 10 CFR 50.59;

   b. Sufficient detailed information to totally support the reason for the change without benefit of additional or supplemental information;

   c. A detailed description of the equipment, components, and processes involved and the interfaces with other plant systems;

   d. An evaluation of the change, which shows the predicted releases of radioactive materials in liquid and gaseous effluents and/or quantity of solid waste that differ from those previously predicted in the license application and amendments thereto;

   e. 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;

   f. A comparison of the predicted releases of radioactive materials, in liquid and gaseous effluents and in solid waste, to the actual releases for the period prior to when the changes are to be made;

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

(continued)

COMMITMENT (continued)

h. Documentation of the fact that the change was reviewed and found acceptable by the Station Manager or the Chemistry Manager.

2. Shall become effective upon review and acceptance by a qualified individual/organization.

APPLICABILITY: At all times.

REMEDIAL ACTIONS None

TESTING REQUIREMENTS None

BASES None

REFERENCES

1. Letter from NRC to Gary R. Peterson, Duke, Issuance of Improved Technical Specifications Amendments for Catawba, September 30, 1998.

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

Catawba Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

The most recent revision to the PCP is Revision 15 which was issued on 09/06/2022 and is included in with this Attachment. Revision 15 was a major rewrite of the entire document to add the DEC PCP material back into the CNS PCP. The general structure was retained from the DEC PCP; however, ONS and MNS specific material was omitted as they are being placed in the ONS PCP and MNS PCP as applicable. Additionally, section 5 and Section 6 were updated to align with current organization responsibilities and procedure references were updated throughout the CNS PCP. New step 9.3.3.2.1 was also added to address CNS NCR 02314994.

DUKE ENERGY

Facility Code :	CN
Applicable Facilities :	
Document Number :	CNS PCP
Document Revision Number :	015
Document EC Number :	
Change Reason :	AR02428883
Document Title :	CNS Process Control Program

Droppers, Amanda J.	Preparer	9/6/2022
Russell, Ronald B	Station Sciences Reviewer	9/6/2022
Gates, Douglas V.	Operations Reviewer	9/6/2022
Smith, Joe W	Station Sciences Approver	9/6/2022
Andrews, Steven J	Operations Approver	9/6/2022
Huecker, Jonathan D	Plant Manager Approval	9/6/2022

Notes :

Catawba Nuclear Station Process Control Program

Radioactive Waste Process Control Program

Revision 15 (DRR 02428883)

Reviews/ Approvals	Name
Prepared: CNS Station Sciences	A. Droppers
Reviewed: CNS Station Sciences	R. Russell
Reviewed CNS Operations	D. Gates
Approved: CNS Management / Station Sciences	Joe Smith
Approved: CNS Management / Operations	Steven Andrews
Approved: CNS Plant Manager	Jon Huecker

Table of Contents

1. INTRODUCTION

1.1. Purpose

The Catawba Nuclear Station (CNS) Process Control Program (PCP) addresses the requirements for solid radioactive waste referenced in Selected Licensing Commitments (SLC) and Technical Specifications at Catawba Nuclear Station.

1.1.1. A Process Control Program (PCP) describes the administrative and operational controls used for the solidification of liquid or wet radioactive wastes and the dewatering of wet radioactive wastes. Its purpose is to assure that the final disposal waste product meets applicable Federal, State and Disposal Site waste form requirements for disposal at a 10CFR61 licensed Low-Level Waste (LLW) disposal site.

1.1.2. Waste processing (solidification or dewatering) equipment and services may be provided by Duke Energy or approved vendors. Vendor services may be performed onsite or offsite. Any process used shall meet all applicable requirements of the PCP.

1.1.3. For waste processed onsite for direct disposal it is the responsibility of the Low-Level Waste (LLW) generator/ shipper to ensure that PCP requirements are met and that the condition of the waste is acceptable upon arrival at the disposal site.

1.1.4. For waste packaged and shipped to an approved off-site processor contracted to meet the requirements for direct disposal at a 10CFR61 licensed LLW disposal site, the final waste form requirements are not applicable prior to shipment to the processor for final processing and disposition.

2. APPLICABILITY

2.1. Liquid and Wet Radioactive Waste Disposal

2.1.1. Licensing documents, e.g., Final Safety Analysis Reports (FSAR), Tech Specs (TS) and SLCs, require that the Solid Radwaste System be operated in a manner to assure compliance with requirements for the transportation and disposal of LLW. They refer to the NRC requirement to follow a process control program for solidification of liquid or wet radioactive wastes or the dewatering of wet radioactive wastes to be shipped for direct disposal at a 10CFR61 licensed disposal site such that the final product meets all applicable disposal site requirements.

2.1.2. These PCP requirements are applicable to all liquid or wet radioactive wastes that are being prepared for direct disposal at a 10CFR61 LLW disposal facility.

2.1.3. Radioactive wastes shipped for off-site processing in accordance with the processor's specifications and transportation requirements are not required to be solidified or dewatered to meet disposal requirements prior to shipment to an offsite processor. They are not subject to the final waste form solidification or dewatering requirements of this PCP as specified in 10CFR61 when an offsite processor is contracted to perform the PCP processing for disposal.

2.2. Mixed Waste

2.2.1. AD-EN-ALL-0700 "Waste Management and Recycling" describes handling of mixed waste at Duke Energy nuclear stations.

2.2.2. Disposal of Mixed Waste at a LLW disposal site is prohibited unless it is approved by the disposal site and meets federal, state and disposal site requirements. (e.g., 40CFR, 10CFR61, site waste acceptance criteria)

2.2.3. All vendors supplying services for Mixed Waste using solidification shall meet the applicable requirements of the PCP and be a Duke Approved Supplier of PCP Services.

2.2.4. Site Staff Personnel and disposal site regulators shall approve the use of solidification for disposal of Mixed Waste.

2.2.5. If Mixed Waste is to be rendered non-hazardous for disposal at a 10CFR61 disposal site using solidification, the final product and packaging must meet all the LLW disposal site requirements.

2.3. Radioactive Waste Oil

2.3.1. Radioactively contaminated oil is to be managed as described in AD-EN-ALL-0730 "Used Oil Management".

2.3.2. Offsite processors are available for waste oil treatment, (e.g., incineration) reducing the regulatory burden on the generating site. Nuclear site programs address the specific waste oil management processes available at the site.

2.3.3. Each LLW disposal site defines the acceptable threshold for incidental levels of waste petroleum-based oil (e.g., less than 1% by volume). Solidified waste containing oil shipped to a 10CFR61 disposal site shall meet the applicable requirements of the PCP and all applicable disposal site acceptance criteria.

2.3.4. If a LLW site accepts greater than incidental concentrations of oil to be solidified for disposal, an oil-specific procedure must meet the requirements of the PCP and the acceptance criteria of that disposal site.

2.4. Radioactive Waste Interim Storage

Sites that have LLW requiring interim storage shall ensure that all of the following requirements that are applicable are met:

2.4.1. Any radioactive waste that is stored for an interim period in a shipping/disposal container shall be packaged such that there is no detrimental interaction between the waste and its container.

2.4.2. If applicable, Certificates of Compliance shall be maintained at each station for all waste shipping/ disposal containers used for interim storage.

2.4.3. Vendor supplied containers used for storage shall be handled and stored according to applicable guidance in vendor documents, including chemical compatibility requirements.

3. REFERENCES

3.1. Regulatory Requirements

The use of and content of the PCP addresses requirements found in the following regulations:

3.1.1. 10CFR20, “Standards for Protection Against Radiation"

3.1.2. 10CFR50, “Domestic Licensing of Production and Utilization Facilities"

3.1.3. 10CFR50 Appendix A, "General Design Criteria for Nuclear Power Plants"

3.1.4. 10CFR61, “Licensing Requirements for Land Disposal of Radioactive Waste"

3.1.5. 10CFR71, “Packaging and Transportation of Radioactive Material"

3.1.6. 40CFR, “Protection of Environment"

3.1.7. 40CFR266 “Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities"

3.1.8. Licensed radioactive waste burial site criteria

3.1.9. State hazardous waste regulations

3.2. Regulatory Guidance and Industry Standards

Technical guidance is provided in the following documents to standardize compliance with the applicable regulations:

3.2.1. NUREG-0133, “Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants"

3.2.2. NUREG-0452, “Standard Technical Specifications for Westinghouse PWR's” (Superseded by NUREG 1431)

3.2.3. NUREG-1431 “Standard Technical Specifications Westinghouse Plants"

3.2.4. NUREG-1430 “Standard Technical Specifications Babcock and Wilcox Plants"

3.2.5. NUREG-800 “Standard Review Plan”, Section 11.4 “Solid Waste Management Systems"

3.2.6. NUREG 800, Section 11.4, Appendix -A, “Design Guidance for Temporary Onsite Storage of Low Level Radioactive Waste"

3.2.7. Branch Technical Position (BTP) - ETSB 11-3, “Design Guidance of Solid Radioactive Waste Management Systems"

3.2.8. NRC Review Criteria for Solid Waste Management Systems

3.2.9. Regulatory Guide 1.143, “Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Plants"

3.2.10. NRC "TECHNICAL POSITION ON WASTE FORM" Revision 1 (January 1991)

3.2.11. NRC "Concentration Averaging and Encapsulation Branch Technical Position", Rev 1 (2015)

3.2.12. ANSI/ANS-40.37-2009 “mobile radioactive waste processing systems"

3.2.13. 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"

3.3. Duke Energy and Vendor PCP Implementing Documents

Duke Energy and Vendor PCP procedures are implemented in the following documents:

3.3.1. AD-RP-ALL-5000, Preparation and Shipment of Radioactive Material and Radioactive Waste

3.3.2. CNS SLC 16.11-11, "Solid Radioactive Wastes"

3.3.3. CNS UFSAR Chapter 11

3.3.4. CS-OP-PR-008, Setup and Operation of Energy Solutions Self-Engaging Dewatering System Fillhead

3.3.5. CS-OP-PR-009, Ecodex Precoat/Powdex/Solka-Floc/Diatomaceous Earth/Zeolite Dewatering Procedure for Energy Solutions 14-215 Or Smaller Liners Utilizing Energy Solutions Self-Engaging Dewatering System (S.E.D.S.)

3.3.6. CS-OP-PR-010, Bead Resin/ Activated Carbon Dewatering Procedure for Energy Solutions 14-215 Or Smaller Liners, Utilizing Energy Solutions Self-Engaging Dewatering System (S.E.D.S.)

3.3.7. Duke Energy Corporation Topical Report: Quality Assurance Program Description Operating Fleet (DUKE-QAPD-001-A)

3.3.8. FO-AD-002, Operating Guidelines for Use of Polyethylene High Integrity Containers

3.3.9. FO-OP-022, Ecodex Pre-Coat/Powdex/Solka-Floc/Diatomaceous/ Earth/Zeolite Dewatering Procedure for Energy Solutions 14-215 Or Smaller Liners

3.3.10. FO-OP-023, Bead Resin/Activated Carbon Dewatering Procedure for Energy Solutions 14-215 Or Smaller Liners

3.3.11. FO-OP-033, Set Up and Operation of Universal Dewatering Fillhead

3.3.12. FO-OP-073, Removing Free Standing Water from Energy Solutions FEXM HICS

3.3.13. OP/0/B/6500/046, Transferring and Dewatering Bead resin in WSF

3.3.14. OP/0/B/6500/069, Monitor Tank Building (MTB) Ion Exchange and Filtration Media Operations

3.3.15. OP/0/B/6500/111, Nuclear Solid Waste (WS) Disposal System (NCR 01430289)

3.3.16. OP/0/B/6500/131, Secondary Contaminated Resin Operations

3.3.17. OP/1/B/6250/008 A, Steam Generator Blowdown Demineralizers

3.3.18. OP/1/B/6500/071, Transfer and Dewatering of Secondary Resin

3.3.19. OP/2/B/6250/008 A, Steam Generator Blowdown Demineralizers

3.3.20. OP/2/B/6500/071, Transfer and Dewatering of Secondary Resin

3.4. Duke Energy Programs that Interface with the PCP

Duke Energy procedures interface with PCP requirements within the following documents:

3.4.1. AD-CP-ALL-0023, Preparation of the Annual Radioactive Effluent Release Report

3.4.2. AD-CP-ALL-0030, Process Control Program (PCP) Review and Revision

3.4.3. AD-DC-ALL-0002, Records Management

3.4.4. AD-DC-ALL-0201, Development and Maintenance of Controlled Procedure Manual Procedures

3.4.5. CN Diagram CN-1565-3.2

3.4.6. CN Diagram CN-1566-1.6

3.4.7. Duke Energy Information Retention Policy

Ref: (Legal 109, 10CFR20 Appendix G (III.A.3), 10CFR61.80)

3.4.8. D-EN-ALL-0700, Waste Management and Recycling

3.4.9. AD-EN-ALL-0730, Used Oil Management

3.4.10. AD-LS-ALL-0019, On-Site Review Committee

3.4.11. AD-RP-ALL-5002, 10 CFR 61 Radioactive Waste Classification

4. DEFINITIONS

4.1. 10CFR Part 61 “Licensing Requirements for Land Disposal of Radioactive Waste"

This NRC regulation requires that low-level radioactive waste (LLW) meet certain waste form acceptance criteria to be received for disposal at NRC and Agreement State licensed radioactive waste disposal sites.

4.2. Boundary Conditions / Acceptance Criteria

4.2.1. Solidification Boundary Conditions or Acceptance Criteria are defined as, the bounding numerical values for solidification process parameters that produce an acceptable product when shipped for direct disposal at a 10CFR61 disposal site.

4.2.2. Dewatering Boundary Conditions or Acceptance Criteria are defined as the bounding numerical values for process parameters that ensure free standing liquid requirements are met when shipped for direct disposal at a 10CFR61 disposal site.

4.2.2.1. Media: Acceptance Criteria for dewatering process media in disposal containers (e.g., HICs) have been determined by vendor tests using real or simulated waste to demonstrate the adequacy of the dewatering process for each combination of waste type and container. These tests are documented in dewatering Topical Reports, or equivalent, that shall be approved by the NRC or other appropriate authority before the containers are certified for use. The Acceptance Criteria are then incorporated into the dewatering procedures for each combination of waste type and container.

4.2.2.2. Filters: Acceptance criteria for mechanical filters (e.g., cartridge, bag, membranes, etc.) may be derived from tests performed on the various types of filters in use. Tests performed by Duke Energy should be documented in a retrievable manner. Acceptance criteria are then incorporated into the applicable procedure for each filter type (e.g., drainage time, drainage conditions, etc.).

4.2.2.3. Filters may also be packaged in disposal containers designed to allow the removal of free standing liquid from the container prior to shipment for direct disposal based on the disposal site's waste acceptance criteria (WAC).

4.3. Dewatering

Dewatering as used in this document is the removal of liquid using a process that is required to meet the requirements of this PCP. Dewatering removes the loosely bound liquid from a wet radioactive waste such that accumulation of Free Standing Liquid in the disposal container is unlikely to approach the disposal limit threshold values as defined by applicable regulations and disposal site criteria. NRC regulations require that the process used to dewater radioactive wastes to meet disposal criteria shall be governed by a PCP.

4.3.1. 10CFR61 FSL criteria requires less than 0.5% FSL by waste volume per container or less than 1.0% FSL if a high integrity container (HIC) is used.

4.3.2. Typically, liquid and wet wastes are pre-staged in vented tanks or containers and are therefore degassed prior to the dewatering process. However, all vendor-required venting practices should be adhered to.

4.4. Free Standing Liquid (FSL)

FSL is liquid that is in a disposal container but is not bound by the waste in the container. FSL is the liquid available for release if disposal container integrity is lost (e.g., punctured). The amount of FSL in a radioactive waste disposal container shall be less than a specified threshold to meet 10CFR61, state and disposal site requirements for disposal.

4.5. High Integrity Container (HIC)

Disposal containers that have been approved by the NRC for disposal of Class A unstable, Class B or Class C LLW and meet the long term disposal requirements of 10CFR61 and the disposal site.

4.6. Liquid Radioactive Wastes

Radioactive wastes comprised primarily of water containing a combination of dissolved and suspended solids (e.g., evaporator concentrates, lab wastes, floor and equipment drain water, laundry, wet waste decant or drainage, etc.).

4.7. Mixed Waste

Defined in Resource Conservation Recovery Act (RCRA) as amended by the Federal Facility Compliance Act of 1992, a Mixed Waste contains both RCRA hazardous waste and source, special nuclear, or byproduct material subject to the Atomic Energy Act of 1954, as amended. The use of solidification to render Mixed Wastes non-hazardous shall ensure that the final product meets all waste form requirements applicable to radioactive waste disposal at a 10CFR61 disposal site. (Ref: 3.1.6. “40 CFR Part 266")

4.8. PCP Topical Report (NCRs 01740840, 01605371, 01423659)

A Topical Report provides the basis for a PCP technology & process. It documents test results that demonstrate regulatory requirements were met during the regulatory required testing for solidification or dewatering technologies and processes. For a time period after implementation of 10CFR61 the NRC approved processes developed to dewater or solidify waste based their review of the Topical Report for that process. The NRC no longer performs the approval of Topical Reports, so this approval is typically the responsibility of the disposal site host agreement state regulatory authorities. Topical report testing was designed to envelope the worst-case dewatering scenarios given the industry's then current practices. As with any topical based program, the critical conditions and parameters identified during testing are incorporated into the implementing process with enough conservative margin to ensure success if you operate within the enveloping conditions and assumptions of the tests performed. When actual conditions vary from the conditions in the specific tests performed for the Topical Report, the correlation with the Topical testing is diminished and degree of processing conservatism may need to increase to compensate.

4.9. Process Parameters

Those conditions measured or observed during a solidification or dewatering process to ensure an acceptable product. These are determined for each waste type and are specific to the process method used.

4.10. QA Approved Supplier List

Radwaste vendors approved to provide PCP processing are included on the Duke QA Approved Supplier List and are subject to the requirements and audits of that program.

4.11. Safety Analysis Report (SAR)

The station’s Technical Specifications (Tech Specs) updated final safety analysis report, licensee commitments, safety evaluation reports and the facility operating license.

4.12. Selected Licensee Commitments (SLCs)

Commitments to control important plant equipment and operating conditions not controlled elsewhere. Operational commitments which are to be removed from existing station Tech Specs may be included in the SLC program. Also included in this program can be selected NRC commitments contained in licensing documents such as the station's SERs, LERs, violation responses, generic letter and bulletin responses, submittal documents and other Duke letters to the NRC.

4.13. Solidification

The meaning of the term Solidification during the original implementation of 10CFR61 was a process that converted radioactive waste into a product meeting 10CFR61, State and disposal site requirements for waste-form stability and FSL. Solidification was accomplished by mixing measured amounts of liquid or wet radioactive waste, binder and required additives that, after sufficient curing time, produce a solid homogeneous, freestanding monolith. At the end of the curing period, the absence of excessive FSL was verified either by confirmation that the PCP boundary conditions were met or by physical verification/testing. Under current practices, generally the solidified waste does not meet waste form stability requirements since few of the processes tested during the early implementation were able to do so. The waste container or barriers in site design or process used at the disposal site meet the stability requirements. The process requirements described in the solidification section do not apply to encapsulation of discrete LLW items as described in the BTP for waste form.

4.14. Unwatering ("Gross Dewatering", "dewatering to loss of vacuum")

Unwatering as used in this document is the removal of water using a process that is not required to meet the requirements for direct disposal at a 10CFR61 disposal site. Unwatering removes loosely bound excess or freeboard water from wet radioactive wastes such that only the requirements for transportation set forth in 49CFR are satisfied (e.g., unwatering may be to complete the first dewatering cycle for a specific container and waste stream to loss of vacuum to prepare waste for shipment to an approved offsite processor who will perform additional processing that will meet the final disposal requirements).

4.15. Waste Batch

A "batch" shall be defined as an isolated quantity of waste to be processed having essentially consistent physical and chemical characteristics.

4.16. Waste Batch Mixing

A Waste Batch shall be adequately mixed using a proceduralized process such as agitation via mixers, air sparging or recirculating flow which meets a specified minimum rate that has been determined to provide a representative sample for the vessel.

4.17. Wet Radioactive Wastes

Wet radioactive wastes are solid radioactive wastes containing loosely bound liquid that can collect in the disposal container as FSL (e.g., slurry wastes are comprised primarily of solid particles suspended in loosely bound interstitial water, spent mechanical filters are solid materials that are adsorbent or porous and retain liquid).

5. PROCESS CONTROL PROGRAM MANAGEMENT

5.1. PCP Responsibilities

5.1.1. On-Site Review Committee (ORC)

5.1.1.1. Reviews and approves PCP changes in accordance with AD-CP-ALL-0030, Process Control Program (PCP) Review and Revision, and as defined in Section 6, Administration of the PCP and Support Documents.

5.1.2. Plant Manager

5.1.2.1. Reviews and approves PCP changes in accordance with AD-CP-

ALL-0030, Process Control Program (PCP) Review and Revision, and as defined in Section 6, Administration of the PCP and Support Documents.

5.1.3. Station Sciences Manager or designee

5.1.3.1. Ensure radioactive waste is shipped in accordance with the appropriate state and federal regulations.

5.1.3.2. Advise the Plant Manager on the appropriate technical standards, regulations, and requirements as related to solidification, dewatering and shipping.

5.1.3.3. Ensure the vendor's PCP and proposed contractual agreements are revised and advising the Plant Manager as to their adequacy

5.1.3.4. Ensure vendor supplied documentation is retained for NRC inspection and review.

5.1.3.5. Reviews and approves PCP changes in accordance with AD-CP-ALL-0030, Process Control Program (PCP) Review and Revision, and as defined in Section 6, Administration of the PCP and Support Documents.

5.1.3.6. Ensure vendor's PCP and operating procedures are reviewed and approved as required.

5.1.4. Site Staff Personnel (Station Sciences and Operations)

5.1.4.1. Provide technical support for PCP issues.

5.1.4.2. Perform PCP revisions in accordance with AD-CP-ALL-0030, Process Control Program (PCP) Review and Revision.

5.1.4.3. Generate Document Revision Requests (DRRs) to support PCP revisions in accordance with AD-CP-ALL-0030, Process Control Program (PCP) Review and Revision.

5.1.4.4. Review PCP revisions in accordance with AD-CP-ALL-0030, Process Control Program (PCP) Review and Revision.

5.1.4.5. Ensure corporate programs comply with applicable PCP requirements.

5.1.4.6. Support nuclear site programs in complying with PCP requirements.

5.1.4.7. Review vendor PCP and operating procedures.

5.1.4.8. Ensure PCP revision summary is provided in accordance with AD-CP-ALL-0023, Preparation of the Annual Radioactive Effluent Release Report.

5.1.4.9. Approve the use of solidification for disposal of Mixed Waste.

5.1.5. Operations Manager or designee

5.1.5.1. Monitor vendor operations to assure compliance with UFSAR and SLC requirements and procedural and contractual agreements.

5.1.5.2. Ensure vendor's PCP and operating procedures are reviewed and approved as required.

5.1.5.3. Reviews and approves PCP changes in accordance with AD-CP-ALL-0030, Process Control Program (PCP) Review and Revision, and as defined in Section 6, Administration of the PCP and Support Documents

5.2. Oversight and Audits

Audits of the Process Control Program and implementing procedures for processing of radioactive wastes shall be performed per DUKE-QAPD-001-A.

6. ADMINISTRATION OF THE PCP AND SUPPORT DOCUMENTS

6.1. PCP Changes: Revisions and Minor Changes

PCP document revisions and minor changes are initiated, reviewed, and approved in accordance with AD-CP-ALL-0030, Process Control Program (PCP) Review and Revision. Document management processes are used to control the PCP while the PCP document revision summary (Section 11) captures PCP changes. The guidance for and descriptions of what constitutes a minor change and revision are:

6.1.1. The Duke Energy Quality Assurance Program Description (QAPD) implementation guidance is in procedure AD-LS-ALL-0019, On-Site Review Committee. This procedure describes when an On-site Review Committee (ORC) should be notified of changes to site documents. (e.g., where NRC notification of the change is required prior to implementation)

6.1.2. Table 1 REVISIONS: Technical or significant changes to PCP documents shall be implemented as a Revision to the affected documents and include the reviews and approvals described in Table 1.

6.1.3. Table 1 MINOR CHANGES: If a change meets the following criteria it does not require a revision. Reviews and approvals are described in Table 1.

6.1.3.1. The change is editorial in nature (e.g., spelling, grammar, format, numbering, procedure name change, adding, deleting, or changing a reference) and only includes administration of the documents affecting only the preparer.

6.1.3.2. The change does not alter the scope, results, requirements, or methods by which the dewatering or solidification process is performed from requirements described in the applicable PCP document.

6.1.3.3. The change does not alter the responsibilities of site personnel in meeting the PCP requirements.

6.1.3.4. The change does not alter a PCP QA approved provider dewatering or solidification process, responsibilities for fulfilling PCP requirements or the vendor interface with the station personnel or work processes described in the PCP documents.

TABLE 1: CNS PCP Reviews and Approvals		
PCP Document Title	**Technical Roles** **Author & Review**	**Approvals**
REVISIONS	Preparer PCP SMEs	ORC Plant Manager
MINOR CHANGES	Preparer PCP SMEs	Station Sciences Manager

6.2. PCP Revision Reports to the NRC

PCP revisions shall be reported to the NRC each year in accordance with AD-CP-ALL-0023, Preparation of the Annual Radioactive Effluent Report.

6.3. PCP Document Revision Record Retention Requirements

See Duke Energy Record Retention Requirements in AD-DC-ALL-0002, Records Management.

6.4. PCP Implementing Procedure Requirements

6.4.1. The Duke Energy PCP Implementing procedures listed in Section 3.3 are published electronically as controlled copy files of the documents maintained in EDMS. These procedures satisfy NRC requirements for a PCP by ensuring that all requirements for solidification or dewatering are met when performed by Duke Energy workers.

6.4.1.1. Completed procedures documenting the onsite solidification verification records shall be retained by the site on each vessel of solidified waste.

6.4.1.2. Documentation of the onsite dewatering verification records shall be retained on each vessel of dewatered waste.

6.4.2. The Duke Energy technical PCP implementing procedures shall identify the fact that they are PCP related to ensure technical reviews consider the PCP requirements.

6.4.3. All revisions to Duke Energy technical PCP implementing procedures listed in Section 3.3 shall be reviewed to determine if they alter or inhibit the procedure's performance of CNS PCP requirements.

6.4.4. QA Approved Suppliers' procedures may be used for onsite PCP activities using non-installed equipment as described in applicable administrative procedures. (e.g., AD-DC-ALL-0201 Development and Maintenance of Controlled Procedure Manual Procedures).

7. APPROVAL PROCESS FOR QA APPROVED SUPPLIERS

Any PCP service supplier shall be approved and incorporated into the QA Approved Supplier Program prior to being used as contracted for process services that use a dewatering or solidification PCP to meet final waste form requirements at a 10CFR61 disposal site.

7.1. Technical Review and Approval

Before vendors can provide PCP related services, they shall be evaluated against the applicable Duke Energy PCP documents and approved by the appropriate designees.

7.1.1. If the vendor provides PCP related services, the vendor PCP and other related program documents are evaluated to ensure they meet the applicable requirements of the Duke Energy PCP documents.

7.1.2. The results of these reviews should be documented appropriately for future reference.

8. PCP REQUIREMENTS FOR VENDOR PROCESSES AND SERVICES

8.1. Topical Report (or equivalent)

Any vendor service or vendor supplied processes utilized for solidification or dewatering by Duke Energy shall have a Topical Report or other form of certification documenting appropriate regulatory approval of the process and associated containers, or shall supply to Duke Energy sufficient documentation of the process and test results to demonstrate that an acceptable product will be produced using the described solidification or dewatering process.

8.2. 10CFR61 Waste Form Compliance

8.2.1. The vendor(s) approved for solidification or dewatering services shall have regulatory certification documenting compliance with waste form requirements in the final product or shall supply Duke Energy sufficient documentation to demonstrate waste form compliance.

8.2.2. Any vendor providing HICs to Duke Energy shall provide proof of regulatory approval documenting compliance with waste form requirements or shall supply Duke Energy sufficient documentation to demonstrate waste form compliance.

8.2.3. All vendor Topical Reports or equivalent shall certify that the final product conforms to the applicable waste form for Class A, B, or C waste.

8.2.4. QA Approved PCP Service Suppliers shall meet the applicable quality requirements set forth in their contract or specific Purchase Order.

8.3. 10CFR61 Waste Classification Compliance

Each container of processed (i.e., solidified or dewatered) waste shall meet the requirements in AD-RP-ALL-5002, 10 CFR 61 Radioactive Waste Classification prior to disposal.

8.4. Minimum Requirements for Onsite Process Vendors

8.4.1. Vendors providing PCP services onsite shall be approved QA Suppliers.

8.4.2. PCP Vendors shall fulfill all the applicable requirements in the vendor Radioactive

Waste PCP and the applicable quality requirements set forth in the contract prior to shipment of the solidified or dewatered waste for direct disposal.

8.4.3. Onsite Vendor System/Equipment Interface Requirements:

8.4.3.1. The vendor documentation, drawings or diagrams supplied to Duke Energy shall include adequate system or process description including all vendor interfaces with installed plant equipment and potential release pathways.

8.4.3.2. Solidification system radioactive effluents are treated or routed to the appropriate plant system to meet effluent discharge requirements.

8.4.3.3. Decanted radioactive liquid is processed as required or routed to the station liquid radwaste systems.

8.4.4. Onsite Vendor Supplied System Design Requirements:

8.4.4.1. The vendor proposal and contract shall verify that the design, construction, operation, and quality assurance provisions are in accordance with applicable portions of NRC ETSB Branch Technical Position 11-3 and Regulatory Guide 1.143.

8.4.4.2. Permanent or portable solidification and dewatering systems used at nuclear sites shall meet the applicable design, construction, operation and quality assurance provisions of NRC ETSB Branch Technical Position 11-3 and Regulatory Guide 1.143.

8.5. Minimum Requirements for Offsite PCP Process Vendors

QA Approved Supplier Vendors providing PCP services offsite shall meet the requirements of their PCP process and the applicable quality requirements set forth in the contract and/or purchase order prior to disposal of the final product.

9. PCP DEWATERING PROCESS DESCRIPTION

The methods used for removal of liquid from wet wastes for final disposal shall comply with the specific requirements of the disposal site at which the waste is being disposed. Dewatering of wet wastes shall be performed in accordance with the applicable PCP requirements equivalent to the process described below. PCP workers shall use approved procedures in a controlled and quality fashion which ensures that all applicable license documents and disposal site criteria are met. Procedures used to direct dewatering shall include enough detail to ensure requirements are met.

9.1. Dewatering Mechanical Filters (e.g., cartridge, bag, membrane)

The guidance below addresses dewatering methods and PCP issues unique to removal of FSL for direct disposal of mechanical filters at a 10CFR61 disposal site.

9.1.1. The dewatering process must ensure subsequent accumulation of free standing liquid in the disposal container is not likely to approach disposal site limits.

9.1.2. The FSL requirements for direct disposal may be met using a container and procedure designed to remove any subsequent FSL accumulation in the container prior to disposal.

9.1.3. Wet spent mechanical filters can be dewatered by several methods including allowing liquid to gravity drain from the filter, blowing the filter down with air, compacting the filter, etc.

9.1.4. The method of dewatering shall be in accordance with a defined, evaluated, and documented process.

9.1.5. The parameters of the process, referred to as boundary conditions, shall be defined and used to ensure quality in the process, which in turn serves to ensure an acceptable characteristic of the waste. An example of a boundary condition is the specified period of time for which a mechanical filter shall be allowed to drain freely to ensure FSL will be less than disposal requirements.

9.1.6. Filters placed in a filter disposal container designed for removal of FSL shall meet the PCP boundary conditions for dewatering the container.

9.1.6.1. If PCP boundary conditions are met after placing the filter in the disposal container, the container shall be dewatered to ensure the container FSL meets disposal requirements.

9.1.6.2. If the PCP boundary conditions have been met prior to placing the filters in the disposal container, dewatering the container to remove incidental FSL is at site discretion.

9.1.6.3. Case-by case circumstances, such as the following, should be considered in determining the appropriateness of performing additional filter disposal container dewatering:

- The time interval between removal of the filters from wet service and placement into the disposal container
- Size of the disposal container relative to the moisture content in the filters
- The number of filters
- The variety of filter types in a single container
- The environmental conditions of filter staging and interim storage

9.1.7. Use of absorbent package material in mechanical filter disposal containers is subject to the requirements of the disposal site acceptance criteria.

9.2. Dewatering Slurries

The guidance below addresses dewatering issues associated with slurry wastes.

9.2.1. Dewatering of “slurried” wet wastes (e.g., resin, carbon, Zeolite, filter precoat, filter backwash solids) removes the loosely bound interstitial liquid from solids such that the disposal container meets applicable regulatory and burial site FSL criteria for disposal.

9.2.2. Wet spent process media dewatering shall be performed using processes, containers and procedures that have met the Duke PCP approval requirements.

9.2.3. Typical container dewatering processes use a vacuum pump that takes suction from the container through a filter system in the container. The water is returned to a station liquid radwaste system and the waste solids are retained in the vessel by the container filter(s).

9.3. Additional Conservatism in Slurry Dewatering Procedures to Address Variation from the Topical Report (NCR 01740840, 01605371, 01423659)

This section only applies to dewatering for direct disposal at a 10CFR61 disposal site performed by Duke Energy workers using Duke Energy dewatering procedures. This section does not apply to QA Approved Suppliers performing PCP activities.

Dewatering processes based on approved and documented testing (e.g., Topical Reports) are applied to actual conditions that can vary from the conditions of the original testing. The results of a Root Cause investigation (NCR 01740840) at Oconee Nuclear Station (ONS) identified several issues and resolutions that should be incorporated into applicable Duke dewatering implementing procedures. Vendor procedures applicable to the technologies and processes used by Duke Energy in implementing the PCP provide the basis for minimal requirements in PCP implementing procedures. In addition, the guidance below was added based on the Root Cause findings at ONS:

9.3.1. All Duke Energy PCP dewatering procedures shall include flexibility/ guidance for the worker to add conservatism to the dewatering process if waste content and/ or process conditions are atypical in a non-conservative manner relative to the testing performed for the Topical report. (e.g., presence of greater than normal non- media solids, dewatering boundary parameters are not easily met, higher than normal volume of FSL is collected during the final dewatering cycle, etc.)

9.3.1.1. Additional conservatism can include but is not limited to the following examples:

A. Additional dewatering cycles.

B. Additional settling time between pumping periods.

C. Additional processing by an approved offsite vendor to verify FSL prior to disposal.

9.3.2. Guidance for dewatering all liners for direct disposal at Barnwell (NCR 01740840 CAPR):

9.3.2.1. Require liner functional testing prior to filling liner with waste to ensure there are no leaks in the liner dewatering system. This testing should include:

A. filling the liner with water.

B. testing each level of the liner dewatering laterals using the dewatering procedure to unwater the liner.

C. verifying that vacuum is not broken prior to exposing the filters for each set of laterals as described in the procedure.

9.3.2.2. Ensure ambient temperature guidance for dewatering will preclude localized freezing conditions during the dewatering sequence. After most of the water is removed during the first dewatering cycle, subsequent cycles pull air through the interstitial spaces of the media and the loss of heat due to evaporation can depress the temperature on surface of the media and dewatering filters below ambient temperature.

A. Follow guidance in the vendor documentation for the process in use.

B. If no other guidance is provided, dewatering should not be performed unless ambient temperature of air entering the liner is 40 degrees Fahrenheit or higher (ref. Energy Solutions procedure FO-OP-022).

9.3.2.3. Ensure final water collection sample point is representative (e.g., as close as possible to the pump discharge).

9.3.3. Mixed Media: Additional guidance for dewatering liners containing Mixed Media with significant non-media solids using a PCP for direct disposal at a 10CFR61 disposal site. (NCR 01740840 CAPR)

The guidance below applies to liners containing combinations of different media with significant quantities of non-media solids (e.g., layered spent zeolite, carbon, resin, etc. containing a large amount of non-media particulate).

9.3.3.1. Require dewatering filters with maximized surface area (e.g., Ecodex filter or equivalent) in all liners that contain mixed media with significant non-media solids.

9.3.3.2. Clearly specify media loading sequence if media is not homogeneously mixed to minimize potential blinding of the lowest level of filters. (e.g., for layered media, use the media with the fewest non-media solids and most consistent and largest diameter beads in the bottom of the liner).

9.3.3.2.1. If media contains silver zeolite and layering of media cannot be performed, then shipment must be sent for processing prior to disposal at a 10CFR61 disposal site. (NCR 02314994).

9.3.3.3. Require additional dewatering Cycles (e.g. 3 additional cycles after the acceptance criteria in the vendor procedure have been met).

9.3.3.4. Require longer settling periods during the additional dewatering cycles (e.g., 24 hours instead of the 16 hours required in the vendor procedure).

9.3.3.5. The PCP implementing procedures must comply with the vendor PCP guidance and procedures applicable to the dewatering system and disposal containers in use. e.g., If the vendor process control program and procedures applicable to the current system and process require dewatering through the bottom 2 laterals during liner filling this must be reflected in the Duke procedures.

9.4. Dewatering Process Requirements

The procedures directing dewatering processes shall address all the following activities that apply to the specific waste type being dewatered.

9.4.1. Waste Characterization

Dewatering procedures shall describe how each type of waste is characterized. The characterization information determines what disposal and container requirements apply and may also be utilized to determine shipment packaging requirements (e.g., shielding). Much of the required information for slurry waste is obtained using a representative sample of the waste media. Characterization requires the following types of information:

9.4.1.1. Radioactivity content

A. To determine 10CFR61 waste class, form, and container requirements.

B. To provide waste radiological characteristics for packaging, transportation, and disposal requirements.

9.4.1.2. Waste compatibility with disposal container and process method

A. Chemical Compatibility: Process knowledge can be applied to determine chemical compatibility with the container.

B. Hazardous Characteristics: Process knowledge can be applied to determine if the waste is a Mixed Waste.

C. If process knowledge is uncertain due to a potential input of incompatible or hazardous materials, then chemical analysis using an approved method shall be performed to determine chemical compatibility or hazardous characteristics

9.4.2. PCP process parameters shall be identified in implementing procedures. Typical parameters are based on:

9.4.2.1. Waste form (e.g., physical, chemical, and radiological characteristics)

9.4.2.2. Settling time

9.4.2.3. Drain (or pump) time

9.4.2.4. Temperature

9.4.2.5. Drying time

9.4.3. PCP boundary conditions shall be established for applicable process parameters to verify FSL threshold limits are met.

9.4.4. Sample analysis results and boundary conditions shall be reviewed by the appropriate knowledgeable individual responsible for the dewatering process.

9.4.5. Actual dewatering shall be performed using approved procedures that ensure the process is performed within the established boundary conditions.

9.5. Product Verification

The amount of FSL shall be verified to be within disposal site criteria for each container of dewatered waste prior to disposal (e.g., 10CFR61 requires that each container shall have less than 0.5% free-standing liquids by waste volume or less than 1.0% free- standing liquid if a High Integrity Container (HIC) is used). Procedures should include guidance for problems during container loading or processing that preclude or fail to meet PCP requirements as required in SLC Remedial Action Requirements

9.5.1. PCP Verification may be accomplished by documenting that the Process Control Program was followed.

9.5.2. A disposal site may define a product verification testing method approved for use for specific waste disposal categories in lieu of a process control method.

9.5.2.1. The approved product verification process may be used for that category of disposal on a case-by-case basis, (e.g., bulk waste non-containerized disposal).

9.5.2.2. Documentation of the method used for product verification and the results shall be included in the dewatering record as described in the Dewatering Documentation Retention section below.

9.5.2.3. Make programmatic changes as necessary to address any problems identified.

9.5.3. The PCP and site procedures must address the Commitments in the “The Solid Radioactive Wastes” sections of SLC 16 “RADIOLOGICAL EFFLUENTS CONTROLS”. These Commitments include a description of the PCP purpose, and requirements for the use of the PCP to process LLW for direct disposal.

9.5.3.1. Remedial Actions address the following conditions:

A. Requirements not met by process or packaging conditions

B. Solidification verification failures

C. Processing not performed per PCP

D. Inoperable Equipment

9.5.3.2. Solidification processes must meet Testing or Surveillance requirements and frequencies.

9.6. Dewatering Document Retention

Documentation of dewatering or solidification completed onsite for direct disposal at a 10CFR61 disposal site shall be retained as part of the radiological shipping and disposal records as described in the applicable procedures and documents. (e.g., PCP implementing procedures, AD-RP-ALL-5000, vendor documents).

10. PCP SOLIDIFICATION PROCESS DESCRIPTION

This section historically described a solidification process for liquid or media LLW in which a radioactive liquid or slurry waste was uniformly mixed into a binding matrix to create a physically uniform final waste form that is a homogeneous, free standing monolith and meets10CFR61 waste form stability and FSL disposal requirements.

No installed solidification systems are operational at the Duke Energy Carolina sites because they were not able to meet all the 10CFR61 disposal requirements and/or were not cost effective. The solidification of liquids and slurry media if required is now performed via contracts with PCP QA approved suppliers under their PCP in controlled and quality fashion which ensures that all applicable regulatory, licensing and disposal site criteria are met. (e.g. the applicable Commitments in the “The Solid Radioactive Wastes” sections of SLC 16 “RADIOLOGICAL EFFLUENTS CONTROLS").

Only the FSL disposal requirements apply to solidification for encapsulation of discrete LLW items as described in the BTP for waste form. Encapsulation is also performed via contracts with PCP QA approved suppliers.

Documentation of onsite solidification for direct disposal at a 10CFR61 disposal site shall be retained as part of the radiological shipping and disposal records as described in the applicable procedures and documents. (e.g., PCP implementing procedures, AD-RP-ALL-5000, vendor documents).

11. REVISION SUMMARY

This revision 15 is major rewrite of the entire document to add the DEC PCP material back into the CNS PCP. The general structure was retained from the DEC PCP; however, ONS and MNS specific material was omitted as they are being placed in the ONS PCP and MNS PCP as applicable. Additionally, section 5 and Section 6 were updated to align with current organization responsibilities and procedure references were updated throughout the PCP. New step 9.3.3.2.1 was added to address CNS NCR 02314994.

ATTACHMENT 11

Summary of Major Modifications to the Radioactive Waste Treatment Systems

This attachment includes a description of major modifications to the radioactive waste treatment systems that are anticipated to affect effluent releases.

Attachment 11
Summary of Major Modifications to the Radioactive Waste Treatment Systems

Catawba Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

No major modifications to the Catawba Nuclear Station liquid, solid, or mobile radioactive waste treatment systems that are anticipated to affect effluent releases occurred in 2022.

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

Catawba Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

There are no amendments to a previous year's ARERR.

ENCLOSURE 3: **HNP Annual Radioactive Effluent Release Report**

Shearon Harris Nuclear Power Plant Unit 1

Annual Radioactive Effluent Release Report

2022

Document Number: 50-400

TABLE OF CONTENTS

TABLES

FIGURES

ATTACHMENTS

1.0 LIST OF ACRONYMS AND DEFINITIONS

1. Airborne Activity Sampling: Sampling of air through the collection of particulates and radionuclides on filter media, collection of noble gases in a container, and collection of water vapor containing tritium.

2. Alpha Particle (α): A charged particle emitted from the nucleus of an atom having a mass and charge equal in magnitude of a helium nucleus.

3. BWR: Boiling Water Reactor

4. Composite Sample: A series of single collected portions (aliquots) analyzed as one sample. The aliquots making up the sample are collected at time intervals that are very short compared to the composite period.

5. Control: A sampling station in a location not likely to be affected by plant effluents due to its distance and/or direction from the Plant.

6. Counting Error: An estimate of the two-sigma uncertainty associated with the sample results based on total counts accumulated.

7. Curie (Ci): A measure of radioactivity; equal to 3.7×10^{10} disintegrations per second, or 2.22×10^{12} disintegrations per minute.

8. Direct Radiation Monitoring: The measurement of radiation dose at various distances from the plant is assessed using thermoluminescent dosimeters (TLDs), optically stimulated luminescent dosimeters (OSLDs), and/or pressurized ionization chambers.

9. EFPD: Effective Full Power Days

10. Grab Sample: A single discrete sample drawn at one point in time.

11. Indicator: A sampling location that is likely to be affected by plant effluents due to its proximity and/or direction from the plant.

12. Ingestion Pathway: The ingestion pathway includes milk, fish, and garden produce. Meat or other food products may also be included.

13. ISFSI: Independent Spent Fuel Storage Installation

14. Lower Limit of Detection (LLD): 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 a 5% probability of a false conclusion that a blank observation represents "real" signal.

15. MDA: Minimum Detectable Activity. - For radiochemistry instruments, the MDA is the a posteriori minimum concentration that a counting system detects. The smallest concentration or activity of radioactive material in a sample that will yield a net count above instrument background and that is detected with 95% probability, with only five % probability of falsely concluding that a blank observation represents a true signal.

16. MDC: Minimum Detectable Concentration, essentially synonymous with MDA for the purposes of radiological monitoring.

17. Mean: The average, i.e., the sum of results divided by the number of results.

18. Microcurie (µCi): 3.7×10^4 disintegrations per second, or 2.22×10^6 disintegrations per minute.

19. millirem (mrem): 1/1000 rem; a unit of radiation dose equivalent in tissue.

20. Milliroentgen (mR): 1/1000 Roentgen; a unit of exposure to X- or gamma radiation.

21. MWe: Megawatts Electric

22. MWTh: Megawatts Thermal

23. NA: Not Applicable

24. NEI: Nuclear Energy Institute

25. NRC: Nuclear Regulatory Commission

26. NS: Not scheduled to be sampled, not sampled due to insufficient volume in well, or well inaccessible during outage

27. N/A: Not Applicable

28. ODCM: Offsite Dose Calculation Manual

29. OSLD: Optically Stimulated Luminescence Dosimeter

30. Protected Area: The fenced area immediately surrounding the Plant. Access to the protected area requires a security badge or escort.

31. PWR: Pressurized Water Reactor

32. REC: Radiological Effluent Control

33. REMP: Radiological Environmental Monitoring Program

34. Restricted Area: Any area where access is controlled for the purpose of protecting individuals from exposure to radiation or radioactive materials.

35. SLCs: Selected Licensee Commitments

36. TEDE: Total Effective Dose Equivalent (TEDE) means the sum of the effective dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).

37. TLD: Thermoluminescent Dosimeter

38. TRM: Technical Requirements Manual

39. TS: Technical Specification

3.0 EXECUTIVE SUMMARY

Shearon Harris Nuclear Power Plant Unit 1 (HNPP) Radiological Effluent Control (REC) Program was established to limit the quantities of radioactive material that may be released based on calculated radiation doses or dose rates. Dose to Members of the Public due to radioactive materials released from the plant is limited by Appendix I of 10 CFR 50 and by 40 CFR 190. Operational doses to the public during 2022 were calculated to be very small compared to the limits required by regulation and compared to other sources of radiation dose and pose no health hazard. These doses are summarized and compared to the regulatory limits in Section 3.1, Comparison to Regulatory Limits, below.

The Annual Radioactive Effluent Release Report (ARERR) is published per HNPP Technical Specification 6.9.1.4 and ODCM Section F.2. and provides data related to plant operation, including: quantities of radioactive materials released in liquid and gaseous effluents; radiation doses to members of the public; solid radioactive waste shipped offsite for disposal; and other information as required by site licensing documents. If a revision to the ODCM has occurred during the report period, it is included pursuant to HNPP Technical Specification 6.14.

In 2022 the Land Use Census dose assessments due to radioactive gaseous effluents showed that the critical receptor for Shearon Harris Nuclear Power Plant Unit 1 was the Child, due to the pathways of Inhalation, Ground Plane, Vegetation and Milk at location 2.14 km in the South West sector. The maximum Annual Organ Dose calculated for this receptor was 7.88E-01 mrems, to the Thyroid. This annual dose is a small fraction (5.25E+00 %) of the 10 CFR 50, Appendix I guideline of 15 mrem to the Maximum Organ per reactor unit.

Solid radioactive waste shipped offsite for disposal included 3.81E-01 Curies and 1217.86 m^3, shipped in 4 shipments.

In addition to monitoring radioactive effluents, HNPP has a Radiological Environmental Monitoring Program (REMP) that monitors for buildup of radioactivity in the offsite environment. Data from the REMP is published in the Annual Radiological Environmental Operating Report (AREOR).

3.1 Comparison to Regulatory Limits

During 2022 all solid, liquid, and gaseous radioactive effluents from Shearon Harris Nuclear Power Plant Unit 1 were well below regulatory limits, as summarized in Table 1 and Table 2.

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

Table 1, Shearon Harris Nuclear Power Plant Unit 1 Dose Summary[1]

		Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual
Liquid Effluent Dose Limit,(1) Total Body	Limit	**1.5 mrem**	**1.5 mrem**	**1.5 mrem**	**1.5 mrem**	**3 mrem**
	Total Body Dose	8.76E-03	3.42E-02	5.29E-02	7.07E-02	1.67E-01
	% of Limit	5.84E-01	2.28E+00	3.53E+00	4.71E+00	5.55E+00
Liquid Effluent Dose Limit, Any Organ	Limit	**5 mrem**	**5 mrem**	**5 mrem**	**5 mrem**	**10 mrem**
	Max Organ Dose(1)	1.76E-02	3.45E-02	6.66E-02	7.46E-02	1.93E-01
	% of Limit	3.52E-01	6.90E-01	1.33E+00	1.49E+00	1.93E+00
Gaseous Effluent Dose Limit,(2) Gamma Air (Noble Gas)	Limit	**5 mrad**	**5 mrad**	**5mrad**	**5 mrad**	**10 mrad**
	Gamma Air Dose(2)	5.74E-06	0.00E+00	0.00E+00	4.09E-05	4.66E-05
	% of Limit	1.15E-04	0.00E+00	0.00E+00	8.17E-04	4.66E-04
Gaseous Effluent Dose Limit, Beta Air (Noble Gas)	Limit	**10 mrad**	**10 mrad**	**10 mrad**	**10 mrad**	**20 mrad**
	Beta Air Dose(2)	1.70E-05	0.00E+00	0.00E+00	1.44E-05	3.14E-05
	% of Limit	1.70E-04	0.00E+00	0.00E+00	1.44E-04	1.57E-04
Gaseous Effluent Organ Dose Limit(3) (Iodine, Tritium, Particulates with > 8-day half-life)	Limit	**7.5 mrem**	**7.5 mrem**	**7.5 mrem**	**7.5 mrem**	**15 mrem**
	Max Organ Dose(3)	1.02E-01	1.97E-01	2.99E-01	1.91E-01	7.88E-01
	% of Limit	1.35E+00	2.62E+00	3.99E+00	2.54E+00	5.25E+00

(1) Critical Age ADULT, Critical Organ GI-LLi

(2) Receptor Location 2.14 km SW

(3) Receptor Location 2.14 km SW, Critical Age Child, Critical Organ Thyroid

[1] Table 1 demonstrates compliance with 10 CFR Part 50, App. I Limits.

Table 2, Total Annual Offsite-Dose Comparison to 40 CFR 190 Limits for HNPP[2]

A. Gaseous Effluent Dose		E. Harris Lake Evaporation H-3 Dose	
1. Location	2.14 km SW	1. Location	6.65 km SSW
2. Critical Age	CHILD	2. Critical Age	CHILD
3. Critical Organ	Thyroid	3. Critical Organ	N/A
4. Organ Dose (mrem)	7.88E-01	4. Organ Dose (mrem)	-
5. Total Body Dose (mrem)	7.88E-01	5. Total Body Dose (mrem)[3]	2.71E-02
B. Liquid Effluent Dose		F. Drinking Water H-3 Dose	
1. Location	2.19 km S	1. Location	Harris Plant
2. Critical Age	ADULT	3. Critical Age	ADULT
3. Critical Organ	GI-LLI	3. Critical Organ	N/A
4. Organ Dose (mrem)	1.93E-01	4. Organ Dose (mrem)	-
5. Total Body Dose (mrem)	1.67E-01	5. Total Body Dose (mrem)[3]	4.10E-02
C. Carbon-14 Dose		G. H-3 in Fish from Harris Lake	
1. Location	1.78 km ENE	1. Location	Harris Lake
2. Critical Age	CHILD	2. Critical Age	ADULT
3. Critical Organ	BONE	3. Critical Organ	N/A
4. Organ Dose (mrem)	2.20E-01	4. Organ Dose (mrem)	-
5. Total Body Dose (mrem)	4.38E-02	5. Total Body Dose (mrem)[3]	7.72E-03
D. Cooling Tower Plume H-3 Dose			
1. Location	2.91 km NNE		
2. Critical Age	CHILD		
3. Critical Organ	N/A		
4. Organ Dose (mrem)	-		
5. Total Body Dose (mrem)[3]	2.16E-03		

[2] Table 2 is a summation of Units to show compliance with 40 CFR Part 190 Limits.
[3] Dose is the same for Organ Dose.

4.0 INTRODUCTION

4.1 <u>About Nuclear Power</u>

Commercial nuclear power plants are generally classified as either Boiling Water Reactors (BWRs) or Pressurized Water Reactors (PWRs), based on their design. A BWR includes a single coolant system where water used as reactor coolant boils as it passes through the core and the steam generated is used to turn the turbine generator for power production. A PWR, in contrast, includes two separate water systems: radioactive reactor coolant and a secondary system. Reactor coolant is maintained under high pressure, preventing boiling. The high-pressure coolant is passed through a heat exchanger called a steam generator where the secondary system water is boiled, and the steam is used to turn the turbine generator for power production.

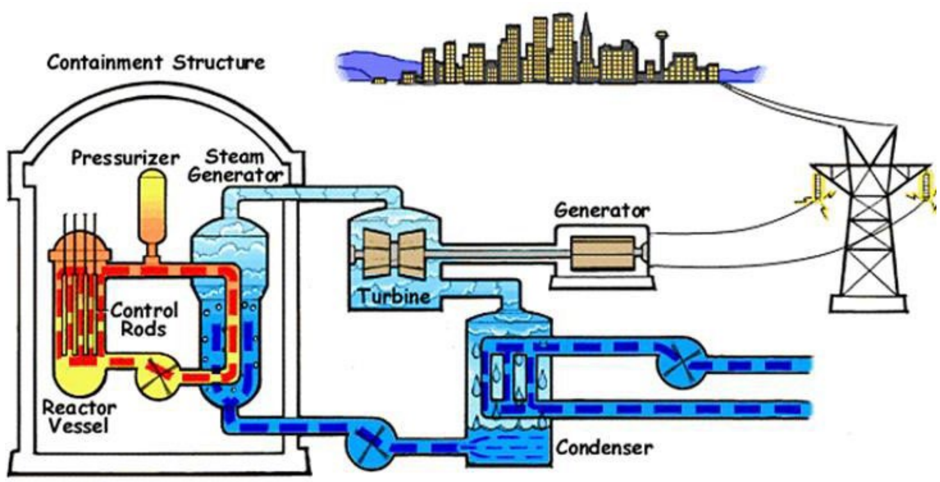

Figure 1, Pressurized Water Reactor (PWR) **[1]**

4.1 (Continued)

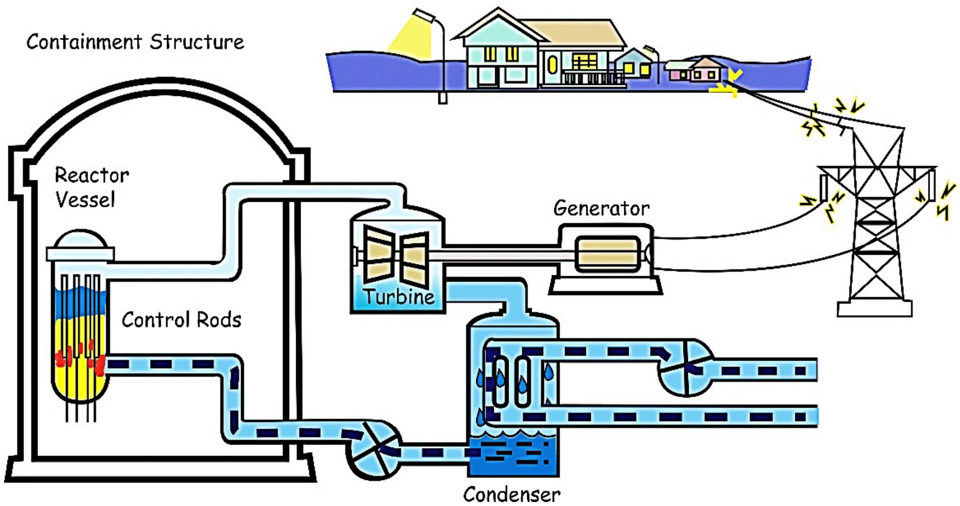

Figure 2, Boiling Water Reactor (BWR) **[2]**

Electricity is generated by a nuclear power plant similarly to the way that electricity is generated at other conventional types of power plants, such as those driven by coal or natural gas. Water is boiled to generate steam; the steam turns a turbine that is attached to a generator and the steam is condensed back into water to be returned to the boiler. What makes nuclear power different from these other types of power plants is that the heat is generated by fission and decay reactions occurring within and around the core containing fissionable uranium (U-235).

Nuclear fission occurs when certain nuclides (primarily U-233, U-235, or Pu-239) absorb a neutron and break into several smaller nuclides (called fission products) as well as some additional neutrons.

Fission results in production of radioactive materials including gases and solids that must be contained to prevent release or treated prior to release. These effluents are generally treated by filtration and/or hold-up prior to release. Releases are generally monitored by sampling and by continuously indicating radiation monitors. The effluent release data is used to calculate doses in order to ensure that dose to the public due to plant operation remains within required limits.

4.2 About Radiation Dose

Ionizing radiation, including alpha, beta, and gamma radiation from radioactive decay, has enough energy to break chemical bonds in tissues and result in damage to tissue or genetic material. The amount of ionization that will be generated by a given exposure to ionizing radiation is quantified as dose. Radiation dose is generally reported in units of millirem (mrem) in the US.

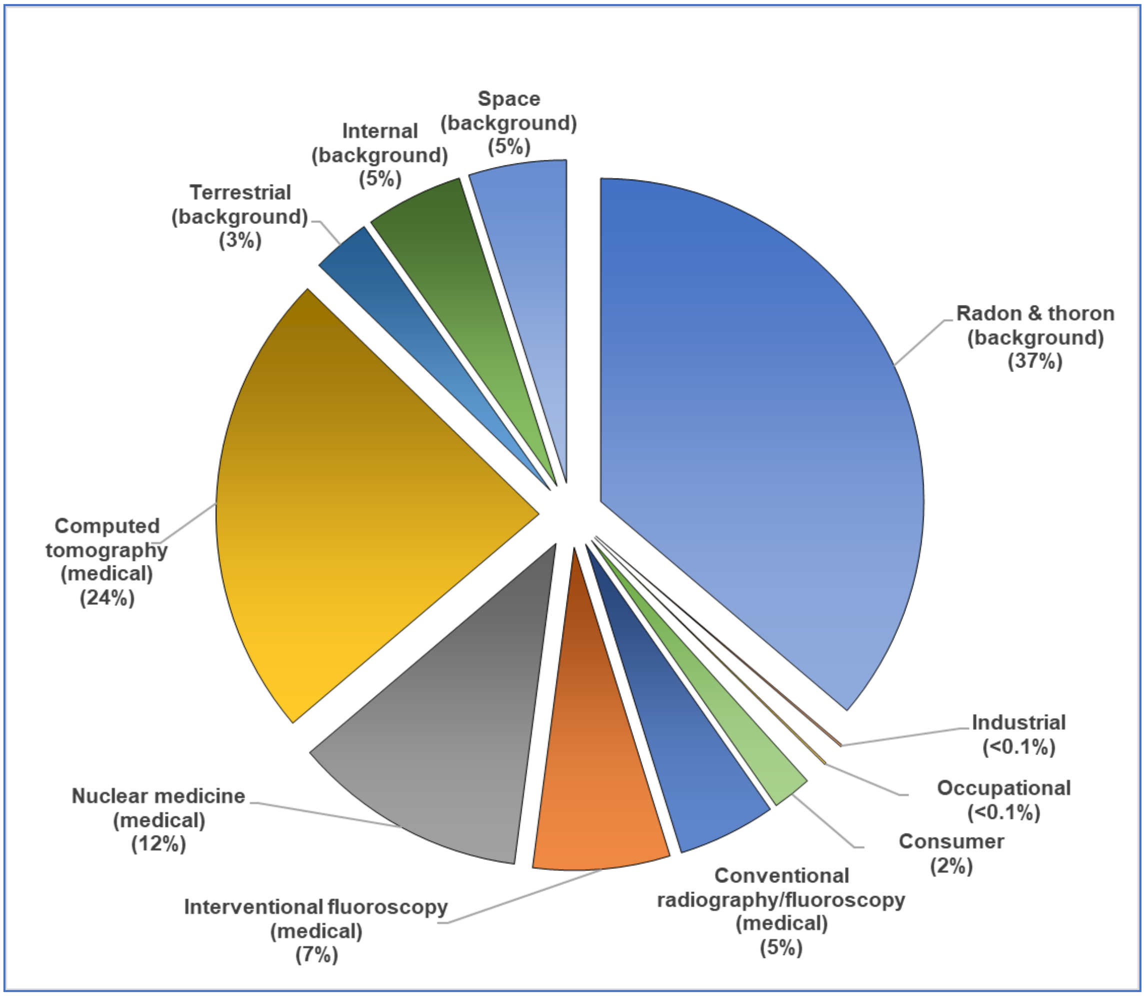

Figure 3, Sources of Radiation Exposure (NCRP Report No. 160) **[3]**

4.2 (Continued)

The National Council on Radiation Protection (NCRP) has evaluated the population dose for the US and determined that the average individual is exposed to approximately 620 mrem per year [3]. There are many sources for radiation dose, ranging from natural background sources to medical procedures, air travel, and industrial processes. Approximately half (310 mrem) of the average exposure is due to natural sources of radiation including exposure to Radon, cosmic radiation, and internal radiation and terrestrial due to naturally occurring radionuclides. The remaining 310 mrem of exposure is due to man-made sources of exposure, with the most significant contributors being medical (48%) due to radiation used in various types of medical scans and treatments. Of the remaining 2% of dose, most is due to consumer activities such as air travel, smoking cigarettes, and building materials. A small fraction of this 2% is due to industrial activities including generation of nuclear power.

Readers that are curious about common sources and effects of radiation dose that they may encounter can find excellent sources of information from the Health Physics Society, including the Radiation Fact Sheets [4], and from the US Nuclear Regulatory Commission website [5].

4.3 About Dose Calculation

Concentrations of radioactive material in the environment resulting from plant operations are very small and it is not possible to determine doses directly using measured activities of environmental samples. To overcome this, Dose Calculations based on measured activities of effluent streams are used to model the dose impact for Members of the Public due to plant operation and effluents. There are several mechanisms that can result in dose to Members of the Public, including: Ingestion of radionuclides in food or water; Inhalation of radionuclides in air; Immersion in a plume of noble gases; and Direct Radiation from the ground, the plant or from an elevated plume.

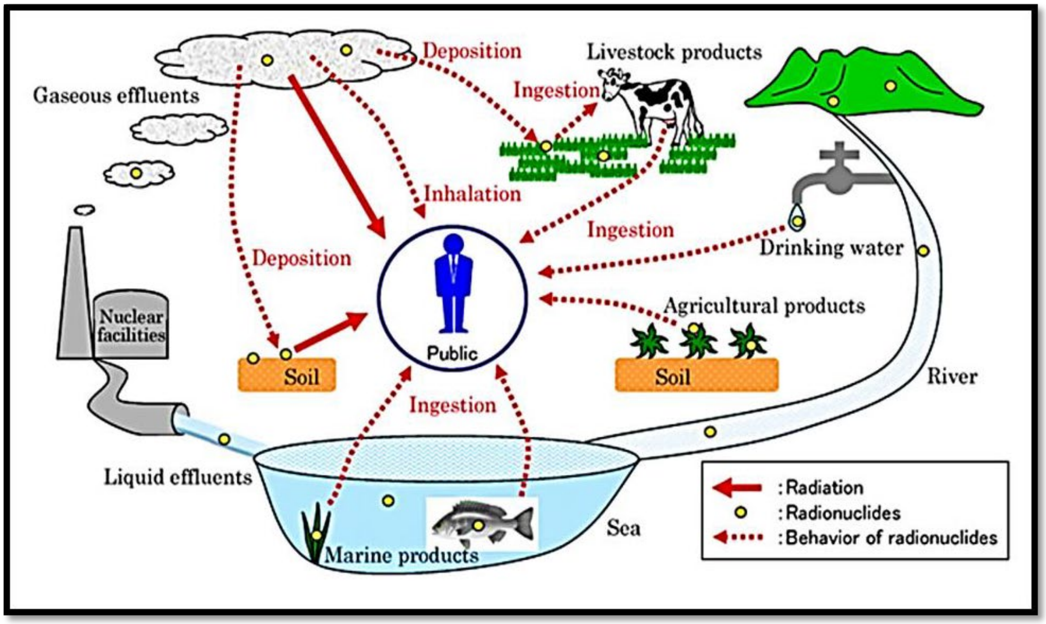

Figure 4, Potential exposure pathways to Members of the Public due to Plant Operations **[6]**

The Offsite Dose Calculation Manual (ODCM) specifies the methodology used to obtain the doses in the Dose Assessment section of this report. The methodology in the ODCM is based on NRC Regulatory Guide 1.109 [7] and NUREG-0133 [8]. Doses are calculated by determining what the nuclide concentration will be in air, water, on the ground, or in food products based on plant effluent releases. Release points are continuously monitored to quantify what concentrations of nuclides are being released. For gaseous releases meteorological data is used to determine how much of the released activity will be present at a given location outside of the plant either deposited onto the ground or in gaseous form. Intake patterns and nuclide bio-concentration factors are used to determine how much activity will be transferred into animal milk or meat. Finally, human ingestion factors and dose factors are used to determine how much activity will be consumed and how much dose the consumer will receive. Inhalation dose is calculated by determining the concentration of nuclides and how much air is breathed by the individual.

4.3 (Continued)

For liquid releases, dilution and mixing factors are used to model the environmental concentrations in water. Drinking water pathways are modeled by determining the concentration of nuclides in the water at the point where the drinking water is sourced. Fish and invertebrate pathways are determined by using concentration at the release point, bioaccumulation factors for the fish or invertebrate and an estimate of the quantity of fish consumed.

Each year a Land Use Census is performed to determine what potential dose pathways currently exist within a five-mile radius around the plant, the area most affected by plant operations. The Annual Land Use Census identifies the locations of vegetable gardens, nearest residences, milk animals and meat animals. The data from the census is used to determine who is the likely to be most exposed to radiation dose due to plant operations.

There is significant uncertainty in dose calculation results, due to modeling dispersion of material released and bioaccumulation factors, as well as assumptions associated with consumption and land-use patterns. Even with these sources of uncertainty, the calculations do provide a reasonable estimate of the order of magnitude of the exposure. Conservative assumptions are made in the calculation inputs such as the number of various foods and water consumed, the amount of air inhaled, and the amount of direct radiation exposure from the ground or plume, such that the actual dose received are likely lower than the calculated dose. Even with the built-in conservatism, doses calculated for the highest hypothetical exposed individual due to plant operation are a very small fraction of the annual dose that is received due to other sources. The low calculated doses due to plant effluents, along with REMP results, serve to provide assurance that the site is not having a negative impact on the environment or people living near the plant.

5.0 DOSE ASSESSMENT FOR PLANT OPERATIONS

5.1 Regulatory Limits

Regulatory limits are detailed in Station Licensing documents such as the Offsite Dose Calculation Manual (ODCM) These documents contain the limits to which HNPP must adhere. HNPP drives to maintain the philosophy to keep dose "as low as reasonably achievable" (ALARA) and actions are taken to reduce the amount of radiation released to the environment. Liquid and gaseous release data show that the dose from HNPP is well below the ODCM limits. The concentration of liquid radioactive material released shall be limited to ten times the concentration specified in 10 CFR 20, Appendix B, Table 2, Column 2, for radionuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the total concentration released shall be limited to 2.0×10^{-4} microcuries/ml. These data reveals that the radioactive effluents have an overall minimal dose contribution to the surrounding environment.

The annual whole body, skin and organ dose was computed using the 2022 source term using the dose calculation methodology provided in the ODCM. The calculated doses due to gaseous effluents to demonstrate compliance with offsite dose limits are presented in Table 1, Shearon Harris Nuclear Power Plant Unit 1 Dose Summary and Table 2, Total Annual Offsite-Dose Comparison to 40 CFR 190 Limits for HNPP.

5.2 Regulatory Limits for Gaseous Effluent Doses:

1. Fission and activation gases:

   a. Noble gases dose rate due to radioactive materials released in gaseous effluents from the site to areas at and beyond the site boundary shall be limited to the following:

      1) Less than or equal to 500 mrems/year to the total body

      2) Less than or equal to 3000 mrems/year to the skin

   b. Noble gas air dose due to noble gases released in gaseous effluents, from each reactor unit to areas at and beyond the site boundary shall be limited to the following:

      1) Quarterly

         a) Less than or equal to 5 mrads gamma

         b) Less than or equal to 10 mrads beta

      2) Yearly

         a) Less than or equal to 10 mrads gamma

         b) Less than or equal to 20 mrads beta

5.2 (Continued)

2. Iodine, tritium, and all radionuclides in particulate form with half-lives greater than 8 days.

    a. The dose rate for iodine-131, iodine-133, tritium, and all radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents released from the site to areas at and beyond the site boundary shall be limited to the following:

        1) Less than or equal to 1500 mrems/year to any organ

    b. 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, from each reactor unit to areas at and beyond the site boundary shall be limited to the following:

        1) Quarterly

            a) Less than or equal to 7.5 mrems to any organ

        2) Yearly

            a) Less than or equal to 15 mrems to any organ

5.3 <u>Regulatory Limits for Liquid Effluent Doses</u>

1. The dose or dose commitment to a MEMBER OF THE PUBLIC from radioactive materials in liquid effluents released, from each reactor unit to unrestricted areas shall be limited to the following:

    a. Quarterly

        1) Less than or equal to 1.5 mrems total body

        2) Less than or equal to 5 mrems critical organ

    b. Yearly

        1) Less than or equal to 3 mrems total body

        2) Less than or equal to 10 mrems critical organ

5.4 40 CFR 190 Regulatory Dose Limits for a Member of the Public

1. Total Dose (40 CFR 190)

   a. The annual (calendar year) dose or dose commitment to any MEMBER OF THE PUBLIC in the unrestricted area due to releases of radioactivity and to radiation from uranium fuel cycle sources shall be limited to the following:

      1) Less than or equal to 25 mrems, Total Body or any Organ except Thyroid.

      2) Less than or equal to 75 mrems, Thyroid.

5.5 Onsite Doses (Within Site Boundary)

This section evaluates dose to non-occupationally exposed workers and members of the public that may be onsite for various reasons. The report must include any other information as may be required by the Commission to estimate maximum potential annual radiation doses to the public resulting from effluent releases as required by 10 CFR 50.36a(a)(2). While within controlled or restricted areas, the limits from Sections 5.1 through 5.4 do not apply; however, 10 CFR 20.1301 dose limit of 100 mrem per year TEDE and dose rate limit of 2 mrem per hour from external sources continue to apply. Occupancy times within the controlled areas are generally sufficiently low to compensate for increase in the atmospheric dispersion factor above the site boundary. HNPP shows compliance with 10 CFR 20.1301 by demonstrating that the annual average concentration of radioactive effluents at the boundary of the unrestricted area do not exceed the values specified in 10 CFR, 20, Appendix B, Table 2, Column 2. Considering all sectors, the total whole-body dose to a member of the general public was 1.32 mrem. This value was determined by summing the annual whole-body doses from liquid and gaseous radioactive effluents, the annual gaseous C-14 dose, the cooling tower plume, lake evaporation, fish consumption from Harris Lake, and on-site drinking water. Since the direct radiation dose, as determined by TLD, was indistinguishable from natural background, it was not included in the calculation. There were no groups onsite of concern identified during 2022 to report.

6.0 SUPPLEMENTAL INFORMATION

6.1 Gaseous Batch Releases

6.1.1 HNPP Unit 1

	Jan - Jun	Jul - Dec	Total	
Number of batch releases	7	15	22	
Total time period for a batch release	1.82E+03	1.91E+04	2.09E+04	minutes
Maximum time period for a batch release	1.06E+03	3.95E+03	3.95E+03	minutes
Average time period for a batch release	2.60E+02	1.27E+03	9.51E+02	minutes
Minimum time period for a batch release	1.00E+00	9.00E+00	1.00E+00	minutes

6.2 Liquid Batch Releases

6.2.1 HNPP Units 1

	Jan - Jun	Jul - Dec	Total	
Number of batch releases	13	24	37	
Total time period for a batch release	1.82E+03	1.93E+04	2.11E+04	minutes
Maximum time period for a batch release	9.10E+02	1.19E+03	1.19E+03	minutes
Average time period for a batch release	8.02E+02	8.05E+02	5.71E+02	minutes
Minimum time period for a batch release	7.46E+02	4.86E+02	4.86E+02	minutes
Average total flow during period of release	9.93E+03	9.09E+03	9.16E+03	gpm

6.3 Abnormal Releases

6.3.1 Gaseous Abnormal Releases

Number of releases	1	
Total activity released	2.82E-04	Ci

- Unplanned Release (02/07/2022) NCR 2415573

6.3.2 Liquid Abnormal Releases

Number of releases	0	
Total activity released	0	Ci

6.4 Land Use Census Changes

Based upon the 2022 HNPP Land Use Census and subsequent site dose evaluation, there are no changes identified or needed to the Harris REMP at this time.

6.4.1 Residences

- No changes were noted in the nearest residences during the 2022 land use census.

6.4.2 Gardens

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

- The garden in the ENE sector at 2.16 miles was replaced with at garden at 1.78 miles.

6.4.3 Milk Animals

- The milk animals (goats) located in the N sector (4.14 miles) were not present during the 2022 land use census.

6.4.4 Meat Animals

NOTE: Meat animals were only identified at the nearest garden or closer in each sector, and poultry and egg laying animals were not classified as meat animals for the 2022 census.

- The meat animals in the ENE sector at 2.01 miles were no longer applicable due to the garden moving to 1.78 miles in the sector. There were not any other meat animals present at or closer than 1.78 miles in the ENE sector during the 2022 land use census.

6.5 Meteorological Data

Joint data recovery includes wind speed and wind direction data for the level indicated in addition to temperature differential data. HNPP achieved a , which met the required 90% Joint frequency distribution (JFD). The lower joint (wind direction, wind speed and delta) for 2022 was 97.4%. The Upper Joint for 2022 was 97.6% JFD is provided in Attachment 3.

Hours of Missing Data	Date(s) of Missing Data	Description of Missing Data Event
159	January	Maintenance of the meteorological system, Sensors freezing during winter event, and sensor error.
46	February	Maintenance of the meteorological system, equipment malfunction, and calculation errors.
67	March	Maintenance of the meteorological system, calculation error, and storm event.
35	April	Calculation/PI Time out errors and sensor errors.
176	May	Semi-annual MET PM, PI errors, and sensor errors.
45	June	Processing and sensor errors.
122	July	Server and sensor errors
56	August	Calculation errors, maintenance, sensor errors.
26	September	Calculation errors, maintenance, and sensor errors.
74	October	Refueling outage, calculation errors, and sensor errors.
75	November	Maintenance of meteorological system, calculation errors, and sensor errors.
110	December	Maintenance, OSI PI outage, calculation errors sensor errors.

6.6 Effluent Radiation Monitors Out of Service Greater Than 30 Days

1. FT-6119, Waste Monitor Tank Pumps Discharge flow was declared inoperable on 10/20/2022 at 0427 (NCR 2450155 generated 11/30/202222) due to the associated chart recorder not responding. LCOTR A-22-00571 was created to track inoperability and WO 20562747 was created to address repairs. The repairs were not completed prior to the ODCM 30-day clock expiring. Per OWP-RM-14 the subject recorder became emergent FIN work when Operations declared it inoperable. At the conclusion of H1R24, shift started troubleshooting. The recorder is obsolete, and the troubleshooting was iterative in efforts to get the recorder motor to move using different parts. Locked in MCB alarms became higher priority for the site with limited FIN resources, forcing the engaged shift tech to work on night shift. Multiple emergent challenges, such a 1A HDP and level switch issues, also became a priority. The night of expiration another resource was able to spend the entire shift working on the recorder but was unable make it operable until after the overdue time.

6.7 Offsite Dose Calculation Manual (ODCM) Changes

The ODCM was revised to incorporate programmatic changes to the site's Radiological Environmental Monitoring Program (REMP), administrative changes to the site's Effluent Management Program (EMS). Changes implemented were driven by DRR's : 2427266, 2421313, 2326048, 2428421, 2435604. A copy of Revision 29 of the Shearon Harris Nuclear Power Plant Offsite Dose Calculation Manual (ODCM) has been included with the 2022 ARERR.

Programmatic Changes were as follows:

- Table 4.1 & 4.2 Deleted Food Sample Point 97.

Administrative Changes were as follows:

- Update Table 4.1, 4.3 & figure 4.1-3- TLD # 19 moved from yard of private residence (0.6 mi E on SR 1142 from Intersection of SR 1141. NNE Sector 5.0 mi from site) AND relocated within the same sector to a power pole (Cross Country Lane and Humie Olive Rd,4.95 (5.0) mi from site, NNE sector).
- Revise the map in Figure 4.1-3 to Show AQV Location 61 at the correct distance (2.5 miles E).
- Added note to Change Summary page denoting that all changes become effective & implemented on date of revision per T.S. 6.14.b.
- Table 4.1 & 4.2 Clarified Sample Point description for Broadleaf Sample Point 5.
- Table 4.2 revised to indicate SW-26 and DW-51 samples are performed on a Monthly/Quarterly aligning sampling frequency requirement table 4.1.
- Pg. 4-16 Updated REMP Note bullet 18 to state "As of Revision 29 of this ODCM, there are no known irrigated gardens."
- Added Figure 4.1-4 "Environmental Radiological Sampling Points (>10 mile Radius)
- Included TLD Site location descriptions for those missing descriptions (Table 4.3)

6.8 Process Control Program (PCP) Changes

In 2022, the HNPP Process Control Program Document, PLP-300, was converted. The conversion from a procedure to a Licensing Document (LICN) was performed to align HNPP with the Duke Fleet and the implementation of fleet procedure AD-CP-ALL-0030, Process Control Program (PCP) Review and Revision. None of the content within the PCP was edited. A copy of revision 0 PCP for HNPP has been included with the 2022 ARERR.

6.9 Radioactive Waste Treatment System Changes

There were no major modifications to Shearon Harris Nuclear Power Plant liquid or solid waste treatment systems in 2022.

6.10 <u>Outside Tanks</u>

The Shearon Harris Nuclear Power Plant Unit 1 did not experience temporary outside liquid storage tanks exceeding 10 Curies total activity (excluding tritium and dissolved or entrained noble gases) during 2022.

6.11 Maximum Permissible Effluent Concentrations

1. Gaseous Effluents - Information found in Offsite Dose Calculation Manual

2. Liquid Effluents - Information found in 10 CFR Part 20, Appendix B, Table 2, Column 2

6.12 Average Energy

Not Applicable to HNPP.

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

6.13.1 Cooling Tower Plume

Tritium in Cooling Tower plume creates an exposure pathway to a member of the public. Murray and Trettle, Inc. was contracted to perform an evaluation of the dose to a member of the public from exposure to tritium in the Cooling Tower plume. Results of the plume exposure are contained in report “Impact of Tritium Release from the Cooling Tower at the Harris Nuclear Plant for 2022”. Using the methodology described in ODCM 2.3.2, the following is a summary of tritium activity released through the Cooling Tower plume and resulting dose for 2022.

	Units	Qtr. 1	Qtr. 2	Qtr. 3	Qtr. 4	Yearly Total
1. H-3 Activity Released	Ci	3.60E-01	3.49E-01	5.92E-01	3.75E-01	1.68E+00
2. H-3 Dose	mrem	3.58E-04	3.52E-04	6.03E-04	3.82E-04	1.69E-03

Receptor Location 2.91 km NNE
Critical Age CHILD
Critical Organ N/A *

6.13.2 Harris Lake Evaporation

Evaporation of water containing tritium in Harris Lake creates an exposure pathway to a member of the public. Murray and Trettle, Inc. was contracted to perform an evaluation of the dose to a member of the public from evaporation of tritium in Harris Lake. Results of the evaluation are contained in report “Impact of Tritium Release from the Water Reservoir (Lake Harris) at the Harris Nuclear Plant for 2022”. Using the methodology described in ODCM 2.3.3, the following is a summary of tritium activity released through evaporation and resulting dose for 2022.

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

	Units	Qtr. 1	Qtr. 2	Qtr. 3	Qtr. 4	Yearly Total
1. H-3 Activity Released	Ci	9.99E+00	1.974E+01	2.07E+01	1.40E+01	6.452E+01
2. H-3 Dose	mrem	1.06E-02	2.11E-02	2.19E-02	1.48E-02	6.84E-02

Receptor Location 6.65 km SSW
Critical Age CHILD
Critical Organ N/A **

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

Concentrations of radionuclides used in this specific drinking water pathway are determined by averaging the monthly concentrations detected in environmental location (REMP) DW-51. In 2022, no plant related gamma emitting radionuclides were detected. Tritium was detected each month, as expected. Using the methodology described in ODCM 2.3.1, the following is a summary of average concentration consumed and resulting dose for 2022.

	Units	Yearly Total
1. Avg. H-3 Concentration	pCi/L	1.50E+03
2. H-3 Dose	mrem	4.10E-02

Critical Age ADULT
Critical Organ N/A *

6.13.4 Tritium in Fish from Harris Lake

Concentrations of radionuclides used in this specific fish consumption pathway are determined by averaging the monthly concentrations detected in environmental location (REMP) SW-26. In 2022, no plant related gamma emitting radionuclides were detected. Tritium was detected each month, as expected. Since tritium is consistently detected in Harris Lake REMP samples, tritium concentration in the fish is assumed to be in equilibrium with Harris Lake. Using the methodology and data described in NRC Regulatory Guide 1.109, Rev.1, October 1977, Equation A-1, Table E-5, and Table E-11, the following is a summary of average concentration consumed and resulting dose for 2022.

	Units	Yearly Total
1. Avg. H-3 Concentration	pCi/L	3.89E+03
2. H-3 Dose	mrem	7.72E-03

Critical Age ADULT
Critical Organ N/A *

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

6.14 Overall Estimate of Error for Effluent Radioactivity Release Reported

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

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

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

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

6.15 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 Unit 1 has been determined to be ± 96%.

6.16 Independent Spent Fuel Storage Installation (ISFSI) Monitoring Program

Not applicable to HNPP.

6.17 Carbon-14

Carbon-14 (C-14) is a naturally occurring radionuclide with a 5730-year half-life. Nuclear weapons testing in the 1950s and 1960s significantly increased the amount of C-14 in the atmosphere. Nuclear power plants also produce C-14, but the amount is infinitesimal compared to what has been distributed in the environment due to weapons testing and what is produced by natural cosmic ray interactions.

The Shearon Harris Nuclear Power Plant 2022 ARERR contains estimates of C-14 radioactivity released in 2022 and estimates of public dose resulting from the C-14 effluent. The concentration and offsite dose from C-14 has been estimated by using a calculation approach, assuming typical or maximum values for the various calculation parameters. Because the dose contribution of C-14 from liquid radioactive waste is much less than that contributed by gaseous radioactive waste, evaluation of C-14 in liquid radioactive waste is not required (Ref. Reg. Guide 1.21, Rev. 2).

The quantity of gaseous C-14 released to the environment can be estimated by use of a C-14 source term scaling factor based on power generation (Ref. Reg. Guide 1.21, Rev. 2). The Shearon Harris Nuclear Power Plant UFSAR Section 11.1.5 states the expected C-14 generation to be 7.3 Curies assuming 292 effective full power days (EFPD) in a calendar year. For the Shearon Harris Nuclear Power Plant 2022 ARERR, a source term scaling factor using actual EFPD of 338.23 days is assumed. Using the source term scaling factor from Shearon Harris Nuclear Power Plant in 2022 results in a site total C-14 gaseous release estimate to the environment of 8.29 Curies. Due to the reducing environment of a Pressured Water Reactor, only 30% of the C-14 is assumed to be released in the Carbon Dioxide (CO2) form. Dose is not expected from other forms (methane, etc.). 70% of the C-14 gaseous effluent is assumed to be from batch releases and the remaining 30% is assumed to be from continuous releases through the plant vent (ref. IAEA Technical Reports Series no. 421, "Management of Waste Containing Tritium and Carbon-14", 2004).

The resultant offsite doses were based upon this source term and the dose calculations described in NRC Regulatory Guide 1.109, Revision 1, and the Shearon Harris Nuclear Power Plant ODCM. The estimated C-14 dose impact on the maximum organ dose from airborne effluents released from Shearon Harris Nuclear Power Plant in 2022 is well below the 10CFR 50, Appendix I, ALARA design objective (i.e., 15 mrem/yr. per unit). The Harris Nuclear Plant Land Use Census did not provide sufficient detail for ages groups at the residences. Therefore, a Child was assumed to be at each residence for the C-14 dose calculation. The receptor location of 2.91 km NNE and the Critical Age of a Child was the most restrictive receptor and age group out of the sixteen sectors.

Table 4, Production of Carbon 14 and Calculated Maximum Dose

	Units	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Year
EFPD	Days	89.84	64.49	91.95	91.95	338.23
C-14 Activity Released	Ci	2.25E+00	1.61E+00	2.30E+00	2.30E+00	8.46E+00
C-14 Total Body Dose	mrem	1.33E-02	9.28E-03	1.32E-02	1.32E-02	4.89E-02
C-14 Organ Dose	mrem	6.69E-02	4.67E-02	6.65E-02	6.65E-02	2.46E-01

6.18 Errata/Corrections to Previous ARERRs

Attachment 4, Corrected Data from Previous ARERR contains amended pages to the HNPP 2020-2021 ARERR. Amended pages are identified with 'Amendment#' on page. Specific changes are identified with change bars in right margin. A copy of the original submittal will appear before the amendment page.

Reasoning:

The Annual Radioactive Effluent Release Report (ARERR) that was submitted to the NRC in 2020 and 2021 included some calculation errors when determining averages for Summary of Gaseous and Liquid Effluents. Instead of adding up each quarters value and dividing by 4, in cases where the value equaled zero the quarter was not used for the average calculation. For example in 2021 the average diluted concentration for Dissolved & Entrained Gases was as follows: (Qtr 1-Zero), (Qtr 2-4.99E-11), (Qtr 3-Zero), (Qtr 4-Zero). The average value for the year was listed on the report as 4.99E-11 and should have been 1.25E-11

7.0 NEI 07-07 ONSITE RADIOLOGICAL GROUNDWATER MONITORING PROGRAM

Shearon Harris Nuclear Power Plant Unit 1 has developed a Groundwater Protection Initiative (GPI) program in accordance with NEI 07-07, Industry Ground Water Protection Initiative – Final Guidance Document [9]. The groundwater sampling and analysis program is a significant surveillance program.

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. HNPP 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.

7.1 <u>Voluntary Notification</u>

During 2022, Shearon Harris Nuclear Power Plant Unit 1 did not make any voluntary NEI 07-07 notification to State/Local officials, NRC, and to other stakeholders required by site procedures.

Table 5, Groundwater Protection Program Monitoring Well Results for the Shearon Harris Site

Well Name	**Number of Samples in 2022**	**Number of Positive H-3 Samples in 2022**	**Average H-3 Activity (pCi/L)**	**Minimum H-3 Activity (pCi/L)***	**Maximum H-3 Activity (pCi/L)**	**Depth of Well (ft)**
76	2	2	410	319	501	11
HMW1S	2	2	260	220	300	26.5
HMW2S	2	0	0	0	0	22.5
HMW3S	1	0	0	0	0	26
HMW4D	2	0	0	0	0	57.5
HMW4S	2	0	0	0	0	30
HMW5S	1	0	0	0	0	32
HMW6S	2	2	405	390	419	31.5
HMW7S	1	0	0	0	0	24
HMW8S	1	0	0	0	0	26
HMW9S	1	0	0	0	0	31
HMW10S	1	0	0	0	0	31.5
HMW11S	1	0	0	0	0	26.5

* The Minimum Detectible Activity (MDA) for monitoring wells is approximately 185 pCi/L

8.0 BIBLIOGRAPHY

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[16] "40 CFR Part 141, “National Primary Drinking Water Regulations,”," US Environmental Protection Agency, Washington, DC..

[17] "40 CFR 190 - Environmental Radiation Protection Standards for Nuclear Power Operation," US Environmental Protection Agency, Washington, DC.

[18] "10 CFR 20 - Standards for Protection Against Radiation," US Nuclear Regulatory Commission, Washington, DC.

Attachment 1, ARERR Release Summary Tables (RG-1.21 Tables)

1.0 GASEOUS EFFLUENTS

Table 6, Gaseous Effluents Summation of All Releases from HNPP Unit 1

A. Fission & Activation Gases	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Yearly Total
1. Total Release	Ci	2.81E-02	N/D	N/D	7.70E-03	3.58E-02
2. Average release rate for the period	µCi/sec	3.62E-03	N/A	N/A	9.68E-04	4.34E-07
B. Iodine						
1. Total Iodine – 131	Ci	N/D	N/D	N/D	N/D	N/A
2. Average release rate for the period	µCi/sec	N/A	N/A	N/A	N/A	N/A
C. Particulates						
1. Particulates with half-lives > 8 days	Ci	0.00E+00	0.00E+00	0.00E+00	1.37E-05	1.37E-05
2. Average release rate for the period	µCi/sec	N/D	N/D	N/D	1.72E-06	4.30E-7
D. Tritium						
1. Total Release	Ci	2.55E+01	4.94E+01	7.51E+01	4.79E+01	1.98E+02
2. Average release rate for the period	µCi/sec	3.28E+00	6.29E+00	9.44E+00	6.03E+00	6.26E+00
E. Gross Alpha						
1. Total Release	Ci	0.00+00	0.00+00	0.00+00	0.00+00	0.00E+00
2. Average release rate for the period	µCi/sec	0.00+00	0.00+00	0.00+00	0.00+00	0.00E+00

% of limit is on Table 1, Shearon Harris Nuclear Power Plant Unit 1 Dose Summary

Attachment 1, ARERR Release Summary Tables (RG-1.21 Tables)

Table 7, Gaseous Effluents – Ground Level Release Batch Mode from HNPP Unit 1

Radionuclide Released	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Yearly Total
Fission Gases						
Ar-41	Ci	N/D	N/D	N/D	7.70E-03	7.70E-03
Kr-88	Ci	2.42E-06	N/D	N/D	N/D	2.42E-06
Xe-133M	Ci	3.10E-04	N/D	N/D	N/D	3.10E-04
Xe-133	Ci	2.78E-02	N/D	N/D	N/D	2.78E-02
Xe-135	Ci	5.73E-05	N/D	N/D	N/D	5.73E-05
	Ci					
	Ci					
	Ci					
	Ci					
	Ci					
Total for Period	**Ci**	**2.81E-02**	**N/D**	**N/D**	**7.70E-03**	**3.59E-02**
Iodines						
None	Ci	N/D	N/D	N/D	N/D	N/D
	Ci					
	Ci					
	Ci					
Total for Period	**Ci**	**N/D**	**N/D**	**N/D**	**N/D**	**N/D**
Particulates with half-lives > 8 days						
None	Ci	N/D	N/D	N/D	N/D	N/D
	Ci					
	Ci					
	Ci					
	Ci					
	Ci					
Total for Period	**Ci**	**N/D**	**N/D**	**N/D**	**N/D**	**N/D**
Tritium						
H-3	Ci	6.64E-05	1.42E-03	3.13E-02	3.26E-01	3.59E-01
Gross Alpha						
Alpha	Ci	N/D	N/D	N/D	N/D	N/D

Attachment 1, ARERR Release Summary Tables (RG-1.21 Tables)

Table 8, Gaseous Effluents – Ground Level Release Continuous Mode from HNPP Unit 1

Radionuclide Released	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Yearly Total
Fission Gases						
None	Ci	N/D	N/D	N/D	N/D	N/D
	Ci					
	Ci					
	Ci					
	Ci					
	Ci					
	Ci					
Total for Period	**Ci**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**
Iodines						
None	Ci	N/D	N/D	N/D	N/D	N/D
	Ci					
	Ci					
	Ci					
Total for Period	**Ci**	**N/D**	**N/D**	**N/D**	**N/D**	**N/D**
Particulates Half-Life > 8 days						
Cr-51	Ci	N/D	N/D	N/D	9.52E-06	9.52E-06
Co-58	Ci	N/D	N/D	N/D	2.33E-06	2.33E-06
Nb-95	Ci	N/D	N/D	N/D	1.85E-06	1.85E-06
	Ci					
	Ci					
	Ci					
	Ci					
	Ci					
	Ci					
Total for Period	**Ci**	**0.00+00**	**0.00E+00**	**0.00E+00**	**1.37E-05**	**1.37E-05**
Tritium						
H-3	Ci	2.55E+01	4.94E+01	7.50E+01	4.76E+01	1.98E+02
Gross Alpha						
Alpha	Ci	N/D	N/D	N/D	N/D	N/D

Attachment 1, ARERR Release Summary Tables (RG-1.21 Tables)

2.0 LIQUID EFFLUENTS

Table 13, Liquid Effluents – Summation of All Releases – HNPP Unit 1

A. Fission & Activation Products	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Yearly Total
1. Total Release	Ci	1.18E-04	3.80E-04	1.16E-03	1.52E-03	3.18E-03
2. Average Diluted Concentration	μCi/mL	2.35E-11	7.98E-11	2.47E-10	3.37E-10	1.72E-10
B. Tritium						
1. Total Release	Ci	2.32E+01	8.41E+01	1.27E+02	8.78E+01	3.22E+02
2. Average Diluted Concentration	μCi/mL	4.65E-06	1.77E-05	2.70E-05	1.94E-05	1.72E-05
C. Dissolved & Entrained Gases						
1. Total Release	Ci	N/D	N/D	9.38E-06	N/D	9.38E-06
2. Average Diluted Concentration	μCi/mL	N/A	N/A	2.00E-12	N/A	5.00E-13
D. Gross Alpha Activity						
1. Total Release	Ci	N/D	N/D	N/D	N/D	N/D
2. Average Diluted Concentration		N/A	N/A	N/A	N/A	N/A
E. Volume of Waste Released (prior to dilution)						
1. Batch Release	Liters	3.86E+05	6.31E+05	1.09E+06	7.43E+05	2.85E+06
2. Continuous Release	Liters	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
F. Volume of Dilution Water Used During Period						
1. Batch Release	Liters	5.00E+09	4.75E+09	4.69E+09	4.51E+09	1.90E+10
2. Continuous Release	Liters	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

% of limit is on the Table 1, Shearon Harris Nuclear Power Plant Unit 1 Dose Summary

Attachment 1, ARERR Release Summary Tables (RG-1.21 Tables)

Table 14, Liquid Effluents – Continuous Mode – HNPP Unit 1

Radionuclide Released	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Yearly Total
Fission and Activation Products						
None	Ci	N/D	N/D	N/D	N/D	N/D
	Ci					
	Ci					
	Ci					
	Ci					
	Ci					
	Ci					
	Ci					
	Ci					
	Ci					
	Ci					
	Ci					
	Ci					
	Ci					
	Ci					
	Ci					
	Ci					
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tritium						
H-3	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gross Alpha						
Gross Alpha	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Entrained Gases						
None	Ci	N/D	N/D	N/D	N/D	N/D
	Ci					
	Ci					
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Attachment 1, ARERR Release Summary Tables (RG-1.21 Tables)

Table 15, Liquid Effluents – Batch Mode – HNPP Unit 1

Radionuclide Released	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Yearly Total
Fission and Activation Products						
Mn-54	Ci	1.57E-05	6.24E-06	7.98E-05	4.97E-05	1.51E-04
Co-58	Ci	6.87E-06	6.56E-06	5.49E-06	4.26E-04	4.45E-04
Co-60	Ci	8.16E-05	1.57E-04	8.96E-04	2.36E-04	1.37E-03
Ni-63	Ci	N/D	1.28E-04	N/D	1.52E-04	2.80E-04
Zr-95	Ci	N/D	N/D	N/D	9.32E-06	9.32E-06
Nb-95	Ci	1.34E-05	N/D	1.97E-05	2.77E-05	6.08E-05
Sb-122	Ci	N/D	N/D	N/D	6.94E-06	6.94E-06
Sb-124	Ci	N/D	N/D	N/D	1.31E-04	1.31E-04
Sb-125	Ci	N/D	8.19E-05	1.43E-04	3.64E-04	5.89E-04
Cs-137	Ci	N/D	N/D	1.45E-05	1.21E-04	1.36E-04
	Ci					
	Ci					
	Ci					
	Ci					
	Ci					
	Ci					
	Ci					
	Ci					
	Ci					
	Ci					
	Ci					
Total for Period	**Ci**	**1.18E-04**	**3.80E-04**	**1.16E-03**	**1.52E-03**	**3.18E-03**
Tritium						
H-3	Ci	2.32E+01	8.41E+01	1.27E+02	8.78E+01	3.22E+02
Gross Alpha						
Alpha	Ci	N/D	N/D	N/D	N/D	N/D
Entrained Gases						
Xe-133	Ci	N/D	N/D	9.38E-06	N/D	9.38E-06
	Ci					
	Ci					
	Ci					
	Ci					
Total for Period	**Ci**	**0.00E+00**	**0.00E+00**	**9.38E-06**	**0.00E+00**	**9.38E-06**

Attachment 2, Solid Waste Information

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

Table 16, Summary of Solid Waste by Waste Class, HNPP

	Type of Waste Shipped	Number of Shipments	Total Activity (Curies)	Estimated Total Error	Waste Class	Burial Volume (m^3)	Solidification Agent	Container Type	Shipment Form
1.	**Waste from Liquid Systems**								
	a. Spent Resins	0	0	96%	A	0	N/A	N/A	N/A
		0	0	96%	B	0	N/A	N/A	N/A
		0	0	96%	C	0	N/A	N/A	N/A
2.	**Dry Solid Waste**								
	b. Dry Active Waste (DAW), mechanical filters, contaminated equipment, etc.	3	3.80E-01	96%	A	215.52	N/A	General Design	Compacted, Non-Compacted
		0	0	96%	B	0	N/A	N/A	N/A
		0	0	96%	C	0	N/A	N/A	N/A
	c. Irradiated components, control rods, etc. (Ex-core detector)	0	0	96%	A	0	N/A	N/A	N/A
		0	0	96%	B	0	N/A	N/A	N/A
		0	0	96%	C	0	N/A	N/A	N/A
	d. Other Waste (Radwaste Oil)	1	7.15E-04	96%	A	2.34	N/A	General Design	Compacted, Non-Compacted
		0	0	96%	B	0	N/A	N/A	N/A
		0	0	96%	C	0	N/A	N/A	N/A
3.	**Total Solid Waste**	**4**	**3.81E-01**	**-**	**-**	**217.86**	**-**	**-**	**-**

Attachment 2, Solid Waste Information

2.0 ESTIMATE OF MAJOR NUCLIDE COMPOSITION (BY WASTE TYPE)

Table 17, Spent Radwaste Bead Resin

Class A Spent Resin Totals

Isotope	Activity (mCi)	Activity (Ci)	Abundance
Grand Total	**N/A**	**N/A**	**N/A**

Note: No waste of this type was shipping during the 2022 reporting period.

Attachment 2, Solid Waste Information

Table 18, Dry Active Waste (DAW), mechanical filters, contaminated equipment, etc.

Class A DAW Totals

Isotope	Activity (mCi)	Activity (Ci)	Abundance
Cr-51	3.84E+01	3.84E-02	10.10%
Mn-54	4.49E+00	4.49E-03	1.18%
Co-58	8.70E+00	8.70E-03	2.29%
Co-60	4.77E+01	4.77E-02	12.54%
Ni-63	5.16E+01	5.16E-02	13.57%
Zr-95	9.25E+01	9.25E-02	24.32%
Nb-95	1.18E+02	1.18E-01	31.03%
Cs-137	4.13E+00	4.13E-03	1.09%
H-3	8.73E+00	8.73E-03	2.30%
C-14	6.74E-01	6.74E-04	0.18%
Tc-99	1.56E+00	1.56E-03	0.41%
Ce-144	2.05E+00	2.05E-03	0.54%
I-129	1.77E+00	1.77E-03	0.47%
Grand Total	**3.80E+02**	**3.80E-01**	**100.00%**

Attachment 2, Solid Waste Information

Table 19, Irradiated components, control rods, etc.

Class A Totals

Isotope	Activity (mCi)	Activity (Ci)	Abundance
Grand Total	**N/A**	**N/A**	**N/A**

Note: No waste of this type was shipping during the 2022 reporting period.

Attachment 2, Solid Waste Information

Table 20, Other (Radwaste Oil) Class A Totals

Isotope	Activity (mCi)	Activity (Ci)	Abundance
Cr-51	0.00E+00	0.00E+00	0.00%
Mn-54	0.00E+00	0.00E+00	0.00%
Co-58	0.00E+00	0.00E+00	0.00%
Co-60	1.14E-05	1.14E-08	0.00%
Ni-63	0.00E+00	0.00E+00	0.00%
Zr-95	0.00E+00	0.00E+00	0.00%
Nb-95	0.00E+00	0.00E+00	0.00%
Cs-137	8.10E-03	8.10E-06	1.13%
H-3	5.95E-01	5.95E-04	83.26%
C-14	6.49E-02	6.49E-05	9.08%
Tc-99	4.61E-02	4.61E-05	6.45%
Ce-144	7.35E-05	7.35E-08	0.01%
I-129	4.85E-04	4.85E-07	0.07%
Grand Total	**7.15E-01**	**7.15E-04**	**100.00%**

Table 21, Solid Waste Shipped for Burial or Disposal by Waste Class

Number of Shipments	Waste Class	Mode of Transportation	Destination
4	A	Truck	Energy Solutions
0	B	N/A	N/A
0	C	N/A	N/A

Attachment 3, Meteorological Data

1.0 METEOROLOGICAL DATA SUMMARY

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

1.1 Joint Frequency Distributions

1. Period of Record: 2022

2. Stability Class: All

   a. Periods of calm (hours): 1,234
   b. Hours of missing data: 991
   c. Meteorological data are reported in percentage for all stability classes.

3. Elevation: Tower height 10 (m), 60 (m)

METEOROLOGICAL VARIABLE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual
Lower Joint (Wind Speed, Wind Direction, and Temperature Differential)	98.7	94.4	98.9	98.8	98.0	99.4	95.3	99.5	99.4	93.6	95.6	97.7	97.4
Upper Joint (Wind Speed, Wind Direction, and Teperature Differential)	99.3	94.4	98.9	98.8	98.0	99.4	96.1	99.7	99.4	93.6	95.6	97.7	97.6
Lower Ambient Temperature	99.3	94.4	99.6	98.8	98.0	99.4	96.1	99.7	99.6	93.6	95.6	97.9	97.7
Upper Ambient Temperature	99.7	97.6	99.6	98.8	98.0	99.4	96.1	99.7	99.6	93.6	95.6	97.9	98.0
Delta1	78.9	94.4	91.0	98.8	98.0	99.4	96.1	99.7	99.6	93.6	95.6	97.7	95.2
Delta2	99.3	93.8	98.9	98.8	93.0	94.3	83.9	92.7	96.5	92.6	91.3	93.7	94.1
Dew Point Temperature	86.0	96.1	91.0	93.9	81.2	98.5	96.0	99.7	99.3	91.0	93.9	89.8	93.0
%Relative Humidity	86.0	96.1	91.0	93.9	81.3	98.5	96.0	99.7	99.3	91.0	93.9	96.8	93.6
Precipitation (% Recovery)	99.6	97.0	99.6	98.8	97.7	99.4	96.1	99.7	99.6	93.6	95.6	97.9	97.9
Atmospheric Pressure	99.6	97.6	99.6	98.8	97.7	99.3	96.1	99.7	99.6	93.6	95.6	97.9	97.9
Solar Irradiance	99.7	97.6	99.6	98.8	98.0	99.4	96.1	99.7	99.6	93.6	95.6	97.7	98.0
Lower Sigma	98.7	97.6	99.6	98.8	98.0	99.4	96.1	99.5	99.4	93.6	95.6	97.9	97.8
Upper Sigma	99.7	97.6	99.6	98.8	98.0	99.4	96.1	99.7	99.4	93.6	95.6	97.9	98.0
NLR	99.3	94.4	98.4	98.8	98.0	99.4	96.1	99.7	99.6	93.2	95.6	97.7	97.5
Precipitation (Total in inches)	4.41	1.06	4.71	2.28	7.01	1.95	3.96	1.50	5.50	1.04	4.74	2.63	40.79

Attachment 3, Meteorological Data

Table 22, Shearon Harris Nuclear Power Plant Unit 1 Meteorological Data January 1 to December 31, 2022

Stability Class	Wind Speed (m/s)	Hours of Occurrence															
		Sector															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
A	0.46-0.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.76-1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1.01-1.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1.26-1.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1.51-2.00	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
	2.01-3.00	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
	3.01-4.00	0	0	1	1	2	0	0	0	0	1	0	1	0	0	0	0
	4.01-5.00	0	2	0	0	0	0	0	0	0	1	0	0	1	1	0	0
	5.01-6.00	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
	6.01-8.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10.01-Max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B	0.46-0.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.76-1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1.01-1.25	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
	1.26-1.50	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0
	1.51-2.00	0	0	0	1	1	3	0	0	0	0	0	0	0	0	0	0
	2.01-3.00	1	1	4	7	9	8	2	5	7	2	2	3	1	2	5	2
	3.01-4.00	7	10	6	6	0	3	0	4	18	9	4	6	3	4	7	11
	4.01-5.00	2	13	0	1	0	0	0	0	6	3	4	7	5	4	1	3
	5.01-6.00	0	0	0	0	0	0	0	0	1	1	2	0	1	3	0	0
	6.01-8.00	0	0	0	0	0	0	0	0	0	2	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 3, Meteorological Data

Table 22, Shearon Harris Nuclear Power Plant Unit 1 Meteorological Data January 1 to December 31, 2022

Stability Class	Wind Speed (m/s)	Hours of Occurrence															
		Sector															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
C	0.46-0.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.76-1.00	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	1.01-1.25	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0
	1.26-1.50	0	1	0	0	1	2	1	0	0	0	0	3	1	1	2	0
	1.51-2.00	2	2	3	9	18	9	10	12	13	10	3	3	2	3	4	2
	2.01-3.00	16	12	30	19	19	14	21	23	46	23	13	32	11	16	21	19
	3.01-4.00	11	16	4	4	2	1	2	8	28	20	14	38	17	11	14	16
	4.01-5.00	3	8	2	0	0	0	0	0	6	6	10	12	8	7	9	8
	5.01-6.00	0	1	0	0	0	0	0	0	1	3	0	0	3	3	2	0
	6.01-8.00	0	0	0	0	0	0	0	0	0	2	2	0	1	1	0	0
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	0	0	0	1	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	6	4	8	2	6	5	3	5	4	7	3	1	2	3	5	7
	0.76-1.00	6	6	13	7	7	5	11	10	9	6	10	4	12	7	11	6
	1.01-1.25	13	15	10	16	11	7	17	10	13	13	7	10	18	12	13	12
	1.26-1.50	24	17	29	15	10	12	21	20	26	23	24	13	20	15	22	24
	1.51-2.00	41	59	70	43	25	23	22	39	59	57	46	53	22	23	45	27
	2.01-3.00	95	134	95	62	20	16	24	67	99	140	120	87	45	40	34	70
	3.01-4.00	69	104	33	10	4	3	2	14	54	50	53	46	30	25	28	44
	4.01-5.00	6	21	3	4	0	0	2	4	39	34	25	12	7	12	13	18
	5.01-6.00	2	8	0	0	0	0	0	0	5	16	8	1	2	4	3	4
	6.01-8.00	1	7	2	0	0	0	0	0	2	6	0	1	0	6	0	0
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
	10.01-Max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment 3, Meteorological Data

Table 22, Shearon Harris Nuclear Power Plant Unit 1 Meteorological Data January 1 to December 31, 2022

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	7	13	18	9	11	9	7	8	11	11	10	7	9	9	7	6
	0.76-1.00	19	14	15	18	13	7	12	6	10	24	16	16	21	13	6	11
	1.01-1.25	26	22	24	17	13	9	14	18	9	22	11	11	16	9	8	14
	1.26-1.50	27	29	20	15	11	6	12	23	18	24	19	24	14	12	15	15
	1.51-2.00	57	19	16	6	6	10	14	27	24	47	46	23	17	8	13	24
	2.01-3.00	39	28	10	3	0	2	4	16	40	83	42	17	13	7	15	22
	3.01-4.00	3	6	2	0	0	0	0	1	12	13	10	6	2	2	2	3
	4.01-5.00	0	1	0	0	0	1	0	1	2	14	2	0	0	1	0	2
	5.01-6.00	0	0	0	0	0	0	0	0	0	1	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
F	0.46-0.75	15	23	38	17	12	10	7	7	2	6	9	5	2	11	7	11
	0.76-1.00	13	10	21	14	13	8	7	8	3	8	6	3	5	9	11	18
	1.01-1.25	8	18	10	6	6	3	3	4	3	5	2	1	1	7	2	9
	1.26-1.50	12	6	5	4	6	2	4	1	7	4	2	5	1	2	3	9
	1.51-2.00	13	4	3	0	0	2	1	0	3	4	2	2	1	3	0	7
	2.01-3.00	2	1	0	0	1	0	0	1	3	0	1	0	0	0	0	1
	3.01-4.00	3	0	0	0	0	0	0	1	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 3, Meteorological Data

Table 22, Shearon Harris Nuclear Power Plant Unit 1 Meteorological Data January 1 to December 31, 2022

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	59	50	46	37	20	6	4	5	5	7	7	4	7	10	35	57
	0.76-1.00	23	11	12	16	8	4	0	0	2	4	1	1	2	1	8	24
	1.01-1.25	5	1	3	1	1	1	1	1	4	2	0	1	0	1	2	7
	1.26-1.50	0	3	1	1	0	1	0	1	1	0	1	0	0	0	1	2
	1.51-2.00	2	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0
	2.01-3.00	1	0	0	0	0	0	0	0	0	0	0	0	0	1	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 3, Meteorological Data

1.2 **Stability class**

Table 23, Classification of Atmospheric Stability

Stability Condition	Pasquill Categories	Percentage
Extremely Unstable	A	0.13
Moderately Stable	B	1.86
Slightly Unstable	C	6.16
Neutral	D	41.50
Slightly Stable	E	23.90
Moderately Stable	F	9.65
Extremely Stable	G	16.79

Attachment 4, Corrected Data from Previous ARERR

2.0 2021 ARERR

Attachment 1
Summary of Gaseous and Liquid Effluents

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2021 - 12/31/2021

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	1.67E-01	0.00E+00	3.86E+00	1.16E-01	4.41E+00
2. Avg. Release Rate	µCi/sec	2.15E-02	0.00E+00	4.86E-01	1.46E-02	1.74E-01
B. Iodine-131						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Release Rate	µCi/sec	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C. Particulates Half-Life ≥ 8 days						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Release Rate	µCi/sec	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Tritium						
1. Total Release	Ci	2.98E+01	2.81E+01	2.15E+01	1.73E+01	9.67E+01
2. Avg. Release Rate	µCi/sec	3.83E+00	3.57E+00	2.70E+00	2.17E+00	3.06E+00
E. Gross Alpha						
1. Total Release	Ci	0.00+00	0.00+00	0.00+00	0.00+00	0.00E+00
2. Avg. Release Rate	µCi/sec	0.00+00	0.00+00	0.00+00	0.00+00	0.00E+00

Attachment 4, Corrected Data from Previous ARERR

Attachment 1
Summary of Gaseous and Liquid Effluents

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2021 - 12/31/2021

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	1.67E-01	0.00E+00	3.86E+00	1.16E-01	4.14E+00
2. Avg. Release Rate	µCi/sec	2.15E-02	0.00E+00	4.86E-01	1.46E-02	1.31E-01
B. Iodine-131						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Release Rate	µCi/sec	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C. Particulates Half-Life ≥ 8 days						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Release Rate	µCi/sec	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Tritium						
1. Total Release	Ci	2.98E+01	2.81E+01	2.15E+01	1.73E+01	9.67E+01
2. Avg. Release Rate	µCi/sec	3.83E+00	3.57E+00	2.70E+00	2.17E+00	3.06E+00
E. Gross Alpha						
1. Total Release	Ci	0.00+00	0.00+00	0.00+00	0.00+00	0.00E+00
2. Avg. Release Rate	µCi/sec	0.00+00	0.00+00	0.00+00	0.00+00	0.00E+00

Attachment 4, Corrected Data from Previous ARERR

Attachment 1
Summary of Gaseous and Liquid Effluents

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2021 - 12/31/2021

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	1.16E-04	4.40E-03	1.73E-03	2.87E-04	6.53E-03
2. Avg. Diluted Conc.	µCi/ml	2.41E-11	9.12E-10	3.65E-10	5.61E-11	3.39E-10
B. Tritium						
1. Total Release	Ci	2.11E+02	1.20E+02	4.33E+01	4.33E+01	4.17E+02
2. Avg. Diluted Conc.	µCi/ml	4.40E-05	2.49E-05	9.11E-06	8.48E-06	2.16E-05
C. Dissolved & Entrained Gases						
1. Total Release	Ci	0.00E+00	2.41E-04	0.00E+00	0.00E+00	2.41E-04
2. Avg. Diluted Conc.	µCi/ml	0.00E+00	4.99E-11	0.00E+00	0.00E+00	4.99E-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	7.84E+05	1.13E+06	1.17E+06	6.05E+05	3.68E+06
2. Continuous Releases	liters	1.26E+07	1.30E+07	1.46E+07	1.15E+07	5.16E+07
F. Volume of Dilution Water						
1. Batch Releases	liters	4.79E+09	4.83E+09	4.75E+09	5.11E+09	1.94E+10
2. Continuous Releases	liters	4.79E+09	4.83E+09	4.75E+09	5.11E+09	1.94E+10

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

Attachment 4, Corrected Data from Previous ARERR

Attachment 1
Summary of Gaseous and Liquid Effluents

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2021 - 12/31/2021

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	1.16E-04	4.40E-03	1.73E-03	2.87E-04	6.53E-03
2. Avg. Diluted Conc.	µCi/ml	2.41E-11	9.12E-10	3.65E-10	5.61E-11	3.39E-10
B. Tritium						
1. Total Release	Ci	2.11E+02	1.20E+02	4.33E+01	4.33E+01	4.17E+02
2. Avg. Diluted Conc.	µCi/ml	4.40E-05	2.49E-05	9.11E-06	8.48E-06	2.16E-05
C. Dissolved & Entrained Gases						
1. Total Release	Ci	0.00E+00	2.41E-04	0.00E+00	0.00E+00	2.41E-04
2. Avg. Diluted Conc.	µCi/ml	0.00E+00	4.99E-11	0.00E+00	0.00E+00	1.25E-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	7.84E+05	1.13E+06	1.17E+06	6.05E+05	3.68E+06
2. Continuous Releases	liters	1.26E+07	1.30E+07	1.46E+07	1.15E+07	5.16E+07
F. Volume of Dilution Water						
1. Batch Releases	liters	4.79E+09	4.83E+09	4.75E+09	5.11E+09	1.94E+10
2. Continuous Releases	liters	4.79E+09	4.83E+09	4.75E+09	5.11E+09	1.94E+10

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

Attachment 4, Corrected Data from Previous ARERR

3.0 2020 ARERR

Attachment 1
Summary of Gaseous and Liquid Effluents

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2020 - 12/31/2020

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	3.97E-02	0.00E+00	9.99E-01	0.00E+00	1.03E+00
2. Avg. Release Rate	µCi/sec	5.05E-03	0.00E+00	1.26E-01	0.00E+00	6.55E-02
B. Iodine-131						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Release Rate	µCi/sec	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C. Particulates Half-Life ≥ 8 days						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Release Rate	µCi/sec	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Tritium						
1. Total Release	Ci	1.78E+01	2.72E+01	3.51E+01	3.73E+01	1.17E+02
2. Avg. Release Rate	µCi/sec	2.41E+00	2.03E+00	1.91E+00	2.57E+00	2.23E+00
E. Gross Alpha						
1. Total Release	Ci	0.00+00	0.00+00	0.00+00	0.00+00	0.00E+00
2. Avg. Release Rate	µCi/sec	0.00+00	0.00+00	0.00+00	0.00+00	0.00E+00

Attachment 4, Corrected Data from Previous ARERR

Attachment 1
Summary of Gaseous and Liquid Effluents

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2020 - 12/31/2020

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	3.97E-02	0.00E+00	9.99E-01	0.00E+00	1.03E+00
2. Avg. Release Rate	µCi/sec	5.05E-03	0.00E+00	1.26E-01	0.00E+00	3.28E-02
B. Iodine-131						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Release Rate	µCi/sec	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C. Particulates Half-Life ≥ 8 days						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Release Rate	µCi/sec	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Tritium						
1. Total Release	Ci	1.78E+01	2.72E+01	3.51E+01	3.73E+01	1.17E+02
2. Avg. Release Rate	µCi/sec	2.41E+00	2.03E+00	1.91E+00	2.57E+00	2.23E+00
E. Gross Alpha						
1. Total Release	Ci	0.00+00	0.00+00	0.00+00	0.00+00	0.00E+00
2. Avg. Release Rate	µCi/sec	0.00+00	0.00+00	0.00+00	0.00+00	0.00E+00

SHEARON HARRIS NUCLEAR POWER PLANT
OFFSITE DOSE CALCULATION MANUAL

(ODCM)

Revision 29

Docket No. STN-50-400

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

Approval by ORC Chairman (Print / Sign) William D. Gunter /

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

Prepared by (Print / Sign) Kyle Baker

Reviewed by (Print / Sign) Nathan Blanton

Effective Date 09/01/2022

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LIST OF TABLES

LIST OF TABLES (continued)

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

LIST OF FIGURES

ODCM REV. 29 CHANGE SUMMARY

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

Revision 29 to the ODCM is as follows:
DRR's 2427266, 2421313, 2326048, 2428421, 2435604

Section	Page	Description
Table of Contents	i	Changed to "ODCM REV.29 CHANGE SUMMARY",
ODCM REV 29 CHANGE SUMMARY	v	Changed to reflect Rev. 29 revisions. Added Note to Change Summary page denoting that all changes become effective & implemented on date of revision per T.S. 6.14.b.
Table 4.1	4-4	Revised location description of TLD # 19 from NNE Sector 5.0 mi site) to Cross Country Lane and Humie Olive Rd,4.95 (5.0) mi from site, NNE sector).
	4-11	Removed and revised Sample Point # 5 to # 300 to match >10 mile map.
	4-12	Deleted Crop Sample Point 97.
	4-13	Updated Sample Point 5 description to WNW sector, 13.3 mi. from site.
	4-14	Updated REMP Note bullet 18 to state "As of Revision 29 of this ODCM, there are no known irrigated gardens."
	4-14	Updated note 10 to provide basis for removal of location 97.
Table 4.2	4-15	Revised to indicate SW-26 samples are performed on a Monthly basis aligning with current sampling practice and table 4.1.
Table 4.3	4-16	Updated description of TLD # 19 from NNE Sector 5.0 mi site) to Cross Country Lane and Humie Olive Rd,4.95 (5.0) mi from site, NNE sector).
	4-16	Inserted location descriptions for TLD sites that were missing location description
Figure 4.1-3	4-19	Map revised Show AQV Location 61 at the correct distance (2.5 miles E). .
		Revised map to Show new location of TLD # 19
Figure 4.1-4	4-20	Added >10 mile REMP map to depict all Sample locations past 10 miles.

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 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, 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:

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

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.

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

where:

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

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

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

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

and

f = 0.5

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

r = 1

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

$$R_{CWMAX} = \frac{F_{avail} \bullet f_{alloc}}{D_{req}} \tag{2.1-6}$$

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

and

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

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

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

4. Minimum Dilution Flow Rate

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

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

$$min\_dflow = \frac{F_{waste} \bullet D_{req}}{f_{alloc}} \tag{2.1-7}$$

where

F_{waste} = waste flow anticipated for this release

2.1.1 Batch Releases (continued)

5. Post Dilution Concentration

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

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

where

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

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

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

6. Setpoint Calculations

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

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

where

S_{adj} = Setpoint adjustment factor.

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

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} = $\Sigma\ slope_i \bullet C_i$

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.

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

where:

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

(3) Check for Excessive Monitor Background

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

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

where:

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

where:

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

Bkg = Background Count Rate, in cpm

= B / E_m

E_m = Monitor efficiency for the Cs-137 gamma energy, cpm/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.

2.1.1 Batch Releases (continued)

7. Post-Release Compliance

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

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

2.1.2 Continuous Releases

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

The software does not calculate continuous release setpoints.

1. Monitor High Alarm Setpoint, S_{max} (μCi/ml).

$$S_{max} = \frac{0.1\ (ECL_{eff} \bullet Sens_{eff}) + Bkg}{E_m} \qquad (2.1\text{-}15)$$

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)

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

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

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

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

3. Check for Excessive Monitor Background

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

$$MDC \leq \frac{0.01\ (ECL_{eff} \bullet Sens_{eff})}{E_m} \qquad (2.1\text{-}17)$$

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:

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

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:

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

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 ater 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:

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

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

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

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 objectives 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:

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

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:

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

and

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

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

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

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

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

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

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

Worker Drinking Water Pathway –

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

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.

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

Where:

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

b. Derive the average evaporation rate from historical data.

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

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

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

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

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

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

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:

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

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 –

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

Where;

R_{apj} = Annual dose to organ j of individual of age group (adult in this case) from tritium in p pathway (ingestion), mrem/yr

U_{ap} = Usage term, 21 kg/yr per Reg. Guide 1.109 Table E-11 for an adult

C_{ip} = Concentration (pCi/L) of drinking water obtained from the annual average monthly composite from SW-26

D_{api} = Dose factor specific to age group (adult in this case), for nuclide i (H-3 in this case) in units of mrem/pCi, 1.05E-07 mrem/pCi for total body & all organs with the exception of bone which is no dose

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

TABLE 2.1-1a

LIQUID EFFLUENT RELEASE TANKS AND PUMPS DESIGN BASIS (1)

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

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

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

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

TABLE 2.1-1b

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

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

4 Typical values used for normal operations.

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

TABLE 2.1-2

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

Setting	Trip Flow Rate (gpm)	Minimum Dilution Flow Rate (gpm)
1	4,000 ± 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.

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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
Se-75	6.04E+02	2.32E+02	4.65E+03	2.32E+02	4.65E+01	5.58E+02	6.51E+02
Br-82	0.00E+00	0.00E+00	1.81E+03	0.00E+00	0.00E+00	0.00E+00	2.07E+03
Br-83	0.00E+00	0.00E+00	1.24E+00	0.00E+00	0.00E+00	0.00E+00	1.79E+00
Br-84	0.00E+00	0.00E+00	8.07E-06	0.00E+00	0.00E+00	0.00E+00	6.33E-11
Rb-86	0.00E+00	9.95E+04	4.63E+04	0.00E+00	0.00E+00	0.00E+00	1.96E+04
Rb-88	0.00E+00	1.94E-10	1.03E-10	0.00E+00	0.00E+00	0.00E+00	2.67E-21
Rb-89	0.00E+00	1.62E-12	1.14E-12	0.00E+00	0.00E+00	0.00E+00	9.43E-26
Sr-89	2.38E+04	0.00E+00	6.84E+02	0.00E+00	0.00E+00	0.00E+00	3.82E+03
Sr-90	5.91E+05	0.00E+00	1.45E+05	0.00E+00	0.00E+00	0.00E+00	1.71E+04
Sr-91	1.84E+02	0.00E+00	7.43E+00	0.00E+00	0.00E+00	0.00E+00	8.77E+02
Sr-92	7.84E+00	0.00E+00	3.39E-01	0.00E+00	0.00E+00	0.00E+00	1.55E+02
Y-90	5.57E-01	0.00E+00	1.49E-02	0.00E+00	0.00E+00	0.00E+00	5.91E+03
Y-91M	2.61E-07	0.00E+00	1.01E-08	0.00E+00	0.00E+00	0.00E+00	7.67E-07
Y-91	9.24E+00	0.00E+00	2.47E-01	0.00E+00	0.00E+00	0.00E+00	5.09E+03
Y-92	5.29E-03	0.00E+00	1.55E-04	0.00E+00	0.00E+00	0.00E+00	9.27E+01
Y-93	7.75E-02	0.00E+00	2.14E-03	0.00E+00	0.00E+00	0.00E+00	2.46E+03
Zr-95	4.20E-01	1.35E-01	9.12E-02	0.00E+00	2.11E-01	0.00E+00	4.27E+02
Zr-97	1.42E-02	2.87E-03	1.31E-03	0.00E+00	4.34E-03	0.00E+00	8.90E+02
Nb-95	4.43E+02	2.47E+02	1.33E+02	0.00E+00	2.44E+02	0.00E+00	1.50E+06

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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
Sn-113	2.52E+03	9.68E+02	1.94E+04	9.68E+02	1.94E+02	2.32E+03	2.71E+03
Sn-117M	2.39E+03	9.20E+02	1.84E+04	9.20E+02	1.84E+02	2.21E+03	2.58E+03
Sb-124	2.33E+01	4.40E-01	9.24E+00	5.65E-02	0.00E+00	1.82E+01	6.62E+02
Sb-125	1.50E+01	1.67E-01	3.57E+00	1.52E-02	0.00E+00	1.16E+01	1.65E+02
Sb-126	2.74E+02	5.58E+00	9.90E+01	1.68E+00	0.00E+00	1.68E+02	2.24E+04
Te-125M	2.57E+03	9.32E+02	3.44E+02	7.73E+02	1.05E+04	0.00E+00	1.03E+04
Te-127m	6.51E+03	2.33E+03	7.94E+02	1.66E+03	2.65E+04	0.00E+00	2.18E+04
Te-127	4.36E+01	1.57E+01	9.44E+00	3.23E+01	1.78E+02	0.00E+00	3.44E+03
Te-129M	1.10E+04	4.10E+03	1.74E+03	3.77E+03	4.59E+04	0.00E+00	5.53E+04
Te-129	2.33E-02	8.76E-03	5.68E-03	1.79E-02	9.80E-02	0.00E+00	1.76E-02
Te-131M	1.27E+03	6.19E+02	5.16E+02	9.80E+02	6.27E+03	0.00E+00	6.14E+04
Te-131	4.07E-08	1.70E-08	1.28E-08	3.35E-08	1.78E-07	0.00E+00	5.76E-09
Te-132	2.19E+03	1.41E+03	1.33E+03	1.56E+03	1.36E+04	0.00E+00	6.69E+04
I-130	1.62E+01	4.77E+01	1.88E+01	4.05E+03	7.45E+01	0.00E+00	4.11E+01
I-131	1.67E+02	2.39E+02	1.37E+02	7.84E+04	4.10E+02	0.00E+00	6.31E+01
I-132	2.29E-01	6.12E-01	2.14E-01	2.14E+01	9.75E-01	0.00E+00	1.15E-01
I-133	4.00E+01	6.95E+01	2.12E+01	1.02E+04	1.21E+02	0.00E+00	6.25E+01
I-134	3.37E-04	9.15E-04	3.27E-04	1.59E-02	1.46E-03	0.00E+00	7.98E-07
I-135	5.29E+00	1.38E+01	5.11E+00	9.13E+02	2.22E+01	0.00E+00	1.56E+01
Cs-134	2.99E+05	7.10E+05	5.81E+05	0.00E+00	2.30E+05	7.63E+04	1.24E+04
Cs-136	3.05E+04	1.20E+05	8.65E+04	0.00E+00	6.69E+04	9.17E+03	1.37E+04
Cs-137	3.83E+05	5.23E+05	3.43E+05	0.00E+00	1.78E+05	5.91E+04	1.01E+04
Cs-138	4.92E-05	9.72E-05	4.82E-05	0.00E+00	7.14E-05	7.06E-06	4.15E-10
Ba-139	3.72E-03	2.65E-06	1.09E-04	0.00E+00	2.48E-06	1.50E-06	6.60E-03
Ba-140	3.08E+02	3.86E-01	2.02E+01	0.00E+00	1.31E-01	2.21E-01	6.33E+02
Ba-141	1.05E-12	7.94E-16	3.55E-14	0.00E+00	7.38E-16	4.51E-16	4.95E-22
Ba-142	1.84E-21	1.89E-24	1.16E-22	0.00E+00	1.60E-24	1.07E-24	2.59E-39
La-140	1.34E-01	6.75E-02	1.78E-02	0.00E+00	0.00E+00	0.00E+00	4.96E+03
La-142	4.51E-05	2.05E-05	5.11E-06	0.00E+00	0.00E+00	0.00E+00	1.50E-01

TABLE 2.2-1

(Continued)

$A_{i\tau}$ 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

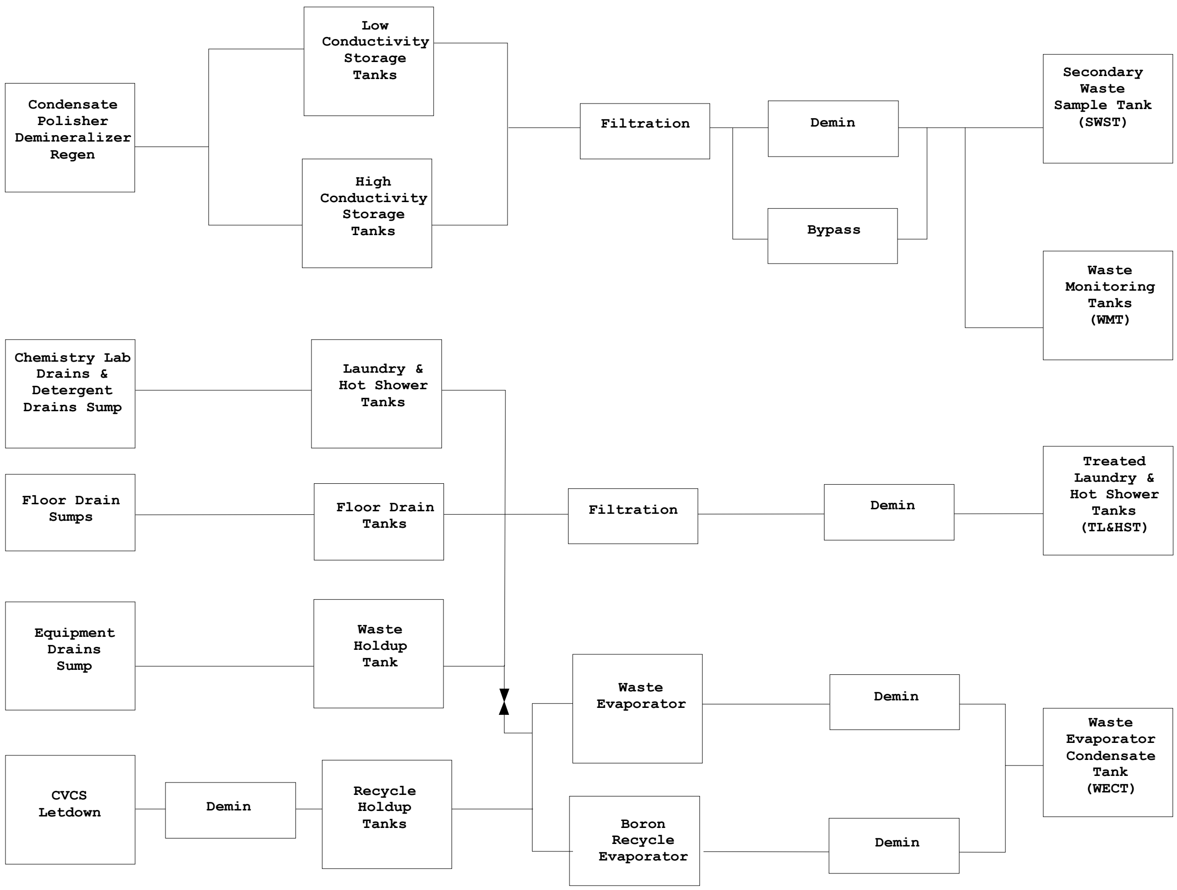


Figure 2.1-2

Liquid Effluent Flow Stream Diagram

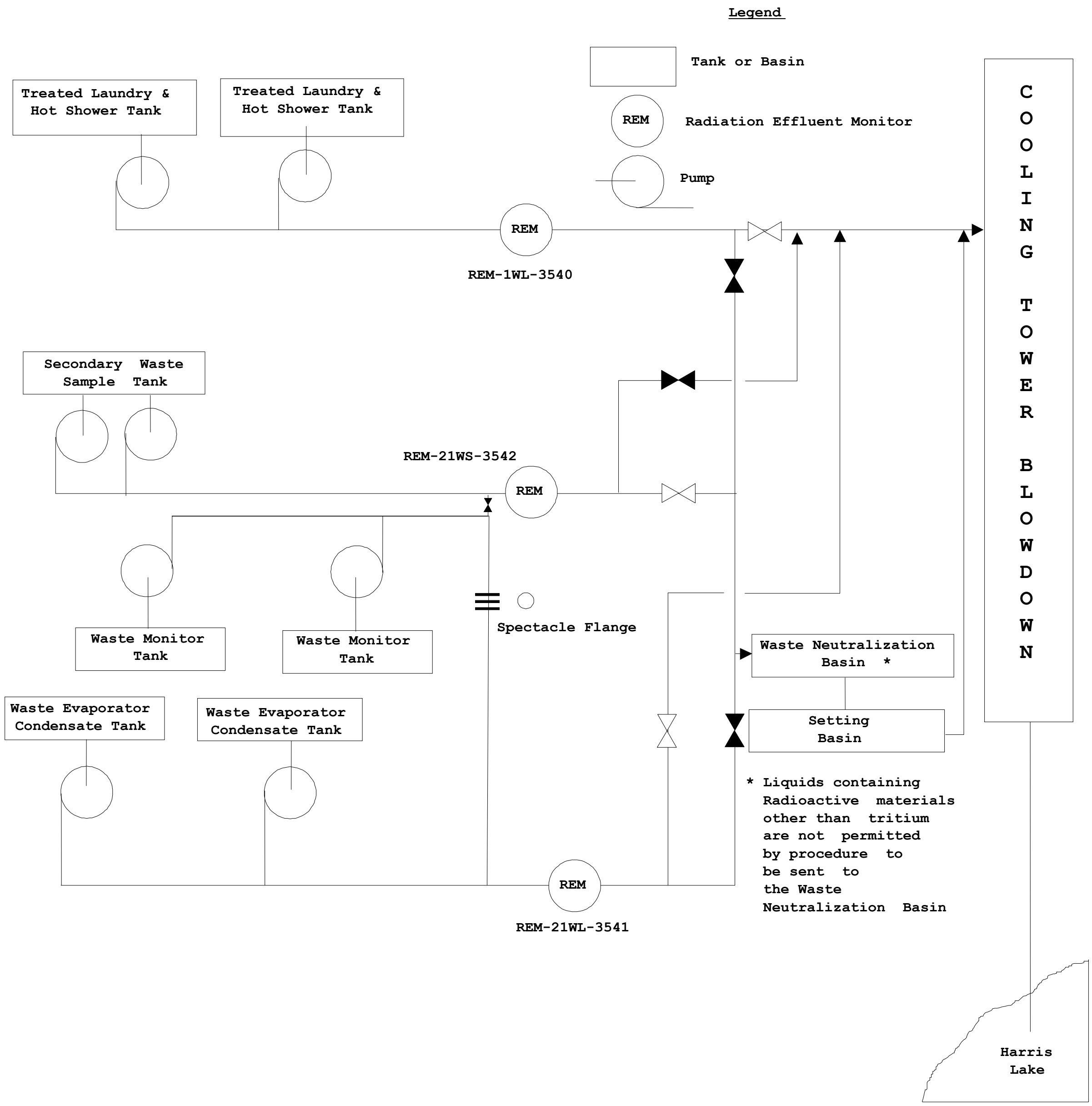
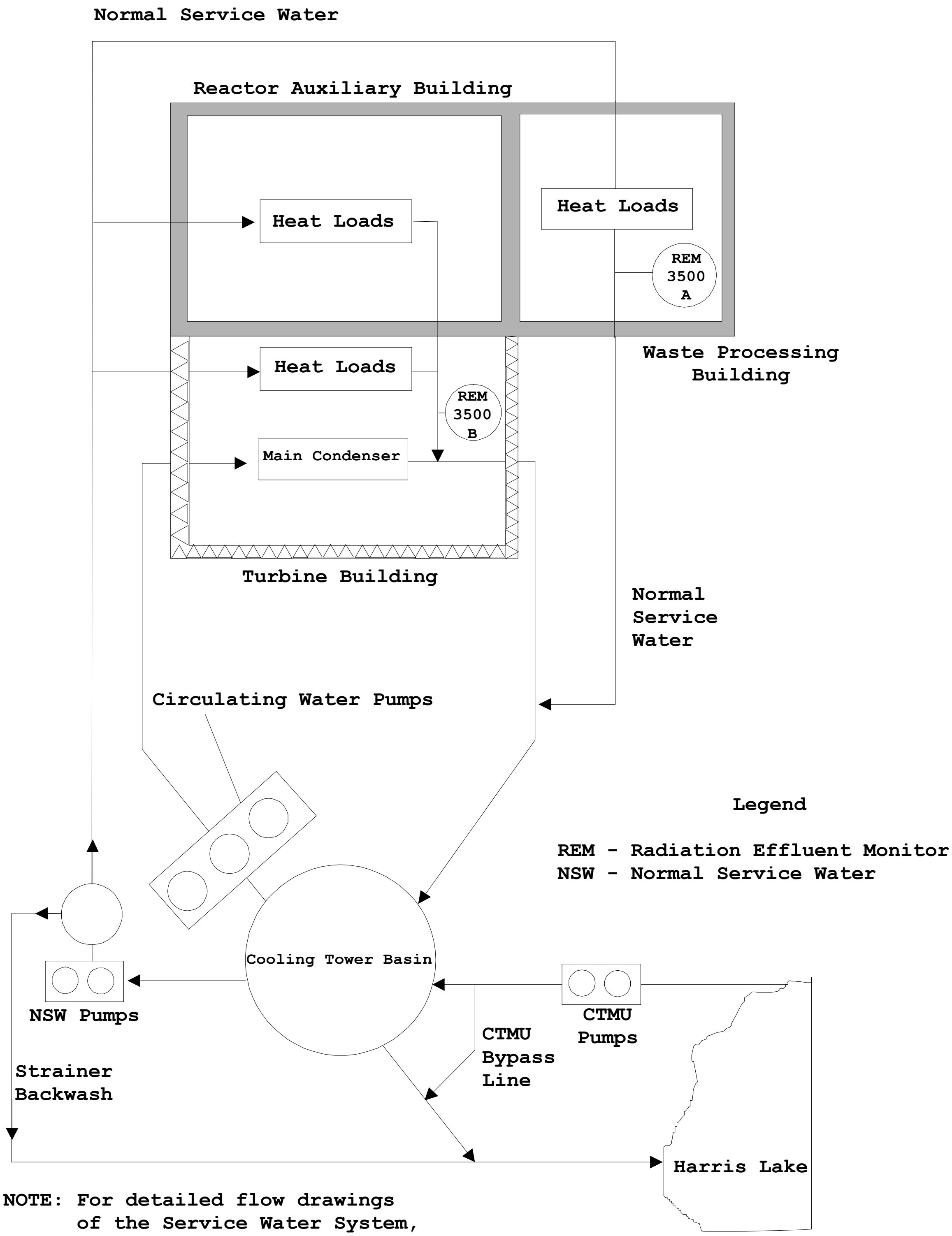


Figure 2.1-3

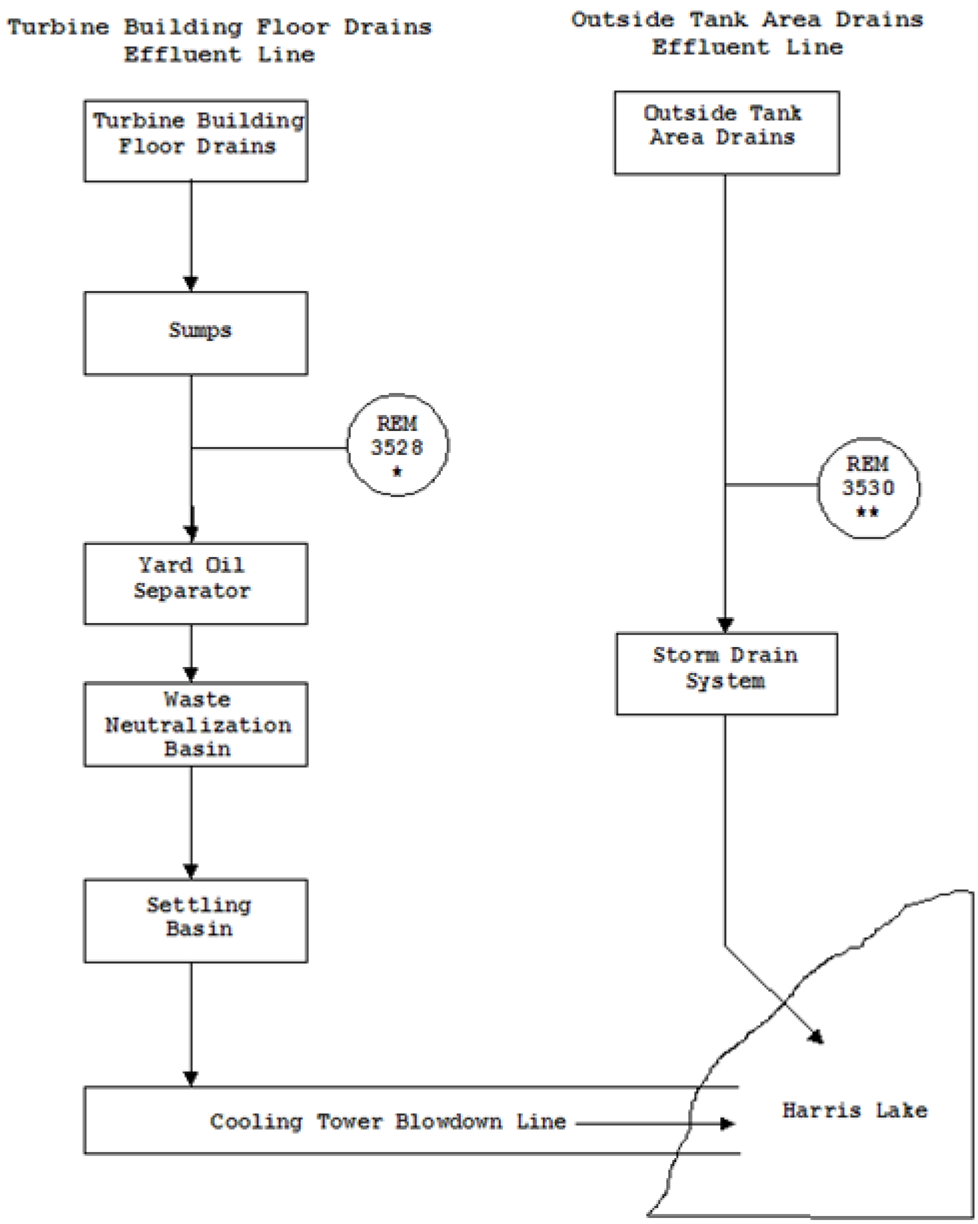
Normal Service Water Flow Diagram



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

Figure 2.1-4

Other Liquid Effluent Pathways

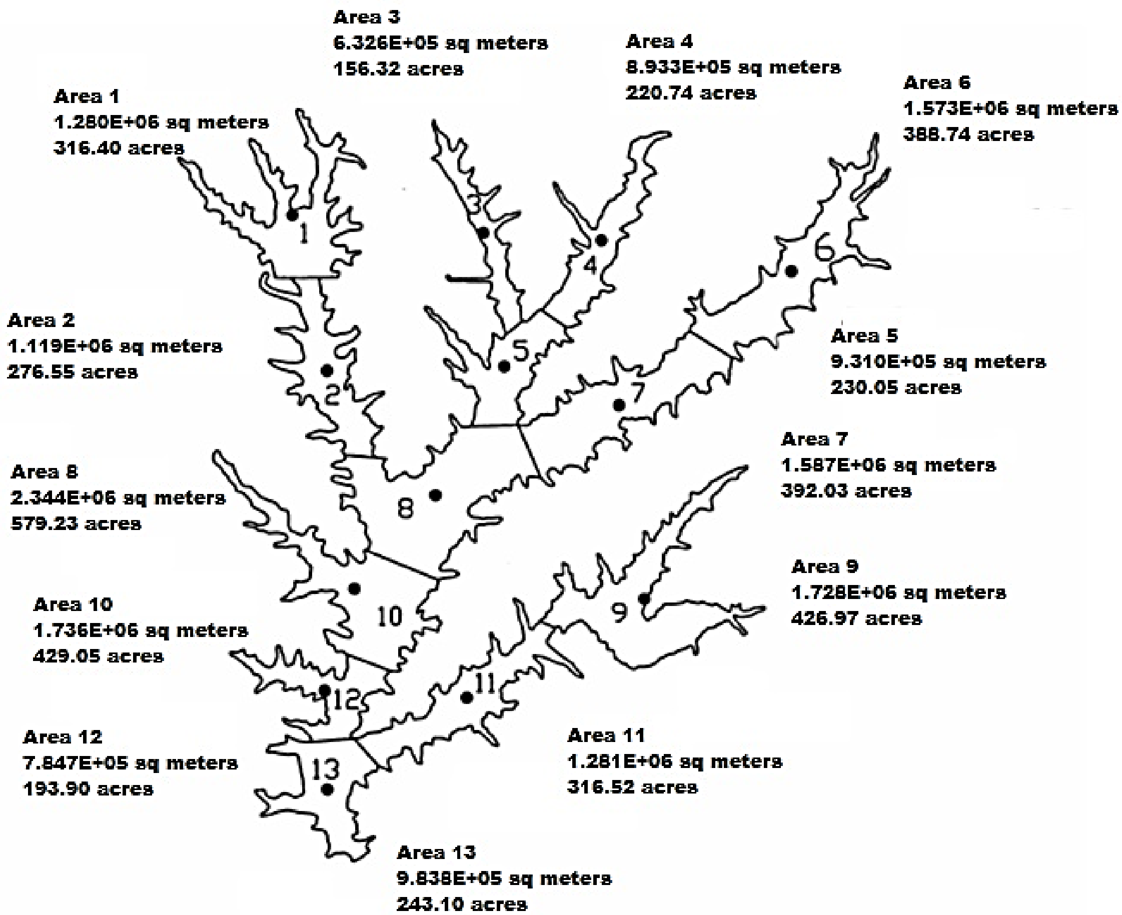


* Turbine Building Floor Drains Effluent can be Diverted to the Secondary Waste Treatment System

** 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 outage the Equipment Hatch is removed and has potential airborne particulate releases. These are shown in Figures 3.1, 3.2, and 3.3 along with their tributaries. Minor release pathways, such as steam leaks, steam dumps, and open penetrations are evaluated for significant of release. All gaseous effluent releases at the plant are considered ground releases.

3.1 Monitor Alarm Setpoint Determination (ODCM Operational Requirement 3.3.3.11)

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

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

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

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

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

1. Determine the noble gas radionuclide activity (Q_i) in µCi, and the activity release rate $\dot{Q}_i$ in 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.

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

and

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

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.

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

and

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

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

and

Skin ratio = $\frac{3000}{Q_{m\text{-}s}}$ (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.

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

and

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

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.

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

and

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

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 Pre-entry 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 Pre-entry 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 pre-entry 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.

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

and

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

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.

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

and

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

where:

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

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

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

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

and

$$RR_{max} = S_{max} \bullet F_v \bullet 28316.85 / 60 \tag{3.2-4b}$$

where:

f_s = safety factor for the discharge point

= 0.5

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

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

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

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

(d) Maximum Effluent Design Flow Rates:
- Plant Vent Ventilation via Stack 1 = 415,000 acfm
- Condenser Vacuum Pump Ventilation via Stack 3A = 28,620 acfm
- WPB Ventilation via Stack 5 = 232,500 acfm
- WPB Ventilation via Stack 5A = 103,050 acfm
- Containment Purge or Pressure Relief via Stack 1 = 37,000 acfm
- WGDT Release via Stack 5 = 15 acfm

TABLE 3.1-2

Deleted

TABLE 3.1-3

GASEOUS MONITOR PARAMETERS

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

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

3.2.1 Noble Gases

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

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

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

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

where:

$\overline{(X/Q)}_v$ = The highest calculated annual average relative concentration for long-term vent stack releases for areas at or beyond the exclusion boundary sec/m^3.

= 1.8E-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 radioiodine's, tritium, and particulates with half-lives ≥ 8 days is limited to 1500 mrem/yr to any organ. Based upon NUREG-0133, the following is used to show compliance:

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

where:

P_{i_I} = The dose parameter for radionuclides other than noble gases for the inhalation pathway, mrem/yr per μCi/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:

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

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

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:

$D_\gamma \leq 5$ mrad (3.3-3)

$D_\beta \leq 10$ mrad (3.3-4)

For the calendar year:

$D_\gamma \leq 10$ mrad (3.3-5)

$D_\beta \leq 20$ mrad (3.3-6)

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

3.3.1 Noble Gases (continued)

2. Source Term Determination

Containment Batch Purge

A purge of containment may be started as a Batch purge and continued as a normal purge. The containment Batch Purge volume is considered to be two air containment volumes (RCB vol = 2.26E+06 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;

$$q_i = C_i \bullet v_b \tag{3.3-7}$$

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;

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

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:

$$Q_x = C_x \bullet V_x \tag{3.3-8}$$

Where;

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

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

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

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

$$Q_i = Q_x \bullet S_i \tag{3.3-8a}$$

Where;

$$S_i = \frac{C_i}{\Sigma C_i} \tag{3.3-8b}$$

and;

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

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

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;

$$Q_{ic} = Q_i - q_i \tag{3.3-9}$$

Where;

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

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

3. Projection of Doses

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

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

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:

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

and

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

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

3.3.2 Radioiodine and Particulates

1. Cumulation of Doses

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

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

where:

D_τ	=	Dose to any organ τ from tritium, radioiodine's, and particulates, mrem.
$\overline{(D/Q)}_v$	=	The highest long-term (> 500 hr/yr) annual average relative deposition: 9.0E-09 m^{-2} for the food and ground plane pathways at the controlling location which is the exclusion boundary in the SW sector (from Table A1 through A4, Appendix A, for ground-level vent stack releases).
$\overline{(D/q)}_v$	=	The relative deposition factor for short term, ground-level vent releases (≤ 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 $\mu Ci/m^3$.
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 $\mu Ci/m^3$.
R_{T_V}	=	Dose factor for an organ for tritium for the vegetable pathway, mrem/yr per $\mu Ci/m^3$.
R_{T_I}	=	Dose factor for an organ for tritium for the inhalation pathway, mrem/yr per $\mu Ci/m^3$.

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 ($\leq$ 500 hrs/yr), μCi.

To show compliance with 10CFR50, Equation 3.3-13 is evaluated for a hypothetical individual at the limiting location. At SHNPP the SW sector has the highest X/Q_v and the SW and SSW 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 radioiodine's and particulates is a function of:

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

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

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

SHNPP ODCM Operational Requirement 3.12.2 requires that a land-use census survey be conducted on an annual basis. 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 radioiodine's and particulates will be projected once every 31 days (monthly). The doses will be projected utilizing Equation 3.3-13, and projected using the following expression:

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

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:

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

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

$$Q_c = \frac{7.3 \text{ x EFPD}}{292} \tag{3.3-19}$$

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:

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

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

X_c = the average ground-level concentration of C-14 in air, in pCi/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 E+07 = (10^{12} pCi/Ci)(10^3 g/kg) / (3.15E+07 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

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

C_{14}^{B}	=	The concentration of C-14 in meat, pCi/kg
F_F	=	average fraction of the animal's daily intake of C-14 that appears in each kilogram of flesh, in days/kg
	=	0.031
C_{14}^{V}	=	The concentration of C-14 in animal's feed, in pCi/kg
Q_f	=	amount of feed consumed by the animal per day, in kg/day
	=	Cow or cattle = 50 kg, goat = 6 kg

5. Dose from Atmospherically Released Carbon-14 in Foods

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

D_{ja}^{D}	=	the dose to organ (j) of an individual in age group (a) from the dietary intake of atmospherically released Carbon-14, in mrem
DFI_{ja}	=	the dose conversion factor for the ingestion of Carbon-14, organ (j), and age group (a), in mrem/pCi Table 3.3-22
U_a^V	=	ingestion rate of produce (non-leafy vegetables, fruit, grains), in kg/yr, Table 3.3-20
U_a^M	=	ingestion rate of milk, in l/yr, Table 3.3-20
U_a^B	=	ingestion rate of meat and poultry in kg/yr, Table 3.3-20
U_a^L	=	ingestion rate of leafy vegetables, in kg/yr, Table 3.3-20
f_g	=	fraction of produce ingested grow in the garden of interest
	=	0.76, in lieu of site specific data
f_l	=	fraction of leafy vegetables in the garden of interest
	=	1.0 , in lieu of site specific data
C_{14}^{V}	=	The concentration of C-14 in vegetation, in pCi/kg
C_{14}^{M}	=	The concentration of C-14 in milk, pCi/kg
C_{14}^{B}	=	The concentration of C-14 in meat, pCi/kg

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

PATHWAY = Ground AGE GROUP = ALL

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

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

TABLE 3.3-7
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 μCi/m^3 for inhalation and tritium and in units of mrem/yr per μCi/sec per m^{-2} for all others.

TABLE 3.3-9
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 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 (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 μCi/m^3 for inhalation and tritium and in units of mrem/yr per μCi/sec per m^{-2} for all others.

TABLE 3.3-12
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 $\mu Ci/m^3$ for inhalation and tritium and in units of mrem/yr per $\mu Ci/sec$ per m^{-2} for all others.

TABLE 3.3-14
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 μCi/m^3 for inhalation and tritium and in units of mrem/yr per μCi/sec per m^{-2} for all others.

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

PATHWAY = Inhalation AGE GROUP = Teen

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

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

TABLE 3.3-17 (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 μCi/m^3 for inhalation and tritium and in units of mrem/yr per μCi/sec per m^{-2} for all others.

TABLE 3.3-18
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 μCi/m^3 for inhalation and tritium and in units of mrem/yr per μCi/sec per m^{-2} for all others.

TABLE 3.3-18 (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 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
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 μCi/m^3 for inhalation and tritium and in units of mrem/yr per μCi/sec per m^{-2} for all others.

Table 3.3-20

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

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

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

Table 3.3-21

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

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

Table 3.3-22

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

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

Figure 3.1

SHNPP Gaseous Waste Streams

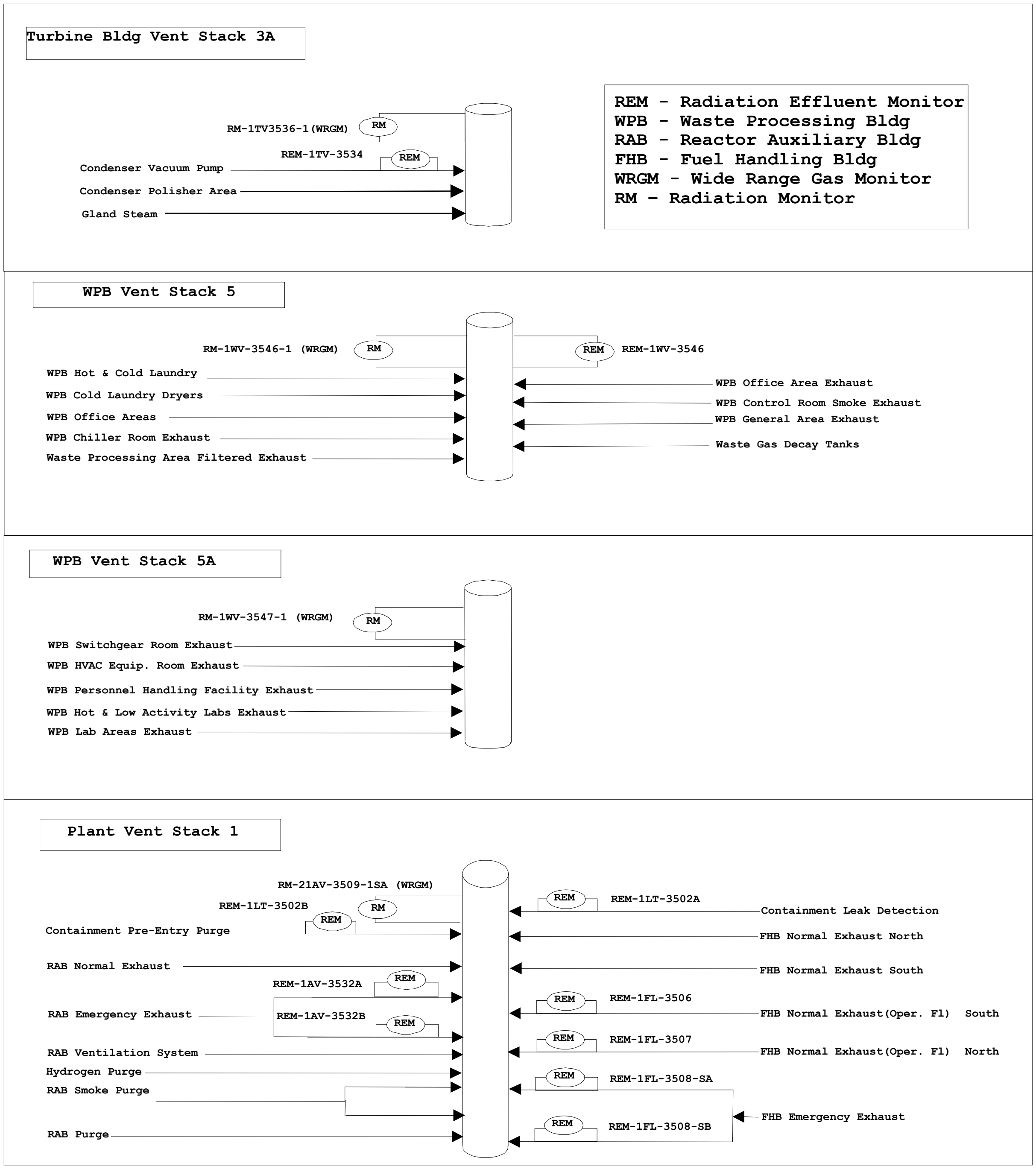


Figure 3.2

Schematic of Airborne Effluent Release Points

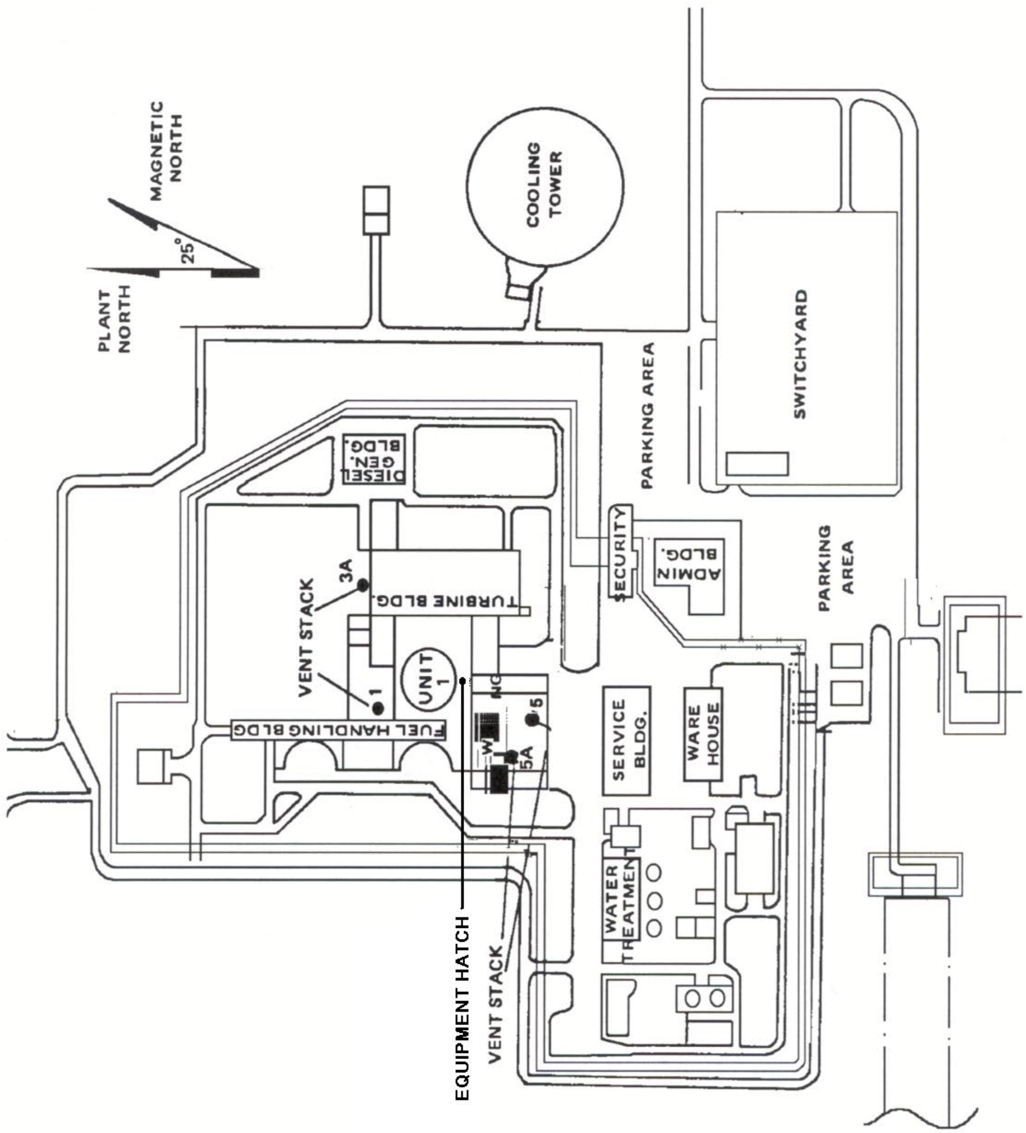
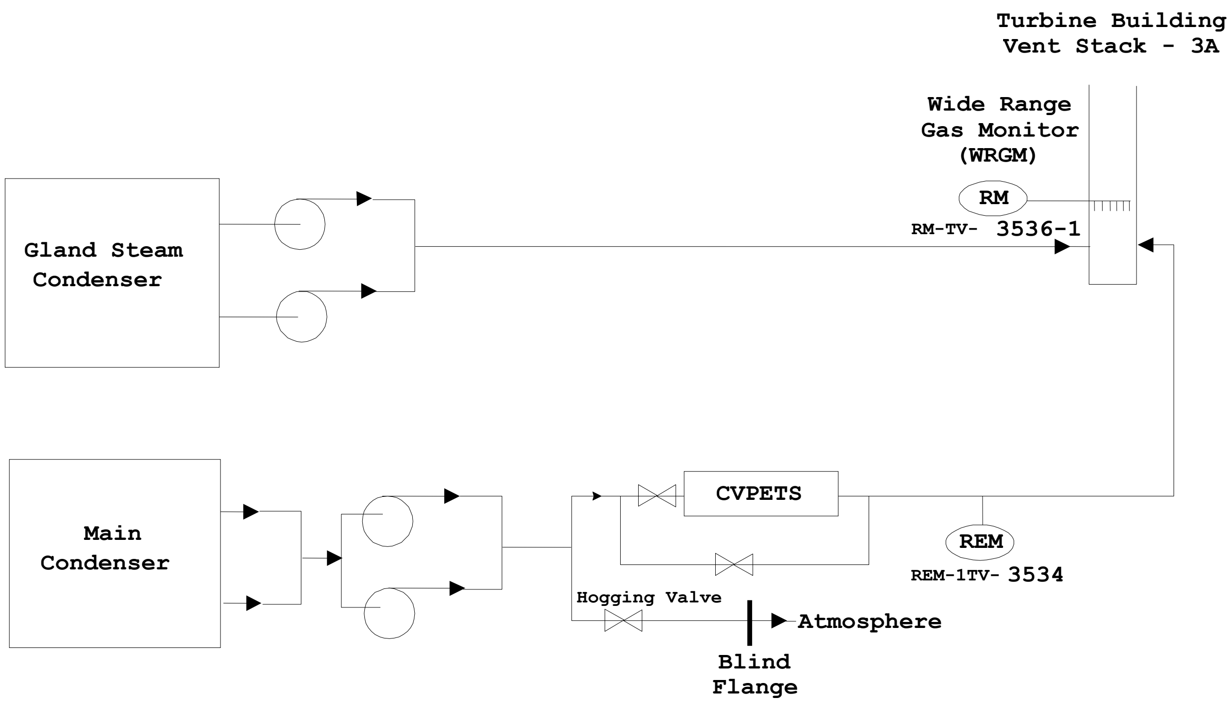


Figure 3.3

SHNPP Condenser Off-Gas System



4.0 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

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

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

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

TABLE 4.1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample:	Airborne Particulates and Radioiodine
Sampling and Collection Frequency:	Continuous operating sampler with sample collection as required by dust loading but at least once per 7 days.
Analysis Frequency and Required Analysis:	Weekly Gross Beta[2] Weekly I-131 (charcoal canisters) Quarterly Gamma Isotopic[4,5] (Composited by location)

Sample Point ID No.	Sample Point, Description[1], Distance, and Direction
2	1.4 mi. S on SR 1134 from SR 1011 intersection. NNE sector, 1.4 mi. from site.
4	0.7 mi. N on SR 1127 from intersection with US 1. NNE sector, 3.1 mi. from site.
5	Pittsboro (Control Station)[3] WNW sector from site, 13.3 mi. from site
26	Harris Lake Spillway S sector, 4.7 mi. from site
63	SHNPP site. SW sector, 0.6 mi. from site.
90	SHNPP site. SSW sector, 0.5 mi. from site.
91	HE&EC, Sewage Treatment Facility ENE Sector, 1.6 mi. from site.

TABLE 4.1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample:	Direct Radiation (TLD)
Sampling and Collection Frequency:	Continuous measurement with an integrated readout at least once per quarter.
Analysis Frequency and Required Analysis:	Quarterly Gamma Dose

Sample Point ID No.	Sample Point, Description[1], Distance, and Direction
1	0.1 mi. S on SR 1134 from SR 1011 intersection. N sector, 2.6 mi. from site.
2	1.4 mi. S on SR 1134 from SR 1011 intersection. NNE sector, 1.4 mi. from site.
3	HE&EC Visitor Center (Population Center) ENE sector, 1.9 mi. from site.
4	New Hill (Population Center) 0.7 mi. N on SR 1127 from intersection with US 1 NNE sector, 3.1 mi. from site.
5	Pittsboro (Control Station)[3] WNW sector from site, 13.3 mi. from site
6	Intersection of SR 1134 & SR 1135. ENE sector, 0.8 mi. from site.
7	Extension of SR 1134. E sector 0.7 mi. from site.
8	Dead end of road. Extension of SR 1134. ESE sector, 0.6 mi. from site.
9	1 mi. S on SR 1130 from intersection of SR 1127, 1115, and 1130. SE sector, 2.2 mi. from site.
10	SR 1130 S of intersection of SR 1127, 1115, and 1130. SSE sector, 2.2 mi. from site.
11	SHNPP site. S sector, 0.6 mi. from site
12	SHNPP site. SSW sector, 0.9 mi. from site.
13	SHNPP site. WSW sector 0.7 mi. from site.
14	SHNPP site. Access road to aux. reservoir. W sector, 1.5 mi. from site.

TABLE 4.1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample:	Direct Radiation (TLD)
Sampling and Collection Frequency:	Continuous measurement with an integrated readout at least once per quarter.
Analysis Frequency and Required Analysis:	Quarterly Gamma Dose

Sample Point ID No.	Sample Point, Description[1], Distance, and Direction
15	SR 1911. W sector, 2.0 mi. from site.
19	Cross Country Lane and Humie Olive Rd NNE sector 4.95 (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 on SR 1916. WSW sector, 5.7 mi. from site.

TABLE 4.1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample:	Direct Radiation (TLD)
Sampling and Collection Frequency:	Continuous measurement with an integrated readout at least once per quarter.
Analysis Frequency and Required Analysis:	Quarterly Gamma Dose

Sample Point ID No.	Sample Point, Description[1], Distance, and Direction
31	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.
48	SR 1142. 1.5 mi. from intersection of SR 1141. N sector, 4.5 mi. from site.
49	SR 1127. 0.3 mi. S from intersection with US 1. NE sector, 2.5 mi. from site.
50	Holleman Crossroad (Population Center) SR 1127 W from intersection SR 1115 and 1130. ESE sector, 2.6 mi. from site.
56	SR 1912 at intersection of SR 1912 and SR 1924. WSW sector, 3.0 mi. from site.
63	SHNPP Site. SW sector, 0.6 mi. from site.
93	SR 1911. WNW sector, 2.2 mi. from site.
94	Old US HWY 1 NW sector, 2.0 mi. from site
95	Bonsal Rd NNW sector, 2.0 mi. from site

TABLE 4.1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

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

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

TABLE 4.1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample:	Waterborne, Groundwater
Sampling and Collection Frequency:	Grab sample collected quarterly
Analysis Frequency and Required Analysis:	Quarterly Gamma Isotopic[4] Quarterly Tritium

Sample Point ID No.	Sample Point, Description[1], Distance, and Direction
57	SHNPP Site (LP-13) N. side of Aux Res Intake canal SSW sector, 0.4 mi. from site.
59	SHNPP Site (W-13) N. side of Old Construction Road. NNE sector, 0.5 mi. from site
60	SHNPP Site (W-9A) W. bank of Harris Lake SE of Cooling Tower. ESE sector, 0.5 mi. from site
68	SHNPP Site (LP-6) N. of old Steam Generator Storage Building W sector, 0.2 mi. from site
69	SHNPP Site (LP-7) S. side of Warehouse 9. NNE sector, 0.2 mi. from site
70	SHNPP Site (LP-9) N. side of Plant Entrance Road. E sector, 0.4 mi. from site
71	SHNPP Site (LP-16) S. of Switch Yard SE sector, 0.3 mi. from site
72	SHNPP Site (MWA-12) N. of Cooling Tower Makeup Water Intake Structures. SE sector, 0.2 mi. from site
73	SHNPP Site N. of Emergency Service Water Screening Structure. S sector, 0.2 mi. from site
74	SHNPP Site N. of helicopter landing pad. SSE sector, 0.2 mi. from site

TABLE 4.1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample:	Waterborne, Groundwater
Sampling and Collection Frequency:	Grab sample collected quarterly
Analysis Frequency and Required Analysis:	Quarterly Gamma Isotopic[4] Quarterly Tritium

Sample Point ID No.	Sample Point, Description[1], Distance, and Direction
75	SHNPP Site W. of Security Building Entrance ESE sector, 0.1 mi. from site
77	SHNPP Site (BD-MW1) Along the Cooling Tower Blowdown Line S sector, 0.4 mi. from site
78	SHNPP Site (BD-MW2) Along the Cooling Tower Blowdown Line S sector, 0.5 mi. from site
79	SHNPP Site (BD-MW3) Along the Cooling Tower Blowdown Line S sector, 0.5 mi. from site
80	SHNPP Site (BD-MW5) Along the Cooling Tower Blowdown Line S sector, 0.6 mi. from site
81	SHNPP Site (BD-MW7) Along the Cooling Tower Blowdown Line S sector, 0.6 mi. from site
82	SHNPP Site (BD-MW8) Along the Cooling Tower Blowdown Line S sector, 0.6 mi. from site
83	SHNPP Site (BD-MW16) Along the Cooling Tower Blowdown Line SSW sector, 1.6 mi. from site
84	SHNPP Site (MW-14) N. of Emergency Service Water Screening Structure. SSW sector, 0.2 mi. from site
85	SHNPP Site (MW-13) W. of site near Settling Basin SSW sector, 0.2 mi. from site
86	SHNPP Site (MW-12) W. of site near Old Reactor Head Storage Building SW sector, 0.2 mi. from site

TABLE 4.1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample:	Waterborne, Drinking Water
Sampling and Collection Frequency:	Composite sample[5] collected over a two-week period if I-131 analysis is performed; monthly composite otherwise.
Analysis Frequency and Required Analysis:	I-131 on each composite when the 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	Deleted
40	Deleted
46	NE Harnett Metro Water Treatment Plant Intake Building Duncan Street, Lillington, N.C. SSE sector,17.2 mi. from site.
51	SHNPP Water Treatment Building On Site
58	Sanford Water Treatment Plant (Control Station)[3] Poplar Springs Church Road, Sanford, NC SW sector, 8.5 miles from site

TABLE 4.1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample:	Waterborne, Sediment from Shoreline
Sampling and Collection Frequency:	Shoreline Sediment sample collected semiannually.
Analysis Frequency and Required Analysis:	Each Sample Gamma Isotopic[4]

Sample Point ID No.	Sample Point, Description[1], Distance, and Direction
26	Harris Lake Spillway S sector, 4.6 mi. from site
41	Shoreline of Mixing Zone of Cooling Tower Blowdown Line S sector, 3.8 miles from site.

TABLE 4.1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample:	Waterborne, Bottom Sediment
Sampling and Collection Frequency:	Bottom Sediment sample collected semiannually.
Analysis Frequency and Required Analysis:	Each Sample Gamma Isotopic[4]

Sample Point ID No.	Sample Point, Description[1], Distance, and Direction
52	Harris Lake in the vicinity of the mixing zone of the cooling tower S sector, 3.8 miles from site.

TABLE 4.1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample:	Ingestion – Milk[8, 17]
Sampling and Collection Frequency:	Grab samples semi-monthly when animals are on pasture; monthly at other times.[9]
Analysis Frequency and Required Analysis:	Each Sample I-131 Each Sample Gamma Isotopic[4]

Sample Point ID No.	Sample Point, Description[1], Distance, and Direction
300	Manco's Dairy, Pittsboro (Control Station)[3] WNW sector from site, > 12 mi. from site
102	Goat Farm, W sector, 2.82 miles from site.

TABLE 4.1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample:	Ingestion - Fish
Sampling and Collection Frequency:	One sample of each of the following semiannually: 1. Catfish (bottom feeders) 2. Sunfish & Largemouth Bass (free swimmers)
Analysis Frequency and Required Analysis:	Each sample - Gamma Isotopic[4] on edible portion for each

Sample Point ID No.	Sample Point, Description[1], Distance, and Direction
44	Site varies within the Harris Lake.
45	Site varies above Buckhorn Dam on Cape Fear River (Control Station)[3]

TABLE 4.1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample:	Ingestion – Food Products[7,10,18]
Sampling and Collection Frequency:	Samples of 3 different kinds of broadleaf vegetation monthly during the growing season[16]
Analysis Frequency and Required Analysis:	Each sample - Gamma Isotopic[4] on edible portion for each One sample of each principle class of food products from any area that is irrigated by water which liquid plant wastes have been discharged[18]

Sample Point ID No.	Sample Point, Description[1], Distance, and Direction
5	Deleted
97	Deleted

TABLE 4.1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample:	Aquatic Vegetation
Sampling and Collection Frequency:	Annually
Analysis Frequency and Required Analysis:	Each sample - Gamma Isotopic[4]

Sample Point ID No.	Sample Point, Description[1], Distance, and Direction
26	Harris Lake Spillway S sector, 4.7 mi. from site
41	Shoreline of Mixing Zone of Cooling Tower Blowdown Line S sector, 3.8 miles from site.
61	Harris Lake East of New Hill- Holleman Rd (Control Location) E sector, 2.5 mi. from site

Exposure Pathway and/or Sample:	Broadleaf Vegetation [8]
Sampling and Collection Frequency:	Monthly, 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] WNW sector, 13.3 mi. from site
12	SHNPP Site SSW sector, 0.9 mi. from site
63	SHNPP Site SW sector, 0.6 mi from site

NOTES TO TABLE 4.1

SHNPP Radiological Environmental Monitoring Program

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

TABLE 4.2

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SAMPLING LOCATIONS

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

(a) During Growing Season per ODCM – May through October
(b) When goats are lactating

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

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

TABLE 4.3

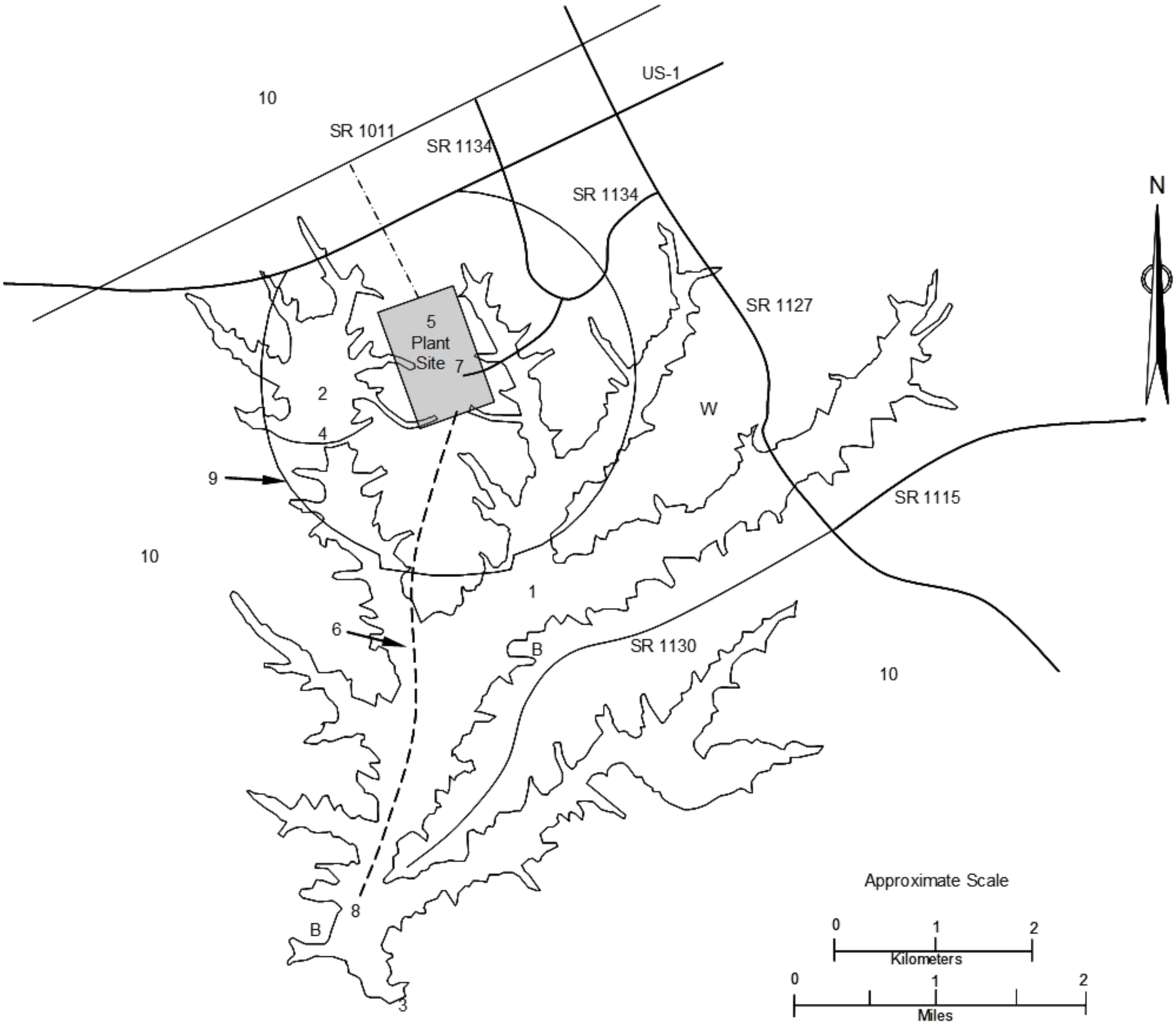
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SAMPLING LOCATIONS
(TLD Sites)

Site #	Measure Type	Location*	Distance (miles)	Sector	Site #	Measure Type	Location*	Distance (miles)	Sector
1	IR	0.1 mi. S on SR 1134 from SR 1011 intersection	2.6	N	26	OR	Harris Lake Spillway	4.7	S
2	IR	1.4 mi. S on SR 1134 from SR 1011 intersection	1.4	NNE	27	OR	NC 42 @ Buckhorn United Methodist Church	4.8	SSW
3	SI	HE&EC Visitor Center (Population Center)	1.9	ENE	28	OR	0.6 mi. on SR 1924 from intersection of SR 1916	4.8	SW
4	SI	New Hill (Population Center)	3.1	NNE	29	OR	Parking lot on SR 1916	5.7	WSW
5	C	Pittsboro (Control Station)	13.3	WNW	31	OR	At intersection of SR 1908, 1909, 1910	4.7	WNW
6	IR	Intersection of SR 1134 & SR 1135	0.8	ENE	32	SI	Jordan Lake (Population Center)	6.4	NNW
7	IR	Extension of SR 1134	0.7	E	33	OR	SR 1142, 1.7 mi. from intersection of SR 1141	4.5	NNW
8	IR	- Dead end of road, Extension of SR 1134	0.6	ESE	48	OR	SR 1142, 1.5 mi. from intersection of SR 1141	4.5	N
9	IR	1 mi. S on SR 1130 from intersection of SR 1127, 1115, and 1130	2.2	SE	49	IR	SR 1127, 0.3 mi. S from intersection with US 1	2.5	NE
10	IR	SR 1130 S of intersection of SR 1127, 1115, and 1130	2.2	SSE	50	SI	Holleman Crossroads (Population Center)	2.6	ESE
11	IR	SHNPP site	0.6	S	56	IR	SR 1912 at intersection of SR 1912 and SR 1924	3.0	WSW
12	IR	SHNPP site	0.9	SSW	63	IR	SHNPP Site	0.6	SW
13	IR	SHNPP site	0.7	WSW	93	IR	SR 1911	2.2	WNW
14	IR	SHNPP site	1.5	W	94	IR	Old US HWY 1	2.0	NW
15	IR	SR 1911	2.0	W	95	IR	Bonsal Road	2.0	NNW
19	OR	Cross Country Lane and Humie Olive Rd	4.95	NNE	98	SI	Holly Springs School Complex (Population Center)	5.9	E
20	OR	US 1 at intersection SR 1149	4.5	NE	99	SI	Friendship School (Population Center)	5.5	NNE
21	OR	1.2 mi. W on SR 1152 from intersection SR 1153	4.8	ENE	130	OR	Old US Hwy 1	3.9	W
22	OR	Formerly Ragan's Dairy on SR 1115	4.3	E	153	OR	Beaver Creek Road	4.5	NW
23	OR	Intersection of SR 1127 and SR 1116	4.8	ESE					
24	OR	Sweet Springs Church on SR 1116	4.0	SE					
25	OR	0.2 mi. W on SR 1402 from intersection of SR 1400	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

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

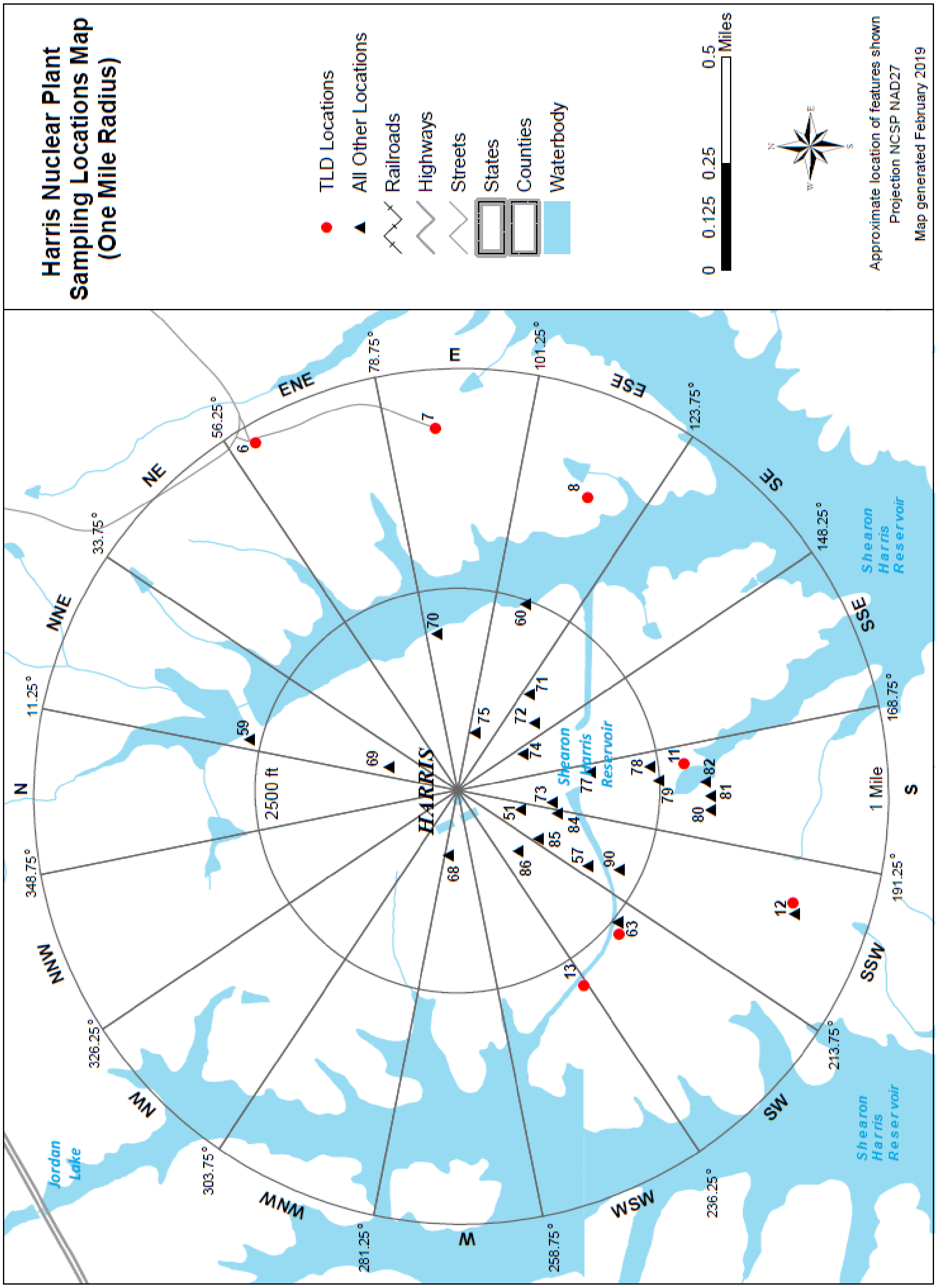


Figure 4.1-3
Environmental Radiological Sampling Points
(10 mile Radius)

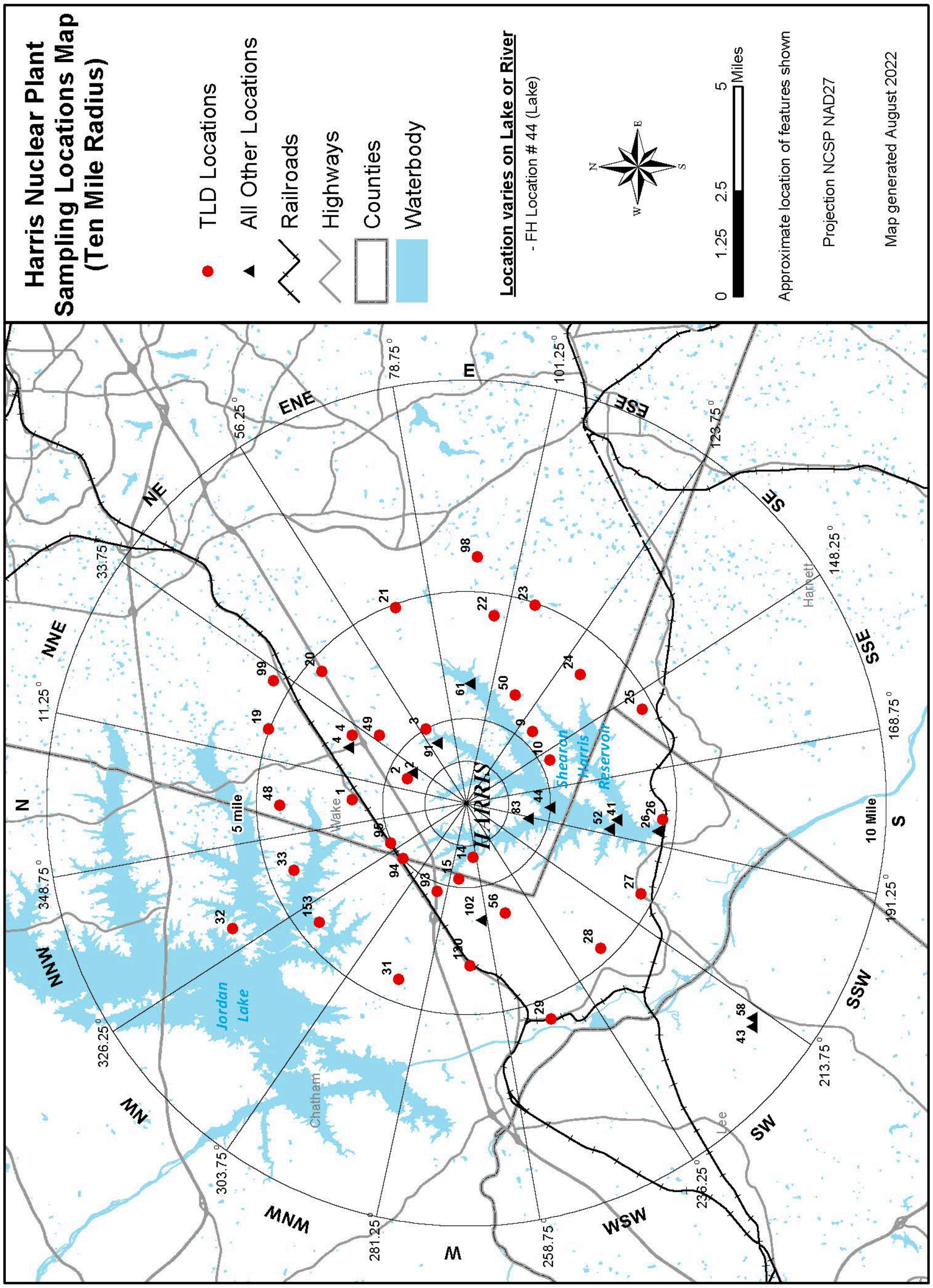
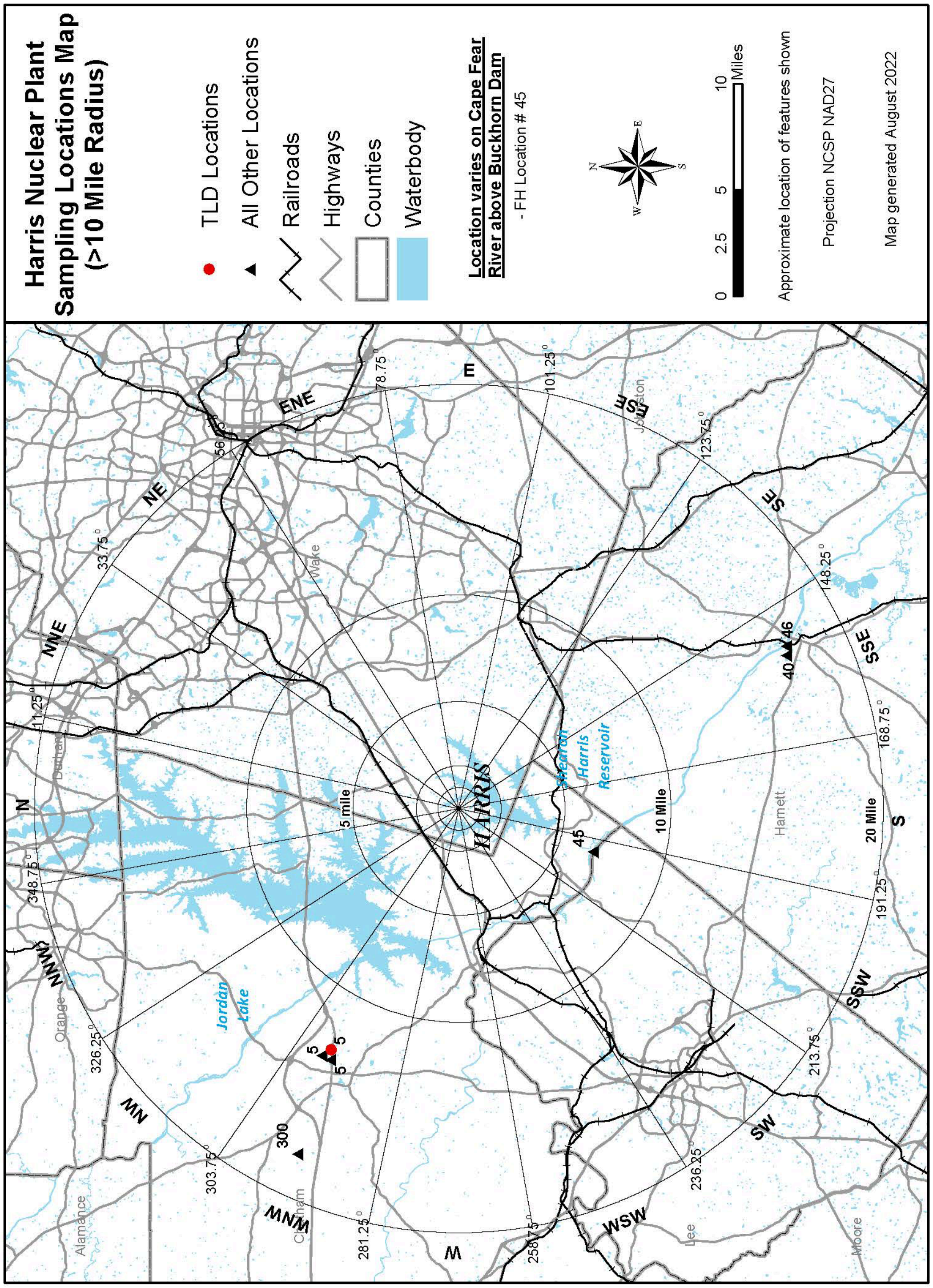


Figure 4.1-4
Environmental Radiological Sampling Points
(>10 mile Radius)



5.0 INTERLABORATORY COMPARISON STUDIES

The objective of this program is to evaluate the total laboratory analysis process by comparing results for an equivalent sample with those obtained by an independent laboratory or laboratories.

Environmental samples from the SHNPP environs are to be analyzed by a qualified laboratory. These laboratories will participate at least annually in a nationally recognized interlaboratory comparison study. The results of the laboratories' performances in the study will be included in the Annual Radiological Environmental Operating Report (see SHNPP ODCM Operational Requirement 4.12.3).

Radiochemical analyses of composite samples required by ODCM Operational Requirements Tables 4.11-1 and 4.11-2 will be performed by a qualified laboratory. The qualified radiochemistry laboratory will participate annually in a corporate interlaboratory comparison study or an equivalent study.

The qualified laboratory results shall be compared to the criteria established in the NRC Inspection Manual (Procedure 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 <u>Total Dose (COMPLIANCE WITH 40 CFR 190) for ODCM OR F.2</u>

To demonstrate compliance with ODCM Operational Requirement F.2, the ODCM dose equations for noble gases, iodine's, particulates, and tritium are used. They provide conservative dose estimates. The X/Q and D/Q 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 ORC and the approval of the Plant General Manager.

c. Shall be submitted to the Commission in the form of a complete, legible copy of the entire ODCM as a part of or concurrent with the Annual Radioactive Effluent Release Report for the period of the report in which any change to the ODCM was made. Each change shall be identified by markings in the margin of the affected pages, clearly indicating the areas of the page that was changed, and shall indicate the date (e.g., month/year) the change was implemented.

A.0 Appendix A

Duke Energy has performed the assessment of the transport and dispersion of the effluent in the atmosphere as outlined in Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants, NUREG 0133 (USNRC,1978). The methodology for this assessment was based on guidelines presented in Regulatory Guide 1.111. Revision 1 (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, radioiodine's and particulates.

A.1 Changes to X/Q and D/Q modeling

Along with updating the ODCM with X/Q and D/Q values using 2010-2014 meteorological data, there were some changes to the XOQDOQ modeling setup based on interpretations of Regulatory Guide 1.111 and NUREG/CRC-2919. The most notable of these changes was to increase the number of wind speed classes from 7 to 13, concentrating more classes for lower wind speeds.

Wind speed classes:

Previous:	**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 land use census. The open-terrain recirculation factors were applied within the model.

Tables A-1 through A-4

X/Q and D/Q Values for Routine Ground Level Releases (Special Receptor Locations)

Model: XOQDOQ – SHNP 10 meter Meteorological Data, 2010-2014

Corrected using Standard Open-Terrain factors

Type of Receptor	Direction From Site	Distance (miles)	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 radioiodine's, particulates, and tritium to show compliance with ODCM Operational Requirement 3.11.2.1.b and Appendix I of 10CFR50 for gaseous effluents. These dose parameters, P_i and R_i, were calculated using the methodology outlined in NUREG 0133 along with Regulatory Guide 1.109, Revision 1. The following sections provide the specific methodology which was utilized in calculating the P_i and R_i values for the various exposure pathways (Tables 3.2-4 and 3.3-1 through 3.3-19, respectively).

B.1 Calculation of P_i

The dose parameter, P_i, contained in the radioiodine and particulates portion of Section 3.2 includes only the inhalation pathway transport parameter of the "i" radionuclide, the receptor's usage of the pathway media, and the dosimetry of the exposure. Inhalation rates and the internal dosimetry are functions of the receptor's age; however, under the exposure conditions for ODCM Operational Requirement 3.11.2.1b, the child is considered to receive the highest dose. The following sections provide in detail the methodology which was used in calculating the P_i values for inclusion into this ODCM.

The age group considered is the child because the bases for the ODCM Operational Requirement 3.11.2.1.b is to restrict the dose to the child's thyroid via inhalation to ≤ 1500 mrem/yr. The child's breathing rate is taken as 3700 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

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

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:

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

B.2 Calculation of R_i

The basis for ODCM Operational Requirement 3.11.2.3 states that conformance with the guidance in Appendix I should be shown by calculational procedures based on models and data such that the actual exposure of a member of the public through appropriate pathways is unlikely to be substantially underestimated. Underestimation of the dose can be avoided by assigning a theoretical individual to the exclusion boundary in the sector with the highest X/Q and D/Q values and employing all of the likely exposure pathways, e.g., inhalation, cow milk, meat, vegetation, and ground plane. R_i values have been calculated for the adult, teen, child, and infant age groups for the inhalation, ground plane, cow milk, goat milk, vegetable, and beef ingestion pathways. The methodology which was utilized to calculate these values is presented below.

B.2.1 Inhalation Pathway

The dose factor from the inhalation pathway is calculated by:

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

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:

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

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 radioiodine's, the value of I_i may vary. However, a value of 1.0 was used in calculating the R values in Table 3.3-2. (Reference NUREG 0133)

B.2.3 Grass Cow or Goat Milk Pathway

The dose factor for the cow milk or goat milk pathway for each radionuclide for each organ is calculated by:

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

$$\left. (1 - f_p f_s) \left(\frac{r(1 - e^{-\lambda_{E_i} t_e})}{Y_s \lambda_{E_i}} + \frac{B_{iv} (1 - e^{-\lambda_i t_b})}{P \lambda_i} \right) e^{-\lambda_i t_h} \right)$$

(B.2-3)

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 radioiodine's, the value of I_i may vary. However, a value of 1.0 was used in calculating the R values in Tables 3.3-8 through 3.3-15. (Reference NUREG 0133)

Milk cattle and goats are considered to be fed from two potential sources, pasture grass and stored feeds. Following the development in Regulatory Guide 1.109, Revision 1, the value of f_s was considered unity in lieu of site-specific information. The value of f_p was 0.667 based upon an 8-month grazing period.

Table B-1 contains the appropriate parameter values and their source in Regulatory Guide 1.109, Revision

B.2.3 Grass Cow or Goat Milk Pathway (continued)

The concentration of tritium in milk is based on the airborne concentration rather than the deposition. Therefore, the R_i is based on X/Q:

$$R_{T_M} = K'K'''F_mQ_FU_{ap}(DFL_i)_a\ 0.75(0.5/H) \qquad \text{(B.2-4)}$$

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:

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

(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 radioiodine's, the value of I_i may vary. However, a value of 1.0 was used in calculating the R values in Tables 3.3-5 through 3.3-7.

All other terms remain the same as defined in Equation B.2-3. Table B-2 contains the values which were used in calculating R_i for the meat pathway.

The concentration of tritium in meat is based on its airborne concentration rather than the deposition. Therefore, the R_i is based on X/Q.

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

where:

R_{T_B} = Dose factor for the meat ingestion pathway for tritium for any organ of interest, mrem/yr per μCi/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_{iV}	=	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_a^S	=	The consumption rate of stored vegetation by the receptor in age group "a," kg/yr;
f_L	=	The fraction of the annual intake of fresh leafy vegetation grown locally;
	=	1.0
f_g	=	The fraction of annual intake of stored vegetation grown locally;
	=	0.76
t_L	=	The average time between harvest of leafy vegetation and its consumption, sec;
t_h	=	The average time between harvest of stored vegetation and its consumption, sec;
Y_v	=	The vegetation a real density, kg/m^2;
t_e	=	Period of leafy vegetable exposure during growing season, sec;
I_i	=	Factor to account for fractional deposition of radionuclide "i."

All other factors as previously defined.

B.2.5 Vegetation Pathway (continued)

For radionuclides other than iodine, the factor I_i is equal to one. For radioiodine's, the value of I_i may vary. However, a value of 1.0 was used in Tables 3.3-2 through 3.3-4.

Table B-3 presents the appropriate parameter values and their source in Regulatory Guide 1.109, Revision 1.

In lieu of site-specific data default values for f_L and f_g, 1.0 and 0.76, respectively, were used in the calculations on R_i. These values were obtained from Table E-15 of Regulatory Guide 1.109, Revision 1.

The concentration of tritium in vegetation is based on the airborne concentration rather than the deposition. Therefore, the R_i is based on X/Q:

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

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 (radioiodine's) 0.2 (particulates)	Table E-15 Table E-15
$(DFL_i)_a$ (mrem/pCi)	Each radionuclide	Table E-11 to E-14
F_m (pCi/liter per pCi/day)	Each stable element	Table E-1 (cow) Table E-2 (goat)
T_b (seconds)	4.75 E+08 (15 yr)	Table E-15
Y_s (kr/m^2)	2.0	Table E-15
t_h (seconds)	7.78 E+06 (90 days)	Table E-15
U_{ap} (liters/yr)	330 infant 330 child 400 teen 310 adult	Table E-5 Table E-5 Table E-5 Table E-5
t_e (seconds)	2.59 E+06 (pasture) 5.18 E+06 (stored feed)	Table E-15
B_{iv} (pCi/kg [wet weight] per pCi/kg [dry soil])	Each stable element	Table E-1
P (kg dry soil/m^2)	240	Table E-15

TABLE B-2

Parameters For The Meat Pathway

Parameter	Value	Reference (Reg. Guide 1.109, Rev. 1)
r	1.0 (radioiodine's) 0.2 (particulates)	Table E-15 Table E-15
F_f (pCi/ke per (pCi/Day)	Each stable element	Table E-1
U_{ap} (kg/yr)	0 infant 41 child 65 teen 110 adult	Table E-5 Table E-5 Table E-5 Table E-5
$(DFL_i)_a$ (mrem/pCi)	Each radionuclide	Tables E-11 to E-14
Y_p (kg/m^2)	0.7	Table E-15
Y_s (kr/m^2)	2.0	Table E-15
T_b (seconds)	4.73 E+08 (15 yr)	Table E-15
T_s (seconds)	1.73 E+06 (20 days)	Table E-15
t_h (seconds)	7.78 E+06 (90 days)	Table E-15
t_e (seconds)	2.59 E+06 (pasture) 5.18 E+06 (stored feed)	Table E-15
Q_F (kg/day)	50	Table E-3
B_{iv} (pCi/kg [wet weight] per pCi/kg [dry soil])	Each stable element	Table E-1
P (kg dry soil/m^2	240	Table E-15

TABLE B-3

Parameters for The Vegetable Pathway

Parameter	Value	Reference (Reg. Guide 1.109, Rev. 1)
r (dimensionless)	1.0 (radioiodine's) 0.2 (particulates)	Table E-1 Table E-1
$(DFL_i)_a$ (mrem/pCi)	Each radionuclide	Tables E-11 to E-14
Q_F (kg/day)	50 (cow) 6 (goat)	Table E-3 Table E-3
U^L_a (kg/yr) - Infant - Child - Teen - Adult	0 26 42 64	Table E-5 Table E-5 Table E-5 Table E-5
U^S_a (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

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* 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 CALIBRATION	DIGITAL CHANNEL OPERATIONAL TEST
1. Radioactivity Monitors Providing Alarm and Automatic Termination of Release				
a. Liquid Radwaste Effluent Lines				
1) Treated Laundry and Hot Shower Tanks Discharge Monitor	D	P	R(3)	Q(1)
2) Waste Monitor Tanks and Waste Evaporator Condensate Tanks Discharge Monitor	D	P	R(3)	Q(1)
3) Secondary Waste Sample Tank Discharge Monitor	D	P, M(5)	R(3)	Q(1)
b. Turbine Building Floor Drains Effluent Line	D	M	R(3)	Q(1)
2. Radioactivity Monitor Providing Alarm and Automatic Stop Signal to Discharge Pump				
a. Outdoor Tank Area Drain Transfer Pump Monitor	D	M	R(3)	Q(1)
3. Radioactivity Monitors Providing Alarm But Not Providing Automatic Termination of Release				
a. Normal Service Water System Return From Waste Processing Building to the Circulating Water System	D	M	R(3)	Q(2)
b. Normal Service Water System Return From the Reactor Auxiliary Building to the Circulating Water System	D	M	R(3)	Q(2)
4. Flow Rate Measurement Devices				
a. Liquid Radwaste Effluent Lines				
1) Treated Laundry and Hot Shower Tanks Discharge	D(4)	N.A.	R	N.A.
2) Waste Monitor Tanks and Waste Evaporator Condensate Tanks Discharge	D(4)	N.A.	R	N.A.
3) Secondary Waste Sample Tank Pump Monitor	D(4)	N.A.	R	N.A.
b. Cooling Tower Blowdown	D(4)	N.A.	R	N.A.

* See Table G-1 for explanation of frequency notation

TABLE 4.3-8 (Continued)

TABLE NOTATIONS

(1) The DIGITAL CHANNEL OPERATIONAL TEST shall also demonstrate automatic isolation of this pathway (or, for the Outdoor Tank Area Drains Monitor, automatic stop signal to the discharge pump) and control room alarm annunciation* occur if any of the following conditions exists (liquid activity channel only):

a. Instrument indicates measured levels above the Alarm/Trip Setpoint,

b. Circuit failure (monitor loss of communications (alarm only), detector loss of counts (Alarm only) and monitor loss of power),

c. Detector check source test failure (alarm only),

d. Detector channel out of service (alarm only),

e. Monitor loss of sample flow (alarm only). (Not applicable for Turbine Building Drain Rad Monitor)

(2) The DIGITAL CHANNEL OPERATIONAL TEST shall also demonstrate that control room alarm annunciation* occurs if any of the following conditions exists (liquid activity channel only):

a. Instrument indicates measured levels above the Alarm Setpoint,

b. Circuit failure (monitor loss of communications, detector loss of counts, and monitor loss of power),

c. Detector check source test failure,

d. Detector channel out of service,

e. Monitor loss of sample flow.

(3) The initial CHANNEL CALIBRATION shall be performed using one or more of the reference standards certified by the National Bureau of Standards (NBS) or using standards that have been obtained from suppliers that participate in measurement assurance activities with NBS. These standards shall permit calibrating the system over its intended range of energy and measurement range. For subsequent CHANNEL CALIBRATION, sources that have been related to the initial calibration shall be used.

(4) CHANNEL CHECK shall consist of verifying indication of flow during periods of release. CHANNEL CHECK shall be made at least once per 24 hours on days on which continuous, periodic, or batch releases are made.

(5) When the Secondary Waste System is being used in the batch release mode, the source check shall be prior to release. When the system is being used in the continuous release mode, the source check shall be monthly.

*Control Room Alarm Annunciation shall consist of a change in state of the tested channel on the RM-11 terminal (i.e., a change in color) or a highlighted message on the DICSP Workstation Channel.

3/4.3.3 MONITORING INSTRUMENTATION

3/4.3.3.11 Radioactive Gaseous Effluent Monitoring Instrumentation

OPERATIONAL REQUIREMENT

3.3.3.11 The radioactive gaseous effluent monitoring instrumentation channels shown in Table 3.3-13 shall be OPERABLE with their Alarm/Trip Setpoints set to ensure that the limits of Operational Requirements 3.11.2.1 are not exceeded. The Alarm/Trip Setpoints of these channels meeting Operational Requirement 3.11.2.1 shall be determined and adjusted in accordance with the methodology and parameters in the ODCM.

APPLICABILITY: As shown in Table 3.3-13

ACTION:

a. With a radioactive gaseous effluent monitoring instrumentation channel Alarm/Trip Setpoint less conservative than required by the above Operational Requirement, immediately (1) suspend the release of radioactive gaseous effluents monitored by the affected channel or (2) declare the channel inoperable and take ACTION as directed by b. below.

b. With the number of OPERABLE radioactive gaseous effluent monitoring instrumentation channels less than the Minimum Channels OPERABLE, take the ACTION shown in Table 3.3-13. Exert best efforts to return the instrument to OPERABLE status within 30 days. If unsuccessful, explain in the next Annual Radioactive Effluent Release Report pursuant to ODCM, Appendix F, Section F.2 why this inoperability was not corrected in a timely manner.

SURVEILLANCE REQUIREMENTS

4.3.3.11 Each radioactive gaseous effluent monitoring instrumentation channel shall be demonstrated OPERABLE by performance of the CHANNEL CHECK, SOURCE CHECK, CHANNEL CALIBRATION and a DIGITAL CHANNEL OPERATIONAL TEST or an ANALOG CHANNEL OPERATIONAL TEST at the frequencies shown in Table 4.3-9.

Each Surveillance Requirement shall be performed within the specified surveillance interval with a maximum allowable extension not to exceed 25% of the specified surveillance interval.

TABLE 3.3-13
RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENT		MIN. CHANNELS OPERABLE	APPLICABILITY	ACTION
1.	GASEOUS WASTE PROCESSING SYSTEM - HYDROGEN AND OXYGEN ANALYZERS			
	Specification is not used in ODCM			
2.	TURBINE BUILDING VENT STACK			
a.	Noble Gas Activity Monitor	1	*	47
b.	Iodine Sampler	1	*	49
c.	Particulate Sampler	1	*	49
d.	Flow Rate Monitor	1	*	46
e.	Sampler Flow Rate Monitor	1	*	46
3.	PLANT VENT STACK			
a.	Noble Gas Activity Monitor	1	*	47
b.	Iodine Sampler	1	*	49
c.	Particulate Sampler	1	*	49
d.	Flow Rate Monitor	1	*	46
e.	Sampler Flow Rate Monitor	1	*	46
4.	WASTE PROCESSING BUILDING VENT STACK 5			
a.1	Noble Gas Activity Monitor (PIG)	1	*	45, 51
a.2	Noble Gas Activity Monitor (WRGM)	1	MODES 1, 2, 3	52
b.	Iodine Sampler	1	*	49
c.	Particulate Sampler	1	*	49
d.	Flow Rate Monitor	1	*	46
e.	Sampler Flow Rate Monitor	1	*	46
5.	WASTE PROCESSING BUILDING STACK 5A			
a.	Noble Gas Activity Monitor	1	*	47
b.	Iodine Sampler	1	*	49
c.	Particulate Sampler	1	*	49
d.	Flow Rate Monitor	1	*	46
e.	Sampler Flow Rate Monitor	1	*	46

TABLE NOTATIONS
* At all times.

TABLE 3.3-13 (Continued)

ACTION STATEMENTS

ACTION 45 - With the number channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, the contents of the waste gas decay tank(s) may be released to the environment provided that prior to initiating the release:

a. At least two independent samples of the tank's contents are analyzed, and

b. At least two technically qualified members of the facility staff independently verify the release rate calculations and discharge valve lineup.

Otherwise, suspend release of radioactive effluents via this pathway.

ACTION 46 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided the flow rate is estimated at least once per 4 hours.

ACTION 47 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided grab samples are taken at least once per 12 hours and these samples are analyzed for radioactivity within 24 hours.

ACTION 48 - Not Used in the ODCM.

ACTION 49 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via the affected pathway may continue provided samples are continuously collected with auxiliary sampling equipment as required in Table 4.11-2.

ACTION 50 - Not used in the ODCM.

ACTION 51 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement for both the PIG and WRGM, effluent releases via this pathway may continue provided grab samples are taken at least once per 12 hours and these samples are analyzed for radioactivity within 24 hours.

ACTION 52 - With the number of OPERABLE accident monitoring instrumentation channels for the radiation monitor(s) less than the Minimum Channels OPERABLE requirements of Technical Specification Table 3.3-10, initiate the preplanned alternate method of monitoring the appropriate parameter(s) within 72 hours, and either restore the inoperable channel(s) to OPERABLE status within 14 days or prepare and submit a Special Report to the Commission, pursuant to Technical Specification 6.9.2, within the next 14 days that provides actions taken, cause of the inoperability, and the plans and schedule for restoring the channel(s) to OPERABLE status.

TABLE 4.3-9

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION
SURVEILLANCE REQUIREMENTS**

INSTRUMENT	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	DIGITAL CHANNEL OPERATIONAL TEST	MODES FOR WHICH SURVEILLANCE IS REQUIRED
1. GASEOUS WASTE PROCESSING SYSTEM - HYDROGEN AND OXYGEN ANALYZERS					
Not Used in the ODCM.					
2. TURBINE BUILDING VENT STACK					
a. Noble Gas Activity	D	M	R(3)	Q(2)	*
b. Iodine Sampler	N.A.	N.A.	N.A.	N.A.	*
c. Particulate Sampler	N.A.	N.A.	N.A.	N.A.	*
d. Flow Rate Monitor	D	N.A.	R	Q	*
e. Sampler Flow Rate Monitor	D	N.A.	R	Q	*
3. PLANT VENT STACK					
a. Noble Gas Activity Monitor	D	M	R(3)	Q(2)	*
b. Iodine Sampler	N.A.	N.A.	N.A.	N.A.	*
c. Particulate Sampler	N.A.	N.A.	N.A.	N.A.	*
d. Flow Rate Monitor	D	N.A.	R	Q	*
e. Sampler Flow Rate Monitor	D	N.A.	R	Q	*
4. WASTE PROCESSING BUILDING VENT STACK 5					
a.1 Noble Gas Activity Monitor (PIG)	D	M	R(3)	Q(1)	*
a.2 Noble Gas Activity Monitor (WRGM)	D	M	R(3)	Q(2)	*
b. Iodine Sampler	N.A.	N.A.	N.A.	N.A.	*
c. Particulate Sampler	N.A.	N.A.	N.A.	N.A.	*
d. Flow Rate Monitor	D	N.A.	R	Q	*
e. Sampler Flow Rate Monitor	D	N.A.	R	Q	*
5. WASTE PROCESSING BUILDING VENT STACK 5A					
a. Noble Gas Activity Monitor	D	M	R(3)	Q(2)	*
b. Iodine Sampler	N.A.	N.A.	N.A.	N.A.	*
c. Particulate Sampler	N.A.	N.A.	N.A.	N.A.	*
d. Flow Rate Monitor	D	N.A.	R	Q	*
e. Sampler Flow Rate Monitor	D	N.A.	R	Q	*

* At all times.
** See Table G-1 for explanation of frequency notation

ABLE 4.3-9 (Continued)

TABLE NOTATIONS

(1) The DIGITAL CHANNEL OPERATIONAL TEST shall also demonstrate that automatic isolation of this pathway and control room annunciation* occur if any of the following conditions exists (gas activity and gas effluent channels only):

a. Instrument indicates measured levels above the Alarm/Trip Setpoint,

b. Circuit failure (monitor loss of communications - (alarm only), detector loss of counts (alarm only) and monitor loss of power),

c. Detector check source test failure (gas activity channel only), (alarm only),

d. Detector channel out of service (alarm only),

e. Monitor loss of sample flow (alarm only).

(2) The DIGITAL CHANNEL OPERATIONAL TEST shall also demonstrate that control room alarm annunciation* occurs if any of the following conditions exists (gas activity and gas effluent channels only):

a. Instrument indicates measured levels above the Alarm Setpoint,

b. Circuit failure (monitor loss of communications (alarm only), detector loss of counts, and monitor loss of power),

c. Detector check source test failure (gas activity channel only),

d. Detector channel out of service,

e. Monitor loss of sample flow.

(3) The initial CHANNEL CALIBRATION shall be performed using one or more of the reference standards certified by the National Bureau of Standards (NBS) or using standards that have been obtained from suppliers that participate in measurement assurance activities with NBS. These standards shall permit calibrating the system over its intended range of energy and measurement range. For subsequent CHANNEL CALIBRATION, sources that have been related to the initial calibration shall be used.

(4) Not used in the ODCM.

(5) Not used in the ODCM.

*Control Room Alarm Annunciation shall consist of a change in state of the tested channel on the RM-11 terminal (i.e., a change in color) or a highlighted message on the DICSP Workstation Channel.

D.2 RADIOACTIVE EFFLUENTS

3/4.11.1 LIQUID EFFLUENTS

3/4.11.1.1 Concentration

OPERATIONAL REQUIREMENT

3.11.1.1 The concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS (see Technical Specification Figure 5.1-3) shall be limited to 10 times the concentrations specified in 10 CFR Part 20.1001 - 20.2401, Appendix B, Table 2, Column 2 for radionuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the concentration shall be limited to 2E-04 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 non-discrete volume, e.g., from a volume of a system that has an input flow during the continuous release.

(6) To be representative of the quantities and concentrations of radioactive materials in liquid effluents, samples shall be collected continuously in proportion to the rate of flow of the effluent stream. Prior to analyses, all samples taken for the composite shall be thoroughly mixed in order for the composite sample to be representative of the effluent release.

(7) These points monitor potential release pathways only and not actual release pathways. The potential contamination points are in the Normal Service Water (NSW) and Secondary Waste (SW) Systems. Action under this Operational Requirement is as follows:

a) If the applicable (NSW or SW) monitors in Table 3.3-12 are OPERABLE and not in alarm, then no analysis under this Operational Requirement is required but weekly composites will be collected.

b) If the applicable monitor is out of service, then the weekly analysis for principal gamma emitters will be performed.

c) If the applicable monitor is in alarm or if the principal gamma emitter analysis indicates the presence of radioactivity as defined in the ODCM, then all other analyses of this Operational Requirement shall be performed at the indicated frequency as long as the initiating conditions exist.

(8) The Secondary Waste System releases can be either batch or continuous. The type of sample required is determined by the mode of operation being used.

3/4.11.1 LIQUID EFFLUENTS

3/4.11.1.2 Dose

OPERATIONAL REQUIREMENT

3.11.1.2 The dose or dose commitment to a MEMBER OF THE PUBLIC from radioactive materials in liquid effluents released to UNRESTRICTED AREAS (see Technical Specification Figure 5.1-3) shall be limited:

a. During any calendar quarter to less than or equal to 1.5 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.

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* One map shall cover stations near the EXCLUSION AREA BOUNDARY; a second shall include the more distant station.

F.2 Annual Radioactive Effluent Release Report
(Formerly part of Specification 6.9.1.4)

Routine Annual Radioactive Effluent Release Report covering the operation of the unit during the previous 12 months of operation shall be submitted by May 1 of each year. The period of the first report shall begin with the date of initial criticality.

The Annual Radioactive Effluent Release Report shall include a summary of the quantities of radioactive liquid and gaseous effluents released from the unit as outlined in Regulatory Guide 1.21, "Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants," Revision 1, June 1974, with data summarized on a quarterly basis following the format of Appendix B thereof.

The Annual Radioactive Effluent Release Report shall include an annual summary of hourly meteorological data collected over the previous year. This annual summary may be either in the form of an hour-by-hour listing on magnetic tape of wind speed, wind direction, atmospheric stability, and precipitation (if measured), or in the form of joint frequency distributions of wind speed, wind direction, and atmospheric stability.** This report shall include an assessment of the radiation doses due to the radioactive liquid and gaseous effluents released from the unit or station during the previous calendar year. For the assessment of radiation doses, approximate and conservative methods are acceptable. The assessment of radiation doses shall be performed in accordance with the methodology and parameters in the Offsite Dose Calculation Manual (ODCM).

The Annual Radioactive Effluent Release Report shall also include an assessment of radiation doses to the likely most exposed MEMBER OF THE PUBLIC from reactor releases and other nearby uranium fuel cycle sources, including doses from primary effluent pathways and direct radiation, for the previous calendar year to show conformance with 40 CFR Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operation."

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

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

The Annual Radioactive Effluent Release Report shall include any changes made during the reporting period to the ODCM, pursuant to Technical Specification 6.14, as well as any major change to Liquid and Gaseous Radwaste Treatment Systems pursuant to ODCM, Appendix F, Section F.3. It shall also include a listing of new locations for dose calculations and/or environmental monitoring identified by the Land Use Census pursuant to Operational Requirement 3.12.2.

The Annual Radioactive Effluent Release Report shall also include the following: an explanation as to why the inoperability of liquid or gaseous effluent monitoring instrumentation was not corrected within the time specified in Operational Requirement 3.3.3.10 or 3.3.3.11, respectively; and a description of the events leading to liquid holdup tanks or gas storage tanks exceeding the limits of Technical Specifications or PLP-114.

The Annual Radioactive Effluent Release Report shall include any dose calculations that were performed as a result of a spill or leak from the site that occurred during the reporting period. The Annual Radioactive Effluent Release Report shall include a summary of any on-site spills and leaks that occurred during the reporting period that are communicated IAW the NEI Voluntary Groundwater Initiative.

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

F.3 Major Changes to Liquid and Gaseous Radwaste Treatment Systems*
(Formerly part of Specification 6.15)

Licensee-initiated major changes to the Radwaste Treatment Systems (liquid and gaseous):

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

1. A summary of the evaluation that led to the determination that the change could be made in accordance with 10 CFR 50.59.

2. Sufficient detailed information to totally support the reason for the change without benefit of additional or supplemental information.

3. A detailed description of the equipment, components, and processes involved and the interfaces with other plant systems.

4. An evaluation of the change, which shows the predicted releases of radioactive materials in liquid and gaseous effluents that differ from those previously predicted in the License application and amendments thereto.

5. An evaluation of the change, which shows the expected maximum exposures, to a MEMBER OF THE PUBLIC in the UNRESTRICTED AREA and to the general population, that differ from those previously estimated in the License application and amendments thereto.

6. A comparison of the predicted releases of radioactive materials in liquid and gaseous effluents to the actual releases for the period prior to when the change is to be made.

7. An estimate of the exposure to plant operating personnel as a result of the change.

8. Documentation of the fact that the change was reviewed and found acceptable by the ORC.

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

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* 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.

<u>DEFINITIONS</u> (continued)

LIQUID WASTE PROCESSING SYSTEM

A LIQUID WASTE PROCESSING SYSTEM provides for the collection, storing, processing, and controlled release of radioactive and potentially radioactive liquids. The system is considered fully utilized when the Modular Fluidized Transfer Demineralization System (MFTDS) is used for the purpose of reducing the total radioactivity prior to release to the environment. Some of the original processing equipment and evaporators have been removed from service but descriptions are still maintained to allow for future reactivation.

MEMBER(S) OF THE PUBLIC

MEMBER(S) OF THE PUBLIC shall include all persons who are not occupationally associated with the plant. This category does not include employees of the licensee, its contractors, or vendors. Also excluded from this category are persons who enter the site to service equipment or to make deliveries. This category does include persons who use portions of the site for recreational, occupational, or other purposes not associated with the plant.

OFFSITE DOSE CALCULATION MANUAL

The OFFSITE DOSE CALCULATION MANUAL (ODCM) shall contain the methodology and parameters used in the calculation of offsite doses due to radioactive gaseous and liquid effluents, in the calculation of gaseous and liquid effluent monitoring Alarm/Trip Setpoints, and in the conduct of the Environmental Radiological Monitoring Program.

OPERABLE - OPERABILITY

A system, subsystem, train, component or device shall be OPERABLE or have OPERABILITY when it is capable of performing its specified function(s),and when all necessary attendant instrumentation, controls, electrical power, cooling or seal water, lubrication or other auxiliary equipment that are required for the system, subsystem, train, component, or device to perform its function(s) are also capable of performing their related support function(s).

OPERATIONAL MODE - MODE

An OPERATIONAL MODE (i.e., MODE) shall correspond to any one inclusive combination of core reactivity condition, power level, and average reactor coolant temperature specified in Table G-2.

PROCESS CONTROL PROGRAM

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

PURGE - PURGING

PURGE or PURGING shall be any controlled process of discharging air or gas from a confinement to maintain temperature, pressure, humidity, concentration or other operating condition, in such a manner that replacement air or gas is required to purify the confinement.

DEFINITIONS (continued)

RELEASE

A RELEASE shall be the discharge of radioactive effluent from the facility in gaseous, particulate or liquid media. Releases can be further categorized for evaluation purposes:

ABNORMAL/UNPLANNED DISCHARGE – Unplanned or uncontrolled emission of licensed radioactive effluent to the unrestricted area. Release may be batch or continuous discharges. Examples: unintentional discharge of a waste gas decay tank, failure of radiation monitor to terminate a release.

ABNORMAL/UNPLANNED RELEASE – Unplanned or uncontrolled release of licensed radioactive material from the plant within the site boundary.

CONTROLLED RELEASE/DISCHARGE – A pre-planned release which can be controlled through component manipulation to assure the discharge was properly accounted, within ODCM limits, and had a pre-planned method of termination or altering the flow rate.

ELEVATED RELEASE – A gaseous effluent release made from a height that is more than twice the height of adjacent solid structures

GROUND-LEVEL RELEASE – A gaseous release made from a height that is at, or less than, the height of adjacent solid structures.

MONITORED RELEASE – A RELEASE which is monitored through installed or portable samplers.

NON-ROUTINE, PLANNED RELEASE/DISCHARGE – An effluent release from a release point that is not defined in the ODCM but that has been planned, monitored, and discharged in accordance with 10 CFR 20.2001.

UNCONTROLLED RELEASE/DISCHARGE – An effluent release that does not meet the definition of a controlled release

SITE BOUNDARY

For these Operational Requirements, the SITE BOUNDARY shall be identical to the EXCLUSION AREA BOUNDARY defined above.

SOLIDIFICATION

SOLIDIFICATION shall be the conversion of wet wastes into a form that meets shipping and burial ground requirements.

SOURCE CHECK

A SOURCE CHECK shall be the qualitative assessment of channel response when the channel sensor is exposed to a source of increased radioactivity.

UNRESTRICTED AREA

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

DEFINITIONS (continued)

VENTILATION EXHAUST TREATMENT SYSTEM

A VENTILATION EXHAUST TREATMENT SYSTEM shall be any system designed and installed to reduce gaseous radioiodine or radioactive material in particulate form in effluents by passing ventilation or vent exhaust gases through charcoal adsorbers and/or HEPA filters for the purpose of removing iodine's or particulates from the gaseous exhaust stream prior to the release to the environment. Such a system is not considered to have any effect on noble gas effluents. Engineered Safety Features Atmospheric Cleanup Systems are not considered to be VENTILATION EXHAUST TREATMENT SYSTEM components.

VENTING

VENTING shall be the controlled process of discharging air or gas from a confinement to maintain temperature, pressure, humidity, concentration, or other operating condition, in such a manner that replacement air or gas is not provided or required during VENTING. Vent, used in system names, does not imply a VENTING process.

TABLE G-1

FREQUENCY NOTATION

NOTATION	FREQUENCY*
S	At least once per 12 hours.
D	At least once per 24 hours.
W	At least once per 7 days.
M	At least once per 31 days.
Q	At least once per 92 days.
SA	At least once per 184 days.
R	At least once per 18 months.
S/U	Prior to each reactor startup.
N.A.	Not applicable.
P	Completed prior to each release.

* Each Surveillance Requirement shall be performed within the specified surveillance interval with a maximum allowable extension not to exceed 25% of the specified surveillance interval.

TABLE G-2

OPERATIONAL MODES

Mode	Reactivity Condition	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.

Shearon Harris Nuclear Power Plant
Unit 1

Process Control Program

Revision 000

REVISION SUMMARY
DRR 2425055 **DESCRIPTION**
PLP-300 superseded to AD-CP-ALL-0030 in Fusion PLP-300 converted to LICN document to align with Duke Energy Nuclear Fleet. AD-CP-ALL-0030, Process Control Program (PCP) Review and Revision added as Procedure reference.

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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 the utmost 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.

3.0 DEFINITIONS (continued)

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

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 lowest requirements of 10CFR61.56(a).

11. **Waste Classification -** The determination of a waste class as outlined in 10CFR61 by radionuclide isotopic analysis 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 <u>General Manager - Harris Plant</u>

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

4.2 <u>Manager - RP</u>

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.

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 / 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 On-Site Review Committee (ORC), approved by the Plant General Manager (Non-Delegated) 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.

2. Changes to the Process Control Program shall become effective after:

   a. Review and acceptance by the Onsite Review Committee (ORC) which was formerly known as the Plant Nuclear Safety Committee. Section 7.3 Miscellaneous Document 8, **[TS 6.13.b]**

   b. Approval by the Plant General Manager (Non-Delegated). Section 7.3 Miscellaneous Document 8**, [TS 6.13.b]**

3. Vendor PCP procedures shall be included in the HNP PCP and are subject to the same review by the ORC as changes to this Program. These procedures are contained in the following Table 1, Vendor Procedures:

Table 1, Vendor Procedures

Vendor Procedure	Vendor Revision Number	Vendor Procedure Title
CS-OP-PR-008	4	Setup And Operation Of Energy Solutions Self-Engaging Dewatering System Fillhead
CS-OP-PR-010	4	Bead Resin/Activated Carbon Dewatering Procedure For Energy Solutions 14-215 Or Smaller Liners, Utilizing Energy Solutions Self-Engaging Dewatering System (S.E.D.S)
FO-AD-002	39	Operating Guidelines For Use Of Polyethylene High Integrity Containers

5.3 General Requirements

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 **NO** 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 or dewatering shall be done by qualified individuals who have completed a solidification or dewatering training and qualification program.

4. If solidification does not 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, or the Solid Waste Processing System to prevent recurrence.

5. If solidification is not 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 Implementation

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/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 as follows:

   a. Review and acceptance by the Onsite Review Committee (ORC) which was formerly known as the Plant Nuclear Safety Committee. Section 7.3 Miscellaneous Document 8 **[TS 6.13.b]**

   b. Approval by the Plant General Manager (Non-Delegated). Section 7.3 Miscellaneous Document 8 **[TS 6.13.b]**

5.5 Waste Streams

1. Radioactive wastes are divided into separate waste stream categories based on scaling factors and characteristics of the waste 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) for addressing 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.

5.6 Vendor Solidification/Dewatering Requirements (continued)

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

e. Detailed procedures for operation of the solidification/dewatering equipment, 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 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 /dewatering of liquid waste. The RP unit is responsible for shipping of solidified and dewatered wastes.

3. Solidification/dewatering shall be done by qualified individuals who have completed a solidification/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/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.

5.6 Vendor Solidification/Dewatering Requirements (continued)

7. **<u>IF</u>** the initial test specimen from a batch of waste fails to verify solidification, **<u>THEN</u>** 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. .... _________

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/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 utmost allowable free liquid in a high integrity container shall be less than one percent of the waste volume.

3. Corrosion and chemical tests to be performed to confirm the suitability of the proposed container. List of prohibited contents shall 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. At the least, the waste pH shall be determined to be within the acceptable range for the HIC.

4. Written procedure 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 need to contain specific storage times. Photosensitive containers shall be kept out of direct sunlight and away from any other sources of ultraviolet radiation.

5.7 High Integrity Containers (continued)

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 as well as 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 shall 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.

5.8 Reporting Of Mishaps (continued)

(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>

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

5.10 <u>Waste Classification 10CFR61.55</u>

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 biennial 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 not be required if the waste stream is not 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.

5.10 Waste Classification 10CFR61.55 (continued)

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. The preference is that resampling not 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 not available. Waste Classification is controlled by AD-RP-ALL-5000, Preparation and Shipment of Radioactive Material and Radioactive Waste.

5.10.2 Radioactive Waste Characteristics 10CFR61.56

1. The eight lowest 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 **<u>NO</u>** case shall the liquid exceed 1% of the volume.

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

    e. Waste must not contain, or be capable of generating:

        (1) Quantities of toxic gases

        (2) Vapors

        (3) 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 the potential hazard from the non-radiological materials within the allowable limits.

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.

5.10.3 Labeling 10CFR61.57

1. Each package of waste shall be clearly labeled to identify the appropriate waste classification per Section 5.6 Step 1.

5.11 10CFR20.2006 Implementation

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

5.12 Shipment Manifest

1. The requirements of 10CFR20.2006 and Appendix F to 20.1001-20.2402 for shipment manifest and record keeping shall be included in AD-RP-ALL-5000, Preparation and Shipment of Radioactive Material and Radioactive Waste.

5.13 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 DUKE-QAPD-001, Duke Energy Corporation Topical Report Quality Assurance Program Description Operating Fleet. 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. AD-DC-ALL-0201, Development and Maintenance of Controlled Procedure Manual Procedures
2. AD-LS-ALL-0019, On Site Review Committee
3. AD-RP-ALL-5000, Preparation and Shipment of Radioactive Material and Radioactive Waste
4. CSD-DC-HNP-0202-01, HNP Specific Approved Abbreviations, Acronyms and Symbols
5. HPP-830, Process Control Program Implementation
6. AD-CP-ALL-0030, Process Control Program (PCP) Review and Revision

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, PCP Energy Solutions Setup & Operation of SEDS Fillhead
4. CS-OP-PR-010, PCP Energy Solutions SEDS Dewatering Bead Resin or Activated Carbon
5. DUKE-QAPD-001, Duke Energy Corporation Topical Report Quality Assurance Program Description Operating Fleet
6. EPRI BTP Implementation Guide 2016 (EPRI Report 3002008189)
7. FO-AD-002, PCP Energy Solutions Operating Guidelines For Use of Polyethylene High Integrity Containers
8. HNP Technical Specification 6.13, Process Control Program

7.3 Miscellaneous Documents (continued)

9. Issuance of Final Branch Technical Position on Concentration Averaging and Encapsulation, Revision in Part to Waste Classification Technical Position - February 2015

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

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

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

13. Technical Position on Waste Form - January 1991

14. 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

15. Energy Solutions Letter of Transmittal (CC#0568, 10/23/18), FO-AD-002, Rev. 39, OPERATING GUIDELINES FOR USE OF POLYETHYLENE HIGH INTEGRITY CONTAINERS.

<< 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, **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.

ENCLOSURE 4: MNS Annual Radioactive Effluent Release Report

McGuire Nuclear Station
Units 1 and 2

Annual Radioactive Effluent Release Report

January 1, 2022 through December 31, 2022

Dockets 50-369 and 50-370

Introduction

The Annual Radioactive Effluent Release Report is pursuant to McGuire Nuclear Station Technical Specification 5.6.3 and Selected Licensee Commitment 16.11.17. The below listed attachments to this report provide the required information. In addition, the ODCM is included pursuant to McGuire Nuclear Station Technical Specification 5.5.1.

Attachment 1	Summary of Gaseous and Liquid Effluents
Attachment 2	Supplemental Information
Attachment 3	Solid Radioactive Waste Disposal
Attachment 4	Meteorological Data
Attachment 5	Unplanned Offsite Releases
Attachment 6	Assessment of Radiation Dose from Radioactive Effluents to Members of the Public
Attachment 7	Information to Support the NEI Ground Water Protection Initiative
Attachment 8	Inoperable Equipment
Attachment 9	Summary of Changes to the Offsite Dose Calculation Manual
Attachment 10	Summary of Changes to the Process Control Program
Attachment 11	Summary of Major Modifications to the Radioactive Waste Treatment Systems
Attachment 12	Errata to a Previous Year's ARERR

Attachment 1
Summary of Gaseous and Liquid Effluents

McGuire Nuclear Station Units 1 & 2
Period 1/1/2022- 12/31/2022

ATTACHMENT 1

Summary of Gaseous and Liquid Effluents

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

Attachment 1
Summary of Gaseous and Liquid Effluents

McGuire Nuclear Station Units 1 & 2
Period 1/1/2022- 12/31/2022

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	6.37E-01	1.07E+00	7.62E-01	7.88E-01	3.26E+00
2. Avg. Release Rate	μCi/sec	8.19E-02	1.36E-01	9.58E-02	9.92E-02	1.03E-01
B. Iodine-131						
1. Total Release	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2. Avg. Release Rate	μCi/sec	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C. Particulates Half-Life ≥ 8 days						
1. Total Release	Ci	0.00E+00	1.37E-05	0.00E+00	0.00E+00	1.37E-05
2. Avg. Release Rate	μCi/sec	0.00E+00	1.74E-06	0.00E+00	0.00E+00	4.33E-07
D. Tritium						
1. Total Release	Ci	1.40E+01	2.68E+01	2.40E+01	2.38E+01	8.86E+01
2. Avg. Release Rate	μCi/sec	1.81E+00	3.41E+00	3.02E+00	2.99E+00	2.81E+00
E. Carbon-14						
1. Total Release	Ci	5.35E+00	4.34E+00	5.54E+00	5.63E+00	2.09E+01
2. Avg. Release Rate	μCi/sec	6.88E-01	5.52E-01	6.96E-01	7.08E-01	6.61E-01
F. Gross Alpha						
1. Total Release	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2. Avg. Release Rate	μCi/sec	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Attachment 1
Summary of Gaseous and Liquid Effluents

McGuire Nuclear Station Units 1 & 2
Period 1/1/2022- 12/31/2022

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. Carbon-14						
N/A	Ci	-	-	-	-	-
F. Gross Alpha						
Total for Period	Ci	-	-	-	-	-

* McGuire Nuclear Station Units 1 and 2 do not have elevated releases.

Attachment 1
Summary of Gaseous and Liquid Effluents

McGuire Nuclear Station Units 1 & 2
Period 1/1/2022- 12/31/2022

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. Carbon-14						
N/A	Ci	-	-	-	-	-
F. Gross Alpha						
Total for Period	Ci	-	-	-	-	-

* McGuire Nuclear Station Units 1 and 2 do not have elevated releases.

Attachment 1
Summary of Gaseous and Liquid Effluents

McGuire Nuclear Station Units 1 & 2
Period 1/1/2022- 12/31/2022

Gaseous Effluents - Ground Releases - Continuous Mode

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Gases						
None	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total for Period	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
B. Iodines						
None	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total for Period	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C. Particulates Half-Life ≥ 8 days						
CO-58	Ci	0.00E+00	8.80E-06	0.00E+00	0.00E+00	8.80E-06
CO-60	Ci	0.00E+00	4.85E-06	0.00E+00	0.00E+00	4.85E-06
Total for Period	Ci	0.00E+00	1.37E-05	0.00E+00	0.00E+00	1.37E-05
D. Tritium						
H-3	Ci	1.40E+01	2.64E+01	2.38E+01	2.37E+01	8.79E+01
E. Carbon-14 *						
C-14	Ci	1.60E+00	1.30E+00	1.66E+00	1.69E+00	6.26E+00
F. Gross Alpha						
Total for Period	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

* 30% of total C-14 released is assumed to be in continuous mode. See Attachment 2, Supplemental Information, of this report.

Attachment 1
Summary of Gaseous and Liquid Effluents

McGuire Nuclear Station Units 1 & 2
Period 1/1/2022- 12/31/2022

Gaseous Effluents - Ground Releases - Batch Mode

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Gases						
AR-41	Ci	5.63E-01	1.01E+00	6.81E-01	7.02E-01	2.95E+00
XE-133	Ci	6.50E-02	5.97E-02	7.51E-02	8.15E-02	2.81E-01
XE-135	Ci	9.30E-03	4.50E-03	5.09E-03	4.71E-03	2.36E-02
Total for Period	Ci	6.37E-01	1.07E+00	7.62E-01	7.88E-01	3.26E+00
B. Iodines						
None	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total for Period	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C. Particulates Half-Life ≥ 8 days	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total for Period	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
D. Tritium						
H-3	Ci	5.40E-02	3.46E-01	1.46E-01	1.09E-01	6.55E-01
E. Carbon-14*						
C-14	Ci	3.74E+00	3.04E+00	3.87E+00	3.94E+00	1.46E+01
F. Gross Alpha Total for Period	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
G. Other	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total for Period	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

* 70% of total C-14 released is assumed to be in batch mode. See Attachment 2, Supplemental Information, of this report.

Attachment 1
Summary of Gaseous and Liquid Effluents

McGuire Nuclear Station Units 1 & 2
Period 1/1/2022- 12/31/2022

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. Carbon-14						
N/A	Ci	-	-	-	-	-
F. Gross Alpha						
Total for Period	Ci	-	-	-	-	-

* McGuire Nuclear Station Units 1 and 2 do not have mixed-mode releases.

Attachment 1
Summary of Gaseous and Liquid Effluents

McGuire Nuclear Station Units 1 & 2
Period 1/1/2022- 12/31/2022

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. Carbon-14						
N/A	Ci	-	-	-	-	-
F. Gross Alpha						
Total for Period	Ci	-	-	-	-	-

* McGuire Nuclear Station Units 1 and 2 do not have mixed-mode releases.

Attachment 1
Summary of Gaseous and Liquid Effluents

McGuire Nuclear Station Units 1 & 2
Period 1/1/2022- 12/31/2022

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	1.73E-02	1.99E-02	1.42E-02	2.25E-02	7.39E-02
2. Avg. Diluted Conc.	μCi/ml	2.04E-11	2.35E-11	1.39E-11	2.37E-11	2.02E-11
3. Batch Releases	μCi/ml	2.04E-11	2.35E-11	1.39E-11	2.37E-11	2.02E-11
B. Tritium						
1. Total Release	Ci	3.04E+02	3.01E+02	2.17E+02	1.99E+02	1.02E+03
2. Avg. Diluted Conc.	μCi/ml	3.57E-07	3.54E-07	2.13E-07	2.09E-07	2.78E-07
3. Batch Releases	μCi/ml	3.57E-07	3.54E-07	2.13E-07	2.09E-07	2.78E-07
C. Dissolved & Entrained Gases						
1. Total Release	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2. Avg. Diluted Conc.	μCi/ml	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
3. Batch Releases	μCi/ml	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
D. Gross Alpha						
1. Total Release	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2. Avg. Diluted Conc.	μCi/ml	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
3. Batch Releases	μCi/ml	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
E. Volume of Liquid Waste						
1. Continuous Releases	liters	6.43E+07	2.57E+08	6.41E+07	5.31E+07	4.38E+08
2. Batch Releases	liters	1.37E+06	1.01E+06	7.85E+05	5.04E+05	3.67E+06
F. Volume of Dilution Water						
1. Continuous Releases	liters	1.35E+12	1.21E+12	9.43E+11	1.15E+12	4.65E+12
2. Batch Releases	liters	8.51E+11	8.48E+11	1.02E+12	9.50E+11	3.67E+12

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

Attachment 1
Summary of Gaseous and Liquid Effluents

McGuire Nuclear Station Units 1 & 2
Period 1/1/2022- 12/31/2022

Liquid Effluents - Continuous Mode

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Products						
None	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total for Period	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
B. Tritium						
H-3	Ci	6.46E-02	7.79E-01	1.83E-01	2.30E-01	1.26E+00
C. Dissolved & Entrained Gases						
None	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total for Period	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
D. Gross Alpha						
Total for Period	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Attachment 1
Summary of Gaseous and Liquid Effluents

McGuire Nuclear Station Units 1 & 2
Period 1/1/2022- 12/31/2022

Liquid Effluents - Batch Mode

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Products						
Br-82	Ci	7.89E-07	0.00E+00	0.00E+00	0.00E+00	7.89E-07
Co-57	Ci	6.70E-06	0.00E+00	0.00E+00	0.00E+00	6.70E-06
Co-58	Ci	1.52E-03	2.22E-03	1.68E-03	6.08E-04	6.02E-03
Co-60	Ci	4.85E-03	2.57E-03	2.94E-03	1.53E-02	2.57E-02
Cr-51	Ci	0.00E+00	9.41E-06	0.00E+00	0.00E+00	9.41E-06
Cs-137	Ci	5.37E-04	3.62E-04	3.10E-04	2.31E-05	1.23E-03
Fe-55	Ci	2.39E-04	5.30E-05	5.65E-04	1.26E-03	2.11E-03
Mn-54	Ci	3.72E-04	1.41E-04	1.42E-04	6.24E-04	1.28E-03
Nb-95	Ci	5.52E-06	7.55E-06	4.97E-06	6.97E-05	8.77E-05
Ni-63	Ci	6.89E-03	3.61E-03	2.31E-03	1.63E-03	1.44E-02
Sb-124	Ci	3.39E-05	1.18E-04	2.71E-05	1.82E-05	1.98E-04
Sb-125	Ci	2.86E-03	1.08E-02	6.24E-03	2.97E-03	2.28E-02
Sr-90	Ci	0.00E+00	3.38E-05	0.00E+00	0.00E+00	3.38E-05
Zn-65	Ci	0.00E+00	0.00E+00	0.00E+00	1.88E-05	1.88E-05
Zr-95	Ci	0.00E+00	8.03E-06	0.00E+00	0.00E+00	8.03E-06
Total for Period	Ci	1.73E-02	1.99E-02	1.42E-02	2.25E-02	7.39E-02
B. Tritium						
H-3	Ci	3.04E+02	3.00E+02	2.17E+02	1.99E+02	1.02E+03
C. Dissolved & Entrained Gases						
None	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total for Period	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
D. Gross Alpha						
Total for Period	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

ATTACHMENT 2

Supplemental Information

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

Attachment 2
Supplemental Information

McGuire Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

I. Regulatory Limits - Per Unit

A. Noble Gases - Air Dose

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

B. Liquid Effluents - Dose

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

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

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

II. Maximum Permissible Effluent Concentrations

A. Gaseous Effluents

1. Information found in Offsite Dose Calculation Manual

B. Liquid Effluents

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

III. Average Energy

(not applicable)

IV. Measurements and Approximations of Total Radioactivity

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

V. Batch Releases

A. Liquid Effluents

1.	Total Number of Batch Releases	=	168
2.	Total Time (min) for Batch Releases	=	1.30E+05
3.	Maximum Time (min) for a Batch Release	=	3.91E+04
4.	Average Time (min) for Batch Releases	=	7.72E+02
5.	Minimum Time (min) for a Batch Release	=	1.80E+01
6.	Average Dilution Water Flow During Release (lpm)	=	1.84E+06

B. Gaseous Effluents

1.	Total Number of Batch Releases	=	30
2.	Total Time (min) for Batch Releases	=	1.04E+06
3.	Maximum Time (min) for a Batch Release	=	4.46E+04
4.	Average Time (min) for Batch Releases	=	3.48E+04
5.	Minimum Time (min) for a Batch Release	=	2.00E+02

VI. Abnormal Releases

See Attachment 5, Unplanned Offsite Releases.

Carbon-14

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

In Regulatory Guide 1.21, Revision 2, “Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste”, the NRC recommends U.S. nuclear power plants evaluate whether C-14 is a "principal radionuclide", and if so, report the amount of C-14 released. Improvements over the years in effluent management practices and fuel performance have resulted in a decrease in gaseous radionuclide (non-C-14) concentrations, and a change in the distribution of gaseous radionuclides released to the environment. As a result, many sites show C-14 has become a "principal radionuclide" for the gaseous effluent pathway, as defined in Regulatory Guide 1.21, Rev. 2. McGuire Nuclear Station 2022 ARERR contains estimates of C-14 radioactivity released in 2022, and estimates of public dose resulting from the C-14 effluent.

Because the dose contribution of C-14 from liquid radioactive waste is much less than that contributed by gaseous radioactive waste, evaluation of C-14 in liquid radioactive waste is not required (Ref. Reg. Guide 1.21, Rev. 2). The quantity of gaseous C-14 released to the environment can be estimated by use of a C-14 source term scaling factor based on power generation (Ref. Reg. Guide 1.21, Rev. 2). Many documents provide information related to the magnitude of C-14 in typical effluents from commercial nuclear power plants. Those documents suggest that nominal annual releases of C-14 in gaseous effluents are approximately 5 to 7.3 curies from PWRs (Ref. Reg. Guide 1.21, Rev. 2). A more recent study recommends a higher C-14 gaseous source term scaling factor of approximately 9.0 to 9.8 Ci/GWe-yr for a PWR (Westinghouse) (Ref. EPRI 1021106). For the McGuire Nuclear Station 2020 ARERR a source term scaling factor of 9.4 Ci/GWe-yr is assumed. Using a source term scaling factor of 9.4 Ci/GWe-yr and actual electric generation (MWe-hrs) from McGuire Nuclear Station in 2020 results in a site total C-14 gaseous release estimate to the environment of 2.101+01 Curies. 70% of the C-14 gaseous effluent is assumed to be from batch releases and 30% of C-14 gaseous effluent is assumed to be from continuous releases through the unit vents (ref. IAEA Technical Reports Series no. 421, "Management of Waste Containing Tritium and Carbon-14", 2004; EPRI 1021106).

C-14 releases in PWRs occur primarily as a mix of organic carbon and carbon dioxide released from the waste gas system. Since the PWR operates with a reducing chemistry, most, if not all, of the C-14 species initially produced are organic (e.g., methane). As a general rule, C-14 in the primary coolant is essentially all organic with a large fraction as a gaseous species. Any time the RCS liquid or gas is exposed to an oxidizing environment (e.g. during shutdown or refueling), a slow transformation from an organic to an inorganic chemical form can occur. Various studies documenting measured C-14 releases from PWRs suggest a range of 70% to 95% organic with an average of 80% organic with the remainder being CO_2 (Ref. EPRI TR-105715). For the McGuire Nuclear Station 2022 ARERR a value of 80% organic C-14 is assumed.

Public dose estimates from airborne C-14 are performed using dose models in NUREG-0133 and Regulatory Guide 1.109. The dose models and assumptions used are documented in the McGuire ODCM. The estimated C-14 dose impact on the maximum organ dose from airborne effluents released from McGuire Nuclear Station in 2022 is well below the 10CFR50, Appendix I, ALARA design objective (i.e., 15 mrem/yr per unit).

Attachment 2
Supplemental Information

McGuire Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

Overall Estimate of Error for Effluent Radioactivity Release Reported

The estimated percentage of overall error for both Liquid and Gaseous effluent release data at McGuire Nuclear Station has been determined to be ± 30.3%. This value was derived by taking the square root of the sum of the squares of the following discrete individual estimates of error:

1. Flow Rate Determining Devices = ± 20%
2. Counting Statistical Error = ± 20%
3. Calibration Error = ± 10%
4. Calibration Source Error = ± 2.5%
5. Sample Preparation Error = ± 3%

Attachment 2
Supplemental Information

McGuire Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

Summary of Changes in Land Use Census Affecting Effluent Dose Calculations

The 2022 Land Use Census was performed May 24-26, 2022, and the results were certified and made available for use on June 20, 2022. The following are changes to residences, gardens, and milk animals from the previous year.

Residences

The residence in the NW sector (0.95 miles) was replaced with a more distant residence at 0.96 miles. The historical residence is under renovation and unoccupied at the time of the Land Use Census.

Gardens

The non-irrigated garden in the NNE sector (4.34 miles) was replaced with a closer garden at 4.23 miles.
The non-irrigated garden in the NE sector (3.80 miles) was replaced with a closer garden at 1.95 miles.
The non-irrigated garden in the ESE sector (1.26 miles) was replaced with a closer garden at 1.23 miles.
The non-irrigated garden in the S sector (3.17 miles) was replaced with a closer garden at 1.85 miles.
The non-irrigated garden in the WSW sector (1.33 miles) was replaced with a closer garden at 1.10 miles.

Milk Animals

No changes to nearest milk animal in each sector.

Environmental Monitoring Locations

Concurrent with implementation of MNS ODCM Revision 061, Air Sampling Location 103, Cottonwood Substation NE sector (4.20 miles) was deactivated.
Concurrent with implementation of MNS ODCM Revision 061, Air Sampling Location 106, M&T Facility E sector (0.47 miles) was activated.

ATTACHMENT 3

Solid Radioactive Waste Disposal

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

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

Attachment 3
Solid Radioactive Waste Disposal

McGuire Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

Type of Waste Shipped	Number of Shipments	Number of Containers	Waste Class	Container Type	Burial Volume (m^3)	Total Activity (Curies)
1. Waste from Liquid Systems						
a. Dewatered Powdex Resin (brokered)	None					
b. Dewatered Powdex Resin	None					
c. Dewatered Bead Resin (brokered)	None					
d. Dewatered Bead Resin	None					
e. Dewatered Radwaste System Resin	None					
f. Dewatered Primary Bead Resins (brokered)	None					
g. Dewatered Mechanical Filter Media	None					
h. Dewatered Mechanical Filter Media (brokered)	None					
i. Solidified Waste	None					
2. Dry Solid Waste						
a. Dry Active Waste (compacted)	None					
b. Dry Active Waste (non-compacted)	None					
c. Dry Active Waste (brokered / compacted)	None					
d. Dry Active Waste (brokered / non-compacted)	10	48	A	DBP	499	0.310
e. Sealed Sources / Smoke Detectors	None					
f. Sealed Sources	None					
g. Irradiated Components	None					
3. Total Waste	**10**	**48**			**499**	**0.310**

Attachment 3
Solid Radioactive Waste Disposal

McGuire Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

Type of Waste Shipped	Radionuclide	% Abundance
1. Waste from Liquid Systems		
a. Dewatered Powdex Resin (brokered)	No shipments in 2022	
b. Dewatered Powdex Resin	No shipments in 2022	
c. Dewatered Bead Resin (brokered)	No shipments in 2022	
d. Dewatered Bead Resin	No shipments in 2022	
e. Dewatered Radwaste System Resin (brokered)	No shipments in 2022	
f. Dewatered Primary Bead Resins (brokered)	No shipments in 2022	
g. Dewatered Mechanical Filter Media	No shipments in 2022	
h. Dewatered Mechanical Filter Media (brokered)	No shipments in 2022	
i. Solidified Waste	No shipments in 2022	
2. Dry Solid Waste		
a. Dry Active Waste (compacted)	Compaction no longer	performed on site
b. Dry Active Waste (non-compacted)	No shipments in 2022	
c. Dry Active Waste (brokered / compacted)		
a. RSRMNS#22-0001	Radionuclide	% Abundance
	Cr-51	8.51%
	Mn-54	5.26%
	Fe-55	11.54%
	Fe-59	0.44%
	Co-57	0.13%
	Co-58	16.26%
	Co-60	35.78%
	Ni-63	1.86%
	Zn-65	1.04%
	Zr-95	5.74%
	Nb-95	12.26%
	Sn-113	0.25%
	Sb-124	0.1%
	Sb-125	0.77%
	Cs-137	0.06%

Attachment 3
Solid Radioactive Waste Disposal

McGuire Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

b. RSRMNS#22-0003

Radionuclide	% Abundance
Cr-51	29.42%
Mn-54	3.42%
Fe-55	6.97%
Fe-59	0.67%
Co-57	0.09%
Co-58	16.46%
Co-60	21.28%
Ni-63	1.09%
Zn-65	0.7%
Zr-95	6.24%
Nb-95	12.85%
Sn-113	0.2%
Sb-124	0.12%
Sb-125	0.46%
Cs-137	0.03%

c. RSR#MNS22-0004

Radionuclide	% Abundance
Cr-51	30.39%
Mn-54	3.17%
Fe-55	6.19%
Fe-59	0.74%
Co-57	0.08%
Co-58	17.67%
Co-60	18.69%
Ni-63	0.95%
Zn-65	0.66%
Zr-95	6.76%
Nb-95	13.92%
Sn-113	0.21%
Sb-124	0.13%
Sb-125	0.41%
Cs-137	0.03%

d. RSR#MNS22-0005

Radionuclide	% Abundance
Cr-51	43.78%
Mn-54	2.25%
Fe-55	4.18%
Fe-59	0.8%
Co-57	0.06%
Co-58	15.88%
Co-60	12.48%
Ni-63	0.63%
Zn-65	0.48%
Zr-95	6.28%
Nb-95	12.62%
Sn-113	0.16%
Sb-124	0.12%
Sb-125	0.28%
Cs-137	0.02%

Attachment 3
Solid Radioactive Waste Disposal

McGuire Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

e. RSR#MNS22-0013

Radionuclide	% Abundance
Cr-51	38.21%
Mn-54	2.1%
Fe-55	14.06%
Fe-59	0.74%
Co-57	0.05%
Co-58	14.82%
Co-60	9.21%
Ni-63	1.56%
Zn-65	0.63%
Zr-95	5.99%
Nb-95	11.84%
Sn-113	0.1%
Sb-124	0.31%
Sb-125	0.33%
Cs-137	0.05%

f. RSR#MNS22-0014

Radionuclide	% Abundance
Cr-51	38.21%
Mn-54	2.1%
Fe-55	14.06%
Fe-59	0.74%
Co-57	0.05%
Co-58	14.82%
Co-60	9.21%
Ni-63	1.56%
Zn-65	0.63%
Zr-95	5.99%
Nb-95	11.84%
Sn-113	0.1%
Sb-124	0.31%
Sb-125	0.33%
Cs-137	0.05%

g. RSR#MNS22-0015

Radionuclide	% Abundance
Cr-51	4.43%
Mn-54	4.35%
Fe-55	35.18%
Fe-59	0.29%
Co-57	0.1%
Co-58	11.76%
Co-60	24.07%
Ni-63	4.26%
Zn-65	1.2%
Zr-95	4.17%
Nb-95	8.91%
Sn-113	0.13%
Sb-124	0.2%
Sb-125	0.83%
Cs-137	0.13%

h. RSR#MNS22-0016

Radionuclide	% Abundance
Cr-51	2.87%
Mn-54	4.49%
Fe-55	37.51%
Fe-59	0.23%
Co-57	0.1%
Co-58	10.42%
Co-60	25.85%
Ni-63	4.61%
Zn-65	1.22%
Zr-95	3.62%
Nb-95	7.77%
Sn-113	0.13%
Sb-124	0.17%
Sb-125	0.88%
Cs-137	0.14%

Attachment 3
Solid Radioactive Waste Disposal

McGuire Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

i. RSR#MNS22-0017

Radionuclide	% Abundance
Cr-51	29.56%
Mn-54	2.57%
Fe-55	17.68%
Fe-59	0.7%
Co-57	0.06%
Co-58	15.55%
Co-60	11.67%
Ni-63	1.99%
Zn-65	0.75%
Zr-95	6.16%
Nb-95	12.41%
Sn-113	0.12%
Sb-124	0.31%
Sb-125	0.42%
Cs-137	0.06%

j. RSR#MNS22-0020

Radionuclide	% Abundance
Cr-51	9.51%
Mn-54	3.9%
Fe-55	29.83%
Fe-59	0.43%
Co-57	0.09%
Co-58	14.1%
Co-60	20.15%
Ni-63	3.52%
Zn-65	1.1%
Zr-95	5.21%
Nb-95	10.96%
Sn-113	0.14%
Sb-124	0.25%
Sb-125	0.7%
Cs-137	0.11%

d.	Sealed Sources / Smoke Detectors	No shipments in 2022
e.	Sealed Sources	No shipments in 2022
f.	Irradiated Components	No shipments in 2022

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

McGuire Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

Stability Class	Wind Speed (m/s)	Hours of Occurrence															
		Sector															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
A	0.46-0.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.76-1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1.01-1.25	4	2	0	0	0	1	0	0	0	0	0	0	0	0	1	0
	1.26-1.50	33	5	2	0	0	0	0	0	0	0	0	1	1	3	2	9
	1.51-2.00	75	24	7	1	3	2	0	0	2	1	0	0	5	5	6	17
	2.01-3.00	28	40	21	8	6	6	3	10	10	8	5	6	11	6	6	7
	3.01-4.00	11	19	14	6	1	2	3	3	6	14	5	6	6	2	4	6
	4.01-5.00	5	1	1	0	0	1	0	0	1	4	12	6	3	3	8	6
	5.01-6.00	7	0	0	0	0	0	0	0	0	0	2	4	0	3	6	8
	6.01-8.00	5	1	0	0	0	0	0	0	0	0	2	0	1	1	6	4
	8.01-10.00	9	0	0	0	0	0	0	0	0	0	0	0	0	1	5	5
	10.01-max	3	1	0	0	0	0	0	0	0	0	0	0	0	0	5	1
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	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1.01-1.25	3	1	0	0	0	0	0	0	1	0	1	0	0	1	4	3
	1.26-1.50	21	12	4	3	1	0	0	0	0	0	0	1	2	1	3	10
	1.51-2.00	16	16	10	1	8	1	1	1	3	0	4	1	6	4	5	7
	2.01-3.00	9	20	17	11	7	4	3	6	6	6	18	12	7	2	4	4
	3.01-4.00	9	13	14	9	4	1	1	0	4	11	12	16	2	5	0	5
	4.01-5.00	3	3	4	2	1	0	0	0	0	5	15	11	2	1	5	2
	5.01-6.00	6	3	4	0	0	0	0	0	0	4	8	5	0	4	7	2
	6.01-8.00	7	1	2	1	0	0	0	0	0	0	6	2	0	1	0	5
	8.01-10.00	1	0	0	0	0	0	0	0	0	0	0	0	1	0	3	1
	10.01-max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0

Attachment 4
Meteorological Data

McGuire Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

Stability Class	Wind Speed (m/s)	Hours of Occurrence															
		Sector															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
C	0.46-0.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.76-1.00	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
	1.01-1.25	7	2	0	0	0	0	0	0	0	0	1	1	3	2	2	3
	1.26-1.50	13	4	0	0	1	0	0	0	1	2	2	2	2	3	6	6
	1.51-2.00	14	14	13	10	6	6	2	1	3	5	2	8	7	2	3	8
	2.01-3.00	13	12	21	16	10	11	4	4	8	25	25	21	11	2	2	9
	3.01-4.00	5	14	27	14	3	2	3	1	0	13	49	20	6	4	7	4
	4.01-5.00	3	8	18	2	0	1	0	0	0	7	28	18	5	3	3	6
	5.01-6.00	9	7	4	1	0	0	0	0	0	2	14	8	2	5	3	8
	6.01-8.00	4	6	6	1	0	0	0	0	0	0	8	3	2	1	10	3
	8.01-10.00	0	2	0	0	0	0	0	0	0	0	2	0	1	0	2	0
	10.01-max	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0
D	0.46-0.75	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0
	0.76-1.00	9	4	2	2	1	2	0	2	2	1	4	2	3	3	2	6
	1.01-1.25	14	10	10	2	1	3	3	10	6	4	7	9	9	3	9	12
	1.26-1.50	12	17	13	7	10	4	9	17	17	14	7	21	18	10	14	12
	1.51-2.00	31	38	52	21	32	31	34	42	49	25	41	52	34	23	11	15
	2.01-3.00	53	91	180	116	113	61	80	53	78	115	162	103	40	39	40	48
	3.01-4.00	39	50	216	104	98	27	19	7	17	76	247	56	24	16	32	38
	4.01-5.00	19	53	128	21	15	9	3	7	4	31	136	31	8	7	14	28
	5.01-6.00	10	20	27	0	0	1	0	0	5	19	44	18	2	3	14	18
	6.01-8.00	1	6	12	0	0	0	0	0	0	5	35	7	5	3	15	10
	8.01-10.00	0	1	2	0	0	0	0	0	0	0	7	4	3	1	6	0
	10.01-max	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0

Attachment 4
Meteorological Data

McGuire Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

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	3	0	0	0	0	0	2	3	3	3	3	3	0	1	0	0
	0.76-1.00	3	0	1	1	2	2	3	4	9	9	8	16	5	5	3	0
	1.01-1.25	1	1	5	2	2	7	7	9	19	15	24	13	12	6	5	4
	1.26-1.50	4	3	15	3	4	5	13	22	29	21	23	26	20	13	10	6
	1.51-2.00	6	11	11	10	3	11	26	29	58	36	45	50	16	9	9	6
	2.01-3.00	11	9	13	13	21	16	55	17	28	123	119	51	27	12	17	7
	3.01-4.00	0	0	0	4	2	4	4	0	1	21	48	8	6	8	7	3
	4.01-5.00	0	0	0	0	0	0	0	0	0	4	8	2	2	1	3	1
	5.01-6.00	0	1	0	0	0	0	0	0	0	0	0	8	1	2	0	0
	6.01-8.00	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	0	1	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	0	0	0	0	0	1	1	2	2	5	7	3	0	2	0	0
	0.76-1.00	2	3	1	0	0	1	3	4	7	27	22	18	7	0	1	1
	1.01-1.25	3	2	0	0	0	0	1	2	17	19	14	11	15	2	3	2
	1.26-1.50	1	1	0	0	0	0	1	6	13	25	9	14	7	2	2	0
	1.51-2.00	2	0	0	0	0	0	2	6	27	27	22	19	2	2	0	0
	2.01-3.00	0	0	0	0	0	0	0	0	6	12	12	11	6	1	0	2
	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 4
Meteorological Data

McGuire Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

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	0	0	0	0	1	0	1	0	8	10	10	1	1	0	0	0
	0.76-1.00	0	0	0	1	0	0	0	1	6	41	39	11	5	0	1	0
	1.01-1.25	0	0	0	0	0	0	0	1	1	28	20	5	2	0	0	0
	1.26-1.50	0	0	0	0	0	0	1	1	6	18	9	3	1	0	0	0
	1.51-2.00	0	0	0	0	0	0	1	0	4	6	2	3	0	0	0	0
	2.01-3.00	0	0	0	0	0	0	0	0	1	0	9	3	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

McGuire Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

McGuire Nuclear Station experienced no unplanned offsite releases in 2022.

ATTACHMENT 6

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

(includes fuel cycle dose calculation results)

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

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

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

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

McGuire Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

Gaseous Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Noble Gases						
1. Maximum Gamma Air	mRAD	4.94E-03	8.77E-03	5.96E-03	6.14E-03	2.58E-02
(a) Limit	mRAD	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
(b) % of Limit		4.94E-02	8.77E-02	5.96E-02	6.14E-02	1.29E-01
2. Maximum Beta Air	mRAD	1.81E-03	3.15E-03	2.18E-03	2.25E-03	9.39E-03
(a) Limit	mRAD	2.00E+01	2.00E+01	2.00E+01	2.00E+01	4.00E+01
(b) % of Limit		9.06E-03	1.58E-02	1.09E-02	1.12E-02	2.35E-02
Receptor Location ***0.5*** miles ***ENE***						
B. Iodine, H-3, & Particulates						
1. Maximum Organ Dose	mREM	1.80E-01	1.46E-01	1.86E-01	1.89E-01	7.00E-01
(a) Limit	mREM	1.50E+01	1.50E+01	1.50E+01	1.50E+01	3.00E+01
(b) % of Limit		1.20E+00	9.72E-01	1.24E+00	1.26E+00	2.33E+00

Receptor Location ***0.5*** miles ***ENE***
Critical Age ***CHILD***
Critical Organ ***BONE***

McGuire Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Batch Mode						
1. Maximum Organ Dose	mREM	4.00E-02	3.90E-02	2.40E-02	2.30E-02	1.23E-01
(a) Limit	mREM	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
(b) % of Limit		4.00E-01	3.90E-01	2.40E-01	2.30E-01	6.17E-01
(c) Critical Age		Child	Child	Child	Child	Child
(d) Critical Organ		Liver	Liver	Liver	GI-Lli	Liver
2. Maximum Total Body Dose	mREM	3.76E-02	3.75E-02	2.28E-02	2.26E-02	1.19E-01
(a) Limit	mREM	3.00E+00	3.00E+00	3.00E+00	3.00E+00	6.00E+00
(b) % of Limit		1.25E+00	1.25E+00	7.61E-01	7.52E-01	1.98E+00
(c) Critical Age		Child	Child	Child	Child	Child
B. Continuous Mode						
1. Maximum Organ Dose	mREM	4.93E-06	6.74E-05	2.04E-05	2.11E-05	1.13E-04
(a) Limit	mREM	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
(b) % of Limit		4.93E-05	6.74E-04	2.04E-04	2.11E-04	5.65E-04
(c) Critical Age		Child	Child	Child	Child	Child
(d) Critical Organ		Liver	Liver	Liver	Liver	Liver
2. Maximum Total Body Dose	mREM	4.93E-06	6.74E-05	2.04E-05	2.11E-05	1.13E-04
(a) Limit	mREM	3.00E+00	3.00E+00	3.00E+00	3.00E+00	6.00E+00
(b) % of Limit		1.64E-04	2.25E-03	6.81E-04	7.03E-04	1.88E-03
(c) Critical Age		Child	Child	Child	Child	Child

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

McGuire Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

40 CFR Part 190 Uranium Fuel Cycle Dose Calculation Results

In accordance with the requirements of 40 CFR Part 190, the annual dose commitment to any member of the general public shall be calculated to assure that doses are limited to 25 millirems to the total body or any organ with the exception of the thyroid which is limited to 75 millirems. The fuel cycle dose assessment for McGuire Nuclear Station includes liquid and gaseous effluent dose contributions from McGuire Nuclear Station and direct and air-scatter dose from the onsite ISFSI. No other uranium fuel cycle facility contributes significantly to the maximum exposed individual. Included in the gaseous effluent dose calculations is an estimate of the dose contributed by Carbon-14 (Ref. Attachment 2, Supplemental Information, of this report for further information). The combined dose to a maximum exposed individual from effluent releases and direct and air-scatter dose from the ISFSI is below 40 CFR Part 190 limits as shown by the following summary.

Note: The 40 CFR Part 190 effluent dose analysis to the maximum exposed individual from liquid and gas releases includes the dose from noble gases (i.e., total body and skin).

40 CFR Part 190 Effluent Dose Summary

A. Maximum Organ Dose (other than TB)	7.179 E-01
1. Location	0.5 miles ENE
2. Critical Age	Child
3. Critical Organ	Bone
4. Gas Contribution %	9.756 E+01
5. Liquid Contribution %	2.436 E+00
B. Maximum Total Body Dose	3.672 E-01
1. Location	0.5 miles ENE
2. Critical Age	Child
3. Gas non-NG Contribution %	6.105 E+01
4. Gas Contribution %	6.678 E+00
5. Liquid Contribution %	3.227 E+01

Direct and air-scatter radiation dose contributions from the onsite ISFSI have been determined from the 10 CFR 72.212 Evaluation Report, MAGNASTOR®, Revision 10.The attached excerpt from the 10 CFR 72.212 Evaluation Report, MAGNASTOR®, Revision 10 is provided to document the method used to calculate the dose from ISFSI as less than 6 mrem/yr to the nearest real individual.

Total dose from liquid and gaseous effluents from McGuire Nuclear Station and direct and air-scatter dose from the onsite ISFSI is conservatively estimated to be less than 9 mrem/yr to the nearest real individual. This meets the 40 CFR Part 190 requirements of an annual dose commitment to any member of the general public of less than 25 mrem total body or any organ and 75 mrem to the thyroid.

10 CFR 72.212 Evaluation Report, MAGNASTOR®, Revision 10

6.0 10 CFR 72.212(b)(5)(iii) - Radioactive Materials in Effluents and Direct Radiation

6.1 PURPOSE

10 CFR 72.212(b)(5)(iii) requires the general licensee to perform written evaluations, before use and before applying the changes authorized by an amended CoC to a cask loaded under the initial CoC or an earlier amended CoC, that establish that the requirements of 10 CFR 72.104 have been met. A copy of this record shall be retained until spent fuel is no longer stored under the general license issued under 10 CFR 72.210.

10 CFR 72.104 provides the regulatory criteria for radioactive materials in effluents and direct radiation from an independent spent fuel storage installation (ISFSI) during normal operation and anticipated occurrences. Specifically, 10 CFR 72.104(a) limits the annual dose equivalent to any real individual who is located beyond the controlled area to 25 mrem to the whole body, 75 mrem to the thyroid, and 25 mrem to any other critical organ. This dose equivalent must include contributions from (1) planned discharges of radioactive materials (radon and its decay products excepted) to the general environment, (2) direct radiation from ISFSI operations, and (3) any other radiation from uranium fuel cycle operations within the region. In addition, 10 CFR 72.104(b) requires that operational restrictions be established to meet as low as is reasonably achievable (ALARA) objectives for radioactive materials in effluents and direct radiation levels associated with ISFSI operations. Also, 10 CFR 72.104(c) requires that operational limits be established for radioactive materials in effluents and direct radiation levels associated with ISFSI operations to meet the above-mentioned dose limits.

Section 6.2 provides the written evaluation required by

10 CFR 72.212(b)(5)(iii), demonstrating Duke Energy's compliance with the requirements of 10 CFR 72.104 for the MNS ISFSI.

6.2 EVALUATION

This evaluation addresses the radiological dose rate from a composite population of all MNS ISFSI cask types.

6.2.1 §72.104(a) – Dose Limits

Duke Energy Engineering Instruction MCEI-0400-241 determined that the distance from the nearest residence to the ISFSI is

0.65 miles (1046 meters). Hence, it is conservative to assume that the closest real individual is at least 700 meters from the ISFSI.

Enercon determined the annual total dose (gamma plus neutron) at a distance of 700 meters from all currently loaded casks

(10 TN-32A casks and 28 NAC-UMS® casks) to be approximately

1.62 mrem. The evaluation was based on actual cask average burn-up (as loaded) and considering cooling time on the storage pads as of September 1, 2010. The distance at which this dose is calculated (700 meters) is conservative compared to the distance to the closest real individual.

NAC International determined the annual total dose (gamma plus neutron) at a distance of 700 meters from a (future) 2x6 array of MAGNASTOR® casks to be approximately 1.01 mrem (2.02 mrem for two arrays). The evaluation was conservatively based on full cask loads of 37 fuel assemblies at the maximum allowable heat load of 35.5 kW. The distance at which this dose is calculated (700 meters) is conservative compared to the distance to the closest real individual.

The total calculated annual public dose from liquid and gaseous effluent pathways averaged over a ten-year period is less than 4 mrem. No other uranium fuel cycle facility contributes significantly to the dose received by the closest real individual.

Based on the above, the calculated annual dose to the closest real individual due to the ISFSI, which is comprised of the currently existing ten TN-32A casks and 28 NAC-UMS® casks, and up to four 2x6 arrays of MAGNASTOR® casks (*see Note below*), is determined to be less than 6 mrem, and the estimated annual dose due to McGuire power generation is less than 4 mrem. Hence, the total annual dose to the closest real individual (less than 10 mrem) is within the 10 CFR 72.104(a) limit.

<u>*Note*</u>*: As stated above, up to four 2x6 arrays of* MAGNASTOR® casks *are assumed in this evaluation. The first eight MAGNASTOR® casks are placed on a concrete pad currently containing four NAC-UMS® casks. This will conservatively count as one 2x6 array. Additional MAGNASTOR® casks will be placed on their own concrete pads in a 2x6 array. Hence, this §72.104(a) evaluation bounds up to 44 MAGNASTOR® casks, arranged as described.*

ATTACHMENT 7

Information to Support the NEI Ground Water Protection Initiative

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

Attachment 7
Information to Support the NEI Ground Water Protection Initiative

McGuire Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

Duke Energy implemented a Ground Water Protection program in 2007. This initiative was developed to ensure timely and effective management of situations involving inadvertent releases of licensed material to ground water. As part of this program, McGuire Nuclear Station monitored 53 Ground Water Protection Initiative wells, 4 surface water points, 1 Leachate Pond, 12 Landfarm wells, and 34 Landfill wells.

Wells are typically sampled quarterly or semi-annually. Ground water samples are regularly analyzed for tritium and gamma emitters, with select wells being analyzed for difficult-to-detect radionuclides. No gamma or difficult-to-detect radionuclides, other than naturally occurring radionuclides, were identified in well samples during 2022. Results from sampling during 2022 confirmed existing knowledge of tritium concentrations in site ground water.

Results from sampling during 2022 are shown in the table below.

No events meeting the criteria for voluntary notification per NEI 07-07, Industry Ground Water Protection Initiative, occurred at McGuire Nuclear Station in 2022.

Key to below table.

McGuire Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

NS	-	Not scheduled to be sampled, not sampled due to insufficient volume in well, or well inaccessible during outage.
ρCi/l	-	picocuries per liter.
< MDA	-	less than minimum detectable activity, typically 250 ρCi/l.
20,000 ρCi/l	-	the Environmental Protection Agency drinking water standard for tritium. This standard applies only to water used for drinking.
1,000,000 ρCi/l	-	the 10 CFR Part 20, Appendix B, Table 2, Column 2, Effluent Concentration Limit for tritium.

Attachment 7
Information to Support the NEI Ground Water Protection Initiative

McGuire Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

Well Name	Location / Description	Tritium Concentration (pCi/l) 1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	# of Samples
M-100R	MNS GWPI / M-100R / SE of WC	NS	<MDA	NS	<MDA	2
M-101	MNS GWPI / M-101 / SE of WC	NS	<MDA	NS	<MDA	2
M-102	MNS GWPI / M-102 / SW of WC	6.89E+02	5.41E+02	4.88E+02	5.18E+02	4
M-103	MNS GWPI / M-103 / S of WC	5.68E+02	5.06E+02	4.52E+02	5.20E+02	4
M-103R	MNS GWPI / M-103R / S of WC	NS	4.84E+02	NS	6.26E+02	2
M-104DR	MNS GWPI / M-104DR / W of WC	NS	5.03E+02	NS	6.39E+02	2
M-104R	MNS GWPI / M-104R / W of WC	8.07E+02	7.13E+02	6.19E+02	6.37E+02	4
M-105	MNS GWPI / M-105 / Landfarm	NS	2.73E+02	NS	2.69E+02	2
M-20	MNS GWPI / M-20 / S of Hwy. 73	NS	4.36E+02	NS	4.05E+02	2
M-20R	MNS GWPI / M-20R / S of Hwy. 73	NS	NS	NS	4.61E+02	1
M-21	MNS GWPI / M-21 / S of Hwy. 73	NS	<MDA	NS	<MDA	2
M-22	MNS GWPI / M-22 / S of Hwy. 73	NS	<MDA	NS	<MDA	2
M-22R	MNS GWPI / M-22R / S of Hwy. 73	NS	NS	NS	<MDA	1
M-23	MNS GWPI / M-23 / S of Acs. Rd.	NS	NS	NS	<MDA	1
M-31	MNS GWPI / M-31 / Access road	NS	NS	NS	<MDA	1
M-32	MNS GWPI / M-32 / Main entrance	NS	<MDA	NS	<MDA	2
M-33	MNS GWPI / M-33 / by softball field / HWY 73	NS	NS	NS	<MDA	1
M-34DR	MNS GWPI / M-34DR / Access road	NS	NS	NS	<MDA	1
M-34R	MNS GWPI / M-34R / Access road	NS	NS	NS	<MDA	1
M-42	MNS GWPI / M-42 / U-2 Rx. Bldg.	2.27E+03	2.64E+03	2.60E+03	3.17E+03	9
M-48DR	MNS GWPI / M-48DR / U-2 SFP	NS	<MDA	NS	<MDA	2
M-48R	MNS GWPI / M-48R / U-2 SFP	NS	5.49E+02	NS	5.93E+02	2
M-53	MNS GWPI / M-53 / N of plant	NS	5.33E+02	NS	6.31E+02	2
M-55	MNS GWPI / M-55 / NAB	NS	<MDA	NS	<MDA	2
M-59	MNS GWPI / M-59 / U-2 Doghouse	1.00E+03	1.23E+03	9.41E+02	9.59E+02	4
M-60	MNS GWPI / M-60 / MOC Parking	NS	NS	NS	<MDA	1
M-62	MNS GWPI / M-62 / S of RWF	2.84E+02	1.82E+02	<MDA	<MDA	4
M-64	MNS GWPI / M-64 / Rdwst. Bldg.	NS	3.13E+02	NS	<MDA	2
M-66	MNS GWPI / M-66 / S of SSF	5.03E+02	4.10E+02	4.78E+02	3.76E+02	4
M-66R	MNS GWPI / M-66R / S of SSF	NS	<MDA	NS	<MDA	2
M-68	MNS GWPI / M-68 / U-1 RMWST	3.98E+02	4.58E+02	2.93E+02	4.38E+02	4
M-70	MNS GWPI / M-70 / U-1 SFP	4.68E+02	2.85E+02	2.89E+02	2.86E+02	4
M-70DR	MNS GWPI / M-70DR / U-1 SFP	NS	2.84E+02	NS	<MDA	2
M-70R	MNS GWPI / M-70R / U-1 SFP	NS	<MDA	NS	3.21E+02	2
M-72	MNS GWPI / M-72 / Rdwst. Trench	6.12E+02	4.97E+02	4.54E+02	3.94E+02	4
M-76	MNS GWPI / M-76 / W of U-1 SFP	3.87E+02	4.19E+02	4.12E+02	3.49E+02	4
M-82	MNS GWPI / M-82 / River	NS	NS	NS	3.17E+02	1
M-84	MNS GWPI / M-84 / River	NS	NS	NS	7.79E+02	1
M-84R	MNS GWPI / M-84R / River	NS	NS	NS	8.75E+02	1
M-85	MNS GWPI / M-85 / River	NS	NS	NS	2.66E+02	1
M-87	MNS GWPI / M-87 / Landfarm	NS	NS	NS	1.97E+02	1
M-89	MNS GWPI / M-89 / Landfarm	NS	NS	NS	<MDA	1

Attachment 7
Information to Support the NEI Ground Water Protection Initiative

McGuire Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

Well Name	Location / Description	Tritium Concentration (pCi/l) 1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	# of Samples
M-90	MNS GWPI / M-90 / Landfarm	NS	NS	NS	4.22E+02	1
M-91	MNS GWPI / M-91 / E of WC	NS	3.61E+02	NS	4.12E+02	2
M-91R	MNS GWPI / M-91R / E of WC	NS	NS	NS	2.47E+02	1
M-92	MNS GWPI / M-92 / N of WC Ponds	NS	<MDA	NS	2.97E+02	2
M-92R	MNS GWPI / M-92R / N of WC Ponds	NS	NS	NS	<MDA	1
M-93	MNS GWPI / M-93 / N of IHUP	NS	3.53E+02	NS	3.77E+02	2
M-93R	MNS GWPI / M-93R / N of IHUP	NS	NS	NS	2.09E+02	1
M-94	MNS GWPI / M-94 / SE of IHUP	NS	<MDA	NS	<MDA	2
M-95	MNS GWPI / M-95 / Lower Parking	NS	<MDA	NS	<MDA	2
M-95R	MNS GWPI / M-95R / Lower Parking	NS	NS	NS	<MDA	1
M-96	MNS GWPI / M-96 / West Parking	NS	<MDA	NS	<MDA	2
M-96R	MNS GWPI / M-96R / West Parking	NS	NS	NS	<MDA	1
M-97	MNS GWPI / M-97 / East Parking	NS	<MDA	NS	<MDA	2
M-98	MNS GWPI / M-98 / S of Amin. Bldg.	NS	<MDA	NS	<MDA	2
M-98R	MNS GWPI / M-98R / S of Amin. Bldg.	NS	NS	NS	<MDA	1
MNS_LEACHP	MNS Landfill 2 / Leachate Pond	NS	7.54E+02	NS	2.39E+02	2
MNS_MW-1	MNS Landfarm 2 / MW-1	NS	NS	NS	<MDA	1
MNS_MW-10A	MNS Landfill 2 / MW-10A	NS	<MDA	NS	<MDA	2
MNS_MW-1A	MNS Landfarm 2 / MW-1A	NS	NS	NS	<MDA	1
MNS_MW-2	MNS Landfarm 2 / MW-2	NS	NS	NS	<MDA	1
MNS_MW-2A	MNS Landfarm 2 / MW-2A	NS	NS	NS	<MDA	1
MNS_MW-3	MNS Landfarm 2 / MW-3	NS	NS	NS	<MDA	1
MNS_MW-3A	MNS Landfarm 2 / MW-3A	NS	NS	NS	<MDA	1
MNS_MW-4A	MNS Landfarm 2 / MW-4A	NS	NS	NS	<MDA	1
MNS_MW-4R	MNS Landfarm 2 / MW-4R	NS	NS	NS	<MDA	1
MNS_MW-5A	MNS Landfill 2 / MW-5A	NS	<MDA	NS	<MDA	2
MNS_MW-5R	MNS Landfill 2 / MW-5R	NS	<MDA	NS	<MDA	2
MNS_MW-6	MNS Landfill 2 / MW-6	NS	<MDA	NS	<MDA	2
MNS_MW-6A	MNS Landfill 2 / MW-6A	NS	<MDA	NS	<MDA	2
MNS_MW-7A	MNS Landfill 2 / MW-7A	NS	<MDA	NS	<MDA	2
MNS_MW-7R	MNS Landfill 2 / MW-7R	NS	<MDA	NS	<MDA	2
MNS_MW-8	MNS Landfill 2 / MW-8	NS	<MDA	NS	<MDA	2
MNS_MW-8A	MNS Landfill 2 / MW-8A	NS	<MDA	NS	<MDA	2
MNS_MW-9	MNS Landfill 2 / MW-9	NS	<MDA	NS	<MDA	2
MNS_MW-9A	MNS Landfill 2 / MW-9A	NS	<MDA	NS	<MDA	2
MNS_SW-1	MNS Landfill 2 / SW-1	NS	<MDA	NS	<MDA	2
MNS_SW-2	MNS Landfill 2 / SW-2	NS	<MDA	NS	<MDA	2
MS-1	MNS GWPI / MS-1 / Surface Water	NS	<MDA	NS	2.16E+02	2
MS-2	MNS GWPI / MS-2 / Surface Water	NS	3.97E+02	NS	4.05E+02	2
MS-3	MNS GWPI / MS-3 / Surface Water	NS	3.09E+02	NS	5.27E+02	2

Attachment 7
Information to Support the NEI Ground Water Protection Initiative

McGuire Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

Well Name	Location / Description	Tritium Concentration (pCi/l) 1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	# of Samples
MS-4	MNS GWPI / MS-4 / Surface Water	NS	3.16E+02	NS	3.40E+02	2
MW-1_ML1	MNS Landfill 1 / MW-1	<MDA	NS	<MDA	NS	2
MW-11_ML1	MNS Landfill 1 / MW-11	<MDA	NS	<MDA	NS	2
MW-11BRML1	MNS Landfill 1 / MW-11BR	<MDA	NS	<MDA	NS	2
MW-11D_ML1	MNS Landfill 1 / MW-11D	<MDA	NS	<MDA	NS	2
MW-12_ML1	MNS Landfill 1 / MW-12	<MDA	NS	<MDA	NS	2
MW-12D_ML1	MNS Landfill 1 / MW-12D	<MDA	NS	<MDA	NS	2
MW-13BRML1	MNS Landfill 1 / MW-13BR	<MDA	NS	<MDA	NS	2
MW-13D_ML1	MNS Landfill 1 / MW-13D	<MDA	NS	<MDA	NS	2
MW-1D_ML1	MNS Landfill 1 / MW-1D	<MDA	NS	<MDA	NS	2
MW-2A_ML1	MNS Landfill 1 / MW-2A	<MDA	NS	<MDA	NS	2
MW-2D_ML1	MNS Landfill 1 / MW-2D	<MDA	NS	<MDA	NS	2
MW-3_ML1	MNS Landfill 1 / MW-3	<MDA	NS	<MDA	NS	2
MW-3BR_ML1	MNS Landfill 1 / MW-3BR	<MDA	NS	<MDA	NS	2
MW-3D_ML1	MNS Landfill 1 / MW-3D	<MDA	NS	<MDA	NS	2
MW-4_ML1	MNS Landfill 1 / MW-4	<MDA	NS	<MDA	NS	2
MW-4BR_ML1	MNS Landfill 1 / MW-4BR	<MDA	NS	<MDA	NS	2
MW-4BRRML1	MNS Landfill 1 / MW-4BRR	<MDA	NS	<MDA	NS	2
MW-4D_ML1	MNS Landfill 1 / MW-4D	<MDA	NS	<MDA	NS	2
MW-4DR_ML1	MNS Landfill 1 / MW-4DR	<MDA	NS	<MDA	NS	2
MW-4R_ML1	MNS Landfill 1 / MW-4R	<MDA	NS	<MDA	NS	2
SW-1_ML1	MNS Landfill 1 / SW-1	<MDA	NS	<MDA	NS	2

ATTACHMENT 8

Inoperable Equipment

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

Attachment 8
Inoperable Equipment

McGuire Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

McGuire Nuclear Station experienced three instances of inoperable equipment relevant to effluent monitoring in excess of SLC limits during 2022. Details are described below.

McGuire Nuclear Station does not have unprotected permanent or temporary outside liquid storage tanks, therefore none exceeded 10 Curies total activity (excluding tritium and dissolved or entrained noble gases) during 2022.

SLC # from Table 16.11.2-1	Title	Completion Time	Determination and Data Reviewed
2.a	2EMF-31	30 Days	For 2EMF-31, out of service time for 2022 is 230 days (1/1/2022* to 8/18/2022) LCOTR A-2-21-02092

For 2022, 2EMF-31 was non-functional from 1/1/2022* to 8/18/2022. 2EMF31 channel failed on 11/24/2021 from a loss of high voltage failure. Maintenance investigation found water intrusion had occurred into the detector assembly. Maintenance attempted to dry out the detector, but channel continued to spike, and maintenance requested detector assembly replacement. When detector assembly was removed, and disassembled maintenance found scintillator to be milky when it should be perfectly clear as glass. A replacement scintillator was not not available. Engineering generated condition report, 2411069. A replacement scintillator was specified, and its primary calibration was performed in 2000 due to replacement detector geometry changes. Engineering recognized this would be the first-time installation and calibration of this replacement scintillator. Engineering Change, EC420494, was developed and prepared to facilitate wiring changes, required to support the installation, and calibration of this replacement detector assembly. EC420494-000 was approved on 5/09/2022. Replacement parts were received and replacement detector was installed along with implementation of EC420494 on 8/16/2022. Detector calibration was performed, and channel returned to service on 8/18/2022.

*2EMF-31 was declared non-functional on 11/24/2021. 37.4 days of non-functionality were accounted for in the MNS 2021 ARERR.

- WO 20503923-02

Attachment 8
Inoperable Equipment

McGuire Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

SLC # from Table 16.11.2-1	Title	Completion Time	Determination and Data Reviewed
4.d	2WPFT5120	30 Days	For 2WPFT5120, out of service time for 2022 is 145 days (8/9/2022 to 1/1/2023*) LCOTR A-2-22-01213

For 2022, 2WPFT5120 was non-functional from 8/9/2022 to 1/1/2023*. During alignment for 2WPLP5120 calibration, 2WPFT5120 failed the acceptance criteria.

*2WPFT5120 remained non-functional through the end of the year 2022. Additional non-functional time will be accounted for in the 2023 ARERR.

- WO 20498458-01
- WO 20498458-02

Attachment 8
Inoperable Equipment

McGuire Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

SLC # from Table 16.11.2-1	Title	Completion Time	Determination and Data Reviewed
1.c	2EMF-44	30 Days	For 2EMF-44, out of service time for 2022 is 136 days (5/31/2022 to 10/13/2022) LCOTR A-2-22-00882

For 2022, 2EMF-44 was non-functional from 5/31/2022 to 10/13/2022. During Unit 2 Ventilation Unit Condensate Drain Tank (VUCDT) effluent release on 5/31/2022 the Flow Rate Measurement Device, required per SLC 16.11.2 Function 4.b, was found to be erratic. 2WLLP5900 was declared NON-FUNCTIONAL for SLC 16.11.2, RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION, and is tracked via LOCT record A-2-22-00882. Due to the Black-Board interlock disablement of 2EMF-44 Minimum Flow Device, required per SLC 16.11.2 Function 1.d, required declaring it NON-FUNCTIONAL. This in turn cascaded to 2EMF44L, Radioactivity Monitors Providing Alarm And Automatic Termination of Release for Containment Ventilation Unit Condensate Line, required per SLC 16.11.2 Function 1.c. Repair work order (WO) 20550764 for 2WLLP5900 NEEDS CALIBRATION was originally coded as Priority 4. No maintenance resources were supplied and 30-day SLC COMPLETION TME requirement was exceeded. LOCT record A-2-22-00882 was updated on 6/30/2002 to evoke condition G to explain why the non-functionality was not corrected within the specified Completion Time in the Annual Radioactive Effluent Release Report. On 7/29/22 the 2EMF-44 Loss of Sample flow annunciator went into alarm status. This resulted in lit control room annunciator and operations elevated repair work to Priority 2. When maintenance worked the flow loop, they found that the totalizer counter is counting high. Troubleshooting indicated parts replacement is required to restore loop to functional. Material Request has been generated and working with Supply Chain to obtain parts for repair. When totalizer repair was initiated, the totalizer was miscounting the number of gallons during a discharge by approximately one million gallons per day. I&C Opened link A-32 in WERP (MCEE-160-01.35). Counting stopped. Placed ammeter across the open link. Counting resumed and ammeter read 100mA for this 4 to 20mA loop. Removed BD fuses to deenergize loop. Used Fluke 754 on A-16 and A-31 terminals to simulate the flow transmitter. With 5mA being fed into loop, totalizer operated erratically, as when first inspected by MFC. Supply is working on finding a replacement Moore Integrator and further testing will be performed. Reinstalled BD fuses in WERP and noted 4mA flowing through 2WLLP5900. Performed loop calibration procedure IP/2/B/3050/017 C section 10.2. Found that all loop components performed satisfactory except for the totalizer, which is fed by a Moore integrator. A new Moore integrator had been ordered and is in the warehouse. Expect Moore replacement will fix totalizer. Removed totalizer and performed bench cal with it connected to new integrator. All As Left data within required tolerances. Moore LIT removed was model LIT/4-20MA/A1-J/117AC-ED8-IT[TS]. New (used) Moore LIT installed is model LIT/4-20MA/A1-J/STD from Radwell, CID 9230044356. Installed new LIT with totalizer. Upon installation, verified 4-20mA loop was reading approx. 4mA. Totalizer was showing flow at a rate less than 1gpm, which is within the acceptable tolerance. Performed F/V in accordance with listed procedure. Functional requirements were met by procedure. Totalizer will count at a rate of approx. 1gpm with 4.00 mA being sent to Integrator. "Count Dropout" potentiometer on the Integrator did not affect this during bench calibration. Instrument declared functional 10/13/22.

- WO 20550764

ATTACHMENT 9

Summary of Changes to the Offsite Dose Calculation Manual

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

Attachment 9
Summary of Changes to the Offsite Dose Calculation Manual

McGuire Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

Offsite Dose Calculation Manual

The McGuire ODCM was revised in 2022. The most recent revision is 61 and is provided with the 2022 ARERR.

DRR 02302566:

Location Description Changes
-Location 160 changed from Anchorage Marine Showroom to intersection Hwy 21 & Westmoreland
-Location 171 changed from Triangle Hardware to Old Hwy 16
-Location 178 changed from Florida Steel Corp. to Approx. 0.25 mi North of Lakeview Rd/David Cox Rd on Hwy 115

DRR 02416128:

Deleted Location 103 and added Location 106 with description "Maintenance Training Facility (0.47 mi E)." Due to populational density and community changes, Location 106 is more representative of a community air sample. Location 103 deleted with implementation of Location 106.

DRR 02420689:

EMF31 Cs-137 correlation factor CFcs-137 changed to 3.02E+08 (1EMF31) or 3.06E+08 (2EMF31).
2EMF31 detector replacement occurred in 2022 requiring a new CFcs-137.
1EMF31 CFcs-137 remained unchanged.

Radiological Effluent Controls (SLC 16.11)

The McGuire Nuclear Station Radiological Effluent Controls are contained in SLC 16.11 and are included in this section. SLC 16.11 was revised in 2022. The most recent revision(s) is provided with the 2022 ARERR.

AR 02427036

During 2022 NRC Radiological Safety Occupational Baseline Inspection, the NRC identified that in several instances, the MNS SLC for radioactive effluent monitoring instruments doesn't adequately differentiate between the High Range and Low Range channels for three radiation monitors. This created confusion and led to the inspection exiting with a URI related to calibration frequency of the high range channels for EMF-36, EMF-44, and EMF-49. The high range channel calibration frequencies for these instruments have been extended under the PM process over time, with basis for changes documented within the PM technical basis fields in CAS. 10CFR20.1501(c) requires these instruments to be calibrated at an appropriate frequency to ensure reliability in an accident and does not define a required frequency.

Because the MNS SLC does not adequately differentiate between high and low range channels, the NRC questioned if changes should have been conducted under licensing commitment change processes. The instrument tables in SLC 16.11.2 and 16.11.7 need to be revised to differentiate between high and low range channels for EMF 36, 44, and 49.

AR 02452188

Clarify applicability is for low range channel of dual-range monitors for SLC 16.7.6, 16.11.2 and 16.11.7.

AR 02452190

Clarify applicability is for low-range monitor for dual-range channels.

DUKE ENERGY

Facility Code :	MC
Applicable Facilities :	
Document Number :	ODCM McGuire
Document Revision Number :	061
Document EC Number :	
Change Reason :	
Document Title :	Offsite Dose Calculation Manual - McGuire

Bridges, Madison B	Approver	9/26/2022

Notes :

McGuire Nuclear Station
Units 1 and 2

ODCM

Offsite Dose
Calculation Manual

McGuire Nuclear Station
Units 1 and 2

OFFSITE DOSE CALCULATION MANUAL (ODCM)

Revision 61

Prepared By: Madison B. Bridges, MNS Scientist, Station Sciences	Signature	Date 9-20-2022
Reviewed By: Dave J. Lloyd, MNS Radiation Protection Superintendent	Signature Dave J Lloyd	Date 9-20-2022
Approved By: Travis Rollins, MNS Station Sciences Manager	Signature Travis Rollins	Date 9-21-2022

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EXECUTIVE SUMMARY

The McGuire Nuclear Station (MNS) Offsite Dose Calculation Manual (ODCM) provides the methodology and parameters to be used in the calculation of offsite doses due to normal operation radioactive liquid and gaseous effluents to assure compliance with the dose limitations of the Selected Licensee Commitments (SLCs, UFSAR Chapter 16) and Technical Specifications (TSs). These dose limitations assure that:

(1) the concentration of radioactive liquid effluents released from the site to the unrestricted area will be limited to 10 times the effluent concentration (EC) levels of 10CFR20, Appendix B, Table 2, and 2.0E-04 μCi/ml for dissolved and entrained noble gases (TS 5.5.5(a)(2), SLC 16.11.1);

(2) the exposures to any individual member of the public from radioactive liquid effluents will not result in doses greater than the ALARA design objectives of 10CFR50, Appendix I or the 10CFR20 limits (TS 5.5.5(a)(4), SLC 16.11.3);

(3) the dose rate at any time at the site boundary from radioactive gaseous effluents will be limited to: for noble gases; less than or equal to 500 mrem/yr to the whole body, and less than or equal to 3000 mrem/yr to the skin; and for iodine-131 and iodine-133, for tritium, and for all radioactive materials in particulate form with half-lives greater than 8 days; less than or equal to 1500 mrem/yr to any organ (TS 5.5.5(a)(7), SLC 16.11.6);

(4) the exposure to any individual member of the public from radioactive gaseous effluents will not result in doses greater than the ALARA design objectives of 10CFR50, Appendix I or the 10CFR20 limits (TS 5.5.5(a) (8 and 9), SLCs 16.11.8 and 16.11.9); and

(5) the dose to any individual member of the public from the nuclear fuel cycle will not exceed the limits of 40CFR190 (TS 5.5.5(a)(10), SLC 16.11.12).

The methodology and parameters used to assure compliance with the dose limitations described above shall be used to prepare the radioactive liquid and gaseous effluent reports required by the SLCs and Technical Specifications. Dose calculations that demonstrate compliance with 40CFR190 will be considered to demonstrate compliance with the 10CFR20 0.1-rem annual dose limit. The ODCM also provides the methodology and parameters to be used in the calculation of radioactive liquid and gaseous effluent monitoring instrumentation alarm/trip setpoints to assure compliance with the concentration and dose rate limitations of the SLCs and Technical Specifications. Software implementing NUREG-0133 methodology is used for the calculation of offsite doses, but the ODCM also provides a method for the calculation of offsite doses when the software is not available.

The ODCM has been prepared as generically as possible in order to minimize the need for revisions. Any changes to the methodology and parameters to be used in this ODCM shall be reviewed by knowledgeable individual(s), and approved by the Station Manager or Radiation Protection Manager prior to implementation. Changes to the ODCM shall be submitted to the Nuclear Regulatory Commission in accordance with the SLCs and Technical Specifications.

The ODCM does not replace any station implementing procedures. Programmatic controls for radioactive effluents and radiological environmental monitoring are contained in the Administrative Controls chapter of the Technical Specifications. Procedural details for radioactive effluents and radiological environmental monitoring consisting of licensee commitments, applicability, remedial actions, surveillance requirements, and the bases for these requirements are contained in Section 16.11 of the SLCs.

1.0 RADWASTE SYSTEMS

1.0.1 LIQUID RADWASTE PROCESSING

The liquid radwaste system at McGuire Nuclear Station is used to collect and treat liquid chemical and radiochemical byproducts of unit operation. The system produces effluents that can be reused in the plant or discharged to the environment. The means of treatment vary with waste type and desired product in the various systems:

(A) Filtration - Waste sources are filtered during processing. In some cases, such as the Floor Drain Tank (FDT) subsystem of the Liquid Waste System (WL), filtration may be the only treatment required.

(B) Adsorption - Adsorption of halides and organic chemicals by activated charcoal (carbon filter) may be used in treating waste in the Laundry and Hot Shower Tank (LHST). The carbon filter is designed to remove organophosphates and free chlorine. Activated charcoal need not be used when these chemicals are not present (e.g., phosphate detergents are not used at the station). Ion exchange resin or other media may be used in the carbon filter vessel as desired.

(C) Ion Exchange - Ion exchange is used to remove radioactive cations from solution, as in the case of the FDT waste after removal of organics by carbon filtration (adsorption). Ion exchange can also be used in removing both cations (cobalt, manganese) and anions (chloride, fluoride) from evaporator distillates in order to purify the distillates for reuse as makeup water. Distillate from the Boron Recycle Evaporator in the Boron Recycle System (NB) can be treated by this method.

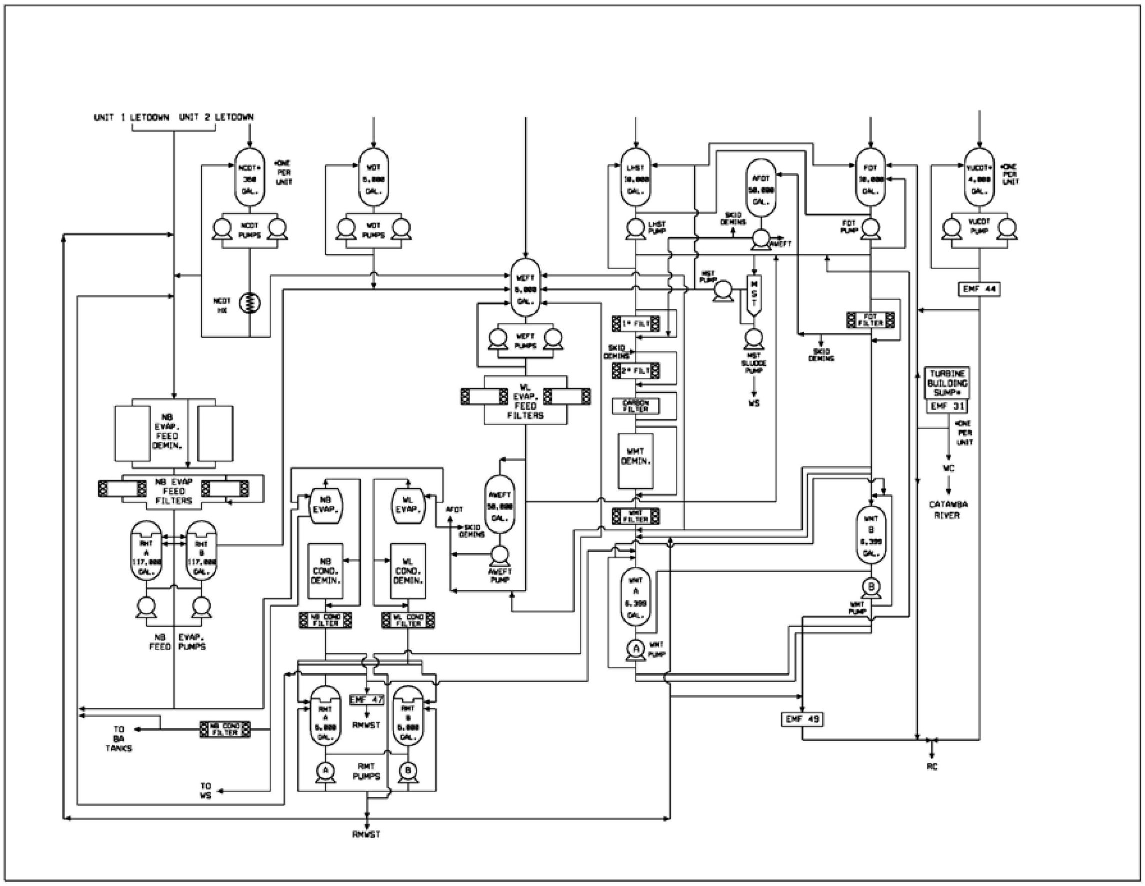
(D) Gas Stripping - Removal of gaseous radioactive fission products is accomplished in the NB Evaporator.

(E) Distillation - Production of pure water from the waste by boiling it away from the contaminated solution which it was originally contained is accomplished by the NB evaporator. Proper control of the process will yield water that can be reused for makeup. Polishing of this product can be achieved by ion exchange as pointed out above.

(F) Concentration - In the NB Evaporator, dissolved chemicals are concentrated in the lower shell as water is boiled away. The dilute boron is normally concentrated to 4% so that it may be reused for makeup to the reactor coolant system.

Figure 1.0-1 is a schematic representation of the liquid radwaste system at McGuire.

Figure 1.0-1 McGuire Nuclear Station Liquid Radwaste System



1.0.2 GASEOUS RADWASTE PROCESSING

The Gaseous Waste System (WG) for McGuire is designed with the capability of processing the fission product gases from contaminated reactor coolant fluids resulting from operation. The design basis for the WG shown schematically in Figure 1.0-2 is the retention, through the plant lifetime, of all the gaseous fission products to be discharged from the reactor coolant system to the Chemical and Volume Control System (NV) and other plant systems to eliminate the need for intentional discharge of radioactive gases from the waste gas holdup tanks. Actual system operation is aimed at maximizing storage time for decay prior to infrequent releases. Unavoidable sources of low level radioactive gaseous discharge to the environment will be from periodic purging operations of the containment, and through the secondary system air ejector. With respect to the former, the potential fission product gas is expected to arise from non-recyclable reactor coolant leakage. With respect to the air ejector, the potential source of fission product gas will be from leakage of the reactor coolant to the secondary system through defects in steam generator tubes. The gaseous waste disposal system includes two waste gas compressors, two catalytic hydrogen recombiners, six gas decay storage tanks for use during normal power generation, and two gas decay storage tanks for use during shutdown and startup operations.

1.0.2.1 GAS COLLECTION SYSTEM

The gas collection system combines the waste hydrogen and fission gases from the volume control tanks, the boron recycle and liquid waste gas stripper evaporators, and other sources produced during normal operation or the gas collected during the shutdown degasification (high percentage of hydrogen), and cycles it through the catalytic recombiners to convert hydrogen to water. After the water vapor is removed, the resulting gas stream is transferred from the recombiner into the waste gas decay tanks (WGDTs), where the accumulated activity may be contained in six approximately equal parts. From the decay tanks, the gas flows back to the compressor suction to complete the loop circuit.

1.0.2.2 CONTAINMENT AND AUXILIARY BUILDING VENTILATION

Non-recyclable reactor coolant leakage occurring either inside the containment or inside the auxiliary building will generate gaseous activity. Gases resulting from leakage inside the containment atmosphere will be circulated through a charcoal adsorber and a particulate filter prior to release to the atmosphere.

Gases resulting from leakage inside the auxiliary building are released, without further decay, to the atmosphere. The ventilation exhaust from potentially contaminated areas in the auxiliary building is passed through charcoal adsorbers and particulate filters to reduce releases to the atmosphere upon a radiation monitor alarm.

1.0.2.3 SECONDARY SYSTEMS

The gases removed from the secondary system by the air ejectors are discharged to the unit vent. If the secondary system contains activity, the steam generator blowdown may be either discharged directly to the condenser cooling water system or through demineralizers to reduce activity levels.

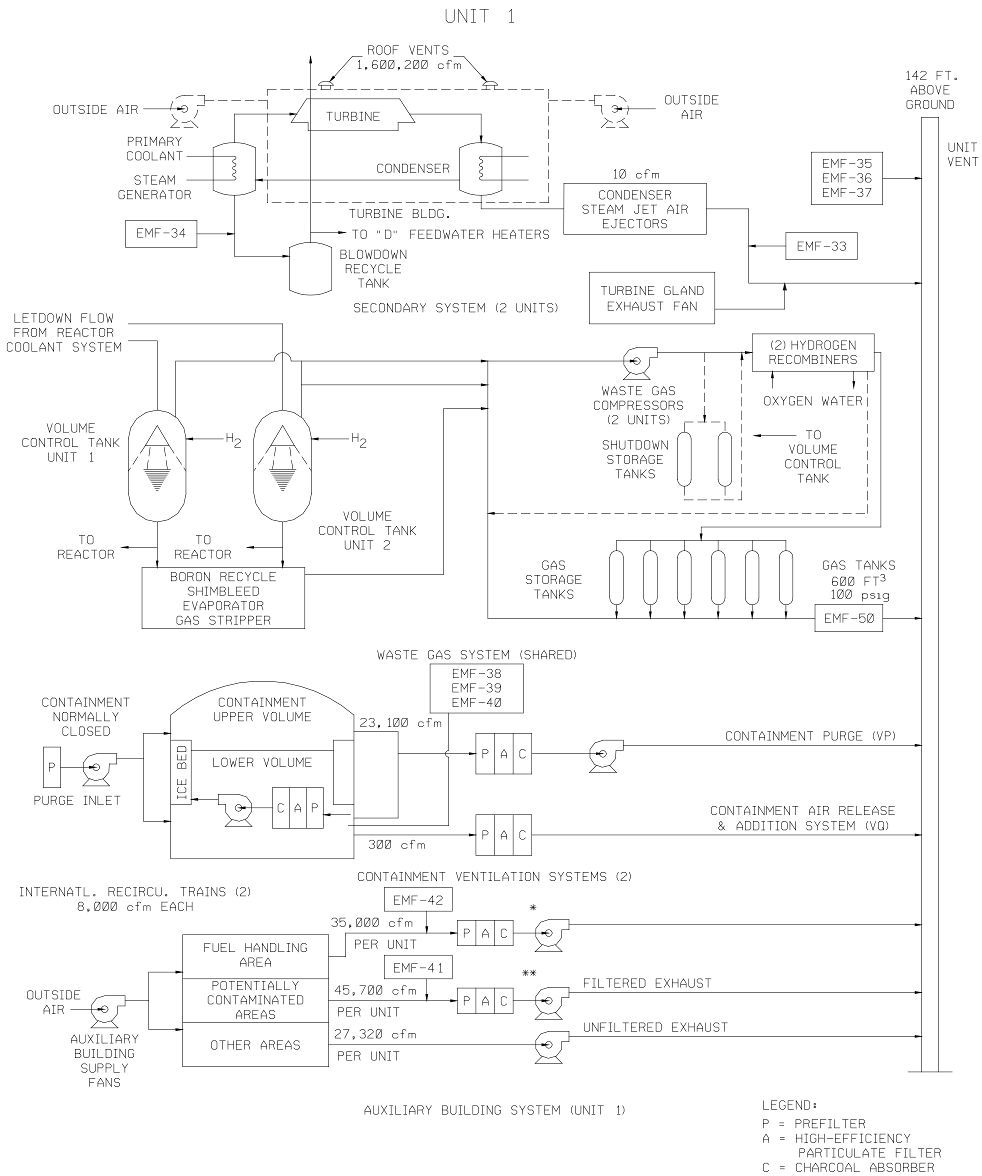
Gland leak-off steam, which represents a minor source of activity, is routed to the gland condenser. The non-condensable gases are exhausted to the unit vent; the condensables are condensed and drained to the condensate storage tank.

Some low radioactivity secondary system steam releases can occur at the site such as from infrequent lifts or testing of the main steam power operated relief valves (PORVs) and the code safety main steam relief valves. Radioactivity released from secondary system steam releases is documented and included in the site effluent release total.

Figure 1.0-2 is a schematic representation of the gaseous radwaste system at McGuire.

Figure 1.0-2 McGuire Nuclear Station Gaseous Radwaste System

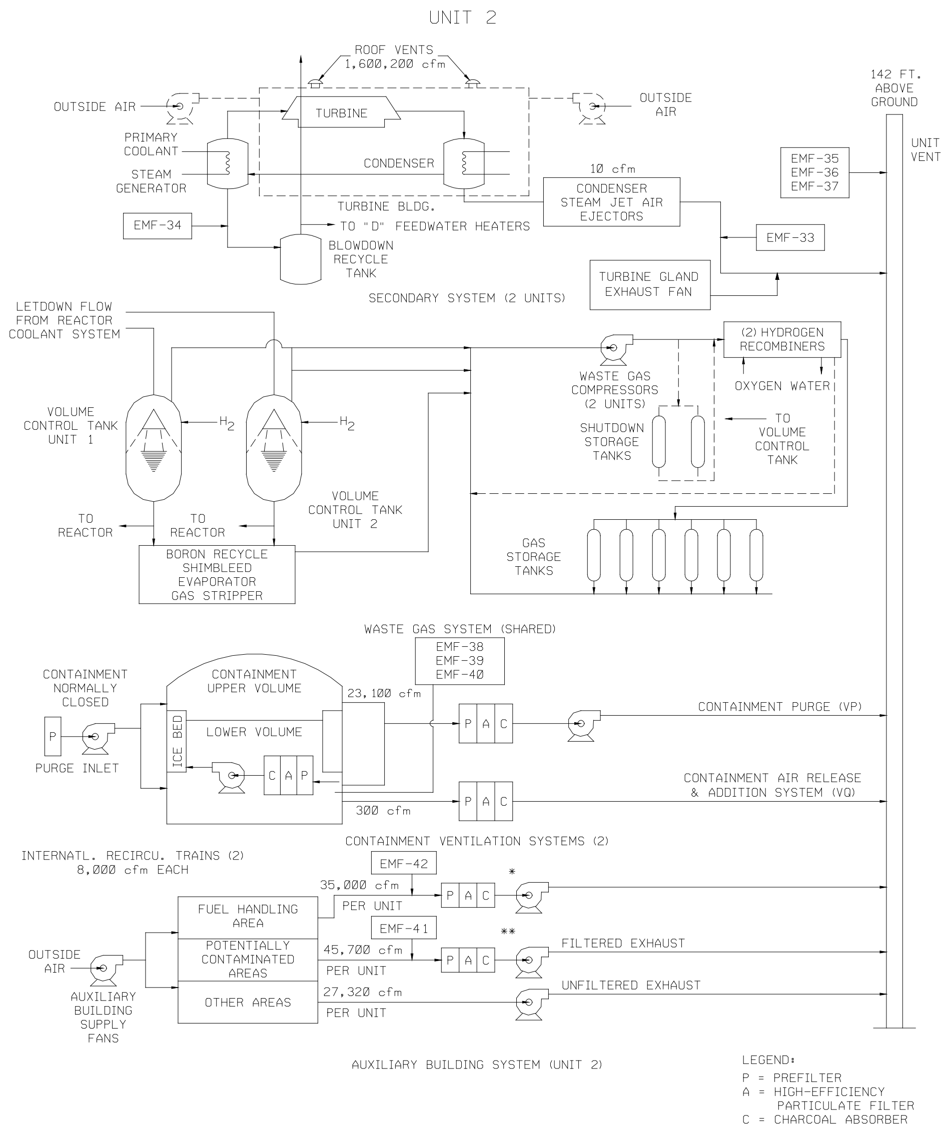
Page 1 of 2



* FUEL HANDLING AREA IS NORMALLY UNFILTERED. UPON A RADIATION ALARM BY EMF-42, THE EXHAUST WILL BE DIVERTED TO THE FILTER MODE.

** POTENTIALLY CONTAMINATED AREAS OF THE AUXILIARY BUILDING ARE NORMALLY UNFILTERED. UPON A RADIATION ALARM BY EMF-41, THE EXHAUST WILL BE DIVERTED TO THE FILTERED MODE.

Figure 1.0-2 McGuire Nuclear Station Gaseous Radwaste System Page 2 0f 2



*FUEL HANDLING AREA IS NORMALLY UNFILTERED. UPON A RADIATION ALARM BY EMF-42, THE EXHAUST WILL BE DIVERTED TO THE FILTER MODE.

**POTENTIALLY CONTAMINATED AREAS OF THE AUXILIARY BUILDING ARE NORMALLY UNFILTERED. UPON A RADIATION ALARM BY EMF-41, THE EXHAUST WILL BE DIVERTED TO THE FILTERED MODE.

2.0 RELEASE RATE CALCULATIONS

2.0.1 LIQUID RELEASE RATE LIMIT CALCULATIONS

There are two liquid radwaste discharge points to the environment at McGuire; (1) the Condenser Cooling Water System (RC) discharge point to Lake Norman, and (2) the Conventional Waste Water System (WC) and Waste Water Collection Basin (WWCB) discharge point to the Catawba River downstream of Cowan's Ford Dam (See Figure 2.0-1).

2.0.1.1 RC DISCHARGE RELEASE RATE LIMIT CALCULATION

Liquid releases to Lake Norman through the RC pathway normally contain the radioactive releases from the site including effluents from the waste monitor tanks and containment ventilation unit condensate drain tanks. The RC discharge point can also contain Turbine Building Sump (TBS) releases, however TBS effluent is normally released through WC. Condenser unwatering (WU) is normally released to the WWCB discharge point. Each unit has four RC pumps that pump 2.5E5 gpm each and provide dilution for releases. Each release path has a radiation monitor (EMF) that is used to monitor the liquid effluent (See Figure 2.0-2).

To comply with Technical Specifications and Selected Licensee Commitments, and to assure that the concentration of radioactive liquid effluents released from the site to the unrestricted area is limited to 10 times the effluent concentrations (ECs) of 10CFR20, Appendix B, Table 2, Column 2, and 2.0E-04 μCi/ml for dissolved and entrained noble gases, the following release rate limit calculation shall be performed for liquid releases to Lake Norman via the RC discharge point:

$$f \leq \left(F \div (DF - 1)\right) \quad \text{Condition: } DF > 1.0 \qquad \text{Equation 2.1}$$

where:

f = the undiluted effluent flow, in gpm.

F = the dilution flow available depending on the number (1-8) of RC pumps in service, in gpm.
= (2.50E+05 gpm/pump) × (# of RC pumps in service)

DF = required dilution factor to be applied to the undiluted effluent flow, unitless.

$$DF = \sigma \times \sum_i \frac{C_i}{(10 \times EC_i)} \qquad \text{Equation 2.2}$$

Note:

If $DF \leq 1.0$ then no dilution is required and the release rate is unrestricted.

If $DF > 1.0$ then dilution flow is required and the allowable release rate is calculated using Equation 2.1. Equation 2.1 is used only when DF > 1.0.

σ = the recirculation factor at equilibrium at the RC discharge location, (dimensionless). The recirculation factor accounts for the fraction of discharged water reused by the station. Equation reference: McGuire Final Environmental Statement, (10/1972)

$$\sigma = 1 + \frac{Q_{df}}{Q_{cf}} = 1 + \frac{3740}{2976} = 2.26$$

where:

Q_{df} = annual average RC dilution flow (3740 cfs). (1990-1994 average flow)

Q_{cf} = annual average flow past Cowans Ford Dam (2970 cfs). (1990-1994 average flow)

C_i = the concentration of radionuclide, 'i', in the undiluted liquid effluent, in μCi/ml.

EC_i = the concentration of radionuclide, 'i', from 10CFR20, Appendix B, Table 2, Column 2, in μCi/ml. Note: if radionuclide, 'i', is a dissolved noble gas, then EC_i = 2.00E-05 μCi/ml.

2.0.1.2 WC AND WWCB DISCHARGE

Liquid releases to the Catawba River through the WC and WWCB discharge pathways normally contain measurable activity above background. The WC/WWCB effluent typically accounts for <1% of the station total liquid activity released. Although designed for continuous discharge, inputs to WC, primarily from the Unit 1 and Unit 2 turbine building sumps, are normally held up in one of two WC Settling Ponds, and then released as a batch. There is a composite sampler at the discharge to the river. An EMF monitors the TBS and Condenser Drain (WU) output (See Figure 2.0-3). It is assumed that no activity is present in the TBS/WU effluent until indicated by radiation monitoring measurements. If an EMF alarms, the TBS/WU pumps are secured. At this time the discharge may be routed to the floor drain tank for processing or routed directly to the condenser cooling water (RC) flow rather than to WC.

Releases going directly to the WWCB are in continuous release. Some activity is planned for release through this pathway during condenser draining; therefore, grab samples are collected and retained for composite generation. Similar to WC, the only radiation monitoring is on the TBS/WU output (see Figure 2.0-3).

WZ (groundwater) Sump C discharges to the Standby Nuclear Service Water Pond (SNSWP). To account for WZ activity discharged into the SNSWP a composite sampler is installed in WZ Sump C (see Figure 2.0-3).

Figure 2.0-1 Liquid Radwaste Discharge Locations

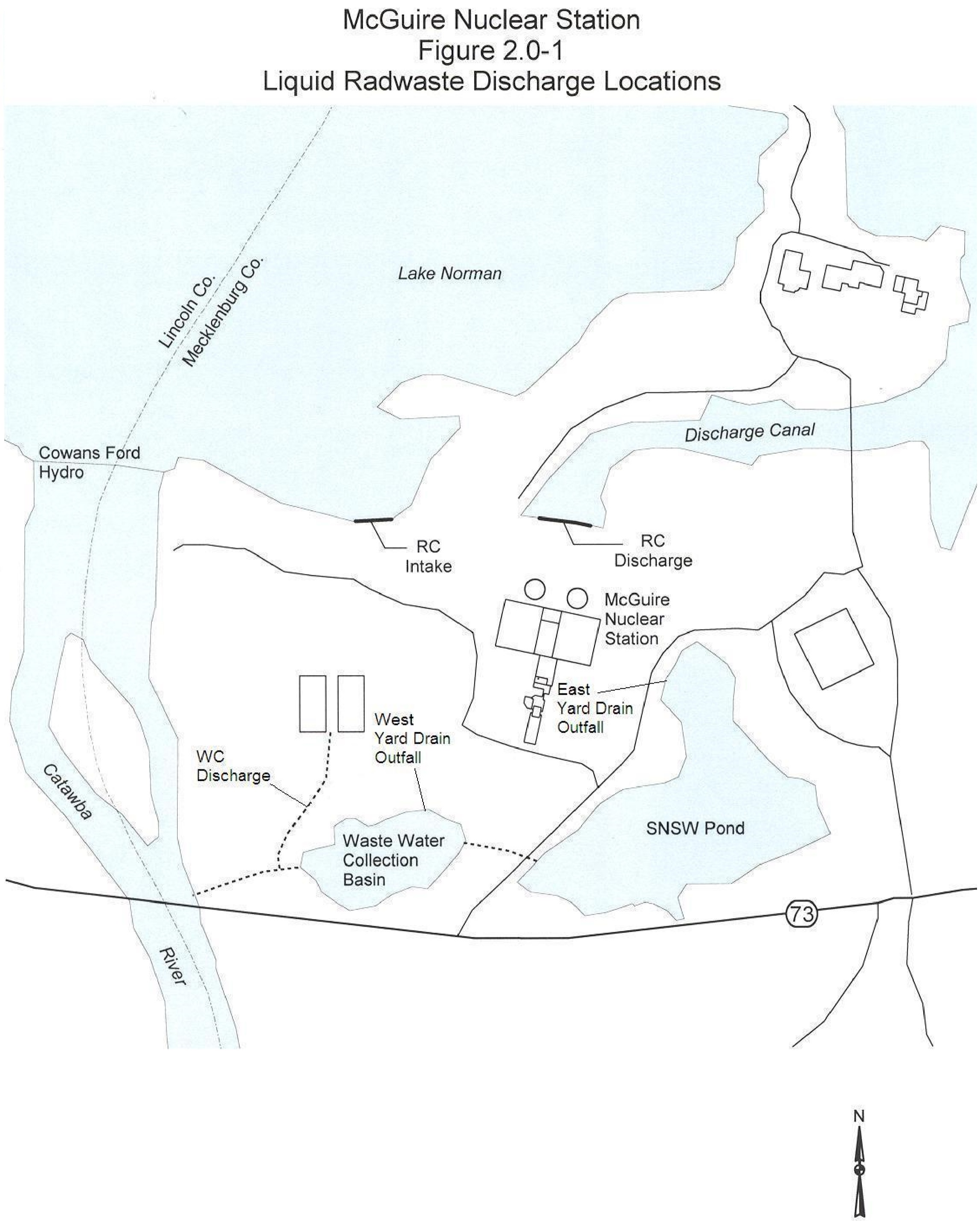


Figure 2.0-2 RC Discharge to Lake Norman

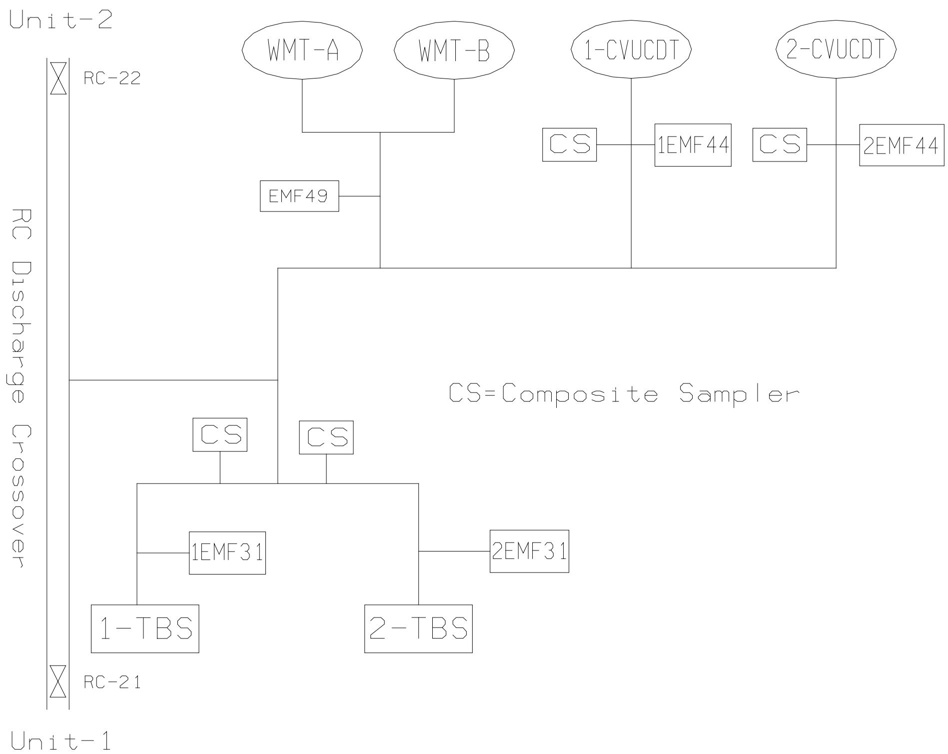
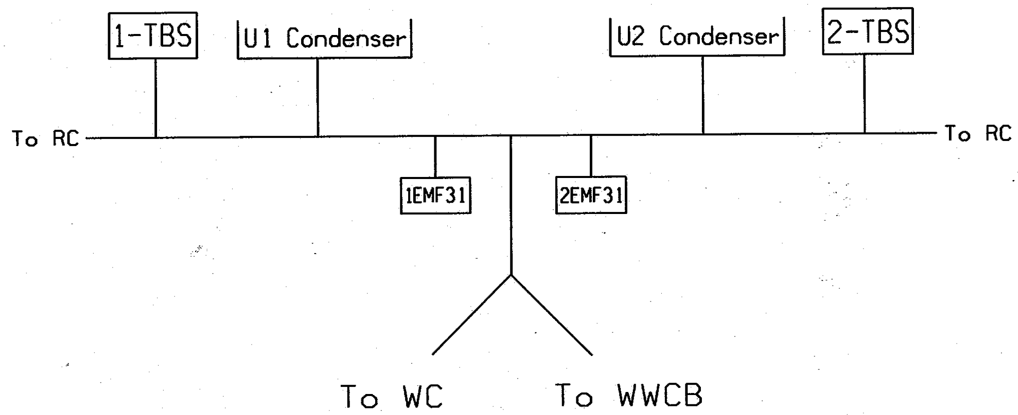
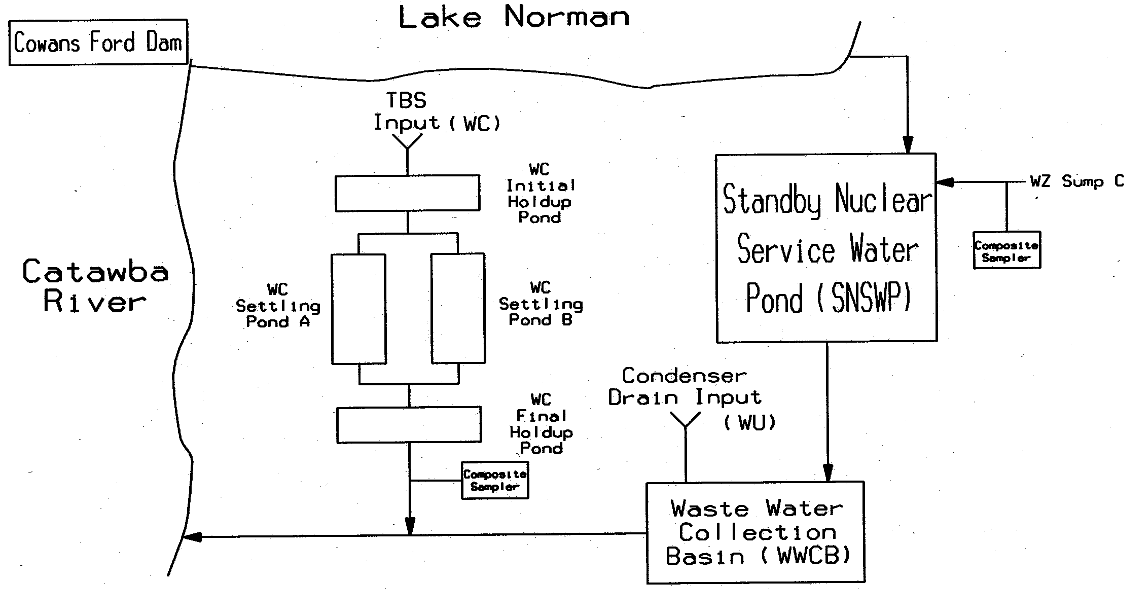


Figure 2.0-3 WC and WWCB Discharge to the Catawba River





2.0.2 GASEOUS RELEASE RATE LIMIT CALCULATIONS

The two unit vents are the primary gaseous radioactive release points at McGuire. The unit vents are the release points for waste gas decay tanks, containment building purges, auxiliary building ventilation, and the condenser air ejector (see Figure 2.0-4). Each unit vent contains multi-range radiation monitors (EMFs) and flow rate measuring instrumentation.

There are three other separate gaseous effluent release points at McGuire; the Waste Management Facility, Waste Handling Area and Unit 2 Staging Building. These three release points contribute a small percentage of the total site gaseous effluent. Each release point has an EMF, composite sampler, and flow totalizer (see Figure 2.0-5).

2.0.2.1 UNIT VENT DISCHARGE RELEASE RATE LIMIT CALCULATION

In order to comply with Technical Specifications and Selected Licensee Commitments and to assure that the dose rate, at any time, at or beyond the site boundary due to radioactive materials released in gaseous effluents from the site is limited to: ≤ 500 mrem/yr to the total body, and ≤ 3000 mrem/yr to the skin for the noble gases, and is limited to ≤ 1500 mrem/yr to any organ for radioiodine and for radioactive materials in particulate form, and radionuclides other than noble gases with half lives greater than 8 days, the following release rate and radiation monitor setpoint calculations shall be performed for releases from the waste gas decay tanks and the containment building. The release rate calculations when solved for the flow rate,'f', are the release rates for noble gases and for radioiodines, particulates and other radionuclides with half-lives greater than 8 days. The most conservative release rate calculated shall control the flow rate. The following equations are based on the site dose rate limits. For simultaneous releases a multiple release calculation is performed to ensure that the site dose rate limits are not exceeded.

a. Noble Gases

Total Body:

$$\sum_i \left(K_i \times \frac{\chi}{Q} \times Q_i \right) < 500 \text{ mrem/yr} \qquad \text{Equation 2.3}$$

Skin:

$$\sum_i \left(\left(L_i + 1.1M_i\right) \times \frac{\chi}{Q} \times Q_i \right) < 3000 \text{ mrem/yr} \qquad \text{Equation 2.4}$$

b. Radioiodines, Particulates, and Others

Inhalation, Ingestion and Ground Organ Pathways:

$$\sum_{p} \sum_{i} \left(P_{opi} \times W \times Q_i \times E_i\right) < 1500 \text{ mrem/yr}$$

To include both the food and ground organ dose and the inhalation organ dose the equation can be expanded to:

$$\sum_{p} \sum_{i} \left(\left\{\left(P_{opi}\right)_{food/gr} \times W_{D/Q} + \left(P_{opi}\right)_{inhal} \times W_{\chi/Q}\right\} \times Q_i \times E_i\right) < 1500 \text{ mrem/yr}$$

Equation 2.5

where:

K_i = the total body dose factor due to gamma emissions for each identified noble gas radionuclide, ‘i’, in mrem/yr per $\mu Ci/m^3$ (See Appendix A).

L_i = the skin dose factor due to beta emissions for each identified noble gas radionuclide, ‘i’, in mrem/yr per $\mu Ci/m^3$ (See Appendix A).

M_i = the air dose factor due to gamma emissions for each identified noble gas radionuclide, ‘i’, in mrad/yr per $\mu Ci/m^3$ (See Appendix A).

1.1 = ratio to convert dose (mrad) to dose equivalent (mrem).

P_{opi} = the dose parameter for radionuclides other than noble gases for the inhalation pathway, in mrem/yr per $\mu Ci/m^3$ and for the food and ground plane pathways in (m^2 × (mrem/yr per μCi/sec)) for organ, ‘o’, and radionuclide, ‘i’, (See Appendix B for the pathway specific dose commitment factors). Note: NUREG-1301, page 75, specifies use of the Child age group, Inhalation pathway, for the P_{opi} values.

χ/Q = the highest calculated annual average dispersion parameter for any area at or beyond the site boundary in sec/m^3. For McGuire this value is 7.611E-5 sec/m^3. The location is the NNE sector at 0.5 mile. The boundary for establishing gaseous effluent release limits is the Exclusion Area Boundary (EAB). As shown in McGuire UFSAR Figure 2-5, the EAB is defined as a 2500 foot (~0.5 mile) radius from the station center.

W = the highest calculated annual average dispersion or deposition parameter for estimating the maximum dose rate to an individual from the total inhalation, food, and ground plane pathways:

$W_{\chi/Q}$ = 7.611E-5 sec/m^3, for the inhalation pathway and the airborne H-3 food pathway. The location is the NNE sector at 0.5 mile.

$W_{D/Q}$ = 1.403E-7 m^{-2}, for the food and ground plane pathways. The location is the NNE sector at 0.5 mile.

E_i = the filter removal factor for radionuclide, 'i', e.g., for 99% removal $E_i = 0.01$. For VQ and VP releases $E_i = 0.1$ for iodine, 0.01 for particulates. There is no filtration for WGDT releases.

Q_i = the release rate of radionuclide, 'i', in gaseous effluent from all release points at the site, in µCi/sec.

$$Q_i = k_1 C_i f \div k_2 = 472 \times C_i f \qquad \text{Equation 2.6}$$

where:

C_i = the concentration of radionuclide, 'i', in undiluted gaseous effluent, in µCi/ml.

f = the undiluted effluent flow, in ft^3/min.

k_1 = conversion factor, 2.83E+04 cc/ft^3.

k_2 = conversion factor, 60 sec/min.

Substituting the expression for Q_i in Equation 2.6 into Equations 2.3, 2.4, and 2.5, and solving for the flow rate, 'f', in each equation gives:

Noble Gases - Total Body Maximum Release Rate:

$$f_{tb} < \frac{500}{472 \times \chi/Q \times \sum_{i} (K_i \times C_i)}$$

Noble Gases - Skin Maximum Release Rate:

$$f_{sk} < \frac{3000}{472 \times \chi/Q \times \sum_{i} [(L_i + 1.1 M_i) \times C_i]}$$

Radioiodines, Particulates, and Others - Organ Maximum Release Rate:

$$f_{or} < \frac{1500}{472 \times \sum_{p} \sum_{i} (\{(P_{opi})_{\text{food/gr}} \times W_{D/Q} + (P_{opi})_{\text{inhal}} \times W_{\chi/Q}\} \times E_i \times C_i)}$$

f_{tb}, f_{sk}, and f_{or}, are calculated for each batch prior to release. The most limiting gaseous release rate is used to assure that no instantaneous dose rate limit is exceeded.

Figure 2.0-4 Unit Vent Release Points

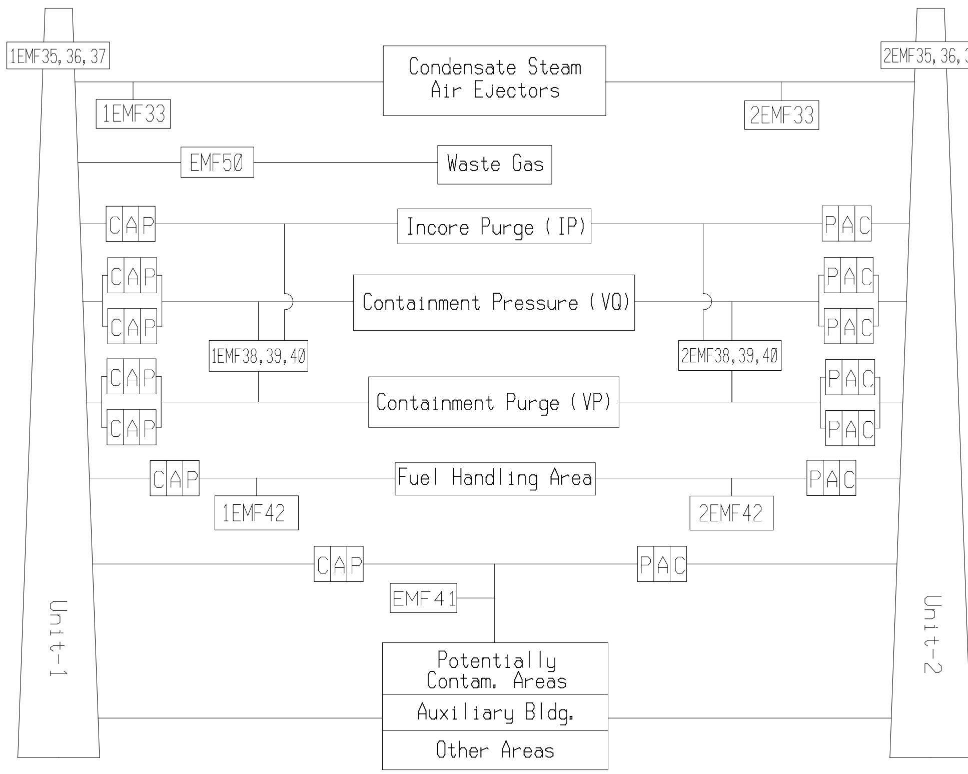
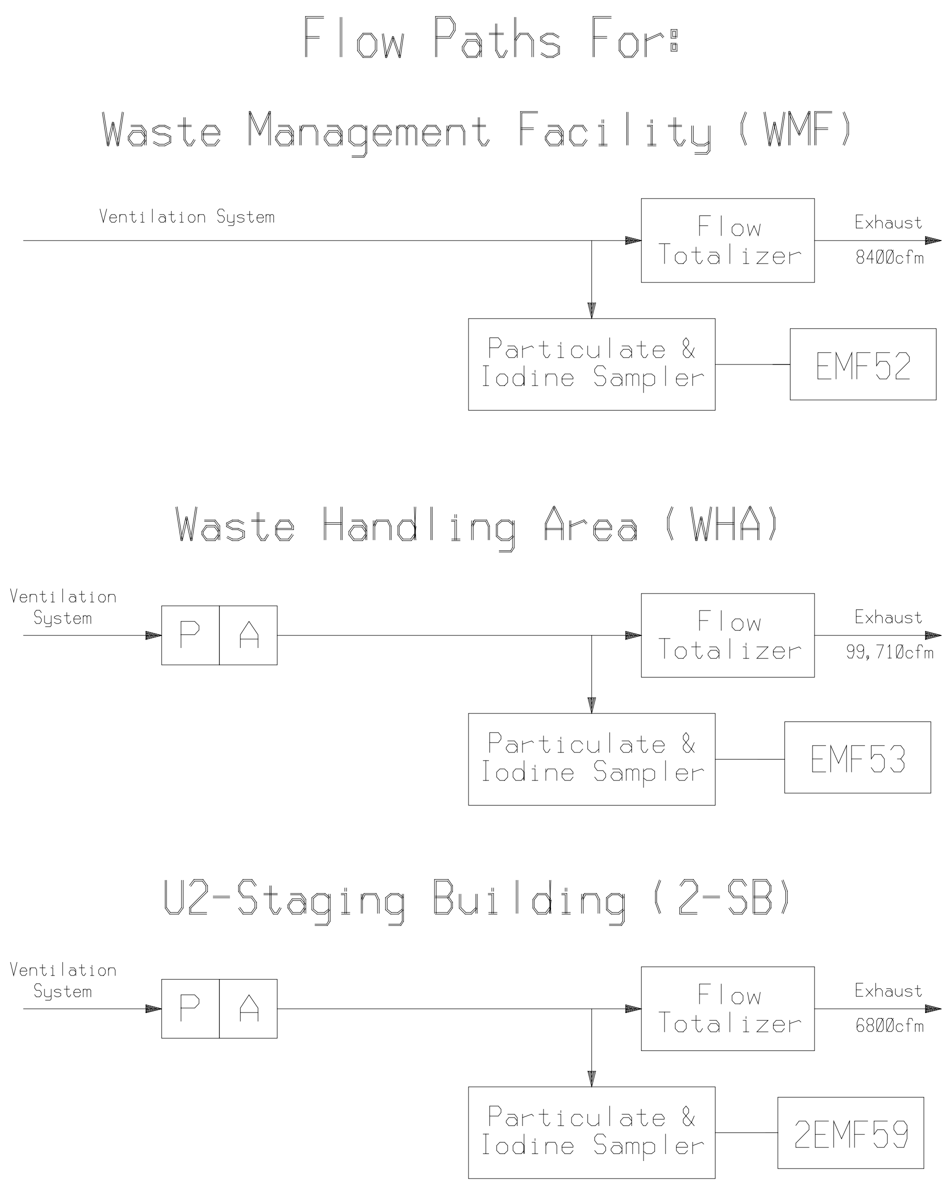


Figure 2.0-5 WMF, WHA, 2-SB Release Points



Derivations of Iodine, Particulate, and H-3 Dose Commitment Factors (P_{opi})

Inhalation Pathway - Child Age Group

$$P_{opi} = K'(BR)(DFA_{oi})$$

Formula: from NUREG-0133, page 25.	
Where:	
P_{opi}	Dose commitment factor for Child age group, organ o, nuclide i, for the inhalation pathway (mrem/yr per μCi/m^3). (See Appendix B for the pathway specific dose commitment factors).
K'	Units conversion factor pCi/μCi (10^6).
BR	Breathing rate for the Child age group (m^3/yr, from Regulatory Guide 1.109): Child – 3700
DFA_{oi}	Organ inhalation dose conversion factor for Child age group, organ o, nuclide i, (mrem/pCi), from Table E-9 of Regulatory Guide 1.109.

3.0 SETPOINT CALCULATIONS

3.0.1 LIQUID RADIATION MONITOR SETPOINT CALCULATIONS

Once the liquid release rate parameters have been established radiation monitor setpoints shall be calculated to assure that the concentration of radioactive liquid effluents released from the site to the unrestricted area is limited to ten times the effluent concentrations (ECs) of 10CFR20, Appendix B, Table 2, Column 2, and 2.0E-04 µCi/ml for dissolved and entrained noble gases. By substituting the dilution factor (DF) from Equation 2.2 into Equation 2.1, solving for the undiluted liquid effluent concentration, C_i, and accounting for the monitor background reading, the liquid radiation monitor setpoint can be readily obtained by multiplying C_i by the radiation monitor correlation factor, CF_i, as follows:

$$C_i \leq \frac{(F + f) \times (10 \times EC_i)}{\sigma \times f}$$ Equation 3.1

$$SP \leq \sum_i (C_i \times CF_i) + bkg$$ Equation 3.2

where:

C_i = the maximum allowable concentration of radionuclide, ‘i’, in the undiluted liquid effluent, in µCi/ml.

SP = radiation monitor setpoint, in cpm.

CF_i = radiation monitor correlation factor for radionuclide, ‘i’, in cpm/µCi/ml. These correlation factors are controlled by station procedures.

bkg = background reading for the radiation monitor, in cpm.

All other parameters were previously defined.

Using conservative or "worst-case" parameters in Equation 3.1 and Equation 3.2 can provide a liquid radiation monitor setpoint that does not need to be revised for every release if activity is low enough to allow for this type of operation such as with continuous releases from the WC release point. However, for batch releases, e.g., waste monitor tanks, through the RC discharge the radiation monitor setpoint is calculated based on actual expected activity in the release. In general, liquid radiation monitors are calibrated to Cs-137, and their setpoints are calculated as follows:

$$C_{Cs-137} = \sum_i \left(C_i \times Eq_i \right)$$

$$Expected\ cpm = \left(C_{Cs-137} \times CF_{Cs-137} \right) + bkg \qquad \text{Equation 3.3}$$

"Trip" setpoints are set based on a multiplier factor above the "expected" cpm calculated in Equation 3.3.

where:

$C_{Cs\text{-}137}$ = Cs-137 equivalent concentration, in µCi/ml.

Eq_i = Cs-137 equivalence factor for each isotope, excluding tritium, to that of Cs-137 due to different gamma energies and abundance. This factor includes a 4-hour decay time due to the average time between sample and release. (See Table 3.0-1).

All other parameters were previously defined.

3.0.1.1 WASTE MONITOR TANK SETPOINTS (EMF 49)

As shown on Figure 2.0-2, EMF 49 is the controlling radiation monitor for Waste Monitor Tank (WMT) releases. EMF 49 setpoints are based on actual tank activity, and are calculated as follows:

$$Expected\ cpm = \left(C_{Cs-137} \times CF_{Cs-137} \right) + bkg$$

$$Trip\ 1\ setpoint = \left(C_{Cs\text{-}137} \times CF_{Cs\text{-}137} \times 1.5 \right) + bkg$$

When $Cs-137$ equivalent concentration ≤ 1.43E-05 µCi/ml:

$Trip\ 2\ setpoint = \left(C_{Cs\text{-}137} \times CF_{Cs\text{-}137} \times 2.0 \right) + bkg$ **or** $3 \times bkg$, whichever is higher.

If the Cs-137 equivalent concentration is ≤ 1.43E-05 µCi/ml, then 1.43E-05 is used in the Trip 1 and Trip 2 setpoint calculations. This is an indication of a low activity tank, and normal EMF fluctuation may cause Trip 2 alarms and release termination.

When $Cs-137$ equivalent concentration > 1.43E-05 µCi/ml:

$$Trip\ 2\ setpoint = \left(C_{Cs\text{-}137} \times CF_{Cs\text{-}137} \times 2.0 \right) + bkg$$

where:

$C_{Cs\text{-}137}$ = Cs-137 equivalent concentration, in µCi/ml.

$CF_{Cs\text{-}137}$ = EMF 49 Cs-137 correlation factor, 3.42E+08 cpm/µCi/ml.

bkg = Background reading from EMF 49 after flushed from previous releases.

3.0.1.2 CONTAINMENT VENTILATION UNIT CONDENSATE DRAIN TANK SETPOINTS (EMF 44)

As shown on Figure 2.0-2, EMF 44 is the controlling radiation monitor for Containment Ventilation Unit Condensate Drain Tank (CVUCDT) releases. EMF 44 setpoints are based on actual tank activity, and are calculated as follows:

$Expected\ cpm = C_{Cs-137} \times CF_{Cs-137}$ **or** *bkg*, whichever is higher.

$Trip\ 1\ setpoint = any\ value\ between\ Expected\ cpm\ and\ Trip\ 2.\ Normally\ 2 \times\ Expected\ cpm$

Trip 2 setpoint = The lesser of 3 × Expected cpm **or** *5.00E+06 cpm × #RC pumps*

where:

$C_{Cs\text{-}137}$ = Cs-137 equivalent concentration, in µCi/ml.

$CF_{Cs\text{-}137}$ = EMF 44 Cs-137 correlation factor, 3.42E+08 cpm/µCi/ml.

bkg = Background reading from EMF 44.

#RC pumps = The least number of available RC pumps that will produce a setpoint greater than Expected cpm.

5.00E+06 = Derived as follows from Equation 3.1:

$$C \leq \frac{(F+f) \times (10 \times EC)}{\sigma \times f}$$

Given the following for each parameter:

C = The gross activity in the undiluted effluent, µCi/ml.

f = Tank flow which varies from 0-60 gpm, assumed to be 60 gpm.

EC = 9.00E-07 µCi/ml, from 10CFR20, the EC for Cs-134 which is the smallest EC value for any detectable radionuclide that is not known to be absent from the mixture.

σ = Recirculation factor, previously defined as 2.26 (see Section 2, Page 2).

F = Dilution flow available: # of RC pumps × 2.50E+05 gpm/pump. Minimum dilution of one pump is used.

Substituting results in C ≤ 1.66E-02 µCi/ml. Next multiply by the EMF 44 correlation factor of 3.42E+08 cpm/µCi/ml: 1.66E-02 × 3.42E+08 = 5.68E+06 cpm. Value is rounded down to 5.00E+06 cpm for added conservatism.

3.0.1.3 TURBINE BUILDING SUMP TO RC SETPOINTS (EMF 31)

As shown on Figure 2.0-2, EMF 31 is the controlling radiation monitor for releases from the Turbine Building Sump (TBS) to the condenser cooling water system (RC). EMF 31 setpoints are based on actual sump activity, and are calculated as follows:

$Expected\ \ cpm = C_{Cs-137} \times CF_{Cs-137}$ **or** *bkg*, whichever is higher.

$Trip\ 1\,setpoint = any\ value\ between\ Expected\ cpm\ and\ Trip\ 2.\ Normally\ 2 \times\ Expected\ cpm$

$Trip\ 2\ setpoint = the\ lesser\ of\ 3 \times\ Expected\ cpm$ **or** $2.10E{+}05\ cpm \times \#RC\ pumps$

where:

$C_{Cs\text{-}137}$ = Cs-137 equivalent concentration, in µCi/ml.

$CF_{Cs\text{-}137}$ = EMF 31 Cs-137 correlation factor, 3.02E+08 (1EMF31) or 3.06E+08 (2EMF31)

bkg = Background reading from EMF 31.

#RC pumps = The least number of available RC pumps that will produce a setpoint greater than Expected cpm.

2.10E+05 = Derived as follows from Equation 3.1:

$$C \le \frac{(F+f) \times (10 \times EC)}{\sigma \times f}$$

Given the following for each parameter:

C = The gross activity in the undiluted effluent, µCi/ml.

f = Sump flow which varies from 0-1340 gpm, assumed to be 1340 gpm.

EC = 9.00E-07 µCi/ml, from 10CFR20, the EC for Cs-134 which is the smallest EC value for any detectable radionuclide that is not known to be absent from the mixture.

σ = Recirculation factor at the RC discharge point, = 2.26.

F = Dilution flow available: # of RC pumps × 2.50E+05 gpm/pump. Minimum dilution of one pump is used.

Substituting the values yields C ≤ 7.47E-04 µCi/ml. Next multiply by the EMF 31 correlation factor of 3.02E+08 (1EMF31) or 3.06E+08 (2EMF31) cpm/µCi/ml: 7.47E-04 × 3.02E+08 (1EMF31) or 3.06E+08 (2EMF31) (1EMF31) or 3.06E+08 (2EMF31) = 2.26E+05 cpm. Value is rounded down to 2.10E+05 cpm for added conservatism.

3.0.1.4 TURBINE BUILDING SUMP TO WC SETPOINTS (EMF 31)

As shown on Figure 2.0-3, EMF 31 is the controlling radiation monitor for releases from the Turbine Building Sump (TBS) to WC. EMF 31 setpoints are based on actual sump activity, and are calculated as follows:

$Expected\ \ cpm = C_{Cs-137} \times CF_{Cs-137}$ **or** *bkg*, whichever is higher.

$Trip\ 1\,setpoint = any\ value\ between\ Expected\ cpm\ and\ Trip\ 2.\ Normally\ 2 \times\ Expected\ cpm$

$Trip\ 2\ setpoint = the\ lesser\ of\ 3 \times\ Expected\ cpm$ **or** $8.46E{+}03\ cpm$

where:

$C_{Cs\text{-}137}$ = Cs-137 equivalent concentration, in µCi/ml.

$CF_{Cs\text{-}137}$ = EMF 31 Cs-137 correlation factor, 3.02E+08 (1EMF31) or 3.06E+08 (2EMF31) cpm/µCi/ml.

bkg = Background reading from EMF 31.

8.46E+03 = Derived as follows from Equation 3.1:

$$C \le \frac{(F \times 0.1 + f) \times (10 \times EC)}{\sigma \times f}$$

Given the following for each parameter:

C = The gross activity in the undiluted effluent, µCi/ml.

f = Sump flow which varies from 0-6700 gpm, assumed to be 6700 gpm.

EC = 9.00E-07 µCi/ml, from 10CFR20, the EC for Cs-134 which is the smallest EC value for any detectable radionuclide that is not known to be absent from the mixture.

σ = Recirculation factor at point where WC enters the Catawba River downstream of Cowans Ford Dam = 1.26.

F = Dilution flow available: Cowans Ford flow may vary from 80 to 50,000 cfs, but is conservatively estimated at 436 cfs (1.96E5 gpm), the historic minimum dilution flow available.

0.1 = Only 10% of Cowans Ford flow is assumed for dilution credit to account for incomplete mixing of the WC effluent downstream of Cowans Ford Dam.

Substituting the values yields C ≤ 2.80E-05 µCi/ml. Next multiply by the EMF 31 correlation factor of 3.02E+08(1EMF31) or 3.06E+08 (2EMF31) cpm/µCi/ml: 2.80E-05 × 3.02E+08 (1EMF31) or 3.06E+08 (2EMF31) = 8.46E+03 cpm. Value is rounded down to 8.00E+03 cpm for added conservatism.

Table 3.0-1 Cs-137 Equivalents

Isotope	Equivalence Factor	Isotope	Equivalence Factor	Isotope	Equivalence Factor
Be-7	0.1282	Mo-99	0.3135	La-141	0.0132
F-18	0.5238	Tc-99m	0.5788	La-142	0.2785
Na-24	1.3013	Tc-101	0.00	Ce-141	0.4966
Cl-38	0.0068	Ru-103	1.1798	Ce-143	0.7066
K-40	0.0913	Ru-105	0.8673	Ce-144	0.1321
Cr-51	0.1207	Ru-106	0.4097	I-130	3.1610
Mn-54	1.0871	Ag-108m	3.2676	I-131	1.2074
Mn-56	0.4826	Ag-110m	3.5043	I-132	1.0137
Fe-59	0.9915	Cd-115	0.4739	I-133	1.0971
Co-57	0.8892	Cd-115m	0.0228	I-134	0.1396
Co-58	1.4883	In-115m	0.3048	I-135	0.8432
Co-60	1.8564	Sb-122	0.8691	Ar-41	0.1987
Cu-64	0.3577	Sb-124	2.0195	Kr-85	0.0054
Ni-65	0.1389	Sb-125	1.0467	Kr-85m	0.5240
Zn-65	0.5278	Sb-126	5.0018	Kr-87	0.1020
Zn-69m	0.9788	Sn-113	0.8413	Kr-88	0.4607
Se-75	1.9710	Sn-123	0.0062	Kr-89	0.00
Br-80m	0.0821	Sn-126	0.1747	Xe-131m	0.0211
Br-82	3.3664	Te-125m	0.0023	Xe-133	0.0520
Br-83	0.0054	Te-127	0.0116	Xe-133m	0.1176
Br-84	0.0056	Te-127m	0.0005	Xe-135	0.8334
Br-85	0.00	Te-129	0.0122	Xe-135m	0.00
Rb-86	0.0873	Te-129m	0.0526	Xe-137	0.00
Rb-88	0.00	Te-131	0.0016	Xe-138	0.00
Rb-89	0.00	Te-131m	1.9281	Nd-147	0.3706
Sr-89	0.0002	Te-132	1.0302	Hf-181	1.7053
Sr-91	0.6398	Te-134	0.0402	W-187	0.8499
Sr-92	0.3415	Cs-134	2.5843	Tl-208	0.00
Y-91	0.0028	Cs-136	3.1799	Bi-212	0.0140
Y-91m	0.0403	Cs-137	1.00	Bi-214	0.0003
Y-92	0.1281	Cs-138	0.0110	Pb-212	0.4507
Y-93	0.1009	Ba-133	1.2331	Pb-214	0.0018
Zr-95	1.1163	Ba-139	0.0255	Ra-226	0.0386
Zr-97	1.1163	Ba-140	0.5022	Ac-228	0.8370
Nb-95	1.1114	Ba-141	0.0002	Th-228	0.0090
Nb-95m	0.2929	Ba-142	0.00	Np-239	0.8989
Nb-97	0.1164	La-140	2.0586		

3.0.2 Gaseous Radiation Monitor Setpoint Calculations

In general, gaseous radiation monitors (EMFs) are calibrated to Xe-133, and for continuous release points, e.g., the two unit vents, are preset at a maximum value based on the 500 mrem/year total body gaseous release rate limit according to the following methodology. Note: when applied to the individual release points the 500 mrem/year site dose rate value is apportioned 40% to each unit vent, 7% to the Waste Handling Area, and 6.5% each to the Waste Management Facility and Unit 2 Staging Building.

$$K_{Xe-133} \times \chi / Q \times Q_{Xe-133} < 500 \text{ mrem/yr}$$

Solve for $Q_{Xe\text{-}133}$:

$$Q_{Xe-133} < \frac{500}{K_{Xe-133} \times \chi / Q} \qquad \text{Equation 3.4}$$

From Equation 2.6:

$$Q_{Xe-133} = 472 \times C_{Xe-133} \times f \qquad \text{Equation 3.5}$$

Substitute Equation 3.5 into Equation 3.4:

$$472 \times C_{Xe-133} \times f < \frac{500}{K_{Xe-133} \times \chi/Q}$$

Solve for $C_{Xe\text{-}133}$:

$$C_{Xe-133} < \frac{500}{472 \times f \times K_{Xe-133} \times \chi/Q}$$

$$SP = \left(C_{Xe-133} \times CF\right) + bkg \qquad \text{Equation 3.6}$$

where:

$K_{Xe\text{-}133}$ = 294, the total body dose factor due to gamma emissions for Xe-133, in mrem/year per $\mu Ci/m^3$ (See Appendix A).

χ/Q = the highest calculated annual average dispersion parameter for any area at or beyond the site boundary in sec/m^3. For McGuire this value is 7.611E-5 sec/m^3. The location is the NNE sector at 0.5 mile.

$Q_{Xe\text{-}133}$ = Xe-133 equivalent release rate limit for the noble gas total body dose pathway, in $\mu Ci/sec$.

472 = Conversion factor, $(cc/ft^3)/(sec/min)$.

$C_{Xe\text{-}133}$ = the maximum allowable Xe-133 equivalent concentration in the gaseous effluent, in μCi/cc.

f = the gaseous effluent flow from the tank, building, or vent, in ft^3/min.

SP = radiation monitor setpoint, in cpm.

CF = the Xe-133 equivalent monitor correlation factor, in cpm/μCi/cc. The correlation factors are controlled by station procedures.

bkg = the radiation monitor background reading, in cpm.

Equation 3.6 provides the methodology to calculate the maximum setpoint for continuous releases. However, most gaseous releases at McGuire are batch releases, e.g., Containment Purge (VP), in which the radiation monitor setpoint is calculated based on actual activity expected in the release. For batch releases with a low activity release rate, e.g., Containment Air Release and Addition (VQ), the expected monitor response is essentially no greater than the existing reading, and the trip setpoints are based on multiples of the existing cpm or a maximum based on flow rate. For batch releases where the effluent can contain activity significantly above background, e.g., Waste Gas Decay Tank (WGDT), the following setpoint methodology is used:

$$C_{Xe-133} = \sum_i \left(C_i \times Eq_i\right)$$

$$Expected\ Cpm = \left(C_{Xe-133} \times CF_{Xe-133}\right) + bkg \qquad \text{Equation 3.7}$$

"Trip" setpoints are set based on a multiplier factor above the "expected" cpm calculated in Equation 3.7.

where:

$C_{Xe\text{-}133}$ = Xe-133 equivalent concentration, in μCi/ml.

Eq_i = Xe-133 equivalence factor for each isotope, excluding tritium, to that of Xe-133 due to different beta energies and abundance. (See Table 3.0-2).

All other parameters were previously defined.

3.0.2.1 CONTAINMENT AIR RELEASE AND ADDITION (VQ) SETPOINTS (EMF 39)

As shown on Figure 2.0-4 and Figure 2.0-5, EMF 39 is the controlling radiation monitor for VQ releases from Containment to the Unit Vent. EMF 39 setpoints for VQ releases are calculated as follows:

$$Expected\ cpm\ = background\ \ = current\ reading$$

$$Trip\ 1\ setpoint\ = any\ number\ between\ Expected\ cpm\ and\ Trip\ 2,\ normally\ 2 \times Expected\ cpm$$

Trip 2 setpoint = $3 \times$ *Expected cpm* **or** 2.9E+04 cpm (setpoint at VP maximum flow rate), whichever is largest, not to exceed 2.2E+06 cpm. 2.2E+06 cpm derived as follows:

From Equation 3.6

$$SP = \left(C_{Xe-133} \times CF\right) + bkg$$

where for a single unit vent release point:

$$C_{Xe-133} < \frac{200}{472 \times f \times K_{Xe-133} \times \chi/Q}$$

Substituting 300 cfm for the VQ flow rate (system max), 294 mrem/yr/μCi/m^3 for the total body Xe-133 dose factor (See Appendix A), and the values for all the other previously defined parameters:

$$C_{Xe-133} < \frac{200}{472 \times 300 \times \ 294 \times 7.611\text{E-05}}$$

$$C_{Xe-133} < \ 6.3\text{E-02}\ \ \mu\text{Ci/ml}$$

Substituting 3.54E+07 cpm/μCi/ml for the EMF 39 monitor correlation factor and given that background is negligible compared to the maximum Trip 2 setpoint yields:

$$SP = 6.3\text{E-02} \times 3.54\text{E+07} \cong \ 2.2\text{E+06 cpm}$$

3.0.2.2 CONTAINMENT PURGE (VP) AND INCORE PURGE (IP) SETPOINTS (EMF 39, EMF 36)

As shown on Figure 2.0-4 and Figure 2.0-5, EMF 39 is the controlling radiation monitor for VP and IP releases from Containment to the Unit Vent.

For VP and IP low activity releases (i.e. Expected cpm ≤ 1.0E+04 cpm) only EMF 39 setpoints are calculated. EMF 39 setpoints for VP and IP low activity releases are calculated as follows:

$$Expected\ cpm\ = background\ \ = current\ reading$$

$$Trip\ 1\ setpoint\ = any\ number\ between\ Expected\ cpm\ and\ Trip\ 2,\ normally\ 2 \times Expected\ cpm$$

Trip 2 setpoint = 2.9E+04 cpm, derived as follows:

From Equation 3.6

$$SP = \left(C_{Xe-133} \times CF\right) + bkg$$

where for a single unit vent release point:

$$C_{Xe-133} < \frac{200}{472 \times f \times K_{Xe-133} \times \chi/Q}$$

Substituting 2.31E+04 cfm for the VP flow rate, 294 mrem/yr/µCi/m^3 for the total body Xe-133 dose factor (See Appendix A), and the values for all the other previously defined parameters:

$$C_{Xe-133} < \frac{200}{472 \times 2.31E{+}04 \times 294 \times 7.611E{-}05}$$

$$C_{Xe-133} < 8.20E{-}04\ \mu Ci/ml$$

Substituting 3.54E+07 cpm/µCi/ml for the EMF 39 monitor correlation factor and given that background is negligible compared to the maximum Trip 2 setpoint yields:

$$SP = 8.20E{-}04 \times 3.54E{+}07 \cong 2.9E{+}04\ \ cpm$$

Note: The flow rate used for VP is 2.31E+04 cfm, but the same setpoint would be used for IP. The IP flow rate is 800 cfm, therefore the 2.9E+04 cpm setpoint is conservative for IP.

For VP and IP high activity releases (i.e. Expected cpm > 1.0E+04 cpm) it may be necessary to give the "affected" unit (the unit making the VP or IP release) a greater allowable release rate than the 200 mrem/yr default value. For the VP and IP high activity cases, in addition to EMF 39 setpoints, the EMF 36 Trip 2 setpoint is calculated as follows:

$$EMF\ 36\ Expected\ CPM = \frac{VP \times\ EMF\ 39\ cpm \times 0.75}{\left(VP\ * + UV\right)}$$

where:

EMF 39 cpm = EMF 39 present or expected reading.

0.75 = approximate value of EMF 36 correlation factor (2.60E+07)/EMF 39 correlation factor (3.54E+07).

UV = Unit Vent flow rate (cfm).

VP = VP calculated flow rate (cfm):

$$VP \text{ Flow Rate} = \frac{2.31\text{E+04 cfm} \times 1.45\text{E+04 cpm} \times \text{M}}{\text{Desired EMF 39 Trip 2 minus bkg (normally 2.90E+04 cpm)}}$$

where:

2.31E+04 cfm = Full VP flow rate.

1.45E+04 cpm = cpm related to 100 mrem at full VP flow rate.

M = Multiplication factor for dose assignment to the affected unit vent. M can be ≥ 2 (= 200 mrem/yr), but, if > 2, both unit vents together must be ≤ 4 (=400 mrem/yr). Note that increasing the Multiplication Factor is in effect giving the "affected" unit more of the station release rate limit, and decreasing the release rate limit for the "unaffected" unit.

*VP** indicates that VP flow is not used in the denominator if VP is already running.

$$\text{AFFECTED EMF 36 Trip 2} = \frac{\text{M}}{2} \times 4.10\text{E+03 cpm}$$

where:

4.10E+03 cpm = Normal EMF 36 Trip 2 setpoint (derived below)

$$\text{UNAFFECTED EMF 36 Trip 2} = 8.20\text{E+03 cpm} - \text{AFFECTED EMF 36 Trip 2}$$

where:

8.20E+03 cpm = Total cpm allowed for both unit vents (2 × 4.10E+03).

4.10E+03 cpm is derived as follows:

From Equation 3.6

$$SP = \left(C_{Xe-133} \times CF\right) + bkg$$

where for a single unit vent release point:

$$C_{Xe-133} < \frac{200}{472 \times f \times K_{Xe-133} \times \chi/Q}$$

Substituting 1.20E+05 cfm for the UV flow rate, 294 mrem/yr/µCi/m^3 for the total body Xe-133 dose factor (See Appendix A), and the values for all the other previously defined parameters:

$$C_{Xe-133} < \frac{200}{472 \times 1.20\text{E}{+}05 \times 294 \times 7.611\text{E-}05}$$

$$C_{Xe-133} < 1.58\text{E-}04\ \mu\text{Ci/ml}$$

Substituting 2.60E+07 cpm/µCi/ml for the EMF 36 monitor correlation factor and given that background is negligible compared to the maximum Trip 2 setpoint yields:

$$SP = 1.58\text{E-}04 \times 2.60\text{E}{+}07 = 4.10\text{E}{+}03\ \text{cpm}$$

3.0.2.3 WASTE GAS DECAY TANK (WGDT) SETPOINTS (EMF 50, EMF 36)

As shown on Figure 2.0-4 and Figure 2.0-5, EMF 50 (when operable) and EMF 36 (when EMF 50 is not operable) are the controlling radiation monitors for WGDT releases to the Unit Vent.

EMF 50 setpoints are based on actual tank activity, and are calculated as follows:

$$\text{Expected cpm} = \left(C_{Xe-133} \times CF_{Xe-133}\right) + \text{bkg}$$

$$\text{Trip 1 setpoint} = \left(C_{Xe-133} \times CF_{Xe-133} \times 1.5\right) + \text{bkg}$$

$$\text{Trip 2 setpoint} = \left(C_{Xe-133} \times CF_{Xe-133} \times 3.0\right) + \text{bkg}$$

where:

$C_{Xe\text{-}133}$ = Xe-133 equivalent concentration, in µCi/ml.

$CF_{Xe\text{-}133}$ = EMF 50 Xe-133 correlation factor, 1.75E+06 cpm/µCi/ml.

bkg = Background reading from EMF 50.

If the Xe-133 equivalent concentration is ≤ 5.71E-05 µCi/ml, then 5.71E-05 is used in the Trip 1 and Trip 2 setpoint calculations. This is an indication of a low activity tank, and normal EMF fluctuation may cause Trip 2 alarms and release termination.

The unit vent gas radiation monitor, EMF 36, is used as the controlling monitor for WGDT releases if EMF 50 is inoperable. In the rare occurrence that EMF 36 must be used as the controlling monitor for WGDT releases only the "expected" cpm is calculated, and the EMF counts are monitored manually during the WGDT release. The EMF 36 expected counts from WGDT activity is calculated as follows:

$$\textit{Expected cpm} = \frac{40\ \textit{cfm} \times C_{Xe-133} \times CF_{Xe-133}}{F_{UV}} + bkg$$

where:

C_{Xe-133} = Xe-133 equivalent concentration, in µCi/ml.

CF_{Xe-133} = EMF 36 Xe-133 correlation factor, 2.60E+07 cpm/µCi/ml.

bkg = Background reading from EMF 36.

40 cfm = Maximum Waste Gas flow rate.

F_{UV} = Current Unit Vent (U1) flow rate.

Table 3.0-2

Xe-133 Equivalents

Isotope	EMF 36/39 Equivalence Factors	EMF 50 Equivalence Factors
Kr-83m	0	0
Kr-85m	2.48	7.60
Kr-85	2.56	7.24
Kr-87	2.93	8.73
Kr-88	2.78	8.20
Kr-89	2.93	8.73
Kr-90	2.93	8.73
Xe-131m	1.69	3.10
Xe-133m	1.99	4.50
Xe-133	1.00	1.00
Xe-135m	0.83	1.44
Xe-135	2.63	7.60
Xe-137	2.93	8.73
Xe-138	2.93	8.73
Ar-41	2.82	8.40
C-11	2.70	8.20

4.0 EFFLUENT DOSE MODELS

The effluent dose models used to show compliance with 10CFR50, Appendix I ALARA design objectives, 40CFR190 fuel cycle dose limits, and the dose values given in station SLCs are based on the methodology given in NUREG-0133 and Regulatory Guide 1.109. Dose contributions to the maximum individual shall be calculated at least every 31 days, quarterly, and annually using software which implements the ODCM methodology. The software is designed to automate many of the tasks required in the administration of effluent releases at McGuire and performs normal operation effluent dose assessment using NUREG-0133 and Regulatory Guide 1.109 methodology.

Station long-term historical and dose projection calculations are performed periodically to determine the station's status with respect to meeting annual ALARA goals specified in the McGuire SLCs. Such calculations are used to verify that adequate margin remains during a report period to allow normal station and radwaste system operation, including anticipated operational occurrences, for the remainder of the report period without exceeding applicable goals. Station 31-day dose projections that are used to assess the need to reduce effluent releases with the Gaseous Waste (WG) or Liquid Waste (WL) systems as required in the McGuire SLCs are estimated by the previous month's calculated dose results.

Fuel cycle dose calculations shall be performed annually or as required by special reports. Dose contributions shall be calculated using the software implementing the ODCM methodology.

4.0.1 LIQUID EFFLUENT DOSE MODEL FOR THE MAXIMUM EXPOSED INDIVIDUAL

Of the possible exposure pathways in the aquatic environment, only three contribute significantly to the total dose; these pathways are ingestion of potable water and aquatic foods, and direct exposure from radioactivity deposited on the shoreline. The dose contribution from these pathways for measured quantities of radioactive materials identified in liquid effluents released to unrestricted areas shall be calculated for the maximum exposed individual in each age group using the methodology provided in this section.

There are two liquid discharge points to the environment at McGuire; (1) the RC discharge point to Lake Norman, and (2) the WC and WWCB discharge point to the Catawba River downstream of Cowan's Ford Dam (See Figure 2.0-1). Liquid dose calculations for the maximum exposed individual are performed and documented in the ARERR for both locations using the applicable activity release and dilution data for each liquid effluent release point. The primary liquid effluent discharge point for McGuire is through RC to Lake Norman. In general, only low activity tritium releases (<1% station total) occur through the WC and WWCB discharge point to the Catawba River. Dose calculations are performed for each of the two liquid discharge points for dose reporting purposes. The highest calculated dose from the two dose calculations is used to define the maximum individual dose from liquid releases at McGuire.

Liquid Dose Calculations

Liquid permit $Dose_{oa}$ is initially calculated using dilution flow based on number of RC pumps running. Liquid permit $Dose_{oa}$ values are updated, typically for the ARERR, using actual monthly, quarterly, and annual RC average dilution flow. For individual liquid permits, $Dose_{oa}$ is determined using C_i, Δt, and F_n during the period of release. Liquid 31-day dose projections to show compliance with SLC limits are performed for each liquid permit and determined by summing individual liquid permit $Dose_{oa}$ values for the previous 31 days. Quarterly and Annual doses to show compliance with SLC limits are performed for each liquid permit and determined by summing individual liquid permit $Dose_{oa}$ values for the applicable quarter and year-to-date.

The following equation is used for calculating liquid dose to the maximum exposed individual from each of the two liquid effluent release points:

$$Dose_{oa} = \sum_{p} \sum_{i} \left(A_{oapi} \times C_i \right) \times \Delta t \times F_n \qquad F_n = \frac{f}{f + F} \times \sigma$$

Formula: adapted from NUREG-0133, pages 15-17.		
Where:		
$Dose_{oa}$	The cumulative dose commitment for organ o and age group a, from the liquid effluent for the total time period, Δt. (mrem)	
A_{oapi}	Dose commitment factor for organ o, age group a, pathway p, and nuclide i (mrem/hr per μCi/ml). (See Appendices C through F for age group and pathway specific dose commitment factors).	
C_i	The average concentration of nuclide i, in undiluted liquid effluent during the time period, Δt. (μCi/ml)	
Δt	The length of time over which C_i and F_n are averaged for all liquid releases. (hr)	
F_n	The near field average dilution factor for C_i during the period of interest, Δt. Includes the recirculation factor. (dimensionless)	
f	Average liquid radwaste flow during the period of interest, Δt. (gpm)	
F	Average dilution flow during the period of interest, Δt. (gpm)	
	RC primary discharge location:	2.50E+05 gpm × # RC pumps running
		RC average dilution flow
	WC discharge location: 10% of Cowans Ford Dam average dilution flow	
σ	Recirculation factor*. (dimensionless)	
	Lake Norman (RC) = 2.26 for fish, shoreline; = 1.26 for potable water	
	Catawba River (WC and WWCB) = 1.26 for fish, potable water, shoreline	

* The recirculation factor accounts for the fraction of discharged water reused by the station. The recirculation factors are based on methodology given in the McGuire Final Environmental Statement (10/1972), and historic annual average values based on 1990-1994 data. These values can be modified to account for deviations from average in a particular year for use in calculating maximum individual dose. A recirculation factor of 4.0 is currently being used for all pathways in the liquid dose calculation model for added conservatism.

Derivation of Liquid Dose Commitment Factors (A_{oapi})

Potable Water

$$A_{oapi} = 1.14 \times 10^5 \times \frac{U_{aw}}{D_w} \times D_{aoi} \times e^{-\lambda_i t_p}$$

Formula: from NUREG-0133, page 16, and Regulatory Guide 1.109, pg. 1.109-12. Where:	
A_{oapi}	Dose commitment factor for organ o, age group a, pathway p, and nuclide i, (mrem/hr per µCi/ml). (See Appendices C through F for age group and pathway specific dose commitment factors).
1.14×10^5	Units conversion factor (pCi-yr-ml)/(µCi-hr-l).
U_{aw}	Water consumption rate in liters per year for age group a. From Table E-5, Regulatory Guide 1.109. Adult – 730 Teen – 510 Child – 510 Infant – 330
D_w	Dilution factor from the near field area to the potable water intake; =1.0 for McGuire.
D_{aoi}	Dose factor for age group a, organ o, nuclide i, in mrem/pCi. From tables E-11 through E-14 of Regulatory Guide 1.109.
λ_i	Decay constant for nuclide i, in sec^{-1}.
t_p	Environmental transit time from release to receptor. Default = 4.32E+04 sec (12 hours). From Regulatory Guide 1.109, Table E-15.

Aquatic Foods

$$A_{oapi} = 1.14 \times 10^5 \times U_{af} \times BF_i \times D_{aoi} \times e^{-\lambda_i t_p}$$

Formula: from NUREG-0133, page 16, and Regulatory Guide 1.109, pg. 1.109-12. Where:	
A_{oapi}	Dose commitment factor for organ o, age group a, pathway p, and nuclide i, (mrem/hr per µCi/ml). (See Appendices C through F for age group and pathway specific dose commitment factors).
1.14×10^5	Units conversion factor (pCi-yr-ml)/(µCi-hr-l).
U_{af}	Fish consumption rate for age group a (kg/yr). From Table E-5, Regulatory Guide 1.109. Adult – 21 Teen – 16 Child – 6.9 Infant – 0
BF_i	Bioaccumulation factor for nuclide i, in fish, in units of (pCi/kg per pCi/liter). From Table A-1 of Regulatory Guide 1.109.
D_{aoi}	Dose factor for age group a, organ o, nuclide i, in mrem/pCi. From tables E-11 through E-14 of Regulatory Guide 1.109.
λ_i	Decay constant for nuclide i, in sec^{-1}.
t_p	Environmental transit time from release to receptor. Default = 8.64E+04 sec (1 day). From Regulatory Guide 1.109, Table E-15.

Shoreline Sediment

$$A_{oapi} = 1.14 \times 10^5 \times 100 \times DFG_{oi} \times w \times U_{as} \times T_i^{\frac{1}{2}} \times e^{-\lambda_i t_p} \times (1 - e^{-\lambda_i t_b})$$

Formula: adapted from Regulatory Guide 1.109, page 1.109-14.	
Where:	
A_{oapi}	Dose commitment factor for organ o, age group a, pathway p, and nuclide i, (mrem/hr per µCi/ml). (See Appendices C through F for age group and pathway specific dose commitment factors).
1.14×10^5	Units conversion factor (pCi-yr-ml)/(µCi-hr-l).
100	Proportionality constant used in the sediment radioactivity model, (liters/(m^2-day).
DFG_{oi}	Ground plane dose conversion factor for organ o, nuclide i (mrem/hr per pCi/m^2), from Table E-6 of Regulatory Guide 1.109.
w	Shoreline width factor. For McGuire = 0.3, from Table A-2, Regulatory Guide 1.109.
U_{as}	Shoreline exposure rate for age group a (hr/yr), From Table E-5, Regulatory Guide 1.109. Adult – 12 Teen – 67 Child – 14 Infant – 0
$T_i^{½}$	Nuclide half life for nuclide i, in days.
λ_i	Nuclide decay constant for nuclide i.
t_p	Average transit time to point of exposure (0 hours).
t_b	Sediment exposure time (15 years). Page 1.109-14.

4.0.2 GASEOUS EFFLUENT DOSE MODEL FOR THE MAXIMUM EXPOSED INDIVIDUAL

The dose contributions from measured quantities of radioactive materials identified in gaseous effluent released to unrestricted areas shall be calculated for the maximum gamma and beta air dose from noble gases, and for the maximum exposed individual from radioiodines, particulates, and others using the following equations:

Gaseous Dose Calculations

Noble Gas Dose Calculations

Gamma Air Dose

$$Dose_{\gamma} = 3.17 \times 10^{-8} \times \chi / Q \times \sum_{i} \left(M_i \times Q_i \right)$$

Formula: adapted from NUREG-0133, page 28.	
Where:	
$Dose_{\gamma}$	Gamma air dose for the time period of interest (mrad).
3.17×10^{-8}	Inverse number of seconds in year (year/seconds).
M_i	Gamma air dose factor due to gamma emissions for nuclide i (mrad/yr per $\mu Ci/m^3$). (See Appendix A).
χ/Q	The highest calculated annual average relative concentration for any area at or beyond the site boundary (sec/m^3). (See Table 6.0-8).
Q_i	Activity for nuclide i released during the time period of interest (μCi).

Beta Air Dose

$$Dose_{\beta} = 3.17 \times 10^{-8} \times \chi / Q \times \sum_{i} \left(N_i \times Q_i \right)$$

Formula: adapted from NUREG-0133, page 28.	
Where:	
$Dose_{\beta}$	Beta air dose for the time period of interest (mrad).
3.17×10^{-8}	Inverse number of seconds in year (year/seconds).
N_i	Beta air dose factor due to beta emissions for nuclide i (mrad/yr per $\mu Ci/m^3$). (See Appendix A).
χ/Q	The highest calculated annual average relative concentration for any area at or beyond the site boundary (sec/m^3). (See Table 6.0-8).
Q_i	Activity for nuclide i released during the time period of interest (μCi).

Iodine, Particulates, and H-3 Dose Organ Dose Calculation

$$Dose_{oa} = 3.17 \times 10^{-8} \times W \times \sum_{p} \sum_{i} \left(R_{oapi} \times Q_i \right)$$

<table>
<tr><td colspan="3">Formula: adapted from NUREG-0133, pages 29 & 30.</td></tr>
<tr><td colspan="3">Where:</td></tr>
<tr><td>$Dose_{oa}$</td><td colspan="2">The cumulative dose commitment to the total body or any organ o, for an individual of age group a (mrem).</td></tr>
<tr><td>3.17×10^{-8}</td><td colspan="2">Inverse number of seconds in year (year/seconds).</td></tr>
<tr><td>R_{oapi}</td><td colspan="2">Dose commitment factor for organ o, age group a, pathway p, and nuclide i. The units are based on whether a dispersion or deposition factor is used. When a χ/Q is used the units are mrem/yr per $\mu Ci/m^3$. When a D/Q is used the units are ($m^2 \cdot$ mrem/yr) per μCi/sec. (See Appendices G through J for age group and pathway specific dose commitment factors).</td></tr>
<tr><td rowspan="8">W^*</td><td colspan="2">Dispersion (χ/Q) or deposition factor (D/Q). The factor used is based upon the pathway. Note: χ/Q is always used for tritium and C-14.</td></tr>
<tr><td>Pathway</td><td>Factor Used</td></tr>
<tr><td>Ground Plane Deposition</td><td>D/Q (m^{-2})</td></tr>
<tr><td>Inhalation</td><td>χ/Q (sec/m^3)</td></tr>
<tr><td>Vegetation</td><td>D/Q (m^{-2})</td></tr>
<tr><td>Grass/Cow/Milk</td><td>D/Q (m^{-2})</td></tr>
<tr><td>Grass/Goat/Milk</td><td>D/Q (m^{-2})</td></tr>
<tr><td>Grass/Cow/Meat</td><td>D/Q (m^{-2})</td></tr>
<tr><td></td><td>Grass/Goat/Meat</td><td>D/Q (m^{-2})</td></tr>
<tr><td>Q_i^{**}</td><td colspan="2">Activity for nuclide i, released during the time period of interest (μCi).</td></tr>
</table>

* Maximum individual organ dose is determined by calculating the organ dose at each of the χ/Q and D/Q locations shown in Table 6.0-8 and Table 6.0-9 (144 locations), and then choosing the maximum dose. Dose is calculated only for pathways (e.g., garden, milk animal, etc.) that actually exist at each location as determined by the land use census. The boundary for establishing gaseous effluent release limits is the Exclusion Area Boundary (EAB). As shown in McGuire UFSAR Figure 2-5, the EAB is defined as a 2500 foot (~0.5 mile) radius from the station center.

** C-14 airborne activity released to the environment is estimated based on actual power generation as discussed in Regulatory Guide 1.21, Revision 2. A value of 9.4 Ci/GWe-yr is used along with actual power generation to estimate C-14 activity released to the environment via gaseous effluents from McGuire. 9.4 Ci/GWe-yr is based on information from "*Estimation of Carbon-14 in Nuclear Power Plant Gaseous Effluents*", EPRI, Palo Alto, CA: 2010. 1021106.

Derivations of Iodine, Particulate, and H-3 Dose Commitment Factors (R_{oapi})

Ground Plane Deposition Pathway

$$R_{oapi} = K'K''(SF)DFG_{oi}\left[\frac{(1-e^{-\lambda_i t})}{\lambda_i}\right]$$

Formula: from NUREG-0133, page 32.	
Where:	
R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for ground plane deposition pathway ($m^2 \cdot$mrem/yr per μCi/sec). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor pCi/μCi (10^6).
K"	Units conversion factor 8760 hr/year.
SF	Shielding factor (dimensionless) (0.7, from Regulatory Guide 1.109).
DFG_{oi}	Ground plane dose conversion factor for organ o, nuclide i (mrem/hr per pCi/m^2), from Table E-6 of Regulatory Guide 1.109.
λ_i	Nuclide decay constant for nuclide i (sec^{-1}).
t	Exposure time, 4.73×10^8 seconds (15 years).

Inhalation Pathway

$$R_{oapi} = K'(BR_a)(DFA_{oi})_a$$

Formula: from NUREG-0133, page 31.	
Where:	
R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for inhalation pathway (mrem/yr per μCi/m^3). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor pCi/μCi (10^6).
BR_a	Breathing rate for age group a (m^3/yr), from Regulatory Guide 1.109: Adult – 8000 Teen – 8000 Child – 3700 Infant – 1400
$(DFA_{oi})_a$	Organ inhalation factor dose conversion factor for organ o, nuclide i, age group a (mrem/pCi), from Tables E-7 through E-10 of Regulatory Guide 1.109.

Vegetation

$$R_{oapi} = K'\left[\frac{(r)}{Y_v(\lambda_i + \lambda_w)}\right] \times (DFL_{oi})_a \times \left[U_a^L f_L e^{-\lambda_i t_L} + U_a^S f_g e^{-\lambda_i t_h}\right]$$

Formula: from NUREG-0133, page 35. Where:	
R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for vegetation pathway ($m^2 \cdot$mrem/yr per μCi/sec). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor pCi/μCi (10^6).
r	Fraction of deposited activity retained on vegetation, from Regulatory Guide 1.109. 1.0 for radioiodine. 0.2 for particulates.
Y_v	Vegetation areal density (kg/m^2) (2.0, from Regulatory Guide 1.109).
λ_i	Nuclide decay constant for nuclide i (sec^{-1}).
λ_w	Decay constant for removal of activity on leaf and plant surfaces by weathering (5.73×10^{-7} sec^{-1}, from NUREG-0133).
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Reg. Guide 1.109 (mrem/pCi).
U^L_a	Consumption rate of fresh leafy vegetation for age group a (kg/yr) (from Regulatory Guide 1.109). Adult – 64 Teen – 42 Child – 26 Infant – 0
f_L	Fraction of annual intake of fresh leafy vegetation grown locally (1.0, from NUREG-0133).
t_L	Average time between harvest of leafy vegetation and consumption (8.6×10^4 seconds, (1 day), from Regulatory Guide 1.109).
U^S_a	Consumption rate of stored vegetation for age group a (kg/yr) (from Regulatory Guide 1.109). Adult – 520 Teen – 630 Child – 520 Infant – 0
f_g	Fraction of annual intake of stored vegetation (0.76, from Regulatory Guide 1.109).
t_h	Average time between harvest of stored vegetation and consumption (5.18×10^6 seconds, (60 days), from Regulatory Guide 1.109).

Vegetation – Tritium

$$R_{oapi} = K' K''' \left[U_a^L f_L + U_a^S f_g \right] (DFL_{oi})_a \left[0.75(0.5/H) \right]$$

Formula: from NUREG-0133, page 36.	
Where:	
R_{oapi}	Dose commitment factor for organ o, age group a, for vegetation pathway and tritium (mrem/yr per µCi/m^3). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor pCi/µCi (10^6).
K'''	Units conversion factor gm/kg (10^3).
U^L_a	Consumption rate of fresh leafy vegetation for age group a (kg/yr) (from Regulatory Guide 1.109). Adult – 64 Teen – 42 Child – 26 Infant – 0
f_L	Fraction of annual intake of fresh leafy vegetation grown locally (1.0, from NUREG-0133).
U^S_a	Consumption rate of stored vegetation for age group a (kg/yr) (from Regulatory Guide 1.109). Adult – 520 Teen – 630 Child – 520 Infant – 0
f_g	Fraction of annual intake of stored vegetation (0.76, from Regulatory Guide 1.109).
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Regulatory Guide 1.109 (mrem/pCi).
0.75	Fraction of total feed that is water. (From NUREG-0133).
0.5	Ratio of specific activity of feed grass water to atmospheric water. (From NUREG-0133).
H	Absolute humidity of the atmosphere (8 gm/m^3, from Regulatory Guide 1.109).

Vegetation – Carbon-14

$$R_{oapi} = \mathrm{K'K'''}\left[U_a^L f_L + U_a^S f_g\right](DFL_{oi})_a\left[0.11/0.16\right](p)(f_I)$$

Formula: from NUREG-0133, page 36 and Regulatory Guide 1.109, page 26.	
Where:	
R_{oapi}	Dose commitment factor for organ o, age group a, for vegetation pathway and carbon-14 (mrem/yr per μCi/m^3). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor pCi/μCi (10^6).
K'''	Units conversion factor gm/kg (10^3).
U^L_a	Consumption rate of fresh leafy vegetation for age group a (kg/yr) (from Regulatory Guide 1.109). Adult – 64 Teen – 42 Child – 26 Infant – 0
f_L	Fraction of annual intake of fresh leafy vegetation grown locally (1.0, from NUREG-0133).
U^S_a	Consumption rate of stored vegetation for age group a (kg/yr) (from Regulatory Guide 1.109). Adult – 520 Teen – 630 Child – 520 Infant – 0
f_g	Fraction of annual intake of stored vegetation (0.76, from Regulatory Guide 1.109).
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Regulatory Guide 1.109 (mrem/pCi).
0.11	Fraction of total plant mass that is natural carbon.
0.16	Concentration of natural carbon in the atmosphere (gm/m^3).
p	Ratio of the total annual C-14 release time to the total annual time during which photosynthesis occurs. This value is assumed to be 0.31, based on 70% of C-14 releases being from WGDTs, and 30% of C-14 releases being continuous from the unit vents (ref. IAEA Technical Reports Series no. 421, "Management of Waste Containing Tritium and Carbon-14", 2004; EPRI TR-1024827, "Carbon-14 Dose Calculation Methods at Nuclear Power Plants", 2012, Section 3.2.5).
f_I	The fraction of C-14 assumed to be in inorganic form (e.g., CO_2). Assumed to be 20%. Reference EPRI TR-105715, "Characterization of Carbon-14 Generated by the Nuclear Power Industry", Table 5-1.

Grass/Cow/Milk

$$R_{oapi} = K' \frac{Q_F(U_{ap})}{\lambda_i + \lambda_w} F_{mi}(r)(DFL_{oi})_a \left[\frac{f_p f_s}{Y_p} + \frac{(1 - f_p f_s) e^{-\lambda_i t_h}}{Y_s} \right] e^{-\lambda_i t_f}$$

Formula: from NUREG-0133, pages 32 & 33. Where:	
R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for grass/cow/milk pathway (m^2·mrem/yr per µCi/sec). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor pCi/µCi (10^6).
Q_F	Cow consumption rate (50 kg/day, from Regulatory Guide 1.109)
U_{ap}	Consumption rate of cow milk for age group a (liters/yr, from Regulatory Guide 1.109). Adult – 310 Teen – 400 Child – 330 Infant – 330
r	Fraction of deposited activity retained on cow's feed grass, (from Regulatory Guide 1.109). 1.0 for radioiodine. 0.2 for particulates.
Y_p	Agricultural productivity by unit area of pasture feed grass (0.7 kg/m^2, from Regulatory Guide 1.109).
Y_s	Agricultural productivity by unit area of stored feed (2.0 kg/m^2, from Regulatory Guide 1.109).
λ_i	Nuclide decay constant for nuclide i (sec^{-1}).
λ_w	Decay constant for removal of activity on leaf and plant surfaces by weathering (5.73×10^{-7} sec^{-1}, from NUREG-0133).
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Regulatory Guide 1.109 (mrem/pCi).
F_{mi}	Stable element transfer coefficient for nuclide i, in days/liter, from Table E-1 of Regulatory Guide 1.109 for cow milk.
f_p	Fraction of year that the cow is on pasture (1.0, from RG 1.109).
f_s	Fraction of the cow feed that is pasture grass while the cow is on pasture (1.0, from Regulatory Guide 1.109).
t_f	Transport time for pasture to cow, to milk, to receptor (1.73E+05 seconds, from Regulatory Guide 1.109).
t_h	Transport time from pasture, to harvest, to cow, to milk, to receptor (7.78E+06 seconds, from Regulatory Guide 1.109).

Grass/Cow/Milk – Tritium

$$R_{oapi} = K' \, K''' \, F_{mi} Q_f U_{ap} (DFL_{io})_a \left[0.75(0.5/H)\right]$$

Formula: from NUREG-0133, page 34.	
Where:	
R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for grass/cow/milk pathway (mrem/yr per μCi/m^3). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor pCi/μCi (10^6).
K'''	Units conversion factor gm/kg (10^3).
Q_F	Cow consumption rate (50 kg/day, from Regulatory Guide 1.109).
U_{ap}	Consumption rate of cow milk for age group a (liters/yr, from Regulatory Guide 1.109). Adult – 310 Teen – 400 Child – 330 Infant – 330
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Regulatory Guide 1.109 (mrem/pCi).
F_{mi}	Stable element transfer coefficient for nuclide i, in days/liter, from Table E-1 of Regulatory Guide 1.109 for cow milk.
0.75	Fraction of total feed that is water (from NUREG-0133).
0.5	Ratio of specific activity of feed grass water to atmospheric water (from NUREG-0133).
H	Absolute humidity of the atmosphere (8 gm/m^3, from Regulatory Guide 1.109).

Grass/Cow/Milk – Carbon-14

$$R_{oapi} = \mathrm{K'K'''}\,\mathrm{F}_{mi}\,\mathrm{Q}_{F}\,\mathrm{U}_{ap}\,(DFL_{oi})_a\left[0.11/0.16\right](p)(f_I)$$

Formula: from NUREG-0133, page 34 and Regulatory Guide 1.109, page 26.	
Where:	
R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for grass/cow/meat pathway (mrem/yr per µCi/m^3). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor pCi/µCi (10^6).
K'''	Units conversion factor gm/kg (10^3).
F_{mi}	Stable element transfer coefficient for nuclide i, in days/liter, from Table E-1 of Regulatory Guide 1.109 for cow milk.
Q_F	Cow consumption rate (50 kg/day, from Regulatory Guide 1.109).
U_{ap}	Consumption rate of cow milk for age group a (liters/yr) (from Regulatory Guide 1.109). Adult – 310 Teen – 400 Child – 330 Infant – 330
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Regulatory Guide 1.109 (mrem/pCi).
0.11	Fraction of total plant mass that is natural carbon.
0.16	Concentration of natural carbon in the atmosphere (gm/m^3).
p	Ratio of the total annual C-14 release time to the total annual time during which photosynthesis occurs. This value is assumed to be 0.31, based on 70% of C-14 releases being from WGDTs, and 30% of C-14 releases being continuous from the unit vents (ref. IAEA Technical Reports Series no. 421, "Management of Waste Containing Tritium and Carbon-14", 2004; EPRI TR-1024827, "Carbon-14 Dose Calculation Methods at Nuclear Power Plants", 2012, Section 3.2.5).
f_I	The fraction of C-14 assumed to be in inorganic form (e.g., CO_2). Assumed to be 20%. Reference EPRI TR-105715, "Characterization of Carbon-14 Generated by the Nuclear Power Industry", Table 5-1.

Grass/Goat/Milk

$$R_{oapi} = K' \frac{Q_F (U_{ap})}{\lambda_i + \lambda_w} F_{mi}(r)(DFL_{oi})_a \left[\frac{f_p f_s}{Y_p} + \frac{(1 - f_p f_s) e^{-\lambda_i t_h}}{Y_s} \right] e^{-\lambda_i t_f}$$

Formula: from NUREG-0133, pages 32 & 33. Where:	
R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for grass/goat/milk pathway (m^2·mrem/yr per µCi/sec). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor pCi/µCi (10^6).
Q_F	Goat consumption rate (6 kg/day, from Regulatory Guide 1.109).
U_{ap}	Consumption rate of goat milk for age group a (liters/yr, from Regulatory Guide 1.109). Adult – 310 Teen – 400 Child – 330 Infant – 330
r	Fraction of deposited activity retained on goat's feed grass, from Regulatory Guide 1.109. 1.0 for radioiodine. 0.2 for particulates.
Y_p	Agricultural productivity by unit area of pasture feed grass (0.7 kg/m^2, from Regulatory Guide 1.109).
Y_s	Agricultural productivity by unit area of stored feed (2.0 kg/m^2, from Regulatory Guide 1.109).
λ_i	Nuclide decay constant for nuclide i (sec^{-1}).
λ_w	Decay constant for removal of activity on leaf and plant surfaces by weathering (5.73×10^{-7} sec^{-1}, from NUREG-0133).
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Regulatory Guide 1.109 (mrem/pCi).
F_{mi}	Stable element transfer coefficient for nuclide i, in days/liter, from Table E-2 of Regulatory Guide 1.109 for goat milk.
f_p	Fraction of year that the goat is on pasture (1.0, from RG 1.109).
f_s	Fraction of the goat feed that is pasture grass while the goat is on pasture (1.0, from Regulatory Guide 1.109).
t_f	Transport time for pasture to goat, to milk, to receptor (1.73E+05 seconds, from Regulatory Guide 1.109).
t_h	Transport time from pasture, to harvest, to goat, to milk, to receptor (7.78E+06 seconds, from Regulatory Guide 1.109).

Grass/Goat/Milk – Tritium

$$R_{oapi} = K' \, K''' \, F_{mi} Q_f U_{ap} (DFL_{oi})_a \left[0.75(0.5/H)\right]$$

Formula: from NUREG-0133, page 34.	
Where:	
R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for grass/goat/milk pathway (mrem/yr per µCi/m^3). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor pCi/µCi (10^6).
K'''	Units conversion factor gm/kg (10^3).
Q_F	Goat consumption rate (6 kg/day, from Regulatory Guide 1.109).
U_{ap}	Consumption rate of goat milk for age group a (liters/yr, from Regulatory Guide 1.109). Adult – 310 Teen – 400 Child – 330 Infant – 330
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Regulatory Guide 1.109 (mrem/pCi).
F_{mi}	Stable element transfer coefficient for nuclide i, in days/liter, from Table E-2 of Regulatory Guide 1.109 for goat milk.
0.75	Fraction of total feed that is water (from NUREG-0133).
0.5	Ratio of specific activity of feed grass water to atmospheric water (from NUREG-0133).
H	Absolute humidity of the atmosphere (8 gm/m^3, from Regulatory Guide 1.109).

Grass/Goat/Milk – Carbon-14

$$R_{oapi} = \mathrm{K'K'''}\,\mathrm{F}_{mi}\,\mathrm{Q}_{F}\,\mathrm{U}_{ap}\,(DFL_{oi})_a\left[0.11/0.16\right](p)(f_I)$$

Formula: from NUREG-0133, page 34 and Regulatory Guide 1.109, page 26.	
Where:	
R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for grass/cow/meat pathway (mrem/yr per µCi/m^3). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor pCi/µCi (10^6).
K'''	Units conversion factor gm/kg (10^3).
F_{mi}	Stable element transfer coefficient for nuclide i, in days/liter, from Table E-2 of Regulatory Guide 1.109 for goat milk (0.10).
Q_F	Goat consumption rate (6 kg/day, from Regulatory Guide 1.109).
U_{ap}	Consumption rate of goat milk for age group a (liters/yr) (from Regulatory Guide 1.109). Adult – 310 Teen – 400 Child – 330 Infant – 330
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Regulatory Guide 1.109 (mrem/pCi).
0.11	Fraction of total plant mass that is natural carbon.
0.16	Concentration of natural carbon in the atmosphere (gm/m^3).
p	Ratio of the total annual C-14 release time to the total annual time during which photosynthesis occurs. This value is assumed to be 0.31, based on 70% of C-14 releases being from WGDTs, and 30% of C-14 releases being continuous from the unit vents (ref. IAEA Technical Reports Series no. 421, "Management of Waste Containing Tritium and Carbon-14", 2004; EPRI TR-1024827, "Carbon-14 Dose Calculation Methods at Nuclear Power Plants", 2012, Section 3.2.5).
f_I	The fraction of C-14 assumed to be in inorganic form (e.g., CO_2). Assumed to be 20%. Reference EPRI TR-105715, "Characterization of Carbon-14 Generated by the Nuclear Power Industry", Table 5-1.

Grass/Cow/Meat

$$R_{oapi} = K' \frac{Q_F (U_{ap})}{\lambda_i + \lambda_w} F_{fi}(r)(DFL_i)_a \left[\frac{f_p f_s}{Y_p} + \frac{(1 - f_p f_s) e^{-\lambda_i t_h}}{Y_s} \right] e^{-\lambda_i t_f}$$

Formula: from NUREG-0133, pages 34 & 35. Where:	
R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for grass/cow/meat pathway ($m^2 \cdot$mrem/yr per µCi/sec). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor pCi/µCi (10^6).
Q_F	Cow consumption rate (50 kg/day, from Regulatory Guide 1.109).
U_{ap}	Consumption rate of cow meat for age group a (kg/yr, from Regulatory Guide 1.109). Adult – 110 Teen – 65 Child – 41 Infant – 0
r	Fraction of deposited activity retained on cow's feed grass (from Regulatory Guide 1.109). 1.0 for radioiodine. 0.2 for particulates.
Y_p	Agricultural productivity by unit area of pasture feed grass (0.7 kg/m^2, from Regulatory Guide 1.109).
Y_s	Agricultural productivity by unit area of stored feed (2.0 kg/m^2, from Regulatory Guide 1.109).
λ_i	Nuclide decay constant for nuclide i (sec^{-1}).
λ_w	Decay constant for removal of activity on leaf and plant surfaces by weathering (5.73×10^{-7} sec^{-1}, from NUREG-0133).
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Regulatory Guide 1.109 (mrem/pCi).
F_{fi}	Stable element transfer coefficient for nuclide i, in days/kg, from Table E-1 of Regulatory Guide 1.109 for cow meat.
f_p	Fraction of year that the cow is on pasture (1.0, from RG 1.109).
f_s	Fraction of the cow feed that is pasture grass while the cow is on pasture (1.0, from Regulatory Guide 1.109).
t_f	Transport time from pasture to receptor (1.73E+06 seconds, from Regulatory Guide 1.109).
t_h	Transport time from crop field to receptor (7.78E+06 seconds, from Regulatory Guide 1.109).

Grass/Cow/Meat – Tritium

$$R_{oapi} = K' \, K''' \, F_{fi} Q_F U_{ap} (DFL_{oi})_a \left[0.75(0.5/H)\right]$$

Formula: from NUREG-0133, page 35.	
Where:	
R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for grass/cow/meat pathway (mrem/yr per µCi/m^3). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor pCi/µCi (10^6).
K'''	Units conversion factor gm/kg (10^3).
Q_F	Cow consumption rate (50 kg/day, from Regulatory Guide 1.109).
U_{ap}	Consumption rate of cow meat for age group a (kg/yr, from Regulatory Guide 1.109). Adult – 110 Teen – 65 Child – 41 Infant – 0
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Regulatory Guide 1.109 (mrem/pCi).
F_{fi}	Stable element transfer coefficient for nuclide i, in days/liter, from Table E-1 of Regulatory Guide 1.109 for cow meat.
0.75	Fraction of total feed that is water (from NUREG-0133).
0.5	Ratio of specific activity of feed grass water to atmospheric water (from NUREG-0133).
H	Absolute humidity of the atmosphere (8 gm/m^3, from Regulatory Guide 1.109).

Grass/Cow/Meat – Carbon-14

$$R_{oapi} = \mathrm{K'K'''}\,\mathrm{F}_{fi}\,\mathrm{Q}_{F}\,\mathrm{U}_{ap}\,(DFL_{oi})_a\left[0.11/0.16\right](p)(f_I)$$

Formula: from NUREG-0133, page 35 and Regulatory Guide 1.109, page 26.	
Where:	
R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for grass/cow/meat pathway (mrem/yr per µCi/m^3). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor pCi/µCi (10^6).
K'''	Units conversion factor gm/kg (10^3).
F_{fi}	Stable element transfer coefficient for nuclide i, in days/liter, from Table E-1 of Regulatory Guide 1.109 for cow meat.
Q_F	Cow consumption rate (50 kg/day, from Regulatory Guide 1.109).
U_{ap}	Consumption rate of cow meat for age group a (kg/yr) (from Regulatory Guide 1.109). Adult – 110 Teen – 65 Child – 41 Infant – 0
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Regulatory Guide 1.109 (mrem/pCi).
0.11	Fraction of total plant mass that is natural carbon.
0.16	Concentration of natural carbon in the atmosphere (gm/m^3).
p	Ratio of the total annual C-14 release time to the total annual time during which photosynthesis occurs. This value is assumed to be 0.31, based on 70% of C-14 releases being from WGDTs, and 30% of C-14 releases being continuous from the unit vents (ref. IAEA Technical Reports Series no. 421, "Management of Waste Containing Tritium and Carbon-14", 2004; EPRI TR-1024827, "Carbon-14 Dose Calculation Methods at Nuclear Power Plants", 2012, Section 3.2.5).
f_I	The fraction of C-14 assumed to be in inorganic form (e.g., CO_2). Assumed to be 20%. Reference EPRI TR-105715, "Characterization of Carbon-14 Generated by the Nuclear Power Industry", Table 5-1.

Grass/Goat/Meat

$$R_{oapi} = K' \frac{Q_F (U_{ap})}{\lambda_i + \lambda_w} F_{fi}(r)(DFL_i)_a \left[\frac{f_p f_s}{Y_p} + \frac{(1 - f_p f_s) e^{-\lambda_i t_h}}{Y_s} \right] e^{-\lambda_i t_f}$$

Formula: from NUREG-0133, pages 34 & 35. Where:	
R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for grass/goat/meat pathway (m^2·mrem/yr per µCi/sec). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor pCi/µCi (10^6).
Q_F	Goat consumption rate (6 kg/day, from Regulatory Guide 1.109).
U_{ap}	Consumption rate of goat meat for age group a (kg/yr, from Regulatory Guide 1.109). Adult – 110 Teen – 65 Child – 41 Infant – 0
r	Fraction of deposited activity retained on goat's feed grass (from Regulatory Guide 1.109). 1.0 for radioiodine. 0.2 for particulates.
Y_p	Agricultural productivity by unit area of pasture feed grass (0.7 kg/m^2, from Regulatory Guide 1.109).
Y_s	Agricultural productivity by unit area of stored feed (2.0 kg/m^2, from Regulatory Guide 1.109).
λ_i	Nuclide decay constant for nuclide i (sec^{-1}).
λ_w	Decay constant for removal of activity on leaf and plant surfaces by weathering (5.73×10^{-7} sec^{-1}, from NUREG-0133).
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Regulatory Guide 1.109 (mrem/pCi).
F_{fi}	Stable element transfer coefficient for nuclide i, in days/kg, from Table E-1 of Regulatory Guide 1.109 for cow meat.
f_p	Fraction of year that the goat is on pasture (1.0, from RG 1.109).
f_s	Fraction of the goat feed that is pasture grass while the cow is on pasture (1.0, from Regulatory Guide 1.109).
t_f	Transport time from pasture to receptor (1.73E+06 seconds, from Regulatory Guide 1.109).
t_h	Transport time from crop field to receptor (7.78E+06 seconds, from Regulatory Guide 1.109).

Grass/Goat/Meat – Tritium

$$R_{oapi} = K' \, K''' \, F_{fi} Q_F U_{ap} (DFL_{oi})_a \left[0.75(0.5/H)\right]$$

Formula: from NUREG-0133, page 35.	
Where:	
R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for grass/goat/meat pathway (mrem/yr per µCi/m^3). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor pCi/µCi (10^6).
K'''	Units conversion factor gm/kg (10^3).
Q_F	Goat consumption rate (6 kg/day, from Regulatory Guide 1.109).
U_{ap}	Consumption rate of goat meat for age group a (kg/yr, from Regulatory Guide 1.109). Adult – 110 Teen – 65 Child – 41 Infant – 0
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Regulatory Guide 1.109 (mrem/pCi).
F_{fi}	Stable element transfer coefficient for nuclide i, in days/liter, from Table E-1 of Regulatory Guide 1.109 for cow meat.
0.75	Fraction of total feed that is water (from NUREG-0133).
0.5	Ratio of specific activity of feed grass water to atmospheric water (from NUREG-0133).
H	Absolute humidity of the atmosphere (8 gm/m^3, from Regulatory Guide 1.109).

Grass/Goat/Meat – Carbon-14

$$R_{oapi} = \mathrm{K'K'''}\,\mathrm{F}_{fi}\,\mathrm{Q}_{F}\,\mathrm{U}_{ap}\,(DFL_{oi})_a\left[0.11/0.16\right](p)(f_I)$$

Formula: from NUREG-0133, page 35 and Regulatory Guide 1.109, page 26.	
Where:	
R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for grass/goat/meat pathway (mrem/yr per µCi/m^3). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor pCi/µCi (10^6).
K'''	Units conversion factor gm/kg (10^3).
F_{fi}	Stable element transfer coefficient for nuclide i, in days/liter, from Table E-1 of Regulatory Guide 1.109 for cow meat.
Q_F	Goat consumption rate (6 kg/day, from Regulatory Guide 1.109).
U_{ap}	Consumption rate of goat meat for age group a (kg/yr) (from Regulatory Guide 1.109). Adult – 110 Teen – 65 Child – 41 Infant – 0
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Regulatory Guide 1.109 (mrem/pCi).
0.11	Fraction of total plant mass that is natural carbon.
0.16	Concentration of natural carbon in the atmosphere (gm/m^3).
p	Ratio of the total annual C-14 release time to the total annual time during which photosynthesis occurs. This value is assumed to be 0.31, based on 70% of C-14 releases being from WGDTs, and 30% of C-14 releases being continuous from the unit vents (ref. IAEA Technical Reports Series no. 421, "Management of Waste Containing Tritium and Carbon-14", 2004; EPRI TR-1024827, "Carbon-14 Dose Calculation Methods at Nuclear Power Plants", 2012, Section 3.2.5).
f_I	The fraction of C-14 assumed to be in inorganic form (e.g., CO_2). Assumed to be 20%. Reference EPRI TR-105715, "Characterization of Carbon-14 Generated by the Nuclear Power Industry", Table 5-1.

4.0.3 DIRECT RADIATION

Direct radiation is that radiation from confined sources, and does not include any external component from radioactive effluents. The point kernel method has been used to calculate offsite dose rates from radioactive materials stored in the refueling water storage tanks, reactor makeup water storage tanks, and temporary onsite radwaste storage tanks. Dose calculations using this method performed for McGuire Nuclear Station indicate direct radiation doses are much less than 0.01 mrem/yr and, therefore, make a negligible contribution to individual dose. Likewise, direct and air-scatter radiation dose contributions from the onsite Independent Spent Fuel Storage Installation (ISFSI) at McGuire have been calculated and documented in the McGuire 10CFR72.212 evaluation report. The results of the calculation demonstrate that the annual dose to any "real individual" beyond the controlled area boundary is below the 10CFR72.104(a) and 40CFR190.10(a) limit of 25 mrem from direct and skyshine radiation, and all other fuel cycle sources (e.g., effluent). Direct radiation doses will not be calculated routinely.

4.0.4 EFFLUENT APPORTIONMENT

For the McGuire Nuclear Station the effluent releases are apportioned equally to each unit for each site as recommended by Section 3.1 of NUREG-0133, because the shared radwaste treatment systems at each site make it impractical to accurately ascribe releases to a specific reactor unit. For Annual Radiological Effluent Release Report purposes effluent releases are summed for each unit, and the maximum individual dose to the public is reported as a site total.

5.0 FUEL CYCLE CALCULATIONS

In accordance with the requirements of 40CFR190, the annual dose commitment to any member of the general public shall be calculated to assure that doses are limited to 25 millirems to the total body or any organ with the exception of the thyroid which is limited to 75 millirems. In accordance with the requirements of the Selected Licensee Commitments, the annual dose commitment shall also be calculated any time twice the specified quarterly dose limit of the Selected Licensee Commitments is exceeded; these annual dose commitments may not just be calculated for the calendar year.

The "Uranium fuel cycle" is defined in 40CFR Part 190.02(b) as:

"Uranium fuel cycle means the operations of milling of uranium ore, chemical conversion of uranium, isotopic enrichment of uranium, fabrication of uranium fuel, generation of electricity by a light-water-cooled nuclear power plant using uranium fuel, and reprocessing of spent uranium fuel, to the extent that these directly support the production of electrical power for public use utilizing nuclear energy, but excludes mining operations, operations at waste disposal sites, transportation of any radioactive material in support of these operations, and the reuse of recovered non-uranium special nuclear and by-product materials from the cycle."

Based on this definition of the fuel cycle and the information in 10CFR51, Table S-3, and Wash-1248, the radiological impact of the following operations has been assessed for McGuire Nuclear Station:

5.0.1 MILLING

No milling operations occur within fifty miles of the McGuire Nuclear Station.

5.0.2 CONVERSION

No uranium hexafluoride production occurs within fifty miles of the McGuire Nuclear Station.

5.0.3 ENRICHMENT

No uranium enrichment operations occur within fifty miles of the McGuire Nuclear Station.

5.0.4 FUEL FABRICATION

No fuel fabrication operations occur within fifty miles of the McGuire Nuclear Station.

5.0.5 NUCLEAR POWER PRODUCTION

The production of electricity for public use using light-water-cooled nuclear power stations results in increments of dose to individuals within fifty miles of any station due to liquid and gaseous effluent releases and direct radiation or skyshine. The increments of dose resulting from liquid and gaseous effluent releases will be calculated using the software implementing the ODCM methodology. The dose from direct radiation, skyshine, and radiation from the station storage facilities has been estimated using conservative assumptions (see Section 4.0.3).

In certain situations more than one nuclear power station site may contribute to the doses to be considered in making fuel cycle dose assessments in accordance with 40CFR190. However, since the McGuire and Catawba nuclear stations are located approximately 30 miles apart the relative dose contribution from each site to the other is insignificant, and can be ignored in assessing compliance with 40CFR190.

5.0.6 FUEL REPROCESSING

No fuel reprocessing operations occur within fifty miles of the McGuire Nuclear Station.

5.0.7 40CFR190 TOTAL DOSE DETERMINATION

To summarize, only dose increments from nuclear power production operations (Section 5.0.5) need be considered in calculations to demonstrate compliance with the requirements of 40CFR190. The fuel cycle dose assessments for McGuire Nuclear Station only include liquid and gaseous dose contributions from McGuire and dose from McGuire's ISFSI since no other uranium fuel cycle facility contributes significantly to McGuire's maximum exposed individual. For this dose assessment, the total body and maximum organ dose contributions to the maximum exposed individual from McGuire's liquid and gaseous effluents are estimated using the following calculations:

$$D_{wb}(T) = D_{wb}(l) + D_{wb}(g)$$

$$D_{mo}(T) = D_{mo}(l) + D_{mo}(g)$$

where:

$D_{wb}(T)$ = Total estimated fuel cycle whole body dose commitment resulting from the combined liquid and gaseous effluents of McGuire during the calendar year of interest, in mrem.

$D_{mo}(T)$ = Total estimated fuel cycle maximum organ dose commitment resulting from the combined liquid and gaseous effluents of McGuire during the calendar year of interest, in mrem.

6.0 ENVIRONMENTAL LOCATIONS

6.0.1 SITE DESCRIPTION AND SAMPLE LOCATIONS

McGuire Nuclear Station is located geographically near the center of a highly industrialized region of the Carolinas. The land is predominantly rural non-farm with a small amount of land being used to support beef cattle and farming. Recreation in the area is confined mostly to the lake and shores of Lake Norman and Mountain Island reservoir. The McGuire site is in northwestern Mecklenburg County, North Carolina, 17 miles north-northwest of Charlotte, North Carolina. The site is bounded to the west by the Catawba River channel and to the north by 32,510 acre Lake Norman. Lake Norman is impounded by Duke Energy's Cowans Ford Dam Hydroelectric Station, which is located immediately west of the site and on the Catawba River channel. The tailwater of Cowans Ford Dam is the upper limit of Mountain Island Reservoir. Mountain Island Dam is located 15 miles downstream from the site. Lookout Shoals Hydroelectric Station is at the upper reaches of Lake Norman. Marshall Steam Station is located on the western shore of Lake Norman, approximately 16 miles upstream from the site. The site exclusion radius is 2500 feet.

Table 6.0-1 and Table 6.0-2 define the sampling and TLD locations for the McGuire Radiological Monitoring Program. Figure 6.0-1 and Figure 6.0-2 illustrate these locations as compared to McGuire Nuclear Station.

6.0.2 LAND USE CENSUS DATA

The Annual Land Use Census, required by Selected Licensee Commitments, is performed to ensure that changes in the use of areas at or beyond the site boundary are identified, and that modifications to the Radiological Environmental Monitoring Program are made if required by changes in land use. This census satisfies the requirements of Section IV.B.3 of Appendix I to 10CFR50. The land use census identifies nearest pathways to the exclusion area boundary (EAB, ~ 0.5 mile) for each of the 16 meteorological sectors. Global Positioning System field measurements are taken as close as possible to the item of interest and are accurate to within 2-5 meters. Locations beyond the nearest pathway for each sector are assumed to contain that pathway for dose calculation purposes. For the 4.5-5.0 mile sector all pathways, i.e., residence, garden, milk animal (goat), and meat animal (cow), are assumed to exist for dose calculation purposes. Results are maintained on file and data reviewed in accordance with procedure AD-CP-ALL-0014, Land Use Census Evaluation.

TABLE 6.0-1

MCGUIRE RADIOLOGICAL MONITORING PROGRAM SAMPLING LOCATIONS

Table 6.0-1 Codes			
W	Weekly	SM	Semimonthly
BW	BiWeekly	Q	Quarterly
M	Monthly	SA	Semiannually
C	Control		

Site #	Location Description	Air Rad. & Part.	Surface Water	Drinking Water	Shoreline Sediment	Food Products	Fish	Milk	Broad Leaf Veg.
101	North Mecklenburg Water Treatment Facility (3.31 mi E)			M					
102 C	Amity Church Road (9.89 mi WNW)	W							M (b)
106	Maintenance Training Facility (0.47 mi E)	W							
119	Mt. Holly Municipal Water Supply (7.40 mi SSW)			M					
120	HP Boathouse - Site Boundary (0.46 mi NNE)	W							M (b)
121	Guardhouse - Site Boundary (0.47 mi NE)	W							
125	Settling Ponds - Site Boundary (0.38 mi SW)	W							M (b)
128	Discharge Canal Bridge (0.45 mi NE)		M						
129	Discharge Canal Entrance to Lake Norman (0.51 mi ENE)				SA		SA		
130	Hwy 73 Bridge Downstream (0.52 mi SW)				SA				
131	Cowans Ford Dam (0.64 mi WNW)		M						
132	Charlotte Municipal Water Supply (11.1 mi SSE)			M					
133	Cornelius (6.23 mi ENE)	W							
135 C	Plant Marshall Intake Canal (11.9 mi N)		M						
136 C	Mooresville Municipal Water Supply (12.7 mi NNE)			M					
137 C	Pinnacle Access Area (12.0 mi N)				SA		SA		
142 C	Lowman Farms-Cows (12.2 mi NNW)							SM	
155	Island Forest Drive (4.87 mi NNE)					M (a)			
193	Site Boundary (0.19 mi N)								M (b)
194	East Lincoln County Water Supply (6.73 mi NNW)			M					
195	Fishing Access Road (0.19 mi N)	W							

(a) During Harvest Season
(b) When Available

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

TABLE 6.0-2

MCGUIRE RADIOLOGICAL MONITORING PROGRAM SAMPLING LOCATIONS (TLD SITES)

Site #	Location	Distance	Sector	Site #	Location	Distance	Sector
143	SITE BOUNDARY	0.27 miles	NW	164	HAMBRIGHT & BEATTIES FORD ROAD	4.64 miles	SSE
144	SITE BOUNDARY	0.46 miles	NNE	165	ARTHER AUTEN ROAD	4.57 miles	S
145	SITE BOUNDARY	0.47 miles	NE	166	NECK ROAD REFUGE BOUNDARY	4.44 miles	SSW
146	SITE BOUNDARY	0.42 miles	ENE	167	LUCIA RIVERBEND HWY/ OLD FIREHOUSE	4.87 miles	SW
147	SITE BOUNDARY	0.44 miles	E	168	OLD PLANK ROAD BRIDGE	4.60 miles	WSW
148	SITE BOUNDARY	0.46 miles	ESE	169	GLOVER LANE	4.03 miles	W
149	SITE BOUNDARY	0.50 miles	SE	170	LITTLE EGYPT ROAD	4.32 miles	WNW
151	SITE BOUNDARY	0.37 miles	S	171	OLD HWY 16	3.95 miles	NW
152	SITE BOUNDARY	0.44 miles	SSW	172	LAKESHORE SOUTH RD & ISLAND VIEW COURT	4.69 miles	NNW
153	SITE BOUNDARY	0.47 miles	SW	173 SI	KEISTLER STORE / GLENWOOD ROAD	8.39 miles	NNW
154	SITE BOUNDARY	0.45 miles	W	174 SI	EAST LINCOLN JR. HIGH SCHOOL	8.85 miles	WNW
156	SITE BOUNDARY	0.44 miles	WNW	175 C	BOGER CITY	15.5 miles	WNW
189	SITE BOUNDARY	0.43 miles	SSE	177 SI	BELMARROW ROAD / COULWOOD COMMUNITY	8.77 miles	S
190	SITE BOUNDARY	0.37 miles	WSW	178 SI	APPRX. 0.25 MI NORTH OF LAKEVIEW RD/ DAVID COX RD ON HWY 115	9.36 miles	SE
157	THE POINTE/MOORESVILLE	4.69 miles	N	180 SI	MOORESVILLE WATER TREATMENT FACILITY	12.7 miles	NNE
158	BETHEL CHURCH ROAD	4.33 miles	NNE	181 SI	OLD DAVIDSON WATER TREATMENT FACILITY	7.02 miles	NE
159	HENDERSON ROAD	4.77 miles	NE	182 SI	CORNELIUS / AIR SITE # 133	6.23 miles	ENE
160	INTERSECTION OF HWY 21 & WESTMORELAND RD	4.89 miles	ENE	186 SI	MCGUIRE FISHING ACCESS ROAD ON PENINSULA	0.24 miles	NNW
161	SAM FURR ROAD & HWY 21	4.70 miles	E	187 SI	ENERGY EXPLORIUM / AIR SITE # 195	0.19 miles	N
162	RANSON ROAD	4.53 miles	ESE	191 SI	PENINSULA DEVELOPMENT / JOHN CONNOR ROAD	2.84 miles	NNE
163	MCCOY ROAD	4.94 miles	SE				

C = Control
SI = Special Interest

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

TABLE 6.0-3

Land Use Census Results

Deleted in ODCM Revision 58.

Figure 6.0-1 Sampling Locations Map (Site Boundary)

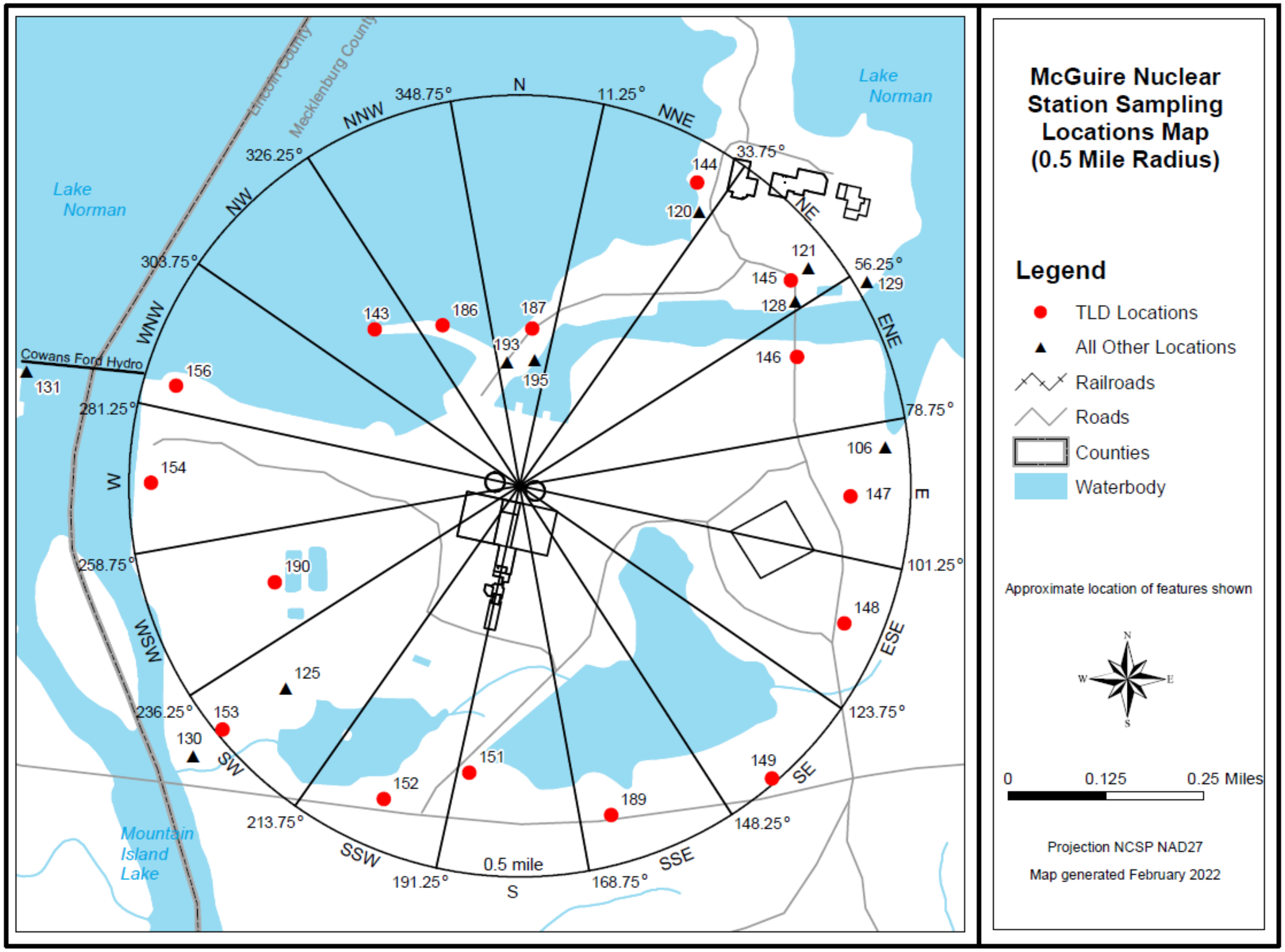
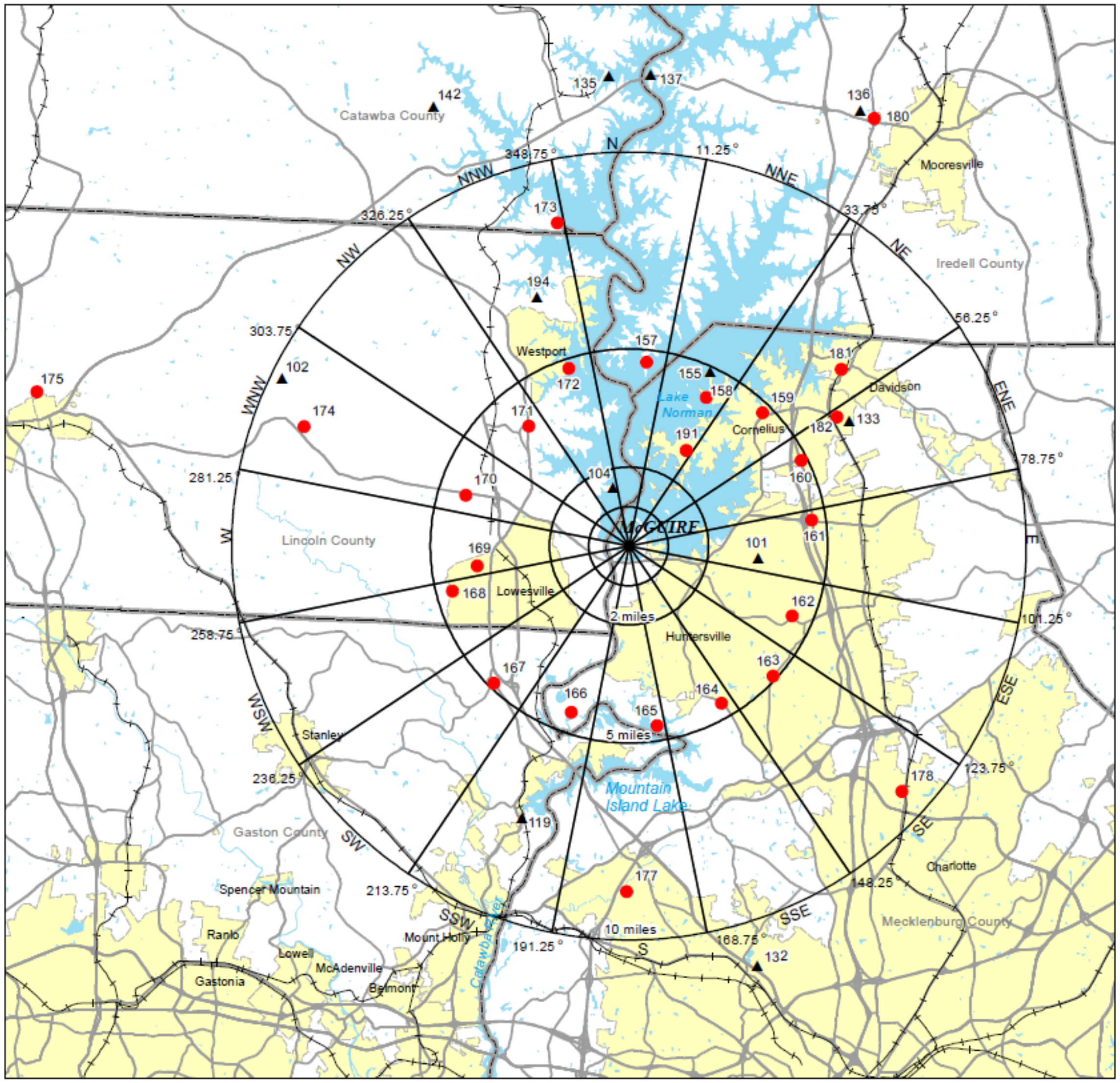


Figure 6.0-2 Sampling Locations Map (Ten Mile Radius)



McGuire Nuclear Station Sampling Locations Map (Ten Mile Radius)

- TLD Locations
- All Other Locations
- Railroads
- Roads
- Counties
- Waterbody
- Incorporated Areas

Approximate location of features shown

0 1 2 3 Miles

Projection NCSP NAD27

Map generated February 2022

Figure 6.0-3 Land Use Census Map

Deleted in ODCM Revision 58.

6.0.3 MCGUIRE METEOROLOGY: RELATIVE AIR CONCENTRATIONS AND DEPOSITION

Calculations of annually averaged air concentrations and deposition values from routine releases provide the air dispersion and deposition factors needed for dose assessment. The methodology is based upon Regulatory Guide 1.111, as implemented by the NRC's computer model "XOQDOQ: Computer Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations," NUREG/CR-2919, PNL-4380, September 1982.

Five years of hourly meteorological data from the onsite instruments are processed into a representative joint frequency distribution of winds and atmospheric stability for input into the XOQDOQ model (Version 2.0). Thus, the air dispersion and deposition factors (χ/Q and D/Q) output by the model are based on a five-year climatology for the site.

6.0.3.1 XOQDOQ METHODOLOGY AND ASSUMPTIONS

A continuous, routine release (non-purge) is simulated from each unit vent. The release type is treated as "ground-level" in the model, for which surrounding terrain elevations are not input. The locale does consist of gently rolling terrain, so the default open terrain recirculation factor is applied in XOQDOQ [KOPT(8)=1]. This correction factor is recommended in RG 1.111 to adjust the straight-line airflow of the model for spatial and temporal variations that are produced by large scale weather patterns, or other non-linear flow conditions at local and regional scales.

In order for XOQDOQ to treat the plume as a ground-level release, the exit velocity and the inside diameter of the unit vent must be input as zero. The heat emission rate of each vent is also assumed to be zero, as recommended by the model. The height of the vent (40.2 m) above plant grade elevation (760 ft msl) is then used to determine the plume centerline height. Using the building height (43.1 m) and minimum cross-sectional area of the containment building (1616 m^2), XOQDOQ applies a building wake correction to the relative air concentrations from the ground level release.

Calculations of relative air concentrations and deposition are made for grid receptor distances per sector. The "no decay" assumption is used in the XOQDOQ model.

6.0.3.2 METEOROLOGICAL DATA

Five years (1988-1992) of hourly, onsite meteorological data are used to produce the joint frequency distributions of wind speed and direction per stability class. The 10 m level winds are used. It is these joint frequency distributions which are input to the XOQDOQ model. Hours of calm winds are distributed by direction with the same frequency as the lowest "noncalm" wind speed class [KOPT(1)=1]. Thus, wind speed classes are established so that the lowest wind speed class is the starting threshold of the anemometer (i.e. the "calm" wind speed class). The largest wind speed class has the upper bound of

(5 m/s + max hourly wind speed). Stability classes (A-G) are based on the vertical temperature gradient, measured by the hourly averaged delta-T variable.

6.0.3.3 ANNUAL XOQDOQ COMPARISON TO THE ODCM

Each year, the prevailing winds and stability class frequencies for MNS are compared to the 5-year period (1988-1992) upon which the χ/Q and D/Q calculations have been made. The 5-year climatology is summarized in Table 6.0-4 and Table 6.0-5 below. Since the comparison is being made to a 5-year climatology, significant differences should not occur in the meteorological variables of concern (i.e. winds and delta-T). The meteorological comparison serves to verify this assumption.

Table 6.0-4

MNS Atmospheric Stability Frequency (1988-1992)

	A	B	C	D	E	F	G
Frequency (%)	13.8	4.7	6.1	33.8	19.3	8.0	14.3

Table 6.0-5

MNS Frequency of Wind Direction (From) and Speed (1988-1992)

Sector	Wind Direction Frequency (%)	Wind Speed Class (m/s)	Wind Speed Frequency (%)
N	5.6	CALM	1.3
NNE	8.8	0.45 - 0.74 m/s	4.3
NE	11.0	0.75 - 0.99 m/s	7.3
ENE	5.8	1.00 - 1.24 m/s	5.8
E	1.6	1.25 - 1.49 m/s	6.7
ESE	1.5	1.50 - 1.99 m/s	12.9
SE	2.3	2.00 - 2.99 m/s	23.5
SSE	3.2	3.00 - 3.99 m/s	17.0
S	13.2	4.00 - 4.99 m/s	10.8
SSW	17.9	5.00 - 5.99 m/s	5.6
SW	9.0	6.00 - 7.99 m/s	3.8
WSW	5.0	8.00 - 9.99 m/s	0.6
W	3.9	> 9.99 m/s	0.4
WNW	4.2		
NW	3.5		
NNW	3.5		

The joint frequency distributions of wind speed and direction versus atmospheric stability class are also determined from the annual data to provide input to the XOQDOQ model. Modeled χ/Q and D/Q values for the 0.5 mile Exclusion Area Boundary at MNS are compared to the maximum of the (1988-1992) χ/Q and D/Q values from all sectors. If the newly calculated annual dispersion and deposition values do not result in a significant increase in the calculated offsite dose relative to the 10CFR50, Appendix I dose objectives then the 5-year χ/Q and D/Q values used in the Annual Radiological Effluent Release Report (ARERR) are not revised. An increase in calculated offsite dose that is greater than five percent of the 10CFR50, Appendix I dose objectives would be considered significant enough to warrant a change in the χ/Q and D/Q values used in the ARERR. If an increasing trend in the annual χ/Q and D/Q values compared to the 5-year values is noted then a revised set of 5-year χ/Q and D/Q values will be generated. These limiting values are listed in Table 6.0-6. The entire χ/Q and D/Q list based on directional sector and distance is given in Table 6.0-8 and 6.0-9.

Table 6.0-6
MNS Limiting χ/Q and D/Q Values (1988-1992)

	(χ/Q,s/m^3) (D/Q,1/m^2)	**Distance**	**Sector**
Maximum χ/Q	7.611E-5	0.5 mile EAB	NNE
Maximum D/Q	1.403E-7	0.5 mile EAB	NNE

Note:
The McGuire 40 m tall meteorological tower was replaced with a new 60 m meteorological tower in August 1998 and relocated on site. The 60 m tower became operational at hour 0000 on September 1, 1998. Determination of atmospheric stability prior to this time uses the 30 m separation criteria shown in Table 6.0-7, while data after this time uses the 50 m separation criteria.

Table 6.0-7
MNS Delta-T Ranges per Vertical Separation Distances

Stability Class	**30 m separation Delta-T (between 40m-10m levels)**	**50 m separation Delta-T (between 60m-10m levels) Starting at hour 0000 on SEPT 1, 1998.**
A	dT < -0.57	dT < -0.95
B	-0.57 < dT < -0.51	-0.95 < dT < -0.85
C	-0.51 < dT < -0.45	-0.85 < dT < -0.75
D	-0.45 < dT < -0.15	-0.75 < dT < -0.25
E	-0.15 < dT < 0.45	-0.25 < dT < 0.75
F	0.45 < dT < 1.2	0.75 < dT < 2.00
G	1.2 < dT	2.00 < dT

Comparison of concurrent data from both the 40 m and 60 m McGuire meteorological towers was made for a limited period of simultaneous operation (August 19 to September 10, 1998) prior to termination of the historical 40 m tower. Results were documented in the Corrective Action Program (NCR 01697913 or PIP M-98-1240).

The analysis indicated the 40m tower was subject to microscale terrain related impacts due to its location below the dam elevation, near plant buildings. The current 60 m tower location north McGuire has an open exposure and is more representative of regional meteorological conditions.

Table 6.0-8

McGuire χ/Q Average Values (1988-1992) (sec/m^3)

Sector	0.5-1.0*	1.0-1.5	1.5-2.0	2.0-2.5	2.5-3.0	3.0-3.5	3.5-4.0	4.0-4.5	4.5-5.0
N	4.795E-05	1.220E-05	5.144E-06	2.879E-06	1.871E-06	1.333E-06	1.009E-06	7.985E-07	6.529E-07
NNE	7.611E-05	1.910E-05	8.103E-06	4.553E-06	2.968E-06	2.118E-06	1.607E-06	1.274E-06	1.043E-06
NE	5.330E-05	1.329E-05	5.662E-06	3.191E-06	2.084E-06	1.490E-06	1.132E-06	8.978E-07	7.357E-07
ENE	2.950E-05	7.487E-06	3.166E-06	1.776E-06	1.155E-06	8.237E-07	6.243E-07	4.943E-07	4.044E-07
E	1.742E-05	4.506E-06	1.884E-06	1.049E-06	6.787E-07	4.818E-07	3.638E-07	2.872E-07	2.344E-07
ESE	1.206E-05	3.143E-06	1.303E-06	7.209E-07	4.646E-07	3.288E-07	2.476E-07	1.951E-07	1.589E-07
SE	7.697E-06	2.011E-06	8.234E-07	4.521E-07	2.897E-07	2.040E-07	1.531E-07	1.202E-07	9.763E-08
SSE	6.179E-06	1.613E-06	6.504E-07	3.533E-07	2.246E-07	1.572E-07	1.173E-07	9.173E-08	7.421E-08
S	6.262E-06	1.581E-06	6.263E-07	3.363E-07	2.120E-07	1.475E-07	1.095E-07	8.525E-08	6.872E-08
SSW	7.346E-06	1.836E-06	7.234E-07	3.872E-07	2.435E-07	1.690E-07	1.253E-07	9.745E-08	7.847E-08
SW	8.606E-06	2.206E-06	8.483E-07	4.456E-07	2.759E-07	1.890E-07	1.386E-07	1.066E-07	8.508E-08
WSW	6.424E-06	1.671E-06	6.526E-07	3.466E-07	2.165E-07	1.493E-07	1.101E-07	8.519E-08	6.829E-08
W	3.523E-06	9.147E-07	3.697E-07	2.012E-07	1.281E-07	8.973E-08	6.705E-08	5.245E-08	4.247E-08
WNW	4.063E-06	1.071E-06	4.351E-07	2.376E-07	1.516E-07	1.064E-07	7.963E-08	6.238E-08	5.056E-08
NW	5.543E-06	1.448E-06	5.898E-07	3.226E-07	2.061E-07	1.448E-07	1.085E-07	8.504E-08	6.898E-08
NNW	1.053E-05	2.735E-06	1.131E-06	6.250E-07	4.024E-07	2.845E-07	2.141E-07	1.686E-07	1.372E-07

* Units are in miles from the station. Each χ/Q value is calculated at the closest location for the sector, e.g., 4.795E-05 sec/m^3 is the χ/Q value at 0.5 miles (N) from the station. The boundary for establishing gaseous effluent release limits is the Exclusion Area Boundary (EAB). As shown in McGuire UFSAR Figure 2-5, the EAB is defined as a 2500 foot (~0.5 mile) radius from the station center.

Table 6.0-9

McGuire D/Q Average Values (1988-1992)
(m^{-2})

Sector	0.5-1.0*	1.0-1.5	1.5-2.0	2.0-2.5	2.5-3.0	3.0-3.5	3.5-4.0	4.0-4.5	4.5-5.0
N	1.031E-07	2.516E-08	9.037E-09	4.482E-09	2.639E-09	1.728E-09	1.216E-09	9.011E-10	6.944E-10
NNE	1.403E-07	3.424E-08	1.230E-08	6.100E-09	3.592E-09	2.352E-09	1.655E-09	1.226E-09	9.451E-10
NE	7.027E-08	1.715E-08	6.161E-09	3.055E-09	1.799E-09	1.178E-09	8.289E-10	6.143E-10	4.734E-10
ENE	3.893E-08	9.504E-09	3.414E-09	1.693E-09	9.969E-10	6.527E-10	4.593E-10	3.404E-10	2.623E-10
E	3.024E-08	7.381E-09	2.651E-09	1.315E-09	7.742E-10	5.069E-10	3.567E-10	2.643E-10	2.037E-10
ESE	3.299E-08	8.052E-09	2.892E-09	1.434E-09	8.445E-10	5.530E-10	3.891E-10	2.884E-10	2.222E-10
SE	2.733E-08	6.673E-09	2.397E-09	1.189E-09	6.999E-10	4.583E-10	3.225E-10	2.390E-10	1.842E-10
SSE	2.765E-08	6.749E-09	2.424E-09	1.202E-09	7.079E-10	4.635E-10	3.262E-10	2.417E-10	1.863E-10
S	4.360E-08	1.064E-08	3.823E-09	1.896E-09	1.116E-09	7.309E-10	5.143E-10	3.811E-10	2.937E-10
SSW	6.929E-08	1.691E-08	6.075E-09	3.013E-09	1.774E-09	1.162E-09	8.174E-10	6.058E-10	4.668E-10
SW	8.605E-08	2.100E-08	7.545E-09	3.742E-09	2.203E-09	1.443E-09	1.015E-09	7.523E-10	5.797E-10
WSW	4.562E-08	1.114E-08	4.000E-09	1.984E-09	1.168E-09	7.648E-10	5.382E-10	3.988E-10	3.073E-10
W	1.268E-08	3.094E-09	1.112E-09	5.512E-10	3.246E-10	2.125E-10	1.495E-10	1.108E-10	8.541E-11
WNW	1.213E-08	2.962E-09	1.064E-09	5.276E-10	3.107E-10	2.034E-10	1.431E-10	1.061E-10	8.175E-11
NW	1.785E-08	4.358E-09	1.565E-09	7.763E-10	4.571E-10	2.993E-10	2.106E-10	1.561E-10	1.203E-10
NNW	2.520E-08	6.152E-09	2.210E-09	1.096E-09	6.453E-10	4.225E-10	2.973E-10	2.203E-10	1.698E-10

* Units are in miles from the station. Each D/Q value is calculated at the closest location for the sector, e.g., 1.031E-07 m^{-2} is the D/Q value at 0.5 miles (N) from the station. The boundary for establishing gaseous effluent release limits is the Exclusion Area Boundary (EAB). As shown in McGuire UFSAR Figure 2-5, the EAB is defined as a 2500 foot (~0.5 mile) radius from the station center.

7.0 LICENSEE INITIATED CHANGES

All ODCM changes are reviewed by knowledgeable individual(s), and approved by either the Station Manager or Radiation Protection Manager. The changes below do not adversely impact the accuracy or reliability of effluent, dose, or setpoint calculations.

ODCM Revision 61 - Implementation Date: 11/16/2022

ODCM Revision 61 was approved by the Radiation Protection Manager. Changes driven by Document Revision Requests (DRR) are noted with DRR number.

Section 3 - Page 4

EMF31 Cs-137 correlation factor ($CF_{Cs\text{-}137}$) changed to 3.02E+08 (1EMF31) or 3.06E+08 (2EMF31). 2EMF31 detector replacement occurred in 2022 and a new $CF_{Cs\text{-}137}$ was generated. 1EMF31 $CF_{Cs\text{-}137}$ remained unchanged. Change made per DRR 02420689

Section 3 - Page 5

EMF31 Cs-137 correlation factor ($CF_{Cs\text{-}137}$) changed to 3.02E+08 (1EMF31) or 3.06E+08 (2EMF31). 2EMF31 detector replacement occurred in 2022 and a new $CF_{Cs\text{-}137}$ was generated. 1EMF31 $CF_{Cs\text{-}137}$ remained unchanged. Change made per DRR 02420689

Section 3 - Page 6

EMF31 Cs-137 correlation factor ($CF_{Cs\text{-}137}$) changed to 3.02E+08 (1EMF31) or 3.06E+08 (2EMF31). 2EMF31 detector replacement occurred in 2022 and a new $CF_{Cs\text{-}137}$ was generated. 1EMF31 $CF_{Cs\text{-}137}$ remained unchanged. Change made per DRR 02420689

Section 6 - Page 3

For Table 6.0-1, deleted location 103 and added new location 106 with description "Maintenance Training Facility (0.47 mi E)." Due to populational density and community changes, Location 106 is more representative of a community air sample. Location 103 deleted with implementation of Location 106. Change made per DRR 02416128 and NCR 02335752.

Section 6 - Page 4

For Table 6.0-2, changed description for Location 160 from "Anchorage Marine Showroom" to "Intersection of Hwy 21 & Westmoreland Rd." Changed description for Location 171 from "Triangle Hardware" to "Old Hwy 16." Changed description for Location 178 SI from "Florida Steel Corporation" to "Apprx. 0.25 mi North of Lakeview Rd/David Cox Rd on Hwy 115." Location descriptions updated with non-business named locations due to community and business location changes. Changes made per DRR 02302566.

APPENDIX A

Dose Factors for Exposure to a Semi-Infinite Cloud of Noble Gases*

Nuclide	K_i Total Body $\frac{mrem/yr}{\mu Ci/m^3}$	L_i Skin $\frac{mrem/yr}{\mu Ci/m^3}$	M_i Gamma Air $\frac{mrad/yr}{\mu Ci/m^3}$	N_i Beta Air $\frac{mrad/yr}{\mu Ci/m^3}$
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
KR-90	1.560E+04	7.290E+03	1.630E+04	7.830E+03
XE-131M	9.150E+01	4.760E+02	1.560E+02	1.110E+03
XE-133M	2.510E+02	9.940E+02	3.270E+02	1.480E+03
XE-133	2.940E+02	3.060E+02	3.530E+02	1.050E+03
XE-135M	3.120E+03	7.110E+02	3.360E+03	7.390E+02
XE-135	1.810E+03	1.860E+03	1.920E+03	2.460E+03
XE-137	1.420E+03	1.220E+04	1.510E+03	1.270E+04
XE-138	8.830E+03	4.130E+03	9.210E+03	4.750E+03

* Reference Regulatory Guide 1.109, Table B-1

APPENDIX B

P_i Dose Factors for use in the Gaseous Release Rate Limit Calculations

Agegroup:	CHILD	Pathway:	Inhalation (INHL)			Units:	mrem/yr / µCi/m³	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	1.120E+03	1.120E+03	1.120E+03	1.120E+03	1.120E+03	0.000E+00	1.120E+03
C-14	3.590E+04	6.730E+03	6.730E+03	6.730E+03	6.730E+03	6.730E+03	0.000E+00	6.730E+03
NA-24	1.610E+04	1.610E+04	1.610E+04	1.610E+04	1.610E+04	1.610E+04	0.000E+00	1.610E+04
P-32	2.600E+06	1.140E+05	0.000E+00	0.000E+00	0.000E+00	4.220E+04	0.000E+00	9.880E+04
CR-51	0.000E+00	0.000E+00	8.550E+01	2.430E+01	1.700E+04	1.080E+03	0.000E+00	1.540E+02
MN-54	0.000E+00	4.290E+04	0.000E+00	1.000E+04	1.580E+06	2.290E+04	0.000E+00	9.510E+03
MN-56	0.000E+00	1.660E+00	0.000E+00	1.670E+00	1.310E+04	1.230E+05	0.000E+00	3.120E-01
FE-55	4.740E+04	2.520E+04	0.000E+00	0.000E+00	1.110E+05	2.870E+03	0.000E+00	7.770E+03
FE-59	2.070E+04	3.340E+04	0.000E+00	0.000E+00	1.270E+06	7.070E+04	0.000E+00	1.670E+04
CO-58	0.000E+00	1.770E+03	0.000E+00	0.000E+00	1.110E+06	3.440E+04	0.000E+00	3.160E+03
CO-60	0.000E+00	1.310E+04	0.000E+00	0.000E+00	7.070E+06	9.620E+04	0.000E+00	2.260E+04
NI-63	8.210E+05	4.620E+04	0.000E+00	0.000E+00	2.750E+05	6.330E+03	0.000E+00	2.800E+04
NI-65	2.990E+00	2.960E-01	0.000E+00	0.000E+00	8.180E+03	8.400E+04	0.000E+00	1.640E-01
CU-64	0.000E+00	1.990E+00	0.000E+00	6.030E+00	9.580E+03	3.670E+04	0.000E+00	1.070E+00
ZN-65	4.260E+04	1.130E+05	0.000E+00	7.140E+04	9.950E+05	1.630E+04	0.000E+00	7.030E+04
ZN-69	6.700E-02	9.660E-02	0.000E+00	5.850E-02	1.420E+03	1.020E+04	0.000E+00	8.920E-03
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.740E+02
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.480E+02
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.530E+01
RB-86	0.000E+00	1.980E+05	0.000E+00	0.000E+00	0.000E+00	7.990E+03	0.000E+00	1.140E+05
RB-88	0.000E+00	5.620E+02	0.000E+00	0.000E+00	0.000E+00	1.720E+01	0.000E+00	3.660E+02
RB-89	0.000E+00	3.450E+02	0.000E+00	0.000E+00	0.000E+00	1.890E+00	0.000E+00	2.900E+02
SR-89	5.990E+05	0.000E+00	0.000E+00	0.000E+00	2.160E+06	1.670E+05	0.000E+00	1.720E+04
SR-90	1.010E+08	0.000E+00	0.000E+00	0.000E+00	1.480E+07	3.430E+05	0.000E+00	6.440E+06
SR-91	1.210E+02	0.000E+00	0.000E+00	0.000E+00	5.330E+04	1.740E+05	0.000E+00	4.590E+00

APPENDIX B

P_i Dose Factors for use in the Gaseous Release Rate Limit Calculations

Agegroup:	CHILD	Pathway:	Inhalation (INHL)			Units:	mrem/yr / µCi/m^3	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	1.310E+01	0.000E+00	0.000E+00	0.000E+00	2.400E+04	2.420E+05	0.000E+00	5.250E-01
Y-90	4.110E+03	0.000E+00	0.000E+00	0.000E+00	2.620E+05	2.680E+05	0.000E+00	1.110E+02
Y-91	9.140E+05	0.000E+00	0.000E+00	0.000E+00	2.630E+06	1.840E+05	0.000E+00	2.440E+04
Y-91M	5.070E-01	0.000E+00	0.000E+00	0.000E+00	2.810E+03	1.720E+03	0.000E+00	1.840E-02
Y-92	2.030E+01	0.000E+00	0.000E+00	0.000E+00	2.390E+04	2.390E+05	0.000E+00	5.810E-01
Y-93	1.860E+02	0.000E+00	0.000E+00	0.000E+00	7.440E+04	3.880E+05	0.000E+00	5.110E+00
ZR-95	1.900E+05	4.180E+04	0.000E+00	5.960E+04	2.230E+06	6.110E+04	0.000E+00	3.700E+04
ZR-97	1.880E+02	2.720E+01	0.000E+00	3.880E+01	1.130E+05	3.510E+05	0.000E+00	1.600E+01
NB-95	2.350E+04	9.180E+03	0.000E+00	8.620E+03	6.140E+05	3.700E+04	0.000E+00	6.550E+03
MO-99	0.000E+00	1.720E+02	0.000E+00	3.920E+02	1.350E+05	1.270E+05	0.000E+00	4.260E+01
TC-99M	1.780E-03	3.480E-03	0.000E+00	5.070E-02	9.510E+02	4.810E+03	0.000E+00	5.770E-02
TC-101	8.100E-05	8.510E-05	0.000E+00	1.450E-03	5.850E+02	1.630E+01	0.000E+00	1.080E-03
RU-103	2.790E+03	0.000E+00	0.000E+00	7.030E+03	6.620E+05	4.480E+04	0.000E+00	1.070E+03
RU-105	1.530E+00	0.000E+00	0.000E+00	1.340E+00	1.590E+04	9.950E+04	0.000E+00	5.550E-01
RU-106	1.360E+05	0.000E+00	0.000E+00	1.840E+05	1.430E+07	4.290E+05	0.000E+00	1.690E+04
AG-110M	1.690E+04	1.140E+04	0.000E+00	2.120E+04	5.480E+06	1.000E+05	0.000E+00	9.140E+03
TE-125M	6.730E+03	2.330E+03	1.920E+03	0.000E+00	4.770E+05	3.380E+04	0.000E+00	9.140E+02
TE-127	2.770E+00	9.510E-01	1.960E+00	7.070E+00	1.000E+04	5.620E+04	0.000E+00	6.100E-01
TE-127M	2.490E+04	8.550E+03	6.070E+03	6.360E+04	1.480E+06	7.140E+04	0.000E+00	3.020E+03
TE-129	9.770E-02	3.500E-02	7.140E-02	2.570E-01	2.930E+03	2.550E+04	0.000E+00	2.380E-02
TE-129M	1.920E+04	6.840E+03	6.330E+03	5.030E+04	1.760E+06	1.820E+05	0.000E+00	3.040E+03
TE-131	2.170E-02	8.440E-03	1.700E-02	5.880E-02	2.050E+03	1.330E+03	0.000E+00	6.590E-03
TE-131M	1.340E+02	5.920E+01	9.770E+01	4.000E+02	2.060E+05	3.080E+05	0.000E+00	5.070E+01
TE-132	4.810E+02	2.720E+02	3.170E+02	1.770E+03	3.770E+05	1.380E+05	0.000E+00	2.630E+02
I-130	8.180E+03	1.640E+04	1.850E+06	2.450E+04	0.000E+00	5.110E+03	0.000E+00	8.440E+03

APPENDIX B

P_i Dose Factors for use in the Gaseous Release Rate Limit Calculations

Agegroup:	CHILD	Pathway:	Inhalation (INHL)			Units:	mrem/yr / µCi/m^3	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	4.810E+04	4.810E+04	1.620E+07	7.880E+04	0.000E+00	2.840E+03	0.000E+00	2.730E+04
I-132	2.120E+03	4.070E+03	1.940E+05	6.250E+03	0.000E+00	3.200E+03	0.000E+00	1.880E+03
I-133	1.660E+04	2.030E+04	3.850E+06	3.380E+04	0.000E+00	5.480E+03	0.000E+00	7.700E+03
I-134	1.170E+03	2.160E+03	5.070E+04	3.300E+03	0.000E+00	9.550E+02	0.000E+00	9.950E+02
I-135	4.920E+03	8.730E+03	7.920E+05	1.340E+04	0.000E+00	4.440E+03	0.000E+00	4.140E+03
CS-134	6.510E+05	1.010E+06	0.000E+00	3.300E+05	1.210E+05	3.850E+03	0.000E+00	2.250E+05
CS-136	6.510E+04	1.710E+05	0.000E+00	9.550E+04	1.450E+04	4.180E+03	0.000E+00	1.160E+05
CS-137	9.060E+05	8.250E+05	0.000E+00	2.820E+05	1.040E+05	3.620E+03	0.000E+00	1.280E+05
CS-138	6.330E+02	8.400E+02	0.000E+00	6.220E+02	6.810E+01	2.700E+02	0.000E+00	5.550E+02
BA-139	1.840E+00	9.840E-04	0.000E+00	8.620E-04	5.770E+03	5.770E+04	0.000E+00	5.360E-02
BA-140	7.400E+04	6.480E+01	0.000E+00	2.110E+01	1.740E+06	1.020E+05	0.000E+00	4.330E+03
BA-141	1.960E-01	1.090E-04	0.000E+00	9.470E-05	2.920E+03	2.750E+02	0.000E+00	6.360E-03
BA-142	5.000E-02	3.600E-05	0.000E+00	2.910E-05	1.640E+03	2.740E+00	0.000E+00	2.790E-03
LA-140	6.440E+02	2.250E+02	0.000E+00	0.000E+00	1.830E+05	2.260E+05	0.000E+00	7.550E+01
LA-142	1.300E+00	4.110E-01	0.000E+00	0.000E+00	8.700E+03	7.580E+04	0.000E+00	1.290E-01
CE-141	3.920E+04	1.950E+04	0.000E+00	8.550E+03	5.440E+05	5.660E+04	0.000E+00	2.900E+03
CE-143	3.660E+02	1.990E+02	0.000E+00	8.360E+01	1.150E+05	1.270E+05	0.000E+00	2.870E+01
CE-144	6.770E+06	2.120E+06	0.000E+00	1.170E+06	1.200E+07	3.880E+05	0.000E+00	3.610E+05
PR-143	1.850E+04	5.550E+03	0.000E+00	3.000E+03	4.330E+05	9.730E+04	0.000E+00	9.140E+02
PR-144	5.960E-02	1.850E-02	0.000E+00	9.770E-03	1.570E+03	1.970E+02	0.000E+00	3.000E-03
ND-147	1.080E+04	8.730E+03	0.000E+00	4.810E+03	3.280E+05	8.210E+04	0.000E+00	6.810E+02
W-187	1.630E+01	9.660E+00	0.000E+00	0.000E+00	4.110E+04	9.100E+04	0.000E+00	4.330E+00
NP-239	4.660E+02	3.340E+01	0.000E+00	9.730E+01	5.810E+04	6.400E+04	0.000E+00	2.350E+01

APPENDIX C

A_i Adult Dose Factors for use in the Liquid Dose Calculations

Age group:	**ADULT**	**Pathway:**	**Potable Water (PWtr)**			**Units:**	**mrem/hr / µCi/ml**	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	8.740E+00	8.740E+00	8.740E+00	8.740E+00	8.740E+00	0.000E+00	8.740E+00
C-14	2.360E+02	4.730E+01	4.730E+01	4.730E+01	4.730E+01	4.730E+01	0.000E+00	4.730E+01
NA-24	8.140E+01	8.140E+01	8.140E+01	8.140E+01	8.140E+01	8.140E+01	0.000E+00	8.140E+01
P-32	1.570E+04	9.750E+02	0.000E+00	0.000E+00	0.000E+00	1.760E+03	0.000E+00	6.060E+02
CR-51	0.000E+00	0.000E+00	1.310E-01	4.820E-02	2.900E-01	5.500E+01	0.000E+00	2.190E-01
MN-54	0.000E+00	3.800E+02	0.000E+00	1.130E+02	0.000E+00	1.160E+03	0.000E+00	7.250E+01
MN-56	0.000E+00	3.800E-01	0.000E+00	4.820E-01	0.000E+00	1.210E+01	0.000E+00	6.740E-02
FE-55	2.290E+02	1.580E+02	0.000E+00	0.000E+00	8.820E+01	9.070E+01	0.000E+00	3.690E+01
FE-59	3.580E+02	8.420E+02	0.000E+00	0.000E+00	2.350E+02	2.810E+03	0.000E+00	3.230E+02
CO-58	0.000E+00	6.170E+01	0.000E+00	0.000E+00	0.000E+00	1.250E+03	0.000E+00	1.380E+02
CO-60	0.000E+00	1.780E+02	0.000E+00	0.000E+00	0.000E+00	3.340E+03	0.000E+00	3.930E+02
NI-63	1.080E+04	7.500E+02	0.000E+00	0.000E+00	0.000E+00	1.560E+02	0.000E+00	3.630E+02
NI-65	1.620E+00	2.100E-01	0.000E+00	0.000E+00	0.000E+00	5.340E+00	0.000E+00	9.600E-02
CU-64	0.000E+00	3.590E+00	0.000E+00	9.060E+00	0.000E+00	3.060E+02	0.000E+00	1.690E+00
ZN-65	4.020E+02	1.280E+03	0.000E+00	8.560E+02	0.000E+00	8.060E+02	0.000E+00	5.780E+02
ZN-69	1.070E-04	2.050E-04	0.000E+00	1.330E-04	0.000E+00	3.080E-05	0.000E+00	1.430E-05
SE-75	1.038E+02	3.991E+01	3.991E+01	7.983E+00	9.579E+01	1.118E+02	0.000E+00	7.983E+02
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.480E-01	0.000E+00	1.030E-01
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.270E-12	0.000E+00	6.710E-07
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.380E-77
RB-86	0.000E+00	1.720E+03	0.000E+00	0.000E+00	0.000E+00	3.400E+02	0.000E+00	8.030E+02
RB-88	0.000E+00	3.360E-12	0.000E+00	0.000E+00	0.000E+00	4.640E-23	0.000E+00	1.780E-12
RB-89	0.000E+00	3.090E-14	0.000E+00	0.000E+00	0.000E+00	1.790E-27	0.000E+00	2.170E-14
SR-89	2.550E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.080E+03	0.000E+00	7.310E+02
SR-90	6.310E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.820E+04	0.000E+00	1.550E+05

APPENDIX C

A_i Adult Dose Factors for use in the Liquid Dose Calculations

Age group:	ADULT	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-91	1.960E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.350E+02	0.000E+00	7.930E+00
SR-92	8.290E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.640E+02	0.000E+00	3.590E-01
Y-90	7.030E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.460E+03	0.000E+00	1.890E-02
Y-91	1.170E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.420E+03	0.000E+00	3.120E-01
Y-91M	3.360E-07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.860E-07	0.000E+00	1.300E-08
Y-92	6.710E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.170E+02	0.000E+00	1.960E-04
Y-93	9.770E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.100E+03	0.000E+00	2.700E-03
ZR-95	2.520E+00	8.070E-01	0.000E+00	1.270E+00	0.000E+00	2.560E+03	0.000E+00	5.460E-01
ZR-97	8.540E-02	1.720E-02	0.000E+00	2.600E-02	0.000E+00	5.340E+03	0.000E+00	7.880E-03
NB-95	5.130E-01	2.850E-01	0.000E+00	2.820E-01	0.000E+00	1.730E+03	0.000E+00	1.530E-01
MO-99	0.000E+00	3.160E+02	0.000E+00	7.160E+02	0.000E+00	7.330E+02	0.000E+00	6.020E+01
TC-99M	5.160E-03	1.460E-02	0.000E+00	2.210E-01	7.140E-03	8.630E+00	0.000E+00	1.860E-01
TC-101	1.130E-17	1.630E-17	0.000E+00	2.930E-16	8.320E-18	4.890E-29	0.000E+00	1.600E-16
RU-103	1.530E+01	0.000E+00	0.000E+00	5.820E+01	0.000E+00	1.780E+03	0.000E+00	6.570E+00
RU-105	1.970E-01	0.000E+00	0.000E+00	2.540E+00	0.000E+00	1.200E+02	0.000E+00	7.760E-02
RU-106	2.290E+02	0.000E+00	0.000E+00	4.410E+02	0.000E+00	1.480E+04	0.000E+00	2.890E+01
AG-108M	9.207E+01	3.541E+01	3.541E+01	7.082E+00	8.498E+01	9.915E+01	0.000E+00	7.082E+02
AG-110M	1.330E+01	1.230E+01	0.000E+00	2.420E+01	0.000E+00	5.020E+03	0.000E+00	7.300E+00
SN-113	2.913E+01	1.121E+01	1.121E+01	2.241E+00	2.689E+01	3.137E+01	0.000E+00	2.241E+02
SN-117M	2.771E+01	1.066E+01	1.066E+01	2.131E+00	2.557E+01	2.984E+01	0.000E+00	2.131E+02
SB-124	2.317E+02	4.377E+00	5.618E-01	0.000E+00	1.804E+02	6.578E+03	0.000E+00	9.184E+01
SB-125	1.489E+02	1.664E+00	1.514E-01	0.000E+00	1.148E+02	1.639E+03	0.000E+00	3.544E+01
SB-126	9.307E+01	1.894E+00	5.697E-01	0.000E+00	5.705E+01	7.607E+03	0.000E+00	3.358E+01
TE-123M	5.588E+01	2.149E+01	2.149E+01	4.298E+00	5.158E+01	6.018E+01	0.000E+00	4.298E+02
TE-125M	2.220E+02	8.030E+01	6.670E+01	9.020E+02	0.000E+00	8.850E+02	0.000E+00	2.970E+01

APPENDIX C

A_i Adult Dose Factors for use in the Liquid Dose Calculations

Age group:	ADULT	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
TE-127	3.780E+00	1.360E+00	2.800E+00	1.540E+01	0.000E+00	2.980E+02	0.000E+00	8.170E-01
TE-127M	5.620E+02	2.010E+02	1.440E+02	2.280E+03	0.000E+00	1.880E+03	0.000E+00	6.840E+01
TE-129	1.920E-03	7.230E-04	1.480E-03	8.080E-03	0.000E+00	1.450E-03	0.000E+00	4.690E-04
TE-129M	9.470E+02	3.530E+02	3.250E+02	3.950E+03	0.000E+00	4.770E+03	0.000E+00	1.500E+02
TE-131	3.520E-09	1.470E-09	2.900E-09	1.540E-08	0.000E+00	4.990E-10	0.000E+00	1.110E-09
TE-131M	1.090E+02	5.340E+01	8.450E+01	5.400E+02	0.000E+00	5.300E+03	0.000E+00	4.450E+01
TE-132	1.880E+02	1.220E+02	1.350E+02	1.170E+03	0.000E+00	5.770E+03	0.000E+00	1.140E+02
I-130	3.210E+01	9.460E+01	8.020E+03	1.480E+02	0.000E+00	8.140E+01	0.000E+00	3.730E+01
I-131	3.320E+02	4.740E+02	1.550E+05	8.130E+02	0.000E+00	1.250E+02	0.000E+00	2.720E+02
I-132	4.540E-01	1.220E+00	4.250E+01	1.940E+00	0.000E+00	2.280E-01	0.000E+00	4.250E-01
I-133	7.920E+01	1.380E+02	2.020E+04	2.400E+02	0.000E+00	1.240E+02	0.000E+00	4.200E+01
I-134	6.580E-04	1.790E-03	3.100E-02	2.840E-03	0.000E+00	1.560E-06	0.000E+00	6.390E-04
I-135	1.050E+01	2.750E+01	1.810E+03	4.400E+01	0.000E+00	3.100E+01	0.000E+00	1.010E+01
CS-134	5.170E+03	1.230E+04	0.000E+00	3.980E+03	1.320E+03	2.150E+02	0.000E+00	1.010E+04
CS-136	5.280E+02	2.080E+03	0.000E+00	1.160E+03	1.590E+02	2.370E+02	0.000E+00	1.500E+03
CS-137	6.630E+03	9.070E+03	0.000E+00	3.080E+03	1.020E+03	1.760E+02	0.000E+00	5.940E+03
CS-138	8.450E-07	1.670E-06	0.000E+00	1.230E-06	1.210E-07	7.120E-12	0.000E+00	8.260E-07
BA-133	6.004E+01	2.309E+01	2.309E+01	4.618E+00	5.542E+01	6.466E+01	0.000E+00	4.618E+02
BA-139	1.990E-02	1.420E-05	0.000E+00	1.330E-05	8.050E-06	3.530E-02	0.000E+00	5.830E-04
BA-140	1.640E+03	2.070E+00	0.000E+00	7.020E-01	1.180E+00	3.390E+03	0.000E+00	1.080E+02
BA-141	5.440E-12	4.120E-15	0.000E+00	3.830E-15	2.340E-15	2.570E-21	0.000E+00	1.840E-13
BA-142	6.290E-21	6.470E-24	0.000E+00	5.460E-24	3.660E-24	8.860E-39	0.000E+00	3.960E-22
LA-140	1.690E-01	8.530E-02	0.000E+00	0.000E+00	0.000E+00	6.260E+03	0.000E+00	2.250E-02
LA-142	5.720E-05	2.600E-05	0.000E+00	0.000E+00	0.000E+00	1.900E-01	0.000E+00	6.480E-06
CE-141	7.710E-01	5.210E-01	0.000E+00	2.420E-01	0.000E+00	1.990E+03	0.000E+00	5.910E-02

APPENDIX C

A_i Adult Dose Factors for use in the Liquid Dose Calculations

Age group:	ADULT	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
CE-143	1.070E-01	7.890E+01	0.000E+00	3.470E-02	0.000E+00	2.950E+03	0.000E+00	8.730E-03
CE-144	4.060E+01	1.700E+01	0.000E+00	1.010E+01	0.000E+00	1.370E+04	0.000E+00	2.180E+00
PR-143	7.460E-01	2.990E-01	0.000E+00	1.730E-01	0.000E+00	3.270E+03	0.000E+00	3.700E-02
PR-144	7.350E-16	3.050E-16	0.000E+00	1.720E-16	0.000E+00	1.060E-22	0.000E+00	3.730E-17
ND-147	5.070E-01	5.860E-01	0.000E+00	3.430E-01	0.000E+00	2.810E+03	0.000E+00	3.510E-02
EU-152	1.623E+01	3.695E+00	0.000E+00	2.288E+01	0.000E+00	2.130E+03	0.000E+00	3.245E+00
W-187	6.050E+00	5.050E+00	0.000E+00	0.000E+00	0.000E+00	1.660E+03	0.000E+00	1.770E+00
NP-239	8.550E-02	8.400E-03	0.000E+00	2.620E-02	0.000E+00	1.720E+03	0.000E+00	4.630E-03

APPENDIX C

A_i Adult Dose Factors for use in the Liquid Dose Calculations

Age group:	ADULT	Pathway:	Fresh Water Fish - Sport (FFSP)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	2.260E-01	2.260E-01	2.260E-01	2.260E-01	2.260E-01	0.000E+00	2.260E-01
C-14	3.130E+04	6.260E+03	6.260E+03	6.260E+03	6.260E+03	6.260E+03	0.000E+00	6.260E+03
NA-24	1.350E+02	1.350E+02	1.350E+02	1.350E+02	1.350E+02	1.350E+02	0.000E+00	1.350E+02
P-32	1.320E+06	8.210E+04	0.000E+00	0.000E+00	0.000E+00	1.480E+05	0.000E+00	5.100E+04
CR-51	0.000E+00	0.000E+00	7.420E-01	2.740E-01	1.650E+00	3.120E+02	0.000E+00	1.240E+00
MN-54	0.000E+00	4.370E+03	0.000E+00	1.300E+03	0.000E+00	1.340E+04	0.000E+00	8.330E+02
MN-56	0.000E+00	1.730E-01	0.000E+00	2.200E-01	0.000E+00	5.530E+00	0.000E+00	3.070E-02
FE-55	6.580E+02	4.550E+02	0.000E+00	0.000E+00	2.540E+02	2.610E+02	0.000E+00	1.060E+02
FE-59	1.020E+03	2.400E+03	0.000E+00	0.000E+00	6.720E+02	8.010E+03	0.000E+00	9.220E+02
CO-58	0.000E+00	8.830E+01	0.000E+00	0.000E+00	0.000E+00	1.790E+03	0.000E+00	1.980E+02
CO-60	0.000E+00	2.560E+02	0.000E+00	0.000E+00	0.000E+00	4.810E+03	0.000E+00	5.650E+02
NI-63	3.110E+04	2.160E+03	0.000E+00	0.000E+00	0.000E+00	4.500E+02	0.000E+00	1.040E+03
NI-65	1.720E-01	2.230E-02	0.000E+00	0.000E+00	0.000E+00	5.660E-01	0.000E+00	1.020E-02
CU-64	0.000E+00	2.680E+00	0.000E+00	6.760E+00	0.000E+00	2.290E+02	0.000E+00	1.260E+00
ZN-65	2.310E+04	7.350E+04	0.000E+00	4.920E+04	0.000E+00	4.630E+04	0.000E+00	3.320E+04
ZN-69	7.730E-07	1.480E-06	0.000E+00	9.610E-07	0.000E+00	2.220E-07	0.000E+00	1.030E-07
SE-75	5.953E+02	2.290E+02	2.290E+02	4.579E+01	5.495E+02	6.411E+02	0.000E+00	4.579E+03
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.500E-02	0.000E+00	3.820E-02
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.850E-18	0.000E+00	1.250E-12
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	9.730E+04	0.000E+00	0.000E+00	0.000E+00	1.920E+04	0.000E+00	4.530E+04
RB-88	0.000E+00	1.290E-22	0.000E+00	0.000E+00	0.000E+00	1.780E-33	0.000E+00	6.830E-23
RB-89	0.000E+00	1.640E-26	0.000E+00	0.000E+00	0.000E+00	9.560E-40	0.000E+00	1.160E-26
SR-89	2.180E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.500E+03	0.000E+00	6.260E+02
SR-90	5.440E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.570E+04	0.000E+00	1.340E+05

APPENDIX C

A_i Adult Dose Factors for use in the Liquid Dose Calculations

Age group:	ADULT	Pathway:	Fresh Water Fish - Sport (FFSP)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-91	7.050E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.360E+02	0.000E+00	2.850E+00
SR-92	3.320E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.570E+00	0.000E+00	1.430E-02
Y-90	4.440E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.710E+03	0.000E+00	1.190E-02
Y-91	8.340E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.590E+03	0.000E+00	2.230E-01
Y-91M	1.070E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.150E-11	0.000E+00	4.150E-13
Y-92	4.600E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.060E+00	0.000E+00	1.340E-05
Y-93	3.080E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.770E+02	0.000E+00	8.500E-04
ZR-95	2.380E-01	7.620E-02	0.000E+00	1.200E-01	0.000E+00	2.410E+02	0.000E+00	5.160E-02
ZR-97	4.960E-03	1.000E-03	0.000E+00	1.510E-03	0.000E+00	3.100E+02	0.000E+00	4.570E-04
NB-95	4.380E+02	2.440E+02	0.000E+00	2.410E+02	0.000E+00	1.480E+06	0.000E+00	1.310E+02
MO-99	0.000E+00	8.020E+01	0.000E+00	1.820E+02	0.000E+00	1.860E+02	0.000E+00	1.530E+01
TC-99M	5.590E-04	1.580E-03	0.000E+00	2.400E-02	7.740E-04	9.340E-01	0.000E+00	2.010E-02
TC-101	2.610E-33	3.760E-33	0.000E+00	6.770E-32	1.920E-33	1.130E-44	0.000E+00	3.690E-32
RU-103	4.350E+00	0.000E+00	0.000E+00	1.660E+01	0.000E+00	5.080E+02	0.000E+00	1.870E+00
RU-105	8.670E-03	0.000E+00	0.000E+00	1.120E-01	0.000E+00	5.300E+00	0.000E+00	3.420E-03
RU-106	6.570E+01	0.000E+00	0.000E+00	1.270E+02	0.000E+00	4.250E+03	0.000E+00	8.320E+00
AG-108M	2.648E+01	1.019E+01	1.019E+01	2.037E+00	2.445E+01	2.852E+01	0.000E+00	2.037E+02
AG-110M	8.790E-01	8.130E-01	0.000E+00	1.600E+00	0.000E+00	3.320E+02	0.000E+00	4.830E-01
SN-113	2.507E+03	9.641E+02	9.641E+02	1.928E+02	2.314E+03	2.699E+03	0.000E+00	1.928E+04
SN-117M	2.331E+03	8.965E+02	8.965E+02	1.793E+02	2.152E+03	2.510E+03	0.000E+00	1.793E+04
SB-124	6.626E+02	1.252E+01	1.607E+00	0.000E+00	5.159E+02	1.881E+04	0.000E+00	2.627E+02
SB-125	4.282E+02	4.785E+00	4.354E-01	0.000E+00	3.301E+02	4.713E+03	0.000E+00	1.019E+02
SB-126	2.603E+02	5.297E+00	1.594E+00	0.000E+00	1.596E+02	2.128E+04	0.000E+00	9.395E+01
TE-123M	6.411E+02	2.466E+02	2.466E+02	4.932E+01	5.918E+02	6.904E+02	0.000E+00	4.932E+03
TE-125M	2.540E+03	9.190E+02	7.630E+02	1.030E+04	0.000E+00	1.010E+04	0.000E+00	3.400E+02

APPENDIX C

A_i Adult Dose Factors for use in the Liquid Dose Calculations

Age group:	ADULT	Pathway:	Fresh Water Fish - Sport (FFSP)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
TE-127	1.790E+01	6.440E+00	1.330E+01	7.300E+01	0.000E+00	1.410E+03	0.000E+00	3.880E+00
TE-127M	6.440E+03	2.300E+03	1.650E+03	2.620E+04	0.000E+00	2.160E+04	0.000E+00	7.850E+02
TE-129	1.630E-05	6.120E-06	1.250E-05	6.850E-05	0.000E+00	1.230E-05	0.000E+00	3.970E-06
TE-129M	1.080E+04	4.020E+03	3.710E+03	4.500E+04	0.000E+00	5.430E+04	0.000E+00	1.710E+03
TE-131	8.710E-17	3.640E-17	7.160E-17	3.820E-16	0.000E+00	1.230E-17	0.000E+00	2.750E-17
TE-131M	9.510E+02	4.650E+02	7.370E+02	4.710E+03	0.000E+00	4.620E+04	0.000E+00	3.880E+02
TE-132	1.950E+03	1.260E+03	1.390E+03	1.210E+04	0.000E+00	5.960E+04	0.000E+00	1.180E+03
I-130	7.050E+00	2.080E+01	1.760E+03	3.250E+01	0.000E+00	1.790E+01	0.000E+00	8.210E+00
I-131	1.370E+02	1.960E+02	6.420E+04	3.360E+02	0.000E+00	5.170E+01	0.000E+00	1.120E+02
I-132	5.270E-03	1.410E-02	4.940E-01	2.250E-02	0.000E+00	2.650E-03	0.000E+00	4.940E-03
I-133	2.290E+01	3.990E+01	5.860E+03	6.950E+01	0.000E+00	3.580E+01	0.000E+00	1.210E+01
I-134	2.120E-08	5.750E-08	9.960E-07	9.140E-08	0.000E+00	5.010E-11	0.000E+00	2.060E-08
I-135	1.290E+00	3.370E+00	2.220E+02	5.410E+00	0.000E+00	3.810E+00	0.000E+00	1.240E+00
CS-134	2.980E+05	7.080E+05	0.000E+00	2.290E+05	7.610E+04	1.240E+04	0.000E+00	5.790E+05
CS-136	2.960E+04	1.170E+05	0.000E+00	6.500E+04	8.900E+03	1.330E+04	0.000E+00	8.400E+04
CS-137	3.820E+05	5.220E+05	0.000E+00	1.770E+05	5.890E+04	1.010E+04	0.000E+00	3.420E+05
CS-138	8.940E-12	1.770E-11	0.000E+00	1.300E-11	1.280E-12	7.530E-17	0.000E+00	8.750E-12
BA-133	6.908E+00	2.657E+00	2.657E+00	5.314E-01	6.376E+00	7.439E+00	0.000E+00	5.314E+01
BA-139	5.650E-06	4.030E-09	0.000E+00	3.760E-09	2.280E-09	1.000E-05	0.000E+00	1.660E-07
BA-140	1.840E+02	2.310E-01	0.000E+00	7.860E-02	1.320E-01	3.790E+02	0.000E+00	1.210E+01
BA-141	8.700E-25	6.580E-28	0.000E+00	6.120E-28	3.730E-28	4.100E-34	0.000E+00	2.940E-26
BA-142	2.570E-42	2.640E-45	0.000E+00	2.230E-45	1.490E-45	3.620E-60	0.000E+00	1.610E-43
LA-140	9.900E-02	4.990E-02	0.000E+00	0.000E+00	0.000E+00	3.660E+03	0.000E+00	1.320E-02
LA-142	2.210E-07	1.000E-07	0.000E+00	0.000E+00	0.000E+00	7.330E-04	0.000E+00	2.500E-08
CE-141	2.190E-02	1.480E-02	0.000E+00	6.890E-03	0.000E+00	5.670E+01	0.000E+00	1.680E-03

APPENDIX C

A_i Adult Dose Factors for use in the Liquid Dose Calculations

Age group:	ADULT	Pathway:	Fresh Water Fish - Sport (FFSP)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
CE-143	2.380E-03	1.760E+00	0.000E+00	7.760E-04	0.000E+00	6.590E+01	0.000E+00	1.950E-04
CE-144	1.170E+00	4.870E-01	0.000E+00	2.890E-01	0.000E+00	3.940E+02	0.000E+00	6.260E-02
PR-143	5.230E-01	2.100E-01	0.000E+00	1.210E-01	0.000E+00	2.290E+03	0.000E+00	2.590E-02
PR-144	1.550E-28	6.440E-29	0.000E+00	3.630E-29	0.000E+00	2.230E-35	0.000E+00	7.880E-30
ND-147	3.530E-01	4.080E-01	0.000E+00	2.390E-01	0.000E+00	1.960E+03	0.000E+00	2.440E-02
EU-152	2.334E+01	5.314E+00	0.000E+00	3.291E+01	0.000E+00	3.064E+03	0.000E+00	4.668E+00
W-187	1.470E+02	1.230E+02	0.000E+00	0.000E+00	0.000E+00	4.030E+04	0.000E+00	4.300E+01
NP-239	2.120E-02	2.090E-03	0.000E+00	6.510E-03	0.000E+00	4.280E+02	0.000E+00	1.150E-03

APPENDIX C

A_i Adult Dose Factors for use in the Liquid Dose Calculations

Age group:	ADULT	Pathway:	Shoreline Sediment (SHDp)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C-14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NA-24	6.410E-01	6.410E-01	6.410E-01	6.410E-01	6.410E-01	6.410E-01	7.440E-01	6.410E-01
P-32	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CR-51	2.500E-01	2.500E-01	2.500E-01	2.500E-01	2.500E-01	2.500E-01	2.960E-01	2.500E-01
MN-54	7.440E+01	7.440E+01	7.440E+01	7.440E+01	7.440E+01	7.440E+01	8.720E+01	7.440E+01
MN-56	4.840E-02	4.840E-02	4.840E-02	4.840E-02	4.840E-02	4.840E-02	5.720E-02	4.840E-02
FE-55	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
FE-59	1.460E+01	1.460E+01	1.460E+01	1.460E+01	1.460E+01	1.460E+01	1.720E+01	1.460E+01
CO-58	2.030E+01	2.030E+01	2.030E+01	2.030E+01	2.030E+01	2.030E+01	2.380E+01	2.030E+01
CO-60	1.150E+03	1.150E+03	1.150E+03	1.150E+03	1.150E+03	1.150E+03	1.360E+03	1.150E+03
NI-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NI-65	1.590E-02	1.590E-02	1.590E-02	1.590E-02	1.590E-02	1.590E-02	1.850E-02	1.590E-02
CU-64	3.260E-02	3.260E-02	3.260E-02	3.260E-02	3.260E-02	3.260E-02	3.690E-02	3.260E-02
ZN-65	4.010E+01	4.010E+01	4.010E+01	4.010E+01	4.010E+01	4.010E+01	4.610E+01	4.010E+01
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE-75	2.425E+02	2.425E+02	2.425E+02	2.425E+02	2.425E+02	2.425E+02	2.838E+02	2.425E+02
BR-83	2.620E-04	2.620E-04	2.620E-04	2.620E-04	2.620E-04	2.620E-04	3.800E-04	2.620E-04
BR-84	1.090E-02	1.090E-02	1.090E-02	1.090E-02	1.090E-02	1.090E-02	1.270E-02	1.090E-02
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	4.820E-01	4.820E-01	4.820E-01	4.820E-01	4.820E-01	4.820E-01	5.510E-01	4.820E-01
RB-88	1.780E-03	1.780E-03	1.780E-03	1.780E-03	1.780E-03	1.780E-03	2.030E-03	1.780E-03
RB-89	6.600E-03	6.600E-03	6.600E-03	6.600E-03	6.600E-03	6.600E-03	7.920E-03	6.600E-03
SR-89	1.160E-03	1.160E-03	1.160E-03	1.160E-03	1.160E-03	1.160E-03	1.350E-03	1.160E-03
SR-90	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

APPENDIX C

A_i Adult Dose Factors for use in the Liquid Dose Calculations

Age group:	ADULT	Pathway:	Shoreline Sediment (SHDp)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-91	1.150E-01	1.150E-01	1.150E-01	1.150E-01	1.150E-01	1.150E-01	1.350E-01	1.150E-01
SR-92	4.170E-02	4.170E-02	4.170E-02	4.170E-02	4.170E-02	4.170E-02	4.630E-02	4.170E-02
Y-90	2.410E-04	2.410E-04	2.410E-04	2.410E-04	2.410E-04	2.410E-04	2.850E-04	2.410E-04
Y-91	5.760E-02	5.760E-02	5.760E-02	5.760E-02	5.760E-02	5.760E-02	6.480E-02	5.760E-02
Y-91M	5.380E-03	5.380E-03	5.380E-03	5.380E-03	5.380E-03	5.380E-03	6.230E-03	5.380E-03
Y-92	9.680E-03	9.680E-03	9.680E-03	9.680E-03	9.680E-03	9.680E-03	1.150E-02	9.680E-03
Y-93	9.840E-03	9.840E-03	9.840E-03	9.840E-03	9.840E-03	9.840E-03	1.350E-02	9.840E-03
ZR-95	1.310E+01	1.310E+01	1.310E+01	1.310E+01	1.310E+01	1.310E+01	1.520E+01	1.310E+01
ZR-97	1.590E-01	1.590E-01	1.590E-01	1.590E-01	1.590E-01	1.590E-01	1.850E-01	1.590E-01
NB-95	7.340E+00	7.340E+00	7.340E+00	7.340E+00	7.340E+00	7.340E+00	8.630E+00	7.340E+00
MO-99	2.140E-01	2.140E-01	2.140E-01	2.140E-01	2.140E-01	2.140E-01	2.480E-01	2.140E-01
TC-99M	9.880E-03	9.880E-03	9.880E-03	9.880E-03	9.880E-03	9.880E-03	1.130E-02	9.880E-03
TC-101	1.090E-03	1.090E-03	1.090E-03	1.090E-03	1.090E-03	1.090E-03	1.210E-03	1.090E-03
RU-103	5.810E+00	5.810E+00	5.810E+00	5.810E+00	5.810E+00	5.810E+00	6.780E+00	5.810E+00
RU-105	3.420E-02	3.420E-02	3.420E-02	3.420E-02	3.420E-02	3.420E-02	3.870E-02	3.420E-02
RU-106	2.270E+01	2.270E+01	2.270E+01	2.270E+01	2.270E+01	2.270E+01	2.720E+01	2.270E+01
AG-108M	2.768E+04	2.768E+04	2.768E+04	2.768E+04	2.768E+04	2.768E+04	3.239E+04	2.768E+04
AG-110M	1.850E+02	1.850E+02	1.850E+02	1.850E+02	1.850E+02	1.850E+02	2.150E+02	1.850E+02
SN-113	8.011E+00	8.011E+00	8.011E+00	8.011E+00	8.011E+00	8.011E+00	9.372E+00	8.011E+00
SN-117M	1.119E+01	1.119E+01	1.119E+01	1.119E+01	1.119E+01	1.119E+01	1.310E+01	1.119E+01
SB-124	3.211E+01	3.211E+01	3.211E+01	3.211E+01	3.211E+01	3.211E+01	3.705E+01	3.211E+01
SB-125	1.252E+02	1.252E+02	1.252E+02	1.252E+02	1.252E+02	1.252E+02	1.414E+02	1.252E+02
SB-126	4.529E+00	4.529E+00	4.529E+00	4.529E+00	4.529E+00	4.529E+00	5.089E+00	4.529E+00
TE-123M	9.088E+01	9.088E+01	9.088E+01	9.088E+01	9.088E+01	9.088E+01	1.063E+02	9.088E+01
TE-125M	8.330E-02	8.330E-02	8.330E-02	8.330E-02	8.330E-02	8.330E-02	1.140E-01	8.330E-02

APPENDIX C

A_i Adult Dose Factors for use in the Liquid Dose Calculations

Age group:	ADULT	Pathway:	Shoreline Sediment (SHDp)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
TE-127	1.600E-04	1.600E-04	1.600E-04	1.600E-04	1.600E-04	1.600E-04	1.760E-04	1.600E-04
TE-127M	4.920E-03	4.920E-03	4.920E-03	4.920E-03	4.920E-03	4.920E-03	5.810E-03	4.920E-03
TE-129	1.410E-03	1.410E-03	1.410E-03	1.410E-03	1.410E-03	1.410E-03	1.670E-03	1.410E-03
TE-129M	1.060E+00	1.060E+00	1.060E+00	1.060E+00	1.060E+00	1.060E+00	1.240E+00	1.060E+00
TE-131	1.570E-03	1.570E-03	1.570E-03	1.570E-03	1.570E-03	1.570E-03	1.850E+00	1.570E-03
TE-131M	4.310E-01	4.310E-01	4.310E-01	4.310E-01	4.310E-01	4.310E-01	5.080E-01	4.310E-01
TE-132	2.270E-01	2.270E-01	2.270E-01	2.270E-01	2.270E-01	2.270E-01	2.670E-01	2.270E-01
I-130	2.960E-01	2.960E-01	2.960E-01	2.960E-01	2.960E-01	2.960E-01	3.590E-01	2.960E-01
I-131	9.240E-01	9.240E-01	9.240E-01	9.240E-01	9.240E-01	9.240E-01	1.120E+00	9.240E-01
I-132	6.680E-02	6.680E-02	6.680E-02	6.680E-02	6.680E-02	6.680E-02	7.860E-02	6.680E-02
I-133	1.320E-01	1.320E-01	1.320E-01	1.320E-01	1.320E-01	1.320E-01	1.600E-01	1.320E-01
I-134	2.400E-02	2.400E-02	2.400E-02	2.400E-02	2.400E-02	2.400E-02	2.850E-02	2.400E-02
I-135	1.360E-01	1.360E-01	1.360E-01	1.360E-01	1.360E-01	1.360E-01	1.580E-01	1.360E-01
CS-134	3.680E+02	3.680E+02	3.680E+02	3.680E+02	3.680E+02	3.680E+02	4.300E+02	3.680E+02
CS-136	8.100E+00	8.100E+00	8.100E+00	8.100E+00	8.100E+00	8.100E+00	9.180E+00	8.100E+00
CS-137	5.520E+02	5.520E+02	5.520E+02	5.520E+02	5.520E+02	5.520E+02	6.440E+02	5.520E+02
CS-138	1.930E-02	1.930E-02	1.930E-02	1.930E-02	1.930E-02	1.930E-02	2.200E-02	1.930E-02
BA-133	4.732E+03	4.732E+03	4.732E+03	4.732E+03	4.732E+03	4.732E+03	5.536E+03	4.732E+03
BA-139	5.680E-03	5.680E-03	5.680E-03	5.680E-03	5.680E-03	5.680E-03	6.390E-03	5.680E-03
BA-140	1.100E+00	1.100E+00	1.100E+00	1.100E+00	1.100E+00	1.100E+00	1.260E+00	1.100E+00
BA-141	2.240E-03	2.240E-03	2.240E-03	2.240E-03	2.240E-03	2.240E-03	2.550E-03	2.240E-03
BA-142	2.410E-03	2.410E-03	2.410E-03	2.410E-03	2.410E-03	2.410E-03	2.740E-03	2.410E-03
LA-140	1.030E+00	1.030E+00	1.030E+00	1.030E+00	1.030E+00	1.030E+00	1.170E+00	1.030E+00
LA-142	4.080E-02	4.080E-02	4.080E-02	4.080E-02	4.080E-02	4.080E-02	4.890E-02	4.080E-02
CE-141	7.330E-01	7.330E-01	7.330E-01	7.330E-01	7.330E-01	7.330E-01	8.270E-01	7.330E-01

APPENDIX C

A_i Adult Dose Factors for use in the Liquid Dose Calculations

Age group:	ADULT	Pathway:	Shoreline Sediment (SHDp)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
CE-143	1.240E-01	1.240E-01	1.240E-01	1.240E-01	1.240E-01	1.240E-01	1.410E-01	1.240E-01
CE-144	3.730E+00	3.730E+00	3.730E+00	3.730E+00	3.730E+00	3.730E+00	4.320E+00	3.730E+00
PR-143	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR-144	9.850E-05	9.850E-05	9.850E-05	9.850E-05	9.850E-05	9.850E-05	1.130E-04	9.850E-05
ND-147	4.510E-01	4.510E-01	4.510E-01	4.510E-01	4.510E-01	4.510E-01	5.410E-01	4.510E-01
EU-152	7.976E+02	7.976E+02	7.976E+02	7.976E+02	7.976E+02	7.976E+02	9.231E+02	7.976E+02
W-187	1.260E-01	1.260E-01	1.260E-01	1.260E-01	1.260E-01	1.260E-01	1.470E-01	1.260E-01
NP-239	9.180E-02	9.180E-02	9.180E-02	9.180E-02	9.180E-02	9.180E-02	1.060E-01	9.180E-02

APPENDIX D

A_i Teen Factors for use in the Liquid Dose Calculations

Age group:	TEEN	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	6.160E+00	6.160E+00	6.160E+00	6.160E+00	6.160E+00	0.000E+00	6.160E+00
C-14	2.360E+02	4.720E+01	4.720E+01	4.720E+01	4.720E+01	4.720E+01	0.000E+00	4.720E+01
NA-24	7.690E+01	7.690E+01	7.690E+01	7.690E+01	7.690E+01	7.690E+01	0.000E+00	7.690E+01
P-32	1.570E+04	9.700E+02	0.000E+00	0.000E+00	0.000E+00	1.320E+03	0.000E+00	6.070E+02
CR-51	0.000E+00	0.000E+00	1.150E-01	4.530E-02	2.950E-01	3.470E+01	0.000E+00	2.070E-01
MN-54	0.000E+00	3.430E+02	0.000E+00	1.020E+02	0.000E+00	7.030E+02	0.000E+00	6.790E+01
MN-56	0.000E+00	3.640E-01	0.000E+00	4.610E-01	0.000E+00	2.400E+01	0.000E+00	6.480E-02
FE-55	2.200E+02	1.560E+02	0.000E+00	0.000E+00	9.880E+01	6.740E+01	0.000E+00	3.630E+01
FE-59	3.390E+02	7.900E+02	0.000E+00	0.000E+00	2.490E+02	1.870E+03	0.000E+00	3.050E+02
CO-58	0.000E+00	5.620E+01	0.000E+00	0.000E+00	0.000E+00	7.750E+02	0.000E+00	1.300E+02
CO-60	0.000E+00	1.630E+02	0.000E+00	0.000E+00	0.000E+00	2.130E+03	0.000E+00	3.680E+02
NI-63	1.030E+04	7.270E+02	0.000E+00	0.000E+00	0.000E+00	1.160E+02	0.000E+00	3.490E+02
NI-65	1.610E+00	2.050E-01	0.000E+00	0.000E+00	0.000E+00	1.110E+01	0.000E+00	9.350E-02
CU-64	0.000E+00	3.470E+00	0.000E+00	8.770E+00	0.000E+00	2.690E+02	0.000E+00	1.630E+00
ZN-65	3.340E+02	1.160E+03	0.000E+00	7.430E+02	0.000E+00	4.920E+02	0.000E+00	5.420E+02
ZN-69	1.070E-04	2.040E-04	0.000E+00	1.330E-04	0.000E+00	3.760E-04	0.000E+00	1.430E-05
SE-75	8.644E+01	3.325E+01	3.325E+01	6.649E+00	7.979E+01	9.309E+01	0.000E+00	6.649E+02
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.030E-01
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.500E-07
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.360E-77
RB-86	0.000E+00	1.700E+03	0.000E+00	0.000E+00	0.000E+00	2.520E+02	0.000E+00	7.990E+02
RB-88	0.000E+00	3.300E-12	0.000E+00	0.000E+00	0.000E+00	2.830E-19	0.000E+00	1.760E-12
RB-89	0.000E+00	2.960E-14	0.000E+00	0.000E+00	0.000E+00	4.540E-23	0.000E+00	2.090E-14
SR-89	2.540E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.030E+03	0.000E+00	7.280E+02
SR-90	4.830E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.350E+04	0.000E+00	1.190E+05

APPENDIX D

A_i Teen Factors for use in the Liquid Dose Calculations

Age group:	TEEN	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / µCi/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-91	1.950E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.850E+02	0.000E+00	7.760E+00
SR-92	8.220E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.090E+02	0.000E+00	3.500E-01
Y-90	7.000E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.770E+03	0.000E+00	1.880E-02
Y-91	1.160E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.760E+03	0.000E+00	3.120E-01
Y-91M	3.330E-07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.570E-05	0.000E+00	1.270E-08
Y-92	6.710E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.840E+02	0.000E+00	1.940E-04
Y-93	9.760E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.980E+03	0.000E+00	2.670E-03
ZR-95	2.380E+00	7.520E-01	0.000E+00	1.100E+00	0.000E+00	1.730E+03	0.000E+00	5.170E-01
ZR-97	8.420E-02	1.670E-02	0.000E+00	2.530E-02	0.000E+00	4.510E+03	0.000E+00	7.670E-03
NB-95	4.730E-01	2.630E-01	0.000E+00	2.540E-01	0.000E+00	1.120E+03	0.000E+00	1.440E-01
MO-99	0.000E+00	3.090E+02	0.000E+00	7.070E+02	0.000E+00	5.530E+02	0.000E+00	5.890E+01
TC-99M	4.840E-03	1.350E-02	0.000E+00	2.010E-01	7.500E-03	8.870E+00	0.000E+00	1.750E-01
TC-101	1.120E-17	1.590E-17	0.000E+00	2.880E-16	9.700E-18	2.720E-24	0.000E+00	1.560E-16
RU-103	1.470E+01	0.000E+00	0.000E+00	5.180E+01	0.000E+00	1.230E+03	0.000E+00	6.280E+00
RU-105	1.940E-01	0.000E+00	0.000E+00	2.450E+00	0.000E+00	1.570E+02	0.000E+00	7.540E-02
RU-106	2.280E+02	0.000E+00	0.000E+00	4.390E+02	0.000E+00	1.090E+04	0.000E+00	2.870E+01
AG-108M	7.830E+01	3.012E+01	3.012E+01	6.023E+00	7.228E+01	8.433E+01	0.000E+00	6.023E+02
AG-110M	1.190E+01	1.130E+01	0.000E+00	2.150E+01	0.000E+00	3.160E+03	0.000E+00	6.850E+00
SN-113	2.565E+01	9.866E+00	9.866E+00	1.973E+00	2.368E+01	2.762E+01	0.000E+00	1.973E+02
SN-117M	2.399E+01	9.227E+00	9.227E+00	1.845E+00	2.215E+01	2.584E+01	0.000E+00	1.845E+02
SB-124	2.237E+02	4.122E+00	5.075E-01	0.000E+00	1.954E+02	4.509E+03	0.000E+00	8.729E+01
SB-125	1.441E+02	1.575E+00	1.377E-01	0.000E+00	1.267E+02	1.122E+03	0.000E+00	3.371E+01
SB-126	8.989E+01	1.837E+00	5.083E-01	0.000E+00	6.445E+01	5.320E+03	0.000E+00	3.228E+01
TE-123M	4.740E+01	1.823E+01	1.823E+01	3.646E+00	4.376E+01	5.105E+01	0.000E+00	3.646E+02
TE-125M	2.210E+02	7.980E+01	6.180E+01	0.000E+00	0.000E+00	6.530E+02	0.000E+00	2.960E+01

APPENDIX D

A_i Teen Factors for use in the Liquid Dose Calculations

Age group:	TEEN	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
TE-127	3.790E+00	1.340E+00	2.610E+00	1.530E+01	0.000E+00	2.930E+02	0.000E+00	8.150E-01
TE-127M	5.600E+02	1.990E+02	1.330E+02	2.270E+03	0.000E+00	1.400E+03	0.000E+00	6.660E+01
TE-129	1.920E-03	7.150E-04	1.370E-03	8.040E-03	0.000E+00	1.050E-02	0.000E+00	4.660E-04
TE-129M	9.380E+02	3.480E+02	3.030E+02	3.920E+03	0.000E+00	3.520E+03	0.000E+00	1.480E+02
TE-131	3.490E-09	1.440E-09	2.690E-09	1.520E-08	0.000E+00	2.860E-10	0.000E+00	1.090E-09
TE-131M	1.080E+02	5.150E+01	7.750E+01	5.380E+02	0.000E+00	4.140E+03	0.000E+00	4.300E+01
TE-132	1.820E+02	1.150E+02	1.220E+02	1.110E+03	0.000E+00	3.660E+03	0.000E+00	1.090E+02
I-130	3.050E+01	8.830E+01	7.200E+03	1.360E+02	0.000E+00	6.790E+01	0.000E+00	3.530E+01
I-131	3.260E+02	4.560E+02	1.330E+05	7.850E+02	0.000E+00	9.020E+01	0.000E+00	2.450E+02
I-132	4.360E-01	1.140E+00	3.850E+01	1.800E+00	0.000E+00	4.970E-01	0.000E+00	4.100E-01
I-133	7.830E+01	1.330E+02	1.860E+04	2.330E+02	0.000E+00	1.010E+02	0.000E+00	4.050E+01
I-134	6.330E-04	1.680E-03	2.800E-02	2.640E-03	0.000E+00	2.210E-05	0.000E+00	6.020E-04
I-135	1.010E+01	2.600E+01	1.670E+03	4.100E+01	0.000E+00	2.880E+01	0.000E+00	9.630E+00
CS-134	4.860E+03	1.140E+04	0.000E+00	3.640E+03	1.390E+03	1.420E+02	0.000E+00	5.310E+03
CS-136	4.860E+02	1.910E+03	0.000E+00	1.040E+03	1.640E+02	1.540E+02	0.000E+00	1.290E+03
CS-137	6.510E+03	8.660E+03	0.000E+00	2.950E+03	1.150E+03	1.230E+02	0.000E+00	3.020E+03
CS-138	8.300E-07	1.590E-06	0.000E+00	1.180E-06	1.370E-07	7.230E-10	0.000E+00	7.970E-07
BA-133	2.041E+02	7.851E+01	7.851E+01	1.570E+01	1.884E+02	2.198E+02	0.000E+00	1.570E+03
BA-139	1.990E-02	1.400E-05	0.000E+00	1.320E-05	9.670E-06	1.780E-01	0.000E+00	5.810E-04
BA-140	1.610E+03	1.970E+00	0.000E+00	6.680E-01	1.320E+00	2.480E+03	0.000E+00	1.040E+02
BA-141	5.420E-12	4.050E-15	0.000E+00	3.760E-15	2.770E-15	1.150E-17	0.000E+00	1.810E-13
BA-142	6.170E-21	6.170E-24	0.000E+00	5.220E-24	4.100E-24	1.890E-32	0.000E+00	3.800E-22
LA-140	1.650E-01	8.090E-02	0.000E+00	0.000E+00	0.000E+00	4.640E+03	0.000E+00	2.150E-02
LA-142	5.590E-05	2.480E-05	0.000E+00	0.000E+00	0.000E+00	7.550E-01	0.000E+00	6.180E-06
CE-141	7.650E-01	5.110E-01	0.000E+00	2.400E-01	0.000E+00	1.460E+03	0.000E+00	5.870E-02

APPENDIX D

A_i Teen Factors for use in the Liquid Dose Calculations

Age group:	TEEN	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
CE-143	1.060E-01	7.730E+01	0.000E+00	3.460E-02	0.000E+00	2.320E+03	0.000E+00	8.630E-03
CE-144	4.040E+01	1.670E+01	0.000E+00	9.990E+00	0.000E+00	1.020E+04	0.000E+00	2.170E+00
PR-143	7.420E-01	2.960E-01	0.000E+00	1.720E-01	0.000E+00	2.440E+03	0.000E+00	3.700E-02
PR-144	7.330E-16	3.000E-16	0.000E+00	1.720E-16	0.000E+00	8.080E-19	0.000E+00	3.720E-17
ND-147	5.280E-01	5.750E-01	0.000E+00	3.370E-01	0.000E+00	2.070E+03	0.000E+00	3.440E-02
EU-152	1.424E+01	3.430E+00	0.000E+00	1.593E+01	0.000E+00	1.262E+03	0.000E+00	3.023E+00
W-187	5.990E+00	4.880E+00	0.000E+00	0.000E+00	0.000E+00	1.320E+03	0.000E+00	1.710E+00
NP-239	8.830E-02	8.330E-03	0.000E+00	2.610E-02	0.000E+00	1.340E+03	0.000E+00	4.630E-03

APPENDIX D

A_i Teen Dose Factors for use in the Liquid Dose Calculations

Age group:	TEEN	Pathway:	Fresh Water Fish - Sport (FFSP)			Units:	mrem/hr / µCi/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
H-3	0.000E+00	1.740E-01	1.740E-01	1.740E-01	1.740E-01	1.740E-01	0.000E+00	1.740E-01
C-14	3.410E+04	6.810E+03	6.810E+03	6.810E+03	6.810E+03	6.810E+03	0.000E+00	6.810E+03
NA-24	1.390E+02	1.390E+02	1.390E+02	1.390E+02	1.390E+02	1.390E+02	0.000E+00	1.390E+02
P-32	1.440E+06	8.910E+04	0.000E+00	0.000E+00	0.000E+00	1.210E+05	0.000E+00	5.580E+04
CR-51	0.000E+00	0.000E+00	7.120E-01	2.810E-01	1.830E+00	2.150E+02	0.000E+00	1.280E+00
MN-54	0.000E+00	4.300E+03	0.000E+00	1.280E+03	0.000E+00	8.810E+03	0.000E+00	8.520E+02
MN-56	0.000E+00	1.810E-01	0.000E+00	2.300E-01	0.000E+00	1.190E+01	0.000E+00	3.230E-02
FE-55	6.890E+02	4.880E+02	0.000E+00	0.000E+00	3.100E+02	2.110E+02	0.000E+00	1.140E+02
FE-59	1.050E+03	2.460E+03	0.000E+00	0.000E+00	7.760E+02	5.820E+03	0.000E+00	9.500E+02
CO-58	0.000E+00	8.780E+01	0.000E+00	0.000E+00	0.000E+00	1.210E+03	0.000E+00	2.020E+02
CO-60	0.000E+00	2.560E+02	0.000E+00	0.000E+00	0.000E+00	3.340E+03	0.000E+00	5.770E+02
NI-63	3.230E+04	2.280E+03	0.000E+00	0.000E+00	0.000E+00	3.630E+02	0.000E+00	1.090E+03
NI-65	1.860E-01	2.370E-02	0.000E+00	0.000E+00	0.000E+00	1.290E+00	0.000E+00	1.080E-02
CU-64	0.000E+00	2.820E+00	0.000E+00	7.140E+00	0.000E+00	2.190E+02	0.000E+00	1.330E+00
ZN-65	2.100E+04	7.280E+04	0.000E+00	4.660E+04	0.000E+00	3.080E+04	0.000E+00	3.390E+04
ZN-69	8.410E-07	1.600E-06	0.000E+00	1.050E-06	0.000E+00	2.950E-06	0.000E+00	1.120E-07
SE-75	5.408E+02	2.080E+02	2.080E+02	4.160E+01	4.992E+02	5.824E+02	0.000E+00	4.160E+03
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.160E-02
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.320E-12
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	1.050E+05	0.000E+00	0.000E+00	0.000E+00	1.550E+04	0.000E+00	4.920E+04
RB-88	0.000E+00	1.380E-22	0.000E+00	0.000E+00	0.000E+00	1.180E-29	0.000E+00	7.360E-23
RB-89	0.000E+00	1.720E-26	0.000E+00	0.000E+00	0.000E+00	2.630E-35	0.000E+00	1.220E-26
SR-89	2.370E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.830E+03	0.000E+00	6.800E+02
SR-90	4.540E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.270E+04	0.000E+00	1.120E+05

APPENDIX D

A_i Teen Dose Factors for use in the Liquid Dose Calculations

Age group:	TEEN	Pathway:	Fresh Water Fish - Sport (FFSP)			Units:	mrem/hr / µCi/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-91	7.640E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.470E+02	0.000E+00	3.040E+00
SR-92	3.590E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.130E+00	0.000E+00	1.530E-02
Y-90	4.820E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.980E+03	0.000E+00	1.300E-02
Y-91	9.060E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.710E+03	0.000E+00	2.430E-01
Y-91M	1.160E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.470E-10	0.000E+00	4.430E-13
Y-92	5.020E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.380E+01	0.000E+00	1.450E-05
Y-93	3.350E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.020E+03	0.000E+00	9.190E-04
ZR-95	2.450E-01	7.740E-02	0.000E+00	1.140E-01	0.000E+00	1.790E+02	0.000E+00	5.320E-02
ZR-97	5.330E-03	1.050E-03	0.000E+00	1.600E-03	0.000E+00	2.850E+02	0.000E+00	4.860E-04
NB-95	4.410E+02	2.450E+02	0.000E+00	2.370E+02	0.000E+00	1.050E+06	0.000E+00	1.350E+02
MO-99	0.000E+00	8.550E+01	0.000E+00	1.960E+02	0.000E+00	1.530E+02	0.000E+00	1.630E+01
TC-99M	5.720E-04	1.600E-03	0.000E+00	2.380E-02	8.860E-04	1.050E+00	0.000E+00	2.070E-02
TC-101	2.820E-33	4.010E-33	0.000E+00	7.240E-32	2.440E-33	6.840E-40	0.000E+00	3.930E-32
RU-103	4.570E+00	0.000E+00	0.000E+00	1.610E+01	0.000E+00	3.820E+02	0.000E+00	1.950E+00
RU-105	9.350E-03	0.000E+00	0.000E+00	1.180E-01	0.000E+00	7.550E+00	0.000E+00	3.630E-03
RU-106	7.140E+01	0.000E+00	0.000E+00	1.380E+02	0.000E+00	3.420E+03	0.000E+00	8.990E+00
AG-108M	2.457E+01	9.448E+00	9.448E+00	1.890E+00	2.268E+01	2.645E+01	0.000E+00	1.890E+02
AG-110M	8.580E-01	8.120E-01	0.000E+00	1.550E+00	0.000E+00	2.280E+02	0.000E+00	4.940E-01
SN-113	2.407E+03	9.257E+02	9.257E+02	1.851E+02	2.222E+03	2.592E+03	0.000E+00	1.851E+04
SN-117M	2.201E+03	8.466E+02	8.466E+02	1.693E+02	2.032E+03	2.371E+03	0.000E+00	1.693E+04
SB-124	6.978E+02	1.286E+01	1.583E+00	0.000E+00	6.095E+02	1.406E+04	0.000E+00	2.723E+02
SB-125	4.520E+02	4.940E+00	4.320E-01	0.000E+00	3.974E+02	3.518E+03	0.000E+00	1.057E+02
SB-126	2.742E+02	5.606E+00	1.551E+00	0.000E+00	1.966E+02	1.623E+04	0.000E+00	9.849E+01
TE-123M	5.931E+02	2.281E+02	2.281E+02	4.563E+01	5.475E+02	6.388E+02	0.000E+00	4.563E+03
TE-125M	2.760E+03	9.950E+02	7.710E+02	0.000E+00	0.000E+00	8.150E+03	0.000E+00	3.690E+02

APPENDIX D

A_i Teen Dose Factors for use in the Liquid Dose Calculations

Age group:	TEEN	Pathway:	Fresh Water Fish - Sport (FFSP)			Units:	mrem/hr / µCi/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
TE-127	1.960E+01	6.950E+00	1.350E+01	7.940E+01	0.000E+00	1.510E+03	0.000E+00	4.220E+00
TE-127M	7.010E+03	2.490E+03	1.670E+03	2.840E+04	0.000E+00	1.750E+04	0.000E+00	8.340E+02
TE-129	1.770E-05	6.600E-06	1.260E-05	7.430E-05	0.000E+00	9.680E-05	0.000E+00	4.310E-06
TE-129M	1.160E+04	4.320E+03	3.760E+03	4.870E+04	0.000E+00	4.370E+04	0.000E+00	1.840E+03
TE-131	9.400E-17	3.870E-17	7.240E-17	4.110E-16	0.000E+00	7.710E-18	0.000E+00	2.940E-17
TE-131M	1.020E+03	4.900E+02	7.370E+02	5.110E+03	0.000E+00	3.930E+04	0.000E+00	4.090E+02
TE-132	2.060E+03	1.300E+03	1.370E+03	1.250E+04	0.000E+00	4.130E+04	0.000E+00	1.230E+03
I-130	7.320E+00	2.120E+01	1.730E+03	3.260E+01	0.000E+00	1.630E+01	0.000E+00	8.460E+00
I-131	1.470E+02	2.060E+02	6.000E+04	3.540E+02	0.000E+00	4.070E+01	0.000E+00	1.100E+02
I-132	5.520E-03	1.440E-02	4.870E-01	2.280E-02	0.000E+00	6.290E-03	0.000E+00	5.180E-03
I-133	2.470E+01	4.190E+01	5.850E+03	7.350E+01	0.000E+00	3.170E+01	0.000E+00	1.280E+01
I-134	2.220E-08	5.890E-08	9.810E-07	9.280E-08	0.000E+00	7.760E-10	0.000E+00	2.110E-08
I-135	1.350E+00	3.480E+00	2.240E+02	5.490E+00	0.000E+00	3.850E+00	0.000E+00	1.290E+00
CS-134	3.050E+05	7.180E+05	0.000E+00	2.280E+05	8.710E+04	8.930E+03	0.000E+00	3.330E+05
CS-136	2.970E+04	1.170E+05	0.000E+00	6.370E+04	1.000E+04	9.410E+03	0.000E+00	7.860E+04
CS-137	4.090E+05	5.440E+05	0.000E+00	1.850E+05	7.190E+04	7.730E+03	0.000E+00	1.890E+05
CS-138	9.580E-12	1.840E-11	0.000E+00	1.360E-11	1.580E-12	8.340E-15	0.000E+00	9.190E-12
BA-133	2.561E+01	9.851E+00	9.851E+00	1.970E+00	2.364E+01	2.758E+01	0.000E+00	1.970E+02
BA-139	6.170E-06	4.340E-09	0.000E+00	4.090E-09	2.990E-09	5.510E-05	0.000E+00	1.800E-07
BA-140	1.960E+02	2.410E-01	0.000E+00	8.160E-02	1.620E-01	3.030E+02	0.000E+00	1.260E+01
BA-141	9.450E-25	7.050E-28	0.000E+00	6.550E-28	4.830E-28	2.010E-30	0.000E+00	3.150E-26
BA-142	2.750E-42	2.750E-45	0.000E+00	2.320E-45	1.830E-45	8.430E-54	0.000E+00	1.690E-43
LA-140	1.050E-01	5.160E-02	0.000E+00	0.000E+00	0.000E+00	2.960E+03	0.000E+00	1.370E-02
LA-142	2.350E-07	1.040E-07	0.000E+00	0.000E+00	0.000E+00	3.180E-03	0.000E+00	2.600E-08
CE-141	2.370E-02	1.590E-02	0.000E+00	7.460E-03	0.000E+00	4.540E+01	0.000E+00	1.820E-03

APPENDIX D

A_i Teen Dose Factors for use in the Liquid Dose Calculations

Age group:	TEEN	Pathway:	Fresh Water Fish - Sport (FFSP)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
CE-143	2.590E-03	1.880E+00	0.000E+00	8.450E-04	0.000E+00	5.660E+01	0.000E+00	2.100E-04
CE-144	1.270E+00	5.240E-01	0.000E+00	3.130E-01	0.000E+00	3.180E+02	0.000E+00	6.810E-02
PR-143	5.680E-01	2.270E-01	0.000E+00	1.320E-01	0.000E+00	1.870E+03	0.000E+00	2.830E-02
PR-144	1.690E-28	6.900E-29	0.000E+00	3.960E-29	0.000E+00	1.860E-31	0.000E+00	8.550E-30
ND-147	4.020E-01	4.370E-01	0.000E+00	2.560E-01	0.000E+00	1.580E+03	0.000E+00	2.620E-02
EU-152	2.234E+01	5.380E+00	0.000E+00	2.499E+01	0.000E+00	1.979E+03	0.000E+00	4.742E+00
W-187	1.590E+02	1.300E+02	0.000E+00	0.000E+00	0.000E+00	3.510E+04	0.000E+00	4.540E+01
NP-239	2.390E-02	2.260E-03	0.000E+00	7.080E-03	0.000E+00	3.630E+02	0.000E+00	1.250E-03

APPENDIX D

A_i Teen Dose Factors for use in the Liquid Dose Calculations

Age group:	TEEN	Pathway:	Shoreline Sediment (SHDp)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C-14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NA-24	3.580E+00	3.580E+00	3.580E+00	3.580E+00	3.580E+00	3.580E+00	4.150E+00	3.580E+00
P-32	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CR-51	1.400E+00	1.400E+00	1.400E+00	1.400E+00	1.400E+00	1.400E+00	1.650E+00	1.400E+00
MN-54	4.150E+02	4.150E+02	4.150E+02	4.150E+02	4.150E+02	4.150E+02	4.870E+02	4.150E+02
MN-56	2.700E-01	2.700E-01	2.700E-01	2.700E-01	2.700E-01	2.700E-01	3.200E-01	2.700E-01
FE-55	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
FE-59	8.180E+01	8.180E+01	8.180E+01	8.180E+01	8.180E+01	8.180E+01	9.610E+01	8.180E+01
CO-58	1.140E+02	1.140E+02	1.140E+02	1.140E+02	1.140E+02	1.140E+02	1.330E+02	1.140E+02
CO-60	6.440E+03	6.440E+03	6.440E+03	6.440E+03	6.440E+03	6.440E+03	7.580E+03	6.440E+03
NI-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NI-65	8.900E-02	8.900E-02	8.900E-02	8.900E-02	8.900E-02	8.900E-02	1.030E-01	8.900E-02
CU-64	1.820E-01	1.820E-01	1.820E-01	1.820E-01	1.820E-01	1.820E-01	2.060E-01	1.820E-01
ZN-65	2.240E+02	2.240E+02	2.240E+02	2.240E+02	2.240E+02	2.240E+02	2.580E+02	2.240E+02
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE-75	1.354E+03	1.354E+03	1.354E+03	1.354E+03	1.354E+03	1.354E+03	1.584E+03	1.354E+03
BR-83	1.460E-03	1.460E-03	1.460E-03	1.460E-03	1.460E-03	1.460E-03	2.120E-03	1.460E-03
BR-84	6.070E-02	6.070E-02	6.070E-02	6.070E-02	6.070E-02	6.070E-02	7.080E-02	6.070E-02
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	2.690E+00	2.690E+00	2.690E+00	2.690E+00	2.690E+00	2.690E+00	3.080E+00	2.690E+00
RB-88	9.910E-03	9.910E-03	9.910E-03	9.910E-03	9.910E-03	9.910E-03	1.130E-02	9.910E-03
RB-89	3.680E-02	3.680E-02	3.680E-02	3.680E-02	3.680E-02	3.680E-02	4.420E-02	3.680E-02
SR-89	6.490E-03	6.490E-03	6.490E-03	6.490E-03	6.490E-03	6.490E-03	7.530E-03	6.490E-03
SR-90	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

APPENDIX D

A_i Teen Dose Factors for use in the Liquid Dose Calculations

Age group:	TEEN	Pathway:	Shoreline Sediment (SHDp)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-91	6.440E-01	6.440E-01	6.440E-01	6.440E-01	6.440E-01	6.440E-01	7.530E-01	6.440E-01
SR-92	2.330E-01	2.330E-01	2.330E-01	2.330E-01	2.330E-01	2.330E-01	2.590E-01	2.330E-01
Y-90	1.350E-03	1.350E-03	1.350E-03	1.350E-03	1.350E-03	1.350E-03	1.590E-03	1.350E-03
Y-91	3.220E-01	3.220E-01	3.220E-01	3.220E-01	3.220E-01	3.220E-01	3.620E-01	3.220E-01
Y-91M	3.010E-02	3.010E-02	3.010E-02	3.010E-02	3.010E-02	3.010E-02	3.480E-02	3.010E-02
Y-92	5.410E-02	5.410E-02	5.410E-02	5.410E-02	5.410E-02	5.410E-02	6.420E-02	5.410E-02
Y-93	5.500E-02	5.500E-02	5.500E-02	5.500E-02	5.500E-02	5.500E-02	7.520E-02	5.500E-02
ZR-95	7.330E+01	7.330E+01	7.330E+01	7.330E+01	7.330E+01	7.330E+01	8.510E+01	7.330E+01
ZR-97	8.870E-01	8.870E-01	8.870E-01	8.870E-01	8.870E-01	8.870E-01	1.030E+00	8.870E-01
NB-95	4.100E+01	4.100E+01	4.100E+01	4.100E+01	4.100E+01	4.100E+01	4.820E+01	4.100E+01
MO-99	1.200E+00	1.200E+00	1.200E+00	1.200E+00	1.200E+00	1.200E+00	1.390E+00	1.200E+00
TC-99M	5.520E-02	5.520E-02	5.520E-02	5.520E-02	5.520E-02	5.520E-02	6.320E-02	5.520E-02
TC-101	6.100E-03	6.100E-03	6.100E-03	6.100E-03	6.100E-03	6.100E-03	6.780E-03	6.100E-03
RU-103	3.250E+01	3.250E+01	3.250E+01	3.250E+01	3.250E+01	3.250E+01	3.790E+01	3.250E+01
RU-105	1.910E-01	1.910E-01	1.910E-01	1.910E-01	1.910E-01	1.910E-01	2.160E-01	1.910E-01
RU-106	1.270E+02	1.270E+02	1.270E+02	1.270E+02	1.270E+02	1.270E+02	1.520E+02	1.270E+02
AG-108M	1.546E+05	1.546E+05	1.546E+05	1.546E+05	1.546E+05	1.546E+05	1.808E+05	1.546E+05
AG-110M	1.030E+03	1.030E+03	1.030E+03	1.030E+03	1.030E+03	1.030E+03	1.200E+03	1.030E+03
SN-113	4.473E+01	4.473E+01	4.473E+01	4.473E+01	4.473E+01	4.473E+01	5.233E+01	4.473E+01
SN-117M	6.250E+01	6.250E+01	6.250E+01	6.250E+01	6.250E+01	6.250E+01	7.313E+01	6.250E+01
SB-124	1.793E+02	1.793E+02	1.793E+02	1.793E+02	1.793E+02	1.793E+02	2.069E+02	1.793E+02
SB-125	6.992E+02	6.992E+02	6.992E+02	6.992E+02	6.992E+02	6.992E+02	7.894E+02	6.992E+02
SB-126	2.529E+01	2.529E+01	2.529E+01	2.529E+01	2.529E+01	2.529E+01	2.841E+01	2.529E+01
TE-123M	5.074E+02	5.074E+02	5.074E+02	5.074E+02	5.074E+02	5.074E+02	5.937E+02	5.074E+02
TE-125M	4.650E-01	4.650E-01	4.650E-01	4.650E-01	4.650E-01	4.650E-01	6.380E-01	4.650E-01

APPENDIX D

A_i Teen Dose Factors for use in the Liquid Dose Calculations

Age group:	TEEN	Pathway:	Shoreline Sediment (SHDp)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
TE-127	8.920E-04	8.920E-04	8.920E-04	8.920E-04	8.920E-04	8.920E-04	9.820E-04	8.920E-04
TE-127M	2.750E-02	2.750E-02	2.750E-02	2.750E-02	2.750E-02	2.750E-02	3.250E-02	2.750E-02
TE-129	7.860E-03	7.860E-03	7.860E-03	7.860E-03	7.860E-03	7.860E-03	9.300E-03	7.860E-03
TE-129M	5.930E+00	5.930E+00	5.930E+00	5.930E+00	5.930E+00	5.930E+00	6.930E+00	5.930E+00
TE-131	8.750E-03	8.750E-03	8.750E-03	8.750E-03	8.750E-03	8.750E-03	1.030E+01	8.750E-03
TE-131M	2.410E+00	2.410E+00	2.410E+00	2.410E+00	2.410E+00	2.410E+00	2.840E+00	2.410E+00
TE-132	1.270E+00	1.270E+00	1.270E+00	1.270E+00	1.270E+00	1.270E+00	1.490E+00	1.270E+00
I-130	1.650E+00	1.650E+00	1.650E+00	1.650E+00	1.650E+00	1.650E+00	2.010E+00	1.650E+00
I-131	5.160E+00	5.160E+00	5.160E+00	5.160E+00	5.160E+00	5.160E+00	6.260E+00	5.160E+00
I-132	3.730E-01	3.730E-01	3.730E-01	3.730E-01	3.730E-01	3.730E-01	4.390E-01	3.730E-01
I-133	7.350E-01	7.350E-01	7.350E-01	7.350E-01	7.350E-01	7.350E-01	8.930E-01	7.350E-01
I-134	1.340E-01	1.340E-01	1.340E-01	1.340E-01	1.340E-01	1.340E-01	1.590E-01	1.340E-01
I-135	7.570E-01	7.570E-01	7.570E-01	7.570E-01	7.570E-01	7.570E-01	8.830E-01	7.570E-01
CS-134	2.060E+03	2.060E+03	2.060E+03	2.060E+03	2.060E+03	2.060E+03	2.400E+03	2.060E+03
CS-136	4.520E+01	4.520E+01	4.520E+01	4.520E+01	4.520E+01	4.520E+01	5.130E+01	4.520E+01
CS-137	3.080E+03	3.080E+03	3.080E+03	3.080E+03	3.080E+03	3.080E+03	3.590E+03	3.080E+03
CS-138	1.080E-01	1.080E-01	1.080E-01	1.080E-01	1.080E-01	1.080E-01	1.230E-01	1.080E-01
BA-133	2.642E+04	2.642E+04	2.642E+04	2.642E+04	2.642E+04	2.642E+04	3.091E+04	2.642E+04
BA-139	3.170E-02	3.170E-02	3.170E-02	3.170E-02	3.170E-02	3.170E-02	3.570E-02	3.170E-02
BA-140	6.150E+00	6.150E+00	6.150E+00	6.150E+00	6.150E+00	6.150E+00	7.030E+00	6.150E+00
BA-141	1.250E-02	1.250E-02	1.250E-02	1.250E-02	1.250E-02	1.250E-02	1.420E-02	1.250E-02
BA-142	1.340E-02	1.340E-02	1.340E-02	1.340E-02	1.340E-02	1.340E-02	1.530E-02	1.340E-02
LA-140	5.760E+00	5.760E+00	5.760E+00	5.760E+00	5.760E+00	5.760E+00	6.530E+00	5.760E+00
LA-142	2.280E-01	2.280E-01	2.280E-01	2.280E-01	2.280E-01	2.280E-01	2.730E-01	2.280E-01
CE-141	4.090E+00	4.090E+00	4.090E+00	4.090E+00	4.090E+00	4.090E+00	4.620E+00	4.090E+00

APPENDIX D

A_i Teen Dose Factors for use in the Liquid Dose Calculations

Age group:	TEEN	Pathway:	Shoreline Sediment (SHDp)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
CE-143	6.930E-01	6.930E-01	6.930E-01	6.930E-01	6.930E-01	6.930E-01	7.870E-01	6.930E-01
CE-144	2.080E+01	2.080E+01	2.080E+01	2.080E+01	2.080E+01	2.080E+01	2.410E+01	2.080E+01
PR-143	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR-144	5.500E-04	5.500E-04	5.500E-04	5.500E-04	5.500E-04	5.500E-04	6.320E-04	5.500E-04
ND-147	2.520E+00	2.520E+00	2.520E+00	2.520E+00	2.520E+00	2.520E+00	3.020E+00	2.520E+00
EU-152	4.453E+03	4.453E+03	4.453E+03	4.453E+03	4.453E+03	4.453E+03	5.154E+03	4.453E+03
W-187	7.050E-01	7.050E-01	7.050E-01	7.050E-01	7.050E-01	7.050E-01	8.190E-01	7.050E-01
NP-239	5.130E-01	5.130E-01	5.130E-01	5.130E-01	5.130E-01	5.130E-01	5.930E-01	5.130E-01

APPENDIX E

A_i Child Dose Factors for use in the Liquid Dose Calculations

Age group:	CHILD	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	1.180E+01	1.180E+01	1.180E+01	1.180E+01	1.180E+01	0.000E+00	1.180E+01
C-14	7.030E+02	1.410E+02	1.410E+02	1.410E+02	1.410E+02	1.410E+02	0.000E+00	1.410E+02
NA-24	1.940E+02	1.940E+02	1.940E+02	1.940E+02	1.940E+02	1.940E+02	0.000E+00	1.940E+02
P-32	4.680E+04	2.190E+03	0.000E+00	0.000E+00	0.000E+00	1.290E+03	0.000E+00	1.800E+03
CR-51	0.000E+00	0.000E+00	2.840E-01	7.750E-02	5.180E-01	2.710E+01	0.000E+00	5.110E-01
MN-54	0.000E+00	6.210E+02	0.000E+00	1.740E+02	0.000E+00	5.220E+02	0.000E+00	1.660E+02
MN-56	0.000E+00	7.700E-01	0.000E+00	9.320E-01	0.000E+00	1.120E+02	0.000E+00	1.740E-01
FE-55	6.680E+02	3.550E+02	0.000E+00	0.000E+00	2.010E+02	6.570E+01	0.000E+00	1.100E+02
FE-59	9.520E+02	1.540E+03	0.000E+00	0.000E+00	4.470E+02	1.600E+03	0.000E+00	7.670E+02
CO-58	0.000E+00	1.040E+02	0.000E+00	0.000E+00	0.000E+00	6.070E+02	0.000E+00	3.190E+02
CO-60	0.000E+00	3.080E+02	0.000E+00	0.000E+00	0.000E+00	1.700E+03	0.000E+00	9.070E+02
NI-63	3.130E+04	1.670E+03	0.000E+00	0.000E+00	0.000E+00	1.130E+02	0.000E+00	1.060E+03
NI-65	4.760E+00	4.480E-01	0.000E+00	0.000E+00	0.000E+00	5.490E+01	0.000E+00	2.610E-01
CU-64	0.000E+00	7.390E+00	0.000E+00	1.780E+01	0.000E+00	3.470E+02	0.000E+00	4.460E+00
ZN-65	7.950E+02	2.120E+03	0.000E+00	1.340E+03	0.000E+00	3.720E+02	0.000E+00	1.320E+03
ZN-69	3.190E-04	4.610E-04	0.000E+00	2.800E-04	0.000E+00	2.900E-02	0.000E+00	4.260E-05
SE-75	2.314E+02	8.902E+01	8.902E+01	1.780E+01	2.136E+02	2.492E+02	0.000E+00	1.780E+03
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.060E-01
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.780E-06
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.300E-76
RB-86	0.000E+00	3.820E+03	0.000E+00	0.000E+00	0.000E+00	2.460E+02	0.000E+00	2.350E+03
RB-88	0.000E+00	7.360E-12	0.000E+00	0.000E+00	0.000E+00	3.610E-13	0.000E+00	5.110E-12
RB-89	0.000E+00	6.300E-14	0.000E+00	0.000E+00	0.000E+00	5.490E-16	0.000E+00	5.600E-14
SR-89	7.620E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.950E+03	0.000E+00	2.180E+03
SR-90	9.880E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.330E+04	0.000E+00	2.510E+05

APPENDIX E

A_i Child Dose Factors for use in the Liquid Dose Calculations

Age group:	CHILD	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / µCi/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-91	5.810E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.280E+03	0.000E+00	2.190E+01
SR-92	2.430E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.610E+02	0.000E+00	9.760E-01
Y-90	2.100E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.980E+03	0.000E+00	5.620E-02
Y-91	3.480E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.640E+03	0.000E+00	9.310E-01
Y-91M	9.860E-07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.930E-03	0.000E+00	3.590E-08
Y-92	2.000E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.770E+02	0.000E+00	5.710E-04
Y-93	2.900E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.330E+03	0.000E+00	7.970E-03
ZR-95	6.710E+00	1.470E+00	0.000E+00	2.110E+00	0.000E+00	1.540E+03	0.000E+00	1.310E+00
ZR-97	2.480E-01	3.590E-02	0.000E+00	5.150E-02	0.000E+00	5.440E+03	0.000E+00	2.120E-02
NB-95	1.300E+00	5.040E-01	0.000E+00	4.740E-01	0.000E+00	9.330E+02	0.000E+00	3.600E-01
MO-99	0.000E+00	6.820E+02	0.000E+00	1.460E+03	0.000E+00	5.640E+02	0.000E+00	1.690E+02
TC-99M	1.350E-02	2.640E-02	0.000E+00	3.840E-01	1.340E-02	1.500E+01	0.000E+00	4.380E-01
TC-101	3.330E-17	3.480E-17	0.000E+00	5.940E-16	1.840E-17	1.110E-16	0.000E+00	4.410E-16
RU-103	4.210E+01	0.000E+00	0.000E+00	1.060E+02	0.000E+00	1.090E+03	0.000E+00	1.620E+01
RU-105	5.750E-01	0.000E+00	0.000E+00	5.060E+00	0.000E+00	3.750E+02	0.000E+00	2.090E-01
RU-106	6.800E+02	0.000E+00	0.000E+00	9.180E+02	0.000E+00	1.060E+04	0.000E+00	8.480E+01
AG-108M	1.818E+02	6.991E+01	6.991E+01	1.398E+01	1.678E+02	1.958E+02	0.000E+00	1.398E+03
AG-110M	3.130E+01	2.110E+01	0.000E+00	3.940E+01	0.000E+00	2.510E+03	0.000E+00	1.690E+01
SN-113	7.249E+01	2.788E+01	2.788E+01	5.576E+00	6.692E+01	7.807E+01	0.000E+00	5.576E+02
SN-117M	6.816E+01	2.621E+01	2.621E+01	5.243E+00	6.291E+01	7.340E+01	0.000E+00	5.243E+02
SB-124	6.416E+02	8.324E+00	1.416E+00	0.000E+00	3.561E+02	4.012E+03	0.000E+00	2.249E+02
SB-125	4.161E+02	3.208E+00	3.853E-01	0.000E+00	2.319E+02	9.939E+02	0.000E+00	8.718E+01
SB-126	2.488E+02	3.805E+00	1.459E+00	0.000E+00	1.187E+02	5.015E+03	0.000E+00	8.933E+01
TE-123M	1.366E+02	5.255E+01	5.255E+01	1.051E+01	1.261E+02	1.471E+02	0.000E+00	1.051E+03
TE-125M	6.590E+02	1.790E+02	1.850E+02	0.000E+00	0.000E+00	6.360E+02	0.000E+00	8.780E+01

APPENDIX E

A_i Child Dose Factors for use in the Liquid Dose Calculations

Age group:	CHILD	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
TE-127	1.130E+01	3.050E+00	7.820E+00	3.210E+01	0.000E+00	4.410E+02	0.000E+00	2.420E+00
TE-127M	1.670E+03	4.510E+02	4.000E+02	4.780E+03	0.000E+00	1.360E+03	0.000E+00	1.990E+02
TE-129	5.730E-03	1.600E-03	4.090E-03	1.680E-02	0.000E+00	3.570E-01	0.000E+00	1.360E-03
TE-129M	2.800E+03	7.830E+02	9.030E+02	8.230E+03	0.000E+00	3.420E+03	0.000E+00	4.350E+02
TE-131	1.040E-08	3.160E-09	7.930E-09	3.140E-08	0.000E+00	5.450E-08	0.000E+00	3.090E-09
TE-131M	3.170E+02	1.100E+02	2.260E+02	1.060E+03	0.000E+00	4.450E+03	0.000E+00	1.170E+02
TE-132	5.280E+02	2.340E+02	3.400E+02	2.170E+03	0.000E+00	2.350E+03	0.000E+00	2.820E+02
I-130	8.650E+01	1.750E+02	1.930E+04	2.610E+02	0.000E+00	8.180E+01	0.000E+00	9.010E+01
I-131	9.580E+02	9.630E+02	3.190E+05	1.580E+03	0.000E+00	8.580E+01	0.000E+00	5.470E+02
I-132	1.250E+00	2.300E+00	1.070E+02	3.520E+00	0.000E+00	2.710E+00	0.000E+00	1.060E+00
I-133	2.310E+02	2.850E+02	5.300E+04	4.750E+02	0.000E+00	1.150E+02	0.000E+00	1.080E+02
I-134	1.820E-03	3.370E-03	7.760E-02	5.160E-03	0.000E+00	2.240E-03	0.000E+00	1.550E-03
I-135	2.890E+01	5.210E+01	4.610E+03	7.990E+01	0.000E+00	3.970E+01	0.000E+00	2.460E+01
CS-134	1.360E+04	2.230E+04	0.000E+00	6.920E+03	2.480E+03	1.200E+02	0.000E+00	4.710E+03
CS-136	1.330E+03	3.660E+03	0.000E+00	1.950E+03	2.910E+02	1.290E+02	0.000E+00	2.370E+03
CS-137	1.900E+04	1.820E+04	0.000E+00	5.930E+03	2.130E+03	1.140E+02	0.000E+00	2.690E+03
CS-138	2.440E-06	3.390E-06	0.000E+00	2.380E-06	2.570E-07	1.560E-06	0.000E+00	2.150E-06
BA-133	1.091E+02	4.194E+01	4.194E+01	8.389E+00	1.007E+02	1.174E+02	0.000E+00	8.389E+02
BA-139	5.940E-02	3.170E-05	0.000E+00	2.770E-05	1.860E-05	3.430E+00	0.000E+00	1.720E-03
BA-140	4.700E+03	4.120E+00	0.000E+00	1.340E+00	2.460E+00	2.380E+03	0.000E+00	2.740E+02
BA-141	1.620E-11	9.050E-15	0.000E+00	7.830E-15	5.310E-14	9.210E-12	0.000E+00	5.260E-13
BA-142	1.800E-20	1.300E-23	0.000E+00	1.050E-23	7.630E-24	2.350E-22	0.000E+00	1.010E-21
LA-140	4.780E-01	1.670E-01	0.000E+00	0.000E+00	0.000E+00	4.650E+03	0.000E+00	5.630E-02
LA-142	1.640E-04	5.210E-05	0.000E+00	0.000E+00	0.000E+00	1.030E+01	0.000E+00	1.630E-05
CE-141	2.280E+00	1.140E+00	0.000E+00	4.990E-01	0.000E+00	1.420E+03	0.000E+00	1.690E-01

APPENDIX E

A_i Child Dose Factors for use in the Liquid Dose Calculations

Age group:	CHILD	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / µCi/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
CE-143	3.160E-01	1.710E+02	0.000E+00	7.180E-02	0.000E+00	2.510E+03	0.000E+00	2.480E-02
CE-144	1.210E+02	3.790E+01	0.000E+00	2.100E+01	0.000E+00	9.870E+03	0.000E+00	6.450E+00
PR-143	2.230E+00	6.690E-01	0.000E+00	3.620E-01	0.000E+00	2.400E+03	0.000E+00	1.110E-01
PR-144	2.200E-15	6.800E-16	0.000E+00	3.600E-16	0.000E+00	1.460E-12	0.000E+00	1.110E-16
ND-147	1.570E+00	1.270E+00	0.000E+00	6.990E-01	0.000E+00	2.020E+03	0.000E+00	9.860E-02
EU-152	3.575E+01	6.511E+00	0.000E+00	2.750E+01	0.000E+00	1.070E+03	0.000E+00	7.732E+00
W-187	1.760E+01	1.040E+01	0.000E+00	0.000E+00	0.000E+00	1.460E+03	0.000E+00	4.680E+00
NP-239	2.630E-01	1.890E-02	0.000E+00	5.470E-02	0.000E+00	1.400E+03	0.000E+00	1.330E-02

APPENDIX E

A_i Child Dose Factors for use in the Liquid Dose Calculations

Age group:	CHILD	Pathway:	Fresh Water Fish - Sport (FFSP)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	1.440E-01	1.440E-01	1.440E-01	1.440E-01	1.440E-01	0.000E+00	1.440E-01
C-14	4.380E+04	8.760E+03	8.760E+03	8.760E+03	8.760E+03	8.760E+03	0.000E+00	8.760E+03
NA-24	1.510E+02	1.510E+02	1.510E+02	1.510E+02	1.510E+02	1.510E+02	0.000E+00	1.510E+02
P-32	1.850E+06	8.680E+04	0.000E+00	0.000E+00	0.000E+00	5.130E+04	0.000E+00	7.150E+04
CR-51	0.000E+00	0.000E+00	7.580E-01	2.070E-01	1.380E+00	7.240E+01	0.000E+00	1.370E+00
MN-54	0.000E+00	3.360E+03	0.000E+00	9.420E+02	0.000E+00	2.820E+03	0.000E+00	8.950E+02
MN-56	0.000E+00	1.650E-01	0.000E+00	2.000E-01	0.000E+00	2.400E+01	0.000E+00	3.730E-02
FE-55	9.040E+02	4.790E+02	0.000E+00	0.000E+00	2.710E+02	8.880E+01	0.000E+00	1.490E+02
FE-59	1.280E+03	2.070E+03	0.000E+00	0.000E+00	5.990E+02	2.150E+03	0.000E+00	1.030E+03
CO-58	0.000E+00	7.010E+01	0.000E+00	0.000E+00	0.000E+00	4.090E+02	0.000E+00	2.150E+02
CO-60	0.000E+00	2.080E+02	0.000E+00	0.000E+00	0.000E+00	1.150E+03	0.000E+00	6.130E+02
NI-63	4.230E+04	2.270E+03	0.000E+00	0.000E+00	0.000E+00	1.530E+02	0.000E+00	1.440E+03
NI-65	2.370E-01	2.230E-02	0.000E+00	0.000E+00	0.000E+00	2.740E+00	0.000E+00	1.300E-02
CU-64	0.000E+00	2.590E+00	0.000E+00	6.260E+00	0.000E+00	1.220E+02	0.000E+00	1.570E+00
ZN-65	2.150E+04	5.730E+04	0.000E+00	3.610E+04	0.000E+00	1.010E+04	0.000E+00	3.560E+04
ZN-69	1.080E-06	1.560E-06	0.000E+00	9.470E-07	0.000E+00	9.840E-05	0.000E+00	1.440E-07
SE-75	6.244E+02	2.402E+02	2.402E+02	4.803E+01	5.764E+02	6.725E+02	0.000E+00	4.803E+03
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.340E-02
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.570E-12
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	1.020E+05	0.000E+00	0.000E+00	0.000E+00	6.530E+03	0.000E+00	6.250E+04
RB-88	0.000E+00	1.330E-22	0.000E+00	0.000E+00	0.000E+00	6.510E-24	0.000E+00	9.220E-23
RB-89	0.000E+00	1.580E-26	0.000E+00	0.000E+00	0.000E+00	1.370E-28	0.000E+00	1.400E-26
SR-89	3.070E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.190E+03	0.000E+00	8.780E+02
SR-90	4.010E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.400E+03	0.000E+00	1.020E+05

APPENDIX E

A_i Child Dose Factors for use in the Liquid Dose Calculations

Age group:	CHILD	Pathway:	Fresh Water Fish - Sport (FFSP)			Units:	mrem/hr / µCi/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-91	9.800E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.160E+02	0.000E+00	3.700E+00
SR-92	4.580E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.670E+00	0.000E+00	1.840E-02
Y-90	6.240E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.780E+03	0.000E+00	1.670E-02
Y-91	1.170E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.560E+03	0.000E+00	3.130E-01
Y-91M	1.480E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.900E-08	0.000E+00	5.390E-13
Y-92	6.440E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.860E+01	0.000E+00	1.840E-05
Y-93	4.300E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.420E+02	0.000E+00	1.180E-03
ZR-95	2.980E-01	6.550E-02	0.000E+00	9.370E-02	0.000E+00	6.830E+01	0.000E+00	5.830E-02
ZR-97	6.780E-03	9.790E-04	0.000E+00	1.410E-03	0.000E+00	1.480E+02	0.000E+00	5.780E-04
NB-95	5.210E+02	2.030E+02	0.000E+00	1.900E+02	0.000E+00	3.750E+05	0.000E+00	1.450E+02
MO-99	0.000E+00	8.130E+01	0.000E+00	1.740E+02	0.000E+00	6.720E+01	0.000E+00	2.010E+01
TC-99M	6.860E-04	1.350E-03	0.000E+00	1.950E-02	6.830E-04	7.650E-01	0.000E+00	2.230E-02
TC-101	3.610E-33	3.780E-33	0.000E+00	6.440E-32	2.000E-33	1.200E-32	0.000E+00	4.790E-32
RU-103	5.650E+00	0.000E+00	0.000E+00	1.420E+01	0.000E+00	1.460E+02	0.000E+00	2.170E+00
RU-105	1.190E-02	0.000E+00	0.000E+00	1.050E-01	0.000E+00	7.790E+00	0.000E+00	4.330E-03
RU-106	9.190E+01	0.000E+00	0.000E+00	1.240E+02	0.000E+00	1.430E+03	0.000E+00	1.150E+01
AG-108M	2.459E+01	9.459E+00	9.459E+00	1.892E+00	2.270E+01	2.648E+01	0.000E+00	1.892E+02
AG-110M	9.720E-01	6.570E-01	0.000E+00	1.220E+00	0.000E+00	7.810E+01	0.000E+00	5.250E-01
SN-113	2.933E+03	1.128E+03	1.128E+03	2.256E+02	2.708E+03	3.159E+03	0.000E+00	2.256E+04
SN-117M	2.697E+03	1.037E+03	1.037E+03	2.074E+02	2.489E+03	2.904E+03	0.000E+00	2.074E+04
SB-124	8.631E+02	1.120E+01	1.905E+00	0.000E+00	4.790E+02	5.396E+03	0.000E+00	3.025E+02
SB-125	5.628E+02	4.339E+00	5.212E-01	0.000E+00	3.136E+02	1.344E+03	0.000E+00	1.179E+02
SB-126	3.273E+02	5.006E+00	1.919E+00	0.000E+00	1.562E+02	6.598E+03	0.000E+00	1.175E+02
TE-123M	7.373E+02	2.836E+02	2.836E+02	5.671E+01	6.806E+02	7.940E+02	0.000E+00	5.671E+03
TE-125M	3.540E+03	9.610E+02	9.950E+02	0.000E+00	0.000E+00	3.420E+03	0.000E+00	4.730E+02

APPENDIX E

A_i Child Dose Factors for use in the Liquid Dose Calculations

Age group:	CHILD	Pathway:	Fresh Water Fish - Sport (FFSP)			Units:	mrem/hr / μCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
TE-127	2.520E+01	6.800E+00	1.750E+01	7.170E+01	0.000E+00	9.850E+02	0.000E+00	5.410E+00
TE-127M	9.040E+03	2.430E+03	2.160E+03	2.580E+04	0.000E+00	7.320E+03	0.000E+00	1.070E+03
TE-129	2.280E-05	6.370E-06	1.630E-05	6.680E-05	0.000E+00	1.420E-03	0.000E+00	5.420E-06
TE-129M	1.500E+04	4.190E+03	4.840E+03	4.410E+04	0.000E+00	1.830E+04	0.000E+00	2.330E+03
TE-131	1.210E-16	3.680E-17	9.220E-17	3.650E-16	0.000E+00	6.330E-16	0.000E+00	3.590E-17
TE-131M	1.300E+03	4.500E+02	9.250E+02	4.350E+03	0.000E+00	1.820E+04	0.000E+00	4.790E+02
TE-132	2.570E+03	1.140E+03	1.650E+03	1.050E+04	0.000E+00	1.140E+04	0.000E+00	1.370E+03
I-130	8.950E+00	1.810E+01	1.990E+03	2.700E+01	0.000E+00	8.460E+00	0.000E+00	9.320E+00
I-131	1.860E+02	1.870E+02	6.190E+04	3.070E+02	0.000E+00	1.670E+01	0.000E+00	1.060E+02
I-132	6.830E-03	1.250E-02	5.820E-01	1.920E-02	0.000E+00	1.480E-02	0.000E+00	5.770E-03
I-133	3.140E+01	3.880E+01	7.210E+03	6.470E+01	0.000E+00	1.560E+01	0.000E+00	1.470E+01
I-134	2.750E-08	5.100E-08	1.170E-06	7.800E-08	0.000E+00	3.380E-08	0.000E+00	2.350E-08
I-135	1.670E+00	3.010E+00	2.660E+02	4.610E+00	0.000E+00	2.290E+00	0.000E+00	1.420E+00
CS-134	3.680E+05	6.040E+05	0.000E+00	1.870E+05	6.710E+04	3.250E+03	0.000E+00	1.270E+05
CS-136	3.510E+04	9.640E+04	0.000E+00	5.130E+04	7.660E+03	3.390E+03	0.000E+00	6.240E+04
CS-137	5.140E+05	4.920E+05	0.000E+00	1.600E+05	5.770E+04	3.080E+03	0.000E+00	7.270E+04
CS-138	1.210E-11	1.690E-11	0.000E+00	1.190E-11	1.280E-12	7.770E-12	0.000E+00	1.070E-11
BA-133								
BA-139	7.930E-06	4.230E-09	0.000E+00	3.700E-09	2.490E-09	4.580E-04	0.000E+00	2.300E-07
BA-140	2.480E+02	2.170E-01	0.000E+00	7.060E-02	1.290E-01	1.250E+02	0.000E+00	1.450E+01
BA-141	1.210E-24	6.800E-28	0.000E+00	5.880E-28	3.990E-27	6.920E-25	0.000E+00	3.950E-26
BA-142	3.460E-42	2.490E-45	0.000E+00	2.020E-45	1.470E-45	4.510E-44	0.000E+00	1.930E-43
LA-140	1.310E-01	4.590E-02	0.000E+00	0.000E+00	0.000E+00	1.280E+03	0.000E+00	1.550E-02
LA-142	2.970E-07	9.470E-08	0.000E+00	0.000E+00	0.000E+00	1.880E-02	0.000E+00	2.960E-08
CE-141	3.060E-02	1.520E-02	0.000E+00	6.680E-03	0.000E+00	1.900E+01	0.000E+00	2.260E-03

APPENDIX E

A_i Child Dose Factors for use in the Liquid Dose Calculations

Age group:	CHILD	Pathway:	Fresh Water Fish - Sport (FFSP)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
CE-143	3.320E-03	1.800E+00	0.000E+00	7.550E-04	0.000E+00	2.640E+01	0.000E+00	2.610E-04
CE-144	1.630E+00	5.120E-01	0.000E+00	2.830E-01	0.000E+00	1.330E+02	0.000E+00	8.710E-02
PR-143	7.340E-01	2.200E-01	0.000E+00	1.190E-01	0.000E+00	7.920E+02	0.000E+00	3.640E-02
PR-144	2.180E-28	6.750E-29	0.000E+00	3.570E-29	0.000E+00	1.450E-25	0.000E+00	1.100E-29
ND-147	5.150E-01	4.170E-01	0.000E+00	2.290E-01	0.000E+00	6.610E+02	0.000E+00	3.230E-02
EU-152	2.418E+01	4.404E+00	0.000E+00	1.860E+01	0.000E+00	7.236E+02	0.000E+00	5.230E+00
W-187	2.010E+02	1.190E+02	0.000E+00	0.000E+00	0.000E+00	1.680E+04	0.000E+00	5.350E+01
NP-239	3.080E-02	2.210E-03	0.000E+00	6.390E-03	0.000E+00	1.630E+02	0.000E+00	1.550E-03

APPENDIX E

A_i Child Dose Factors for use in the Liquid Dose Calculations

Age group:	CHILD	Pathway:	Shoreline Sediment (SHDp)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C-14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NA-24	7.480E-01	7.480E-01	7.480E-01	7.480E-01	7.480E-01	7.480E-01	8.680E-01	7.480E-01
P-32	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CR-51	2.920E-01	2.920E-01	2.920E-01	2.920E-01	2.920E-01	2.920E-01	3.450E-01	2.920E-01
MN-54	8.680E+01	8.680E+01	8.680E+01	8.680E+01	8.680E+01	8.680E+01	1.020E+02	8.680E+01
MN-56	5.650E-02	5.650E-02	5.650E-02	5.650E-02	5.650E-02	5.650E-02	6.680E-02	5.650E-02
FE-55	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
FE-59	1.710E+01	1.710E+01	1.710E+01	1.710E+01	1.710E+01	1.710E+01	2.010E+01	1.710E+01
CO-58	2.370E+01	2.370E+01	2.370E+01	2.370E+01	2.370E+01	2.370E+01	2.780E+01	2.370E+01
CO-60	1.350E+03	1.350E+03	1.350E+03	1.350E+03	1.350E+03	1.350E+03	1.580E+03	1.350E+03
NI-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NI-65	1.860E-02	1.860E-02	1.860E-02	1.860E-02	1.860E-02	1.860E-02	2.160E-02	1.860E-02
CU-64	3.800E-02	3.800E-02	3.800E-02	3.800E-02	3.800E-02	3.800E-02	4.310E-02	3.800E-02
ZN-65	4.680E+01	4.680E+01	4.680E+01	4.680E+01	4.680E+01	4.680E+01	5.380E+01	4.680E+01
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE-75	2.830E+02	2.830E+02	2.830E+02	2.830E+02	2.830E+02	2.830E+02	3.311E+02	2.830E+02
BR-83	3.050E-04	3.050E-04	3.050E-04	3.050E-04	3.050E-04	3.050E-04	4.430E-04	3.050E-04
BR-84	1.270E-02	1.270E-02	1.270E-02	1.270E-02	1.270E-02	1.270E-02	1.480E-02	1.270E-02
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	5.630E-01	5.630E-01	5.630E-01	5.630E-01	5.630E-01	5.630E-01	6.430E-01	5.630E-01
RB-88	2.070E-03	2.070E-03	2.070E-03	2.070E-03	2.070E-03	2.070E-03	2.370E-03	2.070E-03
RB-89	7.700E-03	7.700E-03	7.700E-03	7.700E-03	7.700E-03	7.700E-03	9.240E-03	7.700E-03
SR-89	1.360E-03	1.360E-03	1.360E-03	1.360E-03	1.360E-03	1.360E-03	1.570E-03	1.360E-03
SR-90	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

APPENDIX E

A_i Child Dose Factors for use in the Liquid Dose Calculations

Age group:	CHILD	Pathway:	Shoreline Sediment (SHDp)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-91	1.350E-01	1.350E-01	1.350E-01	1.350E-01	1.350E-01	1.350E-01	1.570E-01	1.350E-01
SR-92	4.860E-02	4.860E-02	4.860E-02	4.860E-02	4.860E-02	4.860E-02	5.410E-02	4.860E-02
Y-90	2.810E-04	2.810E-04	2.810E-04	2.810E-04	2.810E-04	2.810E-04	3.320E-04	2.810E-04
Y-91	6.720E-02	6.720E-02	6.720E-02	6.720E-02	6.720E-02	6.720E-02	7.560E-02	6.720E-02
Y-91M	6.280E-03	6.280E-03	6.280E-03	6.280E-03	6.280E-03	6.280E-03	7.270E-03	6.280E-03
Y-92	1.130E-02	1.130E-02	1.130E-02	1.130E-02	1.130E-02	1.130E-02	1.340E-02	1.130E-02
Y-93	1.150E-02	1.150E-02	1.150E-02	1.150E-02	1.150E-02	1.150E-02	1.570E-02	1.150E-02
ZR-95	1.530E+01	1.530E+01	1.530E+01	1.530E+01	1.530E+01	1.530E+01	1.780E+01	1.530E+01
ZR-97	1.850E-01	1.850E-01	1.850E-01	1.850E-01	1.850E-01	1.850E-01	2.160E-01	1.850E-01
NB-95	8.560E+00	8.560E+00	8.560E+00	8.560E+00	8.560E+00	8.560E+00	1.010E+01	8.560E+00
MO-99	2.500E-01	2.500E-01	2.500E-01	2.500E-01	2.500E-01	2.500E-01	2.900E-01	2.500E-01
TC-99M	1.150E-02	1.150E-02	1.150E-02	1.150E-02	1.150E-02	1.150E-02	1.320E-02	1.150E-02
TC-101	1.270E-03	1.270E-03	1.270E-03	1.270E-03	1.270E-03	1.270E-03	1.420E-03	1.270E-03
RU-103	6.780E+00	6.780E+00	6.780E+00	6.780E+00	6.780E+00	6.780E+00	7.910E+00	6.780E+00
RU-105	3.990E-02	3.990E-02	3.990E-02	3.990E-02	3.990E-02	3.990E-02	4.520E-02	3.990E-02
RU-106	2.640E+01	2.640E+01	2.640E+01	2.640E+01	2.640E+01	2.640E+01	3.170E+01	2.640E+01
AG-108M	3.230E+04	3.230E+04	3.230E+04	3.230E+04	3.230E+04	3.230E+04	3.779E+04	3.230E+04
AG-110M	2.150E+02	2.150E+02	2.150E+02	2.150E+02	2.150E+02	2.150E+02	2.510E+02	2.150E+02
SN-113	9.346E+00	9.346E+00	9.346E+00	9.346E+00	9.346E+00	9.346E+00	1.093E+01	9.346E+00
SN-117M	1.306E+01	1.306E+01	1.306E+01	1.306E+01	1.306E+01	1.306E+01	1.528E+01	1.306E+01
SB-124	3.746E+01	3.746E+01	3.746E+01	3.746E+01	3.746E+01	3.746E+01	4.322E+01	3.746E+01
SB-125	1.461E+02	1.461E+02	1.461E+02	1.461E+02	1.461E+02	1.461E+02	1.650E+02	1.461E+02
SB-126	5.284E+00	5.284E+00	5.284E+00	5.284E+00	5.284E+00	5.284E+00	5.937E+00	5.284E+00
TE-123M	1.060E+02	1.060E+02	1.060E+02	1.060E+02	1.060E+02	1.060E+02	1.241E+02	1.060E+02
TE-125M	9.720E-02	9.720E-02	9.720E-02	9.720E-02	9.720E-02	9.720E-02	1.330E-01	9.720E-02

APPENDIX E

A_i Child Dose Factors for use in the Liquid Dose Calculations

Age group:	CHILD	Pathway:	Shoreline Sediment (SHDp)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
TE-127	1.860E-04	1.860E-04	1.860E-04	1.860E-04	1.860E-04	1.860E-04	2.050E-04	1.860E-04
TE-127M	5.740E-03	5.740E-03	5.740E-03	5.740E-03	5.740E-03	5.740E-03	6.780E-03	5.740E-03
TE-129	1.640E-03	1.640E-03	1.640E-03	1.640E-03	1.640E-03	1.640E-03	1.940E-03	1.640E-03
TE-129M	1.240E+00	1.240E+00	1.240E+00	1.240E+00	1.240E+00	1.240E+00	1.450E+00	1.240E+00
TE-131	1.830E-03	1.830E-03	1.830E-03	1.830E-03	1.830E-03	1.830E-03	2.160E+00	1.830E-03
TE-131M	5.030E-01	5.030E-01	5.030E-01	5.030E-01	5.030E-01	5.030E-01	5.920E-01	5.030E-01
TE-132	2.650E-01	2.650E-01	2.650E-01	2.650E-01	2.650E-01	2.650E-01	3.120E-01	2.650E-01
I-130	3.450E-01	3.450E-01	3.450E-01	3.450E-01	3.450E-01	3.450E-01	4.190E-01	3.450E-01
I-131	1.080E+00	1.080E+00	1.080E+00	1.080E+00	1.080E+00	1.080E+00	1.310E+00	1.080E+00
I-132	7.800E-02	7.800E-02	7.800E-02	7.800E-02	7.800E-02	7.800E-02	9.180E-02	7.800E-02
I-133	1.540E-01	1.540E-01	1.540E-01	1.540E-01	1.540E-01	1.540E-01	1.870E-01	1.540E-01
I-134	2.800E-02	2.800E-02	2.800E-02	2.800E-02	2.800E-02	2.800E-02	3.320E-02	2.800E-02
I-135	1.580E-01	1.580E-01	1.580E-01	1.580E-01	1.580E-01	1.580E-01	1.850E-01	1.580E-01
CS-134	4.300E+02	4.300E+02	4.300E+02	4.300E+02	4.300E+02	4.300E+02	5.010E+02	4.300E+02
CS-136	9.450E+00	9.450E+00	9.450E+00	9.450E+00	9.450E+00	9.450E+00	1.070E+01	9.450E+00
CS-137	6.440E+02	6.440E+02	6.440E+02	6.440E+02	6.440E+02	6.440E+02	7.510E+02	6.440E+02
CS-138	2.250E-02	2.250E-02	2.250E-02	2.250E-02	2.250E-02	2.250E-02	2.570E-02	2.250E-02
BA-133	5.521E+03	5.521E+03	5.521E+03	5.521E+03	5.521E+03	5.521E+03	6.459E+03	5.521E+03
BA-139	6.630E-03	6.630E-03	6.630E-03	6.630E-03	6.630E-03	6.630E-03	7.460E-03	6.630E-03
BA-140	1.290E+00	1.290E+00	1.290E+00	1.290E+00	1.290E+00	1.290E+00	1.470E+00	1.290E+00
BA-141	2.610E-03	2.610E-03	2.610E-03	2.610E-03	2.610E-03	2.610E-03	2.980E-03	2.610E-03
BA-142	2.810E-03	2.810E-03	2.810E-03	2.810E-03	2.810E-03	2.810E-03	3.200E-03	2.810E-03
LA-140	1.200E+00	1.200E+00	1.200E+00	1.200E+00	1.200E+00	1.200E+00	1.360E+00	1.200E+00
LA-142	4.760E-02	4.760E-02	4.760E-02	4.760E-02	4.760E-02	4.760E-02	5.710E-02	4.760E-02
CE-141	8.560E-01	8.560E-01	8.560E-01	8.560E-01	8.560E-01	8.560E-01	9.650E-01	8.560E-01

APPENDIX E

A_i Child Dose Factors for use in the Liquid Dose Calculations

Age group:	CHILD	Pathway:	Shoreline Sediment (SHDp)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
CE-143	1.450E-01	1.450E-01	1.450E-01	1.450E-01	1.450E-01	1.450E-01	1.650E-01	1.450E-01
CE-144	4.350E+00	4.350E+00	4.350E+00	4.350E+00	4.350E+00	4.350E+00	5.040E+00	4.350E+00
PR-143	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR-144	1.150E-04	1.150E-04	1.150E-04	1.150E-04	1.150E-04	1.150E-04	1.320E-04	1.150E-04
ND-147	5.260E-01	5.260E-01	5.260E-01	5.260E-01	5.260E-01	5.260E-01	6.310E-01	5.260E-01
EU-152	9.305E+02	9.305E+02	9.305E+02	9.305E+02	9.305E+02	9.305E+02	1.077E+03	9.305E+02
W-187	1.470E-01	1.470E-01	1.470E-01	1.470E-01	1.470E-01	1.470E-01	1.710E-01	1.470E-01
NP-239	1.070E-01	1.070E-01	1.070E-01	1.070E-01	1.070E-01	1.070E-01	1.240E-01	1.070E-01

APPENDIX F

A_i Infant Dose Factors for use in the Liquid Dose Calculations

Age group:	INFANT	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	1.160E+01	1.160E+01	1.160E+01	1.160E+01	1.160E+01	0.000E+00	1.160E+01
C-14	8.920E+02	1.900E+02	1.900E+02	1.900E+02	1.900E+02	1.900E+02	0.000E+00	1.900E+02
NA-24	2.190E+02	2.190E+02	2.190E+02	2.190E+02	2.190E+02	2.190E+02	0.000E+00	2.190E+02
P-32	6.240E+04	3.670E+03	0.000E+00	0.000E+00	0.000E+00	8.450E+02	0.000E+00	2.420E+03
CR-51	0.000E+00	0.000E+00	3.420E-01	7.470E-02	6.650E-01	1.530E+01	0.000E+00	5.240E-01
MN-54	0.000E+00	7.480E+02	0.000E+00	1.660E+02	0.000E+00	2.750E+02	0.000E+00	1.690E+02
MN-56	0.000E+00	1.220E+00	0.000E+00	1.050E+00	0.000E+00	1.110E+02	0.000E+00	2.100E-01
FE-55	5.230E+02	3.380E+02	0.000E+00	0.000E+00	1.650E+02	4.290E+01	0.000E+00	9.030E+01
FE-59	1.150E+03	2.010E+03	0.000E+00	0.000E+00	5.940E+02	9.590E+02	0.000E+00	7.910E+02
CO-58	0.000E+00	1.350E+02	0.000E+00	0.000E+00	0.000E+00	3.360E+02	0.000E+00	3.360E+02
CO-60	0.000E+00	4.060E+02	0.000E+00	0.000E+00	0.000E+00	9.670E+02	0.000E+00	9.590E+02
NI-63	2.390E+04	1.470E+03	0.000E+00	0.000E+00	0.000E+00	7.340E+01	0.000E+00	8.280E+02
NI-65	6.520E+00	7.380E-01	0.000E+00	0.000E+00	0.000E+00	5.620E+01	0.000E+00	3.360E-01
CU-64	0.000E+00	1.190E+01	0.000E+00	2.010E+01	0.000E+00	2.440E+02	0.000E+00	5.500E+00
ZN-65	6.910E+02	2.370E+03	0.000E+00	1.150E+03	0.000E+00	2.000E+03	0.000E+00	1.090E+03
ZN-69	4.390E-04	7.910E-04	0.000E+00	3.290E-04	0.000E+00	6.450E-02	0.000E+00	5.890E-05
SE-75	3.609E+02	1.388E+02	1.388E+02	2.776E+01	3.331E+02	3.886E+02	0.000E+00	2.776E+03
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.200E-01
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.220E-06
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.800E-76
RB-86	0.000E+00	6.280E+03	0.000E+00	0.000E+00	0.000E+00	1.610E+02	0.000E+00	3.100E+03
RB-88	0.000E+00	1.250E-11	0.000E+00	0.000E+00	0.000E+00	1.220E-11	0.000E+00	6.840E-12
RB-89	0.000E+00	9.960E-14	0.000E+00	0.000E+00	0.000E+00	3.390E-14	0.000E+00	6.860E-14
SR-89	9.380E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.930E+03	0.000E+00	2.690E+03
SR-90	6.960E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.690E+03	0.000E+00	1.770E+05

APPENDIX F

A_i Infant Dose Factors for use in the Liquid Dose Calculations

Age group:	INFANT	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-91	7.830E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.270E+02	0.000E+00	2.830E+01
SR-92	3.350E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.610E+02	0.000E+00	1.240E+00
Y-90	2.870E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.970E+03	0.000E+00	7.700E-02
Y-91	4.230E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.030E+03	0.000E+00	1.130E+00
Y-91M	1.350E-06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.510E-03	0.000E+00	4.610E-08
Y-92	2.740E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.240E+02	0.000E+00	7.710E-04
Y-93	4.010E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.170E+03	0.000E+00	1.090E-02
ZR-95	7.710E+00	1.880E+00	0.000E+00	2.020E+00	0.000E+00	9.350E+02	0.000E+00	1.330E+00
ZR-97	3.400E-01	5.840E-02	0.000E+00	5.890E-02	0.000E+00	3.720E+03	0.000E+00	2.670E-02
NB-95	1.560E+00	6.440E-01	0.000E+00	4.620E-01	0.000E+00	5.440E+02	0.000E+00	3.720E-01
MO-99	0.000E+00	1.130E+03	0.000E+00	1.680E+03	0.000E+00	3.710E+02	0.000E+00	2.200E+02
TC-99M	1.810E-02	3.740E-02	0.000E+00	4.020E-01	1.950E-02	1.090E+01	0.000E+00	4.820E-01
TC-101	4.570E-17	5.750E-17	0.000E+00	6.840E-16	3.140E-17	9.780E-15	0.000E+00	5.690E-16
RU-103	5.520E+01	0.000E+00	0.000E+00	1.150E+02	0.000E+00	6.710E+02	0.000E+00	1.850E+01
RU-105	7.850E-01	0.000E+00	0.000E+00	5.770E+00	0.000E+00	3.120E+02	0.000E+00	2.640E-01
RU-106	9.060E+02	0.000E+00	0.000E+00	1.070E+03	0.000E+00	6.880E+03	0.000E+00	1.130E+02
AG-108M	3.800E+02	1.462E+02	1.462E+02	2.923E+01	3.508E+02	4.092E+02	0.000E+00	2.923E+03
AG-110M	3.740E+01	2.730E+01	0.000E+00	3.910E+01	0.000E+00	1.420E+03	0.000E+00	1.810E+01
SN-113	1.407E+02	5.412E+01	5.412E+01	1.082E+01	1.299E+02	1.515E+02	0.000E+00	1.082E+03
SN-117M	1.358E+02	5.224E+01	5.224E+01	1.045E+01	1.254E+02	1.463E+02	0.000E+00	1.045E+03
SB-124	8.004E+02	1.178E+01	2.125E+00	0.000E+00	5.012E+02	2.469E+03	0.000E+00	2.480E+02
SB-125	4.626E+02	4.475E+00	5.791E-01	0.000E+00	2.903E+02	6.168E+02	0.000E+00	9.515E+01
SB-126	2.949E+02	5.780E+00	2.264E+00	0.000E+00	1.855E+02	3.055E+03	0.000E+00	1.065E+02
TE-123M	3.428E+02	1.319E+02	1.319E+02	2.637E+01	3.164E+02	3.692E+02	0.000E+00	2.637E+03
TE-125M	8.710E+02	2.910E+02	2.930E+02	0.000E+00	0.000E+00	4.150E+02	0.000E+00	1.180E+02

APPENDIX F

A_i Infant Dose Factors for use in the Liquid Dose Calculations

Age group:	INFANT	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
TE-127	1.550E+01	5.200E+00	1.260E+01	3.790E+01	0.000E+00	3.260E+02	0.000E+00	3.340E+00
TE-127M	2.190E+03	7.280E+02	6.340E+02	5.400E+03	0.000E+00	8.850E+02	0.000E+00	2.660E+02
TE-129	7.860E-03	2.710E-03	6.590E-03	1.960E-02	0.000E+00	6.280E-01	0.000E+00	1.840E-03
TE-129M	3.720E+03	1.280E+03	1.430E+03	9.310E+03	0.000E+00	2.220E+03	0.000E+00	5.730E+02
TE-131	1.420E-08	5.250E-09	1.270E-08	3.640E-08	0.000E+00	5.750E-07	0.000E+00	3.990E-09
TE-131M	4.330E+02	1.740E+02	3.540E+02	1.200E+03	0.000E+00	2.940E+03	0.000E+00	1.440E+02
TE-132	7.030E+02	3.480E+02	5.140E+02	2.180E+03	0.000E+00	1.290E+03	0.000E+00	3.250E+02
I-130	1.150E+02	2.530E+02	2.840E+04	2.780E+02	0.000E+00	5.430E+01	0.000E+00	1.020E+02
I-131	1.290E+03	1.520E+03	5.010E+05	1.780E+03	0.000E+00	5.440E+01	0.000E+00	6.700E+02
I-132	1.680E+00	3.410E+00	1.600E+02	3.800E+00	0.000E+00	2.760E+00	0.000E+00	1.210E+00
I-133	3.150E+02	4.590E+02	8.350E+04	5.400E+02	0.000E+00	7.770E+01	0.000E+00	1.340E+02
I-134	2.440E-03	4.990E-03	1.160E-01	5.580E-03	0.000E+00	5.160E-03	0.000E+00	1.780E-03
I-135	3.900E+01	7.750E+01	6.950E+03	8.640E+01	0.000E+00	2.800E+01	0.000E+00	2.830E+01
CS-134	1.420E+04	2.640E+04	0.000E+00	6.810E+03	2.790E+03	7.180E+01	0.000E+00	2.670E+03
CS-136	1.680E+03	4.950E+03	0.000E+00	1.970E+03	4.030E+02	7.510E+01	0.000E+00	1.850E+03
CS-137	1.960E+04	2.300E+04	0.000E+00	6.170E+03	2.500E+03	7.190E+01	0.000E+00	1.630E+03
CS-138	3.330E-06	5.410E-06	0.000E+00	2.700E-06	4.210E-07	8.650E-06	0.000E+00	2.620E-06
BA-133	3.981E+02	1.531E+02	1.531E+02	3.062E+01	3.674E+02	4.287E+02	0.000E+00	3.062E+03
BA-139	8.180E-02	5.420E-05	0.000E+00	3.260E-05	3.290E-05	5.180E+00	0.000E+00	2.370E-03
BA-140	6.260E+03	6.260E+00	0.000E+00	1.490E+00	3.840E+00	1.540E+03	0.000E+00	3.230E+02
BA-141	2.220E-11	1.520E-14	0.000E+00	9.140E-15	9.250E-15	2.710E-10	0.000E+00	7.000E-13
BA-142	2.460E-20	2.040E-23	0.000E+00	1.180E-23	1.240E-23	1.010E-19	0.000E+00	1.210E-21
LA-140	6.460E-01	2.550E-01	0.000E+00	0.000E+00	0.000E+00	2.990E+03	0.000E+00	6.550E-02
LA-142	2.220E-04	8.160E-05	0.000E+00	0.000E+00	0.000E+00	1.390E+01	0.000E+00	1.950E-05
CE-141	2.930E+00	1.790E+00	0.000E+00	5.510E-01	0.000E+00	9.230E+02	0.000E+00	2.100E-01

APPENDIX F

A_i Infant Dose Factors for use in the Liquid Dose Calculations

Age group:	INFANT	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
CE-143	4.330E-01	2.870E+02	0.000E+00	8.360E-02	0.000E+00	1.670E+03	0.000E+00	3.270E-02
CE-144	1.120E+02	4.580E+01	0.000E+00	1.850E+01	0.000E+00	6.430E+03	0.000E+00	6.270E+00
PR-143	2.980E+00	1.110E+00	0.000E+00	4.140E-01	0.000E+00	1.570E+03	0.000E+00	1.480E-01
PR-144	3.020E-15	1.170E-15	0.000E+00	4.240E-16	0.000E+00	5.440E-11	0.000E+00	1.520E-16
ND-147	2.020E+00	2.070E+00	0.000E+00	7.980E-01	0.000E+00	1.310E+03	0.000E+00	1.270E-01
EU-152	2.535E+01	6.734E+00	0.000E+00	1.888E+01	0.000E+00	5.981E+02	0.000E+00	5.680E+00
W-187	2.400E+01	1.670E+01	0.000E+00	0.000E+00	0.000E+00	9.790E+02	0.000E+00	5.760E+00
NP-239	3.600E-01	3.220E-02	0.000E+00	6.430E-02	0.000E+00	9.320E+02	0.000E+00	1.820E-02

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Grs/Cow/Milk (CMILK)			Units:	$m^2 \cdot$mrem/yr / µCi/sec; mrem/yr / µCi/m^3 (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	7.630E+02	7.630E+02	7.630E+02	7.630E+02	7.630E+02	0.000E+00	7.630E+02
C-14	2.250E+04	4.500E+03	4.500E+03	4.500E+03	4.500E+03	4.500E+03	0.000E+00	4.500E+03
NA-24	2.440E+06	2.440E+06	2.440E+06	2.440E+06	2.440E+06	2.440E+06	0.000E+00	2.440E+06
P-32	1.710E+10	1.060E+09	0.000E+00	0.000E+00	0.000E+00	1.920E+09	0.000E+00	6.610E+08
CR-51	0.000E+00	0.000E+00	1.710E+04	6.300E+03	3.790E+04	7.190E+06	0.000E+00	2.860E+04
MN-54	0.000E+00	8.410E+06	0.000E+00	2.500E+06	0.000E+00	2.580E+07	0.000E+00	1.610E+06
MN-56	0.000E+00	4.090E-03	0.000E+00	5.190E-03	0.000E+00	1.310E-01	0.000E+00	7.260E-04
FE-55	2.510E+07	1.740E+07	0.000E+00	0.000E+00	9.680E+06	9.950E+06	0.000E+00	4.050E+06
FE-59	2.970E+07	6.980E+07	0.000E+00	0.000E+00	1.950E+07	2.330E+08	0.000E+00	2.680E+07
CO-58	0.000E+00	4.710E+06	0.000E+00	0.000E+00	0.000E+00	9.550E+07	0.000E+00	1.060E+07
CO-60	0.000E+00	1.640E+07	0.000E+00	0.000E+00	0.000E+00	3.080E+08	0.000E+00	3.620E+07
NI-63	6.730E+09	4.660E+08	0.000E+00	0.000E+00	0.000E+00	9.730E+07	0.000E+00	2.260E+08
NI-65	3.700E-01	4.810E-02	0.000E+00	0.000E+00	0.000E+00	1.220E+00	0.000E+00	2.190E-02
CU-64	0.000E+00	2.380E+04	0.000E+00	6.010E+04	0.000E+00	2.030E+06	0.000E+00	1.120E+04
ZN-65	1.370E+09	4.370E+09	0.000E+00	2.920E+09	0.000E+00	2.750E+09	0.000E+00	1.970E+09
ZN-69	2.090E-12	4.000E-12	0.000E+00	2.600E-12	0.000E+00	6.010E-13	0.000E+00	2.780E-13
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.400E-01	0.000E+00	9.720E-02
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.260E-28	0.000E+00	1.610E-23
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	2.590E+09	0.000E+00	0.000E+00	0.000E+00	5.120E+08	0.000E+00	1.210E+09
RB-88	0.000E+00	2.140E-45	0.000E+00	0.000E+00	0.000E+00	2.960E-56	0.000E+00	1.140E-45
RB-89	0.000E+00	4.330E-53	0.000E+00	0.000E+00	0.000E+00	2.510E-66	0.000E+00	3.040E-53
SR-89	1.450E+09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.330E+08	0.000E+00	4.160E+07
SR-90	4.680E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.350E+09	0.000E+00	1.150E+10
SR-91	2.890E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.380E+05	0.000E+00	1.170E+03

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Grs/Cow/Milk (CMILK)			Units:	m^2·mrem/yr / µCi/sec; mrem/yr / µCi/m^3 (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	4.880E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.680E+00	0.000E+00	2.110E-02
Y-90	7.080E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.510E+05	0.000E+00	1.900E+00
Y-91	8.590E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.730E+06	0.000E+00	2.300E+02
Y-91M	5.980E-20	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.760E-19	0.000E+00	2.320E-21
Y-92	5.580E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.770E-01	0.000E+00	1.630E-06
Y-93	2.230E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.090E+03	0.000E+00	6.170E-03
ZR-95	9.430E+02	3.030E+02	0.000E+00	4.750E+02	0.000E+00	9.590E+05	0.000E+00	2.050E+02
ZR-97	4.330E-01	8.740E-02	0.000E+00	1.320E-01	0.000E+00	2.710E+04	0.000E+00	4.000E-02
NB-95	8.260E+04	4.590E+04	0.000E+00	4.540E+04	0.000E+00	2.790E+08	0.000E+00	2.470E+04
MO-99	0.000E+00	2.480E+07	0.000E+00	5.610E+07	0.000E+00	5.740E+07	0.000E+00	4.710E+06
TC-99M	3.320E+00	9.380E+00	0.000E+00	1.420E+02	4.600E+00	5.550E+03	0.000E+00	1.200E+02
TC-101	2.590E-60	3.740E-60	0.000E+00	6.730E-59	1.910E-60	1.120E-71	0.000E+00	3.670E-59
RU-103	1.020E+03	0.000E+00	0.000E+00	3.890E+03	0.000E+00	1.190E+05	0.000E+00	4.390E+02
RU-105	8.570E-04	0.000E+00	0.000E+00	1.110E-02	0.000E+00	5.240E-01	0.000E+00	3.380E-04
RU-106	2.040E+04	0.000E+00	0.000E+00	3.940E+04	0.000E+00	1.320E+06	0.000E+00	2.580E+03
AG-110M	5.820E+07	5.390E+07	0.000E+00	1.060E+08	0.000E+00	2.200E+10	0.000E+00	3.200E+07
TE-125M	1.630E+07	5.900E+06	4.900E+06	6.630E+07	0.000E+00	6.500E+07	0.000E+00	2.180E+06
TE-127	6.530E+02	2.340E+02	4.840E+02	2.660E+03	0.000E+00	5.150E+04	0.000E+00	1.410E+02
TE-127M	4.580E+07	1.640E+07	1.170E+07	1.860E+08	0.000E+00	1.540E+08	0.000E+00	5.580E+06
TE-129	2.830E-10	1.060E-10	2.170E-10	1.190E-09	0.000E+00	2.130E-10	0.000E+00	6.880E-11
TE-129M	6.020E+07	2.250E+07	2.070E+07	2.510E+08	0.000E+00	3.030E+08	0.000E+00	9.530E+06
TE-131	3.600E-33	1.500E-33	2.960E-33	1.580E-32	0.000E+00	5.100E-34	0.000E+00	1.140E-33
TE-131M	3.610E+05	1.770E+05	2.800E+05	1.790E+06	0.000E+00	1.750E+07	0.000E+00	1.470E+05
TE-132	2.400E+06	1.550E+06	1.720E+06	1.500E+07	0.000E+00	7.350E+07	0.000E+00	1.460E+06
I-130	4.200E+05	1.240E+06	1.050E+08	1.930E+06	0.000E+00	1.070E+06	0.000E+00	4.890E+05

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Grs/Cow/Milk (CMILK)			Units:	$m^2 \cdot$mrem/yr / µCi/sec; mrem/yr / µCi/m^3 (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	2.960E+08	4.230E+08	1.390E+11	7.260E+08	0.000E+00	1.120E+08	0.000E+00	2.430E+08
I-132	1.640E-01	4.390E-01	1.540E+01	7.000E-01	0.000E+00	8.250E-02	0.000E+00	1.540E-01
I-133	3.870E+06	6.730E+06	9.890E+08	1.170E+07	0.000E+00	6.050E+06	0.000E+00	2.050E+06
I-134	2.020E-12	5.480E-12	9.490E-11	8.710E-12	0.000E+00	4.770E-15	0.000E+00	1.960E-12
I-135	1.280E+04	3.360E+04	2.220E+06	5.390E+04	0.000E+00	3.800E+04	0.000E+00	1.240E+04
CS-134	5.650E+09	1.350E+10	0.000E+00	4.350E+09	1.450E+09	2.350E+08	0.000E+00	1.100E+10
CS-136	2.630E+08	1.040E+09	0.000E+00	5.780E+08	7.930E+07	1.180E+08	0.000E+00	7.480E+08
CS-137	7.380E+09	1.010E+10	0.000E+00	3.430E+09	1.140E+09	1.950E+08	0.000E+00	6.610E+09
CS-138	9.050E-24	1.790E-23	0.000E+00	1.310E-23	1.300E-24	7.620E-29	0.000E+00	8.850E-24
BA-139	4.420E-08	3.150E-11	0.000E+00	2.940E-11	1.790E-11	7.830E-08	0.000E+00	1.290E-09
BA-140	2.690E+07	3.380E+04	0.000E+00	1.150E+04	1.930E+04	5.530E+07	0.000E+00	1.760E+06
BA-141	4.090E-46	3.090E-49	0.000E+00	2.880E-49	1.760E-49	1.930E-55	0.000E+00	1.380E-47
BA-142	2.640E-80	2.720E-83	0.000E+00	2.300E-83	1.540E-83	3.720E-98	0.000E+00	1.660E-81
LA-140	4.510E+00	2.270E+00	0.000E+00	0.000E+00	0.000E+00	1.670E+05	0.000E+00	6.010E-01
LA-142	1.860E-11	8.460E-12	0.000E+00	0.000E+00	0.000E+00	6.170E-08	0.000E+00	2.110E-12
CE-141	4.840E+03	3.280E+03	0.000E+00	1.520E+03	0.000E+00	1.250E+07	0.000E+00	3.720E+02
CE-143	4.160E+01	3.070E+04	0.000E+00	1.350E+01	0.000E+00	1.150E+06	0.000E+00	3.400E+00
CE-144	3.580E+05	1.500E+05	0.000E+00	8.870E+04	0.000E+00	1.210E+08	0.000E+00	1.920E+04
PR-143	1.580E+02	6.330E+01	0.000E+00	3.660E+01	0.000E+00	6.920E+05	0.000E+00	7.830E+00
PR-144	5.870E-54	2.440E-54	0.000E+00	1.380E-54	0.000E+00	8.450E-61	0.000E+00	2.990E-55
ND-147	9.420E+01	1.090E+02	0.000E+00	6.360E+01	0.000E+00	5.220E+05	0.000E+00	6.510E+00
W-187	6.510E+03	5.450E+03	0.000E+00	0.000E+00	0.000E+00	1.780E+06	0.000E+00	1.900E+03
NP-239	3.670E+00	3.610E-01	0.000E+00	1.130E+00	0.000E+00	7.410E+04	0.000E+00	1.990E-01

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Grs/Goat/Milk (GMILK)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	1.560E+03	1.560E+03	1.560E+03	1.560E+03	1.560E+03	0.000E+00	1.560E+03
C-14	2.250E+04	4.500E+03	4.500E+03	4.500E+03	4.500E+03	4.500E+03	0.000E+00	4.500E+03
NA-24	2.930E+05	2.930E+05	2.930E+05	2.930E+05	2.930E+05	2.930E+05	0.000E+00	2.930E+05
P-32	2.050E+10	1.280E+09	0.000E+00	0.000E+00	0.000E+00	2.310E+09	0.000E+00	7.930E+08
CR-51	0.000E+00	0.000E+00	2.050E+03	7.550E+02	4.550E+03	8.620E+05	0.000E+00	3.430E+03
MN-54	0.000E+00	1.010E+06	0.000E+00	3.000E+05	0.000E+00	3.090E+06	0.000E+00	1.930E+05
MN-56	0.000E+00	4.910E-04	0.000E+00	6.230E-04	0.000E+00	1.570E-02	0.000E+00	8.710E-05
FE-55	3.260E+05	2.260E+05	0.000E+00	0.000E+00	1.260E+05	1.290E+05	0.000E+00	5.260E+04
FE-59	3.860E+05	9.070E+05	0.000E+00	0.000E+00	2.540E+05	3.020E+06	0.000E+00	3.480E+05
CO-58	0.000E+00	5.660E+05	0.000E+00	0.000E+00	0.000E+00	1.150E+07	0.000E+00	1.270E+06
CO-60	0.000E+00	1.970E+06	0.000E+00	0.000E+00	0.000E+00	3.700E+07	0.000E+00	4.340E+06
NI-63	8.070E+08	5.600E+07	0.000E+00	0.000E+00	0.000E+00	1.170E+07	0.000E+00	2.710E+07
NI-65	4.440E-02	5.770E-03	0.000E+00	0.000E+00	0.000E+00	1.460E-01	0.000E+00	2.630E-03
CU-64	0.000E+00	2.660E+03	0.000E+00	6.700E+03	0.000E+00	2.260E+05	0.000E+00	1.250E+03
ZN-65	1.650E+08	5.240E+08	0.000E+00	3.500E+08	0.000E+00	3.300E+08	0.000E+00	2.370E+08
ZN-69	2.510E-13	4.800E-13	0.000E+00	3.120E-13	0.000E+00	7.210E-14	0.000E+00	3.340E-14
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.680E-02	0.000E+00	1.170E-02
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.520E-29	0.000E+00	1.930E-24
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	3.110E+08	0.000E+00	0.000E+00	0.000E+00	6.140E+07	0.000E+00	1.450E+08
RB-88	0.000E+00	2.570E-46	0.000E+00	0.000E+00	0.000E+00	3.550E-57	0.000E+00	1.360E-46
RB-89	0.000E+00	5.190E-54	0.000E+00	0.000E+00	0.000E+00	3.020E-67	0.000E+00	3.650E-54
SR-89	3.050E+09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.890E+08	0.000E+00	8.750E+07
SR-90	9.830E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.840E+09	0.000E+00	2.410E+10
SR-91	6.070E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.890E+05	0.000E+00	2.450E+03

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Grs/Goat/Milk (GMILK)			Units:	m^2·mrem/yr / µCi/sec; mrem/yr / µCi/m^3 (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	1.030E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.030E+01	0.000E+00	4.440E-02
Y-90	8.500E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.010E+04	0.000E+00	2.280E-01
Y-91	1.030E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.670E+05	0.000E+00	2.760E+01
Y-91M	7.170E-21	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.110E-20	0.000E+00	2.780E-22
Y-92	6.690E-06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.170E-01	0.000E+00	1.960E-07
Y-93	2.680E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.500E+02	0.000E+00	7.400E-04
ZR-95	1.130E+02	3.630E+01	0.000E+00	5.700E+01	0.000E+00	1.150E+05	0.000E+00	2.460E+01
ZR-97	5.200E-02	1.050E-02	0.000E+00	1.580E-02	0.000E+00	3.250E+03	0.000E+00	4.800E-03
NB-95	9.910E+03	5.510E+03	0.000E+00	5.450E+03	0.000E+00	3.340E+07	0.000E+00	2.960E+03
MO-99	0.000E+00	2.970E+06	0.000E+00	6.730E+06	0.000E+00	6.890E+06	0.000E+00	5.660E+05
TC-99M	3.980E-01	1.130E+00	0.000E+00	1.710E+01	5.520E-01	6.660E+02	0.000E+00	1.430E+01
TC-101	3.110E-61	4.490E-61	0.000E+00	8.080E-60	2.290E-61	1.350E-72	0.000E+00	4.400E-60
RU-103	1.220E+02	0.000E+00	0.000E+00	4.660E+02	0.000E+00	1.430E+04	0.000E+00	5.260E+01
RU-105	1.030E-04	0.000E+00	0.000E+00	1.330E-03	0.000E+00	6.290E-02	0.000E+00	4.060E-05
RU-106	2.450E+03	0.000E+00	0.000E+00	4.730E+03	0.000E+00	1.580E+05	0.000E+00	3.100E+02
AG-110M	6.990E+06	6.460E+06	0.000E+00	1.270E+07	0.000E+00	2.640E+09	0.000E+00	3.840E+06
TE-125M	1.950E+06	7.080E+05	5.880E+05	7.950E+06	0.000E+00	7.800E+06	0.000E+00	2.620E+05
TE-127	7.830E+01	2.810E+01	5.800E+01	3.190E+02	0.000E+00	6.180E+03	0.000E+00	1.700E+01
TE-127M	5.490E+06	1.960E+06	1.400E+06	2.230E+07	0.000E+00	1.840E+07	0.000E+00	6.690E+05
TE-129	3.390E-11	1.270E-11	2.600E-11	1.430E-10	0.000E+00	2.560E-11	0.000E+00	8.260E-12
TE-129M	7.220E+06	2.690E+06	2.480E+06	3.020E+07	0.000E+00	3.640E+07	0.000E+00	1.140E+06
TE-131	4.320E-34	1.810E-34	3.550E-34	1.890E-33	0.000E+00	6.120E-35	0.000E+00	1.360E-34
TE-131M	4.330E+04	2.120E+04	3.360E+04	2.150E+05	0.000E+00	2.100E+06	0.000E+00	1.770E+04
TE-132	2.880E+05	1.860E+05	2.060E+05	1.800E+06	0.000E+00	8.820E+06	0.000E+00	1.750E+05
I-130	5.040E+05	1.490E+06	1.260E+08	2.320E+06	0.000E+00	1.280E+06	0.000E+00	5.870E+05

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Grs/Goat/Milk (GMILK)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	3.550E+08	5.080E+08	1.670E+11	8.710E+08	0.000E+00	1.340E+08	0.000E+00	2.910E+08
I-132	1.970E-01	5.270E-01	1.840E+01	8.400E-01	0.000E+00	9.900E-02	0.000E+00	1.840E-01
I-133	4.640E+06	8.080E+06	1.190E+09	1.410E+07	0.000E+00	7.260E+06	0.000E+00	2.460E+06
I-134	2.420E-12	6.570E-12	1.140E-10	1.050E-11	0.000E+00	5.730E-15	0.000E+00	2.350E-12
I-135	1.540E+04	4.030E+04	2.660E+06	6.470E+04	0.000E+00	4.560E+04	0.000E+00	1.490E+04
CS-134	1.700E+10	4.040E+10	0.000E+00	1.310E+10	4.340E+09	7.060E+08	0.000E+00	3.300E+10
CS-136	7.900E+08	3.120E+09	0.000E+00	1.730E+09	2.380E+08	3.540E+08	0.000E+00	2.240E+09
CS-137	2.210E+10	3.030E+10	0.000E+00	1.030E+10	3.420E+09	5.860E+08	0.000E+00	1.980E+10
CS-138	2.710E-23	5.360E-23	0.000E+00	3.940E-23	3.890E-24	2.290E-28	0.000E+00	2.650E-23
BA-139	5.300E-09	3.780E-12	0.000E+00	3.530E-12	2.140E-12	9.400E-09	0.000E+00	1.550E-10
BA-140	3.230E+06	4.050E+03	0.000E+00	1.380E+03	2.320E+03	6.640E+06	0.000E+00	2.110E+05
BA-141	4.910E-47	3.710E-50	0.000E+00	3.450E-50	2.110E-50	2.310E-56	0.000E+00	1.660E-48
BA-142	3.170E-81	3.260E-84	0.000E+00	2.750E-84	1.850E-84	0.000E+00	0.000E+00	2.000E-82
LA-140	5.410E-01	2.730E-01	0.000E+00	0.000E+00	0.000E+00	2.000E+04	0.000E+00	7.210E-02
LA-142	2.230E-12	1.010E-12	0.000E+00	0.000E+00	0.000E+00	7.410E-09	0.000E+00	2.530E-13
CE-141	5.810E+02	3.930E+02	0.000E+00	1.830E+02	0.000E+00	1.500E+06	0.000E+00	4.460E+01
CE-143	4.990E+00	3.690E+03	0.000E+00	1.620E+00	0.000E+00	1.380E+05	0.000E+00	4.080E-01
CE-144	4.290E+04	1.790E+04	0.000E+00	1.060E+04	0.000E+00	1.450E+07	0.000E+00	2.300E+03
PR-143	1.890E+01	7.600E+00	0.000E+00	4.390E+00	0.000E+00	8.300E+04	0.000E+00	9.390E-01
PR-144	7.050E-55	2.930E-55	0.000E+00	1.650E-55	0.000E+00	1.010E-61	0.000E+00	3.580E-56
ND-147	1.130E+01	1.310E+01	0.000E+00	7.630E+00	0.000E+00	6.270E+04	0.000E+00	7.810E-01
W-187	7.820E+02	6.530E+02	0.000E+00	0.000E+00	0.000E+00	2.140E+05	0.000E+00	2.280E+02
NP-239	4.410E-01	4.330E-02	0.000E+00	1.350E-01	0.000E+00	8.890E+03	0.000E+00	2.390E-02

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Age group:	ADULT	Pathway:	Grs/Cow/Meat (CMEAT)			Units:	$m^2 \cdot$mrem/yr / µCi/sec; mrem/yr / µCi/m^3 (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	3.250E+02	3.250E+02	3.250E+02	3.250E+02	3.250E+02	0.000E+00	3.250E+02
C-14	2.060E+04	4.130E+03	4.130E+03	4.130E+03	4.130E+03	4.130E+03	0.000E+00	4.130E+03
NA-24	1.360E-03	1.360E-03	1.360E-03	1.360E-03	1.360E-03	1.360E-03	0.000E+00	1.360E-03
P-32	4.660E+09	2.900E+08	0.000E+00	0.000E+00	0.000E+00	5.240E+08	0.000E+00	1.800E+08
CR-51	0.000E+00	0.000E+00	4.210E+03	1.550E+03	9.350E+03	1.770E+06	0.000E+00	7.050E+03
MN-54	0.000E+00	9.180E+06	0.000E+00	2.730E+06	0.000E+00	2.810E+07	0.000E+00	1.750E+06
MN-56	0.000E+00	1.320E-53	0.000E+00	1.680E-53	0.000E+00	4.220E-52	0.000E+00	2.350E-54
FE-55	2.930E+08	2.030E+08	0.000E+00	0.000E+00	1.130E+08	1.160E+08	0.000E+00	4.720E+07
FE-59	2.660E+08	6.240E+08	0.000E+00	0.000E+00	1.740E+08	2.080E+09	0.000E+00	2.390E+08
CO-58	0.000E+00	1.820E+07	0.000E+00	0.000E+00	0.000E+00	3.690E+08	0.000E+00	4.090E+07
CO-60	0.000E+00	7.520E+07	0.000E+00	0.000E+00	0.000E+00	1.410E+09	0.000E+00	1.660E+08
NI-63	1.890E+10	1.310E+09	0.000E+00	0.000E+00	0.000E+00	2.730E+08	0.000E+00	6.330E+08
NI-65	2.250E-52	2.920E-53	0.000E+00	0.000E+00	0.000E+00	7.400E-52	0.000E+00	1.330E-53
CU-64	0.000E+00	2.710E-07	0.000E+00	6.830E-07	0.000E+00	2.310E-05	0.000E+00	1.270E-07
ZN-65	3.560E+08	1.130E+09	0.000E+00	7.570E+08	0.000E+00	7.130E+08	0.000E+00	5.120E+08
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.650E-57	0.000E+00	6.000E-57
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	4.870E+08	0.000E+00	0.000E+00	0.000E+00	9.600E+07	0.000E+00	2.270E+08
RB-88	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-89	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-89	3.020E+08	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.840E+07	0.000E+00	8.660E+06
SR-90	1.240E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.590E+08	0.000E+00	3.050E+09
SR-91	1.520E-10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.240E-10	0.000E+00	6.140E-12

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Age group:	ADULT	Pathway:	Grs/Cow/Meat (CMEAT)			Units:	$m^2 \cdot$mrem/yr / µCi/sec; mrem/yr / µCi/m^3 (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	1.180E-49	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.340E-48	0.000E+00	5.100E-51
Y-90	1.080E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.140E+06	0.000E+00	2.890E+00
Y-91	1.130E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.230E+08	0.000E+00	3.030E+04
Y-91M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y-92	1.520E-39	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.660E-35	0.000E+00	4.430E-41
Y-93	4.690E-12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.490E-07	0.000E+00	1.300E-13
ZR-95	1.870E+06	6.010E+05	0.000E+00	9.420E+05	0.000E+00	1.900E+09	0.000E+00	4.070E+05
ZR-97	2.070E-05	4.170E-06	0.000E+00	6.300E-06	0.000E+00	1.290E+00	0.000E+00	1.910E-06
NB-95	2.300E+06	1.280E+06	0.000E+00	1.260E+06	0.000E+00	7.760E+09	0.000E+00	6.870E+05
MO-99	0.000E+00	1.000E+05	0.000E+00	2.260E+05	0.000E+00	2.320E+05	0.000E+00	1.900E+04
TC-99M	4.450E-21	1.260E-20	0.000E+00	1.910E-19	6.150E-21	7.430E-18	0.000E+00	1.600E-19
TC-101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-103	1.050E+08	0.000E+00	0.000E+00	4.010E+08	0.000E+00	1.230E+10	0.000E+00	4.530E+07
RU-105	5.780E-28	0.000E+00	0.000E+00	7.460E-27	0.000E+00	3.530E-25	0.000E+00	2.280E-28
RU-106	2.800E+09	0.000E+00	0.000E+00	5.400E+09	0.000E+00	1.810E+11	0.000E+00	3.540E+08
AG-110M	6.680E+06	6.180E+06	0.000E+00	1.220E+07	0.000E+00	2.520E+09	0.000E+00	3.670E+06
TE-125M	3.590E+08	1.300E+08	1.080E+08	1.460E+09	0.000E+00	1.430E+09	0.000E+00	4.810E+07
TE-127	2.120E-10	7.610E-11	1.570E-10	8.640E-10	0.000E+00	1.670E-08	0.000E+00	4.590E-11
TE-127M	1.120E+09	3.990E+08	2.850E+08	4.530E+09	0.000E+00	3.740E+09	0.000E+00	1.360E+08
TE-129	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-129M	1.130E+09	4.230E+08	3.900E+08	4.730E+09	0.000E+00	5.710E+09	0.000E+00	1.790E+08
TE-131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-131M	4.510E+02	2.210E+02	3.490E+02	2.230E+03	0.000E+00	2.190E+04	0.000E+00	1.840E+02
TE-132	1.420E+06	9.180E+05	1.010E+06	8.840E+06	0.000E+00	4.340E+07	0.000E+00	8.620E+05
I-130	2.110E-06	6.220E-06	5.270E-04	9.700E-06	0.000E+00	5.350E-06	0.000E+00	2.450E-06

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Age group:	ADULT	Pathway:	Grs/Cow/Meat (CMEAT)			Units:	$m^2 \cdot$mrem/yr / µCi/sec; mrem/yr / µCi/m^3 (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	1.070E+07	1.540E+07	5.030E+09	2.630E+07	0.000E+00	4.050E+06	0.000E+00	8.800E+06
I-132	6.970E-59	1.860E-58	6.530E-57	2.970E-58	0.000E+00	3.500E-59	0.000E+00	6.530E-59
I-133	3.650E-01	6.350E-01	9.340E+01	1.110E+00	0.000E+00	5.710E-01	0.000E+00	1.940E-01
I-134	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-135	4.420E-17	1.160E-16	7.640E-15	1.860E-16	0.000E+00	1.310E-16	0.000E+00	4.270E-17
CS-134	6.580E+08	1.560E+09	0.000E+00	5.060E+08	1.680E+08	2.740E+07	0.000E+00	1.280E+09
CS-136	1.210E+07	4.760E+07	0.000E+00	2.650E+07	3.630E+06	5.410E+06	0.000E+00	3.420E+07
CS-137	8.720E+08	1.190E+09	0.000E+00	4.050E+08	1.350E+08	2.310E+07	0.000E+00	7.810E+08
CS-138	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-139	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-140	2.870E+07	3.610E+04	0.000E+00	1.230E+04	2.070E+04	5.920E+07	0.000E+00	1.880E+06
BA-141	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA-140	3.710E-02	1.870E-02	0.000E+00	0.000E+00	0.000E+00	1.370E+03	0.000E+00	4.940E-03
LA-142	3.470E-92	1.580E-92	0.000E+00	0.000E+00	0.000E+00	1.150E-88	0.000E+00	3.940E-93
CE-141	1.400E+04	9.500E+03	0.000E+00	4.410E+03	0.000E+00	3.630E+07	0.000E+00	1.080E+03
CE-143	2.010E-02	1.480E+01	0.000E+00	6.530E-03	0.000E+00	5.550E+02	0.000E+00	1.640E-03
CE-144	1.460E+06	6.090E+05	0.000E+00	3.610E+05	0.000E+00	4.930E+08	0.000E+00	7.830E+04
PR-143	2.100E+04	8.410E+03	0.000E+00	4.850E+03	0.000E+00	9.180E+07	0.000E+00	1.040E+03
PR-144	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND-147	7.070E+03	8.170E+03	0.000E+00	4.780E+03	0.000E+00	3.920E+07	0.000E+00	4.890E+02
W-187	2.070E-02	1.730E-02	0.000E+00	0.000E+00	0.000E+00	5.660E+00	0.000E+00	6.040E-03
NP-239	2.590E-01	2.550E-02	0.000E+00	7.950E-02	0.000E+00	5.230E+03	0.000E+00	1.400E-02

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Age group:	ADULT	Pathway:	Grs/Goat/Meat (GMEAT)			Units:	$m^2 \cdot$mrem/yr / µCi/sec; mrem/yr / µCi/m^3 (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	3.900E+01	3.900E+01	3.900E+01	3.900E+01	3.900E+01	0.000E+00	3.900E+01
C-14	2.472E+03	4.956E+02	4.956E+02	4.956E+02	4.956E+02	4.956E+02	0.000E+00	4.956E+02
NA-24	1.632E-04	1.632E-04	1.632E-04	1.632E-04	1.632E-04	1.632E-04	0.000E+00	1.632E-04
P-32	5.592E+08	3.480E+07	0.000E+00	0.000E+00	0.000E+00	6.288E+07	0.000E+00	2.160E+07
CR-51	0.000E+00	0.000E+00	5.052E+02	1.860E+02	1.122E+03	2.124E+05	0.000E+00	8.460E+02
MN-54	0.000E+00	1.102E+06	0.000E+00	3.276E+05	0.000E+00	3.372E+06	0.000E+00	2.100E+05
MN-56	0.000E+00	1.584E-54	0.000E+00	2.016E-54	0.000E+00	5.064E-53	0.000E+00	2.820E-55
FE-55	3.516E+07	2.436E+07	0.000E+00	0.000E+00	1.356E+07	1.392E+07	0.000E+00	5.664E+06
FE-59	3.192E+07	7.488E+07	0.000E+00	0.000E+00	2.088E+07	2.496E+08	0.000E+00	2.868E+07
CO-58	0.000E+00	2.184E+06	0.000E+00	0.000E+00	0.000E+00	4.428E+07	0.000E+00	4.908E+06
CO-60	0.000E+00	9.024E+06	0.000E+00	0.000E+00	0.000E+00	1.692E+08	0.000E+00	1.992E+07
NI-63	2.268E+09	1.572E+08	0.000E+00	0.000E+00	0.000E+00	3.276E+07	0.000E+00	7.596E+07
NI-65	2.700E-53	3.504E-54	0.000E+00	0.000E+00	0.000E+00	8.880E-53	0.000E+00	1.596E-54
CU-64	0.000E+00	3.252E-08	0.000E+00	8.196E-08	0.000E+00	2.772E-06	0.000E+00	1.524E-08
ZN-65	4.272E+07	1.356E+08	0.000E+00	9.084E+07	0.000E+00	8.556E+07	0.000E+00	6.144E+07
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.038E-57	0.000E+00	7.200E-58
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	5.844E+07	0.000E+00	0.000E+00	0.000E+00	1.152E+07	0.000E+00	2.724E+07
RB-88	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-89	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-89	3.624E+07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.808E+06	0.000E+00	1.039E+06
SR-90	1.488E+09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.308E+07	0.000E+00	3.660E+08
SR-91	1.824E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.688E-11	0.000E+00	7.368E-13

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Age group:	ADULT	Pathway:	Grs/Goat/Meat (GMEAT)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	1.416E-50	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.808E-49	0.000E+00	6.120E-52
Y-90	1.296E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.368E+05	0.000E+00	3.468E-01
Y-91	1.356E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.476E+07	0.000E+00	3.636E+03
Y-91M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y-92	1.824E-40	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.192E-36	0.000E+00	5.316E-42
Y-93	5.628E-13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.788E-08	0.000E+00	1.560E-14
ZR-95	2.244E+05	7.212E+04	0.000E+00	1.130E+05	0.000E+00	2.280E+08	0.000E+00	4.884E+04
ZR-97	2.484E-06	5.004E-07	0.000E+00	7.560E-07	0.000E+00	1.548E-01	0.000E+00	2.292E-07
NB-95	2.760E+05	1.536E+05	0.000E+00	1.512E+05	0.000E+00	9.312E+08	0.000E+00	8.244E+04
MO-99	0.000E+00	1.200E+04	0.000E+00	2.712E+04	0.000E+00	2.784E+04	0.000E+00	2.280E+03
TC-99M	5.340E-22	1.512E-21	0.000E+00	2.292E-20	7.380E-22	8.916E-19	0.000E+00	1.920E-20
TC-101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-103	1.260E+07	0.000E+00	0.000E+00	4.812E+07	0.000E+00	1.476E+09	0.000E+00	5.436E+06
RU-105	6.936E-29	0.000E+00	0.000E+00	8.952E-28	0.000E+00	4.236E-26	0.000E+00	2.736E-29
RU-106	3.360E+08	0.000E+00	0.000E+00	6.480E+08	0.000E+00	2.172E+10	0.000E+00	4.248E+07
AG-110M	8.016E+05	7.416E+05	0.000E+00	1.464E+06	0.000E+00	3.024E+08	0.000E+00	4.404E+05
TE-125M	4.308E+07	1.560E+07	1.296E+07	1.752E+08	0.000E+00	1.716E+08	0.000E+00	5.772E+06
TE-127	2.544E-11	9.132E-12	1.884E-11	1.037E-10	0.000E+00	2.004E-09	0.000E+00	5.508E-12
TE-127M	1.344E+08	4.788E+07	3.420E+07	5.436E+08	0.000E+00	4.488E+08	0.000E+00	1.632E+07
TE-129	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-129M	1.356E+08	5.076E+07	4.680E+07	5.676E+08	0.000E+00	6.852E+08	0.000E+00	2.148E+07
TE-131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-131M	5.412E+01	2.652E+01	4.188E+01	2.676E+02	0.000E+00	2.628E+03	0.000E+00	2.208E+01
TE-132	1.704E+05	1.102E+05	1.212E+05	1.061E+06	0.000E+00	5.208E+06	0.000E+00	1.034E+05
I-130	2.532E-07	7.464E-07	6.324E-05	1.164E-06	0.000E+00	6.420E-07	0.000E+00	2.940E-07

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Age group:	ADULT	Pathway:	Grs/Goat/Meat (GMEAT)			Units:	m^2·mrem/yr / µCi/sec; mrem/yr / µCi/m^3 (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	1.284E+06	1.848E+06	6.036E+08	3.156E+06	0.000E+00	4.860E+05	0.000E+00	1.056E+06
I-132	8.364E-60	2.232E-59	7.836E-58	3.564E-59	0.000E+00	4.200E-60	0.000E+00	7.836E-60
I-133	4.380E-02	7.620E-02	1.121E+01	1.332E-01	0.000E+00	6.852E-02	0.000E+00	2.328E-02
I-134	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-135	5.304E-18	1.392E-17	9.168E-16	2.232E-17	0.000E+00	1.572E-17	0.000E+00	5.124E-18
CS-134	7.896E+07	1.872E+08	0.000E+00	6.072E+07	2.016E+07	3.288E+06	0.000E+00	1.536E+08
CS-136	1.452E+06	5.712E+06	0.000E+00	3.180E+06	4.356E+05	6.492E+05	0.000E+00	4.104E+06
CS-137	1.046E+08	1.428E+08	0.000E+00	4.860E+07	1.620E+07	2.772E+06	0.000E+00	9.372E+07
CS-138	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-139	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-140	3.444E+06	4.332E+03	0.000E+00	1.476E+03	2.484E+03	7.104E+06	0.000E+00	2.256E+05
BA-141	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA-140	4.452E-03	2.244E-03	0.000E+00	0.000E+00	0.000E+00	1.644E+02	0.000E+00	5.928E-04
LA-142	4.164E-93	1.896E-93	0.000E+00	0.000E+00	0.000E+00	1.380E-89	0.000E+00	4.728E-94
CE-141	1.680E+03	1.140E+03	0.000E+00	5.292E+02	0.000E+00	4.356E+06	0.000E+00	1.296E+02
CE-143	2.412E-03	1.776E+00	0.000E+00	7.836E-04	0.000E+00	6.660E+01	0.000E+00	1.968E-04
CE-144	1.752E+05	7.308E+04	0.000E+00	4.332E+04	0.000E+00	5.916E+07	0.000E+00	9.396E+03
PR-143	2.520E+03	1.009E+03	0.000E+00	5.820E+02	0.000E+00	1.102E+07	0.000E+00	1.248E+02
PR-144	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND-147	8.484E+02	9.804E+02	0.000E+00	5.736E+02	0.000E+00	4.704E+06	0.000E+00	5.868E+01
W-187	2.484E-03	2.076E-03	0.000E+00	0.000E+00	0.000E+00	6.792E-01	0.000E+00	7.248E-04
NP-239	3.108E-02	3.060E-03	0.000E+00	9.540E-03	0.000E+00	6.276E+02	0.000E+00	1.680E-03

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Vegetation (VEG)			Units:	$m^2 \cdot$mrem/yr / μCi/sec; mrem/yr / μCi/m^3 (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	2.260E+03	2.260E+03	2.260E+03	2.260E+03	2.260E+03	0.000E+00	2.260E+03
C-14	5.560E+04	1.110E+04	1.110E+04	1.110E+04	1.110E+04	1.110E+04	0.000E+00	1.110E+04
NA-24	2.690E+05	2.690E+05	2.690E+05	2.690E+05	2.690E+05	2.690E+05	0.000E+00	2.690E+05
P-32	1.400E+09	8.730E+07	0.000E+00	0.000E+00	0.000E+00	1.580E+08	0.000E+00	5.430E+07
CR-51	0.000E+00	0.000E+00	2.780E+04	1.020E+04	6.160E+04	1.170E+07	0.000E+00	4.640E+04
MN-54	0.000E+00	3.130E+08	0.000E+00	9.310E+07	0.000E+00	9.590E+08	0.000E+00	5.970E+07
MN-56	0.000E+00	1.580E+01	0.000E+00	2.000E+01	0.000E+00	5.040E+02	0.000E+00	2.800E+00
FE-55	2.100E+08	1.450E+08	0.000E+00	0.000E+00	8.080E+07	8.310E+07	0.000E+00	3.380E+07
FE-59	1.260E+08	2.960E+08	0.000E+00	0.000E+00	8.280E+07	9.880E+08	0.000E+00	1.140E+08
CO-58	0.000E+00	3.070E+07	0.000E+00	0.000E+00	0.000E+00	6.230E+08	0.000E+00	6.890E+07
CO-60	0.000E+00	1.670E+08	0.000E+00	0.000E+00	0.000E+00	3.140E+09	0.000E+00	3.690E+08
NI-63	1.040E+10	7.210E+08	0.000E+00	0.000E+00	0.000E+00	1.500E+08	0.000E+00	3.490E+08
NI-65	6.150E+01	7.990E+00	0.000E+00	0.000E+00	0.000E+00	2.030E+02	0.000E+00	3.640E+00
CU-64	0.000E+00	9.200E+03	0.000E+00	2.320E+04	0.000E+00	7.840E+05	0.000E+00	4.320E+03
ZN-65	3.170E+08	1.010E+09	0.000E+00	6.750E+08	0.000E+00	6.360E+08	0.000E+00	4.560E+08
ZN-69	5.490E-06	1.050E-05	0.000E+00	6.830E-06	0.000E+00	1.580E-06	0.000E+00	7.310E-07
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.470E+00	0.000E+00	3.110E+00
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.940E-16	0.000E+00	2.480E-11
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	2.190E+08	0.000E+00	0.000E+00	0.000E+00	4.330E+07	0.000E+00	1.020E+08
RB-88	0.000E+00	3.430E-22	0.000E+00	0.000E+00	0.000E+00	4.740E-33	0.000E+00	1.820E-22
RB-89	0.000E+00	3.890E-26	0.000E+00	0.000E+00	0.000E+00	2.260E-39	0.000E+00	2.730E-26
SR-89	9.970E+09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.600E+09	0.000E+00	2.860E+08
SR-90	6.050E+11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.750E+10	0.000E+00	1.480E+11
SR-91	3.050E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.450E+06	0.000E+00	1.230E+04

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Vegetation (VEG)			Units:	$m^2 \cdot$mrem/yr / μCi/sec; mrem/yr / μCi/m^3 (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	4.270E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.450E+03	0.000E+00	1.850E+01
Y-90	1.330E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.410E+08	0.000E+00	3.570E+02
Y-91	5.110E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.810E+09	0.000E+00	1.370E+05
Y-91M	5.220E-09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.530E-08	0.000E+00	2.020E-10
Y-92	9.150E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.600E+04	0.000E+00	2.680E-02
Y-93	1.700E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.380E+06	0.000E+00	4.680E+00
ZR-95	1.170E+06	3.770E+05	0.000E+00	5.910E+05	0.000E+00	1.190E+09	0.000E+00	2.550E+05
ZR-97	3.370E+02	6.810E+01	0.000E+00	1.030E+02	0.000E+00	2.110E+07	0.000E+00	3.110E+01
NB-95	1.420E+05	7.920E+04	0.000E+00	7.830E+04	0.000E+00	4.810E+08	0.000E+00	4.260E+04
MO-99	0.000E+00	6.150E+06	0.000E+00	1.390E+07	0.000E+00	1.430E+07	0.000E+00	1.170E+06
TC-99M	3.100E+00	8.770E+00	0.000E+00	1.330E+02	4.300E+00	5.190E+03	0.000E+00	1.120E+02
TC-101	8.220E-31	1.180E-30	0.000E+00	2.130E-29	6.050E-31	3.560E-42	0.000E+00	1.160E-29
RU-103	4.770E+06	0.000E+00	0.000E+00	1.820E+07	0.000E+00	5.570E+08	0.000E+00	2.060E+06
RU-105	5.390E+01	0.000E+00	0.000E+00	6.960E+02	0.000E+00	3.290E+04	0.000E+00	2.130E+01
RU-106	1.930E+08	0.000E+00	0.000E+00	3.720E+08	0.000E+00	1.250E+10	0.000E+00	2.440E+07
AG-110M	1.050E+07	9.750E+06	0.000E+00	1.920E+07	0.000E+00	3.980E+09	0.000E+00	5.790E+06
TE-125M	9.660E+07	3.500E+07	2.900E+07	3.930E+08	0.000E+00	3.860E+08	0.000E+00	1.290E+07
TE-127	5.660E+03	2.030E+03	4.190E+03	2.310E+04	0.000E+00	4.470E+05	0.000E+00	1.220E+03
TE-127M	3.490E+08	1.250E+08	8.920E+07	1.420E+09	0.000E+00	1.170E+09	0.000E+00	4.260E+07
TE-129	7.630E-04	2.870E-04	5.850E-04	3.210E-03	0.000E+00	5.760E-04	0.000E+00	1.860E-04
TE-129M	2.510E+08	9.380E+07	8.630E+07	1.050E+09	0.000E+00	1.270E+09	0.000E+00	3.980E+07
TE-131	1.500E-15	6.270E-16	1.230E-15	6.570E-15	0.000E+00	2.130E-16	0.000E+00	4.740E-16
TE-131M	9.120E+05	4.460E+05	7.060E+05	4.520E+06	0.000E+00	4.430E+07	0.000E+00	3.720E+05
TE-132	4.300E+06	2.780E+06	3.070E+06	2.680E+07	0.000E+00	1.320E+08	0.000E+00	2.610E+06
I-130	3.920E+05	1.160E+06	9.810E+07	1.810E+06	0.000E+00	9.960E+05	0.000E+00	4.570E+05

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Vegetation (VEG)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	8.080E+07	1.160E+08	3.790E+10	1.980E+08	0.000E+00	3.050E+07	0.000E+00	6.620E+07
I-132	5.760E+01	1.540E+02	5.390E+03	2.450E+02	0.000E+00	2.890E+01	0.000E+00	5.390E+01
I-133	2.090E+06	3.630E+06	5.330E+08	6.330E+06	0.000E+00	3.260E+06	0.000E+00	1.110E+06
I-134	9.650E-05	2.620E-04	4.540E-03	4.170E-04	0.000E+00	2.290E-07	0.000E+00	9.380E-05
I-135	3.900E+04	1.020E+05	6.730E+06	1.640E+05	0.000E+00	1.150E+05	0.000E+00	3.770E+04
CS-134	4.670E+09	1.110E+10	0.000E+00	3.590E+09	1.190E+09	1.940E+08	0.000E+00	9.080E+09
CS-136	4.270E+07	1.680E+08	0.000E+00	9.380E+07	1.290E+07	1.910E+07	0.000E+00	1.210E+08
CS-137	6.360E+09	8.700E+09	0.000E+00	2.950E+09	9.810E+08	1.680E+08	0.000E+00	5.700E+09
CS-138	3.920E-11	7.730E-11	0.000E+00	5.680E-11	5.610E-12	3.300E-16	0.000E+00	3.830E-11
BA-139	2.860E-02	2.030E-05	0.000E+00	1.900E-05	1.150E-05	5.060E-02	0.000E+00	8.360E-04
BA-140	1.280E+08	1.610E+05	0.000E+00	5.490E+04	9.240E+04	2.650E+08	0.000E+00	8.420E+06
BA-141	1.150E-21	8.700E-25	0.000E+00	8.090E-25	4.940E-25	5.430E-31	0.000E+00	3.890E-23
BA-142	5.960E-39	6.120E-42	0.000E+00	5.170E-42	3.470E-42	8.390E-57	0.000E+00	3.750E-40
LA-140	1.980E+03	9.970E+02	0.000E+00	0.000E+00	0.000E+00	7.320E+07	0.000E+00	2.630E+02
LA-142	2.020E-04	9.190E-05	0.000E+00	0.000E+00	0.000E+00	6.710E-01	0.000E+00	2.290E-05
CE-141	1.970E+05	1.330E+05	0.000E+00	6.190E+04	0.000E+00	5.100E+08	0.000E+00	1.510E+04
CE-143	9.980E+02	7.380E+05	0.000E+00	3.250E+02	0.000E+00	2.760E+07	0.000E+00	8.160E+01
CE-144	3.290E+07	1.380E+07	0.000E+00	8.160E+06	0.000E+00	1.110E+10	0.000E+00	1.770E+06
PR-143	6.260E+04	2.510E+04	0.000E+00	1.450E+04	0.000E+00	2.740E+08	0.000E+00	3.100E+03
PR-144	3.090E-26	1.280E-26	0.000E+00	7.230E-27	0.000E+00	4.440E-33	0.000E+00	1.570E-27
ND-147	3.330E+04	3.850E+04	0.000E+00	2.250E+04	0.000E+00	1.850E+08	0.000E+00	2.310E+03
W-187	3.800E+04	3.180E+04	0.000E+00	0.000E+00	0.000E+00	1.040E+07	0.000E+00	1.110E+04
NP-239	1.430E+03	1.400E+02	0.000E+00	4.380E+02	0.000E+00	2.880E+07	0.000E+00	7.740E+01

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Inhalation (INHL)			Units:	mrem/yr / µCi/m^3	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	1.260E+03	1.260E+03	1.260E+03	1.260E+03	1.260E+03	0.000E+00	1.260E+03
C-14	1.820E+04	3.410E+03	3.410E+03	3.410E+03	3.410E+03	3.410E+03	0.000E+00	3.410E+03
NA-24	1.020E+04	1.020E+04	1.020E+04	1.020E+04	1.020E+04	1.020E+04	0.000E+00	1.020E+04
P-32	1.320E+06	7.710E+04	0.000E+00	0.000E+00	0.000E+00	8.640E+04	0.000E+00	5.010E+04
CR-51	0.000E+00	0.000E+00	5.950E+01	2.280E+01	1.440E+04	3.320E+03	0.000E+00	1.000E+02
MN-54	0.000E+00	3.960E+04	0.000E+00	9.840E+03	1.400E+06	7.740E+04	0.000E+00	6.300E+03
MN-56	0.000E+00	1.240E+00	0.000E+00	1.300E+00	9.440E+03	2.020E+04	0.000E+00	1.830E-01
FE-55	2.460E+04	1.700E+04	0.000E+00	0.000E+00	7.210E+04	6.030E+03	0.000E+00	3.940E+03
FE-59	1.180E+04	2.780E+04	0.000E+00	0.000E+00	1.020E+06	1.880E+05	0.000E+00	1.060E+04
CO-58	0.000E+00	1.580E+03	0.000E+00	0.000E+00	9.280E+05	1.060E+05	0.000E+00	2.070E+03
CO-60	0.000E+00	1.150E+04	0.000E+00	0.000E+00	5.970E+06	2.850E+05	0.000E+00	1.480E+04
NI-63	4.320E+05	3.140E+04	0.000E+00	0.000E+00	1.780E+05	1.340E+04	0.000E+00	1.450E+04
NI-65	1.540E+00	2.100E-01	0.000E+00	0.000E+00	5.600E+03	1.230E+04	0.000E+00	9.120E-02
CU-64	0.000E+00	1.460E+00	0.000E+00	4.620E+00	6.780E+03	4.900E+04	0.000E+00	6.150E-01
ZN-65	3.240E+04	1.030E+05	0.000E+00	6.900E+04	8.640E+05	5.340E+04	0.000E+00	4.660E+04
ZN-69	3.380E-02	6.510E-02	0.000E+00	4.220E-02	9.200E+02	1.630E+01	0.000E+00	4.520E-03
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.320E+02	0.000E+00	2.410E+02
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.640E-03	0.000E+00	3.130E+02
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.280E+01
RB-86	0.000E+00	1.350E+05	0.000E+00	0.000E+00	0.000E+00	1.660E+04	0.000E+00	5.900E+04
RB-88	0.000E+00	3.870E+02	0.000E+00	0.000E+00	0.000E+00	3.340E-09	0.000E+00	1.930E+02
RB-89	0.000E+00	2.560E+02	0.000E+00	0.000E+00	0.000E+00	9.280E-12	0.000E+00	1.700E+02
SR-89	3.040E+05	0.000E+00	0.000E+00	0.000E+00	1.400E+06	3.500E+05	0.000E+00	8.720E+03
SR-90	9.920E+07	0.000E+00	0.000E+00	0.000E+00	9.600E+06	7.220E+05	0.000E+00	6.100E+06
SR-91	6.190E+01	0.000E+00	0.000E+00	0.000E+00	3.650E+04	1.910E+05	0.000E+00	2.500E+00

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Inhalation (INHL)			Units:	mrem/yr / µCi/m^3	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	6.740E+00	0.000E+00	0.000E+00	0.000E+00	1.650E+04	4.300E+04	0.000E+00	2.910E-01
Y-90	2.090E+03	0.000E+00	0.000E+00	0.000E+00	1.700E+05	5.060E+05	0.000E+00	5.610E+01
Y-91	4.620E+05	0.000E+00	0.000E+00	0.000E+00	1.700E+06	3.850E+05	0.000E+00	1.240E+04
Y-91M	2.610E-01	0.000E+00	0.000E+00	0.000E+00	1.920E+03	1.330E+00	0.000E+00	1.020E-02
Y-92	1.030E+01	0.000E+00	0.000E+00	0.000E+00	1.570E+04	7.350E+04	0.000E+00	3.020E-01
Y-93	9.440E+01	0.000E+00	0.000E+00	0.000E+00	4.850E+04	4.220E+05	0.000E+00	2.610E+00
ZR-95	1.070E+05	3.440E+04	0.000E+00	5.420E+04	1.770E+06	1.500E+05	0.000E+00	2.330E+04
ZR-97	9.680E+01	1.960E+01	0.000E+00	2.970E+01	7.870E+04	5.230E+05	0.000E+00	9.040E+00
NB-95	1.410E+04	7.820E+03	0.000E+00	7.740E+03	5.050E+05	1.040E+05	0.000E+00	4.210E+03
MO-99	0.000E+00	1.210E+02	0.000E+00	2.910E+02	9.120E+04	2.480E+05	0.000E+00	2.300E+01
TC-99M	1.030E-03	2.910E-03	0.000E+00	4.420E-02	7.640E+02	4.160E+03	0.000E+00	3.700E-02
TC-101	4.180E-05	6.020E-05	0.000E+00	1.080E-03	3.990E+02	1.090E-11	0.000E+00	5.900E-04
RU-103	1.530E+03	0.000E+00	0.000E+00	5.830E+03	5.050E+05	1.100E+05	0.000E+00	6.580E+02
RU-105	7.900E-01	0.000E+00	0.000E+00	1.020E+00	1.100E+04	4.820E+04	0.000E+00	3.110E-01
RU-106	6.910E+04	0.000E+00	0.000E+00	1.340E+05	9.360E+06	9.120E+05	0.000E+00	8.720E+03
AG-110M	1.080E+04	1.000E+04	0.000E+00	1.970E+04	4.630E+06	3.020E+05	0.000E+00	5.940E+03
TE-125M	3.420E+03	1.580E+03	1.050E+03	1.240E+04	3.140E+05	7.060E+04	0.000E+00	4.670E+02
TE-127	1.400E+00	6.420E-01	1.060E+00	5.100E+00	6.510E+03	5.740E+04	0.000E+00	3.100E-01
TE-127M	1.260E+04	5.770E+03	3.290E+03	4.580E+04	9.600E+05	1.500E+05	0.000E+00	1.570E+03
TE-129	4.980E-02	2.390E-02	3.900E-02	1.870E-01	1.940E+03	1.570E+02	0.000E+00	1.240E-02
TE-129M	9.760E+03	4.670E+03	3.440E+03	3.660E+04	1.160E+06	3.830E+05	0.000E+00	1.580E+03
TE-131	1.110E-02	5.950E-03	9.360E-03	4.370E-02	1.390E+03	1.840E+01	0.000E+00	3.590E-03
TE-131M	6.990E+01	4.360E+01	5.500E+01	3.090E+02	1.460E+05	5.560E+05	0.000E+00	2.900E+01
TE-132	2.600E+02	2.150E+02	1.900E+02	1.460E+03	2.880E+05	5.100E+05	0.000E+00	1.620E+02
I-130	4.580E+03	1.340E+04	1.140E+06	2.090E+04	0.000E+00	7.690E+03	0.000E+00	5.280E+03

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Inhalation (INHL)			Units:	mrem/yr / µCi/m^3	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
I-131	2.520E+04	3.580E+04	1.190E+07	6.130E+04	0.000E+00	6.280E+03	0.000E+00	2.050E+04
I-132	1.160E+03	3.260E+03	1.140E+05	5.180E+03	0.000E+00	4.060E+02	0.000E+00	1.160E+03
I-133	8.640E+03	1.480E+04	2.150E+06	2.580E+04	0.000E+00	8.880E+03	0.000E+00	4.520E+03
I-134	6.440E+02	1.730E+03	2.980E+04	2.750E+03	0.000E+00	1.010E+00	0.000E+00	6.150E+02
I-135	2.680E+03	6.980E+03	4.480E+05	1.110E+04	0.000E+00	5.250E+03	0.000E+00	2.570E+03
CS-134	3.730E+05	8.480E+05	0.000E+00	2.870E+05	9.760E+04	1.040E+04	0.000E+00	7.280E+05
CS-136	3.900E+04	1.460E+05	0.000E+00	8.560E+04	1.200E+04	1.170E+04	0.000E+00	1.100E+05
CS-137	4.780E+05	6.210E+05	0.000E+00	2.220E+05	7.520E+04	8.400E+03	0.000E+00	4.280E+05
CS-138	3.310E+02	6.210E+02	0.000E+00	4.800E+02	4.860E+01	1.860E-03	0.000E+00	3.240E+02
BA-139	9.360E-01	6.660E-04	0.000E+00	6.220E-04	3.760E+03	8.960E+02	0.000E+00	2.740E-02
BA-140	3.900E+04	4.900E+01	0.000E+00	1.670E+01	1.270E+06	2.180E+05	0.000E+00	2.570E+03
BA-141	1.000E-01	7.530E-05	0.000E+00	7.000E-05	1.940E+03	1.160E-07	0.000E+00	3.360E-03
BA-142	2.630E-02	2.700E-05	0.000E+00	2.290E-05	1.190E+03	1.570E-16	0.000E+00	1.660E-03
LA-140	3.440E+02	1.740E+02	0.000E+00	0.000E+00	1.360E+05	4.580E+05	0.000E+00	4.580E+01
LA-142	6.830E-01	3.100E-01	0.000E+00	0.000E+00	6.330E+03	2.110E+03	0.000E+00	7.720E-02
CE-141	1.990E+04	1.350E+04	0.000E+00	6.260E+03	3.620E+05	1.200E+05	0.000E+00	1.530E+03
CE-143	1.860E+02	1.380E+02	0.000E+00	6.080E+01	7.980E+04	2.260E+05	0.000E+00	1.530E+01
CE-144	3.430E+06	1.430E+06	0.000E+00	8.480E+05	7.780E+06	8.160E+05	0.000E+00	1.840E+05
PR-143	9.360E+03	3.750E+03	0.000E+00	2.160E+03	2.810E+05	2.000E+05	0.000E+00	4.640E+02
PR-144	3.010E-02	1.250E-02	0.000E+00	7.050E-03	1.020E+03	2.150E-08	0.000E+00	1.530E-03
ND-147	5.270E+03	6.100E+03	0.000E+00	3.560E+03	2.210E+05	1.730E+05	0.000E+00	3.650E+02
W-187	8.480E+00	7.080E+00	0.000E+00	0.000E+00	2.900E+04	1.550E+05	0.000E+00	2.480E+00
NP-239	2.300E+02	2.260E+01	0.000E+00	7.000E+01	3.760E+04	1.190E+05	0.000E+00	1.240E+01

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Ground Plane Deposition (GPD)			Units:	m^2·mrem/yr / µCi/sec	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C-14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NA-24	1.190E+07	1.190E+07	1.190E+07	1.190E+07	1.190E+07	1.190E+07	1.390E+07	1.190E+07
P-32	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CR-51	4.660E+06	4.660E+06	4.660E+06	4.660E+06	4.660E+06	4.660E+06	5.510E+06	4.660E+06
MN-54	1.390E+09	1.390E+09	1.390E+09	1.390E+09	1.390E+09	1.390E+09	1.630E+09	1.390E+09
MN-56	9.020E+05	9.020E+05	9.020E+05	9.020E+05	9.020E+05	9.020E+05	1.070E+06	9.020E+05
FE-55	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
FE-59	2.730E+08	2.730E+08	2.730E+08	2.730E+08	2.730E+08	2.730E+08	3.210E+08	2.730E+08
CO-58	3.790E+08	3.790E+08	3.790E+08	3.790E+08	3.790E+08	3.790E+08	4.440E+08	3.790E+08
CO-60	2.150E+10	2.150E+10	2.150E+10	2.150E+10	2.150E+10	2.150E+10	2.530E+10	2.150E+10
NI-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NI-65	2.970E+05	2.970E+05	2.970E+05	2.970E+05	2.970E+05	2.970E+05	3.450E+05	2.970E+05
CU-64	6.070E+05	6.070E+05	6.070E+05	6.070E+05	6.070E+05	6.070E+05	6.880E+05	6.070E+05
ZN-65	7.470E+08	7.470E+08	7.470E+08	7.470E+08	7.470E+08	7.470E+08	8.590E+08	7.470E+08
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	4.870E+03	4.870E+03	4.870E+03	4.870E+03	4.870E+03	4.870E+03	7.080E+03	4.870E+03
BR-84	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.360E+05	2.030E+05
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	8.990E+06	8.990E+06	8.990E+06	8.990E+06	8.990E+06	8.990E+06	1.030E+07	8.990E+06
RB-88	3.310E+04	3.310E+04	3.310E+04	3.310E+04	3.310E+04	3.310E+04	3.780E+04	3.310E+04
RB-89	1.230E+05	1.230E+05	1.230E+05	1.230E+05	1.230E+05	1.230E+05	1.480E+05	1.230E+05
SR-89	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.510E+04	2.160E+04
SR-90	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-91	2.150E+06	2.150E+06	2.150E+06	2.150E+06	2.150E+06	2.150E+06	2.510E+06	2.150E+06

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Ground Plane Deposition (GPD)			Units:	$m^2 \cdot$mrem/yr / µCi/sec	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	7.770E+05	7.770E+05	7.770E+05	7.770E+05	7.770E+05	7.770E+05	8.630E+05	7.770E+05
Y-90	4.490E+03	4.490E+03	4.490E+03	4.490E+03	4.490E+03	4.490E+03	5.310E+03	4.490E+03
Y-91	1.070E+06	1.070E+06	1.070E+06	1.070E+06	1.070E+06	1.070E+06	1.210E+06	1.070E+06
Y-91M	1.000E+05	1.000E+05	1.000E+05	1.000E+05	1.000E+05	1.000E+05	1.160E+05	1.000E+05
Y-92	1.800E+05	1.800E+05	1.800E+05	1.800E+05	1.800E+05	1.800E+05	2.140E+05	1.800E+05
Y-93	1.830E+05	1.830E+05	1.830E+05	1.830E+05	1.830E+05	1.830E+05	2.510E+05	1.830E+05
ZR-95	2.450E+08	2.450E+08	2.450E+08	2.450E+08	2.450E+08	2.450E+08	2.840E+08	2.450E+08
ZR-97	2.960E+06	2.960E+06	2.960E+06	2.960E+06	2.960E+06	2.960E+06	3.440E+06	2.960E+06
NB-95	1.370E+08	1.370E+08	1.370E+08	1.370E+08	1.370E+08	1.370E+08	1.610E+08	1.370E+08
MO-99	3.990E+06	3.990E+06	3.990E+06	3.990E+06	3.990E+06	3.990E+06	4.630E+06	3.990E+06
TC-99M	1.840E+05	1.840E+05	1.840E+05	1.840E+05	1.840E+05	1.840E+05	2.110E+05	1.840E+05
TC-101	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.260E+04	2.040E+04
RU-103	1.080E+08	1.080E+08	1.080E+08	1.080E+08	1.080E+08	1.080E+08	1.260E+08	1.080E+08
RU-105	6.360E+05	6.360E+05	6.360E+05	6.360E+05	6.360E+05	6.360E+05	7.210E+05	6.360E+05
RU-106	4.220E+08	4.220E+08	4.220E+08	4.220E+08	4.220E+08	4.220E+08	5.070E+08	4.220E+08
AG-110M	3.440E+09	3.440E+09	3.440E+09	3.440E+09	3.440E+09	3.440E+09	4.010E+09	3.440E+09
TE-125M	1.550E+06	1.550E+06	1.550E+06	1.550E+06	1.550E+06	1.550E+06	2.130E+06	1.550E+06
TE-127	2.980E+03	2.980E+03	2.980E+03	2.980E+03	2.980E+03	2.980E+03	3.280E+03	2.980E+03
TE-127M	9.160E+04	9.160E+04	9.160E+04	9.160E+04	9.160E+04	9.160E+04	1.080E+05	9.160E+04
TE-129	2.620E+04	2.620E+04	2.620E+04	2.620E+04	2.620E+04	2.620E+04	3.100E+04	2.620E+04
TE-129M	1.980E+07	1.980E+07	1.980E+07	1.980E+07	1.980E+07	1.980E+07	2.310E+07	1.980E+07
TE-131	2.920E+04	2.920E+04	2.920E+04	2.920E+04	2.920E+04	2.920E+04	3.450E+07	2.920E+04
TE-131M	8.030E+06	8.030E+06	8.030E+06	8.030E+06	8.030E+06	8.030E+06	9.460E+06	8.030E+06
TE-132	4.230E+06	4.230E+06	4.230E+06	4.230E+06	4.230E+06	4.230E+06	4.980E+06	4.230E+06
I-130	5.510E+06	5.510E+06	5.510E+06	5.510E+06	5.510E+06	5.510E+06	6.690E+06	5.510E+06

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Ground Plane Deposition (GPD)			Units:	$m^2 \cdot$mrem/yr / µCi/sec	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	1.720E+07	1.720E+07	1.720E+07	1.720E+07	1.720E+07	1.720E+07	2.090E+07	1.720E+07
I-132	1.250E+06	1.250E+06	1.250E+06	1.250E+06	1.250E+06	1.250E+06	1.470E+06	1.250E+06
I-133	2.450E+06	2.450E+06	2.450E+06	2.450E+06	2.450E+06	2.450E+06	2.980E+06	2.450E+06
I-134	4.470E+05	4.470E+05	4.470E+05	4.470E+05	4.470E+05	4.470E+05	5.300E+05	4.470E+05
I-135	2.530E+06	2.530E+06	2.530E+06	2.530E+06	2.530E+06	2.530E+06	2.950E+06	2.530E+06
CS-134	6.860E+09	6.860E+09	6.860E+09	6.860E+09	6.860E+09	6.860E+09	8.000E+09	6.860E+09
CS-136	1.510E+08	1.510E+08	1.510E+08	1.510E+08	1.510E+08	1.510E+08	1.710E+08	1.510E+08
CS-137	1.030E+10	1.030E+10	1.030E+10	1.030E+10	1.030E+10	1.030E+10	1.200E+10	1.030E+10
CS-138	3.590E+05	3.590E+05	3.590E+05	3.590E+05	3.590E+05	3.590E+05	4.100E+05	3.590E+05
BA-139	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.190E+05	1.060E+05
BA-140	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.350E+07	2.050E+07
BA-141	4.170E+04	4.170E+04	4.170E+04	4.170E+04	4.170E+04	4.170E+04	4.750E+04	4.170E+04
BA-142	4.490E+04	4.490E+04	4.490E+04	4.490E+04	4.490E+04	4.490E+04	5.110E+04	4.490E+04
LA-140	1.920E+07	1.920E+07	1.920E+07	1.920E+07	1.920E+07	1.920E+07	2.180E+07	1.920E+07
LA-142	7.600E+05	7.600E+05	7.600E+05	7.600E+05	7.600E+05	7.600E+05	9.120E+05	7.600E+05
CE-141	1.370E+07	1.370E+07	1.370E+07	1.370E+07	1.370E+07	1.370E+07	1.540E+07	1.370E+07
CE-143	2.310E+06	2.310E+06	2.310E+06	2.310E+06	2.310E+06	2.310E+06	2.630E+06	2.310E+06
CE-144	6.950E+07	6.950E+07	6.950E+07	6.950E+07	6.950E+07	6.950E+07	8.040E+07	6.950E+07
PR-143	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR-144	1.830E+03	1.830E+03	1.830E+03	1.830E+03	1.830E+03	1.830E+03	2.110E+03	1.830E+03
ND-147	8.390E+06	8.390E+06	8.390E+06	8.390E+06	8.390E+06	8.390E+06	1.010E+07	8.390E+06
W-187	2.350E+06	2.350E+06	2.350E+06	2.350E+06	2.350E+06	2.350E+06	2.730E+06	2.350E+06
NP-239	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.980E+06	1.710E+06

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Grs/Cow/Milk (CMILK)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	9.940E+02	9.940E+02	9.940E+02	9.940E+02	9.940E+02	0.000E+00	9.940E+02
C-14	4.150E+04	8.310E+03	8.310E+03	8.310E+03	8.310E+03	8.310E+03	0.000E+00	8.310E+03
NA-24	4.260E+06	4.260E+06	4.260E+06	4.260E+06	4.260E+06	4.260E+06	0.000E+00	4.260E+06
P-32	3.150E+10	1.950E+09	0.000E+00	0.000E+00	0.000E+00	2.650E+09	0.000E+00	1.220E+09
CR-51	0.000E+00	0.000E+00	2.770E+04	1.090E+04	7.130E+04	8.390E+06	0.000E+00	4.990E+04
MN-54	0.000E+00	1.400E+07	0.000E+00	4.180E+06	0.000E+00	2.870E+07	0.000E+00	2.780E+06
MN-56	0.000E+00	7.250E-03	0.000E+00	9.180E-03	0.000E+00	4.770E-01	0.000E+00	1.290E-03
FE-55	4.450E+07	3.160E+07	0.000E+00	0.000E+00	2.000E+07	1.370E+07	0.000E+00	7.360E+06
FE-59	5.180E+07	1.210E+08	0.000E+00	0.000E+00	3.810E+07	2.860E+08	0.000E+00	4.670E+07
CO-58	0.000E+00	7.940E+06	0.000E+00	0.000E+00	0.000E+00	1.090E+08	0.000E+00	1.830E+07
CO-60	0.000E+00	2.780E+07	0.000E+00	0.000E+00	0.000E+00	3.620E+08	0.000E+00	6.260E+07
NI-63	1.180E+10	8.350E+08	0.000E+00	0.000E+00	0.000E+00	1.330E+08	0.000E+00	4.010E+08
NI-65	6.770E-01	8.650E-02	0.000E+00	0.000E+00	0.000E+00	4.690E+00	0.000E+00	3.940E-02
CU-64	0.000E+00	4.250E+04	0.000E+00	1.070E+05	0.000E+00	3.290E+06	0.000E+00	2.000E+04
ZN-65	2.110E+09	7.320E+09	0.000E+00	4.680E+09	0.000E+00	3.100E+09	0.000E+00	3.410E+09
ZN-69	3.850E-12	7.330E-12	0.000E+00	4.790E-12	0.000E+00	1.350E-11	0.000E+00	5.130E-13
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.790E-01
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.880E-23
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	4.730E+09	0.000E+00	0.000E+00	0.000E+00	7.000E+08	0.000E+00	2.220E+09
RB-88	0.000E+00	3.890E-45	0.000E+00	0.000E+00	0.000E+00	3.330E-52	0.000E+00	2.070E-45
RB-89	0.000E+00	7.660E-53	0.000E+00	0.000E+00	0.000E+00	1.170E-61	0.000E+00	5.420E-53
SR-89	2.670E+09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.190E+08	0.000E+00	7.660E+07
SR-90	6.610E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.860E+09	0.000E+00	1.630E+10
SR-91	5.310E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.410E+05	0.000E+00	2.110E+03

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Grs/Cow/Milk (CMILK)			Units:	$m^2\cdot$mrem/yr / µCi/sec; mrem/yr / µCi/m^3 (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	8.940E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.280E+01	0.000E+00	3.810E-02
Y-90	1.300E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.070E+06	0.000E+00	3.510E+00
Y-91	1.580E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.480E+06	0.000E+00	4.240E+02
Y-91M	1.090E-19	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.170E-18	0.000E+00	4.180E-21
Y-92	1.030E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.830E+00	0.000E+00	2.980E-06
Y-93	4.120E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.260E+04	0.000E+00	1.130E-02
ZR-95	1.650E+03	5.200E+02	0.000E+00	7.650E+02	0.000E+00	1.200E+06	0.000E+00	3.580E+02
ZR-97	7.880E-01	1.560E-01	0.000E+00	2.370E-01	0.000E+00	4.220E+04	0.000E+00	7.190E-02
NB-95	1.410E+05	7.810E+04	0.000E+00	7.570E+04	0.000E+00	3.340E+08	0.000E+00	4.300E+04
MO-99	0.000E+00	4.470E+07	0.000E+00	1.020E+08	0.000E+00	8.010E+07	0.000E+00	8.530E+06
TC-99M	5.760E+00	1.610E+01	0.000E+00	2.390E+02	8.920E+00	1.050E+04	0.000E+00	2.080E+02
TC-101	4.740E-60	6.750E-60	0.000E+00	1.220E-58	4.110E-60	1.150E-66	0.000E+00	6.630E-59
RU-103	1.810E+03	0.000E+00	0.000E+00	6.380E+03	0.000E+00	1.510E+05	0.000E+00	7.740E+02
RU-105	1.560E-03	0.000E+00	0.000E+00	1.970E-02	0.000E+00	1.260E+00	0.000E+00	6.070E-04
RU-106	3.750E+04	0.000E+00	0.000E+00	7.240E+04	0.000E+00	1.800E+06	0.000E+00	4.730E+03
AG-110M	9.630E+07	9.110E+07	0.000E+00	1.740E+08	0.000E+00	2.560E+10	0.000E+00	5.540E+07
TE-125M	3.000E+07	1.080E+07	8.390E+06	0.000E+00	0.000E+00	8.860E+07	0.000E+00	4.020E+06
TE-127	1.210E+03	4.290E+02	8.350E+02	4.900E+03	0.000E+00	9.340E+04	0.000E+00	2.600E+02
TE-127M	8.440E+07	2.990E+07	2.010E+07	3.420E+08	0.000E+00	2.100E+08	0.000E+00	1.000E+07
TE-129	5.200E-10	1.940E-10	3.720E-10	2.180E-09	0.000E+00	2.840E-09	0.000E+00	1.270E-10
TE-129M	1.100E+08	4.090E+07	3.550E+07	4.610E+08	0.000E+00	4.130E+08	0.000E+00	1.740E+07
TE-131	6.580E-33	2.710E-33	5.070E-33	2.880E-32	0.000E+00	5.400E-34	0.000E+00	2.060E-33
TE-131M	6.570E+05	3.150E+05	4.740E+05	3.290E+06	0.000E+00	2.530E+07	0.000E+00	2.630E+05
TE-132	4.290E+06	2.720E+06	2.870E+06	2.610E+07	0.000E+00	8.610E+07	0.000E+00	2.560E+06
I-130	7.380E+05	2.140E+06	1.740E+08	3.290E+06	0.000E+00	1.640E+06	0.000E+00	8.530E+05

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Grs/Cow/Milk (CMILK)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	5.370E+08	7.520E+08	2.190E+11	1.290E+09	0.000E+00	1.490E+08	0.000E+00	4.040E+08
I-132	2.910E-01	7.620E-01	2.570E+01	1.200E+00	0.000E+00	3.320E-01	0.000E+00	2.740E-01
I-133	7.070E+06	1.200E+07	1.670E+09	2.100E+07	0.000E+00	9.070E+06	0.000E+00	3.660E+06
I-134	3.580E-12	9.500E-12	1.580E-10	1.500E-11	0.000E+00	1.250E-13	0.000E+00	3.410E-12
I-135	2.280E+04	5.870E+04	3.780E+06	9.270E+04	0.000E+00	6.510E+04	0.000E+00	2.180E+04
CS-134	9.820E+09	2.310E+10	0.000E+00	7.340E+09	2.800E+09	2.870E+08	0.000E+00	1.070E+10
CS-136	4.480E+08	1.760E+09	0.000E+00	9.600E+08	1.510E+08	1.420E+08	0.000E+00	1.180E+09
CS-137	1.340E+10	1.780E+10	0.000E+00	6.060E+09	2.350E+09	2.530E+08	0.000E+00	6.200E+09
CS-138	1.640E-23	3.150E-23	0.000E+00	2.330E-23	2.710E-24	1.430E-26	0.000E+00	1.580E-23
BA-139	8.170E-08	5.750E-11	0.000E+00	5.420E-11	3.960E-11	7.290E-07	0.000E+00	2.380E-09
BA-140	4.850E+07	5.950E+04	0.000E+00	2.020E+04	4.000E+04	7.480E+07	0.000E+00	3.130E+06
BA-141	7.520E-46	5.620E-49	0.000E+00	5.210E-49	3.850E-49	1.600E-51	0.000E+00	2.510E-47
BA-142	4.790E-80	4.790E-83	0.000E+00	4.050E-83	3.190E-83	1.470E-91	0.000E+00	2.950E-81
LA-140	8.100E+00	3.980E+00	0.000E+00	0.000E+00	0.000E+00	2.290E+05	0.000E+00	1.060E+00
LA-142	3.360E-11	1.490E-11	0.000E+00	0.000E+00	0.000E+00	4.540E-07	0.000E+00	3.710E-12
CE-141	8.880E+03	5.930E+03	0.000E+00	2.790E+03	0.000E+00	1.700E+07	0.000E+00	6.810E+02
CE-143	7.640E+01	5.560E+04	0.000E+00	2.490E+01	0.000E+00	1.670E+06	0.000E+00	6.210E+00
CE-144	6.580E+05	2.720E+05	0.000E+00	1.630E+05	0.000E+00	1.660E+08	0.000E+00	3.540E+04
PR-143	2.900E+02	1.160E+02	0.000E+00	6.730E+01	0.000E+00	9.540E+05	0.000E+00	1.440E+01
PR-144	1.080E-53	4.430E-54	0.000E+00	2.540E-54	0.000E+00	1.190E-56	0.000E+00	5.490E-55
ND-147	1.810E+02	1.970E+02	0.000E+00	1.160E+02	0.000E+00	7.110E+05	0.000E+00	1.180E+01
W-187	1.190E+04	9.710E+03	0.000E+00	0.000E+00	0.000E+00	2.630E+06	0.000E+00	3.400E+03
NP-239	7.010E+00	6.610E-01	0.000E+00	2.070E+00	0.000E+00	1.060E+05	0.000E+00	3.670E-01

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Grs/Goat/Milk (GMILK)			Units:	$m^2 \cdot$mrem/yr / µCi/sec; mrem/yr / µCi/m^3 (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	2.030E+03	2.030E+03	2.030E+03	2.030E+03	2.030E+03	0.000E+00	2.030E+03
C-14	4.150E+04	8.310E+03	8.310E+03	8.310E+03	8.310E+03	8.310E+03	0.000E+00	8.310E+03
NA-24	5.110E+05	5.110E+05	5.110E+05	5.110E+05	5.110E+05	5.110E+05	0.000E+00	5.110E+05
P-32	3.780E+10	2.340E+09	0.000E+00	0.000E+00	0.000E+00	3.180E+09	0.000E+00	1.470E+09
CR-51	0.000E+00	0.000E+00	3.330E+03	1.310E+03	8.550E+03	1.010E+06	0.000E+00	5.990E+03
MN-54	0.000E+00	1.680E+06	0.000E+00	5.020E+05	0.000E+00	3.450E+06	0.000E+00	3.340E+05
MN-56	0.000E+00	8.700E-04	0.000E+00	1.100E-03	0.000E+00	5.730E-02	0.000E+00	1.550E-04
FE-55	5.790E+05	4.110E+05	0.000E+00	0.000E+00	2.600E+05	1.780E+05	0.000E+00	9.570E+04
FE-59	6.740E+05	1.570E+06	0.000E+00	0.000E+00	4.960E+05	3.720E+06	0.000E+00	6.070E+05
CO-58	0.000E+00	9.520E+05	0.000E+00	0.000E+00	0.000E+00	1.310E+07	0.000E+00	2.190E+06
CO-60	0.000E+00	3.340E+06	0.000E+00	0.000E+00	0.000E+00	4.350E+07	0.000E+00	7.520E+06
NI-63	1.420E+09	1.000E+08	0.000E+00	0.000E+00	0.000E+00	1.590E+07	0.000E+00	4.810E+07
NI-65	8.120E-02	1.040E-02	0.000E+00	0.000E+00	0.000E+00	5.630E-01	0.000E+00	4.730E-03
CU-64	0.000E+00	4.730E+03	0.000E+00	1.200E+04	0.000E+00	3.670E+05	0.000E+00	2.230E+03
ZN-65	2.530E+08	8.780E+08	0.000E+00	5.620E+08	0.000E+00	3.720E+08	0.000E+00	4.100E+08
ZN-69	4.620E-13	8.800E-13	0.000E+00	5.750E-13	0.000E+00	1.620E-12	0.000E+00	6.160E-14
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.150E-02
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.450E-24
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	5.670E+08	0.000E+00	0.000E+00	0.000E+00	8.400E+07	0.000E+00	2.670E+08
RB-88	0.000E+00	4.670E-46	0.000E+00	0.000E+00	0.000E+00	4.000E-53	0.000E+00	2.490E-46
RB-89	0.000E+00	9.190E-54	0.000E+00	0.000E+00	0.000E+00	1.410E-62	0.000E+00	6.500E-54
SR-89	5.620E+09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.690E+08	0.000E+00	1.610E+08
SR-90	1.390E+11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.900E+09	0.000E+00	3.430E+10
SR-91	1.120E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.060E+05	0.000E+00	4.440E+03

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Grs/Goat/Milk (GMILK)			Units:	$m^2 \cdot mrem/yr$ / $\mu Ci/sec$; mrem/yr / $\mu Ci/m^3$ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	1.880E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.780E+01	0.000E+00	8.000E-02
Y-90	1.560E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.290E+05	0.000E+00	4.210E-01
Y-91	1.900E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.770E+05	0.000E+00	5.080E+01
Y-91M	1.310E-20	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.200E-19	0.000E+00	5.020E-22
Y-92	1.240E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.390E-01	0.000E+00	3.580E-07
Y-93	4.940E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.510E+03	0.000E+00	1.360E-03
ZR-95	1.980E+02	6.250E+01	0.000E+00	9.180E+01	0.000E+00	1.440E+05	0.000E+00	4.300E+01
ZR-97	9.460E-02	1.870E-02	0.000E+00	2.840E-02	0.000E+00	5.070E+03	0.000E+00	8.620E-03
NB-95	1.690E+04	9.370E+03	0.000E+00	9.080E+03	0.000E+00	4.010E+07	0.000E+00	5.160E+03
MO-99	0.000E+00	5.370E+06	0.000E+00	1.230E+07	0.000E+00	9.610E+06	0.000E+00	1.020E+06
TC-99M	6.910E-01	1.930E+00	0.000E+00	2.870E+01	1.070E+00	1.270E+03	0.000E+00	2.500E+01
TC-101	5.690E-61	8.100E-61	0.000E+00	1.460E-59	4.930E-61	1.380E-67	0.000E+00	7.950E-60
RU-103	2.170E+02	0.000E+00	0.000E+00	7.660E+02	0.000E+00	1.810E+04	0.000E+00	9.290E+01
RU-105	1.880E-04	0.000E+00	0.000E+00	2.370E-03	0.000E+00	1.520E-01	0.000E+00	7.290E-05
RU-106	4.500E+03	0.000E+00	0.000E+00	8.680E+03	0.000E+00	2.160E+05	0.000E+00	5.670E+02
AG-110M	1.160E+07	1.090E+07	0.000E+00	2.080E+07	0.000E+00	3.070E+09	0.000E+00	6.650E+06
TE-125M	3.600E+06	1.300E+06	1.010E+06	0.000E+00	0.000E+00	1.060E+07	0.000E+00	4.820E+05
TE-127	1.450E+02	5.150E+01	1.000E+02	5.880E+02	0.000E+00	1.120E+04	0.000E+00	3.120E+01
TE-127M	1.010E+07	3.590E+06	2.410E+06	4.100E+07	0.000E+00	2.520E+07	0.000E+00	1.200E+06
TE-129	6.240E-11	2.330E-11	4.460E-11	2.620E-10	0.000E+00	3.410E-10	0.000E+00	1.520E-11
TE-129M	1.320E+07	4.900E+06	4.260E+06	5.530E+07	0.000E+00	4.960E+07	0.000E+00	2.090E+06
TE-131	7.900E-34	3.260E-34	6.090E-34	3.450E-33	0.000E+00	6.480E-35	0.000E+00	2.470E-34
TE-131M	7.880E+04	3.780E+04	5.690E+04	3.940E+05	0.000E+00	3.030E+06	0.000E+00	3.150E+04
TE-132	5.150E+05	3.260E+05	3.440E+05	3.130E+06	0.000E+00	1.030E+07	0.000E+00	3.070E+05
I-130	8.860E+05	2.560E+06	2.090E+08	3.950E+06	0.000E+00	1.970E+06	0.000E+00	1.020E+06

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Grs/Goat/Milk (GMILK)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	6.450E+08	9.030E+08	2.630E+11	1.550E+09	0.000E+00	1.790E+08	0.000E+00	4.850E+08
I-132	3.500E-01	9.150E-01	3.080E+01	1.440E+00	0.000E+00	3.980E-01	0.000E+00	3.280E-01
I-133	8.480E+06	1.440E+07	2.010E+09	2.520E+07	0.000E+00	1.090E+07	0.000E+00	4.390E+06
I-134	4.300E-12	1.140E-11	1.900E-10	1.800E-11	0.000E+00	1.500E-13	0.000E+00	4.090E-12
I-135	2.740E+04	7.040E+04	4.530E+06	1.110E+05	0.000E+00	7.810E+04	0.000E+00	2.610E+04
CS-134	2.940E+10	6.930E+10	0.000E+00	2.200E+10	8.410E+09	8.620E+08	0.000E+00	3.220E+10
CS-136	1.340E+09	5.290E+09	0.000E+00	2.880E+09	4.540E+08	4.260E+08	0.000E+00	3.550E+09
CS-137	4.020E+10	5.340E+10	0.000E+00	1.820E+10	7.060E+09	7.600E+08	0.000E+00	1.860E+10
CS-138	4.920E-23	9.450E-23	0.000E+00	6.980E-23	8.120E-24	4.290E-26	0.000E+00	4.730E-23
BA-139	9.800E-09	6.900E-12	0.000E+00	6.500E-12	4.750E-12	8.750E-08	0.000E+00	2.860E-10
BA-140	5.820E+06	7.130E+03	0.000E+00	2.420E+03	4.800E+03	8.980E+06	0.000E+00	3.750E+05
BA-141	9.030E-47	6.740E-50	0.000E+00	6.260E-50	4.610E-50	1.920E-52	0.000E+00	3.010E-48
BA-142	5.750E-81	5.750E-84	0.000E+00	4.860E-84	3.820E-84	1.760E-92	0.000E+00	3.540E-82
LA-140	9.720E-01	4.780E-01	0.000E+00	0.000E+00	0.000E+00	2.740E+04	0.000E+00	1.270E-01
LA-142	4.030E-12	1.790E-12	0.000E+00	0.000E+00	0.000E+00	5.440E-08	0.000E+00	4.450E-13
CE-141	1.070E+03	7.120E+02	0.000E+00	3.350E+02	0.000E+00	2.040E+06	0.000E+00	8.170E+01
CE-143	9.170E+00	6.670E+03	0.000E+00	2.990E+00	0.000E+00	2.000E+05	0.000E+00	7.450E-01
CE-144	7.900E+04	3.270E+04	0.000E+00	1.950E+04	0.000E+00	1.990E+07	0.000E+00	4.240E+03
PR-143	3.480E+01	1.390E+01	0.000E+00	8.080E+00	0.000E+00	1.150E+05	0.000E+00	1.730E+00
PR-144	1.300E-54	5.320E-55	0.000E+00	3.050E-55	0.000E+00	1.430E-57	0.000E+00	6.590E-56
ND-147	2.170E+01	2.360E+01	0.000E+00	1.390E+01	0.000E+00	8.530E+04	0.000E+00	1.420E+00
W-187	1.430E+03	1.170E+03	0.000E+00	0.000E+00	0.000E+00	3.150E+05	0.000E+00	4.080E+02
NP-239	8.410E-01	7.930E-02	0.000E+00	2.490E-01	0.000E+00	1.280E+04	0.000E+00	4.410E-02

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Age group:	TEEN	Pathway:	Grs/Cow/Meat (CMEAT)			Units:	$m^2 \cdot$mrem/yr / µCi/sec; mrem/yr / µCi/m^3 (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	1.940E+02	1.940E+02	1.940E+02	1.940E+02	1.940E+02	0.000E+00	1.940E+02
C-14	1.740E+04	3.490E+03	3.490E+03	3.490E+03	3.490E+03	3.490E+03	0.000E+00	3.490E+03
NA-24	1.080E-03	1.080E-03	1.080E-03	1.080E-03	1.080E-03	1.080E-03	0.000E+00	1.080E-03
P-32	3.930E+09	2.440E+08	0.000E+00	0.000E+00	0.000E+00	3.310E+08	0.000E+00	1.530E+08
CR-51	0.000E+00	0.000E+00	3.130E+03	1.240E+03	8.050E+03	9.470E+05	0.000E+00	5.640E+03
MN-54	0.000E+00	7.000E+06	0.000E+00	2.090E+06	0.000E+00	1.440E+07	0.000E+00	1.390E+06
MN-56	0.000E+00	1.070E-53	0.000E+00	1.360E-53	0.000E+00	7.070E-52	0.000E+00	1.910E-54
FE-55	2.380E+08	1.690E+08	0.000E+00	0.000E+00	1.070E+08	7.310E+07	0.000E+00	3.940E+07
FE-59	2.120E+08	4.950E+08	0.000E+00	0.000E+00	1.560E+08	1.170E+09	0.000E+00	1.910E+08
CO-58	0.000E+00	1.410E+07	0.000E+00	0.000E+00	0.000E+00	1.940E+08	0.000E+00	3.240E+07
CO-60	0.000E+00	5.830E+07	0.000E+00	0.000E+00	0.000E+00	7.600E+08	0.000E+00	1.310E+08
NI-63	1.520E+10	1.070E+09	0.000E+00	0.000E+00	0.000E+00	1.710E+08	0.000E+00	5.150E+08
NI-65	1.880E-52	2.410E-53	0.000E+00	0.000E+00	0.000E+00	1.300E-51	0.000E+00	1.100E-53
CU-64	0.000E+00	2.210E-07	0.000E+00	5.600E-07	0.000E+00	1.720E-05	0.000E+00	1.040E-07
ZN-65	2.500E+08	8.690E+08	0.000E+00	5.560E+08	0.000E+00	3.680E+08	0.000E+00	4.050E+08
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.070E-57
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	4.070E+08	0.000E+00	0.000E+00	0.000E+00	6.020E+07	0.000E+00	1.910E+08
RB-88	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-89	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-89	2.550E+08	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.030E+07	0.000E+00	7.290E+06
SR-90	8.050E+09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.260E+08	0.000E+00	1.990E+09
SR-91	1.280E-10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.800E-10	0.000E+00	5.090E-12

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Age group:	TEEN	Pathway:	Grs/Cow/Meat (CMEAT)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	9.880E-50	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.520E-48	0.000E+00	4.210E-51
Y-90	9.060E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.470E+05	0.000E+00	2.440E+00
Y-91	9.540E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.910E+08	0.000E+00	2.560E+04
Y-91M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y-92	1.280E-39	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.520E-35	0.000E+00	3.710E-41
Y-93	3.960E-12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.210E-07	0.000E+00	1.090E-13
ZR-95	1.500E+06	4.730E+05	0.000E+00	6.950E+05	0.000E+00	1.090E+09	0.000E+00	3.250E+05
ZR-97	1.720E-05	3.410E-06	0.000E+00	5.170E-06	0.000E+00	9.230E-01	0.000E+00	1.570E-06
NB-95	1.790E+06	9.950E+05	0.000E+00	9.650E+05	0.000E+00	4.260E+09	0.000E+00	5.480E+05
MO-99	0.000E+00	8.270E+04	0.000E+00	1.890E+05	0.000E+00	1.480E+05	0.000E+00	1.580E+04
TC-99M	3.530E-21	9.850E-21	0.000E+00	1.470E-19	5.470E-21	6.470E-18	0.000E+00	1.280E-19
TC-101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-103	8.570E+07	0.000E+00	0.000E+00	3.020E+08	0.000E+00	7.160E+09	0.000E+00	3.660E+07
RU-105	4.830E-28	0.000E+00	0.000E+00	6.090E-27	0.000E+00	3.900E-25	0.000E+00	1.880E-28
RU-106	2.360E+09	0.000E+00	0.000E+00	4.550E+09	0.000E+00	1.130E+11	0.000E+00	2.970E+08
AG-110M	5.060E+06	4.790E+06	0.000E+00	9.130E+06	0.000E+00	1.340E+09	0.000E+00	2.910E+06
TE-125M	3.030E+08	1.090E+08	8.470E+07	0.000E+00	0.000E+00	8.940E+08	0.000E+00	4.050E+07
TE-127	1.800E-10	6.380E-11	1.240E-10	7.290E-10	0.000E+00	1.390E-08	0.000E+00	3.870E-11
TE-127M	9.410E+08	3.340E+08	2.240E+08	3.820E+09	0.000E+00	2.350E+09	0.000E+00	1.120E+08
TE-129	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-129M	9.500E+08	3.530E+08	3.070E+08	3.970E+09	0.000E+00	3.570E+09	0.000E+00	1.500E+08
TE-131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-131M	3.760E+02	1.800E+02	2.710E+02	1.880E+03	0.000E+00	1.450E+04	0.000E+00	1.500E+02
TE-132	1.160E+06	7.360E+05	7.750E+05	7.060E+06	0.000E+00	2.330E+07	0.000E+00	6.920E+05
I-130	1.700E-06	4.910E-06	4.000E-04	7.560E-06	0.000E+00	3.770E-06	0.000E+00	1.960E-06

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Age group:	TEEN	Pathway:	Grs/Cow/Meat (CMEAT)			Units:	$m^2 \cdot$ mrem/yr / µCi/sec; mrem/yr / µCi/m^3 (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	8.920E+06	1.250E+07	3.650E+09	2.150E+07	0.000E+00	2.470E+06	0.000E+00	6.710E+06
I-132	5.660E-59	1.480E-58	4.990E-57	2.330E-58	0.000E+00	6.450E-59	0.000E+00	5.320E-59
I-133	3.050E-01	5.180E-01	7.230E+01	9.090E-01	0.000E+00	3.920E-01	0.000E+00	1.580E-01
I-134	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-135	3.600E-17	9.260E-17	5.960E-15	1.460E-16	0.000E+00	1.030E-16	0.000E+00	3.430E-17
CS-134	5.230E+08	1.230E+09	0.000E+00	3.910E+08	1.490E+08	1.530E+07	0.000E+00	5.710E+08
CS-136	9.400E+06	3.700E+07	0.000E+00	2.010E+07	3.170E+06	2.980E+06	0.000E+00	2.480E+07
CS-137	7.240E+08	9.630E+08	0.000E+00	3.280E+08	1.270E+08	1.370E+07	0.000E+00	3.360E+08
CS-138	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-139	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-140	2.380E+07	2.910E+04	0.000E+00	9.870E+03	1.960E+04	3.660E+07	0.000E+00	1.530E+06
BA-141	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA-140	3.050E-02	1.500E-02	0.000E+00	0.000E+00	0.000E+00	8.610E+02	0.000E+00	3.990E-03
LA-142	2.870E-92	1.280E-92	0.000E+00	0.000E+00	0.000E+00	3.880E-88	0.000E+00	3.180E-93
CE-141	1.180E+04	7.870E+03	0.000E+00	3.710E+03	0.000E+00	2.250E+07	0.000E+00	9.040E+02
CE-143	1.690E-02	1.230E+01	0.000E+00	5.510E-03	0.000E+00	3.690E+02	0.000E+00	1.370E-03
CE-144	1.230E+06	5.080E+05	0.000E+00	3.040E+05	0.000E+00	3.090E+08	0.000E+00	6.600E+04
PR-143	1.760E+04	7.040E+03	0.000E+00	4.090E+03	0.000E+00	5.800E+07	0.000E+00	8.780E+02
PR-144	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND-147	6.230E+03	6.770E+03	0.000E+00	3.980E+03	0.000E+00	2.440E+07	0.000E+00	4.060E+02
W-187	1.730E-02	1.410E-02	0.000E+00	0.000E+00	0.000E+00	3.820E+00	0.000E+00	4.940E-03
NP-239	2.260E-01	2.140E-02	0.000E+00	6.700E-02	0.000E+00	3.440E+03	0.000E+00	1.190E-02

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Age group:	TEEN	Pathway:	Grs/Goat/Meat (GMEAT)			Units:	m^2·mrem/yr / µCi/sec; mrem/yr / µCi/m^3 (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	2.328E+01	2.328E+01	2.328E+01	2.328E+01	2.328E+01	0.000E+00	2.328E+01
C-14	2.088E+03	4.188E+02	4.188E+02	4.188E+02	4.188E+02	4.188E+02	0.000E+00	4.188E+02
NA-24	1.296E-04	1.296E-04	1.296E-04	1.296E-04	1.296E-04	1.296E-04	0.000E+00	1.296E-04
P-32	4.716E+08	2.928E+07	0.000E+00	0.000E+00	0.000E+00	3.972E+07	0.000E+00	1.836E+07
CR-51	0.000E+00	0.000E+00	3.756E+02	1.488E+02	9.660E+02	1.136E+05	0.000E+00	6.768E+02
MN-54	0.000E+00	8.400E+05	0.000E+00	2.508E+05	0.000E+00	1.728E+06	0.000E+00	1.668E+05
MN-56	0.000E+00	1.284E-54	0.000E+00	1.632E-54	0.000E+00	8.484E-53	0.000E+00	2.292E-55
FE-55	2.856E+07	2.028E+07	0.000E+00	0.000E+00	1.284E+07	8.772E+06	0.000E+00	4.728E+06
FE-59	2.544E+07	5.940E+07	0.000E+00	0.000E+00	1.872E+07	1.404E+08	0.000E+00	2.292E+07
CO-58	0.000E+00	1.692E+06	0.000E+00	0.000E+00	0.000E+00	2.328E+07	0.000E+00	3.888E+06
CO-60	0.000E+00	6.996E+06	0.000E+00	0.000E+00	0.000E+00	9.120E+07	0.000E+00	1.572E+07
NI-63	1.824E+09	1.284E+08	0.000E+00	0.000E+00	0.000E+00	2.052E+07	0.000E+00	6.180E+07
NI-65	2.256E-53	2.892E-54	0.000E+00	0.000E+00	0.000E+00	1.560E-52	0.000E+00	1.320E-54
CU-64	0.000E+00	2.652E-08	0.000E+00	6.720E-08	0.000E+00	2.064E-06	0.000E+00	1.248E-08
ZN-65	3.000E+07	1.043E+08	0.000E+00	6.672E+07	0.000E+00	4.416E+07	0.000E+00	4.860E+07
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.084E-58
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	4.884E+07	0.000E+00	0.000E+00	0.000E+00	7.224E+06	0.000E+00	2.292E+07
RB-88	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-89	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-89	3.060E+07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.636E+06	0.000E+00	8.748E+05
SR-90	9.660E+08	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.712E+07	0.000E+00	2.388E+08
SR-91	1.536E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.960E-11	0.000E+00	6.108E-13

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Age group:	TEEN	Pathway:	Grs/Goat/Meat (GMEAT)			Units:	m^2·mrem/yr / µCi/sec; mrem/yr / µCi/m^3 (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	1.186E-50	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.024E-49	0.000E+00	5.052E-52
Y-90	1.087E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.964E+04	0.000E+00	2.928E-01
Y-91	1.145E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.692E+07	0.000E+00	3.072E+03
Y-91M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y-92	1.536E-40	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.224E-36	0.000E+00	4.452E-42
Y-93	4.752E-13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.452E-08	0.000E+00	1.308E-14
ZR-95	1.800E+05	5.676E+04	0.000E+00	8.340E+04	0.000E+00	1.308E+08	0.000E+00	3.900E+04
ZR-97	2.064E-06	4.092E-07	0.000E+00	6.204E-07	0.000E+00	1.108E-01	0.000E+00	1.884E-07
NB-95	2.148E+05	1.194E+05	0.000E+00	1.158E+05	0.000E+00	5.112E+08	0.000E+00	6.576E+04
MO-99	0.000E+00	9.924E+03	0.000E+00	2.268E+04	0.000E+00	1.776E+04	0.000E+00	1.896E+03
TC-99M	4.236E-22	1.182E-21	0.000E+00	1.764E-20	6.564E-22	7.764E-19	0.000E+00	1.536E-20
TC-101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-103	1.028E+07	0.000E+00	0.000E+00	3.624E+07	0.000E+00	8.592E+08	0.000E+00	4.392E+06
RU-105	5.796E-29	0.000E+00	0.000E+00	7.308E-28	0.000E+00	4.680E-26	0.000E+00	2.256E-29
RU-106	2.832E+08	0.000E+00	0.000E+00	5.460E+08	0.000E+00	1.356E+10	0.000E+00	3.564E+07
AG-110M	6.072E+05	5.748E+05	0.000E+00	1.096E+06	0.000E+00	1.608E+08	0.000E+00	3.492E+05
TE-125M	3.636E+07	1.308E+07	1.016E+07	0.000E+00	0.000E+00	1.073E+08	0.000E+00	4.860E+06
TE-127	2.160E-11	7.656E-12	1.488E-11	8.748E-11	0.000E+00	1.668E-09	0.000E+00	4.644E-12
TE-127M	1.129E+08	4.008E+07	2.688E+07	4.584E+08	0.000E+00	2.820E+08	0.000E+00	1.344E+07
TE-129	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-129M	1.140E+08	4.236E+07	3.684E+07	4.764E+08	0.000E+00	4.284E+08	0.000E+00	1.800E+07
TE-131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-131M	4.512E+01	2.160E+01	3.252E+01	2.256E+02	0.000E+00	1.740E+03	0.000E+00	1.800E+01
TE-132	1.392E+05	8.832E+04	9.300E+04	8.472E+05	0.000E+00	2.796E+06	0.000E+00	8.304E+04
I-130	2.040E-07	5.892E-07	4.800E-05	9.072E-07	0.000E+00	4.524E-07	0.000E+00	2.352E-07

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Age group:	TEEN	Pathway:	Grs/Goat/Meat (GMEAT)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	1.070E+06	1.500E+06	4.380E+08	2.580E+06	0.000E+00	2.964E+05	0.000E+00	8.052E+05
I-132	6.792E-60	1.776E-59	5.988E-58	2.796E-59	0.000E+00	7.740E-60	0.000E+00	6.384E-60
I-133	3.660E-02	6.216E-02	8.676E+00	1.091E-01	0.000E+00	4.704E-02	0.000E+00	1.896E-02
I-134	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-135	4.320E-18	1.111E-17	7.152E-16	1.752E-17	0.000E+00	1.236E-17	0.000E+00	4.116E-18
CS-134	6.276E+07	1.476E+08	0.000E+00	4.692E+07	1.788E+07	1.836E+06	0.000E+00	6.852E+07
CS-136	1.128E+06	4.440E+06	0.000E+00	2.412E+06	3.804E+05	3.576E+05	0.000E+00	2.976E+06
CS-137	8.688E+07	1.156E+08	0.000E+00	3.936E+07	1.524E+07	1.644E+06	0.000E+00	4.032E+07
CS-138	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-139	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-140	2.856E+06	3.492E+03	0.000E+00	1.184E+03	2.352E+03	4.392E+06	0.000E+00	1.836E+05
BA-141	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA-140	3.660E-03	1.800E-03	0.000E+00	0.000E+00	0.000E+00	1.033E+02	0.000E+00	4.788E-04
LA-142	3.444E-93	1.536E-93	0.000E+00	0.000E+00	0.000E+00	4.656E-89	0.000E+00	3.816E-94
CE-141	1.416E+03	9.444E+02	0.000E+00	4.452E+02	0.000E+00	2.700E+06	0.000E+00	1.085E+02
CE-143	2.028E-03	1.476E+00	0.000E+00	6.612E-04	0.000E+00	4.428E+01	0.000E+00	1.644E-04
CE-144	1.476E+05	6.096E+04	0.000E+00	3.648E+04	0.000E+00	3.708E+07	0.000E+00	7.920E+03
PR-143	2.112E+03	8.448E+02	0.000E+00	4.908E+02	0.000E+00	6.960E+06	0.000E+00	1.054E+02
PR-144	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND-147	7.476E+02	8.124E+02	0.000E+00	4.776E+02	0.000E+00	2.928E+06	0.000E+00	4.872E+01
W-187	2.076E-03	1.692E-03	0.000E+00	0.000E+00	0.000E+00	4.584E-01	0.000E+00	5.928E-04
NP-239	2.712E-02	2.568E-03	0.000E+00	8.040E-03	0.000E+00	4.128E+02	0.000E+00	1.428E-03

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Vegetation (VEG)			Units:	m^2·mrem/yr / µCi/sec; mrem/yr / µCi/m^3 (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	2.590E+03	2.590E+03	2.590E+03	2.590E+03	2.590E+03	0.000E+00	2.590E+03
C-14	9.010E+04	1.800E+04	1.800E+04	1.800E+04	1.800E+04	1.800E+04	0.000E+00	1.800E+04
NA-24	2.390E+05	2.390E+05	2.390E+05	2.390E+05	2.390E+05	2.390E+05	0.000E+00	2.390E+05
P-32	1.610E+09	9.970E+07	0.000E+00	0.000E+00	0.000E+00	1.350E+08	0.000E+00	6.240E+07
CR-51	0.000E+00	0.000E+00	3.430E+04	1.350E+04	8.810E+04	1.040E+07	0.000E+00	6.170E+04
MN-54	0.000E+00	4.540E+08	0.000E+00	1.360E+08	0.000E+00	9.320E+08	0.000E+00	9.010E+07
MN-56	0.000E+00	1.420E+01	0.000E+00	1.800E+01	0.000E+00	9.360E+02	0.000E+00	2.530E+00
FE-55	3.260E+08	2.310E+08	0.000E+00	0.000E+00	1.470E+08	1.000E+08	0.000E+00	5.390E+07
FE-59	1.790E+08	4.190E+08	0.000E+00	0.000E+00	1.320E+08	9.900E+08	0.000E+00	1.620E+08
CO-58	0.000E+00	4.360E+07	0.000E+00	0.000E+00	0.000E+00	6.010E+08	0.000E+00	1.000E+08
CO-60	0.000E+00	2.490E+08	0.000E+00	0.000E+00	0.000E+00	3.240E+09	0.000E+00	5.600E+08
NI-63	1.610E+10	1.130E+09	0.000E+00	0.000E+00	0.000E+00	1.810E+08	0.000E+00	5.450E+08
NI-65	5.720E+01	7.310E+00	0.000E+00	0.000E+00	0.000E+00	3.970E+02	0.000E+00	3.330E+00
CU-64	0.000E+00	8.340E+03	0.000E+00	2.110E+04	0.000E+00	6.470E+05	0.000E+00	3.920E+03
ZN-65	4.240E+08	1.470E+09	0.000E+00	9.420E+08	0.000E+00	6.230E+08	0.000E+00	6.870E+08
ZN-69	5.140E-06	9.800E-06	0.000E+00	6.400E-06	0.000E+00	1.810E-05	0.000E+00	6.860E-07
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.910E+00
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.250E-11
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	2.740E+08	0.000E+00	0.000E+00	0.000E+00	4.050E+07	0.000E+00	1.290E+08
RB-88	0.000E+00	3.170E-22	0.000E+00	0.000E+00	0.000E+00	2.720E-29	0.000E+00	1.690E-22
RB-89	0.000E+00	3.500E-26	0.000E+00	0.000E+00	0.000E+00	5.360E-35	0.000E+00	2.470E-26
SR-89	1.510E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.800E+09	0.000E+00	4.340E+08
SR-90	7.510E+11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.110E+10	0.000E+00	1.850E+11
SR-91	2.850E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.290E+06	0.000E+00	1.130E+04

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Vegetation (VEG)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	3.970E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.010E+04	0.000E+00	1.690E+01
Y-90	1.240E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.020E+08	0.000E+00	3.350E+02
Y-91	7.840E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.210E+09	0.000E+00	2.100E+05
Y-91M	4.860E-09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.290E-07	0.000E+00	1.860E-10
Y-92	8.600E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.360E+04	0.000E+00	2.490E-02
Y-93	1.590E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.860E+06	0.000E+00	4.360E+00
ZR-95	1.720E+06	5.430E+05	0.000E+00	7.980E+05	0.000E+00	1.250E+09	0.000E+00	3.730E+05
ZR-97	3.120E+02	6.180E+01	0.000E+00	9.370E+01	0.000E+00	1.670E+07	0.000E+00	2.850E+01
NB-95	1.920E+05	1.070E+05	0.000E+00	1.030E+05	0.000E+00	4.560E+08	0.000E+00	5.870E+04
MO-99	0.000E+00	5.650E+06	0.000E+00	1.290E+07	0.000E+00	1.010E+07	0.000E+00	1.080E+06
TC-99M	2.740E+00	7.630E+00	0.000E+00	1.140E+02	4.240E+00	5.010E+03	0.000E+00	9.890E+01
TC-101	7.640E-31	1.090E-30	0.000E+00	1.970E-29	6.620E-31	1.860E-37	0.000E+00	1.070E-29
RU-103	6.820E+06	0.000E+00	0.000E+00	2.400E+07	0.000E+00	5.700E+08	0.000E+00	2.920E+06
RU-105	5.000E+01	0.000E+00	0.000E+00	6.310E+02	0.000E+00	4.040E+04	0.000E+00	1.940E+01
RU-106	3.100E+08	0.000E+00	0.000E+00	5.970E+08	0.000E+00	1.480E+10	0.000E+00	3.900E+07
AG-110M	1.520E+07	1.430E+07	0.000E+00	2.740E+07	0.000E+00	4.030E+09	0.000E+00	8.720E+06
TE-125M	1.480E+08	5.340E+07	4.140E+07	0.000E+00	0.000E+00	4.370E+08	0.000E+00	1.980E+07
TE-127	5.330E+03	1.890E+03	3.680E+03	2.160E+04	0.000E+00	4.120E+05	0.000E+00	1.150E+03
TE-127M	5.510E+08	1.960E+08	1.310E+08	2.240E+09	0.000E+00	1.370E+09	0.000E+00	6.560E+07
TE-129	7.140E-04	2.660E-04	5.100E-04	3.000E-03	0.000E+00	3.910E-03	0.000E+00	1.740E-04
TE-129M	3.620E+08	1.340E+08	1.170E+08	1.510E+09	0.000E+00	1.360E+09	0.000E+00	5.730E+07
TE-131	1.390E-15	5.750E-16	1.070E-15	6.100E-15	0.000E+00	1.140E-16	0.000E+00	4.360E-16
TE-131M	8.440E+05	4.050E+05	6.090E+05	4.220E+06	0.000E+00	3.250E+07	0.000E+00	3.380E+05
TE-132	3.910E+06	2.470E+06	2.610E+06	2.370E+07	0.000E+00	7.840E+07	0.000E+00	2.330E+06
I-130	3.510E+05	1.010E+06	8.280E+07	1.560E+06	0.000E+00	7.800E+05	0.000E+00	4.050E+05

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Vegetation (VEG)			Units:	m^2·mrem/yr / µCi/sec; mrem/yr / µCi/m^3 (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	7.690E+07	1.080E+08	3.140E+10	1.850E+08	0.000E+00	2.130E+07	0.000E+00	5.780E+07
I-132	5.190E+01	1.360E+02	4.580E+03	2.140E+02	0.000E+00	5.920E+01	0.000E+00	4.880E+01
I-133	1.940E+06	3.290E+06	4.590E+08	5.760E+06	0.000E+00	2.490E+06	0.000E+00	1.000E+06
I-134	8.720E-05	2.310E-04	3.850E-03	3.640E-04	0.000E+00	3.050E-06	0.000E+00	8.310E-05
I-135	3.520E+04	9.070E+04	5.830E+06	1.430E+05	0.000E+00	1.000E+05	0.000E+00	3.360E+04
CS-134	7.100E+09	1.670E+10	0.000E+00	5.310E+09	2.030E+09	2.080E+08	0.000E+00	7.750E+09
CS-136	4.370E+07	1.720E+08	0.000E+00	9.370E+07	1.480E+07	1.380E+07	0.000E+00	1.160E+08
CS-137	1.010E+10	1.350E+10	0.000E+00	4.590E+09	1.780E+09	1.920E+08	0.000E+00	4.690E+09
CS-138	3.610E-11	6.940E-11	0.000E+00	5.120E-11	5.960E-12	3.150E-14	0.000E+00	3.470E-11
BA-139	2.690E-02	1.890E-05	0.000E+00	1.780E-05	1.300E-05	2.400E-01	0.000E+00	7.830E-04
BA-140	1.380E+08	1.690E+05	0.000E+00	5.740E+04	1.140E+05	2.130E+08	0.000E+00	8.900E+06
BA-141	1.080E-21	8.040E-25	0.000E+00	7.460E-25	5.500E-25	2.290E-27	0.000E+00	3.590E-23
BA-142	5.490E-39	5.490E-42	0.000E+00	4.640E-42	3.650E-42	1.680E-50	0.000E+00	3.380E-40
LA-140	1.810E+03	8.880E+02	0.000E+00	0.000E+00	0.000E+00	5.100E+07	0.000E+00	2.360E+02
LA-142	1.850E-04	8.240E-05	0.000E+00	0.000E+00	0.000E+00	2.510E+00	0.000E+00	2.050E-05
CE-141	2.830E+05	1.890E+05	0.000E+00	8.890E+04	0.000E+00	5.400E+08	0.000E+00	2.170E+04
CE-143	9.330E+02	6.790E+05	0.000E+00	3.040E+02	0.000E+00	2.040E+07	0.000E+00	7.580E+01
CE-144	5.270E+07	2.180E+07	0.000E+00	1.300E+07	0.000E+00	1.330E+10	0.000E+00	2.830E+06
PR-143	7.000E+04	2.800E+04	0.000E+00	1.630E+04	0.000E+00	2.300E+08	0.000E+00	3.490E+03
PR-144	2.900E-26	1.190E-26	0.000E+00	6.800E-27	0.000E+00	3.190E-29	0.000E+00	1.470E-27
ND-147	3.620E+04	3.940E+04	0.000E+00	2.310E+04	0.000E+00	1.420E+08	0.000E+00	2.360E+03
W-187	3.540E+04	2.880E+04	0.000E+00	0.000E+00	0.000E+00	7.800E+06	0.000E+00	1.010E+04
NP-239	1.390E+03	1.310E+02	0.000E+00	4.100E+02	0.000E+00	2.100E+07	0.000E+00	7.260E+01

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Inhalation (INHL)			Units:	mrem/yr / µCi/m³	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
H-3	0.000E+00	1.270E+03	1.270E+03	1.270E+03	1.270E+03	1.270E+03	0.000E+00	1.270E+03
C-14	2.600E+04	4.870E+03	4.870E+03	4.870E+03	4.870E+03	4.870E+03	0.000E+00	4.870E+03
NA-24	1.380E+04	1.380E+04	1.380E+04	1.380E+04	1.380E+04	1.380E+04	0.000E+00	1.380E+04
P-32	1.890E+06	1.100E+05	0.000E+00	0.000E+00	0.000E+00	9.280E+04	0.000E+00	7.160E+04
CR-51	0.000E+00	0.000E+00	7.500E+01	3.070E+01	2.100E+04	3.000E+03	0.000E+00	1.350E+02
MN-54	0.000E+00	5.110E+04	0.000E+00	1.270E+04	1.980E+06	6.680E+04	0.000E+00	8.400E+03
MN-56	0.000E+00	1.700E+00	0.000E+00	1.790E+00	1.520E+04	5.740E+04	0.000E+00	2.520E-01
FE-55	3.340E+04	2.380E+04	0.000E+00	0.000E+00	1.240E+05	6.390E+03	0.000E+00	5.540E+03
FE-59	1.590E+04	3.700E+04	0.000E+00	0.000E+00	1.530E+06	1.780E+05	0.000E+00	1.430E+04
CO-58	0.000E+00	2.070E+03	0.000E+00	0.000E+00	1.340E+06	9.520E+04	0.000E+00	2.780E+03
CO-60	0.000E+00	1.510E+04	0.000E+00	0.000E+00	8.720E+06	2.590E+05	0.000E+00	1.980E+04
NI-63	5.800E+05	4.340E+04	0.000E+00	0.000E+00	3.070E+05	1.420E+04	0.000E+00	1.980E+04
NI-65	2.180E+00	2.930E-01	0.000E+00	0.000E+00	9.360E+03	3.670E+04	0.000E+00	1.270E-01
CU-64	0.000E+00	2.030E+00	0.000E+00	6.410E+00	1.110E+04	6.140E+04	0.000E+00	8.480E-01
ZN-65	3.860E+04	1.340E+05	0.000E+00	8.640E+04	1.240E+06	4.660E+04	0.000E+00	6.240E+04
ZN-69	4.830E-02	9.200E-02	0.000E+00	6.020E-02	1.580E+03	2.850E+02	0.000E+00	6.460E-03
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.440E+02
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.330E+02
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.830E+01
RB-86	0.000E+00	1.900E+05	0.000E+00	0.000E+00	0.000E+00	1.770E+04	0.000E+00	8.400E+04
RB-88	0.000E+00	5.460E+02	0.000E+00	0.000E+00	0.000E+00	2.920E-05	0.000E+00	2.720E+02
RB-89	0.000E+00	3.520E+02	0.000E+00	0.000E+00	0.000E+00	3.380E-07	0.000E+00	2.330E+02
SR-89	4.340E+05	0.000E+00	0.000E+00	0.000E+00	2.420E+06	3.710E+05	0.000E+00	1.250E+04
SR-90	1.080E+08	0.000E+00	0.000E+00	0.000E+00	1.650E+07	7.650E+05	0.000E+00	6.680E+06
SR-91	8.800E+01	0.000E+00	0.000E+00	0.000E+00	6.070E+04	2.590E+05	0.000E+00	3.510E+00

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Inhalation (INHL)			Units:	mrem/yr / µCi/m³	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-92	9.520E+00	0.000E+00	0.000E+00	0.000E+00	2.740E+04	1.190E+05	0.000E+00	4.060E-01
Y-90	2.980E+03	0.000E+00	0.000E+00	0.000E+00	2.930E+05	5.590E+05	0.000E+00	8.000E+01
Y-91	6.610E+05	0.000E+00	0.000E+00	0.000E+00	2.940E+06	4.090E+05	0.000E+00	1.770E+04
Y-91M	3.700E-01	0.000E+00	0.000E+00	0.000E+00	3.200E+03	3.020E+01	0.000E+00	1.420E-02
Y-92	1.470E+01	0.000E+00	0.000E+00	0.000E+00	2.680E+04	1.650E+05	0.000E+00	4.290E-01
Y-93	1.350E+02	0.000E+00	0.000E+00	0.000E+00	8.320E+04	5.790E+05	0.000E+00	3.720E+00
ZR-95	1.460E+05	4.580E+04	0.000E+00	6.740E+04	2.690E+06	1.490E+05	0.000E+00	3.150E+04
ZR-97	1.380E+02	2.720E+01	0.000E+00	4.120E+01	1.300E+05	6.300E+05	0.000E+00	1.260E+01
NB-95	1.860E+04	1.030E+04	0.000E+00	1.000E+04	7.510E+05	9.680E+04	0.000E+00	5.660E+03
MO-99	0.000E+00	1.690E+02	0.000E+00	4.110E+02	1.540E+05	2.690E+05	0.000E+00	3.220E+01
TC-99M	1.380E-03	3.860E-03	0.000E+00	5.760E-02	1.150E+03	6.130E+03	0.000E+00	4.990E-02
TC-101	5.920E-05	8.400E-05	0.000E+00	1.520E-03	6.670E+02	8.720E-07	0.000E+00	8.240E-04
RU-103	2.100E+03	0.000E+00	0.000E+00	7.430E+03	7.830E+05	1.090E+05	0.000E+00	8.960E+02
RU-105	1.120E+00	0.000E+00	0.000E+00	1.410E+00	1.820E+04	9.040E+04	0.000E+00	4.340E-01
RU-106	9.840E+04	0.000E+00	0.000E+00	1.900E+05	1.610E+07	9.600E+05	0.000E+00	1.240E+04
AG-110M	1.380E+04	1.310E+04	0.000E+00	2.500E+04	6.750E+06	2.730E+05	0.000E+00	7.990E+03
TE-125M	4.880E+03	2.240E+03	1.400E+03	0.000E+00	5.360E+05	7.500E+04	0.000E+00	6.670E+02
TE-127	2.010E+00	9.120E-01	1.420E+00	7.280E+00	1.120E+04	8.080E+04	0.000E+00	4.420E-01
TE-127M	1.800E+04	8.160E+03	4.380E+03	6.540E+04	1.660E+06	1.590E+05	0.000E+00	2.180E+03
TE-129	7.100E-02	3.380E-02	5.180E-02	2.660E-01	3.300E+03	1.620E+03	0.000E+00	1.760E-02
TE-129M	1.390E+04	6.580E+03	4.580E+03	5.190E+04	1.980E+06	4.050E+05	0.000E+00	2.250E+03
TE-131	1.580E-02	8.320E-03	1.240E-02	6.180E-02	2.340E+03	1.510E+01	0.000E+00	5.040E-03
TE-131M	9.840E+01	6.010E+01	7.250E+01	4.390E+02	2.380E+05	6.210E+05	0.000E+00	4.020E+01
TE-132	3.600E+02	2.900E+02	2.460E+02	1.950E+03	4.490E+05	4.630E+05	0.000E+00	2.190E+02
I-130	6.240E+03	1.790E+04	1.490E+06	2.750E+04	0.000E+00	9.120E+03	0.000E+00	7.170E+03

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Inhalation (INHL)			Units:	mrem/yr / $\mu Ci/m^3$	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
I-131	3.540E+04	4.910E+04	1.460E+07	8.400E+04	0.000E+00	6.490E+03	0.000E+00	2.640E+04
I-132	1.590E+03	4.380E+03	1.510E+05	6.920E+03	0.000E+00	1.270E+03	0.000E+00	1.580E+03
I-133	1.220E+04	2.050E+04	2.920E+06	3.590E+04	0.000E+00	1.030E+04	0.000E+00	6.220E+03
I-134	8.880E+02	2.320E+03	3.950E+04	3.660E+03	0.000E+00	2.040E+01	0.000E+00	8.400E+02
I-135	3.700E+03	9.440E+03	6.210E+05	1.490E+04	0.000E+00	6.950E+03	0.000E+00	3.490E+03
CS-134	5.020E+05	1.130E+06	0.000E+00	3.750E+05	1.460E+05	9.760E+03	0.000E+00	5.490E+05
CS-136	5.150E+04	1.940E+05	0.000E+00	1.100E+05	1.780E+04	1.090E+04	0.000E+00	1.370E+05
CS-137	6.700E+05	8.480E+05	0.000E+00	3.040E+05	1.210E+05	8.480E+03	0.000E+00	3.110E+05
CS-138	4.660E+02	8.560E+02	0.000E+00	6.620E+02	7.870E+01	2.700E-01	0.000E+00	4.460E+02
BA-139	1.340E+00	9.440E-04	0.000E+00	8.880E-04	6.460E+03	6.450E+03	0.000E+00	3.900E-02
BA-140	5.470E+04	6.700E+01	0.000E+00	2.280E+01	2.030E+06	2.290E+05	0.000E+00	3.520E+03
BA-141	1.420E-01	1.060E-04	0.000E+00	9.840E-05	3.290E+03	7.460E-04	0.000E+00	4.740E-03
BA-142	3.700E-02	3.700E-05	0.000E+00	3.140E-05	1.910E+03	4.790E-10	0.000E+00	2.270E-03
LA-140	4.790E+02	2.360E+02	0.000E+00	0.000E+00	2.140E+05	4.870E+05	0.000E+00	6.260E+01
LA-142	9.600E-01	4.250E-01	0.000E+00	0.000E+00	1.020E+04	1.200E+04	0.000E+00	1.060E-01
CE-141	2.840E+04	1.900E+04	0.000E+00	8.880E+03	6.140E+05	1.260E+05	0.000E+00	2.170E+03
CE-143	2.660E+02	1.940E+02	0.000E+00	8.640E+01	1.300E+05	2.550E+05	0.000E+00	2.160E+01
CE-144	4.890E+06	2.020E+06	0.000E+00	1.210E+06	1.340E+07	8.640E+05	0.000E+00	2.620E+05
PR-143	1.340E+04	5.310E+03	0.000E+00	3.090E+03	4.830E+05	2.140E+05	0.000E+00	6.620E+02
PR-144	4.300E-02	1.760E-02	0.000E+00	1.010E-02	1.750E+03	2.350E-04	0.000E+00	2.180E-03
ND-147	7.860E+03	8.560E+03	0.000E+00	5.020E+03	3.720E+05	1.820E+05	0.000E+00	5.130E+02
W-187	1.200E+01	9.760E+00	0.000E+00	0.000E+00	4.740E+04	1.770E+05	0.000E+00	3.430E+00
NP-239	3.380E+02	3.190E+01	0.000E+00	1.000E+02	6.490E+04	1.320E+05	0.000E+00	1.770E+01

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Ground Plane Deposition (GPD)			Units:	$m^2 \cdot mrem/yr$ / $\mu Ci/sec$	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C-14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NA-24	1.190E+07	1.190E+07	1.190E+07	1.190E+07	1.190E+07	1.190E+07	1.390E+07	1.190E+07
P-32	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CR-51	4.660E+06	4.660E+06	4.660E+06	4.660E+06	4.660E+06	4.660E+06	5.510E+06	4.660E+06
MN-54	1.390E+09	1.390E+09	1.390E+09	1.390E+09	1.390E+09	1.390E+09	1.630E+09	1.390E+09
MN-56	9.020E+05	9.020E+05	9.020E+05	9.020E+05	9.020E+05	9.020E+05	1.070E+06	9.020E+05
FE-55	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
FE-59	2.730E+08	2.730E+08	2.730E+08	2.730E+08	2.730E+08	2.730E+08	3.210E+08	2.730E+08
CO-58	3.790E+08	3.790E+08	3.790E+08	3.790E+08	3.790E+08	3.790E+08	4.440E+08	3.790E+08
CO-60	2.150E+10	2.150E+10	2.150E+10	2.150E+10	2.150E+10	2.150E+10	2.530E+10	2.150E+10
NI-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NI-65	2.970E+05	2.970E+05	2.970E+05	2.970E+05	2.970E+05	2.970E+05	3.450E+05	2.970E+05
CU-64	6.070E+05	6.070E+05	6.070E+05	6.070E+05	6.070E+05	6.070E+05	6.880E+05	6.070E+05
ZN-65	7.470E+08	7.470E+08	7.470E+08	7.470E+08	7.470E+08	7.470E+08	8.590E+08	7.470E+08
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	4.870E+03	4.870E+03	4.870E+03	4.870E+03	4.870E+03	4.870E+03	7.080E+03	4.870E+03
BR-84	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.360E+05	2.030E+05
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	8.990E+06	8.990E+06	8.990E+06	8.990E+06	8.990E+06	8.990E+06	1.030E+07	8.990E+06
RB-88	3.310E+04	3.310E+04	3.310E+04	3.310E+04	3.310E+04	3.310E+04	3.780E+04	3.310E+04
RB-89	1.230E+05	1.230E+05	1.230E+05	1.230E+05	1.230E+05	1.230E+05	1.480E+05	1.230E+05
SR-89	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.510E+04	2.160E+04
SR-90	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-91	2.150E+06	2.150E+06	2.150E+06	2.150E+06	2.150E+06	2.150E+06	2.510E+06	2.150E+06

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Ground Plane Deposition (GPD)			Units:	m²·mrem/yr / µCi/sec	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	7.770E+05	7.770E+05	7.770E+05	7.770E+05	7.770E+05	7.770E+05	8.630E+05	7.770E+05
Y-90	4.490E+03	4.490E+03	4.490E+03	4.490E+03	4.490E+03	4.490E+03	5.310E+03	4.490E+03
Y-91	1.070E+06	1.070E+06	1.070E+06	1.070E+06	1.070E+06	1.070E+06	1.210E+06	1.070E+06
Y-91M	1.000E+05	1.000E+05	1.000E+05	1.000E+05	1.000E+05	1.000E+05	1.160E+05	1.000E+05
Y-92	1.800E+05	1.800E+05	1.800E+05	1.800E+05	1.800E+05	1.800E+05	2.140E+05	1.800E+05
Y-93	1.830E+05	1.830E+05	1.830E+05	1.830E+05	1.830E+05	1.830E+05	2.510E+05	1.830E+05
ZR-95	2.450E+08	2.450E+08	2.450E+08	2.450E+08	2.450E+08	2.450E+08	2.840E+08	2.450E+08
ZR-97	2.960E+06	2.960E+06	2.960E+06	2.960E+06	2.960E+06	2.960E+06	3.440E+06	2.960E+06
NB-95	1.370E+08	1.370E+08	1.370E+08	1.370E+08	1.370E+08	1.370E+08	1.610E+08	1.370E+08
MO-99	3.990E+06	3.990E+06	3.990E+06	3.990E+06	3.990E+06	3.990E+06	4.630E+06	3.990E+06
TC-99M	1.840E+05	1.840E+05	1.840E+05	1.840E+05	1.840E+05	1.840E+05	2.110E+05	1.840E+05
TC-101	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.260E+04	2.040E+04
RU-103	1.080E+08	1.080E+08	1.080E+08	1.080E+08	1.080E+08	1.080E+08	1.260E+08	1.080E+08
RU-105	6.360E+05	6.360E+05	6.360E+05	6.360E+05	6.360E+05	6.360E+05	7.210E+05	6.360E+05
RU-106	4.220E+08	4.220E+08	4.220E+08	4.220E+08	4.220E+08	4.220E+08	5.070E+08	4.220E+08
AG-110M	3.440E+09	3.440E+09	3.440E+09	3.440E+09	3.440E+09	3.440E+09	4.010E+09	3.440E+09
TE-125M	1.550E+06	1.550E+06	1.550E+06	1.550E+06	1.550E+06	1.550E+06	2.130E+06	1.550E+06
TE-127	2.980E+03	2.980E+03	2.980E+03	2.980E+03	2.980E+03	2.980E+03	3.280E+03	2.980E+03
TE-127M	9.160E+04	9.160E+04	9.160E+04	9.160E+04	9.160E+04	9.160E+04	1.080E+05	9.160E+04
TE-129	2.620E+04	2.620E+04	2.620E+04	2.620E+04	2.620E+04	2.620E+04	3.100E+04	2.620E+04
TE-129M	1.980E+07	1.980E+07	1.980E+07	1.980E+07	1.980E+07	1.980E+07	2.310E+07	1.980E+07
TE-131	2.920E+04	2.920E+04	2.920E+04	2.920E+04	2.920E+04	2.920E+04	3.450E+07	2.920E+04
TE-131M	8.030E+06	8.030E+06	8.030E+06	8.030E+06	8.030E+06	8.030E+06	9.460E+06	8.030E+06
TE-132	4.230E+06	4.230E+06	4.230E+06	4.230E+06	4.230E+06	4.230E+06	4.980E+06	4.230E+06
I-130	5.510E+06	5.510E+06	5.510E+06	5.510E+06	5.510E+06	5.510E+06	6.690E+06	5.510E+06

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Ground Plane Deposition (GPD)			Units:	m²·mrem/yr / µCi/sec	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	1.720E+07	1.720E+07	1.720E+07	1.720E+07	1.720E+07	1.720E+07	2.090E+07	1.720E+07
I-132	1.250E+06	1.250E+06	1.250E+06	1.250E+06	1.250E+06	1.250E+06	1.470E+06	1.250E+06
I-133	2.450E+06	2.450E+06	2.450E+06	2.450E+06	2.450E+06	2.450E+06	2.980E+06	2.450E+06
I-134	4.470E+05	4.470E+05	4.470E+05	4.470E+05	4.470E+05	4.470E+05	5.300E+05	4.470E+05
I-135	2.530E+06	2.530E+06	2.530E+06	2.530E+06	2.530E+06	2.530E+06	2.950E+06	2.530E+06
CS-134	6.860E+09	6.860E+09	6.860E+09	6.860E+09	6.860E+09	6.860E+09	8.000E+09	6.860E+09
CS-136	1.510E+08	1.510E+08	1.510E+08	1.510E+08	1.510E+08	1.510E+08	1.710E+08	1.510E+08
CS-137	1.030E+10	1.030E+10	1.030E+10	1.030E+10	1.030E+10	1.030E+10	1.200E+10	1.030E+10
CS-138	3.590E+05	3.590E+05	3.590E+05	3.590E+05	3.590E+05	3.590E+05	4.100E+05	3.590E+05
BA-139	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.190E+05	1.060E+05
BA-140	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.350E+07	2.050E+07
BA-141	4.170E+04	4.170E+04	4.170E+04	4.170E+04	4.170E+04	4.170E+04	4.750E+04	4.170E+04
BA-142	4.490E+04	4.490E+04	4.490E+04	4.490E+04	4.490E+04	4.490E+04	5.110E+04	4.490E+04
LA-140	1.920E+07	1.920E+07	1.920E+07	1.920E+07	1.920E+07	1.920E+07	2.180E+07	1.920E+07
LA-142	7.600E+05	7.600E+05	7.600E+05	7.600E+05	7.600E+05	7.600E+05	9.120E+05	7.600E+05
CE-141	1.370E+07	1.370E+07	1.370E+07	1.370E+07	1.370E+07	1.370E+07	1.540E+07	1.370E+07
CE-143	2.310E+06	2.310E+06	2.310E+06	2.310E+06	2.310E+06	2.310E+06	2.630E+06	2.310E+06
CE-144	6.950E+07	6.950E+07	6.950E+07	6.950E+07	6.950E+07	6.950E+07	8.040E+07	6.950E+07
PR-143	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR-144	1.830E+03	1.830E+03	1.830E+03	1.830E+03	1.830E+03	1.830E+03	2.110E+03	1.830E+03
ND-147	8.390E+06	8.390E+06	8.390E+06	8.390E+06	8.390E+06	8.390E+06	1.010E+07	8.390E+06
W-187	2.350E+06	2.350E+06	2.350E+06	2.350E+06	2.350E+06	2.350E+06	2.730E+06	2.350E+06
NP-239	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.980E+06	1.710E+06

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Grs/Cow/Milk (CMILK)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	1.570E+03	1.570E+03	1.570E+03	1.570E+03	1.570E+03	0.000E+00	1.570E+03
C-14	1.020E+05	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.040E+04	0.000E+00	2.040E+04
NA-24	8.850E+06	8.850E+06	8.850E+06	8.850E+06	8.850E+06	8.850E+06	0.000E+00	8.850E+06
P-32	7.780E+10	3.640E+09	0.000E+00	0.000E+00	0.000E+00	2.150E+09	0.000E+00	3.000E+09
CR-51	0.000E+00	0.000E+00	5.650E+04	1.540E+04	1.030E+05	5.400E+06	0.000E+00	1.020E+05
MN-54	0.000E+00	2.100E+07	0.000E+00	5.880E+06	0.000E+00	1.760E+07	0.000E+00	5.590E+06
MN-56	0.000E+00	1.260E-02	0.000E+00	1.530E-02	0.000E+00	1.830E+00	0.000E+00	2.860E-03
FE-55	1.120E+08	5.930E+07	0.000E+00	0.000E+00	3.350E+07	1.100E+07	0.000E+00	1.840E+07
FE-59	1.200E+08	1.950E+08	0.000E+00	0.000E+00	5.640E+07	2.030E+08	0.000E+00	9.690E+07
CO-58	0.000E+00	1.210E+07	0.000E+00	0.000E+00	0.000E+00	7.070E+07	0.000E+00	3.710E+07
CO-60	0.000E+00	4.320E+07	0.000E+00	0.000E+00	0.000E+00	2.390E+08	0.000E+00	1.270E+08
NI-63	2.960E+10	1.590E+09	0.000E+00	0.000E+00	0.000E+00	1.070E+08	0.000E+00	1.010E+09
NI-65	1.660E+00	1.560E-01	0.000E+00	0.000E+00	0.000E+00	1.910E+01	0.000E+00	9.100E-02
CU-64	0.000E+00	7.460E+04	0.000E+00	1.800E+05	0.000E+00	3.500E+06	0.000E+00	4.510E+04
ZN-65	4.130E+09	1.100E+10	0.000E+00	6.940E+09	0.000E+00	1.930E+09	0.000E+00	6.850E+09
ZN-69	9.460E-12	1.370E-11	0.000E+00	8.300E-12	0.000E+00	8.620E-10	0.000E+00	1.260E-12
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.400E-01
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.510E-23
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	8.770E+09	0.000E+00	0.000E+00	0.000E+00	5.640E+08	0.000E+00	5.390E+09
RB-88	0.000E+00	7.160E-45	0.000E+00	0.000E+00	0.000E+00	3.510E-46	0.000E+00	4.970E-45
RB-89	0.000E+00	1.340E-52	0.000E+00	0.000E+00	0.000E+00	1.170E-54	0.000E+00	1.190E-52
SR-89	6.620E+09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.560E+08	0.000E+00	1.890E+08
SR-90	1.120E+11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.510E+09	0.000E+00	2.830E+10
SR-91	1.300E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.880E+05	0.000E+00	4.920E+03

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Grs/Cow/Milk (CMILK)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	2.180E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.130E+01	0.000E+00	8.750E-02
Y-90	3.220E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.170E+05	0.000E+00	8.620E+00
Y-91	3.900E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.200E+06	0.000E+00	1.040E+03
Y-91M	2.670E-19	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.240E-16	0.000E+00	9.730E-21
Y-92	2.530E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.310E+00	0.000E+00	7.240E-06
Y-93	1.010E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.510E+04	0.000E+00	2.780E-02
ZR-95	3.830E+03	8.420E+02	0.000E+00	1.210E+03	0.000E+00	8.790E+05	0.000E+00	7.500E+02
ZR-97	1.920E+00	2.770E-01	0.000E+00	3.980E-01	0.000E+00	4.200E+04	0.000E+00	1.640E-01
NB-95	3.180E+05	1.240E+05	0.000E+00	1.160E+05	0.000E+00	2.290E+08	0.000E+00	8.840E+04
MO-99	0.000E+00	8.140E+07	0.000E+00	1.740E+08	0.000E+00	6.730E+07	0.000E+00	2.010E+07
TC-99M	1.320E+01	2.590E+01	0.000E+00	3.760E+02	1.320E+01	1.470E+04	0.000E+00	4.290E+02
TC-101	1.160E-59	1.220E-59	0.000E+00	2.080E-58	6.440E-60	3.870E-59	0.000E+00	1.540E-58
RU-103	4.280E+03	0.000E+00	0.000E+00	1.080E+04	0.000E+00	1.110E+05	0.000E+00	1.650E+03
RU-105	3.820E-03	0.000E+00	0.000E+00	3.360E-02	0.000E+00	2.490E+00	0.000E+00	1.390E-03
RU-106	9.240E+04	0.000E+00	0.000E+00	1.250E+05	0.000E+00	1.440E+06	0.000E+00	1.150E+04
AG-110M	2.090E+08	1.410E+08	0.000E+00	2.630E+08	0.000E+00	1.680E+10	0.000E+00	1.130E+08
TE-125M	7.380E+07	2.000E+07	2.070E+07	0.000E+00	0.000E+00	7.120E+07	0.000E+00	9.840E+06
TE-127	2.980E+03	8.020E+02	2.060E+03	8.470E+03	0.000E+00	1.160E+05	0.000E+00	6.380E+02
TE-127M	2.080E+08	5.600E+07	4.970E+07	5.930E+08	0.000E+00	1.680E+08	0.000E+00	2.470E+07
TE-129	1.280E-09	3.580E-10	9.160E-10	3.750E-09	0.000E+00	7.990E-08	0.000E+00	3.050E-10
TE-129M	2.710E+08	7.580E+07	8.750E+07	7.970E+08	0.000E+00	3.310E+08	0.000E+00	4.210E+07
TE-131	1.620E-32	4.920E-33	1.240E-32	4.890E-32	0.000E+00	8.490E-32	0.000E+00	4.810E-33
TE-131M	1.600E+06	5.530E+05	1.140E+06	5.350E+06	0.000E+00	2.240E+07	0.000E+00	5.890E+05
TE-132	1.020E+07	4.530E+06	6.600E+06	4.210E+07	0.000E+00	4.570E+07	0.000E+00	5.480E+06
I-130	1.730E+06	3.490E+06	3.840E+08	5.220E+06	0.000E+00	1.630E+06	0.000E+00	1.800E+06

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Grs/Cow/Milk (CMILK)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	1.300E+09	1.310E+09	4.330E+11	2.150E+09	0.000E+00	1.170E+08	0.000E+00	7.450E+08
I-132	6.890E-01	1.270E+00	5.870E+01	1.940E+00	0.000E+00	1.490E+00	0.000E+00	5.820E-01
I-133	1.720E+07	2.120E+07	3.940E+09	3.540E+07	0.000E+00	8.560E+06	0.000E+00	8.030E+06
I-134	8.480E-12	1.570E-11	3.620E-10	2.410E-11	0.000E+00	1.040E-11	0.000E+00	7.250E-12
I-135	5.400E+04	9.720E+04	8.610E+06	1.490E+05	0.000E+00	7.400E+04	0.000E+00	4.600E+04
CS-134	2.260E+10	3.720E+10	0.000E+00	1.150E+10	4.130E+09	2.000E+08	0.000E+00	7.840E+09
CS-136	1.010E+09	2.780E+09	0.000E+00	1.480E+09	2.210E+08	9.770E+07	0.000E+00	1.800E+09
CS-137	3.220E+10	3.090E+10	0.000E+00	1.010E+10	3.620E+09	1.930E+08	0.000E+00	4.550E+09
CS-138	3.980E-23	5.530E-23	0.000E+00	3.890E-23	4.190E-24	2.550E-23	0.000E+00	3.510E-23
BA-139	2.010E-07	1.070E-10	0.000E+00	9.360E-11	6.300E-11	1.160E-05	0.000E+00	5.820E-09
BA-140	1.170E+08	1.030E+05	0.000E+00	3.340E+04	6.120E+04	5.930E+07	0.000E+00	6.840E+06
BA-141	1.850E-45	1.040E-48	0.000E+00	8.960E-49	6.090E-48	1.050E-45	0.000E+00	6.020E-47
BA-142	1.150E-79	8.310E-83	0.000E+00	6.720E-83	4.890E-83	1.510E-81	0.000E+00	6.450E-81
LA-140	1.940E+01	6.780E+00	0.000E+00	0.000E+00	0.000E+00	1.890E+05	0.000E+00	2.290E+00
LA-142	8.100E-11	2.580E-11	0.000E+00	0.000E+00	0.000E+00	5.120E-06	0.000E+00	8.090E-12
CE-141	2.190E+04	1.090E+04	0.000E+00	4.780E+03	0.000E+00	1.360E+07	0.000E+00	1.620E+03
CE-143	1.870E+02	1.020E+05	0.000E+00	4.260E+01	0.000E+00	1.490E+06	0.000E+00	1.470E+01
CE-144	1.620E+06	5.090E+05	0.000E+00	2.820E+05	0.000E+00	1.330E+08	0.000E+00	8.660E+04
PR-143	7.180E+02	2.160E+02	0.000E+00	1.170E+02	0.000E+00	7.750E+05	0.000E+00	3.560E+01
PR-144	2.680E-53	8.290E-54	0.000E+00	4.380E-54	0.000E+00	1.780E-50	0.000E+00	1.350E-54
ND-147	4.450E+02	3.600E+02	0.000E+00	1.980E+02	0.000E+00	5.700E+05	0.000E+00	2.790E+01
W-187	2.890E+04	1.710E+04	0.000E+00	0.000E+00	0.000E+00	2.400E+06	0.000E+00	7.670E+03
NP-239	1.720E+01	1.240E+00	0.000E+00	3.580E+00	0.000E+00	9.170E+04	0.000E+00	8.710E-01

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Grs/Goat/Milk (GMILK)			Units:	$m^2 \cdot$mrem/yr / µCi/sec; mrem/yr / µCi/m^3 (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	3.200E+03	3.200E+03	3.200E+03	3.200E+03	3.200E+03	0.000E+00	3.200E+03
C-14	1.020E+05	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.040E+04	0.000E+00	2.040E+04
NA-24	1.060E+06	1.060E+06	1.060E+06	1.060E+06	1.060E+06	1.060E+06	0.000E+00	1.060E+06
P-32	9.330E+10	4.370E+09	0.000E+00	0.000E+00	0.000E+00	2.580E+09	0.000E+00	3.600E+09
CR-51	0.000E+00	0.000E+00	6.780E+03	1.850E+03	1.240E+04	6.480E+05	0.000E+00	1.220E+04
MN-54	0.000E+00	2.520E+06	0.000E+00	7.060E+05	0.000E+00	2.110E+06	0.000E+00	6.700E+05
MN-56	0.000E+00	1.520E-03	0.000E+00	1.840E-03	0.000E+00	2.200E-01	0.000E+00	3.430E-04
FE-55	1.450E+06	7.710E+05	0.000E+00	0.000E+00	4.360E+05	1.430E+05	0.000E+00	2.390E+05
FE-59	1.560E+06	2.530E+06	0.000E+00	0.000E+00	7.330E+05	2.630E+06	0.000E+00	1.260E+06
CO-58	0.000E+00	1.450E+06	0.000E+00	0.000E+00	0.000E+00	8.490E+06	0.000E+00	4.450E+06
CO-60	0.000E+00	5.180E+06	0.000E+00	0.000E+00	0.000E+00	2.870E+07	0.000E+00	1.530E+07
NI-63	3.560E+09	1.900E+08	0.000E+00	0.000E+00	0.000E+00	1.280E+07	0.000E+00	1.210E+08
NI-65	1.990E-01	1.870E-02	0.000E+00	0.000E+00	0.000E+00	2.290E+00	0.000E+00	1.090E-02
CU-64	0.000E+00	8.320E+03	0.000E+00	2.010E+04	0.000E+00	3.900E+05	0.000E+00	5.020E+03
ZN-65	4.960E+08	1.320E+09	0.000E+00	8.330E+08	0.000E+00	2.320E+08	0.000E+00	8.220E+08
ZN-69	1.140E-12	1.640E-12	0.000E+00	9.960E-13	0.000E+00	1.030E-10	0.000E+00	1.520E-13
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.280E-02
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.820E-24
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	1.050E+09	0.000E+00	0.000E+00	0.000E+00	6.770E+07	0.000E+00	6.470E+08
RB-88	0.000E+00	8.590E-46	0.000E+00	0.000E+00	0.000E+00	4.210E-47	0.000E+00	5.970E-46
RB-89	0.000E+00	1.610E-53	0.000E+00	0.000E+00	0.000E+00	1.410E-55	0.000E+00	1.430E-53
SR-89	1.390E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.380E+08	0.000E+00	3.970E+08
SR-90	2.350E+11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.160E+09	0.000E+00	5.950E+10
SR-91	2.740E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.040E+05	0.000E+00	1.030E+04

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Grs/Goat/Milk (GMILK)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	4.580E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.680E+01	0.000E+00	1.840E-01
Y-90	3.870E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.100E+05	0.000E+00	1.030E+00
Y-91	4.680E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.240E+05	0.000E+00	1.250E+02
Y-91M	3.210E-20	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.280E-17	0.000E+00	1.170E-21
Y-92	3.040E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.770E-01	0.000E+00	8.690E-07
Y-93	1.210E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.810E+03	0.000E+00	3.330E-03
ZR-95	4.600E+02	1.010E+02	0.000E+00	1.450E+02	0.000E+00	1.050E+05	0.000E+00	9.000E+01
ZR-97	2.300E-01	3.330E-02	0.000E+00	4.780E-02	0.000E+00	5.040E+03	0.000E+00	1.960E-02
NB-95	3.810E+04	1.490E+04	0.000E+00	1.400E+04	0.000E+00	2.750E+07	0.000E+00	1.060E+04
MO-99	0.000E+00	9.760E+06	0.000E+00	2.090E+07	0.000E+00	8.080E+06	0.000E+00	2.420E+06
TC-99M	1.590E+00	3.110E+00	0.000E+00	4.520E+01	1.580E+00	1.770E+03	0.000E+00	5.150E+01
TC-101	1.400E-60	1.460E-60	0.000E+00	2.490E-59	7.720E-61	4.640E-60	0.000E+00	1.850E-59
RU-103	5.140E+02	0.000E+00	0.000E+00	1.290E+03	0.000E+00	1.330E+04	0.000E+00	1.980E+02
RU-105	4.580E-04	0.000E+00	0.000E+00	4.030E-03	0.000E+00	2.990E-01	0.000E+00	1.660E-04
RU-106	1.110E+04	0.000E+00	0.000E+00	1.500E+04	0.000E+00	1.720E+05	0.000E+00	1.380E+03
AG-110M	2.510E+07	1.690E+07	0.000E+00	3.150E+07	0.000E+00	2.010E+09	0.000E+00	1.350E+07
TE-125M	8.850E+06	2.400E+06	2.480E+06	0.000E+00	0.000E+00	8.540E+06	0.000E+00	1.180E+06
TE-127	3.570E+02	9.630E+01	2.470E+02	1.020E+03	0.000E+00	1.390E+04	0.000E+00	7.660E+01
TE-127M	2.500E+07	6.720E+06	5.970E+06	7.120E+07	0.000E+00	2.020E+07	0.000E+00	2.960E+06
TE-129	1.540E-10	4.300E-11	1.100E-10	4.510E-10	0.000E+00	9.590E-09	0.000E+00	3.660E-11
TE-129M	3.260E+07	9.090E+06	1.050E+07	9.560E+07	0.000E+00	3.970E+07	0.000E+00	5.060E+06
TE-131	1.940E-33	5.910E-34	1.480E-33	5.860E-33	0.000E+00	1.020E-32	0.000E+00	5.770E-34
TE-131M	1.920E+05	6.640E+04	1.360E+05	6.420E+05	0.000E+00	2.690E+06	0.000E+00	7.060E+04
TE-132	1.230E+06	5.440E+05	7.920E+05	5.050E+06	0.000E+00	5.480E+06	0.000E+00	6.570E+05
I-130	2.070E+06	4.190E+06	4.610E+08	6.260E+06	0.000E+00	1.960E+06	0.000E+00	2.160E+06

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Grs/Goat/Milk (GMILK)			Units:	$m^2 \cdot$mrem/yr / µCi/sec; mrem/yr / µCi/m^3 (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	1.560E+09	1.570E+09	5.200E+11	2.580E+09	0.000E+00	1.400E+08	0.000E+00	8.940E+08
I-132	8.270E-01	1.520E+00	7.050E+01	2.330E+00	0.000E+00	1.790E+00	0.000E+00	6.990E-01
I-133	2.060E+07	2.550E+07	4.730E+09	4.250E+07	0.000E+00	1.030E+07	0.000E+00	9.640E+06
I-134	1.020E-11	1.890E-11	4.350E-10	2.890E-11	0.000E+00	1.250E-11	0.000E+00	8.700E-12
I-135	6.480E+04	1.170E+05	1.030E+07	1.790E+05	0.000E+00	8.880E+04	0.000E+00	5.520E+04
CS-134	6.790E+10	1.110E+11	0.000E+00	3.450E+10	1.240E+10	6.010E+08	0.000E+00	2.350E+10
CS-136	3.030E+09	8.340E+09	0.000E+00	4.440E+09	6.630E+08	2.930E+08	0.000E+00	5.400E+09
CS-137	9.670E+10	9.260E+10	0.000E+00	3.020E+10	1.090E+10	5.800E+08	0.000E+00	1.370E+10
CS-138	1.190E-22	1.660E-22	0.000E+00	1.170E-22	1.260E-23	7.640E-23	0.000E+00	1.050E-22
BA-139	2.410E-08	1.290E-11	0.000E+00	1.120E-11	7.560E-12	1.390E-06	0.000E+00	6.980E-10
BA-140	1.410E+07	1.230E+04	0.000E+00	4.010E+03	7.340E+03	7.120E+06	0.000E+00	8.200E+05
BA-141	2.220E-46	1.240E-49	0.000E+00	1.080E-49	7.300E-49	1.270E-46	0.000E+00	7.230E-48
BA-142	1.390E-80	9.970E-84	0.000E+00	8.070E-84	5.870E-84	1.810E-82	0.000E+00	7.740E-82
LA-140	2.330E+00	8.140E-01	0.000E+00	0.000E+00	0.000E+00	2.270E+04	0.000E+00	2.740E-01
LA-142	9.730E-12	3.100E-12	0.000E+00	0.000E+00	0.000E+00	6.140E-07	0.000E+00	9.710E-13
CE-141	2.620E+03	1.310E+03	0.000E+00	5.740E+02	0.000E+00	1.630E+06	0.000E+00	1.940E+02
CE-143	2.250E+01	1.220E+04	0.000E+00	5.120E+00	0.000E+00	1.790E+05	0.000E+00	1.770E+00
CE-144	1.950E+05	6.110E+04	0.000E+00	3.380E+04	0.000E+00	1.590E+07	0.000E+00	1.040E+04
PR-143	8.620E+01	2.590E+01	0.000E+00	1.400E+01	0.000E+00	9.300E+04	0.000E+00	4.280E+00
PR-144	3.220E-54	9.950E-55	0.000E+00	5.260E-55	0.000E+00	2.140E-51	0.000E+00	1.620E-55
ND-147	5.330E+01	4.320E+01	0.000E+00	2.370E+01	0.000E+00	6.850E+04	0.000E+00	3.350E+00
W-187	3.470E+03	2.050E+03	0.000E+00	0.000E+00	0.000E+00	2.880E+05	0.000E+00	9.210E+02
NP-239	2.070E+00	1.490E-01	0.000E+00	4.300E-01	0.000E+00	1.100E+04	0.000E+00	1.040E-01

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Grs/Cow/Meat (CMEAT)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	2.340E+02	2.340E+02	2.340E+02	2.340E+02	2.340E+02	0.000E+00	2.340E+02
C-14	3.280E+04	6.560E+03	6.560E+03	6.560E+03	6.560E+03	6.560E+03	0.000E+00	6.560E+03
NA-24	1.720E-03	1.720E-03	1.720E-03	1.720E-03	1.720E-03	1.720E-03	0.000E+00	1.720E-03
P-32	7.420E+09	3.470E+08	0.000E+00	0.000E+00	0.000E+00	2.050E+08	0.000E+00	2.860E+08
CR-51	0.000E+00	0.000E+00	4.880E+03	1.330E+03	8.910E+03	4.660E+05	0.000E+00	8.790E+03
MN-54	0.000E+00	8.010E+06	0.000E+00	2.250E+06	0.000E+00	6.720E+06	0.000E+00	2.130E+06
MN-56	0.000E+00	1.430E-53	0.000E+00	1.730E-53	0.000E+00	2.070E-51	0.000E+00	3.230E-54
FE-55	4.570E+08	2.420E+08	0.000E+00	0.000E+00	1.370E+08	4.490E+07	0.000E+00	7.510E+07
FE-59	3.760E+08	6.090E+08	0.000E+00	0.000E+00	1.770E+08	6.340E+08	0.000E+00	3.030E+08
CO-58	0.000E+00	1.640E+07	0.000E+00	0.000E+00	0.000E+00	9.580E+07	0.000E+00	5.020E+07
CO-60	0.000E+00	6.930E+07	0.000E+00	0.000E+00	0.000E+00	3.840E+08	0.000E+00	2.040E+08
NI-63	2.910E+10	1.560E+09	0.000E+00	0.000E+00	0.000E+00	1.050E+08	0.000E+00	9.910E+08
NI-65	3.520E-52	3.310E-53	0.000E+00	0.000E+00	0.000E+00	4.060E-51	0.000E+00	1.930E-53
CU-64	0.000E+00	2.970E-07	0.000E+00	7.180E-07	0.000E+00	1.390E-05	0.000E+00	1.800E-07
ZN-65	3.750E+08	1.000E+09	0.000E+00	6.300E+08	0.000E+00	1.760E+08	0.000E+00	6.220E+08
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.520E-57
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	5.770E+08	0.000E+00	0.000E+00	0.000E+00	3.710E+07	0.000E+00	3.550E+08
RB-88	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-89	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-89	4.820E+08	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.870E+07	0.000E+00	1.380E+07
SR-90	1.040E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.400E+08	0.000E+00	2.640E+09
SR-91	2.400E-10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.300E-10	0.000E+00	9.050E-12

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Grs/Cow/Meat (CMEAT)			Units:	m^2·mrem/yr / µCi/sec; mrem/yr / µCi/m^3 (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	1.850E-49	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.490E-48	0.000E+00	7.400E-51
Y-90	1.710E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.880E+05	0.000E+00	4.590E+00
Y-91	1.800E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.400E+08	0.000E+00	4.820E+04
Y-91M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y-92	2.410E-39	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.960E-35	0.000E+00	6.890E-41
Y-93	7.440E-12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.110E-07	0.000E+00	2.040E-13
ZR-95	2.660E+06	5.850E+05	0.000E+00	8.380E+05	0.000E+00	6.110E+08	0.000E+00	5.210E+05
ZR-97	3.200E-05	4.630E-06	0.000E+00	6.650E-06	0.000E+00	7.010E-01	0.000E+00	2.730E-06
NB-95	3.100E+06	1.210E+06	0.000E+00	1.130E+06	0.000E+00	2.230E+09	0.000E+00	8.620E+05
MO-99	0.000E+00	1.150E+05	0.000E+00	2.460E+05	0.000E+00	9.510E+04	0.000E+00	2.840E+04
TC-99M	6.190E-21	1.210E-20	0.000E+00	1.760E-19	6.160E-21	6.910E-18	0.000E+00	2.010E-19
TC-101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-103	1.550E+08	0.000E+00	0.000E+00	3.900E+08	0.000E+00	4.010E+09	0.000E+00	5.960E+07
RU-105	9.020E-28	0.000E+00	0.000E+00	7.930E-27	0.000E+00	5.890E-25	0.000E+00	3.270E-28
RU-106	4.440E+09	0.000E+00	0.000E+00	5.990E+09	0.000E+00	6.900E+10	0.000E+00	5.540E+08
AG-110M	8.390E+06	5.670E+06	0.000E+00	1.060E+07	0.000E+00	6.740E+08	0.000E+00	4.530E+06
TE-125M	5.690E+08	1.540E+08	1.600E+08	0.000E+00	0.000E+00	5.490E+08	0.000E+00	7.590E+07
TE-127	3.380E-10	9.120E-11	2.340E-10	9.630E-10	0.000E+00	1.320E-08	0.000E+00	7.260E-11
TE-127M	1.770E+09	4.780E+08	4.240E+08	5.060E+09	0.000E+00	1.440E+09	0.000E+00	2.110E+08
TE-129	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-129M	1.790E+09	5.000E+08	5.770E+08	5.260E+09	0.000E+00	2.180E+09	0.000E+00	2.780E+08
TE-131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-131M	7.000E+02	2.420E+02	4.980E+02	2.340E+03	0.000E+00	9.820E+03	0.000E+00	2.580E+02
TE-132	2.120E+06	9.380E+05	1.370E+06	8.710E+06	0.000E+00	9.450E+06	0.000E+00	1.130E+06
I-130	3.030E-06	6.130E-06	6.750E-04	9.160E-06	0.000E+00	2.870E-06	0.000E+00	3.160E-06

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Grs/Cow/Meat (CMEAT)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	1.650E+07	1.660E+07	5.500E+09	2.730E+07	0.000E+00	1.480E+06	0.000E+00	9.460E+06
I-132	1.020E-58	1.880E-58	8.730E-57	2.880E-58	0.000E+00	2.210E-58	0.000E+00	8.650E-59
I-133	5.670E-01	7.020E-01	1.300E+02	1.170E+00	0.000E+00	2.830E-01	0.000E+00	2.660E-01
I-134	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-135	6.510E-17	1.170E-16	1.040E-14	1.800E-16	0.000E+00	8.930E-17	0.000E+00	5.550E-17
CS-134	9.220E+08	1.510E+09	0.000E+00	4.690E+08	1.680E+08	8.160E+06	0.000E+00	3.190E+08
CS-136	1.620E+07	4.460E+07	0.000E+00	2.370E+07	3.540E+06	1.570E+06	0.000E+00	2.880E+07
CS-137	1.330E+09	1.280E+09	0.000E+00	4.160E+08	1.500E+08	7.990E+06	0.000E+00	1.880E+08
CS-138	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-139	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-140	4.380E+07	3.840E+04	0.000E+00	1.250E+04	2.290E+04	2.220E+07	0.000E+00	2.560E+06
BA-141	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA-140	5.590E-02	1.950E-02	0.000E+00	0.000E+00	0.000E+00	5.440E+02	0.000E+00	6.580E-03
LA-142	5.300E-92	1.690E-92	0.000E+00	0.000E+00	0.000E+00	3.350E-87	0.000E+00	5.290E-93
CE-141	2.220E+04	1.110E+04	0.000E+00	4.850E+03	0.000E+00	1.380E+07	0.000E+00	1.640E+03
CE-143	3.170E-02	1.720E+01	0.000E+00	7.210E-03	0.000E+00	2.520E+02	0.000E+00	2.490E-03
CE-144	2.320E+06	7.260E+05	0.000E+00	4.020E+05	0.000E+00	1.890E+08	0.000E+00	1.240E+05
PR-143	3.340E+04	1.000E+04	0.000E+00	5.430E+03	0.000E+00	3.600E+07	0.000E+00	1.660E+03
PR-144	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND-147	1.170E+04	9.470E+03	0.000E+00	5.190E+03	0.000E+00	1.500E+07	0.000E+00	7.330E+02
W-187	3.210E-02	1.900E-02	0.000E+00	0.000E+00	0.000E+00	2.670E+00	0.000E+00	8.530E-03
NP-239	4.260E-01	3.060E-02	0.000E+00	8.850E-02	0.000E+00	2.260E+03	0.000E+00	2.150E-02

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Grs/Goat/Meat (GMEAT)			Units:	$m^2 \cdot$mrem/yr / µCi/sec; mrem/yr / µCi/m^3 (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	2.808E+01	2.808E+01	2.808E+01	2.808E+01	2.808E+01	0.000E+00	2.808E+01
C-14	3.936E+03	7.872E+02	7.872E+02	7.872E+02	7.872E+02	7.872E+02	0.000E+00	7.872E+02
NA-24	2.064E-04	2.064E-04	2.064E-04	2.064E-04	2.064E-04	2.064E-04	0.000E+00	2.064E-04
P-32	8.904E+08	4.164E+07	0.000E+00	0.000E+00	0.000E+00	2.460E+07	0.000E+00	3.432E+07
CR-51	0.000E+00	0.000E+00	5.856E+02	1.596E+02	1.069E+03	5.592E+04	0.000E+00	1.055E+03
MN-54	0.000E+00	9.612E+05	0.000E+00	2.700E+05	0.000E+00	8.064E+05	0.000E+00	2.556E+05
MN-56	0.000E+00	1.716E-54	0.000E+00	2.076E-54	0.000E+00	2.484E-52	0.000E+00	3.876E-55
FE-55	5.484E+07	2.904E+07	0.000E+00	0.000E+00	1.644E+07	5.388E+06	0.000E+00	9.012E+06
FE-59	4.512E+07	7.308E+07	0.000E+00	0.000E+00	2.124E+07	7.608E+07	0.000E+00	3.636E+07
CO-58	0.000E+00	1.968E+06	0.000E+00	0.000E+00	0.000E+00	1.150E+07	0.000E+00	6.024E+06
CO-60	0.000E+00	8.316E+06	0.000E+00	0.000E+00	0.000E+00	4.608E+07	0.000E+00	2.448E+07
NI-63	3.492E+09	1.872E+08	0.000E+00	0.000E+00	0.000E+00	1.260E+07	0.000E+00	1.189E+08
NI-65	4.224E-53	3.972E-54	0.000E+00	0.000E+00	0.000E+00	4.872E-52	0.000E+00	2.316E-54
CU-64	0.000E+00	3.564E-08	0.000E+00	8.616E-08	0.000E+00	1.668E-06	0.000E+00	2.160E-08
ZN-65	4.500E+07	1.200E+08	0.000E+00	7.560E+07	0.000E+00	2.112E+07	0.000E+00	7.464E+07
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.142E-57
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	6.924E+07	0.000E+00	0.000E+00	0.000E+00	4.452E+06	0.000E+00	4.260E+07
RB-88	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-89	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-89	5.784E+07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.244E+06	0.000E+00	1.656E+06
SR-90	1.248E+09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.680E+07	0.000E+00	3.168E+08
SR-91	2.880E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.360E-11	0.000E+00	1.086E-12

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Grs/Goat/Meat (GMEAT)			Units:	$m^2 \cdot$mrem/yr / µCi/sec; mrem/yr / µCi/m^3 (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	2.220E-50	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.188E-49	0.000E+00	8.880E-52
Y-90	2.052E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.856E+04	0.000E+00	5.508E-01
Y-91	2.160E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.880E+07	0.000E+00	5.784E+03
Y-91M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y-92	2.892E-40	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.352E-36	0.000E+00	8.268E-42
Y-93	8.928E-13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.332E-08	0.000E+00	2.448E-14
ZR-95	3.192E+05	7.020E+04	0.000E+00	1.006E+05	0.000E+00	7.332E+07	0.000E+00	6.252E+04
ZR-97	3.840E-06	5.556E-07	0.000E+00	7.980E-07	0.000E+00	8.412E-02	0.000E+00	3.276E-07
NB-95	3.720E+05	1.452E+05	0.000E+00	1.356E+05	0.000E+00	2.676E+08	0.000E+00	1.034E+05
MO-99	0.000E+00	1.380E+04	0.000E+00	2.952E+04	0.000E+00	1.141E+04	0.000E+00	3.408E+03
TC-99M	7.428E-22	1.452E-21	0.000E+00	2.112E-20	7.392E-22	8.292E-19	0.000E+00	2.412E-20
TC-101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-103	1.860E+07	0.000E+00	0.000E+00	4.680E+07	0.000E+00	4.812E+08	0.000E+00	7.152E+06
RU-105	1.082E-28	0.000E+00	0.000E+00	9.516E-28	0.000E+00	7.068E-26	0.000E+00	3.924E-29
RU-106	5.328E+08	0.000E+00	0.000E+00	7.188E+08	0.000E+00	8.280E+09	0.000E+00	6.648E+07
AG-110M	1.007E+06	6.804E+05	0.000E+00	1.272E+06	0.000E+00	8.088E+07	0.000E+00	5.436E+05
TE-125M	6.828E+07	1.848E+07	1.920E+07	0.000E+00	0.000E+00	6.588E+07	0.000E+00	9.108E+06
TE-127	4.056E-11	1.094E-11	2.808E-11	1.156E-10	0.000E+00	1.584E-09	0.000E+00	8.712E-12
TE-127M	2.124E+08	5.736E+07	5.088E+07	6.072E+08	0.000E+00	1.728E+08	0.000E+00	2.532E+07
TE-129	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-129M	2.148E+08	6.000E+07	6.924E+07	6.312E+08	0.000E+00	2.616E+08	0.000E+00	3.336E+07
TE-131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-131M	8.400E+01	2.904E+01	5.976E+01	2.808E+02	0.000E+00	1.178E+03	0.000E+00	3.096E+01
TE-132	2.544E+05	1.126E+05	1.644E+05	1.045E+06	0.000E+00	1.134E+06	0.000E+00	1.356E+05
I-130	3.636E-07	7.356E-07	8.100E-05	1.099E-06	0.000E+00	3.444E-07	0.000E+00	3.792E-07

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Grs/Goat/Meat (GMEAT)			Units:	$m^2 \cdot$mrem/yr / µCi/sec; mrem/yr / µCi/m^3 (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	1.980E+06	1.992E+06	6.600E+08	3.276E+06	0.000E+00	1.776E+05	0.000E+00	1.135E+06
I-132	1.224E-59	2.256E-59	1.048E-57	3.456E-59	0.000E+00	2.652E-59	0.000E+00	1.038E-59
I-133	6.804E-02	8.424E-02	1.560E+01	1.404E-01	0.000E+00	3.396E-02	0.000E+00	3.192E-02
I-134	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-135	7.812E-18	1.404E-17	1.248E-15	2.160E-17	0.000E+00	1.072E-17	0.000E+00	6.660E-18
CS-134	1.106E+08	1.812E+08	0.000E+00	5.628E+07	2.016E+07	9.792E+05	0.000E+00	3.828E+07
CS-136	1.944E+06	5.352E+06	0.000E+00	2.844E+06	4.248E+05	1.884E+05	0.000E+00	3.456E+06
CS-137	1.596E+08	1.536E+08	0.000E+00	4.992E+07	1.800E+07	9.588E+05	0.000E+00	2.256E+07
CS-138	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-139	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-140	5.256E+06	4.608E+03	0.000E+00	1.500E+03	2.748E+03	2.664E+06	0.000E+00	3.072E+05
BA-141	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA-140	6.708E-03	2.340E-03	0.000E+00	0.000E+00	0.000E+00	6.528E+01	0.000E+00	7.896E-04
LA-142	6.360E-93	2.028E-93	0.000E+00	0.000E+00	0.000E+00	4.020E-88	0.000E+00	6.348E-94
CE-141	2.664E+03	1.332E+03	0.000E+00	5.820E+02	0.000E+00	1.656E+06	0.000E+00	1.968E+02
CE-143	3.804E-03	2.064E+00	0.000E+00	8.652E-04	0.000E+00	3.024E+01	0.000E+00	2.988E-04
CE-144	2.784E+05	8.712E+04	0.000E+00	4.824E+04	0.000E+00	2.268E+07	0.000E+00	1.488E+04
PR-143	4.008E+03	1.200E+03	0.000E+00	6.516E+02	0.000E+00	4.320E+06	0.000E+00	1.992E+02
PR-144	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND-147	1.404E+03	1.136E+03	0.000E+00	6.228E+02	0.000E+00	1.800E+06	0.000E+00	8.796E+01
W-187	3.852E-03	2.280E-03	0.000E+00	0.000E+00	0.000E+00	3.204E-01	0.000E+00	1.024E-03
NP-239	5.112E-02	3.672E-03	0.000E+00	1.062E-02	0.000E+00	2.712E+02	0.000E+00	2.580E-03

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Vegetation (VEG)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	4.010E+03	4.010E+03	4.010E+03	4.010E+03	4.010E+03	0.000E+00	4.010E+03
C-14	2.170E+05	4.340E+04	4.340E+04	4.340E+04	4.340E+04	4.340E+04	0.000E+00	4.340E+04
NA-24	3.730E+05	3.730E+05	3.730E+05	3.730E+05	3.730E+05	3.730E+05	0.000E+00	3.730E+05
P-32	3.370E+09	1.580E+08	0.000E+00	0.000E+00	0.000E+00	9.310E+07	0.000E+00	1.300E+08
CR-51	0.000E+00	0.000E+00	6.500E+04	1.780E+04	1.190E+05	6.210E+06	0.000E+00	1.170E+05
MN-54	0.000E+00	6.650E+08	0.000E+00	1.860E+08	0.000E+00	5.580E+08	0.000E+00	1.770E+08
MN-56	0.000E+00	1.860E+01	0.000E+00	2.250E+01	0.000E+00	2.700E+03	0.000E+00	4.200E+00
FE-55	8.010E+08	4.250E+08	0.000E+00	0.000E+00	2.400E+08	7.870E+07	0.000E+00	1.320E+08
FE-59	3.980E+08	6.430E+08	0.000E+00	0.000E+00	1.860E+08	6.700E+08	0.000E+00	3.200E+08
CO-58	0.000E+00	6.440E+07	0.000E+00	0.000E+00	0.000E+00	3.760E+08	0.000E+00	1.970E+08
CO-60	0.000E+00	3.780E+08	0.000E+00	0.000E+00	0.000E+00	2.100E+09	0.000E+00	1.120E+09
NI-63	3.950E+10	2.110E+09	0.000E+00	0.000E+00	0.000E+00	1.420E+08	0.000E+00	1.340E+09
NI-65	1.050E+02	9.890E+00	0.000E+00	0.000E+00	0.000E+00	1.210E+03	0.000E+00	5.770E+00
CU-64	0.000E+00	1.100E+04	0.000E+00	2.660E+04	0.000E+00	5.160E+05	0.000E+00	6.640E+03
ZN-65	8.130E+08	2.160E+09	0.000E+00	1.360E+09	0.000E+00	3.800E+08	0.000E+00	1.350E+09
ZN-69	9.490E-06	1.370E-05	0.000E+00	8.320E-06	0.000E+00	8.640E-04	0.000E+00	1.270E-06
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.370E+00
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.820E-11
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	4.520E+08	0.000E+00	0.000E+00	0.000E+00	2.910E+07	0.000E+00	2.780E+08
RB-88	0.000E+00	4.380E-22	0.000E+00	0.000E+00	0.000E+00	2.150E-23	0.000E+00	3.040E-22
RB-89	0.000E+00	4.610E-26	0.000E+00	0.000E+00	0.000E+00	4.020E-28	0.000E+00	4.090E-26
SR-89	3.600E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.390E+09	0.000E+00	1.030E+09
SR-90	1.240E+12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.670E+10	0.000E+00	3.150E+11
SR-91	5.240E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.160E+06	0.000E+00	1.980E+04

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Vegetation (VEG)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	7.280E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.380E+04	0.000E+00	2.920E+01
Y-90	2.310E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.570E+07	0.000E+00	6.180E+02
Y-91	1.860E+07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.480E+09	0.000E+00	4.990E+05
Y-91M	8.910E-09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.740E-05	0.000E+00	3.240E-10
Y-92	1.580E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.580E+04	0.000E+00	4.530E-02
Y-93	2.930E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.370E+06	0.000E+00	8.040E+00
ZR-95	3.860E+06	8.480E+05	0.000E+00	1.210E+06	0.000E+00	8.850E+08	0.000E+00	7.550E+05
ZR-97	5.700E+02	8.240E+01	0.000E+00	1.180E+02	0.000E+00	1.250E+07	0.000E+00	4.860E+01
NB-95	4.110E+05	1.600E+05	0.000E+00	1.500E+05	0.000E+00	2.960E+08	0.000E+00	1.140E+05
MO-99	0.000E+00	7.710E+06	0.000E+00	1.650E+07	0.000E+00	6.380E+06	0.000E+00	1.910E+06
TC-99M	4.710E+00	9.230E+00	0.000E+00	1.340E+02	4.690E+00	5.260E+03	0.000E+00	1.530E+02
TC-101	1.410E-30	1.470E-30	0.000E+00	2.510E-29	7.780E-31	4.680E-30	0.000E+00	1.870E-29
RU-103	1.530E+07	0.000E+00	0.000E+00	3.860E+07	0.000E+00	3.970E+08	0.000E+00	5.900E+06
RU-105	9.160E+01	0.000E+00	0.000E+00	8.050E+02	0.000E+00	5.980E+04	0.000E+00	3.320E+01
RU-106	7.450E+08	0.000E+00	0.000E+00	1.010E+09	0.000E+00	1.160E+10	0.000E+00	9.300E+07
AG-110M	3.210E+07	2.170E+07	0.000E+00	4.040E+07	0.000E+00	2.580E+09	0.000E+00	1.730E+07
TE-125M	3.510E+08	9.500E+07	9.840E+07	0.000E+00	0.000E+00	3.380E+08	0.000E+00	4.670E+07
TE-127	9.850E+03	2.650E+03	6.810E+03	2.800E+04	0.000E+00	3.850E+05	0.000E+00	2.110E+03
TE-127M	1.320E+09	3.560E+08	3.160E+08	3.770E+09	0.000E+00	1.070E+09	0.000E+00	1.570E+08
TE-129	1.320E-03	3.690E-04	9.430E-04	3.870E-03	0.000E+00	8.230E-02	0.000E+00	3.140E-04
TE-129M	8.410E+08	2.350E+08	2.710E+08	2.470E+09	0.000E+00	1.030E+09	0.000E+00	1.310E+08
TE-131	2.570E-15	7.830E-16	1.960E-15	7.770E-15	0.000E+00	1.350E-14	0.000E+00	7.640E-16
TE-131M	1.540E+06	5.330E+05	1.100E+06	5.160E+06	0.000E+00	2.160E+07	0.000E+00	5.680E+05
TE-132	7.000E+06	3.100E+06	4.510E+06	2.880E+07	0.000E+00	3.120E+07	0.000E+00	3.740E+06
I-130	6.160E+05	1.240E+06	1.370E+08	1.860E+06	0.000E+00	5.820E+05	0.000E+00	6.410E+05

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Vegetation (VEG)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	1.430E+08	1.440E+08	4.750E+10	2.360E+08	0.000E+00	1.280E+07	0.000E+00	8.170E+07
I-132	9.220E+01	1.690E+02	7.860E+03	2.590E+02	0.000E+00	1.990E+02	0.000E+00	7.790E+01
I-133	3.530E+06	4.370E+06	8.110E+08	7.280E+06	0.000E+00	1.760E+06	0.000E+00	1.650E+06
I-134	1.550E-04	2.880E-04	6.620E-03	4.400E-04	0.000E+00	1.910E-04	0.000E+00	1.320E-04
I-135	6.260E+04	1.130E+05	9.970E+06	1.730E+05	0.000E+00	8.580E+04	0.000E+00	5.330E+04
CS-134	1.600E+10	2.630E+10	0.000E+00	8.150E+09	2.930E+09	1.420E+08	0.000E+00	5.550E+09
CS-136	8.240E+07	2.270E+08	0.000E+00	1.210E+08	1.800E+07	7.960E+06	0.000E+00	1.470E+08
CS-137	2.390E+10	2.290E+10	0.000E+00	7.460E+09	2.680E+09	1.430E+08	0.000E+00	3.380E+09
CS-138	6.570E-11	9.130E-11	0.000E+00	6.430E-11	6.920E-12	4.210E-11	0.000E+00	5.790E-11
BA-139	4.950E-02	2.640E-05	0.000E+00	2.310E-05	1.560E-05	2.860E+00	0.000E+00	1.440E-03
BA-140	2.770E+08	2.420E+05	0.000E+00	7.890E+04	1.450E+05	1.400E+08	0.000E+00	1.610E+07
BA-141	1.990E-21	1.110E-24	0.000E+00	9.620E-25	6.530E-24	1.130E-21	0.000E+00	6.460E-23
BA-142	9.930E-39	7.150E-42	0.000E+00	5.780E-42	4.200E-42	1.300E-40	0.000E+00	5.540E-40
LA-140	3.250E+03	1.130E+03	0.000E+00	0.000E+00	0.000E+00	3.160E+07	0.000E+00	3.820E+02
LA-142	3.360E-04	1.070E-04	0.000E+00	0.000E+00	0.000E+00	2.120E+01	0.000E+00	3.350E-05
CE-141	6.560E+05	3.270E+05	0.000E+00	1.430E+05	0.000E+00	4.080E+08	0.000E+00	4.860E+04
CE-143	1.720E+03	9.310E+05	0.000E+00	3.910E+02	0.000E+00	1.360E+07	0.000E+00	1.350E+02
CE-144	1.270E+08	3.980E+07	0.000E+00	2.210E+07	0.000E+00	1.040E+10	0.000E+00	6.780E+06
PR-143	1.460E+05	4.370E+04	0.000E+00	2.370E+04	0.000E+00	1.570E+08	0.000E+00	7.230E+03
PR-144	5.380E-26	1.660E-26	0.000E+00	8.800E-27	0.000E+00	3.580E-23	0.000E+00	2.710E-27
ND-147	7.150E+04	5.790E+04	0.000E+00	3.180E+04	0.000E+00	9.170E+07	0.000E+00	4.480E+03
W-187	6.430E+04	3.810E+04	0.000E+00	0.000E+00	0.000E+00	5.350E+06	0.000E+00	1.710E+04
NP-239	2.560E+03	1.840E+02	0.000E+00	5.310E+02	0.000E+00	1.360E+07	0.000E+00	1.290E+02

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Inhalation (INHL)			Units:	mrem/yr / µCi/m^3	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
H-3	0.000E+00	1.120E+03	1.120E+03	1.120E+03	1.120E+03	1.120E+03	0.000E+00	1.120E+03
C-14	3.590E+04	6.730E+03	6.730E+03	6.730E+03	6.730E+03	6.730E+03	0.000E+00	6.730E+03
NA-24	1.610E+04	1.610E+04	1.610E+04	1.610E+04	1.610E+04	1.610E+04	0.000E+00	1.610E+04
P-32	2.600E+06	1.140E+05	0.000E+00	0.000E+00	0.000E+00	4.220E+04	0.000E+00	9.880E+04
CR-51	0.000E+00	0.000E+00	8.550E+01	2.430E+01	1.700E+04	1.080E+03	0.000E+00	1.540E+02
MN-54	0.000E+00	4.290E+04	0.000E+00	1.000E+04	1.580E+06	2.290E+04	0.000E+00	9.510E+03
MN-56	0.000E+00	1.660E+00	0.000E+00	1.670E+00	1.310E+04	1.230E+05	0.000E+00	3.120E-01
FE-55	4.740E+04	2.520E+04	0.000E+00	0.000E+00	1.110E+05	2.870E+03	0.000E+00	7.770E+03
FE-59	2.070E+04	3.340E+04	0.000E+00	0.000E+00	1.270E+06	7.070E+04	0.000E+00	1.670E+04
CO-58	0.000E+00	1.770E+03	0.000E+00	0.000E+00	1.110E+06	3.440E+04	0.000E+00	3.160E+03
CO-60	0.000E+00	1.310E+04	0.000E+00	0.000E+00	7.070E+06	9.620E+04	0.000E+00	2.260E+04
NI-63	8.210E+05	4.620E+04	0.000E+00	0.000E+00	2.750E+05	6.330E+03	0.000E+00	2.800E+04
NI-65	2.990E+00	2.960E-01	0.000E+00	0.000E+00	8.180E+03	8.400E+04	0.000E+00	1.640E-01
CU-64	0.000E+00	1.990E+00	0.000E+00	6.030E+00	9.580E+03	3.670E+04	0.000E+00	1.070E+00
ZN-65	4.260E+04	1.130E+05	0.000E+00	7.140E+04	9.950E+05	1.630E+04	0.000E+00	7.030E+04
ZN-69	6.700E-02	9.660E-02	0.000E+00	5.850E-02	1.420E+03	1.020E+04	0.000E+00	8.920E-03
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.740E+02
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.480E+02
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.530E+01
RB-86	0.000E+00	1.980E+05	0.000E+00	0.000E+00	0.000E+00	7.990E+03	0.000E+00	1.140E+05
RB-88	0.000E+00	5.620E+02	0.000E+00	0.000E+00	0.000E+00	1.720E+01	0.000E+00	3.660E+02
RB-89	0.000E+00	3.450E+02	0.000E+00	0.000E+00	0.000E+00	1.890E+00	0.000E+00	2.900E+02
SR-89	5.990E+05	0.000E+00	0.000E+00	0.000E+00	2.160E+06	1.670E+05	0.000E+00	1.720E+04
SR-90	1.010E+08	0.000E+00	0.000E+00	0.000E+00	1.480E+07	3.430E+05	0.000E+00	6.440E+06
SR-91	1.210E+02	0.000E+00	0.000E+00	0.000E+00	5.330E+04	1.740E+05	0.000E+00	4.590E+00

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Inhalation (INHL)			Units:	mrem/yr / µCi/m^3	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	1.310E+01	0.000E+00	0.000E+00	0.000E+00	2.400E+04	2.420E+05	0.000E+00	5.250E-01
Y-90	4.110E+03	0.000E+00	0.000E+00	0.000E+00	2.620E+05	2.680E+05	0.000E+00	1.110E+02
Y-91	9.140E+05	0.000E+00	0.000E+00	0.000E+00	2.630E+06	1.840E+05	0.000E+00	2.440E+04
Y-91M	5.070E-01	0.000E+00	0.000E+00	0.000E+00	2.810E+03	1.720E+03	0.000E+00	1.840E-02
Y-92	2.030E+01	0.000E+00	0.000E+00	0.000E+00	2.390E+04	2.390E+05	0.000E+00	5.810E-01
Y-93	1.860E+02	0.000E+00	0.000E+00	0.000E+00	7.440E+04	3.880E+05	0.000E+00	5.110E+00
ZR-95	1.900E+05	4.180E+04	0.000E+00	5.960E+04	2.230E+06	6.110E+04	0.000E+00	3.700E+04
ZR-97	1.880E+02	2.720E+01	0.000E+00	3.880E+01	1.130E+05	3.510E+05	0.000E+00	1.600E+01
NB-95	2.350E+04	9.180E+03	0.000E+00	8.620E+03	6.140E+05	3.700E+04	0.000E+00	6.550E+03
MO-99	0.000E+00	1.720E+02	0.000E+00	3.920E+02	1.350E+05	1.270E+05	0.000E+00	4.260E+01
TC-99M	1.780E-03	3.480E-03	0.000E+00	5.070E-02	9.510E+02	4.810E+03	0.000E+00	5.770E-02
TC-101	8.100E-05	8.510E-05	0.000E+00	1.450E-03	5.850E+02	1.630E+01	0.000E+00	1.080E-03
RU-103	2.790E+03	0.000E+00	0.000E+00	7.030E+03	6.620E+05	4.480E+04	0.000E+00	1.070E+03
RU-105	1.530E+00	0.000E+00	0.000E+00	1.340E+00	1.590E+04	9.950E+04	0.000E+00	5.550E-01
RU-106	1.360E+05	0.000E+00	0.000E+00	1.840E+05	1.430E+07	4.290E+05	0.000E+00	1.690E+04
AG-110M	1.690E+04	1.140E+04	0.000E+00	2.120E+04	5.480E+06	1.000E+05	0.000E+00	9.140E+03
TE-125M	6.730E+03	2.330E+03	1.920E+03	0.000E+00	4.770E+05	3.380E+04	0.000E+00	9.140E+02
TE-127	2.770E+00	9.510E-01	1.960E+00	7.070E+00	1.000E+04	5.620E+04	0.000E+00	6.100E-01
TE-127M	2.490E+04	8.550E+03	6.070E+03	6.360E+04	1.480E+06	7.140E+04	0.000E+00	3.020E+03
TE-129	9.770E-02	3.500E-02	7.140E-02	2.570E-01	2.930E+03	2.550E+04	0.000E+00	2.380E-02
TE-129M	1.920E+04	6.840E+03	6.330E+03	5.030E+04	1.760E+06	1.820E+05	0.000E+00	3.040E+03
TE-131	2.170E-02	8.440E-03	1.700E-02	5.880E-02	2.050E+03	1.330E+03	0.000E+00	6.590E-03
TE-131M	1.340E+02	5.920E+01	9.770E+01	4.000E+02	2.060E+05	3.080E+05	0.000E+00	5.070E+01
TE-132	4.810E+02	2.720E+02	3.170E+02	1.770E+03	3.770E+05	1.380E+05	0.000E+00	2.630E+02
I-130	8.180E+03	1.640E+04	1.850E+06	2.450E+04	0.000E+00	5.110E+03	0.000E+00	8.440E+03

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Inhalation (INHL)			Units:	mrem/yr / µCi/m^3	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	4.810E+04	4.810E+04	1.620E+07	7.880E+04	0.000E+00	2.840E+03	0.000E+00	2.730E+04
I-132	2.120E+03	4.070E+03	1.940E+05	6.250E+03	0.000E+00	3.200E+03	0.000E+00	1.880E+03
I-133	1.660E+04	2.030E+04	3.850E+06	3.380E+04	0.000E+00	5.480E+03	0.000E+00	7.700E+03
I-134	1.170E+03	2.160E+03	5.070E+04	3.300E+03	0.000E+00	9.550E+02	0.000E+00	9.950E+02
I-135	4.920E+03	8.730E+03	7.920E+05	1.340E+04	0.000E+00	4.440E+03	0.000E+00	4.140E+03
CS-134	6.510E+05	1.010E+06	0.000E+00	3.300E+05	1.210E+05	3.850E+03	0.000E+00	2.250E+05
CS-136	6.510E+04	1.710E+05	0.000E+00	9.550E+04	1.450E+04	4.180E+03	0.000E+00	1.160E+05
CS-137	9.060E+05	8.250E+05	0.000E+00	2.820E+05	1.040E+05	3.620E+03	0.000E+00	1.280E+05
CS-138	6.330E+02	8.400E+02	0.000E+00	6.220E+02	6.810E+01	2.700E+02	0.000E+00	5.550E+02
BA-139	1.840E+00	9.840E-04	0.000E+00	8.620E-04	5.770E+03	5.770E+04	0.000E+00	5.360E-02
BA-140	7.400E+04	6.480E+01	0.000E+00	2.110E+01	1.740E+06	1.020E+05	0.000E+00	4.330E+03
BA-141	1.960E-01	1.090E-04	0.000E+00	9.470E-05	2.920E+03	2.750E+02	0.000E+00	6.360E-03
BA-142	5.000E-02	3.600E-05	0.000E+00	2.910E-05	1.640E+03	2.740E+00	0.000E+00	2.790E-03
LA-140	6.440E+02	2.250E+02	0.000E+00	0.000E+00	1.830E+05	2.260E+05	0.000E+00	7.550E+01
LA-142	1.300E+00	4.110E-01	0.000E+00	0.000E+00	8.700E+03	7.580E+04	0.000E+00	1.290E-01
CE-141	3.920E+04	1.950E+04	0.000E+00	8.550E+03	5.440E+05	5.660E+04	0.000E+00	2.900E+03
CE-143	3.660E+02	1.990E+02	0.000E+00	8.360E+01	1.150E+05	1.270E+05	0.000E+00	2.870E+01
CE-144	6.770E+06	2.120E+06	0.000E+00	1.170E+06	1.200E+07	3.880E+05	0.000E+00	3.610E+05
PR-143	1.850E+04	5.550E+03	0.000E+00	3.000E+03	4.330E+05	9.730E+04	0.000E+00	9.140E+02
PR-144	5.960E-02	1.850E-02	0.000E+00	9.770E-03	1.570E+03	1.970E+02	0.000E+00	3.000E-03
ND-147	1.080E+04	8.730E+03	0.000E+00	4.810E+03	3.280E+05	8.210E+04	0.000E+00	6.810E+02
W-187	1.630E+01	9.660E+00	0.000E+00	0.000E+00	4.110E+04	9.100E+04	0.000E+00	4.330E+00
NP-239	4.660E+02	3.340E+01	0.000E+00	9.730E+01	5.810E+04	6.400E+04	0.000E+00	2.350E+01

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Ground Plane Deposition (GPD)			Units:	$m^2 \cdot$mrem/yr / µCi/sec	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C-14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NA-24	1.190E+07	1.190E+07	1.190E+07	1.190E+07	1.190E+07	1.190E+07	1.390E+07	1.190E+07
P-32	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CR-51	4.660E+06	4.660E+06	4.660E+06	4.660E+06	4.660E+06	4.660E+06	5.510E+06	4.660E+06
MN-54	1.390E+09	1.390E+09	1.390E+09	1.390E+09	1.390E+09	1.390E+09	1.630E+09	1.390E+09
MN-56	9.020E+05	9.020E+05	9.020E+05	9.020E+05	9.020E+05	9.020E+05	1.070E+06	9.020E+05
FE-55	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
FE-59	2.730E+08	2.730E+08	2.730E+08	2.730E+08	2.730E+08	2.730E+08	3.210E+08	2.730E+08
CO-58	3.790E+08	3.790E+08	3.790E+08	3.790E+08	3.790E+08	3.790E+08	4.440E+08	3.790E+08
CO-60	2.150E+10	2.150E+10	2.150E+10	2.150E+10	2.150E+10	2.150E+10	2.530E+10	2.150E+10
NI-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NI-65	2.970E+05	2.970E+05	2.970E+05	2.970E+05	2.970E+05	2.970E+05	3.450E+05	2.970E+05
CU-64	6.070E+05	6.070E+05	6.070E+05	6.070E+05	6.070E+05	6.070E+05	6.880E+05	6.070E+05
ZN-65	7.470E+08	7.470E+08	7.470E+08	7.470E+08	7.470E+08	7.470E+08	8.590E+08	7.470E+08
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	4.870E+03	4.870E+03	4.870E+03	4.870E+03	4.870E+03	4.870E+03	7.080E+03	4.870E+03
BR-84	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.360E+05	2.030E+05
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	8.990E+06	8.990E+06	8.990E+06	8.990E+06	8.990E+06	8.990E+06	1.030E+07	8.990E+06
RB-88	3.310E+04	3.310E+04	3.310E+04	3.310E+04	3.310E+04	3.310E+04	3.780E+04	3.310E+04
RB-89	1.230E+05	1.230E+05	1.230E+05	1.230E+05	1.230E+05	1.230E+05	1.480E+05	1.230E+05
SR-89	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.510E+04	2.160E+04
SR-90	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-91	2.150E+06	2.150E+06	2.150E+06	2.150E+06	2.150E+06	2.150E+06	2.510E+06	2.150E+06

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Ground Plane Deposition (GPD)			Units:	m^2·mrem/yr / µCi/sec	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-92	7.770E+05	7.770E+05	7.770E+05	7.770E+05	7.770E+05	7.770E+05	8.630E+05	7.770E+05
Y-90	4.490E+03	4.490E+03	4.490E+03	4.490E+03	4.490E+03	4.490E+03	5.310E+03	4.490E+03
Y-91	1.070E+06	1.070E+06	1.070E+06	1.070E+06	1.070E+06	1.070E+06	1.210E+06	1.070E+06
Y-91M	1.000E+05	1.000E+05	1.000E+05	1.000E+05	1.000E+05	1.000E+05	1.160E+05	1.000E+05
Y-92	1.800E+05	1.800E+05	1.800E+05	1.800E+05	1.800E+05	1.800E+05	2.140E+05	1.800E+05
Y-93	1.830E+05	1.830E+05	1.830E+05	1.830E+05	1.830E+05	1.830E+05	2.510E+05	1.830E+05
ZR-95	2.450E+08	2.450E+08	2.450E+08	2.450E+08	2.450E+08	2.450E+08	2.840E+08	2.450E+08
ZR-97	2.960E+06	2.960E+06	2.960E+06	2.960E+06	2.960E+06	2.960E+06	3.440E+06	2.960E+06
NB-95	1.370E+08	1.370E+08	1.370E+08	1.370E+08	1.370E+08	1.370E+08	1.610E+08	1.370E+08
MO-99	3.990E+06	3.990E+06	3.990E+06	3.990E+06	3.990E+06	3.990E+06	4.630E+06	3.990E+06
TC-99M	1.840E+05	1.840E+05	1.840E+05	1.840E+05	1.840E+05	1.840E+05	2.110E+05	1.840E+05
TC-101	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.260E+04	2.040E+04
RU-103	1.080E+08	1.080E+08	1.080E+08	1.080E+08	1.080E+08	1.080E+08	1.260E+08	1.080E+08
RU-105	6.360E+05	6.360E+05	6.360E+05	6.360E+05	6.360E+05	6.360E+05	7.210E+05	6.360E+05
RU-106	4.220E+08	4.220E+08	4.220E+08	4.220E+08	4.220E+08	4.220E+08	5.070E+08	4.220E+08
AG-110M	3.440E+09	3.440E+09	3.440E+09	3.440E+09	3.440E+09	3.440E+09	4.010E+09	3.440E+09
TE-125M	1.550E+06	1.550E+06	1.550E+06	1.550E+06	1.550E+06	1.550E+06	2.130E+06	1.550E+06
TE-127	2.980E+03	2.980E+03	2.980E+03	2.980E+03	2.980E+03	2.980E+03	3.280E+03	2.980E+03
TE-127M	9.160E+04	9.160E+04	9.160E+04	9.160E+04	9.160E+04	9.160E+04	1.080E+05	9.160E+04
TE-129	2.620E+04	2.620E+04	2.620E+04	2.620E+04	2.620E+04	2.620E+04	3.100E+04	2.620E+04
TE-129M	1.980E+07	1.980E+07	1.980E+07	1.980E+07	1.980E+07	1.980E+07	2.310E+07	1.980E+07
TE-131	2.920E+04	2.920E+04	2.920E+04	2.920E+04	2.920E+04	2.920E+04	3.450E+07	2.920E+04
TE-131M	8.030E+06	8.030E+06	8.030E+06	8.030E+06	8.030E+06	8.030E+06	9.460E+06	8.030E+06
TE-132	4.230E+06	4.230E+06	4.230E+06	4.230E+06	4.230E+06	4.230E+06	4.980E+06	4.230E+06
I-130	5.510E+06	5.510E+06	5.510E+06	5.510E+06	5.510E+06	5.510E+06	6.690E+06	5.510E+06

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Ground Plane Deposition (GPD)			Units:	m²·mrem/yr / µCi/sec	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	1.720E+07	1.720E+07	1.720E+07	1.720E+07	1.720E+07	1.720E+07	2.090E+07	1.720E+07
I-132	1.250E+06	1.250E+06	1.250E+06	1.250E+06	1.250E+06	1.250E+06	1.470E+06	1.250E+06
I-133	2.450E+06	2.450E+06	2.450E+06	2.450E+06	2.450E+06	2.450E+06	2.980E+06	2.450E+06
I-134	4.470E+05	4.470E+05	4.470E+05	4.470E+05	4.470E+05	4.470E+05	5.300E+05	4.470E+05
I-135	2.530E+06	2.530E+06	2.530E+06	2.530E+06	2.530E+06	2.530E+06	2.950E+06	2.530E+06
CS-134	6.860E+09	6.860E+09	6.860E+09	6.860E+09	6.860E+09	6.860E+09	8.000E+09	6.860E+09
CS-136	1.510E+08	1.510E+08	1.510E+08	1.510E+08	1.510E+08	1.510E+08	1.710E+08	1.510E+08
CS-137	1.030E+10	1.030E+10	1.030E+10	1.030E+10	1.030E+10	1.030E+10	1.200E+10	1.030E+10
CS-138	3.590E+05	3.590E+05	3.590E+05	3.590E+05	3.590E+05	3.590E+05	4.100E+05	3.590E+05
BA-139	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.190E+05	1.060E+05
BA-140	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.350E+07	2.050E+07
BA-141	4.170E+04	4.170E+04	4.170E+04	4.170E+04	4.170E+04	4.170E+04	4.750E+04	4.170E+04
BA-142	4.490E+04	4.490E+04	4.490E+04	4.490E+04	4.490E+04	4.490E+04	5.110E+04	4.490E+04
LA-140	1.920E+07	1.920E+07	1.920E+07	1.920E+07	1.920E+07	1.920E+07	2.180E+07	1.920E+07
LA-142	7.600E+05	7.600E+05	7.600E+05	7.600E+05	7.600E+05	7.600E+05	9.120E+05	7.600E+05
CE-141	1.370E+07	1.370E+07	1.370E+07	1.370E+07	1.370E+07	1.370E+07	1.540E+07	1.370E+07
CE-143	2.310E+06	2.310E+06	2.310E+06	2.310E+06	2.310E+06	2.310E+06	2.630E+06	2.310E+06
CE-144	6.950E+07	6.950E+07	6.950E+07	6.950E+07	6.950E+07	6.950E+07	8.040E+07	6.950E+07
PR-143	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR-144	1.830E+03	1.830E+03	1.830E+03	1.830E+03	1.830E+03	1.830E+03	2.110E+03	1.830E+03
ND-147	8.390E+06	8.390E+06	8.390E+06	8.390E+06	8.390E+06	8.390E+06	1.010E+07	8.390E+06
W-187	2.350E+06	2.350E+06	2.350E+06	2.350E+06	2.350E+06	2.350E+06	2.730E+06	2.350E+06
NP-239	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.980E+06	1.710E+06

APPENDIX J

R_i Infant Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	**INFANT**	**Pathway:**	**Grs/Cow/Milk (CMILK)**			**Units:**	**$m^2\cdot$mrem/yr / μCi/sec; mrem/yr / $\mu Ci/m^3$ (H-3, C-14)**	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	2.380E+03	2.380E+03	2.380E+03	2.380E+03	2.380E+03	0.000E+00	2.380E+03
C-14	2.000E+05	4.270E+04	4.270E+04	4.270E+04	4.270E+04	4.270E+04	0.000E+00	4.270E+04
NA-24	1.540E+07	1.540E+07	1.540E+07	1.540E+07	1.540E+07	1.540E+07	0.000E+00	1.540E+07
P-32	1.600E+11	9.430E+09	0.000E+00	0.000E+00	0.000E+00	2.170E+09	0.000E+00	6.210E+09
CR-51	0.000E+00	0.000E+00	1.050E+05	2.300E+04	2.050E+05	4.700E+06	0.000E+00	1.610E+05
MN-54	0.000E+00	3.900E+07	0.000E+00	8.640E+06	0.000E+00	1.430E+07	0.000E+00	8.840E+06
MN-56	0.000E+00	3.100E-02	0.000E+00	2.660E-02	0.000E+00	2.810E+00	0.000E+00	5.340E-03
FE-55	1.350E+08	8.730E+07	0.000E+00	0.000E+00	4.270E+07	1.110E+07	0.000E+00	2.330E+07
FE-59	2.240E+08	3.920E+08	0.000E+00	0.000E+00	1.160E+08	1.870E+08	0.000E+00	1.540E+08
CO-58	0.000E+00	2.420E+07	0.000E+00	0.000E+00	0.000E+00	6.040E+07	0.000E+00	6.050E+07
CO-60	0.000E+00	8.820E+07	0.000E+00	0.000E+00	0.000E+00	2.100E+08	0.000E+00	2.080E+08
NI-63	3.490E+10	2.160E+09	0.000E+00	0.000E+00	0.000E+00	1.070E+08	0.000E+00	1.210E+09
NI-65	3.510E+00	3.970E-01	0.000E+00	0.000E+00	0.000E+00	3.020E+01	0.000E+00	1.800E-01
CU-64	0.000E+00	1.850E+05	0.000E+00	3.140E+05	0.000E+00	3.810E+06	0.000E+00	8.590E+04
ZN-65	5.550E+09	1.900E+10	0.000E+00	9.230E+09	0.000E+00	1.610E+10	0.000E+00	8.780E+09
ZN-69	2.020E-11	3.630E-11	0.000E+00	1.510E-11	0.000E+00	2.960E-09	0.000E+00	2.700E-12
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.340E-01
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.260E-22
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	2.230E+10	0.000E+00	0.000E+00	0.000E+00	5.690E+08	0.000E+00	1.100E+10
RB-88	0.000E+00	1.880E-44	0.000E+00	0.000E+00	0.000E+00	1.830E-44	0.000E+00	1.030E-44
RB-89	0.000E+00	3.290E-52	0.000E+00	0.000E+00	0.000E+00	1.120E-52	0.000E+00	2.260E-52
SR-89	1.260E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.590E+08	0.000E+00	3.610E+08
SR-90	1.220E+11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.520E+09	0.000E+00	3.100E+10
SR-91	2.720E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.220E+05	0.000E+00	9.830E+03

APPENDIX J

R_i Infant Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	INFANT	Pathway:	Grs/Cow/Milk (CMILK)			Units:	m^2·mrem/yr / µCi/sec; mrem/yr / µCi/m^3 (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	4.640E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.000E+01	0.000E+00	1.720E-01
Y-90	6.810E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.410E+05	0.000E+00	1.830E+01
Y-91	7.330E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.250E+06	0.000E+00	1.950E+03
Y-91M	5.670E-19	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.890E-15	0.000E+00	1.930E-20
Y-92	5.380E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.030E+01	0.000E+00	1.510E-05
Y-93	2.160E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.700E+04	0.000E+00	5.870E-02
ZR-95	6.800E+03	1.660E+03	0.000E+00	1.790E+03	0.000E+00	8.260E+05	0.000E+00	1.180E+03
ZR-97	4.060E+00	6.970E-01	0.000E+00	7.030E-01	0.000E+00	4.450E+04	0.000E+00	3.180E-01
NB-95	5.930E+05	2.440E+05	0.000E+00	1.750E+05	0.000E+00	2.060E+08	0.000E+00	1.410E+05
MO-99	0.000E+00	2.080E+08	0.000E+00	3.110E+08	0.000E+00	6.850E+07	0.000E+00	4.060E+07
TC-99M	2.750E+01	5.670E+01	0.000E+00	6.100E+02	2.960E+01	1.650E+04	0.000E+00	7.300E+02
TC-101	2.470E-59	3.110E-59	0.000E+00	3.700E-58	1.700E-59	5.280E-57	0.000E+00	3.080E-58
RU-103	8.670E+03	0.000E+00	0.000E+00	1.800E+04	0.000E+00	1.050E+05	0.000E+00	2.900E+03
RU-105	8.050E-03	0.000E+00	0.000E+00	5.920E-02	0.000E+00	3.200E+00	0.000E+00	2.710E-03
RU-106	1.900E+05	0.000E+00	0.000E+00	2.250E+05	0.000E+00	1.440E+06	0.000E+00	2.380E+04
AG-110M	3.860E+08	2.820E+08	0.000E+00	4.030E+08	0.000E+00	1.460E+10	0.000E+00	1.860E+08
TE-125M	1.510E+08	5.040E+07	5.070E+07	0.000E+00	0.000E+00	7.180E+07	0.000E+00	2.040E+07
TE-127	6.320E+03	2.120E+03	5.140E+03	1.540E+04	0.000E+00	1.330E+05	0.000E+00	1.360E+03
TE-127M	4.210E+08	1.400E+08	1.220E+08	1.040E+09	0.000E+00	1.700E+08	0.000E+00	5.100E+07
TE-129	2.720E-09	9.380E-10	2.280E-09	6.770E-09	0.000E+00	2.170E-07	0.000E+00	6.350E-10
TE-129M	5.570E+08	1.910E+08	2.140E+08	1.390E+09	0.000E+00	3.330E+08	0.000E+00	8.580E+07
TE-131	3.430E-32	1.270E-32	3.060E-32	8.760E-32	0.000E+00	1.380E-30	0.000E+00	9.610E-33
TE-131M	3.380E+06	1.360E+06	2.750E+06	9.350E+06	0.000E+00	2.290E+07	0.000E+00	1.120E+06
TE-132	2.110E+07	1.040E+07	1.540E+07	6.530E+07	0.000E+00	3.870E+07	0.000E+00	9.750E+06
I-130	3.550E+06	7.810E+06	8.750E+08	8.580E+06	0.000E+00	1.670E+06	0.000E+00	3.130E+06

APPENDIX J

R_i Infant Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	INFANT	Pathway:	Grs/Cow/Milk (CMILK)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	2.720E+09	3.200E+09	1.050E+12	3.740E+09	0.000E+00	1.140E+08	0.000E+00	1.410E+09
I-132	1.430E+00	2.900E+00	1.360E+02	3.240E+00	0.000E+00	2.350E+00	0.000E+00	1.030E+00
I-133	3.630E+07	5.280E+07	9.600E+09	6.210E+07	0.000E+00	8.930E+06	0.000E+00	1.550E+07
I-134	1.760E-11	3.600E-11	8.400E-10	4.030E-11	0.000E+00	3.720E-11	0.000E+00	1.280E-11
I-135	1.120E+05	2.230E+05	2.000E+07	2.490E+05	0.000E+00	8.080E+04	0.000E+00	8.140E+04
CS-134	3.650E+10	6.800E+10	0.000E+00	1.750E+10	7.180E+09	1.850E+08	0.000E+00	6.870E+09
CS-136	1.980E+09	5.810E+09	0.000E+00	2.320E+09	4.740E+08	8.820E+07	0.000E+00	2.170E+09
CS-137	5.150E+10	6.020E+10	0.000E+00	1.620E+10	6.550E+09	1.880E+08	0.000E+00	4.270E+09
CS-138	8.390E-23	1.360E-22	0.000E+00	6.800E-23	1.060E-23	2.180E-22	0.000E+00	6.610E-23
BA-139	4.270E-07	2.830E-10	0.000E+00	1.700E-10	1.720E-10	2.710E-05	0.000E+00	1.240E-08
BA-140	2.410E+08	2.410E+05	0.000E+00	5.720E+04	1.480E+05	5.920E+07	0.000E+00	1.240E+07
BA-141	3.930E-45	2.690E-48	0.000E+00	1.620E-48	1.640E-48	4.800E-44	0.000E+00	1.240E-46
BA-142	2.430E-79	2.020E-82	0.000E+00	1.160E-82	1.220E-82	1.000E-78	0.000E+00	1.200E-80
LA-140	4.050E+01	1.600E+01	0.000E+00	0.000E+00	0.000E+00	1.880E+05	0.000E+00	4.110E+00
LA-142	1.700E-10	6.250E-11	0.000E+00	0.000E+00	0.000E+00	1.060E-05	0.000E+00	1.500E-11
CE-141	4.340E+04	2.640E+04	0.000E+00	8.150E+03	0.000E+00	1.370E+07	0.000E+00	3.110E+03
CE-143	3.970E+02	2.630E+05	0.000E+00	7.670E+01	0.000E+00	1.540E+06	0.000E+00	3.000E+01
CE-144	2.330E+06	9.520E+05	0.000E+00	3.850E+05	0.000E+00	1.330E+08	0.000E+00	1.300E+05
PR-143	1.490E+03	5.550E+02	0.000E+00	2.060E+02	0.000E+00	7.840E+05	0.000E+00	7.360E+01
PR-144	5.690E-53	2.200E-53	0.000E+00	7.980E-54	0.000E+00	1.020E-48	0.000E+00	2.870E-54
ND-147	8.810E+02	9.050E+02	0.000E+00	3.490E+02	0.000E+00	5.740E+05	0.000E+00	5.550E+01
W-187	6.080E+04	4.230E+04	0.000E+00	0.000E+00	0.000E+00	2.480E+06	0.000E+00	1.460E+04
NP-239	3.650E+01	3.260E+00	0.000E+00	6.510E+00	0.000E+00	9.430E+04	0.000E+00	1.840E+00

APPENDIX J

R_i Infant Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	INFANT	Pathway:	Grs/Goat/Milk (GMILK)			Units:	$m^2 \cdot$mrem/yr / µCi/sec; mrem/yr / µCi/m^3 (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	4.860E+03	4.860E+03	4.860E+03	4.860E+03	4.860E+03	0.000E+00	4.860E+03
C-14	2.000E+05	4.270E+04	4.270E+04	4.270E+04	4.270E+04	4.270E+04	0.000E+00	4.270E+04
NA-24	1.850E+06	1.850E+06	1.850E+06	1.850E+06	1.850E+06	1.850E+06	0.000E+00	1.850E+06
P-32	1.920E+11	1.130E+10	0.000E+00	0.000E+00	0.000E+00	2.600E+09	0.000E+00	7.460E+09
CR-51	0.000E+00	0.000E+00	1.260E+04	2.760E+03	2.460E+04	5.640E+05	0.000E+00	1.940E+04
MN-54	0.000E+00	4.680E+06	0.000E+00	1.040E+06	0.000E+00	1.720E+06	0.000E+00	1.060E+06
MN-56	0.000E+00	3.720E-03	0.000E+00	3.190E-03	0.000E+00	3.380E-01	0.000E+00	6.410E-04
FE-55	1.760E+06	1.130E+06	0.000E+00	0.000E+00	5.550E+05	1.440E+05	0.000E+00	3.030E+05
FE-59	2.920E+06	5.100E+06	0.000E+00	0.000E+00	1.510E+06	2.430E+06	0.000E+00	2.010E+06
CO-58	0.000E+00	2.910E+06	0.000E+00	0.000E+00	0.000E+00	7.250E+06	0.000E+00	7.260E+06
CO-60	0.000E+00	1.060E+07	0.000E+00	0.000E+00	0.000E+00	2.520E+07	0.000E+00	2.500E+07
NI-63	4.190E+09	2.590E+08	0.000E+00	0.000E+00	0.000E+00	1.290E+07	0.000E+00	1.450E+08
NI-65	4.210E-01	4.760E-02	0.000E+00	0.000E+00	0.000E+00	3.620E+00	0.000E+00	2.170E-02
CU-64	0.000E+00	2.070E+04	0.000E+00	3.500E+04	0.000E+00	4.240E+05	0.000E+00	9.570E+03
ZN-65	6.660E+08	2.280E+09	0.000E+00	1.110E+09	0.000E+00	1.930E+09	0.000E+00	1.050E+09
ZN-69	2.420E-12	4.360E-12	0.000E+00	1.810E-12	0.000E+00	3.550E-10	0.000E+00	3.240E-13
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.120E-01
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.510E-23
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	2.670E+09	0.000E+00	0.000E+00	0.000E+00	6.830E+07	0.000E+00	1.320E+09
RB-88	0.000E+00	2.250E-45	0.000E+00	0.000E+00	0.000E+00	2.190E-45	0.000E+00	1.230E-45
RB-89	0.000E+00	3.940E-53	0.000E+00	0.000E+00	0.000E+00	1.340E-53	0.000E+00	2.720E-53
SR-89	2.640E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.430E+08	0.000E+00	7.580E+08
SR-90	2.550E+11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.190E+09	0.000E+00	6.500E+10
SR-91	5.700E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.750E+05	0.000E+00	2.060E+04

APPENDIX J

R_i Infant Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	INFANT	Pathway:	Grs/Goat/Milk (GMILK)			Units:	$m^2 \cdot$mrem/yr / µCi/sec; mrem/yr / µCi/m^3 (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	9.750E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.050E+02	0.000E+00	3.620E-01
Y-90	8.170E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.130E+05	0.000E+00	2.190E+00
Y-91	8.790E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.300E+05	0.000E+00	2.340E+02
Y-91M	6.810E-20	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.270E-16	0.000E+00	2.320E-21
Y-92	6.450E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.230E+00	0.000E+00	1.810E-06
Y-93	2.590E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.040E+03	0.000E+00	7.050E-03
ZR-95	8.170E+02	1.990E+02	0.000E+00	2.140E+02	0.000E+00	9.910E+04	0.000E+00	1.410E+02
ZR-97	4.870E-01	8.360E-02	0.000E+00	8.430E-02	0.000E+00	5.340E+03	0.000E+00	3.820E-02
NB-95	7.120E+04	2.930E+04	0.000E+00	2.100E+04	0.000E+00	2.480E+07	0.000E+00	1.700E+04
MO-99	0.000E+00	2.500E+07	0.000E+00	3.730E+07	0.000E+00	8.220E+06	0.000E+00	4.870E+06
TC-99M	3.300E+00	6.800E+00	0.000E+00	7.320E+01	3.550E+00	1.970E+03	0.000E+00	8.760E+01
TC-101	2.960E-60	3.730E-60	0.000E+00	4.440E-59	2.030E-60	6.340E-58	0.000E+00	3.690E-59
RU-103	1.040E+03	0.000E+00	0.000E+00	2.170E+03	0.000E+00	1.270E+04	0.000E+00	3.480E+02
RU-105	9.660E-04	0.000E+00	0.000E+00	7.110E-03	0.000E+00	3.840E-01	0.000E+00	3.250E-04
RU-106	2.280E+04	0.000E+00	0.000E+00	2.700E+04	0.000E+00	1.730E+05	0.000E+00	2.850E+03
AG-110M	4.630E+07	3.380E+07	0.000E+00	4.830E+07	0.000E+00	1.750E+09	0.000E+00	2.240E+07
TE-125M	1.810E+07	6.050E+06	6.090E+06	0.000E+00	0.000E+00	8.620E+06	0.000E+00	2.450E+06
TE-127	7.580E+02	2.540E+02	6.170E+02	1.850E+03	0.000E+00	1.590E+04	0.000E+00	1.630E+02
TE-127M	5.050E+07	1.680E+07	1.460E+07	1.240E+08	0.000E+00	2.040E+07	0.000E+00	6.120E+06
TE-129	3.260E-10	1.130E-10	2.740E-10	8.130E-10	0.000E+00	2.610E-08	0.000E+00	7.620E-11
TE-129M	6.690E+07	2.290E+07	2.570E+07	1.670E+08	0.000E+00	3.990E+07	0.000E+00	1.030E+07
TE-131	4.110E-33	1.520E-33	3.670E-33	1.050E-32	0.000E+00	1.660E-31	0.000E+00	1.150E-33
TE-131M	4.050E+05	1.630E+05	3.310E+05	1.120E+06	0.000E+00	2.750E+06	0.000E+00	1.350E+05
TE-132	2.530E+06	1.250E+06	1.850E+06	7.840E+06	0.000E+00	4.640E+06	0.000E+00	1.170E+06
I-130	4.260E+06	9.370E+06	1.050E+09	1.030E+07	0.000E+00	2.010E+06	0.000E+00	3.760E+06

APPENDIX J

R_i Infant Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	INFANT	Pathway:	Grs/Goat/Milk (GMILK)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	3.260E+09	3.850E+09	1.260E+12	4.490E+09	0.000E+00	1.370E+08	0.000E+00	1.690E+09
I-132	1.720E+00	3.480E+00	1.630E+02	3.890E+00	0.000E+00	2.820E+00	0.000E+00	1.240E+00
I-133	4.350E+07	6.340E+07	1.150E+10	7.450E+07	0.000E+00	1.070E+07	0.000E+00	1.860E+07
I-134	2.110E-11	4.320E-11	1.010E-09	4.830E-11	0.000E+00	4.470E-11	0.000E+00	1.540E-11
I-135	1.350E+05	2.680E+05	2.400E+07	2.990E+05	0.000E+00	9.700E+04	0.000E+00	9.770E+04
CS-134	1.090E+11	2.040E+11	0.000E+00	5.250E+10	2.150E+10	5.540E+08	0.000E+00	2.060E+10
CS-136	5.930E+09	1.740E+10	0.000E+00	6.950E+09	1.420E+09	2.650E+08	0.000E+00	6.510E+09
CS-137	1.540E+11	1.810E+11	0.000E+00	4.850E+10	1.960E+10	5.650E+08	0.000E+00	1.280E+10
CS-138	2.520E-22	4.090E-22	0.000E+00	2.040E-22	3.190E-23	6.540E-22	0.000E+00	1.980E-22
BA-139	5.130E-08	3.400E-11	0.000E+00	2.040E-11	2.060E-11	3.250E-06	0.000E+00	1.480E-09
BA-140	2.890E+07	2.890E+04	0.000E+00	6.870E+03	1.780E+04	7.100E+06	0.000E+00	1.490E+06
BA-141	4.720E-46	3.230E-49	0.000E+00	1.940E-49	1.960E-49	5.760E-45	0.000E+00	1.490E-47
BA-142	2.920E-80	2.430E-83	0.000E+00	1.400E-83	1.470E-83	1.200E-79	0.000E+00	1.440E-81
LA-140	4.860E+00	1.920E+00	0.000E+00	0.000E+00	0.000E+00	2.250E+04	0.000E+00	4.930E-01
LA-142	2.040E-11	7.500E-12	0.000E+00	0.000E+00	0.000E+00	1.270E-06	0.000E+00	1.790E-12
CE-141	5.200E+03	3.170E+03	0.000E+00	9.790E+02	0.000E+00	1.640E+06	0.000E+00	3.740E+02
CE-143	4.760E+01	3.160E+04	0.000E+00	9.200E+00	0.000E+00	1.840E+05	0.000E+00	3.600E+00
CE-144	2.790E+05	1.140E+05	0.000E+00	4.620E+04	0.000E+00	1.600E+07	0.000E+00	1.560E+04
PR-143	1.780E+02	6.670E+01	0.000E+00	2.480E+01	0.000E+00	9.410E+04	0.000E+00	8.840E+00
PR-144	6.830E-54	2.640E-54	0.000E+00	9.570E-55	0.000E+00	1.230E-49	0.000E+00	3.440E-55
ND-147	1.060E+02	1.090E+02	0.000E+00	4.190E+01	0.000E+00	6.880E+04	0.000E+00	6.650E+00
W-187	7.300E+03	5.070E+03	0.000E+00	0.000E+00	0.000E+00	2.980E+05	0.000E+00	1.750E+03
NP-239	4.380E+00	3.910E-01	0.000E+00	7.810E-01	0.000E+00	1.130E+04	0.000E+00	2.210E-01

APPENDIX J

R_i Infant Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	INFANT	Pathway:	Inhalation (INHL)			Units:	mrem/yr / µCi/m^3	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	6.470E+02	6.470E+02	6.470E+02	6.470E+02	6.470E+02	0.000E+00	6.470E+02
C-14	2.650E+04	5.310E+03	5.310E+03	5.310E+03	5.310E+03	5.310E+03	0.000E+00	5.310E+03
NA-24	1.060E+04	1.060E+04	1.060E+04	1.060E+04	1.060E+04	1.060E+04	0.000E+00	1.060E+04
P-32	2.030E+06	1.120E+05	0.000E+00	0.000E+00	0.000E+00	1.610E+04	0.000E+00	7.740E+04
CR-51	0.000E+00	0.000E+00	5.750E+01	1.320E+01	1.280E+04	3.570E+02	0.000E+00	8.950E+01
MN-54	0.000E+00	2.530E+04	0.000E+00	4.980E+03	1.000E+06	7.060E+03	0.000E+00	4.980E+03
MN-56	0.000E+00	1.540E+00	0.000E+00	1.100E+00	1.250E+04	7.170E+04	0.000E+00	2.210E-01
FE-55	1.970E+04	1.170E+04	0.000E+00	0.000E+00	8.690E+04	1.090E+03	0.000E+00	3.330E+03
FE-59	1.360E+04	2.350E+04	0.000E+00	0.000E+00	1.010E+06	2.480E+04	0.000E+00	9.480E+03
CO-58	0.000E+00	1.220E+03	0.000E+00	0.000E+00	7.770E+05	1.110E+04	0.000E+00	1.820E+03
CO-60	0.000E+00	8.020E+03	0.000E+00	0.000E+00	4.510E+06	3.190E+04	0.000E+00	1.180E+04
NI-63	3.390E+05	2.040E+04	0.000E+00	0.000E+00	2.090E+05	2.420E+03	0.000E+00	1.160E+04
NI-65	2.390E+00	2.840E-01	0.000E+00	0.000E+00	8.120E+03	5.010E+04	0.000E+00	1.230E-01
CU-64	0.000E+00	1.880E+00	0.000E+00	3.980E+00	9.300E+03	1.500E+04	0.000E+00	7.740E-01
ZN-65	1.930E+04	6.260E+04	0.000E+00	3.250E+04	6.470E+05	5.140E+04	0.000E+00	3.110E+04
ZN-69	5.390E-02	9.670E-02	0.000E+00	4.020E-02	1.470E+03	1.320E+04	0.000E+00	7.180E-03
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.810E+02
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.000E+02
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.040E+01
RB-86	0.000E+00	1.900E+05	0.000E+00	0.000E+00	0.000E+00	3.040E+03	0.000E+00	8.820E+04
RB-88	0.000E+00	5.570E+02	0.000E+00	0.000E+00	0.000E+00	3.390E+02	0.000E+00	2.870E+02
RB-89	0.000E+00	3.210E+02	0.000E+00	0.000E+00	0.000E+00	6.820E+01	0.000E+00	2.060E+02
SR-89	3.980E+05	0.000E+00	0.000E+00	0.000E+00	2.030E+06	6.400E+04	0.000E+00	1.140E+04
SR-90	4.090E+07	0.000E+00	0.000E+00	0.000E+00	1.120E+07	1.310E+05	0.000E+00	2.590E+06
SR-91	9.560E+01	0.000E+00	0.000E+00	0.000E+00	5.260E+04	7.340E+04	0.000E+00	3.460E+00

APPENDIX J

R_i Infant Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	INFANT	Pathway:	Inhalation (INHL)			Units:	mrem/yr / µCi/m³	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-92	1.050E+01	0.000E+00	0.000E+00	0.000E+00	2.380E+04	1.400E+05	0.000E+00	3.910E-01
Y-90	3.290E+03	0.000E+00	0.000E+00	0.000E+00	2.690E+05	1.040E+05	0.000E+00	8.820E+01
Y-91	5.880E+05	0.000E+00	0.000E+00	0.000E+00	2.450E+06	7.030E+04	0.000E+00	1.570E+04
Y-91M	4.070E-01	0.000E+00	0.000E+00	0.000E+00	2.790E+03	2.350E+03	0.000E+00	1.390E-02
Y-92	1.640E+01	0.000E+00	0.000E+00	0.000E+00	2.450E+04	1.270E+05	0.000E+00	4.610E-01
Y-93	1.500E+02	0.000E+00	0.000E+00	0.000E+00	7.640E+04	1.670E+05	0.000E+00	4.070E+00
ZR-95	1.150E+05	2.790E+04	0.000E+00	3.110E+04	1.750E+06	2.170E+04	0.000E+00	2.030E+04
ZR-97	1.500E+02	2.560E+01	0.000E+00	2.590E+01	1.100E+05	1.400E+05	0.000E+00	1.170E+01
NB-95	1.570E+04	6.430E+03	0.000E+00	4.720E+03	4.790E+05	1.270E+04	0.000E+00	3.780E+03
MO-99	0.000E+00	1.650E+02	0.000E+00	2.650E+02	1.350E+05	4.870E+04	0.000E+00	3.230E+01
TC-99M	1.400E-03	2.880E-03	0.000E+00	3.110E-02	8.110E+02	2.030E+03	0.000E+00	3.720E-02
TC-101	6.510E-05	8.230E-05	0.000E+00	9.790E-04	5.840E+02	8.440E+02	0.000E+00	8.120E-04
RU-103	2.020E+03	0.000E+00	0.000E+00	4.240E+03	5.520E+05	1.610E+04	0.000E+00	6.790E+02
RU-105	1.220E+00	0.000E+00	0.000E+00	8.990E-01	1.570E+04	4.840E+04	0.000E+00	4.100E-01
RU-106	8.680E+04	0.000E+00	0.000E+00	1.070E+05	1.160E+07	1.640E+05	0.000E+00	1.090E+04
AG-110M	9.980E+03	7.220E+03	0.000E+00	1.090E+04	3.670E+06	3.300E+04	0.000E+00	5.000E+03
TE-125M	4.760E+03	1.990E+03	1.620E+03	0.000E+00	4.470E+05	1.290E+04	0.000E+00	6.580E+02
TE-127	2.230E+00	9.530E-01	1.850E+00	4.860E+00	1.030E+04	2.440E+04	0.000E+00	4.890E-01
TE-127M	1.670E+04	6.900E+03	4.870E+03	3.750E+04	1.310E+06	2.730E+04	0.000E+00	2.070E+03
TE-129	7.880E-02	3.470E-02	6.750E-02	1.750E-01	3.000E+03	2.630E+04	0.000E+00	1.880E-02
TE-129M	1.410E+04	6.090E+03	5.470E+03	3.180E+04	1.680E+06	6.900E+04	0.000E+00	2.230E+03
TE-131	1.740E-02	8.220E-03	1.580E-02	3.990E-02	2.060E+03	8.220E+03	0.000E+00	5.000E-03
TE-131M	1.070E+02	5.500E+01	8.930E+01	2.650E+02	1.990E+05	1.190E+05	0.000E+00	3.630E+01
TE-132	3.720E+02	2.370E+02	2.790E+02	1.030E+03	3.400E+05	4.410E+04	0.000E+00	1.760E+02
I-130	6.360E+03	1.390E+04	1.600E+06	1.530E+04	0.000E+00	1.990E+03	0.000E+00	5.570E+03

APPENDIX J

R_i Infant Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	INFANT	Pathway:	Inhalation (INHL)			Units:	mrem/yr / µCi/m³	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	3.790E+04	4.440E+04	1.480E+07	5.180E+04	0.000E+00	1.060E+03	0.000E+00	1.960E+04
I-132	1.690E+03	3.540E+03	1.690E+05	3.950E+03	0.000E+00	1.900E+03	0.000E+00	1.260E+03
I-133	1.320E+04	1.920E+04	3.560E+06	2.240E+04	0.000E+00	2.160E+03	0.000E+00	5.600E+03
I-134	9.210E+02	1.880E+03	4.450E+04	2.090E+03	0.000E+00	1.290E+03	0.000E+00	6.650E+02
I-135	3.860E+03	7.600E+03	6.960E+05	8.470E+03	0.000E+00	1.830E+03	0.000E+00	2.770E+03
CS-134	3.960E+05	7.030E+05	0.000E+00	1.900E+05	7.970E+04	1.330E+03	0.000E+00	7.450E+04
CS-136	4.830E+04	1.350E+05	0.000E+00	5.640E+04	1.180E+04	1.430E+03	0.000E+00	5.290E+04
CS-137	5.490E+05	6.120E+05	0.000E+00	1.720E+05	7.130E+04	1.330E+03	0.000E+00	4.550E+04
CS-138	5.050E+02	7.810E+02	0.000E+00	4.100E+02	6.540E+01	8.760E+02	0.000E+00	3.980E+02
BA-139	1.480E+00	9.840E-04	0.000E+00	5.920E-04	5.950E+03	5.100E+04	0.000E+00	4.300E-02
BA-140	5.600E+04	5.600E+01	0.000E+00	1.340E+01	1.600E+06	3.840E+04	0.000E+00	2.900E+03
BA-141	1.570E-01	1.080E-04	0.000E+00	6.500E-05	2.970E+03	4.750E+03	0.000E+00	4.970E-03
BA-142	3.980E-02	3.300E-05	0.000E+00	1.900E-05	1.550E+03	6.930E+02	0.000E+00	1.960E-03
LA-140	5.050E+02	2.000E+02	0.000E+00	0.000E+00	1.680E+05	8.480E+04	0.000E+00	5.150E+01
LA-142	1.030E+00	3.770E-01	0.000E+00	0.000E+00	8.220E+03	5.950E+04	0.000E+00	9.040E-02
CE-141	2.770E+04	1.670E+04	0.000E+00	5.250E+03	5.170E+05	2.160E+04	0.000E+00	1.990E+03
CE-143	2.930E+02	1.930E+02	0.000E+00	5.640E+01	1.160E+05	4.970E+04	0.000E+00	2.210E+01
CE-144	3.190E+06	1.210E+06	0.000E+00	5.380E+05	9.840E+06	1.480E+05	0.000E+00	1.760E+05
PR-143	1.400E+04	5.240E+03	0.000E+00	1.970E+03	4.330E+05	3.720E+04	0.000E+00	6.990E+02
PR-144	4.790E-02	1.850E-02	0.000E+00	6.720E-03	1.610E+03	4.280E+03	0.000E+00	2.410E-03
ND-147	7.940E+03	8.130E+03	0.000E+00	3.150E+03	3.220E+05	3.120E+04	0.000E+00	5.000E+02
W-187	1.300E+01	9.020E+00	0.000E+00	0.000E+00	3.960E+04	3.560E+04	0.000E+00	3.120E+00
NP-239	3.710E+02	3.320E+01	0.000E+00	6.620E+01	5.950E+04	2.490E+04	0.000E+00	1.880E+01

APPENDIX J

R_i Infant Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	INFANT	Pathway:	Ground Plane Deposition (GPD)			Units:	$m^2 \cdot$mrem/yr / µCi/sec	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C-14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NA-24	1.190E+07	1.190E+07	1.190E+07	1.190E+07	1.190E+07	1.190E+07	1.390E+07	1.190E+07
P-32	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CR-51	4.660E+06	4.660E+06	4.660E+06	4.660E+06	4.660E+06	4.660E+06	5.510E+06	4.660E+06
MN-54	1.390E+09	1.390E+09	1.390E+09	1.390E+09	1.390E+09	1.390E+09	1.630E+09	1.390E+09
MN-56	9.020E+05	9.020E+05	9.020E+05	9.020E+05	9.020E+05	9.020E+05	1.070E+06	9.020E+05
FE-55	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
FE-59	2.730E+08	2.730E+08	2.730E+08	2.730E+08	2.730E+08	2.730E+08	3.210E+08	2.730E+08
CO-58	3.790E+08	3.790E+08	3.790E+08	3.790E+08	3.790E+08	3.790E+08	4.440E+08	3.790E+08
CO-60	2.150E+10	2.150E+10	2.150E+10	2.150E+10	2.150E+10	2.150E+10	2.530E+10	2.150E+10
NI-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NI-65	2.970E+05	2.970E+05	2.970E+05	2.970E+05	2.970E+05	2.970E+05	3.450E+05	2.970E+05
CU-64	6.070E+05	6.070E+05	6.070E+05	6.070E+05	6.070E+05	6.070E+05	6.880E+05	6.070E+05
ZN-65	7.470E+08	7.470E+08	7.470E+08	7.470E+08	7.470E+08	7.470E+08	8.590E+08	7.470E+08
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	4.870E+03	4.870E+03	4.870E+03	4.870E+03	4.870E+03	4.870E+03	7.080E+03	4.870E+03
BR-84	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.360E+05	2.030E+05
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	8.990E+06	8.990E+06	8.990E+06	8.990E+06	8.990E+06	8.990E+06	1.030E+07	8.990E+06
RB-88	3.310E+04	3.310E+04	3.310E+04	3.310E+04	3.310E+04	3.310E+04	3.780E+04	3.310E+04
RB-89	1.230E+05	1.230E+05	1.230E+05	1.230E+05	1.230E+05	1.230E+05	1.480E+05	1.230E+05
SR-89	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.510E+04	2.160E+04
SR-90	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-91	2.150E+06	2.150E+06	2.150E+06	2.150E+06	2.150E+06	2.150E+06	2.510E+06	2.150E+06

APPENDIX J

R_i Infant Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	INFANT	Pathway:	Ground Plane Deposition (GPD)			Units:	$m^2 \cdot$mrem/yr / µCi/sec	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	7.770E+05	7.770E+05	7.770E+05	7.770E+05	7.770E+05	7.770E+05	8.630E+05	7.770E+05
Y-90	4.490E+03	4.490E+03	4.490E+03	4.490E+03	4.490E+03	4.490E+03	5.310E+03	4.490E+03
Y-91	1.070E+06	1.070E+06	1.070E+06	1.070E+06	1.070E+06	1.070E+06	1.210E+06	1.070E+06
Y-91M	1.000E+05	1.000E+05	1.000E+05	1.000E+05	1.000E+05	1.000E+05	1.160E+05	1.000E+05
Y-92	1.800E+05	1.800E+05	1.800E+05	1.800E+05	1.800E+05	1.800E+05	2.140E+05	1.800E+05
Y-93	1.830E+05	1.830E+05	1.830E+05	1.830E+05	1.830E+05	1.830E+05	2.510E+05	1.830E+05
ZR-95	2.450E+08	2.450E+08	2.450E+08	2.450E+08	2.450E+08	2.450E+08	2.840E+08	2.450E+08
ZR-97	2.960E+06	2.960E+06	2.960E+06	2.960E+06	2.960E+06	2.960E+06	3.440E+06	2.960E+06
NB-95	1.370E+08	1.370E+08	1.370E+08	1.370E+08	1.370E+08	1.370E+08	1.610E+08	1.370E+08
MO-99	3.990E+06	3.990E+06	3.990E+06	3.990E+06	3.990E+06	3.990E+06	4.630E+06	3.990E+06
TC-99M	1.840E+05	1.840E+05	1.840E+05	1.840E+05	1.840E+05	1.840E+05	2.110E+05	1.840E+05
TC-101	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.260E+04	2.040E+04
RU-103	1.080E+08	1.080E+08	1.080E+08	1.080E+08	1.080E+08	1.080E+08	1.260E+08	1.080E+08
RU-105	6.360E+05	6.360E+05	6.360E+05	6.360E+05	6.360E+05	6.360E+05	7.210E+05	6.360E+05
RU-106	4.220E+08	4.220E+08	4.220E+08	4.220E+08	4.220E+08	4.220E+08	5.070E+08	4.220E+08
AG-110M	3.440E+09	3.440E+09	3.440E+09	3.440E+09	3.440E+09	3.440E+09	4.010E+09	3.440E+09
TE-125M	1.550E+06	1.550E+06	1.550E+06	1.550E+06	1.550E+06	1.550E+06	2.130E+06	1.550E+06
TE-127	2.980E+03	2.980E+03	2.980E+03	2.980E+03	2.980E+03	2.980E+03	3.280E+03	2.980E+03
TE-127M	9.160E+04	9.160E+04	9.160E+04	9.160E+04	9.160E+04	9.160E+04	1.080E+05	9.160E+04
TE-129	2.620E+04	2.620E+04	2.620E+04	2.620E+04	2.620E+04	2.620E+04	3.100E+04	2.620E+04
TE-129M	1.980E+07	1.980E+07	1.980E+07	1.980E+07	1.980E+07	1.980E+07	2.310E+07	1.980E+07
TE-131	2.920E+04	2.920E+04	2.920E+04	2.920E+04	2.920E+04	2.920E+04	3.450E+07	2.920E+04
TE-131M	8.030E+06	8.030E+06	8.030E+06	8.030E+06	8.030E+06	8.030E+06	9.460E+06	8.030E+06
TE-132	4.230E+06	4.230E+06	4.230E+06	4.230E+06	4.230E+06	4.230E+06	4.980E+06	4.230E+06
I-130	5.510E+06	5.510E+06	5.510E+06	5.510E+06	5.510E+06	5.510E+06	6.690E+06	5.510E+06

APPENDIX J

R_i Infant Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	INFANT	Pathway:	Ground Plane Deposition (GPD)			Units:	m^2·mrem/yr / µCi/sec	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
I-131	1.720E+07	1.720E+07	1.720E+07	1.720E+07	1.720E+07	1.720E+07	2.090E+07	1.720E+07
I-132	1.250E+06	1.250E+06	1.250E+06	1.250E+06	1.250E+06	1.250E+06	1.470E+06	1.250E+06
I-133	2.450E+06	2.450E+06	2.450E+06	2.450E+06	2.450E+06	2.450E+06	2.980E+06	2.450E+06
I-134	4.470E+05	4.470E+05	4.470E+05	4.470E+05	4.470E+05	4.470E+05	5.300E+05	4.470E+05
I-135	2.530E+06	2.530E+06	2.530E+06	2.530E+06	2.530E+06	2.530E+06	2.950E+06	2.530E+06
CS-134	6.860E+09	6.860E+09	6.860E+09	6.860E+09	6.860E+09	6.860E+09	8.000E+09	6.860E+09
CS-136	1.510E+08	1.510E+08	1.510E+08	1.510E+08	1.510E+08	1.510E+08	1.710E+08	1.510E+08
CS-137	1.030E+10	1.030E+10	1.030E+10	1.030E+10	1.030E+10	1.030E+10	1.200E+10	1.030E+10
CS-138	3.590E+05	3.590E+05	3.590E+05	3.590E+05	3.590E+05	3.590E+05	4.100E+05	3.590E+05
BA-139	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.190E+05	1.060E+05
BA-140	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.350E+07	2.050E+07
BA-141	4.170E+04	4.170E+04	4.170E+04	4.170E+04	4.170E+04	4.170E+04	4.750E+04	4.170E+04
BA-142	4.490E+04	4.490E+04	4.490E+04	4.490E+04	4.490E+04	4.490E+04	5.110E+04	4.490E+04
LA-140	1.920E+07	1.920E+07	1.920E+07	1.920E+07	1.920E+07	1.920E+07	2.180E+07	1.920E+07
LA-142	7.600E+05	7.600E+05	7.600E+05	7.600E+05	7.600E+05	7.600E+05	9.120E+05	7.600E+05
CE-141	1.370E+07	1.370E+07	1.370E+07	1.370E+07	1.370E+07	1.370E+07	1.540E+07	1.370E+07
CE-143	2.310E+06	2.310E+06	2.310E+06	2.310E+06	2.310E+06	2.310E+06	2.630E+06	2.310E+06
CE-144	6.950E+07	6.950E+07	6.950E+07	6.950E+07	6.950E+07	6.950E+07	8.040E+07	6.950E+07
PR-143	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR-144	1.830E+03	1.830E+03	1.830E+03	1.830E+03	1.830E+03	1.830E+03	2.110E+03	1.830E+03
ND-147	8.390E+06	8.390E+06	8.390E+06	8.390E+06	8.390E+06	8.390E+06	1.010E+07	8.390E+06
W-187	2.350E+06	2.350E+06	2.350E+06	2.350E+06	2.350E+06	2.350E+06	2.730E+06	2.350E+06
NP-239	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.980E+06	1.710E+06

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.1 Liquid Effluents – Concentration

COMMITMENT The concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS (see Figure 16.11.1-1) shall be limited:

a. For radionuclides other than dissolved or entrained noble gases, 10 times the effluent concentrations specified in 10 CFR Part 20, Appendix B, Table 2, Column 2, and

b. For dissolved or entrained noble gases, the concentration shall be limited to 2 x 10^{-4} microCurie/ml total activity.

APPLICABILITY At all times.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS not within limits.	A.1 Restore the concentration to within limits.	Immediately

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11.1.1 ---------------------------------NOTE-------------------------------- The results of the radioactivity analyses shall be used in accordance with the methodology and parameters in the ODCM to assure that the concentrations at the point of release are maintained within the limits. -- Sample and analyze radioactive liquid wastes according to Table 16.11.1-1.	According to Table 16.11.1-1

TABLE 16.11.1-1
(Page 1 of 3)

RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

LIQUID RELEASE TYPE	SAMPLING FREQUENCY	MINIMUM ANALYSIS FREQUENCY	TYPE OF ACTIVITY ANALYSIS	LOWER LIMIT OF DETECTION (LLD) microCi/ml (1)
1. Batch Waste Release Tanks (WMT and RMT)(4)	P Each Batch	P Each Batch	Principal Gamma Emitters(6)	$5x10^{-7}$
			I-131	$1x10^{-6}$
	P One Batch/M	M	Dissolved and Entrained Gases (Gamma emitters)(7)	$1x10^{-5}$
	P Each Batch	M Composite(2)	H-3	$1x10^{-5}$
			Gross Alpha	$1x10^{-7}$
	P Each Batch	Q Composite(2)	Sr-89, Sr-90	$5x10^{-8}$
2. Continuous Releases (VUCDT discharge, CWWTS outlet and Turbine Building Sump to RC)(5)	Continuous(3)	W Composite(3)	Principal Gamma Emitters (6)	$5x10^{-7}$
			I-131	$1x10^{-6}$
	M Grab Sample	M	Dissolved and Entrained Gases (Gamma emitters)(7)	$1x10^{-5}$
	Continuous(3)	M Composite(3)	H-3	$1x10^{-5}$
			Gross Alpha	$1x10^{-7}$
	Continuous(3)	Q Composite(3)	Sr-89, Sr-90	$5x10^{-8}$

TABLE 16.11.1-1
(Page 2 of 3)

NOTES:

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

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

$$LLD = \frac{(2.71/T) + 4.65S_b}{E \cdot V \cdot 2.22\ x\ 10^6 \cdot Y \cdot \exp(-\lambda\Delta t)}$$

Where:

LLD is the "a priori" lower limit of detection as defined above (as microCurie per unit mass or volume),

S_b is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute),

E is the counting efficiency (as counts per disintegration),

V is the sample size (in units of mass or volume),

2.22×10^6 is the number of disintegrations per minute per microCurie,

Y is the fractional radiochemical yield (when applicable),

λ is the radioactive decay constant for the particular radionuclide,

Δt is the elapsed time between midpoint of sample collection and time of counting (for plant effluents, not environmental samples), and

T is the background and sample counting time in minutes.

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

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

(2) A composite sample is one in which the quantity of liquid sampled is proportional to the quantity of liquid waste discharged and in which the method of sampling employed results in a specimen which is representative of the liquids released.

TABLE 16.11.1-1
(Page 3 of 3)

(3) To be representative of the quantities and concentrations of radioactive materials in liquid effluents, samples shall be collected continuously or intermittently in proportion to the rate of flow of the effluent stream. Prior to analyses, all samples taken for the composite shall be thoroughly mixed in order for the composite sample to be representative of the effluent release.

(4) A batch release is the discharge of liquid wastes of a discrete volume. Prior to sampling for analyses, each batch shall be isolated and thoroughly mixed to assure representative sampling.

(5) A continuous release is the discharge of liquid wastes of a nondiscrete volume; e.g., from a volume of system that has an input flow during the continuous release.

(6) The principal gamma emitters for which the LLD specification applies exclusively are the following radionuclides: Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, and Ce-141. The LLD for Ce-144 is $5x10^{-6}$ microCi/ml. This list does not mean that only these nuclides are to be detected and reported. Other peaks which are measurable and identifiable, together with the above nuclides, shall be identified and reported in the Annual Radioactive Effluent Release Report.

(7) The principal gas gamma emitters for which the LLD specification applies are Xe-133 and Xe-135. These are the reference nuclides in Regulatory Guide 1.21.

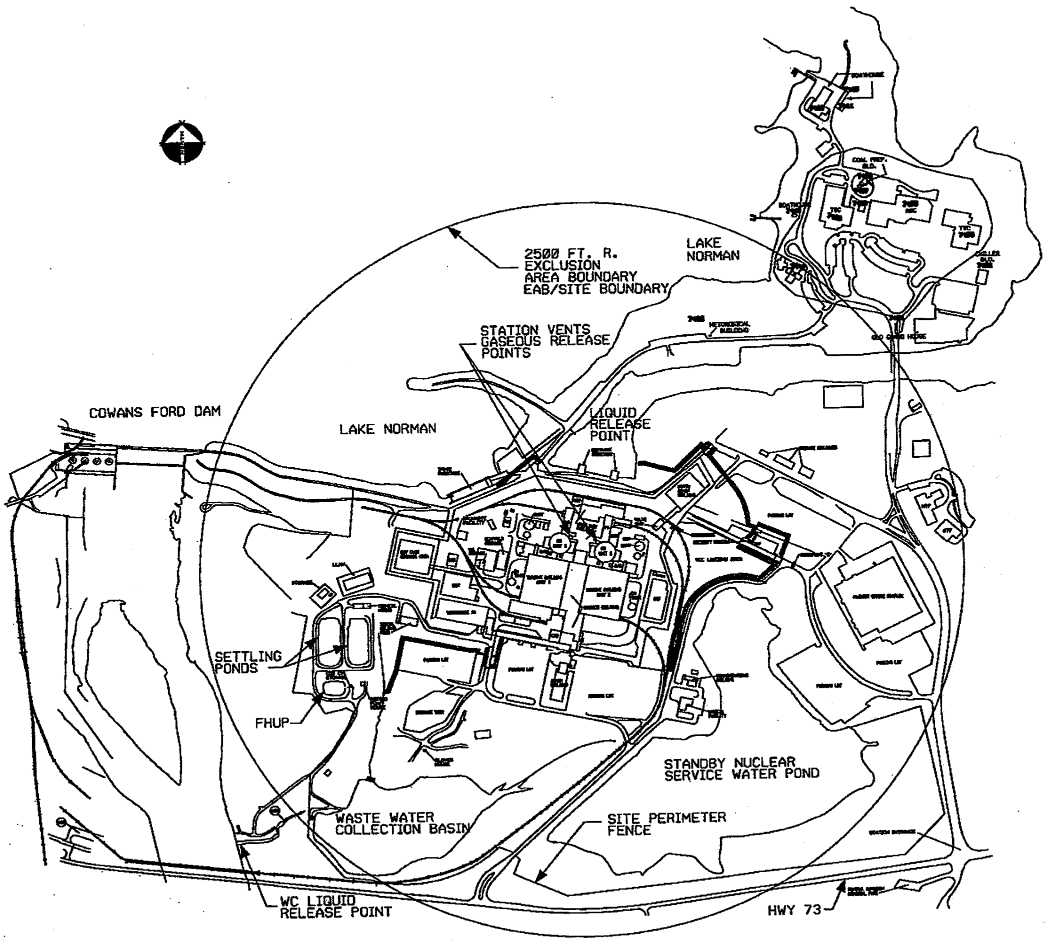


FIGURE 16.11.1-1 SITE BOUNDARY / EXCLUSION AREA BOUNDARY

BASES

This commitment is provided to ensure that the concentration of radioactive materials released in liquid waste effluents to UNRESTRICTED AREAS will be less than 10 times the effluent concentration levels specified in 10 CFR Part 20, Appendix B, Table 2, Column 2. This limitation provides additional assurance that the levels of radioactive materials in bodies of water in UNRESTRICTED AREAS will result in exposures within: (1) the Section II.A design objectives of Appendix I, 10 CFR Part 50, to a MEMBER OF THE PUBLIC, and (2) the limits of 10 CFR Part 20.1301 to the population. The concentration limit for dissolved or entrained noble gases is based upon the assumption that Xe-135 is the controlling radioisotope and its EC in air (submersion) was converted to an equivalent concentration in water using the methods described in International Commission on Radiological Protection (ICRP) Publication 2. This commitment applies to the release of liquid effluents from all reactors at the site.

The basic requirements for the Selected Licensee Commitments concerning effluents from nuclear power reactors are stated in 10CFR50.36a. These requirements indicate that compliance with effluent Selected Licensee Commitments will keep average annual releases of radioactive material in effluents to small percentages of the limits specified in the old 10CFR20.106 (new 10CFR20.1301). These requirements further indicate that operational flexibility is allowed, compatible with considerations of health and safety, which may temporarily result in releases higher than such small percentages, but still within the limits specified in the old 10CFR20.106 which references Appendix B, Table II concentrations (MPCs). These referenced concentrations are specific values which relate to an annual dose of 500 mrem. It is further indicated in 10CFR50.36a that when using operational flexibility, best efforts shall be exerted to keep levels of radioactive materials in effluents as low as is reasonably achievable (ALARA) as set forth in 10CFR50, Appendix I.

As stated in the Introduction to Appendix B of the new 10CFR20, the effluent concentration (EC) limits given in Appendix B, Table 2, Column 2, are based on an annual dose of 50 mrem. Since a release concentration corresponding to a limiting dose rate of 500 mrem/year has been acceptable as a SLC limit for liquid effluents, which applies at all times as an assurance that the limits of 10CFR50, Appendix I are not likely to be exceeded, it should not be necessary to reduce this limit by a factor of 10.

Operational history at Catawba/McGuire/Oconee has demonstrated that the use of the concentration values associated with the old 10CFR20.106 as SLC limits has resulted in calculated maximum individual doses to members of the public that are small percentages of the limits of 10CFR50, Appendix I. Therefore, the use of concentration values which correspond to an annual dose of 500 mrem should not have a negative impact on the ability to continue to operate within the limits of 10CFR50 Appendix I and 40CFR190.

Having sufficient operational flexibility is especially important in establishing a basis for effluent monitor setpoint calculations. As discussed above, the concentrations stated in the new 10CFR20, Appendix B, Table 2, Column 2, relate to a dose of 50 mrem in a year. When applied on an instantaneous basis, this corresponds to a dose rate of 50 mrem/year. This low value is impractical upon which to base effluent monitor setpoint calculations for many liquid effluent release situations when monitor background, monitor sensitivity, and monitor performance must be taken into account.

BASES (continued)

Therefore, to accommodate operational flexibility needed for effluent releases, the limits associated with SLC 16.11.1 are based on ten times the concentrations stated in the new 10CFR20, Appendix B, Table 2, Column 2 to apply at all times. The multiplier of ten is proposed because the annual dose of 500 mrem, upon which the concentrations in the old 10CFR20, Appendix B, Table II, Column 2 are based, is a factor of ten higher than the annual dose of 50 mrem, upon which the concentrations in the new 10CFR20, Appendix B, Table 2, Column 2, are based. Compliance with the limits of the new 10CFR20.1301 will be demonstrated by operating within the limits of 10CFR50, Appendix I and 40CFR190.

The required detection capabilities for radioactive materials in liquid waste samples are tabulated in terms of the lower limits of detection (LLDs). Detailed discussion of the LLD, and other detection limits can be found in HASL Procedures Manual, HASL-300 (revised annually), Currie, L. A., "Limits for Qualitative Detection and Quantitative Determination - Application to Radiochemistry," Anal. Chem. 40, 586-93 (1968), and Hartwell, J. K., "Detection Limits for Radioanalytical Counting Techniques," Atlantic Richfield Hanford Company Report ARH-SA-215 (June 1975).

REFERENCES

1. McGuire Nuclear Station Offsite Dose Calculation Manual (ODCM)

2. International Commission on Radiological Protection (ICRP) Publication 2

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.2 Radioactive Liquid Effluent Monitoring Instrumentation

COMMITMENT The radioactive liquid effluent monitoring instrumentation channels shown in Table 16.11.2-1 shall be FUNCTIONAL with their Alarm/Trip Setpoints set to ensure that the limits of SLC 16.11.1 are not exceeded.

AND

The Alarm/Trip Setpoints of these channels shall be determined and adjusted in accordance with the methodology and parameters in the OFFSITE DOSE CALCULATION MANUAL (ODCM).

APPLICABILITY As shown in Table 16.11.2-1.

REMEDIAL ACTIONS

--NOTE--
Separate Condition entry is allowed for each Function.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or more radioactive liquid effluent monitoring channels Alarm/Trip setpoint less conservative than required.	A.1 Suspend the release of radioactive liquid effluents monitored by the affected channel.	Immediately
	OR	
	A.2 Declare the channel non-functional.	Immediately
	OR	
	A.3 Adjust setpoint to within limit.	Immediately
B. One or more radioactive liquid effluent monitoring instrument channels non-functional.	B.1 Enter the Remedial Action specified in Table 16.11.2-1 for the channel(s).	Immediately

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
C. One channel non-functional.	C.1.1 Analyze two independent samples per TR 16.11.1.1.	Prior to initiating a release
	AND	
	C.1.2 Perform independent verification of the discharge line valving.	Prior to initiating a release
	AND	
	C.1.3.1 Perform independent verification of manual portion of the computer input for the release rate calculations performed by computer.	Prior to initiating a release
	OR	
	C.1.3.2 Perform independent verification of entire release rate calculations for calculations performed manually.	Prior to initiating a release
	AND	
	C.1.4 Restore channel to FUNCTIONAL status.	14 days
	OR	
	C.2 Suspend the release of radioactive effluents via this pathway.	Immediately

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
D. One or more channels non-functional.	D.1 Obtain grab samples from the effluent pathway.	Once per 12 hours during releases.
	AND	
	D.2 Perform an analysis of grab samples for radioactivity.	To meet LLD requirements per Table 16.11.1-1.
	AND	
	D.3 Restore the channel to FUNCTIONAL status.	30 days
E. One or more flow rate measurement channels non-functional.	E.1 -------------NOTE--------------- Pump performance curves generated in place may be used to estimate flow. ------------------------------------ Estimate the flow rate of the release.	Once per 4 hours during releases
	AND	
	E.2 Restore the channel to FUNCTIONAL status.	30 days
F. RC minimum flow interlock non-functional.	F.1 Verify that the number of pumps providing dilution is greater than or equal to the number of pumps required.	Once per 4 hours during releases
	AND	
	F.2 Restore the channel to FUNCTIONAL status.	30 days

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
G. Required Action and associated Completion Time of Condition C, D, E or F not met.	G.1 Explain why the non-functionality was not corrected within the specified Completion Time in the Annual Radioactive Effluent Release Report.	In the next scheduled Annual Radioactive Effluent Release Report

TESTING REQUIREMENTS

---NOTE---
Refer to Table 16.11.2-1 to determine which TRs apply for each Radioactive Liquid Effluent Monitoring channel.

TEST		FREQUENCY
TR 16.11.2.1	Perform CHANNEL CHECK.	24 hours
TR 16.11.2.2	--------------------------------NOTE---------------------------------- The CHANNEL CHECK shall consist of verifying indication of flow. -- Perform CHANNEL CHECK.	Every 24 hours during periods of release
TR 16.11.2.3	Perform SOURCE CHECK.	Prior to each release
TR 16.11.2.4	Perform SOURCE CHECK.	31 days
TR 16.11.2.5	Perform CHANNEL OPERATIONAL TEST.	9 months
TR 16.11.2.6	Perform a CHANNEL CALIBRATION.	18 months

(continued)

TESTING REQUIREMENTS (continued)

TEST		FREQUENCY
TR 16.11.2.7	-----NOTE----- The initial CHANNEL CALIBRATION shall be performed using standards certified by the National Institute of Standards and Technology (NIST) or using standards obtained from suppliers that participate in measurement assurance activities with NIST. These standards shall permit calibrating the system over its intended range of energy and measurement range. For subsequent CHANNEL CALIBRATION, sources that have been related to the initial calibration shall be used. ----- Perform a CHANNEL CALIBRATION.	24 months
TR 16.11.2.8	-----NOTES----- 1. For Instrument 1, the COT shall also demonstrate that automatic isolation of the pathway occurs if the instrument indicates measured levels above the Alarm/Trip Setpoint. 2. For Instruments 1 and 2, the COT shall also demonstrate that control room alarm annunciation occurs if the instrument indicates measured levels above the Alarm/Trip Setpoint; circuit failure and, a downscale failure. ----- Perform a CHANNEL OPERATIONAL TEST	12 months

TABLE 16.11.2-1

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENT	MINIMUM CHANNELS FUNCTIONAL	REMEDIAL ACTION	APPLICABILITY	TESTING REQUIREMENTS
1. Radioactivity Monitors Providing Alarm And Automatic Termination of Release				
a. Waste Liquid Effluent Line (EMF-49, low range)	1 per station	A, C, G	During liquid effluent releases	TR 16.11.2.1 TR 16.11.2.3 TR 16.11.2.8 TR 16.11.2.7
b. EMF-49 Minimum Flow Device (2)	1 per station	C, G	During liquid effluent releases	TR 16.11.2.8 TR 16.11.2.7
c. Containment Ventilation Unit Condensate Line (EMF-44, low range)	1	A, D, G	At all times	TR 16.11.2.1 TR 16.11.2.4 TR 16.11.2.8 TR 16.11.2.7
d. EMF-44 Minimum Flow Device (2)	1	D, G	At all times	TR 16.11.2.8 TR 16.11.2.7
2. Radioactivity Monitors Providing Alarm But Not Automatic Termination of Release				
a. Conventional Waste Water Treatment Line or Turbine Building Sump to RC (EMF- 31)	1	A, D, G	At all times	TR 16.11.2.1 TR 16.11.2.4 TR 16.11.2.8 TR 16.11.2.7
b. EMF-31 Minimum Flow Device (2)	1	D, G	At all times	TR 16.11.2.8 TR 16.11.2.7
3. Continuous Composite Samplers				
a. Containment Ventilation Unit Condensate Line	1	D, G	At all times	TR 16.11.2.2 TR 16.11.2.5 TR 16.11.2.6
b. Conventional Waste Water Treatment Line	1 per station	D, G	At all times	TR 16.11.2.2 TR 16.11.2.5 TR 16.11.2.6
c. Turbine Building Sump to RC	1	D, G	At all times	TR 16.11.2.2 TR 16.11.2.6

(Continued)

4. Flow Rate Measurement Devices				
a. Waste Liquid Effluent Line	1 per station	E, G	During liquid effluent releases	TR 16.11.2.2 TR 16.11.2.5 TR 16.11.2.6
b. Containment Ventilation Unit Condensate Line	1	E, G	At all times	TR 16.11.2.2 TR 16.11.2.5 TR 16.11.2.6
c. Conventional Waste Water Treatment Line	1 per station	E, G	At all times	TR 16.11.2.2 TR 16.11.2.5 TR 16.11.2.6
d. Turbine Building Sump to RC	1	E, G	At all times	TR 16.11.2.2 TR 16.11.2.6
5. RC Minimum Flow Interlock (1)	1 per station	F, G	At all times	TR 16.11.2.5

NOTES:
1. Minimum flow dilution is assured by an interlock which terminates waste liquid release if the number of RC pumps running falls below the number of pumps required for dilution. The required number of RC pumps for dilution is determined per station procedures.

2. Radioactivity Monitor (EMF) shall not be declared functional unless both the EMF and the associated EMF's Minimum Flow Device are rendered functional.

BASES

The radioactive liquid effluent instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in liquid effluents during actual or potential releases of liquid effluents. The minimum flow devices for EMFs listed in Table 16.11.2-1 are required to provide assurance of representative sampling during actual or potential releases of liquid effluents. An interlock between the EMF's minimum flow device and its associated flow rate measurement device disables the remove alarm during non-release timeframes for the purpose of the control room black board annunciator criteria that disable expected alarms. An EMF flow rate measurement device measures total flow of the effluent while the EMF minimum flow device measures the sample flow rate through the EMF. The Alarm/Trip Setpoints of these instruments shall be calculated and adjusted in accordance with the methodology and parameters in the ODCM to ensure that the Alarm/Trip will occur prior to exceeding the limits stated in SLC 16.11.1. The FUNCTIONALITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10 CFR Part 50. The Turbine Building Sump to RC Discharge Flow Measurement and Sampler Devices are for monitoring only and do not alarm or have any controls that require a COT.

REFERENCES

1. McGuire Nuclear Station Offsite Dose Calculation Manual (ODCM)

2. 10 CFR Part 50, Appendix A

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.3 Dose - Liquid Effluents

COMMITMENT The dose or dose commitment to a MEMBER OF THE PUBLIC from radioactive materials in liquid effluents released from each unit to UNRESTRICTED AREAS (see Figure16.11.1-1) shall be limited:

a. During any calendar quarter, to $\leq$ 1.5 mrem to the total body and to $\leq$ 5 mrem to any organ, and

b. During any calendar year, to $\leq$ 3 mrem to the total body and to $\leq$ 10 mrem to any organ.

APPLICABILITY At all times.

REMEDIAL ACTIONS

-----NOTES-----

Enter applicable Conditions and Required Actions of SLC 16.11.12, "Total Dose," when the limits of this SLC are exceeded by twice the specified limit.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Calculated dose from release of radioactive materials in liquid effluents exceeding above limits.	-----NOTE----- The Special Report shall include the results of radiological analyses of the drinking water source, and the radiological impact on finished drinking water supplies with regard to the requirements of 40 CFR 141, Safe Drinking Water Act, as applicable. ---------- A.1 Prepare and submit a Special Report to the NRC which identifies the causes for exceeding the limits, corrective actions taken to reduce releases, and actions taken to ensure that subsequent releases are within limits.	30 days

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11.3.1 Determine cumulative dose contributions from liquid effluents for current calendar quarter and current calendar year in accordance with the methodology and parameters in the ODCM.	31 days

BASES

This commitment is provided to implement the requirements of Sections II.A, III.A and IV.A of Appendix I, 10 CFR Part 50. The commitment implements the guides set forth in Section II.A of Appendix I. The REMEDIAL ACTION statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in liquid effluents to UNRESTRICTED AREAS will be kept "as low as is reasonably achievable." Also, for fresh water sites with drinking water supplies that can be potentially affected by plant operations, there is reasonable assurance that the operation of the facility will not result in radionuclide concentrations in the finished drinking water that are in excess of the requirements of 40 CFR Part 141. These requirements are applicable only if the drinking water supply is taken from the river 3 miles downstream of the plant discharge.

The dose calculation methodology and parameters in the ODCM implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data, such that the actual exposure of a MEMBER OF THE PUBLIC through appropriate pathways is unlikely to be substantially underestimated. The equations specified in the ODCM for calculating the doses due to the actual release rates of radioactive materials in liquid effluents are consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1, October 1977 and Regulatory Guide 1.113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I," April 1977.

This commitment applies to the release of liquid effluents from each unit at the site. For units with shared Radwaste Treatment Systems, the liquid effluents from the shared system are to be proportioned among the units sharing that system in accordance with the guidance given in NUREG-0133, Chapter 3.1.

REFERENCES

1. McGuire Nuclear Station, Off site Dose Calculation Manual

2. 40 CFR Part 141, Safe Drinking Water Act

3. 10 CFR Part 50, Appendix I

4. Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1, October 1977.

5. Regulatory Guide 1.113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I," April 1977.

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.4 Liquid Radwaste Treatment System

COMMITMENT The Liquid Radwaste Treatment System shall be FUNCTIONAL and appropriate portions of the system shall be used to reduce releases of radioactivity when the projected doses due to the liquid effluent from each unit to UNRESTRICTED AREAS (see Figure16.11.1-1) would exceed 0.06 mrem to the total body or 0.2 mrem to any organ in a 31 day period.

APPLICABILITY At all times.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Radioactive liquid waste being discharged without treatment and in excess of above limits. AND Any portion of Liquid Radwaste Treatment System not in operation.	A.1 Prepare and submit a Special Report to the NRC which identifies the reasons liquid radwaste was discharged without treatment, identification of non-functional equipment and reasons for non-functionality, corrective actions taken to restore the equipment to FUNCTIONAL status, and actions taken to prevent recurrence.	30 days

TESTING REQUIREMENTS

---NOTE---

The Liquid Radwaste Treatment System shall be demonstrated FUNCTIONAL by meeting SLC 16.11.1 and16.11.3.

TEST		FREQUENCY
TR 16.11.4.1	Project liquid release doses from each unit to UNRESTRICTED AREAS, in accordance with the methodology and parameters in the ODCM, when water systems are being released without being processed by its radwaste treatment system.	31 days

BASES

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

This commitment applies to the release of liquid effluents from each reactor at the site. For units with shared Radwaste Treatment Systems, the liquid effluents from the shared system are to be proportioned among the units sharing that system in accordance with the guidance given in NUREG-0133, Chapter 3.1.

REFERENCES

1. McGuire Nuclear Station, Off site Dose Calculation Manual

2. 10 CFR Part 50

3. 10 CFR Part 50, Appendix I

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.5 Chemical Treatment Ponds

COMMITMENT

The quantity of radioactive material contained in each chemical treatment pond shall be limited by the following expression (excluding tritium and dissolved or entrained noble gases):

$$\frac{264}{V} \cdot \sum_{j} \frac{A_j}{(C_j \ x\, 10)} < 1.0$$

Where:

A_j = pond inventory limit for single radionuclide “j”, in Curies

C_j = 10 CFR 20, Appendix B, Table 2, Column 2, concentration for single radionuclide “j”, microCuries/ml;

V = design volume of liquid and slurry in the pond, in gallons; and

264 = conversion unit, microCuries/Curie per milliliter/gallon.

APPLICABILITY At all times.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Quantity of radioactive material in any of the chemical treatment ponds exceeding above limit.	A.1 Suspend all additions of radioactive material to the pond.	Immediately
	<u>AND</u>	
	A.2 Initiate corrective action to reduce the pond contents to within limits.	Immediately

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11.5.1 Verify quantity of radioactive material in each batch of slurry (powdex resin) to be transferred to chemical treatment ponds is within limits by analyzing a representative sample of the slurry. Each batch to be transferred to the chemical treatment ponds is limited by: $\sum_j \frac{Q_j}{(C_j \; x \; 10)} < 6.0 \; x \; 10^5 \; \frac{pCi/gm}{\mu Ci/ml}$	Prior to each transfer

BASES

The inventory limits of the chemical treatment ponds (CTP) are based on limiting the consequences of an uncontrolled release of the pond inventory. The expression in SLC 16.11.5 assumes the pond inventory is uniformly mixed, that the pond is located in an uncontrolled area as defined in 10 CFR Part 20, and that the concentration limit in Note 4 to Appendix B of 10 CFR Part 20 applies.

The batch limits of slurry to the chemical treatment ponds assure that radioactive material in the slurry transferred to the CTP are "as low as is reasonably achievable" in accordance with 10 CFR Part 50.36a. The expression in SLC 16.11.5 assures no batch of slurry will be transferred to the CTP unless the sum-of the ratios of the activity of the radionuclides to their respective concentration limitation is less than the ratio of the 10 CFR Part 50, Appendix I, Section II.A, total body dose level to the instantaneous whole body dose rate limitation, or that:

$$\sum_j \frac{c_j}{(C_j \; x \; 10)} < \frac{3 \; mrem/yr}{500 \; mrem/yr} = 0.006$$

Where:

c_j = Radioactive slurry concentration for radionuclide “j” entering the UNRESTRICTED AREA chemical treatment ponds, in microCuries/milliliter; and

C_j = 10 CFR 20, Appendix B, Table 2, Column 2, concentration for single radionuclide “j”, in microCuries/milliliter.

BASES (continued)

For the design of filter/demineralizers using powder resin, the slurry wash volume and the weight of resin used per batch is fixed by the cell surface area, and the slurry volume to resin weight ratio is constant at 100 ml/gram of wet, drained resin with a moisture content of approximately 55 to 60% (bulk density of about 58 pounds per cubic feet). Therefore,

$$\sum_j \frac{c_j}{(C_j \, x \, 10)} = \sum_j \frac{Q_j}{(C_j \, x \, 10)\,(10^2 \; ml/gm)\,(10^6 \; pCi/\mu Ci)} < 0.006, \text{ and}$$

$$\sum_j \frac{Q_j}{(C_j \, x \, 10)} < 6.0 \, x \, 10^5 \; \frac{pCi/gm}{\mu Ci/ml}$$

Where:

Q_j = concentration of radioactive materials in wet, drained slurry (powdex resin) for radionuclide "j", excluding tritium, dissolved or entrained noble gases, and radionuclides with less than an 8-day half-life. The analysis shall include at least Ce-144, Cs-134, Cs-137, Co-58 and Co-60, in picoCuries/gram. Estimates of the Sr-89 and Sr-90 batch concentration shall be included based on the most recent monthly composite analysis (within 3 months); and

C_j = 10 CFR 20, Appendix B, Table 2, Column 2, concentration for single radionuclide "j", in microCuries/milliliter.

The batch limits provide assurance that activity input to the chemical treatment ponds will be minimized, and a means of identifying radioactive material in the inventory limitation of SLC 16.11.5.

The basic requirements for the Selected Licensee Commitments concerning effluents from nuclear power reactors are stated in 10CFR50.36a. These requirements indicate that compliance with effluent Selected Licensee Commitments will keep average annual releases of radioactive material in effluents to small percentages of the limits specified in the old 10CFR20.106 (new 10CFR20.1301). These requirements further indicate that operational flexibility is allowed, compatible with considerations of health and safety, which may temporarily result in releases higher than such small percentages, but still within the limits specified in the old 10CFR20.106 which references Appendix B, Table II concentrations- (MPCs). These referenced concentrations are specific values which relate to an annual dose of 500 mrem. It is further indicated in 10CFR50.36a that when using operational flexibility, best efforts shall be exerted to keep levels of radioactive materials in effluents as low as is reasonably achievable (ALARA) as set forth in 10CFR50, Appendix I.

BASES (continued)

As stated in the Introduction to Appendix B of the new 10CFR20, the effluent concentration (EC) limits given in Appendix B, Table 2, Column 2, are based on an annual dose of 50 mrem. Since a release concentration corresponding to a limiting dose rate of 500 mrem/year has been acceptable as a SLC limit for liquid effluents, which applies at all times as an assurance that the limits of 10CFR50, Appendix I are not likely to be exceeded, it should not be necessary to reduce this limit by a factor of 10.

Operational history at Catawba/McGuire/Oconee has demonstrated that the use of the concentration values associated with the old 10CFR20.106 as SLC limits has resulted in calculated maximum individual doses to members of the public that are small percentages of the limits of 10CFR50, Appendix I. Therefore, the use of concentration values which correspond to an annual dose of 500 mrem should not have a negative impact on the ability to continue to operate within the limits of 10CFR50, Appendix I and 40CFR190.

Having sufficient operational flexibility is especially important in establishing a basis for effluent monitor setpoint calculations. As discussed above, the concentrations stated in the new 10CFR20, Appendix B, Table 2, Column 2, relate to a dose of 50 mrem in a year. When applied on an instantaneous basis, this corresponds to a dose rate of 50 mrem/year. This low value is impractical upon which to base effluent monitor setpoint calculations for many liquid effluent release situations when monitor background, monitor sensitivity, and monitor performance must be taken into account.

Therefore, to accommodate operational flexibility needed for effluent releases, the limits associated with SLC 16.11.1 are based on ten times the concentrations stated in the new 10CFR20, Appendix B, Table 2, Column 2 to apply at all times. The multiplier of ten is proposed because the annual dose of 500 mrem, upon which the concentrations in the old 10CFR20, Appendix B, Table II, Column 2 are based, is a factor of ten higher than the annual dose of 50 mrem, upon which the concentrations in the new 10CFR20, Appendix B, Table 2, Column 2, are based. Compliance with the limits of the new 10CFR20.1301 will be demonstrated by operating within the limits of 10CFR50, Appendix I and 40CFR190.

REFERENCES

1. McGuire Nuclear Station, Off site Dose Calculation Manual

2. 10 CFR 20, Appendix B

3. 10 CFR 50, Appendix I, Section II.A

4. 10 CFR 20

5. 10 CFR 50.36a

16.11 RADIOLOGICAL EFFLUENT CONTROL

16.11.6 Dose Rate - Gaseous Effluents

COMMITMENT

The dose rate due to radioactive materials released in gaseous effluents from the site to areas at and beyond the SITE BOUNDARY (see Figure16.11.1-1) shall be limited to the following:

a. For noble gases: $\leq$ 500 mrem/yr to the whole body and $\leq$ 3000 mrem/yr to the skin, and

b. For Iodine - 131 and 133, for tritium, and for all radioactive materials in particulate form with half-lives greater than 8 days: $\leq$ 1500 mrem/yr to any organ.

APPLICABILITY

At all times.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Dose rate not within limit.	A.1 Restore the release rate to within limits.	Immediately

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11.6.1 Verify dose rates due to noble gases in gaseous effluents are within limits in accordance with the methodology and parameters in the ODCM.	In accordance with the ODCM
TR 16.11.6.2 Verify dose rates due to radioactive materials, other than noble gases, in gaseous effluents are within limits in accordance with the methodology and parameters in the ODCM by obtaining representative samples and performing analyses in accordance with Table16.11.6-1.	In accordance with Table 16.11.6-1

TABLE 16.11.6-1
(Page 1 of 4)

RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM

Gaseous Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD)(1) (μCi/ml)
1. Waste Gas Storage Tanks	P Each Tank Grab Sample	P Each Tank	Principal Gas Gamma Emitters(6)	$1x10^{-4}$
2. Containment Purge	P Each PURGE Grab Sample	P Each PURGE	Principal Gas Gamma Emitters(6)	$1x10^{-4}$
		M	H-3	$1x10^{-6}$
3. Unit Vent	W(2) Grab Sample	W	Principal Gas Gamma Emitters(6)	$1x10^{-4}$
			H-3	$1x10^{-6}$
4.a. Radwaste Facility Vent b. Waste Handling Building c. Equipment Staging Building	W Grab Sample	W	Principal Gas Gamma Emitters(6)	$1x10^{-4}$
			H-3	$1x10^{-6}$
5. Unit Vents	Continuous(5)	W(8) Charcoal Sample	I-131	$1x10^{-12}$
			I-133	$1x10^{-10}$
	Continuous(5)	W(8) Particulate Sample	Principal Gamma Emitters(6) (I-131, Others)	$1x10^{-11}$
	Continuous(5)	M Composite Particulate Sample	Gross Alpha(7)	$1x10^{-11}$
	Continuous(5)	Q Composite Particulate Sample	Sr-89, Sr-90	$1x10^{-11}$

TABLE 16.11.6-1
(Page 2 of 4)

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)
6. All Release Types as listed in 4 above.	Continuous(5)	W(8) Charcoal Sample	I-131	$1x10^{-12}$
			I-133	$1x10^{-10}$
	Continuous(5)	W(8) Particulate Sample	Principal Gamma Emitters(6) (I-131, Others)	$1x10^{-11}$
	Continuous(5)	M Composite Particulate Sample	Gross Alpha(7)	$1x10^{-11}$
	Continuous(5)	Q Composite Particulate Sample	Sr-89, Sr-90	$1x10^{-11}$

TABLE 16.11.6-1
(Page 3 of 4)

NOTES:

1. The LLD is defined, for purposes of these commitments, as the smallest concentration of radioactive material in a sample that will yield a net count, above system background, that will be detected with 95% probability with only 5% probability of falsely concluding that a blank observation represents a "real" signal.

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

$$LLD = \frac{(2.71/T) + 4.65S_b}{E \cdot V \cdot 2.22\, x\, 10^6 \cdot Y \cdot \exp(-\lambda \Delta t)}$$

Where:

LLD	=	the “a priori” lower limit of detection as defined above (as microCurie per unit mass or volume);
s_b	=	the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute);
E	=	the counting efficiency (as counts per disintegration);
V	=	the sample size (in units of mass or volume);
2.22 $x10^6$	=	the number of disintegrations per minute per microCurie;
Y	=	the fractional radiochemical yield (when applicable);
λ	=	the radioactive decay constant for the particular radionuclide;
Δt	=	the elapsed time between midpoint of sample collection and time of counting (for plant effluents, not environmental samples); and
T	=	The background and sample counting time in minutes.

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

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

TABLE 16.11.6-1
(Page 4 of 4)

NOTES:

2. Tritium grab samples shall be taken at least once per 24 hours when the refueling canal is flooded.

3. Not used.

4. Not used.

5. The ratio of the sample flow volume to the sampled stream flow volume shall be known for the time period covered by each dose or dose rate calculation made in accordance with SLCs 16.11.6, 16.11.8 and 16.11.9.

6. The principal gamma emitters for which the LLD specification applies include the following radionuclides: Kr-87, Kr-88, Xe-133, Xe-133m, Xe135, and Xe-138 in noble gas releases and Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, I-131, Cs-134, Cs-137, and Ce-141 in iodine and particulate releases. The LLD for Ce-144 is $5x10^{-9}$ microCi/ml. This list does not mean that only these nuclides are to be considered. Other gamma peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Annual Radioactive Effluent Release Report.

7. The composite filter(s) will be analyzed for alpha activity by analyzing the filter media used during the collection period.

8. Samples shall be changed at least once per 7 days and analyses shall be completed to meet LLD after changing, or after removal from sampler. If the particulate and charcoal sample frequency is changed to a 24 hour frequency the corresponding LLDs may be increased by a factor of 10 (i.e., LLD for I-131 from 1×10^{-12} to 1×10^{-11} microCi/ml).

BASES

Specific release rate limits restrict, at all times, the corresponding gamma and beta dose rates above background to a MEMBER OF THE PUBLIC at or beyond the SITE BOUNDARY to less than or equal to 500 mrem/year to the whole body, and 3000 mrem/year to the skin from noble gases, and 1500 mrem/year to any organ from Iodine 131, Iodine 133, tritium, and all radionuclides in particulate form with half-lives greater than eight days. This commitment applies to the release of gaseous effluents from all reactors at the site. The Exclusion Area Boundary (Site Boundary) is set as the boundary for gaseous effluent release limits. The Exclusion Area Boundary (EAB) is formed by a 2500 ft radius centered on the Reactor Buildings' centerlines as shown on Figure 16.11.1-1.

The basic requirements for the Selected Licensee Commitments concerning effluents from nuclear power reactors are stated in 10CFR50.36a. These requirements indicate that compliance with effluent Selected Licensee Commitments will keep average annual releases of radioactive material in effluents to small percentages of the limits specified in the old 10CFR20.106 (new 10CFR20.1301). These requirements further indicate that operational flexibility is allowed, compatible with considerations of health and safety, which may temporarily result in releases higher than such small percentages, but still within the limits specified in the old 10CFR20.106 which references Appendix B, Table II concentrations (MPCs). These referenced concentrations are specific values which relate to an annual dose of 500 mrem. It is further indicated in 10CFR50.36a that when using operational flexibility, best efforts shall be exerted to keep levels of radioactive materials in effluents as low as is reasonably achievable (ALARA) as set forth in 10CFR50, Appendix I.

As stated in the Introduction to Appendix B of the new 10CFR20, the effluent concentration (EC) limits given in Appendix B, Table 2, Column 1, are based on an annual dose of 50 mrem for isotopes for which inhalation or ingestion is limiting or 100 mrem for isotopes for which submersion (noble gases) is limiting. Since release concentrations corresponding to limiting dose rates of less than or equal to 500 mrem/year to the whole body, 3000 mrem/year to the skin from noble gases, and 1500 mrem/year to any organ from Iodine 131, Iodine 133, tritium and for all radionuclides in particulate form with half-lives greater than eight days at the site boundary has been acceptable as a SLC limit for gaseous effluents to assure that the limits of 10CFR50, Appendix I and 40CFR190 are not likely to be exceeded, it should not be necessary to restrict the operational flexibility by incorporating the EC value for isotopes based on ingestion/inhalation (50 mrem/year) or for isotopes with the EC based on submersion (100 mrem/year).

Having sufficient operational flexibility is especially important in establishing a basis for effluent monitor setpoint calculations. As discussed above, the concentrations stated in the new 10CFR20, Appendix B, Table 2, Column 1, relate to a dose of 50 or 100 mrem in a year. When applied on an instantaneous basis, this corresponds to a dose rate of either 50 or 100 mrem/year. These low values are impractical upon which to base effluent monitor setpoint calculations for many effluent release situations when monitor background, monitor sensitivity, and monitor performance must be taken into account. Therefore, to accommodate operational flexibility needed for effluent releases, the limits associated with SLC 16.11.6 will be maintained at the current dose rate limit for noble gases of 500 mrem/year to the whole body and 3000 mrem/year to the skin, for Iodine 131, Iodine 133, tritium and all radionuclides in particulate form with half-lives greater than eight days an instantaneous dose rate limit of 1500 mrem/year to any organ.

BASES (continued)

Compliance with the limits of the new 10CFR20.1301 will be demonstrated by operating within the limits of 10CFR50, Appendix I and 40CFR190. Operational history at Catawba/McGuire/Oconee has demonstrated that the use of the dose rate values listed above (i.e. 500 mrem/year, 3000 mrem/year and 1500 mrem/year) as SLC limits has resulted in calculated maximum individual doses to members of the public that are small percentages of the limits of 10CFR50, Appendix I and 40CFR190.

The required detection capabilities for radioactive materials in gaseous waste samples are tabulated in terms of the lower limits of detection (LLDs). Detailed discussion of the LLD, and other detection limits can be found in HASL Procedures Manual, HASL-300 (revised annually), Currie, L.A., "Limits for Qualitative Detection and Quantitative Determination - Application to Radiochemistry," Anal. Chem. 40, 586-93· (1968), and Hartwell, J. K. "Detection Limits for Radioanalytical Counting Techniques," Atlantic Richfield Hanford Company Report ARH-SA-215 (June 1975).

REFERENCES

1. McGuire Nuclear Station, Off site Dose Calculation Manual
2. 10 CFR Part 20, Appendix B
3. 10 CFR Part 20
4. 10 CFR Part 50

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.7 Radioactive Gaseous Effluent Monitoring Instrumentation

COMMITMENT

The radioactive gaseous effluent monitoring instrumentation channels shown in Table 16.11.7-1 shall be FUNCTIONAL with Alarm/Trip Setpoints set to ensure that the limits of SLC 16.11.6 are not exceeded.

AND

The Alarm/Trip setpoints shall be determined and adjusted in accordance with the methodology and parameters in the ODCM.

---NOTE-------------------------------------
Brief periods of routine sampling (not to exceed 15 minutes) do not make the instrumentation non-functional.

APPLICABILITY

As shown in Table 16.11.7-1.

REMEDIAL ACTIONS

--NOTE--
Separate Condition entry is allowed for each Function.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or more radioactive gaseous effluent monitoring channels Alarm/Trip setpoint less conservative than required.	A.1 Suspend the release of radioactive gaseous effluents monitored by the affected channel.	Immediately
	OR	
	A.2 Declare the channel non-functional.	Immediately
	OR	
	A.3 Adjust setpoint to within limit.	Immediately

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
B. One or more radioactive gaseous effluent monitoring instrument channels non-functional.	B.1 Enter the Remedial Action specified in Table 16.11.7-1 for the channel(s).	Immediately
C. One channel non-functional.	C.1.1 Analyze two independent samples of the tank contents.	Prior to initiating a release
	AND	
	C.1.2 Perform independent verification of the discharge valve lineup.	Prior to initiating a release
	AND	
	C.1.3.1 Perform independent verification of manual portion of the computer input for the release rate calculations performed by computer.	Prior to initiating a release
	OR	
	C.1.3.2 Perform independent verification of entire release rate calculations for calculations performed manually.	Prior to initiating a release
	AND	
	C.1.4 Restore channel to FUNCTIONAL status.	14 days
	OR	
	C.2 Suspend the release of radioactive effluents via this pathway.	Immediately

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
D. One or more flow rate measurement channels non-functional.	D.1 Estimate the flow rate of the release.	Once per 4 hours during releases
	AND	
	D.2 Restore the channel to FUNCTIONAL status.	30 days
E. One or more noble gas activity monitor channels non-functional.	E.1 Obtain grab samples from the effluent pathway.	Once per 12 hours during releases
	AND	
	E.2 Perform an analysis of grab samples for radioactivity.	To meet LLD requirements per Table 16.11.6-1
	AND	
	E.3 Restore the channel to FUNCTIONAL status.	30 days
F. Noble gas activity monitor providing automatic termination of release non-functional.	F.1 Suspend PURGING or VENTING of radioactive effluents via this pathway.	Immediately
G. One or more sampler channels non-functional.	G.1 Perform sampling with auxiliary sampling equipment as required by Table 16.11.6-1.	Continuously
	AND	
	G.2 Restore the channel to FUNCTIONAL status.	30 days

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
H. One or more Sampler Minimum Flow Device Channels non-functional.	H.1 Verify flow through the sampling apparatus. AND H.2 Restore the channel to FUNCTIONAL status.	Once per 4 hours during releases 30 days
I. Required Action and associated Completion Time of Condition C, D, E, F, G, or H not met.	I.1 Explain why the non-functionality was not corrected within the specified Completion Time in the Annual Radioactive Effluent Release Report.	In the next scheduled Annual Radioactive Effluent Release Report

TESTING REQUIREMENTS

---NOTE---
Refer to Table 16.11.7-1 to determine which TRs apply for each Radioactive Gaseous Effluent Monitoring channel.

TEST	FREQUENCY
TR 16.11.7.1 Perform CHANNEL CHECK.	Prior to each release
TR 16.11.7.2 --------------------------------NOTE---------------------------------- The SOURCE CHECK for these channels shall be the qualitative assessment of channel response when the channel sensor is exposed to a source of increased radioactivity or a simulated source of radioactivity such as a light emitting diode. --- Perform SOURCE CHECK.	Prior to each release
TR 16.11.7.3 Perform CHANNEL CHECK.	24 hours
TR 16.11.7.4 Perform CHANNEL CHECK.	7 days

(continued)

TESTING REQUIREMENTS (continued)

TEST		FREQUENCY
TR 16.11.7.5	--------------------------------NOTE--------------------------------- The SOURCE CHECK for these channels shall be the qualitative assessment of channel response when the channel sensor is exposed to a source of increased radioactivity or a simulated source of radioactivity such as a light emitting diode. --- Perform SOURCE CHECK.	31 days
TR 16.11.7.6	--------------------------------NOTES-------------------------------- 1. For noble gas activity monitors providing automatic termination of release, the COT shall also demonstrate that automatic isolation of the pathway occurs if the instrument indicates measured levels above the Alarm/Trip Setpoint. 2. For all noble gas activity monitors, the COT shall also demonstrate that control room alarm annunciation occurs if the instrument indicates measured levels above the Alarm/Trip Setpoint; circuit failure, or a downscale failure. --- Perform CHANNEL OPERATIONAL TEST.	9 months
TR 16.11.7.7	----------------------------NOTE------------------------------------- For all noble gas activity monitors, the initial CHANNEL CALIBRATION shall be performed using standards certified by the National Institute of Standards and Technology (NIST) or using standards obtained from suppliers that participate in measurement assurance activities with NIST. These standards shall permit calibrating the system over its intended range of energy and measurement range. For subsequent CHANNEL CALIBRATION, sources that have been related to the initial calibration shall be used. --- Perform a CHANNEL CALIBRATION.	18 months

TR 16.11.7.8	-----------------------------NOTE-------------------------------------- 1. For noble gas activity monitors providing automatic termination of release, the COT shall also demonstrate that automatic isolation of the pathway occurs if the instrument indicates measured levels above the Alarm/Trip Setpoint. 2. For all noble gas activity monitors, the COT shall also demonstrate that control room alarm annunciation occurs if the instrument indicates measured levels above the Alarm/Trip Setpoint, circuit failure, or a downscale failure. --- Perform CHANNEL OPERATIONAL TEST.	92 days

TABLE 16.11.7-1
(Page 1 of 3)

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENTS	MINIMUM CHANNELS FUNCTIONAL	REMEDIAL ACTION	APPLICABILITY	TESTING REQUIREMENTS
1. WASTE GAS HOLDUP SYSTEM				
a. Noble Gas Activity Monitor - Providing Alarm and Automatic Termination of Release (0EMF-50L or 1EMF-36L)	1 per station	A, C, I	During gas effluent releases.	TR 16.11.7.1 TR 16.11.7.2 TR 16.11.7.6 TR 16.11.7.7
b. Effluent System Flow Rate Measuring Device	1 per station	D, I	At all times except when isolation valve is closed & locked.	TR 16.11.7.3 TR 16.11.7.6 TR 16.11.7.7
2. Condenser Evacuation System - Noble Gas Activity Monitor (EMF-33)	1	A, E, I	When air ejectors are operable.	TR 16.11.7.3 TR 16.11.7.5 TR 16.11.7.6 TR 16.11.7.7
3. Vent System				
a. Noble Gas Activity Monitor (Low Range - EMF-36)	1	A, E, I	At all times.	TR 16.11.7.3 TR 16.11.7.5 TR 16.11.7.6 TR 16.11.7.7
b. Iodine Sampler	1	G, I	At all times, except during routine sampling.	TR 16.11.7.4
c. Particulate Sampler (EMF-35)	1	G, I	At all times, except during routine sampling.	TR 16.11.7.4
d. Unit Vent Flow Rate Monitor (Totalizer)	1	D, I	At all times.	TR 16.11.7.3 TR 16.11.7.6 TR 16.11.7.7
e. Iodine Sampler Minimum Flow Device	1	H,I	At all times, except during routine sampling.	TR 16.11.7.3 TR 16.11.7.6 TR 16.11.7.7
f. Particulate Sampler Minimum Flow Device (1)	1	G,I	At all times, except during routine sampling.	TR 16.11.7.3 TR 16.11.7.8 TR 16.11.7.7
4. Containment Purge System - Noble Gas Activity Monitor - Providing Alarm and Automatic Termination of Release (Low Range - EMF-39)	1	A, F, I	Modes 1 through 6, except when isolation valve is closed & locked.	TR 16.11.7.2 TR 16.11.7.3 TR 16.11.7.6 TR 16.11.7.7

(continued)

TABLE 16.11.7-1
(Page 2 of 3)

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENTS	MINIMUM CHANNELS FUNCTIONAL	REMEDIAL ACTION	APPLICABILITY	TESTING REQUIREMENTS
5. Auxiliary Building Ventilation System - Noble Gas Activity Monitor (0EMF-41 or EMF-36L)	1	A, E, I	At all times.	TR 16.11.7.3 TR 16.11.7.5 TR 16.11.7.6 TR 16.11.7.7
6. Fuel Storage Area Ventilation System - Noble Gas Activity Monitor (EMF-42 or EMF-36L)	1	A, E, I	At all times.	TR 16.11.7.3 TR 16.11.7.5 TR 16.11.7.6 TR 16.11.7.7
7. Contaminated Parts Warehouse Ventilation System				
a. Noble Gas Activity Monitor (EMF-53)	1 per station	A, E, I	During gaseous effluent releases.	TR 16.11.7.3 TR 16.11.7.5 TR 16.11.7.6 TR 16.11.7.7
b. Flow Rate Monitor	1 per station	D, I	During gaseous effluent releases.	TR 16.11.7.3 TR 16.11.7.6 TR 16.11.7.7
c. EMF-53 Sampler Minimum Flow Device (1)	1 per station	H,I	During gaseous effluent releases.	TR 16.11.7.3 TR 16.11.7.6 TR 16.11.7.7
8. Radwaste Facility Ventilation System				
a. Noble Gas Activity Monitor (EMF-52)	1 per station	A, E, I	During gaseous effluent releases.	TR 16.11.7.3 TR 16.11.7.5 TR 16.11.7.6 TR 16.11.7.7
b. Flow Rate Monitor	1 per station	D, I	During gaseous effluent releases.	TR 16.11.7.3 TR 16.11.7.6 TR 16.11.7.7
c. EMF-52 Sampler Minimum Flow Device (1)	1 per station	H, I	During gaseous effluent releases.	TR 16.11.7.3 TR 16.11.7.6 TR 16.11.7.7

(continued)

TABLE 16.11.7-1
(Page 3 of 3)

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENTS	MINIMUM CHANNELS FUNCTIONAL	REMEDIAL ACTION	APPLICABILITY	TESTING REQUIREMENTS
9. Equipment Staging Building Ventilation System				
a. Noble Gas Activity Monitor (EMF-59)	1 per station	A, E, I	During gaseous effluent releases.	TR 16.11.7.3 TR 16.11.7.5 TR 16.11.7.6 TR 16.11.7.7
b. Flow Rate Monitor	1 per station	D, I	During gaseous effluent releases.	TR 16.11.7.3 TR 16.11.7.6 TR 16.11.7.7
c. EMF-59 Sampler Minimum Flow Device (1)	1 per station	H, I	During gaseous effluent releases.	TR 16.11.7.3 TR 16.11.7.6 TR 16.11.7.7
10. Containment Air Release and Addition System - Noble Gas Activity Monitor (EMF-39L or EMF-36L)	1	A, E, I	At all times except when isolation valve is closed & locked.	TR 16.11.7.3 TR 16.11.7.5 TR 16.11.7.6 TR 16.11.7.7

NOTES:

1. Radioactivity monitor (EMF) shall not be declared FUNCTIONAL unless both the EMF and the associated EMF's Minimum Flow Device are rendered FUNCTIONAL.

BASES

The radioactive gaseous effluent instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in gaseous effluents during actual or potential releases of gaseous effluents. The instrumentation consists of monitoring and sampling instrumentation. Monitors provide continuous display of process parameters with appropriate alarms and trip setpoints established. Samplers collect a portion of the desired process for subsequent laboratory analysis, and do not have alarm/trip capability. Samplers and the analysis program provide a method to assure that long term effluent release quantities do not exceed the requirements of SLC 16.11.6. Monitors provide assurance that instantaneous effluent releases do not exceed the requirements of SLC 16.11.6. The minimum flow devices for EMFs listed in Table 16.11.7-1 are required to provide assurance of representative sampling during actual or potential releases of gaseous effluents. The flow rate monitor quantifies the total gaseous effluent (both non-radioactive and radioactive) released to the environment. During routine sampling, instrumentation may be turned off for short periods of time (not to exceed 15 minutes) in order to meet analysis requirements of SLC 16.11.6. This is considered to be a normal function of the equipment. The Alarm/Trip Setpoints for these instruments shall be calculated and adjusted in accordance with the methodology and parameters in the ODCM to ensure that the Alarm/Trip will occur prior to exceeding the limits stated in SLC 16.11.6. The FUNCTIONALITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10 CFR Part 50.

REFERENCES

1. McGuire Nuclear Station, Offsite Dose Calculation Manual

2. 10 CFR Part 50, Appendix A

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.8 Noble Gases

COMMITMENT Air dose due to noble gases released in gaseous effluents, from each unit, to areas at and beyond the SITE BOUNDARY (see Figure16.11.1-1) shall be limited to the following:

a. During any calendar quarter: Less than or equal to 5 mrad for gamma radiation and less than or equal to 10 mrad for beta radiation, and

b. During any calendar year: Less than or equal to 10 mrad for gamma radiation and less than or equal to 20 mrad for beta radiation.

APPLICABILITY At all times.

REMEDIAL ACTIONS

---NOTES---

Enter applicable Conditions and Required Actions of SLC 16.11.12, "Total Dose," when the limits of this SLC are exceeded by twice the specified limit.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Calculated air dose from radioactive noble gases in gaseous effluents exceeding any of above limits.	A.1 Prepare and submit a Special Report to the NRC which identifies the causes for exceeding the limits, corrective actions taken to reduce releases, and actions taken to ensure that subsequent releases are within limits.	30 days

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11.8.1 Determine cumulative dose contributions from noble gases in gaseous effluents for current calendar quarter and current calendar year in accordance with the methodology and parameters in the ODCM.	31 days

BASES

This commitment is provided to implement the requirements of Sections II.B, III.A and IV.A of Appendix I, 10 CFR Part 50. The Limiting Condition for Operation implements the guides set forth in Section II.B of Appendix I.

The REMEDIAL ACTION statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in gaseous effluents to UNRESTRICTED AREAS will be kept "as low as is reasonably achievable."

The TESTING REQUIREMENTS implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data such that the actual exposure of a MEMBER OF THE PUBLIC through appropriate pathways is unlikely to be substantially under-estimated.

The dose calculation methodology and parameters established in the ODCM for calculating the doses due to the actual release rates of radioactive noble gases in gaseous effluents are consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1, October 1977 and Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water Cooled Reactors," Revision 1, July 1977.

The ODCM equations provided for determining the air doses at and beyond the SITE BOUNDARY are based upon the historical average atmospheric conditions.

This commitment applies at all times to the release of gaseous effluents from each reactor at the site. For units with shared Radwaste Treatment Systems, the gaseous effluents from the shared system are to be proportioned among the units sharing that system in accordance with the guidance given in NUREG-0133, Chapter 3.1.

REFERENCES

1. McGuire Nuclear Station, Off site Dose Calculation Manual
2. 10 CFR Part 50, Appendix I

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.9 Dose - Iodine-131 and 133, Tritium and Radioactive Materials in Particulate Form

COMMITMENT

The dose to a MEMBER OF THE PUBLIC from Iodine-131 and 133, tritium, and all radioactive materials in particulate form with half-lives greater than 8 days in gaseous effluents released from each unit to areas at and beyond the SITE BOUNDARY (see Figure 16.11.1-1) shall be limited to the following:

a. During any calendar quarter: less than or equal to 7.5 mrem to any organ, and

b. During any calendar year: less than or equal to 15 mrem to any organ.

APPLICABILITY

At all times.

REMEDIAL ACTIONS

---NOTES---

Enter applicable Conditions and Required Actions of SLC 16.11.12, "Total Dose," when the limits of this SLC are exceeded by twice the specified limit.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Calculated dose from the release of Iodine 131 and 133, tritium, and radioactive materials in particulate form with half-lives greater than 8 days in gaseous effluents exceeding any of the above limits.	A.1 Prepare and submit a Special Report to the NRC which identifies the causes for exceeding the limits, corrective actions taken to reduce releases, and actions taken to ensure that subsequent releases are within limits.	30 days

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11.9.1 Determine cumulative dose contributions for Iodine 131 and 133, tritium, and radioactive material in particulate form with half lives greater than 8 days in gaseous effluents for current calendar quarter and current calendar year in accordance with the methodology and parameters in the ODCM.	31 days

BASES

This commitment is provided to implement the requirements-of Sections- II.C, III.A and IV.A of Appendix I, 10 CFR Part 50. The Limiting Conditions for Operation are the guides set forth in Section II.C of Appendix I.

The REMEDIAL ACTION statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive materials in gaseous effluents to UNRESTRICTED AREAS will be kept "as low as is reasonably achievable.

The ODCM calculational methods specified in the TESTING REQUIREMENTS implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data, such that the actual exposure of a MEMBER OF THE PUBLIC through appropriate pathways is unlikely to be substantially underestimated.

The ODCM calculational methodology and parameters for calculating the doses due to the actual release rates of the subject materials are consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1, October 1977 and Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water Cooled Reactors, Revision 1, July 1977. These equations also provide for determining the actual doses based upon the historical average atmospheric conditions. The release rate specifications for Iodine-131 and 133, tritium, and radionuclides in particulate form with half-lives greater than 8 days are dependent upon the existing radionuclide pathways to man, in the areas at and beyond the SITE BOUNDARY. The pathways that were examined in the development of these calculations were: (1) individual inhalation of airborne radionuclides; (2) deposition of radionuclides onto green leafy vegetation with subsequent consumption by man; (3) deposition onto grassy areas where milk animals and meat-producing animals graze with consumption of the milk and meat by man; and, (4) deposition on the ground with subsequent exposure of man.

BASES (continued)

This commitment applies at all times to the release of gaseous effluents from each reactor at the site. For units with shared Radwaste Treatment Systems, the gaseous effluents from the shared system are to be proportioned among the units sharing that system in accordance with the guidance given in NUREG 0133, Chapter 3.1.

REFERENCES

1. McGuire Nuclear Station, Off site Dose Calculation Manual

2. 10 CFR Part 50, Appendix I

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.10 Gaseous Radwaste Treatment System

COMMITMENT The VENTILATION EXHAUST TREATMENT and WASTE GAS HOLDUP SYSTEMS shall be FUNCTIONAL and appropriate portions of these systems shall be used to reduce releases of radioactivity when the projected doses in 31 days due to gaseous effluent releases, from each unit, to areas at and beyond the SITE BOUNDARY (see Figure 16.11.1-1) would exceed:

a. 0.2 mrad to air from gamma radiation, or

b. 0.4 mrad to air from beta radiation, or

c. 0.3 mrem to any organ of a MEMBER OF THE PUBLIC.

APPLICABILITY At all times.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Radioactive gases being discharged without treatment and in excess of above limits.	A.1 Prepare and submit a Special Report to the NRC which identifies non-functional equipment and reasons for non-functionality, actions taken to restore the equipment to FUNCTIONAL status, and actions taken to prevent recurrence.	30 days

TESTING REQUIREMENTS

---NOTE---

The installed Gaseous Radwaste Treatment System shall be demonstrated FUNCTIONAL by meeting SLC 16.11.6, 16.11.8 and16.11.9.

TEST	FREQUENCY
TR 16.11.10.1 Project gaseous release doses from each unit to areas at and beyond the SITE BOUNDARY, in accordance with the methodology and parameters in the ODCM, when gaseous systems are being released without being processed by its radwaste treatment system.	31 days

BASES

The FUNCTIONALITY of the WASTE GAS HOLDUP SYSTEM and the VENTILATION EXHAUST TREATMENT SYSTEM ensures that the systems will be available for use whenever gaseous effluents require treatment prior to release to the environment. The requirement that the appropriate portions of these systems be used, when specified, provides reasonable assurance that the releases of radioactive materials in gaseous effluents will be kept "as low as is reasonably achievable."

This commitment implements the requirements of 19 CFR Part 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50 and the design objectives given in Section II.D of Appendix I to 10 CFR Part 50. The specified limits governing the use of appropriate portions of the systems were specified as a suitable fraction of the dose design objectives set forth in Section II.B and II.C of Appendix I, 10 CFR Part 50, for gaseous effluents.

This commitment applies at all times to the release of radioactive materials in gaseous effluents from each unit at the site. For units with shared Radwaste Treatment Systems, the gaseous effluents from the shared system are to be proportioned among the units sharing that system in accordance with NUREG-0133, Chapter 3.1.

REFERENCES

1. McGuire Nuclear Station, Off site Dose Calculation Manual

2. 10 CFR Part 50, Appendix I

3. 10 CFR Part 50

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.11 Solid Radioactive Waste

COMMITMENT

Radioactive wastes shall be processed and packaged to ensure compliance with the applicable requirements of 10 CFR Part 20, 10CFR Part 61, 10 CFR Part 71, and State regulations governing the transportation and disposal of radioactive wastes.

The Solid Radwaste System or an approved alternative process shall be used in accordance with a PROCESS CONTROL PROGRAM (PCP) for the solidification of liquid or wet radioactive wastes or the dewatering of wet radioactive wastes to be shipped for direct disposal at a 10CFR61 licensed disposal site. Wastes shipped for off site processing in accordance with the processor's specifications and transportation requirements are not required to be solidified or dewatered to meet disposal requirements.

- The PCP describes administrative and operational controls used for the solidification of liquid or wet solid radioactive wastes in order to meet applicable 10CFR61 waste form requirements.
- The PCP describes the administrative and operational controls used for the dewatering of wet radioactive wastes to meet 10CFR61 free standing water requirements.
- The process parameters used in establishing the PCP shall be based on demonstrated processing of actual or simulated liquid or wet solid wastes and must adequately verify that the final product of solidification or dewatering meets all applicable Federal, State and disposal site requirements.

APPLICABILITY

At all times.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Applicable regulatory requirements for solidified or dewatered wastes are not satisified.	A.1 Suspend shipments of defectively packaged solid radioactive wastes from the site. <u>AND</u>	Immediately
	A.2 Initiate action to correct the PROCESS CONTROL PROGRAM, procedures, or solid waste equipment as necessary to prevent recurrence.	Prior to next shipment for disposal of solidified or dewatered wastes.
B. A solidification test as described in the PCP fails to verify Solidification.	B.1 Suspend solidification of the batch under test and follow PCP guidance for test failures. <u>AND</u>	Immediately
	B.2 Once a subsequent test verifies Solidification, solidification of the batch may then be resumed as directed by the PCP. The PCP shall be modified as required to assure Solidification of subsequent batches of waste	Prior to next solidification for shipment of waste for disposal at a 10CFR61 disposal site.

(continued)

REMEDIAL ACTIONS (continued)

C. With solidification or dewatering for disposal not performed in accordance with the PROCESS CONTROL PROGRAM.	C.1 Reprocess the waste in accordance with PCP requirements. OR C.2 Follow PCP or procedure quidance for alternative free standing liquid verification to ensure the waste in each container meets disposal requirements and take appropriate administrative action to prevent recurrence.	Prior to shipment for disposal of the inadequately processed waste that requires solidification of dewatering
D. With the solid waste equipment incapable of meeting SLC 16.11.11 or not in service	D.1 Restore the equipment to FUNCTIONAL status or provide for alternative capability to process wastes as necessary to satisfy all applicable disposal requirements	In a time frame that supports the COMMITMENT section of SLC 16.11.11

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11.11.1 The Process Control Program shall be used to verify the Solidification of at least one representative test specimens from at least every tenth batch of each type of radioactive waste to be solidified for disposal at a 10CFR61 disposal site per the COMMITMENT of this SLC.	Every tenth batch of each type of radioactive waste to be solidified.

BASES:

This commitment implements the requirements of 10 CFR Part 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50 and requirements to use a Process Control Program to meet applicable 10CFR61 waste form criteria for solidified and dewatered radioactive wastes.

REFERENCES:

1. 10CFR Part 50, “Domistic Licensing of Production and Utilization Facilities”

2. 10 CFR Part 50, Appendix A

3. 10CFR20, “Standards for Protection Against Radiation”

4. 10CFR61, “Licensing Requirements for Land Disposal of Radioactive Waste

5. 10CFR71, “Packaging and Transportation of Radioactive Materials”

6. DPCo Process Control Program Manual

7. NRC Generic Letter 84-12, “Compliance With 10 CFR Part 61 And Implementation Of the Radiological Effulent Technical Specifications (Rets) and Attendant Process Control Program (PCP)”

8. NRC Generic Letter 89-01, “Implementation of Programmatic Controls for Radiological Effulent Technical Specifications In the Administrative Controls Section of the Technical Specifications and the Relocation of Procedural Details of Rets to the Offsite Dose Calculation Manual or to the Process Control Program”

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.12 Total Dose

COMMITMENT The annual (calendar year) dose or dose commitment to any MEMBER OF THE PUBLIC, due to releases of radioactivity and radiation, from uranium fuel cycle sources shall be limited to $\leq$ 25 mrem to the whole body or any organ, except the thyroid, which shall be limited to $\leq$ 75 mrem.

APPLICABILITY At all times.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Calculated doses from releases exceeding twice the specified limits of SLC 16.11.3, 16.11.8 or 16.11.9.	A.1 Verify, by calculation, the cumulative dose from direct radiation contributions, the ISFSI, outside storage tanks, and radioactivity releases are within the total dose limit.	Immediately
	<u>AND</u>	
	A.2 --------------NOTE------------ Only required to be performed if the total dose limit is exceeded. -----------------------------------	
	Prepare and submit a Special Report to the NRC which identifies corrective actions to be taken to reduce subsequent releases to prevent recurrence and schedule for achieving conformance with specified limits.	30 days

TESTING REQUIREMENTS

---NOTE---

Cumulative dose contributions from liquid and gaseous effluents shall be determined in accordance with SLC 16.11.3, 16.11.8 and16.11.9, and in accordance with the methodology and parameters specified in the ODCM.

TEST	FREQUENCY
TR 16.11.12.1 Determine cumulative dose contributions from direct radiation from the units, the ISFSI, and from radwaste storage tanks in accordance with the methodology and parameters specified in the ODCM.	When calculated doses from effluent releases exceeds twice the limits of SLCs 16.11.3, 16.11.8 or 16.11.9

BASES

This commitment is provided to meet the dose limitations of 40 CFR Part 190 that have been incorporated into 10 CFR Part 20 by 46 FR 18525. The specification requires the preparation and submittal of a Special Report whenever the calculated doses from plant generated radioactive effluents and direct radiation exceed 25 mrem to the whole body or any organ, except the thyroid, which shall be limited to less than or equal to 75 mrem. For sites containing up to four reactors, it is highly unlikely that the resultant dose to a MEMBER OF THE PUBLIC will exceed the dose limits of 40 CFR Part 190 if the individual reactors remain within twice the dose design objectives of 10 CFR Part 50, Appendix I, and if direct radiation doses from the units and outside storage tanks are kept small.

This Special Report, as defined in 10 CFR Part 20.2203(a)(4), shall include an analysis that estimates the radiation exposure (dose) to a MEMBER OF THE PUBLIC from uranium fuel cycle sources, including all effluent pathways and direct radiation, for the calendar year that includes the release(s) covered by this report. It shall also describe levels of radiation and concentrations of radioactive material involved, and the cause of the exposure levels or concentrations. The Special Report will describe a course of action that should result in the limitation of the annual dose to a MEMBER OF THE PUBLIC to within the 40 CFR Part 190 limits. For the purposes of the Special Report, it may be assumed that the dose commitment to the MEMBER of the PUBLIC from other uranium fuel cycle sources is negligible, with the exception that dose contributions from other nuclear fuel cycle facilities at the same site or within a radius of 8 km must be considered.

If the dose to any MEMBER OF THE PUBLIC is estimated to exceed the requirements of 40 CFR Part 190, the Special Report with a request for a variance (provided the release conditions resulting in violation of 40 CFR Part 190 have not already been corrected), in

BASES (continued)

accordance with the provisions of 40 CFR Part 190.11 and 10 CFR Part 20.2203(a)(4), is considered to be a timely request and fulfills the requirements of 40 CFR Part 190 and a variance is granted until NRC staff action is completed. The variance only relates to the limits of 40 CFR Part 190, and does not apply in any way to the other requirements for dose limitation of 10 CFR Part 20, as addressed in SLCs 16.11.1 and 16.11.6.

An individual is not considered a MEMBER OF THE PUBLIC during any period in which he/she is engaged in carrying out any operation that is part of the nuclear fuel cycle.

REFERENCES

1. McGuire Nuclear Station, Offsite Dose Calculation Manual

2. 10 CFR Part 20

3. 40 CFR Part 190

4. 10 CFR Part 50, Appendix I

16.11 RADIOLOGICAL EFFLUENT MONITORING

16.11.13 Radiological Environmental Monitoring Program

COMMITMENT The Radiological Environmental Monitoring Program shall be conducted as specified in Table 16.11.13-1.

APPLICABILITY At all times.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Radiological Environmental Monitoring Program not being conducted as specified in Table 16.11.13-1.	A.1 Identify the reasons for not conducting the program as required and the plans for preventing a recurrence in the Annual Radiological Environmental Operating Report.	Within the next scheduled Annual Radiological Environmental Operating Report
B. Radioactivity level of environmental sampling medium at a specified location in excess of reporting limits of Table 16.11.13-2.	B.1 Prepare and submit a Special Report that defines the corrective actions to be taken to reduce radioactive effluents so that the potential annual dose to a MEMBER OF THE PUBLIC is less than the calendar year limits of SLC 16.11.3, 16.11.8, and 16.11.9.	30 days

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
C. Milk or fresh leafy vegetable samples unavailable from one or more required sample locations.	C.1 --------------NOTE------------- Specific locations from which samples were unavailable may be deleted from the program. ----------------------------------- Revise the Radiological Environmental Monitoring Program to identify locations for obtaining replacement samples.	30 days
	AND	
	C.2 Identify the cause of the unavailability of samples and identify new location(s) for obtaining replacement samples in the next Annual Radioactive Effluent Release Report and also include in the report a revised figure(s) and table for the ODCM reflecting the new location(s).	Within the next scheduled Annual Radioactive Effluent Release Report

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11.13.1 --------------------------------NOTES-------------------------------- The maximum values for the lower limits of detection shall be as specified in Table16.11.13-3. -- The radiological environmental monitoring samples shall be collected from the locations given in the table and figure in the ODCM and shall be analyzed pursuant to the requirements of Tables16.11.13-1.	In accordance with Table 16.11.13-1

TABLE 16.11.13-1
(Page 1 of 6)
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS[1]	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
1. Direct Radiation[2]	Forty routine monitoring stations either with two or more dosimeters or with one instrument for measuring and recording dose rate continuously, placed as follows: An inner ring of stations, one in each meteorological sector in the general area of the SITE BOUNDARY; An outer ring of stations, one in each meteorological sector in the 6- to 8-km range from the site; and The balance of the stations placed in special interest areas such as population centers, nearby residences, schools, and in one or two areas to serve as control stations.	Quarterly	Gamma dose quarterly.

(continued)

TABLE 16.11.13-1
(Page 2 of 6)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS[(1)]	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
2. Airborne Radioiodine and Particulates	Samples from five locations: Three samples from close to the three SITE BOUNDARY locations, in different sectors, of the highest calculated annual average ground level D/Q. One sample from the vicinity of a community having the highest calculated annual average ground level D/Q. One sample from a control location, as for example 15-30 km distant and in the least prevalent wind direction[(3)].	Continuous sampler operation with sample collection weekly, or more frequently if required by dust loading.	Radioiodine Canister: I-131 analysis weekly. Particulate Sampler: Gross beta radioactivity analysis following filter change[(4)]; Gamma isotopic analysis[(5)] of composite (by location quarterly).
3. Waterborne a. Surface[(6)]	One sample upstream. One sample downstream.	Composite sample over 1-month period[(7)].	Gamma isotope analysis[(5)] monthly. Composite for tritium analysis quarterly.
b. Ground	Samples from one or two sources only if likely to be affected[(8)]	Quarterly	Gamma isotopic[(5)] and tritium analysis quarterly.

(continued)

TABLE 16.11.13-1
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RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS[(1)]	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
c. Drinking	One sample of each of one to three of the nearest water supplies that could be affected by its discharge. One sample from a control location.	Composite sample over 2-week period[(7)] when I-131 analysis is performed; monthly composite otherwise.	I-131 analysis on each composite when the dose calculated for the consumption of the water is greater than 1 mrem per year[(9)]. Composite for gross beta and gamma isotopic analyses[(5)] monthly. Composite for tritium analysis quarterly.
d. Sediment from the shoreline	One sample from downstream area with existing or potential recreational value.	Semiannually	Gamma isotopic analysis[(5)] semiannually.
4. Ingestion a. Milk	Samples from milking animals in three locations within 5-km distance having the highest dose potential. If there are none, then one sample from milking animals in each of three areas between 5 to 8 km distant where doses are calculated to be greater than 1 mrem per year[(9)]. One sample from milking animals at a control location 15 to 30 km distant and in the least prevalent wind direction.	Semimonthly when animals are on pasture; monthly at other times.	Gamma isotopic[(5)] and I-131 analysis semimonthly when animals are on pasture; monthly at other times.

(continued)

TABLE 16.11.13-1
(Page 4 of 6)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS(1)	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
b. Fish and Invertebrates	One sample each commercially and recreationally important species in vicinity of plant discharge area. 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(5) on edible portions
c. Food Products	One sample of each principal class of food products from any area that is irrigated by water in which liquid plant wastes have been discharged.	At time of harvest(10)	Gamma isotopic analyses(5) on edible portion.
	Samples of three different kinds of broad leaf vegetation grown nearest each of two different offsite locations of highest predicted annual average ground level D/Q if milk sampling is not performed.	Monthly, when available.	Gamma isotopic(5) and I-131 analysis.
	One sample of each of the similar broad leaf vegetation grown 15 to 30 km distant in the least prevalent wind direction if milk sampling is not performed.	Monthly, when available.	Gamma isotopic(5) and I-131 analysis.

TABLE 16.11.13-1

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RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

NOTES:

1. Specific parameters of distance and direction sector from the centerline of one reactor, and additional description where pertinent, shall be provided for each and every sample location in Table 16.11.13-1 in a table and figure(s) in the ODCM. Refer to NUREG-0133, "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants," October 1978, and to Radiological Assessment Branch Technical Position, Revision 1, November 1979. Deviations are permitted from the required sampling schedule if specimens are unobtainable due to hazardous conditions, seasonal unavailability, malfunction of automatic sampling equipment and other legitimate reasons. If specimens are unobtainable due to sampling equipment malfunction, every effort shall be made to complete corrective action prior to the end of the next sampling period. All deviations from the sampling schedule shall be documented in the Annual Radiological Environmental Operating Report. It is recognized that, at times, it may not be possible or practical to continue to obtain samples of the media of choice at the most desired location or time. In these instances suitable alternative media and locations may be chosen for the particular pathway in question and appropriate substitutions made within 30 days in the Radiological Environmental Monitoring Program. In lieu of an Licensee Event Report, identify the cause of the unavailability of samples for that pathway and identify the new locations(s) for obtaining replacement samples in the next Annual Radioactive Effluent Release Report and also include in the report a revised figure(s) and table for the ODCM reflecting the new location(s).

2. One or more instruments, such as a pressurized ion chamber, for measuring and recording dose rate continuously may be used in place of, or in addition to, integrating dosimeters. For the purposes of this table, a thermoluminescent dosimeter (TLD) is considered to be one phosphor; two or more phosphors in a packet are considered as two or more dosimeters. Film badges shall not be used as dosimeters for measuring direct radiation. The forty stations is not an absolute number. The number of direct radiation monitoring stations may be reduced according to geographical limitations; e.g., at an ocean site, some sections will be over water so that the number of dosimeters may be reduced accordingly. The frequency of analysis or readout for TLD systems will depend upon the characteristics of the specific system used and should be selected to obtain optimum dose information with minimal fading.

3. The purpose of this sample is to obtain background information. If it is not practical to establish control locations in accordance with the distance and wind direction criteria, other sites that provide valid background data may be substituted.

4. Airborne particulate sample filters shall be analyzed for gross beta radioactivity 24 hours or more after sampling to allow for radon and thoron daughter decay. If gross beta activity in air particulate samples is greater than ten times the yearly mean of control samples, gamma isotopic analysis shall be performed on the individual samples.

TABLE 16.11.13-1

(Page 6 of 6)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

NOTES (continued):

5. Gamma isotopic analysis means the identification and quantification of gamma-emitting radionuclides that may be attributable to the effluents from the facility.

6. The "upstream sample" shall be taken at a distance beyond significant influence of the discharge. The "downstream" sample shall be taken in an area beyond but near the mixing zone. "Upstream" samples in an estuary must be taken far enough upstream to be beyond the plant influence. Salt water shall be sampled only when the receiving water is utilized for recreational activities.

7. A composite sample is one in which the quantity (aliquot) of liquid sampled is proportional to the quantity of flowing liquid and in which the method of sampling employed results in a specimen that is representative of the liquid flow. In this program composite sample aliquots shall be collected at time intervals that are very short (e.g., hourly) relative to the compositing period (e.g., monthly) in order to assure obtaining a representative sample.

8. Groundwater samples shall be taken when this source is tapped for drinking or irrigation purposes in areas where the hydraulic gradient or recharge properties are suitable for contamination.

9. The dose shall be calculated for the maximum organ and age group, using the methodology and parameters in the ODCM.

10. If harvest occurs more than once a year, sampling shall be performed during each discrete harvest. If harvest occurs continuously, sampling shall be monthly. Attention shall be paid to including samples of tuborous and root food products.

TABLE 16.11.13-2
(Page 1 of 1)

REPORTING LEVELS FOR RADIOACTIVITY CONCENTRATIONS IN ENVIRONMENTAL SAMPLES

	REPORTING LEVELS				
ANALYSIS	WATER (pCi/l)	AIRBOURNE PARTICULATE OR GASES (pCi/m^3)	FISH (pCi/kg, wet)	MILK (pCi/l)	BROAD LEAF VEGETATION (pCi/kg, wet)
H-3	20,000[(1)]	N/A	N/A	N/A	N/A
Mn-54	1,000	N/A	30,000	N/A	N/A
Fe-59	400	N/A	10,000	N/A	N/A
Co-58	1,000	N/A	30,000	N/A	N/A
Co-60	300	N/A	10,000	N/A	N/A
Zn-65	300	N/A	20,000	N/A	N/A
Zr-Nb-95	400	N/A	N/A	N/A	N/A
I-131	2	0.9	N/A	3	100
Cs-134	30	10	1,000	60	1,000
Cs-137	50	20	2,000	70	2,000
Ba-La-140	200	N/A	N/A	300	N/A

NOTES:

1. For drinking water samples. This is 40 CFR Part 141 value. If no drinking water pathway exists, a value of 30,000 pCi/l may be used.

TABLE 16.11.13-3
(Page 1 of 3)

MAXIMUM VALUES FOR THE LOWER LIMITS OF DETECTION (LLD) (1)(2)(3)

ANALYSIS	WATER (pCi/l)	AIRBORNE PARTICULATE OR GASES (pCi/m^3)	FISH (pCi/kg, wet)	MILK (pCi/l)	BROAD LEAF VEGETATION (pCi/kg, wet)	SEDIMENT (pCi/kg, dry)
Gross Beta	4	0.01	N/A	N/A	N/A	N/A
H-3	2000*	N/A	N/A	N/A	N/A	N/A
Mn-54	15	N/A	130	N/A	N/A	N/A
Fe-59	30	N/A	260	N/A	N/A	N/A
Co-58, 60	15	N/A	130	N/A	N/A	N/A
Zn-65	30	N/A	260	N/A	N/A	N/A
Zr-95	15	N/A	N/A	N/A	N/A	N/A
Nb-95	15	N/A	N/A	N/A	N/A	N/A
I-131	1(4)	0.07	N/A	1	60	N/A
Cs-134	15	0.05	130	15	60	150
Cs-137	18	0.06	150	18	80	180
Ba-140	15	N/A	N/A	15	N/A	N/A
La-140	15	N/A	N/A	15	N/A	N/A

* If no drinking water pathway exists, a value of 3000 pCi/l may be used.

TABLE 16.11.13-3
(Page 2 of 3)

MAXIMUM VALUES FOR THE LOWER LIMITS OF DETECTION (LLD)

NOTES:

1. The LLD is defined, for purposes of these commitments, as the smallest concentration of radioactive material in a sample that will yield a net count (above system background) that will be detected with 95% probability with 5% probability of falsely concluding that a blank observation represents a "real" signal.

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

$$LLD = \frac{(2.71/T) + 4.65S_b}{E \cdot V \cdot 2.22 \cdot Y \cdot \exp(-\lambda\Delta t)}$$

   Where:

   LLD is the "a priori" lower limit of detection as defined above (as picoCurie per unit mass or volume),

   s_b is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute),

   E is the counting efficiency (as counts per disintegration),

   V is the sample size (in units of mass or volume),

   2.22 is the number of disintegrations per minute per picoCurie,

   Y is the fractional radiochemical yield (when applicable),

   λ is the radioactive decay constant for the particular radionuclide,

   Δt is the elapsed time between sample collection (or end of the sample collection period) and time of counting (for environmental samples, not plant effluent samples), and

   T is the background and sample counting time in minutes.

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

TABLE 16.11.13-3
(Page 3 of 3)

MAXIMUM VALUES FOR THE LOWER LIMITS OF DETECTION (LLD)

NOTES (continued):

2. This list does not mean that only these nuclides are to be considered. Other peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Annual Radiological Environmental Operating Report.

3. Required detection capabilities for thermoluminescent dosimeters used for environmental measurements shall be in accordance with the recommendations of Regulatory Guide 4.13.

4. LLD for drinking water samples. If no drinking water pathway exists, the LLD of gamma isotopic analysis may be used.

BASES

The Radiological Environmental Monitoring Program is established to monitor the radiation and radionuclides in the environs of the plant. The program provides representative measurements of radioactivity in the highest potential exposure pathways, and verification of the accuracy of the effluent monitoring program and modeling of environmental exposure pathways. The program is contained in SLC 16.11.13 – 16.11.16 and conforms to the guidance of Appendix I to 10 CFR Part 50. The program includes the following:

1. Monitoring, sampling, analysis, and reporting of radiation and radionuclides in the environment in accordance with the methodology and parameters in the ODCM,

2. A Land Use Census to ensure that changes in the use of areas at and beyond the SITE BOUNDARY are identified and that modifications to the monitoring program are made if required by the results of this census, and

3. Participation in an Interlaboratory Comparison Program to ensure that independent checks on the precision and accuracy of the measurements of radioactive materials in environmental sample matrices are performed as part of the quality assurance program for environmental monitoring.

The portion of the Radiological Environmental Monitoring Program required by this commitment provides representative measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides that lead to the highest potential radiation exposures of MEMBERS OF THE PUBLIC resulting from the station operation. This monitoring program implements Section IV.B.2 of Appendix I to 10 CFR Part 50 and thereby supplements the Radiological Effluent Monitoring Program by verifying that the measurable concentrations of radioactive materials and levels of radiation are not higher than expected on the basis of the effluent measurements and the modeling of the environmental exposure pathways. Guidance for this monitoring program is provided by the Radiological Assessment Branch Technical Position on Environmental Monitoring. The initially specified monitoring program will be effective for at least the first 3 years of commercial operation. Following this period, program changes may be initiated based on operational experience.

The required detection capabilities for environmental sample analyses are tabulated in terms of the lower limits of detection (LLDs). The LLDs required by Table 16.11.13-3 are considered optimum for routine environmental measurements in industrial laboratories. It should be recognized that the LLD is defined as an a priori (before the fact) limit representing the capability of a measurement system and not as an a posteriori (after the fact) limit for a particular measurement.

With the level of radioactivity in an environmental sampling medium at a specified location exceeding the reporting levels of Table 16.11.13-3 when averaged over any calendar quarter, in lieu of a Licensee Event Report, prepare and submit to the Commission within 30 days a Special Report that defines the corrective actions to be

BASES (continued)

taken to reduce radioactive effluents so that the potential annual dose to a MEMBER OF THE PUBLIC is less than the calendar year limits of SLCs 16.11.6, 16.11.8, and 16.11.9. When more than one of the radionuclides in Table 16.11.13-2 are detected in the sampling medium, this report shall be submitted if:

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

When radionuclides other than those in Table 16.11.13-2 are detected and are the result of plant effluents, this report shall be submitted if the potential annual dose to a MEMBER OF THE PUBLIC is equal to or greater than the calendar year limits of SLCs 16.11.6, 16.11.8 and 16.11.9. This report is not required if the measured level of radioactivity was not the result of plant effluents; however, in such an event, the condition shall be reported and described in the Annual Radiological Environmental Operating Report. The methodology and parameters used to estimate the potential annual dose to a MEMBER OF THE PUBLIC shall be indicated in this report.

Detailed discussion of the LLD, and other detection limits, can be found in HASL Procedures Manual, HASL-300 (revised annually), Currie, L. A., "Limits for Qualitative Detection and Quantitative Determination - Application to Radiochemistry," Anal. Chem. 40, 586-93 (1968), and Hartwell, J. K., "Detection Limits for Radioanalytical Counting Techniques," Atlantic Richfield Hanford Company Report ARH-SA-215 (June 1975).

REFERENCES

1. McGuire Nuclear Station, Off site Dose Calculation Manual

2. 10 CFR Part 50, Appendix I

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.14 Land Use Census

COMMITMENT

A land use census shall be conducted and shall identify within a distance of 8 km (5 miles) the location in each of the 16 meteorological sectors of:

a. the nearest milk animal,

b. the nearest residence, and

c. the nearest garden of greater than 50 m^2 (500 ft^2) producing broad leaf vegetation.

For elevated releases as defined in Regulatory Guide 1.111, Revision 1, July 1977, the land use census shall identify within a distance of 5 km (3 miles) the location in each of the 16 meteorological sectors of:

a. all milk animals, and

b. all gardens of greater than 50 m^2 producing broad leaf vegetation.

--NOTE------------------------------------
Broad leaf vegetation sampling of three different kinds of vegetation may be performed at the SITE BOUNDARY in each of two different direction sectors with the highest predicted D/Qs in lieu of the garden census. Specifications for broad leaf vegetation sampling in Table 16.11.13-1 4c shall be followed, including analysis of control samples.

APPLICABILITY

At all times.

REMEDIAL ACTIONS

CONDITION		REQUIRED ACTION		COMPLETION TIME
A.	Location(s) identified which yields a calculated dose/dose commitment greater than values currently calculated in SLC 16.11.9.	A.1	Identify the new location in the Annual Radioactive Effluent Release Report.	In next scheduled Annual Radioactive Effluent Release Report

(continued)

REMEDIAL ACTIONS (continued)

B. Location(s) identified which yields a calculated dose or dose commitment (via same exposure pathway) 20% greater than at a location from which samples are currently being obtained in accordance with SLC 16.11.13.	B.1 Add the new location to the Radiological Environmental Monitoring Program. AND B.2 --------------NOTES----------- If samples cannot be obtained, an explanation of why samples are not obtainable (substitute representative locations if possible) shall be included. ---------------------------------- Identify the new location(s), revised figures and tables for the ODCM, in the next Annual Radiological Release Report.	30 days In the next scheduled Annual Radiological Release Report

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11.14.1 -----------------------------NOTE--------------------------------- The results of the land use census shall be included in the Annual Radiological Environmental Operating Report. -- Conduct a land use census during the growing season using the information which will provide the best results such as a door-to-door survey, aerial survey, or consultation with local agricultural authorities.	12 months

BASES

This commitment is provided to ensure that changes in the use of areas at and beyond the SITE BOUNDARY are identified and that modifications to the Radiological Environmental Monitoring Program are made if required by the results of this census. The best information from the door-to-door survey, from aerial survey, or from consulting with local agricultural authorities shall be used. This census satisfies the requirements of Section IV.B.3 of Appendix I to 10 CFR Part 50. Restricting the census to gardens of greater than 50 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.

With a land use census identifying a location(s) which yields a calculated dose or dose commitment (via the same exposure pathway) 20% greater than at a location from which samples are currently being obtained in accordance with SLC 16.11.13, add the new location to the Radiological Environmental Monitoring Program. The sampling location(s), excluding the control station location, having the lowest calculated dose or dose commitment (via the same exposure pathway) may be deleted from this monitoring program after October 31 of the year in which this land use census was conducted.

REFERENCES

1. McGuire Nuclear Station, Off site Dose Calculation Manual

2. 10 CFR Part 50, Appendix I

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.15 Interlaboratory Comparison Program

COMMITMENT Analyses shall be performed on radioactive materials, supplied as part of an Interlaboratory Comparison Program (ICP), that correspond to samples required by SLC 16.11.13.

APPLICABILITY At all times.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Analyses not being performed as required.	A.1 Report corrective actions taken to prevent recurrence in the Annual Radiological Environmental Operating Report.	In next scheduled Annual Radiological Environmental Operating Report

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11.15.1 Report a summary of the results of the Interlaboratory Comparison Program in the Annual Radiological Environmental Operating Report.	12 months

BASES

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

The Interlaboratory Comparison Program (ICP) shall be described in the Annual Radiological Environmental Operating Report.

REFERENCES

1. 10 CFR Part 50, Appendix I

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.16 Annual Radiological Environmental Operating Report

COMMITMENT

Routine Annual Radiological Environmental Operating Reports covering the operation of the unit during the previous calendar year shall be submitted by May 15 of each year.

The Annual Radiological Environmental Operating Reports shall include summaries, interpretations, and an analysis of trends of the results of the radiological environmental surveillance activities for the report period, including a comparison with pre-operational studies, with operational controls as appropriate, and with previous environmental surveillance reports, and an assessment of the observed impacts of the plant operation on the environment. The reports shall also include the results of land use censuses required by SLC 16.11.14.

The Annual Radiological Environmental Operating Reports shall include the results of analysis of all radiological environmental samples and of all environmental radiation measurements taken during the period pursuant to the locations specified in the Table and Figures in the ODCM, as well as summarized and tabulated results of these analyses and measurements in the format of the table in the Radiological Assessment Branch Technical Position, Revision 1, November 1979. In the event that some individual results are not available for inclusion with the report, the report shall be submitted noting and explaining the reasons for the missing results. The missing data shall be submitted as soon as possible in a supplementary report.

The reports shall also include the following:

- a summary description of the Radiological Environmental Monitoring Program;
- at least two legible maps covering all sampling locations keyed to a table giving distances and directions from the centerline of one reactor (one map shall cover stations near the site boundary; a second shall include the more distant stations);
- the results of licensee participation in the Interlaboratory Comparison Program, required by SLC 16.11.15;
- a discussion of all deviations from the sampling schedule of Table 16.11.13-1; and

COMMITMENT (continued)

- a discussion of all analyses in which the LLD required by Table 16.11.13-3 was not achievable.

A single submittal may be made for a multiple unit station..

APPLICABILITY

At all times.

REMEDIAL ACTIONS

None

TESTING REQUIREMENTS

None

BASES

None

REFERENCES

1. Technical Specification 5.6.2

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.17 Radioactive Effluent Release Reports

COMMITMENT

Routine Radioactive Effluent Release Reports covering the operation of the unit during the previous calendar year of operation shall be submitted before May 1 of each year.

The Radioactive Effluent Release Reports shall include a summary of the quantities of radioactive liquid and gaseous effluents and solid waste released from the unit as outlined in Regulatory Guide 1.21, "Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants," Revision 1, June 1974, with data provided for the reporting period using Appendix B as guidance.

The Radioactive Effluent Release Report shall include an annual summary of hourly meteorological data collected over the previous calendar year. This annual summary may be either in the form of an hour-by-hour listing on magnetic tape of wind speed, wind direction, atmospheric stability, and precipitation (if measured), or in the form of joint frequency distributions of wind speed, wind direction, and atmospheric stability. This same report shall include an assessment of the radiation doses due to the radioactive liquid and gaseous effluents released from the unit or station during the previous calendar year. A five year average of representative onsite meteorological data shall be used in the gaseous effluent dose pathway calculations. Dispersion factors (X/Qs) and deposition factors (D/Qs) shall be generated using the computer code XOQDOQ (NUREG/CR-2919) which implements NRC Regulatory Guide 1.111. The meteorological conditions concurrent with the time of release shall be reviewed annually to determine if the five-year average values should be revised. The assessment of radiation doses shall be performed in accordance with the methodology and parameters in the OFFSITE DOSE CALCULATION MANUAL (ODCM).

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

COMMITMENT (continued)

The Radioactive Effluent Release Reports shall include the following information for each type of solid waste shipped offsite or disposed of in the site landfill during the report period:

a. Total container volume, in cubic meters,

b. Total Curie quantity (determined by measurement or estimate),

c. Principal radionuclides (determined by measurement or estimate),

d. Type of waste (e.g., dewatered spent resin, compacted dry waste, evaporator bottoms),

e. Number of shipments, and

f. Solidification agent or absorbent (e.g., cement, or other approved agents (media)).

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

The Radioactive Effluent Release Reports shall include any changes made during the reporting period to the PROCESS CONTROL PROGRAM (PCP) and to the OFFSITE DOSE CALCULATION MANUAL (ODCM), as well as a listing of new locations for dose calculations and/or environmental monitoring identified by the land use census pursuant to SLC 16.11.14.

The Radioactive Effluent Release Reports shall also identify any licensee initiated major changes to the Radioactive Waste Systems (liquid, gaseous, and solid). Otherwise, this information may be included in the annual UFSAR update. The discussion of each change shall contain:

a. A summary of the evaluation that led to the determination that the change could be made in accordance with 10 CFR Part 50.59;

b. Sufficient detailed information to totally support the reason for the change without benefit of additional or supplemental information;

c. A detailed description of the equipment, components, and processes involved and the interfaces with other plant systems;

d. An evaluation of the change, which shows the predicted releases of radioactive materials in liquid and gaseous effluents and/or quantity of solid waste that differ from those previously predicted in the License application and amendments thereto;

COMMITMENT (continued)

e. An evaluation of the change, which shows expected maximum exposures to individual in the UNRESTRICTED AREA and to the general population that differ from those previously estimated in the License application and amendments thereto;

f. A comparison of the predicted releases of radioactive materials, in liquid and gaseous effluents and in solid waste, to the actual releases for the period prior to when the changes are to be made;

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

h. Documentation of the fact that the change was reviewed and found acceptable by the Station Manager or the Chemistry Manager.

A single submittal may be made for a multiple unit station. The submittal should combine those sections that are common to all units at the station; however, for units with separate Radwaste Systems, the submittal shall specify the releases of radioactive material from each unit.

APPLICABILITY

At all times

REMEDIAL ACTIONS

None

TESTING REQUIREMENTS

None

BASES

None

REFERENCES

1. Technical Specification 5.6.3

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.18 Liquid Holdup Tanks

COMMITMENT The quantity of radioactive material contained in each unprotected outdoor radwaste tank shall be limited to $\leq$ 10 Curies, excluding tritium and dissolved or entrained noble gases.

APPLICABILITY At all times.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Quantity of radioactive material in tank not within limit.	A.1 Suspend all additions of radioactive material to the tank.	Immediately
	AND	
	A.2 Reduce the tank contents to within limit.	48 hours
	AND	
	A.3 Describe the events leading to this condition in the next Annual Radioactive Effluent Release Report.	Within the next scheduled Annual Radioactive Effluent Release Report

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11.18.1 Verify the quantity of radioactive material contained in unprotected outdoor radwaste tanks is within limits by analyzing a representative sample of the tank's contents when radioactive materials are being added to the tank.	7 days

BASES

The tanks applicable to this SLC include all those outdoor radwaste tanks that are not surrounded by liners, dikes, or walls capable of holding the tank contents and that do not have tank overflows and surrounding area drains connected to the Liquid Radwaste Treatment System.

Restricting the quantity of radioactive material contained in the specified tanks provides assurance that in the event of an uncontrolled release of the tanks' contents, the resulting concentrations would be less than the limits of 10 CFR Part 20, Appendix B, Table II, Column 2, at the nearest potable water supply and the nearest surface water supply in an UNRESTRICTED AREA.

REFERENCES

None

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.19 Explosive Gas Mixture

COMMITMENT The concentration of oxygen in the WASTE GAS HOLDUP SYSTEM shall be limited to $\leq$ 2% by volume whenever the hydrogen concentration exceeds 4% by volume.

APPLICABILITY At all times.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Concentration of oxygen in the WASTE GAS HOLDUP SYSTEM > 2% but $\leq$ 4% by volume.	A.1 Reduce oxygen concentration to within limits.	48 hours
B. Concentration of oxygen in the WASTE GAS HOLDUP SYSTEM > 4% and hydrogen concentration > 4% by volume.	B.1 Suspend all additions of waste gases to the system.	Immediately
	AND	
	B.2 Reduce the concentration of oxygen to $\leq$ 4% by volume.	Immediately
	AND	
	B.3 Reduce oxygen concentration to within limits.	48 hours

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11.19.1 Verify the concentrations of hydrogen and oxygen in the WASTE GAS HOLDUP SYSTEM is within limits by monitoring waste gases in the WASTE GAS HOLDUP SYSTEM with the hydrogen and oxygen monitors required by SLC 16.7.8.	During WASTE GAS HOLDUP SYSTEM operation

BASES

This specification is provided to ensure that the concentration of potentially explosive gas mixtures contained in the WASTE GAS HOLDUP SYSTEM is maintained below the flammability limits of hydrogen and oxygen. Automatic control features are included in the system to prevent the hydrogen and oxygen concentrations from reaching these flammability limits. These automatic control features include isolation of the source of hydrogen and/or oxygen, automatic diversion to recombiners, or injection of dilutants to reduce the concentration below the flammability limits. Maintaining the concentration of hydrogen and oxygen below their flammability limits provides assurance that the releases of radioactive materials will be controlled in conformance with the requirements of General Design Criterion 60 of Appendix A to 10 CFR Part 50.

REFERENCES

None

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.20 Gas Storage Tanks

COMMITMENT The quantity of radioactivity contained in each gas storage tank shall be limited $\leq$ 49,000 Curies noble gases (considered as Xe-133).

APPLICABILITY At all times.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Quantity of radioactive material in tank not within limit.	A.1 Suspend all additions of radioactive material to the tank.	Immediately
	AND	
	A.2 Reduce the tank contents to within limit.	48 hours

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11.20.1 Verify the quantity of radioactive material contained in each gas storage tank is within limit when radioactive materials are being added to the tank.	24 hours

BASES

This SLC considers postulated radioactive releases due to a waste gas system leak or failure, and limits the quantity of radioactivity in each pressurized gas storage tank in the WASTE GAS HOLDUP SYSTEM to assure that a release would be substantially below the dose guideline values of 10 CFR Part 100 for a postulated event.

Restricting the quantity of radioactivity contained in each gas storage tank provides assurance that in the event of an uncontrolled release of the tank's contents, the resulting total body exposure to a MEMBER OF THE PUBLIC at the nearest exclusion area boundary will not exceed 0.5 rem. This is consistent with Standard Review Plan 11.3, Branch Technical Position ETSB 11-5, "Postulated Radioactive Releases Due to a Waste Gas System Leak or Failure," in NUREG-0800, July 1981.

REFERENCES

None

ATTACHMENT 10

Summary of Changes to the Process Control Program

This attachment includes a summary of changes to the PCP.

Attachment 10
Summary of Changes to the Process Control Program

McGuire Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

The McGuire Nuclear Station PCP was revised twice in 2022. The most recent revision is 22 and is provided with the 2022 ARERR.

Below is the summary of DRR's incorporated into the revisions.

Rev 21:

DRR 02428884:

The DEC Corporate PCP is no longer supported by a corporate owner and will be retired. Each DEC site is now responsible for incorporating relevant sections of the DEC Corporate PCP into their site-specific PCP. Relevant sections include any information related to the standards and processes of preparing waste for burial. All processes and requirements related to preparing waste for burial have been retained and remain the same as previously approved from both the MNS PCP and the Corporate PCP. Non-relevant sections that were omitted from the Corporate PCP include corporate owners, corporate approvals, and review & revision processes. References specific to Catawba and Oconee Nuclear Station have also been omitted. All procedures, references, diagram documents from the MNS PCP have been retained with the excepted of one procedure which has been deleted. See details below from DRR 02393847. Review and revision of all site PCP documents are now governed by AD-CP-ALL-0030, "Process Control Program (PCP) Review and Revision." Each site has been assigned an SME owner responsible for revising and updating their site PCP as necessary (as stated in AD-CP-ALL-0030). Some procedure references have been updated (new procedure numbers or names). PIP numbers have been replaced NCR numbers that now reference the reports. Waste burial guidelines and state regulations documents specified in the regulatory requirements section. This change is being implanted as part of corrective actions from NCR 02421323 "NOS FINDING: 2022-CNS-RPCH-01-F1 - CNS PCP Ownership & Resp."

DRR 02393847:

Delete line: 3.6 HP/0/B/1004/012 “Utilization of Polyethylene High Integrity Containers”. Procedure has been retired and vendor manuals will be used in its place. AD-RP-ALL-5000 (referenced in the MNS PCP), directs user in checklists to use HIC vendor manual when needed.

Rev 22:

DRR 02442336:

AD-CP-ALL-0030 has been determined not be adequate in addressing the roles and responsibilities per NOS Finding in NCR 02434377. Roles and responsibilities not specified in AD-CP-ALL-0030 added to the MNS PCP in Section 6.2.

Facility Code :	MC
Applicable Facilities :	
Document Number :	MNS PCP
Document Revision Number :	022
Document EC Number :	
Change Reason :	DRR 02442336
Document Title :	MNS Process Control Program

Shatila, Omar H	Preparer	9/21/2022
Rollins, Travis B	Reviewer	9/21/2022
Burleson, Alan E	Reviewer	9/21/2022
Matheny, Michael S	Reviewer	9/21/2022
Hylton, Samuel T	Reviewer	9/21/2022
Hamm, Kevin M	Reviewer	9/21/2022
Fortin, Scott T	Reviewer	9/21/2022
Ceva, Celeste M.	Reviewer	9/21/2022
Bare, Brent A	Approver	9/21/2022

Notes :

Process Control Program
McGuire Nuclear Station (MNS) PCP

Revision 22

Reviews/Approvals	Name
Prepared by: MNS Station Sciences PCP SME	Omar Shatila
MNS Station Sciences Scientist	Alan Burleson
MNS Station Sciences Manager (ORC Member)	Travis Rollins
MNS Operation Manager (ORC Member)	Michael Matheny
MNS Maintenance Manager (ORC Member)	Samuel Hylton
MNS Engineering Manager (ORC Member)	Kevin Hamm
Training Superintendent (ORC Member)	Scott Fortin
MNS ORC Chair	Celeste Ceva
MNS Plant Manager	Brent Bare

1. TABLE OF CONTENTS

Radioactive Waste Process Control Program

McGuire Nuclear Station (MNS) PCP

2. INTRODUCTION

2.1 Purpose

The McGuire Nuclear Station (MNS) Process Control Program (PCP) lists the documents used to implement applicable requirements of the Process Control Program for radioactive waste solidified or dewatered to meet requirements for direct disposal at a 10CFR61 licensed disposal facility as referenced in the MNS Selected Licensing Commitments. AD -RP-ALL-0300 provides guidance for the review and revision of the PCP.

2.1.1 A Process Control Program (PCP) describes the administrative and operational controls used for the solidification of liquid or wet radioactive wastes and the dewatering of wet radioactive wastes. Its purpose is to assure that the final disposal waste product meets applicable Federal, State and Disposal Site waste form requirements for disposal at a 10CFR61 licensed Low-Level Waste (LLW) disposal site.

2.1.2 Waste processing (solidification or dewatering) equipment and services may be provided by Duke Energy or approved vendors. Vendor services may be performed onsite or offsite. Any process used shall meet all applicable requirements of the Process Control Program.

2.1.3 For waste processed onsite for direct disposal it is the responsibility of the LLW generator/ shipper to ensure that PCP requirements are met and that the condition of the waste is acceptable upon arrival at the disposal site.

2.1.4 For waste packaged and shipped to an approved off-site processor contracted to meet the requirements for direct disposal at a 10CFR61 licensed Low-Level Waste (LLW) disposal site, the final waste form requirements are not applicable prior to shipment to the processor for final processing and disposition.

3. APPLICABILITY

3.1 Liquid and Wet Radioactive Waste Disposal

3.1.1 Licensing documents, e.g., Updated Final Safety Analysis Reports (UFSAR) and SLCs, require that the Solid Radwaste System be operated in a manner to assure compliance with requirements for the transportation and disposal of LLW. They refer to the NRC requirement to follow a process control program for solidification of liquid or wet radioactive wastes or the dewatering of wet radioactive wastes to be shipped for direct disposal at a 10CFR61 licensed disposal site such that the final product meets all applicable disposal site requirements.

3.1.2 These “Process Control Program” requirements are applicable to all liquid or wet radioactive wastes that are being prepared for direct disposal at a 10CFR61 LLW disposal facility.

3.1.3 Radioactive wastes shipped for off-site processing in accordance with the processor's specifications and transportation requirements are not required to be solidified or dewatered to meet disposal requirements prior to shipment to an offsite processor. They are not subject to the final waste form solidification or dewatering requirements of this PCP as specified in 10CFR61 when an offsite processor is contracted to perform the PCP processing for disposal.

3.2 Mixed Waste

3.2.1 AD-EN-ALL-0700 "Waste Management and Recycling" describes handling of mixed waste at Duke Energy nuclear stations.

3.2.2 Disposal of Mixed Waste at a LLW disposal site is prohibited unless it is approved by the disposal site and meets federal, state and disposal site requirements. (e.g., 40CFR, 10CFR61, site waste acceptance criteria)

3.2.3 All vendors supplying services for Mixed Waste using solidification shall meet the applicable requirements of the PCP and be a Duke Approved Supplier of PCP Services.

3.2.4 PCP Subject Matter Experts (SMEs) and disposal site regulators shall approve the use of solidification for disposal of Mixed Waste.

3.2.5 If Mixed Waste is to be rendered non-hazardous for disposal at a 10CFR61 disposal site using solidification the final product and packaging must meet all the LLW disposal site requirements.

3.3 Radioactive Waste Oil

3.3.6 Radioactively contaminated oil is to be managed as described in AD-EN-ALL-0730 “Used Oil Management” (superseded EWP 2.8 “Used Oil”).

3.3.7 Offsite processors are available for waste oil treatment, (e.g., incineration) reducing the regulatory burden on the generating site. Nuclear site programs address the specific waste oil management processes available at the site.

3.3.8 Each LLW disposal site defines the acceptable threshold for incidental levels of waste petroleum-based oil (e.g., less than 1% by volume). Solidified waste containing oil shipped to a 10CFR61 disposal site shall meet the applicable requirements of the PCP and all applicable disposal site acceptance criteria.

3.3.9 If a LLW site accepts greater than incidental concentrations of oil to be solidified for disposal, an oil-specific procedure must meet the requirements of the PCP and the acceptance criteria of that disposal site.

3.4 Radioactive Waste Interim Storage

Sites that have LLW requiring interim storage shall ensure that all of the following requirements that are applicable are met.

3.4.1 Any radioactive waste that is stored for an interim period in a shipping/ disposal container shall be packaged such that there is no detrimental interaction between the waste and its container.

3.4.2 If applicable, Certificates of Compliance shall be maintained at each station for all waste shipping/ disposal containers used for interim storage.

3.4.3 Vendor supplied containers used for storage shall be handled and stored according to applicable guidance in vendor documents, including chemical compatibility requirements.

4. REFERENCES

4.1 Regulatory Requirements

4.1.1 10CFR20, “Standards for Protection Against Radiation”

4.1.2 “Domestic Licensing of Production and Utilization Facilities”

4.1.3 10CFR61, “Licensing Requirements for Land Disposal of Radioactive Waste”

4.1.4 10CFR71, “Packaging and Transportation of Radioactive Material”

4.1.5 40CFR, “Protection of Environment”

4.1.6 40CFR266 “Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities”

4.1.7 WAG-501 "Energy Solutions Bear Creek Waste Acceptance Guidelines"

4.1.8 WAG-501A "Energy Solutions Bear Creek Mixed Waste Acceptance Guidelines"

4.1.9 TDEC Rule Chapter 0400-20-10-.31 & .32 "State Regulations for Protection Against Radiation, Fees for Licenses and Licensing of Shippers of Radioactive Material into or within Tennessee"

4.1.10 10A NCAC 15 "North Carolina Administrative Code, Chapter 15 - Radiation Protection"

4.2 Regulatory Guidance and Industry Standards

Technical guidance is provided in the following documents to standardize compliance with the applicable regulations:

4.2.1 NUREG-0133, “Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants”

4.2.2 NUREG-0452, “Standard Technical Specifications for Westinghouse PWR's” (Superseded by NUREG 1431)

4.2.3 NUREG-1431 “Standard Technical Specifications Westinghouse Plants”

4.2.4 NUREG-1430 “Standard Technical Specifications Babcock and Wilcox Plants”

4.2.5 NUREG-800 “Standard Review Plan”, Section 11.4 “Solid Waste Management Systems”

4.2.6 NUREG 800, Section 11.4, Appendix -A, “Design Guidance for Temporary Onsite Storage of Low Level Radioactive Waste”

4.2.7 Branch Technical Position - ETSB 11-3, "Design Guidance of Solid Radioactive Waste Management Systems"

4.2.8 NRC Review Criteria for Solid Waste Management Systems

4.2.9 Regulatory Guide 1.143, "Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Plants"

4.2.10 NRC "TECHNICAL POSITION ON WASTE FORM" Revision 1 (January 1991)

4.2.11 RC "Concentration Averaging and Encapsulation Branch Technical Position", Rev 1 (2015)

4.2.12 ANSI/ANS-40.37-2009 "mobile radioactive waste processing systems"

4.3 Duke Energy, MNS, and Vendor PCP Implementing Documents and Diagrams

4.3.1 Fleet and MNS Site Implementing Procedures

4.3.1.1 AD-RP-ALL-5000, Preparation and Shipment of Radioactive Material and Radioactive Waste

4.3.1.2 CP/0/B/8600/011, Sampling Batching Tank and Resin Sample Preparation

4.3.1.3 OP/0/B/6200/064 "Transfer and Dewatering Media"

4.3.1.4 OP/0/B/6200/083 "WM Process Skid Demineralizers Sluice, Load, and Maintenance"

4.3.1.5 OP/0/A/6200/532 "Solid Waste System Operation"

4.3.1.6 HP/0/B/1004/032 "Packaging Radioactive Filters"

4.3.2 Licensing Documents

4.3.2.1 MNS UFSAR Chapter 16

4.3.2.2 MNS SLC 16.11.11

4.3.3 Vendor Documents

4.3.3.1 CS-OP-PR-008, Setup and Operation of Energy Solutions Self-Engaging Dewatering System Fillhead

4.3.3.2 CS-OP-PR-009, Ecodex Precoat/Powdex/Solka-Floc/Diatomaceous Earth/Zeolite Dewatering Procedure for Energy Solutions 14-215 Or Smaller Liners Utilizing Energy Solutions Self-Engaging Dewatering System (S.E.D.S.)

4.3.3.3 CS-OP-PR-010, Bead Resin/ Activated Carbon Dewatering Procedure for Energy Solutions 14-215 Or Smaller Liners, Utilizing Energy Solutions Self-Engaging Dewatering System (S.E.D.S.)

4.3.3.4 FO-AD-002, Operating Guidelines for Use of Polyethylene High Integrity Containers

4.3.3.5 FO-OP-022, Ecodex Pre-Coat/Powdex/Solka-Floc/Diatomaceous/ Earth/Zeolite Dewatering Procedure for Energy Solutions 14-215 Or Smaller Liners

4.3.3.6 FO-OP-023, Bead Resin/Activated Carbon Dewatering Procedure for Energy Solutions 14-215 Or Smaller Liners

4.3.3.7 FO-OP-033, Set Up and Operation of Universal Dewatering Fillhead

4.3.3.8 FO-OP-073, Removing Free Standing Water from Energy Solutions FEXM HICS

4.3.4 Diagram References

4.3.4.1 MC-1100-01.02

4.3.4.2 MCFD-1566-01.00

4.3.4.3 MCFD-1566-01.01

4.3.4.4 MCFD-1566-02.00

4.3.4.5 MCFD-1566-03.00

4.3.4.6 MCFD-1590-01.03

4.3.4.7 MCFD-2590-01.03

4.3.5 Topical Report

4.3.5.1 Duke Energy Corporation Topical Report: Quality Assurance Program Description Operating Fleet (DUKE-QAPD-001-A)

4.4 Duke Energy Programs that Interface with the PCP

4.4.1 AD-CP-ALL-0023, Preparation of the Annual Radioactive Effluent Release Report

4.4.2 AD-CP-ALL-0030, Process Control Program (PCP) Review and Revision

4.4.3 AD-DC-ALL-0002, Records Management

4.4.4 AD-DC-ALL-0201, Development and Maintenance of Controlled Procedure Manual Procedures

4.4.5 Duke Energy Information Retention Policy

Ref: (Legal 109, 10CFR20 Appendix G (III.A.3), 10CFR61.80)

4.4.6 AD-EN-ALL-0700, Waste Management and Recycling

4.4.7 AD-EN-ALL-0730, Used Oil Management

4.4.8 AD-LS-ALL-0019, On-Site Review Committee

4.4.9 AD-RP-ALL-5002, 10 CFR 61 Radioactive Waste Classification

5. DEFINITIONS

5.1 Safety Analysis Report (SAR)

The station's Technical Specifications (Tech Specs) updated final safety analysis report, licensee commitments, safety evaluation reports and the facility operating license.

5.2 Selected Licensee Commitments (SLCs)

Commitments to control important plant equipment and operating conditions not controlled elsewhere. Operational commitments which are to be removed from existing station Tech Specs may be included in the SLC program. Also included in this program can be selected NRC commitments contained in licensing documents such as the station's SERs, LERs, violation responses, generic letter and bulletin responses, submittal documents and other Duke Energy letters to the NRC.

5.3 10CFR Part 61 "Licensing Requirements for Land Disposal of Radioactive Waste"

This NRC regulation requires that low-level radioactive waste (LLW) meet certain waste form acceptance criteria to be received for disposal at NRC and Agreement State licensed radioactive waste disposal sites.

5.4 Free Standing Liquid (FSL)

FSL is liquid that is in a disposal container but is not bound by the waste in the container. FSL is the liquid available for release if disposal container integrity is lost (e.g., punctured). The amount of FSL in a radioactive waste disposal container shall be less than a specified threshold to meet 10CFR61, state and disposal site requirements for disposal.

5.5 Liquid Radioactive Wastes

Radioactive wastes comprised primarily of water containing a combination of dissolved and suspended solids (e.g., evaporator concentrates, lab wastes, floor and equipment drain water, laundry, wet waste decant or drainage, etc.).

5.6 Wet Radioactive Wastes

Wet radioactive wastes are solid radioactive wastes containing loosely bound liquid that can collect in the disposal container as FSL (e.g., slurry wastes are comprised primarily of solid particles suspended in loosely bound interstitial water, spent mechanical filters are solid materials that are adsorbent or porous and retain liquid).

5.7 Solidification

The meaning of the term Solidification during the original implementation of 10CFR61 was a process that converted radioactive waste into a product meeting 10CFR61, State and disposal site requirements for waste-form stability and FSL. Solidification was accomplished by mixing measured amounts of liquid or wet radioactive waste, binder and required additives that, after sufficient curing time, produce a solid homogeneous, freestanding monolith. At the end of the curing period, the absence of excessive FSL was verified either by confirmation that the PCP boundary conditions were met or by physical verification/testing. Under current practices, generally the solidified waste does not meet waste form stability requirements since few of the processes tested during the early implementation were able to do so. The waste container or barriers in site design or process used at the disposal site meet the stability requirements. The process requirements described in the solidification section do not apply to encapsulation of discrete LLW items as described in the BTP for waste form.

5.8 High Integrity Container (HIC)

Disposal containers that have been approved by the NRC for disposal of Class A unstable, Class B or Class C LLW and meet the long term disposal requirements of 10CFR61 and the disposal site.

5.9 Dewatering

Dewatering as used in this document is the removal of liquid using a process that is required to meet the requirements of this PCP. Dewatering removes the loosely bound liquid from a wet radioactive waste such that accumulation of Free Standing Liquid in the disposal container is unlikely to approach the disposal limit threshold values as defined by applicable regulations and disposal site criteria. NRC regulations require that the process used to dewater radioactive wastes to meet disposal criteria shall be governed by a PCP.

5.9.1 10CFR61 FSL criteria requires less than 0.5% FSL by waste volume per container or less than 1.0% FSL if a high integrity container (HIC) is used.

5.9.2 Typically, liquid and wet wastes are pre-staged in vented tanks or containers and are therefore degassed prior to the dewatering process. However, all vendor-required venting practices should be adhered to.

5.10 Unwatering ("Gross Dewatering", "dewatering to loss of vacuum")

Unwatering as used in this document is the removal of water using a process that is not required to meet the requirements for direct disposal at a 10CFR61 disposal site. Unwatering removes loosely bound excess or freeboard water from wet radioactive wastes such that only the requirements for transportation set forth in 49CFR are satisfied (e.g., unwatering may be to complete the first dewatering cycle for a specific container and waste stream to loss of vacuum to prepare waste for shipment to an approved offsite processor who will perform additional processing that will meet the final disposal requirements).

5.11 Mixed Waste

Defined in Resource Conservation Recovery Act (RCRA) as amended by the Federal Facility Compliance Act of 1992, a Mixed Waste contains both RCRA hazardous waste and source, special nuclear, or byproduct material subject to the Atomic Energy Act of 1954, as amended. The use of solidification to render Mixed Wastes non-hazardous shall ensure that the final product meets all waste form requirements applicable to radioactive waste disposal at a 10CFR61 disposal site (Ref: 3.1.6. “40 CFR Part 266”).

5.12 QA Approved Supplier List

Radwaste vendors approved to provide PCP processing are included on the Duke Energy QA Approved Supplier List and are subject to the requirements and audits of that program.

5.13 Waste Batch

A "batch" shall be defined as an isolated quantity of waste to be processed having essentially consistent physical and chemical characteristics.

5.14 Waste Batch Mixing

A Waste Batch shall be adequately mixed using a procedural process such as agitation via mixers, air sparging or recirculating flow which meets a specified minimum rate that has been determined to provide a representative sample for the vessel.

5.15 Process Parameters

Those conditions measured or observed during a solidification or dewatering process to ensure an acceptable product. These are determined for each waste type and are specific to the process method used.

5.16 Boundary Conditions/ Acceptance Criteria

5.16.1 Solidification Boundary Conditions or Acceptance Criteria are defined as, the bounding numerical values for solidification process parameters that produce an acceptable product when shipped for direct disposal at a 10CFR61 disposal site.

5.16.2 Dewatering Boundary Conditions or Acceptance Criteria are defined as the bounding numerical values for process parameters that ensure free standing liquid requirements are met when shipped for direct disposal at a 10CFR61 disposal site.

5.16.2.1 Media: Acceptance Criteria for dewatering process media in disposal containers (e.g., HICs) have been determined by vendor tests using real or simulated waste to demonstrate the adequacy of the dewatering process for each combination of waste type and container. These tests are documented in dewatering Topical

Reports, or equivalent, that shall be approved by the NRC or other appropriate authority before the containers are certified for use. The Acceptance Criteria are then incorporated into the dewatering procedures for each combination of waste type and container.

5.16.2.2 Filters: Acceptance criteria for mechanical filters (e.g., cartridge, bag, membranes, etc.) may be derived from tests performed on the various types of filters in use. Tests performed by Duke Energy should be documented in a retrievable manner. Acceptance criteria are then incorporated into the applicable procedure for each filter type (e.g., drainage time, drainage conditions, etc.).

Filters may also be packaged in disposal containers designed to allow the removal of free standing liquid from the container prior to shipment for direct disposal based on the disposal site's waste acceptance criteria (WAC).

5.17 PCP Topical Report (NCRs 01740840, 01605371, 01423659)

A Topical Report provides the basis for a PCP technology & process. It documents test results that demonstrate regulatory requirements were met during the regulatory required testing for solidification or dewatering technologies and processes. For a time period after implementation of 10CFR61 the NRC approved processes developed to dewater or solidify waste based their review of the Topical Report for that process. The NRC no longer performs the approval of Topical Reports so this approval is typically the responsibility of the disposal site host agreement state regulatory authorities. Topical report testing was designed to envelope the worst-case dewatering scenarios given the industry's then current practices. As with any topical based program, the critical conditions and parameters identified during testing are incorporated into the implementing process with enough conservative margin to ensure success if you operate within the enveloping conditions and assumptions of the tests performed. When actual conditions vary from the conditions in the specific tests performed for the Topical Report, the correlation with the Topical testing is diminished and degree of processing conservatism may need to increase to compensate.

6. ADMINISTRATION OF THE MNS PCP AND SUPPORT DOCUMENTS

6.1 PCP Changes: Revisions and Changes

PCP document revisions and minor changes are initiated, reviewed and approved in accordance with AD-CP-ALL-0030, Process Control Program (PCP) Review and Revision. The EDMS document management processes should be used to document and issue the new versions.

6.2 PCP Responsibilities

6.2.1 On-Site Review Committee (ORC)

6.2.1.1 Reviews and approves PCP changes in accordance with AD-CP-ALL-0030, Process Control Program (PCP) Review and Revision, and as defined in Section 6, Administration of the MNS PCP and Support Documents.

6.2.2 Plant Manager

6.2.2.1 Reviews and approves PCP changes in accordance with AD-CP-ALL-0030, Process Control Program (PCP) Review and Revision, and as defined in Section 6, Administration of the MNS PCP and Support Documents.

6.2.3 Station Sciences Manager or designee

6.2.3.1 Ensure radioactive waste is shipped in accordance with the appropriate state and federal regulations.

6.2.3.2 Advise the Plant Manager on the appropriate technical standards, regulations, and requirements as related to solidification, dewatering and shipping.

6.2.3.3 Ensure the vendor's PCP and proposed contractual agreements are revised and advising the Plant Manager as to their adequacy.

6.2.3.4 Ensure vendor supplied documentation is retained for NRC inspection and review.

6.2.3.5 Reviews and approves PCP changes in accordance with AD-CP-ALL-0030, Process Control Program (PCP) Review and Revision, and as defined in Section 6, Administration of the MNS PCP and Support Documents.

6.2.3.6 Ensure vendor's PCP and operating procedures are reviewed and approved as required.

6.2.4 Site Staff Personnel (Station Sciences and Operations)

6.2.4.1 Provide technical support for PCP issues.

6.2.4.2 Perform PCP revisions in accordance with AD-CP-ALL-0030, Process Control Program (PCP) Review and Revision.

6.2.4.3 Generate Document Revision Requests (DRRs) to support PCP revisions in accordance with AD-CP-ALL-0030, Process Control Program (PCP) Review and Revision.

6.2.4.4 Review PCP revisions in accordance with AD-CP-ALL-0030, Process Control Program (PCP) Review and Revision.

6.2.4.5 Ensure corporate programs comply with applicable PCP requirements.

6.2.4.6 Support nuclear site programs in complying with PCP requirements.

6.2.4.7 Review vendor PCP and operating procedures.

6.2.4.8 Ensure PCP revision summary is provided in accordance with AD-CP-ALL-0023, Preparation of the Annual Radioactive Effluent Release Report.

6.2.4.9 Approve the use of solidification for disposal of Mixed Waste.

6.2.5 Operations Manager or designee

6.2.5.1 Monitor vendor operations to assure compliance with UFSAR and SLC requirements and procedural and contractual agreements.

6.2.5.2 Ensure vendor's PCP and operating procedures are reviewed and approved as required.

6.2.5.3 Reviews and approves PCP changes in accordance with AD-CP-ALL-0030, Process Control Program (PCP) Review and Revision, and as defined in Section 6, Administration of the MNS PCP and Support Documents.

6.3 PCP Implementing Procedure Requirements

6.3.1 Duke Energy PCP Implementing procedures shall ensure that all requirements for solidification or dewatering are met when performed by Duke Energy workers.

6.3.2 The Duke Energy PCP implementing procedures listed in Section 3.3.1 are published electronically as controlled copy files of the documents maintained in the Duke EDMS. The Duke Energy PCP Implementing documents satisfy NRC requirements for a Process Control Program

6.2.2.1 Completed procedures documenting the onsite solidification verification records shall be retained by the site on each vessel of solidified waste.

6.2.2.2 Documentation of the onsite dewatering verification records shall be retained on each vessel of dewatered waste.

6.3.3 The technical PCP implementing procedures shall identify the fact that they are PCP related to ensure technical reviews consider the PCP requirements.

6.3.4 All revisions to technical PCP implementing procedures listed in the site PCPs shall be reviewed to determine if they alter or inhibit the procedure's performance of the MNS PCP requirements.

6.3.5 QA Approved Suppliers' procedures may be used for onsite PCP activities using non-installed equipment as described in applicable administrative procedures. (e.g., AD-DC-ALL-0201 Development and Maintenance of Controlled Procedure Manual Procedures)

7. APPROVAL PROCESS FOR QA APPROVED SUPPLIERS

Any PCP service supplier shall be approved and incorporated into the QA Approved Supplier Program prior to being used as contracted for process services that use a dewatering or solidification PCP to meet final waste form requirements at a 10CFR61 disposal site.

7.1 Technical Review and Approval

Before vendors can provide PCP related services, they shall be evaluated against the applicable Duke PCP documents and approved by the appropriate designees.

7.1.1 If the vendor provides PCP related services, the vendor PCP and other related program documents are evaluated to ensure they meet the applicable requirements of the Duke PCP documents.

7.1.2 The results of these reviews should be documented appropriately for future reference.

8. PCP REQUIREMENTS FOR VENDOR PROCESSES AND SERVICES

8.1 Topical Report (or equivalent)

Any vendor service or vendor supplied processes utilized for solidification or dewatering by Duke Energy shall have a Topical Report or other form of certification documenting appropriate regulatory approval of the process and associated containers, or shall supply to Duke Energy sufficient documentation of the process and test results to demonstrate that an acceptable product will be produced using the described solidification or dewatering process.

8.2 10CFR61 Waste Form Compliance

8.2.1 The vendor(s) approved for solidification or dewatering services shall have regulatory certification documenting compliance with waste form requirements in the final product, or shall supply Duke Energy sufficient documentation to demonstrate waste form compliance.

8.2.2 Any vendor providing High Integrity Containers (HIC's) to Duke Energy shall provide proof of regulatory approval documenting compliance with waste form requirements, or shall supply Duke Energy sufficient documentation to demonstrate waste form compliance.

8.2.3 All vendor Topical Reports or equivalent shall certify that the final product conforms to the applicable waste form for Class A, B, or C waste.

8.2.4 Vendor PCP Service Quality Requirements

QA Approved PCP Service Suppliers shall meet the applicable quality requirements set forth in their contract or specific Purchase Order.

8.3 10CFR61Waste Classification Compliance

Each container of processed (i.e., solidified or dewatered) waste shall meet the requirements in AD-RP-ALL-5002, 10 CFR 61 Radioactive Waste Classification prior to disposal.

8.4 Minimum Requirements for Onsite Process Vendors

8.4.1 Vendors providing PCP services onsite shall be approved QA Suppliers.

8.4.2 PCP Vendors shall fulfill all the applicable requirements in the vendor Radioactive Waste PCP and the applicable quality requirements set forth in the contract prior to shipment of the solidified or dewatered waste for direct disposal.

8.4.3 Onsite Vendor System/Equipment Interface Requirements:

8.4.3.1 The vendor documentation, drawings or diagrams supplied to Duke Energy shall include adequate system or process description including all vendor interfaces with installed plant equipment and potential release pathways.

8.4.3.2 Solidification system radioactive effluents are treated or routed to the appropriate plant system to meet effluent discharge requirements.

8.4.3.3 Decanted radioactive liquid is processed as required or routed to the station liquid radwaste systems.

8.4.4 Onsite Vendor Supplied System Design Requirements

8.4.4.1 The vendor proposal and contract shall verify that the design, construction, operation and quality assurance provisions are in accordance with applicable portions of NRC ETSB Branch Technical Position 11-3 and Regulatory Guide 1.143.

8.4.4.2 Permanent or portable solidification and dewatering systems used at nuclear sites shall meet the applicable design, construction, operation and quality assurance provisions of NRC ETSB Branch Technical Position 11-3 and Regulatory Guide 1.143.

8.5 Minimum Requirements for Offsite PCP Process Vendors

QA Approved Supplier Vendors providing PCP services offsite shall meet the requirements of their PCP process and the applicable quality requirements set forth in the contract and/or purchase order prior to disposal of the final product.

9. PCP DEWATERING PROCESS DESCRIPTION

The methods used for removal of liquid from wet wastes for final disposal shall comply with the specific requirements of the disposal site at which the waste is being disposed. Dewatering of wet wastes shall be performed in accordance with the applicable PCP requirements equivalent to the process described below. PCP workers shall use approved procedures in a controlled and quality fashion which ensures that all applicable license documents and disposal site criteria are met. Procedures used to direct dewatering shall include enough detail to ensure requirements are met.

9.1 Dewatering Mechanical Filters (e.g., cartridge, bag, membrane)

The guidance below addresses dewatering methods and PCP issues unique to removal of FSL for direct disposal of mechanical filters at a 10CFR61 disposal site.

9.1.1 The dewatering process must ensure subsequent accumulation of FSL in the disposal container is not likely to approach disposal site limits.

9.1.2 The FSL requirements for direct disposal may be met using a container and procedure designed to remove any subsequent FSL accumulation in the container prior to disposal.

9.1.3 Wet spent mechanical filters can be dewatered by several methods including allowing liquid to gravity drain from the filter, blowing the filter down with air, compacting the filter, etc.

9.1.4 The method of dewatering shall be in accordance with a defined, evaluated, and documented process.

9.1.5 The parameters of the process, referred to as boundary conditions, shall be defined and used to ensure quality in the process, which in turn serves to ensure an acceptable characteristic of the waste. An example of a boundary condition is the specified period of time for which a mechanical filter shall be allowed to drain freely to ensure FSL will be less than disposal requirements.

9.1.6 Filters placed in a filter disposal container designed for removal of FSL shall meet the PCP boundary conditions for dewatering the container.

9.1.6.1 If PCP boundary conditions are met after placing the filter in the disposal container, the container shall be dewatered to ensure the container FSL meets disposal requirements.

9.1.6.2 If the PCP boundary conditions have been met prior to placing the filters in the disposal container, dewatering the container to remove incidental FSL is at site discretion.

9.1.6.3 Case-by case circumstances, such as the following, should be considered in determining the appropriateness of performing additional filter disposal container dewatering:

- The time interval between removal of the filters from wet service and placement into the disposal container
- Size of the disposal container relative to the moisture content in the filters
- The number of filters
- The variety of filter types in a single container
- The environmental conditions of filter staging and interim storage

9.1.7 Use of absorbent package material in mechanical filter disposal containers is subject to the requirements of the disposal site acceptance criteria.

9.2 Dewatering Slurries

The guidance below addresses dewatering issues associated with slurry wastes.

9.2.1 Dewatering of “slurried” wet wastes (e.g., resin, carbon, Zeolite, filter precoat, filter backwash solids) removes the loosely bound interstitial liquid from solids such that the disposal container meets applicable regulatory and burial site FSL criteria for disposal.

9.2.2 Wet spent process media dewatering shall be performed using processes, containers and procedures that have met the Duke PCP approval requirements.

9.2.3 Typical container dewatering processes use a vacuum pump that takes suction from the container through a filter system in the container. The water is returned to a station liquid radwaste system and the waste solids are retained in the vessel by the container filter(s).

9.3 Additional Conservatism in Slurry Dewatering Procedures to Address Variation from the Topical Report (NCR 01740840, 01605371, 01423659)

This section only applies to dewatering for direct disposal at a 10CFR61 disposal site performed by Duke Energy Carolinas (DEC) workers using Duke Energy dewatering procedures. This section does not apply to QA Approved Suppliers performing PCP activities.

Dewatering processes based on approved and documented testing (e.g., Topical Reports) are applied to actual conditions that can vary from the conditions of the original testing. The results of a Root Cause investigation at ONS (NCR 01740840) identified several issues and resolutions that should be incorporated into applicable Duke dewatering implementing procedures. Vendor procedures applicable to the technologies and processes used by Duke Energy in implementing the PCP provide the basis for minimal requirements in PCP implementing procedures. In addition, the guidance below was added based on the Root Cause findings at ONS:

9.3.1 All Duke Energy Carolinas (DEC) PCP dewatering procedures shall include flexibility/ guidance for the worker to add conservatism to the dewatering process if waste content and/ or process conditions are atypical in a non-conservative manner relative to the testing performed for the Topical report. (e.g., presence of greater than normal non- media solids, dewatering boundary parameters are not easily met, higher than normal volume of FSL is collected during the final dewatering cycle, etc.)

9.3.1.1 Additional conservatism can include but is not limited to the following examples:

A. Additional dewatering cycles

B. Additional settling time between pumping periods

C. Additional processing by an approved offsite vendor to verify FSL prior to disposal

9.3.2 Guidance for dewatering all liners using the PCP and procedures for direct disposal at Barnwell (NCR 01740840 CAPR)

9.3.2.1 Require liner functional testing prior to filling liner with waste to ensure there are no leaks in the liner dewatering system. This testing should include:

A. filling the liner with water

B. testing each level of the liner dewatering laterals using the dewatering procedure to unwater the liner

C. verifying that vacuum is not broken prior to exposing the filters for each set of laterals as described in the procedure

9.3.2.2 Ensure ambient temperature guidance for dewatering will preclude localized freezing conditions during the dewatering sequence. After most of the water is removed during the first dewatering cycle, subsequent cycles pull air through the interstitial spaces of the media and the loss of heat due to evaporation can depress the temperature on surface of the media and dewatering filters below ambient temperature.

A. Follow guidance in the vendor documentation for the process in use

B. If no other guidance is provided, dewatering should not be performed unless ambient temperature of air entering the liner is 40 degrees Fahrenheit or higher (ref. Energy Solutions procedure FO-OP-022)

9.3.2.3 Ensure final water collection sample point is representative (e.g., as close as possible to the pump discharge)

9.3.3 Mixed Media: Additional guidance for dewatering liners containing Mixed Media with significant non- media solids using a PCP for direct disposal at a 10CFR61 disposal site. (NCR 01740840 CAPR)

The guidance below applies to liners containing combinations of different media with significant quantities of non-media solids (e.g., layered spent zeolite, carbon, resin, etc. containing a large amount of non-media particulate)

9.3.3.1 Require dewatering filters with maximized surface area (e.g., Ecodex filter or equivalent) in all liners that contain mixed media with significant non-media solids

9.3.3.2 Clearly specify media loading sequence if media is not homogeneously mixed to minimize potential blinding of the lowest level of filters. (e.g., for layered media, use the media with the fewest non-media solids and most consistent and largest diameter beads in the bottom of the liner)

9.3.3.3 Require additional dewatering Cycles (e.g. 3 additional cycles after the acceptance criteria in the vendor procedure have been met)

9.3.3.4 Require longer settling periods during the additional dewatering cycles (e.g., 24 hours instead of the 16 hours required in the vendor procedure)

9.3.3.5 The PCP implementing procedures must comply with the vendor PCP guidance and procedures applicable to the dewatering system and disposal containers in use. e.g., If the vendor process control program and procedures applicable to the current system and process require dewatering through the bottom 2 laterals during liner filling this must be reflected in the Duke procedures.

9.4 Dewatering Process Requirements

The procedures directing dewatering processes shall address all the following activities that apply to the specific waste type being dewatered.

9.4.1 Waste Characterization

Dewatering procedures shall describe how each type of waste is characterized. The characterization information determines what disposal and container requirements apply and may also be utilized to determine shipment packaging requirements (e.g., shielding). Much of the required information for slurry waste is obtained using a representative sample of the waste media. Characterization requires the following types of information:

9.4.1.1 Radioactivity content

A. To determine 10CFR61 waste class, form and container requirements

B. To provide waste radiological characteristics for packaging, transportation and disposal requirements

9.4.1.2 Waste compatibility with disposal container and process method

A. Chemical Compatibility: Process knowledge can be applied to determine chemical compatibility with the container.

B. Hazardous Characteristics: Process knowledge can be applied to determine if the waste is a Mixed Waste.

C. If process knowledge is uncertain due to a potential input of incompatible or hazardous materials, then chemical analysis using an approved method shall be performed to determine chemical compatibility or hazardous characteristics.

9.4.2 PCP process parameters shall be identified in implementing procedures. Typical parameters are based on:

9.4.2.1 Waste form (e.g., physical, chemical and radiological characteristics)

9.4.2.2 Settling time

9.4.2.3 Drain (or pump) time

9.4.2.4 Temperature

9.4.2.5 Drying time

9.4.3 PCP boundary conditions shall be established for applicable process parameters to verify FSL threshold limits are met.

9.4.4 Sample analysis results and boundary conditions shall be reviewed by the appropriate knowledgeable individual responsible for the dewatering process.

9.4.5 Actual dewatering shall be performed using approved procedures that ensure the process is performed within the established boundary conditions.

9.5 Product Verification

The amount of free-standing liquid shall be verified to be within disposal site criteria for each container of dewatered waste prior to disposal (e.g., 10CFR61 requires that each container shall have less than 0.5% free-standing liquids by waste volume or less than 1.0% free-standing liquid if a High Integrity Container (HIC) is used). Procedures should include guidance for problems during container loading or processing that preclude or fail to meet PCP requirements as required in SLC Remedial Action Requirements.

9.5.1 PCP Verification may be accomplished by documenting that the Process Control Program was followed.

9.5.2 A disposal site may define a product verification testing method approved for use for specific waste disposal categories in lieu of a process control method.

9.5.2.1 That approved product verification process may be used for that category of disposal on a case-by-case basis, (e.g., bulk waste non-containerized disposal).

9.5.2.2 Documentation of the method used for product verification and the results shall be included in the dewatering record as described in the Dewatering Documentation Retention section below.

9.5.2.3 Make programmatic changes as necessary to address any problems identified.

9.5.3 The PCP and site procedures must address the Commitments in the “The Solid Radioactive Wastes” of MNS SLC 16.11.11. These Commitments include a description of the PCP purpose, and requirements for the use of the PCP to process LLW for direct disposal.

9.5.3.1 Remedial Actions address the following conditions:

A. Requirements not met by process or packaging conditions

B. Solidification verification failures

C. Processing not performed per PCP

D. Inoperable Equipment

9.5.3.2 Solidification processes must meet Testing or Surveillance requirements and frequencies

9.6 Dewatering Document Retention

Documentation of dewatering or solidification completed onsite for direct disposal at a 10CFR61 disposal site shall be retained as part of the radiological shipping and disposal records as described in the applicable procedures and documents. (e.g., PCP implementing procedures, AD-RP-ALL-5000, vendor documents)

10. PCP SOLIDIFICATION PROCESS DESCRIPTION

This section historically described a solidification process for liquid or media LLW in which a radioactive liquid or slurry waste was uniformly mixed into a binding matrix to create a physically uniform final waste form that is a homogeneous, free standing monolith and meets 10CFR61 waste form stability and FSL disposal requirements.

No installed solidification systems are operational at the DEC sites because they were not able to meet all the 10CFR61 disposal requirements and or were not cost effective. The solidification of liquids and slurry media if required is now performed via contracts with PCP QA approved suppliers under their PCP in controlled and quality fashion which ensures that all applicable regulatory, licensing and disposal site criteria are met. e.g. the applicable Commitments in the "The Solid Radioactive Wastes" sections of SLC 16 "RADIOLOGICAL EFFLUENTS CONTROLS".

Only the FSL disposal requirements apply to solidification for encapsulation of discrete LLW items as described in the BTP for waste form. Encapsulation is also performed via contracts with PCP QA approved suppliers.

Documentation of onsite solidification for direct disposal at a 10CFR61 disposal site shall be retained as part of the radiological shipping and disposal records as described in the applicable procedures and documents. (e.g., PCP implementing procedures, AD-RP-ALL-5000, vendor documents).

11. REVISION SUMMARY

DRR 02442336

AD-CP-ALL-0030 has been determined not be adequate in addressing the roles and responsibilities per NOS Finding in NCR 02434377. Roles and responsibilities not specified in AD-CP-ALL-0030 added to the MNS PCP in Section 6.2.

5AD 02442342

ORC review and approval complete on 9/21/2022

ATTACHMENT 11

Summary of Major Modifications to the Radioactive Waste Treatment Systems

This attachment includes a description of major modifications to the radioactive waste treatment systems that are anticipated to affect effluent releases.

Attachment 11
Summary of Major Modifications to the Radioactive Waste Treatment Systems

McGuire Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

No major modifications to McGuire Nuclear Station liquid, gaseous, solid, or mobile radioactive waste treatment systems occurred in 2022.

ATTACHMENT 12

Errata to a Previous Year's ARERR

This attachment includes any amended pages from a previous year's ARERR.

Attachment 12
Errata to a Previous Year's ARERR

McGuire Nuclear Station Units 1 & 2
Period 1/1/2022 - 12/31/2022

There are no changes to a previous year's ARERR.

ENCLOSURE 5: ONS Annual Radioactive Effluent Release Report

Oconee Nuclear Station
Units 1, 2, and 3

Annual Radioactive Effluent Release Report

January 1, 2022 through December 31, 2022

Dockets 50-269, 50-270, and 50-287

Introduction

The Annual Radioactive Effluent Release Report is pursuant to Oconee Nuclear Station Technical Specification 5.6.3 and Selected Licensee Commitment 16.11-9. The below listed attachments to this report provide the required information. In addition, the ODCM is included pursuant to Oconee Nuclear Station Technical Specification 5.5.1.

Attachment 1	Summary of Gaseous and Liquid Effluents
Attachment 2	Supplemental Information
Attachment 3	Solid Radioactive Waste Disposal
Attachment 4	Meteorological Data
Attachment 5	Unplanned Offsite Releases
Attachment 6	Assessment of Radiation Dose from Radioactive Effluents to Members of the Public
Attachment 7	Information to Support the NEI Ground Water Protection Initiative
Attachment 8	Inoperable Equipment
Attachment 9	Summary of Changes to the Offsite Dose Calculation Manual
Attachment 10	Summary of Changes to the Process Control Program
Attachment 11	Summary of Major Modifications to the Radioactive Waste Treatment Systems
Attachment 12	Errata to a Previous Year's ARERR

ATTACHMENT 1

Summary of Gaseous and Liquid Effluents

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

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2022 - 12/31/2022

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	1.53E-01	1.50E+00	9.37E-02	2.38E+00	4.12E+00
2. Avg. Release Rate	µCi/sec	1.97E-02	1.91E-01	1.18E-02	2.99E-01	1.31E-01
B. Iodines and Halogens						
1. Total Release	Ci	8.97E-10	2.28E-03	0.00E+00	4.44E-03	6.72E-03
2. Avg. Release Rate	µCi/sec	1.15E-10	2.89E-04	0.00E+00	5.59E-04	2.13E-04
C. Particulates Half-Life ≥ 8 days						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Release Rate	µCi/sec	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Tritium						
1. Total Release	Ci	1.87E+01	1.80E+01	2.84E+01	4.35E+01	1.09E+02
2. Avg. Release Rate	µCi/sec	2.40E+00	2.30E+00	3.57E+00	5.47E+00	3.44E+00
E. Carbon-14						
1. Total Release	Ci	5.56E+00	5.49E+00	4.05E+00	5.54E+00	2.06E+01
2. Avg. Release Rate	µCi/sec	7.14E-01	6.98E-01	5.09E-01	6.97E-01	6.54E-01
F. 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

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2022 - 12/31/2022

Gaseous Effluents - Mixed Mode - Continuous Mode *

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Gases						
Xe-133	Ci	1.28E-01	5.50E-01	8.96E-02	2.29E+00	3.06E+00
Total for Period	Ci	1.28E-01	5.50E-01	8.96E-02	2.29E+00	3.06E+00
B. Iodines and Halogens						
I-131	Ci	0.00E+00	8.63E-06	0.00E+00	1.34E-05	2.20E-05
I-132	Ci	0.00E+00	2.06E-03	0.00E+00	4.41E-03	6.46E-03
Total for Period	Ci	0.00E+00	2.06E-03	0.00E+00	4.42E-03	6.49E-03
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	1.68E+01	1.65E+01	2.33E+01	4.03E+01	9.69E+01
E. Carbon-14						
C-14	Ci	1.67E+00	1.65E+00	1.21E+00	1.66E+00	6.19E+00
F. Gross Alpha						
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

* 30% of total C-14 released is assumed to be in continuous mode. See Attachment 2, Supplemental Information, of this report.

Attachment 1
Summary of Gaseous and Liquid Effluents

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2022 - 12/31/2022

Gaseous Effluents - Mixed Releases - Batch Mode *

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Gases						
Ar-41	Ci	0.00E+00	6.10E-01	3.27E-03	1.11E-02	6.25E-01
Xe-131m	Ci	6.87E-05	0.00E+00	0.00E+00	0.00E+00	6.87E-05
Xe-133	Ci	2.47E-02	3.40E-01	8.55E-04	7.46E-02	4.40E-01
Xe-133m	Ci	3.39E-04	0.00E+00	0.00E+00	4.05E-05	3.80E-04
Xe-135	Ci	1.92E-04	1.45E-06	0.00E+00	2.16E-05	2.15E-04
Total for Period	Ci	2.53E-02	9.50E-01	4.13E-03	8.58E-02	1.07E+00
B. Iodines and Halogens						
I-132	Ci	0.00E+00	2.08E-04	0.00E+00	2.26E-05	2.30E-04
I-131	Ci	8.97E-10	3.24E-06	0.00E+00	0.00E+00	3.24E-06
Total for Period	Ci	8.97E-10	2.11E-04	0.00E+00	2.26E-05	2.33E-04
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	5.80E-03	7.84E-01	6.43E-03	1.88E+00	2.67E+00
E. Carbon-14						
C-14	Ci	3.89E+00	3.84E+00	2.83E+00	3.88E+00	1.44E+01
F. Gross Alpha						
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

* 70% of total C-14 released is assumed to be in batch mode. See Attachment 2, Supplemental Information, of this report.

Attachment 1
Summary of Gaseous and Liquid Effluents

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2022 - 12/31/2022

Gaseous Effluents - Ground Releases - Continuous Mode

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Gases						
None	Ci	-	-	-	-	-
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
B. Iodines and Halogens						
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	1.89E+00	7.75E-01	5.04E+00	1.25E+00	8.95E+00
E. Carbon-14						
C-14	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
F. 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

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2022 - 12/31/2022

Gaseous Effluents - Ground Releases - Batch Mode

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Gases						
None	Ci	-	-	-	-	-
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
B. Iodines and Halogens						
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	1.38E-02	3.67E-03	6.26E-03	1.27E-03	2.50E-02
E. Carbon-14						
C-14	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
F. 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

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2022 - 12/31/2022

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	2.34E-04	1.09E-04	0.00E+00	1.96E-04	5.38E-04
2. Avg. Diluted Conc	µCi/ml	2.79E-11	1.28E-11	0.00E+00	2.28E-11	1.58E-11
3. Batch Releases	µCi/ml	2.79E-11	1.28E-11	0.00E+00	2.28E-11	1.58E-11
B. Tritium						
1. Total Release	Ci	6.55E+02	3.53E+02	2.43E+02	2.53E+02	1.51E+03
2. Avg. Diluted Conc	µCi/ml	7.81E-05	4.17E-05	2.84E-05	2.95E-05	4.42E-05
3. Batch Releases	µCi/ml	7.81E-05	4.16E-05	2.83E-05	2.95E-05	4.42E-05
C. Dissolved & Entrained Gases						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Diluted Conc	µCi/ml	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3. Batch Releases	µCi/ml	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Gross Alpha						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Diluted Conc	µCi/ml	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3. Batch Releases	µCi/ml	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
E. Primary Liquid Release Volume						
1. Batch Volume	liters	2.07E+06	2.59E+06	1.21E+06	2.08E+06	7.94E+06
2. Continuous Volume	liters	6.63E+08	5.93E+08	4.99E+08	4.05E+08	2.16E+09
F. Dilution Volume						
1. Batch Volume	liters	8.39E+09	8.48E+09	8.58E+09	8.58E+09	3.40E+10
2. Continuous Volume	liters	8.39E+09	8.48E+09	8.58E+09	8.58E+09	3.40E+10

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

Attachment 1
Summary of Gaseous and Liquid Effluents

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2022 - 12/31/2022

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	2.48E-01	1.65E-01	1.98E-01	1.67E-01	7.77E-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

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2022 - 12/31/2022

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	0.00E+00	3.87E-05	3.87E-05
Co-58	Ci	2.25E-04	1.09E-04	0.00E+00	4.43E-05	3.78E-04
Co-60	Ci	9.25E-06	0.00E+00	0.00E+00	5.32E-05	6.24E-05
Ag-110m	Ci	0.00E+00	0.00E+00	0.00E+00	5.95E-05	5.95E-05
Total for Period	Ci	2.34E-04	1.09E-04	0.00E+00	1.96E-04	5.38E-04
B. Tritium						
H-3	Ci	6.55E+02	3.53E+02	2.43E+02	2.53E+02	1.50E+03
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 2

Supplemental Information

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

Attachment 2
Supplemental Information

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2022 - 12/31/2022

I. Regulatory Limits - Per Unit

A. Noble Gases - Air Dose

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

B. Liquid Effluents - Dose

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

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

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

II. Maximum Permissible Effluent Concentrations

A. Gaseous Effluents

1. Information found in Offsite Dose Calculation Manual

B. Liquid Effluents

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

III. Average Energy

(not applicable)

IV. Measurements and Approximations of Total Radioactivity

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

V. Batch Releases

A. Liquid Effluents

1.	Total Number of Batch Releases	=	86
2.	Total Time (min) for Batch Releases	=	1.65E+04
3.	Maximum Time (min) for a Batch Release	=	2.13E+02
4.	Average Time (min) for Batch Releases	=	1.92E+02
5.	Minimum Time (min) for a Batch Release	=	1.33E+02
6.	Average Dilution Water Flow During Release (lpm)	=	6.47E+04

B. Gaseous Effluents

1.	Total Number of Batch Releases	=	54
2.	Total Time (min) for Batch Releases	=	9.00E+04
3.	Maximum Time (min) for a Batch Release	=	1.71E+04
4.	Average Time (min) for Batch Releases	=	1.67E+03
5.	Minimum Time (min) for a Batch Release	=	3.00E+00

VI. Abnormal Releases

See Attachment 5, Unplanned Offsite Releases.

Carbon-14

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

In Regulatory Guide 1.21, Revision 2, “Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste”, the NRC recommends U.S. nuclear power plants evaluate whether C-14 is a "principal radionuclide", and if so, report the amount of C-14 released. Improvements over the years in effluent management practices and fuel performance have resulted in a decrease in gaseous radionuclide (non-C-14) concentrations, and a change in the distribution of gaseous radionuclides released to the environment. As a result, many sites show C-14 has become a "principal radionuclide" for the gaseous effluent pathway, as defined in Regulatory Guide 1.21, Rev. 2. Oconee Nuclear Station 2022 ARERR contains estimates of C-14 radioactivity released in 2022, and estimates of public dose resulting from the C-14 effluent.

Because the dose contribution of C-14 from liquid radioactive waste is much less than that contributed by gaseous radioactive waste, evaluation of C-14 in liquid radioactive waste is not required (Ref. Reg. Guide 1.21, Rev. 2). The quantity of gaseous C-14 released to the environment can be estimated by use of a C-14 source term scaling factor based on power generation (Ref. Reg. Guide 1.21, Rev. 2). Many documents provide information related to the magnitude of C-14 in typical effluents from commercial nuclear power plants. Those documents suggest that nominal annual releases of C-14 in gaseous effluents are approximately 5 to 7.3 curies from PWRs (Ref. Reg. Guide 1.21, Rev. 2). A more recent study recommends a higher C-14 gaseous source term scaling factor of approximately 9.0 to 9.8 Ci/GWe-yr for a PWR (Westinghouse) (Ref. EPRI 1021106). For the Oconee Nuclear Station 2015 ARERR a source term scaling factor of 9.4 Ci/GWe-yr is assumed. Using a source term scaling factor of 9.4 Ci/GWe-yr and actual electric generation (MWe-hrs) from Oconee Nuclear Station in 2022 results in a site total C-14 gaseous release estimate to the environment of 2.34E+01 Curies. 70% of the C-14 gaseous effluent is assumed to be from batch releases and 30% of C-14 gaseous effluent is assumed to be from continuous releases through the unit vents (ref. IAEA Technical Reports Series no. 421, "Management of Waste Containing Tritium and Carbon-14", 2004).

C-14 releases in PWRs occur primarily as a mix of organic carbon and carbon dioxide released from the waste gas system. Since the PWR operates with a reducing chemistry, most, if not all, of the C-14 species initially produced are organic (e.g., methane). As a general rule, C-14 in the primary coolant is essentially all organic with a large fraction as a gaseous species. Any time the RCS liquid or gas is exposed to an oxidizing environment (e.g. during shutdown or refueling), a slow transformation from an organic to an inorganic chemical form can occur. Various studies documenting measured C-14 releases from PWRs suggest a range of 70% to 95% organic with an average of 80% organic with the remainder being CO_2 (Ref. EPRI TR-105715). For the Oconee Nuclear Station 2022 ARERR a value of 80% organic C-14 is assumed.

Public dose estimates from airborne C-14 are performed using dose models in NUREG-0133 and Regulatory Guide 1.109. The dose models and assumptions used are documented in the Oconee ODCM. The estimated C-14 dose impact on the maximum organ dose from airborne effluents released from Oconee Nuclear Station in 2022 is well below the 10CFR50, Appendix I, ALARA design objective (i.e., 15 mrem/yr per unit).

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2022 - 12/31/2022

Overall Estimate of Error for Effluent Radioactivity Release Reported

The estimated percentage of overall error for both Liquid and Gaseous effluent release data at Oconee Nuclear Station has been determined to be ± 30.3%. This value was derived by taking the square root of the sum of the squares of the following discrete individual estimates of error:

1. Flow Rate Determining Devices = ± 20%
2. Counting Statistical Error = ± 20%
3. Calibration Error = ± 10%
4. Calibration Source Error = ± 2.5%
5. Sample Preparation Error = ± 3%

Summary of Changes in Land Use Census Affecting Effluent Dose Calculations

The 2022 Land Use Census was performed May 16-18, 2022, and the results were certified and made available for use on June 7, 2022. The following are changes to residences, gardens, and milk animals from the previous year.

Residences

The residence in the NNE sector at 1.84 miles was replaced with a residence at 1.80 miles.

Gardens

Broad leaf vegetation samples are taken in lieu of a garden census for Oconee Nuclear Station. For dose calculation purposes a garden is assumed to exist at the site boundary and beyond for every sector since a garden location cannot be ruled out.

Milk Animals

A milk animal (goat) in the E sector at 4.18 miles was identified in the Land Use Census

Environmental Monitoring Locations

The milk animal (goat) in the E sector at 4.18 miles was added to the Radiological Environmental Monitoring Program. No additional changes to environmental monitoring locations were made based on the 2022 Land Use Census results.

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
- Type of shipping container
- Solidification agent or absorbent
- Number of shipments
- Other relevant information as necessary

Attachment 3
Solid Radioactive Waste Disposal

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2022 - 12/31/2022

Type of Waste Shipped	Number of Shipments	Container Type	Solidification Agent	Burial Volume (m^3)	Total Activity (curies)
1. Wet radioactive waste (e.g., spent resins, filters, sludges, etc.)	5	Type A	None	9	7.55E+01
2. Dry radioactive waste (e.g., trash, paper, discarded protective clothing, etc.)	13	GDP	None	648	1.75E-01
3. Activated or contaminated metal or equipment, etc.	2	GDP	None	64	4.18E-02
4. Other radioactive waste (e.g., bulk waste, soil, rubble, etc.)	None	NA	NA	0	0.00E+00

Attachment 3
Solid Radioactive Waste Disposal

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2022 - 12/31/2022

Type of Waste Shipped	Radionuclide	% Abundance
1. Wet Radioactive Waste	H-3	54.84
	C-14	6.24
	Fe-55	9.22
	Co-58	3.72
	Co-60	7.88
	Ni-63	12.15
	Cs-137	2.71
2. Dry Radioactive Waste	H-3	29.97
	C-14	1.19
	MN-54	2.65
	Co-58	11.2
	Co-60	6.1
	Ni-63	16.57
	Zr-95	4.86
	Nb-95	6.24
	Cs-137	18.08
	Ce-144	3.01
3. Activated or Contaminated Metal or Equipment	H-3	54.29
	C-14	2.2
	Co-58	3.01
	Co-60	4.54
	Ni-63	30.57
	Cs-137	3.74
4. Other Radioactive Waste	NA	NA

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

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2022 - 12/31/2022

Lower Level

Stability Class	Wind Speed (m/s)	Hours of Occurrence															
		Sector															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
A	0.46-0.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.76-1.00	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	1
	1.01-1.25	1	0	2	0	0	0	1	1	1	2	1	1	0	0	0	1
	1.26-1.50	0	2	0	1	1	0	2	0	0	4	4	1	1	2	1	0
	1.51-2.00	4	5	7	8	2	1	1	0	2	18	45	13	3	1	1	4
	2.01-3.00	4	4	7	11	8	1	0	0	1	50	104	32	8	3	0	4
	3.01-4.00	1	0	0	5	0	0	0	0	0	17	16	6	2	1	0	2
	4.01-5.00	0	0	1	0	0	0	0	0	0	1	7	0	4	1	1	0
	5.01-6.00	0	0	0	1	0	0	0	0	0	0	2	1	0	0	0	0
	6.01-8.00	0	0	0	0	0	0	0	0	0	0	1	3	1	3	1	0
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
	10.01-max	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
B	0.46-0.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.76-1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	1.01-1.25	0	0	0	0	0	0	1	0	0	0	0	1	0	0	1	0
	1.26-1.50	4	3	0	2	0	0	0	0	1	2	3	3	0	2	0	0
	1.51-2.00	8	6	9	6	3	3	0	2	2	16	39	19	10	2	5	2
	2.01-3.00	3	5	5	24	5	4	1	4	4	34	44	25	4	1	4	0
	3.01-4.00	0	0	3	3	0	0	0	0	0	12	19	9	0	2	0	0
	4.01-5.00	0	0	0	0	0	0	0	0	0	1	5	2	0	2	2	0
	5.01-6.00	0	0	2	0	0	0	0	0	0	0	1	2	0	5	1	0
	6.01-8.00	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	0	1	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

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2022 - 12/31/2022

Lower Level

Stability Class	Wind Speed (m/s)	Hours of Occurrence															
		Sector															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
C	0.46-0.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.76-1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1.01-1.25	1	0	0	0	3	1	0	0	0	1	3	0	0	2	1	0
	1.26-1.50	7	3	1	2	1	0	1	0	1	6	10	4	2	3	6	3
	1.51-2.00	3	15	9	11	10	6	3	3	6	30	49	15	10	5	3	2
	2.01-3.00	1	2	10	28	13	2	0	2	7	46	41	19	5	4	1	1
	3.01-4.00	1	0	2	3	0	0	1	0	1	12	13	8	1	1	0	1
	4.01-5.00	0	0	1	1	0	0	0	0	0	1	10	10	0	1	1	1
	5.01-6.00	0	0	0	0	0	0	0	0	0	0	3	4	4	4	0	0
	6.01-8.00	0	0	0	0	0	0	0	0	0	0	1	4	1	1	1	0
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	0	0	1	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	3	1	1	1	0	0	2	0	0	0	3	1	4	2	2	1
	0.76-1.00	12	14	6	5	5	5	7	7	9	8	14	19	16	13	20	14
	1.01-1.25	26	18	7	11	18	14	13	10	18	20	29	24	36	25	23	19
	1.26-1.50	32	45	38	40	36	29	22	24	17	26	47	44	24	20	22	23
	1.51-2.00	19	26	42	134	115	37	54	26	38	70	91	66	37	20	17	13
	2.01-3.00	6	16	126	185	84	19	13	19	28	87	136	76	27	33	13	14
	3.01-4.00	1	1	49	45	4	0	1	5	6	48	72	87	38	42	16	6
	4.01-5.00	1	0	8	1	0	0	0	0	0	9	64	42	26	27	10	4
	5.01-6.00	0	0	0	0	0	0	0	0	0	4	22	29	5	12	8	0
	6.01-8.00	0	0	0	0	0	0	0	0	0	0	8	11	5	9	3	0
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0
	10.01-max	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0

Attachment 4
Meteorological Data

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2022 - 12/31/2022

Lower Level

Stability Class	Wind Speed (m/s)	Hours of Occurrence															
		Sector															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
E	0.46-0.75	24	20	13	11	10	5	5	4	5	7	11	13	19	22	16	22
	0.76-1.00	88	69	54	40	44	40	38	24	22	30	42	43	49	74	95	109
	1.01-1.25	61	34	36	56	54	51	47	38	27	47	37	28	34	44	60	77
	1.26-1.50	24	24	26	50	55	46	55	42	36	31	33	23	17	18	39	48
	1.51-2.00	13	15	32	77	80	28	38	50	55	45	34	24	20	12	16	14
	2.01-3.00	11	13	45	69	25	3	10	18	14	40	52	45	24	19	7	6
	3.01-4.00	3	2	10	5	1	0	3	0	5	13	17	19	10	4	4	0
	4.01-5.00	1	0	0	0	0	0	0	0	0	0	4	2	0	1	0	0
	5.01-6.00	0	0	0	0	0	0	0	0	0	0	4	3	1	0	0	0
	6.01-8.00	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10.01-max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F	0.46-0.75	4	2	0	1	0	4	2	0	0	5	1	4	7	13	7	1
	0.76-1.00	8	5	6	2	4	6	2	0	1	5	3	4	17	38	21	5
	1.01-1.25	3	0	0	4	3	5	5	3	0	0	3	2	5	21	32	4
	1.26-1.50	1	1	0	1	3	8	6	1	1	0	4	1	2	9	25	1
	1.51-2.00	1	0	1	5	4	13	9	0	1	0	3	0	0	0	3	1
	2.01-3.00	1	0	0	0	1	3	1	0	0	1	2	3	0	0	2	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 4
Meteorological Data

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2022 - 12/31/2022

Lower Level

Stability Class	Wind Speed (m/s)	Hours of Occurrence															
		Sector															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
G	0.46-0.75	0	1	0	0	0	0	0	0	1	0	1	0	1	6	0	0
	0.76-1.00	0	0	0	0	0	0	0	1	0	0	2	5	7	8	3	1
	1.01-1.25	0	0	0	0	1	0	0	0	0	0	1	3	3	8	1	1
	1.26-1.50	0	0	0	0	0	0	1	0	0	0	0	2	0	2	2	1
	1.51-2.00	0	0	0	0	1	0	0	0	0	0	0	0	2	1	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 4
Meteorological Data

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2022 - 12/31/2022

Upper Level

Stability Class	Wind Speed (m/s)	Hours of Occurrence															
		Sector															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
A	0.46-0.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.76-1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1.01-1.25	0	0	0	1	0	0	0	1	1	0	0	1	0	1	0	0
	1.26-1.50	0	0	0	1	0	2	0	1	1	1	3	0	0	1	0	0
	1.51-2.00	5	1	4	0	0	0	2	0	1	3	6	2	1	2	0	2
	2.01-3.00	2	7	6	6	7	3	0	1	2	17	50	35	6	2	1	0
	3.01-4.00	1	4	0	6	7	0	0	0	1	30	43	7	2	0	0	2
	4.01-5.00	2	3	0	4	6	1	0	0	1	25	20	4	2	0	1	1
	5.01-6.00	1	0	0	4	0	0	0	0	0	9	20	4	2	2	0	1
	6.01-8.00	0	0	0	0	0	0	0	0	0	3	23	1	2	0	2	1
	8.01-10.00	0	0	0	2	0	0	0	0	0	0	6	1	2	1	0	0
	10.01-max	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4	0
B	0.46-0.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.76-1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1.01-1.25	0	0	0	0	0	0	1	0	0	0	0	0	1	0	1	0
	1.26-1.50	0	0	1	0	0	0	0	0	0	0	1	3	0	0	0	0
	1.51-2.00	1	5	3	0	1	1	1	0	0	4	10	5	5	1	2	2
	2.01-3.00	5	8	7	6	7	5	0	1	5	22	32	23	4	2	1	0
	3.01-4.00	0	4	3	12	8	3	0	2	4	22	19	8	0	1	2	1
	4.01-5.00	0	1	0	4	3	1	0	1	0	8	15	1	0	0	2	1
	5.01-6.00	0	0	1	5	0	0	0	0	0	4	12	8	1	1	1	0
	6.01-8.00	0	0	1	2	0	0	0	0	0	5	19	1	1	3	3	0
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	3	1	1	6	0	0
	10.01-max	0	0	2	0	0	0	0	0	0	0	0	2	2	0	0	0

Attachment 4
Meteorological Data

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2022 - 12/31/2022

Upper Level

Stability Class	Wind Speed (m/s)	Hours of Occurrence															
		Sector															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
C	0.46-0.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.76-1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1.01-1.25	0	0	0	0	0	0	0	0	0	1	1	1	0	0	1	0
	1.26-1.50	2	0	0	2	0	0	1	1	1	1	3	2	3	1	2	1
	1.51-2.00	3	6	4	4	2	2	0	2	0	8	19	8	5	5	2	2
	2.01-3.00	4	4	16	12	9	7	3	3	10	35	36	22	2	0	2	1
	3.01-4.00	0	2	4	9	12	3	0	1	7	24	19	1	1	3	1	0
	4.01-5.00	0	0	2	10	10	1	0	1	3	10	6	3	2	1	1	1
	5.01-6.00	0	0	1	4	0	0	0	0	1	5	17	7	1	2	1	1
	6.01-8.00	1	0	0	1	0	0	0	0	0	5	15	9	0	3	1	1
	8.01-10.00	0	0	2	1	0	0	0	0	0	0	7	8	5	4	1	0
	10.01-max	0	0	0	0	0	0	0	0	0	0	1	3	2	0	0	0
D	0.46-0.75	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	0.76-1.00	7	1	3	2	3	1	2	2	0	4	4	1	4	2	4	4
	1.01-1.25	9	5	6	0	2	1	4	2	4	9	12	11	10	11	14	10
	1.26-1.50	16	10	11	8	4	5	7	8	7	9	14	20	23	19	18	18
	1.51-2.00	33	29	20	26	26	20	17	14	18	32	35	26	33	16	13	14
	2.01-3.00	34	49	66	70	89	50	46	26	56	53	75	67	24	15	13	30
	3.01-4.00	12	16	87	113	87	27	11	16	24	45	60	25	15	17	17	4
	4.01-5.00	4	7	54	87	38	12	2	7	13	30	63	38	18	12	19	8
	5.01-6.00	1	2	27	51	15	3	2	5	8	25	69	49	31	33	18	5
	6.01-8.00	1	1	28	38	2	0	0	1	6	24	85	54	31	48	27	4
	8.01-10.00	0	1	6	0	0	0	0	0	0	1	46	22	10	16	9	3
	10.01-max	0	0	0	0	0	0	0	0	0	0	18	8	6	8	0	0

Attachment 4
Meteorological Data

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2022 - 12/31/2022

Upper Level

Stability Class	Wind Speed (m/s)	Hours of Occurrence															
		Sector															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
E	0.46-0.75	0	0	1	0	1	0	0	0	1	0	1	0	3	0	4	3
	0.76-1.00	12	8	5	3	3	3	3	3	1	3	9	6	8	12	11	18
	1.01-1.25	17	17	7	3	3	7	5	3	3	11	8	7	10	16	30	18
	1.26-1.50	50	25	9	11	12	5	7	7	9	8	14	13	17	33	41	60
	1.51-2.00	146	102	36	34	21	23	15	13	10	11	26	46	31	36	58	85
	2.01-3.00	171	186	85	72	46	42	34	38	37	45	85	56	21	15	30	73
	3.01-4.00	33	32	65	69	43	15	14	25	30	44	68	17	7	18	14	17
	4.01-5.00	16	11	44	31	25	7	4	16	13	21	39	21	13	12	12	7
	5.01-6.00	3	6	9	17	3	0	2	6	6	14	25	14	12	7	7	0
	6.01-8.00	3	2	12	1	3	0	2	0	4	4	22	11	9	2	3	1
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	6	4	1	1	0	0
	10.01-max	0	0	0	0	0	0	0	0	0	0	4	1	0	0	0	0
F	0.46-0.75	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
	0.76-1.00	4	2	1	5	1	4	0	2	1	3	0	0	3	1	0	2
	1.01-1.25	3	5	5	3	3	3	0	1	0	1	1	4	2	1	2	1
	1.26-1.50	10	6	4	3	2	0	3	1	0	2	0	2	6	4	2	7
	1.51-2.00	12	10	8	5	4	3	4	1	2	6	2	7	3	5	3	8
	2.01-3.00	24	36	10	7	2	8	4	3	6	1	5	5	4	1	0	5
	3.01-4.00	4	2	2	2	3	2	1	4	2	2	1	4	0	2	2	1
	4.01-5.00	2	0	0	2	1	1	0	1	0	2	1	0	2	0	1	2
	5.01-6.00	0	0	0	0	0	0	0	0	0	0	0	2	0	0	3	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

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2022 - 12/31/2022

Upper Level

Stability Class	Wind Speed (m/s)	Hours of Occurrence															
		Sector															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
G	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	1	0	0	0	0	1	1	0	0	1	0	0	0	0	0
	1.01-1.25	0	0	1	0	1	0	0	0	0	1	1	0	0	2	1	0
	1.26-1.50	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	1
	1.51-2.00	1	1	0	0	0	0	0	0	0	2	1	1	0	1	1	4
	2.01-3.00	1	1	1	0	0	0	0	3	5	0	8	3	3	1	2	0
	3.01-4.00	0	1	0	0	0	0	0	0	0	0	3	2	0	0	0	1
	4.01-5.00	0	0	1	0	0	0	0	0	0	0	0	2	1	0	1	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

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2022 - 12/31/2022

Oconee Nuclear Station had zero (0) unplanned liquid offsite release radioactive effluents in 2022.

Oconee Nuclear Station had zero (0) unplanned gaseous offsite release of radioactive effluents in 2022.

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

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2022 - 12/31/2022

Gaseous Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Noble Gases						
1. Maximum Gamma Air	mRAD	2.88E-06	3.18E-04	3.31E-06	4.98E-05	3.73E-04
(a) Limit	mRAD	1.50E+01	1.50E+01	1.50E+01	1.50E+01	3.00E+01
(b) % of Limit		1.92E-05	2.12E-03	2.20E-05	3.32E-04	1.24E-03
2. Maximum Beta Air	mRAD	8.54E-06	1.56E-04	5.60E-06	1.34E-04	3.03E-04
(a) Limit	mRAD	3.00E+01	3.00E+01	3.00E+01	3.00E+01	6.00E+01
(b) % of Limit		2.85E-05	5.19E-04	1.87E-05	4.46E-04	5.06E-04

Receptor Location ***1.0*** miles ***SW***

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
B. Iodine, H-3, & Particulates						
1. Maximum Organ Dose	mREM	8.27E-02	8.18E-02	6.03E-02	8.26E-02	3.07E-01
(a) Limit	mREM	2.25E+01	2.25E+01	2.25E+01	2.25E+01	4.50E+01
(b) % of Limit		3.68E-01	3.63E-01	2.68E-01	3.67E-01	6.83E-01

Receptor Location ***1.0*** miles ***SW***
Critical Age ***CHILD***
Critical Organ ***BONE***

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

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2022 - 12/31/2022

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Batch & Continuous Mode						
1. Maximum Organ Dose	mREM	9.07E-02	4.89E-02	3.37E-02	3.50E-02	2.08E-01
(a) Limit	mREM	1.50E+01	1.50E+01	1.50E+01	1.50E+01	3.00E+01
(b) % of Limit		6.04E-01	3.26E-01	2.24E-01	2.34E-01	6.94E-01
(c) Critical Age		Child	Child	Child	Child	Child
(d) Critical Organ		GI-Lli	GI-Lli	Liver	GI-Lli	GI-Lli
2. Maximum Total Body Dose	mREM	9.07E-02	4.89E-02	3.37E-02	3.50E-02	2.08E-01
(a) Limit	mREM	4.50E+00	4.50E+00	4.50E+00	4.50E+00	9.00E+00
(b) % of Limit		2.01E+00	1.09E+00	7.48E-01	7.79E-01	2.31E+00
(c) Critical Age		Child	Child	Child	Child	Child

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 Oconee Nuclear Station includes liquid and gaseous effluent dose contributions from Oconee Nuclear Station and direct and air-scatter dose from the onsite ISFSI. No other uranium fuel cycle facility contributes significantly to the maximum exposed individual. Included in the gaseous effluent dose calculations is an estimate of the dose contributed by Carbon-14 (Ref. Attachment 2, Supplemental Information, of this report for further information). The combined dose to a maximum exposed individual from effluent releases and direct and air-scatter dose from the ISFSI is below 40 CFR Part 190 limits as shown by the following summary.

Note: The 40 CFR Part 190 effluent dose analysis to the maximum exposed individual from liquid and gas releases includes the dose from noble gases (i.e., total body and skin).

40 CFR Part 190 Effluent Dose Summary

A. Maximum Organ Dose (other than TB)	3.074E-01 mrem
1. Location	1.0 miles SW
2. Critical Age	Child
3. Critical Organ	Bone
4. Gas Contribution %	99.994%
5. Liquid Contribution %	0.006%
B. Maximum Total Body Dose	3.027E-01 mrem
1. Location	1.0 miles SW
2. Critical Age	Child
3. Gas non-NG Contribution %	31.104%
4. Gas Contribution %	0.115%
5. Liquid Contribution %	68.781%

Direct and air-scatter radiation dose contributions from the onsite ISFSI have been determined from 10 CFR 72.212 Evaluation Report for Phase IX Standardized NUHOMS® Cask System Rev. 00. The maximum dose rate to the nearest real individual from the ISFSI is conservatively calculated to be less than 17 mrem/yr.

The attached excerpt from the 10 CFR 72.212 Evaluation Report for Phase IX Standardized NUHOMS® Cask System Rev. 00 is provided to document the method used to calculate the dose from ISFSI as less than 17 mrem/yr to the nearest real individual.

Total dose from liquid and gaseous effluents from Oconee Nuclear Station and direct and air-scatter dose from the onsite ISFSI is conservatively estimated to be less than 18 mrem/yr to the nearest real individual. This meets the 40 CFR Part 190 requirements of an annual dose commitment to any member of the general public of less than 25 mrem total body or any organ and 75 mrem to the thyroid.

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

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2022 - 12/31/2022

6.0 10 CFR 72.212(b)(5)(iii) - Radioactive Materials in Effluents and Direct Radiation

6.1 Purpose

10 CFR 72.212(b)(5)(iii) requires the general licensee to perform written evaluations, before use and before applying the changes authorized by an amended CoC to a cask loaded under the initial CoC or an earlier amended CoC, that establish that the requirements of 10 CFR 72.104 have been met. A copy of this record shall be retained until spent fuel is no longer stored under the general license issued under 10 CFR 72.210.

10 CFR 72.104 provides the regulatory criteria for radioactive materials in effluents and direct radiation from an independent spent fuel storage installation (ISFSI) during normal operation and anticipated occurrences. Specifically, 10 CFR 72.104(a) limits the annual dose equivalent to any real individual who is located beyond the controlled area to 25 mrem to the whole body, 75 mrem to the thyroid, and 25 mrem to any other critical organ. This dose equivalent must include contributions from (1) planned discharges of radioactive materials (radon and its decay products excepted) to the general environment, (2) direct radiation from ISFSI operations, and (3) any other radiation from uranium fuel cycle operations within the region. In addition, 10 CFR 72.104(b) requires that operational restrictions be established to meet as low as is reasonably achievable (ALARA) objectives for radioactive materials in effluents and direct radiation levels associated with ISFSI operations. Also, 10 CFR 72.104(c) requires that operational limits be established for radioactive materials in effluents and direct radiation levels associated with ISFSI operations to meet the above-mentioned dose limits.

This section provides the written evaluation required by 10 CFR 72.212(b)(5)(iii), demonstrating Duke Energy's compliance with the requirements of 10 CFR 72.104 for the ONS ISFSI.

6.2 Evaluation

This evaluation addresses the radiological dose rate from a composite population of all ONS ISFSI cask types.

6.2.1 §72.104(a) – Dose Limits

10 CFR 72.104, as clarified by ISG-13[1] stipulates that the licensee perform dose evaluations which establish that any real individual beyond the controlled area boundary not sustain an annual dose equivalent in excess of 0.25 mSv (25 mrem) due to direct radiation from the Independent Spent Fuel Storage Installation and other fuel cycle operations in the area. This same annual dose limit is stipulated by the EPA for the fuel cycle in 40 CFR 190.10(a). In addition, operational restrictions for ALARA and limits for effluents must be established.

In accordance with these requirements, Duke Energy Corporation contracted with a vendor to perform a dose calculation (OSC-11917[10]) that considered the characteristics (initial enrichment, burnup and cooling time) of existing fuel in ISFSI Phases I – VIII, together with the characteristics of assumed "design basis" fuel for canisters in Phase IX of the Oconee ISFSI[2]. Previously, for Phases I – VIII, calculation OSC-8675[3] had developed the radiation source terms that were applied in subsequent shielding and skyshine calculations using the SCALE Code System.

More specifically for Phases I - VIII, the SAS2 Module of the SCALE Code System[4] was used to create a problem-dependent pin-cell model for the purpose of building cell-weighted, multigroup cross section sets for use in subsequent depletion calculations. The ORIGEN-S Module[5] of the SCALE Code System was used to perform the fuel depletion and characterization calculations using the cross section sets created by SAS2. These characterization calculations yielded the photon and neutron source terms to be used as input to subsequent shielding calculations. As mentioned above, problem-dependent cross section sets were developed for these analyses since ORIGEN-S was used within the SAS2 sequence. Duke Energy Corporation Radiological Engineering is experienced in the use of the SCALE Code System, and the SCALE Code System is installed and maintained under the purview of the pertinent software and data quality assurance program.

The results of the radiation source term calculation were used as input to Calculation OSC-8706[6] to evaluate the shielding characteristics of a single Horizontal Storage Module. The MCNP Monte Carlo particle transport computer code[7] was used to perform the transport calculations and to write a surface flux file for use in subsequent skyshine calculations for Phases I - VIII.

Appropriate software quality controls have been implemented for the computer codes and data used in these analyses (specifically, Calculation DPC-1201.30-00-0010[8] contains the verification and validation for MCNP5, while SDQA-30296-NGO[9] documents the quality control measures in place for MCNP5).

6.2.2 §72.104(b) – Operational Restrictions

Operational restrictions must be established to meet ALARA objectives for direct radiation levels associated with ISFSI.

Calculation OSC-11917[10] shows a total annual dose rate (from all of Phases I –IX) of 16.93 mRem per year at 500 meters. The closest residence to the ISFSI is in the SW-SSW direction approximately 1 mile (~1600 meters) from the ISFSI, or 1.36 miles from the centerline of the site.[11] This is conservatively farther than the distance used for computation of dose rates. The 2016 40CFR190 Uranium Fuel Cycle Dose Calculation Results for the ONS site show a maximum total body dose of less than 1 mrem per year (last reported dose was 0.268 mrem[12]). The total dose rate from all operations to the nearest real individual is therefore less than 18 mRem per year.

This calculation did not consider any effluent from Phase IX. The Phase IX HSMs use the NUHOMS-24PTH-S-LC DSCs, which are designed as "leak-tight." Per Appendix P, Section P.11.2.8 of the NUHOMS UFSAR[13], accidental releases are not credible.

6.2.3 §72.104(c) – Operational Limits

Operational limits must be established for direct radiation levels associated with ISFSI to meet the limits given in 72.104(a).

The ISFSI is sited in such a way that direct radiation to the surroundings are minimized.

The station Radiation Protection Program limits for ISFSI boundary dose rates are established to maintain dose rates surrounding the ISFSI and at the owner-controlled area fence.

Previously, for ISFSI Phases I – VIII, calculation OSC-8716[14] used the surface flux files developed in OSC-8706[6] in a repeating array. A skyshine calculation was then performed to obtain near- and far-field dose results from those Phases. Calculation OSC-11917[10] performed another skyshine calculation, using MCNP5, for design basis fuel in the Phase IX HSMs, and added the resulting dose to previous dose results for Phases I – VIII from calculation OSC-8716[14], with conservative decay factors applied to account for additional cooling of the HSMs in those Phases. Calculation OSC-11917[10] did not consider any effluent from Phase IX. The Phase IX HSMs use the NUHOMS-24PTH-S-LC DSCs, which are designed as "leak-tight." Per Appendix P, Section P.11.2.8 of the NUHOMS UFSAR[13], accidental releases are not credible.

6.3 Regulatory Compliance/Conclusion

The evaluation summarized above demonstrates that Duke Energy meets the requirements of 10 CFR 72.212(b)(5)(iii) and 10 CFR 72.104 for the ONS ISFSI.

6.4 References

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5. O. W. Hermann, R. M. Westfall, "ORIGEN-S: SCALE System Module to Calculate Fuel Depletion, Actinide Transmutation, Fission Product Buildup and Decay, and Associated Radiation Source Terms," NUREG/CR-0200, Revision 6, Volume 2, Section F7, ORNLINUREG/CSD-2N21R6.
6. Calculation OSC-8706, "Oconee Horizontal Storage Module Shielding Evaluation," Revision 2.
7. LA-CP-03-0245, "MCNP - A General Monte Carlo N-Particle Transport Code, Version 5 (Volume 1: Overview and Theory, Volume II: User's Guide, Volume III: Developer's Guide).
8. Calculation DPC-1201.30-00-0010, Revision 0, "MCNP5 Computer Code Verification and Validation."
9. SDQA-30296-NGO, MCNP 5 Version 1.6
10. Calculation OSC-11917, "72.104 Offsite Dose Analysis for ONS ISFSI (Vendor ORANO Calculation 13923-0502)," Revision 0.
11. Dale E. Holden to Libby Wehrman, "2005 Oconee Annual Land Use Census," August 31, 2005, File No: OS-778.05 (Oconee Master File Record Retention No. 000377).
12. Thomas D. Ray to U.S. Nuclear Regulatory Commission, "2016 Annual Radioactive Effluent Release Report (ARERR)", May 1, 2017.
13. TN Americas NUH-003, "Updated Final Safety Analysis Report, “Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel," CoC 1004, Revision 18.
14. Calculation OSC-8716, “Oconee ISFSI Dose Rate Evaluations,” Revision 2.

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

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2022 - 12/31/2022

Duke Energy implemented a Ground Water Protection program in 2007. This initiative was developed to ensure timely and effective management of situations involving inadvertent releases of licensed material to ground water. As part of this program, Oconee Nuclear Station monitored 61 wells in 2022. Tritium activity in wells GM-7R and GM-7DR was reported according to NEI 07-07, Industry Ground Water Protection Initiative, in February 2010. The probable source of this activity was determined to be discharges from the turbine building sumps to Chemical Treatment Pond #3 through the east yard drain. Discharges from the turbine building sump through this pathway were discontinued in 2008. Installation of a recovery well, currently RW-1, in 2011 has resulted in decreased tritium concentrations in well GM-7DR to below MDA.

Wells are typically sampled quarterly, semi-annually, or annually. Ground water samples are regularly analyzed for tritium. Results from sampling during 2022 confirmed existing knowledge of tritium concentrations in site ground water.

Results from sampling during 2022 are shown in the table below.

No events meeting the criteria for voluntary notification per NEI 07-07, Industry Ground Water Protection Initiative, occurred at Oconee Nuclear Station in 2022.

Key to below table.

NS	-	Not scheduled to be sampled, not sampled due to insufficient volume in well, or well inaccessible during outage.
ρCi/l	-	picocuries per liter.
< MDA	-	less than minimum detectable activity, typically 250 ρCi/l.
20,000 ρCi/l	-	the Environmental Protection Agency drinking water standard for tritium. This standard applies only to water used for drinking.
1,000,000 ρCi/l	-	the 10 CFR Part 20, Appendix B, Table 2, Column 2, Effluent Concentration Limit for tritium.

Attachment 7
Information to Support the NEI Ground Water Protection Initiative

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2022 - 12/31/2022

Well Name	Location / Description	Tritium Concentration (pCi/l) 1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	# of Samples
A-1	ONS GWPI / A-1 / CTP 1/2	NS	<MDA	NS	<MDA	2
A-10	ONS GWPI / A-10 / CTP 3	NS	<MDA	NS	<MDA	2
A-11	ONS GWPI / A-11 / CTP 3	NS	<MDA	NS	<MDA	2
A-13	ONS GWPI / A-13 / CTP 1/2	NS	3.17E+02	NS	1.84E+02	2
A-14	ONS GWPI / A-14 / CTP 1/2	NS	<MDA	NS	NS	1
BG-4	ONS GWPI / BG-4 / Ball Field	NS	<MDA	NS	<MDA	2
GM-10	ONS GWPI / GM-10 / 525 kv Sw Yard	<MDA	<MDA	<MDA	<MDA	4
GM-10R	ONS GWPI / GM-10R / 525 kv Sw Yard	NS	<MDA	NS	NS	1
GM-11	ONS GWPI / GM-11 / ONS Garage	NS	<MDA	NS	NS	1
GM-11R	ONS GWPI / GM-11R / ONS Garage	NS	<MDA	NS	NS	1
GM-12	ONS GWPI / GM-12 / E of Access Rd.	NS	<MDA	NS	NS	1
GM-12R	ONS GWPI / GM-12R / E of Access Rd.	NS	<MDA	NS	NS	1
GM-13	ONS GWPI / GM-13 / 525 kv Sw Yard	NS	<MDA	NS	NS	1
GM-13R	ONS GWPI / GM-13R / 525 kv Sw Yard	NS	<MDA	NS	NS	1
GM-14	ONS GWPI / GM-14 / Mnt. Trg. Facility	NS	<MDA	NS	NS	1
GM-14R	ONS GWPI / GM-14R / Mnt. Trg. Facility	NS	<MDA	NS	NS	1
GM-15	ONS GWPI / GM-15	NS	<MDA	NS	<MDA	2
GM-15R	ONS GWPI / GM-15R	NS	<MDA	NS	NS	1
GM-16DDR	ONS GWPI / GM-16DDR	NS	<MDA	NS	NS	1
GM-16DR	ONS GWPI / GM-16DR	4.01E+03	3.75E+03	3.83E+03	3.73E+03	4
GM-16R	ONS GWPI / GM-16R	1.44E+03	1.39E+03	1.50E+03	1.08E+03	4
GM-17DR	ONS GWPI / GM-17DR	1.06E+03	9.84E+02	1.18E+03	<MDA	4
GM-17R	ONS GWPI / GM-17R	3.99E+03	3.05E+03	3.55E+03	3.34E+03	4
GM-18R	ONS GWPI / GM-18R	2.23E+03	2.10E+03	2.35E+03	2.30E+03	4
GM-19	ONS GWPI / GM-19	5.17E+02	4.04E+02	5.88E+02	3.72E+02	4
GM-19R	ONS GWPI / GM-19R	1.33E+03	1.16E+03	1.02E+03	1.17E+03	4
GM-1R	ONS GWPI / GM-1R / CTP 1/2	<MDA	<MDA	<MDA	<MDA	4
GM-20	ONS GWPI / GM-20	NS	<MDA	NS	NS	1
GM-20R	ONS GWPI / GM-20R	NS	<MDA	NS	NS	1
GM-21	ONS GWPI / GM-21	NS	<MDA	NS	NS	1
GM-22	ONS GWPI / GM-22	NS	<MDA	NS	NS	1
GM-23	ONS GWPI / GM-23	2.35E+02	3.21E+02	3.44E+02	2.95E+02	4
GM-24R	ONS GWPI / GM-24R	1.40E+03	1.31E+03	1.09E+03	1.08E+03	4
GM-25R	ONS GWPI / GM-25R	NS	2.44E+02	3.01E+02	2.44E+02	3
GM-2DR	ONS GWPI / GM-2DR / U-1/2 SFP	<MDA	8.54E+02	3.05E+02	3.53E+02	5
GM-2R	ONS GWPI / GM-2R / U-1/2 SFP	5.45E+02	6.70E+02	6.77E+02	9.32E+02	4
GM-3DR	ONS GWPI / GM-3DR / U-3 SFP	NS	2.45E+02	NS	<MDA	2
GM-3R	ONS GWPI / GM-3R / U-3 SFP	3.43E+02	2.24E+02	3.71E+02	3.35E+02	4
GM-4	ONS GWPI / GM-4 / Rad. Mat. WH	6.20E+02	4.34E+02	5.27E+02	5.47E+02	4
GM-5	ONS GWPI / GM-5 / Rdwst. Bldg.	<MDA	<MDA	2.04E+02	<MDA	4
GM-5R	ONS GWPI / GM-5R / Rdwst. Bldg.	NS	<MDA	NS	NS	1
GM-6	ONS GWPI / GM-6 / Outflow to CTP-3	<MDA	<MDA	<MDA	<MDA	4

Attachment 7
Information to Support the NEI Ground Water Protection Initiative

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2022 - 12/31/2022

Well Name	Location / Description	Tritium Concentration (pCi/l) 1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	# of Samples
GM-6R	ONS GWPI / GM-6R / Outflow to CTP-3	NS	<MDA	NS	NS	1
GM-7	ONS GWPI / GM-7 / 525 kv Sw Yard	NS	2.64E+02	NS	2.77E+02	2
GM-7DR	ONS GWPI / GM-7DR	NS	<MDA	NS	NS	1
GM-7R	ONS GWPI / GM-7R / 525 kv Sw Yard	1.64E+03	1.11E+03	1.15E+03	1.43E+03	4
GM-8	ONS GWPI / GM-8 / E of U-3 TB	2.66E+02	<MDA	2.98E+02	<MDA	4
GM-8R	ONS GWPI / GM-8R / E of U-3 TB	NS	<MDA	NS	NS	1
GM-9	ONS GWPI / GM-9 / E of U-2 TB	2.07E+02	2.63E+02	3.56E+02	2.87E+02	4
GM-9R	ONS GWPI / GM-9R / E of U-2 TB	NS	<MDA	NS	NS	1
MW-11	ONS GWPI / MW-11 / Landfill	<MDA	NS	NS	NS	1
MW-11D	ONS GWPI / MW-11D / Landfill	<MDA	NS	NS	NS	1
MW-13	ONS GWPI / MW-13 / Landfill	<MDA	NS	NS	NS	1
MW-16	ONS GWPI / MW-16 / Landfill	<MDA	NS	NS	NS	1
MW-3R	ONS GWPI / MW-3R / Landfill	<MDA	NS	NS	NS	1
MW-RP01	ONS GWPI / MW-RP01 / Landfarm/Burial	NS	<MDA	NS	NS	1
MW-RP02	ONS GWPI / MW-RP02 / Landfarm/Burial	NS	<MDA	NS	NS	1
MW-RP03	ONS GWPI / MW-RP03 / Landfarm/Burial	NS	<MDA	NS	NS	1
RW-1	ONS Recovery Well / RW-1	2.89E+02	3.35E+02	2.89E+02	2.66E+02	4
013	ONS / 013 / WH 5	<MDA	<MDA	<MDA	<MDA	4
015	ONS / 015 / Brown's Bottom	<MDA	<MDA	<MDA	<MDA	4

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

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2022 - 12/31/2022

The Rad Waste Facility (RWF) ventilation exhaust noble gas monitor was declared inoperable on 9/6/22. The particulate and iodine sampling was moved from the normal sample locations (AM7, AM8 and AM9) to a contingency sample location as a result of the noble gas monitor being inoperable as they share the same sample line. The noble gas monitor, iodine sampler, and particulate sampler were not returned to service within 30 days as specified in Selected Licensee Commitment (SLC) 16.11.3, Condition C Required Action.

Work request (WR# 20232476) investigated the failure and attempts to repair the noble gas detector were unsuccessful. Spare parts for this monitor are not available and the vendor of the monitor is no longer in business. An engineering change (EC# 421844) to replace the noble gas monitoring skid is in development to correct the issue.

Oconee Nuclear Station did not experience temporary outside liquid storage tanks exceeding 10 Curies total activity (excluding tritium and dissolved or entrained noble gases) during 2022.

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

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2022 - 12/31/2022

ODCM Revision 61

Oconee ODCM revision 61 was approved on 9/28/2022. The REMP sampling locations and maps in the ODCM were changed to remove locations #084 and #059. Location #061 was added for goat milk sampling based on the 2022 Land Use Census results. The changes did not impact the ability to meet the radiological environmental monitoring program requirements in Oconee Selected Licensee Commitments (SLC) 16.11.6. Oconee ODCM revision 61 is included in the 2022 ARERR.

Radiological Effluent Controls (SLC 16.11)

The Oconee Nuclear Station Radiological Effluent Controls are contained in SLC 16.11 and are included in this section. SLC 16.11 was not revised in 2022.

Oconee Nuclear Station
Units 1, 2 and 3

ODCM

Offsite Dose
Calculation Manual

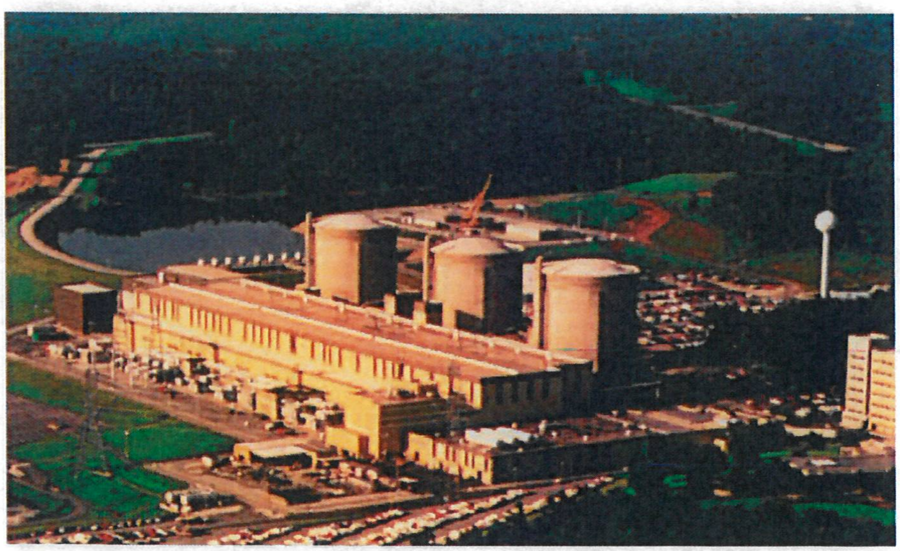
DUKE ENERGY

Oconee Nuclear Station
Units 1, 2 and 3

OFFSITE DOSE CALCULATION MANUAL (ODCM)

Prepared By: Austin K. Wallach ONS Radiation Protection	Austin Wallach **Signature**	9/12/2022 **Date**
Reviewed By: Robert W. Elliot ONS Radiation Protection	Robert W Elliott **Signature**	09/13/22 **Date**
Approved By: Paul V. Fisk ONS Plant Manager	**Signature**	9/28/22 **Date**

Revision 61



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EXECUTIVE SUMMARY

The Oconee Nuclear Station (ONS) Offsite Dose Calculation Manual (ODCM) provides the methodology and parameters to be used in the calculation of offsite doses due to normal operation radioactive liquid and gaseous effluents to assure compliance with the dose limitations of the Selected Licensee Commitments (SLCs, UFSAR Chapter 16) and Technical Specifications (TSs). These dose limitations assure that:

(1) the concentration of radioactive liquid effluents released from the site to the unrestricted area will be limited to 10 times the effluent concentration (EC) levels of 10CFR20, Appendix B, Table 2, and 2.0E-04 μCi/ml for dissolved and entrained noble gases (TS 5.5.5(b), SLC 16.11.1(a)) ;

(2) the exposures to any individual member of the public from radioactive liquid effluents will not result in doses greater than the ALARA design objectives of 10CFR50, Appendix I or the 10CFR20 limits (TS 5.5.5(d), SLC 16.11.1(b)) ;

(3) the dose rate at any time at the site boundary from radioactive gaseous effluents will be limited to: for noble gases; less than or equal to 500 mrem/yr to the whole body, and less than or equal to 3000 mrem/yr to the skin; and for iodine-131 and iodine-133, for tritium, and for all radioactive materials in particulate form with half-lives greater than 8 days; less than or equal to 1500 mrem/yr to any organ (TS 5.5.5(g), SLC 16.11.2(a));

(4) the exposure to any individual member of the public from radioactive gaseous effluents will not result in doses greater than the ALARA design objectives of 10CFR50, Appendix I or the 10CFR20 limits (TS 5.5.5(h and i), SLC 16.11.2(b)); and

(5) the dose to any individual member of the public from the nuclear fuel cycle will not exceed the limits of 40CFR190 (TS 5.5.5(j), SLC 16.11.7).

The methodology and parameters used to assure compliance with the dose limitations described above shall be used to prepare the radioactive liquid and gaseous effluent reports required by the SLCs and Technical Specifications. Dose calculations that demonstrate compliance with 40CFR190 will be considered to demonstrate compliance with 10CFR20 0.1-rem annual dose limit.

The ODCM also provides the methodology and parameters to be used in the calculation of radioactive liquid and gaseous effluent monitoring instrumentation alarm/trip setpoints to assure compliance with the concentration and dose rate limitations of the SLCs and Technical Specifications. Software implementing NUREG-0133 methodology is used for the calculation of offsite doses, but the ODCM also provides a method for the calculation of offsite doses when the software is not available

The ODCM has been prepared as generically as possible in order to minimize the need for revisions. Any changes to the methodology and parameters to be used in this ODCM shall be reviewed by knowledgeable individual(s), and approved by the Station Manager or Radiation Protection Manager prior to implementation. Changes to the ODCM shall be submitted to the Nuclear Regulatory Commission in accordance with the SLCs and Technical Specifications.

The ODCM does not replace any station implementing procedures. Programmatic controls for radioactive effluents and radiological environmental monitoring are contained in the Administrative Controls chapter of the Technical Specifications. Procedural details for radioactive effluents and radiological environmental monitoring consisting of licensee commitments, applicability, remedial actions, surveillance requirements, and the bases for these requirements are contained in Section 16.11 of the SLCs.

1.0 RADWASTE SYSTEMS

1.0.1 LIQUID RADWASTE PROCESSING

The liquid radwaste system at Oconee Nuclear Station is used to collect and treat liquid chemical and radiochemical byproducts of unit operation. The system produces effluents that are discharged in small, dilute quantities to the environment. The means of treatment vary with waste type and desired product in the various systems:

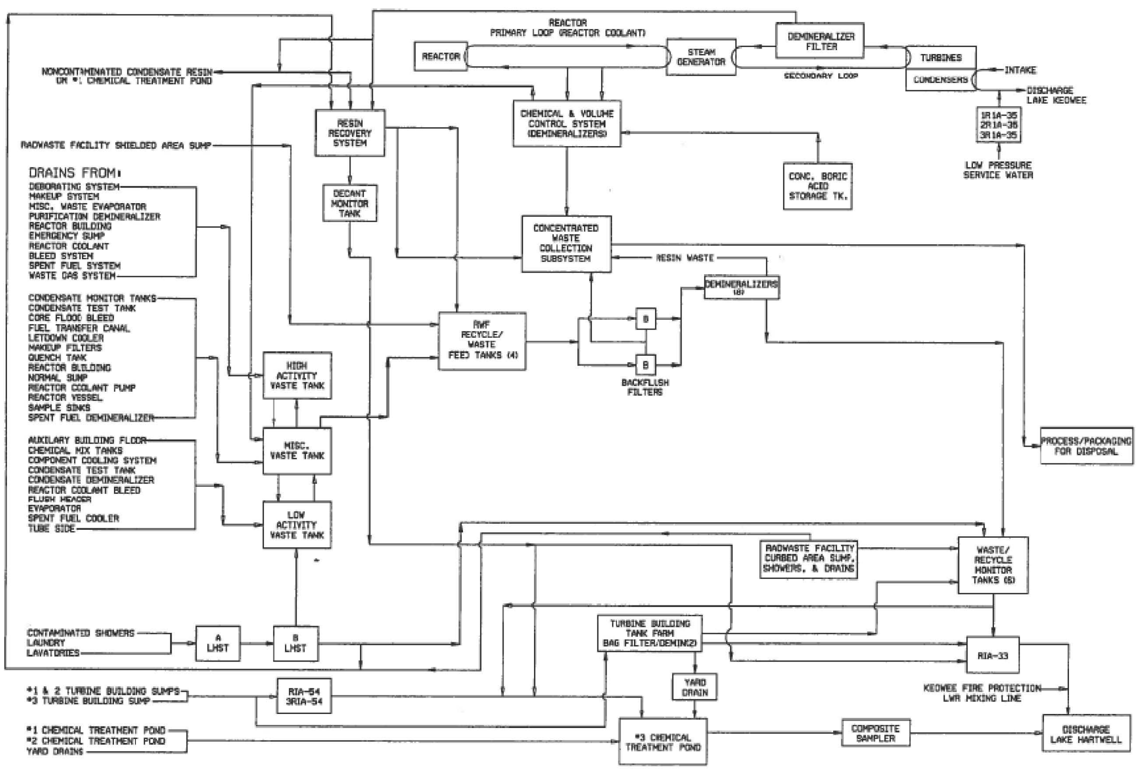
(A) Filtration - Waste sources are filtered prior to processing as necessary.

(B) Ion Exchange - Ion exchange is used to remove radioactive ions from solution. Also, ion exchange is normally used in removing cations (cobalt, cesium, manganese) and anions (chloride, fluoride) from the filtrate in order to purify the filtrate for release.

(C) Gas Stripping - Removal of gaseous radioactive fission products is accomplished through venting of atmospheric holdup tanks.

Figure 1.0-1 is a schematic representation of the liquid radwaste system at Oconee.

Figure 1.0-1 Oconee Nuclear Station Liquid Radwaste System



1.0.2 GASEOUS RADWASTE PROCESSING

The purpose of the gaseous waste disposal system is to:

(1) Maintain a non-oxidizing cover gas of nitrogen in tanks and equipment that contain potentially radioactive gas;

(2) Hold up radioactive gas for decay; and

(3) Release gases (radioactive and non-radioactive) to the atmosphere under controlled conditions.

During power operation of the facilities, radioactive materials released to the atmosphere in gaseous effluents include low concentrations of fission product noble gases (krypton and xenon), halogens (mostly iodines), tritium contained in water vapor, and particulate material including both fission products and activated corrosion products.

The primary source of gaseous radioactive wastes is from the degassing of the primary coolant during letdown of the cooling water into various holding tanks. Additional sources of gaseous waste activity include the auxiliary building exhaust, spent fuel area exhaust, the discharge from the steam jet air ejectors, and purging and venting of the reactor containment building. Some low radioactivity secondary system steam releases can occur at the site such as from infrequent lifts of the main steam relief valves and testing of the main steam manual atmospheric dump valves. Secondary side steam releases are reviewed for inclusion in the site effluent total.

All components that can contain potentially radioactive gases are vented to a vent header. The vent gases are subsequently drawn from this header by one of four waste gas compressors or a waste gas exhauster. The waste gas compressor discharges through a waste gas separator to one of seven waste gas tanks. The waste gas tanks and the waste gas exhauster discharge to the unit vent after passing through a filter bank consisting of a prefilter, an absolute filter, and a charcoal filter.

Radioactive gases may be released inside the reactor containment building when components of the primary system are opened to the building atmosphere for operational reasons or where minor leaks occur in the primary system. Prior to access, the reactor containment atmosphere will be monitored for radioactivity and, when necessary, purged through prefilters, high-efficiency particulate air (HEPA) filters, and charcoal filters, and released to the atmosphere through the unit vent. The purge equipment is sized for a flow rate of 50,000 cfm providing approximately 1.5 air changes per hour in the reactor building. Units 1, 2, and 3 have a separate vent stack which services each unit.

Figure 1.0-2 is a schematic representation of the gaseous radwaste system at Oconee.

Figure 1.0-2 Oconee Nuclear Station Gaseous Radwaste System
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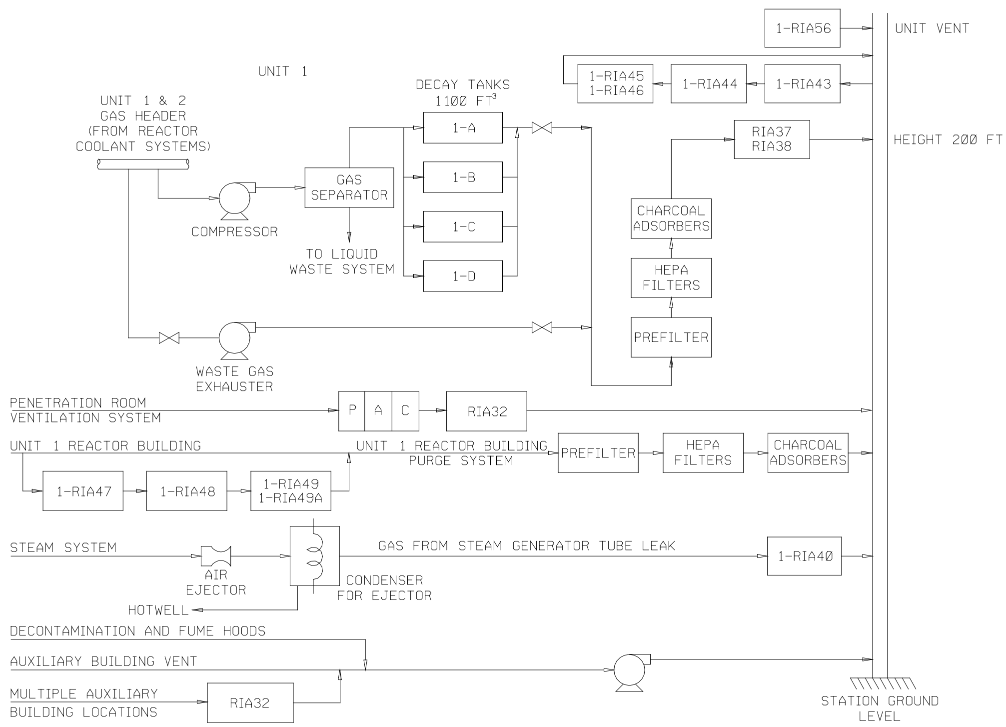

Figure 1.0-2 Oconee Nuclear Station Gaseous Radwaste System
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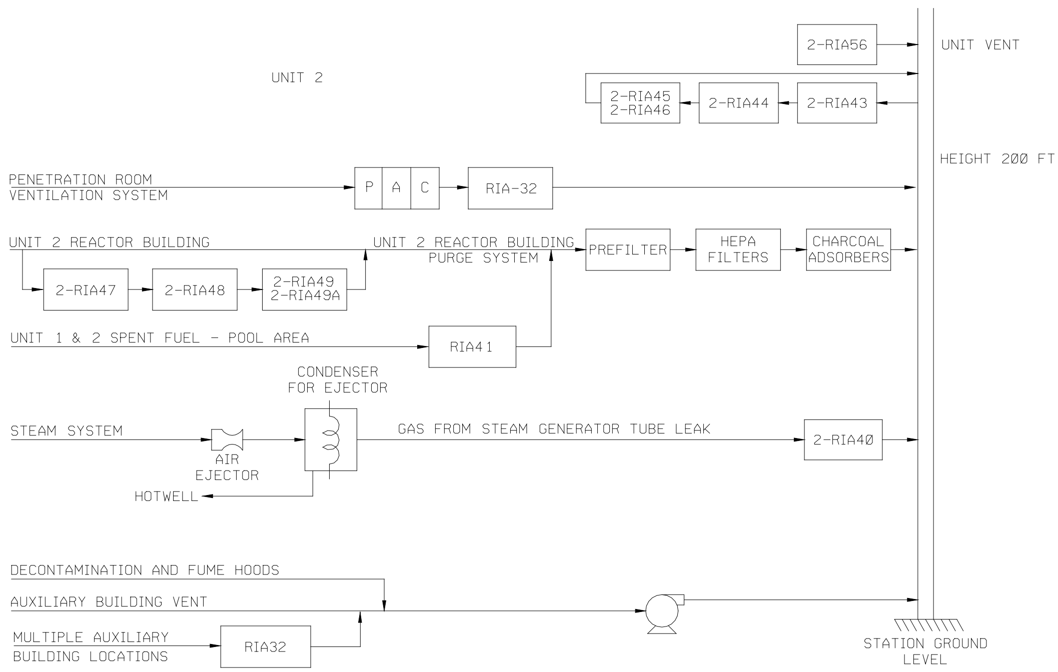

Figure 1.0-2 Oconee Nuclear Station Gaseous Radwaste System
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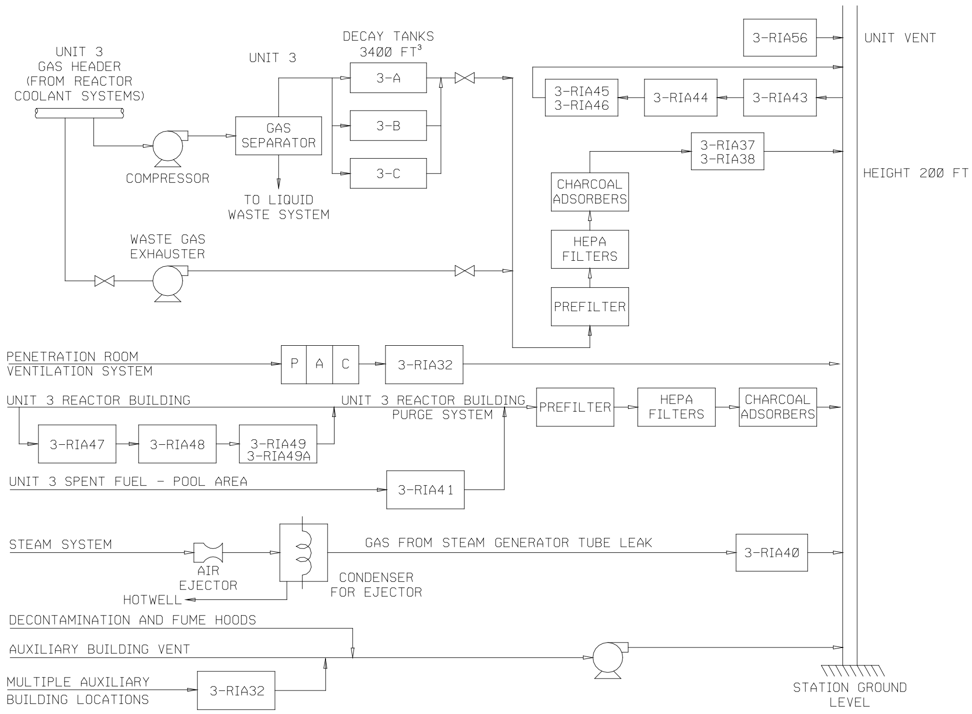

Figure 1.0-2 Oconee Nuclear Station Gaseous Radwaste System
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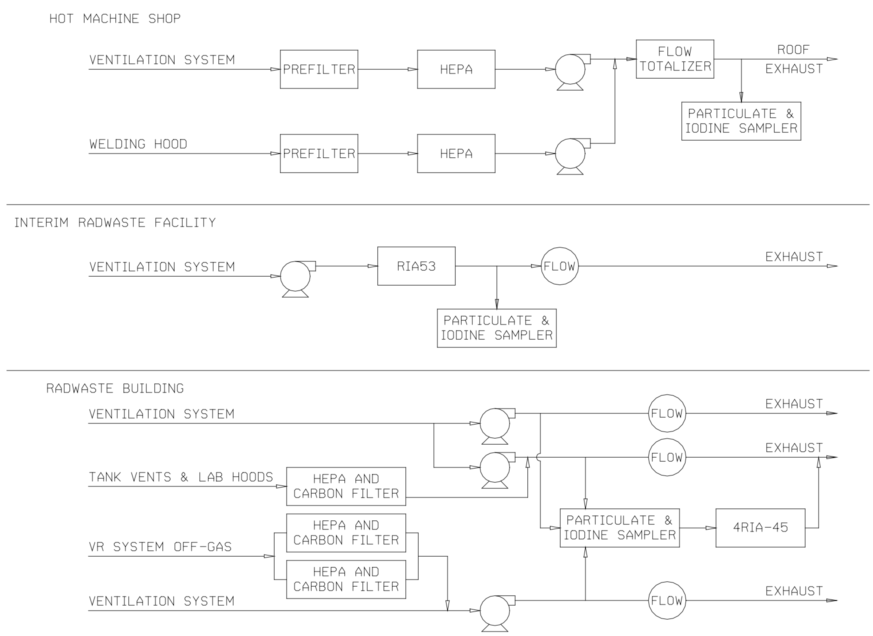


2.0 RELEASE RATE CALCULATIONS

2.0.1 LIQUID RELEASE RATE LIMIT CALCULATIONS

There are two liquid radwaste discharge points to the environment at Oconee; (1) the liquid radwaste effluent line to the Keowee Hydroelectric Unit Tailrace, and (2) the #3 Chemical Treatment Pond effluent line to the Keowee River (See Figure 2.0-1).

2.0.1.1 LIQUID RADWASTE EFFLUENT LINE RELEASE RATE LIMIT CALCULATION

Liquid releases to the Keowee Hydroelectric Unit Tailrace normally contain the radioactive releases from the site including effluents from the Waste Monitor Tanks, Recycle Monitor Tanks, and Decant Monitor Tank. The Keowee Tailrace discharge point can also contain Turbine Building Sump Monitor Tank (TBSMT) releases, however TBSMT effluent normally contains very low (if any) activity, and, therefore is transferred to the #3 Chemical Treatment Pond prior to release. Dilution flow for the liquid radwaste effluent line is provided by the Keowee Hydroelectric Unit and the Keowee Hydro Fire Protection liquid waste release mixing line. For purposes of the release rate calculation, Keowee hydro dilution flow is assumed to be a minimum leakage flow of 38 cfs, and a maximum flow of 6600 cfs based on one hydro unit operating at 50% power. The Keowee Hydro Fire Protection liquid waste release mixing line provides an additional 38 cfs dilution flow. Since Keowee Hydro typically releases only a small percentage of time during the year, 76 cfs (38 cfs leakage + 38 cfs mixing line) is normally assumed for dilution flow when performing liquid release rate calculations.

To comply with Technical Specifications and Selected Licensee Commitments, and to assure that the concentration of radioactive liquid effluents released from the site to the unrestricted area is limited to 10 times the effluent concentrations (ECs) of 10CFR20, Appendix B, Table 2, Column 2, and 2.0E-04 μCi/ml for dissolved and entrained noble gases, the following release rate limit calculation shall be performed for liquid releases to the Keowee Hydro Tailrace via the liquid radwaste effluent line:

$f \le \left(F \div \left(DF - 1\right)\right)$ Condition: DF > 1.0 Equation 2.1

where:

f = the undiluted effluent flow, in gpm.

F = the dilution flow available, in gpm.
= normally 3.41E+04 gpm (76 cfs, based on a leakage rate of 38 cfs (19 cfs per Keowee Hydro unit), plus the Keowee Hydro Fire Protection liquid waste release mixing line whose flow rate is 38 cfs. When Keowee Hydro enters an outage one of the two units is taken offline which temporarily reduces the amount of leakage by half. Therefore, during a Keowee Hydro outage the dilution flow is assumed to be 57 cfs (19 cfs leakage plus 38 cfs raw water, (2.56E+04 gpm)).
= or 2.96E+06 gpm (6600 cfs, based on one hydro unit operating at 50% power). This value is only used if it is known that Keowee Hydro is discharging.

DF = required dilution factor to be applied to the undiluted effluent flow, unitless.

$$DF = \sigma \times \sum_i \frac{C_i}{(10 \times EC_i)} \qquad \text{Equation 2.2}$$

Note:

If $DF \leq 1.0$ then no dilution is required and the release rate is unrestricted.

If $DF > 1.0$ then dilution flow is required and the release rate is calculated using Equation 2.1. Equation 2.1 is used only when DF > 1.0.

σ = the most restrictive recirculation factor at equilibrium, (dimensionless). The recirculation factor accounts for the fraction of discharged water reused by the station. This value equals 1.0 since discharged liquid effluent is not reused at Oconee.

C_i = the concentration of radionuclide, ‘i’, in the undiluted liquid effluent, in μCi/ml.

EC_i = the concentration of radionuclide, ‘i’, from 10CFR20, Appendix B, Table 2, Column 2, in μCi/ml. Note: if radionuclide, ‘i’, is a dissolved noble gas, then EC_i = 2.00E-05 μCi/ml.

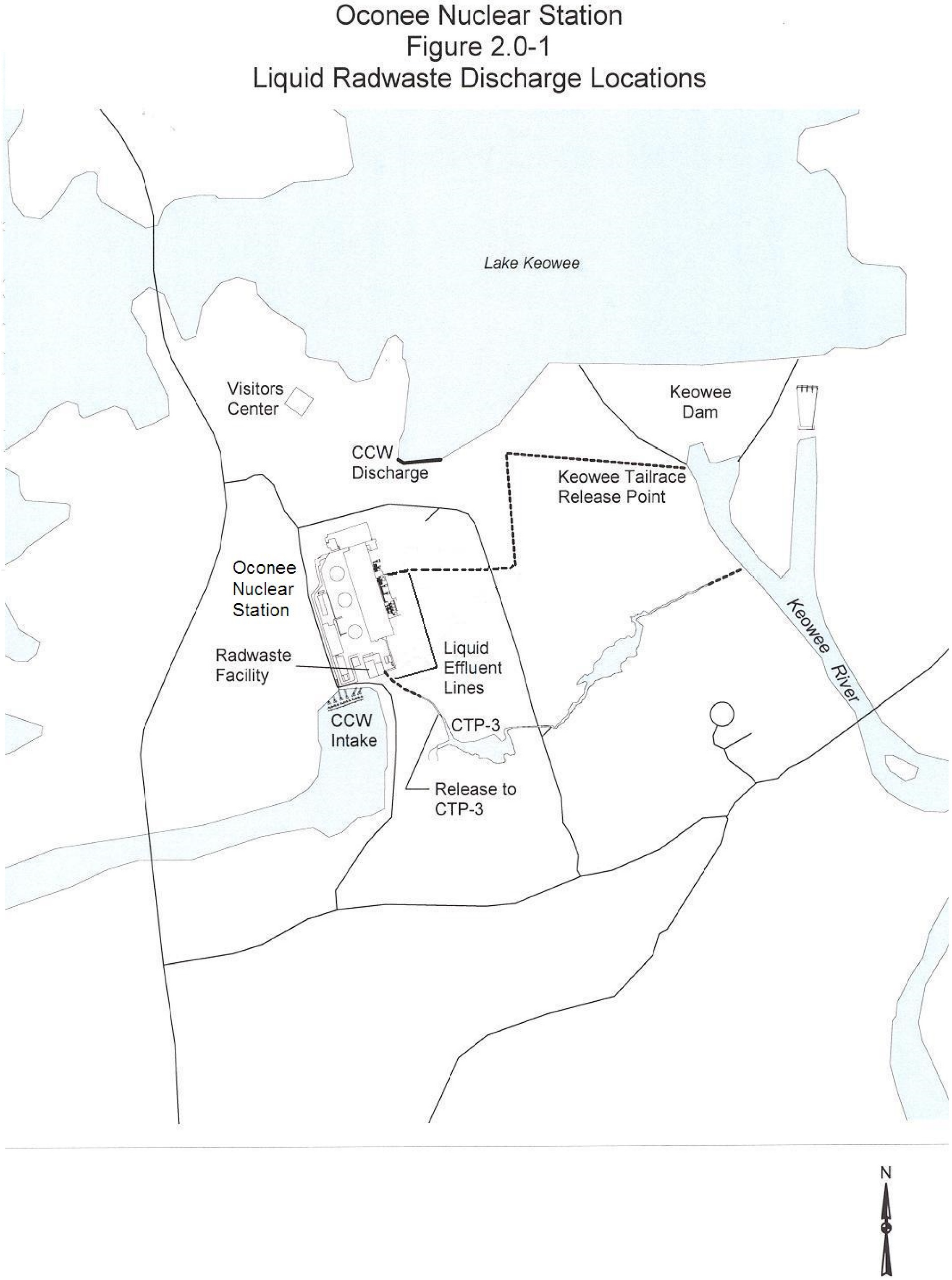
Once the maximum release rate, *f*, is calculated the value is multiplied by 0.8 for additional conservatism.

2.0.1.2 #3 CHEMICAL TREATMENT POND EFFLUENT LINE DISCHARGE

The #3 Chemical Treatment Pond (CTP) effluent line is the release point for station effluents that are normally considered to be non-radioactive; that is, the pond's effluent will not normally contain measurable activity above background with the exception of very low tritium activity. Tritium releases from the #3 CTP typically account for much less than 1% of the station total tritium release. It is assumed that no activity is present in the effluent until indicated by radiation monitoring measurements on the pond's inputs and/or by periodic analyses of the composite sample collected at the pond's discharge point. Inputs to this pond include the station's yard drain system, #1 CTP discharge, #2 CTP discharge, recovery well water, the decant water from the Powdex system, and the discharge from the Turbine Building Sump/TBSMT system whose contents have been determined to be below 10EC. Inputs that have radiation monitors associated with them will be set to assure that Selected Licensee Commitment 16.11-1 will not be exceeded. #3 CTP is a continuous release path that discharges to the Keowee River (see Figure 2.0-1).

The #3 CTP may also be the discharge path for large volumes of slightly contaminated water following a primary-to-secondary leak so long as administrative procedures are implemented to assure that release rate calculations similar to that used in Section 2.0.1.1 are performed, that all detectable radionuclides will be accounted for, and that no station limits will be exceeded.

Figure 2.0-1 Liquid Radwaste Discharge Locations



2.0.2 GASEOUS RELEASE RATE LIMIT CALCULATIONS

The three unit vents are the primary gaseous radioactive release points at Oconee. The unit vents are the semi-elevated release points for waste gas decay tanks, containment building purges, auxiliary building ventilation, spent fuel pool ventilation, and the condenser air ejector (see Figure 1.0-2, pages 1, 2, and 3). Each unit vent contains multi-range radiation monitors (RIAs) and flow rate measuring instrumentation.

There are three other separate gaseous effluent release points at Oconee; the Hot Machine Shop, Interim Radwaste Building and Radwaste Facility that are normally considered non-radioactive; that is, it is possible but unlikely that the effluent will contain measurable activity above background. Each of these release points are considered ground-level, and each has an effluent sampler and flow monitoring device (see Figure 1.0-2, page 4). In addition, the Interim Radwaste Building and Radwaste Facility have a RIA.

2.0.2.1 UNIT VENT DISCHARGE RELEASE RATE LIMIT CALCULATION

In order to comply with Technical Specifications and Selected Licensee Commitments and to assure that the dose rate, at any time, at or beyond the site boundary due to radioactive materials released in gaseous effluents from the site is limited to: ≤ 500 mrem/yr to the total body, and ≤ 3000 mrem/yr to the skin for the noble gases, and is limited to ≤ 1500 mrem/yr to any organ for radioiodine and for radioactive materials in particulate form, and radionuclides other than noble gases with half lives greater than 8 days, the following release rate and radiation monitor setpoint calculations shall be performed for releases from the waste gas decay tanks and the containment building. The release rate calculations when solved for the flow rate, 'f', are the release rates for noble gases and for radioiodines, particulates and other radionuclides with half-lives greater than 8 days. The most conservative release rate calculated shall control the flow rate. The following equations are based on the site dose rate limits. When applied to the individual release points the site dose rate values are apportioned 1/3 to each unit vent.

a. Noble Gases

Total Body:

$$\sum_i \left(K_i \times \frac{\chi}{Q} \times Q_i \right) < 500 \text{ mrem/yr} \qquad \text{Equation 2.3}$$

Skin:

$$\sum_i \left(\left(L_i + 1.1M_i\right) \times \frac{\chi}{Q} \times Q_i \right) < 3000 \text{ mrem/yr} \qquad \text{Equation 2.4}$$

b. Radioiodines, Particulates, and Others

Inhalation, Ingestion and Ground Organ Pathways:

$$\sum_p \sum_i \left(P_{opi} \times W \times Q_i \times E_i\right) < 1500 \text{ mrem/yr}$$

To include both the food and ground organ dose and the inhalation organ dose the equation can be expanded to:

$$\sum_p \sum_i \left(\left\{\left(P_{opi}\right)_{\text{food/gr}} \times W_{D/Q} + \left(P_{opi}\right)_{\text{inhal}} \times W_{\chi/Q}\right\} \times Q_i \times E_i\right) < 1500 \text{ mrem/yr}$$

Equation 2.5

where:

K_i = the total body dose factor due to gamma emissions for each identified noble gas radionuclide, 'i', in mrem/yr per µCi/m^3 (See Appendix A).

L_i = the skin dose factor due to beta emissions for each identified noble gas radionuclide, 'i', in mrem/yr per µCi/m^3 (See Appendix A).

M_i = the air dose factor due to gamma emissions for each identified noble gas radionuclide, 'i', in mrad/yr per µCi/m^3 (See Appendix A).

1.1 = ratio to convert dose (mrad) to dose equivalent (mrem).

P_{opi} = the dose parameter for radionuclides other than noble gases for the inhalation pathway, in mrem/yr per µCi/m^3 and for the food and ground plane pathways in (m^2 × (mrem/yr per µCi/sec)) for organ, 'o', and radionuclide, 'i', (See Appendix B for the pathway specific dose commitment factors). Note: NUREG-1301, page 75, specifies use of the Child age group, Inhalation pathway, for the P_{opi} values.

χ/Q = the highest calculated annual average dispersion parameter for any area at or beyond the site boundary in sec/m^3. For the Oconee Unit Vents this value is 1.672E-6 sec/m^3. The location is the SW sector at 1.0 mile for semi-elevated releases. For the Hot Machine Shop, Interim Radwaste Building and Radwaste Facility this value is 7.308E-6 sec/m^3. The location is the SE sector at 1.0 mile for ground-level releases. As discussed in Oconee UFSAR Section 2.1.1.3, the boundary for establishing gaseous effluent release limits is the exclusion area boundary (EAB). The EAB is defined as a 1 mile radius from the station center.

W = the highest calculated annual average dispersion or deposition parameter for estimating the maximum dose rate to an individual from the total inhalation, food, and ground plane pathways resulting from semi-elevated releases or ground-level releases:

$W_{\chi/Qse}$ = 1.672E-6 sec/m^3, for the inhalation pathway and the airborne H-3 food pathway. The location is the SW sector at 1.0 mile for semi-elevated releases.

$W_{D/Qse}$ = 1.295E-8 m^{-2}, for the food and ground plane pathways. The location is the NE sector at 1.0 mile for semi-elevated releases.

$W_{\chi/Qgl}$ = 7.308E-6 sec/m^3, for the inhalation pathway and the airborne H-3 food pathway. The location is the SE sector at 1.0 mile for ground-level releases.

$W_{D/Qgl}$ = 2.259E-8 m^{-2}, for the food and ground plane pathways. The location is the NE sector at 1.0 mile for ground-level releases.

E_i = the filter removal factor for radionuclide, 'i', e.g., for 99% removal $E_i = 0.01$.
For iodine removal by charcoal adsorbers $E_i = 0.1$.
For particulate removal by HEPA filters $E_i = 0.01$.

Q_i = the release rate of radionuclide, 'i', in gaseous effluent from all release points at the site, in µCi/sec.

$$Q_i = k_1 C_i f \div k_2 = 472 \times C_i f \qquad \text{Equation 2.6}$$

where:

C_i = the concentration of radionuclide, 'i', in undiluted gaseous effluent, in µCi/ml.

f = the undiluted effluent flow, in ft^3/min.

k_1 = conversion factor, 2.83E+04 cc/ft^3.

k_2 = conversion factor, 60 sec/min.

Substituting the expression for Q_i in Equation 2.6 into Equations 2.3, 2.4, and 2.5, and solving for the flow rate, 'f', in each equation gives:

Noble Gases - Total Body Maximum Release Rate:

$$f_{tb} < \frac{500}{472 \times \chi/Q \times \sum_i (K_i \times C_i)}$$

Noble Gases - Skin Maximum Release Rate:

$$f_{sk} < \frac{3000}{472 \times \chi/Q \times \sum_{\mathrm{i}} \left[\left(L_i + 1.1M_i \right) \times C_i \right]}$$

Radioiodines, Particulates, and Others - Organ Maximum Release Rate:

$$f_{or} < \frac{1500}{472 \times \sum_{p} \sum_{i} \left(\left\{ \left(P_{opi} \right)_{food/gr} \times W_{D/Q} + \left(P_{opi} \right)_{inhal} \times W_{\chi/Q} \right\} \times E_i \times C_i \right)}$$

f_{tb}, f_{sk}, and f_{or}, are calculated for each batch prior to release. The most limiting gaseous release rate is used to assure that no instantaneous dose rate limit is exceeded.

Once the maximum release rate, f, is calculated the value is multiplied by 0.8 for additional conservatism.

Derivations of Iodine, Particulate, and H-3 Dose Commitment Factors (P_{opi})

Inhalation Pathway - Child Age Group

$$P_{opi} = K'(BR)(DFA_{oi})$$

Formula: from NUREG-0133, page 25.	
Where:	
P_{opi}	Dose commitment factor for Child age group, organ o, nuclide i, for the inhalation pathway (mrem/yr per µCi/m^3). (See Appendix B for the pathway specific dose commitment factors).
K'	Units conversion factor pCi/µCi (10^6).
BR	Breathing rate for the Child age group (m^3/yr, from Regulatory Guide 1.109): Child – 3700
DFA_{oi}	Organ inhalation dose conversion factor for Child age group, organ o, nuclide i, (mrem/pCi), from Table E-9 of Regulatory Guide 1.109.

3.0 SETPOINT CALCULATIONS

3.0.1 LIQUID RADIATION MONITOR SETPOINT CALCULATIONS

As shown on Figure 1.0-1, RIA-33 is the controlling radiation monitor for liquid batch releases at Oconee. Once the liquid release rate parameters have been established radiation monitor setpoints shall be calculated to assure that the concentration of radioactive liquid effluents released from the site to the unrestricted area is limited to ten times the effluent concentrations (ECs) of 10CFR20, Appendix B, Table 2, Column 2, and 2.0E-04 µCi/ml for dissolved and entrained noble gases. By substituting the dilution factor (DF) from Equation 2.2 into Equation 2.1, solving for the undiluted liquid effluent concentration, C_i, and accounting for the monitor background reading, the liquid radiation monitor setpoint can be readily obtained by multiplying C_i by the radiation monitor correlation factor, CF_i, as follows:

$$C_i \leq \frac{(F + f) \times (10 \times EC_i)}{\sigma \times f} \qquad \text{Equation 3.1}$$

$$SP \leq \sum_i (C_i \times CF_i) + bkg \qquad \text{Equation 3.2}$$

where:

C_i = the maximum allowable concentration of radionuclide, ‘i’, in the undiluted liquid effluent, in µCi/ml.

SP = radiation monitor setpoint, in cpm.

CF_i = radiation monitor correlation factor for radionuclide, ‘i’, in cpm/µCi/ml, e.g., 8.00E+07 cpm/µCi/ml (Cs-137) for RIA-33.

bkg = background reading for the radiation monitor, in cpm.

All other parameters were previously defined.

Using conservative or "worst-case" parameters in Equation 3.1 and Equation 3.2 can provide a liquid radiation monitor setpoint that does not need to be revised for every release if activity is low enough to allow for this type of operation such as with continuous releases from the #3 CTP release point. However, for batch releases, e.g., waste monitor tanks, through the liquid radwaste effluent line to the Keowee hydro tailrace the RIA-33 radiation monitor setpoints are calculated based on the actual expected activity in the release as follows:

First the "Correlation Concentration" (C CONC) is calculated:

$$C\ CONC = \sum_i \left(C_i \times EQ_i \right)$$

where:

C_i = Undiluted liquid effluent concentration for each isotope, excluding tritium, μCi/ml.

EQ_i = RIA-33 Cs-137 equivalence factor for each isotope, excluding tritium, to that of Cs-137 due to different gamma energies and abundance. This factor includes a 4-hour decay time due to the average time between sample and release. (See Table 3.0-1)

Next the RIA-33 setpoints are determined as follows:

If C CONC is > 9.0E-6 μCi/ml then three setpoint values are calculated. The actual "expected" count rate for the release is defined as the "Midpoint of Expected Range". The "Alert" setpoint is defined as 1.5 times the expected counts from activity in the liquid effluent plus background. If the "Alert" setpoint is exceeded, but there is no upward trend, the release will be allowed to continue. If RIA-33 continues to trend upward then the release will be manually terminated. The "Upper Limit of Expected Range" is defined as 3 times the expected counts from activity in the liquid effluent plus background. The "Upper Limit of Expected Range" is called the "Trip" setpoint. If the "Trip" setpoint is exceeded the release will be automatically terminated. The "Lower Limit of Expected Range" is defined as 3 times lower than the expected counts from activity in the liquid effluent plus background. The "Lower Limit of Expected Range" provides assurance that the correct liquid effluent is being released. If the RIA-33 count rate does not increase to at least the "Lower Limit of the Expected Range" then the release will be terminated, and a new sample analysis will be performed. The four RIA-33 setpoints are calculated as follows:

Lower Limit of Expected Range = C CONC × (8.00E7/3) cpm/(μCi/ml) + RIA-33 BKG

Midpoint of Expected Range = C CONC × 8.00E7 cpm/(μCi/ml) + RIA-33 BKG

Alert Setpoint = C CONC × (8.00E7×1.5) cpm/(μCi/ml) + RIA-33 BKG

Upper Limit of Expected Range (Trip Setpoint) = C CONC × (8.00E7×3) cpm/(μCi/ml) + RIA-33 BKG

If C CONC is ≤ 9.0E-6 μCi/ml then the RIA-33 setpoint is 2.16E3 cpm (9.0E-6 × 8.00E7 × 3) plus background (BKG) as the "Upper Limit of Expected Range". This setpoint is used for low activity releases, and is based on limiting the concentration in the effluent to 10 times the 10CFR20 EC of Cs-134 which has the lowest effluent concentration value (9.0E-7 μCi/ml) for any detectable radionuclide in the effluent. Similarly, the RIA-33 "Alert" setpoint for low activity releases is 1.08E3 cpm (9.0E-6 × 8.00E7 × 1.5) plus background (BKG).

As shown in Figure 1.0-1, Turbine Building Sump (TBS) discharge can be routed to either #3 CTP or to the Turbine Building Sump Monitor Tank (TBSMT). The TBS discharge is monitored by RIA-54 which is operated as a continuous sampler. Normally, TBS discharge is sent to #1 CTP or #2 CTP where the effluent is processed if it contains chemicals prior to being sent to #3 CTP. However, if RIA-54 trips on high radiation, then the TBS discharge is processed through the TBSMT where it can go to #3 CTP via the yard drain system if it is < 10EC or be released through RIA-33 if it is ≥ 10EC. RIA-54 alarm setpoints are set to provide an early warning of increased activity, and prevent TBS effluent releases in excess of station regulatory release limits (i.e., 10EC). Setpoint calculations are based on a monitor correlation factor of 7.81E-9 μCi/ml/cpm (Cs-137 equivalent) and a Cs-134 10CFR20 Effluent Concentration of 9E-7 μCi/ml. Cs-134 is the most limiting radionuclide 10CFR20 Effluent Concentration not known to be absent from the TBS effluent. The Cs-134 10CFR20 EC value of 9E-7 μCi/ml is conservatively used as a Cs-137 concentration since Cs-137 has a 10CFR20 EC value of 1E-6 μCi/ml. Setpoints are conservatively calculated using a rounded RIA-54 correlation factor of 8E-9 μCi/ml/cpm. The Alert setpoint limit is set to 1/2 of the 10EC release limit, and is based upon ten times the EC value for Cs-134 as follows:

RIA-54 Alert Setpoint = Background + 562 cpm; (i.e., 1/2 × 10 × 9E-7/8E-9 = 562).

Similarly, the Alarm setpoint limit is set to the 10EC release limit, and is based upon ten times the EC value for Cs-134 as follows:

RIA-54 Alarm Setpoint = Background + 1125 cpm; (i.e., 10 × 9E-7/8E-9 = 1125).

Table 3.0-1

RIA-33 Cs-137 Equivalents

Isotope	Equivalence Factor	Isotope	Equivalence Factor	Isotope	Equivalence Factor
Be-7	0.1462	Mo-99	0.2668	La-141	0.0155
F-18	0.5788	Tc-99m	0.00	La-142	0.2942
Na-24	0.8519	Tc-101	0.00	Ce-141	0.00
Cl-38	0.0090	Ru-103	1.3368	Ce-143	0.7826
K-40	0.1094	Ru-105	0.8783	Ce-144	0.0273
Cr-51	0.1438	Ru-106	0.4429	I-130	3.3095
Mn-54	1.0617	Ag-108m	3.4473	I-131	1.4051
Mn-56	0.4992	Ag-110m	3.5179	I-132	1.0259
Fe-59	1.0556	Cd-115	0.5201	I-133	1.1857
Co-57	0.0022	Cd-115m	0.0235	I-134	0.1388
Co-58	1.4735	In-115m	0.3631	I-135	0.9374
Co-60	2.0495	Sb-122	0.9218	Ar-41	0.2229
Cu-64	0.3954	Sb-124	2.1617	Kr-85	0.0059
Ni-65	0.1591	Sb-125	1.1308	Kr-85m	0.4280
Zn-65	0.5584	Sb-126	5.1762	Kr-87	0.1213
Zn-69m	1.1391	Sn-113	0.9971	Kr-88	0.5278
Se-75	1.3092	Sn-123	0.0066	Kr-89	0.00
Br-80m	0.0860	Sn-126	0.00	Xe-131m	0.0167
Br-82	3.4691	Te-125m	0.00	Xe-133	0.0006
Br-83	0.0059	Te-127	0.0134	Xe-133m	0.1172
Br-84	0.0053	Te-127m	0.0001	Xe-135	0.8564
Br-85	0.00	Te-129	0.0138	Xe-135m	0.00
Rb-86	0.0894	Te-129m	0.0507	Xe-137	0.00
Rb-88	0.00	Te-131	0.0008	Xe-138	0.00
Rb-89	0.00	Te-131m	1.8463	Nd-147	0.2619
Sr-89	0.0002	Te-132	0.9766	Hf-181	1.4209
Sr-91	0.6460	Te-134	0.0408	W-187	0.8027
Sr-92	0.3900	Cs-134	2.5804	Tl-208	0.00
Y-91	0.0031	Cs-136	3.1916	Bi-212	0.0144
Y-91m	0.0439	Cs-137	1.00	Bi-214	0.0003
Y-92	0.1334	Cs-138	0.0120	Pb-212	0.4497
Y-93	0.1091	Ba-133	1.3648	Pb-214	0.0020
Zr-95	1.0909	Ba-139	0.0203	Ra-226	0.0320
Zr-97	1.1210	Ba-140	0.5307	Ac-228	0.8261
Nb-95	1.0821	Ba-141	0.0002	Th-228	0.0038
Nb-95m	0.2919	Ba-142	0.00	Np-239	0.3996
Nb-97	0.1164	La-140	2.3237		

3.0.2 GASEOUS RADIATION MONITOR SETPOINT CALCULATIONS

The unit vent radiation monitor setpoints are established at the Oconee Nuclear Station to help ensure that gaseous release rate limits are not exceeded. For some release pathways in which a specific RIA exists, the setpoints also help to ensure that the effluent being released is the same concentration as indicated by manual samples, e.g. effluent from waste gas decay tanks, thereby reducing the likelihood of releasing the wrong tank. For instances in which the RIA which normally controls the release is not operable, or is "out of service", independent manual samples (IMS) are collected and the noble gas constituents from both samples are compared to help ensure that the intended "batch" is being released. For certain low potential release types, e.g. Integrated Leak Rate Tests, no RIA exists to ensure that release rate limits are not exceeded or to ensure that the effluent being released is the "expected" concentration. For such pathways, independent manual samples are required to be collected and noble gas constituents compared prior to release. The following list defines the controlling RIA for the various gaseous effluent release types at Oconee:

Pathway	Controlling RIA
Unit 1 "A" Waste Gas Decay Tank	1&2 RIA 37/38
Unit 1 "B" Waste Gas Decay Tank	1&2 RIA 37/38
Unit 1 "C" Waste Gas Decay Tank	1&2 RIA 37/38
Unit 1 "D" Waste Gas Decay Tank	1&2 RIA 37/38
Unit 3 "A" Waste Gas Decay Tank	3 RIA 37/38
Unit 3 "B" Waste Gas Decay Tank	3 RIA 37/38
Unit 3 "C" Waste Gas Decay Tank	3 RIA 37/38
Unit 1 Reactor Building Purge	1 RIA 45/46
Unit 2 Reactor Building Purge	2 RIA 45/46
Unit 3 Reactor Building Purge	3 RIA 45/46
Unit 1 Depressurization	IMS 1 RIA 45/46 Alarm Only
Unit 2 Depressurization	IMS 2 RIA 45/46 Alarm Only
Unit 3 Depressurization	IMS 3 RIA 45/46 Alarm Only
Unit 1 Hydrogen Recombiner	IMS 1 RIA 45/46 Alarm Only
Unit 2 Hydrogen Recombiner	IMS 2 RIA 45/46 Alarm Only
Unit 3 Hydrogen Recombiner	IMS 3 RIA 45/46 Alarm Only
Unit 1 Integrated Leak Rate Test	IMS
Unit 2 Integrated Leak Rate Test	IMS
Unit 3 Integrated Leak Rate Test	IMS

The following sections describe the methods by which setpoints are established. In general, gaseous radiation monitors are calibrated to Xe-133, and for continuous release points, e.g., the three unit vents, are preset at a maximum value based on the 500 mrem/year total body gaseous release rate limit according to the following methodology:

Note: when applied to the individual release points the 500 mrem/year site dose rate value is apportioned 30% to each Unit Vent (RIA-45 and RIA-46) semi-elevated release point. The remaining 10% is allocated to the three ground-level release points, the Hot Machine Shop (no monitor), Interim Radwaste Building (RIA-53) and Radwaste Facility (4RIA-45) that are normally considered non-radioactive. Recall from Section 2.0.2.1 the following equation:

$$K_{Xe-133} \times \chi / Q \times Q_{Xe-133} < 500 \text{ mrem/yr}$$

Solve for $Q_{Xe\text{-}133}$:

$$Q_{Xe-133} < \frac{500}{K_{Xe-133} \times \chi / Q} \qquad \text{Equation 3.4}$$

From Equation 2.6:

$$Q_{Xe-133} = 472 \times C_{Xe-133} \times f \qquad \text{Equation 3.5}$$

Substitute Equation 3.5 into Equation 3.4:

$$472 \times C_{Xe-133} \times f < \frac{500}{K_{Xe-133} \times \chi/Q}$$

Solve for $C_{Xe\text{-}133}$:

$$C_{Xe-133} < \frac{500}{472 \times f \times K_{Xe-133} \times \chi/Q}$$

$$SP = \frac{C_{Xe-133}}{CF} + bkg \qquad \text{Equation 3.6}$$

where:

$K_{Xe\text{-}133}$ = 2.94E+02, the total body dose factor due to gamma emissions for Xe-133, in mrem/year per μCi/m^3 (See Appendix A).

χ/Q = the highest calculated semi-elevated annual average dispersion parameter for any area at or beyond the site boundary in sec/m^3. For Oconee this value is 1.672E-6 sec/m^3. The location is the SW sector at 1.0 mile.

$Q_{Xe\text{-}133}$ = Xe-133 equivalent release rate limit for the noble gas total body dose pathway, in μCi/sec.

472 = Conversion factor, (cc/ft^3)/(sec/min).

$C_{Xe\text{-}133}$ = the maximum allowable Xe-133 equivalent concentration in the gaseous effluent, in μCi/cc.

f = the gaseous effluent flow from the tank, building, or vent, in ft^3/min.

SP = radiation monitor setpoint, in cpm.

CF = the Xe-133 equivalent monitor correlation factor, in μCi/cc/cpm.

bkg = the radiation monitor background reading, in cpm.

Equation 3.6 provides the methodology to calculate the maximum setpoint for releases from the Unit Vents (RIA-45 and RIA-46), Radwaste Facility (4RIA-45), and Interim Radwaste Building (RIA-53). The maximum setpoints are termed "High" setpoints.

In addition to High setpoints, Oconee uses "Alert" setpoints that are approximately 1/3 of the High setpoint for each specific release point. Alert setpoints provide early indication to plant operating staff of increased radioactivity.

3.0.2.1 UNIT VENTS SETPOINTS (RIA-45 and RIA-46)

Reactor Building purges from all 3 units are released via the applicable unit vent, either Unit 1, Unit 2, or Unit 3. Each of the 3 unit vents are monitored by a normal/low range RIA (RIA-45) and a high range RIA (RIA-46). In addition to Reactor Building purges, all other releases from the main plant, including the Auxiliary Building ventilation, Waste Gas Decay Tanks, and the Spent Fuel Pools are monitored by each unit's RIA-45 and RIA-46. However, RIA-45 and RIA-46 on each unit vent have release termination authority only for Reactor Building purge releases. Each unit's RIA-45 and RIA-46 will, when operable, activate Control Room alarms if the unit vent concentration exceeds the monitor's setpoint value. The setpoints for each unit's RIA-45 and RIA-46 are established on a "worst case" basis, with the upper bound normally set at 30 percent of the station release rate limit for noble gases in Xe-133 equivalent concentration as follows:

Recall Equation 3.6:

$$SP = \frac{C_{Xe-133}}{CF} + bkg$$

where:

$$C_{Xe-133} < \frac{500}{472 \times f \times K_{Xe-133} \times \chi/Q}$$

$$RIA-45_{unit\ \mathrm{vent,\,high}} = \frac{150}{472 \times 6.5\mathrm{E}+04 \times 294 \times 1.672\mathrm{E}-06 \times 7.09\mathrm{E}-08}$$

$$RIA-45_{unit\ \mathrm{vent,\,high}} \cong 1.40\mathrm{E}+05\ \mathrm{cpm} + \mathrm{bkg}$$

where:

150 = 30% of the 500 mrem/yr total body release rate limit.

6.5E+04 = Unit Vent flow rate with Reactor Building Purge off, ft^3/min.

1.672E-06 = Highest Semi-Elevated release point dispersion factor, sec/m^3.

7.09E-08 = RIA-45 Correlation Factor, µCi/ml/cpm.

All other factors were previously defined.

$$RIA-46_{unit\ \mathrm{vent,\,high}} = \frac{150}{472 \times 6.5\mathrm{E}+04 \times 294 \times 1.672\mathrm{E}-06 \times 3.17\mathrm{E}-04}$$

$$RIA-46_{unit\ \mathrm{vent,\,high}} \cong 31\ \mathrm{cpm} + \mathrm{bkg}$$

where:

3.17E-04 = RIA-46 Correlation Factor, µCi/ml/cpm.

All other factors were previously defined.

Alert setpoints are determined as follows:

$$RIA-45_{unit\ vent,\ alert} = RIA-45_{unit\ \mathrm{vent,\,high}} \times \frac{1}{3}$$

$$RIA-45_{unit\ \mathrm{vent,\,alert}} \cong 4.66\mathrm{E}+04\ \mathrm{cpm} + \mathrm{bkg}$$

$$RIA-46_{unit\ vent,\ alert} = RIA-46_{unit\ \mathrm{vent,\,high}} \times \frac{1}{3}$$

$$RIA-46_{unit\ \mathrm{vent,\,alert}} \cong 10\ \mathrm{cpm} + \mathrm{bkg}$$

1/3 = divisor to account for each of 3 unit vent release points, dimensionless.

All other factors were previously defined.

For instances in which the Reactor Building Purge is on, the High and Alert setpoints are multiplied by 0.65 (65,000 cfm/ (65,000 cfm + 35,000 cfm purge flow)).

3.0.2.2 RADWASTE FACILITY SETPOINTS (4RIA-45)

$$4RIA-45_{\text{high}} = \frac{25}{472 \times 1.297\text{E}+05 \times 294 \times 7.308\text{E}-06}$$

$$4RIA-45_{\text{high}} \cong 1.90\text{E - }04\ \mu\text{Ci/cc}$$

where:

25 = 5% of the 500 mrem/yr total body release rate limit.

1.297E+05 = Radwaste Facility Vent flow rate, ft^3/min.

7.308E-06 = Highest Ground-Level release point dispersion factor, sec/m^3.

All other factors were previously defined.

4RIA-45 reads in units of concentration, μCi/cc.

Alert setpoint is determined as follows:

$$4RIA-45_{alert} = 4RIA-45_{\text{high}} \times \frac{1}{3}$$

$$4RIA-45_{\text{alert}} \cong 6.33\text{E}-05\ \mu\text{Ci/cc} + \text{bkg}$$

All factors were previously defined.

3.0.2.3 INTERIM RADWASTE BUILDING SETPOINTS (RIA-53)

$$RIA-53_{\text{high}} = \frac{25}{472 \times 1.5\text{E}+04 \times 294 \times 7.308\text{E}-06 \times 3.4\text{E}-08}$$

$$RIA-53_{\text{high}} \cong 4.8\text{E}+04\,\text{cpm} + \text{bkg}$$

where:

25 = 5% of the 500 mrem/yr total body release rate limit.

1.5E+04 = Interim Radwaste Building Vent flow rate, ft^3/min.

7.308E-06 = Highest Ground-Level release point dispersion factor, sec/m^3.

3.4E-08 = RIA-53 Correlation Factor, µCi/ml/cpm.

All other factors were previously defined.

Alert setpoint is determined as follows:

$$RIA-53_{\text{alert}} = RIA-53_{\text{high}} \times \frac{1}{3}$$

$$RIA-53_{\text{alert}} \cong 1.6\text{E}+04\,\text{cpm} + \text{bkg}$$

All factors were previously defined.

3.0.2.4 WASTE GAS DECAY TANK SETPOINTS (RIA-37 and RIA-38)

For batch releases where the effluent can contain activity significantly above background, e.g., Waste Gas Decay Tank (WGDT), two additional monitors, RIA-37 and RIA-38 are used to establish setpoints for each WGDT batch released. RIA-37 is the normal/low range noble gas monitor, and RIA-38 is the high range noble gas monitor. The following setpoint methodology is used:

$$C_{Xe-133} = \sum_i \left(C_i \times Eq_i\right)$$

$$Expected\ Cpm = \frac{C_{Xe-133}}{CF_{Xe-133}} + bkg$$

$$RIA\text{-}\ 37\ and\ RIA\text{-}38\ Setpoint = \frac{C_{Xe-133}}{CF_{Xe-133}} \times 1.5 + bkg \qquad \text{Equation 3.7}$$

where:

$C_{Xe\text{-}133}$ = Xe-133 equivalent concentration of the WGDT to be released, in μCi/ml.

Eq_i = Xe-133 equivalence factor for each noble gas isotope, excluding tritium, to that of Xe-133 due to different beta energies and abundance. (See Table 3.0-2).

$CF_{Xe\text{-}133}$ = The expected RIA response to a given Xe-133 equivalent concentration, in μCi/ml/cpm. 1RIA-37 = 4.20E-08 μCi/ml/cpm, 3RIA-37 = 4.20E-08 μCi/ml/cpm, 1RIA-38 and 3RIA-38 = 1.34E-03 μCi/ml/cpm.

1.5 = An adjustment factor to account for expected minor variations in effluent concentration and RIA background.

bkg = The radiation monitor background reading, in cpm.

When the release pathway is from any Unit 1 WGDT (A-D), and the Xe-133 equivalent concentration is less than 2.8E-01 μCi/ml, the 1&2 RIA-38 setpoint is established at 313 cpm, and the 1&2 RIA-37 setpoint is calculated using Equation 3.7.

When the release pathway is from any Unit 1 WGDT (A-D), and the Xe-133 equivalent concentration is greater than 2.8E-01 μCi/ml, the 1&2 RIA-37 setpoint is established as offscale high, and the 1&2 RIA-38 setpoint is calculated using Equation 3.7.

When the release pathway is from any Unit 3 WGDT (A-C), and the Xe-133 equivalent concentration is less than 2.8E-01 μCi/ml, the 3 RIA-38 setpoint is established at 313 cpm, and the 3 RIA-37 setpoint is calculated using Equation 3.7.

When the release pathway is from any Unit 3 WGDT (A-C), and the Xe-133 equivalent concentration is greater than 2.8E-01 μCi/ml, the 3 RIA-37 setpoint is established as offscale high, and the 3 RIA-38 setpoint is calculated using Equation 3.7.

Low activity levels in the WGDTs can result in calculated setpoint values close to background. To prevent spurious alarms, if the 1&2 RIA-37 or 3 RIA-37 setpoint is calculated to be less than 2000 cpm, then the setpoint is established at 2000 cpm above background.

Table 3.0-2

Xe-133 Equivalents

Isotope	Equivalence Factor
Kr-83m	0
Kr-85m	2.48
Kr-85	2.56
Kr-87	2.93
Kr-88	2.78
Kr-89	2.93
Kr-90	2.93
Xe-131m	1.69
Xe-133m	1.99
Xe-133	1.0
Xe-135m	0.83
Xe-135	2.63
Xe-137	2.93
Xe-138	2.93
Ar-41	2.82
C-11	2.70

4.0 EFFLUENT DOSE MODELS

The effluent dose models used to show compliance with 10CFR50, Appendix I ALARA design objectives, 40CFR190 fuel cycle dose limits, and the dose values given in station SLCs are based on the methodology given in NUREG-0133 and Regulatory Guide 1.109. Dose contributions to the maximum individual shall be calculated at least every 31 days, quarterly, and annually using software which implements the ODCM methodology. The software is designed to automate many of the tasks required in the administration of effluent releases at Oconee and performs normal operation effluent dose assessment using NUREG-0133 and Regulatory Guide 1.109 methodology.

Station long-term historical and dose projection calculations are performed periodically to determine the station's status with respect to meeting annual ALARA goals specified in the Oconee SLCs. Such calculations are used to verify that adequate margin remains during a report period to allow normal station and radwaste system operation, including anticipated operational occurrences, for the remainder of the report period without exceeding applicable goals. Station 31-day dose projections that are used to assess the need to reduce effluent releases with the Gaseous Waste (GW) or Liquid Waste (LW) systems as required in the Oconee SLCs are estimated by the previous month's calculated dose results.

Fuel cycle dose calculations shall be performed annually or as required by special reports. Dose contributions shall be calculated using the software implementing the ODCM methodology.

4.0.1 LIQUID EFFLUENT DOSE MODEL FOR THE MAXIMUM EXPOSED INDIVIDUAL

Of the possible exposure pathways in the aquatic environment, only three contribute significantly to the total dose; these pathways are ingestion of potable water and aquatic foods, and direct exposure from radioactivity deposited on the shoreline. The dose contribution from these pathways for measured quantities of radioactive materials identified in liquid effluents released to unrestricted areas shall be calculated for the maximum exposed individual in each age group using the methodology provided in this section.

Liquid waste processed by the LW system can be released to the environment at Oconee from two liquid discharge points; (1) directly to the Keowee Tailrace through RIA-33 and (2) to the Chemical Treatment Pond #3 discharge point into the Keowee River (See Figure 2.0-1). Liquid dose calculations for the maximum exposed individual are performed and documented in the Annual Radioactive Effluent Release Report for both locations using the applicable activity release and dilution data for each liquid effluent release point. The primary liquid effluent discharge point for Oconee is to the Keowee Tailrace through RIA-33. In general, only low activity tritium releases (<1% station total) occur through the Chemical Treatment Pond #3 discharge point into the Keowee River. Dose calculations are performed for each of the two liquid discharge points for dose reporting purposes. The highest calculated dose from the two dose calculations is used to define the maximum individual dose from liquid releases at Oconee.

Liquid Dose Calculations

The following equation is used for calculating liquid dose to the maximum exposed individual from each of the two liquid effluent release points:

$$Dose_{oa} = \sum_{p} \sum_{i} \left(A_{oapi} \times C_i\right) \times \Delta t \times F_n \times \frac{1}{D_w}$$

$$F_n = \frac{f}{f + F} \times \sigma$$

Formula: adapted from NUREG-0133, pages 15-17. Where:	
$Dose_{oa}$	The cumulative dose commitment for organ o and age group a, from the liquid effluent for the total time period, Δt. (mrem)
A_{oapi}	Dose commitment factor for organ o, age group a, pathway p, and nuclide i (mrem/hr per μCi/ml). (See Appendices C through F for age group and pathway specific dose commitment factors).
C_i	The average concentration of nuclide i, in undiluted liquid effluent during the time period, Δt. (μCi/ml)
Δt	The length of time over which C_i and F_n are averaged for all liquid releases. (hr)
F_n	The near field average dilution factor for C_i during the period of interest, Δt. Includes the recirculation factor. (dimensionless)
f	Average liquid radwaste flow during the period of interest, Δt. (gpm)
F	Average dilution flow during the period of interest, Δt. (gpm) Normally this value is conservatively assumed to be 1.71E+04 gpm (38 cfs). A dilution flow of 76 cfs is more realistic since it includes bypass Keowee bypass leakage (19 cfs per Keowee Hydro unit, plus the Keowee Hydro Fire Protection liquid waste release mixing line whose flow rate is 38 cfs). No dilution credit is taken for the relatively short period of time during the year that the Keowee Hydro units are running.
σ	Recirculation factor. (dimensionless) *
D_w	Dilution factor from the near field area to the potable water intake; **= 30.0** for Oconee**. This factor applies to the potable water pathway only**. The nearest potable water intake to Oconee is located at the Anderson water intake approximately 31.5 miles from the site on a separate arm of Lake Hartwell. From a hydrology standpoint the Anderson water intake should not be significantly affected by liquid effluent discharges from Oconee. 30.0 is a conservatively small dilution factor based on environmental sample data.

* The recirculation factor accounts for the fraction of discharged water reused by the station. Liquid effluent discharge cannot be recirculated back into the Oconee station. Therefore, the recirculation factor is 1.0 at Oconee.

Derivation of Liquid Dose Commitment Factors (A_{oapi})

Potable Water

$$A_{oapi} = 1.14 \times 10^5 \times U_{aw} \times D_{aoi} \times e^{-\lambda_i t_p}$$

Formula: from NUREG-0133, page 16 and Regulatory Guide 1.109, page 1.109-12. Where:	
A_{oapi}	Dose commitment factor for organ o, age group a, pathway p, and nuclide i, (mrem/hr per µCi/ml). (See Appendices C through F for age group and pathway specific dose commitment factors).
1.14×10^5	Units conversion factor (pCi-yr-ml)/(µCi-hr-l).
U_{aw}	Water consumption rate in liters per year for age group a. From Table E-5, Regulatory Guide 1.109. Adult – 730 Teen – 510 Child – 510 Infant – 330
D_{aoi}	Dose factor for age group a, organ o, nuclide i, in mrem/pCi. From tables E-11 through E-14 of Regulatory Guide 1.109.
λ_i	Decay constant for nuclide i, in sec^{-1}.
t_p	Environmental transit time from release to receptor. Default = 4.32E+04 sec (12 hours). From Regulatory Guide 1.109, Table E-15.

Aquatic Foods

$$A_{oapi} = 1.14 \times 10^{5} \times U_{af} \times BF_{i} \times D_{aoi} \times e^{-\lambda_i t_p}$$

Formula: from NUREG-0133, page 16 and Regulatory Guide 1.109, page 1.109-12. Where:	
A_{oapi}	Dose commitment factor for organ o, age group a, pathway p, and nuclide i, (mrem/hr per µCi/ml). (See Appendices C through F for age group and pathway specific dose commitment factors).
1.14×10^5	Units conversion factor (pCi-yr-ml)/(µCi-hr-l).
U_{af}	Fish consumption rate for age group a (kg/yr). From Table E-5, Regulatory Guide 1.109. Adult – 21 Teen – 16 Child – 6.9 Infant – 0
BF_i	Bioaccumulation factor for nuclide i, in fish, in units of pCi/kg per pCi/liter. From Table A-1 of Regulatory Guide 1.109.
D_{aoi}	Dose factor for age group a, organ o, nuclide i, in mrem/pCi. From tables E-11 through E-14 of Regulatory Guide 1.109.
λ_i	Decay constant for nuclide i, in sec^{-1}.
t_p	Environmental transit time from release to receptor. Default = 8.64E+04 sec (1 day). From Regulatory Guide 1.109, Table E-15.

Shoreline Sediment

$$A_{oapi} = 1.14 \times 10^5 \times 100 \times DFG_{oi} \times w \times U_{as} \times T_i^{\frac{1}{2}} \times e^{-\lambda_i t_p} \times (1 - e^{-\lambda_i t_b})$$

Formula: adapted from Regulatory Guide 1.109, page 1.109-14.	
Where:	
A_{oapi}	Dose commitment factor for organ o, age group a, pathway p, and nuclide i, (mrem/hr per µCi/ml). (See Appendices C through F for age group and pathway specific dose commitment factors).
1.14×10^5	Units conversion factor (pCi-yr-ml)/(µCi-hr-l).
100	Proportionality constant used in the sediment radioactivity model, (liters/(m^2-day).
DFG_{oi}	Ground plane dose conversion factor for organ o, nuclide i (mrem/hr per pCi/m^2), from Table E-6 of Regulatory Guide 1.109.
w	Shoreline width factor. For Oconee = 0.2, from Table A-2, Regulatory Guide 1.109.
U_{as}	Shoreline exposure rate for age group a (hr/yr), From Table E-5, Regulatory Guide 1.109. Adult – 12 Teen – 67 Child – 14 Infant – 0
$T_i^{½}$	Nuclide half life for nuclide i, in days.
λ_i	Nuclide decay constant for nuclide i.
t_p	Average transit time to point of exposure (0 hours).
t_b	Sediment exposure time (15 years). Page 1.109-14.

4.0.2 GASEOUS EFFLUENT DOSE MODEL FOR THE MAXIMUM EXPOSED INDIVIDUAL

The dose contributions from measured quantities of radioactive materials identified in gaseous effluent released to unrestricted areas shall be calculated for the maximum gamma and beta air dose from noble gases, and for the maximum exposed individual from radioiodines, particulates, and others using the following equations:

Gaseous Dose Calculations

Noble Gas Dose Calculations

Gamma Air Dose

$$Dose_\gamma = 3.17\times10^{-8}\times\chi/Q\times\sum_i\left(M_i\times Q_i\right)$$

Formula: adapted from NUREG-0133, page 28.	
Where:	
$Dose_\gamma$	Gamma air dose for the time period of interest (mrad).
3.17×10^{-8}	Inverse number of seconds in year (year/seconds).
M_i	Gamma air dose factor due to gamma emissions for nuclide i (mrad/yr per μCi/m^3). (See Appendix A).
χ/Q	The highest calculated annual average relative concentration for any area at or beyond the site boundary (sec/m^3)*. (See Table 6.0-9).
Q_i	Activity for nuclide i released during the time period of interest (μCi).

Beta Air Dose

$$Dose_\beta = 3.17\times10^{-8}\times\chi/Q\times\sum_i\left(N_i\times Q_i\right)$$

Formula: adapted from NUREG-0133, page 28.	
Where:	
$Dose_\beta$	Beta air dose for the time period of interest (mrad).
3.17×10^{-8}	Inverse number of seconds in year (year/seconds).
N_i	Beta air dose factor due to beta emissions for nuclide i (mrad/yr per μCi/m^3). (See Appendix A).
χ/Q	The highest calculated annual average relative concentration for any area at or beyond the site boundary (sec/m^3)*. (See Table 6.0-9).
Q_i	Activity for nuclide i released during the time period of interest (μCi).

Iodine, Particulates, and H-3 Dose Organ Dose Calculation

$$Dose_{oa} = 3.17 \times 10^{-8} \times W \times \sum_{p} \sum_{i} \left(R_{oapi} \times Q_{i} \right)$$

<table>
<tr><td colspan="3">Formula: adapted from NUREG-0133, pages 29 & 30.</td></tr>
<tr><td colspan="3">Where:</td></tr>
<tr><td>$Dose_{oa}$</td><td colspan="2">The cumulative dose commitment to the total body or any organ o, for an individual of age group a (mrem).</td></tr>
<tr><td>3.17×10^{-8}</td><td colspan="2">Inverse number of seconds in year (year/seconds).</td></tr>
<tr><td>R_{oapi}</td><td colspan="2">Dose commitment factor for organ o, age group a, pathway p, and nuclide i. The units are based on whether a dispersion or deposition factor is used. When a χ/Q is used the units are mrem/yr per $\mu Ci/m^3$. When a D/Q is used the units are ($m^2 \cdot$ mrem/yr) per μCi/sec. (See Appendices G through J for age group and pathway specific dose commitment factors).</td></tr>
<tr><td rowspan="9">W*</td><td colspan="2">Dispersion (χ/Q) or deposition factor (D/Q). The factor used is based upon the pathway. Note: χ/Q is always used for tritium and C-14.</td></tr>
<tr><td>Pathway</td><td>Factor Used</td></tr>
<tr><td>Ground Plane Deposition</td><td>D/Q (m^{-2})</td></tr>
<tr><td>Inhalation</td><td>χ/Q (sec/m^3)</td></tr>
<tr><td>Vegetation</td><td>D/Q (m^{-2})</td></tr>
<tr><td>Grass/Cow/Milk</td><td>D/Q (m^{-2})</td></tr>
<tr><td>Grass/Goat/Milk</td><td>D/Q (m^{-2})</td></tr>
<tr><td>Grass/Cow/Meat</td><td>D/Q (m^{-2})</td></tr>
<tr><td>Grass/Goat/Meat</td><td>D/Q (m^{-2})</td></tr>
<tr><td>Q_i**</td><td colspan="2">Activity for nuclide i, released during the time period of interest (μCi).</td></tr>
</table>

* The dose from noble gases released from semi-elevated release points, e.g., unit vent, is calculated using the semi-elevated dispersion factors. The dose from noble gases released from ground level release points, e.g., Radwaste Facility vent, is calculated using the ground level dispersion factors. The total dose is the sum of the semi-elevated and ground level dose calculations. Maximum individual organ dose is determined by calculating the organ dose at each of the χ/Q and D/Q locations shown in Table 6.0-9 and Table 6.0-10 (128 locations) for both semi-elevated release points and ground level release points, summing the two at each location, and then choosing the dose from the maximum location. Dose is calculated only for those pathways (e.g., garden, milk animal, etc.) that actually exist at each location as determined by the land use census. As discussed in Oconee UFSAR Section 2.1.1.3, the boundary for establishing gaseous effluent release limits is the exclusion area boundary (EAB). The EAB is defined as a 1 mile radius from the station center.

** C-14 airborne activity released to the environment is estimated based on actual power generation as discussed in Regulatory Guide 1.21, Revision 2. A value of 9.4 Ci/GWe-yr is used along with actual power generation to estimate C-14 activity released to the environment via gaseous effluents from Oconee. 9.4 Ci/GWe-yr is based on information from "*Estimation of Carbon-14 in Nuclear Power Plant Gaseous Effluents",* EPRI, Palo Alto, CA: 2010. 1021106.

Derivations of Iodine, Particulate, and H-3 Dose Commitment Factors (R_{oapi})

Ground Plane Deposition Pathway

$$R_{oapi} = K'K''(SF)DFG_{oi}\left[\frac{(1-e^{-\lambda_i t})}{\lambda_i}\right]$$

Formula: from NUREG-0133, page 32.	
Where:	
R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for ground plane deposition pathway ($m^2 \cdot$mrem/yr per µCi/sec). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor pCi/µCi (10^6).
K"	Units conversion factor 8760 hr/year.
SF	Shielding factor (dimensionless) (0.7, from Regulatory Guide 1.109).
DFG_{oi}	Ground plane dose conversion factor for organ o, nuclide i (mrem/hr per pCi/m^2), from Table E-6 of Regulatory Guide 1.109.
λ_i	Nuclide decay constant for nuclide i (sec^{-1}).
t	Exposure time, 4.73×10^8 seconds (15 years).

Inhalation Pathway

$$R_{oapi} = K'(BR_a)(DFA_{oi})_a$$

Formula: from NUREG-0133, page 31.	
Where:	
R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for inhalation pathway (mrem/yr per µCi/m^3). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor pCi/µCi (10^6).
BR_a	Breathing rate for age group (m^3/yr), from Regulatory Guide 1.109: Adult – 8000 Teen – 8000 Child – 3700 Infant – 1400
$(DFA_{oi})_a$	Organ inhalation factor dose conversion factor for organ o, nuclide i, age group a (mrem/pCi), from Tables E-7 through E-10 of Regulatory Guide 1.109.

Vegetation

$$R_{oapi} = K'\left[\frac{(r)}{Y_v(\lambda_i + \lambda_w)}\right] \times (DFL_{oi})_a \times \left[U_a^L f_L e^{-\lambda_i t_L} + U_a^S f_g e^{-\lambda_i t_h}\right]$$

Formula: from NUREG-0133, page 35. Where:	
R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for vegetation pathway (m^2·mrem/yr per µCi/sec). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor pCi/µCi (10^6).
r	Fraction of deposited activity retained on vegetation, from Regulatory Guide 1.109. 1.0 for radioiodine. 0.2 for particulates.
Y_v	Vegetation areal density (kg/m^2) (2.0, from Regulatory Guide 1.109).
λ_i	Nuclide decay constant for nuclide i (sec^{-1}).
λ_w	Decay constant for removal of activity on leaf and plant surfaces by weathering (5.73×10^{-7} sec^{-1}, from NUREG-0133).
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Reg. Guide 1.109 (mrem/pCi).
U^L_a	Consumption rate of fresh leafy vegetation for age group a (kg/yr) (from Regulatory Guide 1.109). Adult – 64 Teen – 42 Child – 26 Infant – 0
f_L	Fraction of annual intake of fresh leafy vegetation grown locally (1.0, from NUREG-0133).
t_L	Average time between harvest of leafy vegetation and consumption (8.6×10^4 seconds, (1 day), from Regulatory Guide 1.109).
U^S_a	Consumption rate of stored vegetation for age group a (kg/yr) (from Regulatory Guide 1.109). Adult – 520 Teen – 630 Child – 520 Infant – 0
f_g	Fraction of annual intake of stored vegetation (0.76, from Regulatory Guide 1.109).
t_h	Average time between harvest of stored vegetation and consumption (5.18×10^6 seconds, (60 days), from Regulatory Guide 1.109).

Vegetation – Tritium

$$R_{oapi} = K' K''' \left[U_a^L f_L + U_a^S f_g \right] (DFL_{oi})_a \left[0.75(0.5/H) \right]$$

Formula: from NUREG-0133, page 36.	
Where:	
R_{oapi}	Dose commitment factor for organ o, age group a, for vegetation pathway and tritium (mrem/yr per µCi/m^3). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor pCi/µCi (10^6).
K'''	Units conversion factor gm/kg (10^3).
U^L_a	Consumption rate of fresh leafy vegetation for age group a (kg/yr) (from Regulatory Guide 1.109). Adult – 64 Teen – 42 Child – 26 Infant – 0
f_L	Fraction of annual intake of fresh leafy vegetation grown locally (1.0, from NUREG-0133).
U^S_a	Consumption rate of stored vegetation for age group a (kg/yr) (from Regulatory Guide 1.109). Adult – 520 Teen – 630 Child – 520 Infant – 0
f_g	Fraction of annual intake of stored vegetation (0.76, from Regulatory Guide 1.109).
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Regulatory Guide 1.109 (mrem/pCi).
0.75	Fraction of total feed that is water. (From NUREG-0133).
0.5	Ratio of specific activity of feed grass water to atmospheric water. (From NUREG-0133).
H	Absolute humidity of the atmosphere (8 gm/m^3, from Regulatory Guide 1.109).

Vegetation – Carbon-14

$$R_{oapi} = K'K'''\left[U_a^L f_L + U_a^S f_g\right](DFL_{oi})_a\left[0.11/0.16\right](p)(f_I)$$

Formula: from NUREG-0133, page 36 and Regulatory Guide 1.109, page 26.	
Where:	
R_{oapi}	Dose commitment factor for organ o, age group a, for vegetation pathway and carbon-14 (mrem/yr per μCi/m^3). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor pCi/μCi (10^6).
K'''	Units conversion factor gm/kg (10^3).
U^L_a	Consumption rate of fresh leafy vegetation for age group a (kg/yr) (from Regulatory Guide 1.109). Adult – 64 Teen – 42 Child – 26 Infant – 0
f_L	Fraction of annual intake of fresh leafy vegetation grown locally (1.0, from NUREG-0133).
U^S_a	Consumption rate of stored vegetation for age group a (kg/yr) (from Regulatory Guide 1.109). Adult – 520 Teen – 630 Child – 520 Infant – 0
f_g	Fraction of annual intake of stored vegetation (0.76, from Regulatory Guide 1.109).
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Regulatory Guide 1.109 (mrem/pCi).
0.11	Fraction of total plant mass that is natural carbon.
0.16	Concentration of natural carbon in the atmosphere (gm/m^3).
p	Ratio of the total annual C-14 release time to the total annual time during which photosynthesis occurs. This value is assumed to be 0.35, based on 70% of C-14 releases being from WGDTs, and 30% of C-14 releases being continuous from the unit vents (ref. IAEA Technical Reports Series no. 421, "Management of Waste Containing Tritium and Carbon-14", 2004; EPRI TR-1024827, "Carbon-14 Dose Calculation Methods at Nuclear Power Plants", 2012, Section 3.2.5).
f_I	The fraction of C-14 assumed to be in inorganic form (e.g., CO_2). Assumed to be 20%. Reference EPRI TR-105715, "Characterization of Carbon-14 Generated by the Nuclear Power Industry", Table 5-1.

Grass/Cow/Milk

$$R_{oapi} = K' \frac{Q_F (U_{ap})}{\lambda_i + \lambda_w} F_{mi} (r)(DFL_{oi})_a \left[\frac{f_p f_s}{Y_p} + \frac{(1 - f_p f_s) e^{-\lambda_i t_h}}{Y_s} \right] e^{-\lambda_i t_f}$$

Formula: from NUREG-0133, pages 32 & 33. Where:	
R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for grass/cow/milk pathway (m^2·mrem/yr per µCi/sec). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor pCi/µCi (10^6).
Q_F	Cow consumption rate (50 kg/day, from Regulatory Guide 1.109)
U_{ap}	Consumption rate of cow milk for age group a (liters/yr, from Regulatory Guide 1.109). Adult – 310 Teen – 400 Child – 330 Infant – 330
r	Fraction of deposited activity retained on cow's feed grass, (from Regulatory Guide 1.109). 1.0 for radioiodine. 0.2 for particulates.
Y_p	Agricultural productivity by unit area of pasture feed grass (0.7 kg/m^2, from Regulatory Guide 1.109).
Y_s	Agricultural productivity by unit area of stored feed (2.0 kg/m^2, from Regulatory Guide 1.109).
λ_i	Nuclide decay constant for nuclide i (sec^{-1}).
λ_w	Decay constant for removal of activity on leaf and plant surfaces by weathering (5.73×10^{-7} sec^{-1}, from NUREG-0133).
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Regulatory Guide 1.109 (mrem/pCi).
F_{mi}	Stable element transfer coefficient for nuclide i, in days/liter, from Table E-1 of Regulatory Guide 1.109 for cow milk.
f_p	Fraction of year that the cow is on pasture (1.0, from RG 1.109).
f_s	Fraction of the cow feed that is pasture grass while the cow is on pasture (1.0, from Regulatory Guide 1.109).
t_f	Transport time for pasture to cow, to milk, to receptor (1.73E+05 seconds, from Regulatory Guide 1.109).
t_h	Transport time from pasture, to harvest, to cow, to milk, to receptor (7.78e+06 seconds, from Regulatory Guide 1.109).

Grass/Cow/Milk – Tritium

$$R_{oapi} = K' \, K''' \, F_{mi} Q_f U_{ap} (DFL_{io})_a \left[0.75 (0.5 / H) \right]$$

Formula: from NUREG-0133, page 34.	
Where:	
R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for grass/cow/milk pathway (mrem/yr per µCi/m^3). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor pCi/µCi (10^6).
K'''	Units conversion factor gm/kg (10^3).
Q_F	Cow consumption rate (50 kg/day, from Regulatory Guide 1.109).
U_{ap}	Consumption rate of cow milk for age group a (liters/yr, from Regulatory Guide 1.109). Adult – 310 Teen – 400 Child – 330 Infant – 330
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Regulatory Guide 1.109 (mrem/pCi).
F_{mi}	Stable element transfer coefficient for nuclide i, in days/liter, from Table E-1 of Regulatory Guide 1.109 for cow milk.
0.75	Fraction of total feed that is water (from NUREG-0133).
0.5	Ratio of specific activity of feed grass water to atmospheric water (from NUREG-0133).
H	Absolute humidity of the atmosphere (8 gm/m^3, from Regulatory Guide 1.109).

Grass/Cow/Milk – Carbon-14

$$R_{oapi} = \mathrm{K'K'''}\,\mathrm{F}_{mi}\,\mathrm{Q}_F\,\mathrm{U}_{ap}\,(DFL_{oi})_a\left[0.11/0.16\right](p)(f_I)$$

Formula: from NUREG-0133, page 34 and Regulatory Guide 1.109, page 26.	
Where:	
R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for grass/cow/meat pathway (mrem/yr per μCi/m^3). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor pCi/μCi (10^6).
K'''	Units conversion factor gm/kg (10^3).
F_{mi}	Stable element transfer coefficient for nuclide i, in days/liter, from Table E-1 of Regulatory Guide 1.109 for cow milk.
Q_F	Cow consumption rate (50 kg/day, from Regulatory Guide 1.109).
U_{ap}	Consumption rate of cow milk for age group a (liters/yr) (from Regulatory Guide 1.109). Adult – 310 Teen – 400 Child – 330 Infant – 330
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Regulatory Guide 1.109 (mrem/pCi).
0.11	Fraction of total plant mass that is natural carbon.
0.16	Concentration of natural carbon in the atmosphere (gm/m^3).
p	Ratio of the total annual C-14 release time to the total annual time during which photosynthesis occurs. This value is assumed to be 0.35, based on 70% of C-14 releases being from WGDTs, and 30% of C-14 releases being continuous from the unit vents (ref. IAEA Technical Reports Series no. 421, "Management of Waste Containing Tritium and Carbon-14", 2004; EPRI TR-1024827, "Carbon-14 Dose Calculation Methods at Nuclear Power Plants", 2012, Section 3.2.5).
f_I	The fraction of C-14 assumed to be in inorganic form (e.g., CO_2). Assumed to be 20%. Reference EPRI TR-105715, "Characterization of Carbon-14 Generated by the Nuclear Power Industry", Table 5-1.

Grass/Goat/Milk

$$R_{oapi} = K' \frac{Q_F (U_{ap})}{\lambda_i + \lambda_w} F_{mi} (r)(DFL_{oi})_a \left[\frac{f_p f_s}{Y_p} + \frac{(1 - f_p f_s) e^{-\lambda_i t_h}}{Y_s} \right] e^{-\lambda_i t_f}$$

Formula: from NUREG-0133, pages 32 & 33. Where:	
R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for grass/goat/milk pathway (m^2·mrem/yr per μCi/sec). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor pCi/μCi (10^6).
Q_F	Goat consumption rate (6 kg/day, from Regulatory Guide 1.109).
U_{ap}	Consumption rate of goat milk for age group a (liters/yr, from Regulatory Guide 1.109). Adult – 310 Teen – 400 Child – 330 Infant – 330
r	Fraction of deposited activity retained on goat's feed grass, from Regulatory Guide 1.109. 1.0 for radioiodine. 0.2 for particulates.
Y_p	Agricultural productivity by unit area of pasture feed grass (0.7 kg/m^2, from Regulatory Guide 1.109).
Y_s	Agricultural productivity by unit area of stored feed (2.0 kg/m^2, from Regulatory Guide 1.109).
λ_i	Nuclide decay constant for nuclide i (sec^{-1}).
λ_w	Decay constant for removal of activity on leaf and plant surfaces by weathering (5.73×10^{-7} sec^{-1}, from NUREG-0133).
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Regulatory Guide 1.109 (mrem/pCi).
F_{mi}	Stable element transfer coefficient for nuclide i, in days/liter, from Table E-2 of Regulatory Guide 1.109 for goat milk.
f_p	Fraction of year that the goat is on pasture (1.0, from RG 1.109).
f_s	Fraction of the goat feed that is pasture grass while the goat is on pasture (1.0, from Regulatory Guide 1.109).
t_f	Transport time for pasture to goat, to milk, to receptor (1.73E+05 seconds, from Regulatory Guide 1.109).
t_h	Transport time from pasture, to harvest, to goat, to milk, to receptor (7.78e+06 seconds, from Regulatory Guide 1.109).

Grass/Goat/Milk – Tritium

$$R_{oapi} = K' K''' F_{mi} Q_f U_{ap} (DFL_{oi})_a \left[0.75(0.5/H)\right]$$

Formula: from NUREG-0133, page 34.	
Where:	
R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for grass/goat/milk pathway (mrem/yr per μCi/m^3). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor pCi/μCi (10^6).
K'''	Units conversion factor gm/kg (10^3).
Q_F	Goat consumption rate (6 kg/day, from Regulatory Guide 1.109).
U_{ap}	Consumption rate of goat milk for age group a (liters/yr, from Regulatory Guide 1.109). Adult – 310 Teen – 400 Child – 330 Infant – 330
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Regulatory Guide 1.109 (mrem/pCi).
F_{mi}	Stable element transfer coefficient for nuclide i, in days/liter, from Table E-2 of Regulatory Guide 1.109 for goat milk.
0.75	Fraction of total feed that is water (from NUREG-0133).
0.5	Ratio of specific activity of feed grass water to atmospheric water (from NUREG-0133).
H	Absolute humidity of the atmosphere (8 gm/m^3, from Regulatory Guide 1.109).

Grass/Goat/Milk – Carbon-14

$$R_{oapi} = \mathrm{K'K'''}\,\mathrm{F}_{mi}\,\mathrm{Q}_{F}\,\mathrm{U}_{ap}\,(DFL_{oi})_a \left[0.11/0.16\right](p)(f_I)$$

Formula: from NUREG-0133, page 34 and Regulatory Guide 1.109, page 26.	
Where:	
R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for grass/cow/meat pathway (mrem/yr per μCi/m^3). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor pCi/μCi (10^6).
K'''	Units conversion factor gm/kg (10^3).
F_{mi}	Stable element transfer coefficient for nuclide i, in days/liter, from Table E-2 of Regulatory Guide 1.109 for goat milk (0.10).
Q_F	Goat consumption rate (6 kg/day, from Regulatory Guide 1.109).
U_{ap}	Consumption rate of goat milk for age group a (liters/yr) (from Regulatory Guide 1.109). Adult – 310 Teen – 400 Child – 330 Infant – 330
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Regulatory Guide 1.109 (mrem/pCi).
0.11	Fraction of total plant mass that is natural carbon.
0.16	Concentration of natural carbon in the atmosphere (gm/m^3).
p	Ratio of the total annual C-14 release time to the total annual time during which photosynthesis occurs. This value is assumed to be 0.35, based on 70% of C-14 releases being from WGDTs, and 30% of C-14 releases being continuous from the unit vents (ref. IAEA Technical Reports Series no. 421, "Management of Waste Containing Tritium and Carbon-14", 2004; EPRI TR-1024827, "Carbon-14 Dose Calculation Methods at Nuclear Power Plants", 2012, Section 3.2.5).
f_I	The fraction of C-14 assumed to be in inorganic form (e.g., CO_2). Assumed to be 20%. Reference EPRI TR-105715, "Characterization of Carbon-14 Generated by the Nuclear Power Industry", Table 5-1.

Grass/Cow/Meat

$$R_{oapi} = K' \frac{Q_F(U_{ap})}{\lambda_i + \lambda_w} F_{fi}(r)(DFL_i)_a \left[\frac{f_p f_s}{Y_p} + \frac{(1 - f_p f_s)e^{-\lambda_i t_h}}{Y_s} \right] e^{-\lambda_i t_f}$$

Formula: from NUREG-0133, pages 34 & 35. Where:	
R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for grass/cow/meat pathway ($m^2 \cdot$mrem/yr per μCi/sec). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor pCi/μCi (10^6).
Q_F	Cow consumption rate (50 kg/day, from Regulatory Guide 1.109).
U_{ap}	Consumption rate of cow meat for age group a (kg/yr, from Regulatory Guide 1.109). Adult – 110 Teen – 65 Child – 41 Infant – 0
r	Fraction of deposited activity retained on cow's feed grass (from Regulatory Guide 1.109). 1.0 for radioiodine. 0.2 for particulates.
Y_p	Agricultural productivity by unit area of pasture feed grass (0.7 kg/m^2, from Regulatory Guide 1.109).
Y_s	Agricultural productivity by unit area of stored feed (2.0 kg/m^2, from Regulatory Guide 1.109).
λ_i	Nuclide decay constant for nuclide i (sec^{-1}).
λ_w	Decay constant for removal of activity on leaf and plant surfaces by weathering (5.73×10^{-7} sec^{-1}, from NUREG-0133).
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Regulatory Guide 1.109 (mrem/pCi).
F_{fi}	Stable element transfer coefficient for nuclide i, in days/kg, from Table E-1 of Regulatory Guide 1.109 for meat.
f_p	Fraction of year that the cow is on pasture (1.0, from RG 1.109).
f_s	Fraction of the cow feed that is pasture grass while the cow is on pasture (1.0, from Regulatory Guide 1.109).
t_f	Transport time from pasture to receptor (1.73E+06 seconds, from Regulatory Guide 1.109).
t_h	Transport time from crop field to receptor (7.78E+06 seconds, from Regulatory Guide 1.109).

Grass/Cow/Meat – Tritium

$$R_{oapi} = K' K''' F_{fi} Q_F U_{ap} (DFL_{oi})_a \left[0.75(0.5/H)\right]$$

Formula: from NUREG-0133, page 35.	
Where:	
R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for grass/cow/meat pathway (mrem/yr per μCi/m^3). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor pCi/μCi (10^6).
K'''	Units conversion factor gm/kg (10^3).
Q_F	Cow consumption rate (50 kg/day, from Regulatory Guide 1.109).
U_{ap}	Consumption rate of cow meat for age group a (kg/yr, from Regulatory Guide 1.109). Adult – 110 Teen – 65 Child – 41 Infant – 0
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Regulatory Guide 1.109 (mrem/pCi).
F_{fi}	Stable element transfer coefficient for nuclide i, in days/kg, from Table E-1 of Regulatory Guide 1.109 for meat.
0.75	Fraction of total feed that is water (from NUREG-0133).
0.5	Ratio of specific activity of feed grass water to atmospheric water (from NUREG-0133).
H	Absolute humidity of the atmosphere (8 gm/m^3, from Regulatory Guide 1.109).

Grass/Cow/Meat – Carbon-14

$$R_{oapi} = \mathrm{K'K'''}\,\mathrm{F}_{fi}\,\mathrm{Q}_{F}\,\mathrm{U}_{ap}\,(DFL_{oi})_a\left[0.11/0.16\right](p)(f_I)$$

Formula: from NUREG-0133, page 35 and Regulatory Guide 1.109, page 26.	
Where:	
R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for grass/cow/meat pathway (mrem/yr per µCi/m^3). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor pCi/µCi (10^6).
K'''	Units conversion factor gm/kg (10^3).
F_{fi}	Stable element transfer coefficient for nuclide i, in days/kg, from Table E-1 of Regulatory Guide 1.109 for meat.
Q_F	Cow consumption rate (50 kg/day, from Regulatory Guide 1.109).
U_{ap}	Consumption rate of cow meat for age group a (kg/yr) (from Regulatory Guide 1.109). Adult – 110 Teen – 65 Child – 41 Infant – 0
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Regulatory Guide 1.109 (mrem/pCi).
0.11	Fraction of total plant mass that is natural carbon.
0.16	Concentration of natural carbon in the atmosphere (gm/m^3).
p	Ratio of the total annual C-14 release time to the total annual time during which photosynthesis occurs. This value is assumed to be 0.35, based on 70% of C-14 releases being from WGDTs, and 30% of C-14 releases being continuous from the unit vents (ref. IAEA Technical Reports Series no. 421, "Management of Waste Containing Tritium and Carbon-14", 2004; EPRI TR-1024827, "Carbon-14 Dose Calculation Methods at Nuclear Power Plants", 2012, Section 3.2.5).
f_I	The fraction of C-14 assumed to be in inorganic form (e.g., CO_2). Assumed to be 20%. Reference EPRI TR-105715, "Characterization of Carbon-14 Generated by the Nuclear Power Industry", Table 5-1.

Grass/Goat/Meat

$$R_{oapi} = K' \frac{Q_F(U_{ap})}{\lambda_i + \lambda_w} F_{fi}(r)(DFL_i)_a \left[\frac{f_p f_s}{Y_p} + \frac{(1 - f_p f_s)e^{-\lambda_i t_h}}{Y_s} \right] e^{-\lambda_i t_f}$$

Formula: from NUREG-0133, pages 34 & 35. Where:	
R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for grass/goat/meat pathway ($m^2 \cdot$mrem/yr per µCi/sec). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor pCi/µCi (10^6).
Q_F	Goat consumption rate (6 kg/day, from Regulatory Guide 1.109).
U_{ap}	Consumption rate of goat meat for age group a (kg/yr, from Regulatory Guide 1.109). Adult – 110 Teen – 65 Child – 41 Infant – 0
r	Fraction of deposited activity retained on goat's feed grass (from Regulatory Guide 1.109). 1.0 for radioiodine. 0.2 for particulates.
Y_p	Agricultural productivity by unit area of pasture feed grass (0.7 kg/m^2, from Regulatory Guide 1.109).
Y_s	Agricultural productivity by unit area of stored feed (2.0 kg/m^2, from Regulatory Guide 1.109).
λ_i	Nuclide decay constant for nuclide i (sec^{-1}).
λ_w	Decay constant for removal of activity on leaf and plant surfaces by weathering (5.73×10^{-7} sec^{-1}, from NUREG-0133).
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Regulatory Guide 1.109 (mrem/pCi).
F_{fi}	Stable element transfer coefficient for nuclide i, in days/kg, from Table E-1 of Regulatory Guide 1.109 for meat.
f_p	Fraction of year that the goat is on pasture (1.0, from RG 1.109).
f_s	Fraction of the goat feed that is pasture grass while the goat is on pasture (1.0, from Regulatory Guide 1.109).
t_f	Transport time from pasture to receptor (1.73E+06 seconds, from Regulatory Guide 1.109).
t_h	Transport time from crop field to receptor (7.78E+06 seconds, from Regulatory Guide 1.109).

Grass/Goat/Meat – Tritium

$$R_{oapi} = K' \, K''' \, F_{fi} Q_F U_{ap} (DFL_{oi})_a \left[0.75(0.5/H) \right]$$

Formula: from NUREG-0133, page 35.	
Where:	
R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for grass/goat/meat pathway (mrem/yr per µCi/m^3). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor pCi/µCi (10^6).
K'''	Units conversion factor gm/kg (10^3).
Q_F	Goat consumption rate (6 kg/day, from Regulatory Guide 1.109).
U_{ap}	Consumption rate of goat meat for age group a (kg/yr, from Regulatory Guide 1.109). Adult – 110 Teen – 65 Child – 41 Infant – 0
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Regulatory Guide 1.109 (mrem/pCi).
F_{fi}	Stable element transfer coefficient for nuclide i, in days/kg, from Table E-1 of Regulatory Guide 1.109 for meat.
0.75	Fraction of total feed that is water (from NUREG-0133).
0.5	Ratio of specific activity of feed grass water to atmospheric water (from NUREG-0133).
H	Absolute humidity of the atmosphere (8 gm/m^3, from Regulatory Guide 1.109).

Grass/Goat/Meat – Carbon-14

$$R_{oapi} = \mathrm{K'K'''}\,\mathrm{F}_{fi}\,\mathrm{Q}_{F}\,\mathrm{U}_{ap}\,(DFL_{oi})_a\left[0.11/0.16\right](p)(f_I)$$

Formula: from NUREG-0133, page 35 and Regulatory Guide 1.109, page 26.	
Where:	
R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for grass/goat/meat pathway (mrem/yr per μCi/m^3). (See Appendices G through J for age group and pathway specific dose commitment factors).
K'	Units conversion factor pCi/μCi (10^6).
K'''	Units conversion factor gm/kg (10^3).
F_{fi}	Stable element transfer coefficient for nuclide i, in days/kg, from Table E-1 of Regulatory Guide 1.109 for meat.
Q_F	Goat consumption rate (6 kg/day, from Regulatory Guide 1.109).
U_{ap}	Consumption rate of goat meat for age group a (kg/yr) (from Regulatory Guide 1.109). Adult – 110 Teen – 65 Child – 41 Infant – 0
$(DFL_{oi})_a$	Ingestion dose conversion factor for nuclide i, organ o, and age group a, from Tables E-11 through E-14 of Regulatory Guide 1.109 (mrem/pCi).
0.11	Fraction of total plant mass that is natural carbon.
0.16	Concentration of natural carbon in the atmosphere (gm/m^3).
p	Ratio of the total annual C-14 release time to the total annual time during which photosynthesis occurs. This value is assumed to be 0.35, based on 70% of C-14 releases being from WGDTs, and 30% of C-14 releases being continuous from the unit vents (ref. IAEA Technical Reports Series no. 421, "Management of Waste Containing Tritium and Carbon-14", 2004; EPRI TR-1024827, "Carbon-14 Dose Calculation Methods at Nuclear Power Plants", 2012, Section 3.2.5).
f_I	The fraction of C-14 assumed to be in inorganic form (e.g., CO_2). Assumed to be 20%. Reference EPRI TR-105715, "Characterization of Carbon-14 Generated by the Nuclear Power Industry", Table 5-1.

4.0.3 DIRECT RADIATION

Direct radiation is that radiation from confined sources, and does not include any external component from radioactive effluents. The point kernel method has been used to calculate offsite dose rates from radioactive materials stored in the refueling water storage tanks, reactor makeup water storage tanks, and temporary onsite radwaste storage tanks. Dose calculations using this method performed for Oconee Nuclear Station indicate direct radiation doses are much less than 0.01 mrem/yr and, therefore, make a negligible contribution to individual dose.

Likewise, direct and air-scatter radiation dose contributions from the onsite Independent Spent Fuel Storage Installation (ISFSI) at Oconee have been calculated and documented in the Oconee 10CFR72.212 evaluation report. The results of the calculation demonstrate that the annual dose to any "real individual" beyond the controlled area boundary is below the 10CFR72.104(a) and 40CFR190.10(a) limit of 25 mrem from direct and skyshine radiation, and all other fuel cycle sources (e.g., effluent).

Direct radiation doses will not be calculated routinely.

4.0.4 EFFLUENT APPORTIONMENT

For the Oconee Nuclear Station the effluent releases are apportioned equally to each unit for each site as recommended by Section 3.1 of NUREG-0133, because the shared radwaste treatment systems at each site make it impractical to accurately ascribe releases to a specific reactor unit. For Annual Effluent Release Report purposes effluent releases are summed for each unit, and the maximum individual dose to the public is reported as a site total.

5.0 FUEL CYCLE CALCULATIONS

In accordance with the requirements of 40CFR190, the annual dose commitment to any member of the general public shall be calculated to assure that doses are limited to 25 millirems to the total body or any organ with the exception of the thyroid which is limited to 75 millirems. In accordance with the requirements of the Selected Licensee Commitments, the annual dose commitment shall also be calculated any time twice the specified quarterly dose limit of the Selected Licensee Commitments is exceeded; these annual dose commitments may not just be calculated for the calendar year.

The "Uranium fuel cycle" is defined in 40CFR Part 190.02(b) as:

"Uranium fuel cycle means the operations of milling or uranium ore, chemical conversion of uranium, isotopic enrichment of uranium, fabrication of uranium fuel, generation of electricity by a light-water-cooled nuclear power plant using uranium fuel, and reprocessing of spent uranium fuel, to the extent that these directly support the production of electrical power for public use utilizing nuclear energy, but excludes mining operations, operations at waste disposal sites, transportation of any radioactive material in support of these operations, and the reuse of recovered non-uranium special nuclear and by-product materials from the cycle."

Based on this definition of the fuel cycle and the information in 10CFR51, Table S-3, and Wash-1248, the radiological impact of the following operations has been assessed for Oconee Nuclear Station:

5.0.1 MILLING

No milling operations occur within fifty miles of the Oconee Nuclear Station.

5.0.2 CONVERSION

No uranium hexafluoride production occurs within fifty miles of the Oconee Nuclear Station.

5.0.3 ENRICHMENT

No uranium enrichment operations occur within fifty miles of the Oconee Nuclear Station.

5.0.4 FUEL FABRICATION

No fuel fabrication operations occur within fifty miles of the Oconee Nuclear Station.

5.0.5 NUCLEAR POWER PRODUCTION

The production of electricity for public use using light-water-cooled nuclear power stations results in increments of dose to individuals within fifty miles of any station due to liquid and gaseous effluent releases and direct radiation or skyshine. The increments of dose resulting from liquid and gaseous effluent releases will be calculated using the software implementing the ODCM methodology. The dose from direct radiation, skyshine, and radiation from the station storage facilities has been estimated using conservative assumptions (see Section 4.0.3).

In certain situations more than one nuclear power station site may contribute to the doses to be considered in making fuel cycle dose assessments in accordance with 40CFR190. However, since the Oconee nuclear station is located over 100 miles from the Catawba and McGuire nuclear stations, the relative dose contribution from each site to the other is insignificant, and can be ignored in assessing compliance with 40CFR190.

5.0.6 FUEL REPROCESSING

No fuel reprocessing operations occur within fifty miles of the Oconee Nuclear Station.

5.0.7 40CFR190 TOTAL DOSE DETERMINATION

To summarize, only dose increments from nuclear power production operations (Section 5.0.5) need be considered in calculations to demonstrate compliance with the requirements of 40CFR190. The fuel cycle dose assessments for Oconee Nuclear Station only include liquid and gaseous dose contributions from Oconee and dose from Oconee's ISFSI since no other uranium fuel cycle facility contributes significantly to Oconee's maximum exposed individual. For this dose assessment, the total body and maximum organ dose contributions to the maximum exposed individual from Oconee's liquid and gaseous effluents are estimated using the following calculations:

$$D_{wb}(T) = D_{wb}(l) + D_{wb}(g)$$

$$D_{mo}(T) = D_{mo}(l) + D_{mo}(g)$$

where:

$D_{wb}(T)$ = Total estimated fuel cycle whole body dose commitment resulting from the combined liquid and gaseous effluents of Oconee during the calendar year of interest, in mrem.

$D_{mo}(T)$ = Total estimated fuel cycle maximum organ dose commitment resulting from the combined liquid and gaseous effluents of Oconee during the calendar year of interest, in mrem.

6.0 ENVIRONMENTAL LOCATIONS

6.0.1 SITE DESCRIPTION AND SAMPLE LOCATIONS

Oconee Nuclear Station (ONS) is located in Oconee County, South Carolina, approximately 8 miles northeast of Seneca, South Carolina, on the shore of Lake Keowee. This lake was formed by damming the Keowee and Little Rivers in that location. Immediately to the south is the U.S. Government Hartwell Project. The Keowee Hydroelectric Plant near the station joins Lake Keowee and the upper reaches of Lake Hartwell. To the north, the Jocassee Hydroelectric Plant joins Lake Jocassee and Lake Keowee. Jocassee is a pumped storage plant. The ONS exclusion area boundary is 1 mile.

Table 6.0-1 and Table 6.0-2 define the sampling and TLD locations for the Oconee Radiological Monitoring Program. Figure 6.0-1, Figure 6.0.2, and Figure 6.0-3 illustrate these locations as compared to Oconee Nuclear Station.

6.0.2 LAND USE CENSUS DATA

The Annual Land Use Census, required by Selected Licensee Commitments, is performed to ensure that changes in the use of areas at or beyond the site boundary are identified, and that modifications to the Radiological Environmental Monitoring Program are made if required by changes in land use. This census satisfies the requirements of Section IV.B.3 of Appendix I to 10CFR50. The land use census identifies nearest pathways to the exclusion area boundary (EAB, ~ 1.0 mile) for each of the 16 meteorological sectors. Global Positioning System field measurements are taken as close as possible to the item of interest and are accurate to within 2-5 meters. Locations beyond the nearest pathway for each sector are assumed to contain that pathway for dose calculation purposes. For the 4.5-5.0 mile sector all pathways, i.e., residence, garden, milk animal (goat), and meat animal (cow), are assumed to exist for dose calculation purposes. Results are maintained on file and data reviewed in accordance with procedure AD-CP-ALL-0014, Land Use Census Evaluation.

TABLE 6.0-1

OCONEE RADIOLOGICAL MONITORING PROGRAM SAMPLING LOCATIONS

Table 6.0-1 Codes			
W	Weekly	SM	Semimonthly
BW	BiWeekly	Q	Quarterly
M	Monthly	SA	Semiannually
C	Control		

Site #	Location Description*	Air Rad. & Particulate	Surface Water	Drinking Water	Shoreline Sediment	Fish	Milk	Broadleaf Vegetation
060	Greenville Water Intake Road (3.23 NE)			M				
060 C **	Greenville Water Intake Road (2.28 NE)					SA		
061	J Anthony, Goat Milk (4.18 E)						SM	
062 C	Lake Keowee Hydro Intake (0.85 mi ENE)		M					
063	Lake Hartwell Hwy 183 Bridge (0.80 mi ESE) [000.7]					SA		
063.1	Lake Hartwell Hwy 183 (0.79 mi E)		M					
064 C	Seneca Municipal Water Supply (6.67 mi SSW) [004.1]			M				
066	Anderson Municipal Water Supply (18.9 mi SSE) [012]			M				
067	Lawrence Ramsey Bridge Hwy 27 (4.34 mi SSE) [005.2]				SA	SA		
068 C	High Falls County Park (1.82 mi W)				SA			
071 C	Clemson Dairy (10.2 mi SSE) [006.3]						SM	
077	Skimmer Wall (1.00 mi SW)	W						M
078.1	Recreation Site (0.53 mi WSW)	W						
079	Keowee Dam (0.56 mi NE)	W						M
085	Lake Services / Building B9125 (0.88 mi NNW)	W						
091	Holders Landing Road (2.09 miles S)				SA			
093 C	Clemson Operations Center (9.34 mi SE)	W						M

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

** Control for Fish Only

[ ] Location Numbers prior to 1984

TABLE 6.0-2

OCONEE RADIOLOGICAL MONITORING PROGRAM SAMPLING LOCATIONS

(TLD SITES)

Site #	Location*	Distance *	Sector	Site #	Location*	Distance *	Sector
020	Site boundary	0.16 miles	N	044	HWY 130 at Little River Dam	3.96 miles	S
021	Site boundary	0.25 miles	NNE	045	Terminus of HWY 588 at Crooked Creek	4.78 miles	SSW
022	Site boundary	0.53 miles	NE	046	HWY 188 at Crooked Creek	4.61 miles	SW
023	Site boundary	0.93 miles	ENE	048	JCT HWY 175 & 188	3.64 miles	W
024	Site boundary	0.81 miles	E	049	JCT HWY 201 & 92	3.60 miles	WNW
025	Site boundary	0.42 miles	ESE	050	Stamp Creek Landing, End of HWY 92	3.53 miles	NW
026	Site boundary	0.34 miles	SE	051	HWY 128, 1 mile N of HWY 130	4.64 miles	NNW
027	Site boundary	0.49 miles	SSE	052 SI	DPC Branch Office Site, Pickens	12.4 miles	ENE
028	Site boundary	0.46 miles	S	053 SI	DPC Branch Office Site, Liberty	11.7 miles	E
029	Site boundary	0.56 miles	SSW	054 SI	Post Office - HWY 93 Norris	8.60 miles	ESE
030	Site boundary	0.42 miles	SW	055 SI	Clemson Meteorology Plot	9.27 miles	SSE
031	Site boundary	0.27 miles	WSW	056 SI	Water Tower - Seneca	7.30 miles	SSW
076	Site boundary	0.19 miles	W	057 SI	Oconee Memorial Hospital	8.42 miles	SW
032	Site boundary	0.19 miles	WNW	058 C	Branch Rd Substation, Walhalla	9.39 miles	WSW
033	Site boundary	0.21 miles	WNW	077	Skimmer wall shared with air monitoring station	1.00 miles	SW
034	Site boundary	0.22 miles	NW	078.1	ONS Recreation Site shared with air monitoring station	0.53 miles	WSW
035	Site boundary	0.17 miles	NNW	085	Lake Services Bldg 9125 shared with air monitoring location	0.88 miles	NNW
036	Mile Creek Landing	4.18 miles	N	086	Lake Keowee Service Rd at Boat Landing	0.83 miles	NW
037	Keowee Church, HWY 327	4.85 miles	NNE	087	End of Waterfall Rd	1.33 miles	WNW
038	Convenience Mart, JCT HWY 183 & 133	4.24 miles	NE	088	Doug Hollow Rd / Transmission Tower	1.00 miles	SSW
039	HWY 133, 1 mile East of JCT HWY 183 & 133	4.02 miles	ENE	089	Intersection Hwy 130 & Keowee River Rd	1.19 miles	S
040	Microwave Tower, Six Mile	4.74 miles	E	090	Crescent Resources, Keowee River Rd at Beaver Dam	0.79 miles	SE
041	JCT HWY 101 & 133	4.25 miles	ESE	092	Hilton Circle stop sign HWY 188	3.62 miles	WSW
042	Lawrence Chapel Church, HWY 133	4.93 miles	SE	093 C	Clemson Operations Center	9.34 miles	SE
043	HWY 291 at Issaqueena Park	4.09 miles	SSE				

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

TABLE 6.0-3

Land Use Census Results

Deleted in ODCM Revision 58.

Figure 6.0-1 Sampling Locations Map (Site Boundary)

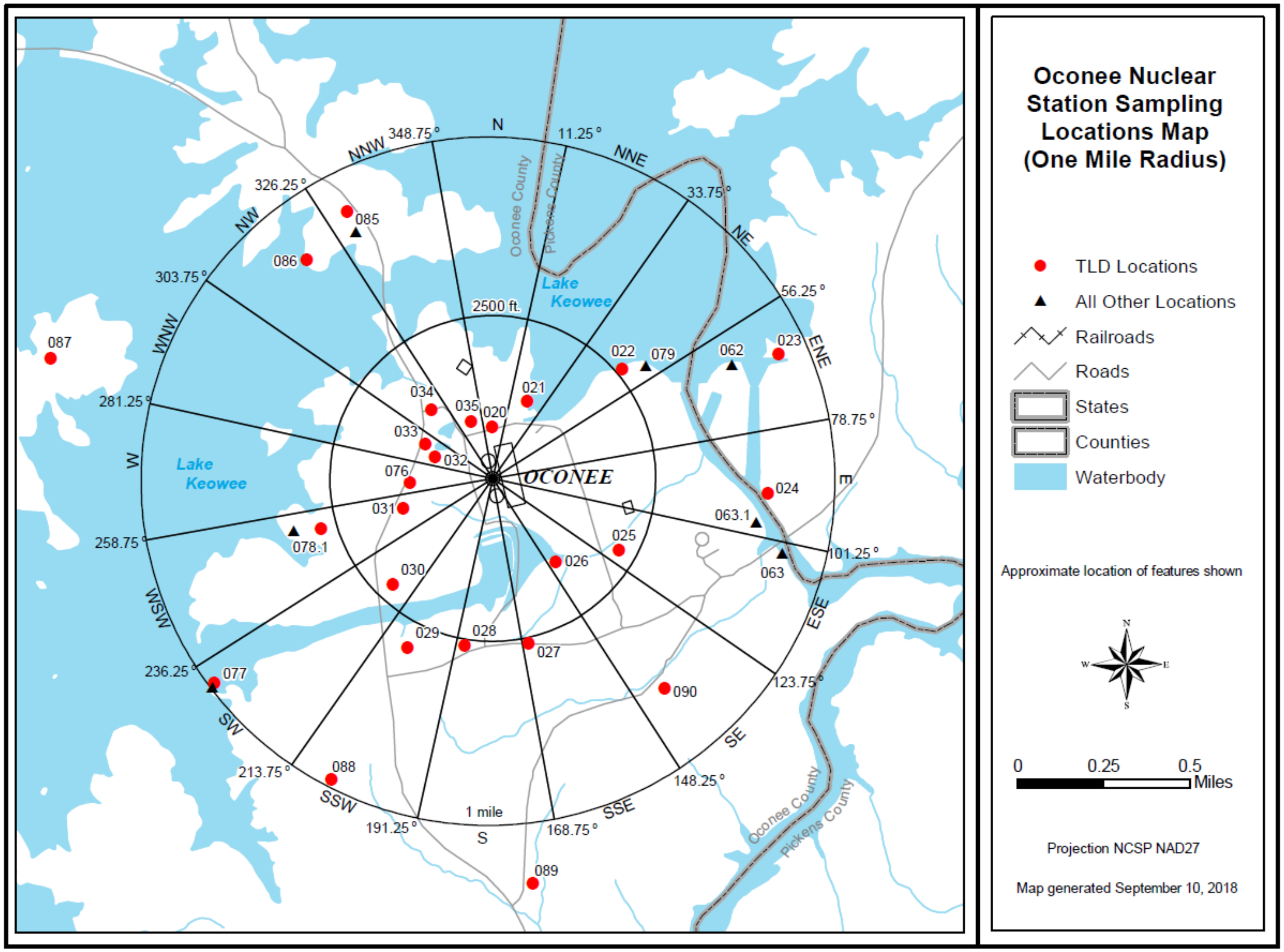


Figure 6.0-2 Sampling Locations Map (Ten Mile Radius)

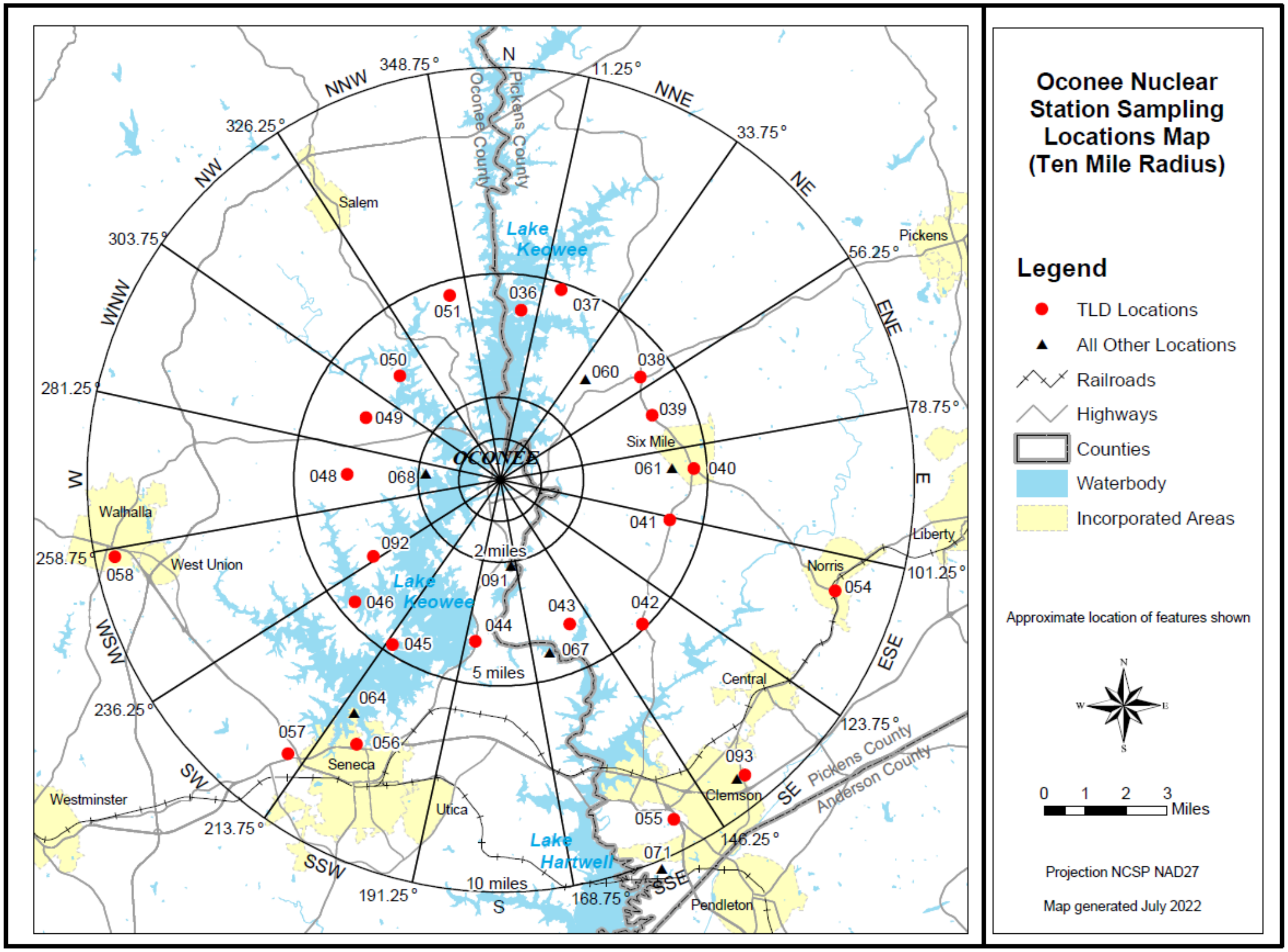
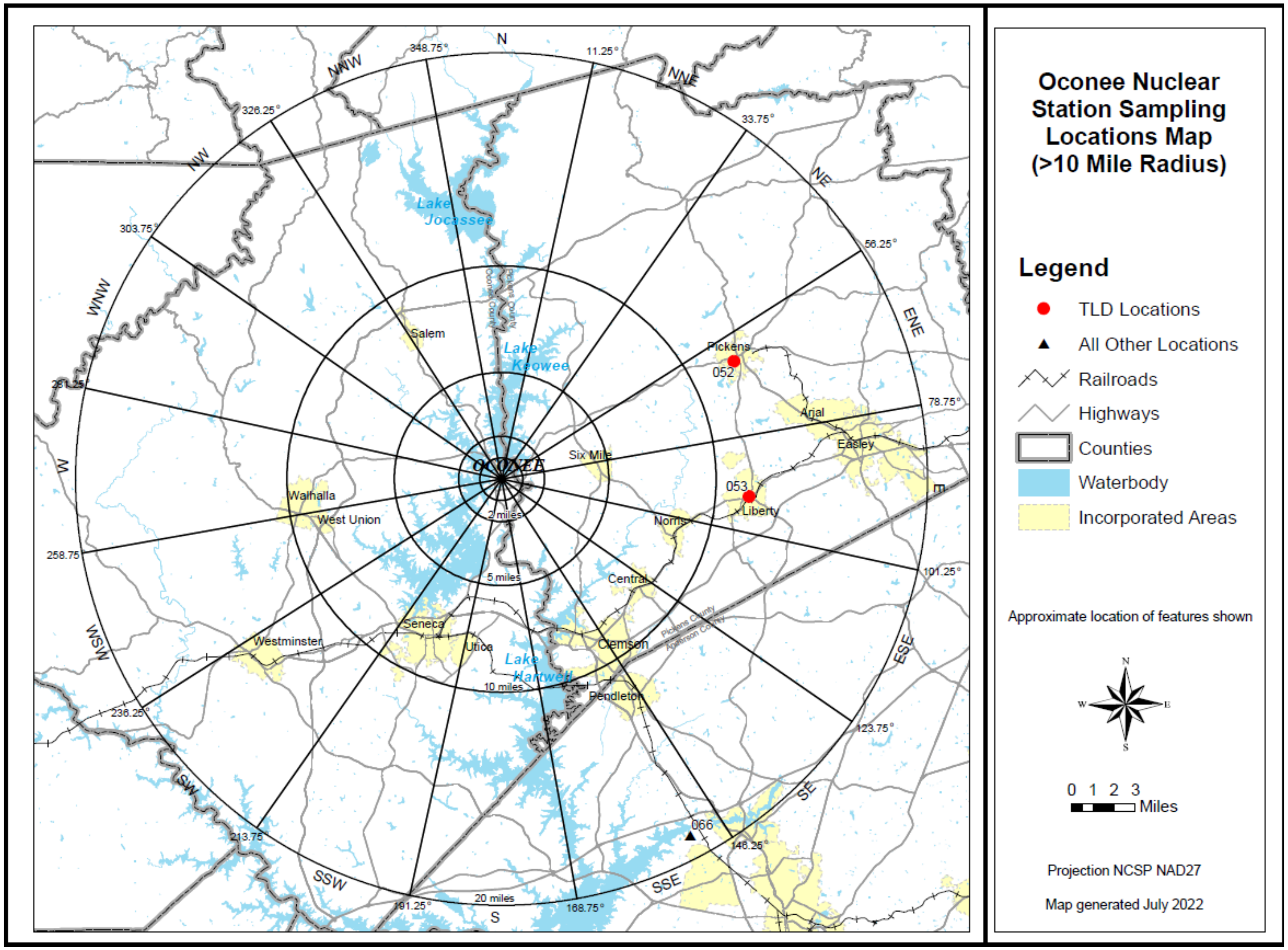


Figure 6.0-3 Sampling Locations Map (>Ten Mile Radius)



September 2022

6.0.3 OCONEE METEOROLOGY: RELATIVE AIR CONCENTRATIONS AND DEPOSITION

Calculations of annually averaged air concentrations and deposition values from routine releases provide the air dispersion and deposition factors needed for dose assessment. The methodology is based upon Regulatory Guide 1.111, as implemented by the NRC's computer model "XOQDOQ: Computer Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations," NUREG/CR-2919, PNL-4380, September 1982.

Five years of hourly meteorological data from the onsite instruments are processed into a representative joint frequency distribution of winds and atmospheric stability for input into the XOQDOQ model (Version 2.0). Thus, the air dispersion and deposition factors (χ/Q and D/Q) output by the model are based on a five-year climatology for the site.

6.0.3.1 XOQDOQ METHODOLOGY AND ASSUMPTIONS

A continuous, routine release (non-purge) is simulated from each unit vent. The unit vent release type is categorized as semi-elevated, being elevated approximately 92% of the time and being at ground-level approximately 8% of the time. This is based on RG 1.111 criteria, with the ratio (i.e. 3.64) of the average exit velocity (11.39 m/s) to the mean wind speed at the 60 m release height (3.13 m/s). To account for all release pathways, Oconee is modeled as both a totally "ground-level" release and as a "mixed-mode" release, with two model runs of XOQDOQ.

Surrounding terrain heights are not input for ground-level releases, but are used for the elevated portion of mixed-mode releases. The locale consists of rolling terrain, so the default open terrain recirculation factor is applied in XOQDOQ [KOPT(8)=1]. This correction factor is recommended in RG 1.111 to adjust the straight-line airflow of the model for spatial and temporal variations that are produced by large scale weather patterns, or other non-linear flow conditions at local and regional scales.

In order for XOQDOQ to treat the plume as a ground-level release, the exit velocity and the inside diameter of the unit vent must be input as zero. The heat emission rate of each vent is also assumed to be zero, as recommended by the model. A release height of 10 m is assumed for the ground-level release, with actual plant grade of 796 ft msl. Using the building height (58 m) and minimum cross-sectional area of the containment building (2296 m^2), XOQDOQ applies a building wake correction to the relative air concentrations.

For the mixed-mode release, the exit velocities (11.1, 11.3, and 11.7 m/s for U1-U3, respectively) and inside diameters (1.8 m) of the unit vents are input to the XOQDOQ model for each vent. The heat emission rate of each vent is still assumed to be zero, as in the ground-level release. Plant grade elevation is now input as zero, however, to properly utilize the input terrain heights above yard grade elevation (Table 6.0-4). The height of the vent (60.7 m) above plant grade is used to determine the plume centerline height.

Table 6.0-4

Terrain Heights Above ONS Yard Grade Elevation (m)

Distance:	0.5 mile	1 mile	1.5 miles	2.0 miles	2.5 miles	3.0 miles	3.5 miles	4.0 miles	4.5 miles	5.0 miles
S	29	38	38	38	38	38	50	50	50	50
SSW	32	44	50	50	50	50	50	50	50	50
SW	38	44	44	44	50	50	50	50	50	50
WSW	44	44	44	44	44	44	44	48	48	57
W	48	48	48	48	48	55	58	73	73	73
WNW	29	29	29	38	65	65	71	71	77	80
NW	30	30	30	48	50	68	69	69	71	71
NNW	30	30	30	48	50	68	69	69	71	71
N	29	30	30	30	30	30	62	62	62	74
NNE	24	24	35	35	53	53	82	82	82	82
NE	7	13	35	44	44	50	78	88	99	100
ENE	4	23	35	38	53	62	74	80	99	100
E	1	24	24	24	57	68	68	74	84	84
ESE	1	1	13	35	62	62	62	65	71	71
SE	7	20	20	44	67	67	67	67	67	67
SSE	7	38	38	38	47	62	62	62	62	62

Calculations of relative air concentrations and deposition are made for gridded receptor distances per sector. The "no decay" assumption is used in the XOQDOQ model.

6.0.3.2 METEOROLOGICAL DATA

Five years (1988-1992) of hourly, onsite meteorological data are used to produce the joint frequency distributions of wind speed and direction per stability class. The 10 m level winds are used. It is these joint frequency distributions which are input to the XOQDOQ model. XOQDOQ extrapolates the 10 m wind speed to the release height during the elevated portion of mixed-mode releases. Hours of calm winds are distributed by direction with the same frequency as the lowest "noncalm" wind speed class [KOPT(1)=1]. Thus, wind speed classes are established so that the lowest wind speed class is the starting threshold of the anemometer (i.e. the "calm" wind speed class). The largest wind speed class has the upper bound of (5 m/s + max hourly wind speed). Stability classes (A-G) are based on the vertical temperature gradient, measured by the hourly averaged delta-T variable.

6.0.3.3 ANNUAL XOQDOQ COMPARISON TO THE ODCM

Each year, the prevailing winds and stability class frequencies for ONS are compared to the 5-year period (1988-1992) upon which the χ/Q and D/Q calculations have been made. The 5-year climatology is summarized in Table 6.0-5 and Table 6.0-6 below. Since the comparison is being made to a 5-year climatology, significant differences should not occur in the meteorological variables of concern (i.e. winds and delta-T). The meteorological comparison serves to verify this assumption.

Table 6.0-5
ONS Atmospheric Stability Frequency (1988-1992)

	A	B	C	D	E	F	G
Frequency (%)	8.8	5.6	6.2	40.4	32.5	5.0	1.4

Table 6.0-6
ONS Frequency of Wind Direction (From) and Speed (1988-1992)

Sector	Wind Direction Frequency (%)	Wind Speed Class (m/s)	Wind Speed Frequency (%)
N	5.3	CALM	1.0
NNE	5.2	0.45 - 0.74 m/s	4.1
NE	9.0	0.75 - 0.99 m/s	10.3
ENE	8.2	1.00 - 1.24 m/s	10.9
E	5.2	1.25 - 1.49 m/s	13.4
ESE	3.1	1.50 - 1.99 m/s	18.3
SE	3.1	2.00 - 2.99 m/s	22.2
SSE	3.5	3.00 - 3.99 m/s	10.5
S	3.6	4.00 - 4.99 m/s	4.9
SSW	8.6	5.00 - 5.99 m/s	2.0
SW	11.8	6.00 - 7.99 m/s	1.5
WSW	7.5	8.00 - 9.99 m/s	0.3
W	5.2	> 9.99 m/s	0.5
WNW	7.0		
NW	7.3		
NNW	6.4		

The joint frequency distributions of wind speed and direction versus atmospheric stability class are also determined from the annual data to provide input to the XOQDOQ model. Modeled χ/Q and D/Q values for the 1.0 mile Exclusion Area Boundary at ONS are compared to the maximum of the (1988-1992) χ/Q and D/Q values from all sectors. If the newly calculated annual dispersion and deposition values do not result in a significant increase in the calculated offsite dose relative to the 10CFR50, Appendix I dose objectives then the 5-year χ/Q and D/Q values used in the Annual Radiological Effluent Release Report (ARERR) are not revised. An increase in calculated offsite dose that is greater than five percent of the 10CFR50, Appendix I dose objectives would be considered significant enough to warrant a change in the χ/Q and D/Q values used in the ARERR. If an increasing trend in the annual χ/Q and D/Q values compared to the 5-year values is noted then a revised set of 5-year χ/Q and D/Q values will be generated. These limiting values are listed in Table 6.0-7. The entire χ/Q and D/Q list based on directional sector and distance is given in Table 6.0-9 and Table 6.0-10.

Table 6.0-7
ONS Maximum χ/Q and D/Q Values (1988-1992)

	(χ/Q,s/m^3) (D/Q,1/m^2)	**Distance**	**Sector**
Ground-level Release: Maximum χ/Q	7.308E-06	1 mile EAB	SE
Ground-level Release: Maximum D/Q	2.259E-08	1 mile EAB	NE
Mixed-mode Release: Maximum χ/Q	1.672E-06	1 mile EAB	SW
Mixed-mode Release: Maximum D/Q	1.295E-08	1 mile EAB	NE

Note:
The Oconee meteorological instruments were relocated from the 46 m microwave tower to a new 60 m onsite meteorological tower in April 1988. The 60 m tower became operational at 1700 hours on April 23, 1988. Therefore, determination of atmospheric stability should use the 36 m separation criteria for the period February 24, 1977-April 22, 1988 shown in Table 6.0-8**.** Data starting on April 23, 1988 or later should use the 50 m separation criteria.

Table 6.0-8
ONS Delta-T Ranges per Vertical Separation Distances

Stability Class	**36m separation Delta-T (between 46m-10m levels) FEB 24, 1977 - APRIL 18, 1988 (4/18/88 ending hour 1430)**	**50m separation Delta-T (between 60m-10m levels) Starting at hour 1700 on April 23, 1988.**
A	dT ≤ -0.68	dT ≤ -0.95
B	-0.68 < dT ≤ -0.61	-0.95 < dT ≤ -0.85
C	-0.61 < dT ≤ -0.54	-0.85 < dT ≤ -0.75
D	-0.54 < dT ≤ -0.18	-0.75 < dT ≤ -0.25
E	-0.18 < dT ≤ 0.54	-0.25 < dT ≤ 0.75
F	0.54 < dT ≤ 1.44	0.75 < dT ≤ 2.00
G	1.44 < dT	2.00 < dT

Table 6.0-9
(page 1 of 2)

Oconee Semi-Elevated χ/Q Average Values (1988-1992)
(sec/m^3)

Sector	1.0-1.5*	1.5-2.0	2.0-2.5	2.5-3.0	3.0-3.5	3.5-4.0	4.0-4.5	4.5-5.0
N	5.220E-07	2.650E-07	1.594E-07	1.069E-07	7.719E-08	7.321E-08	5.665E-08	4.542E-08
NNE	8.379E-07	4.734E-07	2.690E-07	2.003E-07	1.385E-07	1.091E-07	8.379E-08	6.676E-08
NE	9.503E-07	6.350E-07	3.962E-07	2.535E-07	1.847E-07	1.497E-07	1.157E-07	9.246E-08
ENE	8.116E-07	4.856E-07	2.919E-07	2.196E-07	1.619E-07	1.239E-07	9.609E-08	7.720E-08
E	5.950E-07	3.202E-07	2.015E-07	2.270E-07	1.745E-07	1.292E-07	1.024E-07	8.308E-08
ESE	4.531E-07	3.300E-07	3.623E-07	4.020E-07	2.822E-07	2.109E-07	1.688E-07	1.405E-07
SE	7.505E-07	4.573E-07	5.490E-07	5.110E-07	3.560E-07	2.648E-07	2.063E-07	1.665E-07
SSE	1.419E-06	7.428E-07	4.527E-07	3.489E-07	2.866E-07	2.131E-07	1.659E-07	1.337E-07
S	1.170E-06	6.099E-07	3.701E-07	2.496E-07	1.810E-07	1.552E-07	1.218E-07	9.867E-08
SSW	1.214E-06	6.327E-07	3.564E-07	2.301E-07	1.621E-07	1.213E-07	9.481E-08	7.660E-08
SW	1.672E-06	7.285E-07	4.057E-07	2.720E-07	1.891E-07	1.400E-07	1.085E-07	8.708E-08
WSW	1.558E-06	6.820E-07	3.804E-07	2.438E-07	1.708E-07	1.271E-07	1.010E-07	8.114E-08
W	1.193E-06	5.214E-07	2.909E-07	1.867E-07	1.372E-07	1.032E-07	8.326E-08	6.654E-08
WNW	4.658E-07	2.480E-07	1.760E-07	1.482E-07	1.024E-07	7.695E-08	5.943E-08	4.796E-08
NW	4.831E-07	2.524E-07	1.965E-07	1.291E-07	9.959E-08	7.356E-08	5.682E-08	4.566E-08
NNW	5.375E-07	2.769E-07	2.128E-07	1.394E-07	1.072E-07	7.913E-08	6.110E-08	4.907E-08

* Units are in miles from the station. As discussed in Oconee UFSAR Section 2.1.1.3, the boundary for establishing gaseous effluent release limits is the exclusion area boundary (EAB). The EAB is at a radius of 1.0 mile from the station center. Each χ/Q value is calculated at the closest location for the sector, e.g., 1.672E-06 sec/m^3 is the χ/Q value at 1.0 mile (SW) from the station.

Table 6.0-9
(page 2 of 2)

Oconee Semi-Elevated D/Q Average Values (1988-1992)
(m^{-2})

Sector	1.0-1.5*	1.5-2.0	2.0-2.5	2.5-3.0	3.0-3.5	3.5-4.0	4.0-4.5	4.5-5.0
N	2.890E-09	1.184E-09	6.225E-10	3.812E-10	2.586E-10	3.380E-10	2.510E-10	1.943E-10
NNE	9.113E-09	3.989E-09	2.013E-09	1.248E-09	8.235E-10	8.997E-10	6.667E-10	5.138E-10
NE	1.295E-08	5.666E-09	2.919E-09	1.729E-09	1.145E-09	1.224E-09	9.140E-10	7.067E-10
ENE	7.899E-09	3.385E-09	1.756E-09	1.095E-09	9.819E-10	7.671E-10	5.749E-10	4.466E-10
E	4.454E-09	1.775E-09	9.252E-10	7.164E-10	7.491E-10	5.267E-10	3.981E-10	3.125E-10
ESE	4.361E-09	1.838E-09	1.086E-09	1.322E-09	8.696E-10	6.161E-10	5.153E-10	4.139E-10
SE	3.397E-09	1.385E-09	8.341E-10	1.649E-09	1.080E-09	7.595E-10	5.629E-10	4.340E-10
SSE	3.333E-09	1.323E-09	6.920E-10	4.404E-10	7.307E-10	5.202E-10	3.922E-10	3.091E-10
S	3.192E-09	1.256E-09	6.530E-10	4.020E-10	2.788E-10	2.177E-10	1.759E-10	1.501E-10
SSW	5.190E-09	1.972E-09	9.899E-10	5.895E-10	3.928E-10	2.842E-10	2.192E-10	1.778E-10
SW	1.205E-08	4.399E-09	2.193E-09	1.299E-09	8.521E-10	6.028E-10	4.518E-10	3.546E-10
WSW	1.047E-08	3.824E-09	1.908E-09	1.127E-09	7.422E-10	5.277E-10	3.980E-10	3.145E-10
W	5.577E-09	2.044E-09	1.025E-09	6.094E-10	4.134E-10	3.405E-10	3.962E-10	3.052E-10
WNW	2.185E-09	9.042E-10	5.220E-10	6.464E-10	4.227E-10	3.188E-10	2.360E-10	1.868E-10
NW	2.097E-09	8.759E-10	5.225E-10	3.196E-10	4.521E-10	3.178E-10	2.353E-10	1.812E-10
NNW	2.461E-09	1.028E-09	6.219E-10	3.765E-10	5.128E-10	3.604E-10	2.667E-10	2.054E-10

* Units are in miles from the station. As discussed in Oconee UFSAR Section 2.1.1.3, the boundary for establishing gaseous effluent release limits is the exclusion area boundary (EAB). The EAB is defined as a 1 mile radius from the station center. Each D/Q value is calculated at the closest location for the sector, e.g., 1.205E-08 m^{-2} is the D/Q value at 1.0 mile (SW) from the station.

Table 6.0-10
(page 1 of 2)

Oconee Ground Level χ/Q Average Values (1988-1992)
(sec/m^3)

Sector	1.0-1.5*	1.5-2.0	2.0-2.5	2.5-3.0	3.0-3.5	3.5-4.0	4.0-4.5	4.5-5.0
N	2.115E-06	8.389E-07	4.495E-07	2.822E-07	1.952E-07	1.443E-07	1.117E-07	8.961E-08
NNE	2.898E-06	1.137E-06	6.047E-07	3.775E-07	2.602E-07	1.916E-07	1.480E-07	1.184E-07
NE	3.886E-06	1.529E-06	8.158E-07	5.108E-07	3.529E-07	2.604E-07	2.015E-07	1.616E-07
ENE	3.226E-06	1.277E-06	6.848E-07	4.305E-07	2.983E-07	2.207E-07	1.711E-07	1.374E-07
E	3.522E-06	1.410E-06	7.658E-07	4.866E-07	3.400E-07	2.534E-07	1.977E-07	1.596E-07
ESE	5.964E-06	2.407E-06	1.321E-06	8.459E-07	5.950E-07	4.457E-07	3.493E-07	2.832E-07
SE	7.308E-06	2.972E-06	1.631E-06	1.044E-06	7.342E-07	5.497E-07	4.307E-07	3.490E-07
SSE	6.604E-06	2.657E-06	1.440E-06	9.117E-07	6.354E-07	4.723E-07	3.676E-07	2.962E-07
S	5.278E-06	2.121E-06	1.146E-06	7.237E-07	5.032E-07	3.734E-07	2.901E-07	2.335E-07
SSW	3.986E-06	1.589E-06	8.536E-07	5.370E-07	3.721E-07	2.753E-07	2.135E-07	1.714E-07
SW	4.108E-06	1.620E-06	8.628E-07	5.390E-07	3.715E-07	2.735E-07	2.112E-07	1.689E-07
WSW	3.804E-06	1.503E-06	8.018E-07	5.015E-07	3.460E-07	2.549E-07	1.970E-07	1.577E-07
W	2.978E-06	1.186E-06	6.361E-07	3.995E-07	2.765E-07	2.043E-07	1.583E-07	1.270E-07
WNW	2.201E-06	8.791E-07	4.726E-07	2.974E-07	2.062E-07	1.526E-07	1.183E-07	9.502E-08
NW	2.104E-06	8.385E-07	4.499E-07	2.826E-07	1.957E-07	1.447E-07	1.121E-07	8.991E-08
NNW	2.221E-06	8.860E-07	4.755E-07	2.988E-07	2.069E-07	1.529E-07	1.185E-07	9.508E-08

* Units are in miles from the station. As discussed in Oconee UFSAR Section 2.1.1.3, the boundary for establishing gaseous effluent release limits is the exclusion area boundary (EAB). The EAB is defined as a 1 mile radius from the station center. Each χ/Q value is calculated at the closest location for the sector, e.g., 4.108E-06 sec/m^3 is the χ/Q value at 1.0 mile (SW) from the station.

Table 6.0-10
(page 2 of 2)

Oconee Ground Level D/Q Average Values (1988-1992)
(m^{-2})

Sector	1.0-1.5*	1.5-2.0	2.0-2.5	2.5-3.0	3.0-3.5	3.5-4.0	4.0-4.5	4.5-5.0
N	6.916E-09	2.484E-09	1.232E-09	7.255E-10	4.750E-10	3.342E-10	2.477E-10	1.909E-10
NNE	1.642E-08	5.897E-09	2.924E-09	1.722E-09	1.128E-09	7.934E-10	5.880E-10	4.531E-10
NE	2.259E-08	8.114E-09	4.024E-09	2.369E-09	1.551E-09	1.092E-09	8.090E-10	6.235E-10
ENE	1.428E-08	5.130E-09	2.544E-09	1.498E-09	9.810E-10	6.902E-10	5.115E-10	3.942E-10
E	9.899E-09	3.556E-09	1.763E-09	1.038E-09	6.798E-10	4.784E-10	3.545E-10	2.732E-10
ESE	1.336E-08	4.798E-09	2.379E-09	1.401E-09	9.174E-10	6.455E-10	4.784E-10	3.686E-10
SE	1.401E-08	5.034E-09	2.496E-09	1.470E-09	9.625E-10	6.772E-10	5.019E-10	3.868E-10
SSE	1.226E-08	4.404E-09	2.184E-09	1.286E-09	8.420E-10	5.925E-10	4.391E-10	3.384E-10
S	1.008E-08	3.620E-09	1.795E-09	1.057E-09	6.922E-10	4.871E-10	3.610E-10	2.782E-10
SSW	9.941E-09	3.571E-09	1.771E-09	1.043E-09	6.828E-10	4.804E-10	3.560E-10	2.744E-10
SW	1.717E-08	6.169E-09	3.059E-09	1.801E-09	1.180E-09	8.300E-10	6.151E-10	4.740E-10
WSW	1.574E-08	5.655E-09	2.804E-09	1.651E-09	1.081E-09	7.608E-10	5.638E-10	4.345E-10
W	9.988E-09	3.588E-09	1.779E-09	1.048E-09	6.860E-10	4.827E-10	3.577E-10	2.757E-10
WNW	5.953E-09	2.138E-09	1.060E-09	6.244E-10	4.088E-10	2.877E-10	2.132E-10	1.643E-10
NW	5.891E-09	2.116E-09	1.049E-09	6.179E-10	4.046E-10	2.847E-10	2.110E-10	1.626E-10
NNW	6.672E-09	2.397E-09	1.188E-09	6.998E-10	4.582E-10	3.224E-10	2.390E-10	1.841E-10

* Units are in miles from the station. As discussed in Oconee UFSAR Section 2.1.1.3, the boundary for establishing gaseous effluent release limits is the exclusion area boundary (EAB). The EAB is defined as a 1 mile radius from the station center. Each D/Q value is calculated at the closest location for the sector, e.g., 1.717E-08 m^{-2} is the D/Q value at 1.0 mile (SW) from the station.

7.0 LICENSEE INITIATED CHANGES

All ODCM changes are reviewed by knowledgeable individual(s), and approved by either the Station Manager or Radiation Protection Manager. The below changes do not adversely impact the accuracy or reliability of effluent, dose, or setpoint calculations.

ODCM Revision 61
ODCM Revision 61 was approved and implemented on the date shown on the cover sheet. Some changes reflected in this revision were implemented prior to the above date under a different change and approval process (e.g., land use census), and in those cases the implementation date is noted below.

Table of Contents – Page ii
Added Figure 6.0-3, Sampling Locations Map (>Ten Mile Radius), to List of Figures.

Section 6 – Page 1
Added Figure 6.0-3 to the figures depicting sampling locations in relation to Oconee Nuclear Station. (DRR #02437915)

Section 6 – Page 2
Removed Site # 084, Sue Craig Road, from Table 6.0-1. Site #084 was a supplemental location whose air and broadleaf vegetation samples are not needed to meet the radiological environmental monitoring program requirements in Oconee Selected Licensee Commitments (SLC) 16.11.6. The land use census evaluation was used to confirm that the remaining air and broadleaf sites fulfill the SLC 16.11.6 requirements. (DRR #02383844)

Added Site # 061, J Anthony Goat Milk, to Table 6.0-1. The 2022 Land Use Census identified a goat milk animal at 4.18 miles in the east sector. This change was implemented on June 6, 2022. (DRR #02429662)

Section 6 – Page 3
Removed TLD Site # 059 from Table 6.0-2. Land clearance at TLD 059 has occurred that has impacted TLD collection (NCR 2386271) and TLD placement at that exact location is no longer suitable. With removal of TLD 059 ONS will have 8 special interest or control TLD locations, which matches NUREG 1301. TLD 059 was in the sector with the least prevalent wind direction compared to the other special interest locations. Oconee continues to meet SLC 16.11.6 TLD requirements by sampling more than 40 environmental TLD locations. (DRR #02387797)

Section 6 – Page 6
Updated Figure 6.0-2 to reflect changes made to sampling locations.

Section 6 – Page 7
Added Figure 6.0-3 to show the placement of sampling locations greater than 10 miles from Oconee Nuclear Station. (DRR #02437915)

APPENDIX A

Dose Factors for Exposure to a Semi-Infinite Cloud of Noble Gases*

Nuclide	K_i Total Body mrem/yr/ $\mu Ci/m^3$	L_i Skin mrem/yr/ $\mu Ci/m^3$	M_i Gamma Air mrad/yr/ $\mu Ci/m^3$	N_i Beta Air mrad/yr/ $\mu Ci/m^3$
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
KR-90	1.560E+04	7.290E+03	1.630E+04	7.830E+03
XE-131M	9.150E+01	4.760E+02	1.560E+02	1.110E+03
XE-133M	2.510E+02	9.940E+02	3.270E+02	1.480E+03
XE-133	2.940E+02	3.060E+02	3.530E+02	1.050E+03
XE-135M	3.120E+03	7.110E+02	3.360E+03	7.390E+02
XE-135	1.810E+03	1.860E+03	1.920E+03	2.460E+03
XE-137	1.420E+03	1.220E+04	1.510E+03	1.270E+04
XE-138	8.830E+03	4.130E+03	9.210E+03	4.750E+03

* Reference Regulatory Guide 1.109, Table B-1

APPENDIX B

P_i Dose Factors for use in the Gaseous Release Rate Limit Calculations

Agegroup:	CHILD	Pathway:	Inhalation (INHL)			Units:	mrem/yr / µCi/m^3	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	1.120E+03	1.120E+03	1.120E+03	1.120E+03	1.120E+03	0.000E+00	1.120E+03
C-14	3.590E+04	6.730E+03	6.730E+03	6.730E+03	6.730E+03	6.730E+03	0.000E+00	6.730E+03
NA-24	1.610E+04	1.610E+04	1.610E+04	1.610E+04	1.610E+04	1.610E+04	0.000E+00	1.610E+04
P-32	2.600E+06	1.140E+05	0.000E+00	0.000E+00	0.000E+00	4.220E+04	0.000E+00	9.880E+04
CR-51	0.000E+00	0.000E+00	8.550E+01	2.430E+01	1.700E+04	1.080E+03	0.000E+00	1.540E+02
MN-54	0.000E+00	4.290E+04	0.000E+00	1.000E+04	1.580E+06	2.290E+04	0.000E+00	9.510E+03
MN-56	0.000E+00	1.660E+00	0.000E+00	1.670E+00	1.310E+04	1.230E+05	0.000E+00	3.120E-01
FE-55	4.740E+04	2.520E+04	0.000E+00	0.000E+00	1.110E+05	2.870E+03	0.000E+00	7.770E+03
FE-59	2.070E+04	3.340E+04	0.000E+00	0.000E+00	1.270E+06	7.070E+04	0.000E+00	1.670E+04
CO-58	0.000E+00	1.770E+03	0.000E+00	0.000E+00	1.110E+06	3.440E+04	0.000E+00	3.160E+03
CO-60	0.000E+00	1.310E+04	0.000E+00	0.000E+00	7.070E+06	9.620E+04	0.000E+00	2.260E+04
NI-63	8.210E+05	4.620E+04	0.000E+00	0.000E+00	2.750E+05	6.330E+03	0.000E+00	2.800E+04
NI-65	2.990E+00	2.960E-01	0.000E+00	0.000E+00	8.180E+03	8.400E+04	0.000E+00	1.640E-01
CU-64	0.000E+00	1.990E+00	0.000E+00	6.030E+00	9.580E+03	3.670E+04	0.000E+00	1.070E+00
ZN-65	4.260E+04	1.130E+05	0.000E+00	7.140E+04	9.950E+05	1.630E+04	0.000E+00	7.030E+04
ZN-69	6.700E-02	9.660E-02	0.000E+00	5.850E-02	1.420E+03	1.020E+04	0.000E+00	8.920E-03
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.740E+02
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.480E+02
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.530E+01
RB-86	0.000E+00	1.980E+05	0.000E+00	0.000E+00	0.000E+00	7.990E+03	0.000E+00	1.140E+05
RB-88	0.000E+00	5.620E+02	0.000E+00	0.000E+00	0.000E+00	1.720E+01	0.000E+00	3.660E+02
RB-89	0.000E+00	3.450E+02	0.000E+00	0.000E+00	0.000E+00	1.890E+00	0.000E+00	2.900E+02
SR-89	5.990E+05	0.000E+00	0.000E+00	0.000E+00	2.160E+06	1.670E+05	0.000E+00	1.720E+04
SR-90	1.010E+08	0.000E+00	0.000E+00	0.000E+00	1.480E+07	3.430E+05	0.000E+00	6.440E+06
SR-91	1.210E+02	0.000E+00	0.000E+00	0.000E+00	5.330E+04	1.740E+05	0.000E+00	4.590E+00

APPENDIX B

P_i Dose Factors for use in the Gaseous Release Rate Limit Calculations

Agegroup:	CHILD	Pathway:	Inhalation (INHL)			Units:	mrem/yr / µCi/m^3	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	1.310E+01	0.000E+00	0.000E+00	0.000E+00	2.400E+04	2.420E+05	0.000E+00	5.250E-01
Y-90	4.110E+03	0.000E+00	0.000E+00	0.000E+00	2.620E+05	2.680E+05	0.000E+00	1.110E+02
Y-91	9.140E+05	0.000E+00	0.000E+00	0.000E+00	2.630E+06	1.840E+05	0.000E+00	2.440E+04
Y-91M	5.070E-01	0.000E+00	0.000E+00	0.000E+00	2.810E+03	1.720E+03	0.000E+00	1.840E-02
Y-92	2.030E+01	0.000E+00	0.000E+00	0.000E+00	2.390E+04	2.390E+05	0.000E+00	5.810E-01
Y-93	1.860E+02	0.000E+00	0.000E+00	0.000E+00	7.440E+04	3.880E+05	0.000E+00	5.110E+00
ZR-95	1.900E+05	4.180E+04	0.000E+00	5.960E+04	2.230E+06	6.110E+04	0.000E+00	3.700E+04
ZR-97	1.880E+02	2.720E+01	0.000E+00	3.880E+01	1.130E+05	3.510E+05	0.000E+00	1.600E+01
NB-95	2.350E+04	9.180E+03	0.000E+00	8.620E+03	6.140E+05	3.700E+04	0.000E+00	6.550E+03
MO-99	0.000E+00	1.720E+02	0.000E+00	3.920E+02	1.350E+05	1.270E+05	0.000E+00	4.260E+01
TC-99M	1.780E-03	3.480E-03	0.000E+00	5.070E-02	9.510E+02	4.810E+03	0.000E+00	5.770E-02
TC-101	8.100E-05	8.510E-05	0.000E+00	1.450E-03	5.850E+02	1.630E+01	0.000E+00	1.080E-03
RU-103	2.790E+03	0.000E+00	0.000E+00	7.030E+03	6.620E+05	4.480E+04	0.000E+00	1.070E+03
RU-105	1.530E+00	0.000E+00	0.000E+00	1.340E+00	1.590E+04	9.950E+04	0.000E+00	5.550E-01
RU-106	1.360E+05	0.000E+00	0.000E+00	1.840E+05	1.430E+07	4.290E+05	0.000E+00	1.690E+04
AG-110M	1.690E+04	1.140E+04	0.000E+00	2.120E+04	5.480E+06	1.000E+05	0.000E+00	9.140E+03
TE-125M	6.730E+03	2.330E+03	1.920E+03	0.000E+00	4.770E+05	3.380E+04	0.000E+00	9.140E+02
TE-127	2.770E+00	9.510E-01	1.960E+00	7.070E+00	1.000E+04	5.620E+04	0.000E+00	6.100E-01
TE-127M	2.490E+04	8.550E+03	6.070E+03	6.360E+04	1.480E+06	7.140E+04	0.000E+00	3.020E+03
TE-129	9.770E-02	3.500E-02	7.140E-02	2.570E-01	2.930E+03	2.550E+04	0.000E+00	2.380E-02
TE-129M	1.920E+04	6.840E+03	6.330E+03	5.030E+04	1.760E+06	1.820E+05	0.000E+00	3.040E+03
TE-131	2.170E-02	8.440E-03	1.700E-02	5.880E-02	2.050E+03	1.330E+03	0.000E+00	6.590E-03
TE-131M	1.340E+02	5.920E+01	9.770E+01	4.000E+02	2.060E+05	3.080E+05	0.000E+00	5.070E+01
TE-132	4.810E+02	2.720E+02	3.170E+02	1.770E+03	3.770E+05	1.380E+05	0.000E+00	2.630E+02
I-130	8.180E+03	1.640E+04	1.850E+06	2.450E+04	0.000E+00	5.110E+03	0.000E+00	8.440E+03

APPENDIX B

P_i Dose Factors for use in the Gaseous Release Rate Limit Calculations

Agegroup:	CHILD	Pathway:	Inhalation (INHL)			Units:	mrem/yr / µCi/m^3	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
I-131	4.810E+04	4.810E+04	1.620E+07	7.880E+04	0.000E+00	2.840E+03	0.000E+00	2.730E+04
I-132	2.120E+03	4.070E+03	1.940E+05	6.250E+03	0.000E+00	3.200E+03	0.000E+00	1.880E+03
I-133	1.660E+04	2.030E+04	3.850E+06	3.380E+04	0.000E+00	5.480E+03	0.000E+00	7.700E+03
I-134	1.170E+03	2.160E+03	5.070E+04	3.300E+03	0.000E+00	9.550E+02	0.000E+00	9.950E+02
I-135	4.920E+03	8.730E+03	7.920E+05	1.340E+04	0.000E+00	4.440E+03	0.000E+00	4.140E+03
CS-134	6.510E+05	1.010E+06	0.000E+00	3.300E+05	1.210E+05	3.850E+03	0.000E+00	2.250E+05
CS-136	6.510E+04	1.710E+05	0.000E+00	9.550E+04	1.450E+04	4.180E+03	0.000E+00	1.160E+05
CS-137	9.060E+05	8.250E+05	0.000E+00	2.820E+05	1.040E+05	3.620E+03	0.000E+00	1.280E+05
CS-138	6.330E+02	8.400E+02	0.000E+00	6.220E+02	6.810E+01	2.700E+02	0.000E+00	5.550E+02
BA-139	1.840E+00	9.840E-04	0.000E+00	8.620E-04	5.770E+03	5.770E+04	0.000E+00	5.360E-02
BA-140	7.400E+04	6.480E+01	0.000E+00	2.110E+01	1.740E+06	1.020E+05	0.000E+00	4.330E+03
BA-141	1.960E-01	1.090E-04	0.000E+00	9.470E-05	2.920E+03	2.750E+02	0.000E+00	6.360E-03
BA-142	5.000E-02	3.600E-05	0.000E+00	2.910E-05	1.640E+03	2.740E+00	0.000E+00	2.790E-03
LA-140	6.440E+02	2.250E+02	0.000E+00	0.000E+00	1.830E+05	2.260E+05	0.000E+00	7.550E+01
LA-142	1.300E+00	4.110E-01	0.000E+00	0.000E+00	8.700E+03	7.580E+04	0.000E+00	1.290E-01
CE-141	3.920E+04	1.950E+04	0.000E+00	8.550E+03	5.440E+05	5.660E+04	0.000E+00	2.900E+03
CE-143	3.660E+02	1.990E+02	0.000E+00	8.360E+01	1.150E+05	1.270E+05	0.000E+00	2.870E+01
CE-144	6.770E+06	2.120E+06	0.000E+00	1.170E+06	1.200E+07	3.880E+05	0.000E+00	3.610E+05
PR-143	1.850E+04	5.550E+03	0.000E+00	3.000E+03	4.330E+05	9.730E+04	0.000E+00	9.140E+02
PR-144	5.960E-02	1.850E-02	0.000E+00	9.770E-03	1.570E+03	1.970E+02	0.000E+00	3.000E-03
ND-147	1.080E+04	8.730E+03	0.000E+00	4.810E+03	3.280E+05	8.210E+04	0.000E+00	6.810E+02
W-187	1.630E+01	9.660E+00	0.000E+00	0.000E+00	4.110E+04	9.100E+04	0.000E+00	4.330E+00
NP-239	4.660E+02	3.340E+01	0.000E+00	9.730E+01	5.810E+04	6.400E+04	0.000E+00	2.350E+01

APPENDIX C

A_i Adult Dose Factors for use in the Liquid Dose Calculations

Age group:	ADULT	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	8.740E+00	8.740E+00	8.740E+00	8.740E+00	8.740E+00	0.000E+00	8.740E+00
C-14	2.360E+02	4.730E+01	4.730E+01	4.730E+01	4.730E+01	4.730E+01	0.000E+00	4.730E+01
NA-24	8.140E+01	8.140E+01	8.140E+01	8.140E+01	8.140E+01	8.140E+01	0.000E+00	8.140E+01
P-32	1.570E+04	9.750E+02	0.000E+00	0.000E+00	0.000E+00	1.760E+03	0.000E+00	6.060E+02
CR-51	0.000E+00	0.000E+00	1.310E-01	4.820E-02	2.900E-01	5.500E+01	0.000E+00	2.190E-01
MN-54	0.000E+00	3.800E+02	0.000E+00	1.130E+02	0.000E+00	1.160E+03	0.000E+00	7.250E+01
MN-56	0.000E+00	3.800E-01	0.000E+00	4.820E-01	0.000E+00	1.210E+01	0.000E+00	6.740E-02
FE-55	2.290E+02	1.580E+02	0.000E+00	0.000E+00	8.820E+01	9.070E+01	0.000E+00	3.690E+01
FE-59	3.580E+02	8.420E+02	0.000E+00	0.000E+00	2.350E+02	2.810E+03	0.000E+00	3.230E+02
CO-58	0.000E+00	6.170E+01	0.000E+00	0.000E+00	0.000E+00	1.250E+03	0.000E+00	1.380E+02
CO-60	0.000E+00	1.780E+02	0.000E+00	0.000E+00	0.000E+00	3.340E+03	0.000E+00	3.930E+02
NI-63	1.080E+04	7.500E+02	0.000E+00	0.000E+00	0.000E+00	1.560E+02	0.000E+00	3.630E+02
NI-65	1.620E+00	2.100E-01	0.000E+00	0.000E+00	0.000E+00	5.340E+00	0.000E+00	9.600E-02
CU-64	0.000E+00	3.590E+00	0.000E+00	9.060E+00	0.000E+00	3.060E+02	0.000E+00	1.690E+00
ZN-65	4.020E+02	1.280E+03	0.000E+00	8.560E+02	0.000E+00	8.060E+02	0.000E+00	5.780E+02
ZN-69	1.070E-04	2.050E-04	0.000E+00	1.330E-04	0.000E+00	3.080E-05	0.000E+00	1.430E-05
SE-75	1.038E+02	3.991E+01	3.991E+01	7.983E+00	9.579E+01	1.118E+02	0.000E+00	7.983E+02
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.480E-01	0.000E+00	1.030E-01
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.270E-12	0.000E+00	6.710E-07
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.380E-77
RB-86	0.000E+00	1.720E+03	0.000E+00	0.000E+00	0.000E+00	3.400E+02	0.000E+00	8.030E+02
RB-88	0.000E+00	3.360E-12	0.000E+00	0.000E+00	0.000E+00	4.640E-23	0.000E+00	1.780E-12
RB-89	0.000E+00	3.090E-14	0.000E+00	0.000E+00	0.000E+00	1.790E-27	0.000E+00	2.170E-14
SR-89	2.550E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.080E+03	0.000E+00	7.310E+02
SR-90	6.310E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.820E+04	0.000E+00	1.550E+05

APPENDIX C

A_i Adult Dose Factors for use in the Liquid Dose Calculations

Age group:	ADULT	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-91	1.960E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.350E+02	0.000E+00	7.930E+00
SR-92	8.290E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.640E+02	0.000E+00	3.590E-01
Y-90	7.030E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.460E+03	0.000E+00	1.890E-02
Y-91	1.170E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.420E+03	0.000E+00	3.120E-01
Y-91M	3.360E-07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.860E-07	0.000E+00	1.300E-08
Y-92	6.710E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.170E+02	0.000E+00	1.960E-04
Y-93	9.770E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.100E+03	0.000E+00	2.700E-03
ZR-95	2.520E+00	8.070E-01	0.000E+00	1.270E+00	0.000E+00	2.560E+03	0.000E+00	5.460E-01
ZR-97	8.540E-02	1.720E-02	0.000E+00	2.600E-02	0.000E+00	5.340E+03	0.000E+00	7.880E-03
NB-95	5.130E-01	2.850E-01	0.000E+00	2.820E-01	0.000E+00	1.730E+03	0.000E+00	1.530E-01
MO-99	0.000E+00	3.160E+02	0.000E+00	7.160E+02	0.000E+00	7.330E+02	0.000E+00	6.020E+01
TC-99M	5.160E-03	1.460E-02	0.000E+00	2.210E-01	7.140E-03	8.630E+00	0.000E+00	1.860E-01
TC-101	1.130E-17	1.630E-17	0.000E+00	2.930E-16	8.320E-18	4.890E-29	0.000E+00	1.600E-16
RU-103	1.530E+01	0.000E+00	0.000E+00	5.820E+01	0.000E+00	1.780E+03	0.000E+00	6.570E+00
RU-105	1.970E-01	0.000E+00	0.000E+00	2.540E+00	0.000E+00	1.200E+02	0.000E+00	7.760E-02
RU-106	2.290E+02	0.000E+00	0.000E+00	4.410E+02	0.000E+00	1.480E+04	0.000E+00	2.890E+01
AG-108M	9.207E+01	3.541E+01	3.541E+01	7.082E+00	8.498E+01	9.915E+01	0.000E+00	7.082E+02
AG-110M	1.330E+01	1.230E+01	0.000E+00	2.420E+01	0.000E+00	5.020E+03	0.000E+00	7.300E+00
SN-113	2.913E+01	1.121E+01	1.121E+01	2.241E+00	2.689E+01	3.137E+01	0.000E+00	2.241E+02
SN-117M	2.771E+01	1.066E+01	1.066E+01	2.131E+00	2.557E+01	2.984E+01	0.000E+00	2.131E+02
SB-124	2.317E+02	4.377E+00	5.618E-01	0.000E+00	1.804E+02	6.578E+03	0.000E+00	9.184E+01
SB-125	1.489E+02	1.664E+00	1.514E-01	0.000E+00	1.148E+02	1.639E+03	0.000E+00	3.544E+01
SB-126	9.307E+01	1.894E+00	5.697E-01	0.000E+00	5.705E+01	7.607E+03	0.000E+00	3.358E+01
TE-123M	5.588E+01	2.149E+01	2.149E+01	4.298E+00	5.158E+01	6.018E+01	0.000E+00	4.298E+02
TE-125M	2.220E+02	8.030E+01	6.670E+01	9.020E+02	0.000E+00	8.850E+02	0.000E+00	2.970E+01

APPENDIX C

A_i Adult Dose Factors for use in the Liquid Dose Calculations

Age group:	ADULT	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
TE-127	3.780E+00	1.360E+00	2.800E+00	1.540E+01	0.000E+00	2.980E+02	0.000E+00	8.170E-01
TE-127M	5.620E+02	2.010E+02	1.440E+02	2.280E+03	0.000E+00	1.880E+03	0.000E+00	6.840E+01
TE-129	1.920E-03	7.230E-04	1.480E-03	8.080E-03	0.000E+00	1.450E-03	0.000E+00	4.690E-04
TE-129M	9.470E+02	3.530E+02	3.250E+02	3.950E+03	0.000E+00	4.770E+03	0.000E+00	1.500E+02
TE-131	3.520E-09	1.470E-09	2.900E-09	1.540E-08	0.000E+00	4.990E-10	0.000E+00	1.110E-09
TE-131M	1.090E+02	5.340E+01	8.450E+01	5.400E+02	0.000E+00	5.300E+03	0.000E+00	4.450E+01
TE-132	1.880E+02	1.220E+02	1.350E+02	1.170E+03	0.000E+00	5.770E+03	0.000E+00	1.140E+02
I-130	3.210E+01	9.460E+01	8.020E+03	1.480E+02	0.000E+00	8.140E+01	0.000E+00	3.730E+01
I-131	3.320E+02	4.740E+02	1.550E+05	8.130E+02	0.000E+00	1.250E+02	0.000E+00	2.720E+02
I-132	4.540E-01	1.220E+00	4.250E+01	1.940E+00	0.000E+00	2.280E-01	0.000E+00	4.250E-01
I-133	7.920E+01	1.380E+02	2.020E+04	2.400E+02	0.000E+00	1.240E+02	0.000E+00	4.200E+01
I-134	6.580E-04	1.790E-03	3.100E-02	2.840E-03	0.000E+00	1.560E-06	0.000E+00	6.390E-04
I-135	1.050E+01	2.750E+01	1.810E+03	4.400E+01	0.000E+00	3.100E+01	0.000E+00	1.010E+01
CS-134	5.170E+03	1.230E+04	0.000E+00	3.980E+03	1.320E+03	2.150E+02	0.000E+00	1.010E+04
CS-136	5.280E+02	2.080E+03	0.000E+00	1.160E+03	1.590E+02	2.370E+02	0.000E+00	1.500E+03
CS-137	6.630E+03	9.070E+03	0.000E+00	3.080E+03	1.020E+03	1.760E+02	0.000E+00	5.940E+03
CS-138	8.450E-07	1.670E-06	0.000E+00	1.230E-06	1.210E-07	7.120E-12	0.000E+00	8.260E-07
BA-133	6.004E+01	2.309E+01	2.309E+01	4.618E+00	5.542E+01	6.466E+01	0.000E+00	4.618E+02
BA-139	1.990E-02	1.420E-05	0.000E+00	1.330E-05	8.050E-06	3.530E-02	0.000E+00	5.830E-04
BA-140	1.640E+03	2.070E+00	0.000E+00	7.020E-01	1.180E+00	3.390E+03	0.000E+00	1.080E+02
BA-141	5.440E-12	4.120E-15	0.000E+00	3.830E-15	2.340E-15	2.570E-21	0.000E+00	1.840E-13
BA-142	6.290E-21	6.470E-24	0.000E+00	5.460E-24	3.660E-24	8.860E-39	0.000E+00	3.960E-22
LA-140	1.690E-01	8.530E-02	0.000E+00	0.000E+00	0.000E+00	6.260E+03	0.000E+00	2.250E-02
LA-142	5.720E-05	2.600E-05	0.000E+00	0.000E+00	0.000E+00	1.900E-01	0.000E+00	6.480E-06
CE-141	7.710E-01	5.210E-01	0.000E+00	2.420E-01	0.000E+00	1.990E+03	0.000E+00	5.910E-02

APPENDIX C

A_i Adult Dose Factors for use in the Liquid Dose Calculations

Age group:	ADULT	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
CE-143	1.070E-01	7.890E+01	0.000E+00	3.470E-02	0.000E+00	2.950E+03	0.000E+00	8.730E-03
CE-144	4.060E+01	1.700E+01	0.000E+00	1.010E+01	0.000E+00	1.370E+04	0.000E+00	2.180E+00
PR-143	7.460E-01	2.990E-01	0.000E+00	1.730E-01	0.000E+00	3.270E+03	0.000E+00	3.700E-02
PR-144	7.350E-16	3.050E-16	0.000E+00	1.720E-16	0.000E+00	1.060E-22	0.000E+00	3.730E-17
ND-147	5.070E-01	5.860E-01	0.000E+00	3.430E-01	0.000E+00	2.810E+03	0.000E+00	3.510E-02
EU-152	1.623E+01	3.695E+00	0.000E+00	2.288E+01	0.000E+00	2.130E+03	0.000E+00	3.245E+00
W-187	6.050E+00	5.050E+00	0.000E+00	0.000E+00	0.000E+00	1.660E+03	0.000E+00	1.770E+00
NP-239	8.550E-02	8.400E-03	0.000E+00	2.620E-02	0.000E+00	1.720E+03	0.000E+00	4.630E-03

APPENDIX C

A_i Adult Dose Factors for use in the Liquid Dose Calculations

Age group:	ADULT	Pathway:	Fresh Water Fish - Sport (FFSP)			Units:	mrem/hr / µCi/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
H-3	0.000E+00	2.260E-01	2.260E-01	2.260E-01	2.260E-01	2.260E-01	0.000E+00	2.260E-01
C-14	3.130E+04	6.260E+03	6.260E+03	6.260E+03	6.260E+03	6.260E+03	0.000E+00	6.260E+03
NA-24	1.350E+02	1.350E+02	1.350E+02	1.350E+02	1.350E+02	1.350E+02	0.000E+00	1.350E+02
P-32	1.320E+06	8.210E+04	0.000E+00	0.000E+00	0.000E+00	1.480E+05	0.000E+00	5.100E+04
CR-51	0.000E+00	0.000E+00	7.420E-01	2.740E-01	1.650E+00	3.120E+02	0.000E+00	1.240E+00
MN-54	0.000E+00	4.370E+03	0.000E+00	1.300E+03	0.000E+00	1.340E+04	0.000E+00	8.330E+02
MN-56	0.000E+00	1.730E-01	0.000E+00	2.200E-01	0.000E+00	5.530E+00	0.000E+00	3.070E-02
FE-55	6.580E+02	4.550E+02	0.000E+00	0.000E+00	2.540E+02	2.610E+02	0.000E+00	1.060E+02
FE-59	1.020E+03	2.400E+03	0.000E+00	0.000E+00	6.720E+02	8.010E+03	0.000E+00	9.220E+02
CO-58	0.000E+00	8.830E+01	0.000E+00	0.000E+00	0.000E+00	1.790E+03	0.000E+00	1.980E+02
CO-60	0.000E+00	2.560E+02	0.000E+00	0.000E+00	0.000E+00	4.810E+03	0.000E+00	5.650E+02
NI-63	3.110E+04	2.160E+03	0.000E+00	0.000E+00	0.000E+00	4.500E+02	0.000E+00	1.040E+03
NI-65	1.720E-01	2.230E-02	0.000E+00	0.000E+00	0.000E+00	5.660E-01	0.000E+00	1.020E-02
CU-64	0.000E+00	2.680E+00	0.000E+00	6.760E+00	0.000E+00	2.290E+02	0.000E+00	1.260E+00
ZN-65	2.310E+04	7.350E+04	0.000E+00	4.920E+04	0.000E+00	4.630E+04	0.000E+00	3.320E+04
ZN-69	7.730E-07	1.480E-06	0.000E+00	9.610E-07	0.000E+00	2.220E-07	0.000E+00	1.030E-07
SE-75	5.953E+02	2.290E+02	2.290E+02	4.579E+01	5.495E+02	6.411E+02	0.000E+00	4.579E+03
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.500E-02	0.000E+00	3.820E-02
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.850E-18	0.000E+00	1.250E-12
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	9.730E+04	0.000E+00	0.000E+00	0.000E+00	1.920E+04	0.000E+00	4.530E+04
RB-88	0.000E+00	1.290E-22	0.000E+00	0.000E+00	0.000E+00	1.780E-33	0.000E+00	6.830E-23
RB-89	0.000E+00	1.640E-26	0.000E+00	0.000E+00	0.000E+00	9.560E-40	0.000E+00	1.160E-26
SR-89	2.180E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.500E+03	0.000E+00	6.260E+02
SR-90	5.440E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.570E+04	0.000E+00	1.340E+05

APPENDIX C

A_i Adult Dose Factors for use in the Liquid Dose Calculations

Age group:	ADULT	Pathway:	Fresh Water Fish - Sport (FFSP)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-91	7.050E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.360E+02	0.000E+00	2.850E+00
SR-92	3.320E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.570E+00	0.000E+00	1.430E-02
Y-90	4.440E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.710E+03	0.000E+00	1.190E-02
Y-91	8.340E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.590E+03	0.000E+00	2.230E-01
Y-91M	1.070E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.150E-11	0.000E+00	4.150E-13
Y-92	4.600E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.060E+00	0.000E+00	1.340E-05
Y-93	3.080E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.770E+02	0.000E+00	8.500E-04
ZR-95	2.380E-01	7.620E-02	0.000E+00	1.200E-01	0.000E+00	2.410E+02	0.000E+00	5.160E-02
ZR-97	4.960E-03	1.000E-03	0.000E+00	1.510E-03	0.000E+00	3.100E+02	0.000E+00	4.570E-04
NB-95	4.380E+02	2.440E+02	0.000E+00	2.410E+02	0.000E+00	1.480E+06	0.000E+00	1.310E+02
MO-99	0.000E+00	8.020E+01	0.000E+00	1.820E+02	0.000E+00	1.860E+02	0.000E+00	1.530E+01
TC-99M	5.590E-04	1.580E-03	0.000E+00	2.400E-02	7.740E-04	9.340E-01	0.000E+00	2.010E-02
TC-101	2.610E-33	3.760E-33	0.000E+00	6.770E-32	1.920E-33	1.130E-44	0.000E+00	3.690E-32
RU-103	4.350E+00	0.000E+00	0.000E+00	1.660E+01	0.000E+00	5.080E+02	0.000E+00	1.870E+00
RU-105	8.670E-03	0.000E+00	0.000E+00	1.120E-01	0.000E+00	5.300E+00	0.000E+00	3.420E-03
RU-106	6.570E+01	0.000E+00	0.000E+00	1.270E+02	0.000E+00	4.250E+03	0.000E+00	8.320E+00
AG-108M	2.648E+01	1.019E+01	1.019E+01	2.037E+00	2.445E+01	2.852E+01	0.000E+00	2.037E+02
AG-110M	8.790E-01	8.130E-01	0.000E+00	1.600E+00	0.000E+00	3.320E+02	0.000E+00	4.830E-01
SN-113	2.507E+03	9.641E+02	9.641E+02	1.928E+02	2.314E+03	2.699E+03	0.000E+00	1.928E+04
SN-117M	2.331E+03	8.965E+02	8.965E+02	1.793E+02	2.152E+03	2.510E+03	0.000E+00	1.793E+04
SB-124	6.626E+02	1.252E+01	1.607E+00	0.000E+00	5.159E+02	1.881E+04	0.000E+00	2.627E+02
SB-125	4.282E+02	4.785E+00	4.354E-01	0.000E+00	3.301E+02	4.713E+03	0.000E+00	1.019E+02
SB-126	2.603E+02	5.297E+00	1.594E+00	0.000E+00	1.596E+02	2.128E+04	0.000E+00	9.395E+01
TE-123M	6.411E+02	2.466E+02	2.466E+02	4.932E+01	5.918E+02	6.904E+02	0.000E+00	4.932E+03
TE-125M	2.540E+03	9.190E+02	7.630E+02	1.030E+04	0.000E+00	1.010E+04	0.000E+00	3.400E+02

APPENDIX C

A_i Adult Dose Factors for use in the Liquid Dose Calculations

Age group:	ADULT	Pathway:	Fresh Water Fish - Sport (FFSP)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
TE-127	1.790E+01	6.440E+00	1.330E+01	7.300E+01	0.000E+00	1.410E+03	0.000E+00	3.880E+00
TE-127M	6.440E+03	2.300E+03	1.650E+03	2.620E+04	0.000E+00	2.160E+04	0.000E+00	7.850E+02
TE-129	1.630E-05	6.120E-06	1.250E-05	6.850E-05	0.000E+00	1.230E-05	0.000E+00	3.970E-06
TE-129M	1.080E+04	4.020E+03	3.710E+03	4.500E+04	0.000E+00	5.430E+04	0.000E+00	1.710E+03
TE-131	8.710E-17	3.640E-17	7.160E-17	3.820E-16	0.000E+00	1.230E-17	0.000E+00	2.750E-17
TE-131M	9.510E+02	4.650E+02	7.370E+02	4.710E+03	0.000E+00	4.620E+04	0.000E+00	3.880E+02
TE-132	1.950E+03	1.260E+03	1.390E+03	1.210E+04	0.000E+00	5.960E+04	0.000E+00	1.180E+03
I-130	7.050E+00	2.080E+01	1.760E+03	3.250E+01	0.000E+00	1.790E+01	0.000E+00	8.210E+00
I-131	1.370E+02	1.960E+02	6.420E+04	3.360E+02	0.000E+00	5.170E+01	0.000E+00	1.120E+02
I-132	5.270E-03	1.410E-02	4.940E-01	2.250E-02	0.000E+00	2.650E-03	0.000E+00	4.940E-03
I-133	2.290E+01	3.990E+01	5.860E+03	6.950E+01	0.000E+00	3.580E+01	0.000E+00	1.210E+01
I-134	2.120E-08	5.750E-08	9.960E-07	9.140E-08	0.000E+00	5.010E-11	0.000E+00	2.060E-08
I-135	1.290E+00	3.370E+00	2.220E+02	5.410E+00	0.000E+00	3.810E+00	0.000E+00	1.240E+00
CS-134	2.980E+05	7.080E+05	0.000E+00	2.290E+05	7.610E+04	1.240E+04	0.000E+00	5.790E+05
CS-136	2.960E+04	1.170E+05	0.000E+00	6.500E+04	8.900E+03	1.330E+04	0.000E+00	8.400E+04
CS-137	3.820E+05	5.220E+05	0.000E+00	1.770E+05	5.890E+04	1.010E+04	0.000E+00	3.420E+05
CS-138	8.940E-12	1.770E-11	0.000E+00	1.300E-11	1.280E-12	7.530E-17	0.000E+00	8.750E-12
BA-133	6.908E+00	2.657E+00	2.657E+00	5.314E-01	6.376E+00	7.439E+00	0.000E+00	5.314E+01
BA-139	5.650E-06	4.030E-09	0.000E+00	3.760E-09	2.280E-09	1.000E-05	0.000E+00	1.660E-07
BA-140	1.840E+02	2.310E-01	0.000E+00	7.860E-02	1.320E-01	3.790E+02	0.000E+00	1.210E+01
BA-141	8.700E-25	6.580E-28	0.000E+00	6.120E-28	3.730E-28	4.100E-34	0.000E+00	2.940E-26
BA-142	2.570E-42	2.640E-45	0.000E+00	2.230E-45	1.490E-45	3.620E-60	0.000E+00	1.610E-43
LA-140	9.900E-02	4.990E-02	0.000E+00	0.000E+00	0.000E+00	3.660E+03	0.000E+00	1.320E-02
LA-142	2.210E-07	1.000E-07	0.000E+00	0.000E+00	0.000E+00	7.330E-04	0.000E+00	2.500E-08
CE-141	2.190E-02	1.480E-02	0.000E+00	6.890E-03	0.000E+00	5.670E+01	0.000E+00	1.680E-03

APPENDIX C

A_i Adult Dose Factors for use in the Liquid Dose Calculations

Age group:	ADULT	Pathway:	Fresh Water Fish - Sport (FFSP)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
CE-143	2.380E-03	1.760E+00	0.000E+00	7.760E-04	0.000E+00	6.590E+01	0.000E+00	1.950E-04
CE-144	1.170E+00	4.870E-01	0.000E+00	2.890E-01	0.000E+00	3.940E+02	0.000E+00	6.260E-02
PR-143	5.230E-01	2.100E-01	0.000E+00	1.210E-01	0.000E+00	2.290E+03	0.000E+00	2.590E-02
PR-144	1.550E-28	6.440E-29	0.000E+00	3.630E-29	0.000E+00	2.230E-35	0.000E+00	7.880E-30
ND-147	3.530E-01	4.080E-01	0.000E+00	2.390E-01	0.000E+00	1.960E+03	0.000E+00	2.440E-02
EU-152	2.334E+01	5.314E+00	0.000E+00	3.291E+01	0.000E+00	3.064E+03	0.000E+00	4.668E+00
W-187	1.470E+02	1.230E+02	0.000E+00	0.000E+00	0.000E+00	4.030E+04	0.000E+00	4.300E+01
NP-239	2.120E-02	2.090E-03	0.000E+00	6.510E-03	0.000E+00	4.280E+02	0.000E+00	1.150E-03

APPENDIX C

A_i Adult Dose Factors for use in the Liquid Dose Calculations

Age group:	ADULT	Pathway:	Shoreline Sediment (SHDp)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C-14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NA-24	4.270E-01	4.270E-01	4.270E-01	4.270E-01	4.270E-01	4.270E-01	4.960E-01	4.270E-01
P-32	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CR-51	1.670E-01	1.670E-01	1.670E-01	1.670E-01	1.670E-01	1.670E-01	1.970E-01	1.670E-01
MN-54	4.960E+01	4.960E+01	4.960E+01	4.960E+01	4.960E+01	4.960E+01	5.820E+01	4.960E+01
MN-56	3.230E-02	3.230E-02	3.230E-02	3.230E-02	3.230E-02	3.230E-02	3.820E-02	3.230E-02
FE-55	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
FE-59	9.770E+00	9.770E+00	9.770E+00	9.770E+00	9.770E+00	9.770E+00	1.150E+01	9.770E+00
CO-58	1.360E+01	1.360E+01	1.360E+01	1.360E+01	1.360E+01	1.360E+01	1.590E+01	1.360E+01
CO-60	7.690E+02	7.690E+02	7.690E+02	7.690E+02	7.690E+02	7.690E+02	9.050E+02	7.690E+02
NI-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NI-65	1.060E-02	1.060E-02	1.060E-02	1.060E-02	1.060E-02	1.060E-02	1.240E-02	1.060E-02
CU-64	2.170E-02	2.170E-02	2.170E-02	2.170E-02	2.170E-02	2.170E-02	2.460E-02	2.170E-02
ZN-65	2.670E+01	2.670E+01	2.670E+01	2.670E+01	2.670E+01	2.670E+01	3.080E+01	2.670E+01
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE-75	1.617E+01	1.617E+01	1.617E+01	1.617E+01	1.617E+01	1.617E+01	1.892E+01	1.617E+01
BR-83	1.740E-04	1.740E-04	1.740E-04	1.740E-04	1.740E-04	1.740E-04	2.530E-04	1.740E-04
BR-84	7.250E-03	7.250E-03	7.250E-03	7.250E-03	7.250E-03	7.250E-03	8.460E-03	7.250E-03
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	3.220E-01	3.220E-01	3.220E-01	3.220E-01	3.220E-01	3.220E-01	3.680E-01	3.220E-01
RB-88	1.180E-03	1.180E-03	1.180E-03	1.180E-03	1.180E-03	1.180E-03	1.350E-03	1.180E-03
RB-89	4.400E-03	4.400E-03	4.400E-03	4.400E-03	4.400E-03	4.400E-03	5.280E-03	4.400E-03
SR-89	7.740E-04	7.740E-04	7.740E-04	7.740E-04	7.740E-04	7.740E-04	8.990E-04	7.740E-04
SR-90	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

APPENDIX C

A_i Adult Dose Factors for use in the Liquid Dose Calculations

Age group:	ADULT	Pathway:	Shoreline Sediment (SHDp)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-91	7.690E-02	7.690E-02	7.690E-02	7.690E-02	7.690E-02	7.690E-02	8.990E-02	7.690E-02
SR-92	2.780E-02	2.780E-02	2.780E-02	2.780E-02	2.780E-02	2.780E-02	3.090E-02	2.780E-02
Y-90	1.610E-04	1.610E-04	1.610E-04	1.610E-04	1.610E-04	1.610E-04	1.900E-04	1.610E-04
Y-91	3.840E-02	3.840E-02	3.840E-02	3.840E-02	3.840E-02	3.840E-02	4.320E-02	3.840E-02
Y-91M	3.590E-03	3.590E-03	3.590E-03	3.590E-03	3.590E-03	3.590E-03	4.150E-03	3.590E-03
Y-92	6.460E-03	6.460E-03	6.460E-03	6.460E-03	6.460E-03	6.460E-03	7.670E-03	6.460E-03
Y-93	6.560E-03	6.560E-03	6.560E-03	6.560E-03	6.560E-03	6.560E-03	8.980E-03	6.560E-03
ZR-95	8.760E+00	8.760E+00	8.760E+00	8.760E+00	8.760E+00	8.760E+00	1.020E+01	8.760E+00
ZR-97	1.060E-01	1.060E-01	1.060E-01	1.060E-01	1.060E-01	1.060E-01	1.230E-01	1.060E-01
NB-95	4.890E+00	4.890E+00	4.890E+00	4.890E+00	4.890E+00	4.890E+00	5.750E+00	4.890E+00
MO-99	1.430E-01	1.430E-01	1.430E-01	1.430E-01	1.430E-01	1.430E-01	1.660E-01	1.430E-01
TC-99M	6.590E-03	6.590E-03	6.590E-03	6.590E-03	6.590E-03	6.590E-03	7.550E-03	6.590E-03
TC-101	7.280E-04	7.280E-04	7.280E-04	7.280E-04	7.280E-04	7.280E-04	8.090E-04	7.280E-04
RU-103	3.870E+00	3.870E+00	3.870E+00	3.870E+00	3.870E+00	3.870E+00	4.520E+00	3.870E+00
RU-105	2.280E-02	2.280E-02	2.280E-02	2.280E-02	2.280E-02	2.280E-02	2.580E-02	2.280E-02
RU-106	1.510E+01	1.510E+01	1.510E+01	1.510E+01	1.510E+01	1.510E+01	1.810E+01	1.510E+01
AG-108M	1.846E+03	1.846E+03	1.846E+03	1.846E+03	1.846E+03	1.846E+03	2.159E+03	1.846E+03
AG-110M	1.230E+02	1.230E+02	1.230E+02	1.230E+02	1.230E+02	1.230E+02	1.440E+02	1.230E+02
SN-113	5.340E-01	5.340E-01	5.340E-01	5.340E-01	5.340E-01	5.340E-01	6.248E-01	5.340E-01
SN-117M	7.463E-01	7.463E-01	7.463E-01	7.463E-01	7.463E-01	7.463E-01	8.732E-01	7.463E-01
SB-124	2.141E+01	2.141E+01	2.141E+01	2.141E+01	2.141E+01	2.141E+01	2.470E+01	2.141E+01
SB-125	8.349E+01	8.349E+01	8.349E+01	8.349E+01	8.349E+01	8.349E+01	9.426E+01	8.349E+01
SB-126	3.019E+00	3.019E+00	3.019E+00	3.019E+00	3.019E+00	3.019E+00	3.393E+00	3.019E+00
TE-123M	6.059E+00	6.059E+00	6.059E+00	6.059E+00	6.059E+00	6.059E+00	7.089E+00	6.059E+00
TE-125M	5.550E-02	5.550E-02	5.550E-02	5.550E-02	5.550E-02	5.550E-02	7.620E-02	5.550E-02

APPENDIX C

A_i Adult Dose Factors for use in the Liquid Dose Calculations

Age group:	ADULT	Pathway:	Shoreline Sediment (SHDp)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
TE-127	1.070E-04	1.070E-04	1.070E-04	1.070E-04	1.070E-04	1.070E-04	1.170E-04	1.070E-04
TE-127M	3.280E-03	3.280E-03	3.280E-03	3.280E-03	3.280E-03	3.280E-03	3.880E-03	3.280E-03
TE-129	9.390E-04	9.390E-04	9.390E-04	9.390E-04	9.390E-04	9.390E-04	1.110E-03	9.390E-04
TE-129M	7.080E-01	7.080E-01	7.080E-01	7.080E-01	7.080E-01	7.080E-01	8.270E-01	7.080E-01
TE-131	1.040E-03	1.040E-03	1.040E-03	1.040E-03	1.040E-03	1.040E-03	1.230E+00	1.040E-03
TE-131M	2.870E-01	2.870E-01	2.870E-01	2.870E-01	2.870E-01	2.870E-01	3.390E-01	2.870E-01
TE-132	1.520E-01	1.520E-01	1.520E-01	1.520E-01	1.520E-01	1.520E-01	1.780E-01	1.520E-01
I-130	1.970E-01	1.970E-01	1.970E-01	1.970E-01	1.970E-01	1.970E-01	2.390E-01	1.970E-01
I-131	6.160E-01	6.160E-01	6.160E-01	6.160E-01	6.160E-01	6.160E-01	7.480E-01	6.160E-01
I-132	4.460E-02	4.460E-02	4.460E-02	4.460E-02	4.460E-02	4.460E-02	5.240E-02	4.460E-02
I-133	8.770E-02	8.770E-02	8.770E-02	8.770E-02	8.770E-02	8.770E-02	1.070E-01	8.770E-02
I-134	1.600E-02	1.600E-02	1.600E-02	1.600E-02	1.600E-02	1.600E-02	1.900E-02	1.600E-02
I-135	9.040E-02	9.040E-02	9.040E-02	9.040E-02	9.040E-02	9.040E-02	1.050E-01	9.040E-02
CS-134	2.450E+02	2.450E+02	2.450E+02	2.450E+02	2.450E+02	2.450E+02	2.860E+02	2.450E+02
CS-136	5.400E+00	5.400E+00	5.400E+00	5.400E+00	5.400E+00	5.400E+00	6.120E+00	5.400E+00
CS-137	3.680E+02	3.680E+02	3.680E+02	3.680E+02	3.680E+02	3.680E+02	4.290E+02	3.680E+02
CS-138	1.280E-02	1.280E-02	1.280E-02	1.280E-02	1.280E-02	1.280E-02	1.470E-02	1.280E-02
BA-133	3.155E+02	3.155E+02	3.155E+02	3.155E+02	3.155E+02	3.155E+02	3.691E+02	3.155E+02
BA-139	3.790E-03	3.790E-03	3.790E-03	3.790E-03	3.790E-03	3.790E-03	4.260E-03	3.790E-03
BA-140	7.350E-01	7.350E-01	7.350E-01	7.350E-01	7.350E-01	7.350E-01	8.400E-01	7.350E-01
BA-141	1.490E-03	1.490E-03	1.490E-03	1.490E-03	1.490E-03	1.490E-03	1.700E-03	1.490E-03
BA-142	1.610E-03	1.610E-03	1.610E-03	1.610E-03	1.610E-03	1.610E-03	1.830E-03	1.610E-03
LA-140	6.880E-01	6.880E-01	6.880E-01	6.880E-01	6.880E-01	6.880E-01	7.790E-01	6.880E-01
LA-142	2.720E-02	2.720E-02	2.720E-02	2.720E-02	2.720E-02	2.720E-02	3.260E-02	2.720E-02
CE-141	4.890E-01	4.890E-01	4.890E-01	4.890E-01	4.890E-01	4.890E-01	5.510E-01	4.890E-01

APPENDIX C

A_i Adult Dose Factors for use in the Liquid Dose Calculations

Age group:	ADULT	Pathway:	Shoreline Sediment (SHDp)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
CE-143	8.270E-02	8.270E-02	8.270E-02	8.270E-02	8.270E-02	8.270E-02	9.400E-02	8.270E-02
CE-144	2.490E+00	2.490E+00	2.490E+00	2.490E+00	2.490E+00	2.490E+00	2.880E+00	2.490E+00
PR-143	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR-144	6.570E-05	6.570E-05	6.570E-05	6.570E-05	6.570E-05	6.570E-05	7.550E-05	6.570E-05
ND-147	3.000E-01	3.000E-01	3.000E-01	3.000E-01	3.000E-01	3.000E-01	3.600E-01	3.000E-01
EU-152	5.317E+02	5.317E+02	5.317E+02	5.317E+02	5.317E+02	5.317E+02	6.154E+02	5.317E+02
W-187	8.420E-02	8.420E-02	8.420E-02	8.420E-02	8.420E-02	8.420E-02	9.780E-02	8.420E-02
NP-239	6.120E-02	6.120E-02	6.120E-02	6.120E-02	6.120E-02	6.120E-02	7.090E-02	6.120E-02

APPENDIX D

A_i Teen Factors for use in the Liquid Dose Calculations

Age group:	TEEN	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	6.160E+00	6.160E+00	6.160E+00	6.160E+00	6.160E+00	0.000E+00	6.160E+00
C-14	2.360E+02	4.720E+01	4.720E+01	4.720E+01	4.720E+01	4.720E+01	0.000E+00	4.720E+01
NA-24	7.690E+01	7.690E+01	7.690E+01	7.690E+01	7.690E+01	7.690E+01	0.000E+00	7.690E+01
P-32	1.570E+04	9.700E+02	0.000E+00	0.000E+00	0.000E+00	1.320E+03	0.000E+00	6.070E+02
CR-51	0.000E+00	0.000E+00	1.150E-01	4.530E-02	2.950E-01	3.470E+01	0.000E+00	2.070E-01
MN-54	0.000E+00	3.430E+02	0.000E+00	1.020E+02	0.000E+00	7.030E+02	0.000E+00	6.790E+01
MN-56	0.000E+00	3.640E-01	0.000E+00	4.610E-01	0.000E+00	2.400E+01	0.000E+00	6.480E-02
FE-55	2.200E+02	1.560E+02	0.000E+00	0.000E+00	9.880E+01	6.740E+01	0.000E+00	3.630E+01
FE-59	3.390E+02	7.900E+02	0.000E+00	0.000E+00	2.490E+02	1.870E+03	0.000E+00	3.050E+02
CO-58	0.000E+00	5.620E+01	0.000E+00	0.000E+00	0.000E+00	7.750E+02	0.000E+00	1.300E+02
CO-60	0.000E+00	1.630E+02	0.000E+00	0.000E+00	0.000E+00	2.130E+03	0.000E+00	3.680E+02
NI-63	1.030E+04	7.270E+02	0.000E+00	0.000E+00	0.000E+00	1.160E+02	0.000E+00	3.490E+02
NI-65	1.610E+00	2.050E-01	0.000E+00	0.000E+00	0.000E+00	1.110E+01	0.000E+00	9.350E-02
CU-64	0.000E+00	3.470E+00	0.000E+00	8.770E+00	0.000E+00	2.690E+02	0.000E+00	1.630E+00
ZN-65	3.340E+02	1.160E+03	0.000E+00	7.430E+02	0.000E+00	4.920E+02	0.000E+00	5.420E+02
ZN-69	1.070E-04	2.040E-04	0.000E+00	1.330E-04	0.000E+00	3.760E-04	0.000E+00	1.430E-05
SE-75	8.644E+01	3.325E+01	3.325E+01	6.649E+00	7.979E+01	9.309E+01	0.000E+00	6.649E+02
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.030E-01
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.500E-07
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.360E-77
RB-86	0.000E+00	1.700E+03	0.000E+00	0.000E+00	0.000E+00	2.520E+02	0.000E+00	7.990E+02
RB-88	0.000E+00	3.300E-12	0.000E+00	0.000E+00	0.000E+00	2.830E-19	0.000E+00	1.760E-12
RB-89	0.000E+00	2.960E-14	0.000E+00	0.000E+00	0.000E+00	4.540E-23	0.000E+00	2.090E-14
SR-89	2.540E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.030E+03	0.000E+00	7.280E+02
SR-90	4.830E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.350E+04	0.000E+00	1.190E+05

APPENDIX D

A_i Teen Factors for use in the Liquid Dose Calculations

Age group:	TEEN	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-91	1.950E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.850E+02	0.000E+00	7.760E+00
SR-92	8.220E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.090E+02	0.000E+00	3.500E-01
Y-90	7.000E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.770E+03	0.000E+00	1.880E-02
Y-91	1.160E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.760E+03	0.000E+00	3.120E-01
Y-91M	3.330E-07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.570E-05	0.000E+00	1.270E-08
Y-92	6.710E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.840E+02	0.000E+00	1.940E-04
Y-93	9.760E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.980E+03	0.000E+00	2.670E-03
ZR-95	2.380E+00	7.520E-01	0.000E+00	1.100E+00	0.000E+00	1.730E+03	0.000E+00	5.170E-01
ZR-97	8.420E-02	1.670E-02	0.000E+00	2.530E-02	0.000E+00	4.510E+03	0.000E+00	7.670E-03
NB-95	4.730E-01	2.630E-01	0.000E+00	2.540E-01	0.000E+00	1.120E+03	0.000E+00	1.440E-01
MO-99	0.000E+00	3.090E+02	0.000E+00	7.070E+02	0.000E+00	5.530E+02	0.000E+00	5.890E+01
TC-99M	4.840E-03	1.350E-02	0.000E+00	2.010E-01	7.500E-03	8.870E+00	0.000E+00	1.750E-01
TC-101	1.120E-17	1.590E-17	0.000E+00	2.880E-16	9.700E-18	2.720E-24	0.000E+00	1.560E-16
RU-103	1.470E+01	0.000E+00	0.000E+00	5.180E+01	0.000E+00	1.230E+03	0.000E+00	6.280E+00
RU-105	1.940E-01	0.000E+00	0.000E+00	2.450E+00	0.000E+00	1.570E+02	0.000E+00	7.540E-02
RU-106	2.280E+02	0.000E+00	0.000E+00	4.390E+02	0.000E+00	1.090E+04	0.000E+00	2.870E+01
AG-108M	7.830E+01	3.012E+01	3.012E+01	6.023E+00	7.228E+01	8.433E+01	0.000E+00	6.023E+02
AG-110M	1.190E+01	1.130E+01	0.000E+00	2.150E+01	0.000E+00	3.160E+03	0.000E+00	6.850E+00
SN-113	2.565E+01	9.866E+00	9.866E+00	1.973E+00	2.368E+01	2.762E+01	0.000E+00	1.973E+02
SN-117M	2.399E+01	9.227E+00	9.227E+00	1.845E+00	2.215E+01	2.584E+01	0.000E+00	1.845E+02
SB-124	2.237E+02	4.122E+00	5.075E-01	0.000E+00	1.954E+02	4.509E+03	0.000E+00	8.729E+01
SB-125	1.441E+02	1.575E+00	1.377E-01	0.000E+00	1.267E+02	1.122E+03	0.000E+00	3.371E+01
SB-126	8.989E+01	1.837E+00	5.083E-01	0.000E+00	6.445E+01	5.320E+03	0.000E+00	3.228E+01
TE-123M	4.740E+01	1.823E+01	1.823E+01	3.646E+00	4.376E+01	5.105E+01	0.000E+00	3.646E+02
TE-125M	2.210E+02	7.980E+01	6.180E+01	0.000E+00	0.000E+00	6.530E+02	0.000E+00	2.960E+01

APPENDIX D

A_i Teen Factors for use in the Liquid Dose Calculations

Age group:	TEEN	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / µCi/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
TE-127	3.790E+00	1.340E+00	2.610E+00	1.530E+01	0.000E+00	2.930E+02	0.000E+00	8.150E-01
TE-127M	5.600E+02	1.990E+02	1.330E+02	2.270E+03	0.000E+00	1.400E+03	0.000E+00	6.660E+01
TE-129	1.920E-03	7.150E-04	1.370E-03	8.040E-03	0.000E+00	1.050E-02	0.000E+00	4.660E-04
TE-129M	9.380E+02	3.480E+02	3.030E+02	3.920E+03	0.000E+00	3.520E+03	0.000E+00	1.480E+02
TE-131	3.490E-09	1.440E-09	2.690E-09	1.520E-08	0.000E+00	2.860E-10	0.000E+00	1.090E-09
TE-131M	1.080E+02	5.150E+01	7.750E+01	5.380E+02	0.000E+00	4.140E+03	0.000E+00	4.300E+01
TE-132	1.820E+02	1.150E+02	1.220E+02	1.110E+03	0.000E+00	3.660E+03	0.000E+00	1.090E+02
I-130	3.050E+01	8.830E+01	7.200E+03	1.360E+02	0.000E+00	6.790E+01	0.000E+00	3.530E+01
I-131	3.260E+02	4.560E+02	1.330E+05	7.850E+02	0.000E+00	9.020E+01	0.000E+00	2.450E+02
I-132	4.360E-01	1.140E+00	3.850E+01	1.800E+00	0.000E+00	4.970E-01	0.000E+00	4.100E-01
I-133	7.830E+01	1.330E+02	1.860E+04	2.330E+02	0.000E+00	1.010E+02	0.000E+00	4.050E+01
I-134	6.330E-04	1.680E-03	2.800E-02	2.640E-03	0.000E+00	2.210E-05	0.000E+00	6.020E-04
I-135	1.010E+01	2.600E+01	1.670E+03	4.100E+01	0.000E+00	2.880E+01	0.000E+00	9.630E+00
CS-134	4.860E+03	1.140E+04	0.000E+00	3.640E+03	1.390E+03	1.420E+02	0.000E+00	5.310E+03
CS-136	4.860E+02	1.910E+03	0.000E+00	1.040E+03	1.640E+02	1.540E+02	0.000E+00	1.290E+03
CS-137	6.510E+03	8.660E+03	0.000E+00	2.950E+03	1.150E+03	1.230E+02	0.000E+00	3.020E+03
CS-138	8.300E-07	1.590E-06	0.000E+00	1.180E-06	1.370E-07	7.230E-10	0.000E+00	7.970E-07
BA-133	2.041E+02	7.851E+01	7.851E+01	1.570E+01	1.884E+02	2.198E+02	0.000E+00	1.570E+03
BA-139	1.990E-02	1.400E-05	0.000E+00	1.320E-05	9.670E-06	1.780E-01	0.000E+00	5.810E-04
BA-140	1.610E+03	1.970E+00	0.000E+00	6.680E-01	1.320E+00	2.480E+03	0.000E+00	1.040E+02
BA-141	5.420E-12	4.050E-15	0.000E+00	3.760E-15	2.770E-15	1.150E-17	0.000E+00	1.810E-13
BA-142	6.170E-21	6.170E-24	0.000E+00	5.220E-24	4.100E-24	1.890E-32	0.000E+00	3.800E-22
LA-140	1.650E-01	8.090E-02	0.000E+00	0.000E+00	0.000E+00	4.640E+03	0.000E+00	2.150E-02
LA-142	5.590E-05	2.480E-05	0.000E+00	0.000E+00	0.000E+00	7.550E-01	0.000E+00	6.180E-06
CE-141	7.650E-01	5.110E-01	0.000E+00	2.400E-01	0.000E+00	1.460E+03	0.000E+00	5.870E-02

APPENDIX D

A_i Teen Factors for use in the Liquid Dose Calculations

Age group:	TEEN	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / µCi/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
CE-143	1.060E-01	7.730E+01	0.000E+00	3.460E-02	0.000E+00	2.320E+03	0.000E+00	8.630E-03
CE-144	4.040E+01	1.670E+01	0.000E+00	9.990E+00	0.000E+00	1.020E+04	0.000E+00	2.170E+00
PR-143	7.420E-01	2.960E-01	0.000E+00	1.720E-01	0.000E+00	2.440E+03	0.000E+00	3.700E-02
PR-144	7.330E-16	3.000E-16	0.000E+00	1.720E-16	0.000E+00	8.080E-19	0.000E+00	3.720E-17
ND-147	5.280E-01	5.750E-01	0.000E+00	3.370E-01	0.000E+00	2.070E+03	0.000E+00	3.440E-02
EU-152	1.424E+01	3.430E+00	0.000E+00	1.593E+01	0.000E+00	1.262E+03	0.000E+00	3.023E+00
W-187	5.990E+00	4.880E+00	0.000E+00	0.000E+00	0.000E+00	1.320E+03	0.000E+00	1.710E+00
NP-239	8.830E-02	8.330E-03	0.000E+00	2.610E-02	0.000E+00	1.340E+03	0.000E+00	4.630E-03

APPENDIX D

A_i Teen Dose Factors for use in the Liquid Dose Calculations

Age group:	TEEN	Pathway:	Fresh Water Fish - Sport (FFSP)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	1.740E-01	1.740E-01	1.740E-01	1.740E-01	1.740E-01	0.000E+00	1.740E-01
C-14	3.410E+04	6.810E+03	6.810E+03	6.810E+03	6.810E+03	6.810E+03	0.000E+00	6.810E+03
NA-24	1.390E+02	1.390E+02	1.390E+02	1.390E+02	1.390E+02	1.390E+02	0.000E+00	1.390E+02
P-32	1.440E+06	8.910E+04	0.000E+00	0.000E+00	0.000E+00	1.210E+05	0.000E+00	5.580E+04
CR-51	0.000E+00	0.000E+00	7.120E-01	2.810E-01	1.830E+00	2.150E+02	0.000E+00	1.280E+00
MN-54	0.000E+00	4.300E+03	0.000E+00	1.280E+03	0.000E+00	8.810E+03	0.000E+00	8.520E+02
MN-56	0.000E+00	1.810E-01	0.000E+00	2.300E-01	0.000E+00	1.190E+01	0.000E+00	3.230E-02
FE-55	6.890E+02	4.880E+02	0.000E+00	0.000E+00	3.100E+02	2.110E+02	0.000E+00	1.140E+02
FE-59	1.050E+03	2.460E+03	0.000E+00	0.000E+00	7.760E+02	5.820E+03	0.000E+00	9.500E+02
CO-58	0.000E+00	8.780E+01	0.000E+00	0.000E+00	0.000E+00	1.210E+03	0.000E+00	2.020E+02
CO-60	0.000E+00	2.560E+02	0.000E+00	0.000E+00	0.000E+00	3.340E+03	0.000E+00	5.770E+02
NI-63	3.230E+04	2.280E+03	0.000E+00	0.000E+00	0.000E+00	3.630E+02	0.000E+00	1.090E+03
NI-65	1.860E-01	2.370E-02	0.000E+00	0.000E+00	0.000E+00	1.290E+00	0.000E+00	1.080E-02
CU-64	0.000E+00	2.820E+00	0.000E+00	7.140E+00	0.000E+00	2.190E+02	0.000E+00	1.330E+00
ZN-65	2.100E+04	7.280E+04	0.000E+00	4.660E+04	0.000E+00	3.080E+04	0.000E+00	3.390E+04
ZN-69	8.410E-07	1.600E-06	0.000E+00	1.050E-06	0.000E+00	2.950E-06	0.000E+00	1.120E-07
SE-75	5.408E+02	2.080E+02	2.080E+02	4.160E+01	4.992E+02	5.824E+02	0.000E+00	4.160E+03
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.160E-02
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.320E-12
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	1.050E+05	0.000E+00	0.000E+00	0.000E+00	1.550E+04	0.000E+00	4.920E+04
RB-88	0.000E+00	1.380E-22	0.000E+00	0.000E+00	0.000E+00	1.180E-29	0.000E+00	7.360E-23
RB-89	0.000E+00	1.720E-26	0.000E+00	0.000E+00	0.000E+00	2.630E-35	0.000E+00	1.220E-26
SR-89	2.370E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.830E+03	0.000E+00	6.800E+02
SR-90	4.540E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.270E+04	0.000E+00	1.120E+05

APPENDIX D

A_i Teen Dose Factors for use in the Liquid Dose Calculations

Age group:	TEEN	Pathway:	Fresh Water Fish - Sport (FFSP)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-91	7.640E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.470E+02	0.000E+00	3.040E+00
SR-92	3.590E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.130E+00	0.000E+00	1.530E-02
Y-90	4.820E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.980E+03	0.000E+00	1.300E-02
Y-91	9.060E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.710E+03	0.000E+00	2.430E-01
Y-91M	1.160E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.470E-10	0.000E+00	4.430E-13
Y-92	5.020E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.380E+01	0.000E+00	1.450E-05
Y-93	3.350E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.020E+03	0.000E+00	9.190E-04
ZR-95	2.450E-01	7.740E-02	0.000E+00	1.140E-01	0.000E+00	1.790E+02	0.000E+00	5.320E-02
ZR-97	5.330E-03	1.050E-03	0.000E+00	1.600E-03	0.000E+00	2.850E+02	0.000E+00	4.860E-04
NB-95	4.410E+02	2.450E+02	0.000E+00	2.370E+02	0.000E+00	1.050E+06	0.000E+00	1.350E+02
MO-99	0.000E+00	8.550E+01	0.000E+00	1.960E+02	0.000E+00	1.530E+02	0.000E+00	1.630E+01
TC-99M	5.720E-04	1.600E-03	0.000E+00	2.380E-02	8.860E-04	1.050E+00	0.000E+00	2.070E-02
TC-101	2.820E-33	4.010E-33	0.000E+00	7.240E-32	2.440E-33	6.840E-40	0.000E+00	3.930E-32
RU-103	4.570E+00	0.000E+00	0.000E+00	1.610E+01	0.000E+00	3.820E+02	0.000E+00	1.950E+00
RU-105	9.350E-03	0.000E+00	0.000E+00	1.180E-01	0.000E+00	7.550E+00	0.000E+00	3.630E-03
RU-106	7.140E+01	0.000E+00	0.000E+00	1.380E+02	0.000E+00	3.420E+03	0.000E+00	8.990E+00
AG-108M	2.457E+01	9.448E+00	9.448E+00	1.890E+00	2.268E+01	2.645E+01	0.000E+00	1.890E+02
AG-110M	8.580E-01	8.120E-01	0.000E+00	1.550E+00	0.000E+00	2.280E+02	0.000E+00	4.940E-01
SN-113	2.407E+03	9.257E+02	9.257E+02	1.851E+02	2.222E+03	2.592E+03	0.000E+00	1.851E+04
SN-117M	2.201E+03	8.466E+02	8.466E+02	1.693E+02	2.032E+03	2.371E+03	0.000E+00	1.693E+04
SB-124	6.978E+02	1.286E+01	1.583E+00	0.000E+00	6.095E+02	1.406E+04	0.000E+00	2.723E+02
SB-125	4.520E+02	4.940E+00	4.320E-01	0.000E+00	3.974E+02	3.518E+03	0.000E+00	1.057E+02
SB-126	2.742E+02	5.606E+00	1.551E+00	0.000E+00	1.966E+02	1.623E+04	0.000E+00	9.849E+01
TE-123M	5.931E+02	2.281E+02	2.281E+02	4.563E+01	5.475E+02	6.388E+02	0.000E+00	4.563E+03
TE-125M	2.760E+03	9.950E+02	7.710E+02	0.000E+00	0.000E+00	8.150E+03	0.000E+00	3.690E+02

APPENDIX D

A_i Teen Dose Factors for use in the Liquid Dose Calculations

Age group:	TEEN	Pathway:	Fresh Water Fish - Sport (FFSP)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
TE-127	1.960E+01	6.950E+00	1.350E+01	7.940E+01	0.000E+00	1.510E+03	0.000E+00	4.220E+00
TE-127M	7.010E+03	2.490E+03	1.670E+03	2.840E+04	0.000E+00	1.750E+04	0.000E+00	8.340E+02
TE-129	1.770E-05	6.600E-06	1.260E-05	7.430E-05	0.000E+00	9.680E-05	0.000E+00	4.310E-06
TE-129M	1.160E+04	4.320E+03	3.760E+03	4.870E+04	0.000E+00	4.370E+04	0.000E+00	1.840E+03
TE-131	9.400E-17	3.870E-17	7.240E-17	4.110E-16	0.000E+00	7.710E-18	0.000E+00	2.940E-17
TE-131M	1.020E+03	4.900E+02	7.370E+02	5.110E+03	0.000E+00	3.930E+04	0.000E+00	4.090E+02
TE-132	2.060E+03	1.300E+03	1.370E+03	1.250E+04	0.000E+00	4.130E+04	0.000E+00	1.230E+03
I-130	7.320E+00	2.120E+01	1.730E+03	3.260E+01	0.000E+00	1.630E+01	0.000E+00	8.460E+00
I-131	1.470E+02	2.060E+02	6.000E+04	3.540E+02	0.000E+00	4.070E+01	0.000E+00	1.100E+02
I-132	5.520E-03	1.440E-02	4.870E-01	2.280E-02	0.000E+00	6.290E-03	0.000E+00	5.180E-03
I-133	2.470E+01	4.190E+01	5.850E+03	7.350E+01	0.000E+00	3.170E+01	0.000E+00	1.280E+01
I-134	2.220E-08	5.890E-08	9.810E-07	9.280E-08	0.000E+00	7.760E-10	0.000E+00	2.110E-08
I-135	1.350E+00	3.480E+00	2.240E+02	5.490E+00	0.000E+00	3.850E+00	0.000E+00	1.290E+00
CS-134	3.050E+05	7.180E+05	0.000E+00	2.280E+05	8.710E+04	8.930E+03	0.000E+00	3.330E+05
CS-136	2.970E+04	1.170E+05	0.000E+00	6.370E+04	1.000E+04	9.410E+03	0.000E+00	7.860E+04
CS-137	4.090E+05	5.440E+05	0.000E+00	1.850E+05	7.190E+04	7.730E+03	0.000E+00	1.890E+05
CS-138	9.580E-12	1.840E-11	0.000E+00	1.360E-11	1.580E-12	8.340E-15	0.000E+00	9.190E-12
BA-133	2.561E+01	9.851E+00	9.851E+00	1.970E+00	2.364E+01	2.758E+01	0.000E+00	1.970E+02
BA-139	6.170E-06	4.340E-09	0.000E+00	4.090E-09	2.990E-09	5.510E-05	0.000E+00	1.800E-07
BA-140	1.960E+02	2.410E-01	0.000E+00	8.160E-02	1.620E-01	3.030E+02	0.000E+00	1.260E+01
BA-141	9.450E-25	7.050E-28	0.000E+00	6.550E-28	4.830E-28	2.010E-30	0.000E+00	3.150E-26
BA-142	2.750E-42	2.750E-45	0.000E+00	2.320E-45	1.830E-45	8.430E-54	0.000E+00	1.690E-43
LA-140	1.050E-01	5.160E-02	0.000E+00	0.000E+00	0.000E+00	2.960E+03	0.000E+00	1.370E-02
LA-142	2.350E-07	1.040E-07	0.000E+00	0.000E+00	0.000E+00	3.180E-03	0.000E+00	2.600E-08
CE-141	2.370E-02	1.590E-02	0.000E+00	7.460E-03	0.000E+00	4.540E+01	0.000E+00	1.820E-03

APPENDIX D

A_i Teen Dose Factors for use in the Liquid Dose Calculations

Age group:	TEEN	Pathway:	Fresh Water Fish - Sport (FFSP)			Units:	mrem/hr / µCi/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
CE-143	2.590E-03	1.880E+00	0.000E+00	8.450E-04	0.000E+00	5.660E+01	0.000E+00	2.100E-04
CE-144	1.270E+00	5.240E-01	0.000E+00	3.130E-01	0.000E+00	3.180E+02	0.000E+00	6.810E-02
PR-143	5.680E-01	2.270E-01	0.000E+00	1.320E-01	0.000E+00	1.870E+03	0.000E+00	2.830E-02
PR-144	1.690E-28	6.900E-29	0.000E+00	3.960E-29	0.000E+00	1.860E-31	0.000E+00	8.550E-30
ND-147	4.020E-01	4.370E-01	0.000E+00	2.560E-01	0.000E+00	1.580E+03	0.000E+00	2.620E-02
EU-152	2.234E+01	5.380E+00	0.000E+00	2.499E+01	0.000E+00	1.979E+03	0.000E+00	4.742E+00
W-187	1.590E+02	1.300E+02	0.000E+00	0.000E+00	0.000E+00	3.510E+04	0.000E+00	4.540E+01
NP-239	2.390E-02	2.260E-03	0.000E+00	7.080E-03	0.000E+00	3.630E+02	0.000E+00	1.250E-03

APPENDIX D

A_i Teen Dose Factors for use in the Liquid Dose Calculations

Age group:	TEEN	Pathway:	Shoreline Sediment (SHDp)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C-14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NA-24	2.390E+00	2.390E+00	2.390E+00	2.390E+00	2.390E+00	2.390E+00	2.770E+00	2.390E+00
P-32	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CR-51	9.310E-01	9.310E-01	9.310E-01	9.310E-01	9.310E-01	9.310E-01	1.100E+00	9.310E-01
MN-54	2.770E+02	2.770E+02	2.770E+02	2.770E+02	2.770E+02	2.770E+02	3.250E+02	2.770E+02
MN-56	1.800E-01	1.800E-01	1.800E-01	1.800E-01	1.800E-01	1.800E-01	2.130E-01	1.800E-01
FE-55	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
FE-59	5.450E+01	5.450E+01	5.450E+01	5.450E+01	5.450E+01	5.450E+01	6.410E+01	5.450E+01
CO-58	7.570E+01	7.570E+01	7.570E+01	7.570E+01	7.570E+01	7.570E+01	8.870E+01	7.570E+01
CO-60	4.300E+03	4.300E+03	4.300E+03	4.300E+03	4.300E+03	4.300E+03	5.050E+03	4.300E+03
NI-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NI-65	5.930E-02	5.930E-02	5.930E-02	5.930E-02	5.930E-02	5.930E-02	6.900E-02	5.930E-02
CU-64	1.210E-01	1.210E-01	1.210E-01	1.210E-01	1.210E-01	1.210E-01	1.370E-01	1.210E-01
ZN-65	1.490E+02	1.490E+02	1.490E+02	1.490E+02	1.490E+02	1.490E+02	1.720E+02	1.490E+02
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE-75	9.028E+01	9.028E+01	9.028E+01	9.028E+01	9.028E+01	9.028E+01	1.056E+02	9.028E+01
BR-83	9.730E-04	9.730E-04	9.730E-04	9.730E-04	9.730E-04	9.730E-04	1.410E-03	9.730E-04
BR-84	4.050E-02	4.050E-02	4.050E-02	4.050E-02	4.050E-02	4.050E-02	4.720E-02	4.050E-02
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	1.800E+00	1.800E+00	1.800E+00	1.800E+00	1.800E+00	1.800E+00	2.050E+00	1.800E+00
RB-88	6.610E-03	6.610E-03	6.610E-03	6.610E-03	6.610E-03	6.610E-03	7.550E-03	6.610E-03
RB-89	2.460E-02	2.460E-02	2.460E-02	2.460E-02	2.460E-02	2.460E-02	2.950E-02	2.460E-02
SR-89	4.320E-03	4.320E-03	4.320E-03	4.320E-03	4.320E-03	4.320E-03	5.020E-03	4.320E-03
SR-90	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

APPENDIX D

A_i Teen Dose Factors for use in the Liquid Dose Calculations

Age group:	TEEN	Pathway:	Shoreline Sediment (SHDp)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-91	4.290E-01	4.290E-01	4.290E-01	4.290E-01	4.290E-01	4.290E-01	5.020E-01	4.290E-01
SR-92	1.550E-01	1.550E-01	1.550E-01	1.550E-01	1.550E-01	1.550E-01	1.720E-01	1.550E-01
Y-90	8.970E-04	8.970E-04	8.970E-04	8.970E-04	8.970E-04	8.970E-04	1.060E-03	8.970E-04
Y-91	2.140E-01	2.140E-01	2.140E-01	2.140E-01	2.140E-01	2.140E-01	2.410E-01	2.140E-01
Y-91M	2.000E-02	2.000E-02	2.000E-02	2.000E-02	2.000E-02	2.000E-02	2.320E-02	2.000E-02
Y-92	3.600E-02	3.600E-02	3.600E-02	3.600E-02	3.600E-02	3.600E-02	4.280E-02	3.600E-02
Y-93	3.660E-02	3.660E-02	3.660E-02	3.660E-02	3.660E-02	3.660E-02	5.010E-02	3.660E-02
ZR-95	4.890E+01	4.890E+01	4.890E+01	4.890E+01	4.890E+01	4.890E+01	5.670E+01	4.890E+01
ZR-97	5.910E-01	5.910E-01	5.910E-01	5.910E-01	5.910E-01	5.910E-01	6.880E-01	5.910E-01
NB-95	2.730E+01	2.730E+01	2.730E+01	2.730E+01	2.730E+01	2.730E+01	3.210E+01	2.730E+01
MO-99	7.980E-01	7.980E-01	7.980E-01	7.980E-01	7.980E-01	7.980E-01	9.240E-01	7.980E-01
TC-99M	3.680E-02	3.680E-02	3.680E-02	3.680E-02	3.680E-02	3.680E-02	4.210E-02	3.680E-02
TC-101	4.070E-03	4.070E-03	4.070E-03	4.070E-03	4.070E-03	4.070E-03	4.520E-03	4.070E-03
RU-103	2.160E+01	2.160E+01	2.160E+01	2.160E+01	2.160E+01	2.160E+01	2.520E+01	2.160E+01
RU-105	1.270E-01	1.270E-01	1.270E-01	1.270E-01	1.270E-01	1.270E-01	1.440E-01	1.270E-01
RU-106	8.430E+01	8.430E+01	8.430E+01	8.430E+01	8.430E+01	8.430E+01	1.010E+02	8.430E+01
AG-108M	1.030E+04	1.030E+04	1.030E+04	1.030E+04	1.030E+04	1.030E+04	1.206E+04	1.030E+04
AG-110M	6.870E+02	6.870E+02	6.870E+02	6.870E+02	6.870E+02	6.870E+02	8.010E+02	6.870E+02
SN-113	2.982E+00	2.982E+00	2.982E+00	2.982E+00	2.982E+00	2.982E+00	3.489E+00	2.982E+00
SN-117M	4.167E+00	4.167E+00	4.167E+00	4.167E+00	4.167E+00	4.167E+00	4.875E+00	4.167E+00
SB-124	1.195E+02	1.195E+02	1.195E+02	1.195E+02	1.195E+02	1.195E+02	1.379E+02	1.195E+02
SB-125	4.661E+02	4.661E+02	4.661E+02	4.661E+02	4.661E+02	4.661E+02	5.263E+02	4.661E+02
SB-126	1.686E+01	1.686E+01	1.686E+01	1.686E+01	1.686E+01	1.686E+01	1.894E+01	1.686E+01
TE-123M	3.383E+01	3.383E+01	3.383E+01	3.383E+01	3.383E+01	3.383E+01	3.958E+01	3.383E+01
TE-125M	3.100E-01	3.100E-01	3.100E-01	3.100E-01	3.100E-01	3.100E-01	4.250E-01	3.100E-01

APPENDIX D

A_i Teen Dose Factors for use in the Liquid Dose Calculations

Age group:	TEEN	Pathway:	Shoreline Sediment (SHDp)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
TE-127	5.950E-04	5.950E-04	5.950E-04	5.950E-04	5.950E-04	5.950E-04	6.540E-04	5.950E-04
TE-127M	1.830E-02	1.830E-02	1.830E-02	1.830E-02	1.830E-02	1.830E-02	2.160E-02	1.830E-02
TE-129	5.240E-03	5.240E-03	5.240E-03	5.240E-03	5.240E-03	5.240E-03	6.200E-03	5.240E-03
TE-129M	3.950E+00	3.950E+00	3.950E+00	3.950E+00	3.950E+00	3.950E+00	4.620E+00	3.950E+00
TE-131	5.830E-03	5.830E-03	5.830E-03	5.830E-03	5.830E-03	5.830E-03	6.890E+00	5.830E-03
TE-131M	1.600E+00	1.600E+00	1.600E+00	1.600E+00	1.600E+00	1.600E+00	1.890E+00	1.600E+00
TE-132	8.460E-01	8.460E-01	8.460E-01	8.460E-01	8.460E-01	8.460E-01	9.950E-01	8.460E-01
I-130	1.100E+00	1.100E+00	1.100E+00	1.100E+00	1.100E+00	1.100E+00	1.340E+00	1.100E+00
I-131	3.440E+00	3.440E+00	3.440E+00	3.440E+00	3.440E+00	3.440E+00	4.170E+00	3.440E+00
I-132	2.490E-01	2.490E-01	2.490E-01	2.490E-01	2.490E-01	2.490E-01	2.930E-01	2.490E-01
I-133	4.900E-01	4.900E-01	4.900E-01	4.900E-01	4.900E-01	4.900E-01	5.960E-01	4.900E-01
I-134	8.930E-02	8.930E-02	8.930E-02	8.930E-02	8.930E-02	8.930E-02	1.060E-01	8.930E-02
I-135	5.050E-01	5.050E-01	5.050E-01	5.050E-01	5.050E-01	5.050E-01	5.890E-01	5.050E-01
CS-134	1.370E+03	1.370E+03	1.370E+03	1.370E+03	1.370E+03	1.370E+03	1.600E+03	1.370E+03
CS-136	3.010E+01	3.010E+01	3.010E+01	3.010E+01	3.010E+01	3.010E+01	3.420E+01	3.010E+01
CS-137	2.050E+03	2.050E+03	2.050E+03	2.050E+03	2.050E+03	2.050E+03	2.400E+03	2.050E+03
CS-138	7.170E-02	7.170E-02	7.170E-02	7.170E-02	7.170E-02	7.170E-02	8.200E-02	7.170E-02
BA-133	1.761E+03	1.761E+03	1.761E+03	1.761E+03	1.761E+03	1.761E+03	2.061E+03	1.761E+03
BA-139	2.120E-02	2.120E-02	2.120E-02	2.120E-02	2.120E-02	2.120E-02	2.380E-02	2.120E-02
BA-140	4.100E+00	4.100E+00	4.100E+00	4.100E+00	4.100E+00	4.100E+00	4.690E+00	4.100E+00
BA-141	8.330E-03	8.330E-03	8.330E-03	8.330E-03	8.330E-03	8.330E-03	9.490E-03	8.330E-03
BA-142	8.970E-03	8.970E-03	8.970E-03	8.970E-03	8.970E-03	8.970E-03	1.020E-02	8.970E-03
LA-140	3.840E+00	3.840E+00	3.840E+00	3.840E+00	3.840E+00	3.840E+00	4.350E+00	3.840E+00
LA-142	1.520E-01	1.520E-01	1.520E-01	1.520E-01	1.520E-01	1.520E-01	1.820E-01	1.520E-01
CE-141	2.730E+00	2.730E+00	2.730E+00	2.730E+00	2.730E+00	2.730E+00	3.080E+00	2.730E+00

APPENDIX D

A_i Teen Dose Factors for use in the Liquid Dose Calculations

Age group:	TEEN	Pathway:	Shoreline Sediment (SHDp)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
CE-143	4.620E-01	4.620E-01	4.620E-01	4.620E-01	4.620E-01	4.620E-01	5.250E-01	4.620E-01
CE-144	1.390E+01	1.390E+01	1.390E+01	1.390E+01	1.390E+01	1.390E+01	1.610E+01	1.390E+01
PR-143	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR-144	3.670E-04	3.670E-04	3.670E-04	3.670E-04	3.670E-04	3.670E-04	4.220E-04	3.670E-04
ND-147	1.680E+00	1.680E+00	1.680E+00	1.680E+00	1.680E+00	1.680E+00	2.010E+00	1.680E+00
EU-152	2.969E+03	2.969E+03	2.969E+03	2.969E+03	2.969E+03	2.969E+03	3.436E+03	2.969E+03
W-187	4.700E-01	4.700E-01	4.700E-01	4.700E-01	4.700E-01	4.700E-01	5.460E-01	4.700E-01
NP-239	3.420E-01	3.420E-01	3.420E-01	3.420E-01	3.420E-01	3.420E-01	3.960E-01	3.420E-01

APPENDIX E

A_i Child Dose Factors for use in the Liquid Dose Calculations

Age group:	CHILD	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	1.180E+01	1.180E+01	1.180E+01	1.180E+01	1.180E+01	0.000E+00	1.180E+01
C-14	7.030E+02	1.410E+02	1.410E+02	1.410E+02	1.410E+02	1.410E+02	0.000E+00	1.410E+02
NA-24	1.940E+02	1.940E+02	1.940E+02	1.940E+02	1.940E+02	1.940E+02	0.000E+00	1.940E+02
P-32	4.680E+04	2.190E+03	0.000E+00	0.000E+00	0.000E+00	1.290E+03	0.000E+00	1.800E+03
CR-51	0.000E+00	0.000E+00	2.840E-01	7.750E-02	5.180E-01	2.710E+01	0.000E+00	5.110E-01
MN-54	0.000E+00	6.210E+02	0.000E+00	1.740E+02	0.000E+00	5.220E+02	0.000E+00	1.660E+02
MN-56	0.000E+00	7.700E-01	0.000E+00	9.320E-01	0.000E+00	1.120E+02	0.000E+00	1.740E-01
FE-55	6.680E+02	3.550E+02	0.000E+00	0.000E+00	2.010E+02	6.570E+01	0.000E+00	1.100E+02
FE-59	9.520E+02	1.540E+03	0.000E+00	0.000E+00	4.470E+02	1.600E+03	0.000E+00	7.670E+02
CO-58	0.000E+00	1.040E+02	0.000E+00	0.000E+00	0.000E+00	6.070E+02	0.000E+00	3.190E+02
CO-60	0.000E+00	3.080E+02	0.000E+00	0.000E+00	0.000E+00	1.700E+03	0.000E+00	9.070E+02
NI-63	3.130E+04	1.670E+03	0.000E+00	0.000E+00	0.000E+00	1.130E+02	0.000E+00	1.060E+03
NI-65	4.760E+00	4.480E-01	0.000E+00	0.000E+00	0.000E+00	5.490E+01	0.000E+00	2.610E-01
CU-64	0.000E+00	7.390E+00	0.000E+00	1.780E+01	0.000E+00	3.470E+02	0.000E+00	4.460E+00
ZN-65	7.950E+02	2.120E+03	0.000E+00	1.340E+03	0.000E+00	3.720E+02	0.000E+00	1.320E+03
ZN-69	3.190E-04	4.610E-04	0.000E+00	2.800E-04	0.000E+00	2.900E-02	0.000E+00	4.260E-05
SE-75	2.314E+02	8.902E+01	8.902E+01	1.780E+01	2.136E+02	2.492E+02	0.000E+00	1.780E+03
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.060E-01
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.780E-06
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.300E-76
RB-86	0.000E+00	3.820E+03	0.000E+00	0.000E+00	0.000E+00	2.460E+02	0.000E+00	2.350E+03
RB-88	0.000E+00	7.360E-12	0.000E+00	0.000E+00	0.000E+00	3.610E-13	0.000E+00	5.110E-12
RB-89	0.000E+00	6.300E-14	0.000E+00	0.000E+00	0.000E+00	5.490E-16	0.000E+00	5.600E-14
SR-89	7.620E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.950E+03	0.000E+00	2.180E+03
SR-90	9.880E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.330E+04	0.000E+00	2.510E+05

APPENDIX E

A_i Child Dose Factors for use in the Liquid Dose Calculations

Age group:	CHILD	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-91	5.810E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.280E+03	0.000E+00	2.190E+01
SR-92	2.430E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.610E+02	0.000E+00	9.760E-01
Y-90	2.100E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.980E+03	0.000E+00	5.620E-02
Y-91	3.480E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.640E+03	0.000E+00	9.310E-01
Y-91M	9.860E-07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.930E-03	0.000E+00	3.590E-08
Y-92	2.000E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.770E+02	0.000E+00	5.710E-04
Y-93	2.900E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.330E+03	0.000E+00	7.970E-03
ZR-95	6.710E+00	1.470E+00	0.000E+00	2.110E+00	0.000E+00	1.540E+03	0.000E+00	1.310E+00
ZR-97	2.480E-01	3.590E-02	0.000E+00	5.150E-02	0.000E+00	5.440E+03	0.000E+00	2.120E-02
NB-95	1.300E+00	5.040E-01	0.000E+00	4.740E-01	0.000E+00	9.330E+02	0.000E+00	3.600E-01
MO-99	0.000E+00	6.820E+02	0.000E+00	1.460E+03	0.000E+00	5.640E+02	0.000E+00	1.690E+02
TC-99M	1.350E-02	2.640E-02	0.000E+00	3.840E-01	1.340E-02	1.500E+01	0.000E+00	4.380E-01
TC-101	3.330E-17	3.480E-17	0.000E+00	5.940E-16	1.840E-17	1.110E-16	0.000E+00	4.410E-16
RU-103	4.210E+01	0.000E+00	0.000E+00	1.060E+02	0.000E+00	1.090E+03	0.000E+00	1.620E+01
RU-105	5.750E-01	0.000E+00	0.000E+00	5.060E+00	0.000E+00	3.750E+02	0.000E+00	2.090E-01
RU-106	6.800E+02	0.000E+00	0.000E+00	9.180E+02	0.000E+00	1.060E+04	0.000E+00	8.480E+01
AG-108M	1.818E+02	6.991E+01	6.991E+01	1.398E+01	1.678E+02	1.958E+02	0.000E+00	1.398E+03
AG-110M	3.130E+01	2.110E+01	0.000E+00	3.940E+01	0.000E+00	2.510E+03	0.000E+00	1.690E+01
SN-113	7.249E+01	2.788E+01	2.788E+01	5.576E+00	6.692E+01	7.807E+01	0.000E+00	5.576E+02
SN-117M	6.816E+01	2.621E+01	2.621E+01	5.243E+00	6.291E+01	7.340E+01	0.000E+00	5.243E+02
SB-124	6.416E+02	8.324E+00	1.416E+00	0.000E+00	3.561E+02	4.012E+03	0.000E+00	2.249E+02
SB-125	4.161E+02	3.208E+00	3.853E-01	0.000E+00	2.319E+02	9.939E+02	0.000E+00	8.718E+01
SB-126	2.488E+02	3.805E+00	1.459E+00	0.000E+00	1.187E+02	5.015E+03	0.000E+00	8.933E+01
TE-123M	1.366E+02	5.255E+01	5.255E+01	1.051E+01	1.261E+02	1.471E+02	0.000E+00	1.051E+03
TE-125M	6.590E+02	1.790E+02	1.850E+02	0.000E+00	0.000E+00	6.360E+02	0.000E+00	8.780E+01

APPENDIX E

A_i Child Dose Factors for use in the Liquid Dose Calculations

Age group:	CHILD	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
TE-127	1.130E+01	3.050E+00	7.820E+00	3.210E+01	0.000E+00	4.410E+02	0.000E+00	2.420E+00
TE-127M	1.670E+03	4.510E+02	4.000E+02	4.780E+03	0.000E+00	1.360E+03	0.000E+00	1.990E+02
TE-129	5.730E-03	1.600E-03	4.090E-03	1.680E-02	0.000E+00	3.570E-01	0.000E+00	1.360E-03
TE-129M	2.800E+03	7.830E+02	9.030E+02	8.230E+03	0.000E+00	3.420E+03	0.000E+00	4.350E+02
TE-131	1.040E-08	3.160E-09	7.930E-09	3.140E-08	0.000E+00	5.450E-08	0.000E+00	3.090E-09
TE-131M	3.170E+02	1.100E+02	2.260E+02	1.060E+03	0.000E+00	4.450E+03	0.000E+00	1.170E+02
TE-132	5.280E+02	2.340E+02	3.400E+02	2.170E+03	0.000E+00	2.350E+03	0.000E+00	2.820E+02
I-130	8.650E+01	1.750E+02	1.930E+04	2.610E+02	0.000E+00	8.180E+01	0.000E+00	9.010E+01
I-131	9.580E+02	9.630E+02	3.190E+05	1.580E+03	0.000E+00	8.580E+01	0.000E+00	5.470E+02
I-132	1.250E+00	2.300E+00	1.070E+02	3.520E+00	0.000E+00	2.710E+00	0.000E+00	1.060E+00
I-133	2.310E+02	2.850E+02	5.300E+04	4.750E+02	0.000E+00	1.150E+02	0.000E+00	1.080E+02
I-134	1.820E-03	3.370E-03	7.760E-02	5.160E-03	0.000E+00	2.240E-03	0.000E+00	1.550E-03
I-135	2.890E+01	5.210E+01	4.610E+03	7.990E+01	0.000E+00	3.970E+01	0.000E+00	2.460E+01
CS-134	1.360E+04	2.230E+04	0.000E+00	6.920E+03	2.480E+03	1.200E+02	0.000E+00	4.710E+03
CS-136	1.330E+03	3.660E+03	0.000E+00	1.950E+03	2.910E+02	1.290E+02	0.000E+00	2.370E+03
CS-137	1.900E+04	1.820E+04	0.000E+00	5.930E+03	2.130E+03	1.140E+02	0.000E+00	2.690E+03
CS-138	2.440E-06	3.390E-06	0.000E+00	2.380E-06	2.570E-07	1.560E-06	0.000E+00	2.150E-06
BA-133	1.091E+02	4.194E+01	4.194E+01	8.389E+00	1.007E+02	1.174E+02	0.000E+00	8.389E+02
BA-139	5.940E-02	3.170E-05	0.000E+00	2.770E-05	1.860E-05	3.430E+00	0.000E+00	1.720E-03
BA-140	4.700E+03	4.120E+00	0.000E+00	1.340E+00	2.460E+00	2.380E+03	0.000E+00	2.740E+02
BA-141	1.620E-11	9.050E-15	0.000E+00	7.830E-15	5.310E-14	9.210E-12	0.000E+00	5.260E-13
BA-142	1.800E-20	1.300E-23	0.000E+00	1.050E-23	7.630E-24	2.350E-22	0.000E+00	1.010E-21
LA-140	4.780E-01	1.670E-01	0.000E+00	0.000E+00	0.000E+00	4.650E+03	0.000E+00	5.630E-02
LA-142	1.640E-04	5.210E-05	0.000E+00	0.000E+00	0.000E+00	1.030E+01	0.000E+00	1.630E-05
CE-141	2.280E+00	1.140E+00	0.000E+00	4.990E-01	0.000E+00	1.420E+03	0.000E+00	1.690E-01

APPENDIX E

A_i Child Dose Factors for use in the Liquid Dose Calculations

Age group:	CHILD	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
CE-143	3.160E-01	1.710E+02	0.000E+00	7.180E-02	0.000E+00	2.510E+03	0.000E+00	2.480E-02
CE-144	1.210E+02	3.790E+01	0.000E+00	2.100E+01	0.000E+00	9.870E+03	0.000E+00	6.450E+00
PR-143	2.230E+00	6.690E-01	0.000E+00	3.620E-01	0.000E+00	2.400E+03	0.000E+00	1.110E-01
PR-144	2.200E-15	6.800E-16	0.000E+00	3.600E-16	0.000E+00	1.460E-12	0.000E+00	1.110E-16
ND-147	1.570E+00	1.270E+00	0.000E+00	6.990E-01	0.000E+00	2.020E+03	0.000E+00	9.860E-02
EU-152	3.575E+01	6.511E+00	0.000E+00	2.750E+01	0.000E+00	1.070E+03	0.000E+00	7.732E+00
W-187	1.760E+01	1.040E+01	0.000E+00	0.000E+00	0.000E+00	1.460E+03	0.000E+00	4.680E+00
NP-239	2.630E-01	1.890E-02	0.000E+00	5.470E-02	0.000E+00	1.400E+03	0.000E+00	1.330E-02

APPENDIX E

A_i Child Dose Factors for use in the Liquid Dose Calculations

Age group:	CHILD	Pathway:	Fresh Water Fish - Sport (FFSP)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	1.440E-01	1.440E-01	1.440E-01	1.440E-01	1.440E-01	0.000E+00	1.440E-01
C-14	4.380E+04	8.760E+03	8.760E+03	8.760E+03	8.760E+03	8.760E+03	0.000E+00	8.760E+03
NA-24	1.510E+02	1.510E+02	1.510E+02	1.510E+02	1.510E+02	1.510E+02	0.000E+00	1.510E+02
P-32	1.850E+06	8.680E+04	0.000E+00	0.000E+00	0.000E+00	5.130E+04	0.000E+00	7.150E+04
CR-51	0.000E+00	0.000E+00	7.580E-01	2.070E-01	1.380E+00	7.240E+01	0.000E+00	1.370E+00
MN-54	0.000E+00	3.360E+03	0.000E+00	9.420E+02	0.000E+00	2.820E+03	0.000E+00	8.950E+02
MN-56	0.000E+00	1.650E-01	0.000E+00	2.000E-01	0.000E+00	2.400E+01	0.000E+00	3.730E-02
FE-55	9.040E+02	4.790E+02	0.000E+00	0.000E+00	2.710E+02	8.880E+01	0.000E+00	1.490E+02
FE-59	1.280E+03	2.070E+03	0.000E+00	0.000E+00	5.990E+02	2.150E+03	0.000E+00	1.030E+03
CO-58	0.000E+00	7.010E+01	0.000E+00	0.000E+00	0.000E+00	4.090E+02	0.000E+00	2.150E+02
CO-60	0.000E+00	2.080E+02	0.000E+00	0.000E+00	0.000E+00	1.150E+03	0.000E+00	6.130E+02
NI-63	4.230E+04	2.270E+03	0.000E+00	0.000E+00	0.000E+00	1.530E+02	0.000E+00	1.440E+03
NI-65	2.370E-01	2.230E-02	0.000E+00	0.000E+00	0.000E+00	2.740E+00	0.000E+00	1.300E-02
CU-64	0.000E+00	2.590E+00	0.000E+00	6.260E+00	0.000E+00	1.220E+02	0.000E+00	1.570E+00
ZN-65	2.150E+04	5.730E+04	0.000E+00	3.610E+04	0.000E+00	1.010E+04	0.000E+00	3.560E+04
ZN-69	1.080E-06	1.560E-06	0.000E+00	9.470E-07	0.000E+00	9.840E-05	0.000E+00	1.440E-07
SE-75	6.244E+02	2.402E+02	2.402E+02	4.803E+01	5.764E+02	6.725E+02	0.000E+00	4.803E+03
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.340E-02
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.570E-12
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	1.020E+05	0.000E+00	0.000E+00	0.000E+00	6.530E+03	0.000E+00	6.250E+04
RB-88	0.000E+00	1.330E-22	0.000E+00	0.000E+00	0.000E+00	6.510E-24	0.000E+00	9.220E-23
RB-89	0.000E+00	1.580E-26	0.000E+00	0.000E+00	0.000E+00	1.370E-28	0.000E+00	1.400E-26
SR-89	3.070E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.190E+03	0.000E+00	8.780E+02
SR-90	4.010E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.400E+03	0.000E+00	1.020E+05

APPENDIX E

A_i Child Dose Factors for use in the Liquid Dose Calculations

Age group:	CHILD	Pathway:	Fresh Water Fish - Sport (FFSP)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-91	9.800E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.160E+02	0.000E+00	3.700E+00
SR-92	4.580E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.670E+00	0.000E+00	1.840E-02
Y-90	6.240E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.780E+03	0.000E+00	1.670E-02
Y-91	1.170E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.560E+03	0.000E+00	3.130E-01
Y-91M	1.480E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.900E-08	0.000E+00	5.390E-13
Y-92	6.440E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.860E+01	0.000E+00	1.840E-05
Y-93	4.300E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.420E+02	0.000E+00	1.180E-03
ZR-95	2.980E-01	6.550E-02	0.000E+00	9.370E-02	0.000E+00	6.830E+01	0.000E+00	5.830E-02
ZR-97	6.780E-03	9.790E-04	0.000E+00	1.410E-03	0.000E+00	1.480E+02	0.000E+00	5.780E-04
NB-95	5.210E+02	2.030E+02	0.000E+00	1.900E+02	0.000E+00	3.750E+05	0.000E+00	1.450E+02
MO-99	0.000E+00	8.130E+01	0.000E+00	1.740E+02	0.000E+00	6.720E+01	0.000E+00	2.010E+01
TC-99M	6.860E-04	1.350E-03	0.000E+00	1.950E-02	6.830E-04	7.650E-01	0.000E+00	2.230E-02
TC-101	3.610E-33	3.780E-33	0.000E+00	6.440E-32	2.000E-33	1.200E-32	0.000E+00	4.790E-32
RU-103	5.650E+00	0.000E+00	0.000E+00	1.420E+01	0.000E+00	1.460E+02	0.000E+00	2.170E+00
RU-105	1.190E-02	0.000E+00	0.000E+00	1.050E-01	0.000E+00	7.790E+00	0.000E+00	4.330E-03
RU-106	9.190E+01	0.000E+00	0.000E+00	1.240E+02	0.000E+00	1.430E+03	0.000E+00	1.150E+01
AG-108M	2.459E+01	9.459E+00	9.459E+00	1.892E+00	2.270E+01	2.648E+01	0.000E+00	1.892E+02
AG-110M	9.720E-01	6.570E-01	0.000E+00	1.220E+00	0.000E+00	7.810E+01	0.000E+00	5.250E-01
SN-113	2.933E+03	1.128E+03	1.128E+03	2.256E+02	2.708E+03	3.159E+03	0.000E+00	2.256E+04
SN-117M	2.697E+03	1.037E+03	1.037E+03	2.074E+02	2.489E+03	2.904E+03	0.000E+00	2.074E+04
SB-124	8.631E+02	1.120E+01	1.905E+00	0.000E+00	4.790E+02	5.396E+03	0.000E+00	3.025E+02
SB-125	5.628E+02	4.339E+00	5.212E-01	0.000E+00	3.136E+02	1.344E+03	0.000E+00	1.179E+02
SB-126	3.273E+02	5.006E+00	1.919E+00	0.000E+00	1.562E+02	6.598E+03	0.000E+00	1.175E+02
TE-123M	7.373E+02	2.836E+02	2.836E+02	5.671E+01	6.806E+02	7.940E+02	0.000E+00	5.671E+03
TE-125M	3.540E+03	9.610E+02	9.950E+02	0.000E+00	0.000E+00	3.420E+03	0.000E+00	4.730E+02

APPENDIX E

A_i Child Dose Factors for use in the Liquid Dose Calculations

Age group:	CHILD	Pathway:	Fresh Water Fish - Sport (FFSP)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
TE-127	2.520E+01	6.800E+00	1.750E+01	7.170E+01	0.000E+00	9.850E+02	0.000E+00	5.410E+00
TE-127M	9.040E+03	2.430E+03	2.160E+03	2.580E+04	0.000E+00	7.320E+03	0.000E+00	1.070E+03
TE-129	2.280E-05	6.370E-06	1.630E-05	6.680E-05	0.000E+00	1.420E-03	0.000E+00	5.420E-06
TE-129M	1.500E+04	4.190E+03	4.840E+03	4.410E+04	0.000E+00	1.830E+04	0.000E+00	2.330E+03
TE-131	1.210E-16	3.680E-17	9.220E-17	3.650E-16	0.000E+00	6.330E-16	0.000E+00	3.590E-17
TE-131M	1.300E+03	4.500E+02	9.250E+02	4.350E+03	0.000E+00	1.820E+04	0.000E+00	4.790E+02
TE-132	2.570E+03	1.140E+03	1.650E+03	1.050E+04	0.000E+00	1.140E+04	0.000E+00	1.370E+03
I-130	8.950E+00	1.810E+01	1.990E+03	2.700E+01	0.000E+00	8.460E+00	0.000E+00	9.320E+00
I-131	1.860E+02	1.870E+02	6.190E+04	3.070E+02	0.000E+00	1.670E+01	0.000E+00	1.060E+02
I-132	6.830E-03	1.250E-02	5.820E-01	1.920E-02	0.000E+00	1.480E-02	0.000E+00	5.770E-03
I-133	3.140E+01	3.880E+01	7.210E+03	6.470E+01	0.000E+00	1.560E+01	0.000E+00	1.470E+01
I-134	2.750E-08	5.100E-08	1.170E-06	7.800E-08	0.000E+00	3.380E-08	0.000E+00	2.350E-08
I-135	1.670E+00	3.010E+00	2.660E+02	4.610E+00	0.000E+00	2.290E+00	0.000E+00	1.420E+00
CS-134	3.680E+05	6.040E+05	0.000E+00	1.870E+05	6.710E+04	3.250E+03	0.000E+00	1.270E+05
CS-136	3.510E+04	9.640E+04	0.000E+00	5.130E+04	7.660E+03	3.390E+03	0.000E+00	6.240E+04
CS-137	5.140E+05	4.920E+05	0.000E+00	1.600E+05	5.770E+04	3.080E+03	0.000E+00	7.270E+04
CS-138	1.210E-11	1.690E-11	0.000E+00	1.190E-11	1.280E-12	7.770E-12	0.000E+00	1.070E-11
BA-133	5.901E+00	2.270E+00	2.270E+00	4.539E-01	5.447E+00	6.355E+00	0.000E+00	4.539E+01
BA-139	7.930E-06	4.230E-09	0.000E+00	3.700E-09	2.490E-09	4.580E-04	0.000E+00	2.300E-07
BA-140	2.480E+02	2.170E-01	0.000E+00	7.060E-02	1.290E-01	1.250E+02	0.000E+00	1.450E+01
BA-141	1.210E-24	6.800E-28	0.000E+00	5.880E-28	3.990E-27	6.920E-25	0.000E+00	3.950E-26
BA-142	3.460E-42	2.490E-45	0.000E+00	2.020E-45	1.470E-45	4.510E-44	0.000E+00	1.930E-43
LA-140	1.310E-01	4.590E-02	0.000E+00	0.000E+00	0.000E+00	1.280E+03	0.000E+00	1.550E-02
LA-142	2.970E-07	9.470E-08	0.000E+00	0.000E+00	0.000E+00	1.880E-02	0.000E+00	2.960E-08
CE-141	3.060E-02	1.520E-02	0.000E+00	6.680E-03	0.000E+00	1.900E+01	0.000E+00	2.260E-03

APPENDIX E

A_i Child Dose Factors for use in the Liquid Dose Calculations

Age group:	CHILD	Pathway:	Fresh Water Fish - Sport (FFSP)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
CE-143	3.320E-03	1.800E+00	0.000E+00	7.550E-04	0.000E+00	2.640E+01	0.000E+00	2.610E-04
CE-144	1.630E+00	5.120E-01	0.000E+00	2.830E-01	0.000E+00	1.330E+02	0.000E+00	8.710E-02
PR-143	7.340E-01	2.200E-01	0.000E+00	1.190E-01	0.000E+00	7.920E+02	0.000E+00	3.640E-02
PR-144	2.180E-28	6.750E-29	0.000E+00	3.570E-29	0.000E+00	1.450E-25	0.000E+00	1.100E-29
ND-147	5.150E-01	4.170E-01	0.000E+00	2.290E-01	0.000E+00	6.610E+02	0.000E+00	3.230E-02
EU-152	2.418E+01	4.404E+00	0.000E+00	1.860E+01	0.000E+00	7.236E+02	0.000E+00	5.230E+00
W-187	2.010E+02	1.190E+02	0.000E+00	0.000E+00	0.000E+00	1.680E+04	0.000E+00	5.350E+01
NP-239	3.080E-02	2.210E-03	0.000E+00	6.390E-03	0.000E+00	1.630E+02	0.000E+00	1.550E-03

APPENDIX E

A_i Child Dose Factors for use in the Liquid Dose Calculations

Age group:	CHILD	Pathway:	Shoreline Sediment (SHDp)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C-14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NA-24	4.990E-01	4.990E-01	4.990E-01	4.990E-01	4.990E-01	4.990E-01	5.780E-01	4.990E-01
P-32	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CR-51	1.950E-01	1.950E-01	1.950E-01	1.950E-01	1.950E-01	1.950E-01	2.300E-01	1.950E-01
MN-54	5.790E+01	5.790E+01	5.790E+01	5.790E+01	5.790E+01	5.790E+01	6.790E+01	5.790E+01
MN-56	3.770E-02	3.770E-02	3.770E-02	3.770E-02	3.770E-02	3.770E-02	4.450E-02	3.770E-02
FE-55	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
FE-59	1.140E+01	1.140E+01	1.140E+01	1.140E+01	1.140E+01	1.140E+01	1.340E+01	1.140E+01
CO-58	1.580E+01	1.580E+01	1.580E+01	1.580E+01	1.580E+01	1.580E+01	1.850E+01	1.580E+01
CO-60	8.980E+02	8.980E+02	8.980E+02	8.980E+02	8.980E+02	8.980E+02	1.060E+03	8.980E+02
NI-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NI-65	1.240E-02	1.240E-02	1.240E-02	1.240E-02	1.240E-02	1.240E-02	1.440E-02	1.240E-02
CU-64	2.530E-02	2.530E-02	2.530E-02	2.530E-02	2.530E-02	2.530E-02	2.870E-02	2.530E-02
ZN-65	3.120E+01	3.120E+01	3.120E+01	3.120E+01	3.120E+01	3.120E+01	3.590E+01	3.120E+01
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE-75	1.886E+01	1.886E+01	1.886E+01	1.886E+01	1.886E+01	1.886E+01	2.207E+01	1.886E+01
BR-83	2.030E-04	2.030E-04	2.030E-04	2.030E-04	2.030E-04	2.030E-04	2.960E-04	2.030E-04
BR-84	8.460E-03	8.460E-03	8.460E-03	8.460E-03	8.460E-03	8.460E-03	9.870E-03	8.460E-03
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	3.750E-01	3.750E-01	3.750E-01	3.750E-01	3.750E-01	3.750E-01	4.290E-01	3.750E-01
RB-88	1.380E-03	1.380E-03	1.380E-03	1.380E-03	1.380E-03	1.380E-03	1.580E-03	1.380E-03
RB-89	5.130E-03	5.130E-03	5.130E-03	5.130E-03	5.130E-03	5.130E-03	6.160E-03	5.130E-03
SR-89	9.030E-04	9.030E-04	9.030E-04	9.030E-04	9.030E-04	9.030E-04	1.050E-03	9.030E-04
SR-90	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

APPENDIX E

A_i Child Dose Factors for use in the Liquid Dose Calculations

Age group:	CHILD	Pathway:	Shoreline Sediment (SHDp)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-91	8.970E-02	8.970E-02	8.970E-02	8.970E-02	8.970E-02	8.970E-02	1.050E-01	8.970E-02
SR-92	3.240E-02	3.240E-02	3.240E-02	3.240E-02	3.240E-02	3.240E-02	3.600E-02	3.240E-02
Y-90	1.880E-04	1.880E-04	1.880E-04	1.880E-04	1.880E-04	1.880E-04	2.220E-04	1.880E-04
Y-91	4.480E-02	4.480E-02	4.480E-02	4.480E-02	4.480E-02	4.480E-02	5.040E-02	4.480E-02
Y-91M	4.190E-03	4.190E-03	4.190E-03	4.190E-03	4.190E-03	4.190E-03	4.850E-03	4.190E-03
Y-92	7.530E-03	7.530E-03	7.530E-03	7.530E-03	7.530E-03	7.530E-03	8.940E-03	7.530E-03
Y-93	7.660E-03	7.660E-03	7.660E-03	7.660E-03	7.660E-03	7.660E-03	1.050E-02	7.660E-03
ZR-95	1.020E+01	1.020E+01	1.020E+01	1.020E+01	1.020E+01	1.020E+01	1.190E+01	1.020E+01
ZR-97	1.240E-01	1.240E-01	1.240E-01	1.240E-01	1.240E-01	1.240E-01	1.440E-01	1.240E-01
NB-95	5.710E+00	5.710E+00	5.710E+00	5.710E+00	5.710E+00	5.710E+00	6.710E+00	5.710E+00
MO-99	1.670E-01	1.670E-01	1.670E-01	1.670E-01	1.670E-01	1.670E-01	1.930E-01	1.670E-01
TC-99M	7.680E-03	7.680E-03	7.680E-03	7.680E-03	7.680E-03	7.680E-03	8.810E-03	7.680E-03
TC-101	8.500E-04	8.500E-04	8.500E-04	8.500E-04	8.500E-04	8.500E-04	9.440E-04	8.500E-04
RU-103	4.520E+00	4.520E+00	4.520E+00	4.520E+00	4.520E+00	4.520E+00	5.270E+00	4.520E+00
RU-105	2.660E-02	2.660E-02	2.660E-02	2.660E-02	2.660E-02	2.660E-02	3.010E-02	2.660E-02
RU-106	1.760E+01	1.760E+01	1.760E+01	1.760E+01	1.760E+01	1.760E+01	2.110E+01	1.760E+01
AG-108M	2.153E+03	2.153E+03	2.153E+03	2.153E+03	2.153E+03	2.153E+03	2.519E+03	2.153E+03
AG-110M	1.440E+02	1.440E+02	1.440E+02	1.440E+02	1.440E+02	1.440E+02	1.670E+02	1.440E+02
SN-113	6.230E-01	6.230E-01	6.230E-01	6.230E-01	6.230E-01	6.230E-01	7.290E-01	6.230E-01
SN-117M	8.707E-01	8.707E-01	8.707E-01	8.707E-01	8.707E-01	8.707E-01	1.019E+00	8.707E-01
SB-124	2.497E+01	2.497E+01	2.497E+01	2.497E+01	2.497E+01	2.497E+01	2.882E+01	2.497E+01
SB-125	9.740E+01	9.740E+01	9.740E+01	9.740E+01	9.740E+01	9.740E+01	1.100E+02	9.740E+01
SB-126	3.523E+00	3.523E+00	3.523E+00	3.523E+00	3.523E+00	3.523E+00	3.958E+00	3.523E+00
TE-123M	7.069E+00	7.069E+00	7.069E+00	7.069E+00	7.069E+00	7.069E+00	8.270E+00	7.069E+00
TE-125M	6.480E-02	6.480E-02	6.480E-02	6.480E-02	6.480E-02	6.480E-02	8.880E-02	6.480E-02

APPENDIX E

A_i Child Dose Factors for use in the Liquid Dose Calculations

Age group:	CHILD	Pathway:	Shoreline Sediment (SHDp)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
TE-127	1.240E-04	1.240E-04	1.240E-04	1.240E-04	1.240E-04	1.240E-04	1.370E-04	1.240E-04
TE-127M	3.830E-03	3.830E-03	3.830E-03	3.830E-03	3.830E-03	3.830E-03	4.520E-03	3.830E-03
TE-129	1.100E-03	1.100E-03	1.100E-03	1.100E-03	1.100E-03	1.100E-03	1.300E-03	1.100E-03
TE-129M	8.260E-01	8.260E-01	8.260E-01	8.260E-01	8.260E-01	8.260E-01	9.650E-01	8.260E-01
TE-131	1.220E-03	1.220E-03	1.220E-03	1.220E-03	1.220E-03	1.220E-03	1.440E+00	1.220E-03
TE-131M	3.350E-01	3.350E-01	3.350E-01	3.350E-01	3.350E-01	3.350E-01	3.950E-01	3.350E-01
TE-132	1.770E-01	1.770E-01	1.770E-01	1.770E-01	1.770E-01	1.770E-01	2.080E-01	1.770E-01
I-130	2.300E-01	2.300E-01	2.300E-01	2.300E-01	2.300E-01	2.300E-01	2.790E-01	2.300E-01
I-131	7.180E-01	7.180E-01	7.180E-01	7.180E-01	7.180E-01	7.180E-01	8.720E-01	7.180E-01
I-132	5.200E-02	5.200E-02	5.200E-02	5.200E-02	5.200E-02	5.200E-02	6.120E-02	5.200E-02
I-133	1.020E-01	1.020E-01	1.020E-01	1.020E-01	1.020E-01	1.020E-01	1.240E-01	1.020E-01
I-134	1.870E-02	1.870E-02	1.870E-02	1.870E-02	1.870E-02	1.870E-02	2.210E-02	1.870E-02
I-135	1.050E-01	1.050E-01	1.050E-01	1.050E-01	1.050E-01	1.050E-01	1.230E-01	1.050E-01
CS-134	2.860E+02	2.860E+02	2.860E+02	2.860E+02	2.860E+02	2.860E+02	3.340E+02	2.860E+02
CS-136	6.300E+00	6.300E+00	6.300E+00	6.300E+00	6.300E+00	6.300E+00	7.140E+00	6.300E+00
CS-137	4.290E+02	4.290E+02	4.290E+02	4.290E+02	4.290E+02	4.290E+02	5.010E+02	4.290E+02
CS-138	1.500E-02	1.500E-02	1.500E-02	1.500E-02	1.500E-02	1.500E-02	1.710E-02	1.500E-02
BA-133	3.680E+02	3.680E+02	3.680E+02	3.680E+02	3.680E+02	3.680E+02	4.306E+02	3.680E+02
BA-139	4.420E-03	4.420E-03	4.420E-03	4.420E-03	4.420E-03	4.420E-03	4.970E-03	4.420E-03
BA-140	8.570E-01	8.570E-01	8.570E-01	8.570E-01	8.570E-01	8.570E-01	9.800E-01	8.570E-01
BA-141	1.740E-03	1.740E-03	1.740E-03	1.740E-03	1.740E-03	1.740E-03	1.980E-03	1.740E-03
BA-142	1.870E-03	1.870E-03	1.870E-03	1.870E-03	1.870E-03	1.870E-03	2.130E-03	1.870E-03
LA-140	8.020E-01	8.020E-01	8.020E-01	8.020E-01	8.020E-01	8.020E-01	9.090E-01	8.020E-01
LA-142	3.170E-02	3.170E-02	3.170E-02	3.170E-02	3.170E-02	3.170E-02	3.810E-02	3.170E-02
CE-141	5.700E-01	5.700E-01	5.700E-01	5.700E-01	5.700E-01	5.700E-01	6.430E-01	5.700E-01

APPENDIX E

A_i Child Dose Factors for use in the Liquid Dose Calculations

Age group:	CHILD	Pathway:	Shoreline Sediment (SHDp)			Units:	mrem/hr / µCi/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
CE-143	9.650E-02	9.650E-02	9.650E-02	9.650E-02	9.650E-02	9.650E-02	1.100E-01	9.650E-02
CE-144	2.900E+00	2.900E+00	2.900E+00	2.900E+00	2.900E+00	2.900E+00	3.360E+00	2.900E+00
PR-143	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR-144	7.660E-05	7.660E-05	7.660E-05	7.660E-05	7.660E-05	7.660E-05	8.810E-05	7.660E-05
ND-147	3.500E-01	3.500E-01	3.500E-01	3.500E-01	3.500E-01	3.500E-01	4.200E-01	3.500E-01
EU-152	6.203E+02	6.203E+02	6.203E+02	6.203E+02	6.203E+02	6.203E+02	7.180E+02	6.203E+02
W-187	9.820E-02	9.820E-02	9.820E-02	9.820E-02	9.820E-02	9.820E-02	1.140E-01	9.820E-02
NP-239	7.140E-02	7.140E-02	7.140E-02	7.140E-02	7.140E-02	7.140E-02	8.270E-02	7.140E-02

APPENDIX F

A_i Infant Dose Factors for use in the Liquid Dose Calculations

Age group:	INFANT	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / µCi/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
H-3	0.000E+00	1.160E+01	1.160E+01	1.160E+01	1.160E+01	1.160E+01	0.000E+00	1.160E+01
C-14	8.920E+02	1.900E+02	1.900E+02	1.900E+02	1.900E+02	1.900E+02	0.000E+00	1.900E+02
NA-24	2.190E+02	2.190E+02	2.190E+02	2.190E+02	2.190E+02	2.190E+02	0.000E+00	2.190E+02
P-32	6.240E+04	3.670E+03	0.000E+00	0.000E+00	0.000E+00	8.450E+02	0.000E+00	2.420E+03
CR-51	0.000E+00	0.000E+00	3.420E-01	7.470E-02	6.650E-01	1.530E+01	0.000E+00	5.240E-01
MN-54	0.000E+00	7.480E+02	0.000E+00	1.660E+02	0.000E+00	2.750E+02	0.000E+00	1.690E+02
MN-56	0.000E+00	1.220E+00	0.000E+00	1.050E+00	0.000E+00	1.110E+02	0.000E+00	2.100E-01
FE-55	5.230E+02	3.380E+02	0.000E+00	0.000E+00	1.650E+02	4.290E+01	0.000E+00	9.030E+01
FE-59	1.150E+03	2.010E+03	0.000E+00	0.000E+00	5.940E+02	9.590E+02	0.000E+00	7.910E+02
CO-58	0.000E+00	1.350E+02	0.000E+00	0.000E+00	0.000E+00	3.360E+02	0.000E+00	3.360E+02
CO-60	0.000E+00	4.060E+02	0.000E+00	0.000E+00	0.000E+00	9.670E+02	0.000E+00	9.590E+02
NI-63	2.390E+04	1.470E+03	0.000E+00	0.000E+00	0.000E+00	7.340E+01	0.000E+00	8.280E+02
NI-65	6.520E+00	7.380E-01	0.000E+00	0.000E+00	0.000E+00	5.620E+01	0.000E+00	3.360E-01
CU-64	0.000E+00	1.190E+01	0.000E+00	2.010E+01	0.000E+00	2.440E+02	0.000E+00	5.500E+00
ZN-65	6.910E+02	2.370E+03	0.000E+00	1.150E+03	0.000E+00	2.000E+03	0.000E+00	1.090E+03
ZN-69	4.390E-04	7.910E-04	0.000E+00	3.290E-04	0.000E+00	6.450E-02	0.000E+00	5.890E-05
SE-75	3.609E+02	1.388E+02	1.388E+02	2.776E+01	3.331E+02	3.886E+02	0.000E+00	2.776E+03
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.200E-01
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.220E-06
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.800E-76
RB-86	0.000E+00	6.280E+03	0.000E+00	0.000E+00	0.000E+00	1.610E+02	0.000E+00	3.100E+03
RB-88	0.000E+00	1.250E-11	0.000E+00	0.000E+00	0.000E+00	1.220E-11	0.000E+00	6.840E-12
RB-89	0.000E+00	9.960E-14	0.000E+00	0.000E+00	0.000E+00	3.390E-14	0.000E+00	6.860E-14
SR-89	9.380E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.930E+03	0.000E+00	2.690E+03
SR-90	6.960E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.690E+03	0.000E+00	1.770E+05

APPENDIX F

A_i Infant Dose Factors for use in the Liquid Dose Calculations

Age group:	INFANT	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / µCi/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-91	7.830E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.270E+02	0.000E+00	2.830E+01
SR-92	3.350E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.610E+02	0.000E+00	1.240E+00
Y-90	2.870E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.970E+03	0.000E+00	7.700E-02
Y-91	4.230E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.030E+03	0.000E+00	1.130E+00
Y-91M	1.350E-06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.510E-03	0.000E+00	4.610E-08
Y-92	2.740E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.240E+02	0.000E+00	7.710E-04
Y-93	4.010E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.170E+03	0.000E+00	1.090E-02
ZR-95	7.710E+00	1.880E+00	0.000E+00	2.020E+00	0.000E+00	9.350E+02	0.000E+00	1.330E+00
ZR-97	3.400E-01	5.840E-02	0.000E+00	5.890E-02	0.000E+00	3.720E+03	0.000E+00	2.670E-02
NB-95	1.560E+00	6.440E-01	0.000E+00	4.620E-01	0.000E+00	5.440E+02	0.000E+00	3.720E-01
MO-99	0.000E+00	1.130E+03	0.000E+00	1.680E+03	0.000E+00	3.710E+02	0.000E+00	2.200E+02
TC-99M	1.810E-02	3.740E-02	0.000E+00	4.020E-01	1.950E-02	1.090E+01	0.000E+00	4.820E-01
TC-101	4.570E-17	5.750E-17	0.000E+00	6.840E-16	3.140E-17	9.780E-15	0.000E+00	5.690E-16
RU-103	5.520E+01	0.000E+00	0.000E+00	1.150E+02	0.000E+00	6.710E+02	0.000E+00	1.850E+01
RU-105	7.850E-01	0.000E+00	0.000E+00	5.770E+00	0.000E+00	3.120E+02	0.000E+00	2.640E-01
RU-106	9.060E+02	0.000E+00	0.000E+00	1.070E+03	0.000E+00	6.880E+03	0.000E+00	1.130E+02
AG-108M	3.800E+02	1.462E+02	1.462E+02	2.923E+01	3.508E+02	4.092E+02	0.000E+00	2.923E+03
AG-110M	3.740E+01	2.730E+01	0.000E+00	3.910E+01	0.000E+00	1.420E+03	0.000E+00	1.810E+01
SN-113	1.407E+02	5.412E+01	5.412E+01	1.082E+01	1.299E+02	1.515E+02	0.000E+00	1.082E+03
SN-117M	1.358E+02	5.224E+01	5.224E+01	1.045E+01	1.254E+02	1.463E+02	0.000E+00	1.045E+03
SB-124	8.004E+02	1.178E+01	2.125E+00	0.000E+00	5.012E+02	2.469E+03	0.000E+00	2.480E+02
SB-125	4.626E+02	4.475E+00	5.791E-01	0.000E+00	2.903E+02	6.168E+02	0.000E+00	9.515E+01
SB-126	2.949E+02	5.780E+00	2.264E+00	0.000E+00	1.855E+02	3.055E+03	0.000E+00	1.065E+02
TE-123M	3.428E+02	1.319E+02	1.319E+02	2.637E+01	3.164E+02	3.692E+02	0.000E+00	2.637E+03
TE-125M	8.710E+02	2.910E+02	2.930E+02	0.000E+00	0.000E+00	4.150E+02	0.000E+00	1.180E+02

APPENDIX F

A_i Infant Dose Factors for use in the Liquid Dose Calculations

Age group:	INFANT	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / µCi/ml	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
TE-127	1.550E+01	5.200E+00	1.260E+01	3.790E+01	0.000E+00	3.260E+02	0.000E+00	3.340E+00
TE-127M	2.190E+03	7.280E+02	6.340E+02	5.400E+03	0.000E+00	8.850E+02	0.000E+00	2.660E+02
TE-129	7.860E-03	2.710E-03	6.590E-03	1.960E-02	0.000E+00	6.280E-01	0.000E+00	1.840E-03
TE-129M	3.720E+03	1.280E+03	1.430E+03	9.310E+03	0.000E+00	2.220E+03	0.000E+00	5.730E+02
TE-131	1.420E-08	5.250E-09	1.270E-08	3.640E-08	0.000E+00	5.750E-07	0.000E+00	3.990E-09
TE-131M	4.330E+02	1.740E+02	3.540E+02	1.200E+03	0.000E+00	2.940E+03	0.000E+00	1.440E+02
TE-132	7.030E+02	3.480E+02	5.140E+02	2.180E+03	0.000E+00	1.290E+03	0.000E+00	3.250E+02
I-130	1.150E+02	2.530E+02	2.840E+04	2.780E+02	0.000E+00	5.430E+01	0.000E+00	1.020E+02
I-131	1.290E+03	1.520E+03	5.010E+05	1.780E+03	0.000E+00	5.440E+01	0.000E+00	6.700E+02
I-132	1.680E+00	3.410E+00	1.600E+02	3.800E+00	0.000E+00	2.760E+00	0.000E+00	1.210E+00
I-133	3.150E+02	4.590E+02	8.350E+04	5.400E+02	0.000E+00	7.770E+01	0.000E+00	1.340E+02
I-134	2.440E-03	4.990E-03	1.160E-01	5.580E-03	0.000E+00	5.160E-03	0.000E+00	1.780E-03
I-135	3.900E+01	7.750E+01	6.950E+03	8.640E+01	0.000E+00	2.800E+01	0.000E+00	2.830E+01
CS-134	1.420E+04	2.640E+04	0.000E+00	6.810E+03	2.790E+03	7.180E+01	0.000E+00	2.670E+03
CS-136	1.680E+03	4.950E+03	0.000E+00	1.970E+03	4.030E+02	7.510E+01	0.000E+00	1.850E+03
CS-137	1.960E+04	2.300E+04	0.000E+00	6.170E+03	2.500E+03	7.190E+01	0.000E+00	1.630E+03
CS-138	3.330E-06	5.410E-06	0.000E+00	2.700E-06	4.210E-07	8.650E-06	0.000E+00	2.620E-06
BA-133	3.981E+02	1.531E+02	1.531E+02	3.062E+01	3.674E+02	4.287E+02	0.000E+00	3.062E+03
BA-139	8.180E-02	5.420E-05	0.000E+00	3.260E-05	3.290E-05	5.180E+00	0.000E+00	2.370E-03
BA-140	6.260E+03	6.260E+00	0.000E+00	1.490E+00	3.840E+00	1.540E+03	0.000E+00	3.230E+02
BA-141	2.220E-11	1.520E-14	0.000E+00	9.140E-15	9.250E-15	2.710E-10	0.000E+00	7.000E-13
BA-142	2.460E-20	2.040E-23	0.000E+00	1.180E-23	1.240E-23	1.010E-19	0.000E+00	1.210E-21
LA-140	6.460E-01	2.550E-01	0.000E+00	0.000E+00	0.000E+00	2.990E+03	0.000E+00	6.550E-02
LA-142	2.220E-04	8.160E-05	0.000E+00	0.000E+00	0.000E+00	1.390E+01	0.000E+00	1.950E-05
CE-141	2.930E+00	1.790E+00	0.000E+00	5.510E-01	0.000E+00	9.230E+02	0.000E+00	2.100E-01

APPENDIX F

A_i Infant Dose Factors for use in the Liquid Dose Calculations

Age group:	INFANT	Pathway:	Potable Water (PWtr)			Units:	mrem/hr / µCi/ml	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
CE-143	4.330E-01	2.870E+02	0.000E+00	8.360E-02	0.000E+00	1.670E+03	0.000E+00	3.270E-02
CE-144	1.120E+02	4.580E+01	0.000E+00	1.850E+01	0.000E+00	6.430E+03	0.000E+00	6.270E+00
PR-143	2.980E+00	1.110E+00	0.000E+00	4.140E-01	0.000E+00	1.570E+03	0.000E+00	1.480E-01
PR-144	3.020E-15	1.170E-15	0.000E+00	4.240E-16	0.000E+00	5.440E-11	0.000E+00	1.520E-16
ND-147	2.020E+00	2.070E+00	0.000E+00	7.980E-01	0.000E+00	1.310E+03	0.000E+00	1.270E-01
EU-152	2.535E+01	6.734E+00	0.000E+00	1.888E+01	0.000E+00	5.981E+02	0.000E+00	5.680E+00
W-187	2.400E+01	1.670E+01	0.000E+00	0.000E+00	0.000E+00	9.790E+02	0.000E+00	5.760E+00
NP-239	3.600E-01	3.220E-02	0.000E+00	6.430E-02	0.000E+00	9.320E+02	0.000E+00	1.820E-02

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Grs/Cow/Milk (CMILK)			Units:	$m^2 \cdot mrem/yr$ / $\mu Ci/sec$; $mrem/yr$ / $\mu Ci/m^3$ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
H-3	0.000E+00	7.630E+02	7.630E+02	7.630E+02	7.630E+02	7.630E+02	0.000E+00	7.630E+02
C-14	2.540E+04	5.080E+03	5.080E+03	5.080E+03	5.080E+03	5.080E+03	0.000E+00	5.080E+03
NA-24	2.440E+06	2.440E+06	2.440E+06	2.440E+06	2.440E+06	2.440E+06	0.000E+00	2.440E+06
P-32	1.710E+10	1.060E+09	0.000E+00	0.000E+00	0.000E+00	1.920E+09	0.000E+00	6.610E+08
CR-51	0.000E+00	0.000E+00	1.710E+04	6.300E+03	3.790E+04	7.190E+06	0.000E+00	2.860E+04
MN-54	0.000E+00	8.410E+06	0.000E+00	2.500E+06	0.000E+00	2.580E+07	0.000E+00	1.610E+06
MN-56	0.000E+00	4.090E-03	0.000E+00	5.190E-03	0.000E+00	1.310E-01	0.000E+00	7.260E-04
FE-55	2.510E+07	1.740E+07	0.000E+00	0.000E+00	9.680E+06	9.950E+06	0.000E+00	4.050E+06
FE-59	2.970E+07	6.980E+07	0.000E+00	0.000E+00	1.950E+07	2.330E+08	0.000E+00	2.680E+07
CO-58	0.000E+00	4.710E+06	0.000E+00	0.000E+00	0.000E+00	9.550E+07	0.000E+00	1.060E+07
CO-60	0.000E+00	1.640E+07	0.000E+00	0.000E+00	0.000E+00	3.080E+08	0.000E+00	3.620E+07
NI-63	6.730E+09	4.660E+08	0.000E+00	0.000E+00	0.000E+00	9.730E+07	0.000E+00	2.260E+08
NI-65	3.700E-01	4.810E-02	0.000E+00	0.000E+00	0.000E+00	1.220E+00	0.000E+00	2.190E-02
CU-64	0.000E+00	2.380E+04	0.000E+00	6.010E+04	0.000E+00	2.030E+06	0.000E+00	1.120E+04
ZN-65	1.370E+09	4.370E+09	0.000E+00	2.920E+09	0.000E+00	2.750E+09	0.000E+00	1.970E+09
ZN-69	2.090E-12	4.000E-12	0.000E+00	2.600E-12	0.000E+00	6.010E-13	0.000E+00	2.780E-13
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.400E-01	0.000E+00	9.720E-02
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.260E-28	0.000E+00	1.610E-23
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	2.590E+09	0.000E+00	0.000E+00	0.000E+00	5.120E+08	0.000E+00	1.210E+09
RB-88	0.000E+00	2.140E-45	0.000E+00	0.000E+00	0.000E+00	2.960E-56	0.000E+00	1.140E-45
RB-89	0.000E+00	4.330E-53	0.000E+00	0.000E+00	0.000E+00	2.510E-66	0.000E+00	3.040E-53
SR-89	1.450E+09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.330E+08	0.000E+00	4.160E+07
SR-90	4.680E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.350E+09	0.000E+00	1.150E+10
SR-91	2.890E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.380E+05	0.000E+00	1.170E+03

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Grs/Cow/Milk (CMILK)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	4.880E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.680E+00	0.000E+00	2.110E-02
Y-90	7.080E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.510E+05	0.000E+00	1.900E+00
Y-91	8.590E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.730E+06	0.000E+00	2.300E+02
Y-91M	5.980E-20	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.760E-19	0.000E+00	2.320E-21
Y-92	5.580E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.770E-01	0.000E+00	1.630E-06
Y-93	2.230E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.090E+03	0.000E+00	6.170E-03
ZR-95	9.430E+02	3.030E+02	0.000E+00	4.750E+02	0.000E+00	9.590E+05	0.000E+00	2.050E+02
ZR-97	4.330E-01	8.740E-02	0.000E+00	1.320E-01	0.000E+00	2.710E+04	0.000E+00	4.000E-02
NB-95	8.260E+04	4.590E+04	0.000E+00	4.540E+04	0.000E+00	2.790E+08	0.000E+00	2.470E+04
MO-99	0.000E+00	2.480E+07	0.000E+00	5.610E+07	0.000E+00	5.740E+07	0.000E+00	4.710E+06
TC-99M	3.320E+00	9.380E+00	0.000E+00	1.420E+02	4.600E+00	5.550E+03	0.000E+00	1.200E+02
TC-101	2.590E-60	3.740E-60	0.000E+00	6.730E-59	1.910E-60	1.120E-71	0.000E+00	3.670E-59
RU-103	1.020E+03	0.000E+00	0.000E+00	3.890E+03	0.000E+00	1.190E+05	0.000E+00	4.390E+02
RU-105	8.570E-04	0.000E+00	0.000E+00	1.110E-02	0.000E+00	5.240E-01	0.000E+00	3.380E-04
RU-106	2.040E+04	0.000E+00	0.000E+00	3.940E+04	0.000E+00	1.320E+06	0.000E+00	2.580E+03
AG-110M	5.820E+07	5.390E+07	0.000E+00	1.060E+08	0.000E+00	2.200E+10	0.000E+00	3.200E+07
TE-125M	1.630E+07	5.900E+06	4.900E+06	6.630E+07	0.000E+00	6.500E+07	0.000E+00	2.180E+06
TE-127	6.530E+02	2.340E+02	4.840E+02	2.660E+03	0.000E+00	5.150E+04	0.000E+00	1.410E+02
TE-127M	4.580E+07	1.640E+07	1.170E+07	1.860E+08	0.000E+00	1.540E+08	0.000E+00	5.580E+06
TE-129	2.830E-10	1.060E-10	2.170E-10	1.190E-09	0.000E+00	2.130E-10	0.000E+00	6.880E-11
TE-129M	6.020E+07	2.250E+07	2.070E+07	2.510E+08	0.000E+00	3.030E+08	0.000E+00	9.530E+06
TE-131	3.600E-33	1.500E-33	2.960E-33	1.580E-32	0.000E+00	5.100E-34	0.000E+00	1.140E-33
TE-131M	3.610E+05	1.770E+05	2.800E+05	1.790E+06	0.000E+00	1.750E+07	0.000E+00	1.470E+05
TE-132	2.400E+06	1.550E+06	1.720E+06	1.500E+07	0.000E+00	7.350E+07	0.000E+00	1.460E+06
I-130	4.200E+05	1.240E+06	1.050E+08	1.930E+06	0.000E+00	1.070E+06	0.000E+00	4.890E+05

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Grs/Cow/Milk (CMILK)			Units:	$m^2 \cdot$mrem/yr / µCi/sec; mrem/yr / µCi/m^3 (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	2.960E+08	4.230E+08	1.390E+11	7.260E+08	0.000E+00	1.120E+08	0.000E+00	2.430E+08
I-132	1.640E-01	4.390E-01	1.540E+01	7.000E-01	0.000E+00	8.250E-02	0.000E+00	1.540E-01
I-133	3.870E+06	6.730E+06	9.890E+08	1.170E+07	0.000E+00	6.050E+06	0.000E+00	2.050E+06
I-134	2.020E-12	5.480E-12	9.490E-11	8.710E-12	0.000E+00	4.770E-15	0.000E+00	1.960E-12
I-135	1.280E+04	3.360E+04	2.220E+06	5.390E+04	0.000E+00	3.800E+04	0.000E+00	1.240E+04
CS-134	5.650E+09	1.350E+10	0.000E+00	4.350E+09	1.450E+09	2.350E+08	0.000E+00	1.100E+10
CS-136	2.630E+08	1.040E+09	0.000E+00	5.780E+08	7.930E+07	1.180E+08	0.000E+00	7.480E+08
CS-137	7.380E+09	1.010E+10	0.000E+00	3.430E+09	1.140E+09	1.950E+08	0.000E+00	6.610E+09
CS-138	9.050E-24	1.790E-23	0.000E+00	1.310E-23	1.300E-24	7.620E-29	0.000E+00	8.850E-24
BA-139	4.420E-08	3.150E-11	0.000E+00	2.940E-11	1.790E-11	7.830E-08	0.000E+00	1.290E-09
BA-140	2.690E+07	3.380E+04	0.000E+00	1.150E+04	1.930E+04	5.530E+07	0.000E+00	1.760E+06
BA-141	4.090E-46	3.090E-49	0.000E+00	2.880E-49	1.760E-49	1.930E-55	0.000E+00	1.380E-47
BA-142	2.640E-80	2.720E-83	0.000E+00	2.300E-83	1.540E-83	3.720E-98	0.000E+00	1.660E-81
LA-140	4.510E+00	2.270E+00	0.000E+00	0.000E+00	0.000E+00	1.670E+05	0.000E+00	6.010E-01
LA-142	1.860E-11	8.460E-12	0.000E+00	0.000E+00	0.000E+00	6.170E-08	0.000E+00	2.110E-12
CE-141	4.840E+03	3.280E+03	0.000E+00	1.520E+03	0.000E+00	1.250E+07	0.000E+00	3.720E+02
CE-143	4.160E+01	3.070E+04	0.000E+00	1.350E+01	0.000E+00	1.150E+06	0.000E+00	3.400E+00
CE-144	3.580E+05	1.500E+05	0.000E+00	8.870E+04	0.000E+00	1.210E+08	0.000E+00	1.920E+04
PR-143	1.580E+02	6.330E+01	0.000E+00	3.660E+01	0.000E+00	6.920E+05	0.000E+00	7.830E+00
PR-144	5.870E-54	2.440E-54	0.000E+00	1.380E-54	0.000E+00	8.450E-61	0.000E+00	2.990E-55
ND-147	9.420E+01	1.090E+02	0.000E+00	6.360E+01	0.000E+00	5.220E+05	0.000E+00	6.510E+00
W-187	6.510E+03	5.450E+03	0.000E+00	0.000E+00	0.000E+00	1.780E+06	0.000E+00	1.900E+03
NP-239	3.670E+00	3.610E-01	0.000E+00	1.130E+00	0.000E+00	7.410E+04	0.000E+00	1.990E-01

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Grs/Goat/Milk (GMILK)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
H-3	0.000E+00	1.560E+03	1.560E+03	1.560E+03	1.560E+03	1.560E+03	0.000E+00	1.560E+03
C-14	2.540E+04	5.080E+03	5.080E+03	5.080E+03	5.080E+03	5.080E+03	0.000E+00	5.080E+03
NA-24	2.930E+05	2.930E+05	2.930E+05	2.930E+05	2.930E+05	2.930E+05	0.000E+00	2.930E+05
P-32	2.050E+10	1.280E+09	0.000E+00	0.000E+00	0.000E+00	2.310E+09	0.000E+00	7.930E+08
CR-51	0.000E+00	0.000E+00	2.050E+03	7.550E+02	4.550E+03	8.620E+05	0.000E+00	3.430E+03
MN-54	0.000E+00	1.010E+06	0.000E+00	3.000E+05	0.000E+00	3.090E+06	0.000E+00	1.930E+05
MN-56	0.000E+00	4.910E-04	0.000E+00	6.230E-04	0.000E+00	1.570E-02	0.000E+00	8.710E-05
FE-55	3.260E+05	2.260E+05	0.000E+00	0.000E+00	1.260E+05	1.290E+05	0.000E+00	5.260E+04
FE-59	3.860E+05	9.070E+05	0.000E+00	0.000E+00	2.540E+05	3.020E+06	0.000E+00	3.480E+05
CO-58	0.000E+00	5.660E+05	0.000E+00	0.000E+00	0.000E+00	1.150E+07	0.000E+00	1.270E+06
CO-60	0.000E+00	1.970E+06	0.000E+00	0.000E+00	0.000E+00	3.700E+07	0.000E+00	4.340E+06
NI-63	8.070E+08	5.600E+07	0.000E+00	0.000E+00	0.000E+00	1.170E+07	0.000E+00	2.710E+07
NI-65	4.440E-02	5.770E-03	0.000E+00	0.000E+00	0.000E+00	1.460E-01	0.000E+00	2.630E-03
CU-64	0.000E+00	2.660E+03	0.000E+00	6.700E+03	0.000E+00	2.260E+05	0.000E+00	1.250E+03
ZN-65	1.650E+08	5.240E+08	0.000E+00	3.500E+08	0.000E+00	3.300E+08	0.000E+00	2.370E+08
ZN-69	2.510E-13	4.800E-13	0.000E+00	3.120E-13	0.000E+00	7.210E-14	0.000E+00	3.340E-14
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.680E-02	0.000E+00	1.170E-02
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.520E-29	0.000E+00	1.930E-24
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	3.110E+08	0.000E+00	0.000E+00	0.000E+00	6.140E+07	0.000E+00	1.450E+08
RB-88	0.000E+00	2.570E-46	0.000E+00	0.000E+00	0.000E+00	3.550E-57	0.000E+00	1.360E-46
RB-89	0.000E+00	5.190E-54	0.000E+00	0.000E+00	0.000E+00	3.020E-67	0.000E+00	3.650E-54
SR-89	3.050E+09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.890E+08	0.000E+00	8.750E+07
SR-90	9.830E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.840E+09	0.000E+00	2.410E+10
SR-91	6.070E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.890E+05	0.000E+00	2.450E+03

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Grs/Goat/Milk (GMILK)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-92	1.030E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.030E+01	0.000E+00	4.440E-02
Y-90	8.500E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.010E+04	0.000E+00	2.280E-01
Y-91	1.030E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.670E+05	0.000E+00	2.760E+01
Y-91M	7.170E-21	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.110E-20	0.000E+00	2.780E-22
Y-92	6.690E-06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.170E-01	0.000E+00	1.960E-07
Y-93	2.680E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.500E+02	0.000E+00	7.400E-04
ZR-95	1.130E+02	3.630E+01	0.000E+00	5.700E+01	0.000E+00	1.150E+05	0.000E+00	2.460E+01
ZR-97	5.200E-02	1.050E-02	0.000E+00	1.580E-02	0.000E+00	3.250E+03	0.000E+00	4.800E-03
NB-95	9.910E+03	5.510E+03	0.000E+00	5.450E+03	0.000E+00	3.340E+07	0.000E+00	2.960E+03
MO-99	0.000E+00	2.970E+06	0.000E+00	6.730E+06	0.000E+00	6.890E+06	0.000E+00	5.660E+05
TC-99M	3.980E-01	1.130E+00	0.000E+00	1.710E+01	5.520E-01	6.660E+02	0.000E+00	1.430E+01
TC-101	3.110E-61	4.490E-61	0.000E+00	8.080E-60	2.290E-61	1.350E-72	0.000E+00	4.400E-60
RU-103	1.220E+02	0.000E+00	0.000E+00	4.660E+02	0.000E+00	1.430E+04	0.000E+00	5.260E+01
RU-105	1.030E-04	0.000E+00	0.000E+00	1.330E-03	0.000E+00	6.290E-02	0.000E+00	4.060E-05
RU-106	2.450E+03	0.000E+00	0.000E+00	4.730E+03	0.000E+00	1.580E+05	0.000E+00	3.100E+02
AG-110M	6.990E+06	6.460E+06	0.000E+00	1.270E+07	0.000E+00	2.640E+09	0.000E+00	3.840E+06
TE-125M	1.950E+06	7.080E+05	5.880E+05	7.950E+06	0.000E+00	7.800E+06	0.000E+00	2.620E+05
TE-127	7.830E+01	2.810E+01	5.800E+01	3.190E+02	0.000E+00	6.180E+03	0.000E+00	1.700E+01
TE-127M	5.490E+06	1.960E+06	1.400E+06	2.230E+07	0.000E+00	1.840E+07	0.000E+00	6.690E+05
TE-129	3.390E-11	1.270E-11	2.600E-11	1.430E-10	0.000E+00	2.560E-11	0.000E+00	8.260E-12
TE-129M	7.220E+06	2.690E+06	2.480E+06	3.020E+07	0.000E+00	3.640E+07	0.000E+00	1.140E+06
TE-131	4.320E-34	1.810E-34	3.550E-34	1.890E-33	0.000E+00	6.120E-35	0.000E+00	1.360E-34
TE-131M	4.330E+04	2.120E+04	3.360E+04	2.150E+05	0.000E+00	2.100E+06	0.000E+00	1.770E+04
TE-132	2.880E+05	1.860E+05	2.060E+05	1.800E+06	0.000E+00	8.820E+06	0.000E+00	1.750E+05
I-130	5.040E+05	1.490E+06	1.260E+08	2.320E+06	0.000E+00	1.280E+06	0.000E+00	5.870E+05

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Grs/Goat/Milk (GMILK)			Units:	$m^2 \cdot$mrem/yr / µCi/sec; mrem/yr / µCi/m^3 (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	3.550E+08	5.080E+08	1.670E+11	8.710E+08	0.000E+00	1.340E+08	0.000E+00	2.910E+08
I-132	1.970E-01	5.270E-01	1.840E+01	8.400E-01	0.000E+00	9.900E-02	0.000E+00	1.840E-01
I-133	4.640E+06	8.080E+06	1.190E+09	1.410E+07	0.000E+00	7.260E+06	0.000E+00	2.460E+06
I-134	2.420E-12	6.570E-12	1.140E-10	1.050E-11	0.000E+00	5.730E-15	0.000E+00	2.350E-12
I-135	1.540E+04	4.030E+04	2.660E+06	6.470E+04	0.000E+00	4.560E+04	0.000E+00	1.490E+04
CS-134	1.700E+10	4.040E+10	0.000E+00	1.310E+10	4.340E+09	7.060E+08	0.000E+00	3.300E+10
CS-136	7.900E+08	3.120E+09	0.000E+00	1.730E+09	2.380E+08	3.540E+08	0.000E+00	2.240E+09
CS-137	2.210E+10	3.030E+10	0.000E+00	1.030E+10	3.420E+09	5.860E+08	0.000E+00	1.980E+10
CS-138	2.710E-23	5.360E-23	0.000E+00	3.940E-23	3.890E-24	2.290E-28	0.000E+00	2.650E-23
BA-139	5.300E-09	3.780E-12	0.000E+00	3.530E-12	2.140E-12	9.400E-09	0.000E+00	1.550E-10
BA-140	3.230E+06	4.050E+03	0.000E+00	1.380E+03	2.320E+03	6.640E+06	0.000E+00	2.110E+05
BA-141	4.910E-47	3.710E-50	0.000E+00	3.450E-50	2.110E-50	2.310E-56	0.000E+00	1.660E-48
BA-142	3.170E-81	3.260E-84	0.000E+00	2.750E-84	1.850E-84	0.000E+00	0.000E+00	2.000E-82
LA-140	5.410E-01	2.730E-01	0.000E+00	0.000E+00	0.000E+00	2.000E+04	0.000E+00	7.210E-02
LA-142	2.230E-12	1.010E-12	0.000E+00	0.000E+00	0.000E+00	7.410E-09	0.000E+00	2.530E-13
CE-141	5.810E+02	3.930E+02	0.000E+00	1.830E+02	0.000E+00	1.500E+06	0.000E+00	4.460E+01
CE-143	4.990E+00	3.690E+03	0.000E+00	1.620E+00	0.000E+00	1.380E+05	0.000E+00	4.080E-01
CE-144	4.290E+04	1.790E+04	0.000E+00	1.060E+04	0.000E+00	1.450E+07	0.000E+00	2.300E+03
PR-143	1.890E+01	7.600E+00	0.000E+00	4.390E+00	0.000E+00	8.300E+04	0.000E+00	9.390E-01
PR-144	7.050E-55	2.930E-55	0.000E+00	1.650E-55	0.000E+00	1.010E-61	0.000E+00	3.580E-56
ND-147	1.130E+01	1.310E+01	0.000E+00	7.630E+00	0.000E+00	6.270E+04	0.000E+00	7.810E-01
W-187	7.820E+02	6.530E+02	0.000E+00	0.000E+00	0.000E+00	2.140E+05	0.000E+00	2.280E+02
NP-239	4.410E-01	4.330E-02	0.000E+00	1.350E-01	0.000E+00	8.890E+03	0.000E+00	2.390E-02

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Grs/Cow/Meat (CMEAT)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	3.250E+02	3.250E+02	3.250E+02	3.250E+02	3.250E+02	0.000E+00	3.250E+02
C-14	2.330E+04	4.660E+03	4.660E+03	4.660E+03	4.660E+03	4.660E+03	0.000E+00	4.660E+03
NA-24	1.360E-03	1.360E-03	1.360E-03	1.360E-03	1.360E-03	1.360E-03	0.000E+00	1.360E-03
P-32	4.660E+09	2.900E+08	0.000E+00	0.000E+00	0.000E+00	5.240E+08	0.000E+00	1.800E+08
CR-51	0.000E+00	0.000E+00	4.210E+03	1.550E+03	9.350E+03	1.770E+06	0.000E+00	7.050E+03
MN-54	0.000E+00	9.180E+06	0.000E+00	2.730E+06	0.000E+00	2.810E+07	0.000E+00	1.750E+06
MN-56	0.000E+00	1.320E-53	0.000E+00	1.680E-53	0.000E+00	4.220E-52	0.000E+00	2.350E-54
FE-55	2.930E+08	2.030E+08	0.000E+00	0.000E+00	1.130E+08	1.160E+08	0.000E+00	4.720E+07
FE-59	2.660E+08	6.240E+08	0.000E+00	0.000E+00	1.740E+08	2.080E+09	0.000E+00	2.390E+08
CO-58	0.000E+00	1.820E+07	0.000E+00	0.000E+00	0.000E+00	3.690E+08	0.000E+00	4.090E+07
CO-60	0.000E+00	7.520E+07	0.000E+00	0.000E+00	0.000E+00	1.410E+09	0.000E+00	1.660E+08
NI-63	1.890E+10	1.310E+09	0.000E+00	0.000E+00	0.000E+00	2.730E+08	0.000E+00	6.330E+08
NI-65	2.250E-52	2.920E-53	0.000E+00	0.000E+00	0.000E+00	7.400E-52	0.000E+00	1.330E-53
CU-64	0.000E+00	2.710E-07	0.000E+00	6.830E-07	0.000E+00	2.310E-05	0.000E+00	1.270E-07
ZN-65	3.560E+08	1.130E+09	0.000E+00	7.570E+08	0.000E+00	7.130E+08	0.000E+00	5.120E+08
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.650E-57	0.000E+00	6.000E-57
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	4.870E+08	0.000E+00	0.000E+00	0.000E+00	9.600E+07	0.000E+00	2.270E+08
RB-88	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-89	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-89	3.020E+08	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.840E+07	0.000E+00	8.660E+06
SR-90	1.240E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.590E+08	0.000E+00	3.050E+09
SR-91	1.520E-10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.240E-10	0.000E+00	6.140E-12

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Grs/Cow/Meat (CMEAT)			Units:	$m^2 \cdot mrem/yr$ / $\mu Ci/sec$; $mrem/yr$ / $\mu Ci/m^3$ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	1.180E-49	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.340E-48	0.000E+00	5.100E-51
Y-90	1.080E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.140E+06	0.000E+00	2.890E+00
Y-91	1.130E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.230E+08	0.000E+00	3.030E+04
Y-91M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y-92	1.520E-39	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.660E-35	0.000E+00	4.430E-41
Y-93	4.690E-12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.490E-07	0.000E+00	1.300E-13
ZR-95	1.870E+06	6.010E+05	0.000E+00	9.420E+05	0.000E+00	1.900E+09	0.000E+00	4.070E+05
ZR-97	2.070E-05	4.170E-06	0.000E+00	6.300E-06	0.000E+00	1.290E+00	0.000E+00	1.910E-06
NB-95	2.300E+06	1.280E+06	0.000E+00	1.260E+06	0.000E+00	7.760E+09	0.000E+00	6.870E+05
MO-99	0.000E+00	1.000E+05	0.000E+00	2.260E+05	0.000E+00	2.320E+05	0.000E+00	1.900E+04
TC-99M	4.450E-21	1.260E-20	0.000E+00	1.910E-19	6.150E-21	7.430E-18	0.000E+00	1.600E-19
TC-101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-103	1.050E+08	0.000E+00	0.000E+00	4.010E+08	0.000E+00	1.230E+10	0.000E+00	4.530E+07
RU-105	5.780E-28	0.000E+00	0.000E+00	7.460E-27	0.000E+00	3.530E-25	0.000E+00	2.280E-28
RU-106	2.800E+09	0.000E+00	0.000E+00	5.400E+09	0.000E+00	1.810E+11	0.000E+00	3.540E+08
AG-110M	6.680E+06	6.180E+06	0.000E+00	1.220E+07	0.000E+00	2.520E+09	0.000E+00	3.670E+06
TE-125M	3.590E+08	1.300E+08	1.080E+08	1.460E+09	0.000E+00	1.430E+09	0.000E+00	4.810E+07
TE-127	2.120E-10	7.610E-11	1.570E-10	8.640E-10	0.000E+00	1.670E-08	0.000E+00	4.590E-11
TE-127M	1.120E+09	3.990E+08	2.850E+08	4.530E+09	0.000E+00	3.740E+09	0.000E+00	1.360E+08
TE-129	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-129M	1.130E+09	4.230E+08	3.900E+08	4.730E+09	0.000E+00	5.710E+09	0.000E+00	1.790E+08
TE-131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-131M	4.510E+02	2.210E+02	3.490E+02	2.230E+03	0.000E+00	2.190E+04	0.000E+00	1.840E+02
TE-132	1.420E+06	9.180E+05	1.010E+06	8.840E+06	0.000E+00	4.340E+07	0.000E+00	8.620E+05
I-130	2.110E-06	6.220E-06	5.270E-04	9.700E-06	0.000E+00	5.350E-06	0.000E+00	2.450E-06

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Grs/Cow/Meat (CMEAT)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	1.070E+07	1.540E+07	5.030E+09	2.630E+07	0.000E+00	4.050E+06	0.000E+00	8.800E+06
I-132	6.970E-59	1.860E-58	6.530E-57	2.970E-58	0.000E+00	3.500E-59	0.000E+00	6.530E-59
I-133	3.650E-01	6.350E-01	9.340E+01	1.110E+00	0.000E+00	5.710E-01	0.000E+00	1.940E-01
I-134	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-135	4.420E-17	1.160E-16	7.640E-15	1.860E-16	0.000E+00	1.310E-16	0.000E+00	4.270E-17
CS-134	6.580E+08	1.560E+09	0.000E+00	5.060E+08	1.680E+08	2.740E+07	0.000E+00	1.280E+09
CS-136	1.210E+07	4.760E+07	0.000E+00	2.650E+07	3.630E+06	5.410E+06	0.000E+00	3.420E+07
CS-137	8.720E+08	1.190E+09	0.000E+00	4.050E+08	1.350E+08	2.310E+07	0.000E+00	7.810E+08
CS-138	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-139	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-140	2.870E+07	3.610E+04	0.000E+00	1.230E+04	2.070E+04	5.920E+07	0.000E+00	1.880E+06
BA-141	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA-140	3.710E-02	1.870E-02	0.000E+00	0.000E+00	0.000E+00	1.370E+03	0.000E+00	4.940E-03
LA-142	3.470E-92	1.580E-92	0.000E+00	0.000E+00	0.000E+00	1.150E-88	0.000E+00	3.940E-93
CE-141	1.400E+04	9.500E+03	0.000E+00	4.410E+03	0.000E+00	3.630E+07	0.000E+00	1.080E+03
CE-143	2.010E-02	1.480E+01	0.000E+00	6.530E-03	0.000E+00	5.550E+02	0.000E+00	1.640E-03
CE-144	1.460E+06	6.090E+05	0.000E+00	3.610E+05	0.000E+00	4.930E+08	0.000E+00	7.830E+04
PR-143	2.100E+04	8.410E+03	0.000E+00	4.850E+03	0.000E+00	9.180E+07	0.000E+00	1.040E+03
PR-144	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND-147	7.070E+03	8.170E+03	0.000E+00	4.780E+03	0.000E+00	3.920E+07	0.000E+00	4.890E+02
W-187	2.070E-02	1.730E-02	0.000E+00	0.000E+00	0.000E+00	5.660E+00	0.000E+00	6.040E-03
NP-239	2.590E-01	2.550E-02	0.000E+00	7.950E-02	0.000E+00	5.230E+03	0.000E+00	1.400E-02

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Age group:	ADULT	Pathway:	Grs/Goat/Meat (GMEAT)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	3.900E+01	3.900E+01	3.900E+01	3.900E+01	3.900E+01	0.000E+00	3.900E+01
C-14	2.796E+03	5.592E+02	5.592E+02	5.592E+02	5.592E+02	5.592E+02	0.000E+00	5.592E+02
NA-24	1.632E-04	1.632E-04	1.632E-04	1.632E-04	1.632E-04	1.632E-04	0.000E+00	1.632E-04
P-32	5.592E+08	3.480E+07	0.000E+00	0.000E+00	0.000E+00	6.288E+07	0.000E+00	2.160E+07
CR-51	0.000E+00	0.000E+00	5.052E+02	1.860E+02	1.122E+03	2.124E+05	0.000E+00	8.460E+02
MN-54	0.000E+00	1.102E+06	0.000E+00	3.276E+05	0.000E+00	3.372E+06	0.000E+00	2.100E+05
MN-56	0.000E+00	1.584E-54	0.000E+00	2.016E-54	0.000E+00	5.064E-53	0.000E+00	2.820E-55
FE-55	3.516E+07	2.436E+07	0.000E+00	0.000E+00	1.356E+07	1.392E+07	0.000E+00	5.664E+06
FE-59	3.192E+07	7.488E+07	0.000E+00	0.000E+00	2.088E+07	2.496E+08	0.000E+00	2.868E+07
CO-58	0.000E+00	2.184E+06	0.000E+00	0.000E+00	0.000E+00	4.428E+07	0.000E+00	4.908E+06
CO-60	0.000E+00	9.024E+06	0.000E+00	0.000E+00	0.000E+00	1.692E+08	0.000E+00	1.992E+07
NI-63	2.268E+09	1.572E+08	0.000E+00	0.000E+00	0.000E+00	3.276E+07	0.000E+00	7.596E+07
NI-65	2.700E-53	3.504E-54	0.000E+00	0.000E+00	0.000E+00	8.880E-53	0.000E+00	1.596E-54
CU-64	0.000E+00	3.252E-08	0.000E+00	8.196E-08	0.000E+00	2.772E-06	0.000E+00	1.524E-08
ZN-65	4.272E+07	1.356E+08	0.000E+00	9.084E+07	0.000E+00	8.556E+07	0.000E+00	6.144E+07
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.038E-57	0.000E+00	7.200E-58
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	5.844E+07	0.000E+00	0.000E+00	0.000E+00	1.152E+07	0.000E+00	2.724E+07
RB-88	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-89	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-89	3.624E+07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.808E+06	0.000E+00	1.039E+06
SR-90	1.488E+09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.308E+07	0.000E+00	3.660E+08
SR-91	1.824E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.688E-11	0.000E+00	7.368E-13

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Age group:	ADULT	Pathway:	Grs/Goat/Meat (GMEAT)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	1.416E-50	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.808E-49	0.000E+00	6.120E-52
Y-90	1.296E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.368E+05	0.000E+00	3.468E-01
Y-91	1.356E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.476E+07	0.000E+00	3.636E+03
Y-91M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y-92	1.824E-40	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.192E-36	0.000E+00	5.316E-42
Y-93	5.628E-13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.788E-08	0.000E+00	1.560E-14
ZR-95	2.244E+05	7.212E+04	0.000E+00	1.130E+05	0.000E+00	2.280E+08	0.000E+00	4.884E+04
ZR-97	2.484E-06	5.004E-07	0.000E+00	7.560E-07	0.000E+00	1.548E-01	0.000E+00	2.292E-07
NB-95	2.760E+05	1.536E+05	0.000E+00	1.512E+05	0.000E+00	9.312E+08	0.000E+00	8.244E+04
MO-99	0.000E+00	1.200E+04	0.000E+00	2.712E+04	0.000E+00	2.784E+04	0.000E+00	2.280E+03
TC-99M	5.340E-22	1.512E-21	0.000E+00	2.292E-20	7.380E-22	8.916E-19	0.000E+00	1.920E-20
TC-101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-103	1.260E+07	0.000E+00	0.000E+00	4.812E+07	0.000E+00	1.476E+09	0.000E+00	5.436E+06
RU-105	6.936E-29	0.000E+00	0.000E+00	8.952E-28	0.000E+00	4.236E-26	0.000E+00	2.736E-29
RU-106	3.360E+08	0.000E+00	0.000E+00	6.480E+08	0.000E+00	2.172E+10	0.000E+00	4.248E+07
AG-110M	8.016E+05	7.416E+05	0.000E+00	1.464E+06	0.000E+00	3.024E+08	0.000E+00	4.404E+05
TE-125M	4.308E+07	1.560E+07	1.296E+07	1.752E+08	0.000E+00	1.716E+08	0.000E+00	5.772E+06
TE-127	2.544E-11	9.132E-12	1.884E-11	1.037E-10	0.000E+00	2.004E-09	0.000E+00	5.508E-12
TE-127M	1.344E+08	4.788E+07	3.420E+07	5.436E+08	0.000E+00	4.488E+08	0.000E+00	1.632E+07
TE-129	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-129M	1.356E+08	5.076E+07	4.680E+07	5.676E+08	0.000E+00	6.852E+08	0.000E+00	2.148E+07
TE-131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-131M	5.412E+01	2.652E+01	4.188E+01	2.676E+02	0.000E+00	2.628E+03	0.000E+00	2.208E+01
TE-132	1.704E+05	1.102E+05	1.212E+05	1.061E+06	0.000E+00	5.208E+06	0.000E+00	1.034E+05
I-130	2.532E-07	7.464E-07	6.324E-05	1.164E-06	0.000E+00	6.420E-07	0.000E+00	2.940E-07

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Age group:	ADULT	Pathway:	Grs/Goat/Meat (GMEAT)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	1.284E+06	1.848E+06	6.036E+08	3.156E+06	0.000E+00	4.860E+05	0.000E+00	1.056E+06
I-132	8.364E-60	2.232E-59	7.836E-58	3.564E-59	0.000E+00	4.200E-60	0.000E+00	7.836E-60
I-133	4.380E-02	7.620E-02	1.121E+01	1.332E-01	0.000E+00	6.852E-02	0.000E+00	2.328E-02
I-134	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-135	5.304E-18	1.392E-17	9.168E-16	2.232E-17	0.000E+00	1.572E-17	0.000E+00	5.124E-18
CS-134	7.896E+07	1.872E+08	0.000E+00	6.072E+07	2.016E+07	3.288E+06	0.000E+00	1.536E+08
CS-136	1.452E+06	5.712E+06	0.000E+00	3.180E+06	4.356E+05	6.492E+05	0.000E+00	4.104E+06
CS-137	1.046E+08	1.428E+08	0.000E+00	4.860E+07	1.620E+07	2.772E+06	0.000E+00	9.372E+07
CS-138	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-139	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-140	3.444E+06	4.332E+03	0.000E+00	1.476E+03	2.484E+03	7.104E+06	0.000E+00	2.256E+05
BA-141	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA-140	4.452E-03	2.244E-03	0.000E+00	0.000E+00	0.000E+00	1.644E+02	0.000E+00	5.928E-04
LA-142	4.164E-93	1.896E-93	0.000E+00	0.000E+00	0.000E+00	1.380E-89	0.000E+00	4.728E-94
CE-141	1.680E+03	1.140E+03	0.000E+00	5.292E+02	0.000E+00	4.356E+06	0.000E+00	1.296E+02
CE-143	2.412E-03	1.776E+00	0.000E+00	7.836E-04	0.000E+00	6.660E+01	0.000E+00	1.968E-04
CE-144	1.752E+05	7.308E+04	0.000E+00	4.332E+04	0.000E+00	5.916E+07	0.000E+00	9.396E+03
PR-143	2.520E+03	1.009E+03	0.000E+00	5.820E+02	0.000E+00	1.102E+07	0.000E+00	1.248E+02
PR-144	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND-147	8.484E+02	9.804E+02	0.000E+00	5.736E+02	0.000E+00	4.704E+06	0.000E+00	5.868E+01
W-187	2.484E-03	2.076E-03	0.000E+00	0.000E+00	0.000E+00	6.792E-01	0.000E+00	7.248E-04
NP-239	3.108E-02	3.060E-03	0.000E+00	9.540E-03	0.000E+00	6.276E+02	0.000E+00	1.680E-03

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Vegetation (VEG)			Units:	$m^2 \cdot$mrem/yr / µCi/sec; mrem/yr / µCi/m^3 (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	2.260E+03	2.260E+03	2.260E+03	2.260E+03	2.260E+03	0.000E+00	2.260E+03
C-14	6.280E+04	1.260E+04	1.260E+04	1.260E+04	1.260E+04	1.260E+04	0.000E+00	1.260E+04
NA-24	2.690E+05	2.690E+05	2.690E+05	2.690E+05	2.690E+05	2.690E+05	0.000E+00	2.690E+05
P-32	1.400E+09	8.730E+07	0.000E+00	0.000E+00	0.000E+00	1.580E+08	0.000E+00	5.430E+07
CR-51	0.000E+00	0.000E+00	2.780E+04	1.020E+04	6.160E+04	1.170E+07	0.000E+00	4.640E+04
MN-54	0.000E+00	3.130E+08	0.000E+00	9.310E+07	0.000E+00	9.590E+08	0.000E+00	5.970E+07
MN-56	0.000E+00	1.580E+01	0.000E+00	2.000E+01	0.000E+00	5.040E+02	0.000E+00	2.800E+00
FE-55	2.100E+08	1.450E+08	0.000E+00	0.000E+00	8.080E+07	8.310E+07	0.000E+00	3.380E+07
FE-59	1.260E+08	2.960E+08	0.000E+00	0.000E+00	8.280E+07	9.880E+08	0.000E+00	1.140E+08
CO-58	0.000E+00	3.070E+07	0.000E+00	0.000E+00	0.000E+00	6.230E+08	0.000E+00	6.890E+07
CO-60	0.000E+00	1.670E+08	0.000E+00	0.000E+00	0.000E+00	3.140E+09	0.000E+00	3.690E+08
NI-63	1.040E+10	7.210E+08	0.000E+00	0.000E+00	0.000E+00	1.500E+08	0.000E+00	3.490E+08
NI-65	6.150E+01	7.990E+00	0.000E+00	0.000E+00	0.000E+00	2.030E+02	0.000E+00	3.640E+00
CU-64	0.000E+00	9.200E+03	0.000E+00	2.320E+04	0.000E+00	7.840E+05	0.000E+00	4.320E+03
ZN-65	3.170E+08	1.010E+09	0.000E+00	6.750E+08	0.000E+00	6.360E+08	0.000E+00	4.560E+08
ZN-69	5.490E-06	1.050E-05	0.000E+00	6.830E-06	0.000E+00	1.580E-06	0.000E+00	7.310E-07
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.470E+00	0.000E+00	3.110E+00
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.940E-16	0.000E+00	2.480E-11
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	2.190E+08	0.000E+00	0.000E+00	0.000E+00	4.330E+07	0.000E+00	1.020E+08
RB-88	0.000E+00	3.430E-22	0.000E+00	0.000E+00	0.000E+00	4.740E-33	0.000E+00	1.820E-22
RB-89	0.000E+00	3.890E-26	0.000E+00	0.000E+00	0.000E+00	2.260E-39	0.000E+00	2.730E-26
SR-89	9.970E+09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.600E+09	0.000E+00	2.860E+08
SR-90	6.050E+11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.750E+10	0.000E+00	1.480E+11
SR-91	3.050E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.450E+06	0.000E+00	1.230E+04

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Vegetation (VEG)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	4.270E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.450E+03	0.000E+00	1.850E+01
Y-90	1.330E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.410E+08	0.000E+00	3.570E+02
Y-91	5.110E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.810E+09	0.000E+00	1.370E+05
Y-91M	5.220E-09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.530E-08	0.000E+00	2.020E-10
Y-92	9.150E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.600E+04	0.000E+00	2.680E-02
Y-93	1.700E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.380E+06	0.000E+00	4.680E+00
ZR-95	1.170E+06	3.770E+05	0.000E+00	5.910E+05	0.000E+00	1.190E+09	0.000E+00	2.550E+05
ZR-97	3.370E+02	6.810E+01	0.000E+00	1.030E+02	0.000E+00	2.110E+07	0.000E+00	3.110E+01
NB-95	1.420E+05	7.920E+04	0.000E+00	7.830E+04	0.000E+00	4.810E+08	0.000E+00	4.260E+04
MO-99	0.000E+00	6.150E+06	0.000E+00	1.390E+07	0.000E+00	1.430E+07	0.000E+00	1.170E+06
TC-99M	3.100E+00	8.770E+00	0.000E+00	1.330E+02	4.300E+00	5.190E+03	0.000E+00	1.120E+02
TC-101	8.220E-31	1.180E-30	0.000E+00	2.130E-29	6.050E-31	3.560E-42	0.000E+00	1.160E-29
RU-103	4.770E+06	0.000E+00	0.000E+00	1.820E+07	0.000E+00	5.570E+08	0.000E+00	2.060E+06
RU-105	5.390E+01	0.000E+00	0.000E+00	6.960E+02	0.000E+00	3.290E+04	0.000E+00	2.130E+01
RU-106	1.930E+08	0.000E+00	0.000E+00	3.720E+08	0.000E+00	1.250E+10	0.000E+00	2.440E+07
AG-110M	1.050E+07	9.750E+06	0.000E+00	1.920E+07	0.000E+00	3.980E+09	0.000E+00	5.790E+06
TE-125M	9.660E+07	3.500E+07	2.900E+07	3.930E+08	0.000E+00	3.860E+08	0.000E+00	1.290E+07
TE-127	5.660E+03	2.030E+03	4.190E+03	2.310E+04	0.000E+00	4.470E+05	0.000E+00	1.220E+03
TE-127M	3.490E+08	1.250E+08	8.920E+07	1.420E+09	0.000E+00	1.170E+09	0.000E+00	4.260E+07
TE-129	7.630E-04	2.870E-04	5.850E-04	3.210E-03	0.000E+00	5.760E-04	0.000E+00	1.860E-04
TE-129M	2.510E+08	9.380E+07	8.630E+07	1.050E+09	0.000E+00	1.270E+09	0.000E+00	3.980E+07
TE-131	1.500E-15	6.270E-16	1.230E-15	6.570E-15	0.000E+00	2.130E-16	0.000E+00	4.740E-16
TE-131M	9.120E+05	4.460E+05	7.060E+05	4.520E+06	0.000E+00	4.430E+07	0.000E+00	3.720E+05
TE-132	4.300E+06	2.780E+06	3.070E+06	2.680E+07	0.000E+00	1.320E+08	0.000E+00	2.610E+06
I-130	3.920E+05	1.160E+06	9.810E+07	1.810E+06	0.000E+00	9.960E+05	0.000E+00	4.570E+05

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Vegetation (VEG)			Units:	$m^2 \cdot$mrem/yr / µCi/sec; mrem/yr / µCi/m^3 (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	8.080E+07	1.160E+08	3.790E+10	1.980E+08	0.000E+00	3.050E+07	0.000E+00	6.620E+07
I-132	5.760E+01	1.540E+02	5.390E+03	2.450E+02	0.000E+00	2.890E+01	0.000E+00	5.390E+01
I-133	2.090E+06	3.630E+06	5.330E+08	6.330E+06	0.000E+00	3.260E+06	0.000E+00	1.110E+06
I-134	9.650E-05	2.620E-04	4.540E-03	4.170E-04	0.000E+00	2.290E-07	0.000E+00	9.380E-05
I-135	3.900E+04	1.020E+05	6.730E+06	1.640E+05	0.000E+00	1.150E+05	0.000E+00	3.770E+04
CS-134	4.670E+09	1.110E+10	0.000E+00	3.590E+09	1.190E+09	1.940E+08	0.000E+00	9.080E+09
CS-136	4.270E+07	1.680E+08	0.000E+00	9.380E+07	1.290E+07	1.910E+07	0.000E+00	1.210E+08
CS-137	6.360E+09	8.700E+09	0.000E+00	2.950E+09	9.810E+08	1.680E+08	0.000E+00	5.700E+09
CS-138	3.920E-11	7.730E-11	0.000E+00	5.680E-11	5.610E-12	3.300E-16	0.000E+00	3.830E-11
BA-139	2.860E-02	2.030E-05	0.000E+00	1.900E-05	1.150E-05	5.060E-02	0.000E+00	8.360E-04
BA-140	1.280E+08	1.610E+05	0.000E+00	5.490E+04	9.240E+04	2.650E+08	0.000E+00	8.420E+06
BA-141	1.150E-21	8.700E-25	0.000E+00	8.090E-25	4.940E-25	5.430E-31	0.000E+00	3.890E-23
BA-142	5.960E-39	6.120E-42	0.000E+00	5.170E-42	3.470E-42	8.390E-57	0.000E+00	3.750E-40
LA-140	1.980E+03	9.970E+02	0.000E+00	0.000E+00	0.000E+00	7.320E+07	0.000E+00	2.630E+02
LA-142	2.020E-04	9.190E-05	0.000E+00	0.000E+00	0.000E+00	6.710E-01	0.000E+00	2.290E-05
CE-141	1.970E+05	1.330E+05	0.000E+00	6.190E+04	0.000E+00	5.100E+08	0.000E+00	1.510E+04
CE-143	9.980E+02	7.380E+05	0.000E+00	3.250E+02	0.000E+00	2.760E+07	0.000E+00	8.160E+01
CE-144	3.290E+07	1.380E+07	0.000E+00	8.160E+06	0.000E+00	1.110E+10	0.000E+00	1.770E+06
PR-143	6.260E+04	2.510E+04	0.000E+00	1.450E+04	0.000E+00	2.740E+08	0.000E+00	3.100E+03
PR-144	3.090E-26	1.280E-26	0.000E+00	7.230E-27	0.000E+00	4.440E-33	0.000E+00	1.570E-27
ND-147	3.330E+04	3.850E+04	0.000E+00	2.250E+04	0.000E+00	1.850E+08	0.000E+00	2.310E+03
W-187	3.800E+04	3.180E+04	0.000E+00	0.000E+00	0.000E+00	1.040E+07	0.000E+00	1.110E+04
NP-239	1.430E+03	1.400E+02	0.000E+00	4.380E+02	0.000E+00	2.880E+07	0.000E+00	7.740E+01

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Inhalation (INHL)			Units:	mrem/yr / µCi/m^3	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	1.260E+03	1.260E+03	1.260E+03	1.260E+03	1.260E+03	0.000E+00	1.260E+03
C-14	1.820E+04	3.410E+03	3.410E+03	3.410E+03	3.410E+03	3.410E+03	0.000E+00	3.410E+03
NA-24	1.020E+04	1.020E+04	1.020E+04	1.020E+04	1.020E+04	1.020E+04	0.000E+00	1.020E+04
P-32	1.320E+06	7.710E+04	0.000E+00	0.000E+00	0.000E+00	8.640E+04	0.000E+00	5.010E+04
CR-51	0.000E+00	0.000E+00	5.950E+01	2.280E+01	1.440E+04	3.320E+03	0.000E+00	1.000E+02
MN-54	0.000E+00	3.960E+04	0.000E+00	9.840E+03	1.400E+06	7.740E+04	0.000E+00	6.300E+03
MN-56	0.000E+00	1.240E+00	0.000E+00	1.300E+00	9.440E+03	2.020E+04	0.000E+00	1.830E-01
FE-55	2.460E+04	1.700E+04	0.000E+00	0.000E+00	7.210E+04	6.030E+03	0.000E+00	3.940E+03
FE-59	1.180E+04	2.780E+04	0.000E+00	0.000E+00	1.020E+06	1.880E+05	0.000E+00	1.060E+04
CO-58	0.000E+00	1.580E+03	0.000E+00	0.000E+00	9.280E+05	1.060E+05	0.000E+00	2.070E+03
CO-60	0.000E+00	1.150E+04	0.000E+00	0.000E+00	5.970E+06	2.850E+05	0.000E+00	1.480E+04
NI-63	4.320E+05	3.140E+04	0.000E+00	0.000E+00	1.780E+05	1.340E+04	0.000E+00	1.450E+04
NI-65	1.540E+00	2.100E-01	0.000E+00	0.000E+00	5.600E+03	1.230E+04	0.000E+00	9.120E-02
CU-64	0.000E+00	1.460E+00	0.000E+00	4.620E+00	6.780E+03	4.900E+04	0.000E+00	6.150E-01
ZN-65	3.240E+04	1.030E+05	0.000E+00	6.900E+04	8.640E+05	5.340E+04	0.000E+00	4.660E+04
ZN-69	3.380E-02	6.510E-02	0.000E+00	4.220E-02	9.200E+02	1.630E+01	0.000E+00	4.520E-03
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.320E+02	0.000E+00	2.410E+02
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.640E-03	0.000E+00	3.130E+02
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.280E+01
RB-86	0.000E+00	1.350E+05	0.000E+00	0.000E+00	0.000E+00	1.660E+04	0.000E+00	5.900E+04
RB-88	0.000E+00	3.870E+02	0.000E+00	0.000E+00	0.000E+00	3.340E-09	0.000E+00	1.930E+02
RB-89	0.000E+00	2.560E+02	0.000E+00	0.000E+00	0.000E+00	9.280E-12	0.000E+00	1.700E+02
SR-89	3.040E+05	0.000E+00	0.000E+00	0.000E+00	1.400E+06	3.500E+05	0.000E+00	8.720E+03
SR-90	9.920E+07	0.000E+00	0.000E+00	0.000E+00	9.600E+06	7.220E+05	0.000E+00	6.100E+06
SR-91	6.190E+01	0.000E+00	0.000E+00	0.000E+00	3.650E+04	1.910E+05	0.000E+00	2.500E+00

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Inhalation (INHL)			Units:	mrem/yr / µCi/m^3	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	6.740E+00	0.000E+00	0.000E+00	0.000E+00	1.650E+04	4.300E+04	0.000E+00	2.910E-01
Y-90	2.090E+03	0.000E+00	0.000E+00	0.000E+00	1.700E+05	5.060E+05	0.000E+00	5.610E+01
Y-91	4.620E+05	0.000E+00	0.000E+00	0.000E+00	1.700E+06	3.850E+05	0.000E+00	1.240E+04
Y-91M	2.610E-01	0.000E+00	0.000E+00	0.000E+00	1.920E+03	1.330E+00	0.000E+00	1.020E-02
Y-92	1.030E+01	0.000E+00	0.000E+00	0.000E+00	1.570E+04	7.350E+04	0.000E+00	3.020E-01
Y-93	9.440E+01	0.000E+00	0.000E+00	0.000E+00	4.850E+04	4.220E+05	0.000E+00	2.610E+00
ZR-95	1.070E+05	3.440E+04	0.000E+00	5.420E+04	1.770E+06	1.500E+05	0.000E+00	2.330E+04
ZR-97	9.680E+01	1.960E+01	0.000E+00	2.970E+01	7.870E+04	5.230E+05	0.000E+00	9.040E+00
NB-95	1.410E+04	7.820E+03	0.000E+00	7.740E+03	5.050E+05	1.040E+05	0.000E+00	4.210E+03
MO-99	0.000E+00	1.210E+02	0.000E+00	2.910E+02	9.120E+04	2.480E+05	0.000E+00	2.300E+01
TC-99M	1.030E-03	2.910E-03	0.000E+00	4.420E-02	7.640E+02	4.160E+03	0.000E+00	3.700E-02
TC-101	4.180E-05	6.020E-05	0.000E+00	1.080E-03	3.990E+02	1.090E-11	0.000E+00	5.900E-04
RU-103	1.530E+03	0.000E+00	0.000E+00	5.830E+03	5.050E+05	1.100E+05	0.000E+00	6.580E+02
RU-105	7.900E-01	0.000E+00	0.000E+00	1.020E+00	1.100E+04	4.820E+04	0.000E+00	3.110E-01
RU-106	6.910E+04	0.000E+00	0.000E+00	1.340E+05	9.360E+06	9.120E+05	0.000E+00	8.720E+03
AG-110M	1.080E+04	1.000E+04	0.000E+00	1.970E+04	4.630E+06	3.020E+05	0.000E+00	5.940E+03
TE-125M	3.420E+03	1.580E+03	1.050E+03	1.240E+04	3.140E+05	7.060E+04	0.000E+00	4.670E+02
TE-127	1.400E+00	6.420E-01	1.060E+00	5.100E+00	6.510E+03	5.740E+04	0.000E+00	3.100E-01
TE-127M	1.260E+04	5.770E+03	3.290E+03	4.580E+04	9.600E+05	1.500E+05	0.000E+00	1.570E+03
TE-129	4.980E-02	2.390E-02	3.900E-02	1.870E-01	1.940E+03	1.570E+02	0.000E+00	1.240E-02
TE-129M	9.760E+03	4.670E+03	3.440E+03	3.660E+04	1.160E+06	3.830E+05	0.000E+00	1.580E+03
TE-131	1.110E-02	5.950E-03	9.360E-03	4.370E-02	1.390E+03	1.840E+01	0.000E+00	3.590E-03
TE-131M	6.990E+01	4.360E+01	5.500E+01	3.090E+02	1.460E+05	5.560E+05	0.000E+00	2.900E+01
TE-132	2.600E+02	2.150E+02	1.900E+02	1.460E+03	2.880E+05	5.100E+05	0.000E+00	1.620E+02
I-130	4.580E+03	1.340E+04	1.140E+06	2.090E+04	0.000E+00	7.690E+03	0.000E+00	5.280E+03

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Inhalation (INHL)			Units:	mrem/yr / µCi/m^3	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	2.520E+04	3.580E+04	1.190E+07	6.130E+04	0.000E+00	6.280E+03	0.000E+00	2.050E+04
I-132	1.160E+03	3.260E+03	1.140E+05	5.180E+03	0.000E+00	4.060E+02	0.000E+00	1.160E+03
I-133	8.640E+03	1.480E+04	2.150E+06	2.580E+04	0.000E+00	8.880E+03	0.000E+00	4.520E+03
I-134	6.440E+02	1.730E+03	2.980E+04	2.750E+03	0.000E+00	1.010E+00	0.000E+00	6.150E+02
I-135	2.680E+03	6.980E+03	4.480E+05	1.110E+04	0.000E+00	5.250E+03	0.000E+00	2.570E+03
CS-134	3.730E+05	8.480E+05	0.000E+00	2.870E+05	9.760E+04	1.040E+04	0.000E+00	7.280E+05
CS-136	3.900E+04	1.460E+05	0.000E+00	8.560E+04	1.200E+04	1.170E+04	0.000E+00	1.100E+05
CS-137	4.780E+05	6.210E+05	0.000E+00	2.220E+05	7.520E+04	8.400E+03	0.000E+00	4.280E+05
CS-138	3.310E+02	6.210E+02	0.000E+00	4.800E+02	4.860E+01	1.860E-03	0.000E+00	3.240E+02
BA-139	9.360E-01	6.660E-04	0.000E+00	6.220E-04	3.760E+03	8.960E+02	0.000E+00	2.740E-02
BA-140	3.900E+04	4.900E+01	0.000E+00	1.670E+01	1.270E+06	2.180E+05	0.000E+00	2.570E+03
BA-141	1.000E-01	7.530E-05	0.000E+00	7.000E-05	1.940E+03	1.160E-07	0.000E+00	3.360E-03
BA-142	2.630E-02	2.700E-05	0.000E+00	2.290E-05	1.190E+03	1.570E-16	0.000E+00	1.660E-03
LA-140	3.440E+02	1.740E+02	0.000E+00	0.000E+00	1.360E+05	4.580E+05	0.000E+00	4.580E+01
LA-142	6.830E-01	3.100E-01	0.000E+00	0.000E+00	6.330E+03	2.110E+03	0.000E+00	7.720E-02
CE-141	1.990E+04	1.350E+04	0.000E+00	6.260E+03	3.620E+05	1.200E+05	0.000E+00	1.530E+03
CE-143	1.860E+02	1.380E+02	0.000E+00	6.080E+01	7.980E+04	2.260E+05	0.000E+00	1.530E+01
CE-144	3.430E+06	1.430E+06	0.000E+00	8.480E+05	7.780E+06	8.160E+05	0.000E+00	1.840E+05
PR-143	9.360E+03	3.750E+03	0.000E+00	2.160E+03	2.810E+05	2.000E+05	0.000E+00	4.640E+02
PR-144	3.010E-02	1.250E-02	0.000E+00	7.050E-03	1.020E+03	2.150E-08	0.000E+00	1.530E-03
ND-147	5.270E+03	6.100E+03	0.000E+00	3.560E+03	2.210E+05	1.730E+05	0.000E+00	3.650E+02
W-187	8.480E+00	7.080E+00	0.000E+00	0.000E+00	2.900E+04	1.550E+05	0.000E+00	2.480E+00
NP-239	2.300E+02	2.260E+01	0.000E+00	7.000E+01	3.760E+04	1.190E+05	0.000E+00	1.240E+01

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Ground Plane Deposition (GPD)			Units:	m²·mrem/yr / µCi/sec	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C-14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NA-24	1.190E+07	1.190E+07	1.190E+07	1.190E+07	1.190E+07	1.190E+07	1.390E+07	1.190E+07
P-32	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CR-51	4.660E+06	4.660E+06	4.660E+06	4.660E+06	4.660E+06	4.660E+06	5.510E+06	4.660E+06
MN-54	1.390E+09	1.390E+09	1.390E+09	1.390E+09	1.390E+09	1.390E+09	1.630E+09	1.390E+09
MN-56	9.020E+05	9.020E+05	9.020E+05	9.020E+05	9.020E+05	9.020E+05	1.070E+06	9.020E+05
FE-55	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
FE-59	2.730E+08	2.730E+08	2.730E+08	2.730E+08	2.730E+08	2.730E+08	3.210E+08	2.730E+08
CO-58	3.790E+08	3.790E+08	3.790E+08	3.790E+08	3.790E+08	3.790E+08	4.440E+08	3.790E+08
CO-60	2.150E+10	2.150E+10	2.150E+10	2.150E+10	2.150E+10	2.150E+10	2.530E+10	2.150E+10
NI-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NI-65	2.970E+05	2.970E+05	2.970E+05	2.970E+05	2.970E+05	2.970E+05	3.450E+05	2.970E+05
CU-64	6.070E+05	6.070E+05	6.070E+05	6.070E+05	6.070E+05	6.070E+05	6.880E+05	6.070E+05
ZN-65	7.470E+08	7.470E+08	7.470E+08	7.470E+08	7.470E+08	7.470E+08	8.590E+08	7.470E+08
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	4.870E+03	4.870E+03	4.870E+03	4.870E+03	4.870E+03	4.870E+03	7.080E+03	4.870E+03
BR-84	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.360E+05	2.030E+05
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	8.990E+06	8.990E+06	8.990E+06	8.990E+06	8.990E+06	8.990E+06	1.030E+07	8.990E+06
RB-88	3.310E+04	3.310E+04	3.310E+04	3.310E+04	3.310E+04	3.310E+04	3.780E+04	3.310E+04
RB-89	1.230E+05	1.230E+05	1.230E+05	1.230E+05	1.230E+05	1.230E+05	1.480E+05	1.230E+05
SR-89	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.510E+04	2.160E+04
SR-90	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-91	2.150E+06	2.150E+06	2.150E+06	2.150E+06	2.150E+06	2.150E+06	2.510E+06	2.150E+06

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Ground Plane Deposition (GPD)			Units:	m²·mrem/yr / µCi/sec	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	7.770E+05	7.770E+05	7.770E+05	7.770E+05	7.770E+05	7.770E+05	8.630E+05	7.770E+05
Y-90	4.490E+03	4.490E+03	4.490E+03	4.490E+03	4.490E+03	4.490E+03	5.310E+03	4.490E+03
Y-91	1.070E+06	1.070E+06	1.070E+06	1.070E+06	1.070E+06	1.070E+06	1.210E+06	1.070E+06
Y-91M	1.000E+05	1.000E+05	1.000E+05	1.000E+05	1.000E+05	1.000E+05	1.160E+05	1.000E+05
Y-92	1.800E+05	1.800E+05	1.800E+05	1.800E+05	1.800E+05	1.800E+05	2.140E+05	1.800E+05
Y-93	1.830E+05	1.830E+05	1.830E+05	1.830E+05	1.830E+05	1.830E+05	2.510E+05	1.830E+05
ZR-95	2.450E+08	2.450E+08	2.450E+08	2.450E+08	2.450E+08	2.450E+08	2.840E+08	2.450E+08
ZR-97	2.960E+06	2.960E+06	2.960E+06	2.960E+06	2.960E+06	2.960E+06	3.440E+06	2.960E+06
NB-95	1.370E+08	1.370E+08	1.370E+08	1.370E+08	1.370E+08	1.370E+08	1.610E+08	1.370E+08
MO-99	3.990E+06	3.990E+06	3.990E+06	3.990E+06	3.990E+06	3.990E+06	4.630E+06	3.990E+06
TC-99M	1.840E+05	1.840E+05	1.840E+05	1.840E+05	1.840E+05	1.840E+05	2.110E+05	1.840E+05
TC-101	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.260E+04	2.040E+04
RU-103	1.080E+08	1.080E+08	1.080E+08	1.080E+08	1.080E+08	1.080E+08	1.260E+08	1.080E+08
RU-105	6.360E+05	6.360E+05	6.360E+05	6.360E+05	6.360E+05	6.360E+05	7.210E+05	6.360E+05
RU-106	4.220E+08	4.220E+08	4.220E+08	4.220E+08	4.220E+08	4.220E+08	5.070E+08	4.220E+08
AG-110M	3.440E+09	3.440E+09	3.440E+09	3.440E+09	3.440E+09	3.440E+09	4.010E+09	3.440E+09
TE-125M	1.550E+06	1.550E+06	1.550E+06	1.550E+06	1.550E+06	1.550E+06	2.130E+06	1.550E+06
TE-127	2.980E+03	2.980E+03	2.980E+03	2.980E+03	2.980E+03	2.980E+03	3.280E+03	2.980E+03
TE-127M	9.160E+04	9.160E+04	9.160E+04	9.160E+04	9.160E+04	9.160E+04	1.080E+05	9.160E+04
TE-129	2.620E+04	2.620E+04	2.620E+04	2.620E+04	2.620E+04	2.620E+04	3.100E+04	2.620E+04
TE-129M	1.980E+07	1.980E+07	1.980E+07	1.980E+07	1.980E+07	1.980E+07	2.310E+07	1.980E+07
TE-131	2.920E+04	2.920E+04	2.920E+04	2.920E+04	2.920E+04	2.920E+04	3.450E+07	2.920E+04
TE-131M	8.030E+06	8.030E+06	8.030E+06	8.030E+06	8.030E+06	8.030E+06	9.460E+06	8.030E+06
TE-132	4.230E+06	4.230E+06	4.230E+06	4.230E+06	4.230E+06	4.230E+06	4.980E+06	4.230E+06
I-130	5.510E+06	5.510E+06	5.510E+06	5.510E+06	5.510E+06	5.510E+06	6.690E+06	5.510E+06

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Ground Plane Deposition (GPD)			Units:	m²·mrem/yr / µCi/sec	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	1.720E+07	1.720E+07	1.720E+07	1.720E+07	1.720E+07	1.720E+07	2.090E+07	1.720E+07
I-132	1.250E+06	1.250E+06	1.250E+06	1.250E+06	1.250E+06	1.250E+06	1.470E+06	1.250E+06
I-133	2.450E+06	2.450E+06	2.450E+06	2.450E+06	2.450E+06	2.450E+06	2.980E+06	2.450E+06
I-134	4.470E+05	4.470E+05	4.470E+05	4.470E+05	4.470E+05	4.470E+05	5.300E+05	4.470E+05
I-135	2.530E+06	2.530E+06	2.530E+06	2.530E+06	2.530E+06	2.530E+06	2.950E+06	2.530E+06
CS-134	6.860E+09	6.860E+09	6.860E+09	6.860E+09	6.860E+09	6.860E+09	8.000E+09	6.860E+09
CS-136	1.510E+08	1.510E+08	1.510E+08	1.510E+08	1.510E+08	1.510E+08	1.710E+08	1.510E+08
CS-137	1.030E+10	1.030E+10	1.030E+10	1.030E+10	1.030E+10	1.030E+10	1.200E+10	1.030E+10
CS-138	3.590E+05	3.590E+05	3.590E+05	3.590E+05	3.590E+05	3.590E+05	4.100E+05	3.590E+05
BA-139	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.190E+05	1.060E+05
BA-140	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.350E+07	2.050E+07
BA-141	4.170E+04	4.170E+04	4.170E+04	4.170E+04	4.170E+04	4.170E+04	4.750E+04	4.170E+04
BA-142	4.490E+04	4.490E+04	4.490E+04	4.490E+04	4.490E+04	4.490E+04	5.110E+04	4.490E+04
LA-140	1.920E+07	1.920E+07	1.920E+07	1.920E+07	1.920E+07	1.920E+07	2.180E+07	1.920E+07
LA-142	7.600E+05	7.600E+05	7.600E+05	7.600E+05	7.600E+05	7.600E+05	9.120E+05	7.600E+05
CE-141	1.370E+07	1.370E+07	1.370E+07	1.370E+07	1.370E+07	1.370E+07	1.540E+07	1.370E+07
CE-143	2.310E+06	2.310E+06	2.310E+06	2.310E+06	2.310E+06	2.310E+06	2.630E+06	2.310E+06
CE-144	6.950E+07	6.950E+07	6.950E+07	6.950E+07	6.950E+07	6.950E+07	8.040E+07	6.950E+07
PR-143	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR-144	1.830E+03	1.830E+03	1.830E+03	1.830E+03	1.830E+03	1.830E+03	2.110E+03	1.830E+03
ND-147	8.390E+06	8.390E+06	8.390E+06	8.390E+06	8.390E+06	8.390E+06	1.010E+07	8.390E+06
W-187	2.350E+06	2.350E+06	2.350E+06	2.350E+06	2.350E+06	2.350E+06	2.730E+06	2.350E+06
NP-239	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.980E+06	1.710E+06

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Grs/Cow/Milk (CMILK)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	9.940E+02	9.940E+02	9.940E+02	9.940E+02	9.940E+02	0.000E+00	9.940E+02
C-14	4.690E+04	9.380E+03	9.380E+03	9.380E+03	9.380E+03	9.380E+03	0.000E+00	9.380E+03
NA-24	4.260E+06	4.260E+06	4.260E+06	4.260E+06	4.260E+06	4.260E+06	0.000E+00	4.260E+06
P-32	3.150E+10	1.950E+09	0.000E+00	0.000E+00	0.000E+00	2.650E+09	0.000E+00	1.220E+09
CR-51	0.000E+00	0.000E+00	2.770E+04	1.090E+04	7.130E+04	8.390E+06	0.000E+00	4.990E+04
MN-54	0.000E+00	1.400E+07	0.000E+00	4.180E+06	0.000E+00	2.870E+07	0.000E+00	2.780E+06
MN-56	0.000E+00	7.250E-03	0.000E+00	9.180E-03	0.000E+00	4.770E-01	0.000E+00	1.290E-03
FE-55	4.450E+07	3.160E+07	0.000E+00	0.000E+00	2.000E+07	1.370E+07	0.000E+00	7.360E+06
FE-59	5.180E+07	1.210E+08	0.000E+00	0.000E+00	3.810E+07	2.860E+08	0.000E+00	4.670E+07
CO-58	0.000E+00	7.940E+06	0.000E+00	0.000E+00	0.000E+00	1.090E+08	0.000E+00	1.830E+07
CO-60	0.000E+00	2.780E+07	0.000E+00	0.000E+00	0.000E+00	3.620E+08	0.000E+00	6.260E+07
NI-63	1.180E+10	8.350E+08	0.000E+00	0.000E+00	0.000E+00	1.330E+08	0.000E+00	4.010E+08
NI-65	6.770E-01	8.650E-02	0.000E+00	0.000E+00	0.000E+00	4.690E+00	0.000E+00	3.940E-02
CU-64	0.000E+00	4.250E+04	0.000E+00	1.070E+05	0.000E+00	3.290E+06	0.000E+00	2.000E+04
ZN-65	2.110E+09	7.320E+09	0.000E+00	4.680E+09	0.000E+00	3.100E+09	0.000E+00	3.410E+09
ZN-69	3.850E-12	7.330E-12	0.000E+00	4.790E-12	0.000E+00	1.350E-11	0.000E+00	5.130E-13
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.790E-01
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.880E-23
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	4.730E+09	0.000E+00	0.000E+00	0.000E+00	7.000E+08	0.000E+00	2.220E+09
RB-88	0.000E+00	3.890E-45	0.000E+00	0.000E+00	0.000E+00	3.330E-52	0.000E+00	2.070E-45
RB-89	0.000E+00	7.660E-53	0.000E+00	0.000E+00	0.000E+00	1.170E-61	0.000E+00	5.420E-53
SR-89	2.670E+09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.190E+08	0.000E+00	7.660E+07
SR-90	6.610E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.860E+09	0.000E+00	1.630E+10
SR-91	5.310E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.410E+05	0.000E+00	2.110E+03

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Grs/Cow/Milk (CMILK)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	8.940E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.280E+01	0.000E+00	3.810E-02
Y-90	1.300E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.070E+06	0.000E+00	3.510E+00
Y-91	1.580E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.480E+06	0.000E+00	4.240E+02
Y-91M	1.090E-19	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.170E-18	0.000E+00	4.180E-21
Y-92	1.030E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.830E+00	0.000E+00	2.980E-06
Y-93	4.120E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.260E+04	0.000E+00	1.130E-02
ZR-95	1.650E+03	5.200E+02	0.000E+00	7.650E+02	0.000E+00	1.200E+06	0.000E+00	3.580E+02
ZR-97	7.880E-01	1.560E-01	0.000E+00	2.370E-01	0.000E+00	4.220E+04	0.000E+00	7.190E-02
NB-95	1.410E+05	7.810E+04	0.000E+00	7.570E+04	0.000E+00	3.340E+08	0.000E+00	4.300E+04
MO-99	0.000E+00	4.470E+07	0.000E+00	1.020E+08	0.000E+00	8.010E+07	0.000E+00	8.530E+06
TC-99M	5.760E+00	1.610E+01	0.000E+00	2.390E+02	8.920E+00	1.050E+04	0.000E+00	2.080E+02
TC-101	4.740E-60	6.750E-60	0.000E+00	1.220E-58	4.110E-60	1.150E-66	0.000E+00	6.630E-59
RU-103	1.810E+03	0.000E+00	0.000E+00	6.380E+03	0.000E+00	1.510E+05	0.000E+00	7.740E+02
RU-105	1.560E-03	0.000E+00	0.000E+00	1.970E-02	0.000E+00	1.260E+00	0.000E+00	6.070E-04
RU-106	3.750E+04	0.000E+00	0.000E+00	7.240E+04	0.000E+00	1.800E+06	0.000E+00	4.730E+03
AG-110M	9.630E+07	9.110E+07	0.000E+00	1.740E+08	0.000E+00	2.560E+10	0.000E+00	5.540E+07
TE-125M	3.000E+07	1.080E+07	8.390E+06	0.000E+00	0.000E+00	8.860E+07	0.000E+00	4.020E+06
TE-127	1.210E+03	4.290E+02	8.350E+02	4.900E+03	0.000E+00	9.340E+04	0.000E+00	2.600E+02
TE-127M	8.440E+07	2.990E+07	2.010E+07	3.420E+08	0.000E+00	2.100E+08	0.000E+00	1.000E+07
TE-129	5.200E-10	1.940E-10	3.720E-10	2.180E-09	0.000E+00	2.840E-09	0.000E+00	1.270E-10
TE-129M	1.100E+08	4.090E+07	3.550E+07	4.610E+08	0.000E+00	4.130E+08	0.000E+00	1.740E+07
TE-131	6.580E-33	2.710E-33	5.070E-33	2.880E-32	0.000E+00	5.400E-34	0.000E+00	2.060E-33
TE-131M	6.570E+05	3.150E+05	4.740E+05	3.290E+06	0.000E+00	2.530E+07	0.000E+00	2.630E+05
TE-132	4.290E+06	2.720E+06	2.870E+06	2.610E+07	0.000E+00	8.610E+07	0.000E+00	2.560E+06
I-130	7.380E+05	2.140E+06	1.740E+08	3.290E+06	0.000E+00	1.640E+06	0.000E+00	8.530E+05

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Grs/Cow/Milk (CMILK)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	5.370E+08	7.520E+08	2.190E+11	1.290E+09	0.000E+00	1.490E+08	0.000E+00	4.040E+08
I-132	2.910E-01	7.620E-01	2.570E+01	1.200E+00	0.000E+00	3.320E-01	0.000E+00	2.740E-01
I-133	7.070E+06	1.200E+07	1.670E+09	2.100E+07	0.000E+00	9.070E+06	0.000E+00	3.660E+06
I-134	3.580E-12	9.500E-12	1.580E-10	1.500E-11	0.000E+00	1.250E-13	0.000E+00	3.410E-12
I-135	2.280E+04	5.870E+04	3.780E+06	9.270E+04	0.000E+00	6.510E+04	0.000E+00	2.180E+04
CS-134	9.820E+09	2.310E+10	0.000E+00	7.340E+09	2.800E+09	2.870E+08	0.000E+00	1.070E+10
CS-136	4.480E+08	1.760E+09	0.000E+00	9.600E+08	1.510E+08	1.420E+08	0.000E+00	1.180E+09
CS-137	1.340E+10	1.780E+10	0.000E+00	6.060E+09	2.350E+09	2.530E+08	0.000E+00	6.200E+09
CS-138	1.640E-23	3.150E-23	0.000E+00	2.330E-23	2.710E-24	1.430E-26	0.000E+00	1.580E-23
BA-139	8.170E-08	5.750E-11	0.000E+00	5.420E-11	3.960E-11	7.290E-07	0.000E+00	2.380E-09
BA-140	4.850E+07	5.950E+04	0.000E+00	2.020E+04	4.000E+04	7.480E+07	0.000E+00	3.130E+06
BA-141	7.520E-46	5.620E-49	0.000E+00	5.210E-49	3.850E-49	1.600E-51	0.000E+00	2.510E-47
BA-142	4.790E-80	4.790E-83	0.000E+00	4.050E-83	3.190E-83	1.470E-91	0.000E+00	2.950E-81
LA-140	8.100E+00	3.980E+00	0.000E+00	0.000E+00	0.000E+00	2.290E+05	0.000E+00	1.060E+00
LA-142	3.360E-11	1.490E-11	0.000E+00	0.000E+00	0.000E+00	4.540E-07	0.000E+00	3.710E-12
CE-141	8.880E+03	5.930E+03	0.000E+00	2.790E+03	0.000E+00	1.700E+07	0.000E+00	6.810E+02
CE-143	7.640E+01	5.560E+04	0.000E+00	2.490E+01	0.000E+00	1.670E+06	0.000E+00	6.210E+00
CE-144	6.580E+05	2.720E+05	0.000E+00	1.630E+05	0.000E+00	1.660E+08	0.000E+00	3.540E+04
PR-143	2.900E+02	1.160E+02	0.000E+00	6.730E+01	0.000E+00	9.540E+05	0.000E+00	1.440E+01
PR-144	1.080E-53	4.430E-54	0.000E+00	2.540E-54	0.000E+00	1.190E-56	0.000E+00	5.490E-55
ND-147	1.810E+02	1.970E+02	0.000E+00	1.160E+02	0.000E+00	7.110E+05	0.000E+00	1.180E+01
W-187	1.190E+04	9.710E+03	0.000E+00	0.000E+00	0.000E+00	2.630E+06	0.000E+00	3.400E+03
NP-239	7.010E+00	6.610E-01	0.000E+00	2.070E+00	0.000E+00	1.060E+05	0.000E+00	3.670E-01

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Grs/Goat/Milk (GMILK)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	2.030E+03	2.030E+03	2.030E+03	2.030E+03	2.030E+03	0.000E+00	2.030E+03
C-14	4.690E+04	9.380E+03	9.380E+03	9.380E+03	9.380E+03	9.380E+03	0.000E+00	9.380E+03
NA-24	5.110E+05	5.110E+05	5.110E+05	5.110E+05	5.110E+05	5.110E+05	0.000E+00	5.110E+05
P-32	3.780E+10	2.340E+09	0.000E+00	0.000E+00	0.000E+00	3.180E+09	0.000E+00	1.470E+09
CR-51	0.000E+00	0.000E+00	3.330E+03	1.310E+03	8.550E+03	1.010E+06	0.000E+00	5.990E+03
MN-54	0.000E+00	1.680E+06	0.000E+00	5.020E+05	0.000E+00	3.450E+06	0.000E+00	3.340E+05
MN-56	0.000E+00	8.700E-04	0.000E+00	1.100E-03	0.000E+00	5.730E-02	0.000E+00	1.550E-04
FE-55	5.790E+05	4.110E+05	0.000E+00	0.000E+00	2.600E+05	1.780E+05	0.000E+00	9.570E+04
FE-59	6.740E+05	1.570E+06	0.000E+00	0.000E+00	4.960E+05	3.720E+06	0.000E+00	6.070E+05
CO-58	0.000E+00	9.520E+05	0.000E+00	0.000E+00	0.000E+00	1.310E+07	0.000E+00	2.190E+06
CO-60	0.000E+00	3.340E+06	0.000E+00	0.000E+00	0.000E+00	4.350E+07	0.000E+00	7.520E+06
NI-63	1.420E+09	1.000E+08	0.000E+00	0.000E+00	0.000E+00	1.590E+07	0.000E+00	4.810E+07
NI-65	8.120E-02	1.040E-02	0.000E+00	0.000E+00	0.000E+00	5.630E-01	0.000E+00	4.730E-03
CU-64	0.000E+00	4.730E+03	0.000E+00	1.200E+04	0.000E+00	3.670E+05	0.000E+00	2.230E+03
ZN-65	2.530E+08	8.780E+08	0.000E+00	5.620E+08	0.000E+00	3.720E+08	0.000E+00	4.100E+08
ZN-69	4.620E-13	8.800E-13	0.000E+00	5.750E-13	0.000E+00	1.620E-12	0.000E+00	6.160E-14
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.150E-02
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.450E-24
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	5.670E+08	0.000E+00	0.000E+00	0.000E+00	8.400E+07	0.000E+00	2.670E+08
RB-88	0.000E+00	4.670E-46	0.000E+00	0.000E+00	0.000E+00	4.000E-53	0.000E+00	2.490E-46
RB-89	0.000E+00	9.190E-54	0.000E+00	0.000E+00	0.000E+00	1.410E-62	0.000E+00	6.500E-54
SR-89	5.620E+09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.690E+08	0.000E+00	1.610E+08
SR-90	1.390E+11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.900E+09	0.000E+00	3.430E+10
SR-91	1.120E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.060E+05	0.000E+00	4.440E+03

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Grs/Goat/Milk (GMILK)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	1.880E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.780E+01	0.000E+00	8.000E-02
Y-90	1.560E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.290E+05	0.000E+00	4.210E-01
Y-91	1.900E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.770E+05	0.000E+00	5.080E+01
Y-91M	1.310E-20	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.200E-19	0.000E+00	5.020E-22
Y-92	1.240E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.390E-01	0.000E+00	3.580E-07
Y-93	4.940E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.510E+03	0.000E+00	1.360E-03
ZR-95	1.980E+02	6.250E+01	0.000E+00	9.180E+01	0.000E+00	1.440E+05	0.000E+00	4.300E+01
ZR-97	9.460E-02	1.870E-02	0.000E+00	2.840E-02	0.000E+00	5.070E+03	0.000E+00	8.620E-03
NB-95	1.690E+04	9.370E+03	0.000E+00	9.080E+03	0.000E+00	4.010E+07	0.000E+00	5.160E+03
MO-99	0.000E+00	5.370E+06	0.000E+00	1.230E+07	0.000E+00	9.610E+06	0.000E+00	1.020E+06
TC-99M	6.910E-01	1.930E+00	0.000E+00	2.870E+01	1.070E+00	1.270E+03	0.000E+00	2.500E+01
TC-101	5.690E-61	8.100E-61	0.000E+00	1.460E-59	4.930E-61	1.380E-67	0.000E+00	7.950E-60
RU-103	2.170E+02	0.000E+00	0.000E+00	7.660E+02	0.000E+00	1.810E+04	0.000E+00	9.290E+01
RU-105	1.880E-04	0.000E+00	0.000E+00	2.370E-03	0.000E+00	1.520E-01	0.000E+00	7.290E-05
RU-106	4.500E+03	0.000E+00	0.000E+00	8.680E+03	0.000E+00	2.160E+05	0.000E+00	5.670E+02
AG-110M	1.160E+07	1.090E+07	0.000E+00	2.080E+07	0.000E+00	3.070E+09	0.000E+00	6.650E+06
TE-125M	3.600E+06	1.300E+06	1.010E+06	0.000E+00	0.000E+00	1.060E+07	0.000E+00	4.820E+05
TE-127	1.450E+02	5.150E+01	1.000E+02	5.880E+02	0.000E+00	1.120E+04	0.000E+00	3.120E+01
TE-127M	1.010E+07	3.590E+06	2.410E+06	4.100E+07	0.000E+00	2.520E+07	0.000E+00	1.200E+06
TE-129	6.240E-11	2.330E-11	4.460E-11	2.620E-10	0.000E+00	3.410E-10	0.000E+00	1.520E-11
TE-129M	1.320E+07	4.900E+06	4.260E+06	5.530E+07	0.000E+00	4.960E+07	0.000E+00	2.090E+06
TE-131	7.900E-34	3.260E-34	6.090E-34	3.450E-33	0.000E+00	6.480E-35	0.000E+00	2.470E-34
TE-131M	7.880E+04	3.780E+04	5.690E+04	3.940E+05	0.000E+00	3.030E+06	0.000E+00	3.150E+04
TE-132	5.150E+05	3.260E+05	3.440E+05	3.130E+06	0.000E+00	1.030E+07	0.000E+00	3.070E+05
I-130	8.860E+05	2.560E+06	2.090E+08	3.950E+06	0.000E+00	1.970E+06	0.000E+00	1.020E+06

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Grs/Goat/Milk (GMILK)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	6.450E+08	9.030E+08	2.630E+11	1.550E+09	0.000E+00	1.790E+08	0.000E+00	4.850E+08
I-132	3.500E-01	9.150E-01	3.080E+01	1.440E+00	0.000E+00	3.980E-01	0.000E+00	3.280E-01
I-133	8.480E+06	1.440E+07	2.010E+09	2.520E+07	0.000E+00	1.090E+07	0.000E+00	4.390E+06
I-134	4.300E-12	1.140E-11	1.900E-10	1.800E-11	0.000E+00	1.500E-13	0.000E+00	4.090E-12
I-135	2.740E+04	7.040E+04	4.530E+06	1.110E+05	0.000E+00	7.810E+04	0.000E+00	2.610E+04
CS-134	2.940E+10	6.930E+10	0.000E+00	2.200E+10	8.410E+09	8.620E+08	0.000E+00	3.220E+10
CS-136	1.340E+09	5.290E+09	0.000E+00	2.880E+09	4.540E+08	4.260E+08	0.000E+00	3.550E+09
CS-137	4.020E+10	5.340E+10	0.000E+00	1.820E+10	7.060E+09	7.600E+08	0.000E+00	1.860E+10
CS-138	4.920E-23	9.450E-23	0.000E+00	6.980E-23	8.120E-24	4.290E-26	0.000E+00	4.730E-23
BA-139	9.800E-09	6.900E-12	0.000E+00	6.500E-12	4.750E-12	8.750E-08	0.000E+00	2.860E-10
BA-140	5.820E+06	7.130E+03	0.000E+00	2.420E+03	4.800E+03	8.980E+06	0.000E+00	3.750E+05
BA-141	9.030E-47	6.740E-50	0.000E+00	6.260E-50	4.610E-50	1.920E-52	0.000E+00	3.010E-48
BA-142	5.750E-81	5.750E-84	0.000E+00	4.860E-84	3.820E-84	1.760E-92	0.000E+00	3.540E-82
LA-140	9.720E-01	4.780E-01	0.000E+00	0.000E+00	0.000E+00	2.740E+04	0.000E+00	1.270E-01
LA-142	4.030E-12	1.790E-12	0.000E+00	0.000E+00	0.000E+00	5.440E-08	0.000E+00	4.450E-13
CE-141	1.070E+03	7.120E+02	0.000E+00	3.350E+02	0.000E+00	2.040E+06	0.000E+00	8.170E+01
CE-143	9.170E+00	6.670E+03	0.000E+00	2.990E+00	0.000E+00	2.000E+05	0.000E+00	7.450E-01
CE-144	7.900E+04	3.270E+04	0.000E+00	1.950E+04	0.000E+00	1.990E+07	0.000E+00	4.240E+03
PR-143	3.480E+01	1.390E+01	0.000E+00	8.080E+00	0.000E+00	1.150E+05	0.000E+00	1.730E+00
PR-144	1.300E-54	5.320E-55	0.000E+00	3.050E-55	0.000E+00	1.430E-57	0.000E+00	6.590E-56
ND-147	2.170E+01	2.360E+01	0.000E+00	1.390E+01	0.000E+00	8.530E+04	0.000E+00	1.420E+00
W-187	1.430E+03	1.170E+03	0.000E+00	0.000E+00	0.000E+00	3.150E+05	0.000E+00	4.080E+02
NP-239	8.410E-01	7.930E-02	0.000E+00	2.490E-01	0.000E+00	1.280E+04	0.000E+00	4.410E-02

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Grs/Cow/Meat (CMEAT)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	1.940E+02	1.940E+02	1.940E+02	1.940E+02	1.940E+02	0.000E+00	1.940E+02
C-14	1.970E+04	3.940E+03	3.940E+03	3.940E+03	3.940E+03	3.940E+03	0.000E+00	3.940E+03
NA-24	1.080E-03	1.080E-03	1.080E-03	1.080E-03	1.080E-03	1.080E-03	0.000E+00	1.080E-03
P-32	3.930E+09	2.440E+08	0.000E+00	0.000E+00	0.000E+00	3.310E+08	0.000E+00	1.530E+08
CR-51	0.000E+00	0.000E+00	3.130E+03	1.240E+03	8.050E+03	9.470E+05	0.000E+00	5.640E+03
MN-54	0.000E+00	7.000E+06	0.000E+00	2.090E+06	0.000E+00	1.440E+07	0.000E+00	1.390E+06
MN-56	0.000E+00	1.070E-53	0.000E+00	1.360E-53	0.000E+00	7.070E-52	0.000E+00	1.910E-54
FE-55	2.380E+08	1.690E+08	0.000E+00	0.000E+00	1.070E+08	7.310E+07	0.000E+00	3.940E+07
FE-59	2.120E+08	4.950E+08	0.000E+00	0.000E+00	1.560E+08	1.170E+09	0.000E+00	1.910E+08
CO-58	0.000E+00	1.410E+07	0.000E+00	0.000E+00	0.000E+00	1.940E+08	0.000E+00	3.240E+07
CO-60	0.000E+00	5.830E+07	0.000E+00	0.000E+00	0.000E+00	7.600E+08	0.000E+00	1.310E+08
NI-63	1.520E+10	1.070E+09	0.000E+00	0.000E+00	0.000E+00	1.710E+08	0.000E+00	5.150E+08
NI-65	1.880E-52	2.410E-53	0.000E+00	0.000E+00	0.000E+00	1.300E-51	0.000E+00	1.100E-53
CU-64	0.000E+00	2.210E-07	0.000E+00	5.600E-07	0.000E+00	1.720E-05	0.000E+00	1.040E-07
ZN-65	2.500E+08	8.690E+08	0.000E+00	5.560E+08	0.000E+00	3.680E+08	0.000E+00	4.050E+08
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.070E-57
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	4.070E+08	0.000E+00	0.000E+00	0.000E+00	6.020E+07	0.000E+00	1.910E+08
RB-88	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-89	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-89	2.550E+08	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.030E+07	0.000E+00	7.290E+06
SR-90	8.050E+09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.260E+08	0.000E+00	1.990E+09
SR-91	1.280E-10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.800E-10	0.000E+00	5.090E-12

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Grs/Cow/Meat (CMEAT)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-92	9.880E-50	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.520E-48	0.000E+00	4.210E-51
Y-90	9.060E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.470E+05	0.000E+00	2.440E+00
Y-91	9.540E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.910E+08	0.000E+00	2.560E+04
Y-91M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y-92	1.280E-39	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.520E-35	0.000E+00	3.710E-41
Y-93	3.960E-12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.210E-07	0.000E+00	1.090E-13
ZR-95	1.500E+06	4.730E+05	0.000E+00	6.950E+05	0.000E+00	1.090E+09	0.000E+00	3.250E+05
ZR-97	1.720E-05	3.410E-06	0.000E+00	5.170E-06	0.000E+00	9.230E-01	0.000E+00	1.570E-06
NB-95	1.790E+06	9.950E+05	0.000E+00	9.650E+05	0.000E+00	4.260E+09	0.000E+00	5.480E+05
MO-99	0.000E+00	8.270E+04	0.000E+00	1.890E+05	0.000E+00	1.480E+05	0.000E+00	1.580E+04
TC-99M	3.530E-21	9.850E-21	0.000E+00	1.470E-19	5.470E-21	6.470E-18	0.000E+00	1.280E-19
TC-101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-103	8.570E+07	0.000E+00	0.000E+00	3.020E+08	0.000E+00	7.160E+09	0.000E+00	3.660E+07
RU-105	4.830E-28	0.000E+00	0.000E+00	6.090E-27	0.000E+00	3.900E-25	0.000E+00	1.880E-28
RU-106	2.360E+09	0.000E+00	0.000E+00	4.550E+09	0.000E+00	1.130E+11	0.000E+00	2.970E+08
AG-110M	5.060E+06	4.790E+06	0.000E+00	9.130E+06	0.000E+00	1.340E+09	0.000E+00	2.910E+06
TE-125M	3.030E+08	1.090E+08	8.470E+07	0.000E+00	0.000E+00	8.940E+08	0.000E+00	4.050E+07
TE-127	1.800E-10	6.380E-11	1.240E-10	7.290E-10	0.000E+00	1.390E-08	0.000E+00	3.870E-11
TE-127M	9.410E+08	3.340E+08	2.240E+08	3.820E+09	0.000E+00	2.350E+09	0.000E+00	1.120E+08
TE-129	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-129M	9.500E+08	3.530E+08	3.070E+08	3.970E+09	0.000E+00	3.570E+09	0.000E+00	1.500E+08
TE-131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-131M	3.760E+02	1.800E+02	2.710E+02	1.880E+03	0.000E+00	1.450E+04	0.000E+00	1.500E+02
TE-132	1.160E+06	7.360E+05	7.750E+05	7.060E+06	0.000E+00	2.330E+07	0.000E+00	6.920E+05
I-130	1.700E-06	4.910E-06	4.000E-04	7.560E-06	0.000E+00	3.770E-06	0.000E+00	1.960E-06

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Grs/Cow/Meat (CMEAT)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	8.920E+06	1.250E+07	3.650E+09	2.150E+07	0.000E+00	2.470E+06	0.000E+00	6.710E+06
I-132	5.660E-59	1.480E-58	4.990E-57	2.330E-58	0.000E+00	6.450E-59	0.000E+00	5.320E-59
I-133	3.050E-01	5.180E-01	7.230E+01	9.090E-01	0.000E+00	3.920E-01	0.000E+00	1.580E-01
I-134	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-135	3.600E-17	9.260E-17	5.960E-15	1.460E-16	0.000E+00	1.030E-16	0.000E+00	3.430E-17
CS-134	5.230E+08	1.230E+09	0.000E+00	3.910E+08	1.490E+08	1.530E+07	0.000E+00	5.710E+08
CS-136	9.400E+06	3.700E+07	0.000E+00	2.010E+07	3.170E+06	2.980E+06	0.000E+00	2.480E+07
CS-137	7.240E+08	9.630E+08	0.000E+00	3.280E+08	1.270E+08	1.370E+07	0.000E+00	3.360E+08
CS-138	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-139	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-140	2.380E+07	2.910E+04	0.000E+00	9.870E+03	1.960E+04	3.660E+07	0.000E+00	1.530E+06
BA-141	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA-140	3.050E-02	1.500E-02	0.000E+00	0.000E+00	0.000E+00	8.610E+02	0.000E+00	3.990E-03
LA-142	2.870E-92	1.280E-92	0.000E+00	0.000E+00	0.000E+00	3.880E-88	0.000E+00	3.180E-93
CE-141	1.180E+04	7.870E+03	0.000E+00	3.710E+03	0.000E+00	2.250E+07	0.000E+00	9.040E+02
CE-143	1.690E-02	1.230E+01	0.000E+00	5.510E-03	0.000E+00	3.690E+02	0.000E+00	1.370E-03
CE-144	1.230E+06	5.080E+05	0.000E+00	3.040E+05	0.000E+00	3.090E+08	0.000E+00	6.600E+04
PR-143	1.760E+04	7.040E+03	0.000E+00	4.090E+03	0.000E+00	5.800E+07	0.000E+00	8.780E+02
PR-144	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND-147	6.230E+03	6.770E+03	0.000E+00	3.980E+03	0.000E+00	2.440E+07	0.000E+00	4.060E+02
W-187	1.730E-02	1.410E-02	0.000E+00	0.000E+00	0.000E+00	3.820E+00	0.000E+00	4.940E-03
NP-239	2.260E-01	2.140E-02	0.000E+00	6.700E-02	0.000E+00	3.440E+03	0.000E+00	1.190E-02

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Age group:	TEEN	Pathway:	Grs/Goat/Meat (GMEAT)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	2.328E+01	2.328E+01	2.328E+01	2.328E+01	2.328E+01	0.000E+00	2.328E+01
C-14	2.364E+03	4.728E+02	4.728E+02	4.728E+02	4.728E+02	4.728E+02	0.000E+00	4.728E+02
NA-24	1.296E-04	1.296E-04	1.296E-04	1.296E-04	1.296E-04	1.296E-04	0.000E+00	1.296E-04
P-32	4.716E+08	2.928E+07	0.000E+00	0.000E+00	0.000E+00	3.972E+07	0.000E+00	1.836E+07
CR-51	0.000E+00	0.000E+00	3.756E+02	1.488E+02	9.660E+02	1.136E+05	0.000E+00	6.768E+02
MN-54	0.000E+00	8.400E+05	0.000E+00	2.508E+05	0.000E+00	1.728E+06	0.000E+00	1.668E+05
MN-56	0.000E+00	1.284E-54	0.000E+00	1.632E-54	0.000E+00	8.484E-53	0.000E+00	2.292E-55
FE-55	2.856E+07	2.028E+07	0.000E+00	0.000E+00	1.284E+07	8.772E+06	0.000E+00	4.728E+06
FE-59	2.544E+07	5.940E+07	0.000E+00	0.000E+00	1.872E+07	1.404E+08	0.000E+00	2.292E+07
CO-58	0.000E+00	1.692E+06	0.000E+00	0.000E+00	0.000E+00	2.328E+07	0.000E+00	3.888E+06
CO-60	0.000E+00	6.996E+06	0.000E+00	0.000E+00	0.000E+00	9.120E+07	0.000E+00	1.572E+07
NI-63	1.824E+09	1.284E+08	0.000E+00	0.000E+00	0.000E+00	2.052E+07	0.000E+00	6.180E+07
NI-65	2.256E-53	2.892E-54	0.000E+00	0.000E+00	0.000E+00	1.560E-52	0.000E+00	1.320E-54
CU-64	0.000E+00	2.652E-08	0.000E+00	6.720E-08	0.000E+00	2.064E-06	0.000E+00	1.248E-08
ZN-65	3.000E+07	1.043E+08	0.000E+00	6.672E+07	0.000E+00	4.416E+07	0.000E+00	4.860E+07
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.084E-58
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	4.884E+07	0.000E+00	0.000E+00	0.000E+00	7.224E+06	0.000E+00	2.292E+07
RB-88	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-89	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-89	3.060E+07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.636E+06	0.000E+00	8.748E+05
SR-90	9.660E+08	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.712E+07	0.000E+00	2.388E+08
SR-91	1.536E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.960E-11	0.000E+00	6.108E-13

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Age group:	TEEN	Pathway:	Grs/Goat/Meat (GMEAT)			Units:	$m^2 \cdot mrem/yr / \mu Ci/sec$; mrem/yr / $\mu Ci/m^3$ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	1.186E-50	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.024E-49	0.000E+00	5.052E-52
Y-90	1.087E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.964E+04	0.000E+00	2.928E-01
Y-91	1.145E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.692E+07	0.000E+00	3.072E+03
Y-91M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y-92	1.536E-40	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.224E-36	0.000E+00	4.452E-42
Y-93	4.752E-13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.452E-08	0.000E+00	1.308E-14
ZR-95	1.800E+05	5.676E+04	0.000E+00	8.340E+04	0.000E+00	1.308E+08	0.000E+00	3.900E+04
ZR-97	2.064E-06	4.092E-07	0.000E+00	6.204E-07	0.000E+00	1.108E-01	0.000E+00	1.884E-07
NB-95	2.148E+05	1.194E+05	0.000E+00	1.158E+05	0.000E+00	5.112E+08	0.000E+00	6.576E+04
MO-99	0.000E+00	9.924E+03	0.000E+00	2.268E+04	0.000E+00	1.776E+04	0.000E+00	1.896E+03
TC-99M	4.236E-22	1.182E-21	0.000E+00	1.764E-20	6.564E-22	7.764E-19	0.000E+00	1.536E-20
TC-101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-103	1.028E+07	0.000E+00	0.000E+00	3.624E+07	0.000E+00	8.592E+08	0.000E+00	4.392E+06
RU-105	5.796E-29	0.000E+00	0.000E+00	7.308E-28	0.000E+00	4.680E-26	0.000E+00	2.256E-29
RU-106	2.832E+08	0.000E+00	0.000E+00	5.460E+08	0.000E+00	1.356E+10	0.000E+00	3.564E+07
AG-110M	6.072E+05	5.748E+05	0.000E+00	1.096E+06	0.000E+00	1.608E+08	0.000E+00	3.492E+05
TE-125M	3.636E+07	1.308E+07	1.016E+07	0.000E+00	0.000E+00	1.073E+08	0.000E+00	4.860E+06
TE-127	2.160E-11	7.656E-12	1.488E-11	8.748E-11	0.000E+00	1.668E-09	0.000E+00	4.644E-12
TE-127M	1.129E+08	4.008E+07	2.688E+07	4.584E+08	0.000E+00	2.820E+08	0.000E+00	1.344E+07
TE-129	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-129M	1.140E+08	4.236E+07	3.684E+07	4.764E+08	0.000E+00	4.284E+08	0.000E+00	1.800E+07
TE-131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-131M	4.512E+01	2.160E+01	3.252E+01	2.256E+02	0.000E+00	1.740E+03	0.000E+00	1.800E+01
TE-132	1.392E+05	8.832E+04	9.300E+04	8.472E+05	0.000E+00	2.796E+06	0.000E+00	8.304E+04
I-130	2.040E-07	5.892E-07	4.800E-05	9.072E-07	0.000E+00	4.524E-07	0.000E+00	2.352E-07

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Age group:	TEEN	Pathway:	Grs/Goat/Meat (GMEAT)			Units:	m²·mrem/yr / μCi/sec; mrem/yr / μCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	1.070E+06	1.500E+06	4.380E+08	2.580E+06	0.000E+00	2.964E+05	0.000E+00	8.052E+05
I-132	6.792E-60	1.776E-59	5.988E-58	2.796E-59	0.000E+00	7.740E-60	0.000E+00	6.384E-60
I-133	3.660E-02	6.216E-02	8.676E+00	1.091E-01	0.000E+00	4.704E-02	0.000E+00	1.896E-02
I-134	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-135	4.320E-18	1.111E-17	7.152E-16	1.752E-17	0.000E+00	1.236E-17	0.000E+00	4.116E-18
CS-134	6.276E+07	1.476E+08	0.000E+00	4.692E+07	1.788E+07	1.836E+06	0.000E+00	6.852E+07
CS-136	1.128E+06	4.440E+06	0.000E+00	2.412E+06	3.804E+05	3.576E+05	0.000E+00	2.976E+06
CS-137	8.688E+07	1.156E+08	0.000E+00	3.936E+07	1.524E+07	1.644E+06	0.000E+00	4.032E+07
CS-138	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-139	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-140	2.856E+06	3.492E+03	0.000E+00	1.184E+03	2.352E+03	4.392E+06	0.000E+00	1.836E+05
BA-141	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA-140	3.660E-03	1.800E-03	0.000E+00	0.000E+00	0.000E+00	1.033E+02	0.000E+00	4.788E-04
LA-142	3.444E-93	1.536E-93	0.000E+00	0.000E+00	0.000E+00	4.656E-89	0.000E+00	3.816E-94
CE-141	1.416E+03	9.444E+02	0.000E+00	4.452E+02	0.000E+00	2.700E+06	0.000E+00	1.085E+02
CE-143	2.028E-03	1.476E+00	0.000E+00	6.612E-04	0.000E+00	4.428E+01	0.000E+00	1.644E-04
CE-144	1.476E+05	6.096E+04	0.000E+00	3.648E+04	0.000E+00	3.708E+07	0.000E+00	7.920E+03
PR-143	2.112E+03	8.448E+02	0.000E+00	4.908E+02	0.000E+00	6.960E+06	0.000E+00	1.054E+02
PR-144	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND-147	7.476E+02	8.124E+02	0.000E+00	4.776E+02	0.000E+00	2.928E+06	0.000E+00	4.872E+01
W-187	2.076E-03	1.692E-03	0.000E+00	0.000E+00	0.000E+00	4.584E-01	0.000E+00	5.928E-04
NP-239	2.712E-02	2.568E-03	0.000E+00	8.040E-03	0.000E+00	4.128E+02	0.000E+00	1.428E-03

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Vegetation (VEG)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	2.590E+03	2.590E+03	2.590E+03	2.590E+03	2.590E+03	0.000E+00	2.590E+03
C-14	1.020E+05	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.040E+04	0.000E+00	2.040E+04
NA-24	2.390E+05	2.390E+05	2.390E+05	2.390E+05	2.390E+05	2.390E+05	0.000E+00	2.390E+05
P-32	1.610E+09	9.970E+07	0.000E+00	0.000E+00	0.000E+00	1.350E+08	0.000E+00	6.240E+07
CR-51	0.000E+00	0.000E+00	3.430E+04	1.350E+04	8.810E+04	1.040E+07	0.000E+00	6.170E+04
MN-54	0.000E+00	4.540E+08	0.000E+00	1.360E+08	0.000E+00	9.320E+08	0.000E+00	9.010E+07
MN-56	0.000E+00	1.420E+01	0.000E+00	1.800E+01	0.000E+00	9.360E+02	0.000E+00	2.530E+00
FE-55	3.260E+08	2.310E+08	0.000E+00	0.000E+00	1.470E+08	1.000E+08	0.000E+00	5.390E+07
FE-59	1.790E+08	4.190E+08	0.000E+00	0.000E+00	1.320E+08	9.900E+08	0.000E+00	1.620E+08
CO-58	0.000E+00	4.360E+07	0.000E+00	0.000E+00	0.000E+00	6.010E+08	0.000E+00	1.000E+08
CO-60	0.000E+00	2.490E+08	0.000E+00	0.000E+00	0.000E+00	3.240E+09	0.000E+00	5.600E+08
NI-63	1.610E+10	1.130E+09	0.000E+00	0.000E+00	0.000E+00	1.810E+08	0.000E+00	5.450E+08
NI-65	5.720E+01	7.310E+00	0.000E+00	0.000E+00	0.000E+00	3.970E+02	0.000E+00	3.330E+00
CU-64	0.000E+00	8.340E+03	0.000E+00	2.110E+04	0.000E+00	6.470E+05	0.000E+00	3.920E+03
ZN-65	4.240E+08	1.470E+09	0.000E+00	9.420E+08	0.000E+00	6.230E+08	0.000E+00	6.870E+08
ZN-69	5.140E-06	9.800E-06	0.000E+00	6.400E-06	0.000E+00	1.810E-05	0.000E+00	6.860E-07
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.910E+00
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.250E-11
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	2.740E+08	0.000E+00	0.000E+00	0.000E+00	4.050E+07	0.000E+00	1.290E+08
RB-88	0.000E+00	3.170E-22	0.000E+00	0.000E+00	0.000E+00	2.720E-29	0.000E+00	1.690E-22
RB-89	0.000E+00	3.500E-26	0.000E+00	0.000E+00	0.000E+00	5.360E-35	0.000E+00	2.470E-26
SR-89	1.510E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.800E+09	0.000E+00	4.340E+08
SR-90	7.510E+11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.110E+10	0.000E+00	1.850E+11
SR-91	2.850E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.290E+06	0.000E+00	1.130E+04

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Vegetation (VEG)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	3.970E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.010E+04	0.000E+00	1.690E+01
Y-90	1.240E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.020E+08	0.000E+00	3.350E+02
Y-91	7.840E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.210E+09	0.000E+00	2.100E+05
Y-91M	4.860E-09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.290E-07	0.000E+00	1.860E-10
Y-92	8.600E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.360E+04	0.000E+00	2.490E-02
Y-93	1.590E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.860E+06	0.000E+00	4.360E+00
ZR-95	1.720E+06	5.430E+05	0.000E+00	7.980E+05	0.000E+00	1.250E+09	0.000E+00	3.730E+05
ZR-97	3.120E+02	6.180E+01	0.000E+00	9.370E+01	0.000E+00	1.670E+07	0.000E+00	2.850E+01
NB-95	1.920E+05	1.070E+05	0.000E+00	1.030E+05	0.000E+00	4.560E+08	0.000E+00	5.870E+04
MO-99	0.000E+00	5.650E+06	0.000E+00	1.290E+07	0.000E+00	1.010E+07	0.000E+00	1.080E+06
TC-99M	2.740E+00	7.630E+00	0.000E+00	1.140E+02	4.240E+00	5.010E+03	0.000E+00	9.890E+01
TC-101	7.640E-31	1.090E-30	0.000E+00	1.970E-29	6.620E-31	1.860E-37	0.000E+00	1.070E-29
RU-103	6.820E+06	0.000E+00	0.000E+00	2.400E+07	0.000E+00	5.700E+08	0.000E+00	2.920E+06
RU-105	5.000E+01	0.000E+00	0.000E+00	6.310E+02	0.000E+00	4.040E+04	0.000E+00	1.940E+01
RU-106	3.100E+08	0.000E+00	0.000E+00	5.970E+08	0.000E+00	1.480E+10	0.000E+00	3.900E+07
AG-110M	1.520E+07	1.430E+07	0.000E+00	2.740E+07	0.000E+00	4.030E+09	0.000E+00	8.720E+06
TE-125M	1.480E+08	5.340E+07	4.140E+07	0.000E+00	0.000E+00	4.370E+08	0.000E+00	1.980E+07
TE-127	5.330E+03	1.890E+03	3.680E+03	2.160E+04	0.000E+00	4.120E+05	0.000E+00	1.150E+03
TE-127M	5.510E+08	1.960E+08	1.310E+08	2.240E+09	0.000E+00	1.370E+09	0.000E+00	6.560E+07
TE-129	7.140E-04	2.660E-04	5.100E-04	3.000E-03	0.000E+00	3.910E-03	0.000E+00	1.740E-04
TE-129M	3.620E+08	1.340E+08	1.170E+08	1.510E+09	0.000E+00	1.360E+09	0.000E+00	5.730E+07
TE-131	1.390E-15	5.750E-16	1.070E-15	6.100E-15	0.000E+00	1.140E-16	0.000E+00	4.360E-16
TE-131M	8.440E+05	4.050E+05	6.090E+05	4.220E+06	0.000E+00	3.250E+07	0.000E+00	3.380E+05
TE-132	3.910E+06	2.470E+06	2.610E+06	2.370E+07	0.000E+00	7.840E+07	0.000E+00	2.330E+06
I-130	3.510E+05	1.010E+06	8.280E+07	1.560E+06	0.000E+00	7.800E+05	0.000E+00	4.050E+05

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Vegetation (VEG)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	7.690E+07	1.080E+08	3.140E+10	1.850E+08	0.000E+00	2.130E+07	0.000E+00	5.780E+07
I-132	5.190E+01	1.360E+02	4.580E+03	2.140E+02	0.000E+00	5.920E+01	0.000E+00	4.880E+01
I-133	1.940E+06	3.290E+06	4.590E+08	5.760E+06	0.000E+00	2.490E+06	0.000E+00	1.000E+06
I-134	8.720E-05	2.310E-04	3.850E-03	3.640E-04	0.000E+00	3.050E-06	0.000E+00	8.310E-05
I-135	3.520E+04	9.070E+04	5.830E+06	1.430E+05	0.000E+00	1.000E+05	0.000E+00	3.360E+04
CS-134	7.100E+09	1.670E+10	0.000E+00	5.310E+09	2.030E+09	2.080E+08	0.000E+00	7.750E+09
CS-136	4.370E+07	1.720E+08	0.000E+00	9.370E+07	1.480E+07	1.380E+07	0.000E+00	1.160E+08
CS-137	1.010E+10	1.350E+10	0.000E+00	4.590E+09	1.780E+09	1.920E+08	0.000E+00	4.690E+09
CS-138	3.610E-11	6.940E-11	0.000E+00	5.120E-11	5.960E-12	3.150E-14	0.000E+00	3.470E-11
BA-139	2.690E-02	1.890E-05	0.000E+00	1.780E-05	1.300E-05	2.400E-01	0.000E+00	7.830E-04
BA-140	1.380E+08	1.690E+05	0.000E+00	5.740E+04	1.140E+05	2.130E+08	0.000E+00	8.900E+06
BA-141	1.080E-21	8.040E-25	0.000E+00	7.460E-25	5.500E-25	2.290E-27	0.000E+00	3.590E-23
BA-142	5.490E-39	5.490E-42	0.000E+00	4.640E-42	3.650E-42	1.680E-50	0.000E+00	3.380E-40
LA-140	1.810E+03	8.880E+02	0.000E+00	0.000E+00	0.000E+00	5.100E+07	0.000E+00	2.360E+02
LA-142	1.850E-04	8.240E-05	0.000E+00	0.000E+00	0.000E+00	2.510E+00	0.000E+00	2.050E-05
CE-141	2.830E+05	1.890E+05	0.000E+00	8.890E+04	0.000E+00	5.400E+08	0.000E+00	2.170E+04
CE-143	9.330E+02	6.790E+05	0.000E+00	3.040E+02	0.000E+00	2.040E+07	0.000E+00	7.580E+01
CE-144	5.270E+07	2.180E+07	0.000E+00	1.300E+07	0.000E+00	1.330E+10	0.000E+00	2.830E+06
PR-143	7.000E+04	2.800E+04	0.000E+00	1.630E+04	0.000E+00	2.300E+08	0.000E+00	3.490E+03
PR-144	2.900E-26	1.190E-26	0.000E+00	6.800E-27	0.000E+00	3.190E-29	0.000E+00	1.470E-27
ND-147	3.620E+04	3.940E+04	0.000E+00	2.310E+04	0.000E+00	1.420E+08	0.000E+00	2.360E+03
W-187	3.540E+04	2.880E+04	0.000E+00	0.000E+00	0.000E+00	7.800E+06	0.000E+00	1.010E+04
NP-239	1.390E+03	1.310E+02	0.000E+00	4.100E+02	0.000E+00	2.100E+07	0.000E+00	7.260E+01

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Inhalation (INHL)			Units:	mrem/yr / µCi/m^3	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	1.270E+03	1.270E+03	1.270E+03	1.270E+03	1.270E+03	0.000E+00	1.270E+03
C-14	2.600E+04	4.870E+03	4.870E+03	4.870E+03	4.870E+03	4.870E+03	0.000E+00	4.870E+03
NA-24	1.380E+04	1.380E+04	1.380E+04	1.380E+04	1.380E+04	1.380E+04	0.000E+00	1.380E+04
P-32	1.890E+06	1.100E+05	0.000E+00	0.000E+00	0.000E+00	9.280E+04	0.000E+00	7.160E+04
CR-51	0.000E+00	0.000E+00	7.500E+01	3.070E+01	2.100E+04	3.000E+03	0.000E+00	1.350E+02
MN-54	0.000E+00	5.110E+04	0.000E+00	1.270E+04	1.980E+06	6.680E+04	0.000E+00	8.400E+03
MN-56	0.000E+00	1.700E+00	0.000E+00	1.790E+00	1.520E+04	5.740E+04	0.000E+00	2.520E-01
FE-55	3.340E+04	2.380E+04	0.000E+00	0.000E+00	1.240E+05	6.390E+03	0.000E+00	5.540E+03
FE-59	1.590E+04	3.700E+04	0.000E+00	0.000E+00	1.530E+06	1.780E+05	0.000E+00	1.430E+04
CO-58	0.000E+00	2.070E+03	0.000E+00	0.000E+00	1.340E+06	9.520E+04	0.000E+00	2.780E+03
CO-60	0.000E+00	1.510E+04	0.000E+00	0.000E+00	8.720E+06	2.590E+05	0.000E+00	1.980E+04
NI-63	5.800E+05	4.340E+04	0.000E+00	0.000E+00	3.070E+05	1.420E+04	0.000E+00	1.980E+04
NI-65	2.180E+00	2.930E-01	0.000E+00	0.000E+00	9.360E+03	3.670E+04	0.000E+00	1.270E-01
CU-64	0.000E+00	2.030E+00	0.000E+00	6.410E+00	1.110E+04	6.140E+04	0.000E+00	8.480E-01
ZN-65	3.860E+04	1.340E+05	0.000E+00	8.640E+04	1.240E+06	4.660E+04	0.000E+00	6.240E+04
ZN-69	4.830E-02	9.200E-02	0.000E+00	6.020E-02	1.580E+03	2.850E+02	0.000E+00	6.460E-03
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.440E+02
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.330E+02
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.830E+01
RB-86	0.000E+00	1.900E+05	0.000E+00	0.000E+00	0.000E+00	1.770E+04	0.000E+00	8.400E+04
RB-88	0.000E+00	5.460E+02	0.000E+00	0.000E+00	0.000E+00	2.920E-05	0.000E+00	2.720E+02
RB-89	0.000E+00	3.520E+02	0.000E+00	0.000E+00	0.000E+00	3.380E-07	0.000E+00	2.330E+02
SR-89	4.340E+05	0.000E+00	0.000E+00	0.000E+00	2.420E+06	3.710E+05	0.000E+00	1.250E+04
SR-90	1.080E+08	0.000E+00	0.000E+00	0.000E+00	1.650E+07	7.650E+05	0.000E+00	6.680E+06
SR-91	8.800E+01	0.000E+00	0.000E+00	0.000E+00	6.070E+04	2.590E+05	0.000E+00	3.510E+00

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Inhalation (INHL)			Units:	mrem/yr / µCi/m^3	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-92	9.520E+00	0.000E+00	0.000E+00	0.000E+00	2.740E+04	1.190E+05	0.000E+00	4.060E-01
Y-90	2.980E+03	0.000E+00	0.000E+00	0.000E+00	2.930E+05	5.590E+05	0.000E+00	8.000E+01
Y-91	6.610E+05	0.000E+00	0.000E+00	0.000E+00	2.940E+06	4.090E+05	0.000E+00	1.770E+04
Y-91M	3.700E-01	0.000E+00	0.000E+00	0.000E+00	3.200E+03	3.020E+01	0.000E+00	1.420E-02
Y-92	1.470E+01	0.000E+00	0.000E+00	0.000E+00	2.680E+04	1.650E+05	0.000E+00	4.290E-01
Y-93	1.350E+02	0.000E+00	0.000E+00	0.000E+00	8.320E+04	5.790E+05	0.000E+00	3.720E+00
ZR-95	1.460E+05	4.580E+04	0.000E+00	6.740E+04	2.690E+06	1.490E+05	0.000E+00	3.150E+04
ZR-97	1.380E+02	2.720E+01	0.000E+00	4.120E+01	1.300E+05	6.300E+05	0.000E+00	1.260E+01
NB-95	1.860E+04	1.030E+04	0.000E+00	1.000E+04	7.510E+05	9.680E+04	0.000E+00	5.660E+03
MO-99	0.000E+00	1.690E+02	0.000E+00	4.110E+02	1.540E+05	2.690E+05	0.000E+00	3.220E+01
TC-99M	1.380E-03	3.860E-03	0.000E+00	5.760E-02	1.150E+03	6.130E+03	0.000E+00	4.990E-02
TC-101	5.920E-05	8.400E-05	0.000E+00	1.520E-03	6.670E+02	8.720E-07	0.000E+00	8.240E-04
RU-103	2.100E+03	0.000E+00	0.000E+00	7.430E+03	7.830E+05	1.090E+05	0.000E+00	8.960E+02
RU-105	1.120E+00	0.000E+00	0.000E+00	1.410E+00	1.820E+04	9.040E+04	0.000E+00	4.340E-01
RU-106	9.840E+04	0.000E+00	0.000E+00	1.900E+05	1.610E+07	9.600E+05	0.000E+00	1.240E+04
AG-110M	1.380E+04	1.310E+04	0.000E+00	2.500E+04	6.750E+06	2.730E+05	0.000E+00	7.990E+03
TE-125M	4.880E+03	2.240E+03	1.400E+03	0.000E+00	5.360E+05	7.500E+04	0.000E+00	6.670E+02
TE-127	2.010E+00	9.120E-01	1.420E+00	7.280E+00	1.120E+04	8.080E+04	0.000E+00	4.420E-01
TE-127M	1.800E+04	8.160E+03	4.380E+03	6.540E+04	1.660E+06	1.590E+05	0.000E+00	2.180E+03
TE-129	7.100E-02	3.380E-02	5.180E-02	2.660E-01	3.300E+03	1.620E+03	0.000E+00	1.760E-02
TE-129M	1.390E+04	6.580E+03	4.580E+03	5.190E+04	1.980E+06	4.050E+05	0.000E+00	2.250E+03
TE-131	1.580E-02	8.320E-03	1.240E-02	6.180E-02	2.340E+03	1.510E+01	0.000E+00	5.040E-03
TE-131M	9.840E+01	6.010E+01	7.250E+01	4.390E+02	2.380E+05	6.210E+05	0.000E+00	4.020E+01
TE-132	3.600E+02	2.900E+02	2.460E+02	1.950E+03	4.490E+05	4.630E+05	0.000E+00	2.190E+02
I-130	6.240E+03	1.790E+04	1.490E+06	2.750E+04	0.000E+00	9.120E+03	0.000E+00	7.170E+03

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Inhalation (INHL)			Units:	mrem/yr / µCi/m^3	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	3.540E+04	4.910E+04	1.460E+07	8.400E+04	0.000E+00	6.490E+03	0.000E+00	2.640E+04
I-132	1.590E+03	4.380E+03	1.510E+05	6.920E+03	0.000E+00	1.270E+03	0.000E+00	1.580E+03
I-133	1.220E+04	2.050E+04	2.920E+06	3.590E+04	0.000E+00	1.030E+04	0.000E+00	6.220E+03
I-134	8.880E+02	2.320E+03	3.950E+04	3.660E+03	0.000E+00	2.040E+01	0.000E+00	8.400E+02
I-135	3.700E+03	9.440E+03	6.210E+05	1.490E+04	0.000E+00	6.950E+03	0.000E+00	3.490E+03
CS-134	5.020E+05	1.130E+06	0.000E+00	3.750E+05	1.460E+05	9.760E+03	0.000E+00	5.490E+05
CS-136	5.150E+04	1.940E+05	0.000E+00	1.100E+05	1.780E+04	1.090E+04	0.000E+00	1.370E+05
CS-137	6.700E+05	8.480E+05	0.000E+00	3.040E+05	1.210E+05	8.480E+03	0.000E+00	3.110E+05
CS-138	4.660E+02	8.560E+02	0.000E+00	6.620E+02	7.870E+01	2.700E-01	0.000E+00	4.460E+02
BA-139	1.340E+00	9.440E-04	0.000E+00	8.880E-04	6.460E+03	6.450E+03	0.000E+00	3.900E-02
BA-140	5.470E+04	6.700E+01	0.000E+00	2.280E+01	2.030E+06	2.290E+05	0.000E+00	3.520E+03
BA-141	1.420E-01	1.060E-04	0.000E+00	9.840E-05	3.290E+03	7.460E-04	0.000E+00	4.740E-03
BA-142	3.700E-02	3.700E-05	0.000E+00	3.140E-05	1.910E+03	4.790E-10	0.000E+00	2.270E-03
LA-140	4.790E+02	2.360E+02	0.000E+00	0.000E+00	2.140E+05	4.870E+05	0.000E+00	6.260E+01
LA-142	9.600E-01	4.250E-01	0.000E+00	0.000E+00	1.020E+04	1.200E+04	0.000E+00	1.060E-01
CE-141	2.840E+04	1.900E+04	0.000E+00	8.880E+03	6.140E+05	1.260E+05	0.000E+00	2.170E+03
CE-143	2.660E+02	1.940E+02	0.000E+00	8.640E+01	1.300E+05	2.550E+05	0.000E+00	2.160E+01
CE-144	4.890E+06	2.020E+06	0.000E+00	1.210E+06	1.340E+07	8.640E+05	0.000E+00	2.620E+05
PR-143	1.340E+04	5.310E+03	0.000E+00	3.090E+03	4.830E+05	2.140E+05	0.000E+00	6.620E+02
PR-144	4.300E-02	1.760E-02	0.000E+00	1.010E-02	1.750E+03	2.350E-04	0.000E+00	2.180E-03
ND-147	7.860E+03	8.560E+03	0.000E+00	5.020E+03	3.720E+05	1.820E+05	0.000E+00	5.130E+02
W-187	1.200E+01	9.760E+00	0.000E+00	0.000E+00	4.740E+04	1.770E+05	0.000E+00	3.430E+00
NP-239	3.380E+02	3.190E+01	0.000E+00	1.000E+02	6.490E+04	1.320E+05	0.000E+00	1.770E+01

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Ground Plane Deposition (GPD)			Units:	m²·mrem/yr / µCi/sec	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C-14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NA-24	1.190E+07	1.190E+07	1.190E+07	1.190E+07	1.190E+07	1.190E+07	1.390E+07	1.190E+07
P-32	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CR-51	4.660E+06	4.660E+06	4.660E+06	4.660E+06	4.660E+06	4.660E+06	5.510E+06	4.660E+06
MN-54	1.390E+09	1.390E+09	1.390E+09	1.390E+09	1.390E+09	1.390E+09	1.630E+09	1.390E+09
MN-56	9.020E+05	9.020E+05	9.020E+05	9.020E+05	9.020E+05	9.020E+05	1.070E+06	9.020E+05
FE-55	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
FE-59	2.730E+08	2.730E+08	2.730E+08	2.730E+08	2.730E+08	2.730E+08	3.210E+08	2.730E+08
CO-58	3.790E+08	3.790E+08	3.790E+08	3.790E+08	3.790E+08	3.790E+08	4.440E+08	3.790E+08
CO-60	2.150E+10	2.150E+10	2.150E+10	2.150E+10	2.150E+10	2.150E+10	2.530E+10	2.150E+10
NI-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NI-65	2.970E+05	2.970E+05	2.970E+05	2.970E+05	2.970E+05	2.970E+05	3.450E+05	2.970E+05
CU-64	6.070E+05	6.070E+05	6.070E+05	6.070E+05	6.070E+05	6.070E+05	6.880E+05	6.070E+05
ZN-65	7.470E+08	7.470E+08	7.470E+08	7.470E+08	7.470E+08	7.470E+08	8.590E+08	7.470E+08
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	4.870E+03	4.870E+03	4.870E+03	4.870E+03	4.870E+03	4.870E+03	7.080E+03	4.870E+03
BR-84	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.360E+05	2.030E+05
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	8.990E+06	8.990E+06	8.990E+06	8.990E+06	8.990E+06	8.990E+06	1.030E+07	8.990E+06
RB-88	3.310E+04	3.310E+04	3.310E+04	3.310E+04	3.310E+04	3.310E+04	3.780E+04	3.310E+04
RB-89	1.230E+05	1.230E+05	1.230E+05	1.230E+05	1.230E+05	1.230E+05	1.480E+05	1.230E+05
SR-89	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.510E+04	2.160E+04
SR-90	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-91	2.150E+06	2.150E+06	2.150E+06	2.150E+06	2.150E+06	2.150E+06	2.510E+06	2.150E+06

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Ground Plane Deposition (GPD)			Units:	m²·mrem/yr / µCi/sec	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**GIlLI**	**Skin**	**Total Body**
SR-92	7.770E+05	7.770E+05	7.770E+05	7.770E+05	7.770E+05	7.770E+05	8.630E+05	7.770E+05
Y-90	4.490E+03	4.490E+03	4.490E+03	4.490E+03	4.490E+03	4.490E+03	5.310E+03	4.490E+03
Y-91	1.070E+06	1.070E+06	1.070E+06	1.070E+06	1.070E+06	1.070E+06	1.210E+06	1.070E+06
Y-91M	1.000E+05	1.000E+05	1.000E+05	1.000E+05	1.000E+05	1.000E+05	1.160E+05	1.000E+05
Y-92	1.800E+05	1.800E+05	1.800E+05	1.800E+05	1.800E+05	1.800E+05	2.140E+05	1.800E+05
Y-93	1.830E+05	1.830E+05	1.830E+05	1.830E+05	1.830E+05	1.830E+05	2.510E+05	1.830E+05
ZR-95	2.450E+08	2.450E+08	2.450E+08	2.450E+08	2.450E+08	2.450E+08	2.840E+08	2.450E+08
ZR-97	2.960E+06	2.960E+06	2.960E+06	2.960E+06	2.960E+06	2.960E+06	3.440E+06	2.960E+06
NB-95	1.370E+08	1.370E+08	1.370E+08	1.370E+08	1.370E+08	1.370E+08	1.610E+08	1.370E+08
MO-99	3.990E+06	3.990E+06	3.990E+06	3.990E+06	3.990E+06	3.990E+06	4.630E+06	3.990E+06
TC-99M	1.840E+05	1.840E+05	1.840E+05	1.840E+05	1.840E+05	1.840E+05	2.110E+05	1.840E+05
TC-101	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.260E+04	2.040E+04
RU-103	1.080E+08	1.080E+08	1.080E+08	1.080E+08	1.080E+08	1.080E+08	1.260E+08	1.080E+08
RU-105	6.360E+05	6.360E+05	6.360E+05	6.360E+05	6.360E+05	6.360E+05	7.210E+05	6.360E+05
RU-106	4.220E+08	4.220E+08	4.220E+08	4.220E+08	4.220E+08	4.220E+08	5.070E+08	4.220E+08
AG-110M	3.440E+09	3.440E+09	3.440E+09	3.440E+09	3.440E+09	3.440E+09	4.010E+09	3.440E+09
TE-125M	1.550E+06	1.550E+06	1.550E+06	1.550E+06	1.550E+06	1.550E+06	2.130E+06	1.550E+06
TE-127	2.980E+03	2.980E+03	2.980E+03	2.980E+03	2.980E+03	2.980E+03	3.280E+03	2.980E+03
TE-127M	9.160E+04	9.160E+04	9.160E+04	9.160E+04	9.160E+04	9.160E+04	1.080E+05	9.160E+04
TE-129	2.620E+04	2.620E+04	2.620E+04	2.620E+04	2.620E+04	2.620E+04	3.100E+04	2.620E+04
TE-129M	1.980E+07	1.980E+07	1.980E+07	1.980E+07	1.980E+07	1.980E+07	2.310E+07	1.980E+07
TE-131	2.920E+04	2.920E+04	2.920E+04	2.920E+04	2.920E+04	2.920E+04	3.450E+07	2.920E+04
TE-131M	8.030E+06	8.030E+06	8.030E+06	8.030E+06	8.030E+06	8.030E+06	9.460E+06	8.030E+06
TE-132	4.230E+06	4.230E+06	4.230E+06	4.230E+06	4.230E+06	4.230E+06	4.980E+06	4.230E+06
I-130	5.510E+06	5.510E+06	5.510E+06	5.510E+06	5.510E+06	5.510E+06	6.690E+06	5.510E+06

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Ground Plane Deposition (GPD)			Units:	m^2·mrem/yr / µCi/sec	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	1.720E+07	1.720E+07	1.720E+07	1.720E+07	1.720E+07	1.720E+07	2.090E+07	1.720E+07
I-132	1.250E+06	1.250E+06	1.250E+06	1.250E+06	1.250E+06	1.250E+06	1.470E+06	1.250E+06
I-133	2.450E+06	2.450E+06	2.450E+06	2.450E+06	2.450E+06	2.450E+06	2.980E+06	2.450E+06
I-134	4.470E+05	4.470E+05	4.470E+05	4.470E+05	4.470E+05	4.470E+05	5.300E+05	4.470E+05
I-135	2.530E+06	2.530E+06	2.530E+06	2.530E+06	2.530E+06	2.530E+06	2.950E+06	2.530E+06
CS-134	6.860E+09	6.860E+09	6.860E+09	6.860E+09	6.860E+09	6.860E+09	8.000E+09	6.860E+09
CS-136	1.510E+08	1.510E+08	1.510E+08	1.510E+08	1.510E+08	1.510E+08	1.710E+08	1.510E+08
CS-137	1.030E+10	1.030E+10	1.030E+10	1.030E+10	1.030E+10	1.030E+10	1.200E+10	1.030E+10
CS-138	3.590E+05	3.590E+05	3.590E+05	3.590E+05	3.590E+05	3.590E+05	4.100E+05	3.590E+05
BA-139	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.190E+05	1.060E+05
BA-140	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.350E+07	2.050E+07
BA-141	4.170E+04	4.170E+04	4.170E+04	4.170E+04	4.170E+04	4.170E+04	4.750E+04	4.170E+04
BA-142	4.490E+04	4.490E+04	4.490E+04	4.490E+04	4.490E+04	4.490E+04	5.110E+04	4.490E+04
LA-140	1.920E+07	1.920E+07	1.920E+07	1.920E+07	1.920E+07	1.920E+07	2.180E+07	1.920E+07
LA-142	7.600E+05	7.600E+05	7.600E+05	7.600E+05	7.600E+05	7.600E+05	9.120E+05	7.600E+05
CE-141	1.370E+07	1.370E+07	1.370E+07	1.370E+07	1.370E+07	1.370E+07	1.540E+07	1.370E+07
CE-143	2.310E+06	2.310E+06	2.310E+06	2.310E+06	2.310E+06	2.310E+06	2.630E+06	2.310E+06
CE-144	6.950E+07	6.950E+07	6.950E+07	6.950E+07	6.950E+07	6.950E+07	8.040E+07	6.950E+07
PR-143	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR-144	1.830E+03	1.830E+03	1.830E+03	1.830E+03	1.830E+03	1.830E+03	2.110E+03	1.830E+03
ND-147	8.390E+06	8.390E+06	8.390E+06	8.390E+06	8.390E+06	8.390E+06	1.010E+07	8.390E+06
W-187	2.350E+06	2.350E+06	2.350E+06	2.350E+06	2.350E+06	2.350E+06	2.730E+06	2.350E+06
NP-239	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.980E+06	1.710E+06

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Grs/Cow/Milk (CMILK)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	1.570E+03	1.570E+03	1.570E+03	1.570E+03	1.570E+03	0.000E+00	1.570E+03
C-14	1.150E+05	2.310E+04	2.310E+04	2.310E+04	2.310E+04	2.310E+04	0.000E+00	2.310E+04
NA-24	8.850E+06	8.850E+06	8.850E+06	8.850E+06	8.850E+06	8.850E+06	0.000E+00	8.850E+06
P-32	7.780E+10	3.640E+09	0.000E+00	0.000E+00	0.000E+00	2.150E+09	0.000E+00	3.000E+09
CR-51	0.000E+00	0.000E+00	5.650E+04	1.540E+04	1.030E+05	5.400E+06	0.000E+00	1.020E+05
MN-54	0.000E+00	2.100E+07	0.000E+00	5.880E+06	0.000E+00	1.760E+07	0.000E+00	5.590E+06
MN-56	0.000E+00	1.260E-02	0.000E+00	1.530E-02	0.000E+00	1.830E+00	0.000E+00	2.860E-03
FE-55	1.120E+08	5.930E+07	0.000E+00	0.000E+00	3.350E+07	1.100E+07	0.000E+00	1.840E+07
FE-59	1.200E+08	1.950E+08	0.000E+00	0.000E+00	5.640E+07	2.030E+08	0.000E+00	9.690E+07
CO-58	0.000E+00	1.210E+07	0.000E+00	0.000E+00	0.000E+00	7.070E+07	0.000E+00	3.710E+07
CO-60	0.000E+00	4.320E+07	0.000E+00	0.000E+00	0.000E+00	2.390E+08	0.000E+00	1.270E+08
NI-63	2.960E+10	1.590E+09	0.000E+00	0.000E+00	0.000E+00	1.070E+08	0.000E+00	1.010E+09
NI-65	1.660E+00	1.560E-01	0.000E+00	0.000E+00	0.000E+00	1.910E+01	0.000E+00	9.100E-02
CU-64	0.000E+00	7.460E+04	0.000E+00	1.800E+05	0.000E+00	3.500E+06	0.000E+00	4.510E+04
ZN-65	4.130E+09	1.100E+10	0.000E+00	6.940E+09	0.000E+00	1.930E+09	0.000E+00	6.850E+09
ZN-69	9.460E-12	1.370E-11	0.000E+00	8.300E-12	0.000E+00	8.620E-10	0.000E+00	1.260E-12
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.400E-01
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.510E-23
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	8.770E+09	0.000E+00	0.000E+00	0.000E+00	5.640E+08	0.000E+00	5.390E+09
RB-88	0.000E+00	7.160E-45	0.000E+00	0.000E+00	0.000E+00	3.510E-46	0.000E+00	4.970E-45
RB-89	0.000E+00	1.340E-52	0.000E+00	0.000E+00	0.000E+00	1.170E-54	0.000E+00	1.190E-52
SR-89	6.620E+09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.560E+08	0.000E+00	1.890E+08
SR-90	1.120E+11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.510E+09	0.000E+00	2.830E+10
SR-91	1.300E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.880E+05	0.000E+00	4.920E+03

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Grs/Cow/Milk (CMILK)			Units:	$m^2 \cdot mrem/yr$ / $\mu Ci/sec$; mrem/yr / $\mu Ci/m^3$ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	2.180E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.130E+01	0.000E+00	8.750E-02
Y-90	3.220E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.170E+05	0.000E+00	8.620E+00
Y-91	3.900E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.200E+06	0.000E+00	1.040E+03
Y-91M	2.670E-19	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.240E-16	0.000E+00	9.730E-21
Y-92	2.530E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.310E+00	0.000E+00	7.240E-06
Y-93	1.010E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.510E+04	0.000E+00	2.780E-02
ZR-95	3.830E+03	8.420E+02	0.000E+00	1.210E+03	0.000E+00	8.790E+05	0.000E+00	7.500E+02
ZR-97	1.920E+00	2.770E-01	0.000E+00	3.980E-01	0.000E+00	4.200E+04	0.000E+00	1.640E-01
NB-95	3.180E+05	1.240E+05	0.000E+00	1.160E+05	0.000E+00	2.290E+08	0.000E+00	8.840E+04
MO-99	0.000E+00	8.140E+07	0.000E+00	1.740E+08	0.000E+00	6.730E+07	0.000E+00	2.010E+07
TC-99M	1.320E+01	2.590E+01	0.000E+00	3.760E+02	1.320E+01	1.470E+04	0.000E+00	4.290E+02
TC-101	1.160E-59	1.220E-59	0.000E+00	2.080E-58	6.440E-60	3.870E-59	0.000E+00	1.540E-58
RU-103	4.280E+03	0.000E+00	0.000E+00	1.080E+04	0.000E+00	1.110E+05	0.000E+00	1.650E+03
RU-105	3.820E-03	0.000E+00	0.000E+00	3.360E-02	0.000E+00	2.490E+00	0.000E+00	1.390E-03
RU-106	9.240E+04	0.000E+00	0.000E+00	1.250E+05	0.000E+00	1.440E+06	0.000E+00	1.150E+04
AG-110M	2.090E+08	1.410E+08	0.000E+00	2.630E+08	0.000E+00	1.680E+10	0.000E+00	1.130E+08
TE-125M	7.380E+07	2.000E+07	2.070E+07	0.000E+00	0.000E+00	7.120E+07	0.000E+00	9.840E+06
TE-127	2.980E+03	8.020E+02	2.060E+03	8.470E+03	0.000E+00	1.160E+05	0.000E+00	6.380E+02
TE-127M	2.080E+08	5.600E+07	4.970E+07	5.930E+08	0.000E+00	1.680E+08	0.000E+00	2.470E+07
TE-129	1.280E-09	3.580E-10	9.160E-10	3.750E-09	0.000E+00	7.990E-08	0.000E+00	3.050E-10
TE-129M	2.710E+08	7.580E+07	8.750E+07	7.970E+08	0.000E+00	3.310E+08	0.000E+00	4.210E+07
TE-131	1.620E-32	4.920E-33	1.240E-32	4.890E-32	0.000E+00	8.490E-32	0.000E+00	4.810E-33
TE-131M	1.600E+06	5.530E+05	1.140E+06	5.350E+06	0.000E+00	2.240E+07	0.000E+00	5.890E+05
TE-132	1.020E+07	4.530E+06	6.600E+06	4.210E+07	0.000E+00	4.570E+07	0.000E+00	5.480E+06
I-130	1.730E+06	3.490E+06	3.840E+08	5.220E+06	0.000E+00	1.630E+06	0.000E+00	1.800E+06

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Grs/Cow/Milk (CMILK)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	1.300E+09	1.310E+09	4.330E+11	2.150E+09	0.000E+00	1.170E+08	0.000E+00	7.450E+08
I-132	6.890E-01	1.270E+00	5.870E+01	1.940E+00	0.000E+00	1.490E+00	0.000E+00	5.820E-01
I-133	1.720E+07	2.120E+07	3.940E+09	3.540E+07	0.000E+00	8.560E+06	0.000E+00	8.030E+06
I-134	8.480E-12	1.570E-11	3.620E-10	2.410E-11	0.000E+00	1.040E-11	0.000E+00	7.250E-12
I-135	5.400E+04	9.720E+04	8.610E+06	1.490E+05	0.000E+00	7.400E+04	0.000E+00	4.600E+04
CS-134	2.260E+10	3.720E+10	0.000E+00	1.150E+10	4.130E+09	2.000E+08	0.000E+00	7.840E+09
CS-136	1.010E+09	2.780E+09	0.000E+00	1.480E+09	2.210E+08	9.770E+07	0.000E+00	1.800E+09
CS-137	3.220E+10	3.090E+10	0.000E+00	1.010E+10	3.620E+09	1.930E+08	0.000E+00	4.550E+09
CS-138	3.980E-23	5.530E-23	0.000E+00	3.890E-23	4.190E-24	2.550E-23	0.000E+00	3.510E-23
BA-139	2.010E-07	1.070E-10	0.000E+00	9.360E-11	6.300E-11	1.160E-05	0.000E+00	5.820E-09
BA-140	1.170E+08	1.030E+05	0.000E+00	3.340E+04	6.120E+04	5.930E+07	0.000E+00	6.840E+06
BA-141	1.850E-45	1.040E-48	0.000E+00	8.960E-49	6.090E-48	1.050E-45	0.000E+00	6.020E-47
BA-142	1.150E-79	8.310E-83	0.000E+00	6.720E-83	4.890E-83	1.510E-81	0.000E+00	6.450E-81
LA-140	1.940E+01	6.780E+00	0.000E+00	0.000E+00	0.000E+00	1.890E+05	0.000E+00	2.290E+00
LA-142	8.100E-11	2.580E-11	0.000E+00	0.000E+00	0.000E+00	5.120E-06	0.000E+00	8.090E-12
CE-141	2.190E+04	1.090E+04	0.000E+00	4.780E+03	0.000E+00	1.360E+07	0.000E+00	1.620E+03
CE-143	1.870E+02	1.020E+05	0.000E+00	4.260E+01	0.000E+00	1.490E+06	0.000E+00	1.470E+01
CE-144	1.620E+06	5.090E+05	0.000E+00	2.820E+05	0.000E+00	1.330E+08	0.000E+00	8.660E+04
PR-143	7.180E+02	2.160E+02	0.000E+00	1.170E+02	0.000E+00	7.750E+05	0.000E+00	3.560E+01
PR-144	2.680E-53	8.290E-54	0.000E+00	4.380E-54	0.000E+00	1.780E-50	0.000E+00	1.350E-54
ND-147	4.450E+02	3.600E+02	0.000E+00	1.980E+02	0.000E+00	5.700E+05	0.000E+00	2.790E+01
W-187	2.890E+04	1.710E+04	0.000E+00	0.000E+00	0.000E+00	2.400E+06	0.000E+00	7.670E+03
NP-239	1.720E+01	1.240E+00	0.000E+00	3.580E+00	0.000E+00	9.170E+04	0.000E+00	8.710E-01

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Grs/Goat/Milk (GMILK)			Units:	m^2·mrem/yr / μCi/sec; mrem/yr / μCi/m^3 (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	3.200E+03	3.200E+03	3.200E+03	3.200E+03	3.200E+03	0.000E+00	3.200E+03
C-14	1.150E+05	2.310E+04	2.310E+04	2.310E+04	2.310E+04	2.310E+04	0.000E+00	2.310E+04
NA-24	1.060E+06	1.060E+06	1.060E+06	1.060E+06	1.060E+06	1.060E+06	0.000E+00	1.060E+06
P-32	9.330E+10	4.370E+09	0.000E+00	0.000E+00	0.000E+00	2.580E+09	0.000E+00	3.600E+09
CR-51	0.000E+00	0.000E+00	6.780E+03	1.850E+03	1.240E+04	6.480E+05	0.000E+00	1.220E+04
MN-54	0.000E+00	2.520E+06	0.000E+00	7.060E+05	0.000E+00	2.110E+06	0.000E+00	6.700E+05
MN-56	0.000E+00	1.520E-03	0.000E+00	1.840E-03	0.000E+00	2.200E-01	0.000E+00	3.430E-04
FE-55	1.450E+06	7.710E+05	0.000E+00	0.000E+00	4.360E+05	1.430E+05	0.000E+00	2.390E+05
FE-59	1.560E+06	2.530E+06	0.000E+00	0.000E+00	7.330E+05	2.630E+06	0.000E+00	1.260E+06
CO-58	0.000E+00	1.450E+06	0.000E+00	0.000E+00	0.000E+00	8.490E+06	0.000E+00	4.450E+06
CO-60	0.000E+00	5.180E+06	0.000E+00	0.000E+00	0.000E+00	2.870E+07	0.000E+00	1.530E+07
NI-63	3.560E+09	1.900E+08	0.000E+00	0.000E+00	0.000E+00	1.280E+07	0.000E+00	1.210E+08
NI-65	1.990E-01	1.870E-02	0.000E+00	0.000E+00	0.000E+00	2.290E+00	0.000E+00	1.090E-02
CU-64	0.000E+00	8.320E+03	0.000E+00	2.010E+04	0.000E+00	3.900E+05	0.000E+00	5.020E+03
ZN-65	4.960E+08	1.320E+09	0.000E+00	8.330E+08	0.000E+00	2.320E+08	0.000E+00	8.220E+08
ZN-69	1.140E-12	1.640E-12	0.000E+00	9.960E-13	0.000E+00	1.030E-10	0.000E+00	1.520E-13
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.280E-02
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.820E-24
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	1.050E+09	0.000E+00	0.000E+00	0.000E+00	6.770E+07	0.000E+00	6.470E+08
RB-88	0.000E+00	8.590E-46	0.000E+00	0.000E+00	0.000E+00	4.210E-47	0.000E+00	5.970E-46
RB-89	0.000E+00	1.610E-53	0.000E+00	0.000E+00	0.000E+00	1.410E-55	0.000E+00	1.430E-53
SR-89	1.390E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.380E+08	0.000E+00	3.970E+08
SR-90	2.350E+11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.160E+09	0.000E+00	5.950E+10
SR-91	2.740E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.040E+05	0.000E+00	1.030E+04

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Grs/Goat/Milk (GMILK)			Units:	$m^2 \cdot$mrem/yr / µCi/sec; mrem/yr / µCi/m^3 (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	4.580E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.680E+01	0.000E+00	1.840E-01
Y-90	3.870E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.100E+05	0.000E+00	1.030E+00
Y-91	4.680E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.240E+05	0.000E+00	1.250E+02
Y-91M	3.210E-20	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.280E-17	0.000E+00	1.170E-21
Y-92	3.040E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.770E-01	0.000E+00	8.690E-07
Y-93	1.210E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.810E+03	0.000E+00	3.330E-03
ZR-95	4.600E+02	1.010E+02	0.000E+00	1.450E+02	0.000E+00	1.050E+05	0.000E+00	9.000E+01
ZR-97	2.300E-01	3.330E-02	0.000E+00	4.780E-02	0.000E+00	5.040E+03	0.000E+00	1.960E-02
NB-95	3.810E+04	1.490E+04	0.000E+00	1.400E+04	0.000E+00	2.750E+07	0.000E+00	1.060E+04
MO-99	0.000E+00	9.760E+06	0.000E+00	2.090E+07	0.000E+00	8.080E+06	0.000E+00	2.420E+06
TC-99M	1.590E+00	3.110E+00	0.000E+00	4.520E+01	1.580E+00	1.770E+03	0.000E+00	5.150E+01
TC-101	1.400E-60	1.460E-60	0.000E+00	2.490E-59	7.720E-61	4.640E-60	0.000E+00	1.850E-59
RU-103	5.140E+02	0.000E+00	0.000E+00	1.290E+03	0.000E+00	1.330E+04	0.000E+00	1.980E+02
RU-105	4.580E-04	0.000E+00	0.000E+00	4.030E-03	0.000E+00	2.990E-01	0.000E+00	1.660E-04
RU-106	1.110E+04	0.000E+00	0.000E+00	1.500E+04	0.000E+00	1.720E+05	0.000E+00	1.380E+03
AG-110M	2.510E+07	1.690E+07	0.000E+00	3.150E+07	0.000E+00	2.010E+09	0.000E+00	1.350E+07
TE-125M	8.850E+06	2.400E+06	2.480E+06	0.000E+00	0.000E+00	8.540E+06	0.000E+00	1.180E+06
TE-127	3.570E+02	9.630E+01	2.470E+02	1.020E+03	0.000E+00	1.390E+04	0.000E+00	7.660E+01
TE-127M	2.500E+07	6.720E+06	5.970E+06	7.120E+07	0.000E+00	2.020E+07	0.000E+00	2.960E+06
TE-129	1.540E-10	4.300E-11	1.100E-10	4.510E-10	0.000E+00	9.590E-09	0.000E+00	3.660E-11
TE-129M	3.260E+07	9.090E+06	1.050E+07	9.560E+07	0.000E+00	3.970E+07	0.000E+00	5.060E+06
TE-131	1.940E-33	5.910E-34	1.480E-33	5.860E-33	0.000E+00	1.020E-32	0.000E+00	5.770E-34
TE-131M	1.920E+05	6.640E+04	1.360E+05	6.420E+05	0.000E+00	2.690E+06	0.000E+00	7.060E+04
TE-132	1.230E+06	5.440E+05	7.920E+05	5.050E+06	0.000E+00	5.480E+06	0.000E+00	6.570E+05
I-130	2.070E+06	4.190E+06	4.610E+08	6.260E+06	0.000E+00	1.960E+06	0.000E+00	2.160E+06

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Grs/Goat/Milk (GMILK)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	1.560E+09	1.570E+09	5.200E+11	2.580E+09	0.000E+00	1.400E+08	0.000E+00	8.940E+08
I-132	8.270E-01	1.520E+00	7.050E+01	2.330E+00	0.000E+00	1.790E+00	0.000E+00	6.990E-01
I-133	2.060E+07	2.550E+07	4.730E+09	4.250E+07	0.000E+00	1.030E+07	0.000E+00	9.640E+06
I-134	1.020E-11	1.890E-11	4.350E-10	2.890E-11	0.000E+00	1.250E-11	0.000E+00	8.700E-12
I-135	6.480E+04	1.170E+05	1.030E+07	1.790E+05	0.000E+00	8.880E+04	0.000E+00	5.520E+04
CS-134	6.790E+10	1.110E+11	0.000E+00	3.450E+10	1.240E+10	6.010E+08	0.000E+00	2.350E+10
CS-136	3.030E+09	8.340E+09	0.000E+00	4.440E+09	6.630E+08	2.930E+08	0.000E+00	5.400E+09
CS-137	9.670E+10	9.260E+10	0.000E+00	3.020E+10	1.090E+10	5.800E+08	0.000E+00	1.370E+10
CS-138	1.190E-22	1.660E-22	0.000E+00	1.170E-22	1.260E-23	7.640E-23	0.000E+00	1.050E-22
BA-139	2.410E-08	1.290E-11	0.000E+00	1.120E-11	7.560E-12	1.390E-06	0.000E+00	6.980E-10
BA-140	1.410E+07	1.230E+04	0.000E+00	4.010E+03	7.340E+03	7.120E+06	0.000E+00	8.200E+05
BA-141	2.220E-46	1.240E-49	0.000E+00	1.080E-49	7.300E-49	1.270E-46	0.000E+00	7.230E-48
BA-142	1.390E-80	9.970E-84	0.000E+00	8.070E-84	5.870E-84	1.810E-82	0.000E+00	7.740E-82
LA-140	2.330E+00	8.140E-01	0.000E+00	0.000E+00	0.000E+00	2.270E+04	0.000E+00	2.740E-01
LA-142	9.730E-12	3.100E-12	0.000E+00	0.000E+00	0.000E+00	6.140E-07	0.000E+00	9.710E-13
CE-141	2.620E+03	1.310E+03	0.000E+00	5.740E+02	0.000E+00	1.630E+06	0.000E+00	1.940E+02
CE-143	2.250E+01	1.220E+04	0.000E+00	5.120E+00	0.000E+00	1.790E+05	0.000E+00	1.770E+00
CE-144	1.950E+05	6.110E+04	0.000E+00	3.380E+04	0.000E+00	1.590E+07	0.000E+00	1.040E+04
PR-143	8.620E+01	2.590E+01	0.000E+00	1.400E+01	0.000E+00	9.300E+04	0.000E+00	4.280E+00
PR-144	3.220E-54	9.950E-55	0.000E+00	5.260E-55	0.000E+00	2.140E-51	0.000E+00	1.620E-55
ND-147	5.330E+01	4.320E+01	0.000E+00	2.370E+01	0.000E+00	6.850E+04	0.000E+00	3.350E+00
W-187	3.470E+03	2.050E+03	0.000E+00	0.000E+00	0.000E+00	2.880E+05	0.000E+00	9.210E+02
NP-239	2.070E+00	1.490E-01	0.000E+00	4.300E-01	0.000E+00	1.100E+04	0.000E+00	1.040E-01

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Grs/Cow/Meat (CMEAT)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	2.340E+02	2.340E+02	2.340E+02	2.340E+02	2.340E+02	0.000E+00	2.340E+02
C-14	3.700E+04	7.400E+03	7.400E+03	7.400E+03	7.400E+03	7.400E+03	0.000E+00	7.400E+03
NA-24	1.720E-03	1.720E-03	1.720E-03	1.720E-03	1.720E-03	1.720E-03	0.000E+00	1.720E-03
P-32	7.420E+09	3.470E+08	0.000E+00	0.000E+00	0.000E+00	2.050E+08	0.000E+00	2.860E+08
CR-51	0.000E+00	0.000E+00	4.880E+03	1.330E+03	8.910E+03	4.660E+05	0.000E+00	8.790E+03
MN-54	0.000E+00	8.010E+06	0.000E+00	2.250E+06	0.000E+00	6.720E+06	0.000E+00	2.130E+06
MN-56	0.000E+00	1.430E-53	0.000E+00	1.730E-53	0.000E+00	2.070E-51	0.000E+00	3.230E-54
FE-55	4.570E+08	2.420E+08	0.000E+00	0.000E+00	1.370E+08	4.490E+07	0.000E+00	7.510E+07
FE-59	3.760E+08	6.090E+08	0.000E+00	0.000E+00	1.770E+08	6.340E+08	0.000E+00	3.030E+08
CO-58	0.000E+00	1.640E+07	0.000E+00	0.000E+00	0.000E+00	9.580E+07	0.000E+00	5.020E+07
CO-60	0.000E+00	6.930E+07	0.000E+00	0.000E+00	0.000E+00	3.840E+08	0.000E+00	2.040E+08
NI-63	2.910E+10	1.560E+09	0.000E+00	0.000E+00	0.000E+00	1.050E+08	0.000E+00	9.910E+08
NI-65	3.520E-52	3.310E-53	0.000E+00	0.000E+00	0.000E+00	4.060E-51	0.000E+00	1.930E-53
CU-64	0.000E+00	2.970E-07	0.000E+00	7.180E-07	0.000E+00	1.390E-05	0.000E+00	1.800E-07
ZN-65	3.750E+08	1.000E+09	0.000E+00	6.300E+08	0.000E+00	1.760E+08	0.000E+00	6.220E+08
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.520E-57
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	5.770E+08	0.000E+00	0.000E+00	0.000E+00	3.710E+07	0.000E+00	3.550E+08
RB-88	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-89	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-89	4.820E+08	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.870E+07	0.000E+00	1.380E+07
SR-90	1.040E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.400E+08	0.000E+00	2.640E+09
SR-91	2.400E-10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.300E-10	0.000E+00	9.050E-12

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Grs/Cow/Meat (CMEAT)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-92	1.850E-49	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.490E-48	0.000E+00	7.400E-51
Y-90	1.710E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.880E+05	0.000E+00	4.590E+00
Y-91	1.800E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.400E+08	0.000E+00	4.820E+04
Y-91M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y-92	2.410E-39	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.960E-35	0.000E+00	6.890E-41
Y-93	7.440E-12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.110E-07	0.000E+00	2.040E-13
ZR-95	2.660E+06	5.850E+05	0.000E+00	8.380E+05	0.000E+00	6.110E+08	0.000E+00	5.210E+05
ZR-97	3.200E-05	4.630E-06	0.000E+00	6.650E-06	0.000E+00	7.010E-01	0.000E+00	2.730E-06
NB-95	3.100E+06	1.210E+06	0.000E+00	1.130E+06	0.000E+00	2.230E+09	0.000E+00	8.620E+05
MO-99	0.000E+00	1.150E+05	0.000E+00	2.460E+05	0.000E+00	9.510E+04	0.000E+00	2.840E+04
TC-99M	6.190E-21	1.210E-20	0.000E+00	1.760E-19	6.160E-21	6.910E-18	0.000E+00	2.010E-19
TC-101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-103	1.550E+08	0.000E+00	0.000E+00	3.900E+08	0.000E+00	4.010E+09	0.000E+00	5.960E+07
RU-105	9.020E-28	0.000E+00	0.000E+00	7.930E-27	0.000E+00	5.890E-25	0.000E+00	3.270E-28
RU-106	4.440E+09	0.000E+00	0.000E+00	5.990E+09	0.000E+00	6.900E+10	0.000E+00	5.540E+08
AG-110M	8.390E+06	5.670E+06	0.000E+00	1.060E+07	0.000E+00	6.740E+08	0.000E+00	4.530E+06
TE-125M	5.690E+08	1.540E+08	1.600E+08	0.000E+00	0.000E+00	5.490E+08	0.000E+00	7.590E+07
TE-127	3.380E-10	9.120E-11	2.340E-10	9.630E-10	0.000E+00	1.320E-08	0.000E+00	7.260E-11
TE-127M	1.770E+09	4.780E+08	4.240E+08	5.060E+09	0.000E+00	1.440E+09	0.000E+00	2.110E+08
TE-129	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-129M	1.790E+09	5.000E+08	5.770E+08	5.260E+09	0.000E+00	2.180E+09	0.000E+00	2.780E+08
TE-131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-131M	7.000E+02	2.420E+02	4.980E+02	2.340E+03	0.000E+00	9.820E+03	0.000E+00	2.580E+02
TE-132	2.120E+06	9.380E+05	1.370E+06	8.710E+06	0.000E+00	9.450E+06	0.000E+00	1.130E+06
I-130	3.030E-06	6.130E-06	6.750E-04	9.160E-06	0.000E+00	2.870E-06	0.000E+00	3.160E-06

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Grs/Cow/Meat (CMEAT)			Units:	$m^2 \cdot mrem/yr$ / $\mu Ci/sec$; $mrem/yr$ / $\mu Ci/m^3$ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	1.650E+07	1.660E+07	5.500E+09	2.730E+07	0.000E+00	1.480E+06	0.000E+00	9.460E+06
I-132	1.020E-58	1.880E-58	8.730E-57	2.880E-58	0.000E+00	2.210E-58	0.000E+00	8.650E-59
I-133	5.670E-01	7.020E-01	1.300E+02	1.170E+00	0.000E+00	2.830E-01	0.000E+00	2.660E-01
I-134	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-135	6.510E-17	1.170E-16	1.040E-14	1.800E-16	0.000E+00	8.930E-17	0.000E+00	5.550E-17
CS-134	9.220E+08	1.510E+09	0.000E+00	4.690E+08	1.680E+08	8.160E+06	0.000E+00	3.190E+08
CS-136	1.620E+07	4.460E+07	0.000E+00	2.370E+07	3.540E+06	1.570E+06	0.000E+00	2.880E+07
CS-137	1.330E+09	1.280E+09	0.000E+00	4.160E+08	1.500E+08	7.990E+06	0.000E+00	1.880E+08
CS-138	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-139	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-140	4.380E+07	3.840E+04	0.000E+00	1.250E+04	2.290E+04	2.220E+07	0.000E+00	2.560E+06
BA-141	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA-140	5.590E-02	1.950E-02	0.000E+00	0.000E+00	0.000E+00	5.440E+02	0.000E+00	6.580E-03
LA-142	5.300E-92	1.690E-92	0.000E+00	0.000E+00	0.000E+00	3.350E-87	0.000E+00	5.290E-93
CE-141	2.220E+04	1.110E+04	0.000E+00	4.850E+03	0.000E+00	1.380E+07	0.000E+00	1.640E+03
CE-143	3.170E-02	1.720E+01	0.000E+00	7.210E-03	0.000E+00	2.520E+02	0.000E+00	2.490E-03
CE-144	2.320E+06	7.260E+05	0.000E+00	4.020E+05	0.000E+00	1.890E+08	0.000E+00	1.240E+05
PR-143	3.340E+04	1.000E+04	0.000E+00	5.430E+03	0.000E+00	3.600E+07	0.000E+00	1.660E+03
PR-144	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND-147	1.170E+04	9.470E+03	0.000E+00	5.190E+03	0.000E+00	1.500E+07	0.000E+00	7.330E+02
W-187	3.210E-02	1.900E-02	0.000E+00	0.000E+00	0.000E+00	2.670E+00	0.000E+00	8.530E-03
NP-239	4.260E-01	3.060E-02	0.000E+00	8.850E-02	0.000E+00	2.260E+03	0.000E+00	2.150E-02

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Age group:	CHILD	Pathway:	Grs/Goat/Meat (GMEAT)			Units:	$m^2\cdot$mrem/yr / µCi/sec; mrem/yr / µCi/m^3 (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	2.808E+01	2.808E+01	2.808E+01	2.808E+01	2.808E+01	0.000E+00	2.808E+01
C-14	4.440E+03	8.880E+02	8.880E+02	8.880E+02	8.880E+02	8.880E+02	0.000E+00	8.880E+02
NA-24	2.064E-04	2.064E-04	2.064E-04	2.064E-04	2.064E-04	2.064E-04	0.000E+00	2.064E-04
P-32	8.904E+08	4.164E+07	0.000E+00	0.000E+00	0.000E+00	2.460E+07	0.000E+00	3.432E+07
CR-51	0.000E+00	0.000E+00	5.856E+02	1.596E+02	1.069E+03	5.592E+04	0.000E+00	1.055E+03
MN-54	0.000E+00	9.612E+05	0.000E+00	2.700E+05	0.000E+00	8.064E+05	0.000E+00	2.556E+05
MN-56	0.000E+00	1.716E-54	0.000E+00	2.076E-54	0.000E+00	2.484E-52	0.000E+00	3.876E-55
FE-55	5.484E+07	2.904E+07	0.000E+00	0.000E+00	1.644E+07	5.388E+06	0.000E+00	9.012E+06
FE-59	4.512E+07	7.308E+07	0.000E+00	0.000E+00	2.124E+07	7.608E+07	0.000E+00	3.636E+07
CO-58	0.000E+00	1.968E+06	0.000E+00	0.000E+00	0.000E+00	1.150E+07	0.000E+00	6.024E+06
CO-60	0.000E+00	8.316E+06	0.000E+00	0.000E+00	0.000E+00	4.608E+07	0.000E+00	2.448E+07
NI-63	3.492E+09	1.872E+08	0.000E+00	0.000E+00	0.000E+00	1.260E+07	0.000E+00	1.189E+08
NI-65	4.224E-53	3.972E-54	0.000E+00	0.000E+00	0.000E+00	4.872E-52	0.000E+00	2.316E-54
CU-64	0.000E+00	3.564E-08	0.000E+00	8.616E-08	0.000E+00	1.668E-06	0.000E+00	2.160E-08
ZN-65	4.500E+07	1.200E+08	0.000E+00	7.560E+07	0.000E+00	2.112E+07	0.000E+00	7.464E+07
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.142E-57
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	6.924E+07	0.000E+00	0.000E+00	0.000E+00	4.452E+06	0.000E+00	4.260E+07
RB-88	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-89	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-89	5.784E+07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.244E+06	0.000E+00	1.656E+06
SR-90	1.248E+09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.680E+07	0.000E+00	3.168E+08
SR-91	2.880E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.360E-11	0.000E+00	1.086E-12

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Age group:	CHILD	Pathway:	Grs/Goat/Meat (GMEAT)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	2.220E-50	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.188E-49	0.000E+00	8.880E-52
Y-90	2.052E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.856E+04	0.000E+00	5.508E-01
Y-91	2.160E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.880E+07	0.000E+00	5.784E+03
Y-91M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y-92	2.892E-40	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.352E-36	0.000E+00	8.268E-42
Y-93	8.928E-13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.332E-08	0.000E+00	2.448E-14
ZR-95	3.192E+05	7.020E+04	0.000E+00	1.006E+05	0.000E+00	7.332E+07	0.000E+00	6.252E+04
ZR-97	3.840E-06	5.556E-07	0.000E+00	7.980E-07	0.000E+00	8.412E-02	0.000E+00	3.276E-07
NB-95	3.720E+05	1.452E+05	0.000E+00	1.356E+05	0.000E+00	2.676E+08	0.000E+00	1.034E+05
MO-99	0.000E+00	1.380E+04	0.000E+00	2.952E+04	0.000E+00	1.141E+04	0.000E+00	3.408E+03
TC-99M	7.428E-22	1.452E-21	0.000E+00	2.112E-20	7.392E-22	8.292E-19	0.000E+00	2.412E-20
TC-101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-103	1.860E+07	0.000E+00	0.000E+00	4.680E+07	0.000E+00	4.812E+08	0.000E+00	7.152E+06
RU-105	1.082E-28	0.000E+00	0.000E+00	9.516E-28	0.000E+00	7.068E-26	0.000E+00	3.924E-29
RU-106	5.328E+08	0.000E+00	0.000E+00	7.188E+08	0.000E+00	8.280E+09	0.000E+00	6.648E+07
AG-110M	1.007E+06	6.804E+05	0.000E+00	1.272E+06	0.000E+00	8.088E+07	0.000E+00	5.436E+05
TE-125M	6.828E+07	1.848E+07	1.920E+07	0.000E+00	0.000E+00	6.588E+07	0.000E+00	9.108E+06
TE-127	4.056E-11	1.094E-11	2.808E-11	1.156E-10	0.000E+00	1.584E-09	0.000E+00	8.712E-12
TE-127M	2.124E+08	5.736E+07	5.088E+07	6.072E+08	0.000E+00	1.728E+08	0.000E+00	2.532E+07
TE-129	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-129M	2.148E+08	6.000E+07	6.924E+07	6.312E+08	0.000E+00	2.616E+08	0.000E+00	3.336E+07
TE-131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-131M	8.400E+01	2.904E+01	5.976E+01	2.808E+02	0.000E+00	1.178E+03	0.000E+00	3.096E+01
TE-132	2.544E+05	1.126E+05	1.644E+05	1.045E+06	0.000E+00	1.134E+06	0.000E+00	1.356E+05
I-130	3.636E-07	7.356E-07	8.100E-05	1.099E-06	0.000E+00	3.444E-07	0.000E+00	3.792E-07

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Age group:	CHILD	Pathway:	Grs/Goat/Meat (GMEAT)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	1.980E+06	1.992E+06	6.600E+08	3.276E+06	0.000E+00	1.776E+05	0.000E+00	1.135E+06
I-132	1.224E-59	2.256E-59	1.048E-57	3.456E-59	0.000E+00	2.652E-59	0.000E+00	1.038E-59
I-133	6.804E-02	8.424E-02	1.560E+01	1.404E-01	0.000E+00	3.396E-02	0.000E+00	3.192E-02
I-134	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-135	7.812E-18	1.404E-17	1.248E-15	2.160E-17	0.000E+00	1.072E-17	0.000E+00	6.660E-18
CS-134	1.106E+08	1.812E+08	0.000E+00	5.628E+07	2.016E+07	9.792E+05	0.000E+00	3.828E+07
CS-136	1.944E+06	5.352E+06	0.000E+00	2.844E+06	4.248E+05	1.884E+05	0.000E+00	3.456E+06
CS-137	1.596E+08	1.536E+08	0.000E+00	4.992E+07	1.800E+07	9.588E+05	0.000E+00	2.256E+07
CS-138	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-139	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-140	5.256E+06	4.608E+03	0.000E+00	1.500E+03	2.748E+03	2.664E+06	0.000E+00	3.072E+05
BA-141	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA-140	6.708E-03	2.340E-03	0.000E+00	0.000E+00	0.000E+00	6.528E+01	0.000E+00	7.896E-04
LA-142	6.360E-93	2.028E-93	0.000E+00	0.000E+00	0.000E+00	4.020E-88	0.000E+00	6.348E-94
CE-141	2.664E+03	1.332E+03	0.000E+00	5.820E+02	0.000E+00	1.656E+06	0.000E+00	1.968E+02
CE-143	3.804E-03	2.064E+00	0.000E+00	8.652E-04	0.000E+00	3.024E+01	0.000E+00	2.988E-04
CE-144	2.784E+05	8.712E+04	0.000E+00	4.824E+04	0.000E+00	2.268E+07	0.000E+00	1.488E+04
PR-143	4.008E+03	1.200E+03	0.000E+00	6.516E+02	0.000E+00	4.320E+06	0.000E+00	1.992E+02
PR-144	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND-147	1.404E+03	1.136E+03	0.000E+00	6.228E+02	0.000E+00	1.800E+06	0.000E+00	8.796E+01
W-187	3.852E-03	2.280E-03	0.000E+00	0.000E+00	0.000E+00	3.204E-01	0.000E+00	1.024E-03
NP-239	5.112E-02	3.672E-03	0.000E+00	1.062E-02	0.000E+00	2.712E+02	0.000E+00	2.580E-03

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Vegetation (VEG)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	4.010E+03	4.010E+03	4.010E+03	4.010E+03	4.010E+03	0.000E+00	4.010E+03
C-14	2.450E+05	4.910E+04	4.910E+04	4.910E+04	4.910E+04	4.910E+04	0.000E+00	4.910E+04
NA-24	3.730E+05	3.730E+05	3.730E+05	3.730E+05	3.730E+05	3.730E+05	0.000E+00	3.730E+05
P-32	3.370E+09	1.580E+08	0.000E+00	0.000E+00	0.000E+00	9.310E+07	0.000E+00	1.300E+08
CR-51	0.000E+00	0.000E+00	6.500E+04	1.780E+04	1.190E+05	6.210E+06	0.000E+00	1.170E+05
MN-54	0.000E+00	6.650E+08	0.000E+00	1.860E+08	0.000E+00	5.580E+08	0.000E+00	1.770E+08
MN-56	0.000E+00	1.860E+01	0.000E+00	2.250E+01	0.000E+00	2.700E+03	0.000E+00	4.200E+00
FE-55	8.010E+08	4.250E+08	0.000E+00	0.000E+00	2.400E+08	7.870E+07	0.000E+00	1.320E+08
FE-59	3.980E+08	6.430E+08	0.000E+00	0.000E+00	1.860E+08	6.700E+08	0.000E+00	3.200E+08
CO-58	0.000E+00	6.440E+07	0.000E+00	0.000E+00	0.000E+00	3.760E+08	0.000E+00	1.970E+08
CO-60	0.000E+00	3.780E+08	0.000E+00	0.000E+00	0.000E+00	2.100E+09	0.000E+00	1.120E+09
NI-63	3.950E+10	2.110E+09	0.000E+00	0.000E+00	0.000E+00	1.420E+08	0.000E+00	1.340E+09
NI-65	1.050E+02	9.890E+00	0.000E+00	0.000E+00	0.000E+00	1.210E+03	0.000E+00	5.770E+00
CU-64	0.000E+00	1.100E+04	0.000E+00	2.660E+04	0.000E+00	5.160E+05	0.000E+00	6.640E+03
ZN-65	8.130E+08	2.160E+09	0.000E+00	1.360E+09	0.000E+00	3.800E+08	0.000E+00	1.350E+09
ZN-69	9.490E-06	1.370E-05	0.000E+00	8.320E-06	0.000E+00	8.640E-04	0.000E+00	1.270E-06
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.370E+00
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.820E-11
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	4.520E+08	0.000E+00	0.000E+00	0.000E+00	2.910E+07	0.000E+00	2.780E+08
RB-88	0.000E+00	4.380E-22	0.000E+00	0.000E+00	0.000E+00	2.150E-23	0.000E+00	3.040E-22
RB-89	0.000E+00	4.610E-26	0.000E+00	0.000E+00	0.000E+00	4.020E-28	0.000E+00	4.090E-26
SR-89	3.600E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.390E+09	0.000E+00	1.030E+09
SR-90	1.240E+12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.670E+10	0.000E+00	3.150E+11
SR-91	5.240E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.160E+06	0.000E+00	1.980E+04

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Vegetation (VEG)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	7.280E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.380E+04	0.000E+00	2.920E+01
Y-90	2.310E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.570E+07	0.000E+00	6.180E+02
Y-91	1.860E+07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.480E+09	0.000E+00	4.990E+05
Y-91M	8.910E-09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.740E-05	0.000E+00	3.240E-10
Y-92	1.580E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.580E+04	0.000E+00	4.530E-02
Y-93	2.930E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.370E+06	0.000E+00	8.040E+00
ZR-95	3.860E+06	8.480E+05	0.000E+00	1.210E+06	0.000E+00	8.850E+08	0.000E+00	7.550E+05
ZR-97	5.700E+02	8.240E+01	0.000E+00	1.180E+02	0.000E+00	1.250E+07	0.000E+00	4.860E+01
NB-95	4.110E+05	1.600E+05	0.000E+00	1.500E+05	0.000E+00	2.960E+08	0.000E+00	1.140E+05
MO-99	0.000E+00	7.710E+06	0.000E+00	1.650E+07	0.000E+00	6.380E+06	0.000E+00	1.910E+06
TC-99M	4.710E+00	9.230E+00	0.000E+00	1.340E+02	4.690E+00	5.260E+03	0.000E+00	1.530E+02
TC-101	1.410E-30	1.470E-30	0.000E+00	2.510E-29	7.780E-31	4.680E-30	0.000E+00	1.870E-29
RU-103	1.530E+07	0.000E+00	0.000E+00	3.860E+07	0.000E+00	3.970E+08	0.000E+00	5.900E+06
RU-105	9.160E+01	0.000E+00	0.000E+00	8.050E+02	0.000E+00	5.980E+04	0.000E+00	3.320E+01
RU-106	7.450E+08	0.000E+00	0.000E+00	1.010E+09	0.000E+00	1.160E+10	0.000E+00	9.300E+07
AG-110M	3.210E+07	2.170E+07	0.000E+00	4.040E+07	0.000E+00	2.580E+09	0.000E+00	1.730E+07
TE-125M	3.510E+08	9.500E+07	9.840E+07	0.000E+00	0.000E+00	3.380E+08	0.000E+00	4.670E+07
TE-127	9.850E+03	2.650E+03	6.810E+03	2.800E+04	0.000E+00	3.850E+05	0.000E+00	2.110E+03
TE-127M	1.320E+09	3.560E+08	3.160E+08	3.770E+09	0.000E+00	1.070E+09	0.000E+00	1.570E+08
TE-129	1.320E-03	3.690E-04	9.430E-04	3.870E-03	0.000E+00	8.230E-02	0.000E+00	3.140E-04
TE-129M	8.410E+08	2.350E+08	2.710E+08	2.470E+09	0.000E+00	1.030E+09	0.000E+00	1.310E+08
TE-131	2.570E-15	7.830E-16	1.960E-15	7.770E-15	0.000E+00	1.350E-14	0.000E+00	7.640E-16
TE-131M	1.540E+06	5.330E+05	1.100E+06	5.160E+06	0.000E+00	2.160E+07	0.000E+00	5.680E+05
TE-132	7.000E+06	3.100E+06	4.510E+06	2.880E+07	0.000E+00	3.120E+07	0.000E+00	3.740E+06
I-130	6.160E+05	1.240E+06	1.370E+08	1.860E+06	0.000E+00	5.820E+05	0.000E+00	6.410E+05

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Vegetation (VEG)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	1.430E+08	1.440E+08	4.750E+10	2.360E+08	0.000E+00	1.280E+07	0.000E+00	8.170E+07
I-132	9.220E+01	1.690E+02	7.860E+03	2.590E+02	0.000E+00	1.990E+02	0.000E+00	7.790E+01
I-133	3.530E+06	4.370E+06	8.110E+08	7.280E+06	0.000E+00	1.760E+06	0.000E+00	1.650E+06
I-134	1.550E-04	2.880E-04	6.620E-03	4.400E-04	0.000E+00	1.910E-04	0.000E+00	1.320E-04
I-135	6.260E+04	1.130E+05	9.970E+06	1.730E+05	0.000E+00	8.580E+04	0.000E+00	5.330E+04
CS-134	1.600E+10	2.630E+10	0.000E+00	8.150E+09	2.930E+09	1.420E+08	0.000E+00	5.550E+09
CS-136	8.240E+07	2.270E+08	0.000E+00	1.210E+08	1.800E+07	7.960E+06	0.000E+00	1.470E+08
CS-137	2.390E+10	2.290E+10	0.000E+00	7.460E+09	2.680E+09	1.430E+08	0.000E+00	3.380E+09
CS-138	6.570E-11	9.130E-11	0.000E+00	6.430E-11	6.920E-12	4.210E-11	0.000E+00	5.790E-11
BA-139	4.950E-02	2.640E-05	0.000E+00	2.310E-05	1.560E-05	2.860E+00	0.000E+00	1.440E-03
BA-140	2.770E+08	2.420E+05	0.000E+00	7.890E+04	1.450E+05	1.400E+08	0.000E+00	1.610E+07
BA-141	1.990E-21	1.110E-24	0.000E+00	9.620E-25	6.530E-24	1.130E-21	0.000E+00	6.460E-23
BA-142	9.930E-39	7.150E-42	0.000E+00	5.780E-42	4.200E-42	1.300E-40	0.000E+00	5.540E-40
LA-140	3.250E+03	1.130E+03	0.000E+00	0.000E+00	0.000E+00	3.160E+07	0.000E+00	3.820E+02
LA-142	3.360E-04	1.070E-04	0.000E+00	0.000E+00	0.000E+00	2.120E+01	0.000E+00	3.350E-05
CE-141	6.560E+05	3.270E+05	0.000E+00	1.430E+05	0.000E+00	4.080E+08	0.000E+00	4.860E+04
CE-143	1.720E+03	9.310E+05	0.000E+00	3.910E+02	0.000E+00	1.360E+07	0.000E+00	1.350E+02
CE-144	1.270E+08	3.980E+07	0.000E+00	2.210E+07	0.000E+00	1.040E+10	0.000E+00	6.780E+06
PR-143	1.460E+05	4.370E+04	0.000E+00	2.370E+04	0.000E+00	1.570E+08	0.000E+00	7.230E+03
PR-144	5.380E-26	1.660E-26	0.000E+00	8.800E-27	0.000E+00	3.580E-23	0.000E+00	2.710E-27
ND-147	7.150E+04	5.790E+04	0.000E+00	3.180E+04	0.000E+00	9.170E+07	0.000E+00	4.480E+03
W-187	6.430E+04	3.810E+04	0.000E+00	0.000E+00	0.000E+00	5.350E+06	0.000E+00	1.710E+04
NP-239	2.560E+03	1.840E+02	0.000E+00	5.310E+02	0.000E+00	1.360E+07	0.000E+00	1.290E+02

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Inhalation (INHL)			Units:	mrem/yr / µCi/m^3	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	1.120E+03	1.120E+03	1.120E+03	1.120E+03	1.120E+03	0.000E+00	1.120E+03
C-14	3.590E+04	6.730E+03	6.730E+03	6.730E+03	6.730E+03	6.730E+03	0.000E+00	6.730E+03
NA-24	1.610E+04	1.610E+04	1.610E+04	1.610E+04	1.610E+04	1.610E+04	0.000E+00	1.610E+04
P-32	2.600E+06	1.140E+05	0.000E+00	0.000E+00	0.000E+00	4.220E+04	0.000E+00	9.880E+04
CR-51	0.000E+00	0.000E+00	8.550E+01	2.430E+01	1.700E+04	1.080E+03	0.000E+00	1.540E+02
MN-54	0.000E+00	4.290E+04	0.000E+00	1.000E+04	1.580E+06	2.290E+04	0.000E+00	9.510E+03
MN-56	0.000E+00	1.660E+00	0.000E+00	1.670E+00	1.310E+04	1.230E+05	0.000E+00	3.120E-01
FE-55	4.740E+04	2.520E+04	0.000E+00	0.000E+00	1.110E+05	2.870E+03	0.000E+00	7.770E+03
FE-59	2.070E+04	3.340E+04	0.000E+00	0.000E+00	1.270E+06	7.070E+04	0.000E+00	1.670E+04
CO-58	0.000E+00	1.770E+03	0.000E+00	0.000E+00	1.110E+06	3.440E+04	0.000E+00	3.160E+03
CO-60	0.000E+00	1.310E+04	0.000E+00	0.000E+00	7.070E+06	9.620E+04	0.000E+00	2.260E+04
NI-63	8.210E+05	4.620E+04	0.000E+00	0.000E+00	2.750E+05	6.330E+03	0.000E+00	2.800E+04
NI-65	2.990E+00	2.960E-01	0.000E+00	0.000E+00	8.180E+03	8.400E+04	0.000E+00	1.640E-01
CU-64	0.000E+00	1.990E+00	0.000E+00	6.030E+00	9.580E+03	3.670E+04	0.000E+00	1.070E+00
ZN-65	4.260E+04	1.130E+05	0.000E+00	7.140E+04	9.950E+05	1.630E+04	0.000E+00	7.030E+04
ZN-69	6.700E-02	9.660E-02	0.000E+00	5.850E-02	1.420E+03	1.020E+04	0.000E+00	8.920E-03
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.740E+02
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.480E+02
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.530E+01
RB-86	0.000E+00	1.980E+05	0.000E+00	0.000E+00	0.000E+00	7.990E+03	0.000E+00	1.140E+05
RB-88	0.000E+00	5.620E+02	0.000E+00	0.000E+00	0.000E+00	1.720E+01	0.000E+00	3.660E+02
RB-89	0.000E+00	3.450E+02	0.000E+00	0.000E+00	0.000E+00	1.890E+00	0.000E+00	2.900E+02
SR-89	5.990E+05	0.000E+00	0.000E+00	0.000E+00	2.160E+06	1.670E+05	0.000E+00	1.720E+04
SR-90	1.010E+08	0.000E+00	0.000E+00	0.000E+00	1.480E+07	3.430E+05	0.000E+00	6.440E+06
SR-91	1.210E+02	0.000E+00	0.000E+00	0.000E+00	5.330E+04	1.740E+05	0.000E+00	4.590E+00

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Inhalation (INHL)			Units:	mrem/yr / µCi/m^3	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	1.310E+01	0.000E+00	0.000E+00	0.000E+00	2.400E+04	2.420E+05	0.000E+00	5.250E-01
Y-90	4.110E+03	0.000E+00	0.000E+00	0.000E+00	2.620E+05	2.680E+05	0.000E+00	1.110E+02
Y-91	9.140E+05	0.000E+00	0.000E+00	0.000E+00	2.630E+06	1.840E+05	0.000E+00	2.440E+04
Y-91M	5.070E-01	0.000E+00	0.000E+00	0.000E+00	2.810E+03	1.720E+03	0.000E+00	1.840E-02
Y-92	2.030E+01	0.000E+00	0.000E+00	0.000E+00	2.390E+04	2.390E+05	0.000E+00	5.810E-01
Y-93	1.860E+02	0.000E+00	0.000E+00	0.000E+00	7.440E+04	3.880E+05	0.000E+00	5.110E+00
ZR-95	1.900E+05	4.180E+04	0.000E+00	5.960E+04	2.230E+06	6.110E+04	0.000E+00	3.700E+04
ZR-97	1.880E+02	2.720E+01	0.000E+00	3.880E+01	1.130E+05	3.510E+05	0.000E+00	1.600E+01
NB-95	2.350E+04	9.180E+03	0.000E+00	8.620E+03	6.140E+05	3.700E+04	0.000E+00	6.550E+03
MO-99	0.000E+00	1.720E+02	0.000E+00	3.920E+02	1.350E+05	1.270E+05	0.000E+00	4.260E+01
TC-99M	1.780E-03	3.480E-03	0.000E+00	5.070E-02	9.510E+02	4.810E+03	0.000E+00	5.770E-02
TC-101	8.100E-05	8.510E-05	0.000E+00	1.450E-03	5.850E+02	1.630E+01	0.000E+00	1.080E-03
RU-103	2.790E+03	0.000E+00	0.000E+00	7.030E+03	6.620E+05	4.480E+04	0.000E+00	1.070E+03
RU-105	1.530E+00	0.000E+00	0.000E+00	1.340E+00	1.590E+04	9.950E+04	0.000E+00	5.550E-01
RU-106	1.360E+05	0.000E+00	0.000E+00	1.840E+05	1.430E+07	4.290E+05	0.000E+00	1.690E+04
AG-110M	1.690E+04	1.140E+04	0.000E+00	2.120E+04	5.480E+06	1.000E+05	0.000E+00	9.140E+03
TE-125M	6.730E+03	2.330E+03	1.920E+03	0.000E+00	4.770E+05	3.380E+04	0.000E+00	9.140E+02
TE-127	2.770E+00	9.510E-01	1.960E+00	7.070E+00	1.000E+04	5.620E+04	0.000E+00	6.100E-01
TE-127M	2.490E+04	8.550E+03	6.070E+03	6.360E+04	1.480E+06	7.140E+04	0.000E+00	3.020E+03
TE-129	9.770E-02	3.500E-02	7.140E-02	2.570E-01	2.930E+03	2.550E+04	0.000E+00	2.380E-02
TE-129M	1.920E+04	6.840E+03	6.330E+03	5.030E+04	1.760E+06	1.820E+05	0.000E+00	3.040E+03
TE-131	2.170E-02	8.440E-03	1.700E-02	5.880E-02	2.050E+03	1.330E+03	0.000E+00	6.590E-03
TE-131M	1.340E+02	5.920E+01	9.770E+01	4.000E+02	2.060E+05	3.080E+05	0.000E+00	5.070E+01
TE-132	4.810E+02	2.720E+02	3.170E+02	1.770E+03	3.770E+05	1.380E+05	0.000E+00	2.630E+02
I-130	8.180E+03	1.640E+04	1.850E+06	2.450E+04	0.000E+00	5.110E+03	0.000E+00	8.440E+03

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Inhalation (INHL)			Units:	mrem/yr / µCi/m³	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	4.810E+04	4.810E+04	1.620E+07	7.880E+04	0.000E+00	2.840E+03	0.000E+00	2.730E+04
I-132	2.120E+03	4.070E+03	1.940E+05	6.250E+03	0.000E+00	3.200E+03	0.000E+00	1.880E+03
I-133	1.660E+04	2.030E+04	3.850E+06	3.380E+04	0.000E+00	5.480E+03	0.000E+00	7.700E+03
I-134	1.170E+03	2.160E+03	5.070E+04	3.300E+03	0.000E+00	9.550E+02	0.000E+00	9.950E+02
I-135	4.920E+03	8.730E+03	7.920E+05	1.340E+04	0.000E+00	4.440E+03	0.000E+00	4.140E+03
CS-134	6.510E+05	1.010E+06	0.000E+00	3.300E+05	1.210E+05	3.850E+03	0.000E+00	2.250E+05
CS-136	6.510E+04	1.710E+05	0.000E+00	9.550E+04	1.450E+04	4.180E+03	0.000E+00	1.160E+05
CS-137	9.060E+05	8.250E+05	0.000E+00	2.820E+05	1.040E+05	3.620E+03	0.000E+00	1.280E+05
CS-138	6.330E+02	8.400E+02	0.000E+00	6.220E+02	6.810E+01	2.700E+02	0.000E+00	5.550E+02
BA-139	1.840E+00	9.840E-04	0.000E+00	8.620E-04	5.770E+03	5.770E+04	0.000E+00	5.360E-02
BA-140	7.400E+04	6.480E+01	0.000E+00	2.110E+01	1.740E+06	1.020E+05	0.000E+00	4.330E+03
BA-141	1.960E-01	1.090E-04	0.000E+00	9.470E-05	2.920E+03	2.750E+02	0.000E+00	6.360E-03
BA-142	5.000E-02	3.600E-05	0.000E+00	2.910E-05	1.640E+03	2.740E+00	0.000E+00	2.790E-03
LA-140	6.440E+02	2.250E+02	0.000E+00	0.000E+00	1.830E+05	2.260E+05	0.000E+00	7.550E+01
LA-142	1.300E+00	4.110E-01	0.000E+00	0.000E+00	8.700E+03	7.580E+04	0.000E+00	1.290E-01
CE-141	3.920E+04	1.950E+04	0.000E+00	8.550E+03	5.440E+05	5.660E+04	0.000E+00	2.900E+03
CE-143	3.660E+02	1.990E+02	0.000E+00	8.360E+01	1.150E+05	1.270E+05	0.000E+00	2.870E+01
CE-144	6.770E+06	2.120E+06	0.000E+00	1.170E+06	1.200E+07	3.880E+05	0.000E+00	3.610E+05
PR-143	1.850E+04	5.550E+03	0.000E+00	3.000E+03	4.330E+05	9.730E+04	0.000E+00	9.140E+02
PR-144	5.960E-02	1.850E-02	0.000E+00	9.770E-03	1.570E+03	1.970E+02	0.000E+00	3.000E-03
ND-147	1.080E+04	8.730E+03	0.000E+00	4.810E+03	3.280E+05	8.210E+04	0.000E+00	6.810E+02
W-187	1.630E+01	9.660E+00	0.000E+00	0.000E+00	4.110E+04	9.100E+04	0.000E+00	4.330E+00
NP-239	4.660E+02	3.340E+01	0.000E+00	9.730E+01	5.810E+04	6.400E+04	0.000E+00	2.350E+01

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Ground Plane Deposition (GPD)			Units:	$m^2 \cdot mrem/yr$ / µCi/sec	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C-14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NA-24	1.190E+07	1.190E+07	1.190E+07	1.190E+07	1.190E+07	1.190E+07	1.390E+07	1.190E+07
P-32	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CR-51	4.660E+06	4.660E+06	4.660E+06	4.660E+06	4.660E+06	4.660E+06	5.510E+06	4.660E+06
MN-54	1.390E+09	1.390E+09	1.390E+09	1.390E+09	1.390E+09	1.390E+09	1.630E+09	1.390E+09
MN-56	9.020E+05	9.020E+05	9.020E+05	9.020E+05	9.020E+05	9.020E+05	1.070E+06	9.020E+05
FE-55	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
FE-59	2.730E+08	2.730E+08	2.730E+08	2.730E+08	2.730E+08	2.730E+08	3.210E+08	2.730E+08
CO-58	3.790E+08	3.790E+08	3.790E+08	3.790E+08	3.790E+08	3.790E+08	4.440E+08	3.790E+08
CO-60	2.150E+10	2.150E+10	2.150E+10	2.150E+10	2.150E+10	2.150E+10	2.530E+10	2.150E+10
NI-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NI-65	2.970E+05	2.970E+05	2.970E+05	2.970E+05	2.970E+05	2.970E+05	3.450E+05	2.970E+05
CU-64	6.070E+05	6.070E+05	6.070E+05	6.070E+05	6.070E+05	6.070E+05	6.880E+05	6.070E+05
ZN-65	7.470E+08	7.470E+08	7.470E+08	7.470E+08	7.470E+08	7.470E+08	8.590E+08	7.470E+08
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	4.870E+03	4.870E+03	4.870E+03	4.870E+03	4.870E+03	4.870E+03	7.080E+03	4.870E+03
BR-84	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.360E+05	2.030E+05
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	8.990E+06	8.990E+06	8.990E+06	8.990E+06	8.990E+06	8.990E+06	1.030E+07	8.990E+06
RB-88	3.310E+04	3.310E+04	3.310E+04	3.310E+04	3.310E+04	3.310E+04	3.780E+04	3.310E+04
RB-89	1.230E+05	1.230E+05	1.230E+05	1.230E+05	1.230E+05	1.230E+05	1.480E+05	1.230E+05
SR-89	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.510E+04	2.160E+04
SR-90	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-91	2.150E+06	2.150E+06	2.150E+06	2.150E+06	2.150E+06	2.150E+06	2.510E+06	2.150E+06

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Ground Plane Deposition (GPD)			Units:	$m^2 \cdot mrem/yr$ / $\mu Ci/sec$	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	7.770E+05	7.770E+05	7.770E+05	7.770E+05	7.770E+05	7.770E+05	8.630E+05	7.770E+05
Y-90	4.490E+03	4.490E+03	4.490E+03	4.490E+03	4.490E+03	4.490E+03	5.310E+03	4.490E+03
Y-91	1.070E+06	1.070E+06	1.070E+06	1.070E+06	1.070E+06	1.070E+06	1.210E+06	1.070E+06
Y-91M	1.000E+05	1.000E+05	1.000E+05	1.000E+05	1.000E+05	1.000E+05	1.160E+05	1.000E+05
Y-92	1.800E+05	1.800E+05	1.800E+05	1.800E+05	1.800E+05	1.800E+05	2.140E+05	1.800E+05
Y-93	1.830E+05	1.830E+05	1.830E+05	1.830E+05	1.830E+05	1.830E+05	2.510E+05	1.830E+05
ZR-95	2.450E+08	2.450E+08	2.450E+08	2.450E+08	2.450E+08	2.450E+08	2.840E+08	2.450E+08
ZR-97	2.960E+06	2.960E+06	2.960E+06	2.960E+06	2.960E+06	2.960E+06	3.440E+06	2.960E+06
NB-95	1.370E+08	1.370E+08	1.370E+08	1.370E+08	1.370E+08	1.370E+08	1.610E+08	1.370E+08
MO-99	3.990E+06	3.990E+06	3.990E+06	3.990E+06	3.990E+06	3.990E+06	4.630E+06	3.990E+06
TC-99M	1.840E+05	1.840E+05	1.840E+05	1.840E+05	1.840E+05	1.840E+05	2.110E+05	1.840E+05
TC-101	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.260E+04	2.040E+04
RU-103	1.080E+08	1.080E+08	1.080E+08	1.080E+08	1.080E+08	1.080E+08	1.260E+08	1.080E+08
RU-105	6.360E+05	6.360E+05	6.360E+05	6.360E+05	6.360E+05	6.360E+05	7.210E+05	6.360E+05
RU-106	4.220E+08	4.220E+08	4.220E+08	4.220E+08	4.220E+08	4.220E+08	5.070E+08	4.220E+08
AG-110M	3.440E+09	3.440E+09	3.440E+09	3.440E+09	3.440E+09	3.440E+09	4.010E+09	3.440E+09
TE-125M	1.550E+06	1.550E+06	1.550E+06	1.550E+06	1.550E+06	1.550E+06	2.130E+06	1.550E+06
TE-127	2.980E+03	2.980E+03	2.980E+03	2.980E+03	2.980E+03	2.980E+03	3.280E+03	2.980E+03
TE-127M	9.160E+04	9.160E+04	9.160E+04	9.160E+04	9.160E+04	9.160E+04	1.080E+05	9.160E+04
TE-129	2.620E+04	2.620E+04	2.620E+04	2.620E+04	2.620E+04	2.620E+04	3.100E+04	2.620E+04
TE-129M	1.980E+07	1.980E+07	1.980E+07	1.980E+07	1.980E+07	1.980E+07	2.310E+07	1.980E+07
TE-131	2.920E+04	2.920E+04	2.920E+04	2.920E+04	2.920E+04	2.920E+04	3.450E+07	2.920E+04
TE-131M	8.030E+06	8.030E+06	8.030E+06	8.030E+06	8.030E+06	8.030E+06	9.460E+06	8.030E+06
TE-132	4.230E+06	4.230E+06	4.230E+06	4.230E+06	4.230E+06	4.230E+06	4.980E+06	4.230E+06
I-130	5.510E+06	5.510E+06	5.510E+06	5.510E+06	5.510E+06	5.510E+06	6.690E+06	5.510E+06

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Ground Plane Deposition (GPD)			Units:	m²·mrem/yr / µCi/sec	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	1.720E+07	1.720E+07	1.720E+07	1.720E+07	1.720E+07	1.720E+07	2.090E+07	1.720E+07
I-132	1.250E+06	1.250E+06	1.250E+06	1.250E+06	1.250E+06	1.250E+06	1.470E+06	1.250E+06
I-133	2.450E+06	2.450E+06	2.450E+06	2.450E+06	2.450E+06	2.450E+06	2.980E+06	2.450E+06
I-134	4.470E+05	4.470E+05	4.470E+05	4.470E+05	4.470E+05	4.470E+05	5.300E+05	4.470E+05
I-135	2.530E+06	2.530E+06	2.530E+06	2.530E+06	2.530E+06	2.530E+06	2.950E+06	2.530E+06
CS-134	6.860E+09	6.860E+09	6.860E+09	6.860E+09	6.860E+09	6.860E+09	8.000E+09	6.860E+09
CS-136	1.510E+08	1.510E+08	1.510E+08	1.510E+08	1.510E+08	1.510E+08	1.710E+08	1.510E+08
CS-137	1.030E+10	1.030E+10	1.030E+10	1.030E+10	1.030E+10	1.030E+10	1.200E+10	1.030E+10
CS-138	3.590E+05	3.590E+05	3.590E+05	3.590E+05	3.590E+05	3.590E+05	4.100E+05	3.590E+05
BA-139	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.190E+05	1.060E+05
BA-140	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.350E+07	2.050E+07
BA-141	4.170E+04	4.170E+04	4.170E+04	4.170E+04	4.170E+04	4.170E+04	4.750E+04	4.170E+04
BA-142	4.490E+04	4.490E+04	4.490E+04	4.490E+04	4.490E+04	4.490E+04	5.110E+04	4.490E+04
LA-140	1.920E+07	1.920E+07	1.920E+07	1.920E+07	1.920E+07	1.920E+07	2.180E+07	1.920E+07
LA-142	7.600E+05	7.600E+05	7.600E+05	7.600E+05	7.600E+05	7.600E+05	9.120E+05	7.600E+05
CE-141	1.370E+07	1.370E+07	1.370E+07	1.370E+07	1.370E+07	1.370E+07	1.540E+07	1.370E+07
CE-143	2.310E+06	2.310E+06	2.310E+06	2.310E+06	2.310E+06	2.310E+06	2.630E+06	2.310E+06
CE-144	6.950E+07	6.950E+07	6.950E+07	6.950E+07	6.950E+07	6.950E+07	8.040E+07	6.950E+07
PR-143	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR-144	1.830E+03	1.830E+03	1.830E+03	1.830E+03	1.830E+03	1.830E+03	2.110E+03	1.830E+03
ND-147	8.390E+06	8.390E+06	8.390E+06	8.390E+06	8.390E+06	8.390E+06	1.010E+07	8.390E+06
W-187	2.350E+06	2.350E+06	2.350E+06	2.350E+06	2.350E+06	2.350E+06	2.730E+06	2.350E+06
NP-239	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.980E+06	1.710E+06

APPENDIX J

R_i Infant Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	INFANT	Pathway:	Grs/Cow/Milk (CMILK)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	2.380E+03	2.380E+03	2.380E+03	2.380E+03	2.380E+03	0.000E+00	2.380E+03
C-14	2.260E+05	4.820E+04	4.820E+04	4.820E+04	4.820E+04	4.820E+04	0.000E+00	4.820E+04
NA-24	1.540E+07	1.540E+07	1.540E+07	1.540E+07	1.540E+07	1.540E+07	0.000E+00	1.540E+07
P-32	1.600E+11	9.430E+09	0.000E+00	0.000E+00	0.000E+00	2.170E+09	0.000E+00	6.210E+09
CR-51	0.000E+00	0.000E+00	1.050E+05	2.300E+04	2.050E+05	4.700E+06	0.000E+00	1.610E+05
MN-54	0.000E+00	3.900E+07	0.000E+00	8.640E+06	0.000E+00	1.430E+07	0.000E+00	8.840E+06
MN-56	0.000E+00	3.100E-02	0.000E+00	2.660E-02	0.000E+00	2.810E+00	0.000E+00	5.340E-03
FE-55	1.350E+08	8.730E+07	0.000E+00	0.000E+00	4.270E+07	1.110E+07	0.000E+00	2.330E+07
FE-59	2.240E+08	3.920E+08	0.000E+00	0.000E+00	1.160E+08	1.870E+08	0.000E+00	1.540E+08
CO-58	0.000E+00	2.420E+07	0.000E+00	0.000E+00	0.000E+00	6.040E+07	0.000E+00	6.050E+07
CO-60	0.000E+00	8.820E+07	0.000E+00	0.000E+00	0.000E+00	2.100E+08	0.000E+00	2.080E+08
NI-63	3.490E+10	2.160E+09	0.000E+00	0.000E+00	0.000E+00	1.070E+08	0.000E+00	1.210E+09
NI-65	3.510E+00	3.970E-01	0.000E+00	0.000E+00	0.000E+00	3.020E+01	0.000E+00	1.800E-01
CU-64	0.000E+00	1.850E+05	0.000E+00	3.140E+05	0.000E+00	3.810E+06	0.000E+00	8.590E+04
ZN-65	5.550E+09	1.900E+10	0.000E+00	9.230E+09	0.000E+00	1.610E+10	0.000E+00	8.780E+09
ZN-69	2.020E-11	3.630E-11	0.000E+00	1.510E-11	0.000E+00	2.960E-09	0.000E+00	2.700E-12
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.340E-01
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.260E-22
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	2.230E+10	0.000E+00	0.000E+00	0.000E+00	5.690E+08	0.000E+00	1.100E+10
RB-88	0.000E+00	1.880E-44	0.000E+00	0.000E+00	0.000E+00	1.830E-44	0.000E+00	1.030E-44
RB-89	0.000E+00	3.290E-52	0.000E+00	0.000E+00	0.000E+00	1.120E-52	0.000E+00	2.260E-52
SR-89	1.260E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.590E+08	0.000E+00	3.610E+08
SR-90	1.220E+11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.520E+09	0.000E+00	3.100E+10
SR-91	2.720E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.220E+05	0.000E+00	9.830E+03

APPENDIX J

R_i Infant Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	INFANT	Pathway:	Grs/Cow/Milk (CMILK)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	4.640E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.000E+01	0.000E+00	1.720E-01
Y-90	6.810E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.410E+05	0.000E+00	1.830E+01
Y-91	7.330E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.250E+06	0.000E+00	1.950E+03
Y-91M	5.670E-19	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.890E-15	0.000E+00	1.930E-20
Y-92	5.380E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.030E+01	0.000E+00	1.510E-05
Y-93	2.160E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.700E+04	0.000E+00	5.870E-02
ZR-95	6.800E+03	1.660E+03	0.000E+00	1.790E+03	0.000E+00	8.260E+05	0.000E+00	1.180E+03
ZR-97	4.060E+00	6.970E-01	0.000E+00	7.030E-01	0.000E+00	4.450E+04	0.000E+00	3.180E-01
NB-95	5.930E+05	2.440E+05	0.000E+00	1.750E+05	0.000E+00	2.060E+08	0.000E+00	1.410E+05
MO-99	0.000E+00	2.080E+08	0.000E+00	3.110E+08	0.000E+00	6.850E+07	0.000E+00	4.060E+07
TC-99M	2.750E+01	5.670E+01	0.000E+00	6.100E+02	2.960E+01	1.650E+04	0.000E+00	7.300E+02
TC-101	2.470E-59	3.110E-59	0.000E+00	3.700E-58	1.700E-59	5.280E-57	0.000E+00	3.080E-58
RU-103	8.670E+03	0.000E+00	0.000E+00	1.800E+04	0.000E+00	1.050E+05	0.000E+00	2.900E+03
RU-105	8.050E-03	0.000E+00	0.000E+00	5.920E-02	0.000E+00	3.200E+00	0.000E+00	2.710E-03
RU-106	1.900E+05	0.000E+00	0.000E+00	2.250E+05	0.000E+00	1.440E+06	0.000E+00	2.380E+04
AG-110M	3.860E+08	2.820E+08	0.000E+00	4.030E+08	0.000E+00	1.460E+10	0.000E+00	1.860E+08
TE-125M	1.510E+08	5.040E+07	5.070E+07	0.000E+00	0.000E+00	7.180E+07	0.000E+00	2.040E+07
TE-127	6.320E+03	2.120E+03	5.140E+03	1.540E+04	0.000E+00	1.330E+05	0.000E+00	1.360E+03
TE-127M	4.210E+08	1.400E+08	1.220E+08	1.040E+09	0.000E+00	1.700E+08	0.000E+00	5.100E+07
TE-129	2.720E-09	9.380E-10	2.280E-09	6.770E-09	0.000E+00	2.170E-07	0.000E+00	6.350E-10
TE-129M	5.570E+08	1.910E+08	2.140E+08	1.390E+09	0.000E+00	3.330E+08	0.000E+00	8.580E+07
TE-131	3.430E-32	1.270E-32	3.060E-32	8.760E-32	0.000E+00	1.380E-30	0.000E+00	9.610E-33
TE-131M	3.380E+06	1.360E+06	2.750E+06	9.350E+06	0.000E+00	2.290E+07	0.000E+00	1.120E+06
TE-132	2.110E+07	1.040E+07	1.540E+07	6.530E+07	0.000E+00	3.870E+07	0.000E+00	9.750E+06
I-130	3.550E+06	7.810E+06	8.750E+08	8.580E+06	0.000E+00	1.670E+06	0.000E+00	3.130E+06

APPENDIX J

R_i Infant Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	INFANT	Pathway:	Grs/Cow/Milk (CMILK)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	2.720E+09	3.200E+09	1.050E+12	3.740E+09	0.000E+00	1.140E+08	0.000E+00	1.410E+09
I-132	1.430E+00	2.900E+00	1.360E+02	3.240E+00	0.000E+00	2.350E+00	0.000E+00	1.030E+00
I-133	3.630E+07	5.280E+07	9.600E+09	6.210E+07	0.000E+00	8.930E+06	0.000E+00	1.550E+07
I-134	1.760E-11	3.600E-11	8.400E-10	4.030E-11	0.000E+00	3.720E-11	0.000E+00	1.280E-11
I-135	1.120E+05	2.230E+05	2.000E+07	2.490E+05	0.000E+00	8.080E+04	0.000E+00	8.140E+04
CS-134	3.650E+10	6.800E+10	0.000E+00	1.750E+10	7.180E+09	1.850E+08	0.000E+00	6.870E+09
CS-136	1.980E+09	5.810E+09	0.000E+00	2.320E+09	4.740E+08	8.820E+07	0.000E+00	2.170E+09
CS-137	5.150E+10	6.020E+10	0.000E+00	1.620E+10	6.550E+09	1.880E+08	0.000E+00	4.270E+09
CS-138	8.390E-23	1.360E-22	0.000E+00	6.800E-23	1.060E-23	2.180E-22	0.000E+00	6.610E-23
BA-139	4.270E-07	2.830E-10	0.000E+00	1.700E-10	1.720E-10	2.710E-05	0.000E+00	1.240E-08
BA-140	2.410E+08	2.410E+05	0.000E+00	5.720E+04	1.480E+05	5.920E+07	0.000E+00	1.240E+07
BA-141	3.930E-45	2.690E-48	0.000E+00	1.620E-48	1.640E-48	4.800E-44	0.000E+00	1.240E-46
BA-142	2.430E-79	2.020E-82	0.000E+00	1.160E-82	1.220E-82	1.000E-78	0.000E+00	1.200E-80
LA-140	4.050E+01	1.600E+01	0.000E+00	0.000E+00	0.000E+00	1.880E+05	0.000E+00	4.110E+00
LA-142	1.700E-10	6.250E-11	0.000E+00	0.000E+00	0.000E+00	1.060E-05	0.000E+00	1.500E-11
CE-141	4.340E+04	2.640E+04	0.000E+00	8.150E+03	0.000E+00	1.370E+07	0.000E+00	3.110E+03
CE-143	3.970E+02	2.630E+05	0.000E+00	7.670E+01	0.000E+00	1.540E+06	0.000E+00	3.000E+01
CE-144	2.330E+06	9.520E+05	0.000E+00	3.850E+05	0.000E+00	1.330E+08	0.000E+00	1.300E+05
PR-143	1.490E+03	5.550E+02	0.000E+00	2.060E+02	0.000E+00	7.840E+05	0.000E+00	7.360E+01
PR-144	5.690E-53	2.200E-53	0.000E+00	7.980E-54	0.000E+00	1.020E-48	0.000E+00	2.870E-54
ND-147	8.810E+02	9.050E+02	0.000E+00	3.490E+02	0.000E+00	5.740E+05	0.000E+00	5.550E+01
W-187	6.080E+04	4.230E+04	0.000E+00	0.000E+00	0.000E+00	2.480E+06	0.000E+00	1.460E+04
NP-239	3.650E+01	3.260E+00	0.000E+00	6.510E+00	0.000E+00	9.430E+04	0.000E+00	1.840E+00

APPENDIX J

R_i Infant Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	INFANT	Pathway:	Grs/Goat/Milk (GMILK)			Units:	m^2·mrem/yr / µCi/sec; mrem/yr / µCi/m^3 (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	4.860E+03	4.860E+03	4.860E+03	4.860E+03	4.860E+03	0.000E+00	4.860E+03
C-14	2.260E+05	4.820E+04	4.820E+04	4.820E+04	4.820E+04	4.820E+04	0.000E+00	4.820E+04
NA-24	1.850E+06	1.850E+06	1.850E+06	1.850E+06	1.850E+06	1.850E+06	0.000E+00	1.850E+06
P-32	1.920E+11	1.130E+10	0.000E+00	0.000E+00	0.000E+00	2.600E+09	0.000E+00	7.460E+09
CR-51	0.000E+00	0.000E+00	1.260E+04	2.760E+03	2.460E+04	5.640E+05	0.000E+00	1.940E+04
MN-54	0.000E+00	4.680E+06	0.000E+00	1.040E+06	0.000E+00	1.720E+06	0.000E+00	1.060E+06
MN-56	0.000E+00	3.720E-03	0.000E+00	3.190E-03	0.000E+00	3.380E-01	0.000E+00	6.410E-04
FE-55	1.760E+06	1.130E+06	0.000E+00	0.000E+00	5.550E+05	1.440E+05	0.000E+00	3.030E+05
FE-59	2.920E+06	5.100E+06	0.000E+00	0.000E+00	1.510E+06	2.430E+06	0.000E+00	2.010E+06
CO-58	0.000E+00	2.910E+06	0.000E+00	0.000E+00	0.000E+00	7.250E+06	0.000E+00	7.260E+06
CO-60	0.000E+00	1.060E+07	0.000E+00	0.000E+00	0.000E+00	2.520E+07	0.000E+00	2.500E+07
NI-63	4.190E+09	2.590E+08	0.000E+00	0.000E+00	0.000E+00	1.290E+07	0.000E+00	1.450E+08
NI-65	4.210E-01	4.760E-02	0.000E+00	0.000E+00	0.000E+00	3.620E+00	0.000E+00	2.170E-02
CU-64	0.000E+00	2.070E+04	0.000E+00	3.500E+04	0.000E+00	4.240E+05	0.000E+00	9.570E+03
ZN-65	6.660E+08	2.280E+09	0.000E+00	1.110E+09	0.000E+00	1.930E+09	0.000E+00	1.050E+09
ZN-69	2.420E-12	4.360E-12	0.000E+00	1.810E-12	0.000E+00	3.550E-10	0.000E+00	3.240E-13
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.120E-01
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.510E-23
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	0.000E+00	2.670E+09	0.000E+00	0.000E+00	0.000E+00	6.830E+07	0.000E+00	1.320E+09
RB-88	0.000E+00	2.250E-45	0.000E+00	0.000E+00	0.000E+00	2.190E-45	0.000E+00	1.230E-45
RB-89	0.000E+00	3.940E-53	0.000E+00	0.000E+00	0.000E+00	1.340E-53	0.000E+00	2.720E-53
SR-89	2.640E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.430E+08	0.000E+00	7.580E+08
SR-90	2.550E+11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.190E+09	0.000E+00	6.500E+10
SR-91	5.700E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.750E+05	0.000E+00	2.060E+04

APPENDIX J

R_i Infant Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	INFANT	Pathway:	Grs/Goat/Milk (GMILK)			Units:	m^2·mrem/yr / µCi/sec; mrem/yr / µCi/m^3 (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	9.750E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.050E+02	0.000E+00	3.620E-01
Y-90	8.170E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.130E+05	0.000E+00	2.190E+00
Y-91	8.790E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.300E+05	0.000E+00	2.340E+02
Y-91M	6.810E-20	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.270E-16	0.000E+00	2.320E-21
Y-92	6.450E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.230E+00	0.000E+00	1.810E-06
Y-93	2.590E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.040E+03	0.000E+00	7.050E-03
ZR-95	8.170E+02	1.990E+02	0.000E+00	2.140E+02	0.000E+00	9.910E+04	0.000E+00	1.410E+02
ZR-97	4.870E-01	8.360E-02	0.000E+00	8.430E-02	0.000E+00	5.340E+03	0.000E+00	3.820E-02
NB-95	7.120E+04	2.930E+04	0.000E+00	2.100E+04	0.000E+00	2.480E+07	0.000E+00	1.700E+04
MO-99	0.000E+00	2.500E+07	0.000E+00	3.730E+07	0.000E+00	8.220E+06	0.000E+00	4.870E+06
TC-99M	3.300E+00	6.800E+00	0.000E+00	7.320E+01	3.550E+00	1.970E+03	0.000E+00	8.760E+01
TC-101	2.960E-60	3.730E-60	0.000E+00	4.440E-59	2.030E-60	6.340E-58	0.000E+00	3.690E-59
RU-103	1.040E+03	0.000E+00	0.000E+00	2.170E+03	0.000E+00	1.270E+04	0.000E+00	3.480E+02
RU-105	9.660E-04	0.000E+00	0.000E+00	7.110E-03	0.000E+00	3.840E-01	0.000E+00	3.250E-04
RU-106	2.280E+04	0.000E+00	0.000E+00	2.700E+04	0.000E+00	1.730E+05	0.000E+00	2.850E+03
AG-110M	4.630E+07	3.380E+07	0.000E+00	4.830E+07	0.000E+00	1.750E+09	0.000E+00	2.240E+07
TE-125M	1.810E+07	6.050E+06	6.090E+06	0.000E+00	0.000E+00	8.620E+06	0.000E+00	2.450E+06
TE-127	7.580E+02	2.540E+02	6.170E+02	1.850E+03	0.000E+00	1.590E+04	0.000E+00	1.630E+02
TE-127M	5.050E+07	1.680E+07	1.460E+07	1.240E+08	0.000E+00	2.040E+07	0.000E+00	6.120E+06
TE-129	3.260E-10	1.130E-10	2.740E-10	8.130E-10	0.000E+00	2.610E-08	0.000E+00	7.620E-11
TE-129M	6.690E+07	2.290E+07	2.570E+07	1.670E+08	0.000E+00	3.990E+07	0.000E+00	1.030E+07
TE-131	4.110E-33	1.520E-33	3.670E-33	1.050E-32	0.000E+00	1.660E-31	0.000E+00	1.150E-33
TE-131M	4.050E+05	1.630E+05	3.310E+05	1.120E+06	0.000E+00	2.750E+06	0.000E+00	1.350E+05
TE-132	2.530E+06	1.250E+06	1.850E+06	7.840E+06	0.000E+00	4.640E+06	0.000E+00	1.170E+06
I-130	4.260E+06	9.370E+06	1.050E+09	1.030E+07	0.000E+00	2.010E+06	0.000E+00	3.760E+06

APPENDIX J

R_i Infant Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	INFANT	Pathway:	Grs/Goat/Milk (GMILK)			Units:	m²·mrem/yr / µCi/sec; mrem/yr / µCi/m³ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	3.260E+09	3.850E+09	1.260E+12	4.490E+09	0.000E+00	1.370E+08	0.000E+00	1.690E+09
I-132	1.720E+00	3.480E+00	1.630E+02	3.890E+00	0.000E+00	2.820E+00	0.000E+00	1.240E+00
I-133	4.350E+07	6.340E+07	1.150E+10	7.450E+07	0.000E+00	1.070E+07	0.000E+00	1.860E+07
I-134	2.110E-11	4.320E-11	1.010E-09	4.830E-11	0.000E+00	4.470E-11	0.000E+00	1.540E-11
I-135	1.350E+05	2.680E+05	2.400E+07	2.990E+05	0.000E+00	9.700E+04	0.000E+00	9.770E+04
CS-134	1.090E+11	2.040E+11	0.000E+00	5.250E+10	2.150E+10	5.540E+08	0.000E+00	2.060E+10
CS-136	5.930E+09	1.740E+10	0.000E+00	6.950E+09	1.420E+09	2.650E+08	0.000E+00	6.510E+09
CS-137	1.540E+11	1.810E+11	0.000E+00	4.850E+10	1.960E+10	5.650E+08	0.000E+00	1.280E+10
CS-138	2.520E-22	4.090E-22	0.000E+00	2.040E-22	3.190E-23	6.540E-22	0.000E+00	1.980E-22
BA-139	5.130E-08	3.400E-11	0.000E+00	2.040E-11	2.060E-11	3.250E-06	0.000E+00	1.480E-09
BA-140	2.890E+07	2.890E+04	0.000E+00	6.870E+03	1.780E+04	7.100E+06	0.000E+00	1.490E+06
BA-141	4.720E-46	3.230E-49	0.000E+00	1.940E-49	1.960E-49	5.760E-45	0.000E+00	1.490E-47
BA-142	2.920E-80	2.430E-83	0.000E+00	1.400E-83	1.470E-83	1.200E-79	0.000E+00	1.440E-81
LA-140	4.860E+00	1.920E+00	0.000E+00	0.000E+00	0.000E+00	2.250E+04	0.000E+00	4.930E-01
LA-142	2.040E-11	7.500E-12	0.000E+00	0.000E+00	0.000E+00	1.270E-06	0.000E+00	1.790E-12
CE-141	5.200E+03	3.170E+03	0.000E+00	9.790E+02	0.000E+00	1.640E+06	0.000E+00	3.740E+02
CE-143	4.760E+01	3.160E+04	0.000E+00	9.200E+00	0.000E+00	1.840E+05	0.000E+00	3.600E+00
CE-144	2.790E+05	1.140E+05	0.000E+00	4.620E+04	0.000E+00	1.600E+07	0.000E+00	1.560E+04
PR-143	1.780E+02	6.670E+01	0.000E+00	2.480E+01	0.000E+00	9.410E+04	0.000E+00	8.840E+00
PR-144	6.830E-54	2.640E-54	0.000E+00	9.570E-55	0.000E+00	1.230E-49	0.000E+00	3.440E-55
ND-147	1.060E+02	1.090E+02	0.000E+00	4.190E+01	0.000E+00	6.880E+04	0.000E+00	6.650E+00
W-187	7.300E+03	5.070E+03	0.000E+00	0.000E+00	0.000E+00	2.980E+05	0.000E+00	1.750E+03
NP-239	4.380E+00	3.910E-01	0.000E+00	7.810E-01	0.000E+00	1.130E+04	0.000E+00	2.210E-01

APPENDIX J

R_i Infant Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	INFANT	Pathway:	Inhalation (INHL)			Units:	mrem/yr / µCi/m^3	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	6.470E+02	6.470E+02	6.470E+02	6.470E+02	6.470E+02	0.000E+00	6.470E+02
C-14	2.650E+04	5.310E+03	5.310E+03	5.310E+03	5.310E+03	5.310E+03	0.000E+00	5.310E+03
NA-24	1.060E+04	1.060E+04	1.060E+04	1.060E+04	1.060E+04	1.060E+04	0.000E+00	1.060E+04
P-32	2.030E+06	1.120E+05	0.000E+00	0.000E+00	0.000E+00	1.610E+04	0.000E+00	7.740E+04
CR-51	0.000E+00	0.000E+00	5.750E+01	1.320E+01	1.280E+04	3.570E+02	0.000E+00	8.950E+01
MN-54	0.000E+00	2.530E+04	0.000E+00	4.980E+03	1.000E+06	7.060E+03	0.000E+00	4.980E+03
MN-56	0.000E+00	1.540E+00	0.000E+00	1.100E+00	1.250E+04	7.170E+04	0.000E+00	2.210E-01
FE-55	1.970E+04	1.170E+04	0.000E+00	0.000E+00	8.690E+04	1.090E+03	0.000E+00	3.330E+03
FE-59	1.360E+04	2.350E+04	0.000E+00	0.000E+00	1.010E+06	2.480E+04	0.000E+00	9.480E+03
CO-58	0.000E+00	1.220E+03	0.000E+00	0.000E+00	7.770E+05	1.110E+04	0.000E+00	1.820E+03
CO-60	0.000E+00	8.020E+03	0.000E+00	0.000E+00	4.510E+06	3.190E+04	0.000E+00	1.180E+04
NI-63	3.390E+05	2.040E+04	0.000E+00	0.000E+00	2.090E+05	2.420E+03	0.000E+00	1.160E+04
NI-65	2.390E+00	2.840E-01	0.000E+00	0.000E+00	8.120E+03	5.010E+04	0.000E+00	1.230E-01
CU-64	0.000E+00	1.880E+00	0.000E+00	3.980E+00	9.300E+03	1.500E+04	0.000E+00	7.740E-01
ZN-65	1.930E+04	6.260E+04	0.000E+00	3.250E+04	6.470E+05	5.140E+04	0.000E+00	3.110E+04
ZN-69	5.390E-02	9.670E-02	0.000E+00	4.020E-02	1.470E+03	1.320E+04	0.000E+00	7.180E-03
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.810E+02
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.000E+02
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.040E+01
RB-86	0.000E+00	1.900E+05	0.000E+00	0.000E+00	0.000E+00	3.040E+03	0.000E+00	8.820E+04
RB-88	0.000E+00	5.570E+02	0.000E+00	0.000E+00	0.000E+00	3.390E+02	0.000E+00	2.870E+02
RB-89	0.000E+00	3.210E+02	0.000E+00	0.000E+00	0.000E+00	6.820E+01	0.000E+00	2.060E+02
SR-89	3.980E+05	0.000E+00	0.000E+00	0.000E+00	2.030E+06	6.400E+04	0.000E+00	1.140E+04
SR-90	4.090E+07	0.000E+00	0.000E+00	0.000E+00	1.120E+07	1.310E+05	0.000E+00	2.590E+06
SR-91	9.560E+01	0.000E+00	0.000E+00	0.000E+00	5.260E+04	7.340E+04	0.000E+00	3.460E+00

APPENDIX J

R_i Infant Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	INFANT	Pathway:	Inhalation (INHL)			Units:	mrem/yr / µCi/m^3	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	1.050E+01	0.000E+00	0.000E+00	0.000E+00	2.380E+04	1.400E+05	0.000E+00	3.910E-01
Y-90	3.290E+03	0.000E+00	0.000E+00	0.000E+00	2.690E+05	1.040E+05	0.000E+00	8.820E+01
Y-91	5.880E+05	0.000E+00	0.000E+00	0.000E+00	2.450E+06	7.030E+04	0.000E+00	1.570E+04
Y-91M	4.070E-01	0.000E+00	0.000E+00	0.000E+00	2.790E+03	2.350E+03	0.000E+00	1.390E-02
Y-92	1.640E+01	0.000E+00	0.000E+00	0.000E+00	2.450E+04	1.270E+05	0.000E+00	4.610E-01
Y-93	1.500E+02	0.000E+00	0.000E+00	0.000E+00	7.640E+04	1.670E+05	0.000E+00	4.070E+00
ZR-95	1.150E+05	2.790E+04	0.000E+00	3.110E+04	1.750E+06	2.170E+04	0.000E+00	2.030E+04
ZR-97	1.500E+02	2.560E+01	0.000E+00	2.590E+01	1.100E+05	1.400E+05	0.000E+00	1.170E+01
NB-95	1.570E+04	6.430E+03	0.000E+00	4.720E+03	4.790E+05	1.270E+04	0.000E+00	3.780E+03
MO-99	0.000E+00	1.650E+02	0.000E+00	2.650E+02	1.350E+05	4.870E+04	0.000E+00	3.230E+01
TC-99M	1.400E-03	2.880E-03	0.000E+00	3.110E-02	8.110E+02	2.030E+03	0.000E+00	3.720E-02
TC-101	6.510E-05	8.230E-05	0.000E+00	9.790E-04	5.840E+02	8.440E+02	0.000E+00	8.120E-04
RU-103	2.020E+03	0.000E+00	0.000E+00	4.240E+03	5.520E+05	1.610E+04	0.000E+00	6.790E+02
RU-105	1.220E+00	0.000E+00	0.000E+00	8.990E-01	1.570E+04	4.840E+04	0.000E+00	4.100E-01
RU-106	8.680E+04	0.000E+00	0.000E+00	1.070E+05	1.160E+07	1.640E+05	0.000E+00	1.090E+04
AG-110M	9.980E+03	7.220E+03	0.000E+00	1.090E+04	3.670E+06	3.300E+04	0.000E+00	5.000E+03
TE-125M	4.760E+03	1.990E+03	1.620E+03	0.000E+00	4.470E+05	1.290E+04	0.000E+00	6.580E+02
TE-127	2.230E+00	9.530E-01	1.850E+00	4.860E+00	1.030E+04	2.440E+04	0.000E+00	4.890E-01
TE-127M	1.670E+04	6.900E+03	4.870E+03	3.750E+04	1.310E+06	2.730E+04	0.000E+00	2.070E+03
TE-129	7.880E-02	3.470E-02	6.750E-02	1.750E-01	3.000E+03	2.630E+04	0.000E+00	1.880E-02
TE-129M	1.410E+04	6.090E+03	5.470E+03	3.180E+04	1.680E+06	6.900E+04	0.000E+00	2.230E+03
TE-131	1.740E-02	8.220E-03	1.580E-02	3.990E-02	2.060E+03	8.220E+03	0.000E+00	5.000E-03
TE-131M	1.070E+02	5.500E+01	8.930E+01	2.650E+02	1.990E+05	1.190E+05	0.000E+00	3.630E+01
TE-132	3.720E+02	2.370E+02	2.790E+02	1.030E+03	3.400E+05	4.410E+04	0.000E+00	1.760E+02
I-130	6.360E+03	1.390E+04	1.600E+06	1.530E+04	0.000E+00	1.990E+03	0.000E+00	5.570E+03

APPENDIX J

R_i Infant Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	INFANT	Pathway:	Inhalation (INHL)			Units:	mrem/yr / µCi/m^3	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	3.790E+04	4.440E+04	1.480E+07	5.180E+04	0.000E+00	1.060E+03	0.000E+00	1.960E+04
I-132	1.690E+03	3.540E+03	1.690E+05	3.950E+03	0.000E+00	1.900E+03	0.000E+00	1.260E+03
I-133	1.320E+04	1.920E+04	3.560E+06	2.240E+04	0.000E+00	2.160E+03	0.000E+00	5.600E+03
I-134	9.210E+02	1.880E+03	4.450E+04	2.090E+03	0.000E+00	1.290E+03	0.000E+00	6.650E+02
I-135	3.860E+03	7.600E+03	6.960E+05	8.470E+03	0.000E+00	1.830E+03	0.000E+00	2.770E+03
CS-134	3.960E+05	7.030E+05	0.000E+00	1.900E+05	7.970E+04	1.330E+03	0.000E+00	7.450E+04
CS-136	4.830E+04	1.350E+05	0.000E+00	5.640E+04	1.180E+04	1.430E+03	0.000E+00	5.290E+04
CS-137	5.490E+05	6.120E+05	0.000E+00	1.720E+05	7.130E+04	1.330E+03	0.000E+00	4.550E+04
CS-138	5.050E+02	7.810E+02	0.000E+00	4.100E+02	6.540E+01	8.760E+02	0.000E+00	3.980E+02
BA-139	1.480E+00	9.840E-04	0.000E+00	5.920E-04	5.950E+03	5.100E+04	0.000E+00	4.300E-02
BA-140	5.600E+04	5.600E+01	0.000E+00	1.340E+01	1.600E+06	3.840E+04	0.000E+00	2.900E+03
BA-141	1.570E-01	1.080E-04	0.000E+00	6.500E-05	2.970E+03	4.750E+03	0.000E+00	4.970E-03
BA-142	3.980E-02	3.300E-05	0.000E+00	1.900E-05	1.550E+03	6.930E+02	0.000E+00	1.960E-03
LA-140	5.050E+02	2.000E+02	0.000E+00	0.000E+00	1.680E+05	8.480E+04	0.000E+00	5.150E+01
LA-142	1.030E+00	3.770E-01	0.000E+00	0.000E+00	8.220E+03	5.950E+04	0.000E+00	9.040E-02
CE-141	2.770E+04	1.670E+04	0.000E+00	5.250E+03	5.170E+05	2.160E+04	0.000E+00	1.990E+03
CE-143	2.930E+02	1.930E+02	0.000E+00	5.640E+01	1.160E+05	4.970E+04	0.000E+00	2.210E+01
CE-144	3.190E+06	1.210E+06	0.000E+00	5.380E+05	9.840E+06	1.480E+05	0.000E+00	1.760E+05
PR-143	1.400E+04	5.240E+03	0.000E+00	1.970E+03	4.330E+05	3.720E+04	0.000E+00	6.990E+02
PR-144	4.790E-02	1.850E-02	0.000E+00	6.720E-03	1.610E+03	4.280E+03	0.000E+00	2.410E-03
ND-147	7.940E+03	8.130E+03	0.000E+00	3.150E+03	3.220E+05	3.120E+04	0.000E+00	5.000E+02
W-187	1.300E+01	9.020E+00	0.000E+00	0.000E+00	3.960E+04	3.560E+04	0.000E+00	3.120E+00
NP-239	3.710E+02	3.320E+01	0.000E+00	6.620E+01	5.950E+04	2.490E+04	0.000E+00	1.880E+01

APPENDIX J

R_i Infant Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	INFANT	Pathway:	Ground Plane Deposition (GPD)			Units:	m^2·mrem/yr / µCi/sec	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C-14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NA-24	1.190E+07	1.190E+07	1.190E+07	1.190E+07	1.190E+07	1.190E+07	1.390E+07	1.190E+07
P-32	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CR-51	4.660E+06	4.660E+06	4.660E+06	4.660E+06	4.660E+06	4.660E+06	5.510E+06	4.660E+06
MN-54	1.390E+09	1.390E+09	1.390E+09	1.390E+09	1.390E+09	1.390E+09	1.630E+09	1.390E+09
MN-56	9.020E+05	9.020E+05	9.020E+05	9.020E+05	9.020E+05	9.020E+05	1.070E+06	9.020E+05
FE-55	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
FE-59	2.730E+08	2.730E+08	2.730E+08	2.730E+08	2.730E+08	2.730E+08	3.210E+08	2.730E+08
CO-58	3.790E+08	3.790E+08	3.790E+08	3.790E+08	3.790E+08	3.790E+08	4.440E+08	3.790E+08
CO-60	2.150E+10	2.150E+10	2.150E+10	2.150E+10	2.150E+10	2.150E+10	2.530E+10	2.150E+10
NI-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NI-65	2.970E+05	2.970E+05	2.970E+05	2.970E+05	2.970E+05	2.970E+05	3.450E+05	2.970E+05
CU-64	6.070E+05	6.070E+05	6.070E+05	6.070E+05	6.070E+05	6.070E+05	6.880E+05	6.070E+05
ZN-65	7.470E+08	7.470E+08	7.470E+08	7.470E+08	7.470E+08	7.470E+08	8.590E+08	7.470E+08
ZN-69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR-83	4.870E+03	4.870E+03	4.870E+03	4.870E+03	4.870E+03	4.870E+03	7.080E+03	4.870E+03
BR-84	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.030E+05	2.360E+05	2.030E+05
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB-86	8.990E+06	8.990E+06	8.990E+06	8.990E+06	8.990E+06	8.990E+06	1.030E+07	8.990E+06
RB-88	3.310E+04	3.310E+04	3.310E+04	3.310E+04	3.310E+04	3.310E+04	3.780E+04	3.310E+04
RB-89	1.230E+05	1.230E+05	1.230E+05	1.230E+05	1.230E+05	1.230E+05	1.480E+05	1.230E+05
SR-89	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.160E+04	2.510E+04	2.160E+04
SR-90	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-91	2.150E+06	2.150E+06	2.150E+06	2.150E+06	2.150E+06	2.150E+06	2.510E+06	2.150E+06

APPENDIX J

R_i Infant Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	INFANT	Pathway:	Ground Plane Deposition (GPD)			Units:	m²·mrem/yr / µCi/sec	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	7.770E+05	7.770E+05	7.770E+05	7.770E+05	7.770E+05	7.770E+05	8.630E+05	7.770E+05
Y-90	4.490E+03	4.490E+03	4.490E+03	4.490E+03	4.490E+03	4.490E+03	5.310E+03	4.490E+03
Y-91	1.070E+06	1.070E+06	1.070E+06	1.070E+06	1.070E+06	1.070E+06	1.210E+06	1.070E+06
Y-91M	1.000E+05	1.000E+05	1.000E+05	1.000E+05	1.000E+05	1.000E+05	1.160E+05	1.000E+05
Y-92	1.800E+05	1.800E+05	1.800E+05	1.800E+05	1.800E+05	1.800E+05	2.140E+05	1.800E+05
Y-93	1.830E+05	1.830E+05	1.830E+05	1.830E+05	1.830E+05	1.830E+05	2.510E+05	1.830E+05
ZR-95	2.450E+08	2.450E+08	2.450E+08	2.450E+08	2.450E+08	2.450E+08	2.840E+08	2.450E+08
ZR-97	2.960E+06	2.960E+06	2.960E+06	2.960E+06	2.960E+06	2.960E+06	3.440E+06	2.960E+06
NB-95	1.370E+08	1.370E+08	1.370E+08	1.370E+08	1.370E+08	1.370E+08	1.610E+08	1.370E+08
MO-99	3.990E+06	3.990E+06	3.990E+06	3.990E+06	3.990E+06	3.990E+06	4.630E+06	3.990E+06
TC-99M	1.840E+05	1.840E+05	1.840E+05	1.840E+05	1.840E+05	1.840E+05	2.110E+05	1.840E+05
TC-101	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.260E+04	2.040E+04
RU-103	1.080E+08	1.080E+08	1.080E+08	1.080E+08	1.080E+08	1.080E+08	1.260E+08	1.080E+08
RU-105	6.360E+05	6.360E+05	6.360E+05	6.360E+05	6.360E+05	6.360E+05	7.210E+05	6.360E+05
RU-106	4.220E+08	4.220E+08	4.220E+08	4.220E+08	4.220E+08	4.220E+08	5.070E+08	4.220E+08
AG-110M	3.440E+09	3.440E+09	3.440E+09	3.440E+09	3.440E+09	3.440E+09	4.010E+09	3.440E+09
TE-125M	1.550E+06	1.550E+06	1.550E+06	1.550E+06	1.550E+06	1.550E+06	2.130E+06	1.550E+06
TE-127	2.980E+03	2.980E+03	2.980E+03	2.980E+03	2.980E+03	2.980E+03	3.280E+03	2.980E+03
TE-127M	9.160E+04	9.160E+04	9.160E+04	9.160E+04	9.160E+04	9.160E+04	1.080E+05	9.160E+04
TE-129	2.620E+04	2.620E+04	2.620E+04	2.620E+04	2.620E+04	2.620E+04	3.100E+04	2.620E+04
TE-129M	1.980E+07	1.980E+07	1.980E+07	1.980E+07	1.980E+07	1.980E+07	2.310E+07	1.980E+07
TE-131	2.920E+04	2.920E+04	2.920E+04	2.920E+04	2.920E+04	2.920E+04	3.450E+07	2.920E+04
TE-131M	8.030E+06	8.030E+06	8.030E+06	8.030E+06	8.030E+06	8.030E+06	9.460E+06	8.030E+06
TE-132	4.230E+06	4.230E+06	4.230E+06	4.230E+06	4.230E+06	4.230E+06	4.980E+06	4.230E+06
I-130	5.510E+06	5.510E+06	5.510E+06	5.510E+06	5.510E+06	5.510E+06	6.690E+06	5.510E+06

APPENDIX J

R_i Infant Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	**INFANT**	**Pathway:**	**Ground Plane Deposition (GPD)**			**Units:**	**m²·mrem/yr / µCi/sec**	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	1.720E+07	1.720E+07	1.720E+07	1.720E+07	1.720E+07	1.720E+07	2.090E+07	1.720E+07
I-132	1.250E+06	1.250E+06	1.250E+06	1.250E+06	1.250E+06	1.250E+06	1.470E+06	1.250E+06
I-133	2.450E+06	2.450E+06	2.450E+06	2.450E+06	2.450E+06	2.450E+06	2.980E+06	2.450E+06
I-134	4.470E+05	4.470E+05	4.470E+05	4.470E+05	4.470E+05	4.470E+05	5.300E+05	4.470E+05
I-135	2.530E+06	2.530E+06	2.530E+06	2.530E+06	2.530E+06	2.530E+06	2.950E+06	2.530E+06
CS-134	6.860E+09	6.860E+09	6.860E+09	6.860E+09	6.860E+09	6.860E+09	8.000E+09	6.860E+09
CS-136	1.510E+08	1.510E+08	1.510E+08	1.510E+08	1.510E+08	1.510E+08	1.710E+08	1.510E+08
CS-137	1.030E+10	1.030E+10	1.030E+10	1.030E+10	1.030E+10	1.030E+10	1.200E+10	1.030E+10
CS-138	3.590E+05	3.590E+05	3.590E+05	3.590E+05	3.590E+05	3.590E+05	4.100E+05	3.590E+05
BA-139	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.190E+05	1.060E+05
BA-140	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.350E+07	2.050E+07
BA-141	4.170E+04	4.170E+04	4.170E+04	4.170E+04	4.170E+04	4.170E+04	4.750E+04	4.170E+04
BA-142	4.490E+04	4.490E+04	4.490E+04	4.490E+04	4.490E+04	4.490E+04	5.110E+04	4.490E+04
LA-140	1.920E+07	1.920E+07	1.920E+07	1.920E+07	1.920E+07	1.920E+07	2.180E+07	1.920E+07
LA-142	7.600E+05	7.600E+05	7.600E+05	7.600E+05	7.600E+05	7.600E+05	9.120E+05	7.600E+05
CE-141	1.370E+07	1.370E+07	1.370E+07	1.370E+07	1.370E+07	1.370E+07	1.540E+07	1.370E+07
CE-143	2.310E+06	2.310E+06	2.310E+06	2.310E+06	2.310E+06	2.310E+06	2.630E+06	2.310E+06
CE-144	6.950E+07	6.950E+07	6.950E+07	6.950E+07	6.950E+07	6.950E+07	8.040E+07	6.950E+07
PR-143	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR-144	1.830E+03	1.830E+03	1.830E+03	1.830E+03	1.830E+03	1.830E+03	2.110E+03	1.830E+03
ND-147	8.390E+06	8.390E+06	8.390E+06	8.390E+06	8.390E+06	8.390E+06	1.010E+07	8.390E+06
W-187	2.350E+06	2.350E+06	2.350E+06	2.350E+06	2.350E+06	2.350E+06	2.730E+06	2.350E+06
NP-239	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.980E+06	1.710E+06

Oconee Nuclear Station
Selected Licensee Commitments Revised 10/26/2022

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16.7.18	001	04/26/22
16.8.1	000	08/09/01
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16.8.3	002	06/29/22
16.8.4	001	12/19/19
16.8.5	000	05/21/15
16.8.6	001	02/27/20
16.8.7	000	01/31/00
16.8.8	000	01/31/00
16.8.9	000	06/21/05
16.9.1	002	04/04/22
16.9.2	002	08/16/16
16.9.3	---	Deleted 01/08/18
16.9.4	003	07/17/18
16.9.5	003	03/02/21
16.9.6	009	10/26/22
16.9.7	002	02/24/21
16.9.8	---	Deleted 09/26/18
16.9.8a	001	08/11/20
16.9.9	003	09/07/22

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16.11.9	000	03/22/10
16.11.10	000	05/14/14
16.11.11	001	12/19/19
16.11.12	000	04/10/03
16.11.13	000	03/27/99
16.11.14	000	03/27/99
16.12.1	000	03/27/99
16.12.2	000	05/03/07
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16.13.6	001	08/02/22
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16.14.1	000	11/15/12
16.14.2	000	07/23/12
16.14.3	000	03/27/99
16.14.4	---	Deleted 03/15/11
16.14.4.a	000	03/15/11
16.15.1	000	04/12/06
16.15.2	000	11/15/12
16.15.3	000	11/15/12

Note: With the introduction of Fusion in June 2015, all controlled documents require a three-digit revision number. Thus, the revision numbers were set to “000” in the summer of 2015. As such, the revision dates for Revision 000 are based on the implementation dates for revisions in effect prior to this change.

16.11 RADIOLOGICAL EFFLUENTS CONTROL

16.11.1 Radioactive Liquid Effluents

COMMITMENT Establish conditions for the controlled release of radioactive liquid effluents. Implement the requirements of 10 CFR 20, 10 CFR 50.36a, Appendix A to 10 CFR 50, Appendix I to 10 CFR 50, 40 CFR 141 and 40 CFR 190.

a. Concentration

The concentration of radioactive material released at anytime from the site boundary for liquid effluents to Unrestricted Areas [denoted in Figure 2-5 of the Oconee Nuclear Station Updated Final Safety Analysis Report] shall be limited to 10 times the effluent concentrations specified in 10 CFR Part 20, Appendix B, Table 2, Column 2 for radionuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases the concentration shall be limited to 2 x $l0^{-4}$ μCi/ml total activity.

b. Dose

The dose or dose commitment to a Member Of The Public from radioactive materials in liquid effluents to Unrestricted Areas shall be limited to:

1. during any calendar quarter:

   $\leq$ 4.5 mrem to the total body

   $\leq$ 15 mrem to any organ; and

2. during any calendar year:

   $\leq$ 9 mrem to the total body

   $\leq$ 30 mrem to any organ.

c. Liquid Waste Treatment

The appropriate subsystems of the liquid radwaste treatment system shall be used to reduce the radioactive materials in liquid waste prior to their discharge, if the projected dose due to liquid effluent releases to unrestricted areas, when averaged over 31 days would exceed 0.18 mrem to the total body or 0.6 mrem to any organ.

---------------------------------NOTE--
Appendix I dose limits for radioactive liquid effluent releases are applicable only during normal operating conditions which include expected operational occurrences, and are not applicable during unusual operating conditions that result in activation of the Oconee Emergency Plan.

APPLICABILITY: At all times

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Concentration of radioactive material released in liquid effluents to Unrestricted Areas exceeds the limits specified in Commitment a.	A.1 Restore concentration to within the limit.	Immediately

CONDITION	REQUIRED ACTION	COMPLETION TIME
B. Calculated dose from the release of radioactive materials in liquid effluents exceeds any of the limits in Commitment b.	B.1 -------------NOTE-------------- Not required during unusual operating conditions that result in activation of the Oconee Emergency Plan. ----------------------------------	
	Submit report to the regional NRC Office which includes the following:	30 days from the end of the quarter during which the release occurred
	a. Cause(s) for exceeding the limit(s).	
	b. A description of the program of corrective action initiated to: reduce the releases of radioactive materials in liquid effluents, and to keep these levels of radioactive materials in liquid effluents in compliance with the above limits, or as low as reasonably achievable.	
	c. Results of radiological analyses of the drinking water source and the radiological impact on finished drinking water supplies with regard to the requirements of 40 CFR 141.	

CONDITION	REQUIRED ACTION	COMPLETION TIME
C. Radioactive liquid waste is discharged without treatment and in excess of the specified limit.	C.1 Submit report to the regional NRC Office which includes the following: a. Cause of equipment or subsystem inoperability. b. Corrective action to restore equipment and prevent recurrence.	30 days

SURVEILLANCE REQUIREMENTS

SURVEILLANCE	FREQUENCY
SR 16.11.1.1 N/A	N/A

BASES

The concentration commitment is provided to ensure that the concentration of radioactive materials released in liquid waste effluents from the site to unrestricted areas will be less than 10 times the effluent concentration levels specified in 10 CFR Part 20, Appendix B, Table 2, Column 2. The concentration limit for noble gases is based upon the assumption that Xe-135 is the controlling radioisotope and its EC in air (submersion) was converted to an equivalent concentration in water using the methods described in International Commission on Radiological Protection (ICRP) Publication 2.

The basic requirements for Selected Licensee Commitments concerning effluent from nuclear power reactors are stated in 10 CFR 50.36a. Compliance with effluent Selected Licensee Commitments will ensure that average annual releases of radioactive material in effluents will be small percentages of the limits specified in the old 10 CFR 20.106 (new 10 CFR 20.1302). The requirements contained in 10 CFR 50.36a further indicate that operational flexibility is allowed, compatible with considerations of health and safety, which may temporarily result in releases higher than such small percentages, but still within the limits specified in the old 10 CFR 20.106 which references Appendix B, Table II concentrations (MPCs). These referenced concentrations are specific values which relate to an annual dose of 500 mrem. It is further indicated in 10 CFR 50.36a that when using operational flexibility, best efforts shall be exerted to keep levels of radioactive materials in effluents as low as reasonably achievable (ALARA) as set forth in 10 CFR 50 Appendix I. Also, for fresh water sites with drinking water supplies which can be potentially affected by plant operations, there is reasonable assurance that the operation of the facility will not result in radionuclide concentrations in the finished drinking water that are in excess of the requirements of 40 CFR 141. Therefore, to accommodate operational flexibility needed for effluent releases, the limits associated with this SLC are based on ten times the instantaneous dose rate value of 50 mrem/year to apply at all times. Compliance with the limits of the new 10 CFR 20.1001 will be demonstrated by operating within the limits of 10 CFR 50, Appendix I, 40 CFR 141 and 4O CFR 190.

Section I of Appendix I of 10 CFR 50 states that this appendix provides specific numerical guides for design objectives and limiting conditions for operation, to assist holders of licenses for light water cooled nuclear power reactors in meeting the requirements to keep releases of radioactive material to unrestricted areas as low as practical and reasonably achievable, during normal reactor operations, including expected operational occurrences. Using the flexibility granted during unusual operating conditions, and the stated applicability of the design objectives for the Oconee Nuclear Station, Appendix I dose limits for radioactive liquid effluent releases are concluded to be not applicable during unusual operating conditions that result in the activation of the Oconee Emergency Plan.

For units with shared radwaste treatment systems, the liquid effluents from the shared system are proportioned among the units sharing that system.

The requirements 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 SLC implements the requirements of 10 CFR Part 50.36a. General Design Criterion 60 of Appendix A to 10 CFR Part 50 and design objective Section II.D of Appendix A to 10 CFR Part 50.

REFERENCES:

1. 10 CFR Part 20, Appendix B.
2. 40 CFR Part 141.
3. 10 CFR Part 50, Appendices A and I.
4. 40 CFR Part 190.
5. Offsite Dose Calculation Manual.
6. Regulatory Guide 1.109.
7. NUREG-1301

16.11 RADIOLOGICAL EFFLUENTS CONTROL

16.11.2 Radioactive Gaseous Effluents

COMMITMENT

Establish conditions for the controlled release of radioactive gaseous effluents. Implement the requirements of 10 CFR 20, 10 CFR 50.36a, Appendix A to 10 CFR 50, Appendix I to 10 CFR 50, and 40 CFR 190.

a. Dose Rate

The instantaneous dose rate at the site (exclusion area) boundary for gaseous effluents [Figure 2.1-4(a) of the Oconee Nuclear Station Updated Final Safety Analysis Report] due to radioactive materials released in gaseous effluents from the site shall be limited to the following values:

1. The dose rate limit for noble gases shall be:

   ≤ 500 mrem/yr to the total body

   ≤ 3000 mrem/yr to the skin; and

2. The dose rate limit for all radioiodines and for all radioactive materials in particulate form and radionuclides other than noble gases with half-lives greater than 8 days shall be ≤ 1500 mrem/yr to any organ.

b. Dose

1. The air dose due to noble gases released in gaseous effluent from the site shall be limited to the following:

   i. During any calendar quarter:

      ≤ 15 mrad for gamma radiation

      ≤ 30 mrad for beta radiation

   ii. During any calendar year:

      ≤ 30 mrad for gamma radiation

      ≤ 60 mrad for beta radiation

2. The dose to a Member Of The Public from radioiodines, tritium and radioactive materials in particulate form with half-lives greater than 8 days in gaseous effluents released from the site, shall be limited to the following:

i. During any calendar quarter:

$\leq$ 22.5 mrem to any organ

ii. During any calendar year:

$\leq$ 45 mrem to any organ.

c. Gaseous Radwaste Treatment

1. The Gaseous Radwaste Treatment System shall be used to reduce the noble gases in gaseous wastes prior to their discharge, if the projected gaseous effluent air dose due to gaseous effluent release from the site, when averaged over 31 days exceeds 0.6 mrad for gamma radiation and 1.2 mrad for beta radiation.

2. The Ventilation Treatment Exhaust System shall be used to reduce radioactive materials other than noble gases in gaseous waste prior to their discharge when the projected doses due to effluent releases to unrestricted areas when averaged over 31 days would exceed 0.9 mrem to any organ.

d. Used Oil Incineration

During incineration of used oil contaminated by radioactive material in the Station Auxiliary Boiler, the dose to a Member Of The Public from radioiodines, tritium and radioactive materials in particulate form with half-lives greater than 8 days in gaseous effluents released from the Station Auxiliary Boiler shall be $\leq$ 0.045 mrem to any organ in any calendar year.

--NOTE--
The requirement of c.2 does not apply to the Auxiliary Building Exhaust System since it is not “treated” prior to release.

APPLICABILITY: At all times

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Dose rate exceeds the limits specified in Commitment a.	A.1 Restore release rate to within limits.	Immediately
B. Calculated dose exceeds specified limits.	B.1 Submit report to the regional NRC Office which includes the following: a. Cause(s) for exceeding the limit(s), and b. A description of the program of corrective action initiated to: reduce the releases of radioactive materials in gaseous effluents, and to keep these levels of radioactive materials in gaseous effluents in compliance with the specified limits or as low as reasonably achievable.	30 days from the end of the quarter during which the release occurred

CONDITION	REQUIRED ACTION	COMPLETION TIME
C. Radioactive gaseous waste is discharged greater than limits specified in Commitment c.1 or c.2. <u>AND</u> Radioactive gaseous waste is discharged without treatment for more than 31 days.	C.1 Submit a report to the regional NRC Office which includes the following: a. Cause of equipment or subsystems inoperability, and b. Corrective action to restore equipment and prevent recurrence.	30 days

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 16.11.2.1	N/A	N/A

<u>BASES</u>

The basic requirements for Selected Licensee Commitments concerning effluent from nuclear power reactors are stated in I0CFR50.36. Compliance with effluent Selected Licensee Commitments will ensure that average annual releases of radioactive material in effluents will be small percentages of the limits specified in the old I0CFR20.106 (new I0CFR20.1302). The requirements contained in I0CFR50.36a further indicate that operational flexibility is allowed, compatible with considerations of health and safety, which may temporarily result in releases higher than such small percentages, but still within the limits specified in the old I0CFR20.106 which references Appendix B, Table II concentrations (MPCs). These referenced concentrations are specific values which relate to an annual dose of 500 mrem to the total body, 3000 mrem to the skin, and 1500 mrem to an infant via the milk animal-milk-infant pathway. It is further indicated in I0CFR50.36a that when using operational flexibility, best efforts shall be exerted to keep levels of radioactive materials in effluents as low as reasonably achievable (ALARA) as set forth in I0CFR50 Appendix I. Therefore, to accommodate operational flexibility needed for effluent releases, the limits associated with gaseous release rate SLCs will be maintained at the current instantaneous dose rate limit for noble gases of 500 mrem/year to the total body and 3000 mrem/year to the skin; and for Iodine-131, for Iodine-133, for tritium, and for all radionuclides in particulate form with half-lives greater than 8 days. an instantaneous dose rate limit of 1500 mrem/year.

The ODCM calculational methods for calculating the doses due to the actual release rates of the subject materials will be consistent with the methodology provided in Regulatory Guide 1.109, “Calculating 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.”

Equations in the ODCM are provided for determining the actual doses based upon the historical average atmospheric conditions. The release rate commitments for radioiodines, radioactive material in particulate form and radionuclides other than noble gases are dependent on the existing radionuclide pathways to man, in the unrestricted area. The pathways which are examined in the development of these calculations are: 1) individual inhalation of airborne radionuclides, 2) deposition of radionuclides into green leafy vegetation with subsequent consumption by man, 3) deposition onto grassy areas where milk animals and meat producing animals graze with consumption of the milk and meat by man, and 4) deposition on the ground with subsequent exposure of man.

The requirement that the appropriate portions of these systems be used when specified provides reasonable assurance that the release of radioactive materials in gaseous effluents will be kept "as low as is reasonably achievable." This commitment implements the requirements of 10 CFR Part 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50, and design objective Section IID of Appendix I to 10 CFR Part 50.

REFERENCES:

1 10 CFR Part 20, Appendix 8.
2. 10 CFR Part 50, Appendices A and I.
3. Regulatory Guide 1.109.
4. 40 CFR Part 190.
5. Offsite Dose Calculation Manual.

16.11 RADIOLOGICAL EFFLUENTS CONTROL

16.11.3 Radioactive Effluent Monitoring Instrumentation

COMMITMENT

Radioactive Effluent Monitoring Instrumentation shall be OPERABLE as follows:

a. Liquid Effluents

The radioactive liquid effluent monitoring instrumentation channels shown in Table 16.11.3-1 shall be OPERABLE with their alarm/trip setpoints set to ensure that the limits of SLC 16.11.1.a are not exceeded.

b. Gaseous Process and Effluents

The radioactive gaseous process and effluent monitoring instrumentation channels shown in Table 16.11.3-2 shall be OPERABLE with their alarm/trip setpoints set to ensure that the limits of SLC 16.11.2.a are not exceeded.

c. The setpoints shall be determined in accordance with the methodology described in the ODCM and shall be recorded.

--NOTE--

Correction to setpoints determined in accordance with Commitment c may be permitted without declaring the channel inoperable.

APPLICABILITY: According to Table 16.11.3-1 and Table 16.11.3-2.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Alarm/trip setpoint less conservative than required for one or more effluent monitoring instrument channels.	A.1 Declare channel inoperable. <u>OR</u> A.2 Suspend release of effluent monitored by the channel.	Immediately Immediately

CONDITION	REQUIRED ACTION		COMPLETION TIME
B. One or more required liquid effluent monitoring instrument channels inoperable.	B.1	Enter the Condition referenced in Table 16.11.3-1 for the function.	Immediately
	<u>AND</u>		
	B.2	Restore the instrument(s) to OPERABLE status.	30 days
C. One or more required gaseous effluent monitoring instrument channels inoperable.	C.1	Enter the Condition referenced in Table 16.11.3-2 for the function.	Immediately
	<u>AND</u>		
	C.2	Restore the instrument(s) to OPERABLE status.	30 days
D. Required Action and associated Completion Time of Required Action B.2 or C.2 not met.	D.1	Explain in next Annual Radiological Effluent Release Report why inoperability was not corrected in a timely manner.	April 30 of following calendar year

CONDITION	REQUIRED ACTION	COMPLETION TIME
E. As required by Required Action B.1 and referenced in Table 16.11.3-1. (RIA-33)	E.1.1 Analyze two independent samples in accordance with SLC 16.11.4.	Prior to initiating subsequent release
	AND	
	E.1.2 Conduct two independent data entry checks for release rate calculations	Prior to initiating subsequent release
	AND	
	E.1.3 Conduct two independent valve lineups of the effluent pathway.	Prior to initiating subsequent release
	OR	
	E.2 Suspend release of radioactive effluents by this pathway.	Immediately
F. As required by Required Action B.1 and referenced in Table 16.11.3-1. (RIA-54)	F.1 Suspend release of radioactive effluents by this pathway.	Immediately
	OR	
	F.2 Collect and analyze grab samples for gross radioactivity (beta and/or gamma) at a lower limit of detection of at least 10^{-7} μCi/ml.	Prior to each discrete release of the sump

CONDITION	REQUIRED ACTION	COMPLETION TIME
G. As required by Required Action B.1 and referenced in Table 16.11.3-1. (Liquid Radwaste Effluent Line Flow Rate Monitor)	-----------------NOTE------------------ Not required during short, controlled outages of liquid effluent monitoring instrumentation. Short controlled outages are defined as planned removals from service for durations not to exceed 1 hour, for purposes of sample filter changeouts, setpoint adjustments, service checks, and/or routine maintenance procedures. This guidance may be applied successively, provided that time between successive short, controlled outages is always at least equal to duration of immediately preceding outage. ---	
	G.1 Suspend release of radioactive effluents by this pathway.	Immediately
	<u>OR</u>	
	G.2 Estimate flow rate during actual releases.	Immediately <u>AND</u> Once per 4 hours thereafter

CONDITION	REQUIRED ACTION	COMPLETION TIME
H. As required by Required Action B.1 and referenced in Table 16.11.3-1. (RIA-35, #3 Chemical Treatment Pond Composite Sampler and Sampler Flow Monitor (Turbine Building Sumps Effluent))	-----------------NOTE------------------ Not required during short, controlled outages of liquid effluent monitoring instrumentation. Short controlled outages are defined as planned removals from service for durations not to exceed 1 hour, for purposes of sample filter changeouts, setpoint adjustments, service checks, and/or routine maintenance procedures. This guidance may be applied successively, provided that time between successive short, controlled outages is always at least equal to duration of immediately preceding outage. ---	
	H.1 Suspend release of radioactive effluents by this pathway.	Immediately
	<u>OR</u>	
	H.2 Collect and analyze grab samples for gross radioactivity (beta and/or gamma) at a lower limit of detection of at least 10^{-7} μCi/ml.	Immediately <u>AND</u> Once per 12 hours thereafter

CONDITION	REQUIRED ACTION	COMPLETION TIME
I. As required by Required Action C.1 and referenced in Table 16.11.3-2 for effluent releases from waste gas tanks (RIA-37, RIA-38) or containment purges (RIA-45).	-----------------NOTE------------------ Not required during short, controlled outages of gaseous effluent monitoring instrumentation. Short controlled outages are defined as planned removals from service for durations not to exceed 1 hour, for purposes of sample filter changeouts, setpoint adjustments, service checks, and/or routine maintenance procedures. This guidance may be applied successively, provided that time between successive short, controlled outages is always at least equal to duration of immediately preceding outage. ---	
	I.1.1 Analyze two independent samples.	Prior to initiating subsequent release
	<u>AND</u>	
	I.1.2 Conduct two independent data entry checks for release rate calculations	Prior to initiating subsequent release
	<u>AND</u>	
	I.1.3 Conduct two independent valve lineups of the effluent pathway.	Prior to initiating subsequent release
	<u>OR</u>	
	I.2 Suspend release of radioactive effluents by this pathway.	Immediately

CONDITION	REQUIRED ACTION	COMPLETION TIME
J. As required by Required Action C.1 and referenced in Table 16.11.3-2. (Effluent Flow Rate Monitor (Unit Vent, Containment Purge, Interim Radwaste Exhaust, Hot Machine Shop Exhaust, Radwaste Facility Exhaust, Waste Gas Discharge))	---------------NOTE-------------------- Not required during short, controlled outages of gaseous effluent monitoring instrumentation. Short controlled outages are defined as planned removals from service for durations not to exceed 1 hour, for purposes of sample filter changeouts, setpoint adjustments, service checks, and/or routine maintenance procedures. This guidance may be applied successively, provided that time between successive short, controlled outages is always at least equal to duration of immediately preceding outage. ---	
	J.1 Suspend release of radioactive effluents by this pathway.	Immediately
	<u>OR</u>	
	J.2 Estimate flow rate	Immediately <u>AND</u> Once per 4 hours thereafter

CONDITION	REQUIRED ACTION	COMPLETION TIME
K. As required by Required Action C.1 and referenced in Table 16.11.3-2. (RIA-45, RIA-53, 4RIA-45)	-----------------NOTE------------------ Not required during short, controlled outages of gaseous effluent monitoring instrumentation. Short controlled outages are defined as planned removals from service for durations not to exceed 1 hour, for purposes of sample filter changeouts, setpoint adjustments, service checks, and/or routine maintenance procedures. This guidance may be applied successively, provided that time between successive short, controlled outages is always at least equal to duration of immediately preceding outage. ---	
	K.1 Suspend release of radioactive effluents by this pathway.	Immediately
	OR	
	K.2.1 Collect grab sample.	Immediately AND Once per 8 hours
	AND	
	K.2.2 Analyze grab samples for gross activity (beta and/or gamma).	24 hours from collection of sample

CONDITION	REQUIRED ACTION	COMPLETION TIME
L. As required by Required Action C.1 and referenced in Table 16.11.3-2. (Unit Vent Monitoring Iodine Sampler, Unit Vent Monitoring Particulate Sampler, Interim Radwaste Building Ventilation Monitoring Iodine Sampler, Interim Radwaste Building Ventilation Monitoring Particulate Sampler, Hot Machine Shop Iodine Sampler, Hot Machine Shop Particulate Sampler, Radwaste Facility Iodine Sampler, Radwaste Facility Particulate Sampler)	-----------------NOTE------------------ Not required during short, controlled outages of gaseous effluent monitoring instrumentation. Short controlled outages are defined as planned removals from service for durations not to exceed 1 hour, for purposes of sample filter changeouts, setpoint adjustments, service checks, and/or routine maintenance procedures. This guidance may be applied successively, provided that time between successive short, controlled outages is always at least equal to duration of immediately preceding outage. ---	
	L.1 Suspend release of radioactive effluents by this pathway.	Immediately
	<u>OR</u>	
	L.2.1 -----------NOTE----------- The collection time of each sample shall not exceed 7 days. ------------------------------- Collect samples continuously using auxiliary sampling equipment.	Immediately
	<u>AND</u>	
	L.2.2 Analyze each sample.	48 hours from end of each sample collection

CONDITION	REQUIRED ACTION	COMPLETION TIME
M. As required by Required Action C.1 and referenced in Table 16.11.3-2 for effluent from ventilation system or condenser air ejectors. (RIA-40)	-----------------NOTE------------------ Not required during short, controlled outages of gaseous effluent monitoring instrumentation. Short controlled outages are defined as planned removals from service for durations not to exceed 1 hour, for purposes of sample filter changeouts, setpoint adjustments, service checks, and/or routine maintenance procedures. This guidance may be applied successively, provided that time between successive short, controlled outages is always at least equal to duration of immediately preceding outage. ---	
	M.1 Continuously monitor release through the unit vent.	Immediately
	<u>OR</u>	
	M.2 Suspend release of radioactive effluents by this pathway.	Immediately
	<u>OR</u>	
	M.3.1 Collect grab sample.	Immediately <u>AND</u> Once per 8 hours
	<u>AND</u>	
	M.3.2 Analyze grab sample for gross activity (beta and/or gamma).	24 hours from collection of grab sample

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 16.11.3.1	------------------------NOTE---------------------------- The Channel Response check shall consist of verifying indications during periods of release. Channel response checks shall be made at least once per calendar day on days in which continuous, periodic or batch releases are made. -- Perform Channel Response Check.	During each release via this pathway
SR 16.11.3.2	------------------------NOTE---------------------------- The Channel Response check shall consist of verifying indications during periods of release. Channel response checks shall be made at least once per calendar day on days in which continuous, periodic or batch releases are made. -- Perform Channel Response Check.	24 hours
SR 16.11.3.3	Perform Source Check.	24 hours
SR 16.11.3.4	Perform Source Check.	31 days
SR 16.11.3.5	Perform Source Check.	92 days

SURVEILLANCE		FREQUENCY
SR 16.11.3.6	----------------------NOTE--------------------------- The CHANNEL FUNCTIONAL TEST shall also demonstrate that automatic isolation of this pathway and control room annunciation occurs if any of the following conditions exist: 1. Instrument indicates measured levels above the alarm/trip setpoint. 2. Circuit failure (downscale only). -- Perform CHANNEL FUNCTIONAL TEST.	92 days
SR 16.11.3.7	-----------------------NOTE--------------------------- The CHANNEL FUNCTIONAL TEST shall also demonstrate that control room annunciation occurs if any of the following conditions exist: 1. Instrument indicates measured levels above the alarm/trip setpoint. 2. Circuit failure (downscale only). -- Perform CHANNEL FUNCTIONAL TEST.	92 days
SR 16.11.3.8	Perform CHANNEL FUNCTIONAL TEST.	92 days

SURVEILLANCE		FREQUENCY
SR 16.11.3.9	-------------------------NOTE--------------------------- The initial CHANNEL CALIBRATION shall be performed using one or more of the reference standards certified by the National Bureau of Standards or using standards that have been obtained from suppliers that participate in measurement assurance activities with the National Institute of Standards and Technology (NIST). The standards shall permit calibrating the system over its intended range of energy and measurement. For subsequent CHANNEL CALIBRATION, sources that have been related to the initial calibration shall be used. (Operating plants may substitute previously established calibration procedures for these requirements.) -- Perform CHANNEL CALIBRATION.	12 months
SR 16.11.3.10	Perform CHANNEL CALIBRATION.	12 months
SR 16.11.3.11	Perform leak test.	When cylinder gates or wicket gates are reworked
SR 16.11.3.12	Perform Source Check.	Within 24 hours prior to each release via associated pathway

Table 16.11.3-1
LIQUID EFFLUENT MONITORING INSTRUMENTATION
OPERATING CONDITIONS AND SURVEILLANCE REQUIREMENTS

INSTRUMENT	MINIMUM OPERABLE CHANNELS	APPLICABILITY	SURVEILLANCE REQUIREMENTS	CONDITION REFERENCED FROM REQUIRED ACTION B.1
1. Monitors Providing Automatic Termination of Release				
a. Liquid Radwaste Effluent Line Monitor, RIA-33	1	At all times	SR 16.11.3.1 SR 16.11.3.3 SR 16.11.3.6 SR 16.11.3.9	E
b. Turbine Building Sump, RIA-54	1	At all times	SR 16.11.3.2 SR 16.11.3.4 SR 16.11.3.7 SR 16.11.3.9	F
2. Monitors not Providing Automatic Termination of Release				
Low Pressure Service Water RIA-35	1	At all times	SR 16.11.3.2 SR 16.11.3.4 SR 16.11.3.7 SR 16.11.3.9	H
3. Flow Rate Measuring Devices				
a. Liquid Radwaste Effluent Line Flow Rate Monitor (0LW CR0725 or 0LW SS0920)	1	At all times	SR 16.11.3.1 SR 16.11.3.10	G
b. Liquid Radwaste Effluent Line Minimum Flow Device	NA	NA	SR 16.11.3.1 SR 16.11.3.10	NA
c. Turbine Building Sump Minimum Flow Device	NA	NA	SR 16.11.3.1 SR 16.11.3.10	NA
d. Low Pressure Service Water Minimum Flow Device	NA	NA	SR 16.11.3.1 SR 16.11.3.10	NA

Table 16.11.3-1
LIQUID EFFLUENT MONITORING INSTRUMENTATION
OPERATING CONDITIONS AND SURVEILLANCE REQUIREMENTS

	INSTRUMENT	MINIMUM OPERABLE CHANNELS	APPLICABILITY	SURVEILLANCE REQUIREMENTS	CONDITION REFERENCED FROM REQUIRED ACTION B.1
e.	Keowee Hydroelectric Tailrace Discharge [(a)]	NA	NA	SR 16.11.3.11	NA
4.	Continuous Composite Sampler				
	#3 Chemical Treatment Pond Composite Sampler and Sampler Flow Monitor (Turbine Building Sumps Effluent)	1	At all times	SR 16.11.3.2 SR 16.11.3.10	H

(a) Flow is determined from the number of hydro units operating. If no hydro units are operating, leakage flow will be assumed to be 38 cfs based on historical data.

Table 16.11.3-2
GASEOUS EFFLUENT MONITORING INSTRUMENTATION
OPERATING CONDITIONS AND SURVEILLANCE REQUIREMENTS

	INSTRUMENT	MINIMUM OPERABLE CHANNELS (PER RELEASE PATH)	APPLICABILITY	SURVEILLANCE REQUIREMENTS	CONDITION REFERENCED FROM REQUIRED ACTION C.1
1.	Unit Vent Monitoring System				
a.	Noble Gas Activity Monitor Providing Alarm and Automatic Termination of Containment Purge Release (RIA-45 - Purge Isolation Function)	1	At All Times	SR 16.11.3.2 SR 16.11.3.4 SR 16.11.3.7 SR 16.11.3.9	I
b.	Noble Gas Activity Monitor Providing Alarm. (RIA-45 - Vent Stack Monitor Function)	1	At all times	SR 16.11.3.2 SR 16.11.3.4 SR 16.11.3.7 SR 16.11.3.9	K
c.	Iodine Sampler	1	At All Times	SR 16.11.3.2	L
d.	Particulate Sampler	1	At All Times	SR 16.11.3.2	L
e.	Effluent Flow Rate Monitor (Unit Vent Flow) (MSC CR0001)	1	At All Times	SR 16.11.3.2 SR 16.11.3.10	J
f.	Sampler Flow Rate Monitor [(a)] (Annunciator)	1	At All Times	SR 16.11.3.2 SR 16.11.3.10	NA
g.	Effluent Flow Rate Monitor (Containment Purge)(MSC CR0001)	1	During Containment Purge Operation	SR 16.11.3.2 SR 16.11.3.10	J
h.	CSAE Off Gas Monitor (RIA-40)	1	During Operation of CSAE	SR 16.11.3.2 SR 16.11.3.5 SR 16.11.3.8 SR 16.11.3.9	M
2.	Interim Radwaste Building Ventilation Monitoring System				
a.	Noble Gas Activity Monitor (RIA - 53)	1	At All Times	SR 16.11.3.2 SR 16.11.3.4 SR 16.11.3.7 SR 16.11.3.9	K
b.	Iodine Sampler	1	At All Times	SR 16.11.3.2	L
c.	Particulate Sampler	1	At All Times	SR 16.11.3.2	L
d.	Effluent Flow Rate Monitor (Interim Radwaste Exhaust) (GWD FT0082)	1	At All Times	SR 16.11.3.2 SR 16.11.3.10	J
e.	Sampler Flow Rate Monitor[(a)] (Annunciator)	1	At All Times	SR 16.11.3.2 SR 16.11.3.10	NA

Table 16.11.3-2
GASEOUS EFFLUENT MONITORING INSTRUMENTATION
OPERATING CONDITIONS AND SURVEILLANCE REQUIREMENTS

	INSTRUMENT	MINIMUM OPERABLE CHANNELS (PER RELEASE PATH)	APPLICABILITY	SURVEILLANCE REQUIREMENTS	CONDITION REFERENCED FROM REQUIRED ACTION C.1
3.	Hot Machine Shop Ventilation Sampling System				
	a. Iodine Sampler	1	At All Times	SR 16.11.3.2	L
	b. Particulate Sampler	1	At All Times	SR 16.11.3.2	L
	c. Effluent Flow Rate Monitor (Hot Machine Shop Exhaust) (Totalizer)	1	At All Times	SR 16.11.3.2 SR 16.11.3.10	J
	d. Sampler Flow Rate Monitor [(a)] (Annunciator)	1	At All Times	SR 16.11.3.2 SR 16.11.3.10	NA
4.	Radwaste Facility Ventilation Monitoring System				
	a. Noble Gas Activity Monitor (4-RIA-45)	1	At All Times	SR 16.11.3.2 SR 16.11.3.4 SR 16.11.3.7 SR 16.11.3.9	K
	b. Iodine Sampler	1	At All Times	SR 16.11.3.2	L
	c. Particulate Sampler	1	At All Times	SR 16.11.3.2	L
	d. Effluent Flow Rate Monitor (Radwaste Facility Exhaust) (0VS CR2060)	1	At All Times	SR 16.11.3.2 SR 16.11.3.10	J
	e. Sampler Flow Rate Monitor [(a)] (Annunciator)	1	At All Times	SR 16.11.3.2 SR 16.11.3.10	NA
5.	Waste Gas Holdup Tanks				
	a. Noble Gas Activity Monitor - Providing Alarm and Automatic Termination of Release (RIA-37,-38)[b]	1	During Waste Gas Holdup Tank Releases	SR 16.11.3.1 SR 16.11.3.6 SR 16.11.3.9 SR 16.11.3.12	I
	b. Effluent Flow Rate Monitor (Waste Gas Discharge Flow) (MSC CR0001)	1	During Waste Gas Holdup Tank Releases	SR 16.11.3.1 SR 16.11.3.10	J

(a)Alarms indicating low flow may be substituted for flow measuring devices.
(b)Either Normal or High Range monitor is required dependent upon activity in tank being released.

BASES

The radioactive liquid effluent instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in liquid effluents during actual or potential releases. The alarm/trip setpoints for these instruments shall be calculated in accordance with NRC approved methods in the ODCM to assure that the alarm/trip will occur prior to exceeding 10 times 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 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. The alarm/trip setpoints for these instruments shall be calculated in accordance with NRC approved methods in the ODCM to assure that the alarm/trip will occur prior to exceeding applicable dose limits in SLC 16.11.2. The operability end 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.

For certain applicable cases, grab samples or flow estimates are required at frequencies between every 4 hours end every 12 hours upon RIA removal from service. SLC 16.11.3 does not explicitly require Action (grab samples or flow estimates) to be initiated immediately upon RIA removal from service, when removal is for the purposes of sample filter changeouts, setpoint adjustments, service checks, or routine maintenance. Therefore, during the defined short, controlled outages, Action is not required.

For the cases in which Action is defined as continuous sampling by auxiliary equipment (Action L) initiation of continuous sampling by auxiliary sampling equipment requires approximately 1 hour. One hour is the accepted reasonable time to initiate collect and change samples. Therefore. for the defined short, controlled outages (not to exceed 1 hour), Action is not required.

Failures such as blown instrument fuses, defective indicators, and faulted amplifiers are, in many cases, revealed by alarm or annunciator action. Comparison of output and/or state of independent channels measuring the same variable supplements this type of built-in surveillance. Based on experience in operation of both conventional and nuclear systems, when the unit is in operation, the minimum checking frequency stated is deemed adequate.

REFERENCES:

1. 10 CFR Part 20.
2. 10 CFR Part 50, Appendix A.
3. Offsite Dose Calculation Manual.
4. UFSAR, Section 7.2.3.4.

16.11 RADIOLOGICAL EFFLUENTS CONTROL

16.11.4 Operational Safety Review

COMMITMENT Required sampling should be performed as detailed in Table 16.11.4-1.

APPLICABILITY: At all times

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. NA	A.1 NA	NA

SURVEILLANCE REQUIREMENTS

SURVEILLANCE	FREQUENCY
SR 16.11.4.1 N/A	N/A

Table 16.11.4-1
Minimum Sampling Frequency and Analysis Program

Item		Check		Frequency	Lower Limit of Detection[b] of Lab Analysis for Waste
1.	Decant Monitor Tank, Turbine Building Sump Monitor Tanks, Waste and Recycle Monitor Tanks	a.	Principal Gamma Emitters[c] including Dissolved Noble Gases	Composite Grab Sample prior to release of each batch[h]	<5E-06 μCi/ml (Ce-144) <5E-07 μCi/ml (Other Gamma Nuclides) <1E-05 μCi/ml (Dissolved Gases) <1E-06 μCi/ml (I-131)
		b.	Radiochemical Analysis Sr-89 and Sr-90	Quarterly from all composited batches[f]	<5E-08 μCi/ml
		c.	Tritium	Monthly Composite	<1E-05 μCi/ml
		d.	Gross Alpha Activity	Monthly Composite	<1E-07 μCi/ml
2.	Unit Vent Sampling (Includes Waste Gas Decay Tanks, Reactor Building Purges, Auxiliary Building Ventilation, Spent Fuel Pool Ventilation, Air Ejectors)	a.	Iodine Spectrum[a]	Continuous monitor, weekly sample[e]	<1E-10 μCi/cc (I-133)[j] <1E-12 μCi/cc (I-131)[j]
		b.	Particulates[a]		
		i.	Ce-144 & Mo-99	Weekly Composite[e]	<5E-10 μCi/cc[j][k]
		ii.	Other Principle Gamma Emitters[d]	Weekly Composite[e]	<1E-11 μCi/cc[j]
		iii.	Gross Alpha Activity	Monthly, using composite samples of one week	<1E-11 μCi/cc
		iv.	Radiochemical Analysis Sr-89, Sr-90	Quarterly Composite	<1E-11 μCi/cc
		c.	Gases by Principle Gamma Emitters[d]	Weekly Grab Sample	<1E-04 μCi/cc
		d.	Tritium	Weekly Grab Sample	<1E-06 μCi/cc
3.	Waste Gas Decay Tank	a.	Principle Gamma Emitters[d]	Grab Sample prior to release of each batch	<1E-04 μCi/cc (gases) <1E-10 μCi/cc (particulates and iodines) <5E-09 μCi/cc (Ce-144 and Mo-99)
		b.	Tritium	Grab Sample prior to release of each batch	<1E-06 μCi/cc
4.	Reactor Building	a.	Principle Gamma Emitters[d]	Grab sample each purge	<1E-04 μCi/cc (gases) <1E-10 μCi/cc (particulates and iodines) <5E-09 μCi/cc (Ce-144 and Mo-99)
		b.	Tritium	Grab sample each purge	<1E-06 μCi/cc

Table 16.11.4-1
Minimum Sampling Frequency and Analysis Program

Item		Check		Frequency	Lower Limit of Detection[b] of Lab Analysis for Waste
5.	Not Used				
6.	#3 Chemical Treatment Pond Effluent[i]	a.	Principle Gamma Emitters[c]	Weekly Continuous Composite[g]	<5E-07 µCi/ml
		b.	I-131	Weekly Continuous Composite[g]	<1E-06 µCi/ml
		c.	Tritium	Monthly Continuous Composite[g]	<1E-05 µCi/ml
		d.	Gross Alpha Activity	Monthly Continuous Composite[g]	<1E-07 µCi/ml
		e.	Sr-89 & Sr-90	Quarterly Continuous Composite[g]	<5E-08 µCi/ml
		f.	Dissolved and Entrained gases (Gamma Emitters)	Monthly Grab	<1E-05 µCi/ml
7.	Radwaste Facility Ventilation	a.	Iodine Spectrum[a]	Continuous monitor, weekly sample[e]	(I-133) <1E-09 µCi/cc (I-131) <1E-11 µCi/cc
		b.	Particulate[a]		
		i.	Ce-144 and Mo-99	Weekly Composite[e]	<5E-10 µCi/cc[j]
		ii.	Other Principle Gamma Emitters[d]	Weekly Composite[e]	<1E-11 µCi/cc[j]
		iii.	Gross Alpha Activity	Monthly, using composite samples of one week	<1E-11 µCi/cc
		iv.	Radiochemical Analysis Sr-89, Sr-90	Quarterly Composite	<1E-11 µCi/cc
		c.	Gases by Principle Gamma[d] Emitters	Weekly Grab Sample	<1E-04 µCi/cc
		d.	Tritium	Weekly Grab Sample	<1E-06 µCi/cc

Table 16.11.4-1
Minimum Sampling Frequency and Analysis Program

Item	Check	Frequency	Lower Limit of Detection(b) of Lab Analysis for Waste
8. Hot Machine Shop Ventilation	a. Iodine Spectrum	Weekly Sample(e)	(I-133) <1E-10 μCi/cc(j) (I-131) <1E-12 μCi/cc(j)
	b. Particulate		
	i. Ce-144 and Mo-99	Weekly Composite(e)	<5E-10 μCi/cc(j)(k)
	ii. Other Principle Gamma Emitters (d)	Weekly Composite(e)	<1E-11 μCi/cc(j)
	iii. Gross Alpha Activity	Monthly, using composite samples of one week	<1E-11 μCi/cc
	iv. Radiochemical Analysis Sr-89, Sr-90	Quarterly Composite	<1E-11 μCi/cc
	c. Gases by Principle Gamma Emitters	NA	NA
	d. Tritium	NA	NA
9. Interim Radwaste Building Ventilation	a. Iodine Spectrum	Weekly sample(e)	(I-133) <1E-10 μCi/cc(j) (I-131) <1E-12 μCi/cc(j)
	b. Particulate		
	i. Ce-144 and Mo-99	Weekly Composite(e)	<5E-10 μCi/cc(j)
	ii. Other Principle Gamma Emitters(d)	Weekly Composite(e)	<1E-11 μCi/cc(j)
	iii. Gross Alpha Activity	Monthly, using composite samples of one week	<1E-11 μCi/cc
	iv. Radiochemical Analysis Sr-89, Sr-90	Quarterly Composite	<1E-11 μCi/cc
	c. Gases by Principle Gamma(d) Emitters	Weekly Grab Sample	<1E-04 μCi/cc
	d. Tritium	Weekly Grab Sample	<1E-06 μCi/cc

(a) 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) analyses show 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.

(b) The LLD is defined for purposes of these commitments as the smallest concentration of radioactive material in a sample that would be detected with 95% probability with 5% probability of falsely concluding that a blank observation represents a "real" signal.

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

$$LLD = \frac{(2.71 / T) + 4.65\, s_b}{E \times V \times 2.22E06 \times Y \times \exp(-\lambda\Delta t)}$$

Where:

LLD is the "a priori" lower limit of detection as defined above (as micro Curies per unit mass or volume),

s_b is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute),

E is the counting efficiency (as counts per disintegration),

V is the sample size (in units of mass or volume),

2.22E06 is the number of disintegrations per minute per micro Curie,

Y is the fractional radiochemical yield (when applicable),

λ is the radioactive decay constant for the particular nuclide

Δ t is the elapsed time between midpoint of sample collection and time of counting (for plant effluents, not environmental samples). NOTE: This assumes decay correction is applied (at the time of analysis) for the duration of sample collection, for the time between collection and analysis, and for the duration of the counting. Additionally, it does not apply to isolated systems such as Waste Gas Decay Tanks and Waste Monitor Tanks.

T is the sample counting time in minutes

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

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

(c) The principal gamma emitters for which the LLD control 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 μCi/ml. This list does not mean that only these nuclides are to be considered. 0ther gamma peaks that are identifiable, together with the above nuclides shall also be analyzed and reported in the Annual Radioactive Effluent Release Report.

(d) The principal gamma emitters for which the LLD commitment applies exclusively are the following radionuclides: Kr-87. Kr-88, Xe-133. Xe-133m, Xe-135. and Xe-138 for gaseous emissions and Mn-54, Fe-59. Co-58, Co-60, Zn-65. Mo-99, Cs-134, Cs-137, Ce-141, and Ce-144 for particulates. This list does not mean that only these nuclides are to be detected and reported. 0ther peaks which are measurable and identifiable, together with the above nuclides shall also be identified and reported.

(e) 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 SLC 16.11.2.a, SLC 16.11.2.b.1, and SLC 16.11.2.b.2.

(f) A composite sample is one in which the quantity of liquid sampled is proportional to the quantity of liquid waste discharged and in which the method of sampling employed results in a specimen which is representative of the liquids released.

(g) 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 analysis, all samples taken for the composite shall be thoroughly mixed in order for the composite sample to be representative of the effluent release.

(h) A batch release is the discharge of liquid wastes of a discrete volume. Prior to sampling for analysis, each batch shall be isolated, and then thoroughly mixed, to assure representative sampling.

(i) A continuous release is the discharge of liquid wastes of a non-discrete volume, e.g., from a volume of a system that has an input flow during the continuous release. Samples shall be analyzed within 48 hours after changing (on or after removal from sampler).

(j) When samples collected for 24 hours are analyzed, the corresponding LLDs may be increased by a factor of 10. Samples shall be analyzed within 48 hours after changing (on or after removal from sampler).

(k) Ce-144 and Mo-99 LLD as approved by NRC SER dated January 16, 1984 (Reference 1).

BASES

N/A

REFERENCES:

1. Safety Evaluation Report dated January 16, 1984, supporting Amendment Nos. 125, 125, and 122 for Oconee Nuclear Station to revise Technical Specifications to incorporate changes to the Radiological Effluent Technical Specifications (RETS) in order to bring them into compliance with Appendix I of 10 CFR Part 50.

16.11 RADIOLOGICAL EFFLUENTS CONTROL

16.11.5 Solid Radioactive Waste

COMMITMENT

Radioactive wastes shall be processed and packaged to ensure compliance with the applicable requirements of 10 CFR Part 20, 10 CFR Part 61, 10 CFR Part 71, and State regulations governing the transportation and disposal of radioactive wastes.

The Solid Radwaste System or an approved alternative process shall be used in accordance with a Process Control Program (PCP), for the solidification of liquid or wet radioactive wastes or the dewatering of wet radioactive wastes to be shipped for direct disposal at a 10 CFR 61 licensed disposal site. Wastes shipped for off site processing in accordance with the processor’s specifications and transportation requirements are not required to be solidified or dewatered to meet disposal requirements.

- The PCP describes administrative and operational controls used for the solidification of liquid or wet solid radioactive wastes in order to meet applicable 10 CFR 61 waste form requirements.
- The PCP describes the administrative and operational controls used for the dewatering of wet radioactive wastes to meet 10 CFR 61 free standing water requirements.
- The process parameters used in establishing the PCP shall be based on demonstrated processing of actual or simulated liquid or wet solid wastes and must adequately verify that the final product of solidification or dewatering meets all applicable Federal, State and disposal site requirements.

APPLICABILITY: At all times

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Applicable regulatory requirements for solidified or dewatered wastes are not satisfied.	A.1 Suspend shipments of defectively packaged solid radioactive wastes from the site.	Immediately
	AND	
	A.2 Initiate action to correct PCP, procedures, or solid waste equipment as necessary to prevent recurrence.	Prior to next shipment for disposal of solidified or dewatered wastes
B. A solidification test as described in the PCP fails to verify Solidification.	B.1 Suspend solidification of the batch under test and follow PCP guidance for test failures until solidification of the batch is verified by subsequent tests.	Immediately
	AND	
	B.2 The PCP shall be modified as required to assure Solidification of subsequent batches of waste.	Prior to next solidification for shipment of waste for disposal at a 10 CFR 61 disposal site

CONDITION	REQUIRED ACTION	COMPLETION TIME
C. With solidification or dewatering for disposal not performed in accordance with the PCP.	C.1 Reprocess or repackage the waste in accordance with PCP requirements. <u>OR</u> C.2 Follow PCP or procedure guidance for alternative free standing liquid verification to ensure the waste in each container meets disposal requirements and take appropriate administrative action to prevent recurrence.	Prior to shipment for disposal of the inadequately processed waste that requires solidification or dewatering
D. With the solid waste equipment incapable of meeting commitment or not in service.	D.1 Restore the equipment to OPERABLE status or provide for alternative capability to process wastes as necessary to satisfy all applicable disposal requirements.	In a time frame that supports the commitment

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 16.11.5.1	The Process Control Program shall be used to verify the solidification of at least one representative test specimen from at least every tenth batch of each type of radioactive waste to be solidified for disposal at a 10 CFR 61 disposal site.	Every tenth batch of each type of radioactive waste to be solidified.

BASES

This commitment implements the requirements of 10 CFR Part 50.36a, General Design Criterion 60 of 10 CFR Part 50, Appendix A and requirements to use a Process Control Program to meet applicable 10CFR61 waste form criteria for solidified and dewatered radioactive wastes.

REFERENCES:

1. 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities".
2. 10 CFR Part 50, Appendix A.
3. 10 CFR20, "Standards for Protection Against Radiation".
4. 10 CFR61, "Licensing Requirements for Land Disposal of Radioactive Waste".
5. 10 CFR71, "Packaging and Transportation of Radioactive Materials".
6. DPCo Process Control Program Manual.
7. NRC Generic Letter 87-12, "Compliance with 10 CFR Part 61 And Implementation Of the Radiological Effluent Technical Specifications (Rets) and Attendant Process Control Program (PCP)".
8. NRC Generic Letter 89-01, "Implementation of Programmatic Controls for Radiological Effluent Technical Specifications In the Administrative Controls Section of the Technical Specifications and the Relocation of Procedural Details of Rets to the Offsite Dose Calculation Manual or to the Process Control Program".

16.11 RADIOLOGICAL EFFLUENTS CONTROL

16.11.6 Radiological Environmental Monitoring

COMMITMENT

a. The radiological environmental monitoring samples shall be collected in accordance with Table 16.11.6-1 and shall be analyzed pursuant to the requirements of Tables 16.11.6-1 and 16.11.6-2.

b. A land use census shall be conducted and shall identify the location of the nearest milk animal and the nearest residence in each of the 16 meteorological sectors within a distance of eight kilometers (five miles). Broad leaf vegetation sampling shall be performed at the site boundary in the direction sector with the highest D/Q in lieu of the garden census.

c. Analyses shall be performed on radioactive materials supplied as part of an Interlaboratory Comparison Program. A summary of the results obtained as part of the Interlaboratory Comparison Program shall be included in the Annual Radiological Environmental Operating Report. The Interlaboratory Comparison Program shall be described in the Annual Radiological Environmental Operating Report.

d. The results of the land use census shall be included in the Annual Radiological Environmental Operating Report.

---NOTE---
If samples required by Commitment part a, become permanently unavailable from any of the required sample locations, the locations from which samples were unavailable may then be deleted from the program provided replacement samples were obtained and added to the environmental monitoring program, if available. These new locations will be identified in the Annual Radioactive Effluent Release Report.

APPLICABILITY: At all times

ACTIONS

CONDITION	REQUIRED ACTION		COMPLETION TIME
A. Radiological environmental monitoring program is not conducted as required.	A.1	Submit a description of the reason for not conducting the program as required and plans to prevent a recurrence shall be included in the Annual Radiological Environmental Operating Report.	May 15 of following calendar year
B. Land use census identifies a Location which yields a calculated dose or dose commitment (via the same exposure pathway) 20% greater than a location from which samples are currently being obtained.	B.1	-----------NOTE----------- The sampling location having the lowest calculated dose or dose commitment (via the same exposure pathway) may be deleted from this monitoring program after October 31 of the year in which this land use census was conducted. ------------------------------	
		Add new location to the radiological environmental monitoring program.	30 days
	AND		
	B.2	Identify new locations in the next Annual Radioactive Effluent Release Report.	April 30 of following calendar year

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
C. Interlaboratory Comparison Program analyses not performed as required.	C.1 Report corrective actions in the Annual Radiological Environmental Operating Report.	May 15 of following calendar year
D. Radioactivity level resulting from plant effluents in environmental sampling medium at a specified location in excess of reporting limits of Table 16.11.6-3 when averaged over a calendar quarter.	D.1 Prepare and submit a Special report that identifies the cause for exceeding the limits 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 SLC 16.11.1 or 16.11.2.	30 days

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 16.11.6.1	Conduct land use census during growing season 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.	12 months

Table 16.11.6-1
Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample	Number of Sample Locations (b)	Sampling and Collection Frequency (d)	Time and Frequency of Analysis
1. AIRBORNE			
Radioiodine and Particulates	5	Continuous sampler operation with sample collection weekly, or more frequently if required by dust loading.	Radioiodine canister: I-131 analysis weekly. Particulate sampler: Gross beta radioactivity analysis following filter change; and gamma isotopic analysis of composite (by location) quarterly. (c)
2. DIRECT RADIATION	40	Quarterly.	Gamma dose quarterly.
3. WATERBORNE			
a. Surface	2	Composite (a) sample over a 1-month period.	Gamma isotopic analysis monthly. Composite for tritium analysis quarterly.
b. Drinking	3	Composite (a) sample over a 1-month period.	Composite for gross beta and gamma isotopic analyses monthly. Composite for tritium analysis quarterly.
c. Sediment from Shoreline	2	Semiannually.	Gamma isotopic analysis semiannually.

Table 16.11.6-1
Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample	Number of Sample Locations (b)	Sampling and Collection Frequency (d)	Time and Frequency of Analysis
4. INGESTION			
a. Milk	4(e)	Semimonthly when animals are on pasture; monthly at other times.	Gamma isotopic and I-131 analysis semimonthly when animals are on pasture; monthly at other times.
b. Fish	2	Semiannually. One sample each commercially and recreationally important species.	Gamma isotopic analysis semiannually on edible portion.
c. Broad-leaf Vegetation	2	Monthly.	Gamma isotopic analysis monthly.

(a) Composite samples shall be collected by collecting an aliquot at intervals not exceeding 2 hours.

(b) Sample locations are identified in the ODCM.

(c) Airborne particulate sample filters shall be analyzed for gross beta radioactivity 24 hours or more after sampling to allow 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.

(d) Deviations are permitted from the required sampling schedule if specimens are unobtainable due to hazardous conditions, seasonal unavailability, or to malfunction of automatic sampling equipment. If the latter, every effort shall be made to complete corrective action prior to the end of the next sampling period.

(e) Samples from milking animals in three locations within 5 km distance having the highest dose potential. If there are none, then one sample from milking animals in each of three areas between 5 to 8 km distant where doses are calculated to be greater than 1 mrem per year. One sample from milking animals at a control location, as for example 15 to 30 km distant and in the least prevalent wind direction.

Table 16.11.6-2
Maximum Values for the Lower Limits of Detection (LLD) (a) (c)

Analysis	Water (pCi/l)	Airborne Particulate or Gases (pCi/m^3)	Fish (pCi/kg, wet)	Milk (pCi/l)	Broad-leaf Vegetation (pCi/kg, wet)	Sediment (pCi/kg, dry)
Gross Beta	4	1E-02				
H_3	2,000					
Mn-54	15		130			
Fe-59	30		260			
Co-58	15		130			
Co-60	15		130			
Zn-65	30		260			
Zr-95	15					
Nb-95	15					
I-131	15(b)	7E-02		1	60	
Cs-134	15	5E-02	130	15	60	150
Cs-137	18	6E-02	150	18	80	180
Ba-140	15			60		
La-140	15			15		

(a) The LLD is defined, for purposes of these commitments, as the smallest concentration of radioactive material in a sample with 95% probability of detection and with 5% probability of falsely concluding that a blank observation represents a "real" signal.

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

$$LLD = \frac{(2.71 / T) + 4.65\, s_b}{E \times V \times 2.22 \times Y \times \exp(-\lambda \Delta t)}$$

Where:

LLD is the lower limit of detection as defined above (as pCi per unit mass or volume)

Sb is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute)

Table 16.11.6-2
Maximum Values for the Lower Limits of Detection (LLD) (a) (c)

E is the counting efficiency (as counts per disintegration)

V is the sample size (in units of mass or volume)

2.22 is the number of disintegrations per minute per picocurie

Y is the fractional radiochemical yield (when applicable)

λ is the radioactive decay constant for the particular radionuclide

Δt is the elapsed time between sample collection (or end of the sample collection period) and time of counting

T is the sample counting time in minutes

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

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

Analyses shall be performed in such a manner that the stated LLDs will be achieved under routine conditions. Occasionally background fluctuations, unavoidably small sample sizes, the presence of interfering nuclides, or other uncontrollable circumstances, may render these LLDs unachievable. In such cases, the contributing factors will be identified and described in the Annual Radiological Environmental Operating Report.

(b) LLD for gamma isotopic analysis for I-131 in drinking water samples. Low level I-131 analysis on drinking water will not be routinely performed because the calculated dose from I-131 in drinking water at all locations is less than 1 mrem per year. Low level I-131 analyses will be performed if abnormal releases occur which could reasonably result in > 1 pCi/liter of I-131 in drinking water. For low level analyses of I-131 an LLD of 1 pCi/liter will be achieved.

(c) Other peaks which are measurable and identifiable, together with the radionuclides in Table 16.11.6-2, shall be identified and reported.

Table 16.11.6-3
Reporting Levels for Radioactivity Concentrations in Environmental Samples (c) (d)

Analysis	Water (pCi/l)	Airborne Particulate or Gases (pCi/m^3)	Fish (pCi/kg, wet)	Milk (pCi/l)	Broad-leaf Vegetation (pCi/kg, wet)
H-3	2E04(a)				
Mn-54	1E03		3E04		
Fe-59	4E02		1E04		
Co-58	1E03		3E04		
Co-60	3E02		1E04		
Zn-65	3E02		2E04		
Zr-Nb-95	4E02				
I-131	2(b)	0.9		3	1E02
Cs-134	30	10	1E03	60	1E03
Cs-137	50	20	2E03	70	2E03
Ba-La-140	2E02			3E02	

(a) For drinking water samples. This is 40 CFR Part 141 value.

(b) If low level I-131 analyses are performed.

(c) Report shall be submitted when any single radionuclide exceeds the reporting level in Table 16.11.6-3 or when more than one of the radionuclides in Table 16.11.6-3 are detected in sampling medium and

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

(d) Report shall be submitted when radionuclides other than those in table 16.11.6-3 are detected and are the result of plant effluents 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 SLC 16.11.1 or 16.11.2.

BASES

The environmental monitoring program required by this commitment provides measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides which lead to the highest potential radiation exposures of individuals resulting from the station operation. This monitoring program thereby supplements the radiological effluent monitoring program by verifying that the measurable concentrations of radioactive materials and levels of radiation are not higher than expected on the basis of the effluent measurements and modeling of exposure pathways. The initially specified monitoring program will be effective for at least the first three years of commercial operation. Following this period, program changes may be initiated based on operational experience.

The detection capabilities required by Table 16.11.6-2 are considered optimum for routine environmental measurements in industrial laboratories. The specified lower limits of detection correspond to less than the 10 CFR 50. Appendix I, design objective dose-equivalent of 45 mrem/year for atmospheric releases to the most sensitive organ and individual. The land use census commitment is provided to assure that changes in the use of unrestricted areas are identified and that modifications to the monitoring program are provided if required by the results of this census.

The requirements for participation in an Interlaboratory Comparison Program is provided to assure that independent checks on the precision and accuracy of the measurements of radioactive material in environmental sample matrices are performed as part of a quality assurance program for environmental monitoring in order to demonstrate that the results are reasonably valid.

With the level of radioactivity in an environmental sampling medium at a specified location exceeding the reporting levels of Table 16.11.6-3 when averaged over any calendar quarter, in lieu of a Licensee Event Report, prepare and submit to the Commission within 30 days a Special Report that defines the corrective action to be taken to reduce radioactive effluents so that the potential annual dose to a MEMBER OF THE PUBLIC is less than the calendar year limits of SLC 16.11.1 or SLC 16.11.2. When more than one of the radionuclides in Table 16.11.6-3 are detected in the sampling medium, this report shall be submitted if

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

When radionuclides other than those in Table 16.11.6-3 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 SLC 16.11.1 or SLC 16.11.2. 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 Technical Specification 5.6.2. The methodology and parameters used to estimate the potential annual dose to a MEMBER OF THE PUBLIC shall be indicated in the 30-day Special Report.

The following requirement(s) were relocated from the CTS 6.4.4.f during the conversion to ITS.

The station shall have a program to monitor the radiation and radionuclides in the environs of the plant. The program shall provide (1) representative measurements of radioactivity in the highest potential exposure pathways, and (2) verification of the accuracy of the effluent monitoring program and modeling of environmental exposure pathways. The program shall (1) be contained in UFSAR Chapter 16, (2) conform to the guidance of Appendix I to 10 CFR Part 50, and (3) include the following:

1. Monitoring, sampling, analysis, and reporting of radiation and radionuclides in the environment in accordance with the methodology and parameters in the ODCM;
2. A Land Use Census to ensure that changes in the use of areas at and beyond the SITE BOUNDARY are identified and that modifications to the monitoring program are made if required by the results of this census; and,
3. Participation in an Interlaboratory Comparison Program to ensure that independent checks on the precision and accuracy of the measurements of radioactive materials in environmental sample matrices are performed as part of the quality assurance program for environmental monitoring.

<u>REFERENCES</u>:

1. 10 CFR Part 50, Appendix I.
2. Offsite Dose Calculation Manual.

16.11 RADIOLOGICAL EFFLUENTS CONTROL

16.11.7 Dose Calculations

COMMITMENT 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 ≤ 25 mrems to the total body or to any organ, except the thyroid, which shall be limited to ≤ 75 mrems.

APPLICABILITY: At all times

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Calculated doses from the release of radioactive materials in liquid or gaseous effluents exceeding twice the limits of SLC 16.11.1.b, SLC 16.11.2.b.1, or SLC 16.11.2.b.2	A.1 Determine by calculation, including direct radiation contributions from the reactor units and from outside storage tanks, whether the limits of Commitment 16.11.7 have been exceeded.	None

CONDITION	REQUIRED ACTION	COMPLETION TIME
B. Calculated dose exceeds limits of Commitment 16.11.7.	-------------------NOTE---------------- This Special Report, as defined in 10 CFR Part 20.2203(a), 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 the levels of radiation and concentration of radioactive material involved, and the cause of the exposure levels or concentrations. ---	
	B.1 Prepare and submit to the Commission a Special Report that defines the corrective action to be taken to reduce subsequent releases to prevent recurrence of exceeding the specified limits and includes the schedule for achieving conformance with the specified limits.	30 days

CONDITION	REQUIRED ACTION	COMPLETION TIME
C. Calculated dose exceeds limit of Commitment 16.11.7. AND Release condition resulting in violation of 40 CFR 190 not corrected at time of report submittal.	C.1 -----------NOTE----------- Submittal of the report is considered a timely request, and a variance is granted until staff action on the request is complete. ------------------------------- Include a request for a variance in accordance with the provisions of 40 CFR Part 190.	30 days from exceeding the limit

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 16.11.7.1	Determine cumulative dose contributions from liquid effluents in accordance with Offsite Dose Calculation Manual.	31 days
SR 16.11.7.2	Determine cumulative dose contributions from gaseous effluents in accordance with Offsite Dose Calculation Manual.	31 days

BASES

The dose commitment is provided to assure that the release of radioactive material in liquid and gaseous effluents will be kept "as low as is reasonably achievable." The dose calculations in the ODCM implement the requirements in Section III.A of Appendix I in that conformance with the guides of Appendix I is to be shown by calculations and procedures based on models and data such that the actual exposure of an individual through appropriate pathways is unlikely to be substantially underestimated.

REFERENCES:

1. 10 CFR Part 20.
2. 40 CFR Part 190.
3. Offsite Dose Calculation Manual.
4. 10 CFR Part 50, Appendix I.

16.11 RADIOLOGICAL EFFLUENTS CONTROL

16.11.8 Reports

COMMITMENT Special reports shall be submitted to the Regional Administrator, Region II, within the time period specified for each report. These reports shall be submitted covering the activities identified below pursuant to the requirements of the applicable SLC:

a. Radioactive Liquid Effluents,
Dose, SLC 16.11.1.b
Liquid Waste Treatment, SLC 16.11.1.c

b. Radioactive Gaseous Effluents,
Dose, SLC 16.11.2.b
Gaseous Radwaste Treatment, SLC 16.11.2.c

c. Radiological Environmental Monitoring Program, SLC 16.11.6.a, b, and c

d. Land Use Census, SLC 16.11.6.d

e. Dose Calculations, SLC 16.11.7

APPLICABILITY: At all times.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Individual milk samples show I-131 concentrations of 10 picocuries per liter or greater.	A.1 Submit plan advising the NRC of the proposed action to ensure the plant related annual doses will be within the design objective of 45 mrem/yr to the thyroid of any individual.	7 days

CONDITION	REQUIRED ACTION	COMPLETION TIME
B. Milk samples collected over a calendar quarter show I-131 average concentrations of 4.8 picoCuries per liter or greater	B.1 Submit a plan advising the NRC of the proposed action to ensure the plant related annual doses will be within the design objective of 45 mrem/yr to the thyroid of any individual.	30 days

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 16.11.8.1	NA	NA

BASES

Reference applicable commitments.

REFERENCES:

1. 10 CFR Part 20.
2. 40 CFR Part 190.
3. Offsite Dose Calculation Manual.

16.11 RADIOLOGICAL EFFLUENTS CONTROL

16.11.9 Radioactive Effluent Release Report

COMMITMENT

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

A single submittal may be made for a multiple unit station. The submittal shall combine those sections that are common to all units at the station; however, for units with separate radwaste systems, the submittal shall specify the release of radioactive material from each unit.

The Annual Radioactive Effluent Release Report shall include a summary of the quantities of radioactive liquid and gaseous effluents and solid waste released from the station during the reporting period.

The annual Radioactive Effluent Release Report shall include a summary of the meteorological conditions concurrent with the release of gaseous effluents during each quarter.

The Annual Radioactive Effluent Release Report shall include the following information for all unplanned releases to unrestricted areas of radioactive materials in gaseous and liquid effluents:

a. A description of the event and equipment involved;

b. Cause(s) for the unplanned release;

c. Actions taken to prevent recurrence; and,

d. Consequences of the unplanned release.

The Annual Radioactive Effluent Release Report shall include an assessment of radiation doses from the radioactive liquid and gaseous effluents released from the station during each calendar quarter. In addition, the unrestricted area boundary maximum noble gas gamma air and beta air doses shall be evaluated. The annual average meteorological conditions shall be used for determining the gaseous pathway doses. Approximate and conservative approximate methods are acceptable. The assessment of radiation doses shall be performed in accordance with the Offsite Dose Calculation Manual.

The Annual Radioactive Effluent Release Report shall include an explanation of why the inoperability of liquid or gaseous effluent monitoring instrumentation out of service for greater than 30 days was not corrected in a timely manner per SLC 16.11.3.

The Annual Radioactive Effluent Release Report shall include the following information for each type of solid waste shipped offsite during the report period:

a. Total container volume (cubic meters);

b. Total curie quantity (determined by measurement or estimate);

c. Principal radionuclides (determined by measurement or estimate);

d. Type of waste, (e.g., spent resin, compacted dry waste evaporator bottoms);

e. Number of shipments; and,

f. Solidification agent (e.g., cement, or other approved agents (media)).

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 Offsite Dose Calculation Manual (ODCM), as well as a listing of new locations for dose calculations and/or environmental monitoring identified by the land use census.

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 190, Environmental Radiation Protection Standards for Nuclear Power Operation. Methods for calculating the dose contribution from liquid and gaseous effluents are given in the ODCM.

APPLICABILITY: At all times.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. N/A	A.1 N/A	N/A

SURVEILLANCE REQUIREMENTS

SURVEILLANCE	FREQUENCY
SR 16.11.9.1 N/A	N/A

BASES

N/A

REFERENCES:

1. Oconee ITS.
2. Offsite Dose Calculation Manual.

16.11 RADIOLOGICAL EFFLUENTS CONTROL

16.11.10 Radiological Environmental Operating Report

COMMITMENT

Routine Radiological Environmental Operating Reports covering the operation of the unit during the previous calendar year shall be submitted by May 15 of each year.

The Annual Radiological Environmental Operating Report shall include summaries, interpretations. and statistical evaluation of the results of the radiological environmental surveillance activities for the report period, including a comparison with preoperational studies, operational controls (as appropriate), and previous environmental surveillance reports and an assessment of the observed impacts of the plant operation on the environment. The reports shall also include the results of the land use censuses. If harmful effects are detected by the monitoring, the report shall provide an analysis of the problem and a planned course of action to alleviate the problem.

The Annual Radiological Environmental Operating Report shall include a summary of the results obtained as part of the required Interlaboratory Comparison Program. The Interlaboratory Comparison Program shall be described in the Annual Radiological Environmental Operating Report.

The Annual Radiological Environmental Operating Report shall include summarized and tabulated results of the radiological environmental samples required by SLCs taken during the report period. In the event that some results are not available for inclusion with the report, the report shall be submitted noting and explaining the reasons for the missing results. The missing data shall be submitted as soon as practical in a supplementary report.

The initial report shall also include the following: a summary description of the radiological environmental monitoring program including sampling methods for each sample type, size and physical characteristics of each sample type, sample preparation methods, analytical methods, and measuring equipment used; a map of all sampling locations keyed to a table giving distances and directions from one reactor; and, the result of land use censuses. Subsequent reports shall describe all substantial changes in these aspects.

APPLICABILITY: At all times.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. NA	A.1 NA	NA

SURVEILLANCE REQUIREMENTS

SURVEILLANCE	FREQUENCY
SR 16.11.10.1 NA	NA

BASES

NA

REFERENCES:

1. Oconee ITS
2. Offsite Dose Calculation Manual

16.11 RADIOLOGICAL EFFLUENTS CONTROL

16.11.11 Iodine Radiation Monitoring Filters

COMMITMENT Assure that the iodine radiation monitoring filters perform their intended function.

APPLICABILITY: At all times.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. NA	A.1 NA	NA

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 16.11.11.1	Remove and replace iodine radiation monitoring filters in RIA-44.	30 days of operation
SR 16.11.11.2	Discard spare iodine radiation monitoring filters.	After manufacturer expiration date.

BASES

The purpose of this commitment is to assure the reliability of the iodine radiation monitoring charcoal filters. Plant procedures prevent the use of spare filters after the manufacturer expiration date.

REFERENCES:

1. Oconee CTS Amendment No. 3/3 SER date July, 1974.

16.11 RADIOLOGICAL EFFLUENTS CONTROL

16.11.12 Radioactive Material in Outside Temporary Tanks Exceeding Limit

COMMITMENT The quantity of radioactive material in outside temporary storage tanks shall not exceed the limit specified in ITS 5.5.13.c.

APPLICABILITY: At all times.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. The quantity of radioactive material in outside temporary storage tank not within limit.	A.1 Suspend addition of radioactive material to tank.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 16.11.12.1	Verify the quantity of radioactive material contained in each of the outside temporary tanks is within the limit by analyzing a representative sample of the tanks' contents.	Within 7 days after addition of radioactive materials to an outside temporary tank
	<u>OR</u>	
	Verify the quantity of radioactive material in each of the outside temporary tanks does not result in exceeding the limit by analyzing a representative sample of radioactive material to be added.	Prior to addition of radioactive materials to an outside temporary tank.

BASES

The requirement(s) of this SLC section were relocated from CTS 3.9.1.c during the conversion to ITS.

The tanks included in this specification are all those outdoor radwaste liquid storage tanks that are not surrounded by liners, dikes, or walls capable of holding the tank contents and that do not have tank overflows and surrounding area drains connected to the liquid radwaste treatment system. Restricting the quantity of radioactive material contained in the specified tanks provides assurance that in the event of an uncontrolled release of a tank's contents, the resulting concentrations would be less than the limits of 10CFR Part 20, Appendix B, Table II, Column 2, at the nearest potable water supply and the nearest surface water supply in an UNRESTRICTED AREA.

REFERENCES

N/A

16.11 RADIOLOGICAL EFFLUENTS CONTROL

16.11.13 Radioactive Material in Waste Gas Holdup Tank Exceeding Limit

COMMITMENT The quantity of radioactive material in the Waste Gas Holdup tanks shall not exceed the limit specified in ITS 5.5.13.b.

APPLICABILITY: At all times.

ACTIONS

--NOTE--

Separate Condition Entry is allowed for each tank.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. The quantity of radioactive material in the Waste Gas Holdup tank not within limit.	A.1 Suspend addition of radioactive material to tank. AND A.2 Reduce tank contents to within limit.	Immediately 48 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 16.11.13.1	Verify quantity of radioactive materials in each tank is within limit.	24 hours when tank is being filled

BASES

The requirement(s) of this SLC section were relocated from CTS 3.10.1.b and 3.10.1.c during the conversion to ITS.

Restricting the quantity of radioactivity contained in each waste gas holdup tank provides assurance that in the event of an uncontrolled release of the tank contents, the resulting total body exposure to an individual at the exclusion area boundary will not exceed 0.5 rem.

REFERENCE

UFSAR, Section 15.10

16.11 RADIOLOGICAL EFFLUENTS CONTROL

16.11.14 Explosive Gas Mixture

COMMITMENT The concentration of Hydrogen in the Waste Gas Holdup Tanks shall be ≤ 3% by volume.

APPLICABILITY: At all times.

ACTIONS

--NOTE--
Separate Condition Entry is allowed for each tank.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Concentration of Hydrogen in Waste Gas Holdup tank is > 3% and ≤ 4% by volume.	A.1 Reduce Concentration of Hydrogen to within limit.	48 hours
B. Concentration of Hydrogen in Waste Gas Holdup tank is > 4% by volume.	B.1 Suspend addition of waste gases to tank.	Immediately
	AND	
	B.2 Reduce Concentration of Hydrogen to within limit.	24 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 16.11.14.1	Verify Hydrogen concentration in Waste Gas Holdup Tank is ≤ 3% by volume.	5 times/week on each tank when in service AND once within 24 hours after isolation of the tank

BASES

The requirement(s) of this SLC section were relocated from CTS 3.10.2 and Table 4.1-3, Item 13 during the conversion to ITS.

This Commitment is provided to ensure that the concentration of potentially explosive gas mixtures contained in the Waste Gas Holdup Tanks is maintained below the flammability limits of hydrogen. (Administrative controls are used to prevent the hydrogen concentrations from reaching the flammability limit.) These controls include sampling each tank 5 times a week while in service, and/or once in 24 hours after isolation of the tank; injection of dilutants to reduce the concentration of hydrogen below its flammability limits provides assurance that the releases of radioactive material will be controlled in conformance with the requirements of GDC 60 of Appendix A to CFR Part 50.

REFERENCES

N/A

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

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2022 - 12/31/2022

Oconee PCP revision 18 was issued in 2022 and is a major rewrite of the entire document to add information from the DEC Corporate PCP to the ONS PCP in order to supersede the DEC Corporate PCP. References to the CNS and MNS PCPs were removed from the DEC Corporate PCP and the balance of the information was incorporated into Revision 18 of the ONS PCP. Additionally, references to CP/0/B/6001 Paint Filter Liquids Test were removed as an implementing procedure. Oconee PCP revision 18 is included in the 2022 ARERR.

Oconee Nuclear Station Process Control

Revision 18 (DRRs 02428885 & 02424996)

Reviews/ Approvals	Name
Prepared: ONS Station Sciences	R.W. Elliott
Reviewed: ONS Station Sciences/Radiation Protection	T. A. McCall
Reviewed: ONS Operations	David Corbett
Reviewed and Accepted: ORC / ONS Management / Radiation and Chemistry	Sheila Dalton
Reviewed and Accepted: ORC / ONS Management / Operations	Jamie Dodson
Reviewed and Accepted: ORC / ONS Management / Engineering	Todd Grant
Reviewed and Accepted: ORC / ONS Management / Maintenance	Doug Phelps
Approved: ORC / ONS Plant Manager	Paul Fisk

On-site Review Committee Review and Acceptance, Plant Manager Approval Documented in ORC meeting minutes: _02440988_____________ / _09/08/2022_
NTM# Date

OCONEE NUCLEAR STATION
PROCESS CONTROL PROGRAM

1. PURPOSE

The Oconee Nuclear Station (ONS) Process Control Program (PCP) addresses the requirements for solid radioactive waste referenced in Selected Licensing Commitments and Technical Specifications.

1.1 A Process Control Program (PCP) describes the administrative and operational controls used for the solidification of liquid or wet radioactive wastes and the dewatering of wet radioactive wastes. Its purpose is to assure that the final disposal waste product meets applicable Federal, State and Disposal Site waste form requirements for burial at a 10CFR61 licensed Low-Level Waste (LLW) disposal site.

1.2 Waste processing (solidification or dewatering) equipment and services may be provided by Duke Energy or approved vendors. Vendor services may be performed onsite or offsite. Any process used shall meet all applicable requirements of the PCP.

1.3 For waste processed onsite for direct disposal it is the responsibility of the LLW generator/ shipper to ensure that PCP requirements are met and that the condition of the waste is acceptable upon arrival at the disposal site.

1.4 For waste packaged and shipped to an approved off-site processor contracted to meet the requirements for direct disposal at a 10CFR61 licensed Low-Level Waste (LLW) disposal site, the final waste form requirements are not applicable prior to shipment to the processor for final processing and disposition.

2. APPLICABILITY

2.1 Liquid and Wet Radioactive Waste Disposal

2.1.1 Licensing documents, e.g., Final Safety Analysis Reports (FSAR), Tech Specs and SLCs, require that the Solid Radwaste System be operated in a manner to assure compliance with requirements for the transportation and disposal of LLW. They refer to the NRC requirement to follow a process control program for solidification of liquid or wet radioactive wastes or the dewatering of wet radioactive wastes to be shipped for direct disposal at a 10CFR61 licensed disposal site such that the final product meets all applicable disposal site requirements.

2.1.2 These "Process Control Program" requirements are applicable to all liquid or wet radioactive wastes that are being prepared for direct disposal at a 10CFR61 LLW disposal facility.

2.1.3 Radioactive wastes shipped for off-site processing in accordance with the processor's specifications and transportation requirements are not required to be solidified or dewatered to meet disposal requirements prior to shipment to an offsite processor. They are not subject to the final waste form solidification or dewatering requirements of this PCP as specified in 10CFR61 when an offsite processor is contracted to perform the PCP processing for disposal.

2.2 Mixed Waste

2.2.1 AD-EN-ALL-0700 Waste Management and Recycling describes handling of mixed waste at Duke Energy nuclear stations.

2.2.2 Disposal of Mixed Waste at a LLW disposal site is prohibited unless it is approved by the disposal site and meets federal, state and disposal site requirements. (E.g., 40CFR, 10CFR61, site waste acceptance criteria)

2.2.3 All vendors supplying services for Mixed Waste using solidification shall meet the applicable requirements of the PCP and be a Duke Approved Supplier of PCP Services.

2.2.4 PCP Subject Matter Experts (SMEs) and disposal site regulators shall approve the use of solidification for disposal of Mixed Waste.

2.2.5 If Mixed Waste is to be rendered non-hazardous for disposal at a 10CFR61 disposal site using solidification the final product and packaging must meet all the LLW disposal site requirements.

2.3 Radioactive Waste Oil

2.3.1 Radioactively contaminated oil is to be managed as described in AD-EN-ALL-0730 "Used Oil Management".

2.3.2 Offsite processors are available for waste oil treatment, (e.g., incineration) reducing the regulatory burden on the generating site. Nuclear site programs address the specific waste oil management processes available at the site.

2.3.3 Each LLW disposal site defines the acceptable threshold for incidental levels of waste petroleum-based oil (e.g., less than 1% by volume). Solidified waste containing oil shipped to a 10CFR61 disposal site shall meet the applicable requirements of the PCP and all applicable disposal site acceptance criteria.

2.3.4 If a LLW site accepts greater than incidental concentrations of oil to be solidified for disposal, an oil-specific procedure must meet the requirements of the PCP and the acceptance criteria of that disposal site.

2.4 Radioactive Waste Interim Storage

LLW requiring interim storage shall ensure that all of the following requirements that are applicable are met.

2.4.1 Any radioactive waste that is stored for an interim period in a shipping/ disposal container shall be packaged such that there is no detrimental interaction between the waste and its container.

2.4.2 If applicable, Certificates of Compliance shall be maintained for all waste shipping/ disposal containers used for interim storage.

2.4.3 Vendor supplied containers used for storage shall be handled and stored according to applicable guidance in vendor documents, including chemical compatibility requirements.

3. DEFINITIONS

3.1 10CFR Part 61 "Licensing Requirements for Land Disposal of Radioactive Waste"

This NRC regulation requires that low-level radioactive waste (LLW) meet certain waste form acceptance criteria to be received for disposal at NRC and Agreement State licensed radioactive waste disposal sites.

3.2 Free Standing Liquid (FSL)

FSL is liquid that is in a disposal container but is not bound by the waste in the container. FSL is the liquid available for release if disposal container integrity is lost (e.g., punctured). The amount of FSL in a radioactive waste disposal container shall be less than a specified threshold to meet 10CFR61, state and disposal site requirements for disposal.

3.3 Liquid Radioactive Wastes

Radioactive wastes comprised primarily of water containing a combination of dissolved and suspended solids (e.g., evaporator concentrates, lab wastes, floor and equipment drain water, laundry, wet waste decant or drainage, etc.).

3.4 Wet Radioactive Wastes

Wet radioactive wastes are solid radioactive wastes containing loosely bound liquid that can collect in the disposal container as FSL (e.g., slurry wastes are comprised primarily of solid particles suspended in loosely bound interstitial water, spent mechanical filters are solid materials that are adsorbent or porous and retain liquid).

3.5 Solidification

The meaning of the term Solidification during the original implementation of 10CFR61 was a process that converted radioactive waste into a product meeting 10CFR61, State and disposal site requirements for waste-form stability and FSL. Solidification was accomplished by mixing measured amounts of liquid or wet radioactive waste, binder and required additives that, after sufficient curing time, produce a solid homogeneous, freestanding monolith. At the end of the curing period, the absence of excessive FSL was verified either by confirmation that the PCP boundary conditions were met or by physical verification/testing. Under current practices, generally the solidified waste does not meet waste form stability requirements since few of the processes tested during the early implementation were able to do so. The waste container or barriers in site design or process used
at the disposal site meet the stability requirements. The process requirements described in the solidification section do not apply to encapsulation of discrete LLW items as described in the BTP for waste form.

3.6 High Integrity Container (HIC)

Disposal containers that have been approved by the NRC for disposal of Class A unstable, Class B or Class C LLW and meet the long term disposal requirements of 10CFR61 and the disposal site.

3.7 Dewatering

Dewatering as used in this document is the removal of liquid using a process that is required to meet the requirements of this PCP. Dewatering removes the loosely bound liquid from a wet radioactive waste such that accumulation of Free Standing Liquid in the disposal container is unlikely to approach the disposal limit threshold values as defined by applicable regulations and disposal site criteria. NRC regulations require that the process used to dewater radioactive wastes to meet disposal criteria shall be governed by a PCP.

3.7.1 10CFR61 FSL criteria requires less than 0.5% FSL by waste volume per container or less than 1.0% FSL if a high integrity container (HIC) is used.

3.7.2 Typically, liquid and wet wastes are pre-staged in vented tanks or containers and are therefore degassed prior to the dewatering process. However, all vendor required venting practices should be adhered to.

3.8 Unwatering ("Gross Dewatering", "dewatering to loss of vacuum")

Unwatering as used in this document is the removal of water using a process that is not required to meet the requirements for direct disposal at a 10CFR61 disposal site. Unwatering removes loosely bound excess or freeboard water from wet radioactive wastes such that only the requirements for transportation set forth in 49CFR are satisfied (e.g., unwatering may be to complete the first dewatering cycle for a specific container and waste stream to loss of vacuum to prepare waste for shipment to an approved offsite processor who will perform additional processing that will meet the final disposal requirements).

3.9 Mixed Waste

Defined in Resource Conservation Recovery Act (RCRA) as amended by the Federal Facility Compliance Act of 1992, a Mixed Waste contains both RCRA hazardous waste and source, special nuclear, or byproduct material subject to the Atomic Energy Act of 1954, as amended. The use of solidification to render Mixed Wastes non-hazardous shall ensure that the final product meets all waste form requirements applicable to radioactive waste disposal at a 10CFR61 disposal site (Ref: 3.1.6. “40 CFR Part 266”).

3.10 QA Approved Supplier List

Radwaste vendors approved to provide PCP processing are included on the Duke QA Approved Supplier List and are subject to the requirements and audits of that program.

3.11 Waste Batch

A "batch" shall be defined as an isolated quantity of waste to be processed having essentially consistent physical and chemical characteristics.

3.12 Waste Batch Mixing

A Waste Batch shall be adequately mixed using a proceduralized process such as agitation via mixers, air sparging or recirculating flow which meets a specified minimum rate that has been determined to provide a representative sample for the vessel.

3.13 Process Parameters

Those conditions measured or observed during a solidification or dewatering process to ensure an acceptable product. These are determined for each waste type and are specific to the process method used.

3.14 Boundary Conditions/ Acceptance Criteria

3.14.1 Solidification Boundary Conditions or Acceptance Criteria are defined as, the bounding numerical values for solidification process parameters that produce an acceptable product when shipped for direct disposal at a 10CFR61 disposal site.

3.14.2 Dewatering Boundary Conditions or Acceptance Criteria are defined as the bounding numerical values for process parameters that ensure free standing liquid requirements are met when shipped for direct disposal at a 10CFR61 disposal site.

3.14.2.1 Media: Acceptance Criteria for dewatering process media in disposal containers (e.g., HICs) have been determined by vendor tests using real or simulated waste to demonstrate the adequacy of the dewatering process for each combination of waste type and container. These tests are documented in dewatering Topical Reports, or equivalent, that shall be approved by the NRC or other appropriate authority before the containers are certified for use. The Acceptance Criteria are then incorporated into the dewatering procedures for each combination of waste type and container.

3.14.2.2 Filters: Acceptance criteria for mechanical filters (e.g., cartridge, bag, membranes, etc.) may be derived from tests performed on the various types of filters in use. Tests performed by Duke Energy should be documented in a retrievable manner. Acceptance criteria are then incorporated into the applicable procedure for each filter type (e.g., drainage time, drainage conditions, etc.).

3.14.2.3 Filters may also be packaged in disposal containers designed to allow the removal of free-standing liquid from the container prior to shipment for direct disposal based on the disposal site's waste acceptance criteria (WAC).

3.15 PCP Topical Report (NCRs 01740840, 01605371 and 01423659)

A Topical Report provides the basis for a PCP technology & process. It documents test results that demonstrate regulatory requirements were met during the regulatory required testing for solidification or dewatering technologies and processes. For a time after implementation of 10CFR61 the NRC approved processes developed to dewater or solidify waste based their review of the Topical Report for that process. The NRC no longer performs the approval of Topical Reports, so this approval is typically the responsibility of the disposal site host agreement state regulatory authorities. Topical report testing was designed to envelop the worst-case dewatering scenarios given the industry's then current practices. As with any topical based program, the critical conditions and parameters identified during testing are incorporated into the implementing process with enough conservative margin to ensure success if you operate within the enveloping conditions and assumptions of the tests performed. When actual conditions vary from the conditions in the specific tests performed for the Topical Report, the correlation with the Topical testing is diminished and degree of processing conservatism may need to increase to compensate.

4. RESPONSIBILITIES

4.1 Process Control Program Content and Implementation

The PCP is owned, sponsored, and administrated by individuals designated by ONS management pursuant to the requirements of site licensing documents. These individuals may be designated as PCP subject matter experts (SME) or program owners. Their responsibilities may include:

4.1.1 Revise and publish the PCP.

4.1.2 Technical contact for PCP issues.

4.1.3 Provide review and approval of PCP service providers.

4.1.4 Provide review and approval of radioactive waste processors and manage vendor service and disposal contracts for the fleet.

4.1.5 Review PCP revisions.

4.2 Oversight and Audits

Audits of the Process Control Program and implementing procedures for processing of radioactive wastes shall be performed per DUKE QADP-001-A.

4.3 PCP Responsibilities

The PCP applies to liquid or wet radioactive waste generated at ONS when it is solidified or dewatered for direct disposal at a 10CFR61 disposal site. Any group that has responsibility for activities that generate or manage these wastes shall ensure their programs and processes comply with and support compliance with the applicable portions of the PCP. The following responsibilities are applicable to any group performing PCP related activities. Any changes in these responsibilities and the groups to whom they are assigned should be evaluated for impact and potential incorporation into applicable PCP documents.

4.3.1. On-Site Review Committee (ORC)

4.3.1.1. Reviews and approves PCP changes in accordance with AD-CP-ALL-0030, Process Control Program (PCP) Review and Revision, and as defined in Section 6, Administration of the PCP and Support Documents.

4.3.2. Plant Manager

4.3.2.1. Reviews and approves PCP changes in accordance with AD-CP-ALL-0030, Process Control Program (PCP) Review and Revision, and as defined in Section 6, Administration of the PCP and Support Documents.

4.3.3. Station Sciences Manager or designee

4.3.3.1. Ensure radioactive waste is shipped in accordance with the appropriate state and federal regulations.

4.3.3.2. Advise the Plant Manager on the appropriate technical standards, regulations, and requirements as related to solidification, dewatering and shipping.

4.3.3.3. Ensure the vendor's PCP and proposed contractual agreements are revised and advising the Plant Manager as to their adequacy

4.3.3.4. Ensure vendor supplied documentation is retained for NRC inspection and review.

4.3.3.5. Reviews and approves PCP changes in accordance with AD-CP-ALL-0030, Process Control Program (PCP) Review and Revision, and as defined in Section 6, Administration of the PCP and Support Documents.

4.3.3.6. Ensure vendor's PCP and operating procedures are reviewed and approved as required.

4.3.4. Site Staff Personnel (Station Sciences and Operations)

4.3.4.1. Provide technical support for PCP issues.

4.3.4.2. Perform PCP revisions in accordance with AD-CP-ALL-

0030, Process Control Program (PCP) Review and Revision.

4.3.4.3. Generate Document Revision Requests (DRRs) to support PCP revisions in accordance with AD-CP-ALL-0030, Process Control Program (PCP) Review and Revision.

4.3.4.4. Review PCP revisions in accordance with AD-CP-ALL-0030, Process Control Program (PCP) Review and Revision.

4.3.4.5. Ensure corporate programs comply with applicable PCP requirements.

4.3.4.6. Support nuclear site programs in complying with PCP requirements.

4.3.4.7. Review vendor PCP and operating procedures.

4.3.4.8. Ensure PCP revision summary is provided in accordance with AD-CP-ALL-0023, Preparation of the Annual Radioactive Effluent Release Report.

4.3.4.9. Approve the use of solidification for disposal of Mixed Waste.

4.3.5. Operations Manager or designee

4.3.5.1. Monitor vendor operations to assure compliance with UFSAR and SLC requirements and procedural and contractual agreements.

4.3.5.2. Ensure vendor's PCP and operating procedures are reviewed and approved as required.

4.3.5.3. Reviews and approves PCP changes in accordance with AD-CP-ALL-0030, Process Control Program (PCP) Review and Revision, and as defined in Section 6, Administration of the PCP and Support Documents

5. ONS and VENDOR PCP IMPLEMENTING PROCEDURES

Operations Radwaste Procedures

5.1 OP/0/A/1104/072 “Resin Recovery System”

5.2 OP/0/A/1104/078 “Radwaste HIC Dewatering & Operating Guidelines”

5.3 OP/0/A/1104/070 “Radwaste Powdex Liner Dewatering and Operating Guidelines”

5.4 OP/0/A/1104/080 “LW Demineralizers Sluice and Reload and BFST Transfer”

5.5 OP/0/A/1104/082 “Resin Batch Tank Sluice”

Radiation Protection Procedures

5.6 HP/0/B/1006/012 "Handling Procedure for High Integrity Containers"

5.7 AD-RP-ALL-5000 "Preparation and Shipment of Radioactive Material and Radioactive Waste"

Vendor Documents

5.8 FO-AD-002, Operating Guidelines for Use of Polyethylene High Integrity Containers

5.9 CS-OP-PR-008, Setup and Operation of Energy Solutions Self-Engaging Dewatering System Fillhead.

5.10 CS-OP-PR-009, Ecodex Precoat/Powdex/Solka-Floc/Diatomaceous Earth/Zeolite Dewatering Procedure for Energy Solutions 14-215 Or Smaller Liners Utilizing Energy Solutions Self-Engaging Dewatering System (S.E.D.S.)

5.11 CS-OP-PR-010, Bead Resin/ Activated Carbon Dewatering Procedure for Energy Solutions 14-215 Or Smaller Liners, Utilizing Energy Solutions Self-Engaging Dewatering System (S.E.D.S.)

5.12 FO-OP-022, Ecodex Pre-Coat/Powdex/Solka-Floc/Diatomaceous/ Earth/Zeolite Dewatering Procedure for Energy Solutions 14-215 Or Smaller Liners

5.13 FO-OP-023, Bead Resin/Activated Carbon Dewatering Procedure for Energy Solutions 14-215 Or Smaller Liners

5.14 FO-OP-033, Set Up and Operation of Universal Dewatering Fillhead

5.15 FO-OP-073, Removing Free Standing Water from Energy Solutions FEXM HICS

6. ADMINISTRATION OF THE PCP AND SUPPORT DOCUMENTS

6.1 PCP Changes: Revisions and Minor Changes

PCP document revisions and minor changes are initiated, reviewed, and approved following the applicable guidance in licensing documents and administrative procedures. The guidance for and descriptions of what constitutes a minor change and revision are:

6.1.1 The Duke Energy QADP implementation guidance is in procedure AD-LS-ALL-0019, On-Site Review Committee. This procedure describes when an ORC should be notified of changes to site documents. E.g., where NRC notification of the change is required prior to implementation.

6.1.2 Technical or significant changes to PCP documents shall be implemented as a Revision to the affected documents by the Preparer or SME and include reviews and approvals by the Operations and Station Sciences managers, and other site management as required by AD-CP-ALL-0030, Process Control Program (PCP) Review and Revision.

6.1.3 PCP MINOR CHANGES: If a change meets the following criteria, it does not require a revision. Reviews and approvals are performed by the Preparer’s management as required by AD-CP-ALL-0030, Process Control Program (PCP) Review and Revision:

6.1.3.1 The change is editorial in nature, e.g., spelling, grammar, format, numbering, procedure name change, adding, deleting, or changing a reference, only includes administration of the documents affecting only the preparer.

6.1.3.2 The change does not alter the scope, results, requirements, methods by which the dewatering or solidification process is performed from requirements described in the applicable PCP document.

6.1.3.3 The change does not alter the responsibilities of site personnel in meeting the PCP requirements.

6.1.3.4 The change does not alter a PCP QA approved provider dewatering or solidification process, responsibilities for fulfilling PCP requirements or the vendor interface with the station personnel or work processes described in the PCP documents.

6.2 PCP Document Revision Record Retention Requirements

See Duke Energy Record Retention Requirements in AD-DC-ALL-0002, Records Management.

6.3 PCP Revision Reports to the NRC

Revisions to the ONS PCP shall be included annually in the ONS ARERR as described in the site's licensing documents. The required documentation for the ARERR shall be provided using the process and procedures for preparation of the ARERR.

6.4 PCP Document Revision Record Retention Requirements

See Duke Energy Record Retention Requirements.

1.5 PCP Implementing Procedure Requirements

6.5.1 Station procedures that implement PCP requirements shall ensure that all requirements for solidification or dewatering are met when performed by Duke Energy workers per ONS PCP documents.

1.5.1.1 The ONS PCP implementing procedures are listed in this document and published in the Duke EDMS. Completed procedures documenting the onsite solidification verification records shall be retained by the site on each vessel of solidified waste.

1.5.1.2 Documentation of the onsite dewatering verification records shall be retained on each vessel of dewatered waste.

6.5.2 The technical PCP implementing procedures shall identify the fact that they are PCP related to ensure technical reviews consider the PCP requirements.

6.5.3 All revisions to technical PCP implementing procedures listed in the ONS PCP shall be reviewed to determine if they alter or inhibit the procedure's performance of the ONS PCP requirements.

6.5.4 QA Approved Suppliers' procedures may be used for onsite PCP activities using non-plant equipment as described in applicable administrative procedures. (e.g., AD-DC-ALL-0201 Development and Maintenance of Controlled Procedure Manual Procedures)

7. REFERENCES

7.1 Regulatory Requirements

The use of and content of the PCP addresses requirements found in the following regulations:

7.1.1 10CFR20, “Standards for Protection Against Radiation”

7.1.2 10CFR50, “Domestic Licensing of Production and Utilization Facilities”

7.1.3 10CFR61, “Licensing Requirements for Land Disposal of Radioactive

Waste"

7.1.4 10CFR71, "Packaging and Transportation of Radioactive Material"

7.1.5 40CFR, "Protection of Environment"

7.1.6 40CFR266 "Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities"

7.1.7 Licensed radioactive waste burial site criteria

7.1.8 State hazardous waste regulations

7.2 Regulatory Guidance and Industry Standards

Technical guidance is provided in the following documents to standardize compliance with the applicable regulations:

7.2.1 NUREG-0133, "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants"

7.2.2 NUREG-0452, "Standard Technical Specifications for Westinghouse PWR's" (Superseded by NUREG 1431)

7.2.3 NUREG-1431 "Standard Technical Specifications Westinghouse Plants"

7.2.4 NUREG-1430 "Standard Technical Specifications Babcock and Wilcox Plants"

7.2.5 NUREG-800 "Standard Review Plan", Section 11.4 "Solid Waste Management Systems"

7.2.6 NUREG 800, Section 11.4, Appendix -A, "Design Guidance for Temporary Onsite Storage of Low Level Radioactive Waste"

7.2.7 Branch Technical Position - ETSB 11-3, "Design Guidance of Solid Radioactive Waste Management Systems"

7.2.8 NRC Review Criteria for Solid Waste Management Systems

7.2.9 Regulatory Guide 1.143, "Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Plants"

7.2.10 NRC "TECHNICAL POSITION ON WASTE FORM" Revision 1 (January 1991)

7.2.11 NRC "Concentration Averaging and Encapsulation Branch Technical Position", Rev 1 (2015)

7.2.12 ANSI/ANS-40.37-2009 “mobile radioactive waste processing systems”

7.3 ONS License Documents and Duke Energy Programs that Interface with the PCP

7.3.1 AD-CP-ALL-0023, Preparation of the Annual Radioactive Effluent Release Report

7.3.2 AD-CP-ALL-0030, Process Control Program (PCP) Review and Revision

7.3.3 AD-RP-ALL-5000, Preparation and Shipment of Radioactive Material and Radioactive Waste

7.3.4 AD-RP-ALL-5002, 10 CFR 61 Radioactive Waste Classification

7.3.5 ONS Technical Specification 5

7.3.6 ONS SLC 16.11

7.3.7 ONS UFSAR Chapter 11

7.3.8 Duke Energy Corporation Topical Report: Quality Assurance Program Description Operating Fleet (DUKE-QAPD-001 -A)

7.3.9 AD-DC-ALL-0002, Records Management

7.3.10 AD-DC-ALL-0201, Development and Maintenance of Controlled Procedure Manual Procedures

7.3.11 Duke Energy Information Retention Policy

Ref: (Legal 109, 10CFR20 Appendix G (III.A.3), 10CFR61.80)

7.3.12 AD-EN-ALL-0700, Waste Management and Recycling

7.3.13 AD-EN-ALL-0730, Used Oil Management

7.3.14 AD-LS-ALL-0019, On-Site Review Committee

AD-RP-ALL-5000, Preparation and Shipment of Radioactive Material and Radioactive Waste

8. APPROVAL PROCESS FOR QA APPROVED SUPPLIERS

Any PCP service supplier shall be approved and incorporated into the QA Approved Supplier Program prior to being used as contracted for process services that use a dewatering or solidification PCP to meet final waste form requirements at a 10CFR61 disposal site.

8.1. Technical Review and Approval

Before vendors can provide PCP related services, they shall be evaluated against the applicable ONS PCP documents and approved by the appropriate designees.

8.1.1. If the vendor provides PCP related services, the vendor PCP and other related program documents are evaluated to ensure they meet the applicable requirements of the Duke Energy PCP documents.

8.1.2. The results of these reviews should be documented appropriately for future reference.

9. PCP REQUIREMENTS FOR VENDOR PROCESSES AND SERVICES

9.1 Topical Report (or equivalent)

Any vendor service or vendor supplied processes utilized for solidification or dewatering by Duke Energy shall have a Topical Report or other form of certification documenting appropriate regulatory approval of the process and associated containers or shall supply to Duke Energy sufficient documentation of the process and test results to demonstrate that an acceptable product will be produced using the described solidification or dewatering process.

9.2 10CFR61 Waste Form Compliance

9.2.1 The vendor(s) approved for solidification or dewatering services shall have regulatory certification documenting compliance with waste form requirements in the final product or shall supply Duke Energy sufficient documentation to demonstrate waste form compliance.

9.2.2 Any vendor providing High Integrity Containers (HIC's) to Duke Energy shall provide proof of regulatory approval documenting compliance with waste form requirements or shall supply Duke Energy sufficient documentation to demonstrate waste form compliance.

9.2.3 All vendor Topical Reports or equivalent shall certify that the final product conforms to the applicable waste form for Class A, B, or C waste.

9.2.4 Vendor PCP Service Quality Requirements QA Approved PCP Service Suppliers shall meet the applicable quality requirements set forth in their contract or specific Purchase Order.

9.3 10CFR61Waste Classification Compliance

Each container of processed (i.e., solidified or dewatered) waste shall meet the requirements in AD-RP-ALL-5002, 10 CFR 61 Radioactive Waste Classification prior to disposal.

9.4 Minimum Requirements for Onsite Process Vendors

9.4.1 Vendors providing PCP services onsite shall be approved QA Suppliers.

9.4.2 PCP Vendors shall fulfill all the applicable requirements in the vendor Radioactive Waste PCP and the applicable quality requirements set forth in the contract prior to shipment of the solidified or dewatered waste for direct disposal.

9.4.3 Onsite Vendor System/Equipment Interface Requirements:

9.4.3.1 The vendor documentation, drawings or diagrams supplied to Duke Energy shall include adequate system or process description including all vendor interfaces with installed plant equipment and potential release pathways.

9.4.3.2 Solidification system radioactive effluents are treated or routed to the appropriate plant system to meet effluent discharge requirements.

9.4.3.3 Decanted radioactive liquid is processed as required or routed to the station liquid radwaste systems.

9.4.4 Onsite Vendor Supplied System Design Requirements

9.4.4.1 The vendor proposal and contract shall verify that the design, construction, operation, and quality assurance provisions are in accordance with applicable portions of NRC ETSB Branch Technical Position 11-3 and Regulatory Guide 1.143.

9.4.4.2 Permanent or portable solidification and dewatering systems shall meet the applicable design, construction, operation and quality assurance provisions of NRC ETSB Branch Technical Position 11-3 and Regulatory Guide 1.143.

9.5 Minimum Requirements for Offsite PCP Process Vendors

QA Approved Supplier Vendors providing PCP services offsite shall meet the requirements of their PCP process and the applicable quality requirements set forth in the contract and/or purchase order prior to disposal of the final product.

10. PCP DEWATERING PROCESS DESCRIPTION

The methods used for removal of liquid from wet wastes for final disposal shall comply with the specific requirements of the disposal site at which the waste is being disposed. Dewatering of wet wastes shall be performed in accordance with the applicable PCP requirements equivalent to the process described below. PCP workers shall use approved procedures in a controlled and quality fashion which ensures that all applicable license documents and disposal site criteria are met. Procedures used to direct dewatering shall include enough detail to ensure requirements are met.

10.1 Dewatering Mechanical Filters (e.g., cartridge, bag, membrane)

10.1.1 The dewatering process must ensure subsequent accumulation of free-standing liquid in the disposal container is not likely to approach disposal site limits.

10.1.2 The FSL requirements for direct disposal may be met using a container and procedure designed to remove any subsequent FSL accumulation in the container prior to disposal.

10.1.3 Wet spent mechanical filters can be dewatered by several methods including allowing liquid to gravity drain from the filter, blowing the filter down with air, compacting the filter, etc.

10.1.4 The method of dewatering shall be in accordance with a defined, evaluated, and documented process.

10.1.5 The parameters of the process, referred to as boundary conditions, shall be defined and used to ensure quality in the process, which in turn serves to ensure an acceptable characteristic of the waste. An example of a boundary condition is the specified period of time for which a mechanical filter shall be allowed to drain freely to ensure FSL will be less than disposal requirements.

10.1.6 Filters placed in a filter disposal container designed for removal of FSL shall meet the PCP boundary conditions for dewatering the container.

10.1.6.1 If PCP boundary conditions are met after placing the filter in the disposal container, the container shall be dewatered to ensure the container FSL meets disposal requirements.

10.1.6.2 If the PCP boundary conditions have been met prior to placing the filters in the disposal container, dewatering the container to remove incidental FSL is at site discretion.

10.1.6.3 Case-by case circumstances, such as the following, should be considered in determining the appropriateness of performing additional filter disposal container dewatering:

- The time interval between removal of the filters from wet service and placement into the disposal container
- Size of the disposal container relative to the moisture content in the filters
- The number of filters
- The variety of filter types in a single container
- The environmental conditions of filter staging and interim storage

10.1.7 Use of absorbent package material in mechanical filter disposal containers is subject to the requirements of the disposal site acceptance criteria.

10.2 Dewatering Slurries

The guidance below addresses dewatering issues associated with slurry wastes.

10.2.1 Dewatering of “slurried” wet wastes (e.g., resin, carbon, Zeolite, filter precoat, filter backwash solids) removes the loosely bound interstitial liquid from solids such that the disposal container meets applicable regulatory and burial site FSL criteria for disposal.

10.2.2 Wet spent process media dewatering shall be performed using processes, containers and procedures that have met the PCP approval requirements.

10.2.3 Typical container dewatering processes use a vacuum pump that takes suction from the container through a filter system in the container. The water is returned to a station liquid radwaste system, and the waste solids are retained in the vessel by the container filter(s).

10.3 Additional Conservatism in Slurry Dewatering Procedures to Address Variation from the Topical Report (NCRs 01740840, 01605371 and 01423659)

This section only applies to dewatering for direct disposal at a 10CFR61 disposal site performed by Duke Energy workers using ONS dewatering procedures. This section does not apply to QA Approved Suppliers performing PCP activities.

Dewatering processes based on approved and documented testing (e.g., Topical Reports) are applied to actual conditions that can vary from the conditions of the original testing. The results of a Root Cause investigation at ONS (NCR 01740840) identified several issues and resolutions that should be incorporated into applicable Duke dewatering implementing procedures. Vendor procedures applicable to the technologies and processes used by Duke Energy in implementing the PCP provide the basis for minimal requirements in PCP implementing procedures. In addition, the guidance below was added based on the Root Cause findings at ONS:

10.3.1 All ONS PCP dewatering procedures shall include flexibility/ guidance for the worker to add conservatism to the dewatering process if waste content and/ or process conditions are atypical in a non-conservative manner relative to the testing performed for the Topical report. (e.g., presence of greater than normal non- media solids, dewatering boundary parameters are not easily met, higher than normal volume of FSL is collected during the final dewatering cycle, etc.)

10.3.1.1 Additional conservatism can include but is not limited to the following examples:

A. Additional dewatering cycles

B. Additional settling time between pumping periods

C. Additional processing by an approved offsite vendor to verify FSL prior to disposal

10.3.2 Guidance for dewatering all liners using the ONS PCP and procedures for direct disposal at Barnwell (NCR 01740840 CAPR)

10.3.2.1 Require liner functional testing prior to filling liner with waste to ensure there are no leaks in the liner dewatering system. This testing should include:

A. filling the liner with water

B. testing each level of the liner dewatering laterals using the dewatering procedure to unwater the liner

C. verifying that vacuum is not broken prior to exposing the filters for each set of laterals as described in the procedure

10.3.2.2 Ensure ambient temperature guidance for dewatering will preclude localized freezing conditions during the dewatering sequence. After most of the water is removed during the first dewatering cycle, subsequent cycles pull air through the interstitial spaces of the media and the loss of heat due to evaporation can depress the temperature on surface of the media and dewatering filters below ambient temperature.

A. Follow guidance in the vendor documentation for the process in use

B. If no other guidance is provided, dewatering should not be performed unless ambient temperature of air entering the liner is 40 degrees Fahrenheit or higher (ref. EnergySolutions procedure FO-OP-022)

10.3.2.3 Ensure final water collection sample point is representative (e.g., as close as possible to the pump discharge)

10.3.3 Mixed Media: Additional guidance for dewatering liners containing Mixed Media with significant non- media solids using a PCP for direct disposal at a 10CFR61 disposal site. (NCR 01740840 CAPR)

The guidance below applies to liners containing combinations of different media with significant quantities of non-media solids (e.g., layered spent zeolite, carbon, resin, etc. containing a large amount of non-media particulate)

10.3.3.1 Require dewatering filters with maximized surface area (e.g., Ecodex filter or equivalent) in all liners that contain mixed media with significant non-media solids

10.3.3.2 Clearly specify media loading sequence if media is not homogeneously mixed to minimize potential blinding of the lowest level of filters. (e.g., for layered media, use the media with the fewest non-media solids and most consistent and largest diameter beads in the bottom of the liner)

10.3.3.3 Require additional dewatering Cycles (e.g. 3 additional cycles after the acceptance criteria in the vendor procedure have been met)

10.3.3.4 Require longer settling periods during the additional dewatering cycles (e.g., 24 hours instead of the 16 hours required in the vendor procedure)

10.3.3.5 The PCP implementing procedures must comply with the vendor PCP guidance and procedures applicable to the dewatering system and disposal containers in use. e.g., If the vendor process control program and procedures applicable to the current system and process require dewatering through the bottom 2 laterals during liner filling this must be reflected in the ONS procedures

10.4 Dewatering Process Requirements

The procedures directing dewatering processes shall address all the following activities that apply to the specific waste type being dewatered.

10.4.1 Waste Characterization

Dewatered waste is characterized according to AD-RP-ALL-5002, 10CFR61, Radioactive Waste Classification. The characterization information determines what disposal and container requirements apply and may also be utilized to determine shipment packaging requirements (e.g., shielding). Much of the required information for slurry waste is obtained using a representative sample of the waste media. Characterization requires the following types of information:

10.4.1.1 Radioactivity content

A. To determine 10CFR61 waste class, form and container requirements

B. To provide waste radiological characteristics for packaging, transportation and disposal requirements

10.4.1.2 Waste compatibility with disposal container and process method

A. Chemical Compatibility: Process knowledge can be applied to determine chemical compatibility with the container.

B. Hazardous Characteristics: Process knowledge can be applied to determine if the waste is a Mixed Waste.

C. If process knowledge is uncertain due to a potential input of incompatible or hazardous materials, then chemical analysis using an approved method shall be performed to determine chemical compatibility or hazardous characteristics.

10.4.2 PCP process parameters shall be identified in implementing procedures. Typical parameters are based on:

10.4.2.1 Waste form (e.g., physical, chemical and radiological characteristics)

10.4.2.2 Settling time

10.4.2.3 Drain (or pump) time

10.4.2.4 Temperature

10.4.2.5 Drying time

10.4.3 PCP boundary conditions shall be established for applicable process parameters to verify FSL threshold limits are met.

10.4.4 Sample analysis results and boundary conditions shall be reviewed by the appropriate knowledgeable individual responsible for the dewatering process.

10.4.5 Actual dewatering shall be performed using approved procedures that ensure the process is performed within the established boundary conditions.

10.5 Product Verification

The amount of free-standing liquid shall be verified to be within disposal site criteria for each container of dewatered waste prior to disposal (e.g., 10CFR61 requires that each container shall have less than 0.5% free-standing liquids by waste volume or less than 1.0% freestanding liquid if a High Integrity Container (HIC) is used). Procedures should include guidance for problems during container loading or processing that preclude or fail to meet PCP requirements as required in SLC Remedial Action Requirements.

10.5.1 PCP Verification may be accomplished by documenting that the Process Control Program was followed.

10.5.2 A disposal site may define a product verification testing method approved for use for specific waste disposal categories in lieu of a process control method.

10.5.2.1 That approved product verification process may be used for that category of disposal on a case-by-case basis, (e.g., bulk waste noncontainerized disposal).

10.5.2.2 Documentation of the method used for product verification and the results shall be included in the dewatering record as described in the Dewatering Documentation Retention section below.

10.5.2.3 Make programmatic changes as necessary to address any problems identified.

10.5.3 The PCP and site procedures must address the Commitments in the "The Solid Radioactive Wastes" sections of SLC 16 "RADIOLOGICAL EFFLUENTS CONTROLS". These Commitments include a description of the PCP purpose, and requirements for the use of the PCP to process LLW for direct disposal.

10.5.3.1 Remedial Actions address the following conditions:

A. Requirements not met by process or packaging conditions

B. Solidification verification failures

C. Processing not performed per PCP

D. Inoperable Equipment

10.5.3.2 Solidification processes must meet Testing or Surveillance requirements and frequencies

10.6 Dewatering Document Retention

Documentation of dewatering or solidification completed onsite for direct disposal at a 10CFR61 disposal site shall be retained as part of the radiological shipping and disposal records as described in the applicable procedures and documents. (e.g., PCP implementing procedures, AD-RP-ALL-5000, vendor documents)

11. PCP SOLIDIFICATION PROCESS DESCRIPTION

This section historically described a solidification process for liquid or media LLW in which a radioactive liquid or slurry waste was uniformly mixed into a binding matrix to create a physically uniform final waste form that is a homogeneous, free-standing monolith and meets10CFR61 waste form stability and FSL disposal requirements.

No installed solidification systems are operational at ONS because they were not able to meet all the 10CFR61 disposal requirements and / or were not cost effective. The solidification of liquids and slurry media if required is now performed via contracts with PCP QA approved suppliers under their PCP in controlled and quality fashion which ensures that all applicable regulatory, licensing and disposal site criteria are met. e.g. the applicable Commitments in the “The Solid Radioactive Wastes” sections of SLC 16 “RADIOLOGICAL EFFLUENTS CONTROLS”.

Only the FSL disposal requirements apply to solidification for encapsulation of discrete LLW items as described in the BTP for waste form. Encapsulation is also performed via contracts with PCP QA approved suppliers.

12. REVISION SUMMARY

This section describes the changes in the current revision of the ONS PCP.
This revision 18 is a rewrite of the entire document, retaining the general structure with changes in every section. Ref: (DRRs 02428885 & 02424996)

The changes to the ONS PCP are made under AD-CP-ALL-0030, Process Control Program (PCP) Review and Revision. This change is a total rewrite of ONS PCP R17 resulting from the Duke Fleet decision to delete DEC Corporate PCP R16. This change does not affect any technical, regulatory or license basis guidance within ONS

PCP R17.

Updated to reflect current organization and programs:

12.1	Updated Roles and Responsibilities to include organizational and individual ownership Ref: (NCR 02421323)
12.2	Updated administration, review, and approval for the ONS PCP Ref: (NCR 02421323)
12.3	Updated ONS PCP to include information from DEC Corporate PCP R16 for the purpose of providing a valuable basis behind the implementing procedures and overall PCP foundational philosophy.
12.4	Deleted Step 3.6 CSD-CP-ONS-L903, Paint Filter Liquids Test, (Superseded CP/0/B/6001/018) from ONS PCP Rev 17 listed Implementation Procedures. The method is not used by Operations or within the Fleet to meet 10CFR61 requirements. (DRR 02424996)

ATTACHMENT 11

Summary of Major Modifications to the Radioactive Waste Treatment Systems

This attachment includes a description of major modifications to the radioactive waste treatment systems that are anticipated to affect effluent releases.

Attachment 11
Summary of Major Modifications to the Radioactive Waste Treatment Systems

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2022 - 12/31/2022

No major modifications to Oconee Nuclear Station liquid, gaseous, solid, or mobile radioactive waste treatment systems occurred in 2022.

<u>ATTACHMENT 12</u>

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

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2022 - 12/31/2022

There are 2 changes to a previous year's ARERR.

The following contains amended pages to the Oconee Nuclear Station 2019 and 2020 ARERR. Amended pages are identified with "Amendment #" on page. Specific changes are identified with change bars in right margin.

The Oconee Nuclear Station 2019 ARERR Amendment #2 requires the following changes to Attachment 1 (Reference NCR 02432377).

Oconee Nuclear Station 2019 ARERR Attachment 1 Page 1-7 as submitted:

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Products *						
1. Total Release	Ci	2.19E-04	1.51E-04	1.08E-04	0.00E+00	4.78E-04
2. Avg. Diluted Conc.	µCi/ml	5.95E-14	3.32E-14	3.19E-14	0.00E+00	0.00E+00
3. Batch Releases	µCi/ml	2.61E-11	1.79E-11	1.27E-11	0.00E+00	0.00E+00
B. Tritium						
1. Total Release	Ci	1.51E+02	1.04E+02	2.78E+02	4.09E+02	9.43E+02
2. Avg. Diluted Conc.	µCi/ml	6.14E-08	3.78E-08	1.03E-07	1.92E-07	0.00E+00
3. Batch Releases	µCi/ml	1.80E-05	1.23E-05	3.25E-05	4.78E-05	0.00E+00

Oconee Nuclear Station 2019 ARERR Attachment 1 Page 1-7 Amendment #2 as revised:

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
C. Fission and Activation Products *						
1. Total Release	Ci	2.19E-04	1.51E-04	1.08E-04	0.00E+00	4.78E-04
2. Avg. Diluted Conc.	µCi/ml	5.95E-14	3.32E-14	3.19E-14	0.00E+00	3.12E-14
3. Batch Releases	µCi/ml	2.61E-11	1.79E-11	1.27E-11	0.00E+00	1.42E-11
D. Tritium						
1. Total Release	Ci	1.51E+02	1.04E+02	2.78E+02	4.09E+02	9.43E+02
2. Avg. Diluted Conc.	µCi/ml	6.14E-08	3.78E-08	1.03E-07	1.92E-07	9.86E-08
3. Batch Releases	µCi/ml	1.80E-05	1.23E-05	3.25E-05	4.78E-05	2.77E-05

The Oconee Nuclear Station 2020 ARERR Amendment #2 requires the following changes to Attachment 1 (Reference NCR 02432377).

Oconee Nuclear Station 2020 ARERR Attachment 1 Page 1-7 as submitted:

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Products *						
1. Total Release	Ci	6.27E-05	0.00E+00	0. 00E+00	1.85E-04	2.48E-04
2. Avg. Diluted Conc.	µCi/ml	1.93E-14	0.00E+00	0.00E+00	7.39E-14	4.66E-14
3. Batch Releases	µCi/ml	7.40E-12	0.00E+00	0.00E+00	2.17E-11	1.46E-11

Oconee Nuclear Station 2020 ARERR Attachment 1 Page 1-7 Amendment #2 as revised:

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Products *						
1. Total Release	Ci	6.27E-05	0.00E+00	0. 00E+00	1.85E-04	2.48E-04
2. Avg. Diluted Conc.	µCi/ml	1.93E-14	0.00E+00	0.00E+00	7.39E-14	2.33E-14
3. Batch Releases	µCi/ml	7.40E-12	0.00E+00	0.00E+00	2.17E-11	2.28E-12

Attachment 12
Errata to a Previous Year's ARERR

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2022 - 12/31/2022

Attachment 1
Summary of Gaseous and Liquid Effluents

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2019 - 12/31/2019

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	2.19E-04	1.51E-04	1.08E-04	0.00E+00	4.78E-04
2. Avg. Diluted Conc.	µCi/ml	5.95E-14	3.32E-14	3.19E-14	0.00E+00	3.12E-14
3. Batch Releases	µCi/ml	2.61E-11	1.79E-11	1.27E-11	0.00E+00	1.42E-11
B. Tritium						
1. Total Release	Ci	1.51E+02	1.04E+02	2.78E+02	4.09E+02	9.43E+02
2. Avg. Diluted Conc.	µCi/ml	6.14E-08	3.78E-08	1.03E-07	1.92E-07	9.86E-08
3. Batch Releases	µCi/ml	1.80E-05	1.23E-05	3.25E-05	4.78E-05	2.77E-05
C. Dissolved & Entrained Gases						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Diluted Conc.	µCi/ml	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3. Batch Releases	µCi/ml	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Gross Alpha						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Diluted Conc.	µCi/ml	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3. Batch Releases	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	1.33E+06	7.94E+05	1.19E+06	2.51E+06	5.82E+06
2. Continuous Releases	liters	5.82E+08	4.27E+08	4.71E+08	7.10E+08	2.19E+09
F. Volume of Dilution Water						
1. Batch Releases	liters	8.37E+09	8.46E+09	8.55E+09	8.55E+09	3.39E+10
2. Continuous Releases	liters	8.37E+09	8.46E+09	8.55E+09	8.55E+09	3.39E+10

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

Attachment 1
Summary of Gaseous and Liquid Effluents

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2020 - 12/31/2020

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	6.27E-05	0.00E+00	0. 00E+00	1.85E-04	2.48E-04
2. Avg. Diluted Conc.	μCi/ml	1.93E-14	0.00E+00	0.00E+00	7.39E-14	2.33E-14
3. Batch Releases	μCi/ml	7.40E-12	0.00E+00	0.00E+00	2.17E-11	2.28E-12
B. Tritium						
1. Total Release	Ci	4.00E+02	2.83E+02	1.50E+02	1.85E+02	1.02E+03
2. Avg. Diluted Conc.	μCi/ml	1.44E-07	1.86E-07	5.89E-08	1.03E-07	1.23E-07
3. Batch Releases	μCi/ml	4.73E-05	3.34E-05	1.75E-05	2.16E-05	3.00E-05
C. Dissolved & Entrained Gases						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Diluted Conc.	μCi/ml	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3. Batch Releases	μCi/ml	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Gross Alpha						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Diluted Conc.	μCi/ml	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3. Batch Releases	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	1.48E+06	2.39E+06	1.04E+06	2.57E+06	7.48E+06
2. Continuous Releases	liters	5.67E+08	4.64E+08	5.62E+08	7.52E+08	2.35E+09
F. Volume of Dilution Water						
1. Batch Releases	liters	8.46E+09	8.46E+09	8.55E+09	8.55E+09	3.40E+10
2. Continuous Releases	liters	8.46E+09	8.46E+09	8.55E+09	8.55E+09	3.40E+10

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

ENCLOSURE 6: RNP Annual Radioactive Effluent Release Report

H.B. Robinson Steam Electric Plant
Unit 2

Annual Radioactive Effluent Release Report

January 1, 2022 through December 31, 2022

Docket 50-261

Introduction

The Annual Radioactive Effluent Release Report is pursuant to H.B. Robinson Steam Electric Plant Technical Specification 5.6.3 and ODCM 9.1. The below listed attachments to this report provide the required information. In addition, the ODCM is included pursuant to H.B. Robinson Steam Electric Plant Technical Specification 5.5.1.

Attachment 1	Summary of Gaseous and Liquid Effluents
Attachment 2	Supplemental Information
Attachment 3	Solid Radioactive Waste Disposal
Attachment 4	Meteorological Data
Attachment 5	Unplanned Offsite Releases
Attachment 6	Assessment of Radiation Dose from Radioactive Effluents to Members of the Public
Attachment 7	Information to Support the NEI Ground Water Protection Initiative
Attachment 8	Inoperable Equipment
Attachment 9	Summary of Changes to the Offsite Dose Calculation Manual
Attachment 10	Summary of Changes to the Process Control Program
Attachment 11	Summary of Major Modifications to the Radioactive Waste Treatment Systems
Attachment 12	Errata to a Previous Year's ARERR

ATTACHMENT 1

Summary of Gaseous and Liquid Effluents

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

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2022 - 12/31/2022

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	4.38E-02	4.05E-02	1.40E-01	2.44E+00	2.66E+00
2. Avg. Release Rate	μCi/sec	5.56E-03	5.14E-03	1.78E-02	3.09E-01	8.45E-02
B. Iodine-131						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Release Rate	μCi/sec	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C. Particulates Half-Life ≥ 8 days						
1. Total Release	Ci	2.88E-07	2.58E-07	6.67E-07	3.39E-05	3.51E-05
2. Avg. Release Rate	μCi/sec	3.65E-08	3.27E-08	8.46E-08	4.30E-06	1.11E-06
D. Tritium						
1. Total Release	Ci	6.03E-01	9.43E-01	5.05E+00	1.43E+00	8.03E+00
2. Avg. Release Rate	μCi/sec	7.65E-02	1.20E-01	6.41E-01	1.81E-01	2.55E-01
E. Carbon-14						
1. Total Release	Ci	1.88E+00	1.90E+00	1.92E+00	1.92E+00	7.62E+00
2. Avg. Release Rate	μCi/sec	2.38E-01	2.41E-01	2.44E-01	2.44E-01	2.42E-01
F. 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

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2022 - 12/31/2022

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. Carbon-14						
N/A	Ci	-	-	-	-	-
F. Gross Alpha						
Total for Period	Ci	-	-	-	-	-

* H.B. Robinson Steam Electric Plant Unit 2 does not have elevated releases.

Attachment 1
Summary of Gaseous and Liquid Effluents

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2022 - 12/31/2022

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. Carbon-14						
N/A	Ci	-	-	-	-	-
F. Gross Alpha						
Total for Period	Ci	-	-	-	-	-

* H.B. Robinson Steam Electric Plant Unit 2 does not have elevated releases.

Attachment 1
Summary of Gaseous and Liquid Effluents

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2022 - 12/31/2022

Gaseous Effluents - Ground & Mixed-Mode Releases - Continuous Mode

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Gases						
Ar-41	Ci	0.00E+00	0.00E+00	0.00E+00	1.39E-07	1.39E-07
Xe-133	Ci	0.00E+00	0.00E+00	1.66E-02	2.06E+00	2.08E+00
Total for Period	Ci	0.00E+00	0.00E+00	1.66E-02	2.06E+00	2.08E+00
B. Iodines						
None	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C. Particulates Half-Life ≥ 8 days						
Co-56	Ci	2.88E-07	0.00E+00	0.00E+00	0.00E+00	2.88E-07
Co-58	Ci	0.00E+00	0.00E+00	5.45E-07	6.98E-06	7.53E-06
Total for Period	Ci	2.88E-07	0.00E+00	5.45E-07	6.98E-06	7.81E-06
D. Tritium						
H-3	Ci	4.66E-01	7.62E-01	4.57E+00	1.14E+00	6.94E+00
E. Carbon-14						
C-14	Ci	1.16E+00	1.17E+00	1.18E+00	1.19E+00	4.70E+00
F. 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

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2022 - 12/31/2022

Gaseous Effluents - Ground & Mixed Mode Releases - Batch Mode

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Gases						
Ar-41	Ci	4.25E-02	3.96E-02	4.71E-02	3.06E-01	4.35E-01
Kr-85m	Ci	0.00E+00	0.00E+00	1.24E-04	1.59E-04	2.83E-04
Kr-88	Ci	0.00E+00	0.00E+00	4.52E-05	1.95E-04	2.40E-04
Xe-131m	Ci	0.00E+00	0.00E+00	7.67E-05	5.78E-05	1.35E-04
Xe-133m	Ci	0.00E+00	0.00E+00	1.40E-03	1.03E-03	2.43E-03
Xe-133	Ci	1.29E-03	9.43E-04	6.38E-02	6.43E-02	1.30E-01
Xe-135	Ci	0.00E+00	0.00E+00	1.04E-02	5.04-03	1.54E-02
Total for Period	Ci	4.38E-02	4.05E-02	1.23E-01	3.77E-01	5.84E-01
B. Iodines						
None	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C. Particulates Half-Life ≥ 8 days						
Cr-51	Ci	0.00E+00	0.00E+00	0.00E+00	3.62E-06	3.62E-06
Co-58	Ci	0.00E+00	0.00E+00	1.09E-07	1.95E-05	1.96E-05
Co-60	Ci	0.00E+00	2.58E-07	0.00E+00	1.12E-06	1.38E-06
Zr-95	Ci	0.00E+00	0.00E+00	0.00E+00	1.03E-06	1.03E-06
Nb-95	Ci	0.00E+00	0.00E+00	1.34E-08	1.71E-06	1.72E-06
Total for Period	Ci	0.00E+00	2.58E-07	1.22E-07	2.70E-05	2.74E-05
D. Tritium						
H-3	Ci	1.38E-01	1.81E-01	4.78E-01	2.98E-01	1.10E+00
E. Carbon-14						
C-14	Ci	7.21E-01	7.30E-01	7.38E-01	7.38E-01	2.93E+00
F. 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

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2022 - 12/31/2022

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	5.72E-04	9.53E-04	2.64E-04	1.63E-02	1.81E-02
2. Avg. Diluted Conc.	µCi/ml	2.49E-12	3.95E-12	9.96E-13	1.03E-10	2.77E-11
B. Tritium						
1. Total Release	Ci	7.25E+00	8.59E+01	2.75E+02	1.38E+02	5.06E+02
2. Avg. Diluted Conc.	µCi/ml	3.15E-08	3.56E-07	1.04E-06	8.73E-07	5.75E-07
C. Dissolved & Entrained Gases						
1. Total Release	Ci	0.00E+00	4.94E-05	1.96E-03	3.75E-03	5.76E-03
2. Avg. Diluted Conc.	µCi/ml	0.00E+00	2.05E-13	7.40E-12	2.37E-11	7.83E-12
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. Total	liters	6.69E+04	2.54E+05	5.18E+05	1.85E+06	2.69E+06
F. Volume of Dilution Water						
1. Total	liters	2.30E+11	2.41E+11	2.65E+11	1.58E+11	8.94E+11

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

Attachment 1
Summary of Gaseous and Liquid Effluents

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2022 - 12/31/2022

Liquid Effluents - Continuous Mode

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Products						
Co-58	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
B. Tritium						
H-3	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C. Dissolved & Entrained Gases						
None	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Gross Alpha						
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Attachment 1
Summary of Gaseous and Liquid Effluents

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2022 - 12/31/2022

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	0.00E+00	5.28E-04	5.28E-04
Mn-54	Ci	5.15E-06	0.00E+00	0.00E+00	5.88E-05	6.39E-05
Fe-55	Ci	2.33E-04	3.98E-04	7.61E-05	1.28E-03	1.99E-03
Fe-59	Ci	0.00E+00	0.00E+00	0.00E+00	6.82E-05	6.82E-05
Co-57	Ci	0.00E+00	2.23E-06	0.00E+00	3.96E-05	4.18E-05
Co-58	Ci	1.60E-04	1.61E-04	3.12E-05	1.15E-02	1.19E-02
Co-60	Ci	1.24E-04	7.63E-05	3.38E-05	1.43E-03	1.66E-03
Ni-63	Ci	5.02E-05	3.15E-04	8.55E-05	5.56E-04	1.01E-03
Ni-65	Ci	0.00E+00	0.00E+00	0.00E+00	2.97E-05	2.97E-05
Zn-65	Ci	0.00E+00	0.00E+00	0.00E+00	7.48E-06	7.48E-06
Sr-90	Ci	0.00E+00	0.00E+00	3.33E-05	0.00E+00	3.33E-05
Zr-95	Ci	0.00E+00	0.00E+00	0.00E+00	2.19E-04	2.19E-04
Nb-95	Ci	0.00E+00	0.00E+00	0.00E+00	3.94E-04	3.94E-04
Ru-105	Ci	0.00E+00	0.00E+00	0.00E+00	8.13E-06	8.13E-06
Ag-110m	Ci	0.00E+00	0.00E+00	0.00E+00	7.27E-05	7.27E-05
Sn-117m	Ci	0.00E+00	0.00E+00	0.00E+00	4.03E-06	4.03E-06
Sb-124	Ci	0.00E+00	0.00E+00	0.00E+00	5.69E-05	5.69E-05
Sb-125	Ci	0.00E+00	0.00E+00	0.00E+00	6.96E-05	6.96E-05
Te-123m	Ci	0.00E+00	0.00E+00	0.00E+00	4.14E-06	4.14E-06
Ba-142	Ci	0.00E+00	0.00E+00	0.00E+00	1.29E-05	1.29E-05
Ce-144	Ci	0.00E+00	0.00E+00	1.76E-06	0.00E+00	1.76E-06
W-187	Ci	0.00E+00	0.00E+00	2.03E-06	0.00E+00	2.03E-06
Total for Period	Ci	5.72E-04	9.53E-04	2.64E-04	1.63E-02	1.81E-02
B. Tritium						
H-3	Ci	7.25E+00	8.59E+01	2.75E+02	1.38E+02	5.06E+02
C. Dissolved & Entrained Gases						
Xe-133m	Ci	0.00E+00	0.00E+00	6.46E-06	5.99E-06	1.25E-05
Xe-133	Ci	0.00E+00	4.94E-05	1.96E-03	3.73E-03	5.74E-03
Xe-135	Ci	0.00E+00	0.00E+00	0.00E+00	1.38E-05	1.38E-05
Total for Period	Ci	0.00E+00	4.94E-05	1.97E-03	3.75E-03	5.77E-03
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

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2022 - 12/31/2022

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	=	11	85
2. Total Time (min) for Batch Releases	=	2.61E+03	1.63E+04
3. Maximum Time (min) for a Batch Release	=	3.30E+02	2.40E+02
4. Average Time (min) for Batch Releases	=	2.37E+02	1.92E+02
5. Minimum Time (min) for a Batch Release	=	1.67E+02	1.18E+02
6. Average Dilution Water Flow During Release (gpm)	=	4.00E+05	3.03E+05

B. Gaseous Effluents		Jan - Jun	Jul - Dec
1. Total Number of Batch Releases	=	51	83
2. Total Time (min) for Batch Releases	=	2.31E+04	7.69E+04
3. Maximum Time (min) for a Batch Release	=	4.72E+03	1.02E+04
4. Average Time (min) for Batch Releases	=	4.52E+02	9.26E+02
5. Minimum Time (min) for a Batch Release	=	3.50E+01	1.00E+00

VI. Abnormal Releases

See Attachment 5, Unplanned Offsite Releases.

Carbon-14

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

In Regulatory Guide 1.21, Revision 2, “Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste”, the NRC recommends U.S. nuclear power plants evaluate whether C-14 is a "principal radionuclide", and if so, report the amount of C-14 released. Improvements over the years in effluent management practices and fuel performance have resulted in a decrease in gaseous radionuclide (non-C-14) concentrations, and a change in the distribution of gaseous radionuclides released to the environment. As a result, many sites show C-14 has become a "principal radionuclide" for the gaseous effluent pathway, as defined in Regulatory Guide 1.21, Rev. 2. H.B. Robinson Steam Electric Plant 2022 ARERR contains estimates of C-14 radioactivity released in 2022 and estimates of public dose resulting from the C-14 effluent.

Because the dose contribution of C-14 from liquid radioactive waste is much less than that contributed by gaseous radioactive waste, evaluation of C-14 in liquid radioactive waste is not required (Ref. Reg. Guide 1.21, Rev. 2). The quantity of gaseous C-14 released to the environment can be estimated by use of a C-14 source term scaling factor based on power generation (Ref. Reg. Guide 1.21, Rev. 2). Many documents provide information related to the magnitude of C-14 in typical effluents from commercial nuclear power plants. Those documents suggest that nominal annual releases of C-14 in gaseous effluents are approximately 5 to 7.3 curies from PWRs (Ref. Reg. Guide 1.21, Rev. 2). A more recent study recommends a higher C-14 gaseous source term scaling factor of approximately 9.0 to 9.8 Ci/GWe-yr for a PWR (Westinghouse) (Ref. EPRI 1021106). The H.B. Robinson Steam Electric Plant ODCM states the expected C-14 generation to be 7.3 Curies assuming 292 effective full power days (EFPD) in a calendar year. 2.8 of the 7.3 Curies are released in batch mode from the Containment building and Waste Gas Decay Tanks. The remaining 4.5 Curies are released in continuous mode from the Auxiliary and Fuel Handling buildings. The total C-14 activity released compares favorably with more recent studies. For the H.B. Robinson Steam Electric Plant 2022 ARERR, a source term scaling factor using actual EFPD of 305.08 days is assumed. Using the source term scaling factor from H.B. Robinson Steam Electric Plant in 2022 results in a site total C-14 gaseous release estimate to the environment of 7.63 Curies, 2.93 Curies in batch mode and 4.70 Curies in continuous mode.

C-14 releases in PWRs occur primarily as a mix of organic carbon and carbon dioxide released from the waste gas system. Since the PWR operates with a reducing chemistry, most, if not all, of the C-14 species initially produced are organic (e.g., methane). As a general rule, C-14 in the primary coolant is essentially all organic with a large fraction as a gaseous species. Any time the RCS liquid or gas is exposed to an oxidizing environment (e.g. during shutdown or refueling), a slow transformation from an organic to an inorganic chemical form can occur. Various studies documenting measured C-14 releases from PWRs suggest a range of 70% to 95% organic with an average of 80% organic with the remainder being CO_2 (Ref. EPRI TR-105715). For the H.B. Robinson Steam Electric Plant 2022 ARERR a value of 70% organic C-14 is assumed.

Public dose estimates from airborne C-14 are performed using dose models in and Regulatory Guide 1.109. The dose models and assumptions used are documented in the H.B. Robinson Steam Electric Plant ODCM. The estimated C-14 dose impact on the maximum organ dose from airborne effluents released from H.B. Robinson Steam Electric Plant in 2022 is well below the 10CFR50, Appendix I, ALARA design objective (i.e., 15 mrem/yr per unit).

Dose from Evaporation of Lake Robinson

Evaporation of water containing tritium in Lake Robinson 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 Lake Robinson. Results of the evaluation are contained in report "*Impact of Tritium Release from Lake Robinson at the Robinson Nuclear Plant for 2022*". Using the methodology described in ODCM 2.5.3, the following is a summary of tritium activity released through evaporation and resulting dose for 2022.

	Units	Year
1. H-3 Activity Released	Ci	4.50E+01
2. H-3 Dose	mREM	2.49E-01

Receptor Location ***6.38*** km ***N***
Critical Age ***CHILD***
Critical Organ ***N/A*** *

Tritium in Fish from Lake Robinson

Concentrations of radionuclides used in this specific fish consumption pathway are determined by averaging the monthly concentrations detected in environmental location (REMP) SW-40. In 2022, no plant related gamma emitting radionuclides were detected. Since tritium is consistently detected in Lake Robinson REMP samples, tritium concentration in the fish is assumed to be in equilibrium with Lake Robinson. Using the methodology and data described in NRC Regulatory Guide 1.109, Rev.1, October 1977, Equation A-1, Table E-5, and Table E-11, the following is a summary of average concentration consumed and resulting dose for 2022.

	Units	Year
1. Avg. H-3 Concentration	ρCi/L	3.50E+03
2. H-3 Dose	mREM	7.72E-03

Critical Age ***ADULT***
Critical Organ ***N/A*** *

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

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2022 - 12/31/2022

Overall Estimate of Error for Effluent Radioactivity Release Reported

The estimated percentage of overall error for both Liquid and Gaseous effluent release data at H.B. Robinson Steam Electric Plant has been determined to be ± 30.3%. This value was derived by taking the square root of the sum of the squares of the following discrete individual estimates of error:

1. Flow Rate Determining Devices = ± 20%
2. Counting Statistical Error = ± 20%
3. Calibration Error = ± 10%
4. Calibration Source Error = ± 2.5%
5. Sample Preparation Error = ± 3%

Attachment 2
Supplemental Information

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2022 - 12/31/2022

Summary of Changes in Land Use Census Affecting Effluent Dose Calculations

The 2022 Land Use Census was performed June 13 – June 15, 2022, and the results were certified and made available for use on July 21, 2022. The following are changes to residences, gardens, and milk animals from the previous year.

Residences

• There were no changes identified to the residences previously located during the 2022 LUC.

Gardens

NOTE: There were no gardens within the 5 mile radius in any of the 16 meteorological sectors identified by the census as being irrigated from plant discharge water. Any of the irrigation sources identified by the census are from other sources; such as wells or public utilities.

- *The garden in the N sector (4.34 miles) was replaced with a new garden at 4.48 miles.*
- *The garden in the ENE sector (1.08 miles) was replaced with a new garden at 0.96 miles.*
- *The garden in the SSE sector (2.91 miles) was replaced with a new garden at 2.69 miles.*
- *The garden in the SSW sector (2.49 miles) was replaced with a new garden at 4.11 miles.*
- *The garden in the SW sector (2.11 miles) was replaced with a new garden at 2.02 miles.*
- *The garden in the WSW sector (0.86 miles) was replaced with a new garden at 0.88 miles.*

Meat Animals

NOTE: Meat animals were only identified at the nearest garden or closer in each sector. There were no changes identified to the meat animals previously located during the 2022 LUC.

Milk Animals

No milk animals (cows or goats) were identified in the 5 mile radius in any of the 16 meteorological sectors by the 2022 census.

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 (specify whether determined by measurement or estimate)
- 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

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2022 - 12/31/2022

	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 Secondary Resins	N/A	N/A	N/A	N/A	N/A	N/A	N/A
b.	Dewatered Primary Resins	4	4	A,B	8-120/10-160 Poly HIC	N/A	12.3	62.9
c.	Evaporator Concentrates	N/A	N/A	N/A	N/A	N/A	N/A	N/A
d.	Dewatered Mechanical Filters	N/A	N/A	N/A	N/A	N/A	N/A	N/A
e.	Dewatered Demineralizers	N/A	N/A	N/A	N/A	N/A	N/A	N/A
f.	Solidified (cement) Acids, Oils, Sludge	N/A	N/A	N/A	N/A	N/A	N/A	N/A
g.	***Other (add as necessary)***	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.	**Dry Solid Waste**							
a.	Dry Active Waste (compacted)	5	10	A-U	20’ Sealand,	N/A	316	0.0688
b.	Dry Active Waste (non-compacted)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
c.	Dry Active Waste (brokered)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
d.	Irradiated Components (brokered)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
e.	Sources for Disposal (brokered)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3.	**Total Solid Waste**	9	14	N/A	N/A	N/A	329.3	62.9

Attachment 3
Solid Radioactive Waste Disposal

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2022 - 12/31/2022

	Type of Waste Shipped	Radionuclide	% Abundance
1.	**Waste from Liquid Systems**		
a.	Dewatered Secondary Resins	N/A	N/A
b.	Dewatered Primary Resins*	H-3	0.03
		C-14	0.26
		Mn-54	1.5
		Fe-55	11.33
		Co-57	0.59
		Co-58	9.42
		Co-60	31.02
		Ni-59	0.34
		Ni-63	44.43
		Zn-65	0.44
		Sr-90	0.02
		Cs-137	0.46
		Ce-144	0.15
c.	Evaporator Concentrates	N/A	N/A
d.	Dewatered Mechanical Filters	N/A	N/A
e.	Dewatered Demineralizers	N/A	N/A
f.	Solidified (cement) Acids, Oils, Sludge*	N/A	N/A
2.			
a.	Dry Active Waste (compacted)*	C-14	1.3
		Cr-51	5.02
		Mn-54	0.42
		Co-58	44.89
		Co-60	2.84
		Zr-95	17.52
		Nb-95	27.23
		Cs-137	0.16
		Ce-144	0.61
b.	Dry Active Waste (non-compacted)	N/A	N/A
c.	Dry Active Waste (brokered)	N/A	N/A
d.	Irradiated Components	N/A	N/A
e.	Sources (for Disposal)	N/A	N/A

* Radionuclide not included in % Abundance if less than 0.01%

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

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2022 - 12/31/2022

Stability Class	Wind Speed (mph)	Hours of Occurrence															
		Sector															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
A	0.75-3.50	0	0	0	5	7	12	9	2	1	1	0	2	1	0	0	0
	3.51-7.50	6	14	15	21	16	18	23	27	31	42	77	63	30	14	9	2
	7.51-12.50	21	1	0	0	0	0	0	1	14	37	59	8	6	9	8	0
	12.51-18.50	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0
	18.51-25.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	25+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B	0.75-3.50	2	3	10	12	15	16	17	12	2	8	4	6	5	0	1	1
	3.51-7.50	24	52	19	12	12	5	13	22	18	39	69	29	20	8	14	1
	7.51-12.50	30	8	0	0	0	0	0	3	13	18	18	2	3	5	7	6
	12.51-18.50	1	0	0	0	0	0	0	0	1	1	2	0	0	0	0	1
	18.51-25.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	25+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	0.75-3.50	5	16	31	20	12	29	31	9	6	7	8	10	7	3	3	2
	3.51-7.50	45	56	20	13	6	2	2	29	23	50	61	16	16	10	19	8
	7.51-12.50	21	13	0	0	0	0	0	5	6	8	10	1	3	2	3	3
	12.51-18.50	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0
	18.51-25.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	25+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D	0.75-3.50	45	104	182	107	90	63	73	83	61	59	50	49	49	37	28	36
	3.51-7.50	242	389	127	65	15	4	12	136	166	188	116	73	43	20	44	86
	7.51-12.50	88	150	0	2	0	0	0	27	68	64	37	6	3	5	14	50
	12.51-18.50	6	4	0	0	0	0	0	1	6	8	5	0	0	2	4	9
	18.51-25.00	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
	25+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment 4
Meteorological Data

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2022 - 12/31/2022

Stability Class	Wind Speed (mph)	Hours of Occurrence															
		Sector															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
E	0.75-3.50	60	59	36	31	7	10	22	81	212	153	129	91	72	45	54	79
	3.51-7.50	68	9	4	0	2	3	3	66	142	62	42	32	7	7	28	117
	7.51-12.50	0	0	0	0	0	0	0	4	10	9	3	1	3	0	0	7
	12.51-18.50	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0
	18.51-25.00	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
	25+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F	0.75-3.50	44	17	6	4	1	6	10	40	75	59	75	57	38	23	68	91
	3.51-7.50	4	1	0	0	0	0	1	4	1	0	1	0	0	4	15	37
	7.51-12.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	12.51-18.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	18.51-25.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	25+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G	0.75-3.50	61	12	1	0	1	3	13	23	42	39	29	23	31	49	110	156
	3.51-7.50	10	1	0	0	0	0	0	0	0	0	1	0	0	0	0	15
	7.51-12.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	12.51-18.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	18.51-25.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	25+	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

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2022 - 12/31/2022

H.B. Robinson Steam Electric Plant had zero (0) unplanned liquid release in 2022.

H.B. Robinson Steam Electric Plant had zero (0) unplanned gaseous release in 2022.

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

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2022 - 12/31/2022

Gaseous Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Noble Gases						
1. Maximum Gamma Air	mRAD	1.01E-03	9.44E-04	1.25E-03	9.26E-03	1.25E-02
(a) Limit	mRAD	5.00	5.00	5.00	5.00	10.00
(b) % of Limit		2.02E-02	1.89E-02	2.50E-02	1.85E-01	1.25E-01
2. Maximum Beta Air	mRAD	3.60E-04	3.35E-04	6.84E-04	8.33E-03	9.71E-03
(a) Limit	mRAD	10	10	10	10	20
(b) % of Limit		3.60E-03	3.35E-03	6.84E-03	8.33E-02	4.85E-02

Receptor Location ***0.42*** km ***SSE***

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
B. Iodine, H-3, & Particulates						
1. Maximum Organ Dose	mREM	1.28E-01	1.30E-01	1.31E-01	1.31E-01	5.20E-01
(a) Limit	mREM	7.5	7.5	7.5	7.5	15
(b) % of Limit		1.71E+00	1.73E+00	1.75E+00	1.75E+00	3.47E+00

Receptor Location ***0.42*** km ***SSE***
Critical Age ***CHILD***
Critical Organ ***BONE***

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

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2022 - 12/31/2022

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Batch & Continuous Mode						
1. Maximum Organ Dose	mREM	3.11E-05	2.25E-04	6.96E-04	2.55E-02	2.65E-02
(a) Limit	mREM	5	5	5	5	10
(b) % of Limit		6.22E-04	4.50E-03	1.39E-02	5.10E-01	2.65E-01
2. Maximum Total Body Dose	mREM	2.17E-05	2.20E-04	7.36E-04	8.18E-04	1.80E-03
(a) Limit	mREM	1.5	1.5	1.5	1.5	3
(b) % of Limit		1.45E-03	1.47E-02	4.91E-02	5.45E-02	5.99E-02

Critical Age ***ADULT***
Critical Organ ***GI-LLI***

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

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2022 - 12/31/2022

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 H.B. Robinson Steam Electric Plant includes liquid and gaseous effluent dose contributions from H.B. Robinson Steam Electric Plant and direct and air-scatter dose from the onsite ISFSI. No other direct or air-scatter source or uranium fuel cycle facility contributes significantly to the maximum exposed individual. Included in the gaseous effluent dose below is the estimated dose contributed by Carbon-14 (Ref. Attachment 2, Supplemental Information, of this report for further information). Also included is dose from evaporation of H-3 in Lake Robinson and H-3 in fish from Lake Robinson. 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	
1. Location	0.42 km SSE
2. Critical Age	CHILD
3. Critical Organ	BONE
4. Organ Dose (mREM)	5.20E-01
5. Total Body Dose (mREM)	2.14E-01
B. Liquid Effluent Dose	
1. Location	6.76 km NE
2. Critical Age	ADULT
3. Critical Organ	GI-LLI
4. Organ Dose (mREM)	2.65E-02
5. Total Body Dose (mREM)	1.80E-03
C. Lake Robinson Evaporation H-3 Dose*	
1. Location	6.38 km N
2. Critical Age	CHILD
3. Critical Organ	N/A
4. Organ Dose (mREM)	2.49E-01
5. Total Body Dose (mREM)	2.49E-01
D. H-3 in Fish from Lake Robinson*	
1. Location	Lake
2. Critical Age	ADULT
3. Critical Organ	N/A
4. Organ Dose (mREM)	7.72E-03
5. Total Body Dose (mREM)	7.72E-03

* = Ref. Attachment 2, Supplemental Information, of this report.

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

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2022 - 12/31/2022

Dose contributions from Carbon-14 in gaseous effluents have been determined from ODCM 3.16, Methodology for Carbon-14 Dose. 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 5.20E-01 mrem/yr based on 7.63 Curies released in 2022 (Ref. Attachment 2, Supplemental Information, of this report).

Direct and air-scatter radiation dose contributions from the onsite ISFSI at H.B. Robinson Steam Electric Plant have been calculated and documented in the ISFSI Safety Analysis Report, Chapter 7 Radiation Protection, Revision 22. The dose rate to the maximum exposed individual from the ISFSI is conservatively calculated to be less than 5 mrem/yr.

The below excerpt from the H.B. Robinson Steam Electric Plant ISFSI Safety Analysis Report is provided to document the conclusion that the H.B. Robinson Steam Electric Plant ISFSI contributes less than 5 mrem/year to the maximum exposed individual.

> *7.6.2 ANALYSIS OF MULTIPLE CONTRIBUTION*
> *An analysis of multiple contribution was performed in order to determine the radiological impact the ISFSI will impose on the population surrounding the HBR plant. This impact added to contributions made by other uranium cycle facilities were compared to the natural background radiation and the regulatory requirements of 40 CFR 190.*
> *The maximally exposed member of the public would receive approximately 1.6 mrem per year from an ISFSI made up of a three-unit HSM (reference Figure 7.6.1). An ISFSI consisting of an eight-unit HSM would contribute approximately 4.3 mrem per year. This is a result of external radiation only; there are no gaseous, particulate, or liquid effluents associated with the normal operation of the ISFSI. It can be concluded that the actual exposure contribution from the ISFSI along with the total of all other uranium fuel cycle activities is within the regulatory limits set forth in 40CFR190.*

Assessment of the actual dose from direct radiation is performed as part of the H.B. Robinson Steam Electric Plant REMP and reported in the AREOR. During 2022, the assessment of dose from direct radiation, performed as part of the REMP, demonstrated no measurable contribution above background attributable to H.B. Robinson Steam Electric Plant operations.

Total dose from liquid and gaseous effluents from H.B. Robinson Steam Electric Plant and the additional pathways listed in table above is conservatively estimated to be less than 6 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 H.B. Robinson Steam Electric 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

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2022 - 12/31/2022

H.B. Robinson Steam Electric Plant has implemented a Ground Water Protection program in accordance with NEI 07-07. This initiative was developed to ensure timely and effective management of situations involving inadvertent releases of licensed material to ground water. As part of this program, H.B. Robinson Steam Electric Plant monitored 42 wells in 2022. 41 wells not sampled as part of the ODCM REMP are reported below. The remaining 1 well is sampled in accorance with the ODCM REMP and reported in the AREOR.

Wells are sampled quarterly. Ground water samples are analyzed for tritium and gamma emitters. No gamma, other than naturally occurring radionuclides, were identified in well samples during 2022. There were no anomalous results identified in 2022.

Results from sampling during 2022 are shown in the table below.

No events meeting the criteria for voluntary notification per NEI 07-07, Industry Ground Water Protection Initiative, occurred at H.B. Robinson Steam Electric Plant in 2022. No special dose calculations were performed as part of the Ground Water Protection program.

Key to below table.

NS	-	Not scheduled to be sampled, not sampled due to insufficient volume in well, or well inaccessible during outage.
ρCi/l	-	picocuries per liter.
< MDA	-	less than minimum detectable activity, typically 250 ρCi/l.
20,000 ρCi/l	-	the Environmental Protection Agency drinking water standard for tritium. This standard applies only to water used for drinking.
1,000,000 ρCi/l	-	the 10 CFR Part 20, Appendix B, Table 2, Column 2, Effluent Concentration Limit for tritium.

Attachment 7
Information to Support the NEI Ground Water Protection Initiative

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2022 - 12/31/2022

Well Name	Location / Description	Tritium Concentration (pCi/l) 1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	# of Samples
R42	Unit 1 North Deep Wells	NS	<MDA	NS	<MDA	2
R64	Artesian Well - 0.6 miles SE	<MDA	<MDA	<MDA	<MDA	4
R68	Well A - Between Unit 1 Switchyard and breakroom	NS	2.23E+02	NS	2.02E+02	2
R69	Well B - Behind the Training Building	NS	<MDA	NS	<MDA	2
R70	Well C - Between the O&M Building & Fab Shop	NS	<MDA	NS	<MDA	2
R72	MW-06 - 0.10 miles E - U/1 North Deep Well Pump	NS	<MDA	NS	<MDA	2
R73	MW-13 - 0.11 miles ENE - Near Discharge Canal	<MDA	1.90E+02	3.10E+02	7.23E+02	4
R75	PSW-02 - 0.05 miles NE - By U/1 boundary fence	NS	<MDA	NS	<MDA	2
R76	PSW-03 - 0.49 miles N - Northeast corner of the MET Tower Station	NS	<MDA	NS	<MDA	2
R77	TS-01B - 0.25 miles SSE - By entrance road to Unit 1	<MDA	<MDA	2.31E+02	<MDA	4
R78	TS-02C - 0.17 miles SSE - Northeast corner by East Settling Pond	NS	<MDA	NS	<MDA	2
R79	TS-07C - 1.0 miles N - South corner by cove & Discharge Canal	<MDA	2.34E+02	2.42E+02	<MDA	4
R81	TS-17B - 0.19 miles SSE - West of West Settling Pond	<MDA	<MDA	<MDA	<MDA	4
R82	PDW-01 - 0.30 miles SSE - By entrance road to Unit 1	NS	<MDA	NS	<MDA	2
RDW6	Robinson Deep Well #6	2.96E+02	2.65E+02	3.30E+02	2.27E+02	4
RMW07	MW-07 - Robinson Monitoring Well	NS	<MDA	NS	<MDA	2
RMW09	MW-09 - Robinson Monitoring Well	NS	<MDA	NS	<MDA	2
RMW-101D	MW-101D - Robinson Monitoring Well	3.66E+02	3.80E+02	4.30E+02	2.45E+02	4
RMW-101S	MW-101S - Robinson Monitoring Well	<MDA	<MDA	<MDA	<MDA	4
RMW-102	MW-102 - Robinson Monitoring Well	<MDA	<MDA	<MDA	<MDA	4
RMW-103D	MW-103D - Robinson Monitoring Well	2.45E+02	<MDA	<MDA	1.97E+02	4
RMW-103S	MW-103S - Robinson Monitoring Well	<MDA	<MDA	<MDA	<MDA	4
RMW-104	MW-104 - Robinson Monitoring Well	<MDA	<MDA	2.23E+02	<MDA	4
RMW-105	MW-105 - Robinson Monitoring Well	<MDA	<MDA	<MDA	<MDA	4
RMW-106	MW-106 - Robinson Monitoring Well	1.32E+03	7.09E+03	2.23E+03	2.05E+03	4
RMW-107	MW-107 - Robinson Monitoring Well	1.93E+02	1.83E+02	2.12E+02	<MDA	4
RMW-108	MW-108 - Robinson Monitoring Well	6.52E+02	1.80E+03	1.31E+03	8.46E+02	4
RMW-110	MW-110 - Robinson Monitoring Well	<MDA	<MDA	<MDA	<MDA	4
RMW-112	MW-112 - Robinson Monitoring Well	<MDA	<MDA	<MDA	<MDA	4
RMW1RASH	MW-1R (NPDES) ASH - Robinson	<MDA	<MDA	<MDA	<MDA	4
RMW2RASH	MW-2R (NPDES) ASH - Robinson	<MDA	<MDA	<MDA	<MDA	4
RMW3RASH	MW-3R (NPDES) ASH - Robinson	2.58E+02	2.21E+02	2.41E+02	<MDA	4
RMW4RASH	MW-4R (NPDES) ASH - Robinson	NS	2.27E+02	NS	<MDA	2
RMW5ASH	MW-5 (NPDES) ASH- Robinson	<MDA	1.84E+02	<MDA	<MDA	4
RMW6ASH	MW-6 (NPDES) ASH - Robinson	<MDA	<MDA	<MDA	<MDA	4
RMW7ASH	MW-7 (NPDES) ASH - Robinson	<MDA	<MDA	<MDA	<MDA	4
RP1	P1 (North of discharge canal) - Robinson Monitoring Well	<MDA	2.30E+02	6.37E+02	1.13E+03	4
RP2	P2 (South of discharge canal) - Robinson Monitoring Well	<MDA	<MDA	<MDA	<MDA	4
RPSW04	PSW-04	<MDA	<MDA	<MDA	<MDA	4
RPSW05	SW of Plant in a grass area on Entrance Road (Background Well)	NS	<MDA	NS	<MDA	2
RTS04B	RTS04B	NS	<MDA	NS	<MDA	2
U1SDEEP	Unit 1 South Deep Well	1.84E+02	NS	3.42E+02	NS	2

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 permanent or temporary outside liquid storage tanks exceeding 10 Curies total activity (excluding tritium and dissolved or entrained noble gases).

Attachment 8
Inoperable Equipment

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2022 - 12/31/2022

H.B. Robinson Steam Electric Plant experienced one (1) instance of inoperable equipment relevant to effluent monitoring in excess of ODCM/TRMS limits during 2022. Details are described below.

H.B. Robinson Steam Electric Plant did not experience permanent or temporary outside liquid storage tanks not surrounded by liners, dikes, or walls, capable of holding the tank's contents and that does not have tank overflows and surrounding area drains connected to the Liquid Waste Disposal System exceeding 10 Curies total activity (excluding tritium and dissolved or entrained noble gases) during 2022.

ODCM # or TRMS #	Title	Completion Time	Description
ODCM 2.6, Condition "Table 2.6-1 Item 5.a."	R-16 Containment Fan Cooling Water Monitor	30 Days	NCR 02453169 : R-16, Containment Fan Cooling Water Monitor, was not restored to an operable status within 30 days as required by ODCM 2.6, Table 2.6-1 Item 5.a. This 30-day time limit was exceeded on 12/14/22 at 2124. The monitor was removed from service on 11/14/22 due to R-16 indicating loss of counts. The monitor was unable to be returned to service within the 30-day requirement because the installed detector could not be repaired or replaced by vendor due to obsolescence. Effluent releases via this pathway may continue provided that, once per 24 hours, grab samples are collected and analyzed for gross radioactivity (beta or gamma) with a lower limit of detection of at least 1.0E-07 µCi/ml or are analyzed for principal gamma emitters consistent with Table 2.8-1.

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

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2022 - 12/31/2022

SUMMARY OF CHANGES

The H.B. Robinson Steam Electric Plant Unit 2 Offsite Dose Calculation Manual Revision 37 was issued and made effective February 24th, 2022. Additionally, The H.B. Robinson Steam Electric Plant Unit 2 Offsite Dose Calculation Manual Revision 38 was issued and made effective March 30th, 2023. The most recent revision is Revision 38. Both revisions are attached.

H.B. Robinson Steam Electric Plant
Unit 2

ODCM
Offsite Dose Calculation Manual

Docket No. 50-261

H.B. Robinson Steam Electric Plant
Unit 2

OFFSITE DOSE CALCULATION MANUAL (ODCM)

Revision 37

Docket Number: 50-261

Effective Date: 2/24/2022

Prepared By: Chase Gainey RNP Chemistry	**Signature**	2/24/2022 **Date**
Reviewed By: Catherine Kemmerlin RNP Chemistry	**Signature**	2/24/2022 **Date**
Reviewed By (Print): Laura Basta RNP ORC Chairman	**Signature**	2/24/2022 **Date**
Approved By: Laura Basta RNP Plant Manager	**Signature**	2/24/2022 **Date**

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1.0 INTRODUCTION

The Off-Site Dose Calculation Manual (ODCM) provides the information and methodologies to be used by H. B. Robinson Steam Electric Plant Unit 2 (HBR) to assure compliance with 10 CFR 20, Appendix I of 10 CFR 50, and 40 CFR 190.

The ODCM is based on "Radiological Effluent Technical Specifications for PWRs (NUREG 0472, Rev. 3, Draft 7), "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants" (NUREG 0133), and guidance from the United States Nuclear Regulatory Commission (NRC). Specific plant procedures for implementation of this manual are presented in H. B. Robinson Unit 2 Plant Operating Manual. These procedures will be utilized by the operating staff of HBR to assure compliance with technical specifications.

Changes to the ODCM which affect the methodologies showing compliance with 10 CFR 20, Appendix I of 10 CFR 50, and 40 CFR 190 will be properly reviewed and approved as indicated in the Administrative Control Section of Plant Technical Specifications. Site specific parameters such as vent fractions, dilution water flow rates (gpm), and liquid/gaseous discharge flow rates are listed in this document as typical system values. Actual values derived from actual operating Plant conditions should be used in lieu of these typical values. Specific Plant procedures control the values of the above parameters; therefore, minimizing the need for frequent revisions to the ODCM.

The Annual Radioactive Effluent Release Report will be prepared as outlined in Regulatory Guide 1.21, "Measuring, Evaluating, and Reporting Radioactivity in Solid Waste and 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. This report will be inclusive of the requirements as outlined in the HBR Technical Specifications.

The gaseous and liquid radwaste systems at HBR are used to collect and treat gaseous and liquid radiochemical byproducts of unit operation. These systems produce effluents that can be discharged in discrete and measurable quantities to the environment.

After processing, liquid wastes may be discharged from the Steam Generator Blowdown Flash Tank, a series of Waste Condensate Tanks, or a series of Monitor Tanks.

Gaseous wastes are mainly discharged from the Plant Vent Stack. Less significant sources of gaseous waste may come from the Upper Fuel Handling Building Exhaust, Lower Fuel Handling Building Exhaust, E&RC Laboratory Exhaust, Radwaste Building Exhaust, or Building 457. Building 457 is used only intermittently mainly for pre-outage activities, therefore effluent accountability will be performed as needed. Additionally, secondary system steam releases may occur from normal plant operation or system response. Any secondary system steam releases containing licensed radioactivity are evaluated for inclusion in the site effluent release total.

2.0 LIQUID EFFLUENTS

2.1 Monitor Alarm Setpoint Determination

This methodology determines the monitor alarm setpoint that indicates if the concentration of radionuclides in the liquid effluent released from the site to unrestricted areas exceeds 10 times the concentrations specified in 10 CFR 20, Appendix B, Table 2, Column 2, for radionuclides other than dissolved or entrained noble gases or exceeds a concentration 2E-04 μCi/ml for dissolved or entrained noble gases. Two methodologies may be utilized to calculate monitor alarm setpoints. Section 2.1.1 determines a fixed setpoint based on the worst case assumptions that Cs-134 is the only nuclide being discharged. This is consistent with the limit of 10 CFR 20, Appendix B, Note 2. Section 2.1.2 methodology determines the setpoint based on the radionuclide mix via analysis prior to release to demonstrate compliance with 10 CFR 20, Appendix B, limits and may also be used as an alternative method for calculating setpoints.

2.1.1 Setpoint Based on Cs-134

The following method applies to liquid releases via the discharge canal when determining the alarm/trip setpoint for the Condensate Polisher Liquid Waste Monitor (R-37) and the Steam Generator Blowdown Monitor (R-19A, R-19B, and R-19C) during operational conditions when there is no primary to secondary leaks. The Condensate Polisher Sump discharge (monitored by R-37) discharges to the Settling Ponds prior to release via the discharge canal. Even though the Settling Ponds provide additional dilution prior to discharge, no dilution from the Settling Ponds is used in calculating setpoints for R-37. The setpoint for R-37 is calculated using circulating water for dilution, or service water when circulating water is unavailable. This methodology complies with Specification 2.2.1 of the ODCM by satisfying the following equation:

$$\frac{c * f}{f + F} \leq C$$

where:

C = The effluent concentration (EC) limit (Specification 2.2.1) implementing 10 CFR 20 for the site (μCi/ml).

c = The setpoint of the radioactivity monitor measuring the radioactivity concentration in the effluent line prior to dilution and subsequent release; the setpoint represents a value which, if exceeded, would result in concentrations exceeding 10 times the limits of 10 CFR 20 in the unrestricted area. (μCi/ml)

f = The waste effluent flow rate (gpm).

F = The dilution water flow rate (gpm).

2.1.1.1 Determine 'c' (the effluent monitor setpoint) in µCi/ml for each of the dilution water flow rates.

$$c = \frac{C * (F + f)}{f} * S$$

where:

C	=	9E-07, the effluent concentration limit based on 10 CFR 20, Appendix B, for Cs-134 (µCi/ml).
F	=	Dilution water flow rate (gpm).
	=	160,000 gpm from one circulating water pump[1], Unit 2.
	=	250,000 gpm from two circulating water pumps[1], Unit 2.
	=	400,000 gpm from three circulating water pumps[1], Unit 2.
		OR
	=	50,000 gpm from one circulating water pump[2], Retired Fossil Plant.
	=	80,000 gpm from two circulating water pumps[2], Retired Fossil Plant.
		OR
	=	7,000 gpm from one service water pump[4], Unit 2.
f	=	The maximum acceptable discharge flow rate prior to dilution (gpm).
	=	60 gpm for the Waste Disposal System Liquid Effluent Monitor[3].
	=	160 gpm for each Steam Generator Blowdown Monitor.
	=	130 gpm for each Steam Generator Blowdown Monitor while draining a steam generator.
	=	300 gpm for the Condensate Polisher Liquid Waste Monitor.
S	=	0.5, safety factor used as a conservatism to assure that the radionuclide concentrations are less than the limits specified in 10 CFR 20, Appendix B, at the point of discharge (dimensionless).

2.1.1.2 Determine 'CR' (calculated monitor count rate in corrected counts per minute ccpm) attributed to the radionuclides for each of the dilution water flow rates.

$$CR = c * E$$

where:

E	=	The applicable effluent monitor efficiency located in the Station Curve Book. Use the radioactivity concentration 'c' to find CR.

2.1.1.3 Determine 'SP' (the monitor alarm/trip setpoint including background cpm) for each of the dilution water flow rates.

$$SP = (T_m * CR) + Bkg$$

where:

T_m = 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 due to simultaneous releases from several pathways (dimesionless).
= 0.16 for each Steam Generator Blowdown Monitor (R-19A, R-19B, and R-19C).
= 0.25 for the Condensate Polisher Liquid Waste (R-37).

Bkg = the monitor background (cpm).

2.1.2 Setpoint Based on an Analysis of Liquid Prior to Discharge.

The following method applies to liquid releases via the discharge canal when determining the alarm setpoint for the Waste Disposal System liquid Effluent Monitor (R-18), the Steam Generator Blowdown Monitors (R-19A, R-19B, and R-19C), and the Condensate Polisher Liquid Waste Monitor (R-37) when an analysis of the activity of the principal gamma emitters has been made prior to or during the release. The Condensate Polisher Sump discharge (monitored by R-37) discharges to the Settling Ponds prior to release via the discharge canal. Even though the Settling Ponds provide additional dilution prior to discharge, no dilution from the Settling Ponds is used in calculating setpoints for R-37. The setpoint for R-37 is calculated using circulating water for dilution, or service water when circulating water is unavailable.

2.1.2.1 Determine D_{req} (the minimum acceptable dilution factor).

$$D_{req} = D_{req,g} + D_{req,ng}$$

$$D_{req,g} = \frac{\sum_{i=g} \frac{C_i}{ECL_i}}{S * R_{max}} \qquad D_{req,ng} = \frac{\sum_{i=ng} \frac{C_i}{ECL_i}}{S * R_{max}}$$

where:

$D_{req,g}$ = Required dilution factor for gamma-emitters (dimensionless).

$D_{req,ng}$ = Required dilution factor for non-gamma-emitters, e.g. Gross Alpha, H-3, Sr-89, Sr-90, and Fe-55 (dimensionless).

ECL_i = Effluent concentration limit of nuclide 'i' (µCi/ml).

C_i = The concentration of nuclide 'i', if all gamma-emitting are < LLD (as defined in ODCM Table 2.8-1), Ci may be assumed to consist only of Cs-134 at concentration of 9.0E-07 µCi/ml. This nuclide has the lowest ECL of any nuclides to be found in liquid effluents and provides a conservative basis for a monitor setpoint (µCi/ml).

S = 0.5, a safety factor used for conservatism to assure that the radionuclide concentrations are less than the limits specified in 10 CFR Part 20 Appendix B, at the point of discharge (dimensionless).

R_{max} = The maximum ECL ratio limit (dimensionless).

2.1.2.2 Determine the maximum waste flow, R_{cwmax}.

$$R_{cwmax} = \frac{F_{avail} * F_{alloc}}{\left(D_{req} - 1.0\right)}$$

where:

R_{cwmax} = Maximum allowable release flowrate from the waste source (gpm).

F_{avail} = Available dilution flow (gpm).
= 160,000 gpm from one circulating water pump[1], Unit 2.
= 250,000 gpm from two circulating water pumps[1], Unit 2.
= 400,000 gpm from three circulating water pumps[1], Unit 2.

OR

= 50,000 gpm from one circulating water pump[2], Retired Fossil Plant.
= 80,000 gpm from two circulating water pumps[2], Retired Fossil Plant.

OR

= 7,000 gpm from one service water pump[4], Unit 2.

F_{alloc} = 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 due to simultaneous releases from more than one pathway (dimensionless).
= 0.25 for the Waste Disposal System Liquid Effluent Monitor (R-18).
= 0.16 for each of the Steam Generator Blowdown Monitor (R-19A, R-19B or R-19C).
= 0.25 for the Condensate Polisher Liquid Waste (R-37)

If it is determined that:

$$\frac{(F_{avail} + F_{waste})}{D_{req} * F_{waste}} < 1$$

where:

F_{waste} = Waste flow anticipated for this release (gpm).
= 60 gpm for the Waste Disposal System Liquid Effluent Monitor[3].
= 160 gpm for each Steam Generator Blowdown Monitor.
= 130 gpm for each Steam Generator Blowdown Monitor while draining a steam generator.
= 300 gpm for the Condensate Polisher Liquid Waste Monitor

Then the release cannot be made.

If it is determined that:

$$\frac{(F_{avail} + F_{waste})}{D_{req} * F_{waste}} > 1$$

Then the release can be made.

2.1.2.3 Determine the setpoint adjustment factor, S_{adj}.

$$S_{adj} = \frac{\frac{[(F_{alloc} * F_{avail}) + F_{waste}]}{F_{waste}} - D_{req,ng}}{D_{req,g}}$$

2.1.2.4 Determine S_{max} monitor alarm setpoint (µCi/ml).

$$S_{max} = S_{adj} * \sum_i C_i$$

where:

C_i = Concentration of gamma emitting nuclide 'i' (µCi/ml).

2.1.2.5 Determine the monitor alarm setpoint, S_{maxcpm} (cpm).

$$S_{maxcpm} = (S_{max} * E_m) + Bkg$$

where:

E_m = The applicable effluent monitor efficiency based on S_{max} from the efficiency curves located in the Station Curve Book.

Bkg = The monitor background (cpm).

Section 2.1 References

1. Carolina Power & Light Company Drawing Number G-190825. Using the System Q-H Curve for Emergency Low Water Level.

2. Carolina Power & Light Company, Darlington County S.E. Plant. 1960-182 MW Installation, Unit 1. SYSTEM HEAD CURVES Unit 1 Circulating Water System Draining Quosig.

3. H.B. Robinson Electric Plant Unit 2, Updated Final Safety Analysis Report.

4. RNP-M/MECH-1653, Service Water System Hydraulic Evaluation.

2.2 Requirements for Compliance with 10 CFR Part 20 (Liquids)

Applicability

Applies to radioactive material in liquid effluents released from the site to unrestricted areas.

Objective

To define the concentration limits of 10 CFR 20 for radioactive material in liquid effluents released to unrestricted areas.

Specification

CONTROLS

2.2.1 The concentration of radioactive material in liquid effluents released at any time from the site to unrestricted areas (see Figure 7-1) shall be limited to 10 times the concentrations specified in 10 CFR 20, Appendix B, Table 2, Column 2 for radionuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the concentration shall be limited to 2E-04 µCi/ml total activity.

ACTIONS

2.2.2 With the concentration of radioactive material in liquid effluents released from the site to unrestricted areas exceeding the above limits, without delay restore the concentration to within the above limits. In addition, notification must be made to the Commission in accordance with 10 CFR 50.72 and 10 CFR 50.73.

2.2.3 The provisions of Specification 8.1 are not applicable.

Bases

Compliance With 10 CFR Part 20 - Radioactive Materials in Liquid Effluents

This specification is provided to ensure that the concentration of radioactive materials in liquid effluents released from the site to unrestricted areas will be less than 10 times the concentrations specified in 10 CFR Part 20, Appendix B, Table 2, Column 2. This limitation provides the additional assurance that the concentrations of radioactive materials in bodies of water outside the site will result in exposures within the limits of 10 CFR Part 20.1302 to the population. The concentration limit for dissolved or entrained noble gases is based upon the assumption that Xe-135 is the controlling radionuclide and its EC in air (submersion) was converted to an equivalent concentration in water using the methods described in International Commission on Radiological Protection (ICRP) Publication 2.

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).

2.3 Compliance with 10 CFR 20 (Liquids)

Liquid effluents from H.B. Robinson Unit 2 (HBR) will occur both continuously and on a batch basis. The following sections discuss the methodology which will be utilized by the HBR to show compliance with 10 CFR 20.

2.3.1 Continuous Releases

Steam generator blowdown may be a continuous release from HBR. During release periods grab samples will be taken of steam generator blowdown and analyzed for I-131, fission, activation, and corrosion products as outlined in Table 2.8-1 of the ODCM for HBR. These samples are then composited at a rate using the following equation:

$$V_{up} = V_{cp} * \frac{V_a}{V_t}$$

where:

V_{up} = Volume to be replaced/updated (milliliters).

V_{cp} = Volume of the composite (milliliters).

V_a = Actual volume released from grab sample (gallons).

V_t = Total waste volume released to date, including volume V_a , within the compositing period (gallons).

Compliance with 10 CFR 20 during actual release is established through the steam generator blowdown effluent monitor alarm setpoint. This setpoint is based upon Cs-134 as noted in Section 2.1. However, if a continuous release should occur in which the effluent monitor alarm setpoint is exceeded, then actual compliance with 10 CFR 20 may be determined utilizing the actual radionuclide mix and the following equation:

$$Conc_i = \frac{C_{ic} * V_c}{V_{dc}} \tag{2.3-1}$$

where:

$Conc_i$ = Concentration of radionuclide 'i' at the unrestricted area (µCi/ml).

C_{ic} = Concentration of radionuclide 'i' in the continuous release (µCi/ml).

V_c = Volume of continuous effluent released (gallons).

V_{dc} = Volume of dilution flow during release (gallons).

2.3.2 Batch Releases

Batch releases will occur during normal operation. When this does occur at HBR, a continuous release will usually be occurring at the same time. However, during certain shutdown conditions, only batch releases may occur at HBR. Therefore, both situations are treated here to provide the methodology to show compliance with 10 CFR 20.

2.3.2.1 Pre-release

The radioactivity content of each batch release will be determined prior to release in accordance with Table 2.8-1 of the ODCM for HBR. HBR will show compliance with 10 CFR 20 in the following manner:

For the case where only a batch release is to occur, the concentration of the various radionuclides in the batch release, determined in accordance with Table 2.8-1 of the ODCM for HBR, is multiplied by the ratio of the maximum release rate of the potential batch release to the dilution flow rate to obtain the concentration at the unrestricted area. This calculation is shown in the following equation:

$$Conc_i = \frac{C_{ib} * R_b}{D_{fr} * T_m} \qquad (2.3\text{-}2)$$

where:

$Conc_i$ = Concentration of radionuclide 'i' at the unrestricted area (µCi/ml).

C_{ib} = Concentration of radionuclide 'i' in the potential batch release (µCi/ml).

R_b = Release rate of the potential batch release (gpm).

D_{fr} = The dilution flow rate based upon the number of circulating water pumps in service, or service water pumps when circulating water pumps are unavailable, during the release (gpm).
= 160,000 gpm from one circulating water pump, Unit 2.
= 250,000 gpm from two circulating water pumps, Unit 2.
= 400,000 gpm from three circulating water pumps, Unit 2.

OR

= 50,000 gpm from one circulating water pump, Retired Fossil Plant.
= 80,000 gpm from two circulating water pumps, Retired Fossil Plant.

OR

= 7,000 gpm from one service water pump, Unit 2.

T_m = Fraction of dilution flow allocated to this release (dimensionless).

The concentration in the unrestricted area is compared to 10 times the concentrations in Appendix B, Table 2, Column 2, of 10 CFR 20. Before release may occur, the mixture of radionuclides released must be of such concentration that Equation 2.3-3 is met:

$$\sum_i \frac{Conc_i}{10 * EC_i} \le 1 \tag{2.3-3}$$

where:

EC_i = Effluent Concentration Limit of radionuclide 'i' from Appendix B, Table 2, Column 2 of 10 CFR 20 (µCi/ml).

For those cases where batch releases may be occurring at the same time that continuous releases are occurring, the concentration in the unrestricted area will be calculated by the following equation:

$$Conc_i = \frac{(C_{ib} * R_b) + (C_{ic} * R_c)}{D_{fr} * \sum T_m} \tag{2.3-4}$$

where:

R_c = Maximum continuous liquid effluent release rate (gpm).

$\Sigma\, T_m$ = Summation of allocation fractions for those concurrent releases (dimensionless).

The mixture of radionuclides released must be of such concentrations that Equation 2.3-3 must be met.

For HBR, the liquid radwaste effluent line discharges to the circulating water system. Therefore, the dilution flow rate (D_{fr}) is a function of the number of circulating water pumps operating, or one Unit 2 service water pump when no circulating water pumps are available. At least one circulating water pump must be operating during any liquid waste discharge during normal plant operation. During periods when no circulating water pumps are available (e.g. refueling outage), one Unit 2 service water pump may be used for dilution.

Batch releases from the HBR liquid radwaste system may occur from the waste condensate tanks, the monitor tanks, and the steam generators (during drainage). Continuous release may occur from Steam Generator Blowdown and the Condensate Polisher Liquid Waste. The maximum administrative release rate (R_b) is 160 gpm for each of the steam generators during blowdown, 60 gpm from the monitor and waste condensate tanks, and 300 gpm for the Condensate Polisher Liquid Wastes, and 130 gpm for each of the steam generators during drainage.

2.3.2.2 Post-release

The Steam Generation Blowdown Monitor (R-19A, R-19B, and R-19C), the Waste Disposal System Liquid Monitor (R-18), and the Condensate Polisher Liquid Waste Monitor (R-37) setpoint will each be limited to 50 percent of 10 times the 10 CFR 20 limits. These setpoints will ensure that 10 times the 10 CFR 20 limits are met. However, because they are based upon a given mix, the possibility exists that the alarm trip setpoints may be exceeded, while 10 times the 10 CFR 20 limits are not exceeded. The following methodology is provided to determine whether actual releases exceeded 10 times the 10 CFR 20 limits.

The concentration of each radionuclide in the unrestricted area following release from a batch tank will be calculated in the following manner:

For the case where only batch releases are occurring, the total activity of radionuclide 'i' released is divided by the actual dilution flow to obtain the concentration in the unrestricted area. This calculation is shown in the following equation:

$$Conc_{ik} = \frac{C_{ikb} * V_{kb}}{V_{kd}} \tag{2.3-5}$$

where:

$Conc_{ik}$ = The concentration of radionuclide 'i' at the unrestricted area during release 'k' (µCi/ml).

C_{ikb} = Concentration of radionuclide 'i' in the batch release 'k' (µCi/ml).

V_{kb} = Volume of batch release 'k' (gal).

V_{kd} = Actual volume of dilution during release 'k' (gal).

To show compliance with 10 CFR 20, the following relationship must hold:

$$\sum_i \frac{Conc_{ik}}{10 * EC_i} \leq 1 \tag{2.3-6}$$

The actual dilution volume during release 'k' (V_{kd}) is calculated by the following equation:

$$V_{kd} = 60 * \sum_{k} D_{fr} * t_k \tag{2.3-7}$$

where :

60 = Conversion factor (min/hr).

t_k = Duration of release 'k' (hr).

D_{fr} = Dilution flow rate from circulating water pumps or service water pump during release 'k' (gpm).

The circulating water pump and service water pump flow rates were given in Section 2.3.2.1 above.

For the case where a batch release is occurring at the same time that a continuous release is occurring, the compliance with 10 CFR 20 limits may be determined by the following equation:

$$Conc_{ik} = \frac{(C_{ikb} * V_{kb}) + (C_{ikc} * V_{kc})}{V_{kd}} \tag{2.3-8}$$

where:

C_{ikc} = Concentration of radionuclide 'i' in continuous releases during release period 'k' (µCi/ml).

V_{kc} = Volume of continuous release during period 'k' (gal).

Calculated concentrations are to be compared to 10 times the concentrations in Appendix B, Table 2, Column 2, of 10 CFR 20.

2.4 Requirements for Compliance with 10 CFR 50 (Liquids)

Applicability

Applies to radioactive material in liquid effluents released from the site to unrestricted areas.

Objective

To define the calculated dose limits of 10 CFR 50 for radioactive materials in liquid effluents released to unrestricted areas.

Specification

CONTROLS

2.4.1 The dose commitment at all times to a member of the public from radioactive material in liquid effluents released to unrestricted areas (See Figure 7-1) shall be limited:

a. During any calendar quarter to ≤ 1.5 mrem to the total body and to ≤ 5 mrem to any organ.

AND

b. During any calendar year to ≤ 3 mrem to the total body and to ≤ 10 mrem to any organ.

ACTIONS

2.4.2 With the calculated dose commitment from the release of radioactive materials in liquid effluents exceeding any of the limits prescribed by ODCM Specification 2.4.1 above, prepare and submit a report to the Commission in accordance with the ODCM Specification 9.3.

Bases

Compliance With 10 CFR Part 50 - Radioactive Materials in Liquid Effluents

This specification is provided to implement the requirements of Sections II.A, and III.A and IV.A of Appendix I, 10 CFR Part 50. The Control implements the guides set forth in Section II.A of Appendix I. The action statement provides the required operating flexibility and at the same time implements the guides set forth in Section IV.A of Appendix I of 10 CFR Part 50 to assure that the release of radioactive material in liquid effluents will be kept "as low as is reasonably achievable." The dose calculations in the ODCM implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculative procedures based on models and data, such that the actual exposure of an individual 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 the 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.

2.5 Compliance with 10 CFR 50 (Liquids)

2.5.1 Cumulation of Doses

The dose contribution from the release of liquid effluents will be calculated once per month, and a cumulative summation of these total body and any organ doses should be maintained for each calendar quarter. The dose contribution for all batch releases will be calculated using the following equation:

$$D_{\tau b} = \sum_{k}\sum_{i} A_{i\tau} * t_{kb} * C_{ikb} * F_{kb} \tag{2.5-1}$$

where:

$A_{i\tau}$ = The site-related dose commitment factor to the total body or any organ τ for each identified principal gamma and beta emitter based on ingestion of aquatic food and shore line sediment exposure (mrem/hr per µCi/ml).

t_{kb} = The length of time of batch release 'k' over which C_{ikb} and F_{kb} are averaged for each batch liquid release (hr).

C_{ikb} = The average concentration of radionuclide 'i' in undiluted batch liquid effluent during batch release 'k' (µCi/ml).

F_{kb} = The near-field average dilution factor for C_{ikb} during any batch liquid effluent release 'k'. Defined as the ratio of the volume of undiluted liquid waste released to the product of the dilution volume from the site discharge structure to unrestricted receiving waters times 1.0. (1.0 is the site-specific applicable factor for the mixing effect of the HBR discharge structure as defined in NUREG-0133, October 1978).

$$F_{kb} = \frac{V_{kb}}{V_{kd} * 1.0}$$

where V_{kb} and V_{kd} are as defined in Equation 2.3-5.

The dose factor $A_{i\tau}$ was calculated for an adult for each isotope using the following equation:

$$A_{i\tau} = (1.14x10^5 * 21 * BF_i * DF_{i\tau}) + \left[1.14x10^5 * 100 * 12 * 0.3 * T_i * e^{-\lambda_i * t_p} * \left(1 - e^{-\lambda_i * t_b}\right) * DFG_i\right] \quad (2.5\text{-}2)$$

where:

$1.14x10^5$ = $\frac{10^6\ pCi}{\mu Ci} * \frac{10^3\ ml}{l} * \frac{1\ yr}{8760\ hr}$

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

BF_i = Bioaccumulation factor for radionuclide 'i' in fish from Table A-1 of Regulatory Guide 1.109, Revision 1 (ρCi/kg per ρCi/l).

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

100 = Sediment proportionality constant from Regulatory Guide 1.109, Revision 1 (liters per m^2-day).

12 = Adult shoreline exposure rate from Table E-5 of Regulatory Guide 1.109, Revision 1 (hrs/yr).

0.3 = Shoreline width factor from Table A-2 of Regulatory Guide 1.109, Revision 1.

T_i = Nuclide half-life for radionuclide 'i' (days).

λ_i = Nuclide decay constant for radionuclide 'i' (sec^{-1}).

t_p = Average transit time to point of exposure (0 seconds).

t_b = Sediment exposure time of 4.73E+08 seconds (15 years) from page 1.109-14 of Regulatory Guide 1.109, Revision 1.

DFG_i = The ground plane dose conversion factor for radionuclide 'i' from Table E-6 of Regulatory Guide 1.109, Revision 1 (mrem/hr per pCi/m^2).

The potable water pathway does not exist either within Lake Robinson or downstream of the Lake Robinson dam. Therefore, the potable water term was excluded from the calculation of $A_{i\tau}$ values. Table 2.5-1 presents $A_{i\tau}$ values for an adult at HBR.

As noted in Section 2.3.1, steam generator blowdown is continuously released from HBR. The dose from continuous releases will be calculated using the following equation:

$$D_{\tau c} = \sum_{k} \sum_{i} A_{i\tau} * t_{kc} * C_{ikc} * F_{kc} \tag{2.5-3}$$

where:

$D_{\tau c}$ = The cumulative dose commitment to the total body or any organ τ, from liquid effluents for continuous releases (mrem).

t_{kc} = The length of time of continuous release period 'k' over which C_{ikc} and F_{kc} are averaged for all continuous liquid releases (hours).

C_{ikc} = The average concentration of radionuclide 'i' in undiluted liquid effluent during continuous release period 'k' from any continuous liquid release (µCi/ml).

F_{kc} = The near-field average dilution factor for C_{ikc} during continuous liquid effluent release 'k'. Defined as the ratio of the volume of undiluted liquid waste released to the product of the dilution volume from the site discharge structure to unrestricted receiving waters times 1.0. (1.0 is the site-specific applicable factor for the mixing effect of the HBR discharge structure as defined in NUREG-0133, October 1978).

$$F_{kc} = \frac{V_{kc}}{V_{kd} * 1.0}$$

where V_{kc} and V_{kd} are as defined in Equation 2.3-8 and Equation 2.3-5, respectively, only now distinguished for continuous releases.

The sum of the cumulative dose from all batch and continuous releases for a quarter are compared to one half the design objectives for total body and any organ. The sum of the cumulative doses from all batch and continuous releases for a calendar year are compared to the design objective doses. The following relationships should hold for HBR to show compliance with Specification 2.4.1 of the ODCM for H.B. Robinson Unit 2.

For the calendar quarter:

$$D_\tau \leq 1.5\ mrem\ total\ body \tag{2.5-4}$$

$$D_\tau \leq 5\ mrem\ any\ organ \tag{2.5-5}$$

For the calendar year:

$$D_\tau \leq 3\ mrem\ total\ body \tag{2.5-6}$$

$$D_\tau \leq 10\ mrem\ any\ organ \tag{2.5-7}$$

where:

D_τ = Cumulative total dose to any organ τ or the total body from continuous and batch releases (mrem).

= $D_{\tau b} + D_{\tau c}$

The quarterly limits given above represent one half the annual design objective of Section II.A of Appendix I of 10 CFR 50. If any of the limits in Expressions 2.5-4 through 2.5-7 are exceeded, a special report pursuant to ODCM Specification 9.3 must be filed with the NRC. This report complies with Section IV.A, of Appendix I of 10 CFR 50.

2.5.2 Projection of Doses

Doses resulting from the release of liquid effluents will be projected once per 31 days. These projections will include a safety margin, based upon expected operational conditions, which will take into consideration both planned and unplanned releases. Projected dose will be calculated as follows:

$$PD = \frac{92 * (DA + DB)}{TE} + M \qquad (2.5\text{-}8)$$

where:

PD = projected doses (mrem).

92 = time in quarter (days).

DA = dose accumulated during current quarter (mrem).

DB = projected dose from this release (mrem).

TE = time elapsed in quarter (days).

M = safety margin (mrem).

If the projected doses exceed 0.2 mrem to the whole body or 0.6 mrem to any organ when averaged over a calendar quarter, the liquid radwaste equipment will be operated to reduce the radioactive materials in the liquid effluent.

2.5.3 Dose from Evaporation of Lake Robinson

Dose resulting from the evaporation of previously discharged liquids to Lake Robinson shall be calculated annually for inclusion in the Annual Effluent Report. The curies released by evaporation from Lake Robinson will be calculated based on annual meteorological data, lake temperature, and the monthly lake composite tritium data. Due to the size and length of Lake Robinson, the lake was split into five sections to more accurately quantify the resulting dose (Refer to figure D-3). To show compliance with 10 CFR 50, Equation 2.5-9 is evaluated at the limiting pathway location. The limiting location is defined as a resident with a vegetable garden and beef animal present at 3.96 miles in the north sector. The critical receptor is a child.

H. B. Robinson air dispersion and deposition factors are calculated annually from annual averaged air concentrations and deposition values obtained during routine releases. The methodology for calculating air dispersion and deposition factors are discussed in Appendix A. Five year climatology (2005 – 2009) data was used to generated air dispersion factors listed below. Annually, air dispersion factors are compared to the five year data for each of the Lake Sections. If the newly calculated annual air dispersion and deposition factors do not result in a significant increase in the calculated offsite dose relative to the 10CFR50, Appendix I dose objectives then the 5-year χ/Q and D/Q factors are not revised. An increase in calculated offsite dose that is greater than five percent of the 10CFR50, Appendix I dose objectives would be considered significant enough to warrant a change in the χ/Q and D/Q factors. If an increasing trend in the annual χ/Q and D/Q factors compared to the 5-year values is noted then a revised set of 5-year χ/Q and D/Q factors will be generated.

X/Q values were obtained based on 2005 through 2009 meteorological data.

Lake Section	X/Q (sec/m^3)
1	1.33E-6
2	2.61E-6
3	7.97E-6
4	1.26E-4
5	1.52E-6

$$D_\tau = 3.17x10^{-8} * \left(R_{T_B} + R_{T_I} + R_{T_V}\right) * \sum_{i=1}^{5} \left[\left(\overline{\chi/Q}\right)_i * Q_i\right] \qquad (2.5\text{-}9)$$

where:

D_τ = Dose to any organ τ from tritium (mrem).

$3.17x10^{-8}$ = Inverse of the number of seconds in a year (sec/year)$^{-1}$.

R_{T_B} = Organ dose factor for tritium meat pathway (mrem/yr per μCi/m^3).

R_{T_I} = Organ dose factor for tritium inhalation pathway (mrem/yr per μCi/m^3).

R_{T_V} = Organ dose factor for tritium vegetation pathway (mrem/yr per μCi/m^3).

$\left(\overline{\chi/Q}\right)_i$ = Relative concentration from Lake Section 'i' (sec/m^3).

Q_i = Release of tritium from Lake Section 'i' (μCi).

Tritium released from each lake section is determined using lake evaporation, lake section area, and average monthly tritium concentration from REMP Surface Water location SW-40. Evaporation is derived using annual meteorological data, including wind speed and humidity, and average lake temperature. Lake section evaporation is determined annually from any of the following: a proprietary vendor method, Duke Energy internal calculation, values published by National Oceanic and Atmospheric Administration, or estimates from the State Climatology Office. Q_i values use in Equation 2.5-9 are reported annually in ARERR.

$$Q_i = A_i * E_i * C_i * 10^{-6} \tag{2.5-10}$$

where:

A_i	=	Area of lake section 'i' listed in Appendix E (m^2).
E_i	=	Monthly evaporation of lake section 'i' (mm H_2O).
C_i	=	Monthly concentration of tritium from REMP Surface Water location SW-40 (pCi/L).
10^{-6}	=	Conversion (1E-03 mm/m * 1E-06 µCi/pCi * 1E+03 L/m^3).

2.5.4 Dose from Tritium in Fish in Lake Robinson

The concentration of tritium in fish is directly related to the concentration in Lake Robinson. 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 the only age group considered. This calculation is performed annually for inclusion in the ARERR.

$$R_{apj} = U_{ap} * D_{apj} * C_{ip} * BF_i \tag{2.5-11}$$

where:

R_{apj}	=	Annual dose to organ 'j' from tritium ingestion to adult age group (mrem/yr).
U_{ap}	=	Usage term for adult from Regulatory Guide 1.109 Table E-11 (21 kg/yr).
D_{apj}	=	Adult dose factor for tritium ingestion, same for Total Body and all organs (1.05E-07 mrem/pCi).
C_{ip}	=	Concentration of tritium from REMP Surface Water location SW-40 (pCi/L).
BF_i	=	Bioaccumulation factor for tritium in fish from Regulatory Guide 1.109 Table A-1 (0.90 pCi/kg per pCi/L).

TABLE 2.5-1
$A_{i\tau}$ VALUES FOR THE ADULT FOR THE H.B. ROBINSON STEAM ELECTRIC PLANT
(mrem/hr per μCi/ml)

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI	Skin
H-3	0.00E+00	2.27E-01	2.27E-01	2.27E-01	2.27E-01	2.27E-01	2.27E-01	2.27E-01
F-18	2.30E-02	2.13E-02	2.15E-02	2.13E-02	2.13E-02	2.13E-02	2.13E-02	2.51E-02
NA-24	1.35E+02	1.35E+02	1.35E+02	1.35E+02	1.35E+02	1.35E+02	1.35E+02	7.45E-01
CR-51	2.51E-01	2.51E-01	1.49E+00	9.94E-01	5.25E-01	1.90E+00	3.13E+02	2.96E-01
MN-54	7.45E+01	4.45E+03	9.09E+02	7.45E+01	1.38E+03	7.45E+01	1.35E+04	8.74E+01
MN-56	4.86E-02	2.23E-01	7.94E-02	4.86E-02	2.69E-01	4.86E-02	5.60E+00	5.74E-02
FE-55	6.59E+02	4.55E+02	1.06E+02	0.00E+00	0.00E+00	2.54E+02	2.61E+02	0.00E+00
FE-59	1.04E+03	2.42E+03	9.38E+02	1.47E+01	1.47E+01	6.88E+02	8.04E+03	1.72E+01
CO-57	1.01E+01	2.89E+01	4.49E+01	1.01E+01	1.01E+01	1.01E+01	5.41E+02	1.11E+01
CO-58	2.04E+01	1.09E+02	2.19E+02	2.04E+01	2.04E+01	2.04E+01	1.81E+03	2.39E+01
CO-60	1.16E+03	1.41E+03	1.72E+03	1.16E+03	1.16E+03	1.16E+03	5.98E+03	1.36E+03
NI-63	3.12E+04	2.16E+03	1.05E+03	0.00E+00	0.00E+00	0.00E+00	4.51E+02	0.00E+00
NI-65	1.88E-01	3.83E-02	2.62E-02	1.60E-02	1.60E-02	1.60E-02	5.83E-01	1.86E-02
CU-64	3.26E-02	2.73E+00	1.30E+00	3.26E-02	6.83E+00	3.26E-02	2.30E+02	3.70E-02
ZN-65	2.32E+04	7.37E+04	3.33E+04	4.02E+01	4.93E+04	4.02E+01	4.64E+04	4.62E+01
BR-82	1.15E+00	1.15E+00	1.42E+03	1.15E+00	1.15E+00	1.15E+00	1.63E+03	1.33E+00
BR-83	2.62E-04	2.62E-04	3.87E-02	2.62E-04	2.62E-04	2.62E-04	5.56E-02	3.81E-04
BR-84	1.09E-02	1.09E-02	1.09E-02	1.09E-02	1.09E-02	1.09E-02	1.09E-02	1.27E-02
RB-86	4.83E-01	9.75E+04	4.54E+04	4.83E-01	4.83E-01	4.83E-01	1.92E+04	5.52E-01
RB-88	1.78E-03	1.78E-03	1.78E-03	1.78E-03	1.78E-03	1.78E-03	1.78E-03	2.03E-03
RB-89	6.61E-03	6.61E-03	6.61E-03	6.61E-03	6.61E-03	6.61E-03	6.61E-03	7.93E-03
SR-89	2.19E+04	1.16E-03	6.27E+02	1.16E-03	1.16E-03	1.16E-03	3.51E+03	1.35E-03
SR-90	5.45E+05	0.00E+00	1.34E+05	0.00E+00	0.00E+00	0.00E+00	1.58E+04	0.00E+00
SR-91	7.09E+01	1.16E-01	2.98E+00	1.16E-01	1.16E-01	1.16E-01	3.37E+02	1.35E-01
SR-92	3.76E-01	4.18E-02	5.62E-02	4.18E-02	4.18E-02	4.18E-02	6.66E+00	4.64E-02
Y-91M	5.39E-03	5.39E-03	5.39E-03	5.39E-03	5.39E-03	5.39E-03	5.39E-03	6.24E-03
Y-91	8.41E+00	5.77E-02	2.81E-01	5.77E-02	5.77E-02	5.77E-02	4.60E+03	6.49E-02
Y-92	1.02E-02	9.70E-03	9.72E-03	9.70E-03	9.70E-03	9.70E-03	8.09E+00	1.15E-02
Y-93	4.08E-02	9.86E-03	1.07E-02	9.86E-03	9.86E-03	9.86E-03	9.82E+02	1.35E-02
ZR-95	1.34E+01	1.32E+01	1.32E+01	1.32E+01	1.33E+01	1.32E+01	2.55E+02	1.53E+01
ZR-97	1.64E-01	1.60E-01	1.60E-01	1.59E-01	1.61E-01	1.59E-01	3.11E+02	1.85E-01
NB-95	4.46E+02	2.51E+02	1.39E+02	7.35E+00	2.49E+02	7.35E+00	1.48E+06	8.65E+00
NB-97	9.47E-03	9.47E-03	9.47E-03	9.47E-03	9.47E-03	9.47E-03	1.29E-02	1.11E-02
MO-99	2.15E-01	8.06E+01	1.55E+01	2.15E-01	1.82E+02	2.15E-01	1.86E+02	2.49E-01
TC-99M	1.05E-02	1.15E-02	3.01E-02	9.90E-03	3.40E-02	1.07E-02	9.47E-01	1.13E-02
TC-101	1.09E-03	1.09E-03	1.09E-03	1.09E-03	1.09E-03	1.09E-03	1.09E-03	1.22E-03
RU-103	1.02E+01	5.82E+00	7.70E+00	5.82E+00	2.25E+01	5.82E+00	5.15E+02	6.79E+00
RU-105	4.29E-02	3.42E-02	3.77E-02	3.42E-02	1.47E-01	3.42E-02	5.36E+00	3.88E-02
RU-106	8.85E+01	2.27E+01	3.10E+01	2.27E+01	1.50E+02	2.27E+01	4.28E+03	2.72E+01
AG-110M	1.86E+02	1.86E+02	1.85E+02	1.85E+02	1.86E+02	1.85E+02	5.17E+02	2.16E+02
SN-113	2.00E+03	7.80E+01	1.90E+03	2.80E+01	5.75E+01	7.66E-01	3.50E+04	2.19E+00
SB-124	3.88E+01	3.23E+01	3.48E+01	3.22E+01	3.22E+01	3.73E+01	2.21E+02	3.71E+01
SB-125	1.30E+02	1.26E+02	1.27E+02	1.26E+02	1.26E+02	1.29E+02	1.73E+02	1.42E+02
TE-129M	1.08E+04	4.03E+03	1.71E+03	3.71E+03	4.51E+04	1.06E+00	5.44E+04	1.24E+00
TE-129	1.43E-03	1.42E-03	1.42E-03	1.42E-03	1.49E-03	1.41E-03	1.42E-03	1.67E-03
TE-131M	9.54E+02	4.67E+02	3.89E+02	7.39E+02	4.72E+03	4.32E-01	4.63E+04	5.09E-01
TE-132	1.95E+03	1.26E+03	1.19E+03	1.40E+03	1.22E+04	2.28E-01	5.98E+04	2.68E-01
I-131	1.38E+02	1.97E+02	1.13E+02	6.44E+04	3.38E+02	9.25E-01	5.27E+01	1.12E+00
I-132	7.23E-02	8.11E-02	7.19E-02	5.61E-01	8.95E-02	6.70E-02	6.96E-02	7.88E-02
I-133	2.31E+01	4.01E+01	1.23E+01	5.87E+03	6.98E+01	1.32E-01	3.60E+01	1.60E-01
I-134	2.40E-02	2.40E-02	2.40E-02	2.40E-02	2.40E-02	2.40E-02	2.40E-02	2.85E-02
I-135	1.42E+00	3.50E+00	1.38E+00	2.22E+02	5.54E+00	1.36E-01	3.94E+00	1.59E-01

TABLE 2.5-1 (continued)

$A_{i\tau}$ VALUES FOR THE ADULT FOR THE
H.B. ROBINSON STEAM ELECTRIC PLANT
(mrem/hr per μCi/ml)

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI	Skin
CS-134	2.98E+05	7.10E+05	5.80E+05	3.69E+02	2.30E+05	7.66E+04	1.28E+04	4.30E+02
CS-136	2.96E+04	1.17E+05	8.42E+04	8.12E+00	6.51E+04	8.93E+03	1.33E+04	9.20E+00
CS-137	3.83E+05	5.23E+05	3.43E+05	5.55E+02	1.78E+05	5.95E+04	1.07E+04	6.47E+02
CS-138	1.93E-02	1.93E-02	1.93E-02	1.93E-02	1.93E-02	1.93E-02	1.93E-02	2.21E-02
BA-139	5.70E-03	5.69E-03	5.69E-03	5.69E-03	5.69E-03	5.69E-03	5.70E-03	6.41E-03
BA-140	1.86E+02	1.34E+00	1.32E+01	1.10E+00	1.18E+00	1.24E+00	3.81E+02	1.26E+00
BA-142	2.41E-03	2.41E-03	2.41E-03	2.41E-03	2.41E-03	2.41E-03	2.41E-03	2.75E-03
LA-140	1.13E+00	1.08E+00	1.05E+00	1.03E+00	1.03E+00	1.03E+00	3.67E+03	1.17E+00
LA-142	4.09E-02	4.09E-02	4.09E-02	4.09E-02	4.09E-02	4.09E-02	4.16E-02	4.90E-02
CE-141	7.57E-01	7.50E-01	7.37E-01	7.35E-01	7.42E-01	7.35E-01	5.75E+01	8.28E-01
CE-143	1.27E-01	1.89E+00	1.25E-01	1.24E-01	1.25E-01	1.24E-01	6.62E+01	1.41E-01
CE-144	4.91E+00	4.23E+00	3.80E+00	3.74E+00	4.03E+00	3.74E+00	3.98E+02	4.32E+00
PR-144	9.87E-05	9.87E-05	9.87E-05	9.87E-05	9.87E-05	9.87E-05	9.87E-05	1.13E-04
HF-181	1.33E+01	1.06E+01	1.09E+01	1.06E+01	1.06E+01	1.06E+01	2.12E+02	1.50E+01
W-187	1.48E+02	1.23E+02	4.32E+01	1.26E-01	1.26E-01	1.26E-01	4.04E+04	1.47E-01
NP-239	1.13E-01	9.41E-02	9.31E-02	9.20E-02	9.85E-02	9.20E-02	4.29E+02	1.06E-01

2.6 Radioactive Liquid Effluent Monitoring Instrumentation

Applicability

Applies to the radioactive liquid effluent instrumentation system.

Objective

To define the operating requirements for the radioactive liquid effluent instrumentation system.

Specification

CONTROLS

2.6.1 The radioactive liquid effluent monitoring instrumentation channels shown in Table 2.6-1 shall be operable with their alarm/trip setpoint set to ensure that the limits of ODCM Specification 2.2.1 are not exceeded. The alarm/trip setpoints shall be determined in accordance with the ODCM.

ACTIONS

2.6.2 With the calculated dose commitment from the release of radioactive materials in liquid effluents exceeding any of the limits prescribed by ODCM Specification 2.4.1 above, prepare and submit a report to the Commission in accordance with the ODCM Specification 9.3.

2.6.3 With less than the minimum number of radioactive liquid effluent monitoring instrumentation operable, take the action shown in Table 2.6-1.

2.6.4 The provisions of Specification 8.1 are not applicable.

Bases

Radioactive Liquid Effluent Instrumentation

The radioactive liquid effluent monitoring instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in liquid effluents during actual or potential releases of liquid effluents. The alarm/trip setpoints for these instruments shall be calculated in accordance with the procedures in the ODCM to ensure that the alarm/trip will occur prior to exceeding 10 times the limits of 10 CFR Part 20, Appendix B, Table 2, Column 2. The operability and use of this instrumentation are consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10 CFR Part 50.

TABLE 2.6-1
RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

Release Pathway / Instrumentation	MCO*	Compensatory Measures
1. Liquid Radwaste Effluent Discharge Line a. Monitor (R-18) provides automatic termination of release upon exceeding alarm/trip setpoint.	1	With the number of channels operable less than the MCO requirements: a. Exert best efforts to return the instruments to operable status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner in accordance with Technical Specification 5.6.3 and, b. Effluent releases via this pathway may continue provided that prior to initiating a release: 1. Two independent samples are analyzed in accordance with the Surveillance Requirements of ODCM Specification 2.2.1 and; 2. Two members of the facility staff independently verify the release rate calculations and the discharge line valving.
b. Flow rate measurement device	1	With the number of channels operable less than the MCO requirement: a. Exert best efforts to return the instruments to operable status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner in accordance with Technical Specification 5.6.3 and, b. Effluent releases via this pathway may be continued, provided that the flow rate is estimated at least once per 4 hours during actual releases. Pump performance curves generated "in situ" and tank volumes may be used to estimate flow.

*MCO - Minimum Channels Operable

TABLE 2.6-1 (continued)
RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

Release Pathway / Instrumentation	MCO*	Compensatory Measures
2. Steam Generator Blowdown Effluent Line a. Monitor (R-19A,B, and C) provides automatic termination of blowdown from the affected Steam Generators upon exceeding alarm/trip setpoint.	1 per S/G	With the number of channels operable less than the MCO requirement: a. Exert best efforts to return the instruments to operable status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner in accordance with Technical Specification 5.6.3 and, b. Effluent releases via this pathway may continue provided that grab samples are analyzed for gross radioactivity (beta or gamma) with a lower limit of detection of at least 1.0E-07µCi/ml or are analyzed for principle gamma emitters consistent with Table 2.8-1; 1. Once per 24 hours when the specific activity of the secondary coolant is ≤0.01 µCi/ml Dose Equivalent I-131, or; 2. Once per 12 hours when the specific activity of the secondary coolant is >0.01 µCi/ml dose Equivalent I-131.
b. Flow rate measurement devices - each Steam Generator has its own blowdown flow rate measuring device. These devices only measure flow directed through the heat recovery system, and will not measure flow which bypasses the heat recovery system.	1 per S/G	With the number of channels operable less than the MCO requirement due to inoperable equipment: a. Exert best efforts to return the instruments to operable status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner in accordance with Technical Specification 5.6.3 **AND**, With the number of channels operable less than the MCO requirement due to inoperable equipment, **OR** if the steam generator blowdown system is aligned such that any flow bypasses the flow measurement device(s) (i.e. heat recovery is not in service): b. Effluent releases via this pathway may continue provided that the flow rate for the affected blowdown line(s) is estimated at least once per 24 hours.

*MCO - Minimum Channels Operable

TABLE 2.6-1 (continued)
RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

Release Pathway/Instrumentation	MCO*	Compensatory Measures
2. Steam Generator Blowdown Effluent Line (continued) c. R-19A, B and C flow measurement device – each monitor has its own flow rate measurement device	1 per S/G	With the number of channels operable less than the MCO requirement due to inoperable equipment: a. Exert best efforts to return the instruments to operable status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner in accordance with Technical Specification 5.6.3 and, b. Effluent releases via this pathway may continue provided that the flow rate for the affected monitor line(s) is estimated at least once per 24 hours.
3. Discharge Canal Flow	Note 1	With the number of channels operable less than the MCO requirement suspend effluent release via this pathway.
4. Tank Level Indicating Devices a. Refueling Water Storage Tank b. Monitor Tanks Tank A Tank B c. Waste Condensate Tanks Tank C Tank D Tank E d. Deleted	 1 1 1 1 1 1	With the number of channels operable less than the MCO requirement: a. Exert best efforts to return the instruments to operable status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner in accordance with Technical Specification 5.6.3 and, b. Liquid additions to the affected tank(s) may continue provided that the liquid level for the affected tanks is estimated during all liquid additions to the affected tank(s).

*MCO - Minimum Channels Operable

TABLE 2.6-1 (continued)

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

Release Pathway/Instrumentation	MCO*	Compensatory Measures
5. Containment Fan Cooling Water Monitor (Service Water Effluent Line) a. Monitor (R-16) does not provide automatic termination of release upon exceeding alarm setpoint.	1	With the number of channels operable less than the MCO requirement: a. Exert best efforts to return the instruments to operable status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner in accordance with Technical Specification 5.6.3 and, b. Effluent releases via this pathway may continue provided that, once per 24 hours, grab samples are collected and analyzed for gross radioactivity (beta or gamma) with a lower limit of detection of at least 1.0E-07 μCi/ml or are analyzed for principal gamma emitters consistent with Table 2.8-1.
6. Composite Sampler for Settling Ponds	1	With the number of channels operable less than the MCO requirement: a. Exert best efforts to return the instruments to operable status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner in accordance with Technical Specification 5.6.3 and, b. Effluent releases via this pathway may continue provided that, grab samples are collected and composited three times per week and analyzed in accordance with Table 2.8-1.

*MCO - Minimum Channels Operable

TABLE 2.6-1 (continued)

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

Release Pathway/Instrumentation	MCO*	Compensatory Measures
7. Condensate Polisher Liquid Waste Monitor a. Monitor (R-37) provides automatic termination of release upon exceeding alarm/trip setpoint	1	With the number of channels operable less than the MCO requirement: a. Exert best efforts to return the instruments to operable status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner in accordance with Technical Specification 5.6.3 and, b. Effluent releases via this pathway may continue provided that, once per 24 hours, grab samples are collected and analyzed for gross radioactivity (beta or gamma) with a lower limit of detection of at least 1.0E-07 μCi/ml or are analyzed for principal gamma emitters consistent with Table 2.8-1.

*MCO - Minimum Channels Operable

NOTES TO TABLE 2.6-1

Note 1 Pump curves for Unit 2 operating circulating water pumps may be used to satisfy this MCO. If no Unit 2 circulating water pumps are operating the pump curves for circulating water pumps operating in Retired Fossil Plant may be used to satisfy this MCO.

Note 2 Deleted

2.7 Radioactive Liquid Effluent Monitoring Instrumentation - Surveillance Requirements

Applicability

Applies to the radioactive liquid effluent instrumentation system.

Objective

To ascertain that the radioactive liquid effluent instrumentation system is functioning properly in order to accurately monitor radioactive liquid effluent releases.

Specification

SURVEILLANCE REQUIREMENTS

2.7.1 Each radioactive liquid effluent monitoring instrumentation channel shall be demonstrated operable by performance of the channel check, source check, channel calibration, and Channel Operational Test operations at the frequencies shown in Table 2.7-1.

TABLE 2.7-1
RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

Pathway/Instruments	Channel Check	Source Check	Channel Calibration	Channel Operational Test
1. Liquid Radwaste Effluent Line				
a. Monitor (R-18)	D	P	C (Note 3)	Q (Note 4)
b. Flow rate measurement device	(Note 1)	N.A.	C	N.A.
2. Steam Generator Blowdown Effluent Line				
a. Monitor (R-19A)	D	M	C (Note 3)	Q (Note 4)
(R-19B)	D	M	C (Note 3)	Q (Note 4)
(R-19C)	D	M	C (Note 3)	Q (Note 4)
b. Flow rate measurement devices for measuring flow of sample to R-19	(Note 2)	N.A.	N.A.	N.A.
c. Flow rate measuring devices for each steam generator blowdown line	(Note 2)	N.A.	C	N.A.
3. Containment Fan Cooling Water Monitor (Service Water Effluent Line)				
a. Monitor (R-16)	D	M	C (Note 3)	Q (Note 5)
4. Tank Level Indicating Devices				
a. Refueling Water Storage Tank	D	N.A.	R	Q
b. Monitor Tanks A & B	D*	N.A.	R	Q
c. Waste Condensate Tanks C D & E	D*	N.A.	R	Q
5. Condensate Polisher Waste Monitor (R-37)	D	M	C	Q

* During liquid additions to the tank

NOTES TO TABLE 2.7-1

Note 1 The channel check shall consist of verifying indication of flow at least once during each batch type release or shall consist of verifying indication of flow at least once per 24 hours for continuous type releases.

Note 2 The channel check shall consist of verifying indication of flow at least once during each batch type release or shall consist of verifying indication of flow at least once per 24 hours for continuous releases, except during steam generator drain at cold shutdown.

Note 3 The channel calibration shall be performed using one or more of the reference standards certified by the National Institute of Standards and Technology (NIST) or using standards that have been obtained from suppliers that participate in measurement assurance activities or otherwise NIST traceable.

Note 4 The Channel Operational Test shall also demonstrate that automatic isolation of this pathway and Control Room alarm annunciation occur if any of the following conditions exists:

1. Instrument indicates measured levels above the alarm/trip setpoint.
2. Power failure.
3. Instrument controls not set in operate mode.

Note 5 The Channel Operational Test shall also demonstrate that Control Room alarm annunciation occurs if any of the following conditions exists:

1. Instrument indicates measured levels above the alarm setpoint.
2. Power failure.
3. Instrument indicates a downscale failure.
4. Instrument controls not set in operate mode.

NOTATION

P Completed prior to making a radioactive materials release
D At least once per 24 hours
W At least once per 7 days
N.A. Not applicable
M At least once per 31 days
R At least once per 18 months
Q At least once per 92 days
C At least once per 24 months

2.8 Radioactive Liquid Effluents Sampling and Analysis Requirements

Applicability

Applies to the monitoring of radioactive liquid effluents.

Objective

To ascertain that radioactive liquid effluent releases are being maintained as low as reasonably achievable and within allowable limits.

Specification

SURVEILLANCE REQUIREMENTS

2.8.1 The radioactivity content of each batch of radioactive liquid waste to be discharge shall be determined prior to release by sampling and analysis in accordance with Table 2.8-1. The results of pre-release analyses shall be used with the calculative methods in the ODCM to assure that the concentration at the point of release to the unrestricted area is maintained within the limits of Specification 2.2.1.

2.8.2 Analyses of samples composited from batch releases shall be performed in accordance with Table 2.8-1. The results of the post-release analyses shall be used with the calculative methods in the ODCM to assure that the concentrations at the point of release were maintained within the limits of Specification 2.2.1.

2.8.3 The concentration of radioactive materials in liquid effluents discharged from continuous release points shall be determined by collection and analysis of samples in accordance with Table 2.8-1. The results of the analyses shall be used with the calculative methods in the ODCM to assure that the concentrations at the point of release are maintained within the limits of Specification 2.2.1.

2.8.4 Dose Calculations: Cumulative dose commitments for the current calendar quarter and calendar year from liquid effluents shall be determined in accordance with the ODCM once per 31 days.

TABLE 2.8-1
RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

Type of Release	Sampling Frequency	Minimum Analysis Frequency	Required Activity Analysis	Required LLD [a] µCi/ml
Batch Waste Releases [b]	P Grab Sample	P on Grab Sample	Principal Gamma Emitters [c]	5E-07
			I-131	1E-06
1. Monitor Tanks	P Grab Sample One Batch/M	M on Grab Sample	Dissolved and Entrained Gases (gamma emitters)	1E-05
2. Waste Condensate Tanks	P Grab Sample Each Batch and Composited [d]	M on Composite	Tritium [h]	1E-05
			Gross Alpha	1E-07
3. Drainage of Systems	P Grab Sample Each Batch and Composited [d]	Q on Composite	Sr-89, Sr-90	5E-08
			Fe-55	1E-06
Continuous Releases [e]	3/W Grab Sample	W on Composite	Principal Gamma Emitters [c, i]	5E-07
			I-131 [i]	1E-06
1. Steam Generator Blowdown	M Grab Sample	M on Grab Sample	Dissolved and Entrained Gases (gamma emitters)	1E-05
2. Condensate Polisher Waste Water Discharge [g]	3/W Grab Sample and Composited [d, f]	M on Composite	Tritium [i]	1E-05
			Gross Alpha	1E-07
3. Settling Ponds [g]	3/W Grab Sample and Composited [d, f]	Q on Composite	Sr-89, Sr-90	5E-08
			Fe-55	1E-06

TABLE NOTATION

a. The LLD is defined, for purposes of these specifications, as the smallest concentration of radioactive material in a sample that will yield a net count, above system background, that will be detected with 95% probability with only 5% probability of falsely concluding that a blank observation represents a "real" signal.

For a particular measurement system, which may include radiochemical separation:

$$LLD = \frac{4.66 * S_b}{E * V * 2.22x10^6 * Y * e^{-\lambda \Delta t}}$$

where:

LLD is the "a priori" lower limit of detection as defined above, as microcuries per unit mass or volume,

S_b is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate, as counts per minute,

E is the counting efficiency, as counts per disintegration,

V is the sample size in units of mass or volume,

$2.22x10^6$ is the number of disintegrations per minute per microcurie,

Y is the fractional radiochemical yield, when applicable,

λ is the radioactive decay constant for the particular radionuclide, and

Δt for plant effluents is the elapsed time between the midpoint of sample collection and time of counting.

Typical values of efficiency (E), volume/mass (V), chemical yield (Y), and radionuclide decay correction time (Δt) are to 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.

b. A batch release is the discharge of liquid wastes of a discrete volume. Prior to sampling for analyses each batch shall be isolated and thoroughly mixed whenever possible, to assure representative sampling. Residual liquids in systems such as feedwater heaters and lines cannot be thoroughly mixed for representative samples of their respective system. Grab samples from these systems will be accepted as representative of their respective system.

c. The principal gamma emitters for which the LLD specification applies exclusively are the following radionuclides: Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, Ce-141, and Ce-144. This list does not mean that only these nuclides are to be detected and reported. Other peaks which are measurable and identifiable, together with the above nuclides, shall also be identified and reported.

d. A composite sample is one in which the quantity of liquid sampled is proportional to the quantity of liquid waste discharged and in which the method of sampling employed results in a specimen which is representative of the liquids released.

e. A continuous release is the discharge of liquid wastes of a nondiscrete volume; e.g., from a system that has an input flow during the continuous release.

f. Grab sample of continuous flows taken for compositing purposes will be taken in volumes proportional to the existing flow rate of the system in a manner described in the ODCM.

g. Normal grab sampling for the Condensate Polisher Waste Water Discharge & Settling Ponds is performed by an automatic composite sampler on the discharge line in lieu of three times per week sampling. If composite sampler is rendered inoperable, manual grab samples should be collected and composited.

h. In lieu of a tritium analysis being performed on a batch tank composite sample, each individual release may be analyzed for tritium.

i. For continuous releases, where a periodic grab sample is performed, a gamma or tritium analysis may be performed on each sample in lieu of a composite analysis.

NOTATION

P Completed prior to making a radioactive materials release
W At least once per 7 days
M At least once per 31 days
Q At least once per 92 days
3/W 3 times per week

2.9 Liquid Radwaste Treatment System

Applicability

Applies to the liquid radwaste treatment system.

Objective

To define the operating requirements for the liquid radwaste treatment system and to ascertain that the concentration of radioactive materials in the liquid waste treatment system is maintained as low as reasonably achievable and within allowable limits.

Specification

CONTROLS

2.9.1 The appropriate portions of the Liquid Radwaste Treatment System shall be maintained and used to reduce the concentrations of radioactive materials in liquid wastes prior to their discharge when the projected dose commitments, due to the release of radioactive liquid effluents to unrestricted areas (See Figure 7-1) when averaged over a calendar quarter, would exceed 0.2 mrem to the total body or 0.6 mrem to any organ.

ACTIONS

2.9.2 With radioactive liquid wastes being discharged without treatment while in excess of the limits of ODCM Specification 2.9.1 above, prepare and submit a report to the Commission in accordance with ODCM Specification 9.3.b.

SURVEILLANCE REQUIREMENTS

2.9.3 Dose commitments from liquid releases shall be projected at least once per 31 days, in accordance with the ODCM to ensure the provisions of ODCM Specification 2.9.1 are satisfied when the Liquid Radwaste Treatment System is not in use.

Bases

Liquid Radwaste Treatment System

The requirements that the appropriate portions of this system be maintained and used when specified provides assurance that the releases of radioactive materials in liquid effluents will be kept "as low as reasonably achievable".

This specification implements the requirements of 10 CFR Part 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50 and the design objective given in Section II.D of Appendix I to 10 CFR Part 50. The specified limits governing the use of appropriate portions of the Liquid Radwaste Treatment System were specified as the dose design objective set forth in Section II.A of Appendix I, 10 CFR Part 50, for liquid effluents.

3.0 GASEOUS EFFLUENTS

3.1 Monitor Alarm Setpoint Determination

This methodology determines the monitor alarm setpoint if the dose rate in the unrestricted areas due to radionoble gases in the gaseous effluent released from the site to areas at and beyond the site boundary exceeds 500 mrem/year to the whole body or exceeds 3000 mrem/year to the skin using a conservative mix (GALE Code).

The methodology described in Section 3.1.2 provides an alternative means to determine monitor alarm setpoints when an analysis is performed prior to release.

3.1.1 Setpoint Based on Conservative Radionuclide Mix (Ground and Mixed Mode Releases)

Releases through the steam generator flash tank vent can only occur through this vent when significant primary-to-secondary leakage exists within the steam generators and the blowdown is not going through heat recovery. Steam generator blowdown is continuously monitored by R-19A, R-19B, and R-19C as a liquid pathway. The condenser vacuum pump vent discharges via plant vent which is monitored by R-14.

The following method applies to gaseous releases via the plant vent when determining the high-alarm setpoint for the plant vent gas monitor (R-14C) and the Fuel Handling Basement Exhaust Monitor (R-20), using the GALE code during the following operational conditions:

- Continuous release via the plant vent (R-14C).
- Continuous release via the Fuel Handling Basement Exhaust (R-20).

3.1.1.1 Determine the "mix" (noble gas radionuclides and composition) of the gaseous effluent.

$$S_i = \frac{A_i}{\sum_i A_i} \tag{3.1-1}$$

where:

S_i = The fraction of the total noble gas radioactivity in the gaseous effluent comprised by noble gas radionuclide 'i' for each individual noble gas radionuclide in the gaseous effluent or the S_i from Table 3.1-1 when using GALE Code.

A_i = The radioactivity of noble gas radionuclide 'i' in the gaseous effluent from Table 3.1-1 (Ci/yr).

3.1.1.2 Determine the Q_m, the maximum acceptable total release rate (µCi/sec) of all noble gas radionuclides in the gaseous effluent based upon the whole body exposure limit of 500 mrem/year by:

$$Q_m = \frac{500}{(\overline{\chi/Q}) * \sum_i (K_i * S_i)}$$

(3.1-2)

where:

$(\overline{\chi/Q})$	=	The highest calculated annual average relative dispersion factor for any area at or beyond the unrestricted area boundary for all sectors (sec/m^3).
	=	8.1E-05 sec/m^3 (Continuous Ground Release) from Table A-1, Appendix A.
	=	9.9E-07 sec/m^3 (Mixed Mode Release) from Table A-10, Appendix A.
K_i	=	The total whole body dose factor due to gamma emissions from noble gas radionuclide 'i' from Table 3.1-2 (mrem/yr per µCi/m^3).

3.1.1.3 Determine the Q_m, the maximum acceptable release rate (µCi/sec) of all gas radionuclides in the gaseous effluent based upon the skin exposure limit of 3000 mrem/year by:

$$Q_m = \frac{3000}{(\overline{\chi/Q}) * \sum_i [(L_i + 1.11 M_i) * S_i]}$$

(3.1-3)

where:

$L_i + 1.11M_i$	=	The total skin dose factor due to emissions from noble gas radionuclide 'i' from Table 3.1-2 (mrem/yr per µCi/m^3).

3.1.1.4 Determine the C_m, the maximum acceptable total radioactivity concentration (µCi/cm^3) of all noble gas radionuclides in the gaseous effluent.

$$C_m = \frac{2.12x10^{-3} * Q_m}{F} * T_m * S$$

(3.1-4)

NOTE: Use the lower of the Q_m values obtained in Sections 3.1.1.2 and 3.1.1.3. This will protect both the skin and total body from being exposed to the limit.

where:

T_m	=	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 due to simultaneous releases from several pathways (dimensionless).
	=	0.92 for Plant Vent Gas Monitor (R-14C).
	=	0.05 for the Fuel Handling Basement Exhaust Monitor (R-20).

F	=	The maximum acceptable effluent flow rate at the point of release (cfm).
	=	60,600 cfm for plant vent.
	=	10,200 cfm for the fuel-handling building.
$2.12\text{x}10^{-3}$	=	Unit conversion constant to convert µCi/sec/cfm to µCi/cm^3.
	=	$\frac{\text{sec}-\text{ft}^3}{\text{min}-\text{cm}^3}$
S	=	0.5, an engineering factor used to provide a margin of safety for cumulated measurement uncertainties (dimensionless).

3.1.1.5 Determine CR, the calculated monitor count rate above background attributed to the noble gas radionuclides (cpm) by:

$$CR = C_m * E_m \tag{3.1-5}$$

where:

E_m = Obtained from the applicable effluent monitor efficiency curve located in the Station Curve Book. Use the radioactivity concentration 'C_m' to find CR.

3.1.1.6 Determine HSP, the monitor high-alarm setpoint including background (cpm) by:

$$HSP = CR + background \tag{3.1-6}$$

3.1.2 <u>Setpoint Based on Sample Analysis Prior to Release</u>

The following method applies to gaseous releases when determining the high-alarm setpoint with prior sample analysis and using the maximum acceptable effluent flow rate at the point of release. The method applies to the following conditions.

Batch Releases

- Containment purge.*
- Containment pressure relief.
- Waste gas decay tanks.

Continuous Releases

- Plant vent.
- Fuel handling basement exhaust.
- Environmental and Radiation Control Building Hood Exhaust.
- Containment purge.
- Radwaste Building exhaust vent.

* Batch containment purge is considered as one volume of containment air removed.

3.1.2.1 Determine R_i, the noble gas release rate (µCi/sec) for radionuclide 'i':

$$R_i = 472 * C_i * F \tag{3.1-7}$$

where:

472 = A conversion factor to convert cfm to cm^3/sec.

C_i = The radioactivity concentration of noble gas radionuclide 'i' from analysis of gaseous effluent from the Plant Vent (stack), Fuel Handling Basement Exhaust, Environmental & Radiation Control (E&RC) Building Hood Exhaust, Radwaste Building Exhaust Vent and the Containment Vessel when R-12 is sampling from the Containment. If there are no isotopes identified in the sample, the EC for Xe-133 may be used as an actual value for the purpose of the setpoint calculation (µCi/cm^3).

Containment Purge: Used for R-14 or R-12 when R-11/12 aligned to the Plant Vent.

$$= \left(\frac{\mu\text{Ci}}{\text{cm}^3}\text{ from analysis of Containment Vent} * 0.366\right) + \left(\frac{\mu\text{Ci}}{\text{cm}^3}\text{ from analysis of Plant Vent} * 0.634\right)$$

0.366 = Dilution correction factor for C.V. Purge.

$$= \frac{35{,}000\text{ cfm}}{(60{,}600+35{,}000)\text{ cfm}}$$

0.634 = Dilution correction factor for Plant Vent during C.V. Purge.

$$= \frac{60{,}600\text{ cfm}}{(60{,}600+35{,}000)\text{ cfm}}$$

Containment Pressure Relief: Used for R-14 or R-12 when R-11/12 aligned to the Plant Vent.

$$= \left(\frac{\mu\text{Ci}}{\text{cm}^3}\text{ from analysis of Containment Vent} * 0.040\right) + \left(\frac{\mu\text{Ci}}{\text{cm}^3}\text{ from analysis of Plant Vent} * 0.960\right)$$

0.040 = Dilution correction factor for C.V. Pressure Relief.

$$= \frac{2{,}500^{\dagger}\text{ cfm}}{(60{,}600+2{,}500^{\dagger})\text{ cfm}}$$

0.960 = Dilution correction factor for Plant Vent during C.V. Pressure Relief.

$$= \frac{60{,}600\text{ cfm}}{(60{,}600+2{,}500^{\dagger})\text{ cfm}}$$

† 2,500 CFM - Refer to Appendix B.3 for additional information

Waste Gas Decay Tanks (WGDT).

= $\left(\frac{\mu Ci}{cm^3}\text{ from analysis of WGDT} * 0.0016\right) + \left(\frac{\mu Ci}{cm^3}\text{ from analysis of Plant Vent} * 0.9984\right)$

0.0016 = Dilution correction factor for WGDT.
= $\frac{100\ \text{cfm}}{(60{,}600+100)\ \text{cfm}}$

0.9984 = Dilution correction factor for Plant Vent during WGDT Release.
= $\frac{60{,}600\ \text{cfm}}{(60{,}600+100)\ \text{cfm}}$

WGDT during Containment Purge.

= $\left(\frac{\mu Ci}{cm^3}\text{ from analysis of WGDT} * 0.001\right) + \left(\frac{\mu Ci}{cm^3}\text{ from analysis of Plant Vent} * 0.633\right) +$
$\left(\frac{\mu Ci}{cm^3}\text{ from analysis of C.V.} * 0.366\right)$

0.001 = Dilution correction factor for WGDT during a Continuous C.V. Purge and Plant Vent Release.
= $\frac{100\ \text{cfm}}{(60{,}600+35{,}000+100)\ \text{cfm}}$

0.633 = Dilution correction factor for Plant Vent during a Continuous C.V. Purge and Plant Vent Release.
= $\frac{60{,}600\ \text{cfm}}{(60{,}600+35{,}000+100)\ \text{cfm}}$

0.366 = Dilution correction factor for Continuous C.V. Purge during WGDT Release.
= $\frac{35{,}000\ \text{cfm}}{(60{,}600+35{,}000+100)\ \text{cfm}}$

F = The maximum acceptable effluent flow rate at the point of release (cfm)
= 60,600 CFM for the plant vent
= 10,200 CFM for the fuel handling basement exhaust
= 11,500 CFM for the E&RC building hood exhaust
= 15,000 CFM for the Radwaste Building exhaust vent
= 60,700 CFM for the waste gas decay tank
= 95,700 CFM for the WGDT during a continuous containment vessel purge
= 95,600 CFM for the containment vessel purge plus plant vent (R-14 or R-12 when R-11/12 is sampling from the Plant Vent)
= 63,100 CFM for the containment vessel pressure relief (R-14 or R-12 when R-11/12 is sampling from the Plant Vent)
= 35,000 CFM for containment vessel purge or continuous release (R-12 when R-11/12 is sampling from the Containment Vessel)
= 2,500 CFM for containment vessel pressure relief releases (R-12 when R-11/12 is sampling from the Containment Vessel)

† 2,500 CFM - Refer to Appendix B.3 for additional information

3.1.2.2 Determine the monitor alarm setpoint based on total body and skin dose rate:

a. Determine dose rate for total body (mrem/yr).

$$DR_{TB} = (\overline{\chi/Q}) * \sum_{i} (K_i * R_i) \tag{3.1-8}$$

where:

$(\overline{\chi/Q})$ = The highest calculated annual average relative dispersion factor for any area at or beyond the unrestricted area boundary for all sectors from Appendix A (sec/m^3).
= 8.1E-05 sec/m^3 (continuous ground release) from Table A-1, Appendix A. To be conservative this can be used for all releases.
= 9.9E-07 sec/m^3 (continuous mixed mode release) from Table A-10, Appendix A, only with upper wind speeds of ≤ 9 mph.
= 5.1E-05 sec/m^3 (batch ground release) from Table A-7, Appendix A.
= 2.9E-06 sec/m^3 (batch mixed mode release) from Table A-16, Appendix A.

K_i = The total whole body dose factor due to gamma emissions from noble gas radionuclide 'i' from Table 3.1-2 (mrem/yr per µCi/m^3).

b. Determine dose rate for skin (mrem/yr).

$$DR_{SK} = (\overline{\chi/Q}) * \sum_{i} [(L_i + 1.11M_i) * R_i] \tag{3.1-9}$$

where:

$L_i + 1.11M_i$ = The total skin dose factor for noble gas emission 'i' radionuclide from Table 3.1-2 (mrem/yr per µCi/m^3).

c. Determine the noble gas emission Projected Dose Rate Ratio (PDRR) for Total Body and Skin.

$$PDRR_{TB} = \frac{DR_{TB}}{500} \tag{3.1-10}$$

$$PDRR_{SK} = \frac{DR_{SK}}{3000} \tag{3.1-11}$$

where:

500 = The allowable total body dose rate due to noble gas gamma emissions (mrem/yr).

3000 = The allowable skin dose rate due to noble gas beta emissions (mrem/yr).

d. Determine the maximum monitor setpoint concentration ($\mu Ci/cm^3$) for total body and skin.

$$Maximum\ Monitor\ Total\ Body\ Setpoint = \frac{\sum_i C_i}{PDRR_{TB}} * S * T_m \tag{3.1-12}$$

$$Maximum\ Monitor\ Skin\ Setpoint = \frac{\sum_i C_i}{PDRR_{SK}} * S * T_m \tag{3.1-13}$$

where:

S = 0.5, an engineering factor used to provide a margin of safety for cumulative uncertainties of measurements (dimensionless).

T_m = 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 due to simultaneous releases from several pathways (dimensionless).
= 0.92 for the Plant Vent Gas Monitor (R-14C).
= 0.05 for the Fuel Handling Basement Exhaust Monitor (R-20).
= 0.01 for other potential release points.
= 0.01 for the E&RC Building Hood Exhaust Monitor (R-22).
= 0.01 for the Radwaste Building exhaust vent Monitor (R-23).
= 0.81 for C.V. releases via R-11 and R-12.
[This indicates 0.81 of 10 CFR 20 limits for Containment releases and is also monitored by R-14C. 0.92 = 0.81 + 0.11 (Normal Plant Releases)]

e. Determine the maximum monitor setpoint (cpm) for total body (S_t) and skin (S_s).

$$S_t = \frac{Maximum\ Monitor\ Total\ Body\ Setpoint}{Monitor\ Efficiency} + Bkg \tag{3.1-14}$$

$$S_s = \frac{Maximum\ Monitor\ Skin\ Setpoint}{Monitor\ Efficiency} + Bkg \tag{3.1-15}$$

where:

Monitor Efficiency	=	Obtained from the applicable effluent monitor efficiency curve located in the Station Curve Book. Use the radioactivity concentration (µCi/cc) to find (CPM).
Bkg	=	The monitor background (CPM)

f. Determine the actual gaseous monitor setpoint:

The setpoints that were determined based on the dose rate limits to the total body (S_t) and to the skin (S_s) are compared and the lesser value is used as the actual setpoint.

TABLE 3.1-1
GASEOUS SOURCE TERMS*

	Plant Vent Release[1]		Condenser Vacuum Pump Vent[2]		Containment Purge or Pressure Relief		Waste Gas Decay Tanks[3]	
Radionuclide	A_i (Ci/yr)	S_i	A_i (Ci/yr)	S_i	A_i (Ci/yr)	S_i	A_i (Ci/yr)	S_i
Kr-85m	2.0E+00	5.26E-02	1.0E+00	4.35E-02	0.00	0.00	0.00	0.00
Kr-85	0.00	0.00	0.00	0.00	0.00	0.00	1.6E+02	8.00E-01
Kr-87	1.0E+00	2.63E-02	0.00	0.00	0.00	0.00	0.00	0.00
Kr-88	3.0E+00	7.89E-02	2.0E+00	8.70E-02	1.0E+00	2.90E-03	0.00	0.00
Xe-131m	0.00	0.00	0.00	0.00	1.0E+00	2.90E-03	9.0E+00	4.50E-02
Xe-133m	0.00	0.00	0.00	0.00	4.0E+00	1.16E-02	0.00	0.00
Xe-133	2.8E+01	7.37E-01	1.8E+01	7.83E-01	3.1E+02	8.99E-01	3.1E+01	1.55E-01
Xe-135	4.0E+00	1.05E-01	2.0E+00	8.70E-02	4.0E+00	1.16E-02	0.00	0.00
Ar-41	0.00	0.00	0.00	0.00	2.5E+01	7.25E-02	0.00	0.00
TOTAL	3.8E+01		2.3E+01		3.45E+02		2.0E+02	

* Source terms are based upon GALE Code (not actual releases) from the evaluation of H.B. Robinson Unit 2 to demonstrate conformance to the design objectives of 10 CFR 50, Appendix I, Table 2-4. These values are only for routine releases and not for a complete inventory of gases in an emergency.

[1] These values are used to determine the monitor alarm setpoints for the Plant Vent Gas Monitor (R-14C).

[2] These values are used to determine the monitor alarm setpoint for the Condenser Vacuum Pump Vent Monitor (R-15). R-15 is a process monitor and its effluents are monitored by R-14C. This column is intentionally left for reference.

[3] These values are used to determine the monitor alarm setpoint for the Fuel Handling Basement Exhaust Monitor (R-20).

TABLE 3.1-2
DOSE FACTORS AND CONSTANTS*

Radionuclide	Total Whole Body Dose Factor (K_i) (mrem/yr per µCi/m^3)	Total Skin Dose Factor (L_i + 1.11 M_i) (mrem/yr per µCi/m^3)
Kr-83m	7.56E-02	2.12E+01
Kr-85m	1.17E+03	2.81E+03
Kr-85	1.61E+01	1.36E+03
Kr-87	5.92E+03	1.65E+04
Kr-88	1.47E+04	1.91E+04
Kr-89	1.66E+04	2.91E+04
Kr-90	1.56E+04	2.52E+04
Xe-131m	9.15E+01	6.48E+02
Xe-133m	2.51E+02	1.35E+03
Xe-133	2.94E+02	6.94E+02
Xe-135m	3.12E+03	4.41E+03
Xe-135	1.81E+03	3.97E+03
Xe-137	1.42E+03	1.39E+04
Xe-138	8.83E+03	1.43E+04
Xe-139	0.00	0.00
Ar-41	8.84E+03	1.29E+04

*Regulatory Guide 1.109, October 1977, Table B-1, times (1.0E+06 ρCi/µCi).

3.2 Requirements for Compliance with 10 CFR 20 (Gaseous)

Applicability

Applies to radioactive materials in gaseous effluents released from the site to unrestricted areas.

Objective

To define the dose rate limits for radioactive materials in gaseous effluents released to unrestricted areas.

Specification

CONTROLS

3.2.1 The dose rate due to radioactive materials in gaseous effluents released from the site boundary (see Figure 7-1) shall be limited to the following:

a. For radionoble gases: ≤ 500 mrem/yr to total body, ≤ 3000 mrem/yr to skin

AND

b. For I-131, I-133, and tritium, and for all radioactive materials in particulate form, inhalation pathway only, with half-lives greater than 8 days: ≤ 1500 mrem/yr to any organ.

ACTIONS

3.2.2 With the dose rate(s) exceeding the above limits, without delay decrease the release rate to within the above limits. In addition, a notification must be made to the Commission in accordance with 10 CFR 50.72 and 10 CFR 50.73.

BASES

Compliance With 10 CFR Part 20 - Radioactive Materials in Gaseous Effluents

This specification is provided to ensure that the dose rate at any time at the site boundary from gaseous effluents from H. B. Robinson Unit No. 2 will be within the annual dose limits of 10 CFR Part 20 for unrestricted areas. The annual dose limits are the doses associated with the concentrations of 10 CFR Part 20 Appendix B, Table 2, Column 1. These limits provide reasonable assurance that radioactive material discharged in gaseous effluents will result in the exposure of individuals outside the site boundary, to annual average concentrations within the limits specified in Appendix B Table 2 of 10 CFR Part 20, (10 CFR Part 20.1302). For individuals who may at times be within the site boundary, the occupancy of the individual will be sufficiently low to compensate for any increase in the atmospheric diffusion factor above that for the site boundary unrestricted area. The specified release rate limits restrict, at all times, the corresponding gamma and beta dose rate equivalents above background to an individual in unrestricted areas to ≤ 500 mrem/year to the total body or to ≤ 3000 mrem/year to the skin.

3.3 Compliance with 10 CFR 20 (Gaseous)

3.3.1 Noble Gases

The gaseous effluent monitors setpoints are utilized to show compliance with 10 CFR 20 for noble gases. However, because they are based upon a conservative mix of radionuclides, the possibility exists that the setpoints could be exceeded and yet 10 CFR 20 limits may actually be met. Therefore, the following methodology has been provided in the event that if the alarm trip setpoints are exceeded, a determination may be made as to whether the actual releases have exceeded 10 CFR 20.

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 NRC Regulatory Guide 1.109, Revision 1, and NUREG 0133, the following are used to show compliance with 10 CFR 20.

$$S_F * \sum_i \left[K_i * \left(\left(\overline{\chi/Q}\right)_v * \dot{Q}_{iv} + \left(\overline{\chi/Q}\right)_e * \dot{Q}_{ie}\right)\right] \leq 500\; mrem/yr \quad (3.3\text{-}1)$$

$$S_F * \sum_i \left[(L_i + 1.11M_i) * \left(\left(\overline{\chi/Q}\right)_v * \dot{Q}_{iv} + \left(\overline{\chi/Q}\right)_e * \dot{Q}_{ie}\right)\right] \leq 3000\; mrem/yr \quad (3.3\text{-}2)$$

where:

$\left(\overline{\chi/Q}\right)_v$	=	Annual average relative dilution for plant vent releases at the site boundary (sec/m^3).
	=	From Table A-1 for ground level releases used for additional conservatism.
	=	From Table A-10 for mixed mode releases.
$\left(\overline{\chi/Q}\right)_e$	=	Annual average relative dilution for the Fuel Handling Basement Exhaust, the Environmental and Radiation Control Building Exhaust, and Radwaste Building Exhaust releases at the site boundary (sec/m^3).
	=	From Table A-1 for ground level releases.
K_i	=	The total body dose factor due to gamma emissions for noble gas radionuclide 'i' (mrem/year per µCi/m^3).
L_i	=	The skin dose factor due to beta emissions for noble gas radionuclide 'i' (mrem/year per µCi/m^3).
M_i	=	The air dose factor due to gamma emissions for noble gas radionuclide 'i' (mrad/year per µCi/m^3).
1.11	=	The ratio of the tissue to air absorption coefficients over the energy range of the photon of interest (mrem/mrad). (reference NRC Regulatory Guide 1.109, Revision 1)

$\dot{Q}_{ie}$ = The release rate of noble gas radionuclide 'i' in gaseous effluents from the radwaste building exhaust vent, fuel handling basement exhaust, and the environmental and radiation control building hood exhaust (µCi/sec).

$\dot{Q}_{iv}$ = The release rate of noble gas radionuclide 'i' in gaseous effluents from the plant vent (µCi/sec).

S_F = 1.0, shielding factor accounting for the dose reduction due to shielding provided by residential structures (dimensionless).

The determination of limiting location for implementation of 10CFR20 for noble gases is a function of the radionuclide mix, release rate, and the meteorology. For the most limiting location, the radionuclide mix will be based on sample analysis of the effluent gases.

The χ/Q value utilized in the equations for implementation of 10 CFR 20 is based upon the maximum long-term annual average $(\overline{\chi/Q})$ in the unrestricted area. Table 3.3-2 presents the distances from HBR to the nearest area for each of the 16 sectors as well as to the nearest residence, vegetable garden, cow, goat, and beef animal. Long-term annual average $(\overline{\chi/Q})$ values for the HBR release points to the special locations in Table 3.3-2 are presented in Appendix A. A description of their derivation is also provided in this appendix.

To select the limiting location, the highest annual average $(\overline{\chi/Q})$ value for the ground level releases and the mixed mode releases was used. Since mixed mode releases may not necessarily decrease with distance (i.e., the site boundary may not have the highest $(\overline{\chi/Q})$value), long-term annual average $(\overline{\chi/Q})$ values, calculated at the midpoint of 10 standard distances as given in Appendix A were also considered. For HBR, mixed mode release χ/Q values decrease with distance for all directions except the WNW, NW, and NNW so that the maximum site boundary χ/Q is usually greater at the site boundary than at distances greater than the site boundary. In addition, the maximum site boundary χ/Q for both the ground level and mixed mode releases occurs at the SSE site boundary. Therefore, the limiting location for implementation of 10 CFR 20 for noble gases is the SSE site boundary.

Values for K_i, L_i, and M_i, which were used in the determination of the limiting location and which are to be used by HBR in Expressions 3.3-1 and 3.3-2 to show compliance with 10CFR20, are presented in Table 3.3-3. 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 picocuries to microcuries for use in equations 3.3-1 and 3.3-2.

3.3.2 Radioiodines, Particulates, and Tritium

The dose rate in an unrestricted area resulting from the release 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 with 10 CFR 20:

$$\sum_i \left[P_{iI} * \left(\left(\overline{\chi/Q}\right)_v * \dot{Q}_{iv} + \left(\overline{\chi/Q}\right)_e * \dot{Q}_{ie}\right)\right] \leq 1500\, mrem/yr \tag{3.3-3}$$

where:

P_{iI} = The dose parameter for Iodine-131, Iodine-133, tritium, and all radionuclides in particulate form with half-lives > 8 days for the inhalation pathway only in the most restrictive sector. The dose factor is based on the most restrictive group (child) and most restrictive organ at the SITE BOUNDARY (see Table 3.3-4) (mrem/yr per µCi/m^3).

$\left(\overline{\chi/Q}\right)_v$ = Annual average relative dilution for plant vent releases at the site boundary (sec/m^3).

$\dot{Q}_{iv}$ = Release rate of radionuclide 'i' from the plant vent (µCi/sec).

$\left(\overline{\chi/Q}\right)_e$ = Annual average relative dilution for fuel handling building basement exhaust, environmental and radiation control building exhaust, and radwaste building exhaust vent releases at the site boundary (sec/m^3).

$\dot{Q}_{ie}$ = The release rate of radionuclide 'i' from the radwaste building exhaust vent, fuel handling basement exhaust, and the environmental and radiation control building hood exhaust (µCi/sec).

In the calculation to show compliance with 10 CFR 20, only the inhalation is considered. A description of the methodology used in calculating the P_i values is presented in Appendix B. Compliance with 10 CFR 20 is achieved if the dose rate via inhalation pathway to a child is ≤1500 mrem/year.

TABLE 3.3-1
RELEASES FROM H.B. ROBINSON UNIT NO. 2*
(Ci/yr)

Isotope	Plant Vent $(Q)_v$	Condenser Vacuum Pump Vent $(Q)_e$	Total
Kr-85m	2.0E+00	1.0E+00	3.0E+00
Kr-85	1.6E+02	0.00	1.6E+02
Kr-87	1.0E+00	0.00	1.0E+00
Kr-88	4.0E+00	2.0E+00	6.0E+00
Xe-131m	1.0E+01	0.00	1.0E+01
Xe-133m	4.0E+00	0.00	4.0E+00
Xe-133	3.7E+02	1.8E+01	3.9E+02
Xe-135	8.0E+00	2.0E+00	1.0E+01
I-131	3.6E-02	2.3E-02	5.9E-02
I-133	5.4E-02	3.4E-02	9.8E-02
Mn-54	4.7E-03	0.00	4.7E-03
Fe-59	1.6E-03	0.00	1.6E-03
Co-58	1.6E-02	0.00	1.6E-02
Co-60	7.3E-03	0.00	7.3E-03
Sr-89	3.4E-04	0.00	3.4E-04
Sr-90	6.3E-05	0.00	6.3E-05
Cs-134	4.7E-03	0.00	4.7E-03
Cs-137	7.8E-03	0.00	7.8E-03

* Calculations based upon GALE Code and do not reflect actual release data from the Evaluation Conformance to the Design Objectives of 10CFR50, Appendix I. These values are only for routine releases and not for a complete inventory of gases in an emergency. Condenser vacuum pump vent is intentionally left in for reference.

TABLE 3.3-2
DISTANCE TO SPECIAL LOCATIONS FOR THE H.B. ROBINSON PLANT (MILES)

Sector	Site Boundary	Milk Cow	Milk Goat	Meat Animal	Nearest Resident	Nearest Garden
NNE	1.26	-	-	1.65	1.3	1.4
NE	1.01	-	-	1.16	1.2	1.3
ENE	0.86	-	-	2.41	0.9	2.2
E	0.61	4.2	-	3.12	0.8	2.8
ESE	0.50	-	-	1.99	0.6	0.6
SE	0.29	-	-	-	0.3	0.3
SSE	0.26	-	-	-	0.3	0.3
S	0.28	-	-	2.32	0.3	0.4
SSW	0.29	-	-	2.08	0.3	0.5
SW	0.36	-	2.5*	2.27	0.4	0.5
WSW	0.36	-	-	2.69	0.4	0.6
W	0.50	-	-	3.97	0.6	0.6
WNW	0.55	-	-	4.07	0.7	0.9
NW	1.23	-	-	1.60	1.3	1.3
NNW	1.89	-	-	2.84	2.9	3.0
N	1.94	-	-	2.93	2.9	2.9

* Milk is not presently used for human consumption.

TABLE 3.3-3
DOSE FACTORS FOR NOBLE GASES AND DAUGHTERS*

Radionuclide	Total Body Dose Factor K_i (mrem/yr per µCi/m^3)	Skin Dose Factor L_i (mrem/yr per µCi/m^3)	Gamma Air Dose Factor M_i (mrad/yr per µCi/m^3)	Beta Air Dose Factor N_i (mrad/yr per µCi/m^3)
Kr-83m	7.56E-02	---	1.93E+01	2.88E+02
Kr-85m	1.17E+03	1.46E+03	1.23E+03	1.97E+03
Kr-85	1.61E+01	1.34E+03	1.72E+01	1.95E+03
Kr-87	5.92E+03	9.73E+03	6.17E+03	1.03E+04
Kr-88	1.47E+04	2.37E+03	1.52E+04	2.93E+03
Kr-89	1.66E+04	1.01E+04	1.73E+04	1.06E+04
Kr-90	1.56E+04	7.29E+03	1.63E+04	7.83E+03
Xe-131m	9.15E+01	4.76E+02	1.56E+02	1.11E+03
Xe-133m	2.51E+02	9.94E+02	3.27E+02	1.48E+03
Xe-133	2.94E+02	3.06E+02	3.53E+02	1.05E+03
Xe-135m	3.12E+03	7.11E+02	3.36E+03	7.39E+02
Xe-135	1.81E+03	1.86E+03	1.92E+03	2.46E+03
Xe-137	1.42E+03	1.22E+04	1.51E+03	1.27E+04
Xe-138	8.83E+03	4.13E+03	9.21E+03	4.75E+03
Ar-41	8.84E+03	2.69E+03	9.30E+03	3.28E+03

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

TABLE 3.3-4

P_i VALUES FOR A CHILD FOR H.B. ROBINSON UNIT NO. 2[1]

Nuclide	P_i Bone	P_i Liver	P_i T.Body	P_i Thyroid	P_i Kidney	P_i Lung	P_i GI-Tract	P_i Skin
H-3	0.00E+00	1.12E+03	1.12E+03	1.12E+03	1.12E+03	1.12E+03	1.12E+03	1.12E+03
F-18	6.96E+03	0.00E+00	6.85E+02	0.00E+00	0.00E+00	0.00E+00	1.25E+03	0.00E+00
NA-24	1.61E+04	1.61E+04	1.61E+04	1.61E+04	1.61E+04	1.61E+04	1.61E+04	0.00E+00
CR-51	0.00E+00	0.00E+00	1.54E+02	8.55E+01	2.43E+01	1.70E+04	1.08E+03	0.00E+00
MN-54	0.00E+00	4.29E+04	9.51E+03	0.00E+00	1.00E+04	1.58E+06	2.29E+04	0.00E+00
MN-56	0.00E+00	1.66E+00	3.12E-01	0.00E+00	1.67E+00	1.31E+04	1.23E+05	0.00E+00
FE-55	4.74E+04	2.52E+04	7.77E+03	0.00E+00	0.00E+00	1.11E+05	2.87E+03	0.00E+00
FE-59	2.07E+04	3.34E+04	1.67E+04	0.00E+00	0.00E+00	1.27E+06	7.07E+04	0.00E+00
CO-57	0.00E+00	9.03E+02	1.07E+03	0.00E+00	0.00E+00	5.07E+05	1.32E+04	0.00E+00
CO-58	0.00E+00	1.77E+03	3.16E+03	0.00E+00	0.00E+00	1.11E+06	3.44E+04	0.00E+00
CO-60	0.00E+00	1.31E+04	2.26E+04	0.00E+00	0.00E+00	7.07E+06	9.62E+04	0.00E+00
NI-65	2.99E+00	2.96E-01	1.64E-01	0.00E+00	0.00E+00	8.18E+03	8.40E+04	0.00E+00
CU-64	0.00E+00	1.99E+00	1.07E+00	0.00E+00	6.03E+00	9.58E+03	3.67E+04	0.00E+00
ZN-65	4.26E+04	1.13E+05	7.03E+04	0.00E+00	7.14E+04	9.95E+05	1.63E+04	0.00E+00
BR-82	0.00E+00	0.00E+00	2.09E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-83	0.00E+00	0.00E+00	4.74E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-84	0.00E+00	0.00E+00	5.48E+02	0.00E+00	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	7.99E+03	0.00E+00
RB-88	0.00E+00	5.62E+02	3.66E+02	0.00E+00	0.00E+00	0.00E+00	1.72E+01	0.00E+00
RB-89	0.00E+00	3.45E+02	2.90E+02	0.00E+00	0.00E+00	0.00E+00	1.89E+00	0.00E+00
SR-89	5.99E+05	0.00E+00	1.72E+04	0.00E+00	0.00E+00	2.16E+06	1.67E+05	0.00E+00
SR-90	1.01E+08	0.00E+00	6.44E+06	0.00E+00	0.00E+00	1.48E+07	3.43E+05	0.00E+00
SR-91	1.21E+02	0.00E+00	4.59E+00	0.00E+00	0.00E+00	5.33E+04	1.74E+05	0.00E+00
SR-92	1.31E+01	0.00E+00	5.25E-01	0.00E+00	0.00E+00	2.40E+04	2.42E+05	0.00E+00
Y-91M	5.07E-01	0.00E+00	1.84E-02	0.00E+00	0.00E+00	2.81E+03	1.72E+03	0.00E+00
Y-91	9.14E+05	0.00E+00	2.44E+04	0.00E+00	0.00E+00	2.63E+06	1.84E+05	0.00E+00
Y-92	2.04E+01	0.00E+00	5.81E-01	0.00E+00	0.00E+00	2.39E+04	2.39E+05	0.00E+00
Y-93	1.86E+02	0.00E+00	5.11E+00	0.00E+00	0.00E+00	7.44E+04	3.89E+05	0.00E+00
ZR-95	1.90E+05	4.18E+04	3.70E+04	0.00E+00	5.96E+04	2.23E+06	6.11E+04	0.00E+00
ZR-97	1.88E+02	2.72E+01	1.60E+01	0.00E+00	3.88E+01	1.13E+05	3.51E+05	0.00E+00
NB-95	2.35E+04	9.18E+03	6.55E+03	0.00E+00	8.62E+03	6.14E+05	3.70E+04	0.00E+00
NB-97	4.29E-01	7.70E-02	3.50E-02	0.00E+00	8.55E-02	3.42E+03	2.78E+16	0.00E+00
MO-99	0.00E+00	1.72E+02	4.25E+01	0.00E+00	3.92E+02	1.35E+05	1.27E+05	0.00E+00
TC-99M	1.78E-03	3.48E-03	5.77E-02	0.00E+00	5.07E-02	9.51E+02	4.81E+03	0.00E+00
TC-101	8.10E-05	8.51E-05	1.08E-03	0.00E+00	1.45E-03	5.85E+02	1.63E+01	0.00E+00
RU-103	2.79E+03	0.00E+00	1.07E+03	0.00E+00	7.03E+03	6.62E+05	4.48E+04	0.00E+00
RU-105	1.53E+00	0.00E+00	5.55E-01	0.00E+00	1.34E+00	1.59E+04	9.95E+04	0.00E+00
RU-106	1.36E+05	0.00E+00	1.69E+04	0.00E+00	1.84E+05	1.43E+07	4.29E+05	0.00E+00
AG-110M	1.69E+04	1.14E+04	9.14E+03	0.00E+00	2.12E+04	5.48E+06	1.00E+05	0.00E+00
SN-113	8.99E+03	2.90E+02	9.81E+03	1.19E+02	2.03E+02	3.40E+05	7.44E+03	0.00E+00
SB-124	5.74E+04	7.40E+02	2.00E+04	1.26E+02	0.00E+00	3.24E+06	1.64E+05	0.00E+00
SB-125	9.84E+04	7.59E+02	2.07E+04	9.10E+01	0.00E+00	2.32E+06	4.03E+04	0.00E+00
TE-129M	1.92E+04	6.85E+03	3.04E+03	6.33E+03	5.03E+04	1.76E+06	1.82E+05	0.00E+00
TE-129	9.77E-02	3.50E-02	2.38E-02	7.14E-02	2.57E-01	2.93E+03	2.55E+04	0.00E+00
TE-131M	1.34E+02	5.92E+01	5.07E+01	9.77E+01	4.00E+02	2.06E+05	3.08E+05	0.00E+00
TE-132	4.81E+02	2.72E+02	2.63E+02	3.17E+02	1.77E+03	3.77E+05	1.38E+05	0.00E+00
I-131	4.81E+04	4.81E+04	2.73E+04	1.62E+07	7.88E+04	0.00E+00	2.84E+03	0.00E+00
I-132	2.12E+03	4.07E+03	1.88E+03	1.94E+05	6.25E+03	0.00E+00	3.20E+03	0.00E+00
I-133	1.66E+04	2.03E+04	7.70E+03	3.85E+06	3.38E+04	0.00E+00	5.48E+03	0.00E+00
I-134	1.17E+03	2.16E+03	9.95E+02	5.07E+04	3.30E+03	0.00E+00	9.55E+02	0.00E+00
I-135	4.92E+03	8.73E+03	4.14E+03	7.92E+05	1.34E+04	0.00E+00	4.44E+03	0.00E+00
CS-134	6.51E+05	1.01E+06	2.25E+05	0.00E+00	3.30E+05	1.21E+05	3.85E+03	0.00E+00
CS-136	6.51E+04	1.71E+05	1.16E+05	0.00E+00	9.55E+04	1.45E+04	4.18E+03	0.00E+00
CS-137	9.07E+05	8.25E+05	1.28E+05	0.00E+00	2.82E+05	1.04E+05	3.62E+03	0.00E+00
CS-138	6.33E+02	8.40E+02	5.55E+02	0.00E+00	6.22E+02	6.81E+01	2.70E+02	0.00E+00
BA-139	1.84E+00	9.84E-04	5.36E-02	0.00E+00	8.62E-04	5.77E+03	5.77E+04	0.00E+00
BA-140	7.40E+04	6.48E+01	4.33E+03	0.00E+00	2.11E+01	1.74E+06	1.02E+05	0.00E+00
BA-142	4.99E-02	3.60E-05	2.79E-03	0.00E+00	2.91E-05	1.64E+03	2.74E+00	0.00E+00
LA-140	6.44E+02	2.25E+02	7.55E+01	0.00E+00	0.00E+00	1.83E+05	2.26E+05	0.00E+00
LA-142	1.29E+00	4.11E-01	1.29E-01	0.00E+00	0.00E+00	8.70E+03	7.59E+04	0.00E+00
CE-141	3.92E+04	1.95E+04	2.90E+03	0.00E+00	8.55E+03	5.44E+05	5.66E+04	0.00E+00
CE-143	3.66E+02	1.99E+02	2.87E+01	0.00E+00	8.36E+01	1.15E+05	1.27E+05	0.00E+00

TABLE 3.3-4 (continued)
P_i VALUES FOR A CHILD FOR H.B. ROBINSON UNIT NO. 2[1]

Nuclide	P_i Bone	P_i Liver	P_i T.Body	P_i Thyroid	P_i Kidney	P_i Lung	P_i GI-Tract	P_i Skin
CE-144	6.77E+06	2.12E+06	3.61E+05	0.00E+00	1.17E+06	1.20E+07	3.89E+05	0.00E+00
PR-144	5.96E-02	1.85E-02	3.00E-03	0.00E+00	9.77E-03	1.57E+03	1.97E+02	0.00E+00
HF-181	8.33E+04	3.28E+02	8.47E+03	2.76E+02	2.63E+02	7.96E+05	5.29E+04	0.00E+00
W-187	1.63E+01	9.66E+00	4.33E+00	0.00E+00	0.00E+00	4.11E+04	9.10E+04	0.00E+00
NP-239	4.66E+02	3.34E+01	2.35E+01	0.00E+00	9.73E+01	5.81E+04	6.40E+04	0.00E+00

1 (a) NUREG 0133, Section 5.2.1.1 (Calculation of P_i (Inhalation)).
(b) Regulatory Guide 1.109, Table E-5 and Table E-9 (Breathing Rate Constant and Inhalation dose factors).
(c) Units are mrem/yr per µCi/m^3.

3.4 Requirements for Compliance with 10 CFR 50 (Gaseous)

Applicability

Applies to radionoble gases released in gaseous effluents to unrestricted areas.

Objective

To define the air dose limits of 10 CFR 50 Appendix I for radionoble gases released in gaseous effluents to unrestricted areas.

Specification

CONTROLS

3.4.1 The air dose commitment due to radionoble gases released in gaseous effluents to areas at and beyond the site boundary (See Figure 7-1) shall be limited, at all times, to the following:

a. During any calendar quarter, to ≤ 5 mrad for gamma radiation and ≤ 10 mrad for beta radiation;

b. During any calendar year, to ≤ 10 mrad for gamma radiation and ≤ 20 mrad for beta radiation.

ACTIONS

3.4.2 With the calculated air dose commitment from radioactive noble gases in gaseous effluents exceeding any of the limits, prescribed by ODCM Specification 3.4.1 above, prepare and submit a report to the Commission in accordance with the ODCM Specification 9.3.

Bases

Compliance With 10 CFR part 50 - Radionoble Gases

This specification is provided to implement the requirements of Section II.B, III.A and IV.A of Appendix I, 10 CFR Part 50. The Control implementing the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in gaseous effluents will be kept "as low as reasonable 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 calculative procedures based on models and data such that the actual exposure of an individual through appropriate pathways is unlikely to be substantially underestimated. The methods 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 the Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I", Revision 1, October 1977 and Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water Cooled Reactors", Revision 1, July, 1977. The ODCM equations provided for determining the air dose commitments at the site boundary are based upon historical average atmospheric conditions.

3.5 Compliance with 10 CFR 50 (Gaseous)

3.5.1 Noble Gases

3.5.1.1 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:

$$D_\gamma = 3.17x10^{-8} * \sum_i \left[M_i * \left[\left(\left(\overline{\chi/Q}\right)_v * \bar{Q}_{iv} \right) + \left(\left(\overline{\chi/q}\right)_v * \bar{q}_{iv} \right) + \left(\left(\overline{\chi/Q}\right)_e * \bar{Q}_{ie} \right) \right] \right] \quad (3.5\text{-}1)$$

$$D_\beta = 3.17x10^{-8} * \sum_i \left[N_i * \left[\left(\left(\overline{\chi/Q}\right)_v * \bar{Q}_{iv} \right) + \left(\left(\overline{\chi/q}\right)_v * \bar{q}_{iv} \right) + \left(\left(\overline{\chi/Q}\right)_e * \bar{Q}_{ie} \right) \right] \right] \quad (3.5\text{-}2)$$

where:

D_γ = The air dose from gamma radiation (mrad).

D_β = The air dose from beta radiation (mrad).

M_i = The air dose factor due to gamma emissions for each identified noble gas radionuclide 'i' (mrad/year per μCi/m^3).

N_i = The air dose factor due to beta emissions for each identified noble gas radionuclide 'i' (mrad/year per μCi/m^3).

$\left(\overline{\chi/Q}\right)_v$ = The annual average dilution for areas at or beyond the unrestricted area boundary for long-term plant vent releases, > 500 hrs/year (sec/m^3).
= From Table A-1 for ground level releases used for conservatism.
= From Table A-10 for mixed mode releases.

$\left(\overline{\chi/q}\right)_v$ = The dilution for areas at or beyond the unrestricted area boundary for short-term plant vent releases, < 500 hrs/year (sec/m^3).
= From Table A-1 for ground level continuous release for conservatism.
= From Table A-7 for ground level releases.
= From Table A-16 for mixed mode releases.

$\left(\overline{\chi/Q}\right)_e$ = Annual average relative dilution for fuel handling basement exhaust, the environmental and radiation control building exhaust, and radwaste building exhaust vent releases at the site boundary, > 500 hrs/year (sec/m^3).
= From Table A-1 for ground level releases.

$\bar{Q}_{iv}$ = The average release of noble gas radionuclide 'i' in gaseous effluents for long-term vent releases, > 500 hrs/year (μCi).

$\overline{q}_{iv}$ = The average release of noble gas radionuclide 'i' in gaseous releases for short-term plant releases, < 500 hrs/year (μCi).

$\overline{Q}_{ie}$ = The average release of noble gas radionuclide 'i' in gaseous releases for long-term fuel handling basement exhaust, the environmental and radiation control building exhaust, and radwaste building exhaust, > 500 hrs/year (μCi).

$3.17x10^{-8}$ = The inverse of the number of seconds in a year $(sec/year)^{-1}$.

At HBR the limiting location is 0.26 miles SSE. Based upon the tables presented in Appendix A, substitution of the short-term χ/Q value into Equation 3.5-1 yields lower dose value than the long-term χ/Q values used. In order to be conservative, for purposes of this document only, long-term annual average $\left(\overline{\chi/Q}\right)$ values will be used. Should the calculated doses exceed 10 CFR 50 limits, recalculation of doses may be performed using short-term X/Q values for batch releases.

To select the limiting location, the highest annual average $\left(\overline{\chi/Q}\right)$ value for ground level and mixed mode releases and the highest short-term χ/Q value for ground level and mixed mode releases were considered. Since mixed mode releases may increase and then decrease with distance (i.e., the site boundary may not have the highest χ/Q value), long-term χ/Q values were calculated at the midpoint of 10 standard distances as given in Appendix A. The calculated values decreased with the distance for all but the WNW, NW, and NNW sectors. The values for these sectors were not found to be limiting such that the maximum site boundary χ/Q for both long-term and short-term ground level and mixed mode releases occurred at the SSE site boundary. The limiting location for implementation of 10 CFR 20 for noble gases is the SSE site boundary.

Values for M_i and N_i which are utilized in the calculation of the gamma air and beta air doses in Equation 3.5-1 to show compliance with 10 CFR 50 were presented in Table 3.3-3. These values originate from NUREG 0472, Revision 0, and were taken from Table B-1 of the NRC Regulatory Guide 1.109, Revision 1. The values have been multiplied by 1.0E6 to convert from picocuries to microcuries. The following relationship should hold for HBR to show compliance with HBR's ODCM Specification 3.4.1.

For the calendar quarter:

$$D_\gamma \leq 5 \text{ mrad} \quad (3.5\text{-}3)$$

$$D_\beta \leq 10 \text{ mrad} \quad (3.5\text{-}4)$$

For the calendar year:

$$D_\gamma \leq 10 \text{ mrad} \quad (3.5\text{-}5)$$

$$D_\beta \leq 20 \text{ mrad} \quad (3.5\text{-}6)$$

The quarterly limits given above represent one-half of the annual design objectives of Section II.B.1 of Appendix I of 10 CFR 50. If any of the limits of Equations 3.5-3 through 3.5-6 are exceeded, a special report pursuant to ODCM Specification 9.3 must be filed with the NRC. This report complies with Section IV.A of Appendix I of 10 CFR 50.

3.5.1.2 Projection of Doses

Doses resulting from the release of gaseous effluents will be projected once per 31 days. These projections will include a safety margin based upon expected operational conditions which will take into consideration both planned and unplanned releases. Projected dose will be calculated as follows:

$$PD = \frac{92 * (DA + DB)}{TE} + M \tag{3.5-7}$$

where:

PD = projected doses (mrad).

92 = time in quarter (days).

DA = dose accumulated during current quarter (mrad).

DB = projected dose from this release (mrad).

TE = time elapsed in quarter (days).

M = safety margin (mrad).

If the projected doses exceed 0.6 mrad for gamma radiation or 1.3 mrad for beta radiation when averaged over a calendar quarter, the ventilation exhaust treatment system will be operated to reduce releases of radioactive materials.

3.5.2 Compliance with 10 CFR Part 50 - Radioiodines, Radioactive Materials in Particulate Form, and Radionuclides other than Radionoble Gases

Applicability

Applies to radioiodines, radioactive materials in particulate form, and radionuclides other than radionoble gases released from the site to unrestricted areas.

Objective

To define the dose limits of 10 CFR 50 for radioiodines, radioactive materials in particulate form, and radionuclides other than radionoble gases released from the site to unrestricted areas.

Specification

CONTROLS

3.5.2.1 The dose to a member of the public from I-131, I-133, tritium and radioactive materials in particulate form, with half-lives greater than 8 days in gaseous effluents released to unrestricted areas (See Figure 7-1), shall be limited, at all times, to the following:

a. During any calendar quarter, ≤ 7.5 mrem to an organ

AND

b. During any calendar year, ≤ 15 mrem to any organ.

ACTIONS

3.5.2.2 With the calculated dose commitment from the release of I-131, I-133, tritium and radioactive materials in particulate form, with half-lives greater than 8 days, in gaseous effluents exceeding any of the limits prescribed by ODCM Specification 3.5.2.1 above, prepare and submit a report to the Commission in accordance with ODCM Specification 9.3.

BASES

Compliance With 10 CFR Part 50 - Radioiodines, Radioactive Materials in Particulate Form, and Radionuclides Other Than Radionoble Gases

This specification is provided to implement the requirements of Section II.C, III.A, and IV.A of Appendix I, 10 CFR Part 50. The Control implements the guides set forth in Section II.C of Appendix I. The action statement provides the required operating flexibility and at the same time implements the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive materials as gaseous effluents will be kept "as low as 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 calculative procedures based on models and data, such that the actual exposure of an individual through appropriate pathways is unlikely to be substantially underestimated. The methods established in the ODCM 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. The ODCM equations provided for determining the commitment are based upon historical average atmospheric conditions.

3.5.3 Radioiodine, Particulates, and Tritium

3.5.3.1 Cumulation of Doses

Section II.C of Appendix I of 10 CFR 50 limits the release of radioiodines and radioactive material in particulate form from each reactor such that estimated annual 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, tritium, and particulates with half-lives ≥ 8 days in gaseous effluents released to unrestricted areas can be determined by the following equation:

$$D_\tau = 3.17x10^{-8} * \sum_i R_{iI} * \left[\left(\left(\overline{\chi/Q}\right)_v * \bar{Q}_{iv}\right) + \left(\left(\overline{\chi/q}\right)_v * \bar{q}_{iv}\right) + \left(\left(\overline{\chi/Q}\right)_e * \bar{Q}_{ie}\right)\right]$$
$$+ (R_{iB} + R_{iM} + R_{iV} + R_{iG}) * \left[\left(\left(\overline{D/Q}\right)_v * \bar{Q}_{iv}\right) + \left(\left(\overline{D/q}\right)_v * \bar{q}_{iv}\right) + \left(\left(\overline{D/Q}\right)_e * \bar{Q}_{ie}\right)\right]$$
$$+ \left(R_{T_M} + R_{T_B} + R_{T_I} + R_{T_V}\right) * \left[\left(\left(\overline{\chi/Q}\right)_v * \bar{Q}_{Tv}\right) + \left(\left(\overline{\chi/q}\right)_v * \bar{q}_{Tv}\right) + \left(\left(\overline{\chi/Q}\right)_e * \bar{Q}_{TE}\right)\right] \quad (3.5\text{-}8)$$

where:

D_τ = Dose to any organ τ from I-131, I-133, particulates with ≥ 8 day half-lives, and Tritium (mrem).

$3.17x10^{-8}$ = The inverse of the number of seconds in a year $(sec/year)^{-1}$.

$\left(\overline{\chi/Q}\right)_v$ = Annual average relative concentration for plant vent releases, > 500 hrs/yr (sec/m^3).
= From Table A-1 for ground level releases for conservatism.
= From Table A-10 for mixed mode releases.

$\left(\overline{\chi/q}\right)_v$ = Annual average relative concentration for plant vent releases, ≤ 500 hrs/yr (sec/m^3).
= From Table A-7 for ground release.
= From Table A-16 for mixed mode releases.

$\left(\overline{\chi/Q}\right)_e$ = Annual average dilution for radwaste building vent, fuel handling basement exhaust, and the environmental and radiation control building hood exhaust releases, > 500 hrs/yr (sec/m^3).
= From Table A-1 for ground level releases.

$\left(\overline{D/Q}\right)_v$ = Annual average deposition factor for plant vent releases, > 500 hrs/yr (m^{-2}).
= From Table A-3 for ground level releases for conservatism.
= From Table A-12 for mixed mode releases.

$(\overline{D/q})_v$ = Relative deposition factor for short-term plant vent releases, < 500 hrs/yr (m^{-2}).
= From Table A-3 for ground level continuous releases for conservatism.
= From Table A-9 for ground level releases.
= From Table A-18 for mixed mode releases.

$(\overline{D/Q})_e$ = Annual average relative deposition factor for radwaste building vent, fuel handling basement exhaust, and the environmental and radiation control building hood exhaust releases, > 500 hrs/yr (m^{-2}).
= From Table A-3 for ground level releases.

$\overline{Q}_{iv}$ = Release of radionuclide 'i' in gaseous effluents for long-term plant vent releases > 500 hrs/yr (µCi).

$\overline{q}_{iv}$ = Release of radionuclide 'i' in gaseous effluents for short-term plant vent releases < 500 hrs/yr (µCi).

$\overline{Q}_{ie}$ = Release of radionuclide 'i' in gaseous effluents for long-term radwaste building vent, fuel handling basement exhaust, and the environmental and radiation control building hood exhaust releases, > 500 hrs/yr (µCi).

$\overline{Q}_{Tv}$ = Release of tritium in gaseous effluents for long-term plant vent releases > 500 hrs/yr (µCi).

$\overline{q}_{Tv}$ = Release of tritium in gaseous effluents for short-term plant vent releases < 500 hrs/yr (µCi).

$\overline{Q}_{TE}$ = Release of tritium in gaseous effluents for long-term radwaste building vent, fuel handling basement exhaust, and the environmental and radiation control building hood exhaust > 500 hrs/yr (µCi).

R_{iI} = Dose factor for an organ for radionuclide 'i' for the inhalation pathway (mrem/yr per $\mu Ci/m^3$).

R_{iB} = Dose factor for an organ for radionuclide 'i' for the meat exposure pathway (m^2-mrem/yr per µCi/sec).

R_{iM} = Dose factor for an organ for radionuclide 'i' for the milk exposure pathway (m^2-mrem/yr per µCi/sec).

R_{iV} = Dose factor for an organ for radionuclide 'i' for the vegetable pathway (m^2-mrem/yr per µCi/sec).

R_{iG} = Dose factor for an organ for radionuclide 'i' for the ground plane exposure pathway (m^2-mrem/yr per µCi/sec).

R_{TM} = Dose factor for an organ for tritium for the milk pathway (mrem/yr per $\mu Ci/m^3$).

R_{TB} = Dose factor for an organ for tritium for the meat pathway (mrem/yr per $\mu Ci/m^3$).

R_{TI} = Dose factor for an organ for tritium for the inhalation pathway (mrem/yr per $\mu Ci/m^3$).

R_{TV} = Dose factor for an organ for tritium for the vegetable pathway (mrem/yr per $\mu Ci/m^3$).

To show compliance with 10 CFR 50, Equation 3.5-8 is evaluated at the limiting pathway location. At HBR this location is the vegetable garden 0.3 miles in the SSE sector. The critical receptor is a child. Substitution of the appropriate χ/Q and D/Q values from tables in Appendix A into Equation 3.5-8 would yield an equation with the short-term χ/Q and D/Q values being less than the long-term values. Therefore, for this document, only long-term annual χ/Q and D/Q values (i.e., more conservative values) are used.

The determination of a limiting location for implementation of 10 CFR 50 for radioiodines and particulates is a function of:

1. Radionuclide mix and isotopic release
2. Meteorology
3. Exposure pathway
4. Receptor's age

In the determination of the limiting location, the radionuclide mix of radioiodines and particulates was based upon the source terms calculated using the GALE Code. This mix is presented in Table 3.3-1 as a function of release point. The only source of short-term releases from the plant vent is containment purges. In the determination of the limiting location, all of the exposure pathways, as presented in Table 3.3-2, were evaluated. These include cow milk, goat milk, beef and vegetable ingestion, and inhalation and ground plane exposure.

An infant was assumed to be present at all milk pathway locations. A child was assumed to be present at all vegetable garden and beef animal locations. The ground plane exposure pathway was not considered a viable pathway for an infant. Naturally, the inhalation pathway was present everywhere an individual was present. HBR ODCM Specification 4.4.1 requires that a land-use census survey be conducted on an annual basis. Depending on the results of the survey, a new limiting location could result.

For the determination of the limiting location, the highest D/Q values for the vegetable garden, cow milk, and goat milk pathways were selected. The thyroid dose was calculated at each of these locations using the radionuclide mix and releases of Table 3.3-1. Based upon these calculations, it was determined that the limiting receptor pathway is the vegetable/child pathway.

In the determination of the limiting location, annual average χ/Q and D/Q values are used. A description of the derivation of the various χ/Q and D/Q values is presented in Appendix A. Short-term and long-term χ/Q and D/Q values for ground level releases and for long-term mixed mode 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 Table 3.3-2.

Tables 3.5-1 through 3.5-19 present Ri values for the total body, GI-tract, bone, liver , kidney, thyroid, skin, 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 using a grazing period of eight months. A description of the methodology is presented in Appendix B.

The following relationship should hold for HBR to show compliance with HBR ODCM Specification 3.5.2.1.

For the calendar quarter:

$$D_\tau \leq 7.5 \text{ mrem} \qquad (3.5\text{-}9)$$

For the calendar year:

$$D_\tau \leq 15 \text{ mrem} \qquad (3.5\text{-}10)$$

The quarterly limit given above represent one-half the annual design objectives of Section II.C of Appendix I of 10 CFR 50. If any of the limits of Equations 3.5-9 or 3.5-10 are exceeded, a special report pursuant ODCM Specification 9.3 must be filed with the NRC. This report complies with Section IV.A of Appendix I of 10 CFR 50.

3.5.3.2 Projection of Doses

Doses resulting from release of radioiodines and particulate effluents will be projected once per 31 days. These projections will include a safety margin based upon expected operational conditions which will take into consideration both planned and unplanned releases. Projected dose will be calculated as follows:

$$PD = \frac{92 * (DA + DB)}{TE} + M \tag{3.5-11}$$

where:

PD = Projected doses (mrem).

92 = time in quarter (days).

DA = Dose accumulated during current quarter (mrem).

DB = Projected dose from this release (mrem).

TE = Time elapsed in quarter (days).

M = Safety margin (mrem).

If the projected doses exceed 1.0 mrem to any organ when averaged over a calendar quarter, the ventilation exhaust treatment system will be operated to reduce releases of radioactive materials.

TABLE 3.5-1
R VALUES for the H.B. ROBINSON STEAM ELECTRIC PLANT[1]
(Reference Regulatory Guide 1.109)

PATHWAY = Ground

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-Tract	Skin
F-18	3.96E+05	3.96E+05	3.96E+05	3.96E+05	3.96E+05	3.96E+05	3.96E+05	4.66E+05
NA-24	1.19E+07	1.19E+07	1.19E+07	1.19E+07	1.19E+07	1.19E+07	1.19E+07	1.39E+07
CR-51	4.66E+06	4.66E+06	4.66E+06	4.66E+06	4.66E+06	4.66E+06	4.66E+06	5.51E+06
MN-54	1.39E+09	1.39E+09	1.39E+09	1.39E+09	1.39E+09	1.39E+09	1.39E+09	1.62E+09
MN-56	9.03E+05	9.03E+05	9.03E+05	9.03E+05	9.03E+05	9.03E+05	9.03E+05	1.07E+06
FE-59	2.73E+08	2.73E+08	2.73E+08	2.73E+08	2.73E+08	2.73E+08	2.73E+08	3.21E+08
CO-57	1.88E+08	1.88E+08	1.88E+08	1.88E+08	1.88E+08	1.88E+08	1.88E+08	2.07E+08
CO-58	3.79E+08	3.79E+08	3.79E+08	3.79E+08	3.79E+08	3.79E+08	3.79E+08	4.44E+08
CO-60	2.15E+10	2.15E+10	2.15E+10	2.15E+10	2.15E+10	2.15E+10	2.15E+10	2.53E+10
NI-65	2.97E+05	2.97E+05	2.97E+05	2.97E+05	2.97E+05	2.97E+05	2.97E+05	3.45E+05
CU-64	6.07E+05	6.07E+05	6.07E+05	6.07E+05	6.07E+05	6.07E+05	6.07E+05	6.88E+05
ZN-65	7.47E+08	7.47E+08	7.47E+08	7.47E+08	7.47E+08	7.47E+08	7.47E+08	8.59E+08
BR-82	2.14E+07	2.14E+07	2.14E+07	2.14E+07	2.14E+07	2.14E+07	2.14E+07	2.47E+07
BR-83	4.87E+03	4.87E+03	4.87E+03	4.87E+03	4.87E+03	4.87E+03	4.87E+03	7.08E+03
BR-84	2.03E+05	2.03E+05	2.03E+05	2.03E+05	2.03E+05	2.03E+05	2.03E+05	2.36E+05
RB-86	8.99E+06	8.99E+06	8.99E+06	8.99E+06	8.99E+06	8.99E+06	8.99E+06	1.03E+07
RB-88	3.31E+04	3.31E+04	3.31E+04	3.31E+04	3.31E+04	3.31E+04	3.31E+04	3.78E+04
RB-89	1.23E+05	1.23E+05	1.23E+05	1.23E+05	1.23E+05	1.23E+05	1.23E+05	1.48E+05
SR-89	2.16E+04	2.16E+04	2.16E+04	2.16E+04	2.16E+04	2.16E+04	2.16E+04	2.51E+04
SR-91	2.15E+06	2.15E+06	2.15E+06	2.15E+06	2.15E+06	2.15E+06	2.15E+06	2.51E+06
SR-92	7.77E+05	7.77E+05	7.77E+05	7.77E+05	7.77E+05	7.77E+05	7.77E+05	8.63E+05
Y-91M	1.00E+05	1.00E+05	1.00E+05	1.00E+05	1.00E+05	1.00E+05	1.00E+05	1.16E+05
Y-91	1.07E+06	1.07E+06	1.07E+06	1.07E+06	1.07E+06	1.07E+06	1.07E+06	1.21E+06
Y-92	1.80E+05	1.80E+05	1.80E+05	1.80E+05	1.80E+05	1.80E+05	1.80E+05	2.14E+05
Y-93	1.83E+05	1.83E+05	1.83E+05	1.83E+05	1.83E+05	1.83E+05	1.83E+05	2.51E+05
ZR-95	2.45E+08	2.45E+08	2.45E+08	2.45E+08	2.45E+08	2.45E+08	2.45E+08	2.84E+08
ZR-97	2.96E+06	2.96E+06	2.96E+06	2.96E+06	2.96E+06	2.96E+06	2.96E+06	3.44E+06
NB-95	1.37E+08	1.37E+08	1.37E+08	1.37E+08	1.37E+08	1.37E+08	1.37E+08	1.61E+08
NB-97	1.76E+05	1.76E+05	1.76E+05	1.76E+05	1.76E+05	1.76E+05	1.76E+05	2.07E+05
MO-99	3.99E+06	3.99E+06	3.99E+06	3.99E+06	3.99E+06	3.99E+06	3.99E+06	4.63E+06
TC-99M	1.84E+05	1.84E+05	1.84E+05	1.84E+05	1.84E+05	1.84E+05	1.84E+05	2.11E+05
TC-101	2.04E+04	2.04E+04	2.04E+04	2.04E+04	2.04E+04	2.04E+04	2.04E+04	2.26E+04
RU-103	1.08E+08	1.08E+08	1.08E+08	1.08E+08	1.08E+08	1.08E+08	1.08E+08	1.26E+08
RU-105	6.36E+05	6.36E+05	6.36E+05	6.36E+05	6.36E+05	6.36E+05	6.36E+05	7.21E+05
RU-106	4.22E+08	4.22E+08	4.22E+08	4.22E+08	4.22E+08	4.22E+08	4.22E+08	5.07E+08
AG-110M	3.44E+09	3.44E+09	3.44E+09	3.44E+09	3.44E+09	3.44E+09	3.44E+09	4.01E+09
SN-113	1.42E+07	1.42E+07	1.42E+07	1.42E+07	1.42E+07	1.42E+07	1.42E+07	4.08E+07
SB-124	5.98E+08	5.98E+08	5.98E+08	5.98E+08	5.98E+08	5.98E+08	5.98E+08	6.90E+08
SB-125	2.34E+09	2.34E+09	2.34E+09	2.34E+09	2.34E+09	2.34E+09	2.34E+09	2.64E+09
TE-129M	1.98E+07	1.98E+07	1.98E+07	1.98E+07	1.98E+07	1.98E+07	1.98E+07	2.31E+07
TE-129	2.62E+04	2.62E+04	2.62E+04	2.62E+04	2.62E+04	2.62E+04	2.62E+04	3.10E+04
TE-131M	8.03E+06	8.03E+06	8.03E+06	8.03E+06	8.03E+06	8.03E+06	8.03E+06	9.46E+06
TE-132	4.23E+06	4.23E+06	4.23E+06	4.23E+06	4.23E+06	4.23E+06	4.23E+06	4.98E+06
I-131	1.72E+07	1.72E+07	1.72E+07	1.72E+07	1.72E+07	1.72E+07	1.72E+07	2.09E+07
I-132	1.25E+06	1.25E+06	1.25E+06	1.25E+06	1.25E+06	1.25E+06	1.25E+06	1.46E+06
I-133	2.45E+06	2.45E+06	2.45E+06	2.45E+06	2.45E+06	2.45E+06	2.45E+06	2.98E+06
I-134	4.47E+05	4.47E+05	4.47E+05	4.47E+05	4.47E+05	4.47E+05	4.47E+05	5.30E+05
I-135	2.53E+06	2.53E+06	2.53E+06	2.53E+06	2.53E+06	2.53E+06	2.53E+06	2.95E+06
CS-134	6.86E+09	6.86E+09	6.86E+09	6.86E+09	6.86E+09	6.86E+09	6.86E+09	8.00E+09
CS-136	1.51E+08	1.51E+08	1.51E+08	1.51E+08	1.51E+08	1.51E+08	1.51E+08	1.71E+08
CS-137	1.03E+10	1.03E+10	1.03E+10	1.03E+10	1.03E+10	1.03E+10	1.03E+10	1.20E+10
CS-138	3.59E+05	3.59E+05	3.59E+05	3.59E+05	3.59E+05	3.59E+05	3.59E+05	4.10E+05
BA-139	1.06E+05	1.06E+05	1.06E+05	1.06E+05	1.06E+05	1.06E+05	1.06E+05	1.19E+05
BA-140	2.05E+07	2.05E+07	2.05E+07	2.05E+07	2.05E+07	2.05E+07	2.05E+07	2.35E+07
BA-142	4.49E+04	4.49E+04	4.49E+04	4.49E+04	4.49E+04	4.49E+04	4.49E+04	5.11E+04

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

TABLE 3.5-1 (continued)

R VALUES for the H.B. ROBINSON STEAM ELECTRIC PLANT[1]

PATHWAY = Ground

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-Tract	Skin
LA-140	1.92E+07	1.92E+07	1.92E+07	1.92E+07	1.92E+07	1.92E+07	1.92E+07	2.18E+07
LA-142	7.60E+05	7.60E+05	7.60E+05	7.60E+05	7.60E+05	7.60E+05	7.60E+05	9.11E+05
CE-141	1.37E+07	1.37E+07	1.37E+07	1.37E+07	1.37E+07	1.37E+07	1.37E+07	1.54E+07
CE-143	2.31E+06	2.31E+06	2.31E+06	2.31E+06	2.31E+06	2.31E+06	2.31E+06	2.63E+06
CE-144	6.95E+07	6.95E+07	6.95E+07	6.95E+07	6.95E+07	6.95E+07	6.95E+07	8.04E+07
PR-144	1.83E+03	1.83E+03	1.83E+03	1.83E+03	1.83E+03	1.83E+03	1.83E+03	2.11E+03
HF-181	1.96E+08	1.96E+08	1.96E+08	1.96E+08	1.96E+08	1.96E+08	1.96E+08	2.80E+08
W-187	2.35E+06	2.35E+06	2.35E+06	2.35E+06	2.35E+06	2.35E+06	2.35E+06	2.73E+06
NP-239	1.71E+06	1.71E+06	1.71E+06	1.71E+06	1.71E+06	1.71E+06	1.71E+06	1.98E+06

1 R Values in units of mrem/yr per µCi/m^3 for inhalation and tritium, and units of m^2-mrem/yr per µCi/sec for all others.

TABLE 3.5-2

R VALUES for the H.B. ROBINSON STEAM ELECTRIC PLANT[2]

(Reference Regulatory Guide 1.109)

PATHWAY = Vegetation
AGE GROUP = Adult

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-Tract	Skin
H-3	0.00E+00	2.26E+03	2.26E+03	2.26E+03	2.26E+03	2.26E+03	2.26E+03	2.26E+03
F-18	4.22E+00	0.00E+00	4.68E-01	0.00E+00	0.00E+00	0.00E+00	1.25E-01	0.00E+00
NA-24	2.68E+05	2.68E+05	2.68E+05	2.68E+05	2.68E+05	2.68E+05	2.68E+05	0.00E+00
CR-51	0.00E+00	0.00E+00	4.59E+04	2.74E+04	1.01E+04	6.09E+04	1.15E+07	0.00E+00
MN-54	0.00E+00	3.08E+08	5.87E+07	0.00E+00	9.15E+07	0.00E+00	9.42E+08	0.00E+00
MN-56	0.00E+00	1.54E+01	2.74E+00	0.00E+00	1.96E+01	0.00E+00	4.93E+02	0.00E+00
FE-55	2.00E+08	1.38E+08	3.22E+07	0.00E+00	0.00E+00	7.70E+07	7.91E+07	0.00E+00
FE-59	1.24E+08	2.90E+08	1.11E+08	0.00E+00	0.00E+00	8.11E+07	9.68E+08	0.00E+00
CO-57	0.00E+00	1.01E+07	1.88E+07	0.00E+00	0.00E+00	0.00E+00	2.86E+08	0.00E+00
CO-58	0.00E+00	2.99E+07	6.70E+07	0.00E+00	0.00E+00	0.00E+00	6.06E+08	0.00E+00
CO-60	0.00E+00	1.67E+08	3.67E+08	0.00E+00	0.00E+00	0.00E+00	3.13E+09	0.00E+00
NI-65	5.97E+01	7.75E+00	3.54E+00	0.00E+00	0.00E+00	0.00E+00	1.97E+02	0.00E+00
CU-64	0.00E+00	9.19E+03	4.31E+03	0.00E+00	2.32E+04	0.00E+00	7.83E+05	0.00E+00
ZN-65	4.01E+08	1.28E+09	5.77E+08	0.00E+00	8.54E+08	0.00E+00	8.04E+08	0.00E+00
BR-82	0.00E+00	0.00E+00	1.55E+06	0.00E+00	0.00E+00	0.00E+00	1.78E+06	0.00E+00
BR-83	0.00E+00	0.00E+00	3.10E+00	0.00E+00	0.00E+00	0.00E+00	4.47E+00	0.00E+00
BR-84	0.00E+00	0.00E+00	2.21E-11	0.00E+00	0.00E+00	0.00E+00	1.73E-16	0.00E+00
RB-86	0.00E+00	2.21E+08	1.03E+08	0.00E+00	0.00E+00	0.00E+00	4.35E+07	0.00E+00
RB-88	0.00E+00	2.66E-22	1.41E-22	0.00E+00	0.00E+00	0.00E+00	3.67E-33	0.00E+00
RB-89	0.00E+00	2.90E-26	2.04E-26	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-89	9.77E+09	0.00E+00	2.80E+08	0.00E+00	0.00E+00	0.00E+00	1.57E+09	0.00E+00
SR-90	6.71E+11	0.00E+00	1.65E+11	0.00E+00	0.00E+00	0.00E+00	1.94E+10	0.00E+00
SR-91	3.02E+05	0.00E+00	1.22E+04	0.00E+00	0.00E+00	0.00E+00	1.44E+06	0.00E+00
SR-92	4.15E+02	0.00E+00	1.79E+01	0.00E+00	0.00E+00	0.00E+00	8.22E+03	0.00E+00
Y-91M	4.76E-09	0.00E+00	1.84E-10	0.00E+00	0.00E+00	0.00E+00	1.40E-08	0.00E+00
Y-91	4.98E+06	0.00E+00	1.33E+05	0.00E+00	0.00E+00	0.00E+00	2.74E+09	0.00E+00
Y-92	8.96E-01	0.00E+00	2.62E-02	0.00E+00	0.00E+00	0.00E+00	1.57E+04	0.00E+00
Y-93	1.68E+02	0.00E+00	4.65E+00	0.00E+00	0.00E+00	0.00E+00	5.34E+06	0.00E+00
ZR-95	1.14E+06	3.66E+05	2.48E+05	0.00E+00	5.75E+05	0.00E+00	1.16E+09	0.00E+00
ZR-97	3.36E+02	6.78E+01	3.10E+01	0.00E+00	1.02E+02	0.00E+00	2.10E+07	0.00E+00
NB-95	1.40E+05	7.80E+04	4.19E+04	0.00E+00	7.71E+04	0.00E+00	4.73E+08	0.00E+00
NB-97	2.02E-06	5.11E-07	1.87E-07	0.00E+00	5.96E-07	0.00E+00	1.89E-03	0.00E+00
MO-99	0.00E+00	6.18E+06	1.18E+06	0.00E+00	1.40E+07	0.00E+00	1.43E+07	0.00E+00
TC-99M	3.10E+00	8.75E+00	1.11E+02	0.00E+00	1.33E+02	4.29E+00	5.18E+03	0.00E+00
TC-101	6.00E-31	8.64E-31	8.47E-30	0.00E+00	1.56E-29	4.41E-31	0.00E+00	0.00E+00
RU-103	4.72E+06	0.00E+00	2.03E+06	0.00E+00	1.80E+07	0.00E+00	5.51E+08	0.00E+00
RU-105	5.30E+01	0.00E+00	2.09E+01	0.00E+00	6.85E+02	0.00E+00	3.24E+04	0.00E+00
RU-106	1.95E+08	0.00E+00	2.47E+07	0.00E+00	3.76E+08	0.00E+00	1.26E+10	0.00E+00
AG-110M	1.13E+07	1.05E+07	6.22E+06	0.00E+00	2.06E+07	0.00E+00	4.27E+09	0.00E+00
SN-113	1.43E+07	5.50E+05	1.35E+07	1.94E+05	4.04E+05	0.00E+00	2.49E+08	0.00E+00
SB-124	1.01E+08	1.91E+06	4.01E+07	2.45E+05	0.00E+00	7.88E+07	2.87E+09	0.00E+00
SB-125	1.34E+08	1.50E+06	3.20E+07	1.37E+05	0.00E+00	1.04E+08	1.48E+09	0.00E+00
TE-129M	2.94E+08	1.10E+08	4.65E+07	1.01E+08	1.23E+09	0.00E+00	1.48E+09	0.00E+00
TE-129	7.52E-04	2.83E-04	1.83E-04	5.77E-04	3.16E-03	0.00E+00	5.68E-04	0.00E+00
TE-131M	9.63E+05	4.71E+05	3.93E+05	7.46E+05	4.77E+06	0.00E+00	4.68E+07	0.00E+00
TE-132	4.58E+06	2.96E+06	2.78E+06	3.27E+06	2.85E+07	0.00E+00	1.40E+08	0.00E+00
I-131	8.07E+07	1.15E+08	6.61E+07	3.78E+10	1.98E+08	0.00E+00	3.04E+07	0.00E+00
I-132	5.57E+01	1.49E+02	5.21E+01	5.21E+03	2.37E+02	0.00E+00	2.80E+01	0.00E+00
I-133	2.08E+06	3.61E+06	1.10E+06	5.31E+08	6.31E+06	0.00E+00	3.25E+06	0.00E+00
I-134	8.84E-05	2.40E-04	8.59E-05	4.16E-03	3.82E-04	0.00E+00	2.09E-07	0.00E+00
I-135	3.85E+04	1.01E+05	3.72E+04	6.65E+06	1.62E+05	0.00E+00	1.14E+05	0.00E+00

2 R Values in units of mrem/yr per μCi/m^3 for inhalation and tritium, and units of m^2-mrem/yr per μCi/sec for all others.

TABLE 3.5-2 (continued)
R VALUES for the H.B. ROBINSON STEAM ELECTRIC PLANT[2]

PATHWAY = Vegetation
AGE GROUP = Adult

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-Tract	Skin
CS-134	4.55E+09	1.08E+10	8.84E+09	0.00E+00	3.50E+09	1.16E+09	1.89E+08	0.00E+00
CS-136	4.26E+07	1.68E+08	1.21E+08	0.00E+00	9.36E+07	1.28E+07	1.91E+07	0.00E+00
CS-137	6.64E+09	9.08E+09	5.95E+09	0.00E+00	3.08E+09	1.03E+09	1.76E+08	0.00E+00
CS-138	3.39E-11	6.70E-11	3.32E-11	0.00E+00	4.92E-11	4.86E-12	2.86E-16	0.00E+00
BA-139	2.70E-02	1.93E-05	7.91E-04	0.00E+00	1.80E-05	1.09E-05	4.79E-02	0.00E+00
BA-140	1.28E+08	1.61E+05	8.40E+06	0.00E+00	5.47E+04	9.22E+04	2.64E+08	0.00E+00
LA-140	1.97E+03	9.95E+02	2.63E+02	0.00E+00	0.00E+00	0.00E+00	7.30E+07	0.00E+00
LA-142	1.92E-04	8.75E-05	2.18E-05	0.00E+00	0.00E+00	0.00E+00	6.39E-01	0.00E+00
CE-141	1.94E+05	1.31E+05	1.49E+04	0.00E+00	6.10E+04	0.00E+00	5.02E+08	0.00E+00
CE-143	9.96E+02	7.36E+05	8.15E+01	0.00E+00	3.24E+02	0.00E+00	2.75E+07	0.00E+00
CE-144	3.15E+07	1.32E+07	1.69E+06	0.00E+00	7.81E+06	0.00E+00	1.07E+10	0.00E+00
PR-144	2.36E-26	9.81E-27	1.20E-27	0.00E+00	5.53E-27	0.00E+00	3.40E-33	0.00E+00
HF-181	9.50E+06	5.36E+04	1.08E+06	3.40E+04	4.47E+04	0.00E+00	7.05E+08	0.00E+00
W-187	3.79E+04	3.17E+04	1.11E+04	0.00E+00	0.00E+00	0.00E+00	1.04E+07	0.00E+00
NP-239	1.43E+03	1.40E+02	7.73E+01	0.00E+00	4.37E+02	0.00E+00	2.88E+07	0.00E+00

[2] R Values in units of mrem/yr per μCi/m^3 for inhalation and tritium, and units of m^2-mrem/yr per μCi/sec for all others.

TABLE 3.5-3
R VALUES for the H.B. ROBINSON STEAM ELECTRIC PLANT[3]
(Reference Regulatory Guide 1.109)

PATHWAY = Vegetation
AGE GROUP = Teen

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-Tract	Skin
H-3	0.00E+00	2.59E+03	2.59E+03	2.59E+03	2.59E+03	2.59E+03	2.59E+03	2.59E+03
F-18	3.83E+00	0.00E+00	4.20E-01	0.00E+00	0.00E+00	0.00E+00	3.45E-01	0.00E+00
NA-24	2.38E+05	2.38E+05	2.38E+05	2.38E+05	2.38E+05	2.38E+05	2.38E+05	0.00E+00
CR-51	0.00E+00	0.00E+00	6.09E+04	3.38E+04	1.34E+04	8.70E+04	1.02E+07	0.00E+00
MN-54	0.00E+00	4.47E+08	8.86E+07	0.00E+00	1.33E+08	0.00E+00	9.16E+08	0.00E+00
MN-56	0.00E+00	1.39E+01	2.48E+00	0.00E+00	1.76E+01	0.00E+00	9.17E+02	0.00E+00
FE-55	3.10E+08	2.20E+08	5.13E+07	0.00E+00	0.00E+00	1.40E+08	9.53E+07	0.00E+00
FE-59	1.76E+08	4.10E+08	1.58E+08	0.00E+00	0.00E+00	1.29E+08	9.70E+08	0.00E+00
CO-57	0.00E+00	1.72E+07	2.89E+07	0.00E+00	0.00E+00	0.00E+00	3.21E+08	0.00E+00
CO-58	0.00E+00	4.24E+07	9.78E+07	0.00E+00	0.00E+00	0.00E+00	5.85E+08	0.00E+00
CO-60	0.00E+00	2.48E+08	5.58E+08	0.00E+00	0.00E+00	0.00E+00	3.23E+09	0.00E+00
NI-65	5.56E+01	7.10E+00	3.23E+00	0.00E+00	0.00E+00	0.00E+00	3.85E+02	0.00E+00
CU-64	0.00E+00	8.33E+03	3.92E+03	0.00E+00	2.11E+04	0.00E+00	6.46E+05	0.00E+00
ZN-65	5.36E+08	1.86E+09	8.68E+08	0.00E+00	1.19E+09	0.00E+00	7.88E+08	0.00E+00
BR-82	0.00E+00	0.00E+00	1.37E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-83	0.00E+00	0.00E+00	2.91E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-84	0.00E+00	0.00E+00	2.01E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RB-86	0.00E+00	2.75E+08	1.29E+08	0.00E+00	0.00E+00	0.00E+00	4.07E+07	0.00E+00
RB-88	0.00E+00	2.46E-22	1.31E-22	0.00E+00	0.00E+00	0.00E+00	2.11E-29	0.00E+00
RB-89	0.00E+00	2.61E-26	1.84E-26	0.00E+00	0.00E+00	0.00E+00	4.00E-35	0.00E+00
SR-89	1.48E+10	0.00E+00	4.25E+08	0.00E+00	0.00E+00	0.00E+00	1.77E+09	0.00E+00
SR-90	8.33E+11	0.00E+00	2.06E+11	0.00E+00	0.00E+00	0.00E+00	2.34E+10	0.00E+00
SR-91	2.83E+05	0.00E+00	1.12E+04	0.00E+00	0.00E+00	0.00E+00	1.28E+06	0.00E+00
SR-92	3.86E+02	0.00E+00	1.65E+01	0.00E+00	0.00E+00	0.00E+00	9.84E+03	0.00E+00
Y-91M	4.43E-09	0.00E+00	1.69E-10	0.00E+00	0.00E+00	0.00E+00	2.09E-07	0.00E+00
Y-91	7.64E+06	0.00E+00	2.05E+05	0.00E+00	0.00E+00	0.00E+00	3.13E+09	0.00E+00
Y-92	8.42E-01	0.00E+00	2.43E-02	0.00E+00	0.00E+00	0.00E+00	2.31E+04	0.00E+00
Y-93	1.58E+02	0.00E+00	4.33E+00	0.00E+00	0.00E+00	0.00E+00	4.82E+06	0.00E+00
ZR-95	1.67E+06	5.28E+05	3.63E+05	0.00E+00	7.76E+05	0.00E+00	1.22E+09	0.00E+00
ZR-97	3.11E+02	6.15E+01	2.83E+01	0.00E+00	9.33E+01	0.00E+00	1.67E+07	0.00E+00
NB-95	1.89E+05	1.05E+05	5.78E+04	0.00E+00	1.02E+05	0.00E+00	4.49E+08	0.00E+00
NB-97	1.87E-06	4.65E-07	1.70E-07	0.00E+00	5.44E-07	0.00E+00	1.11E-02	0.00E+00
MO-99	0.00E+00	5.67E+06	1.08E+06	0.00E+00	1.30E+07	0.00E+00	1.02E+07	0.00E+00
TC-99M	2.73E+00	7.62E+00	9.87E+01	0.00E+00	1.13E+02	4.23E+00	5.00E+03	0.00E+00
TC-101	5.58E-31	7.93E-31	7.79E-30	0.00E+00	1.43E-29	4.83E-31	1.36E-37	0.00E+00
RU-103	6.75E+06	0.00E+00	2.88E+06	0.00E+00	2.38E+07	0.00E+00	5.64E+08	0.00E+00
RU-105	4.93E+01	0.00E+00	1.91E+01	0.00E+00	6.22E+02	0.00E+00	3.98E+04	0.00E+00
RU-106	3.13E+08	0.00E+00	3.94E+07	0.00E+00	6.03E+08	0.00E+00	1.50E+10	0.00E+00
AG-110M	1.63E+07	1.54E+07	9.37E+06	0.00E+00	2.94E+07	0.00E+00	4.33E+09	0.00E+00
SN-113	1.88E+07	7.89E+05	2.00E+07	2.60E+05	5.58E+05	0.00E+00	2.26E+08	0.00E+00
SB-124	1.51E+08	2.78E+06	5.88E+07	3.42E+05	0.00E+00	1.32E+08	3.04E+09	0.00E+00
SB-125	2.11E+08	2.30E+06	4.92E+07	2.01E+05	0.00E+00	1.85E+08	1.64E+09	0.00E+00
TE-129M	4.23E+08	1.57E+08	6.69E+07	1.36E+08	1.77E+09	0.00E+00	1.59E+09	0.00E+00
TE-129	7.04E-04	2.63E-04	1.71E-04	5.03E-04	2.96E-03	0.00E+00	3.85E-03	0.00E+00
TE-131M	8.92E+05	4.28E+05	3.57E+05	6.43E+05	4.46E+06	0.00E+00	3.43E+07	0.00E+00
TE-132	4.16E+06	2.64E+06	2.48E+06	2.78E+06	2.53E+07	0.00E+00	8.35E+07	0.00E+00
I-131	7.67E+07	1.07E+08	5.77E+07	3.14E+10	1.85E+08	0.00E+00	2.13E+07	0.00E+00
I-132	5.02E+01	1.31E+02	4.72E+01	4.43E+03	2.07E+02	0.00E+00	5.73E+01	0.00E+00
I-133	1.93E+06	3.27E+06	9.99E+05	4.57E+08	5.74E+06	0.00E+00	2.48E+06	0.00E+00
I-134	7.99E-05	2.12E-04	7.61E-05	3.53E-03	3.34E-04	0.00E+00	2.79E-06	0.00E+00
I-135	3.48E+04	8.96E+04	3.32E+04	5.77E+06	1.42E+05	0.00E+00	9.93E+04	0.00E+00

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

TABLE 3.5-3 (continued)
R VALUES for the H.B. ROBINSON STEAM ELECTRIC PLANT[3]

PATHWAY = Vegetation
AGE GROUP = Teen

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-Tract	Skin
CS-134	6.92E+09	1.63E+10	7.55E+09	0.00E+00	5.17E+09	1.97E+09	2.02E+08	0.00E+00
CS-136	4.36E+07	1.72E+08	1.15E+08	0.00E+00	9.35E+07	1.47E+07	1.38E+07	0.00E+00
CS-137	1.06E+10	1.41E+10	4.90E+09	0.00E+00	4.79E+09	1.86E+09	2.00E+08	0.00E+00
CS-138	3.13E-11	6.01E-11	3.01E-11	0.00E+00	4.44E-11	5.16E-12	2.73E-14	0.00E+00
BA-139	2.54E-02	1.79E-05	7.41E-04	0.00E+00	1.69E-05	1.23E-05	2.27E-01	0.00E+00
BA-140	1.38E+08	1.69E+05	8.87E+06	0.00E+00	5.72E+04	1.13E+05	2.12E+08	0.00E+00
LA-140	1.80E+03	8.86E+02	2.36E+02	0.00E+00	0.00E+00	0.00E+00	5.09E+07	0.00E+00
LA-142	1.77E-04	7.85E-05	1.95E-05	0.00E+00	0.00E+00	0.00E+00	2.39E+00	0.00E+00
CE-141	2.79E+05	1.86E+05	2.14E+04	0.00E+00	8.76E+04	0.00E+00	5.32E+08	0.00E+00
CE-143	9.31E+02	6.77E+05	7.56E+01	0.00E+00	3.04E+02	0.00E+00	2.04E+07	0.00E+00
CE-144	5.05E+07	2.09E+07	2.71E+06	0.00E+00	1.25E+07	0.00E+00	1.27E+10	0.00E+00
PR-144	2.22E-26	9.07E-27	1.12E-27	0.00E+00	5.20E-27	0.00E+00	2.44E-29	0.00E+00
HF-181	1.38E+07	7.58E+04	1.54E+06	4.62E+04	6.30E+04	0.00E+00	6.89E+08	0.00E+00
W-187	3.53E+04	2.87E+04	1.01E+04	0.00E+00	0.00E+00	0.00E+00	7.78E+06	0.00E+00
NP-239	1.38E+03	1.31E+02	7.25E+01	0.00E+00	4.10E+02	0.00E+00	2.10E+07	0.00E+00

[3] R Values in units of mrem/yr per µCi/m^3 for inhalation and tritium, and units of m^2-mrem/yr per µCi/sec for all others.

TABLE 3.5-4
R VALUES for the H.B. ROBINSON STEAM ELECTRIC PLANT[4]
(Reference Regulatory Guide 1.109)

PATHWAY = Vegetation
AGE GROUP = Child

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-Tract	Skin
H-3	0.00E+00	4.01E+03	4.01E+03	4.01E+03	4.01E+03	4.01E+03	4.01E+03	4.01E+03
F-18	6.84E+00	0.00E+00	6.78E-01	0.00E+00	0.00E+00	0.00E+00	1.85E+00	0.00E+00
NA-24	3.72E+05	3.72E+05	3.72E+05	3.72E+05	3.72E+05	3.72E+05	3.72E+05	0.00E+00
CR-51	0.00E+00	0.00E+00	1.16E+05	6.42E+04	1.75E+04	1.17E+05	6.14E+06	0.00E+00
MN-54	0.00E+00	6.54E+08	1.74E+08	0.00E+00	1.83E+08	0.00E+00	5.49E+08	0.00E+00
MN-56	0.00E+00	1.82E+01	4.11E+00	0.00E+00	2.20E+01	0.00E+00	2.64E+03	0.00E+00
FE-55	7.63E+08	4.05E+08	1.25E+08	0.00E+00	0.00E+00	2.29E+08	7.50E+07	0.00E+00
FE-59	3.89E+08	6.30E+08	3.14E+08	0.00E+00	0.00E+00	1.83E+08	6.56E+08	0.00E+00
CO-57	0.00E+00	2.88E+07	5.83E+07	0.00E+00	0.00E+00	0.00E+00	2.36E+08	0.00E+00
CO-58	0.00E+00	6.27E+07	1.92E+08	0.00E+00	0.00E+00	0.00E+00	3.65E+08	0.00E+00
CO-60	0.00E+00	3.77E+08	1.11E+09	0.00E+00	0.00E+00	0.00E+00	2.09E+09	0.00E+00
NI-65	1.02E+02	9.60E+00	5.60E+00	0.00E+00	0.00E+00	0.00E+00	1.18E+03	0.00E+00
CU-64	0.00E+00	1.10E+04	6.63E+03	0.00E+00	2.65E+04	0.00E+00	5.15E+05	0.00E+00
ZN-65	1.03E+09	2.74E+09	1.70E+09	0.00E+00	1.72E+09	0.00E+00	4.81E+08	0.00E+00
BR-82	0.00E+00	0.00E+00	2.10E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-83	0.00E+00	0.00E+00	5.36E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-84	0.00E+00	0.00E+00	3.41E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RB-86	0.00E+00	4.55E+08	2.80E+08	0.00E+00	0.00E+00	0.00E+00	2.93E+07	0.00E+00
RB-88	0.00E+00	3.39E-22	2.36E-22	0.00E+00	0.00E+00	0.00E+00	1.66E-23	0.00E+00
RB-89	0.00E+00	3.43E-26	3.05E-26	0.00E+00	0.00E+00	0.00E+00	2.99E-28	0.00E+00
SR-89	3.52E+10	0.00E+00	1.01E+09	0.00E+00	0.00E+00	0.00E+00	1.36E+09	0.00E+00
SR-90	1.38E+12	0.00E+00	3.50E+11	0.00E+00	0.00E+00	0.00E+00	1.86E+10	0.00E+00
SR-91	5.20E+05	0.00E+00	1.96E+04	0.00E+00	0.00E+00	0.00E+00	1.15E+06	0.00E+00
SR-92	7.08E+02	0.00E+00	2.84E+01	0.00E+00	0.00E+00	0.00E+00	1.34E+04	0.00E+00
Y-91M	8.12E-09	0.00E+00	2.95E-10	0.00E+00	0.00E+00	0.00E+00	1.59E-05	0.00E+00
Y-91	1.82E+07	0.00E+00	4.86E+05	0.00E+00	0.00E+00	0.00E+00	2.42E+09	0.00E+00
Y-92	1.55E+00	0.00E+00	4.44E-02	0.00E+00	0.00E+00	0.00E+00	4.48E+04	0.00E+00
Y-93	2.91E+02	0.00E+00	7.98E+00	0.00E+00	0.00E+00	0.00E+00	4.34E+06	0.00E+00
ZR-95	3.75E+06	8.25E+05	7.34E+05	0.00E+00	1.18E+06	0.00E+00	8.60E+08	0.00E+00
ZR-97	5.68E+02	8.20E+01	4.84E+01	0.00E+00	1.18E+02	0.00E+00	1.24E+07	0.00E+00
NB-95	4.04E+05	1.57E+05	1.12E+05	0.00E+00	1.48E+05	0.00E+00	2.91E+08	0.00E+00
NB-97	3.41E-06	6.16E-07	2.88E-07	0.00E+00	6.84E-07	0.00E+00	1.90E-01	0.00E+00
SR-91	5.20E+05	0.00E+00	1.96E+04	0.00E+00	0.00E+00	0.00E+00	1.15E+06	0.00E+00
SR-92	7.08E+02	0.00E+00	2.84E+01	0.00E+00	0.00E+00	0.00E+00	1.34E+04	0.00E+00
Y-91M	8.12E-09	0.00E+00	2.95E-10	0.00E+00	0.00E+00	0.00E+00	1.59E-05	0.00E+00
Y-91	1.82E+07	0.00E+00	4.86E+05	0.00E+00	0.00E+00	0.00E+00	2.42E+09	0.00E+00
Y-92	1.55E+00	0.00E+00	4.44E-02	0.00E+00	0.00E+00	0.00E+00	4.48E+04	0.00E+00
Y-93	2.91E+02	0.00E+00	7.98E+00	0.00E+00	0.00E+00	0.00E+00	4.34E+06	0.00E+00
ZR-95	3.75E+06	8.25E+05	7.34E+05	0.00E+00	1.18E+06	0.00E+00	8.60E+08	0.00E+00
ZR-97	5.68E+02	8.20E+01	4.84E+01	0.00E+00	1.18E+02	0.00E+00	1.24E+07	0.00E+00
NB-95	4.04E+05	1.57E+05	1.12E+05	0.00E+00	1.48E+05	0.00E+00	2.91E+08	0.00E+00
NB-97	3.41E-06	6.16E-07	2.88E-07	0.00E+00	6.84E-07	0.00E+00	1.90E-01	0.00E+00
MO-99	0.00E+00	7.75E+06	1.92E+06	0.00E+00	1.65E+07	0.00E+00	6.41E+06	0.00E+00
TC-99M	4.70E+00	9.21E+00	1.53E+02	0.00E+00	1.34E+02	4.68E+00	5.24E+03	0.00E+00
TC-101	1.03E-30	1.07E-30	1.36E-29	0.00E+00	1.83E-29	5.68E-31	3.41E-30	0.00E+00
RU-103	1.52E+07	0.00E+00	5.83E+06	0.00E+00	3.82E+07	0.00E+00	3.92E+08	0.00E+00
RU-105	9.02E+01	0.00E+00	3.27E+01	0.00E+00	7.93E+02	0.00E+00	5.89E+04	0.00E+00
RU-106	7.54E+08	0.00E+00	9.40E+07	0.00E+00	1.02E+09	0.00E+00	1.17E+10	0.00E+00
AG-110M	3.45E+07	2.33E+07	1.86E+07	0.00E+00	4.34E+07	0.00E+00	2.77E+09	0.00E+00
SN-113	3.60E+07	1.16E+06	3.93E+07	4.75E+05	7.96E+05	0.00E+00	1.44E+08	0.00E+00
SB-124	3.43E+08	4.46E+06	1.20E+08	7.58E+05	0.00E+00	1.91E+08	2.15E+09	0.00E+00
SB-125	4.91E+08	3.79E+06	1.03E+08	4.55E+05	0.00E+00	2.74E+08	1.17E+09	0.00E+00

4 R Values in units of mrem/yr per µCi/m^3 for inhalation and tritium, and units of m^2-mrem/yr per µCi/sec for all others.

TABLE 3.5-4 (continued)
R VALUES for the H.B. ROBINSON STEAM ELECTRIC PLANT[4]

PATHWAY = Vegetation
AGE GROUP = Child

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-Tract	Skin
TE-129M	9.83E+08	2.74E+08	1.53E+08	3.17E+08	2.89E+09	0.00E+00	1.20E+09	0.00E+00
TE-129	1.30E-03	3.64E-04	3.09E-04	9.30E-04	3.81E-03	0.00E+00	8.12E-02	0.00E+00
TE-131M	1.63E+06	5.63E+05	5.99E+05	1.16E+06	5.45E+06	0.00E+00	2.28E+07	0.00E+00
TE-132	7.46E+06	3.30E+06	3.99E+06	4.81E+06	3.07E+07	0.00E+00	3.32E+07	0.00E+00
I-131	1.43E+08	1.44E+08	8.16E+07	4.75E+10	2.36E+08	0.00E+00	1.28E+07	0.00E+00
I-132	8.92E+01	1.64E+02	7.53E+01	7.60E+03	2.51E+02	0.00E+00	1.93E+02	0.00E+00
I-133	3.52E+06	4.35E+06	1.65E+06	8.08E+08	7.25E+06	0.00E+00	1.75E+06	0.00E+00
I-134	1.42E-04	2.64E-04	1.21E-04	6.07E-03	4.03E-04	0.00E+00	1.75E-04	0.00E+00
I-135	6.18E+04	1.11E+05	5.27E+04	9.86E+06	1.71E+05	0.00E+00	8.48E+04	0.00E+00
CS-134	1.56E+10	2.56E+10	5.41E+09	0.00E+00	7.94E+09	2.85E+09	1.38E+08	0.00E+00
CS-136	8.22E+07	2.26E+08	1.46E+08	0.00E+00	1.20E+08	1.79E+07	7.94E+06	0.00E+00
CS-137	2.50E+10	2.39E+10	3.53E+09	0.00E+00	7.79E+09	2.80E+09	1.50E+08	0.00E+00
CS-138	5.69E-11	7.92E-11	5.02E-11	0.00E+00	5.57E-11	5.99E-12	3.65E-11	0.00E+00
BA-139	4.69E-02	2.50E-05	1.36E-03	0.00E+00	2.18E-05	1.47E-05	2.71E+00	0.00E+00
BA-140	2.76E+08	2.42E+05	1.61E+07	0.00E+00	7.87E+04	1.44E+05	1.40E+08	0.00E+00
LA-140	3.24E+03	1.13E+03	3.82E+02	0.00E+00	0.00E+00	0.00E+00	3.16E+07	0.00E+00
LA-142	3.20E-04	1.02E-04	3.20E-05	0.00E+00	0.00E+00	0.00E+00	2.02E+01	0.00E+00
CE-141	6.46E+05	3.22E+05	4.79E+04	0.00E+00	1.41E+05	0.00E+00	4.02E+08	0.00E+00
CE-143	1.71E+03	9.29E+05	1.35E+02	0.00E+00	3.90E+02	0.00E+00	1.36E+07	0.00E+00
CE-144	1.22E+08	3.82E+07	6.50E+06	0.00E+00	2.11E+07	0.00E+00	9.95E+09	0.00E+00
PR-144	4.11E-26	1.27E-26	2.07E-27	0.00E+00	6.73E-27	0.00E+00	2.74E-23	0.00E+00
HF-181	3.12E+07	1.22E+05	3.14E+06	1.03E+05	9.80E+04	0.00E+00	5.18E+08	0.00E+00
W-187	6.41E+04	3.80E+04	1.70E+04	0.00E+00	0.00E+00	0.00E+00	5.34E+06	0.00E+00
NP-239	2.56E+03	1.84E+02	1.29E+02	0.00E+00	5.31E+02	0.00E+00	1.36E+07	0.00E+00

4 R Values in units of mrem/yr per µCi/m^3 for inhalation and tritium, and units of m^2-mrem/yr per µCi/sec for all others.

TABLE 3.5-5

R VALUES for the H.B. ROBINSON STEAM ELECTRIC PLANT[5]

(Reference Regulatory Guide 1.109)

PATHWAY = Meat
AGE GROUP = Adult

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-Tract	Skin
H-3	0.00E+00	3.24E+02	3.24E+02	3.24E+02	3.24E+02	3.24E+02	3.24E+02	3.24E+02
NA-24	1.39E-03	1.39E-03	1.39E-03	1.39E-03	1.39E-03	1.39E-03	1.39E-03	0.00E+00
CR-51	0.00E+00	0.00E+00	6.30E+03	3.76E+03	1.39E+03	8.36E+03	1.58E+06	0.00E+00
MN-54	0.00E+00	7.33E+06	1.40E+06	0.00E+00	2.18E+06	0.00E+00	2.24E+07	0.00E+00
FE-55	2.28E+08	1.58E+08	3.68E+07	0.00E+00	0.00E+00	8.81E+07	9.06E+07	0.00E+00
FE-59	2.28E+08	5.36E+08	2.05E+08	0.00E+00	0.00E+00	1.50E+08	1.79E+09	0.00E+00
CO-57	0.00E+00	4.01E+06	7.43E+06	0.00E+00	0.00E+00	0.00E+00	1.13E+08	0.00E+00
CO-58	0.00E+00	1.52E+07	3.40E+07	0.00E+00	0.00E+00	0.00E+00	3.07E+08	0.00E+00
CO-60	0.00E+00	5.96E+07	1.31E+08	0.00E+00	0.00E+00	0.00E+00	1.12E+09	0.00E+00
CU-64	0.00E+00	2.80E-07	1.31E-07	0.00E+00	7.05E-07	0.00E+00	2.38E-05	0.00E+00
ZN-65	3.20E+08	1.02E+09	4.60E+08	0.00E+00	6.81E+08	0.00E+00	6.42E+08	0.00E+00
BR-82	0.00E+00	0.00E+00	1.25E+03	0.00E+00	0.00E+00	0.00E+00	1.43E+03	0.00E+00
RB-86	0.00E+00	4.53E+08	2.11E+08	0.00E+00	0.00E+00	0.00E+00	8.94E+07	0.00E+00
SR-89	2.57E+08	0.00E+00	7.37E+06	0.00E+00	0.00E+00	0.00E+00	4.12E+07	0.00E+00
SR-90	1.03E+10	0.00E+00	2.53E+09	0.00E+00	0.00E+00	0.00E+00	2.98E+08	0.00E+00
SR-91	1.58E-10	0.00E+00	6.39E-12	0.00E+00	0.00E+00	0.00E+00	7.53E-10	0.00E+00
Y-91	9.53E+05	0.00E+00	2.55E+04	0.00E+00	0.00E+00	0.00E+00	5.24E+08	0.00E+00
Y-93	4.87E-12	0.00E+00	1.35E-13	0.00E+00	0.00E+00	0.00E+00	1.55E-07	0.00E+00
ZR-95	1.57E+06	5.02E+05	3.40E+05	0.00E+00	7.88E+05	0.00E+00	1.59E+09	0.00E+00
ZR-97	2.11E-05	4.27E-06	1.95E-06	0.00E+00	6.44E-06	0.00E+00	1.32E+00	0.00E+00
NB-95	2.01E+06	1.12E+06	6.02E+05	0.00E+00	1.11E+06	0.00E+00	6.79E+09	0.00E+00
MO-99	0.00E+00	1.01E+05	1.92E+04	0.00E+00	2.28E+05	0.00E+00	2.33E+05	0.00E+00
TC-99M	4.76E-21	1.35E-20	1.71E-19	0.00E+00	2.04E-19	6.59E-21	7.96E-18	0.00E+00
RU-103	9.15E+07	0.00E+00	3.94E+07	0.00E+00	3.49E+08	0.00E+00	1.07E+10	0.00E+00
RU-105	6.30E-28	0.00E+00	2.49E-28	0.00E+00	8.15E-27	0.00E+00	3.86E-25	0.00E+00
RU-106	2.26E+09	0.00E+00	2.85E+08	0.00E+00	4.36E+09	0.00E+00	1.46E+11	0.00E+00
AG-110M	5.57E+06	5.15E+06	3.06E+06	0.00E+00	1.01E+07	0.00E+00	2.10E+09	0.00E+00
SN-113	3.94E+07	1.52E+06	3.73E+07	5.36E+05	1.12E+06	0.00E+00	6.89E+08	0.00E+00
SB-124	1.66E+07	3.14E+05	6.60E+06	4.03E+04	0.00E+00	1.30E+07	4.72E+08	0.00E+00
SB-125	1.51E+07	1.69E+05	3.59E+06	1.53E+04	0.00E+00	1.16E+07	1.66E+08	0.00E+00
TE-129M	1.07E+09	3.99E+08	1.69E+08	3.67E+08	4.46E+09	0.00E+00	5.38E+09	0.00E+00
TE-131M	4.66E+02	2.28E+02	1.90E+02	3.61E+02	2.31E+03	0.00E+00	2.26E+04	0.00E+00
TE-132	1.46E+06	9.44E+05	8.86E+05	1.04E+06	9.09E+06	0.00E+00	4.46E+07	0.00E+00
I-131	1.06E+07	1.51E+07	8.66E+06	4.95E+09	2.59E+07	0.00E+00	3.99E+06	0.00E+00
I-133	3.72E-01	6.47E-01	1.97E-01	9.51E+01	1.13E+00	0.00E+00	5.82E-01	0.00E+00
I-135	4.69E-17	1.23E-16	4.53E-17	8.10E-15	1.97E-16	0.00E+00	1.39E-16	0.00E+00
CS-134	5.18E+08	1.23E+09	1.01E+09	0.00E+00	3.99E+08	1.32E+08	2.16E+07	0.00E+00
CS-136	1.15E+07	4.54E+07	3.27E+07	0.00E+00	2.53E+07	3.46E+06	5.16E+06	0.00E+00
CS-137	7.04E+08	9.63E+08	6.31E+08	0.00E+00	3.27E+08	1.09E+08	1.86E+07	0.00E+00
BA-140	2.75E+07	3.45E+04	1.80E+06	0.00E+00	1.17E+04	1.98E+04	5.66E+07	0.00E+00
LA-140	3.74E-02	1.89E-02	4.99E-03	0.00E+00	0.00E+00	0.00E+00	1.38E+03	0.00E+00
CE-141	1.24E+04	8.37E+03	9.49E+02	0.00E+00	3.89E+03	0.00E+00	3.20E+07	0.00E+00
CE-143	2.03E-02	1.50E+01	1.66E-03	0.00E+00	6.61E-03	0.00E+00	5.61E+02	0.00E+00
CE-144	1.15E+06	4.82E+05	6.19E+04	0.00E+00	2.86E+05	0.00E+00	3.90E+08	0.00E+00
HF-181	1.79E+08	1.01E+06	2.03E+07	6.41E+05	8.41E+05	0.00E+00	1.33E+10	0.00E+00
W-187	2.08E-02	1.74E-02	6.09E-03	0.00E+00	0.00E+00	0.00E+00	5.71E+00	0.00E+00
NP-239	2.61E-01	2.56E-02	1.41E-02	0.00E+00	8.00E-02	0.00E+00	5.26E+03	0.00E+00

5 R Values in units of mrem/yr per μCi/m^3 for inhalation and tritium, and units of m^2-mrem/yr per μCi/sec for all others.

TABLE 3.5-6
R VALUES for the H.B. ROBINSON STEAM ELECTRIC PLANT[6]
(Reference Regulatory Guide 1.109)

PATHWAY = Meat
AGE GROUP = Teen

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-Tract	Skin
H-3	0.00E+00	1.93E+02	1.93E+02	1.93E+02	1.93E+02	1.93E+02	1.93E+02	1.93E+02
NA-24	1.11E-03	1.11E-03	1.11E-03	1.11E-03	1.11E-03	1.11E-03	1.11E-03	0.00E+00
CR-51	0.00E+00	0.00E+00	5.04E+03	2.80E+03	1.10E+03	7.19E+03	8.46E+05	0.00E+00
MN-54	0.00E+00	5.59E+06	1.11E+06	0.00E+00	1.67E+06	0.00E+00	1.15E+07	0.00E+00
FE-55	1.86E+08	1.32E+08	3.07E+07	0.00E+00	0.00E+00	8.35E+07	5.69E+07	0.00E+00
FE-59	1.82E+08	4.25E+08	1.64E+08	0.00E+00	0.00E+00	1.34E+08	1.01E+09	0.00E+00
CO-57	0.00E+00	3.59E+06	6.02E+06	0.00E+00	0.00E+00	0.00E+00	6.70E+07	0.00E+00
CO-58	0.00E+00	1.17E+07	2.69E+07	0.00E+00	0.00E+00	0.00E+00	1.61E+08	0.00E+00
CO-60	0.00E+00	4.62E+07	1.04E+08	0.00E+00	0.00E+00	0.00E+00	6.02E+08	0.00E+00
CU-64	0.00E+00	2.28E-07	1.07E-07	0.00E+00	5.77E-07	0.00E+00	1.77E-05	0.00E+00
ZN-65	2.25E+08	7.82E+08	3.65E+08	0.00E+00	5.00E+08	0.00E+00	3.31E+08	0.00E+00
BR-82	0.00E+00	0.00E+00	9.94E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RB-86	0.00E+00	3.78E+08	1.78E+08	0.00E+00	0.00E+00	0.00E+00	5.60E+07	0.00E+00
SR-89	2.17E+08	0.00E+00	6.21E+06	0.00E+00	0.00E+00	0.00E+00	2.58E+07	0.00E+00
SR-90	6.68E+09	0.00E+00	1.65E+09	0.00E+00	0.00E+00	0.00E+00	1.88E+08	0.00E+00
SR-91	1.33E-10	0.00E+00	5.29E-12	0.00E+00	0.00E+00	0.00E+00	6.04E-10	0.00E+00
Y-91	8.03E+05	0.00E+00	2.15E+04	0.00E+00	0.00E+00	0.00E+00	3.29E+08	0.00E+00
Y-93	4.11E-12	0.00E+00	1.13E-13	0.00E+00	0.00E+00	0.00E+00	1.26E-07	0.00E+00
ZR-95	1.25E+06	3.96E+05	2.72E+05	0.00E+00	5.82E+05	0.00E+00	9.13E+08	0.00E+00
ZR-97	1.76E-05	3.49E-06	1.61E-06	0.00E+00	5.29E-06	0.00E+00	9.44E-01	0.00E+00
NB-95	1.57E+06	8.72E+05	4.80E+05	0.00E+00	8.45E+05	0.00E+00	3.73E+09	0.00E+00
MO-99	0.00E+00	8.33E+04	1.59E+04	0.00E+00	1.91E+05	0.00E+00	1.49E+05	0.00E+00
TC-99M	3.78E-21	1.05E-20	1.37E-19	0.00E+00	1.57E-19	5.85E-21	6.92E-18	0.00E+00
RU-103	7.45E+07	0.00E+00	3.18E+07	0.00E+00	2.63E+08	0.00E+00	6.22E+09	0.00E+00
RU-105	5.27E-28	0.00E+00	2.05E-28	0.00E+00	6.65E-27	0.00E+00	4.26E-25	0.00E+00
RU-106	1.90E+09	0.00E+00	2.39E+08	0.00E+00	3.66E+09	0.00E+00	9.11E+10	0.00E+00
AG-110M	4.21E+06	3.99E+06	2.43E+06	0.00E+00	7.60E+06	0.00E+00	1.12E+09	0.00E+00
SN-113	2.78E+07	1.16E+06	2.95E+07	3.84E+05	8.23E+05	0.00E+00	3.33E+08	0.00E+00
SB-124	1.36E+07	2.50E+05	5.30E+06	3.08E+04	0.00E+00	1.19E+07	2.74E+08	0.00E+00
SB-125	1.24E+07	1.35E+05	2.89E+06	1.18E+04	0.00E+00	1.09E+07	9.61E+07	0.00E+00
TE-129M	8.96E+08	3.32E+08	1.42E+08	2.89E+08	3.75E+09	0.00E+00	3.36E+09	0.00E+00
TE-131M	3.89E+02	1.86E+02	1.55E+02	2.80E+02	1.94E+03	0.00E+00	1.50E+04	0.00E+00
TE-132	1.19E+06	7.56E+05	7.12E+05	7.97E+05	7.25E+06	0.00E+00	2.40E+07	0.00E+00
I-131	8.78E+06	1.23E+07	6.60E+06	3.59E+09	2.12E+07	0.00E+00	2.43E+06	0.00E+00
I-133	3.11E-01	5.28E-01	1.61E-01	7.37E+01	9.26E-01	0.00E+00	3.99E-01	0.00E+00
I-135	3.82E-17	9.83E-17	3.64E-17	6.32E-15	1.55E-16	0.00E+00	1.09E-16	0.00E+00
CS-134	4.12E+08	9.69E+08	4.50E+08	0.00E+00	3.08E+08	1.18E+08	1.21E+07	0.00E+00
CS-136	8.97E+06	3.53E+07	2.37E+07	0.00E+00	1.92E+07	3.03E+06	2.84E+06	0.00E+00
CS-137	5.85E+08	7.78E+08	2.71E+08	0.00E+00	2.65E+08	1.03E+08	1.11E+07	0.00E+00
BA-140	2.27E+07	2.78E+04	1.46E+06	0.00E+00	9.44E+03	1.87E+04	3.50E+07	0.00E+00
LA-140	3.08E-02	1.51E-02	4.02E-03	0.00E+00	0.00E+00	0.00E+00	8.69E+02	0.00E+00
CE-141	1.04E+04	6.94E+03	7.97E+02	0.00E+00	3.27E+03	0.00E+00	1.98E+07	0.00E+00
CE-143	1.71E-02	1.24E+01	1.39E-03	0.00E+00	5.58E-03	0.00E+00	3.74E+02	0.00E+00
CE-144	9.71E+05	4.02E+05	5.22E+04	0.00E+00	2.40E+05	0.00E+00	2.44E+08	0.00E+00
HF-181	1.47E+08	8.06E+05	1.64E+07	4.91E+05	6.70E+05	0.00E+00	7.33E+09	0.00E+00
W-187	1.75E-02	1.42E-02	4.99E-03	0.00E+00	0.00E+00	0.00E+00	3.85E+00	0.00E+00
NP-239	2.28E-01	2.15E-02	1.19E-02	0.00E+00	6.75E-02	0.00E+00	3.46E+03	0.00E+00

6 R Values in units of mrem/yr per μCi/m^3 for inhalation and tritium, and units of m^2-mrem/yr per μCi/sec for all others.

TABLE 3.5-7
R VALUES for the H.B. ROBINSON STEAM ELECTRIC PLANT[7]
(Reference Regulatory Guide 1.109)

PATHWAY = Meat
AGE GROUP = Child

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-Tract	Skin
H-3	0.00E+00	2.33E+02	2.33E+02	2.33E+02	2.33E+02	2.33E+02	2.33E+02	2.33E+02
NA-24	1.77E-03	1.77E-03	1.77E-03	1.77E-03	1.77E-03	1.77E-03	1.77E-03	0.00E+00
CR-51	0.00E+00	0.00E+00	7.85E+03	4.36E+03	1.19E+03	7.96E+03	4.16E+05	0.00E+00
MN-54	0.00E+00	6.39E+06	1.70E+06	0.00E+00	1.79E+06	0.00E+00	5.37E+06	0.00E+00
FE-55	3.56E+08	1.89E+08	5.85E+07	0.00E+00	0.00E+00	1.07E+08	3.50E+07	0.00E+00
FE-59	3.23E+08	5.23E+08	2.60E+08	0.00E+00	0.00E+00	1.51E+08	5.44E+08	0.00E+00
CO-57	0.00E+00	4.69E+06	9.50E+06	0.00E+00	0.00E+00	0.00E+00	3.85E+07	0.00E+00
CO-58	0.00E+00	1.37E+07	4.18E+07	0.00E+00	0.00E+00	0.00E+00	7.97E+07	0.00E+00
CO-60	0.00E+00	5.49E+07	1.62E+08	0.00E+00	0.00E+00	0.00E+00	3.04E+08	0.00E+00
CU-64	0.00E+00	3.06E-07	1.85E-07	0.00E+00	7.41E-07	0.00E+00	1.44E-05	0.00E+00
ZN-65	3.38E+08	9.00E+08	5.60E+08	0.00E+00	5.67E+08	0.00E+00	1.58E+08	0.00E+00
BR-82	0.00E+00	0.00E+00	1.56E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RB-86	0.00E+00	5.37E+08	3.30E+08	0.00E+00	0.00E+00	0.00E+00	3.45E+07	0.00E+00
SR-89	4.10E+08	0.00E+00	1.17E+07	0.00E+00	0.00E+00	0.00E+00	1.59E+07	0.00E+00
SR-90	8.64E+09	0.00E+00	2.19E+09	0.00E+00	0.00E+00	0.00E+00	1.16E+08	0.00E+00
SR-91	2.50E-10	0.00E+00	9.42E-12	0.00E+00	0.00E+00	0.00E+00	5.51E-10	0.00E+00
Y-91	1.52E+06	0.00E+00	4.06E+04	0.00E+00	0.00E+00	0.00E+00	2.02E+08	0.00E+00
Y-93	7.73E-12	0.00E+00	2.12E-13	0.00E+00	0.00E+00	0.00E+00	1.15E-07	0.00E+00
ZR-95	2.23E+06	4.90E+05	4.36E+05	0.00E+00	7.01E+05	0.00E+00	5.11E+08	0.00E+00
ZR-97	3.28E-05	4.74E-06	2.80E-06	0.00E+00	6.80E-06	0.00E+00	7.18E-01	0.00E+00
NB-95	2.71E+06	1.06E+06	7.55E+05	0.00E+00	9.92E+05	0.00E+00	1.95E+09	0.00E+00
MO-99	0.00E+00	1.16E+05	2.87E+04	0.00E+00	2.47E+05	0.00E+00	9.58E+04	0.00E+00
TC-99M	6.63E-21	1.30E-20	2.15E-19	0.00E+00	1.89E-19	6.60E-21	7.40E-18	0.00E+00
RU-103	1.35E+08	0.00E+00	5.18E+07	0.00E+00	3.39E+08	0.00E+00	3.48E+09	0.00E+00
RU-105	9.84E-28	0.00E+00	3.57E-28	0.00E+00	8.65E-27	0.00E+00	6.42E-25	0.00E+00
RU-106	3.58E+09	0.00E+00	4.46E+08	0.00E+00	4.83E+09	0.00E+00	5.56E+10	0.00E+00
AG-110M	6.99E+06	4.72E+06	3.77E+06	0.00E+00	8.79E+06	0.00E+00	5.61E+08	0.00E+00
SN-113	4.17E+07	1.34E+06	4.56E+07	5.51E+05	9.23E+05	0.00E+00	1.67E+08	0.00E+00
SB-124	2.46E+07	3.19E+05	8.62E+06	5.43E+04	0.00E+00	1.36E+07	1.54E+08	0.00E+00
SB-125	2.25E+07	1.73E+05	4.71E+06	2.08E+04	0.00E+00	1.25E+07	5.37E+07	0.00E+00
TE-129M	1.69E+09	4.71E+08	2.62E+08	5.44E+08	4.96E+09	0.00E+00	2.06E+09	0.00E+00
TE-131M	7.23E+02	2.50E+02	2.66E+02	5.14E+02	2.42E+03	0.00E+00	1.01E+04	0.00E+00
TE-132	2.18E+06	9.65E+05	1.17E+06	1.41E+06	8.96E+06	0.00E+00	9.71E+06	0.00E+00
I-131	1.63E+07	1.64E+07	9.30E+06	5.41E+09	2.69E+07	0.00E+00	1.46E+06	0.00E+00
I-133	5.78E-01	7.15E-01	2.71E-01	1.33E+02	1.19E+00	0.00E+00	2.88E-01	0.00E+00
I-135	6.91E-17	1.24E-16	5.88E-17	1.10E-14	1.91E-16	0.00E+00	9.47E-17	0.00E+00
CS-134	7.26E+08	1.19E+09	2.51E+08	0.00E+00	3.69E+08	1.33E+08	6.43E+06	0.00E+00
CS-136	1.55E+07	4.26E+07	2.75E+07	0.00E+00	2.27E+07	3.38E+06	1.50E+06	0.00E+00
CS-137	1.08E+09	1.03E+09	1.52E+08	0.00E+00	3.36E+08	1.21E+08	6.45E+06	0.00E+00
BA-140	4.19E+07	3.67E+04	2.45E+06	0.00E+00	1.20E+04	2.19E+04	2.12E+07	0.00E+00
LA-140	5.64E-02	1.97E-02	6.64E-03	0.00E+00	0.00E+00	0.00E+00	5.49E+02	0.00E+00
CE-141	1.96E+04	9.76E+03	1.45E+03	0.00E+00	4.28E+03	0.00E+00	1.22E+07	0.00E+00
CE-143	3.21E-02	1.74E+01	2.52E-03	0.00E+00	7.29E-03	0.00E+00	2.55E+02	0.00E+00
CE-144	1.83E+06	5.74E+05	9.77E+04	0.00E+00	3.18E+05	0.00E+00	1.50E+08	0.00E+00
HF-181	2.66E+08	1.04E+06	2.68E+07	8.75E+05	8.35E+05	0.00E+00	4.42E+09	0.00E+00
W-187	3.24E-02	1.92E-02	8.60E-03	0.00E+00	0.00E+00	0.00E+00	2.69E+00	0.00E+00
NP-239	4.29E-01	3.08E-02	2.16E-02	0.00E+00	8.90E-02	0.00E+00	2.28E+03	0.00E+00

7 R Values in units of mrem/yr per µCi/m^3 for inhalation and tritium, and units of m^2-mrem/yr per µCi/sec for all others.

TABLE 3.5-8
R VALUES for the H.B. ROBINSON STEAM ELECTRIC PLANT[8]
(Reference Regulatory Guide 1.109)

PATHWAY = Cow Milk
AGE GROUP = Adult

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-Tract	Skin
H-3	0.00E+00	7.63E+02	7.63E+02	7.63E+02	7.63E+02	7.63E+02	7.63E+02	7.63E+02
F-18	4.57E-03	0.00E+00	5.07E-04	0.00E+00	0.00E+00	0.00E+00	1.35E-04	0.00E+00
NA-24	2.45E+06	2.45E+06	2.45E+06	2.45E+06	2.45E+06	2.45E+06	2.45E+06	0.00E+00
CR-51	0.00E+00	0.00E+00	2.55E+04	1.53E+04	5.62E+03	3.39E+04	6.42E+06	0.00E+00
MN-54	0.00E+00	6.71E+06	1.28E+06	0.00E+00	2.00E+06	0.00E+00	2.06E+07	0.00E+00
MN-56	0.00E+00	4.21E-03	7.47E-04	0.00E+00	5.35E-03	0.00E+00	1.34E-01	0.00E+00
FE-55	1.96E+07	1.35E+07	3.15E+06	0.00E+00	0.00E+00	7.54E+06	7.75E+06	0.00E+00
FE-59	2.55E+07	5.99E+07	2.30E+07	0.00E+00	0.00E+00	1.67E+07	2.00E+08	0.00E+00
CO-57	0.00E+00	9.10E+05	1.69E+06	0.00E+00	0.00E+00	0.00E+00	2.57E+07	0.00E+00
CO-58	0.00E+00	3.92E+06	8.79E+06	0.00E+00	0.00E+00	0.00E+00	7.95E+07	0.00E+00
CO-60	0.00E+00	1.30E+07	2.87E+07	0.00E+00	0.00E+00	0.00E+00	2.44E+08	0.00E+00
NI-65	3.76E-01	4.88E-02	2.23E-02	0.00E+00	0.00E+00	0.00E+00	1.24E+00	0.00E+00
CU-64	0.00E+00	2.39E+04	1.12E+04	0.00E+00	6.04E+04	0.00E+00	2.04E+06	0.00E+00
ZN-65	1.23E+09	3.93E+09	1.78E+09	0.00E+00	2.63E+09	0.00E+00	2.47E+09	0.00E+00
BR-82	0.00E+00	0.00E+00	3.27E+07	0.00E+00	0.00E+00	0.00E+00	3.75E+07	0.00E+00
BR-83	0.00E+00	0.00E+00	9.98E-02	0.00E+00	0.00E+00	0.00E+00	1.44E-01	0.00E+00
BR-84	0.00E+00	0.00E+00	1.75E-23	0.00E+00	0.00E+00	0.00E+00	1.37E-28	0.00E+00
RB-86	0.00E+00	2.41E+09	1.12E+09	0.00E+00	0.00E+00	0.00E+00	4.76E+08	0.00E+00
SR-89	1.23E+09	0.00E+00	3.54E+07	0.00E+00	0.00E+00	0.00E+00	1.98E+08	0.00E+00
SR-90	3.89E+10	0.00E+00	9.54E+09	0.00E+00	0.00E+00	0.00E+00	1.12E+09	0.00E+00
SR-91	2.91E+04	0.00E+00	1.17E+03	0.00E+00	0.00E+00	0.00E+00	1.38E+05	0.00E+00
SR-92	4.95E-01	0.00E+00	2.14E-02	0.00E+00	0.00E+00	0.00E+00	9.82E+00	0.00E+00
Y-91M	6.27E-20	0.00E+00	2.43E-21	0.00E+00	0.00E+00	0.00E+00	1.84E-19	0.00E+00
Y-91	7.23E+03	0.00E+00	1.93E+02	0.00E+00	0.00E+00	0.00E+00	3.98E+06	0.00E+00
Y-92	5.64E-05	0.00E+00	1.65E-06	0.00E+00	0.00E+00	0.00E+00	9.88E-01	0.00E+00
Y-93	2.24E-01	0.00E+00	6.19E-03	0.00E+00	0.00E+00	0.00E+00	7.11E+03	0.00E+00
ZR-95	7.89E+02	2.53E+02	1.71E+02	0.00E+00	3.97E+02	0.00E+00	8.02E+05	0.00E+00
ZR-97	4.34E-01	8.76E-02	4.01E-02	0.00E+00	1.32E-01	0.00E+00	2.71E+04	0.00E+00
NB-95	7.23E+04	4.02E+04	2.16E+04	0.00E+00	3.97E+04	0.00E+00	2.44E+08	0.00E+00
NB-97	3.40E-12	8.59E-13	3.14E-13	0.00E+00	1.00E-12	0.00E+00	3.17E-09	0.00E+00
MO-99	0.00E+00	2.48E+07	4.72E+06	0.00E+00	5.62E+07	0.00E+00	5.76E+07	0.00E+00
TC-99M	3.35E+00	9.48E+00	1.21E+02	0.00E+00	1.44E+02	4.64E+00	5.61E+03	0.00E+00
RU-103	8.85E+02	0.00E+00	3.81E+02	0.00E+00	3.38E+03	0.00E+00	1.03E+05	0.00E+00
RU-105	8.65E-04	0.00E+00	3.41E-04	0.00E+00	1.12E-02	0.00E+00	5.29E-01	0.00E+00
RU-106	1.64E+04	0.00E+00	2.08E+03	0.00E+00	3.17E+04	0.00E+00	1.06E+06	0.00E+00
AG-110M	4.85E+07	4.49E+07	2.66E+07	0.00E+00	8.82E+07	0.00E+00	1.83E+10	0.00E+00
SN-113	3.87E+06	1.49E+05	3.66E+06	5.26E+04	1.10E+05	0.00E+00	6.77E+07	0.00E+00
SB-124	2.16E+07	4.09E+05	8.58E+06	5.25E+04	0.00E+00	1.68E+07	6.14E+08	0.00E+00
SB-125	1.61E+07	1.80E+05	3.84E+06	1.64E+04	0.00E+00	1.24E+07	1.78E+08	0.00E+00
TE-129M	5.67E+07	2.12E+07	8.98E+06	1.95E+07	2.37E+08	0.00E+00	2.86E+08	0.00E+00
TE-129	2.97E-10	1.12E-10	7.25E-11	2.28E-10	1.25E-09	0.00E+00	2.25E-10	0.00E+00
TE-131M	3.69E+05	1.80E+05	1.50E+05	2.86E+05	1.83E+06	0.00E+00	1.79E+07	0.00E+00
TE-132	2.46E+06	1.59E+06	1.49E+06	1.76E+06	1.53E+07	0.00E+00	7.52E+07	0.00E+00
I-131	2.91E+08	4.16E+08	2.38E+08	1.36E+11	7.13E+08	0.00E+00	1.10E+08	0.00E+00
I-132	1.67E-01	4.47E-01	1.56E-01	1.56E+01	7.12E-01	0.00E+00	8.39E-02	0.00E+00
I-133	3.88E+06	6.74E+06	2.06E+06	9.91E+08	1.18E+07	0.00E+00	6.06E+06	0.00E+00
I-134	2.11E-12	5.72E-12	2.05E-12	9.92E-11	9.10E-12	0.00E+00	4.99E-15	0.00E+00
I-135	1.29E+04	3.38E+04	1.25E+04	2.23E+06	5.42E+04	0.00E+00	3.82E+04	0.00E+00

8 R Values in units of mrem/yr per μCi/m^3 for inhalation and tritium, and units of m^2-mrem/yr per μCi/sec for all others.

TABLE 3.5-8 (continued)
R VALUES for the H.B. ROBINSON STEAM ELECTRIC PLANT[8]

PATHWAY = Cow Milk
AGE GROUP = Adult

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-Tract	Skin
CS-134	4.45E+09	1.06E+10	8.66E+09	0.00E+00	3.43E+09	1.14E+09	1.85E+08	0.00E+00
CS-136	2.51E+08	9.91E+08	7.14E+08	0.00E+00	5.52E+08	7.56E+07	1.13E+08	0.00E+00
CS-137	5.96E+09	8.15E+09	5.34E+09	0.00E+00	2.77E+09	9.20E+08	1.58E+08	0.00E+00
CS-138	9.72E-24	1.92E-23	9.51E-24	0.00E+00	1.41E-23	1.39E-24	8.19E-29	0.00E+00
BA-139	4.54E-08	3.24E-11	1.33E-09	0.00E+00	3.03E-11	1.84E-11	8.06E-08	0.00E+00
BA-140	2.57E+07	3.23E+04	1.68E+06	0.00E+00	1.10E+04	1.85E+04	5.29E+07	0.00E+00
LA-140	4.52E+00	2.28E+00	6.01E-01	0.00E+00	0.00E+00	0.00E+00	1.67E+05	0.00E+00
LA-142	1.90E-11	8.66E-12	2.16E-12	0.00E+00	0.00E+00	0.00E+00	6.32E-08	0.00E+00
CE-141	4.27E+03	2.89E+03	3.27E+02	0.00E+00	1.34E+03	0.00E+00	1.10E+07	0.00E+00
CE-143	4.16E+01	3.08E+04	3.40E+00	0.00E+00	1.35E+01	0.00E+00	1.15E+06	0.00E+00
CE-144	2.83E+05	1.18E+05	1.52E+04	0.00E+00	7.01E+04	0.00E+00	9.56E+07	0.00E+00
HF-181	8.46E+03	4.77E+01	9.57E+02	3.03E+01	3.97E+01	0.00E+00	6.28E+05	0.00E+00
W-187	6.52E+03	5.45E+03	1.90E+03	0.00E+00	0.00E+00	0.00E+00	1.78E+06	0.00E+00
NP-239	3.67E+00	3.61E-01	1.99E-01	0.00E+00	1.13E+00	0.00E+00	7.41E+04	0.00E+00

8 R Values in units of mrem/yr per µCi/m^3 for inhalation and tritium, and units of m^2-mrem/yr per µCi/sec for all others.

TABLE 3.5-9

R VALUES for the H.B. ROBINSON STEAM ELECTRIC PLANT[9]

(Reference Regulatory Guide 1.109)

PATHWAY = Cow Milk
AGE GROUP = Teen

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-Tract	Skin
H-3	0.00E+00	9.93E+02	9.93E+02	9.93E+02	9.93E+02	9.93E+02	9.93E+02	9.93E+02
F-18	8.16E-03	0.00E+00	8.94E-04	0.00E+00	0.00E+00	0.00E+00	7.35E-04	0.00E+00
A-24	4.27E+06	4.27E+06	4.27E+06	4.27E+06	4.27E+06	4.27E+06	4.27E+06	0.00E+00
CR-51	0.00E+00	0.00E+00	4.46E+04	2.48E+04	9.77E+03	6.36E+04	7.49E+06	0.00E+00
MN-54	0.00E+00	1.12E+07	2.22E+06	0.00E+00	3.34E+06	0.00E+00	2.29E+07	0.00E+00
MN-56	0.00E+00	7.47E-03	1.33E-03	0.00E+00	9.45E-03	0.00E+00	4.91E-01	0.00E+00
FE-55	3.47E+07	2.46E+07	5.74E+06	0.00E+00	0.00E+00	1.56E+07	1.06E+07	0.00E+00
FE-59	4.45E+07	1.04E+08	4.01E+07	0.00E+00	0.00E+00	3.27E+07	2.45E+08	0.00E+00
CO-57	0.00E+00	1.78E+06	2.99E+06	0.00E+00	0.00E+00	0.00E+00	3.32E+07	0.00E+00
CO-58	0.00E+00	6.60E+06	1.52E+07	0.00E+00	0.00E+00	0.00E+00	9.10E+07	0.00E+00
CO-60	0.00E+00	2.20E+07	4.96E+07	0.00E+00	0.00E+00	0.00E+00	2.87E+08	0.00E+00
NI-65	6.88E-01	8.79E-02	4.00E-02	0.00E+00	0.00E+00	0.00E+00	4.76E+00	0.00E+00
CU-64	0.00E+00	4.27E+04	2.01E+04	0.00E+00	1.08E+05	0.00E+00	3.31E+06	0.00E+00
ZN-65	1.90E+09	6.58E+09	3.07E+09	0.00E+00	4.21E+09	0.00E+00	2.79E+09	0.00E+00
BR-82	0.00E+00	0.00E+00	5.68E+07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-83	0.00E+00	0.00E+00	1.84E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-84	0.00E+00	0.00E+00	3.13E-23	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RB-86	0.00E+00	4.40E+09	2.07E+09	0.00E+00	0.00E+00	0.00E+00	6.51E+08	0.00E+00
SR-89	2.28E+09	0.00E+00	6.52E+07	0.00E+00	0.00E+00	0.00E+00	2.71E+08	0.00E+00
SR-90	5.49E+10	0.00E+00	1.36E+10	0.00E+00	0.00E+00	0.00E+00	1.54E+09	0.00E+00
SR-91	5.34E+04	0.00E+00	2.12E+03	0.00E+00	0.00E+00	0.00E+00	2.42E+05	0.00E+00
SR-92	9.07E-01	0.00E+00	3.87E-02	0.00E+00	0.00E+00	0.00E+00	2.31E+01	0.00E+00
Y-91M	1.15E-19	0.00E+00	4.39E-21	0.00E+00	0.00E+00	0.00E+00	5.42E-18	0.00E+00
Y-91	1.33E+04	0.00E+00	3.56E+02	0.00E+00	0.00E+00	0.00E+00	5.45E+06	0.00E+00
Y-92	1.04E-04	0.00E+00	3.01E-06	0.00E+00	0.00E+00	0.00E+00	2.86E+00	0.00E+00
Y-93	4.14E-01	0.00E+00	1.13E-02	0.00E+00	0.00E+00	0.00E+00	1.26E+04	0.00E+00
ZR-95	1.38E+03	4.35E+02	2.99E+02	0.00E+00	6.40E+02	0.00E+00	1.00E+06	0.00E+00
ZR-97	7.90E-01	1.56E-01	7.20E-02	0.00E+00	2.37E-01	0.00E+00	4.23E+04	0.00E+00
NB-95	1.23E+05	6.84E+04	3.76E+04	0.00E+00	6.63E+04	0.00E+00	2.92E+08	0.00E+00
NB-97	6.19E-12	1.54E-12	5.61E-13	0.00E+00	1.80E-12	0.00E+00	3.67E-08	0.00E+00
MO-99	0.00E+00	4.48E+07	8.55E+06	0.00E+00	1.03E+08	0.00E+00	8.03E+07	0.00E+00
TC-99M	5.82E+00	1.62E+01	2.10E+02	0.00E+00	2.42E+02	9.01E+00	1.07E+04	0.00E+00
RU-103	1.57E+03	0.00E+00	6.73E+02	0.00E+00	5.55E+03	0.00E+00	1.31E+05	0.00E+00
RU-105	1.58E-03	0.00E+00	6.13E-04	0.00E+00	1.99E-02	0.00E+00	1.28E+00	0.00E+00
RU-106	3.02E+04	0.00E+00	3.81E+03	0.00E+00	5.83E+04	0.00E+00	1.45E+06	0.00E+00
AG-110M	8.02E+07	7.59E+07	4.61E+07	0.00E+00	1.45E+08	0.00E+00	2.13E+10	0.00E+00
SN-113	5.95E+06	2.49E+05	6.33E+06	8.23E+04	1.76E+05	0.00E+00	7.14E+07	0.00E+00
SB-124	3.86E+07	7.11E+05	1.51E+07	8.75E+04	0.00E+00	3.37E+07	7.78E+08	0.00E+00
SB-125	2.89E+07	3.15E+05	6.75E+06	2.76E+04	0.00E+00	2.54E+07	2.25E+08	0.00E+00
TE-129M	1.04E+08	3.85E+07	1.64E+07	3.35E+07	4.34E+08	0.00E+00	3.90E+08	0.00E+00
TE-129	5.48E-10	2.04E-10	1.33E-10	3.91E-10	2.30E-09	0.00E+00	2.99E-09	0.00E+00
TE-131M	6.71E+05	3.22E+05	2.69E+05	4.84E+05	3.36E+06	0.00E+00	2.58E+07	0.00E+00
TE-132	4.39E+06	2.78E+06	2.62E+06	2.93E+06	2.67E+07	0.00E+00	8.81E+07	0.00E+00
I-131	5.28E+08	7.39E+08	3.97E+08	2.16E+11	1.27E+09	0.00E+00	1.46E+08	0.00E+00
I-132	2.96E-01	7.75E-01	2.78E-01	2.61E+01	1.22E+00	0.00E+00	3.38E-01	0.00E+00
I-133	7.08E+06	1.20E+07	3.66E+06	1.68E+09	2.11E+07	0.00E+00	9.09E+06	0.00E+00
I-134	3.74E-12	9.93E-12	3.56E-12	1.65E-10	1.56E-11	0.00E+00	1.31E-13	0.00E+00
I-135	2.29E+04	5.91E+04	2.19E+04	3.80E+06	9.33E+04	0.00E+00	6.54E+04	0.00E+00

9 R Values in units of mrem/yr per µCi/m^3 for inhalation and tritium, and units of m^2-mrem/yr per µCi/sec for all others.

TABLE 3.5-9 (continued)
R VALUES for the H.B. ROBINSON STEAM ELECTRIC PLANT[9]

PATHWAY = Cow Milk
AGE GROUP = Teen

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-Tract	Skin
CS-134	7.73E+09	1.82E+10	8.44E+09	0.00E+00	5.78E+09	2.21E+09	2.26E+08	0.00E+00
CS-136	4.27E+08	1.68E+09	1.13E+09	0.00E+00	9.16E+08	1.44E+08	1.35E+08	0.00E+00
CS-137	1.08E+10	1.44E+10	5.01E+09	0.00E+00	4.89E+09	1.90E+09	2.05E+08	0.00E+00
CS-138	1.76E-23	3.38E-23	1.69E-23	0.00E+00	2.50E-23	2.91E-24	1.54E-26	0.00E+00
BA-139	8.40E-08	5.91E-11	2.45E-09	0.00E+00	5.57E-11	4.07E-11	7.50E-07	0.00E+00
BA-140	4.64E+07	5.68E+04	2.99E+06	0.00E+00	1.93E+04	3.82E+04	7.15E+07	0.00E+00
LA-140	8.11E+00	3.99E+00	1.06E+00	0.00E+00	0.00E+00	0.00E+00	2.29E+05	0.00E+00
LA-142	3.44E-11	1.53E-11	3.80E-12	0.00E+00	0.00E+00	0.00E+00	4.64E-07	0.00E+00
CE-141	7.82E+03	5.22E+03	6.00E+02	0.00E+00	2.46E+03	0.00E+00	1.49E+07	0.00E+00
CE-143	7.65E+01	5.56E+04	6.22E+00	0.00E+00	2.50E+01	0.00E+00	1.67E+06	0.00E+00
CE-144	5.20E+05	2.15E+05	2.80E+04	0.00E+00	1.29E+05	0.00E+00	1.31E+08	0.00E+00
HF-181	1.51E+04	8.32E+01	1.69E+03	5.06E+01	6.91E+01	0.00E+00	7.57E+05	0.00E+00
W-187	1.19E+04	9.72E+03	3.40E+03	0.00E+00	0.00E+00	0.00E+00	2.63E+06	0.00E+00
NP-239	7.01E+00	6.61E-01	3.67E-01	0.00E+00	2.08E+00	0.00E+00	1.06E+05	0.00E+00

9 R Values in units of mrem/yr per µCi/m^3 for inhalation and tritium, and units of m^2-mrem/yr per µCi/sec for all others.

TABLE 3.5-10
R VALUES for the H.B. ROBINSON STEAM ELECTRIC PLANT[10]
(Reference Regulatory Guide 1.109)

PATHWAY = Cow Milk
AGE GROUP = Child

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-Tract	Skin
H-3	0.00E+00	1.57E+03	1.57E+03	1.57E+03	1.57E+03	1.57E+03	1.57E+03	1.57E+03
F-18	1.94E-02	0.00E+00	1.92E-03	0.00E+00	0.00E+00	0.00E+00	5.25E-03	0.00E+00
NA-24	8.88E+06	8.88E+06	8.88E+06	8.88E+06	8.88E+06	8.88E+06	8.88E+06	0.00E+00
CR-51	0.00E+00	0.00E+00	9.09E+04	5.05E+04	1.38E+04	9.21E+04	4.82E+06	0.00E+00
MN-54	0.00E+00	1.67E+07	4.46E+06	0.00E+00	4.69E+06	0.00E+00	1.40E+07	0.00E+00
MN-56	0.00E+00	1.30E-02	2.94E-03	0.00E+00	1.57E-02	0.00E+00	1.89E+00	0.00E+00
FE-55	8.71E+07	4.62E+07	1.43E+07	0.00E+00	0.00E+00	2.61E+07	8.56E+06	0.00E+00
FE-59	1.03E+08	1.67E+08	8.31E+07	0.00E+00	0.00E+00	4.84E+07	1.74E+08	0.00E+00
CO-57	0.00E+00	3.04E+06	6.16E+06	0.00E+00	0.00E+00	0.00E+00	2.49E+07	0.00E+00
CO-58	0.00E+00	1.01E+07	3.09E+07	0.00E+00	0.00E+00	0.00E+00	5.88E+07	0.00E+00
CO-60	0.00E+00	3.42E+07	1.01E+08	0.00E+00	0.00E+00	0.00E+00	1.89E+08	0.00E+00
NI-65	1.68E+00	1.58E-01	9.24E-02	0.00E+00	0.00E+00	0.00E+00	1.94E+01	0.00E+00
CU-64	0.00E+00	7.50E+04	4.53E+04	0.00E+00	1.81E+05	0.00E+00	3.52E+06	0.00E+00
ZN-65	3.72E+09	9.91E+09	6.16E+09	0.00E+00	6.24E+09	0.00E+00	1.74E+09	0.00E+00
BR-82	0.00E+00	0.00E+00	1.16E+08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-83	0.00E+00	0.00E+00	4.52E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-84	0.00E+00	0.00E+00	7.08E-23	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RB-86	0.00E+00	8.16E+09	5.02E+09	0.00E+00	0.00E+00	0.00E+00	5.25E+08	0.00E+00
SR-89	5.63E+09	0.00E+00	1.61E+08	0.00E+00	0.00E+00	0.00E+00	2.18E+08	0.00E+00
SR-90	9.28E+10	0.00E+00	2.35E+10	0.00E+00	0.00E+00	0.00E+00	1.25E+09	0.00E+00
SR-91	1.31E+05	0.00E+00	4.94E+03	0.00E+00	0.00E+00	0.00E+00	2.89E+05	0.00E+00
SR-92	2.21E+00	0.00E+00	8.88E-02	0.00E+00	0.00E+00	0.00E+00	4.19E+01	0.00E+00
Y-91M	2.80E-19	0.00E+00	1.02E-20	0.00E+00	0.00E+00	0.00E+00	5.49E-16	0.00E+00
Y-91	3.28E+04	0.00E+00	8.78E+02	0.00E+00	0.00E+00	0.00E+00	4.38E+06	0.00E+00
Y-92	2.56E-04	0.00E+00	7.32E-06	0.00E+00	0.00E+00	0.00E+00	7.39E+00	0.00E+00
Y-93	1.02E+00	0.00E+00	2.79E-02	0.00E+00	0.00E+00	0.00E+00	1.51E+04	0.00E+00
ZR-95	3.20E+03	7.04E+02	6.27E+02	0.00E+00	1.01E+03	0.00E+00	7.35E+05	0.00E+00
ZR-97	1.92E+00	2.78E-01	1.64E-01	0.00E+00	3.99E-01	0.00E+00	4.21E+04	0.00E+00
NB-95	2.78E+05	1.08E+05	7.74E+04	0.00E+00	1.02E+05	0.00E+00	2.00E+08	0.00E+00
NB-97	1.50E-11	2.72E-12	1.27E-12	0.00E+00	3.01E-12	0.00E+00	8.38E-07	0.00E+00
MO-99	0.00E+00	8.16E+07	2.02E+07	0.00E+00	1.74E+08	0.00E+00	6.75E+07	0.00E+00
TC-99M	1.33E+01	2.62E+01	4.34E+02	0.00E+00	3.80E+02	1.33E+01	1.49E+04	0.00E+00
RU-103	3.72E+03	0.00E+00	1.43E+03	0.00E+00	9.37E+03	0.00E+00	9.62E+04	0.00E+00
RU-105	3.86E-03	0.00E+00	1.40E-03	0.00E+00	3.39E-02	0.00E+00	2.52E+00	0.00E+00
RU-106	7.45E+04	0.00E+00	9.29E+03	0.00E+00	1.01E+05	0.00E+00	1.16E+06	0.00E+00
AG-110M	1.74E+08	1.17E+08	9.39E+07	0.00E+00	2.19E+08	0.00E+00	1.40E+10	0.00E+00
SN-113	1.17E+07	3.76E+05	1.28E+07	1.54E+05	2.59E+05	0.00E+00	4.67E+07	0.00E+00
SB-124	9.13E+07	1.18E+06	3.20E+07	2.01E+05	0.00E+00	5.07E+07	5.71E+08	0.00E+00
SB-125	6.87E+07	5.30E+05	1.44E+07	6.36E+04	0.00E+00	3.83E+07	1.64E+08	0.00E+00
TE-129M	2.56E+08	7.14E+07	3.97E+07	8.25E+07	7.51E+08	0.00E+00	3.12E+08	0.00E+00
TE-129	1.35E-09	3.77E-10	3.21E-10	9.64E-10	3.95E-09	0.00E+00	8.41E-08	0.00E+00
TE-131M	1.63E+06	5.65E+05	6.02E+05	1.16E+06	5.47E+06	0.00E+00	2.29E+07	0.00E+00
TE-132	1.05E+07	4.64E+06	5.61E+06	6.76E+06	4.31E+07	0.00E+00	4.67E+07	0.00E+00
I-131	1.28E+09	1.29E+09	7.32E+08	4.26E+11	2.11E+09	0.00E+00	1.15E+08	0.00E+00
I-132	7.01E-01	1.29E+00	5.92E-01	5.97E+01	1.97E+00	0.00E+00	1.52E+00	0.00E+00
I-133	1.72E+07	2.13E+07	8.05E+06	3.95E+09	3.55E+07	0.00E+00	8.57E+06	0.00E+00
I-134	8.87E-12	1.65E-11	7.57E-12	3.79E-10	2.52E-11	0.00E+00	1.09E-11	0.00E+00
I-135	5.43E+04	9.77E+04	4.62E+04	8.66E+06	1.50E+05	0.00E+00	7.45E+04	0.00E+00

10 R Values in units of mrem/yr per μCi/m^3 for inhalation and tritium, and units of m^2-mrem/yr per μCi/sec for all others.

TABLE 3.5-10 (continued)
R VALUES for the H.B. ROBINSON STEAM ELECTRIC PLANT[10]

PATHWAY = Cow Milk
AGE GROUP = Child

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-Tract	Skin
CS-134	1.78E+10	2.93E+10	6.17E+09	0.00E+00	9.07E+09	3.25E+09	1.58E+08	0.00E+00
CS-136	9.65E+08	2.65E+09	1.72E+09	0.00E+00	1.41E+09	2.11E+08	9.32E+07	0.00E+00
CS-137	2.60E+10	2.49E+10	3.68E+09	0.00E+00	8.12E+09	2.92E+09	1.56E+08	0.00E+00
CS-138	4.27E-23	5.94E-23	3.77E-23	0.00E+00	4.18E-23	4.50E-24	2.74E-23	0.00E+00
BA-139	2.06E-07	1.10E-10	5.98E-09	0.00E+00	9.62E-11	6.48E-11	1.19E-05	0.00E+00
BA-140	1.12E+08	9.80E+04	6.53E+06	0.00E+00	3.19E+04	5.85E+04	5.67E+07	0.00E+00
LA-140	1.94E+01	6.79E+00	2.29E+00	0.00E+00	0.00E+00	0.00E+00	1.89E+05	0.00E+00
LA-142	8.30E-11	2.64E-11	8.28E-12	0.00E+00	0.00E+00	0.00E+00	5.24E-06	0.00E+00
CE-141	1.93E+04	9.61E+03	1.43E+03	0.00E+00	4.21E+03	0.00E+00	1.20E+07	0.00E+00
CE-143	1.88E+02	1.02E+05	1.47E+01	0.00E+00	4.27E+01	0.00E+00	1.49E+06	0.00E+00
CE-144	1.28E+06	4.02E+05	6.85E+04	0.00E+00	2.23E+05	0.00E+00	1.05E+08	0.00E+00
HF-181	3.59E+04	1.40E+02	3.61E+03	1.18E+02	1.13E+02	0.00E+00	5.96E+05	0.00E+00
W-187	2.89E+04	1.71E+04	7.68E+03	0.00E+00	0.00E+00	0.00E+00	2.40E+06	0.00E+00
NP-239	1.73E+01	1.24E+00	8.71E-01	0.00E+00	3.58E+00	0.00E+00	9.17E+04	0.00E+00

10 R Values in units of mrem/yr per μCi/m^3 for inhalation and tritium, and units of m^2-mrem/yr per μCi/sec for all others.

TABLE 3.5-11
R VALUES for the H.B. ROBINSON STEAM ELECTRIC PLANT[11]
(Reference Regulatory Guide 1.109)

PATHWAY = Cow Milk
AGE GROUP = Infant

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-Tract	Skin
H-3	0.00E+00	2.38E+03	2.38E+03	2.38E+03	2.38E+03	2.38E+03	2.38E+03	2.38E+03
F-18	4.04E-02	0.00E+00	3.45E-03	0.00E+00	0.00E+00	0.00E+00	9.51E-03	0.00E+00
NA-24	1.55E+07	1.55E+07	1.55E+07	1.55E+07	1.55E+07	1.55E+07	1.55E+07	0.00E+00
CR-51	0.00E+00	0.00E+00	1.44E+05	9.40E+04	2.05E+04	1.83E+05	4.20E+06	0.00E+00
MN-54	0.00E+00	3.11E+07	7.05E+06	0.00E+00	6.90E+06	0.00E+00	1.14E+07	0.00E+00
MN-56	0.00E+00	3.19E-02	5.50E-03	0.00E+00	2.74E-02	0.00E+00	2.90E+00	0.00E+00
FE-55	1.05E+08	6.80E+07	1.82E+07	0.00E+00	0.00E+00	3.32E+07	8.63E+06	0.00E+00
FE-59	1.93E+08	3.36E+08	1.33E+08	0.00E+00	0.00E+00	9.94E+07	1.61E+08	0.00E+00
CO-57	0.00E+00	7.10E+06	1.15E+07	0.00E+00	0.00E+00	0.00E+00	2.42E+07	0.00E+00
CO-58	0.00E+00	2.02E+07	5.03E+07	0.00E+00	0.00E+00	0.00E+00	5.03E+07	0.00E+00
CO-60	0.00E+00	6.98E+07	1.65E+08	0.00E+00	0.00E+00	0.00E+00	1.66E+08	0.00E+00
NI-65	3.56E+00	4.03E-01	1.83E-01	0.00E+00	0.00E+00	0.00E+00	3.07E+01	0.00E+00
CU-64	0.00E+00	1.86E+05	8.63E+04	0.00E+00	3.15E+05	0.00E+00	3.83E+06	0.00E+00
ZN-65	5.00E+09	1.71E+10	7.90E+09	0.00E+00	8.31E+09	0.00E+00	1.45E+10	0.00E+00
BR-82	0.00E+00	0.00E+00	1.96E+08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-83	0.00E+00	0.00E+00	9.60E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-84	0.00E+00	0.00E+00	1.37E-22	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RB-86	0.00E+00	2.07E+10	1.02E+10	0.00E+00	0.00E+00	0.00E+00	5.30E+08	0.00E+00
SR-89	1.07E+10	0.00E+00	3.07E+08	0.00E+00	0.00E+00	0.00E+00	2.20E+08	0.00E+00
SR-90	1.01E+11	0.00E+00	2.57E+10	0.00E+00	0.00E+00	0.00E+00	1.26E+09	0.00E+00
SR-91	2.73E+05	0.00E+00	9.87E+03	0.00E+00	0.00E+00	0.00E+00	3.23E+05	0.00E+00
SR-92	4.71E+00	0.00E+00	1.75E-01	0.00E+00	0.00E+00	0.00E+00	5.08E+01	0.00E+00
Y-91M	5.94E-19	0.00E+00	2.03E-20	0.00E+00	0.00E+00	0.00E+00	1.98E-15	0.00E+00
Y-91	6.16E+04	0.00E+00	1.64E+03	0.00E+00	0.00E+00	0.00E+00	4.42E+06	0.00E+00
Y-92	5.44E-04	0.00E+00	1.53E-05	0.00E+00	0.00E+00	0.00E+00	1.04E+01	0.00E+00
Y-93	2.16E+00	0.00E+00	5.90E-02	0.00E+00	0.00E+00	0.00E+00	1.71E+04	0.00E+00
ZR-95	5.69E+03	1.39E+03	9.83E+02	0.00E+00	1.49E+03	0.00E+00	6.91E+05	0.00E+00
ZR-97	4.07E+00	6.99E-01	3.19E-01	0.00E+00	7.04E-01	0.00E+00	4.46E+04	0.00E+00
NB-95	5.19E+05	2.14E+05	1.24E+05	0.00E+00	1.53E+05	0.00E+00	1.81E+08	0.00E+00
NB-97	3.18E-11	6.78E-12	2.45E-12	0.00E+00	5.30E-12	0.00E+00	2.14E-06	0.00E+00
MO-99	0.00E+00	2.09E+08	4.07E+07	0.00E+00	3.12E+08	0.00E+00	6.87E+07	0.00E+00
TC-99M	2.78E+01	5.73E+01	7.37E+02	0.00E+00	6.16E+02	2.99E+01	1.66E+04	0.00E+00
RU-103	7.54E+03	0.00E+00	2.52E+03	0.00E+00	1.57E+04	0.00E+00	9.17E+04	0.00E+00
RU-105	8.13E-03	0.00E+00	2.74E-03	0.00E+00	5.98E-02	0.00E+00	3.23E+00	0.00E+00
RU-106	1.53E+05	0.00E+00	1.92E+04	0.00E+00	1.81E+05	0.00E+00	1.16E+06	0.00E+00
AG-110M	3.21E+08	2.35E+08	1.55E+08	0.00E+00	3.36E+08	0.00E+00	1.22E+10	0.00E+00
SN-113	1.78E+07	6.79E+05	1.84E+07	2.59E+05	3.65E+05	0.00E+00	3.79E+07	0.00E+00
SB-124	1.76E+08	2.59E+06	5.45E+07	4.67E+05	0.00E+00	1.10E+08	5.43E+08	0.00E+00
SB-125	1.18E+08	1.14E+06	2.43E+07	1.48E+05	0.00E+00	6.83E+07	1.57E+08	0.00E+00
TE-129M	5.25E+08	1.80E+08	8.09E+07	2.02E+08	1.31E+09	0.00E+00	3.14E+08	0.00E+00
TE-129	2.86E-09	9.87E-10	6.69E-10	2.40E-09	7.13E-09	0.00E+00	2.29E-07	0.00E+00
TE-131M	3.45E+06	1.39E+06	1.15E+06	2.82E+06	9.56E+06	0.00E+00	2.34E+07	0.00E+00
TE-132	2.16E+07	1.07E+07	9.98E+06	1.58E+07	6.69E+07	0.00E+00	3.96E+07	0.00E+00
I-131	2.67E+09	3.15E+09	1.38E+09	1.03E+12	3.68E+09	0.00E+00	1.12E+08	0.00E+00
I-132	1.45E+00	2.95E+00	1.05E+00	1.38E+02	3.29E+00	0.00E+00	2.39E+00	0.00E+00
I-133	3.63E+07	5.29E+07	1.55E+07	9.62E+09	6.22E+07	0.00E+00	8.95E+06	0.00E+00
I-134	1.84E-11	3.77E-11	1.34E-11	8.78E-10	4.21E-11	0.00E+00	3.89E-11	0.00E+00
I-135	1.13E+05	2.25E+05	8.19E+04	2.01E+07	2.50E+05	0.00E+00	8.13E+04	0.00E+00

11 R Values in units of mrem/yr per μCi/m^3 for inhalation and tritium, and units of m^2-mrem/yr per μCi/sec for all others.

TABLE 3.5-11 (continued)

R VALUES for the H.B. ROBINSON STEAM ELECTRIC PLANT[11]

PATHWAY = Cow Milk
AGE GROUP = Infant

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-Tract	Skin
CS-134	2.87E+10	5.36E+10	5.41E+09	0.00E+00	1.38E+10	5.65E+09	1.46E+08	0.00E+00
CS-136	1.88E+09	5.54E+09	2.07E+09	0.00E+00	2.21E+09	4.52E+08	8.42E+07	0.00E+00
CS-137	4.16E+10	4.86E+10	3.45E+09	0.00E+00	1.31E+10	5.29E+09	1.52E+08	0.00E+00
CS-138	9.01E-23	1.47E-22	7.10E-23	0.00E+00	7.31E-23	1.14E-23	2.34E-22	0.00E+00
BA-139	4.39E-07	2.91E-10	1.27E-08	0.00E+00	1.75E-10	1.77E-10	2.78E-05	0.00E+00
BA-140	2.30E+08	2.30E+05	1.19E+07	0.00E+00	5.47E+04	1.41E+05	5.66E+07	0.00E+00
LA-140	4.06E+01	1.60E+01	4.11E+00	0.00E+00	0.00E+00	0.00E+00	1.88E+05	0.00E+00
LA-142	1.74E-10	6.40E-11	1.53E-11	0.00E+00	0.00E+00	0.00E+00	1.09E-05	0.00E+00
CE-141	3.82E+04	2.33E+04	2.74E+03	0.00E+00	7.18E+03	0.00E+00	1.20E+07	0.00E+00
CE-143	3.97E+02	2.64E+05	3.01E+01	0.00E+00	7.68E+01	0.00E+00	1.54E+06	0.00E+00
CE-144	1.84E+06	7.52E+05	1.03E+05	0.00E+00	3.04E+05	0.00E+00	1.05E+08	0.00E+00
HF-181	6.86E+04	3.22E+02	6.06E+03	2.73E+02	1.89E+02	0.00E+00	5.62E+05	0.00E+00
W-187	6.08E+04	4.23E+04	1.46E+04	0.00E+00	0.00E+00	0.00E+00	2.49E+06	0.00E+00
NP-239	3.65E+01	3.26E+00	1.84E+00	0.00E+00	6.51E+00	0.00E+00	9.44E+04	0.00E+00

11 R Values in units of mrem/yr per μCi/m^3 for inhalation and tritium, and units of m^2-mrem/yr per μCi/sec for all others.

TABLE 3.5-12
R VALUES for the H.B. ROBINSON STEAM ELECTRIC PLANT[12]
(Reference Regulatory Guide 1.109)

PATHWAY = Goat Milk
AGE GROUP = Adult

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-Tract	Skin
H-3	0.00E+00	1.56E+03	1.56E+03	1.56E+03	1.56E+03	1.56E+03	1.56E+03	1.56E+03
F-18	5.48E-04	0.00E+00	6.08E-05	0.00E+00	0.00E+00	0.00E+00	1.63E-05	0.00E+00
NA-24	2.93E+05	2.93E+05	2.93E+05	2.93E+05	2.93E+05	2.93E+05	2.93E+05	0.00E+00
CR-51	0.00E+00	0.00E+00	3.06E+03	1.83E+03	6.75E+02	4.06E+03	7.70E+05	0.00E+00
MN-54	0.00E+00	8.06E+05	1.54E+05	0.00E+00	2.40E+05	0.00E+00	2.47E+06	0.00E+00
MN-56	0.00E+00	5.05E-04	8.96E-05	0.00E+00	6.42E-04	0.00E+00	1.61E-02	0.00E+00
FE-55	2.54E+05	1.76E+05	4.10E+04	0.00E+00	0.00E+00	9.80E+04	1.01E+05	0.00E+00
FE-59	3.31E+05	7.79E+05	2.98E+05	0.00E+00	0.00E+00	2.18E+05	2.60E+06	0.00E+00
CO-57	0.00E+00	1.09E+05	2.02E+05	0.00E+00	0.00E+00	0.00E+00	3.09E+06	0.00E+00
CO-58	0.00E+00	4.71E+05	1.05E+06	0.00E+00	0.00E+00	0.00E+00	9.54E+06	0.00E+00
CO-60	0.00E+00	1.56E+06	3.44E+06	0.00E+00	0.00E+00	0.00E+00	2.93E+07	0.00E+00
NI-65	4.51E-02	5.86E-03	2.67E-03	0.00E+00	0.00E+00	0.00E+00	1.49E-01	0.00E+00
CU-64	0.00E+00	2.67E+03	1.25E+03	0.00E+00	6.73E+03	0.00E+00	2.27E+05	0.00E+00
ZN-65	1.48E+08	4.71E+08	2.13E+08	0.00E+00	3.15E+08	0.00E+00	2.97E+08	0.00E+00
BR-82	0.00E+00	0.00E+00	3.93E+06	0.00E+00	0.00E+00	0.00E+00	4.50E+06	0.00E+00
BR-83	0.00E+00	0.00E+00	1.20E-02	0.00E+00	0.00E+00	0.00E+00	1.73E-02	0.00E+00
BR-84	0.00E+00	0.00E+00	2.10E-24	0.00E+00	0.00E+00	0.00E+00	1.65E-29	0.00E+00
RB-86	0.00E+00	2.90E+08	1.35E+08	0.00E+00	0.00E+00	0.00E+00	5.71E+07	0.00E+00
SR-89	2.59E+09	0.00E+00	7.44E+07	0.00E+00	0.00E+00	0.00E+00	4.16E+08	0.00E+00
SR-90	8.16E+10	0.00E+00	2.00E+10	0.00E+00	0.00E+00	0.00E+00	2.36E+09	0.00E+00
SR-91	6.10E+04	0.00E+00	2.46E+03	0.00E+00	0.00E+00	0.00E+00	2.91E+05	0.00E+00
SR-92	1.04E+00	0.00E+00	4.50E-02	0.00E+00	0.00E+00	0.00E+00	2.06E+01	0.00E+00
Y-91M	7.52E-21	0.00E+00	2.91E-22	0.00E+00	0.00E+00	0.00E+00	2.21E-20	0.00E+00
Y-91	8.67E+02	0.00E+00	2.32E+01	0.00E+00	0.00E+00	0.00E+00	4.77E+05	0.00E+00
Y-92	6.77E-06	0.00E+00	1.98E-07	0.00E+00	0.00E+00	0.00E+00	1.19E-01	0.00E+00
Y-93	2.69E-02	0.00E+00	7.43E-04	0.00E+00	0.00E+00	0.00E+00	8.53E+02	0.00E+00
ZR-95	9.47E+01	3.04E+01	2.06E+01	0.00E+00	4.76E+01	0.00E+00	9.62E+04	0.00E+00
ZR-97	5.21E-02	1.05E-02	4.81E-03	0.00E+00	1.59E-02	0.00E+00	3.26E+03	0.00E+00
NB-95	8.67E+03	4.82E+03	2.59E+03	0.00E+00	4.77E+03	0.00E+00	2.93E+07	0.00E+00
NB-97	4.08E-13	1.03E-13	3.76E-14	0.00E+00	1.20E-13	0.00E+00	3.80E-10	0.00E+00
MO-99	0.00E+00	2.98E+06	5.67E+05	0.00E+00	6.75E+06	0.00E+00	6.91E+06	0.00E+00
TC-99M	4.03E-01	1.14E+00	1.45E+01	0.00E+00	1.73E+01	5.57E-01	6.73E+02	0.00E+00
RU-103	1.06E+02	0.00E+00	4.58E+01	0.00E+00	4.05E+02	0.00E+00	1.24E+04	0.00E+00
RU-105	1.04E-04	0.00E+00	4.10E-05	0.00E+00	1.34E-03	0.00E+00	6.35E-02	0.00E+00
RU-106	1.97E+03	0.00E+00	2.50E+02	0.00E+00	3.81E+03	0.00E+00	1.28E+05	0.00E+00
AG-110M	5.82E+06	5.38E+06	3.20E+06	0.00E+00	1.06E+07	0.00E+00	2.20E+09	0.00E+00
SN-113	4.64E+05	1.79E+04	4.39E+05	6.31E+03	1.32E+04	0.00E+00	8.12E+06	0.00E+00
SB-124	2.60E+06	4.90E+04	1.03E+06	6.29E+03	0.00E+00	2.02E+06	7.37E+07	0.00E+00
SB-125	1.94E+06	2.16E+04	4.61E+05	1.97E+03	0.00E+00	1.49E+06	2.13E+07	0.00E+00
TE-129M	6.81E+06	2.54E+06	1.08E+06	2.34E+06	2.84E+07	0.00E+00	3.43E+07	0.00E+00
TE-129	3.57E-11	1.34E-11	8.70E-12	2.74E-11	1.50E-10	0.00E+00	2.69E-11	0.00E+00
TE-131M	4.43E+04	2.17E+04	1.80E+04	3.43E+04	2.19E+05	0.00E+00	2.15E+06	0.00E+00
TE-132	2.95E+05	1.91E+05	1.79E+05	2.11E+05	1.84E+06	0.00E+00	9.02E+06	0.00E+00
I-131	3.49E+08	4.99E+08	2.86E+08	1.64E+11	8.56E+08	0.00E+00	1.32E+08	0.00E+00
I-132	2.00E-01	5.36E-01	1.88E-01	1.88E+01	8.54E-01	0.00E+00	1.01E-01	0.00E+00
I-133	4.65E+06	8.09E+06	2.47E+06	1.19E+09	1.41E+07	0.00E+00	7.27E+06	0.00E+00
I-134	2.53E-12	6.87E-12	2.46E-12	1.19E-10	1.09E-11	0.00E+00	5.99E-15	0.00E+00
I-135	1.55E+04	4.06E+04	1.50E+04	2.68E+06	6.51E+04	0.00E+00	4.58E+04	0.00E+00

12 R Values in units of mrem/yr per μCi/m^3 for inhalation and tritium, and units of m^2-mrem/yr per μCi/sec for all others.

TABLE 3.5-12 (continued)

R VALUES for the H.B. ROBINSON STEAM ELECTRIC PLANT[12]

PATHWAY = Goat Milk
AGE GROUP = Adult

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-Tract	Skin
CS-134	1.34E+10	3.18E+10	2.60E+10	0.00E+00	1.03E+10	3.41E+09	5.56E+08	0.00E+00
CS-136	7.53E+08	2.97E+09	2.14E+09	0.00E+00	1.65E+09	2.27E+08	3.38E+08	0.00E+00
CS-137	1.79E+10	2.45E+10	1.60E+10	0.00E+00	8.30E+09	2.76E+09	4.73E+08	0.00E+00
CS-138	2.91E-23	5.76E-23	2.85E-23	0.00E+00	4.23E-23	4.18E-24	2.46E-28	0.00E+00
BA-139	5.45E-09	3.88E-12	1.60E-10	0.00E+00	3.63E-12	2.20E-12	9.67E-09	0.00E+00
BA-140	3.08E+06	3.87E+03	2.02E+05	0.00E+00	1.32E+03	2.22E+03	6.35E+06	0.00E+00
LA-140	5.42E-01	2.73E-01	7.22E-02	0.00E+00	0.00E+00	0.00E+00	2.00E+04	0.00E+00
LA-142	2.28E-12	1.04E-12	2.59E-13	0.00E+00	0.00E+00	0.00E+00	7.58E-09	0.00E+00
CE-141	5.12E+02	3.46E+02	3.93E+01	0.00E+00	1.61E+02	0.00E+00	1.32E+06	0.00E+00
CE-143	4.99E+00	3.69E+03	4.09E-01	0.00E+00	1.63E+00	0.00E+00	1.38E+05	0.00E+00
CE-144	3.39E+04	1.42E+04	1.82E+03	0.00E+00	8.41E+03	0.00E+00	1.15E+07	0.00E+00
HF-181	1.01E+03	5.73E+00	1.15E+02	3.63E+00	4.77E+00	0.00E+00	7.53E+04	0.00E+00
W-187	7.82E+02	6.54E+02	2.29E+02	0.00E+00	0.00E+00	0.00E+00	2.14E+05	0.00E+00
NP-239	4.41E-01	4.34E-02	2.39E-02	0.00E+00	1.35E-01	0.00E+00	8.89E+03	0.00E+00

12 R Values in units of mrem/yr per μCi/m^3 for inhalation and tritium, and units of m^2-mrem/yr per μCi/sec for all others.

TABLE 3.5-13
R VALUES for the H.B. ROBINSON STEAM ELECTRIC PLANT[13]
(Reference Regulatory Guide 1.109)

PATHWAY = Goat Milk
AGE GROUP = Teen

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-Tract	Skin
H-3	0.00E+00	2.03E+03	2.03E+03	2.03E+03	2.03E+03	2.03E+03	2.03E+03	2.03E+03
F-18	9.79E-04	0.00E+00	1.07E-04	0.00E+00	0.00E+00	0.00E+00	8.82E-05	0.00E+00
NA-24	5.12E+05	5.12E+05	5.12E+05	5.12E+05	5.12E+05	5.12E+05	5.12E+05	0.00E+00
CR-51	0.00E+00	0.00E+00	5.35E+03	2.97E+03	1.17E+03	7.64E+03	8.99E+05	0.00E+00
MN-54	0.00E+00	1.34E+06	2.66E+05	0.00E+00	4.00E+05	0.00E+00	2.75E+06	0.00E+00
MN-56	0.00E+00	8.96E-04	1.59E-04	0.00E+00	1.13E-03	0.00E+00	5.90E-02	0.00E+00
FE-55	4.51E+05	3.20E+05	7.46E+04	0.00E+00	0.00E+00	2.03E+05	1.38E+05	0.00E+00
FE-59	5.78E+05	1.35E+06	5.21E+05	0.00E+00	0.00E+00	4.25E+05	3.19E+06	0.00E+00
CO-57	0.00E+00	2.14E+05	3.58E+05	0.00E+00	0.00E+00	0.00E+00	3.99E+06	0.00E+00
CO-58	0.00E+00	7.92E+05	1.83E+06	0.00E+00	0.00E+00	0.00E+00	1.09E+07	0.00E+00
CO-60	0.00E+00	2.64E+06	5.95E+06	0.00E+00	0.00E+00	0.00E+00	3.44E+07	0.00E+00
NI-65	8.25E-02	1.05E-02	4.80E-03	0.00E+00	0.00E+00	0.00E+00	5.72E-01	0.00E+00
CU-64	0.00E+00	4.75E+03	2.24E+03	0.00E+00	1.20E+04	0.00E+00	3.69E+05	0.00E+00
ZN-65	2.27E+08	7.90E+08	3.68E+08	0.00E+00	5.05E+08	0.00E+00	3.34E+08	0.00E+00
BR-82	0.00E+00	0.00E+00	6.82E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-83	0.00E+00	0.00E+00	2.21E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-84	0.00E+00	0.00E+00	3.75E-24	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RB-86	0.00E+00	5.28E+08	2.48E+08	0.00E+00	0.00E+00	0.00E+00	7.81E+07	0.00E+00
SR-89	4.78E+09	0.00E+00	1.37E+08	0.00E+00	0.00E+00	0.00E+00	5.69E+08	0.00E+00
SR-90	1.15E+11	0.00E+00	2.85E+10	0.00E+00	0.00E+00	0.00E+00	3.24E+09	0.00E+00
SR-91	1.12E+05	0.00E+00	4.46E+03	0.00E+00	0.00E+00	0.00E+00	5.08E+05	0.00E+00
SR-92	1.90E+00	0.00E+00	8.12E-02	0.00E+00	0.00E+00	0.00E+00	4.85E+01	0.00E+00
Y-91M	1.38E-20	0.00E+00	5.26E-22	0.00E+00	0.00E+00	0.00E+00	6.50E-19	0.00E+00
Y-91	1.59E+03	0.00E+00	4.28E+01	0.00E+00	0.00E+00	0.00E+00	6.54E+05	0.00E+00
Y-92	1.25E-05	0.00E+00	3.62E-07	0.00E+00	0.00E+00	0.00E+00	3.43E-01	0.00E+00
Y-93	4.96E-02	0.00E+00	1.36E-03	0.00E+00	0.00E+00	0.00E+00	1.52E+03	0.00E+00
ZR-95	1.66E+02	5.22E+01	3.59E+01	0.00E+00	7.68E+01	0.00E+00	1.21E+05	0.00E+00
ZR-97	9.48E-02	1.88E-02	8.64E-03	0.00E+00	2.84E-02	0.00E+00	5.08E+03	0.00E+00
NB-95	1.48E+04	8.20E+03	4.52E+03	0.00E+00	7.95E+03	0.00E+00	3.51E+07	0.00E+00
NB-97	7.43E-13	1.84E-13	6.73E-14	0.00E+00	2.16E-13	0.00E+00	4.40E-09	0.00E+00
MO-99	0.00E+00	5.38E+06	1.03E+06	0.00E+00	1.23E+07	0.00E+00	9.63E+06	0.00E+00
TC-99M	6.98E-01	1.95E+00	2.52E+01	0.00E+00	2.90E+01	1.08E+00	1.28E+03	0.00E+00
RU-103	1.89E+02	0.00E+00	8.07E+01	0.00E+00	6.66E+02	0.00E+00	1.58E+04	0.00E+00
RU-105	1.90E-04	0.00E+00	7.36E-05	0.00E+00	2.39E-03	0.00E+00	1.53E-01	0.00E+00
RU-106	3.63E+03	0.00E+00	4.57E+02	0.00E+00	7.00E+03	0.00E+00	1.74E+05	0.00E+00
AG-110M	9.62E+06	9.10E+06	5.54E+06	0.00E+00	1.74E+07	0.00E+00	2.56E+09	0.00E+00
SN-113	7.14E+05	2.99E+04	7.59E+05	9.88E+03	2.12E+04	0.00E+00	8.57E+06	0.00E+00
SB-124	4.63E+06	8.53E+04	1.81E+06	1.05E+04	0.00E+00	4.04E+06	9.33E+07	0.00E+00
SB-125	3.46E+06	3.78E+04	8.10E+05	3.31E+03	0.00E+00	3.04E+06	2.69E+07	0.00E+00
TE-129M	1.25E+07	4.62E+06	1.97E+06	4.02E+06	5.21E+07	0.00E+00	4.68E+07	0.00E+00
TE-129	6.57E-11	2.45E-11	1.60E-11	4.69E-11	2.76E-10	0.00E+00	3.59E-10	0.00E+00
TE-131M	8.06E+04	3.86E+04	3.22E+04	5.81E+04	4.03E+05	0.00E+00	3.10E+06	0.00E+00
TE-132	5.27E+05	3.34E+05	3.14E+05	3.52E+05	3.20E+06	0.00E+00	1.06E+07	0.00E+00
I-131	6.34E+08	8.87E+08	4.76E+08	2.59E+11	1.53E+09	0.00E+00	1.75E+08	0.00E+00
I-132	3.55E-01	9.30E-01	3.34E-01	3.13E+01	1.47E+00	0.00E+00	4.05E-01	0.00E+00
I-133	8.50E+06	1.44E+07	4.40E+06	2.01E+09	2.53E+07	0.00E+00	1.09E+07	0.00E+00
I-134	4.49E-12	1.19E-11	4.28E-12	1.99E-10	1.88E-11	0.00E+00	1.57E-13	0.00E+00
I-135	2.75E+04	7.09E+04	2.63E+04	4.56E+06	1.12E+05	0.00E+00	7.85E+04	0.00E+00

13 R Values in units of mrem/yr per μCi/m^3 for inhalation and tritium, and units of m^2-mrem/yr per μCi/sec for all others.

TABLE 3.5-13 (continued)
R VALUES for the H.B. ROBINSON STEAM ELECTRIC PLANT[13]

PATHWAY = Goat Milk
AGE GROUP = Teen

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-Tract	Skin
CS-134	2.32E+10	5.46E+10	2.53E+10	0.00E+00	1.73E+10	6.62E+09	6.79E+08	0.00E+00
CS-136	1.28E+09	5.05E+09	3.39E+09	0.00E+00	2.75E+09	4.33E+08	4.06E+08	0.00E+00
CS-137	3.24E+10	4.31E+10	1.50E+10	0.00E+00	1.47E+10	5.70E+09	6.14E+08	0.00E+00
CS-138	5.29E-23	1.02E-22	5.08E-23	0.00E+00	7.50E-23	8.72E-24	4.61E-26	0.00E+00
BA-139	1.01E-08	7.09E-12	2.94E-10	0.00E+00	6.69E-12	4.89E-12	8.99E-08	0.00E+00
BA-140	5.56E+06	6.82E+03	3.58E+05	0.00E+00	2.31E+03	4.58E+03	8.58E+06	0.00E+00
LA-140	9.73E-01	4.78E-01	1.27E-01	0.00E+00	0.00E+00	0.00E+00	2.75E+04	0.00E+00
LA-142	4.12E-12	1.83E-12	4.56E-13	0.00E+00	0.00E+00	0.00E+00	5.57E-08	0.00E+00
CE-141	9.39E+02	6.27E+02	7.20E+01	0.00E+00	2.95E+02	0.00E+00	1.79E+06	0.00E+00
CE-143	9.18E+00	6.68E+03	7.46E-01	0.00E+00	3.00E+00	0.00E+00	2.01E+05	0.00E+00
CE-144	6.24E+04	2.58E+04	3.35E+03	0.00E+00	1.54E+04	0.00E+00	1.57E+07	0.00E+00
HF-181	1.82E+03	9.98E+00	2.03E+02	6.08E+00	8.29E+00	0.00E+00	9.08E+04	0.00E+00
W-187	1.43E+03	1.17E+03	4.09E+02	0.00E+00	0.00E+00	0.00E+00	3.16E+05	0.00E+00
NP-239	8.42E-01	7.94E-02	4.41E-02	0.00E+00	2.49E-01	0.00E+00	1.28E+04	0.00E+00

13 R Values in units of mrem/yr per µCi/m^3 for inhalation and tritium, and units of m^2-mrem/yr per µCi/sec for all others.

TABLE 3.5-14
R VALUES for the H.B. ROBINSON STEAM ELECTRIC PLANT[14]
(Reference Regulatory Guide 1.109)

PATHWAY = Goat Milk
AGE GROUP = Child

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-Tract	Skin
H-3	0.00E+00	3.20E+03	3.20E+03	3.20E+03	3.20E+03	3.20E+03	3.20E+03	3.20E+03
F-18	2.33E-03	0.00E+00	2.31E-04	0.00E+00	0.00E+00	0.00E+00	6.30E-04	0.00E+00
NA-24	1.07E+06	1.07E+06	1.07E+06	1.07E+06	1.07E+06	1.07E+06	1.07E+06	0.00E+00
CR-51	0.00E+00	0.00E+00	1.09E+04	6.05E+03	1.65E+03	1.11E+04	5.79E+05	0.00E+00
MN-54	0.00E+00	2.01E+06	5.35E+05	0.00E+00	5.63E+05	0.00E+00	1.69E+06	0.00E+00
MN-56	0.00E+00	1.56E-03	3.53E-04	0.00E+00	1.89E-03	0.00E+00	2.26E-01	0.00E+00
FE-55	1.13E+06	6.00E+05	1.86E+05	0.00E+00	0.00E+00	3.40E+05	1.11E+05	0.00E+00
FE-59	1.34E+06	2.17E+06	1.08E+06	0.00E+00	0.00E+00	6.29E+05	2.26E+06	0.00E+00
CO-57	0.00E+00	3.65E+05	7.39E+05	0.00E+00	0.00E+00	0.00E+00	2.99E+06	0.00E+00
CO-58	0.00E+00	1.21E+06	3.71E+06	0.00E+00	0.00E+00	0.00E+00	7.06E+06	0.00E+00
CO-60	0.00E+00	4.11E+06	1.21E+07	0.00E+00	0.00E+00	0.00E+00	2.27E+07	0.00E+00
NI-65	2.02E-01	1.90E-02	1.11E-02	0.00E+00	0.00E+00	0.00E+00	2.33E+00	0.00E+00
CU-64	0.00E+00	8.35E+03	5.05E+03	0.00E+00	2.02E+04	0.00E+00	3.92E+05	0.00E+00
ZN-65	4.46E+08	1.19E+09	7.40E+08	0.00E+00	7.49E+08	0.00E+00	2.09E+08	0.00E+00
BR-82	0.00E+00	0.00E+00	1.40E+07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-83	0.00E+00	0.00E+00	5.42E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-84	0.00E+00	0.00E+00	8.49E-24	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RB-86	0.00E+00	9.79E+08	6.02E+08	0.00E+00	0.00E+00	0.00E+00	6.30E+07	0.00E+00
SR-89	1.18E+10	0.00E+00	3.38E+08	0.00E+00	0.00E+00	0.00E+00	4.58E+08	0.00E+00
SR-90	1.95E+11	0.00E+00	4.94E+10	0.00E+00	0.00E+00	0.00E+00	2.62E+09	0.00E+00
SR-91	2.75E+05	0.00E+00	1.04E+04	0.00E+00	0.00E+00	0.00E+00	6.07E+05	0.00E+00
SR-92	4.65E+00	0.00E+00	1.86E-01	0.00E+00	0.00E+00	0.00E+00	8.81E+01	0.00E+00
Y-91M	3.36E-20	0.00E+00	1.22E-21	0.00E+00	0.00E+00	0.00E+00	6.59E-17	0.00E+00
Y-91	3.94E+03	0.00E+00	1.05E+02	0.00E+00	0.00E+00	0.00E+00	5.25E+05	0.00E+00
Y-92	3.07E-05	0.00E+00	8.78E-07	0.00E+00	0.00E+00	0.00E+00	8.87E-01	0.00E+00
Y-93	1.22E-01	0.00E+00	3.35E-03	0.00E+00	0.00E+00	0.00E+00	1.82E+03	0.00E+00
ZR-95	3.85E+02	8.45E+01	7.53E+01	0.00E+00	1.21E+02	0.00E+00	8.82E+04	0.00E+00
ZR-97	2.31E-01	3.33E-02	1.97E-02	0.00E+00	4.79E-02	0.00E+00	5.05E+03	0.00E+00
NB-95	3.34E+04	1.30E+04	9.29E+03	0.00E+00	1.22E+04	0.00E+00	2.40E+07	0.00E+00
NB-97	1.80E-12	3.26E-13	1.52E-13	0.00E+00	3.62E-13	0.00E+00	1.01E-07	0.00E+00
MO-99	0.00E+00	9.79E+06	2.42E+06	0.00E+00	2.09E+07	0.00E+00	8.10E+06	0.00E+00
TC-99M	1.60E+00	3.14E+00	5.20E+01	0.00E+00	4.56E+01	1.59E+00	1.79E+03	0.00E+00
RU-103	4.47E+02	0.00E+00	1.72E+02	0.00E+00	1.12E+03	0.00E+00	1.15E+04	0.00E+00
RU-105	4.63E-04	0.00E+00	1.68E-04	0.00E+00	4.07E-03	0.00E+00	3.02E-01	0.00E+00
RU-106	8.93E+03	0.00E+00	1.11E+03	0.00E+00	1.21E+04	0.00E+00	1.39E+05	0.00E+00
AG-110M	2.09E+07	1.41E+07	1.13E+07	0.00E+00	2.62E+07	0.00E+00	1.68E+09	0.00E+00
SN-113	1.40E+06	4.52E+04	1.53E+06	1.85E+04	3.10E+04	0.00E+00	5.61E+06	0.00E+00
SB-124	1.10E+07	1.42E+05	3.84E+06	2.42E+04	0.00E+00	6.08E+06	6.85E+07	0.00E+00
SB-125	8.25E+06	6.36E+04	1.73E+06	7.64E+03	0.00E+00	4.60E+06	1.97E+07	0.00E+00
TE-129M	3.07E+07	8.57E+06	4.76E+06	9.90E+06	9.01E+07	0.00E+00	3.74E+07	0.00E+00
TE-129	1.62E-10	4.53E-11	3.85E-11	1.16E-10	4.74E-10	0.00E+00	1.01E-08	0.00E+00
TE-131M	1.96E+05	6.78E+04	7.22E+04	1.39E+05	6.57E+05	0.00E+00	2.75E+06	0.00E+00
TE-132	1.26E+06	5.57E+05	6.73E+05	8.11E+05	5.17E+06	0.00E+00	5.61E+06	0.00E+00
I-131	1.54E+09	1.55E+09	8.78E+08	5.11E+11	2.54E+09	0.00E+00	1.38E+08	0.00E+00
I-132	8.41E-01	1.55E+00	7.11E-01	7.17E+01	2.36E+00	0.00E+00	1.82E+00	0.00E+00
I-133	2.06E+07	2.55E+07	9.66E+06	4.74E+09	4.25E+07	0.00E+00	1.03E+07	0.00E+00
I-134	1.06E-11	1.98E-11	9.09E-12	4.54E-10	3.02E-11	0.00E+00	1.31E-11	0.00E+00
I-135	6.52E+04	1.17E+05	5.55E+04	1.04E+07	1.80E+05	0.00E+00	8.94E+04	0.00E+00

14 R Values in units of mrem/yr per μCi/m^3 for inhalation and tritium, and units of m^2-mrem/yr per μCi/sec for all others.

TABLE 3.5-14 (continued)

R VALUES for the H.B. ROBINSON STEAM ELECTRIC PLANT[14]

PATHWAY = Goat Milk
AGE GROUP = Child

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-Tract	Skin
CS-134	5.35E+10	8.78E+10	1.85E+10	0.00E+00	2.72E+10	9.76E+09	4.73E+08	0.00E+00
CS-136	2.89E+09	7.96E+09	5.15E+09	0.00E+00	4.24E+09	6.32E+08	2.80E+08	0.00E+00
CS-137	7.81E+10	7.48E+10	1.10E+10	0.00E+00	2.44E+10	8.77E+09	4.68E+08	0.00E+00
CS-138	1.28E-22	1.78E-22	1.13E-22	0.00E+00	1.25E-22	1.35E-23	8.21E-23	0.00E+00
BA-139	2.48E-08	1.32E-11	7.18E-10	0.00E+00	1.15E-11	7.78E-12	1.43E-06	0.00E+00
BA-140	1.34E+07	1.18E+04	7.84E+05	0.00E+00	3.83E+03	7.01E+03	6.80E+06	0.00E+00
LA-140	2.33E+00	8.14E-01	2.75E-01	0.00E+00	0.00E+00	0.00E+00	2.27E+04	0.00E+00
LA-142	9.95E-12	3.17E-12	9.94E-13	0.00E+00	0.00E+00	0.00E+00	6.29E-07	0.00E+00
CE-141	2.31E+03	1.15E+03	1.71E+02	0.00E+00	5.05E+02	0.00E+00	1.44E+06	0.00E+00
CE-143	2.25E+01	1.22E+04	1.77E+00	0.00E+00	5.12E+00	0.00E+00	1.79E+05	0.00E+00
CE-144	1.54E+05	4.82E+04	8.21E+03	0.00E+00	2.67E+04	0.00E+00	1.26E+07	0.00E+00
HF-181	4.30E+03	1.68E+01	4.33E+02	1.42E+01	1.35E+01	0.00E+00	7.15E+04	0.00E+00
W-187	3.47E+03	2.05E+03	9.22E+02	0.00E+00	0.00E+00	0.00E+00	2.89E+05	0.00E+00
NP-239	2.07E+00	1.49E-01	1.05E-01	0.00E+00	4.30E-01	0.00E+00	1.10E+04	0.00E+00

14 R Values in units of mrem/yr per μCi/m^3 for inhalation and tritium, and units of m^2-mrem/yr per μCi/sec for all others.

TABLE 3.5-15
R VALUES for the H.B. ROBINSON STEAM ELECTRIC PLANT[15]
(Reference Regulatory Guide 1.109)

PATHWAY = Goat Milk
AGE GROUP = Infant

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-Tract	Skin
H-3	0.00E+00	4.86E+03	4.86E+03	4.86E+03	4.86E+03	4.86E+03	4.86E+03	4.86E+03
F-18	4.85E-03	0.00E+00	4.14E-04	0.00E+00	0.00E+00	0.00E+00	1.14E-03	0.00E+00
NA-24	1.86E+06	1.86E+06	1.86E+06	1.86E+06	1.86E+06	1.86E+06	1.86E+06	0.00E+00
CR-51	0.00E+00	0.00E+00	1.73E+04	1.13E+04	2.46E+03	2.19E+04	5.04E+05	0.00E+00
MN-54	0.00E+00	3.73E+06	8.46E+05	0.00E+00	8.28E+05	0.00E+00	1.37E+06	0.00E+00
MN-56	0.00E+00	3.83E-03	6.60E-04	0.00E+00	3.29E-03	0.00E+00	3.48E-01	0.00E+00
FE-55	1.37E+06	8.84E+05	2.36E+05	0.00E+00	0.00E+00	4.32E+05	1.12E+05	0.00E+00
FE-59	2.50E+06	4.37E+06	1.72E+06	0.00E+00	0.00E+00	1.29E+06	2.09E+06	0.00E+00
CO-57	0.00E+00	8.52E+05	1.39E+06	0.00E+00	0.00E+00	0.00E+00	2.90E+06	0.00E+00
CO-58	0.00E+00	2.42E+06	6.04E+06	0.00E+00	0.00E+00	0.00E+00	6.03E+06	0.00E+00
CO-60	0.00E+00	8.38E+06	1.98E+07	0.00E+00	0.00E+00	0.00E+00	1.99E+07	0.00E+00
NI-65	4.27E-01	4.84E-02	2.20E-02	0.00E+00	0.00E+00	0.00E+00	3.68E+00	0.00E+00
CU-64	0.00E+00	2.08E+04	9.62E+03	0.00E+00	3.51E+04	0.00E+00	4.26E+05	0.00E+00
ZN-65	5.99E+08	2.06E+09	9.48E+08	0.00E+00	9.97E+08	0.00E+00	1.74E+09	0.00E+00
BR-82	0.00E+00	0.00E+00	2.35E+07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-83	0.00E+00	0.00E+00	1.15E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-84	0.00E+00	0.00E+00	1.64E-23	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RB-86	0.00E+00	2.48E+09	1.23E+09	0.00E+00	0.00E+00	0.00E+00	6.36E+07	0.00E+00
SR-89	2.25E+10	0.00E+00	6.45E+08	0.00E+00	0.00E+00	0.00E+00	4.62E+08	0.00E+00
SR-90	2.12E+11	0.00E+00	5.40E+10	0.00E+00	0.00E+00	0.00E+00	2.65E+09	0.00E+00
SR-91	5.73E+05	0.00E+00	2.07E+04	0.00E+00	0.00E+00	0.00E+00	6.78E+05	0.00E+00
SR-92	9.89E+00	0.00E+00	3.67E-01	0.00E+00	0.00E+00	0.00E+00	1.07E+02	0.00E+00
Y-91M	7.13E-20	0.00E+00	2.43E-21	0.00E+00	0.00E+00	0.00E+00	2.38E-16	0.00E+00
Y-91	7.40E+03	0.00E+00	1.97E+02	0.00E+00	0.00E+00	0.00E+00	5.30E+05	0.00E+00
Y-92	6.52E-05	0.00E+00	1.83E-06	0.00E+00	0.00E+00	0.00E+00	1.24E+00	0.00E+00
Y-93	2.60E-01	0.00E+00	7.08E-03	0.00E+00	0.00E+00	0.00E+00	2.05E+03	0.00E+00
ZR-95	6.83E+02	1.66E+02	1.18E+02	0.00E+00	1.79E+02	0.00E+00	8.29E+04	0.00E+00
ZR-97	4.89E-01	8.38E-02	3.83E-02	0.00E+00	8.45E-02	0.00E+00	5.35E+03	0.00E+00
NB-95	6.23E+04	2.57E+04	1.48E+04	0.00E+00	1.84E+04	0.00E+00	2.17E+07	0.00E+00
NB-97	3.82E-12	8.14E-13	2.93E-13	0.00E+00	6.36E-13	0.00E+00	2.57E-07	0.00E+00
MO-99	0.00E+00	2.50E+07	4.88E+06	0.00E+00	3.74E+07	0.00E+00	8.24E+06	0.00E+00
TC-99M	3.33E+00	6.87E+00	8.85E+01	0.00E+00	7.39E+01	3.59E+00	2.00E+03	0.00E+00
RU-103	9.04E+02	0.00E+00	3.02E+02	0.00E+00	1.88E+03	0.00E+00	1.10E+04	0.00E+00
RU-105	9.76E-04	0.00E+00	3.29E-04	0.00E+00	7.17E-03	0.00E+00	3.88E-01	0.00E+00
RU-106	1.84E+04	0.00E+00	2.30E+03	0.00E+00	2.18E+04	0.00E+00	1.40E+05	0.00E+00
AG-110M	3.86E+07	2.81E+07	1.86E+07	0.00E+00	4.03E+07	0.00E+00	1.46E+09	0.00E+00
SN-113	2.13E+06	8.15E+04	2.20E+06	3.10E+04	4.37E+04	0.00E+00	4.55E+06	0.00E+00
SB-124	2.11E+07	3.11E+05	6.54E+06	5.61E+04	0.00E+00	1.32E+07	6.52E+07	0.00E+00
SB-125	1.42E+07	1.37E+05	2.91E+06	1.77E+04	0.00E+00	8.20E+06	1.89E+07	0.00E+00
TE-129M	6.30E+07	2.16E+07	9.71E+06	2.42E+07	1.58E+08	0.00E+00	3.76E+07	0.00E+00
TE-129	3.44E-10	1.18E-10	8.02E-11	2.88E-10	8.56E-10	0.00E+00	2.75E-08	0.00E+00
TE-131M	4.14E+05	1.67E+05	1.38E+05	3.38E+05	1.15E+06	0.00E+00	2.81E+06	0.00E+00
TE-132	2.59E+06	1.28E+06	1.20E+06	1.89E+06	8.02E+06	0.00E+00	4.75E+06	0.00E+00
I-131	3.21E+09	3.78E+09	1.66E+09	1.24E+12	4.41E+09	0.00E+00	1.35E+08	0.00E+00
I-132	1.74E+00	3.54E+00	1.26E+00	1.66E+02	3.95E+00	0.00E+00	2.87E+00	0.00E+00
I-133	4.36E+07	6.35E+07	1.86E+07	1.15E+10	7.46E+07	0.00E+00	1.07E+07	0.00E+00
I-134	2.21E-11	4.52E-11	1.61E-11	1.05E-09	5.05E-11	0.00E+00	4.67E-11	0.00E+00
I-135	1.36E+05	2.70E+05	9.83E+04	2.42E+07	3.00E+05	0.00E+00	9.76E+04	0.00E+00

15 R Values in units of mrem/yr per μCi/m^3 for inhalation and tritium, and units of m^2-mrem/yr per μCi/sec for all others.

TABLE 3.5-15 (continued)
R VALUES for the H.B. ROBINSON STEAM ELECTRIC PLANT[15]

PATHWAY = Goat Milk
AGE GROUP = Infant

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-Tract	Skin
CS-134	8.62E+10	1.61E+11	1.62E+10	0.00E+00	4.14E+10	1.70E+10	4.37E+08	0.00E+00
CS-136	5.65E+09	1.66E+10	6.21E+09	0.00E+00	6.63E+09	1.35E+09	2.52E+08	0.00E+00
CS-137	1.25E+11	1.46E+11	1.03E+10	0.00E+00	3.92E+10	1.59E+10	4.56E+08	0.00E+00
CS-138	2.70E-22	4.40E-22	2.13E-22	0.00E+00	2.19E-22	3.42E-23	7.03E-22	0.00E+00
BA-139	5.27E-08	3.49E-11	1.53E-09	0.00E+00	2.10E-11	2.12E-11	3.34E-06	0.00E+00
BA-140	2.76E+07	2.76E+04	1.42E+06	0.00E+00	6.56E+03	1.70E+04	6.79E+06	0.00E+00
LA-140	4.87E+00	1.92E+00	4.94E-01	0.00E+00	0.00E+00	0.00E+00	2.25E+04	0.00E+00
LA-142	2.09E-11	7.68E-12	1.84E-12	0.00E+00	0.00E+00	0.00E+00	1.30E-06	0.00E+00
CE-141	4.58E+03	2.80E+03	3.29E+02	0.00E+00	8.62E+02	0.00E+00	1.44E+06	0.00E+00
CE-143	4.77E+01	3.16E+04	3.61E+00	0.00E+00	9.21E+00	0.00E+00	1.85E+05	0.00E+00
CE-144	2.21E+05	9.03E+04	1.24E+04	0.00E+00	3.65E+04	0.00E+00	1.27E+07	0.00E+00
HF-181	8.23E+03	3.87E+01	7.27E+02	3.28E+01	2.27E+01	0.00E+00	6.75E+04	0.00E+00
W-187	7.30E+03	5.08E+03	1.75E+03	0.00E+00	0.00E+00	0.00E+00	2.98E+05	0.00E+00
NP-239	4.38E+00	3.92E-01	2.21E-01	0.00E+00	7.81E-01	0.00E+00	1.13E+04	0.00E+00

15 R Values in units of mrem/yr per µCi/m^3 for inhalation and tritium, and units of m^2-mrem/yr per µCi/sec for all others.

TABLE 3.5-16
R VALUES for the H.B. ROBINSON STEAM ELECTRIC PLANT[16]
(Reference Regulatory Guide 1.109)

PATHWAY = Inhalation
AGE GROUP = Adult

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-Tract	Skin
H-3	0.00E+00	1.26E+03	1.26E+03	1.26E+03	1.26E+03	1.26E+03	1.26E+03	1.26E+03
F-18	4.99E+03	0.00E+00	5.54E+02	0.00E+00	0.00E+00	0.00E+00	1.48E+02	0.00E+00
NA-24	1.02E+04	1.02E+04	1.02E+04	1.02E+04	1.02E+04	1.02E+04	1.02E+04	0.00E+00
CR-51	0.00E+00	0.00E+00	1.00E+02	5.95E+01	2.28E+01	1.44E+04	3.32E+03	0.00E+00
MN-54	0.00E+00	3.96E+04	6.30E+03	0.00E+00	9.84E+03	1.40E+06	7.74E+04	0.00E+00
MN-56	0.00E+00	1.24E+00	1.83E-01	0.00E+00	1.30E+00	9.44E+03	2.02E+04	0.00E+00
FE-55	2.46E+04	1.70E+04	3.94E+03	0.00E+00	0.00E+00	7.21E+04	6.03E+03	0.00E+00
FE-59	1.18E+04	2.78E+04	1.06E+04	0.00E+00	0.00E+00	1.02E+06	1.88E+05	0.00E+00
CO-57	0.00E+00	6.92E+02	6.71E+02	0.00E+00	0.00E+00	3.70E+05	3.14E+04	0.00E+00
CO-58	0.00E+00	1.58E+03	2.07E+03	0.00E+00	0.00E+00	9.28E+05	1.06E+05	0.00E+00
CO-60	0.00E+00	1.15E+04	1.48E+04	0.00E+00	0.00E+00	5.97E+06	2.85E+05	0.00E+00
NI-65	1.54E+00	2.10E-01	9.12E-02	0.00E+00	0.00E+00	5.60E+03	1.23E+04	0.00E+00
CU-64	0.00E+00	1.46E+00	6.15E-01	0.00E+00	4.62E+00	6.78E+03	4.90E+04	0.00E+00
ZN-65	3.24E+04	1.03E+05	4.66E+04	0.00E+00	6.90E+04	8.64E+05	5.34E+04	0.00E+00
BR-82	0.00E+00	0.00E+00	1.35E+04	0.00E+00	0.00E+00	0.00E+00	1.04E+04	0.00E+00
BR-83	0.00E+00	0.00E+00	2.41E+02	0.00E+00	0.00E+00	0.00E+00	2.32E+02	0.00E+00
BR-84	0.00E+00	0.00E+00	3.13E+02	0.00E+00	0.00E+00	0.00E+00	1.64E-03	0.00E+00
RB-86	0.00E+00	1.35E+05	5.90E+04	0.00E+00	0.00E+00	0.00E+00	1.66E+04	0.00E+00
RB-88	0.00E+00	3.87E+02	1.93E+02	0.00E+00	0.00E+00	0.00E+00	3.34E-09	0.00E+00
RB-89	0.00E+00	2.56E+02	1.70E+02	0.00E+00	0.00E+00	0.00E+00	9.28E-12	0.00E+00
SR-89	3.04E+05	0.00E+00	8.72E+03	0.00E+00	0.00E+00	1.40E+06	3.50E+05	0.00E+00
SR-90	9.92E+07	0.00E+00	6.10E+06	0.00E+00	0.00E+00	9.60E+06	7.22E+05	0.00E+00
SR-91	6.19E+01	0.00E+00	2.50E+00	0.00E+00	0.00E+00	3.65E+04	1.91E+05	0.00E+00
SR-92	6.74E+00	0.00E+00	2.91E-01	0.00E+00	0.00E+00	1.65E+04	4.30E+04	0.00E+00
Y-91M	2.61E-01	0.00E+00	1.02E-02	0.00E+00	0.00E+00	1.92E+03	1.33E+00	0.00E+00
Y-91	4.62E+05	0.00E+00	1.24E+04	0.00E+00	0.00E+00	1.70E+06	3.85E+05	0.00E+00
Y-92	1.03E+01	0.00E+00	3.02E-01	0.00E+00	0.00E+00	1.57E+04	7.35E+04	0.00E+00
Y-93	9.44E+01	0.00E+00	2.61E+00	0.00E+00	0.00E+00	4.85E+04	4.22E+05	0.00E+00
ZR-95	1.07E+05	3.44E+04	2.33E+04	0.00E+00	5.42E+04	1.77E+06	1.50E+05	0.00E+00
ZR-97	9.68E+01	1.96E+01	9.04E+00	0.00E+00	2.97E+01	7.87E+04	5.23E+05	0.00E+00
NB-95	1.41E+04	7.82E+03	4.21E+03	0.00E+00	7.74E+03	5.05E+05	1.04E+05	0.00E+00
NB-97	2.22E-01	5.62E-02	2.05E-02	0.00E+00	6.54E-02	2.40E+03	2.42E+02	0.00E+00
MO-99	0.00E+00	1.21E+02	2.30E+01	0.00E+00	2.91E+02	9.12E+04	2.48E+05	0.00E+00
TC-99M	1.03E-03	2.91E-03	3.70E-02	0.00E+00	4.42E-02	7.64E+02	4.16E+03	0.00E+00
TC-101	4.18E-05	6.02E-05	5.90E-04	0.00E+00	1.08E-03	3.99E+02	1.09E-11	0.00E+00
RU-103	1.53E+03	0.00E+00	6.58E+02	0.00E+00	5.83E+03	5.05E+05	1.10E+05	0.00E+00
RU-105	7.90E-01	0.00E+00	3.11E-01	0.00E+00	1.02E+00	1.10E+04	4.82E+04	0.00E+00
RU-106	6.91E+04	0.00E+00	8.72E+03	0.00E+00	1.34E+05	9.36E+06	9.12E+05	0.00E+00
AG-110M	1.08E+04	1.00E+04	5.94E+03	0.00E+00	1.97E+04	4.63E+06	3.02E+05	0.00E+00
SN-113	6.86E+03	2.66E+02	6.48E+03	9.28E+01	1.97E+02	2.99E+05	2.48E+04	0.00E+00
SB-124	3.12E+04	5.89E+02	1.24E+04	7.55E+01	0.00E+00	2.48E+06	4.06E+05	0.00E+00
SB-125	5.34E+04	5.95E+02	1.26E+04	5.40E+01	0.00E+00	1.74E+06	1.01E+05	0.00E+00
TE-129M	9.76E+03	4.67E+03	1.58E+03	3.44E+03	3.66E+04	1.16E+06	3.83E+05	0.00E+00
TE-129	4.98E-02	2.39E-02	1.24E-02	3.90E-02	1.87E-01	1.94E+03	1.57E+02	0.00E+00
TE-131M	6.99E+01	4.36E+01	2.90E+01	5.50E+01	3.09E+02	1.46E+05	5.56E+05	0.00E+00
TE-132	2.60E+02	2.15E+02	1.62E+02	1.90E+02	1.46E+03	2.88E+05	5.10E+05	0.00E+00

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

TABLE 3.5-16 (continued)

R VALUES for the H.B. ROBINSON STEAM ELECTRIC PLANT[16]

PATHWAY = Inhalation
AGE GROUP = Adult

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-Tract	Skin
I-131	2.52E+04	3.58E+04	2.05E+04	1.19E+07	6.13E+04	0.00E+00	6.28E+03	0.00E+00
I-132	1.16E+03	3.26E+03	1.16E+03	1.14E+05	5.18E+03	0.00E+00	4.06E+02	0.00E+00
I-133	8.64E+03	1.48E+04	4.52E+03	2.15E+06	2.58E+04	0.00E+00	8.88E+03	0.00E+00
I-134	6.44E+02	1.73E+03	6.15E+02	2.98E+04	2.75E+03	0.00E+00	1.01E+00	0.00E+00
I-135	2.68E+03	6.98E+03	2.57E+03	4.48E+05	1.11E+04	0.00E+00	5.25E+03	0.00E+00
CS-134	3.73E+05	8.48E+05	7.28E+05	0.00E+00	2.87E+05	9.76E+04	1.04E+04	0.00E+00
CS-136	3.90E+04	1.46E+05	1.10E+05	0.00E+00	8.56E+04	1.20E+04	1.17E+04	0.00E+00
CS-137	4.78E+05	6.21E+05	4.28E+05	0.00E+00	2.22E+05	7.52E+04	8.40E+03	0.00E+00
CS-138	3.31E+02	6.21E+02	3.24E+02	0.00E+00	4.80E+02	4.86E+01	1.86E-03	0.00E+00
BA-139	9.36E-01	6.66E-04	2.74E-02	0.00E+00	6.22E-04	3.76E+03	8.96E+02	0.00E+00
BA-140	3.90E+04	4.90E+01	2.57E+03	0.00E+00	1.67E+01	1.27E+06	2.18E+05	0.00E+00
BA-142	2.63E-02	2.70E-05	1.66E-03	0.00E+00	2.29E-05	1.19E+03	1.57E-16	0.00E+00
LA-140	3.44E+02	1.74E+02	4.58E+01	0.00E+00	0.00E+00	1.36E+05	4.58E+05	0.00E+00
LA-142	6.83E-01	3.10E-01	7.72E-02	0.00E+00	0.00E+00	6.33E+03	2.11E+03	0.00E+00
CE-141	1.99E+04	1.35E+04	1.53E+03	0.00E+00	6.26E+03	3.62E+05	1.20E+05	0.00E+00
CE-143	1.86E+02	1.38E+02	1.53E+01	0.00E+00	6.08E+01	7.98E+04	2.26E+05	0.00E+00
CE-144	3.43E+06	1.43E+06	1.84E+05	0.00E+00	8.48E+05	7.78E+06	8.16E+05	0.00E+00
PR-144	3.01E-02	1.25E-02	1.53E-03	0.00E+00	7.05E-03	1.02E+03	2.15E-08	0.00E+00
HF-181	4.56E+04	2.57E+02	5.15E+03	1.63E+03	2.14E+02	5.98E+05	1.29E+05	0.00E+00
W-187	8.48E+00	7.08E+00	2.48E+00	0.00E+00	0.00E+00	2.90E+04	1.55E+05	0.00E+00
NP-239	2.30E+02	2.26E+01	1.24E+01	0.00E+00	7.00E+01	3.76E+04	1.19E+05	0.00E+00

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

TABLE 3.5-17
R VALUES for the H.B. ROBINSON STEAM ELECTRIC PLANT[17]
(Reference Regulatory Guide 1.109)

PATHWAY = Inhalation
AGE GROUP = Teen

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-Tract	Skin
H-3	0.00E+00	1.27E+03	1.27E+03	1.27E+03	1.27E+03	1.27E+03	1.27E+03	1.27E+03
F-18	5.22E+03	0.00E+00	5.68E+02	0.00E+00	0.00E+00	0.00E+00	3.11E+02	0.00E+00
NA-24	1.38E+04	1.38E+04	1.38E+04	1.38E+04	1.38E+04	1.38E+04	1.38E+04	0.00E+00
CR-51	0.00E+00	0.00E+00	1.35E+02	7.50E+01	3.07E+01	2.10E+04	3.00E+03	0.00E+00
MN-54	0.00E+00	5.11E+04	8.40E+03	0.00E+00	1.27E+04	1.98E+06	6.68E+04	0.00E+00
MN-56	0.00E+00	1.70E+00	2.52E-01	0.00E+00	1.79E+00	1.52E+04	5.74E+04	0.00E+00
FE-55	3.34E+04	2.38E+04	5.54E+03	0.00E+00	0.00E+00	1.24E+05	6.39E+03	0.00E+00
FE-59	1.59E+04	3.70E+04	1.43E+04	0.00E+00	0.00E+00	1.53E+06	1.78E+05	0.00E+00
CO-57	0.00E+00	9.44E+02	9.20E+02	0.00E+00	0.00E+00	5.86E+05	3.14E+04	0.00E+00
CO-58	0.00E+00	2.07E+03	2.78E+03	0.00E+00	0.00E+00	1.34E+06	9.52E+04	0.00E+00
CO-60	0.00E+00	1.51E+04	1.98E+04	0.00E+00	0.00E+00	8.72E+06	2.59E+05	0.00E+00
NI-65	2.18E+00	2.93E-01	1.27E-01	0.00E+00	0.00E+00	9.36E+03	3.67E+04	0.00E+00
CU-64	0.00E+00	2.03E+00	8.48E-01	0.00E+00	6.41E+00	1.11E+04	6.14E+04	0.00E+00
ZN-65	3.86E+04	1.34E+05	6.24E+04	0.00E+00	8.64E+04	1.24E+06	4.66E+04	0.00E+00
BR-82	0.00E+00	0.00E+00	1.82E+04	0.00E+00	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	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	0.00E+00
RB-86	0.00E+00	1.90E+05	8.40E+04	0.00E+00	0.00E+00	0.00E+00	1.77E+04	0.00E+00
RB-88	0.00E+00	5.46E+02	2.72E+02	0.00E+00	0.00E+00	0.00E+00	2.92E-05	0.00E+00
RB-89	0.00E+00	3.52E+02	2.33E+02	0.00E+00	0.00E+00	0.00E+00	3.38E-07	0.00E+00
SR-89	4.34E+05	0.00E+00	1.25E+04	0.00E+00	0.00E+00	2.42E+06	3.71E+05	0.00E+00
SR-90	1.08E+08	0.00E+00	6.68E+06	0.00E+00	0.00E+00	1.65E+07	7.65E+05	0.00E+00
SR-91	8.80E+01	0.00E+00	3.51E+00	0.00E+00	0.00E+00	6.07E+04	2.59E+05	0.00E+00
SR-92	9.52E+00	0.00E+00	4.06E-01	0.00E+00	0.00E+00	2.74E+04	1.19E+05	0.00E+00
Y-91M	3.70E-01	0.00E+00	1.42E-02	0.00E+00	0.00E+00	3.20E+03	3.02E+01	0.00E+00
Y-91	6.61E+05	0.00E+00	1.77E+04	0.00E+00	0.00E+00	2.94E+06	4.09E+05	0.00E+00
Y-92	1.47E+01	0.00E+00	4.29E-01	0.00E+00	0.00E+00	2.68E+04	1.65E+05	0.00E+00
Y-93	1.35E+02	0.00E+00	3.72E+00	0.00E+00	0.00E+00	8.32E+04	5.79E+05	0.00E+00
ZR-95	1.46E+05	4.58E+04	3.15E+04	0.00E+00	6.74E+04	2.69E+06	1.49E+05	0.00E+00
ZR-97	1.38E+02	2.72E+01	1.26E+01	0.00E+00	4.12E+01	1.30E+05	6.30E+05	0.00E+00
NB-95	1.86E+04	1.03E+04	5.66E+03	0.00E+00	1.00E+04	7.51E+05	9.68E+04	0.00E+00
NB-97	3.14E-01	7.78E-02	2.84E-02	0.00E+00	9.12E-02	3.93E+03	2.17E+03	0.00E+00
MO-99	0.00E+00	1.69E+02	3.22E+01	0.00E+00	4.11E+02	1.54E+05	2.69E+05	0.00E+00
TC-99M	1.38E-03	3.86E-03	4.99E-02	0.00E+00	5.76E-02	1.15E+03	6.13E+03	0.00E+00
TC-101	5.92E-05	8.40E-05	8.24E-04	0.00E+00	1.52E-03	6.67E+02	8.72E-07	0.00E+00
RU-103	2.10E+03	0.00E+00	8.96E+02	0.00E+00	7.43E+03	7.83E+05	1.09E+05	0.00E+00
RU-105	1.12E+00	0.00E+00	4.34E-01	0.00E+00	1.41E+00	1.82E+04	9.04E+04	0.00E+00
RU-106	9.84E+04	0.00E+00	1.24E+04	0.00E+00	1.90E+05	1.61E+07	9.60E+05	0.00E+00
AG-110M	1.38E+04	1.31E+04	7.99E+03	0.00E+00	2.50E+04	6.75E+06	2.73E+05	0.00E+00
SN-113	8.16E+03	3.44E+02	8.64E+03	1.13E+02	2.46E+02	4.26E+05	2.03E+04	0.00E+00
SB-124	4.30E+04	7.94E+02	1.68E+04	9.76E+01	0.00E+00	3.85E+06	3.98E+05	0.00E+00
SB-125	7.38E+04	8.08E+02	1.72E+04	7.04E+01	0.00E+00	2.74E+06	9.92E+04	0.00E+00
TE-129M	1.39E+04	6.58E+03	2.25E+03	4.58E+03	5.19E+04	1.98E+06	4.05E+05	0.00E+00
TE-129	7.10E-02	3.38E-02	1.76E-02	5.18E-02	2.66E-01	3.30E+03	1.62E+03	0.00E+00
TE-131M	9.84E+01	6.01E+01	4.02E+01	7.25E+01	4.39E+02	2.38E+05	6.21E+05	0.00E+00
TE-132	3.60E+02	2.90E+02	2.19E+02	2.46E+02	1.95E+03	4.49E+05	4.63E+05	0.00E+00

17 R Values in units of mrem/yr per μCi/m^3 for inhalation and tritium, and units of m^2-mrem/yr per μCi/sec for all others.

TABLE 3.5-17 (continued)
R VALUES for the H.B. ROBINSON STEAM ELECTRIC PLANT[17]

PATHWAY = Inhalation
AGE GROUP = Teen

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-Tract	Skin
I-131	3.54E+04	4.91E+04	2.64E+04	1.46E+07	8.40E+04	0.00E+00	6.49E+03	0.00E+00
I-132	1.59E+03	4.38E+03	1.58E+03	1.51E+05	6.92E+03	0.00E+00	1.27E+03	0.00E+00
I-133	1.22E+04	2.05E+04	6.22E+03	2.92E+06	3.59E+04	0.00E+00	1.03E+04	0.00E+00
I-134	8.88E+02	2.32E+03	8.40E+02	3.95E+04	3.66E+03	0.00E+00	2.04E+01	0.00E+00
I-135	3.70E+03	9.44E+03	3.49E+03	6.21E+05	1.49E+04	0.00E+00	6.95E+03	0.00E+00
CS-134	5.02E+05	1.13E+06	5.49E+05	0.00E+00	3.75E+05	1.46E+05	9.76E+03	0.00E+00
CS-136	5.15E+04	1.94E+05	1.37E+05	0.00E+00	1.10E+05	1.78E+04	1.09E+04	0.00E+00
CS-137	6.70E+05	8.48E+05	3.11E+05	0.00E+00	3.04E+05	1.21E+05	8.48E+03	0.00E+00
CS-138	4.66E+02	8.56E+02	4.46E+02	0.00E+00	6.62E+02	7.87E+01	2.70E-01	0.00E+00
BA-139	1.34E+00	9.44E-04	3.90E-02	0.00E+00	8.88E-04	6.46E+03	6.45E+03	0.00E+00
BA-140	5.47E+04	6.70E+01	3.52E+03	0.00E+00	2.28E+01	2.03E+06	2.29E+05	0.00E+00
BA-142	3.70E-02	3.70E-05	2.27E-03	0.00E+00	3.14E-05	1.91E+03	4.79E-10	0.00E+00
LA-140	4.79E+02	2.36E+02	6.26E+01	0.00E+00	0.00E+00	2.14E+05	4.87E+05	0.00E+00
LA-142	9.60E-01	4.25E-01	1.06E-01	0.00E+00	0.00E+00	1.02E+04	1.20E+04	0.00E+00
CE-141	2.84E+04	1.90E+04	2.17E+03	0.00E+00	8.88E+03	6.14E+05	1.26E+05	0.00E+00
CE-143	2.66E+02	1.94E+02	2.16E+01	0.00E+00	8.64E+01	1.30E+05	2.55E+05	0.00E+00
CE-144	4.89E+06	2.02E+06	2.62E+05	0.00E+00	1.21E+06	1.34E+07	8.64E+05	0.00E+00
PR-144	4.30E-02	1.76E-02	2.18E-03	0.00E+00	1.01E-02	1.75E+03	2.35E-04	0.00E+00
HF-181	6.31E+04	3.47E+02	7.04E+03	2.12E+02	2.90E+02	9.36E+05	1.20E+05	0.00E+00
W-187	1.20E+01	9.76E+00	3.43E+00	0.00E+00	0.00E+00	4.74E+04	1.77E+05	0.00E+00
NP-239	3.38E+02	3.19E+01	1.77E+01	0.00E+00	1.00E+02	6.49E+04	1.32E+05	0.00E+00

17 R Values in units of mrem/yr per µCi/m^3 for inhalation and tritium, and units of m^2-mrem/yr per µCi/sec for all others.

TABLE 3.5-18
R VALUES for the H.B. ROBINSON STEAM ELECTRIC PLANT[18]
(Reference Regulatory Guide 1.109)

PATHWAY = Inhalation
AGE GROUP = Child

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-Tract	Skin
H-3	0.00E+00	1.12E+03	1.12E+03	1.12E+03	1.12E+03	1.12E+03	1.12E+03	1.12E+03
F-18	6.96E+03	0.00E+00	6.85E+02	0.00E+00	0.00E+00	0.00E+00	1.25E+03	0.00E+00
NA-24	1.61E+04	1.61E+04	1.61E+04	1.61E+04	1.61E+04	1.61E+04	1.61E+04	0.00E+00
CR-51	0.00E+00	0.00E+00	1.54E+02	8.55E+01	2.43E+01	1.70E+04	1.08E+03	0.00E+00
MN-54	0.00E+00	4.29E+04	9.51E+03	0.00E+00	1.00E+04	1.58E+06	2.29E+04	0.00E+00
MN-56	0.00E+00	1.66E+00	3.12E-01	0.00E+00	1.67E+00	1.31E+04	1.23E+05	0.00E+00
FE-55	4.74E+04	2.52E+04	7.77E+03	0.00E+00	0.00E+00	1.11E+05	2.87E+03	0.00E+00
FE-59	2.07E+04	3.34E+04	1.67E+04	0.00E+00	0.00E+00	1.27E+06	7.07E+04	0.00E+00
CO-57	0.00E+00	9.03E+02	1.07E+03	0.00E+00	0.00E+00	5.07E+05	1.32E+04	0.00E+00
CO-58	0.00E+00	1.77E+03	3.16E+03	0.00E+00	0.00E+00	1.11E+06	3.44E+04	0.00E+00
CO-60	0.00E+00	1.31E+04	2.26E+04	0.00E+00	0.00E+00	7.07E+06	9.62E+04	0.00E+00
NI-65	2.99E+00	2.96E-01	1.64E-01	0.00E+00	0.00E+00	8.18E+03	8.40E+04	0.00E+00
CU-64	0.00E+00	1.99E+00	1.07E+00	0.00E+00	6.03E+00	9.58E+03	3.67E+04	0.00E+00
ZN-65	4.26E+04	1.13E+05	7.03E+04	0.00E+00	7.14E+04	9.95E+05	1.63E+04	0.00E+00
BR-82	0.00E+00	0.00E+00	2.09E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-83	0.00E+00	0.00E+00	4.74E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-84	0.00E+00	0.00E+00	5.48E+02	0.00E+00	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	7.99E+03	0.00E+00
RB-88	0.00E+00	5.62E+02	3.66E+02	0.00E+00	0.00E+00	0.00E+00	1.72E+01	0.00E+00
RB-89	0.00E+00	3.45E+02	2.90E+02	0.00E+00	0.00E+00	0.00E+00	1.89E+00	0.00E+00
SR-89	5.99E+05	0.00E+00	1.72E+04	0.00E+00	0.00E+00	2.16E+06	1.67E+05	0.00E+00
SR-90	1.01E+08	0.00E+00	6.44E+06	0.00E+00	0.00E+00	1.48E+07	3.43E+05	0.00E+00
SR-91	1.21E+02	0.00E+00	4.59E+00	0.00E+00	0.00E+00	5.33E+04	1.74E+05	0.00E+00
SR-92	1.31E+01	0.00E+00	5.25E-01	0.00E+00	0.00E+00	2.40E+04	2.42E+05	0.00E+00
Y-91M	5.07E-01	0.00E+00	1.84E-02	0.00E+00	0.00E+00	2.81E+03	1.72E+03	0.00E+00
Y-91	9.14E+05	0.00E+00	2.44E+04	0.00E+00	0.00E+00	2.63E+06	1.84E+05	0.00E+00
Y-92	2.04E+01	0.00E+00	5.81E-01	0.00E+00	0.00E+00	2.39E+04	2.39E+05	0.00E+00
Y-93	1.86E+02	0.00E+00	5.11E+00	0.00E+00	0.00E+00	7.44E+04	3.89E+05	0.00E+00
ZR-95	1.90E+05	4.18E+04	3.70E+04	0.00E+00	5.96E+04	2.23E+06	6.11E+04	0.00E+00
ZR-97	1.88E+02	2.72E+01	1.60E+01	0.00E+00	3.88E+01	1.13E+05	3.51E+05	0.00E+00
NB-95	2.35E+04	9.18E+03	6.55E+03	0.00E+00	8.62E+03	6.14E+05	3.70E+04	0.00E+00
NB-97	4.29E-01	7.70E-02	3.50E-02	0.00E+00	8.55E-02	3.42E+03	2.78E+16	0.00E+00
MO-99	0.00E+00	1.72E+02	4.25E+01	0.00E+00	3.92E+02	1.35E+05	1.27E+05	0.00E+00
TC-99M	1.78E-03	3.48E-03	5.77E-02	0.00E+00	5.07E-02	9.51E+02	4.81E+03	0.00E+00
TC-101	8.10E-05	8.51E-05	1.08E-03	0.00E+00	1.45E-03	5.85E+02	1.63E+01	0.00E+00
RU-103	2.79E+03	0.00E+00	1.07E+03	0.00E+00	7.03E+03	6.62E+05	4.48E+04	0.00E+00
RU-105	1.53E+00	0.00E+00	5.55E-01	0.00E+00	1.34E+00	1.59E+04	9.95E+04	0.00E+00
RU-106	1.36E+05	0.00E+00	1.69E+04	0.00E+00	1.84E+05	1.43E+07	4.29E+05	0.00E+00
AG-110M	1.69E+04	1.14E+04	9.14E+03	0.00E+00	2.12E+04	5.48E+06	1.00E+05	0.00E+00
SN-113	8.99E+03	2.90E+02	9.81E+03	1.19E+02	2.03E+02	3.40E+05	7.44E+03	0.00E+00
SB-124	5.74E+04	7.40E+02	2.00E+04	1.26E+02	0.00E+00	3.24E+06	1.64E+05	0.00E+00
SB-125	9.84E+04	7.59E+02	2.07E+04	9.10E+01	0.00E+00	2.32E+06	4.03E+04	0.00E+00
TE-129M	1.92E+04	6.85E+03	3.04E+03	6.33E+03	5.03E+04	1.76E+06	1.82E+05	0.00E+00
TE-129	9.77E-02	3.50E-02	2.38E-02	7.14E-02	2.57E-01	2.93E+03	2.55E+04	0.00E+00
TE-131M	1.34E+02	5.92E+01	5.07E+01	9.77E+01	4.00E+02	2.06E+05	3.08E+05	0.00E+00
TE-132	4.81E+02	2.72E+02	2.63E+02	3.17E+02	1.77E+03	3.77E+05	1.38E+05	0.00E+00

18 R Values in units of mrem/yr per μCi/m^3 for inhalation and tritium, and units of m^2-mrem/yr per μCi/sec for all others.

TABLE 3.5-18 (continued)

R VALUES for the H.B. ROBINSON STEAM ELECTRIC PLANT[18]

PATHWAY = Inhalation
AGE GROUP = Child

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-Tract	Skin
I-131	4.81E+04	4.81E+04	2.73E+04	1.62E+07	7.88E+04	0.00E+00	2.84E+03	0.00E+00
I-132	2.12E+03	4.07E+03	1.88E+03	1.94E+05	6.25E+03	0.00E+00	3.20E+03	0.00E+00
I-133	1.66E+04	2.03E+04	7.70E+03	3.85E+06	3.38E+04	0.00E+00	5.48E+03	0.00E+00
I-134	1.17E+03	2.16E+03	9.95E+02	5.07E+04	3.30E+03	0.00E+00	9.55E+02	0.00E+00
I-135	4.92E+03	8.73E+03	4.14E+03	7.92E+05	1.34E+04	0.00E+00	4.44E+03	0.00E+00
CS-134	6.51E+05	1.01E+06	2.25E+05	0.00E+00	3.30E+05	1.21E+05	3.85E+03	0.00E+00
CS-136	6.51E+04	1.71E+05	1.16E+05	0.00E+00	9.55E+04	1.45E+04	4.18E+03	0.00E+00
CS-137	9.07E+05	8.25E+05	1.28E+05	0.00E+00	2.82E+05	1.04E+05	3.62E+03	0.00E+00
CS-138	6.33E+02	8.40E+02	5.55E+02	0.00E+00	6.22E+02	6.81E+01	2.70E+02	0.00E+00
BA-139	1.84E+00	9.84E-04	5.36E-02	0.00E+00	8.62E-04	5.77E+03	5.77E+04	0.00E+00
BA-140	7.40E+04	6.48E+01	4.33E+03	0.00E+00	2.11E+01	1.74E+06	1.02E+05	0.00E+00
BA-142	4.99E-02	3.60E-05	2.79E-03	0.00E+00	2.91E-05	1.64E+03	2.74E+00	0.00E+00
LA-140	6.44E+02	2.25E+02	7.55E+01	0.00E+00	0.00E+00	1.83E+05	2.26E+05	0.00E+00
LA-142	1.29E+00	4.11E-01	1.29E-01	0.00E+00	0.00E+00	8.70E+03	7.59E+04	0.00E+00
CE-141	3.92E+04	1.95E+04	2.90E+03	0.00E+00	8.55E+03	5.44E+05	5.66E+04	0.00E+00
CE-143	3.66E+02	1.99E+02	2.87E+01	0.00E+00	8.36E+01	1.15E+05	1.27E+05	0.00E+00
CE-144	6.77E+06	2.12E+06	3.61E+05	0.00E+00	1.17E+06	1.20E+07	3.89E+05	0.00E+00
PR-144	5.96E-02	1.85E-02	3.00E-03	0.00E+00	9.77E-03	1.57E+03	1.97E+02	0.00E+00
HF-181	8.33E+04	3.28E+02	8.47E+03	2.76E+02	2.63E+02	7.96E+05	5.29E+04	0.00E+00
W-187	1.63E+01	9.66E+00	4.33E+00	0.00E+00	0.00E+00	4.11E+04	9.10E+04	0.00E+00
NP-239	4.66E+02	3.34E+01	2.35E+01	0.00E+00	9.73E+01	5.81E+04	6.40E+04	0.00E+00

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

TABLE 3.5-19

R VALUES for the H.B. ROBINSON STEAM ELECTRIC PLANT[19]

(Reference Regulatory Guide 1.109)

PATHWAY = Inhalation
AGE GROUP = Infant

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-Tract	Skin
H-3	0.00E+00	6.47E+02	6.47E+02	6.47E+02	6.47E+02	6.47E+02	6.47E+02	6.47E+02
F-18	5.49E+03	0.00E+00	4.66E+02	0.00E+00	0.00E+00	0.00E+00	8.54E+02	0.00E+00
NA-24	1.06E+04	1.06E+04	1.06E+04	1.06E+04	1.06E+04	1.06E+04	1.06E+04	0.00E+00
CR-51	0.00E+00	0.00E+00	8.95E+01	5.75E+01	1.32E+01	1.28E+04	3.57E+02	0.00E+00
MN-54	0.00E+00	2.53E+04	4.98E+03	0.00E+00	4.98E+03	1.00E+06	7.06E+03	0.00E+00
MN-56	0.00E+00	1.54E+00	2.21E-01	0.00E+00	1.10E+00	1.25E+04	7.17E+04	0.00E+00
FE-55	1.97E+04	1.17E+04	3.33E+03	0.00E+00	0.00E+00	8.69E+04	1.09E+03	0.00E+00
FE-59	1.36E+04	2.35E+04	9.48E+03	0.00E+00	0.00E+00	1.02E+06	2.48E+04	0.00E+00
CO-57	0.00E+00	6.51E+02	6.41E+02	0.00E+00	0.00E+00	3.79E+05	4.86E+03	0.00E+00
CO-58	0.00E+00	1.22E+03	1.82E+03	0.00E+00	0.00E+00	7.77E+05	1.11E+04	0.00E+00
CO-60	0.00E+00	8.02E+03	1.18E+04	0.00E+00	0.00E+00	4.51E+06	3.19E+04	0.00E+00
NI-65	2.39E+00	2.84E-01	1.23E-01	0.00E+00	0.00E+00	8.12E+03	5.01E+04	0.00E+00
CU-64	0.00E+00	1.88E+00	7.74E-01	0.00E+00	3.98E+00	9.30E+03	1.50E+04	0.00E+00
ZN-65	1.93E+04	6.26E+04	3.11E+04	0.00E+00	3.25E+04	6.47E+05	5.14E+04	0.00E+00
BR-82	0.00E+00	0.00E+00	1.33E+04	0.00E+00	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	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	0.00E+00
RB-86	0.00E+00	1.90E+05	8.82E+04	0.00E+00	0.00E+00	0.00E+00	3.04E+03	0.00E+00
RB-88	0.00E+00	5.57E+02	2.87E+02	0.00E+00	0.00E+00	0.00E+00	3.39E+02	0.00E+00
RB-89	0.00E+00	3.21E+02	2.06E+02	0.00E+00	0.00E+00	0.00E+00	6.82E+01	0.00E+00
SR-89	3.98E+05	0.00E+00	1.14E+04	0.00E+00	0.00E+00	2.03E+06	6.40E+04	0.00E+00
SR-90	4.09E+07	0.00E+00	2.59E+06	0.00E+00	0.00E+00	1.12E+07	1.31E+05	0.00E+00
SR-91	9.56E+01	0.00E+00	3.46E+00	0.00E+00	0.00E+00	5.26E+04	7.34E+04	0.00E+00
SR-92	1.05E+01	0.00E+00	3.91E-01	0.00E+00	0.00E+00	2.38E+04	1.40E+05	0.00E+00
Y-91M	4.07E-01	0.00E+00	1.39E-02	0.00E+00	0.00E+00	2.79E+03	2.35E+03	0.00E+00
Y-91	5.88E+05	0.00E+00	1.57E+04	0.00E+00	0.00E+00	2.45E+06	7.03E+04	0.00E+00
Y-92	1.64E+01	0.00E+00	4.61E-01	0.00E+00	0.00E+00	2.45E+04	1.27E+05	0.00E+00
Y-93	1.50E+02	0.00E+00	4.07E+00	0.00E+00	0.00E+00	7.64E+04	1.67E+05	0.00E+00
ZR-95	1.15E+05	2.79E+04	2.03E+04	0.00E+00	3.11E+04	1.75E+06	2.17E+04	0.00E+00
ZR-97	1.50E+02	2.56E+01	1.17E+01	0.00E+00	2.59E+01	1.10E+05	1.40E+05	0.00E+00
NB-95	1.57E+04	6.43E+03	3.78E+03	0.00E+00	4.72E+03	4.79E+05	1.27E+04	0.00E+00
NB-97	3.42E-01	7.29E-02	2.63E-02	0.00E+00	5.70E-02	3.32E+03	2.69E+04	0.00E+00
MO-99	0.00E+00	1.65E+02	3.23E+01	0.00E+00	2.65E+02	1.35E+05	4.87E+04	0.00E+00
TC-99M	1.40E-03	2.88E-03	3.72E-02	0.00E+00	3.11E-02	8.11E+02	2.03E+03	0.00E+00
TC-101	6.51E-05	8.23E-05	8.12E-04	0.00E+00	9.79E-04	5.84E+02	8.44E+02	0.00E+00
RU-103	2.02E+03	0.00E+00	6.79E+02	0.00E+00	4.24E+03	5.52E+05	1.61E+04	0.00E+00
RU-105	1.22E+00	0.00E+00	4.10E-01	0.00E+00	8.99E-01	1.57E+04	4.84E+04	0.00E+00
RU-106	8.68E+04	0.00E+00	1.09E+04	0.00E+00	1.07E+05	1.16E+07	1.64E+05	0.00E+00
AG-110M	9.98E+03	7.22E+03	5.00E+03	0.00E+00	1.09E+04	3.67E+06	3.30E+04	0.00E+00
SN-113	4.68E+03	1.74E+02	4.89E+03	6.72E+01	9.94E+01	2.30E+05	2.28E+03	0.00E+00
SB-124	3.04E+04	5.56E+02	1.20E+04	1.01E+02	0.00E+00	2.65E+06	3.42E+04	0.00E+00
SB-125	5.17E+04	4.77E+02	1.09E+04	6.23E+00	5.70E-02	3.32E+03	2.69E+04	0.00E+00
TE-129M	1.41E+04	6.09E+03	2.23E+03	5.47E+03	3.18E+04	1.68E+06	6.90E+04	0.00E+00
TE-129	7.88E-02	3.47E-02	1.88E-02	6.75E-02	1.75E-01	3.00E+03	2.63E+04	0.00E+00
TE-131M	1.07E+02	5.50E+01	3.63E+01	8.93E+01	2.65E+02	1.99E+05	1.19E+05	0.00E+00
TE-132	3.72E+02	2.37E+02	1.76E+02	2.79E+02	1.03E+03	3.40E+05	4.41E+04	0.00E+00

19 R Values in units of mrem/yr per μCi/m^3 for inhalation and tritium, and units of m^2-mrem/yr per μCi/sec for all others.

TABLE 3.5-19 (continued)

R VALUES for the H.B. ROBINSON STEAM ELECTRIC PLANT[19]

PATHWAY = Inhalation
AGE GROUP = Infant

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-Tract	Skin
I-131	3.79E+04	4.44E+04	1.96E+04	1.48E+07	5.18E+04	0.00E+00	1.06E+03	0.00E+00
I-132	1.69E+03	3.54E+03	1.26E+03	1.69E+05	3.95E+03	0.00E+00	1.90E+03	0.00E+00
I-133	1.32E+04	1.92E+04	5.60E+03	3.56E+06	2.24E+04	0.00E+00	2.16E+03	0.00E+00
I-134	9.21E+02	1.88E+03	6.65E+02	4.45E+04	2.09E+03	0.00E+00	1.29E+03	0.00E+00
I-135	3.86E+03	7.60E+03	2.77E+03	6.96E+05	8.47E+03	0.00E+00	1.83E+03	0.00E+00
CS-134	3.96E+05	7.03E+05	7.45E+04	0.00E+00	1.90E+05	7.97E+04	1.33E+03	0.00E+00
CS-136	4.83E+04	1.35E+05	5.29E+04	0.00E+00	5.64E+04	1.18E+04	1.43E+03	0.00E+00
CS-137	5.49E+05	6.12E+05	4.55E+04	0.00E+00	1.72E+05	7.13E+04	1.33E+03	0.00E+00
CS-138	5.05E+02	7.81E+02	3.98E+02	0.00E+00	4.10E+02	6.54E+01	8.76E+02	0.00E+00
BA-139	1.48E+00	9.84E-04	4.30E-02	0.00E+00	5.92E-04	5.95E+03	5.10E+04	0.00E+00
BA-140	5.60E+04	5.60E+01	2.90E+03	0.00E+00	1.34E+01	1.60E+06	3.84E+04	0.00E+00
BA-142	3.98E-02	3.30E-05	1.96E-03	0.00E+00	1.90E-05	1.55E+03	6.93E+02	0.00E+00
LA-140	5.05E+02	2.00E+02	5.15E+01	0.00E+00	0.00E+00	1.68E+05	8.48E+04	0.00E+00
LA-142	1.03E+00	3.77E-01	9.04E-02	0.00E+00	0.00E+00	8.22E+03	5.95E+04	0.00E+00
CE-141	2.77E+04	1.67E+04	1.99E+03	0.00E+00	5.25E+03	5.17E+05	2.16E+04	0.00E+00
CE-143	2.93E+02	1.93E+02	2.21E+01	0.00E+00	5.64E+01	1.16E+05	4.97E+04	0.00E+00
CE-144	3.19E+06	1.21E+06	1.76E+05	0.00E+00	5.38E+05	9.84E+06	1.48E+05	0.00E+00
PR-144	4.79E-02	1.85E-02	2.41E-03	0.00E+00	6.72E-03	1.61E+03	4.28E+03	0.00E+00
HF-181	5.64E+04	2.66E+02	5.05E+03	2.25E+02	1.58E+02	6.72E+05	1.90E+04	0.00E+00
W-187	1.30E+01	9.02E+00	3.12E+00	0.00E+00	0.00E+00	3.96E+04	3.56E+04	0.00E+00
NP-239	3.71E+02	3.32E+01	1.88E+01	0.00E+00	6.62E+01	5.95E+04	2.49E+04	0.00E+00

19 R Values in units of mrem/yr per µCi/m^3 for inhalation and tritium, and units of m^2-mrem/yr per µCi/sec for all others.

3.6 Methodology for R-11 Setpoint (Air Particulate)

Determine the Monitor Alarm Setpoint based on the inhalation pathway to the child. The most restrictive organ 'j' will be determined from the following methodology.

3.6.1 Determine dose rate for organ 'j' (mrem/yr).

$$DR_j = (\overline{\chi/Q}) \sum_i (R_{ij} * Q_i) \tag{3.6-1}$$

where:

$(\overline{\chi/Q})$ = the highest calculated annual average relative dispersion factor for any area at or beyond the unrestricted area boundary for all sectors from Appendix A (sec/m^3).
= 8.1E-05 sec/m^3 (continuous ground release) from Table A-1, Appendix A.

R_{ij} = the organ 'j' dose factor due to gamma emissions from particulates greater than or equal to 8 day half-life, I-133, I-131, and H-3.

Q_i = the particulate release rate for radionuclide 'i' (µCi/sec).

$$Q_i = 472 * C_i * F$$

where:

472 = A conversion factor to convert cfm to cm^3/sec.

When R-11 is sampling the Plant Vent for C.V. Purges:

C_i = $\left(\frac{\mu Ci}{cm^3} \text{ from analysis of Containment Vessel} * 0.366 * DF\right) + \left(\frac{\mu Ci}{cm^3} \text{ from analysis of Plant Vent} * 0.634\right)$

0.366 = Dilution correction factor for C.V. Purge.
= $\frac{35{,}000 \text{ cfm}}{(60{,}600+35{,}000) \text{ cfm}}$

0.634 = Dilution correction factor for Plant Vent during C.V. Purge.
= $\frac{60{,}600 \text{ cfm}}{(60{,}600+35{,}000) \text{ cfm}}$

When R-11 is sampling the Plant Vent for C.V. Pressure Relief:

C_i = $\left(\frac{\mu Ci}{cm^3}\text{ from analysis of Containment Vent} * 0.040 * DF\right) + \left(\frac{\mu Ci}{cm^3}\text{ from analysis of Plant Vent} * 0.960\right)$

0.040 = Dilution correction factor for C.V. Pressure Relief.
= $\frac{2{,}500^{\dagger}\text{ cfm}}{(60{,}600+2{,}500^{\dagger})\text{ cfm}}$

0.960 = Dilution correction factor for Plant Vent during C.V. Pressure Relief.
= $\frac{60{,}600\text{ cfm}}{(60{,}600+2{,}500^{\dagger})\text{ cfm}}$

When R-11 is sampling C.V. :

C_i = $\left(\frac{\mu Ci}{cm^3}\text{ from analysis of Containment Vent} * DF\right)$

DF = Filter removal factor (dimensionless).
= 1.0 for Tritium.
= 10 for Iodines when using charcoal filters.
= 100 for Particulates ≥ 8 day half-lives when using HEPA Filters.

F = The maximum acceptable effluent flow rate at the point of release (cfm).
= 95,600 cfm for CV purge when R-11 is sampling from Plant Vent.
= 35,000 cfm for CV purge when R-11 is sampling from CV.
= 2,500 cfm for CV pressure relief when R-11 is sampling from CV.
= 63,100 cfm for CV pressure relief when R-11 is sampling Plant Vent.

† 2,500 CFM - Refer to Appendix B.3 for additional information

3.6.2 Determine the particulate emission Projected Dose Rate Ratio (PDRR) for the most critical organ 'j'.

$$PDRR_j = \frac{DR_j}{1500} \tag{3.6-2}$$

where:

1500 = the allowable organ dose rate due to particulates with ≥ 8 day half-life, I-131, I-133, H-3 (mrem/year).

3.6.3 Determine the maximum monitor setpoint concentration (μCi/cm^3) for the most critical organ 'j'.

$$Maximum\ Monitor\ Setpoint\ for\ Organ\ 'j' = \frac{\sum_i C_i}{PDRR_j} * S * T_m * TL \tag{3.6-3}$$

where:

S = 0.5, an engineering factor used to provide a margin of safety for cumulative measurement uncertainties.

T_m = 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 due to simultaneous releases from several pathways.
= 0.81 for R-11 particulate monitor.

T_L = total activity divided by $\sum_i C_i$, where the total activity is the sum of all detectable particulates from analysis of particulate filter divided by the detectable particulates of ≥ 8 day half-lives. If this ratio is not known use 1.0.
= 1.0 when R-11 sampling from Plant Vent.

3.6.4 Determine the maximum monitor setpoint (cpm) for the most critical organ 'j'.

$$Setpoint = \left(Maximum\ Monitor\ Setpoint\ for\ Organ\ 'j'in\ \frac{\mu Ci}{cm^3}\right) * (Monitor\ Eff) + Bkg \tag{3.6-4}$$

where:

Monitor Eff = monitor efficiency obtained from the applicable effluent monitor curve efficiency located in the Station Curve Book. Use the radioactivity concentration (μCi/cc) to find cpm.

Bkg = the monitor background (cpm).

3.7 Deleted

3.8 Deleted

3.9 Methodology for R-22 Setpoint Determination for the Iodine and Particulate Monitors

This section describes the methodology in determining high alarm setpoint for the particulate and iodine channels for the Environmental and Radiation Control Building (R-22) based on the inhalation pathway to the most restrictive organ and age group (child).

3.9.1

The dose rate in an unrestricted area resulting from the release of radioiodines, tritium, and particulates with half-lives ≥ 8 days is limited to 1500 mrem/yr to any organ via inhalation (10 CFR 20). The iodine and particulate monitor setpoints for R-22 are limited to 1.0% of 10 CFR 20 over one hour period. Therefore, the iodine and particulate channels high alarms shall be set to 1.0% of 10 CFR 20 for any given hour.

3.9.2 Determine Q_i, the maximum release rate (µCi/sec) for Iodine-131 and Cobalt-60 (the most restrictive particulate ≥ 8 day half-life) based on the most restrictive organ 'j' via inhalation to a child.

$$Q_i = \frac{15}{R_i * (\overline{\chi/Q})} \tag{3.9-1}$$

where:

15 = 1.0% of the maximum allowable dose rate in an unrestricted area in gaseous effluents due to radioparticulates with half-lives greater than or equal to 8 days, radioiodine, and tritium via the inhalation pathway to the child (mrem/yr).

R_i = The dose factor based on the most restrictive age group (child) and the most restrictive organ (thyroid) for Iodine-131 (1.62E+07 mrem/yr per µCi/m^3) and lung for Co-60 (7.06E+06 mrem/yr per µCi/m^3) at the most restrictive location (SITE BOUNDARY).

$(\overline{\chi/Q})$ = Annual average relative dilution for continuous ground level releases for the most restrictive section at the SITE BOUNDARY (8.08E-05 sec/m^3 for the SSE sector from Table A-1).

Therefore:

$Q_{i,Iodine\text{-}131}$ = 1.15E-02 µCi/sec

$Q_{i,Cobalt\text{-}60}$ = 2.63E-22 µCi/sec

3.9.3 Determine $S_{C,i}$, the air particulate filter and charcoal cartridge sample collection rate (µCi/sec) by:

$$S_{C,i} = Q_i * \frac{f}{F}$$

(3.9-2)

where:

f = typical value is 2.5 cfm for R-22, sampler flow rate (cfm).

F = typical value is 11,500 cfm, Environmental and Radiation Control Building exhaust vent flow rate (cfm).

Therefore:

The typical Co-60 sample collection rate is 5.72E-06 µCi/sec for R-22.

The typical I-131 sample collection rate is 2.5E-06 µCi/sec for R-22.

3.9.4 Determine $Q_{m,i}$, the setpoint activity (µCi) accumulated on the air particulate filter and charcoal filter for any given hour by:

$$Q_{m,i} = S_{C,i} * T$$

(3.9-3)

where:

T = 3600 (sec/hr).

Therefore:

The typical setpoint activity for the air particulate filter and the charcoal cartridge is:

Monitor	Particulate	Iodine
R-22	2.06E-02	9.00E-03

3.9.5 Determine HSP, the High Alarm Setpoint including background (cpm) by:

$$HSP = (Q_{m,i} * E_m) + Bkg \tag{3.9-4}$$

where:

E_m = efficiency of the detector (cpm/μCi).

Bkg = the background of the detector (cpm).

The above methodology shall be used for the iodine cartridge and air particulate filter setpoint determinations for the Environmental and Radiation Control Building. The sampling and building vent flow rates used in the above equations are subject to change and shall be controlled by plant procedures. If or when this occurs, the recalculations of setpoints shall be performed by approved procedures using the above methodology.

3.10 Radioactive Gaseous Effluent Monitoring Instrumentation

Applicability

Applies to the radioactive gaseous effluent instrumentation system.

Objective

To define the operating requirements for the radioactive gaseous effluent instrumentation system.

Specification

CONTROLS

3.10.1 The radioactive gaseous effluent monitoring instrumentation channels shown in Table 3.10-1 shall be operable with their alarm/trip setpoints set to ensure that the limits of ODCM Specification 3.2.1 are not exceeded. The alarm/trip setpoints of these channels shall be determined in accordance with the ODCM.

ACTIONS

3.10.2 With a radioactive effluent monitoring instrumentation channel alarm/trip setpoint less conservative than required by the above specification, without delay suspend the release of radioactive gaseous effluents, change the setpoint so it is acceptably conservative, or declare the channel not operable.

3.10.3 With less than the minimum number of radioactive gaseous effluent monitoring instrumentation channels operable take the action shown in Table 3.10-1.

3.10.4 The provisions of ODCM Specification 8.1 are not applicable.

BASES

Radioactive Gaseous Effluent Instrumentation

The radioactive gaseous effluent monitoring 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 setpoints for these instruments shall be calculated in accordance with the procedures in the ODCM to ensure that the alarm/trip will occur prior to exceeding the limits of 10 CFR Part 20, Appendix B, Table 2, Column 1. The operability and use of this instrumentation are consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10 CFR Part 50.

TABLE 3.10-1
RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

Release Pathway/Instrumentation	MCO*	Compensatory Measures
1. Plant Vent (R-14)		
a. Radionoble gas monitor (R14C) provides automatic termination of Waste Gas Decay Tank releases upon exceeding alarm/trip setpoint.	1	With the number of channels operable less than the MCO requirements: a. Exert best efforts to return the instruments to operable status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner in accordance with Technical Specification 5.6.3 and, b. Effluent releases via this pathway may continue provided that prior to initiating a waste gas decay tank release: 1. Two independent samples are analyzed in accordance with the Surveillance Requirements of ODCM Specification 3.2.1 and; 2. Two members of the facility staff independently verify the release rate calculations and the discharge line valving.
b. Radionoble gas monitor (R14C) monitors all effluents from Auxiliary Building Ventilation System without providing automatic termination of release upon exceeding their respective alarm setpoints.	1	With the number of channels operable less than the MCO requirement: a. Exert best efforts to return the instruments to operable status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner in accordance with Technical Specification 5.6.3 and, b. Effluent releases via this pathway may continue provided that grab samples are collected once per 12 hours and are analyzed for radionoble gases within 24 hours.

* MCO - Minimum Channels Operable

TABLE 3.10-1 (continued)
RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

Release Pathway/Instrumentation	MCO*	Compensatory Measures
1. Plant Vent (Continued)		
c. Radioiodine Sampler	1	With the number of channels operable less than the MCO requirements: a. Exert best efforts to return the instruments to operable status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner in accordance with Technical Specification 5.6.3 and, b. Effluent releases via this pathway may continue provided that a continuous sample is collected utilizing auxiliary sampling equipment as required by Table 3.12-1. (note 1)
d. Particulate Sampler	1	With the number of channels operable less than the MCO requirement: a. Exert best efforts to return the instruments to operable status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner in accordance with Technical Specification 5.6.3 and, b. Effluent releases via this pathway may be continued, provided that a continuous sample is collected utilizing auxiliary sampling equipment as required by Table 3.12-1. (note 1)
e. Sampler flow rate monitor	1	With the number of channels operable less than the MCO requirement: a. Exert best efforts to return the instruments to operable status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner in accordance with Technical Specification 5.6.3 and, b. Effluent releases via this pathway may continue provided the flow rate is estimated once per 4 hours.

* MCO - Minimum Channels Operable

TABLE 3.10-1 (continued)
RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

Release Pathway/Instrumentation	MCO*	Compensatory Measures
1. Plant Vent (Continued)		
f. Plant Vent flow rate	1	With the number of channels operable less than the MCO requirement: a. Exert best efforts to return the instruments to operable status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner in accordance with Technical Specification 5.6.3 and, b. Effluent releases via this pathway may continue provided that flow rate is estimated once per 4 hours.
2. Containment Vessel via Plant Vent		
a. Radionoble gas monitor (R-12) provides automatic termination of Containment Vessel releases upon exceeding alarm/trip Setpoint.	1	With the number of channels operable less than the MCO requirement: a. Exert best efforts to return the instruments to operable status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner in accordance with Technical Specification 5.6.3 and, b. Effluent releases via this pathway may continue provided that the Plant Vent Radionoble Gas Monitor (R14C) is operable; otherwise, suspend all releases via this pathway. (note 2)
b. Radioparticulate Monitor (R-11) provides automatic termination of containment vessel releases exceeding alarm/trip setpoints.	1	With the number of channels operable less than the MCO requirement: a. Exert best efforts to return the instruments to operable status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner in accordance with Technical Specification 5.6.3 and, b. Effluent releases via this pathway may continue provided that the Plant Vent Radionoble Gas Monitor (R14C) is operable; otherwise, suspend all releases via this pathway. (note 2)

* MCO - Minimum Channels Operable

TABLE 3.10-1 (continued)
RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

Release Pathway/Instrumentation	MCO*	Compensatory Measures
2. Containment Vessel via Plant Vent (Continued)		
c. Sampler flow rate monitor (R-11)	1	With the number of channels operable less than the MCO requirement: a. Exert best efforts to return the instruments to operable status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner in accordance with Technical Specification 5.6.3 and, b. Effluent releases via this pathway may continue provided that either the Plant Vent Radionoble Gas Monitor (R-14C) is operable or the flow rate is estimated once per 4 hours. (note 2)
3. Fuel Handling Building Lower Level Exhaust Vent		
a. Radionoble gas monitor (R-20)	1	With the number of channels operable less than the MCO requirement: a. Exert best efforts to return the instruments to operable status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner in accordance with Technical Specification 5.6.3 and, b. Effluent releases via this pathway may continue provided that grab samples are taken once per 12 hours and analyzed for radionoble gases within 24 hours.
b. Sampler flow rate monitor (R-20)	1	With the number of channels operable less than the MCO requirement: a. Exert best efforts to return the instruments to operable status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner in accordance with Technical Specification 5.6.3 and, b. Effluent releases via this pathway may continue provided the flow rate is estimated once per 4 hours.

* MCO - Minimum Channels Operable

TABLE 3.10-1 (continued)
RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

Release Pathway/Instrumentation	MCO*	Compensatory Measures
3. Fuel Handling Building Lower Level Exhaust Vent (continued)		
c. Radioiodine sampler	1	With the number of channels operable less than the MCO requirements: a. Exert best efforts to return the instruments to operable status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner in accordance with Technical Specification 5.6.3 and, b. Effluent releases via this pathway may continue provided that a continuous sample is collected utilizing auxiliary sampling equipment as required by Table 3.12-1. (note 1)
d. Particulate sampler	1	With the number of channels operable less than the MCO requirement: a. Exert best efforts to return the instruments to operable status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner in accordance with Technical Specification 5.6.3 and, b. Effluent releases via this pathway may be continued, provided that a continuous sample is collected utilizing auxiliary sampling equipment as required by Table 3.12-1. (note 1)

* MCO - Minimum Channels Operable

TABLE 3.10-1 (continued)
RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

Release Pathway/Instrumentation	MCO*	Compensatory Measures
4. Fuel Handling Building Upper Level Exhaust Vent		
a. Radionoble gas monitor (R-21) trips the exhaust and supply fans for the upper level of the Fuel Handling Building upon exceeding alarm/trip setpoint.	1	With the number of channels operable less than the MCO requirement: a. Exert best efforts to return the instruments to operable status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner in accordance with Technical Specification 5.6.3 and, b. Effluent releases via this pathway may continue provided that: 1. The Plant Vent Radionoble Gas Monitor (R14C) is operable, or; 2. Grab samples are collected once per 12 hours and are analyzed within 24 hours for radionoble gases.
b. Sampler flow rate monitor (R-21)	1	With the number of channels operable less than the MCO requirement: a. Exert best efforts to return the instruments to operable status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner in accordance with Technical Specification 5.6.3 and, b. Effluent releases via this pathway may continue provided the flow rate is estimated once per 4 hours.

* MCO - Minimum Channels Operable

TABLE 3.10-1 (continued)
RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

Release Pathway/Instrumentation	MCO*	Compensatory Measures
5. E&RC Building Exhaust (R-22)		
a. Radionoble gas monitor (R-22C) monitors all effluents from E&RC Laboratory Building Ventilation System without providing automatic termination of release upon exceeding their respective alarm setpoints.	1	With the number of channels operable less than the MCO requirement: a. Exert best efforts to return the instruments to operable status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner in accordance with Technical Specification 5.6.3 and, b. Effluent releases via this pathway may continue provided that grab samples are collected once per 12 hours and are analyzed for radionoble gases within 24 hours.
b. Radioiodine Sampler	1	With the number of channels operable less than the MCO requirements: a. Exert best efforts to return the instruments to operable status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner in accordance with Technical Specification 5.6.3 and, b. Effluent releases via this pathway may continue provided that a continuous sample is collected utilizing auxiliary sampling equipment as required by Table 3.12-1. (note 1)
c. Particulate Sampler	1	With the number of channels operable less than the MCO requirements: a. Exert best efforts to return the instruments to operable status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner in accordance with Technical Specification 5.6.3 and, b. Effluent releases via this pathway may continue provided that a continuous sample is collected utilizing auxiliary sampling equipment as required by Table 3.12-1. (note 1)

* MCO - Minimum Channels Operable

TABLE 3.10-1 (continued)
RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

Release Pathway/Instrumentation	MCO*	Compensatory Measures
5. E&RC Building Exhaust (Continued)		
d. Sampler flow rate gauge	1	With the number of channels operable less than the MCO requirement: a. Exert best efforts to return the instruments to operable status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner in accordance with Technical Specification 5.6.3 and, b. Effluent releases via this pathway may continue provided the flow rate is estimated once per 4 hours.
6. Radwaste Building Exhaust		
a. Radioiodine Sampler	1	With the number of channels operable less than the MCO requirements: a. Exert best efforts to return the instruments to operable status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner in accordance with Technical Specification 5.6.3 and, b. Effluent releases via this pathway may continue provided that a continuous sample is collected utilizing auxiliary sampling equipment as required by Table 3.12-1. (note 1)
b. Particulate Sampler	1	With the number of channels operable less than the MCO requirements: a. Exert best efforts to return the instruments to operable status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner in accordance with Technical Specification 5.6.3 and, b. Effluent releases via this pathway may continue provided that a continuous sample is collected utilizing auxiliary sampling equipment as required by Table 3.12-1. (note 1)

* MCO - Minimum Channels Operable

TABLE 3.10-1 (continued)
RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

Release Pathway/Instrumentation	MCO*	Compensatory Measures
6. Radwaste Building Exhaust (Continued)		
c. Sampler flow rate gauge	1	With the number of channels operable less than the MCO requirement: a. Exert best efforts to return the instruments to operable status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner in accordance with Technical Specification 5.6.3 and, b. Effluent releases via this pathway may continue provided the flow rate is estimated once per 4 hours.
7. Deleted.	NA	NA

* MCO - Minimum Channels Operable

NOTES TO TABLE 3.10-1

Note 1 - No auxiliary sampling is required for periods when normal sampling is off $\leq$ 45 minutes.

Note 2 - This MCO is required during Modes 1, 2, 3, 4, and during the movement of recently irradiated fuel assemblies within the containment.

3.11 Radioactive Gaseous Effluent Monitoring Instrumentation Surveillance Requirements

Applicability

Applies to the radioactive gaseous effluent instrumentation system.

Objective

To ascertain that the radioactive gaseous effluent instrumentation system is functioning properly in order to accurately monitor radioactive gaseous effluent releases.

Specification

SURVEILLANCE REQUIREMENTS

3.11.1 Each radioactive gaseous effluent monitoring instrumentation channel shall be demonstrated operable by performance of the channel check, source check, channel calibration, and Channel Operational Test operations at the frequencies shown in Table 3.11-1.

TABLE 3.11-1
RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

Pathway / Instruments	Channel Check	Source Check	Channel Calibration	Channel Operational Test
1. Plant Vent (R-14)				
a. (Deleted)	(Deleted)	(Deleted)	(Deleted)	(Deleted)
b. (Deleted)	(Deleted)	(Deleted)	(Deleted)	(Deleted)
c. Radionoble gas (R14C)	P (Note 4)/D	P (Note 4)/M	R (Note 2)	Q (Note 5)
d. Sampler flow rate	D (Note 1)	N.A.	R	Q
e. Plant Vent flow rate monitor (F14)	D (Note 1)	N.A.	R	Q
2. Containment Vessel via Plant Vent				
a. Radioparticulate Monitor (R-11)	D	D	C (Note 2)	Q
b. Radionoble gas monitor (R-12)	D	P (Note 3)	C (Note 2)	Q
c. Sampler flow rate monitor (R-12)	D	N.A.	R	Q
3. Fuel Handling Building Lower Level Exhaust Vent				
a. Radionoble gas monitor (R-20)	D	M	C (Note 2)	Q
b. Sampler flow rate monitor (R-20)	D (Note 1)	N.A.	N.A.	N.A.
4. Fuel Handling Building Upper Level Exhaust Vent				
a. Radionoble gas monitor (R-21)	D	M	C (Note 2)	Q
b. Sampler flow rate monitor (R-21)	D (Note 1)	N.A.	N.A.	N.A.
5. Environmental and Radiation Control Laboratory Exhaust				
a. Radionoble gas monitor (R-22C)	D	M	C (Note 2)	Q
b. Sampler flow rate monitor (R-22)	D (Note 1)	N.A.	N.A.	N.A.
6. Radwaste Building Exhaust				
a. Sampler flow rate monitor	D (Note 1)	N.A.	N.A.	N.A.
7. Deleted.	N.A.	N.A.	N.A.	N.A.

NOTES TO TABLE 3.11-1

Note 1 The channel check shall consist of verifying indication of flow whenever plant conditions dictate that flow is supposed to be present.

Note 2 The channel calibration shall be performed using one or more of the reference standards certified by the National Institute of Standards and Technology (NIST) or using standards that have been obtained from suppliers that participate in measurement assurance activities or otherwise NIST traceable.

Note 3 Prior to each containment release.

Note 4 Prior to each Waste Gas Decay Tank release.

Note 5 The Channel Operational Test shall also demonstrate that automatic isolation of this pathway and control room alarm annunciation occur if any of the following conditions exists:

1. Instrument indicates measured levels above the alarm/trip setpoint.
2. Power failure.
3. Channel Fail Alarm.

Note 6 The Channel Operational Test shall also demonstrate that Control Room alarm annunciation occurs if any of the following conditions exists:

1. Instrument indicates measured levels above the alarm setpoint.
2. Power failure.
3. Instrument indicates a downscale failure.
4. Instrument controls not set in operate mode.

NOTATION

P Completed prior to making a radioactive materials release
D At least once per 24 hours
W At least once per 7 days
N.A. Not applicable
M At least once per 31 days
R At least once per 18 months
Q At least once per 92 days
C At least once per 24 months

3.12 Radioactive Gaseous Effluents Sampling and Analysis Requirements

Applicability

Applies to the monitoring of radioactive gaseous effluents.

Objective

To ascertain that radioactive gaseous effluent releases are being maintained as low as reasonably achievable and within allowable limits.

Specification

SURVEILLANCE REQUIREMENTS

3.12.1 The dose rate due to radioactive materials in gaseous effluents shall be determined to be within the limits of ODCM Specification 3.2.1 in accordance with the methods and procedures of the ODCM by obtaining representative samples and performing analyses in accordance with the sampling and analysis program specified in Table 3.12-1.

TABLE 3.12-1

RADIOACTIVE GASEOUS WASTE SAMPLING ANALYSIS PROGRAM

Type of Release	Sampling Frequency	Minimum Analysis Frequency	Required Activity Analysis	Required LLD [a] µCi/ml
Waste Gas Decay Tanks	P	P	Principal Gamma Emitters [c]	1E-04
			Tritium	1E-06
Containment Pressure Reliefs and Containment Purges	P , M [e] Grab Sample	P , M [e] on Grab Sample	Principal Gamma Emitters [c]	1E-04
			Tritium	1E-06
Continuous Releases 1. Plant Vent 2. E&RC Building 3. Lower Fuel Handling Building 4. Radwaste Building [k]	M [e, g, h] Grab Sample for Radionoble Gases and Tritium	M [e] on Grab Sample	Principal Gamma Emitters [c]	1E-04
			Tritium	1E-06
	Continuous [d, j] Radioiodine Sample	W [f]	I-131 I-133 on Sample	1E-12 1E-10
	Continuous [d, j] Particulate Sample	W [f] on Sample	Principal Gamma Emitters [c]	1E-11
	Continuous [d] Particulate Samples to be Composited	Q On Composite	Sr-89, Sr-90	1E-11
		M On Composite	Alpha	1E-11
	Continuous	Noble Gas Monitor	Noble Gases Gross Beta and Gamma	2E-5 µCi/cm^3

TABLE 3.12-1 NOTATION

a. Lower Limit of Detection (LLD) is an "a priori" limit representing the capability of a measurement system. LLD is calculated in accordance with methodology established in ODCM Table 2.8-1, Note a.

b. (deleted)

c. The principal gamma emitters for which the LLD specification applies exclusively are the following radionuclides: Kr-87, Kr-88, Xe-133, Xe-133m, Xe-135, and Xe-138 for gaseous emissions, I-131 for halogen emissions, and Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, Ce-141, and Ce-144 for particulate emissions. This list does not mean that only these nuclides are to be detected and reported. Other peaks which are measurable and identifiable, together with the above nuclides, shall also be identified and reported.

d. The ratio of the sample flow rate to the sampled stream flow rate shall be known for the time period covered by each dose or dose rate calculation.

e. Sampling and analysis shall also be performed following shutdown, startup, or a power change exceeding 15 percent of rated power within one hour unless (1) analysis shows that the dose equivalent I-131 concentration in the primary coolant has not increased more than a factor of 3; (2) the noble gas activity monitor shows that effluent activity has not increased by more than a factor of 3.

f. Samples shall be changed once per 7 days and analyses shall be completed within 48 hours after changing (or after removal from sampler). Sampling and analyses shall also be performed once per 24 hours for 7 days following shutdown, start-up or thermal power level change exceeding 15% of rated thermal power in one hour and if I-131 Dose Equivalent in the RCS is greater than 0.1 $\mu Ci/cm^3$. When samples collected for 24 hours are analyzed, the corresponding LLD's may be increased by a factor of 10. The analyses shall be performed within 48 hours.

g. Tritium grab samples shall be taken at least once per 24 hours when the refueling canal is flooded.

h. 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.

i. (deleted)

j. No auxiliary sampling is required for periods when normal sampling is off ≤ 45 minutes.

TABLE 3.12-1 NOTATION (continued)

k. Monthly grab samples to be analyzed for principle gamma emitters and tritium are not applicable for the Radwaste Building release point. Additionally, the Radwaste Building release point does not have a noble gas monitor and, therefore, the noble gas monitor requirements do not apply.

NOTATION

P Completed prior to making a radioactive materials release
W At least once per 7 days
M At least once per 31 days
Q At least once per 92 days

3.13 Radionoble Gases - Cumulative Doses

Applicability

Applies to the determination of cumulative doses from radionoble gases.

Objective

To ascertain that cumulative doses from radionoble gases are being maintained as low as reasonably achievable and within allowable limits.

Specification

SURVEILLANCE REQUIREMENTS

3.13.1 Cumulative dose commitments for the current calendar quarter and current calendar year shall be determined in accordance with the ODCM once per 31 days.

3.14 Radioiodines, Radioactive Materials in Particulate Form, and Radionuclides Other Than Radionoble Gases - Cumulative Doses

Applicability

Applies to the determination of cumulative doses from radioiodines, radioactive materials in particulate form, and radionuclides other than radionoble gases.

Objective

To ascertain that cumulative doses form radioiodines, radioactive materials in particulate form, and radionuclides other than radionoble gases are maintained as low as reasonably achievable and within allowable limits.

Specification

SURVEILLANCE REQUIREMENTS

3.14.1 Cumulative dose contributions for the current calendar quarter and current calendar year for I-131, I-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.

3.15 Gaseous Radwaste and Ventilation Exhaust Treatment Systems

Applicability

Applies to the gaseous radwaste and ventilation exhaust treatment systems.

Objective

To define the operating requirements for the gaseous radwaste and ventilation exhaust treatment systems and to ascertain that the concentration of radioactive materials in the gaseous radwaste and ventilation exhaust treatment systems is maintained as low as reasonably achievable and within allowable limits.

Specification

CONTROLS

3.15.1 The appropriate portions of the Gaseous Radwaste Treatment System and the Ventilation Exhaust Treatment System shall be maintained and used to reduce the concentrations of radioactive materials in gaseous wastes prior to their discharge when the projected dose commitments due to the release of gaseous effluents to unrestricted areas (See Figure 7-1) when averaged over a calendar quarter would exceed:

a. 0.6 mrem for gamma radiation and 1.3 mrem for beta radiation due to radionoble gases

OR

b. 1.0 mrem to any organ due to radioiodines, radioactive materials in particulate form, and radionuclides other than radionoble gases.

ACTIONS

3.15.2 With the Gaseous Radwaste Treatment System and/or the Ventilation Exhaust Treatment System not operable and with radioactive gaseous wastes being discharged without treatment while in excess of the limits of ODCM Specification 3.15.1 above, prepare and submit a report to the Commission in accordance with ODCM Specification 9.3.b.

SURVEILLANCE REQUIREMENTS

3.15.3 Dose commitments due to gaseous releases shall be projected at least once per 31 days, in accordance with the ODCM to ensure the provisions of ODCM Specification 3.15.1 are satisfied.

BASES

Gaseous Radwaste and Ventilation Exhaust Treatment Systems

The requirements that the appropriate portions of these systems be maintained and used when specified provides reasonable assurance that the releases of radioactive materials in gaseous effluents will be kept "as low as reasonably achievable". This specification implements the requirements of 10 CFR Part 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50, and the design objectives given in Section II.D of Appendix I to 10 CFR Part 50. The specified limits governing the use of appropriate portions of the systems were specified as the dose design objectives set forth in Section II.B and II.C of Appendix I, 10 CFR Part 50, for gaseous effluents.

3.16 Methodology for Carbon-14 Dose

Applicability

Applies to the determination of cumulative doses from the releases of C-14 from gaseous effluent releases.

Objective

To define the methodology to be used for the determination of the cumulative doses from C-14 from release of gaseous effluents.

Specification

SURVEILLANCE REQUIREMENTS

3.16.1 Cumulative dose commitments from the release of C-14 in gaseous effluents shall be determined once per year in accordance with the ODCM.

CONTROLS

3.16.2 Annual Dose from Inhalation of Carbon-14 Releases in Air.

3.16.2.1 Airborne Concentration for Short Term Mixed Mode Release at Receptor.

Determine the annual average airborne concentration pCi/m^3 for C-14 at the location with respect to the release point for short term mixed mode releases from WGDT and Containment releases.

$$X_S = 3.17x10^4 * Q_{SY} * \left(\overline{\chi/q}\right)_v \qquad (3.16\text{-}1)$$

where:

X_S = The annual average ground-level concentration of C-14 in air from short term mixed mode WGDT and Containment Building releases (pCi/m^3).

$\left(\overline{\chi/q}\right)_v$ = Annual average relative concentration for the short term mixed mode plant vent releases, < 500 hrs/yr, from Table A-16, (2.90E-06 sec/m^3).

$3.17x10^4$ = The number of pCi/Ci divided by the number of sec/yr.

Q_{SY} = Estimated pro-rated release rate of C-14 for short term mixed mode releases based on actual EFPD for the year.

= $Q_S * \frac{EFPD}{292}$

where:

Q_S = 2.8 Ci/yr for short term mixed mode releases, Table 3.16-3.

EFPD = Effective full power days for the year.

292 = Effective full power days per year which NUREG-0017 release rates are based on.

3.16.2.2 Airborne Concentration for Long Term Mixed Mode Release at Receptor.

Determine the annual average airborne concentration pCi/m^3 for C-14 at the location with respect to the release point for long term mixed mode releases from the Auxiliary Building and Upper Fuel Handling Building.

$$X_L = 3.17x10^4 * Q_{LY} * \left(\overline{\chi/Q}\right)_v \tag{3.16-2}$$

where:

X_L = The annual average ground-level concentration of C-14 in air from mixed mode long term releases from Auxiliary Building and Upper Fuel Handling Building Releases (pCi/m^3).

$\left(\overline{\chi/Q}\right)_v$ = Annual average relative concentration for the long term plant vent mixed mode releases, > 500 hrs/yr, from Table A-10, (9.94E-07 sec/m^3)

$3.17x10^4$ = The number of pCi/Ci divided by the number of sec/yr.

Q_{LY} = Estimated pro-rated release rate of C-14 for long term mixed mode releases based on actual EFPD for the year.

= $Q_L * \frac{EFPD}{292}$

where:

Q_L = 4.5 Ci/yr for short term mixed mode releases, Table 3.16-4.

EFPD = Effective full power days for the year.

292 = Effective full power days per year which NUREG-0017 release rates are based on.

3.16.2.3 Inhalation Dose.

Determine the annual inhalation dose from C-14, to organ (j) to an age group (a) for both the short term and long term releases using the following equation:

$$D_{ja,Inhal} = U_{ga} * DFA_{ja} * (X_S + X_L) \tag{3.16-3}$$

where:

$D_{ja,Inhal}$ = Annual dose from inhalation to an organ (j) of an age group (a) from C-14 (mrem/yr).

U_{ga} = Inhalation rate for age group (a), Section B.2.1 (m^3/yr).

DFA_{ja} = Dose factor for an organ (j) from C-14 for the inhalation pathway to an age group (a), Table 3.16-1 (mrem/pCi).

X_s = Annual average ground-level concentration of C-14 in air from WGDT and Containment Building short term mixed mode releases (pCi/m^3).

X_L = Annual average ground-level concentration of C-14 in air from Aux. Building, Upper Fuel Handling Building long term mixed mode releases (pCi/m^3).

3.16.3 Annual Dose from Ingestion of Carbon-14 Released in Air.

3.16.3.1 Concentration of Airborne Carbon-14 in vegetation.

Determine the concentration of Carbon-14 in vegetation at location with respect to the release point for both the short term and long term releases using the following equation:

$$C_V = 3.17x10^7 * p * \frac{0.11}{0.16} * \left[\left(Q_{SY} * 0.30 * \left(\overline{\chi/q}\right)_v\right) + \left(Q_{LY} * 0.30 * \left(\overline{\chi/Q}\right)_v\right)\right] \quad (3.16\text{-}4)$$

where:

C_V	=	The concentration of C-14 in vegetation (pCi/kg)
$3.17x10^7$	=	(10^{12} pCi/Ci) * (10^3 g/kg) / (3.15E+07 sec/yr)
p	=	1.0, the fractional equilibrium ratio fraction (dimensionless).
0.11	=	Fraction of total plant mass that is natural carbon (dimensionless).
0.16	=	Concentration of natural carbon in the atmosphere (g/m^3).
0.30	=	Fractional estimate of C-14 as CO_2, EPRI Technical Report 1021106, 2010, page 4-28 (dimensionless).
$\left(\overline{\chi/q}\right)_v$	=	Annual average relative concentration for the short term plant vent mixed mode releases, < 500 hrs/yr, from Table A-16 (2.90E-06 sec/m^3).
$\left(\overline{\chi/Q}\right)_v$	=	Annual average relative concentration for the long term plant vent mixed mode releases, >500 hrs/yr, from Table A-10 (9.94E-07 sec/m^3).

3.16.3.2 Concentration of Airborne Carbon-14 in Milk.

Determine the concentration of Carbon-14 in milk at location with respect to the release point for both the short and long term releases.

$$C_M = F_M * C_V * Q_f \tag{3.16-5}$$

where:

C_M = The concentration of C-14 in milk (pCi/L).

F_M = 0.012 days/liter, average fraction of the animal's daily intake of C-14 that appears in each liter of milk.

C_V = The concentration of C-14 in vegetation (pCi/kg).

Q_f = Amount of feed consumed by the animal per day, Table B-1 (kg/day).

3.16.3.3 Concentration of Airborne Carbon-14 in Meat.

Determine the concentration of Carbon-14 in meat at location with respect to the release point for both the short term and long term releases.

$$C_{Meat} = F_f * C_V * Q_f \tag{3.16-6}$$

where:

C_{Meat} = The concentration of C-14 in meat (pCi/kg).

F_f = 0.031 days/kg, average fraction of the animal's daily intake of C-14 that appears in each kilogram of flesh.

C_V = The concentration of C-14 in vegetation (pCi/kg).

Q_f = Amount of feed consumed by the animal per day, Table B-1 (kg/day).

3.16.3.4 Annual Dose from Ingestion (Produce, Milk, Meat & Leafy Vegetation).

Determine the annual dose from atmospherically released Carbon-14 from foods for both short term and long term releases.

$$D_{ja,Ingest} = DFI_{ja} * \left[\left(U_a^S * f_g * C_V\right) + \left(U_{ap,Milk} * C_{Milk}\right) + \left(U_{ap,Meat} * C_{Meat}\right) + \left(U_a^L * f_L * C_V\right)\right] \quad (3.16\text{-}7)$$

where:

$D_{ja,Ingest}$	=	The annual dose to organ (j) of an individual in age group (a) resulting from ingestion of C-14 in produce, milk, meat, and leafy vegetables for both the short term and long term releases (mrem/yr).
DFI_{ja}	=	The dose conversion factor for the ingestion of Carbon-14, organ (j), and age group (a), Table 3.16-2 (mrem/pCi).
U_a^S	=	Ingestion rate of produce (non-leafy vegetables, fruit, grains), Table B-3 (kg/yr).
f_g	=	0.76, fraction of produce ingested grown in garden of interest (dimensionless).
C_V	=	The concentration of C-14 in vegetation (pCi/kg).
$U_{ap,Milk}$	=	Ingestion rate of milk, Table B-1 (L/yr).
C_{Milk}	=	The concentration of C-14 in milk (pCi/L).
$U_{ap,Meat}$	=	Ingestion rate of meat and poultry, Table B-1 (kg/yr).
C_{Meat}	=	The concentration of C-14 in meat (pCi/kg).
U_a^L	=	Ingestion rate of leafy vegetables, Table B-3 (kg/yr).
f_L	=	1.0, fraction of leafy vegetables grown in garden of interest (dimensionless).

3.16.4 Total Annual Dose from Inhalation and Food Consumption for Carbon-14 Releases.

Determine the total annual C-14 dose to organ (j) in an age group (a) for inhalation and ingestion for both the short term and long term releases using the following equation:

$$D_{ja,Tot} = D_{ja,Inhal} + D_{ja,Ingest} \tag{3.16-8}$$

where:

$D_{ja,Tot}$	=	The total annual C-14 dose to an organ (j) of an individual in age group (a) resulting from the inhalation and ingestion of C-14 from short term and long term mixed mode releases (mrem/yr).
$D_{ja,Inhal}$	=	The annual inhalation dose from C-14, to organ (j) in an age group (a) (mrem/yr).
$D_{ja,Ingest}$	=	The annual ingestion dose from C-14, to organ (j) in an age group (a) (mrem/yr).

TABLE 3.16-1
INHALATION DOSE FACTORS FROM CARBON-14

Age Group	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

NRC regulatory Guide 1.109, Rev. 1, Tables E-7 to E-10

TABLE 3.16-2
INGESTION DOSE FACTORS FROM CARBON-14

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

NRC regulatory Guide 1.109, Rev. 1, Tables E-11 to E-14

TABLE 3.16-3
CARBON-14 SOURCE TERMS

Release Points	Ci/yr Released
Containment Building	1.6
Aux. Bldg. & Fuel Handling	4.5
Waste Decay Tanks	1.2
Total	7.3

NUREG-0017, REV 1 (GALE CODE) SECTION 2.2.25.2, PAGE 2-90, TABLES 2-38 & 2-39, SECTION 1.5.1.1 CAPACITY FACTOR = 80% (292 EFFECTIVE FULL POWER DAYS/YR)

BASES

Carbon-14 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 according to NUREG-0017 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 based on land–use census are evaluated using the highest mixed mode χ/Q value in Appendix A for short and long term releases. These could include milk, meat and vegetable ingestion, and inhalation pathways. Atmosphere Carbon Dioxide (CO_2) is incorporated in cellular material by the photosynthetic actions of green plants. Plants and grasses, from which most foodstuff 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 organic form.

To show compliance with 10 CFR 50, equation 3.16-8 is evaluated at the limiting pathway location. At HBR this location is the vegetable garden 0.3 miles in the SSE sector. The critical receptor is a child.

RNP ODCM Radiological Environmental Monitoring Program 4.2.1 requires that a land-use census survey be conducted on an annual basis. Depending on the results of the survey, a new limiting location could result.

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

4.0 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

4.1 Monitoring Program - Implementation

Applicability

Applies to the radiological environmental monitoring program.

Objective

To define the requirements for implementation of the radiological environmental monitoring program.

Specification

CONTROLS

4.1.1 The Radiological Environmental Monitoring Program shall be conducted as specified in Table 4.1-1.

ACTIONS

4.1.2 With the Radiological Environmental Monitoring Program not being conducted as specified in Table 4.1-1, prepare and submit to the Commission, in the Annual Radiological Environmental Operating Report required by Technical Specification 5.6.2, a description of the reasons for not conducting the program as required and the plans for preventing a recurrence.

4.1.3 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 4.1-2 when averaged over any calendar quarter, prepare and submit to the Commission within 30 days, pursuant to ODCM Specification 9.5, 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 ODCM Specifications 2.4.1, 3.4.1, and 3.5.2.1. When more than one of the radionuclides in Table 4.1-2 are detected in the sampling medium, this report shall be submitted if:

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

When radionuclides other than those in Table 4.1-2 are detected and are the result of plant effluents, this report shall be submitted if the potential annual dose* to a member of the public is equal to or greater than the calendar year limits of ODCM Specifications 2.4.1, 3.4.1, and 3.5.2.1. This report is not required if the measured level of radioactivity was not the result of plant effluents; however, in such an event, the condition shall be reported and described in the Annual Radiological Environmental Operating Report.

* the methodology and parameters used to estimate the potential annual dose to a member of the public shall be indicated in this report.

4.1.4 With milk or fresh leafy vegetable samples unavailable from one or more of the sample locations required by Table 4.1-1, identify locations for obtaining replacement samples and add them to the radiological environmental monitoring program within 30 days. The specific locations from which samples were unavailable may then be deleted from the monitoring program. Pursuant to Technical Specification 5.6.2, identify the cause of the unavailability of samples and identify the new location(s) for obtaining replacement samples in the next Annual Radioactive Effluent Release Report and also include in the report a revised figure(s) and table for the ODCM reflecting the new location(s).

4.1.5 The provisions of ODCM Specification 8.1 are not applicable.

4.1.6 Deviations are permitted from the required sampling schedule if specimens are unobtainable due to hazardous conditions, seasonal unavailability, or to malfunction of automatic sampling equipment. If the latter, every effort shall be made to complete corrective action prior to the end of the next sampling period.

BASES

Monitoring Program

The radiological environmental monitoring program required by this specification provides representative measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides that lead to the highest potential radiation exposures of members of the public resulting from the station operation. This monitoring program implements Section IV.B.2 of Appendix I to 10 CFR Part 50 and thereby supplements the radiological effluent monitoring program by verifying that the measurable concentrations of radioactive materials and levels of radiation are not higher than expected on the basis of the effluent measurements and the modeling of the environmental exposure pathways. Guidance for this monitoring program is provided by the Radiological Assessment Branch Technical Position on Environmental Monitoring. The initially specified monitoring program will be effective for at least the first three 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 (LLD). The LLDs required by Table 4.1-3 are considered optimum for routine environmental measurements in industrial laboratories. It should be recognized that the LLD is defined as an a priori (before the fact) limit representing the capability of a measurement system and not as 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 (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).

TABLE 4.1-1
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Number of Representative Samples and Sample Locations	Sampling and Collection Frequency	Type and Frequency of Analysis
1. DIRECT RADIATION[a]	33 routine monitoring stations with two or more dosimeters or with one instrument for measuring and recording dose rate continuously, placed as follows:	Quarterly	Gamma dose quarterly.
	an inner ring of stations, one in each of the 16 meteorological sectors in the general area of the site boundary;		
	an outer ring of stations, one in each of the 16 meteorological sectors in the 6- to 8-km range from site;		
	area to serve as a control[b] station.		
2. AIRBORNE Radioiodine and Particulates	Samples from 5 locations 3 samples from close to the 3 site boundary locations, in different sectors, of the highest calculated annual average ground level D/Q.	Continuous sampler operation with sample collection weekly, or more frequently if required by dust loading.	Radioiodine Canister: I-131 analysis weekly. Particulate Sampler: Gross beta radioactivity analysis following filter change; Gamma isotopic analysis[d] of composite (by location) quarterly.
	1 sample from the vicinity of a community having the highest calculated annual average ground level D/Q.		
	1 sample from a control[b] location, as for example 15-30 km distant and in the least prevalent wind direction.		

TABLE 4.1-1 (continued)
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Number of Representative Samples and Sample Locations	Sampling and Collection	Type and Frequency of Analysis
3. WATERBORNE a. Surface [e]	1 sample upstream control location [b] 1 sample downstream	Composite sample over 1-month period [f]	Gamma isotopic analysis [d] monthly. Composite for tritium analysis quarterly.
b. Ground [g]	1 sample	Quarterly	Gamma isotopic [d] and tritium analysis quarterly.
c. Sediment from shoreline	1 sample from downstream area with existing or potential recreational value	Semiannually	Gamma isotopic analysis [d] semiannually.
4. INGESTION a. Milk [j]	1 sample from milking animals within 5 km distance having the highest dose potential. If there are none, then, 1 sample from milking animals between 5 to 8 km distant where doses are calculated to be greater than 1 mrem per year [h].	Semimonthly when animals are on pasture, monthly at other times	Gamma isotopic [d] and I-131 analysis semimonthly when animals are on pasture; monthly at other times.
	1 sample from milking animals at a control location. [b] 15-30 km distant and in the least prevalent wind direction.		
b. Fish	1 sample of recreationally important species in vicinity of plant discharge area including at least one free swimmer and one bottom feeder.	Semiannually	Gamma isotopic analysis [d] on edible portions semiannually.
	1 sample of comparable species in areas not influenced by plant discharge to serve as control location.[b]		
c. Food Products	1 sample of each principal class of food products from any area that is irrigated by water in which liquid plant wastes have been discharged.	At time of harvest [i]	Gamma isotopic analyses [d] on edible portion
	Samples of 3 different kinds of broad leaf vegetation grown nearest each of two different locations at or near the site boundary of highest predicted annual average ground level D/Q if milk sampling is not performed.	Monthly during growing season[k]	Gamma isotopic [d] and I-131 analysis.
	1 sample of each of the similar broad leaf vegetation grown 15-30 km distant in the least prevalent wind direction if milk sampling is not performed.	Monthly during growing season[k]	Gamma isotopic [d] and I-131 analysis.

TABLE 4.1-1 NOTATION

a. One or more instruments, such a as 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.

b. The purpose of this sample is to obtain background information.

c. Airborne particulate sample filters shall be analyzed for gross beta radioactivity 24 hours or more after sampling to allow for radon and thoron daughter decay. If gross beta activity in air particulate samples is greater than ten times the yearly mean of control samples, gamma isotopic analysis shall be performed on the individual samples.

d. Gamma isotopic analysis means the identification and quantification of gamma-emitting radionuclides that may be attributable to the effluents from the facility.

e. 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.

f. A composite sample is one 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.

g. Ground water 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.

h. The dose shall be calculated for the maximum organ and age group, using the methodology and parameters in the ODCM.

i. If harvest occurs more than once a year, sampling shall be performed during each discrete harvest. If harvest occurs continuously, sampling shall be monthly. Attention shall be paid to including samples of tuberous and root food products.

j. There are currently no identified milk producing animals. Doses to a MEMBER OF THE PUBLIC due to a milk pathway will be evaluated annually, but not included in the annual report. Doses via this pathway will be estimated as ≤ 1 mrem/yr, unless it can be shown to exist.

k. Broad leaf vegetation refers to any natural vegetation, plants, shrubs, or trees that have wide, flat leaves with veins which branch from a main vein. Typically, leaves are only present during the growing season May through October.

TABLE 4.1-2
REPORTING LEVELS FOR RADIOACTIVITY CONCENTRATIONS IN ENVIRONMENTAL SAMPLES

Radionuclide	Water (pCi/l)	Airborne (pCi/m^3)	Fish (pCi/Kg, wet)	Milk (pCi/l)	Food Products (pCi/Kg, wet)
H-3	2E+04[a]				
Mn-54	1E+03		3E+04		
Fe-59	4E+02		1E+04		
Co-58	1E+03		3E+04		
Co-60	3E+02		1E+04		
Zn-65	3E+02		2E+04		
Zr-Nb-95	4E+02				
I-131	2E+00[b]	9E-01		3E+00	1E+02
Cs-134	3E+01	1E+01	1E+03	6E+01	1E+03
Cs-137	5E+01	2E+01	2E+03	7E+01	2E+03
Ba-La-140	2E+02			3E+02	

[a] For drinking water samples. This is a 40 CFR Part 141 value. If no drinking water pathway exists, a value of 30,000 pCi/l may be used.

[b] If no drinking water pathway exists, a value of 20 pCi/l may be used.

TABLE 4.1-3
LOWER LIMITS OF DETECTION (LLD)[a]

Analysis	Water (pCi/l)	Airborne (pCi/m^3)	Fish (pCi/Kg,wet)	Milk (pCi/l)	Food Products (pCi/Kg,wet)	Sediment (pCi/Kg,dry)
gross beta		1E-02				
H-3	2E+03[c]					
Mn-54	1.5E+01		1.3E+02			
Fe-59	3E+01		2.6E+02			
Co-58,60	1.5E+01		1.3E+02			
Zn-65	3E+01		2.6E+02			
Zr-Nb-95[b]	1.5E+01					
I-131	1.0E+00[d]	7E-02		1E+00	6E+01	
Cs-134	1.5E+01	5E-02	1.3E+02	1.5E+01	6E+01	1.5E+02
Cs-137	1.8E+01	6E-02	1.5E+02	1.8E+01	8E+01	1.8E+02
Ba-La-140[b]	1.5E+01			1.5E+01		

TABLE 4.1-3 NOTATION

a. The LLD is defined, for purposes of these specifications, as the smallest concentration of radioactive material in a sample that will yield a net count, above system background, that will be detected with 95% probability with only 5% probability of falsely concluding that a blank observation represents a "real" signal.

For a particular measurement system, which may include radiochemical separation:

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

where:

LLD is the "a priori" lower limit of detection as defined above, as picocuries per unit mass or volume,

S_b is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate, as counts per minute,

E is the counting efficiency, as counts per disintegration,

V is the sample size in units of mass or volume,

2.22 is the number of disintegrations per minute per picocurie,

Y is the fractional radiochemical yield, when applicable,

λ is the radioactive decay constant for the particular radionuclide, and

Δt for environmental samples is the elapsed time between sample collection, or end of the sample collection period, and time of counting

Typical values of efficiency (E), volume/mass (V), chemical yield (Y), and radionuclide decay correction time (Δt) are to be used in the calculation.

It should be recognized that the LLD is defined as 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. Analysis 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 Technical Specification 5.6.2.

TABLE 4.1-3 NOTATION (continued)

b. The specified LLD applies to the daughter nuclide of an equilibrium mixture of the parent and daughter nuclides.

c. If no drinking water pathway exists, a value of 3,000 pCi/l may be used.

d. If no drinking water pathway exists, a value of 15 pCi/l may be used.

4.2 Land Use Census - Implementation

Applicability

Applies to the land use census.

Objective

To define the requirements for the conduct of the land use census.

Specification

CONTROLS

4.2.1 A land use census shall be conducted and shall identify the location of the nearest milk animal, the nearest residence and the nearest garden of greater than 500 square feet producing fresh leafy vegetables in each of the 16 meteorological sectors within a distance of five miles.

ACTIONS

4.2.2 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 ODCM Specification 3.14.1, identify the new location(s) in the next Annual Radioactive Effluent Release report, pursuant to Technical Specification 5.6.3.

4.2.3 With the land use census identifying a location which yields an annual calculated dose or dose commitment of a specific pathway which is 20% greater than that at a current sampling location:

a. Add the new location(s) to the radiological environmental monitoring program within 30 days.

AND

b. If desired, delete the sampling location having the lowest calculated dose or dose commitments via the same exposure pathway, excluding the control station location, from the monitoring program after October 31 of the year in which the land use census was conducted.

AND

c. Identify the new location(s) in the next Annual Radioactive Effluent Release Report, Technical Specification 5.6.3, including a revised figure(s) and table for the ODCM reflecting the new location(s).

BASES

Land Use Census

This specification is provided to ensure that changes in the use of areas at and beyond the Site Boundary are identified and that modifications to the monitoring program are made if required by the results of the census. 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 500 square feet 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, Revision 1 for consumption by a child. To determine this minimum garden size, the following assumptions were used: 1) that 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/square meter.

4.3 Monitoring Program - Sampling Requirements

Applicability

Applies to the radiological environmental monitoring program.

Objective

To ascertain that radiological environmental monitoring samples are collected and analyzed in accordance with the radiological environmental monitoring program.

Specification

SURVEILLANCE REQUIREMENTS

4.3.1 The radiological environmental monitoring samples shall be collected pursuant to Table 4.1-1 from the locations defined in the ODCM and shall be analyzed pursuant to the requirements of Tables 4.1-2 and 4.1-3.

4.4 Land Use Census - Surveillance Requirements

Applicability

Applies to the land use census.

Objective

To ascertain that the land use census is conducted in accordance with the radiological environmental monitoring program.

Specification

SURVEILLANCE REQUIREMENTS

4.4.1 The land use census shall be conducted once per 12 months during the growing season by any one of the following methods: door-to-door survey, aerial survey, and by consulting local agriculture authorities. This sampling may be performed at the site boundary in each of two different direction sectors with the highest predicted D/Qs in lieu of the garden census. Specifications for broad leaf vegetation sampling in Table 4.1-1, Item 4.C shall be followed, including analysis of control samples.

4.5 Analysis and Sample Point Description

Table 4.5-1 contains the sample point description, sampling and collection frequency analysis, and analysis frequency for various exposure pathways in the vicinity of HBR for the Radiological Monitoring Program. Figures 4-1 and 4-2 show the location of the various sampling points.

At the time of initial preparation of this manual, the limiting cow milk location was 1.3 miles in the NE sector. As of the time of submittal of this manual, there is no longer a cow present at this location. The radiological environmental monitoring program has been altered to reflect this change. However, the χ/Q, and D/Q values associated with this location have been retained for future reference.

TABLE 4.5-1
H. B. ROBINSON RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Sample Point	Sample Point Description, Distance, and Direction	Sampling and Collection Frequency	Analysis[1] Frequency	Analysis[1]
1. Airborne Particulates and Radioiodines	1.	Florence, S. C. (Control Station)[2] 24.4 miles ESE	Continuous operating sampler with sample collection at least weekly	Weekly	I-131 for Air Cartridges
	2.	Information Center 0.2 miles S		Weekly	Gross Beta[3]
	4.	Spillway 0.4 miles ESE		Quarterly	Gamma Scan[4] of composite (by location)
	5.	East Shore of lake near Johnson's Landing			
	6.	Information Center 0.2 miles SSW			
	7.	CP&L facility on Railroad Ave., Hartsville			
	55.	South of the West Settling Pond 0.2 miles SSE			
	60.	Robinson Picnic Area 0.2 miles SE			

TABLE 4.5-1 (continued)
H. B. ROBINSON RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Sample Point	Sample Point Description, Distance, and Direction	Sampling and Collection Frequency	Analysis[1] Frequency	Analysis[1]
2. Direct Radiation	1.	Florence, S. C. (Control Station)[2] 24.4 miles ESE	Continuous measurement with readout at least once per quarter (TLDs)	Quarterly	Gamma Dose[5]
	2.	Information Center[10,11] 0.2 mile S			
	3.	Microwave tower 0.5 mile N			
	4.	Spillway 0.4 mile ESE			
	5.	East shore of lake near Johnson's landing 0.9 mile ENE			
	6.	Information Center[10,11] 0.2 mile SSW			
	7.	CP&L facility on Railroad Ave., Hartsville 6.4 miles ESE			
	9.	Transmission right-of-way 1.0 mile S			

TABLE 4.5-1 (continued)
H. B. ROBINSON RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Sample Point	Sample Point Description, Distance, and Direction	Sampling and Collection Frequency	Analysis[1] Frequency	Analysis[1]
2. Direct Radiation (continued)	10.	Clyde Church of God 1.0 mile WSW	Continuous measurement with readout at least once per quarter (TLDs)	Quarterly	Gamma Dose[5]
	11.	Old Camden Road 1.0 mile SW			
	13.	Corner of Saluda and Sandpit Roads 0.7 miles W			
	14.	First Baptist Church of Pine Ridge 0.8 mile WNW			
	15.	Transmission right-of-way 0.7 miles NW			
	16.	South side of Darlington County I.C. Turbine Plant 1.0 mile NNW			
	17.	Darlington County Plant emergency fire pump 1.2 miles N			

TABLE 4.5-1 (continued)
H. B. ROBINSON RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Sample Point	Sample Point Description, Distance, and Direction	Sampling and Collection Frequency	Analysis[1] Frequency	Analysis[1]
2. Direct Radiation (continued)	18.	Old Black Creek RR trestle 0.7 mile SE	Continuous measurement with readout at least once per quarter (TLDs)	Quarterly	Gamma Dose [5]
	19.	Old Camden Road (#S-16-23) 1.0 mile E			
	20.	New Market Road (#S-16-39) 1.0 miles ENE			
	21.	New Market Road (#S-16-39) 1.4 miles NE			
	22.	Shady Rest entrance off of Cloverdale Drive 1.7 miles NNE			
	23.	New Market Road (#S-16-39) 1.0 miles ESE			
	24.	Sowell Road (#S-13-711) 4.6 miles NW			
	25.	Lake Robinson Road (#S-13-346) 4.0 miles NNW			
	26.	Lake Robinson Road (#S-13-346) 5.0 miles N			

TABLE 4.5-1 (continued)

H. B. ROBINSON RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Sample Point	Sample Point Description, Distance, and Direction	Sampling and Collection Frequency	Analysis[1] Frequency	Analysis[1]
2. Direct Radiation (continued)	27.	Prospect Church Road (#S-13-763) 5.4 miles NNE	Continuous measurement with readout at least once per quarter (TLDs)	Quarterly	Gamma Dose[5]
	28.	New Market Road (#S-13-39) 4.3 miles NE			
	29.	Ruby Road (#S-16-20) 4.0 mile ENE			
	30.	Ruby Road (#S-16-20) 4.4 miles E			
	31.	Lakeshore Drive 4.6 miles ESE			
	32.	Transmission right-of-way 4.0 miles SE			
	33.	Bay Road (#S-16-493) 4.5 miles SSE			
	34.	Kellybell Road (#S-16-772) 4.7 miles S			

TABLE 4.5-1 (continued)

H. B. ROBINSON RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Sample Point	Sample Point Description, Distance, and Direction	Sampling and Collection Frequency	Analysis[1] Frequency	Analysis[1]
2. Direct Radiation (continued)	35.	Kelly Bridge Road (#S-31-51) 4.5 miles SSW	Continuous measurement with readout at least once per quarter (TLDs)	Quarterly	Gamma Dose[5]
	36.	Kingston Drive 5.0 miles SW			
	37.	Pine Cone Road 5.0 miles WSW			
	38.	Union Church Road 4.9 miles W			
	39.	King's Pond Road 5.1 miles WNW			
	55.	South of the West Settling Pond 0.2 miles SSE			
	56.	North of the center of the 7P-ISFSI[10,11] 0.4 miles NNW			
	61.	West parking lot near RR tracks[11] 0.3 miles WSW			
	65.	Northwest of the 24P-ISFSI[11] 0.3 miles WNW			
	84.	Greater Heights Baptist Church 0.9 miles SSE			
	85.	Off Hayden Lane 0.9 miles SSW			

TABLE 4.5-1 (continued)
H. B. ROBINSON RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Sample Point	Sample Point Description, Distance, and Direction	Sampling and Collection Frequency	Analysis[1] Frequency	Analysis[1]
3. Waterborne a. Surface Water	40.	Black Creek at Old Camden Road (S-16-23) 0.6 mile ESE	Composite sample[6] over one-month period	Monthly	Gamma Scan[4] H-3
	41.	Black Creek at US Highway 1 (Control Station)[2] 8.0 miles N			
b. Groundwater	64.	Artesian Well (0.6 miles SE)	Quarterly Grab	Quarterly	Gamma Scan[4] H-3
c. Drinking water	NA	Not required[7]			
d. Shoreline Sediment	44.	East Shore of Lake, Shady Rest Club 1.6 miles NNE	Semi-annually	Semi-annually	Gamma Scan[4]
4. Ingestion a. Milk	NA	(There are no milk samples available within 8 Km of Plant. Broad-leaf vegetation are to be sampled and analyzed in lieu of milk samples.)	NA	NA	NA
b. Broadleaf	50.	SSE Close to Site Boundary[9].	Monthly during growing season[12] (3 different kinds of broad-leaf vegetation)	Each sample	Gamma Scan[4] I-131
	51.	SSW Close to Site Boundary.			
	52.	10 miles W, near Bethune (Control Station for Broad-leaf Vegetation).			
	62.	SE Close to Site Boundary.			
	67.	S Close to Site Boundary[9].			
	83.	1.7 miles NNE, near Shady Rest Club			
c. Fish	45.	Site varies within Lake Robinson	Semiannually (collect comparable species at all three locations)	Each sample	Gamma Scan[4] Edible portion
	46.	Site varies within Prestwood Lake			
	47.	Control station[2], Any lake not influenced by plant discharge.			
d. Food Products leafy vegetables	54.	Auburndale Plantation[8] 10.1 miles E (One sample of each principal class of irrigated food products).	Annual at harvest	Each sample	Gamma Scan[4]

TABLE 4.5-1 NOTATION

1. The LLD for each analysis is specified in Table 4.1-3 of the HBR ODCM.

2. Control stations are locations outside the influence of plant effluents.

3. Airborne particulate sample filter 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 is greater than ten times the yearly mean of control samples, gamma isotopic analysis shall be performed on the individual samples.

4. Gamma scan means the identification and quantification of gamma-emitting radionuclides that may be attributable to the effluents from the facility.

5. Thermoluminescent dosimeter (TLD) is considered to be one phosphor; two or more phosphors in a packet are considered as two or more dosimeters.

6. Composite sample aliquots shall be collected at time interval that are short (5 or 6 times daily) relative to the compositing period (monthly in order to assure obtaining a representative sample).

7. Collection of drinking water samples is not required since there are no known reservoirs on Black Creek used for drinking purposes.

8. Water from Black Creek is sometimes used to irrigate food crops at Auburndale Plantation which is located 11 miles east @ 90° from the plant.

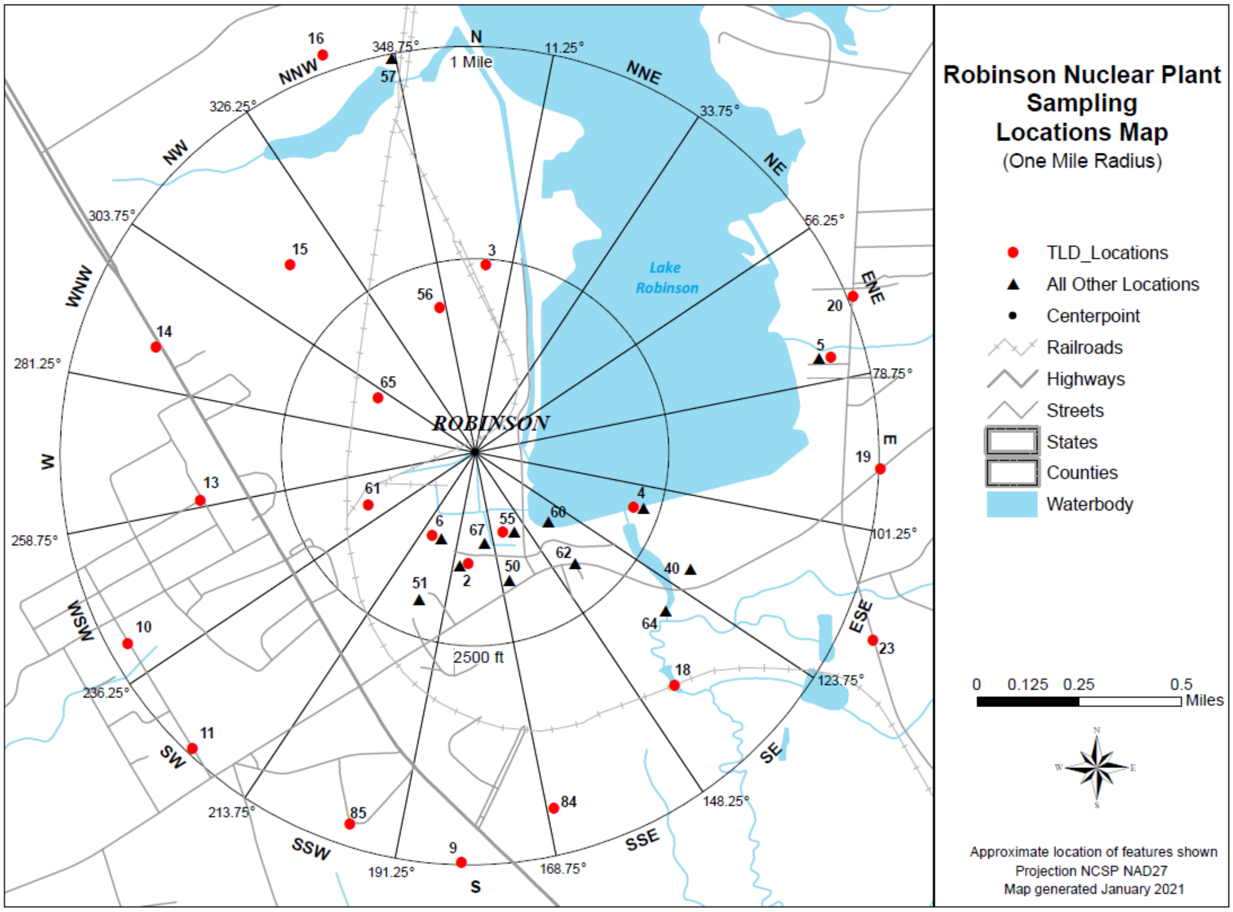
9. Sample Points 50 and 67 are the highest and the second highest D/Q values, respectively.

10. These samples are required for monitoring of the 7P-ISFSI.

11. These samples are required for monitoring of the 24P-ISFSI.

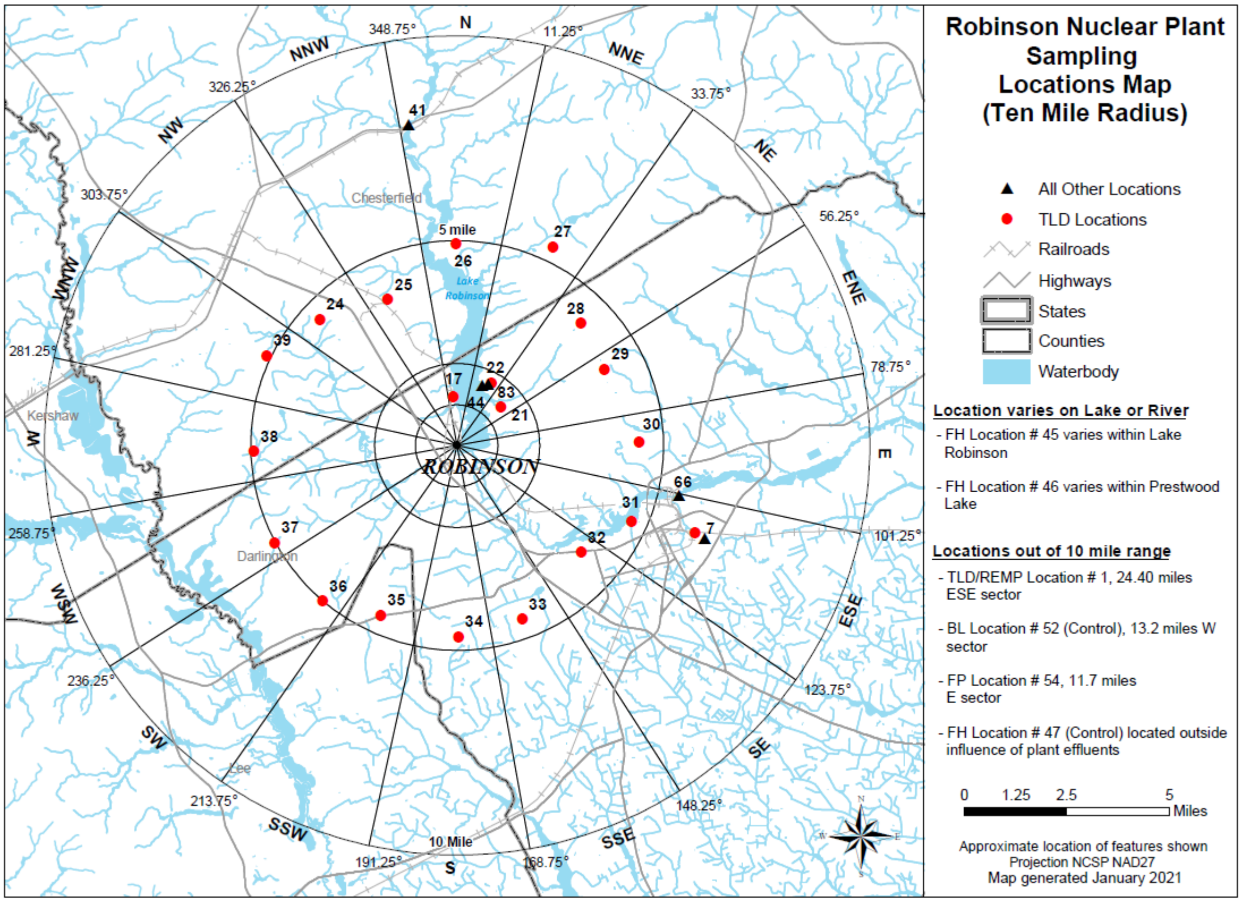
12. Broad leaf vegetation refers to any natural vegetation, plants, shrubs, or trees that have wide, flat leaves with veins which branch from a main vein. Typically, leaves are only present during the growing season May through October.

FIGURE 4-1
RADIOLOGICAL SAMPLE LOCATIONS NEAR SITE



Sample Types	Sample Locations
Air Cartridge & Particulate	1, 2, 4, 5, 6, 7, 55, 60
Shoreline Sediment	44
Ground Water	64
Broadleaf Vegetation	50, 51, 52, 62, 67, 83
Surface Water	40, 41
Thermoluminescent Dosimeter	1-7, 9-11, 13-39, 55, 56, 61, 65, 84, 85
Fish	45 – 47
Food Products	54

FIGURE 4-2
RADIOLOGICAL SAMPLE LOCATIONS DISTANT LOCATIONS



Sample Types	**Sample Locations**
Air Cartridge & Particulate	1, 2, 4, 5, 6, 7, 55, 60
Shoreline Sediment	44
Ground Water	64
Broadleaf Vegetation	50, 51, 52, 62, 67, 83
Surface Water	40, 41
Thermoluminescent Dosimeter	1-7, 9-11, 13-39, 55, 56, 61, 65, 84, 85
Fish	45 – 47
Food Products	54

5.0 INTERLABORATORY COMPARISON PROGRAM

Applicability

Applies to the interlaboratory comparison program of like media.

Objective

To ensure precision and accuracy of laboratory analyses.

Specification

CONTROLS

5.1 Analyses shall be performed on radioactive materials supplied as a part of an Interlaboratory Comparison Program of like media within the environmental program as per Table 4.1-1 and pursuant to ODCM Specification 5.2, 5.3, and 5.4.

ACTIONS

5.2 With analyses not being performed as required above, report the corrective action taken to prevent a recurrence to the Commission in the Annual Radiological Environmental Operating Report pursuant to Technical Specification 5.6.2.

5.3 The provisions of ODCM Specification 8.1 are not applicable.

SURVEILLANCE REQUIREMENTS

5.4 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 Technical Specification 5.6.2.

BASES

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 material in environmental sample matrices are performed as part of the quality assurance program for environmental monitoring in order to demonstrate that the results are valid for the purposes of Section IV.B.2 of Appendix I to 10 CFR Part 50.

5.5 Interlaboratory Comparison Studies - Program Requirements

5.5.1 Objective

The objective of this program is to evaluate the total laboratory analysis process by comparing results with results obtained by a separate laboratory or laboratories for an equivalent sample.

5.6 Program

5.6.1 Environmental Sample Analyses Comparison Program

Environmental samples from the HBR environs are to be analyzed by the EnRad Laboratories or by a qualified contracting 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 provided to HBR E&RC and will be included in the Annual Radiological Environmental Operating Report.

5.6.2 Effluent Release Analyses Program

HBR E&RC will perform sample analyses for gamma-emitting radionuclides in effluent releases. The E&RC radiochemistry laboratory will participate annually in a corporate interlaboratory comparison study or an equivalent study. The results of these studies will be provided to the NRC upon request.

5.6.3 Abnormal Results

Company Internal laboratory or vendor laboratory results shall be compared to the criteria established in the USNRC 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	0.40 - 2.50
4 - 7	0.50 - 2.00
8 - 15	0.60 - 1.66
16 - 50	0.75 - 1.33
51 - 200	0.80 - 1.25
> 200	0.85 - 1.18

If the Company Internal laboratory or vendor laboratory results lie outside the ratio criteria, an evaluation will be performed to identify any recommended actions to reduce anomalous errors. Complete documentation of the evaluation will be available to HBR and will be provided to the USNRC upon request.

6.0 COMPLIANCE WITH 40 CFR PART 190

6.1 Requirements For Compliance With 40 CFR Part 190 - Radioactive Effluents From Uranium Fuel Cycle Sources

Applicability

Applies to radioactive effluents from uranium fuel cycle sources.

Objective

To define the dose limits of 40 CFR 190 for radioactive effluents from uranium fuel cycle sources.

Specification

CONTROLS

6.1.1 The dose commitment to any member of the public, due to releases of licensed materials and radiation, from uranium fuel cycle sources shall be limited to ≤ 25 mrem to the total body or any organ except the thyroid, which shall be limited to ≤ 75 mrem over 12 consecutive months. This specification is applicable to Robinson Unit 2 only for the area within a five mile radius around the Robinson Plant.

ACTIONS

6.1.2 With the calculated doses from the release of the radioactive materials in liquid or gaseous effluents exceeding twice the limits of OCDM Specification 2.4.1.a, 2.4.1.b, 3.4.1.a, 3.4.1.b, 3.5.2.1.a, or 3.5.2.1.b, calculations should be made including direct radiation contributions from the reactor unit and from outside storage tanks to determine whether the above limits of ODCM Specification 6.1.1 have been exceeded. If such is the case, prepare and submit to the Commission within 30 days, pursuant to ODCM Specification 9.3.d, 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 Part 20.2203(a)(4), shall include an analysis that estimates the radiation exposure (dose) to a member of the public from uranium fuel cycle sources, including all effluent pathways and direct radiation, for the calendar year that includes the release(s) covered by this report. It shall also describe levels of radiation and concentrations of radioactive material involved, and the cause of the exposure levels or concentrations. 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 same request is complete.

6.1.3 The provisions of ODCM Specification 8.1 are not applicable.

BASES

Compliance with 40 CFR Part 190 - Radioactive Effluents From Uranium Fuel Cycle Sources

This specification is provided to meet the dose limitations of 40 CFR Part 190 that have been incorporated into 10 CFR Part 20 by 46 FR 18525. The specification requires the preparation and submittal of a Special Report whenever the calculated doses from plant generated radioactive effluents and direct radiation exceed 25 mrems to the total body or any organ, except the thyroid, which shall be limited to less than or equal to 75 mrems. It is highly unlikely that the resultant dose to a member of the public will exceed dose limits of 40 CFR Part 190 if the reactor remains within twice the dose design objectives of Appendix I, and if direct radiation doses from the reactor unit and 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 Part 190.11 and 10 CFR Part 20.2203(a)(4), is considered to be a timely request and fulfills the requirements of 40 CFR Part 190 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 ODCM Specifications 2.2.1 and 3.2.1. 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.

6.2 Total Dose (40 CFR 190 Conformance)

6.2.1 Compliance with 40 CFR 190

Compliance with 40 CFR 190 as prescribed by ODCM Specification 6.1 is to be demonstrated only when one or more of ODCM Specifications 2.4.1.a, 2.4.1.b, 3.4.1.a, 3.4.1.b, 3.5.2.1.a, and 3.5.2.1.b is exceeded by a factor of 2. Once this occurs the Company has 30 days to submit this report in accordance with ODCM Specification 9.3.

6.2.1 Calculations Evaluating Conformance with 40 CFR 190

To perform the calculations to evaluate conformance with 40 CFR 190, an effort is made to develop doses that are realistic by removing assumptions that lead to overestimates of dose to a MEMBER OF THE PUBLIC (i.e., calculations for compliance with 10 CFR 50, App.I). To accomplish this the following calculational rules are used:

1. Doses to a MEMBER OF THE PUBLIC via the liquid release pathway will be calculated.

2. Doses to a MEMBER OF THE PUBLIC due to a milk pathway will be evaluated only as can be shown to exist. Otherwise, doses via this pathway will be estimated as ≤ 1 mrem / yr.

3. Environmental sampling data which demonstrate that no pathway exists may be used to delete a pathway to man from a calculation.

4. To sum numbers represented as "less than" (<), use the value of the largest number in the group.

   $$(\text{i.e. } <5 + <1 + <1 + <3 = 5)$$

5. When doses via direct radiation are added to doses via inhalation pathway, they will be calculated for the same distance in the same sector.

6. The calculational locations for a MEMBER OF THE PUBLIC will only be at residences or places of employment.

NOTE: Additional assumptions may be used to provide situation-specific parameters, provided they are documented along with their concomitant bases.

6.3 Calculations of Total Body Dose

Estimates will be made for each of the following exposure pathways to the same location by age class. Only those age classes known to exist at a location are considered.

6.3.1 Direct Radiation

The component of dose to a MEMBER OF THE PUBLIC due to direct radiation will be determined by:

1. Determine the direct radiation dose at the plant boundary in each sector, $D_{B,\theta}$.

2. Extrapolate that dose to the calculational location as follows:

$$D_{L,\theta} = \frac{D_{B,\theta} * 1.49E{+}06}{\left(X_{L,\theta}\right)^2}$$

where:

$D_{L,\theta}$	=	Dose at calculational location in sector θ (mrem).
1.49E+06	=	Square of mean distance to the site boundary (1220^2 m^2).
$X_{L,\theta}$	=	Distance to calculational locations in sector θ (m).

6.3.2 Inhalation Dose

The inhalation dose will be determined at the calculational locations for each age class at risk according to the methods outlined in Section 3.5 of this manual.

6.3.3 Ingestion Pathway

The dose via the ingestion pathway will be calculated at the consumer locations for the consumers at risk. If no milk pathway exits in a sector, the dose via this pathway will be treated as < 1 mrem/yr.

6.3.4 Other Uranium Fuel Cycle Sources

The dose from other fuel cycle sources will be treated as < 1 mrem/yr.

6.4 Thyroid Dose

The dose of the thyroid will be calculated for each sector as the sum of inhalation dose and milk ingestion dose (if existing). The calculational methods will be those identified in Section 3.5 of this manual.

6.5 Dose Projections

Dose projections are to incorporate planned plant operations such as power reduction or outages for the projected period.

6.6 Radioactive Effluents from Uranium Fuel Cycle Sources - Cumulative Doses

Applicability

Applies to the determination of cumulative doses from radioactive effluents from uranium fuel cycle sources.

Objective

To ascertain that cumulative doses from radioactive effluents from uranium fuel cycle sources are maintained as low as reasonably achievable and within allowable limits.

Specification

SURVEILLANCE REQUIREMENTS

6.6.1 Cumulative dose contributions from liquid and gaseous effluents shall be determined in accordance with ODCM Specifications 2.4.1, 3.4.1, and 3.5.2.1 in accordance with the methodology and parameters in the ODCM. For the purposes of this Surveillance Requirement, it may be assumed that fuel cycle sources are negligible, with the exception that dose contributions from other nuclear fuel cycle facilities at the same site or within a radius of 5 miles must considered. In addition, an individual is not considered a member of the public during any period in which he/she is engaged in carrying out any operation which is part of the nuclear fuel cycle.

6.6.2 Cumulative dose contributions from direct radiation from the reactor 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 ODCM Specification 6.1.2.

7.0 DEFINITIONS

The following frequently used terms are defined for the uniform interpretation of the specifications.

7.1 Rated Thermal Power

RTP shall be a total reactor core heat transfer (RTP) rate to the reactor coolant of 2339 MWt.

7.2 Mode

A mode shall be as required by Technical Specifications.

7.3 Operable - Operability

A system, subsystem, train, component, or device shall be OPERABLE or have OPERABILITY when it is capable of performing its specified safety function(s) and when all necessary attendant instrumentation, controls, normal or emergency electrical power, cooling and seal water, lubrication, and other auxiliary equipment that are required for the system, subsystem, train, component, or device to perform its specified safety function(s) are also capable of performing their related support function(s).

7.4 Instrumentation Surveillance

7.4.1 Action

Action shall be that part of a specification which prescribes remedial measures required under designated conditions.

7.4.2 Channel Calibration

A CHANNEL CALIBRATION shall be the adjustment, as necessary, of the channel so that it responds within the required range and accuracy to known input. The CHANNEL CALIBRATION shall encompass the entire channel, including the required sensor, alarm, interlock, display, and trip functions.

7.4.3 Channel Check

A CHANNEL CHECK shall be the qualitative assessment, by observation, of channel behavior during operation. This determination shall include, where possible, comparison of the channel indication and status to other indications or status derived from independent instrument channels measuring the same parameter.

7.4.4 Channel Operational Test (COT)

A COT shall be the injection of a simulated or actual signal into the channel as close to the sensor as practicable to verify the OPERABILITY of required alarm, interlock, display, and trip functions. The COT shall include adjustments, as necessary, of the required alarm, interlock, and trip setpoints so that the setpoints are within the required range and accuracy.

7.4.5 Source Check

A source check shall be the qualitative assessment of channel response when the channel sensor is exposed to a radioactive source.

7.5 Gaseous Radwaste Treatment System

The Gaseous Radwaste Treatment System is the 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.

7.6 Ventilation Exhaust Treatment System

The Ventilation Exhaust Treatment System is the 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 absorbers and/or HEPA filters prior to their release to the environment. Engineered Safety Feature (ESF) atmospheric cleanup systems are not considered to be Ventilation Exhaust Treatment System components.

7.7 Offsite Dose Calculation Manual

a. The ODCM shall contain the methodology and parameters used in the calculation of offsite doses resulting from radioactive gaseous and liquid effluents, in the calculation of gaseous and liquid effluent monitoring alarm and trip setpoints, and in the conduct of the radiological environmental monitoring program; and

b. The ODCM shall also contain the radioactive effluent controls and radiological environmental monitoring activities, and descriptions of the information that should be included in the Annual Radiological Environmental Operating, and Radioactive Effluent Release Reports required by Specification 5.6.2 and Specification 5.6.3.

c. Licensee initiated changes to the ODCM:

1. Shall be documented and records of reviews performed shall be retained. This documentation shall contain:

    (a) sufficient information to support the change(s) together with the appropriate analyses or evaluations justifying the change(s),

    AND

    (b) a determination that the change(s) maintain the levels of radioactive effluent control required by 10 CFR 20.1302, 40 CFR 190, 10 CFR 50.36a, and 10 CFR 50, Appendix I, and do not adversely impact the accuracy or reliability of effluent, dose, or setpoint calculations;

2. Shall become effective after the approval of the Plant Manager;

    AND

3. Shall be submitted to the NRC in the form of a complete, legible copy of the entire ODCM as a part of or concurrent with the Radioactive Effluent Release Report for the period of the report in which any change in the ODCM was made. “Each change shall be identified by markings in the margin of the affected pages. Each change, affected page number(s) and technical justification will be listed in Chapter 10, Licensee Initiated Changes. .

7.8 Dose Equivalent I-131

The Dose Equivalent I-131 shall be that concentration of I-131 (microcuries/gram) that alone would produce the same dose as the quantity and isotopic mixture of I-131, I-132, I-133, I-134, and I-135 actually present. The dose conversion factors used for this calculation shall be those listed under the “Effective” column of Table 2.1 of Federal Guidance Report 11.

7.9 Purge - Purging

Purge or purging is 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 than replacement air or gas is required to purify the confinement.

7.10 Venting

Venting is 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.

7.11 Site Boundary

The site boundary shall be that line beyond which the land is not owned, leased, or otherwise controlled by the licensee, as defined by Figure 7-1.

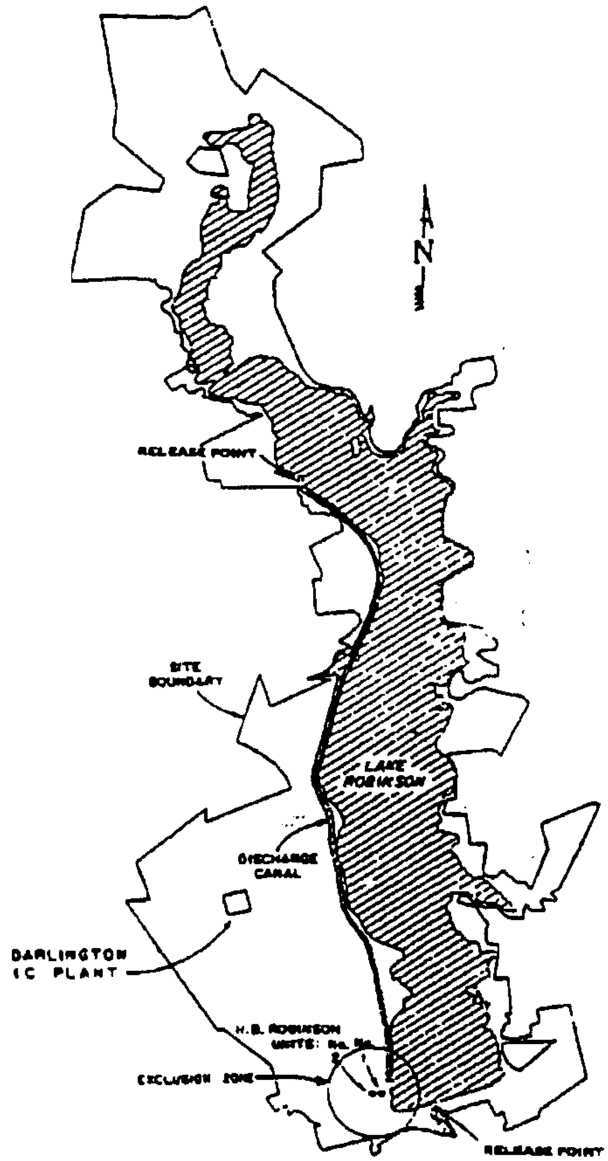
7.12 Member(s) of the Public

Member(s) of the public shall include all individuals who by virtue of their occupational status have no formal association with the plant. This category shall include non-employees of the licensee who are permitted to use portions of the site for recreational, occupational or other purposes not associated with plant function. This category shall not include non-employees such as vending machine servicemen, or postmen who, as part of their formal job function, occasionally enter an area that is controlled by the licensee for the purposes of protection of individuals from exposure to radiation and radioactive materials.

7.13 Unrestricted Area

Unrestricted area shall be any area at or beyond the Site Boundary to which access 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.

FIGURE 7-1
PLANT SITE BOUNDARY AND EXCLUSION ZONE



8.0 CONTROLS APPLICABILITY AND SURVEILLANCE/COMPENSATORY REQUIREMENTS

8.1 Controls Applicability

CONTROL 8.1.1 CONTROLS shall be met during the MODES or other specified conditions in the Applicability, except as provided in CONTROL 8.1.2.

CONTROL 8.1.2 Upon discovery of a failure to meet an CONTROL, the Required COMPENSATORY MEASURES of the associated Conditions shall be met, except as provided in CONTROL 8.1.5.

If the CONTROL is met or is no longer applicable prior to expiration of the specified Completion Time(s), completion of the Required Action(s) is not required unless otherwise stated.

CONTROL 8.1.3 When an CONTROL is not met and the associated COMPENSATORY MEASURES are not met, an associated ACTION is not provided, or if directed by the associated COMPENSATORY MEASURES, the unit shall be placed in a MODE or other specified condition in which the CONTROL is not applicable. Action shall be initiated within 1 hour to place the unit, as applicable, in:

a. MODE 3 within 7 hours; and

b. MODE 4 within 13 hours; and

c. MODE 5 within 37 hours.

Exceptions to this Specification are stated in the individual Specifications.

Where corrective measures are completed that permit operation in accordance with the CONTROL or COMPENSATORY MEASURES, completion of the COMPENSATORY MEASURES required by CONTROL 8.1.3 is not required.

CONTROL 3.0.3 is only applicable in MODES 1, 2, 3, and 4

CONTROL 8.1.4 When a CONTROL is not met, entry into a MODE or other specified condition in the Applicability shall not be made except when the associated COMPENSATORY MEASURES to be entered permit continued operation in the MODE or other specified condition in the Applicability for an unlimited period of time.

This Specification shall not prevent changes in MODES or other specified conditions in the Applicability that are required to comply with COMPENSATORY MEASURES or that are part of a shutdown of the unit.

Exceptions to this Specification are stated in the individual Specifications. These exceptions allow entry into MODES or other specified conditions in the Applicability when the associated COMPENSATORY MEASURES to be entered allow unit operation in the MODE or other specified condition in the Applicability only for a limited period of time.

CONTROL 8.1.4 is only applicable for entry into a MODE or other specified condition in the Applicability in MODES 1, 2, 3,and 4.

CONTROL 8.1.5 Equipment removed from service or declared inoperable to comply with COMPENSATORY MEASURES may be returned to service under administrative control solely to perform testing required to demonstrate its OPERABILITY or the OPERABILITY of other equipment. This is an exception to CONTROL 8.1.2 for the system returned to service under administrative control to perform the testing required to demonstrate OPERABILITY.

8.2 Surveillance Requirements

SR 8.2.1 SRs shall be met during the MODES or other specified conditions in the Applicability for individual CONTROLS, unless otherwise stated in the SR. Failure to meet a Surveillance, whether such failure is experienced during the performance of the Surveillance or between performances of the Surveillance, shall be failure to meet the CONTROL. Failure to perform a Surveillance within the specified Frequency shall be failure to meet the CONTROL except as provided in SR 8.2.3. Surveillances do not have to be performed on inoperable equipment or variables outside specified limits.

SR 8.2.2 The specified Frequency for each SR is met if the Surveillance is performed within 1.25 times the interval specified in the Frequency, as measured from the previous performance or as measured from the time a specified condition of the Frequency is met.

For Frequencies specified as "once," the above interval extension does not apply.

If a Completion Time requires periodic performance on a "once per…." basis, the above Frequency extension applies to each performance after the initial performance.

Exceptions to this Specification are stated in the individual Specifications.

SR 8.2.3 If it is discovered that a Surveillance was not performed within its specified Frequency, then compliance with the requirement to declare the CONTROL not met may be delayed, from the time of discovery, up to 24 hours or up to the limit of the specified Frequency, whichever is less. This delay period is permitted to allow performance of the Surveillance.

If the Surveillance is not performed within the delay period, the CONTROL must immediately be declared not met, and the applicable Condition(s) must be entered.

When the Surveillance is performed within the delay period and the Surveillance is not met, the CONTROL must immediately be declared not met, and the applicable Condition(s) must be entered.

SR 8.2.4 Entry into a MODE or other specified condition in the Applicability of an CONTROL shall not be made unless the CONTROL's Surveillances have been met within their specified Frequency. This provision shall not prevent entry into MODES or other specified conditions in the Applicability that are required to comply with COMPENSATORY MEASURES or that are part of a shutdown of the unit.

SR 8.2.4 is only applicable for entry into a MODE or other specified condition in the Applicability in MODES 1, 2, 3, and 4.

SR 8.2.5 Surveillance Requirements shall be applicable as follows in Table 8.2-1:

TABLE 8.2-1
SURVEILLANCE REQUIREMENTS

Frequency	Time Interval
P	Completed prior to making a radioactive materials release.
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.
R	At least once per 18 months.
3/W	At least 3 times per week.

8.3 Compensatory Requirements

CR 8.3.1 CR 8.3.1 establishes the requirements for meeting the specified Frequency for any Required Compensatory Measure with a Completion Time that requires the periodic performance of the Required Compensatory Measure on a "once per..." interval.

CR 8.3.1 permits a 25% extension of the interval specified in the Frequency. This extension facilitates scheduling and considers plant operating conditions that may not be suitable for conducting the Test (e.g., transient conditions or other ongoing Test or maintenance activities).

The 25% extension does not significantly degrade the reliability that results from performing the action at its specified Frequency. This is based on the recognition that the most probable result of any particular Test being performed is the verification of conformance with the applicable requirements. The 25% extension also does not apply to the initial portion of a periodic Completion Time that requires performance on a "once per..." basis. The 25% extension applies to each performance after the initial performance. The initial performance of the Required Compensatory Measure is considered a single compensatory measure with a single Completion Time.

The provisions of CR 8.3.1 are not intended to be used repeatedly merely as an operational convenience to extend periodic Completion Time intervals beyond those specified.

Exceptions to this Specification are stated in the individual Specifications.

9.0 REPORTING REQUIREMENTS

9.1 Annual Radioactive Effluent Release Report

Routine radioactive effluent release reports covering the operation of the unit during the previous twelve months shall be submitted within twelve months of the previous report in accordance with Technical Specification 5.6.3. The report shall be submitted by May 1 of each year. Those portions of the report shall include:

9.1.1

A summary of the quantities of radioactive liquid and gaseous effluent and solid waste released from the unit as outlined in Regulatory Guide 1.21, "Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and 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.

9.1.2

The Radioactive Effluent Release Report shall include an annual summary of hourly meteorological data collected over the previous year. This annual summary may be either in the form of an hour-by- hour listing on magnetic tape of wind speed, wind direction, atmospheric stability, and precipitation (if measured), or in the form of joint frequency distributions of wind speed, wind direction, and atmospheric stability.* This same report shall include an assessment of the radiation doses due to the radioactive liquid and gaseous effluents released from the unit or station during the previous calendar year. For the assessment of radiation doses, approximate and conservative approximate 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).

* In lieu of submission with the Radioactive Effluent Releases 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.

9.1.3

The Radioactive Effluent Release Report shall also include an assessment of radiation doses to the likely most exposed member of the public from reactor releases and other nearby uranium fuel cycle sources, including doses from primary effluent pathways and direct radiation, for the previous calendar year to show conformance with 40 CFR Part 190, Environmental Radiation Protection Standards for Nuclear Power Operation.

9.1.4

The Radioactive Effluent Release Report shall include the following information for each class of solid waste (as defined by 10 CFR Part 61) shipped offsite during the report period:

a. Waste volume.

b. Total curie quantity (specify whether determined by measurement or estimate).

c. Principal radionuclides (specify whether determined by measurement or estimate).

d. Source of waste and processing employed (e.g., dewatered spent resin, compacted dry waste, evaporator bottoms).

e. Deleted.

f. Deleted.

g. The number of shipments, the mode of transport, and the destination.

9.1.5

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

9.1.6

The Radioactive Effluent Release Report shall include any changes made during the reporting period to the Process Control Program (PCP) and to the Offsite Dose Calculation Manual (ODCM), as well as a listing of new locations for dose calculations and/or environmental monitoring identified by the land use census pursuant to ODCM Specification 4.2.2.

9.1.7

Changes to the radioactive waste systems (liquid, gaseous, and solid) shall be reported to the Commission in the Annual Radioactive Effluent Release Report for the period in which the evaluation was reviewed by the Plant Nuclear Safety Committee (PNSC).* The discussion of each change shall contain:

a. A summary of the evaluation that led to the determination that the change could be made in accordance with 10 CFR Part 50.59.

b. Sufficient detailed information to totally support the reason for the change without benefit of additional or supplemental information.

c. A detailed description of the equipment, components and processes involved and the interfaces with other plant systems.

d. An evaluation of the change, which shows the predicted releases of radioactive materials in liquid and gaseous effluents and/or quantity of solid waste that differ from those previously predicted in the license application and amendments thereto.

e. An evaluation of the change, which shows the expected maximum exposures to an individual in the unrestricted area and to the general population that differ from those previously estimated in the license application and amendments thereto.

f. A comparison of the predicted releases of radioactive materials, in liquid and gaseous effluents and in solid waste, to the actual releases for the period prior to when the changes are to be made.

g. An estimate of the exposure to plant operating personnel as a result of the change.

h. Documentation of the fact that the change was reviewed and found acceptable by the PNSC.

* The licensee may choose to submit the information called for in this Specification as part of the annual FSAR update

9.1.8

Changes to the radioactive waste systems (liquid, gaseous, and solid) shall become effective upon review and acceptance by the PNSC.

9.1.9

The Radioactive Effluent Release Report shall include results from any groundwater samples that are drawn IAW the REMP program during the reporting period that are not described in the ODCM.

9.1.10

Deleted.

9.1.11

The 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 ODCM 9.4 Special Ground Water Protection Reports.

9.2 Annual Radiological Environmental Operating Report

Routine radiological environmental operating reports covering the operation of the unit during the previous calendar year shall be submitted prior to May 15 of each year in accordance with Technical Specification 5.6.2. With the radiological environmental monitoring program not being conducted as specified in Table 4.1-1, a description of the reasons for not conducting the program as required and the plans for preventing a recurrence shall be included.

The Annual Radiological Environmental Operating Reports shall include summaries, interpretations, and analysis of trends of the results of the radiological environmental surveillance activities for the report period, including a comparison with preoperational studies, operational controls (as appropriate), and previous environmental surveillance reports and an assessment of the observed impacts of the plant operations on the environment. The reports shall also include the results of land use censuses required by ODCM Specification 4.2.

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 ODCM, as well as summarized and tabulated results of these analyses and measurements in the format of the table in the Radiological Assessment Branch Technical Position, Revision 1, November 1979. In the event that some individual results are not available for inclusion with the report, the report shall be submitted noting and explaining the reasons for the missing results. The missing data shall be submitted as soon as possible in a supplementary report.

The reports shall also include the following: a summary description of the radiological environmental monitoring program: at least two legible maps* covering all sampling locations keyed to a table giving distances and directions from the centerline of the reactor, the results of licensee participation in the Interlaboratory Comparison Program, required by ODCM Specification 5.0; discussion of all deviations from the sampling schedule of Table 4.1-1; and discussion of all analyses in which the LLD required by Table 4.1-3 was not achievable.

* One map shall cover stations near the site boundary; a second shall be the more distant stations

9.3 Special Radiological Effluent Report

The Special radiological effluent reports discussed below shall be the subject of written reports to the NRC within 30 days of the occurrence of the event.

a. Exceeding any of the limits prescribed by ODCM Specification 2.4.1, 3.4.1, and/or 3.5.2.1. This report shall include the following information:

   1. The cause for exceeding the limit(s).

   2. The corrective action(s) to be taken to reduce the releases of radioactive materials in the affected effluents (i.e., liquid, radionoble gas, and/or radioiodines, particulates) within the specification and the proposed corrective actions to be taken to assure that subsequent releases will be in compliance with the above limits.

   3. If any of the limits of ODCM Specification 2.4.1 were exceeded, the report must include a statement that no drinking water source exists that could be affected or include the results of radiological impact on finished drinking water supplied with regard to the requirements of 40 CFR 141, Safe Drinking Water Act.

b. Exceeding any of the limits prescribed by ODCM Specification 2.9.1, and/or 3.15.1. This report shall include the following information:

   1. Identification of equipment or subsystem that rendered the affected radwaste system not operable.

   2. The corrective action(s) taken to restore the affected radwaste treatment system to an operable status.

   3. A summary description of the action(s) taken to prevent a similar recurrence.

c. Exceeding the reporting level for environmental sample media as specified in ODCM Specifications 4.1.3. This report shall include the following information:

   1. An evaluation of any environmental factor, release condition or other aspect which may have caused the reporting level to be exceeded.

   2. A description of action(s) taken or planned to reduce the levels of licensed materials in the affected environmental media to below reporting level.

d. Exceeding the limits prescribed by ODCM Specification 6.1.1. This report shall be made in lieu of any other report and shall include the following:

   1. The corrective action(s) to be taken to reduce subsequent releases to prevent recurrence of exceeding the limits prescribed by ODCM Specification 6.1.1.

   2. An analysis which estimates the dose commitment to a member of the general public from uranium fuel cycle source including all effluent pathways and direct radiation for a 12 month period that includes releases covered by this report.

   3. If the release conditions resulting in violation of 40 CFR 190 have not already been corrected, include a request for a variance in accordance with the provisions of 40 CFR 190 and include the specified information of 40 CFR 190.11(b).

9.4 Special Groundwater Protection Reports

a. Special Ground Water Protection Reports as listed below in 9.4.c, d, & e are not required for subsequent samples results that are from the same plume and have already been reported in accordance with this section.

b. Notification time requirements for water samples that exceed the reporting criteria start following the notification of sample results from the applicable vendor or corporate laboratory to the RNP Environmental & Chemistry Section.

c. 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 4.1-2, 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 in ODCM 9.4.f.

d. If any of the following samples exceed the reporting criteria of ODCM Table 4.1-2,

1. Any offsite groundwater, or
2. Any offsite surface water, or
3. Any onsite groundwater monitoring well, or
4. Any onsite surface water that is hydrologically connected to groundwater

then make informal notification to the designated state/local offices listed in ODCM 9.4.f by the end of the next business day.

e. If a liquid spill or leak from any of the following has the potential to enter groundwater,

1. Spill or leak that exceeds or may have exceeded 100 gallons from a source containing licensed material, or
2. Deleted
3. Any spill or leak, regardless of volume or activity, deemed by the licensee to warrant voluntary communication,

then make informal notification to the designated state/local offices listed in ODCM 9.4.f by the end of the next business day.

f. Designated state/local offices for notification:

1. Office of the Darlington County Director of Emergency Management

2. Office of the SC DHEC Director of Water Monitoring Assessment and Protection Division, Bureau of Water

3. Office of the SC DHEC Director, Bureau of Radiological Health

4. American Nuclear Insurers (ANI)

10.0 LICENSEE INITIATED CHANGES

All ODCM changes are reviewed by knowledgeable individual(s), the ORC Chairman, and approved by the Plant Manager. Revision 37 changes do not adversely impact the accuracy or reliability of effluent, dose, or setpoint calculations.

ODCM Revision 37 – Implementation Date: refer to Cover Page

Section 2 - Page 2-34
Table 2.7-1:

Modified frequency requirement for Channel Calibration on table items 1.a., 1.b., 2.a., 2.c., 3.a., and 5 by changing notation from 'R' to 'C'. Change made per DRR 02374694 to allow for process monitor calibration frequency to be changed from an 18-month frequency to a 24-month frequency. Setpoint, compliance with 10CFR20 Appendix B, and compliance with 10CFR50 Appendix I methodologies are unchanged.

Section 2 - Page 2-35
NOTES TO TABLE 2.7-1: Notation

Added 'C' to notation portion of notes section, 'C' denotes 'at least once per 24 months'. Change made per DRR 02374694 to allow for process monitor calibration frequency to be changed from an 18-month frequency to a 24-month frequency. Setpoint, compliance with 10CFR20 Appendix B, and compliance with 10CFR50 Appendix I methodologies are unchanged.

Section 3 – Page 3-29

Deleted "The age groupings at the various receptor locations are also determined during this survey; a new limiting location and receptor age group can result." Replaced with "Depending on the results of the survey, a new limiting location could result." Change made per DRR 02325355 to align with REG Guide 1.109.

Section 3 - Page 3-84
Table 3.11-1:

Modified frequency requirement for Channel Calibration on table items 2.a., 2.b., 3.a., 4.a., and 5.a. by changing notation from 'R' to 'C'. Change made per DRR 02374694, DRR 02255909, and EC 405861 to allow for process monitor calibration frequency to be changed from an 18-month frequency to a 24-month frequency. Setpoint, compliance with 10CFR20 Appendix B, and compliance with 10CFR50 Appendix I methodologies are unchanged.

<u>Section 3 - Page 3-85</u>

NOTES TO TABLE 3.11-1: Notation

Added 'C' to notation portion of notes section, 'C' denotes 'at least once per 24 months'. Change made per DRR 02374694, DRR 02255909, and EC 405861 to allow for process monitor calibration frequency to be changed from an 18-month frequency to a 24-month frequency. Setpoint, compliance with 10CFR20 Appendix B, and compliance with 10CFR50 Appendix I methodologies are unchanged.

<u>Section 3 – Page 3-104</u>

Deleted "The age groupings at the various receptor locations are also determined during this survey; a new limiting location and receptor age group can result." Replaced with "Depending on the results of the survey, a new limiting location could result." Change made per DRR 02325355 to align with REG Guide 1.109.

<u>Section 4 - Page 4-5</u>

Table 4.1-1:

Changed wording in the Sampling and Collection Frequency column for c. Food Products to "monthly during growing season." Change made per DRR 02315686.

<u>Section 4 - page 4-6</u>

Table 4.1-1: NOTATION

Added footnote "k. Broad leaf 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." Change made per DRR 02315686.

<u>Section 4 – Page 4-16</u>

Table 4.5-1:

Removed Sample Points 3 Microwave Tower & 61 West Parking lot near RR tracks. Change made per DRR 02183248 and written evaluation AR 2139602-24.

<u>Section 4 - Page 4-17</u>

Table 4.5-1:

Deleted Sample Point 8. Transmission right-of-way 0.8 mile SSE. Change made per DRR 02341415.

<u>Section 4 - Page 4-18</u>

Table 4.5-1:

Deleted Sample Point 12. Off Old Camden Road 1.2 miles SSW. Change made per DRR 02341415.

<u>Section 4 - Page 4-21</u>

Table 4.5-1:

Added sample point 84. Greater Heights Baptist Church 0.9 miles SSE and sample point 85. Off Hayden Lane 0.9 miles SSW. Change made per DRR 02341415.

Section 4 - Page 4-22

Table 4.5-1:

Added Broad leaf sampling Location 83. 1.7 miles NNW, near Shady Rest Club to Sample Description, Distance, and Direction. Changed wording in the Sampling and Collection Frequency column to "monthly during growing season." Change made per DRR 02315686.

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TABLE 4.1-1 NOTATION:

Added footnote "12. Broad leaf 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." Change made per DRR 02315686.

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Figure 4-1:

Added Sample Location '83" to Broad leaf Vegetation Sample Location. Change made per DRR 02315686. Removed sample location 3 and 61 key items from Robinson Nuclear Plant Sampling Locations Map and from Air Cartridge and Particulate Sample Locations column per DRR 02183248 and written evaluation AR 2139602-24. Deleted Sample Locations 8 and 12 from the Thermoluminescent Dosimeter column and added Sample Locations 84 and 85 to the Thermoluminescent Dosimeter column. Removed TLD location 8 from Robinson Nuclear Plant Sampling Locations Map per DRR 2341415.

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Figure 4-2:

Added Sample Location '83" to Robinson Nuclear Plant Sampling Locations Map and to Broad leaf Vegetation Sample Location. Change made per DRR 02315686. Removed sample location 3 and 61 from Air Cartridge and Particulate Sample Locations column per DRR 02183248 and written evaluation AR 2139602-24. Deleted Sample Locations 8 and 12 from the Thermoluminescent Dosimeter column and added Sample Locations 84 and 85 to the Thermoluminescent Dosimeter column. Removed TLD location 12 from Robinson Nuclear Plant Sampling Locations Map per DRR 2341415.

APPENDIX A: METEOROLOGICAL DISPERSION FACTOR COMPUTATIONS

Carolina Power & Light Company (CP&L) engaged the services of Dames & Moore to assess 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 (RG) 1.111, Revision 1 (USNRC 1977). The results of the assessment were to provide the relative deposition flux and relative concentrations (undepleted and depleted) based on numerical models acceptable for use in Appendix I evaluations.

Regulatory Guide 1.111 presented three acceptable diffusion models for use in estimating deposition flux and concentrations. These were (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 described in XOQDOQ Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations (Draft), NUREG 0324 (USNRC September 1977) would be used for generating the required analyses of Appendix I. To provide a more realistic accounting of the variability of wind around the plant site, terrain/recirculation correction factors (TCF) were to be determined from a combined puff-advection/straight-line scheme for a one-year meteorological data base.

Dames & Moore was provided a one-year record of meteorological data from the on-site meteorological program at the H. B. Robinson Steam Electric Plant. These data consisted of all collected parameters at both the 11.03-meter and 62.39-meter tower levels for the year 1977. Dames & Moore computed dispersions and depositions using the model described in the reference. The following tables from the reference provide the basis for the meteorological dilution factor development of the technical specifications for Appendix I and were the source of the X/Q and D/Q values used to show compliance with 10 CFR 20 and 10 CFR 50 for noble gases and radioiodines and particulates.

Tables A-1 through A-6	Relative undepleted concentration, relative depleted concentration, and relative deposition flux estimates for ground level releases for both standard distances and special locations for long-term releases.

Tables A-7 through A-9 — Relative undepleted concentration, relative depleted concentration, and relative deposition flux estimates for ground level releases for special locations for short-term releases.

The χ/Q and D/Q values which are used in Appendix B for showing compliance with 10 CFR 20 and 10 CFR 50 when the HBR Plant vent has been modified such that it qualifies as a mixed mode release were based upon the following tables:

Tables A-10 through A-15 — Relative undepleted concentration, relative depleted concentration, and relative deposition flux estimates for elevated release for both standard distances and special locations for long-term releases.

Tables A-16 through A-18 — Relative undepleted concentration, relative depleted concentration, and relative deposition flux estimates for mixed mode releases for special locations for short-term releases.

It should be noted that the short-term releases were based upon 100 hours per year of containment purges.

Future Operation Computations

NRC's XOQDOQ program will be used to determine the annual averaged χ/Q and D/Q values for annual radiological effluent release reporting.

In general, Dames & Moore concluded that the straight-line model is as reasonable a projection of concentrations as the puff-advection model. By inclusion of the terrain correction factors developed by a combination of the puff-advection/straight-line scheme with the results of the XOQDOQ Program, ready evaluation of on-site meteorological data may be made.

For routine meteorological dispersion evaluations, the "XOQDOQ" Program will be run with the appropriate physical plant data, appropriate meteorological information for the standard distances, and special locations of interest without a terrain/recirculation factor. The resulting computations will have applied the TCFs to produce a final atmospheric diffusion estimate for the site. The input to "XOQDOQ" for ground level releases at HBR are presented in Table A-19 and for mixed mode releases at HBR in Table A-20.

Reference

Chandler, Martin W. and George Hoopes, Revised Radiological Effluent Technical Specifications. Gaseous Effluent Dilution Factors, Prepared for Carolina Power & Light Company, Robinson Facility, Dames & Moore, January 18, 1979.

TABLE A-1
χ/Q VALUES FOR LONG-TERM GROUND LEVEL RELEASES AT SPECIAL LOCATIONS (sec/m^3) *

Carolina Power & Light Company - Robinson
Release Type: Annual
Release Mode: Ground Level
Variable: Relative Concentration (Sec./Cubic Meter)
Calculation Points: Special
Model: Straight Line (ANNX0Q9)
Application of Terrain Correction Factors: Yes
Number of Observations: 8703

Affected Sector	Site Boundary	Meat	Dairy	Resident	Garden
NNE	6.67E-06	4.13E-06	0.00	6.26E-06	5.56E-06
NE	3.02E-06	2.56E-06	2.13E-06	2.44E-06	2.13E-06
ENE	4.41E-06	4.93E-07	0.00	4.18E-06	7.36E-07
E	6.39E-06	3.02E-07	1.44E-07	3.51E-06	3.68E-07
ESE	1.12E-05	1.18E-06	0.00	7.90E-06	7.90E-06
SE	3.28E-05	0.00	0.00	3.27E-05	3.27E-05
SSE	8.08E-05	0.00	0.00	6.01E-05	6.01E-05
S	3.29E-05	4.22E-07	0.00	2.78E-05	1.65E-05
SSW	2.10E-05	5.61E-07	0.00	2.04E-05	8.07E-06
SW	8.91E-06	2.61E-07	2.14E-07**	6.90E-06	5.38E-06
WSW	3.97E-06	1.16E-07	0.00	3.22E-06	1.83E-06
W	2.11E-06	3.89E-08	0.00	1.38E-06	1.38E-06
WNW	1.62E-06	5.32E-08	0.00	1.03E-06	6.06E-07
NW	7.93E-07	5.06E-07	0.00	7.39E-07	7.39E-07
NNW	1.31E-06	4.78E-07	0.00	4.42E-07	3.82E-07
N	1.45E-06	6.44E-07	0.00	6.67E-07	6.67E-07

* Zeroes indicate that this point was not calculated

** A milk goat was located here

TABLE A-2
DEPLETED χ/Q VALUES FOR LONG-TERM GROUND LEVEL RELEASES AT SPECIAL LOCATIONS (sec/m^3) *

Carolina Power & Light Company - Robinson
Release Type: Annual
Release Mode: Ground Level
Variable: Relative Depleted Concentration (Sec./Cubic Meter)
Calculation Points: Special
Model: Straight Line (ANNX0Q9)
Application of Terrain Correction Factors: Yes
Number of Observations: 8703

Affected Sector	Site Boundary	Meat	Dairy	Resident	Garden
NNE	5.84E-06	3.38E-06	0.00	5.25E-06	4.77E-06
NE	2.68E-06	2.21E-06	1.79E-06	2.09E-06	1.79E-06
ENE	3.95E-06	3.99E-07	0.00	3.72E-06	5.93E-07
E	5.79E-06	2.42E-07	1.08E-07	3.12E-06	2.86E-07
ESE	1.01E-05	9.72E-07	0.00	7.11E-06	7.11E-06
SE	3.08E-05	0.00	0.00	3.05E-05	3.05E-05
SSE	7.46E-05	0.00	0.00	5.61E-05	5.61E-05
S	3.11E-05	3.42E-07	0.00	2.61E-05	1.53E-05
SSW	1.91E-05	4.55E-07	0.00	1.96E-05	7.35E-06
SW	8.25E-06	2.14E-07	2.44E-07**	6.44E-06	4.88E-06
WSW	3.68E-06	8.92E-08	0.00	2.94E-06	1.68E-06
W	1.98E-06	2.96E-08	0.00	1.26E-06	1.26E-06
WNW	1.47E-06	4.07E-08	0.00	9.26E-07	5.42E-07
NW	6.71E-07	4.19E-07	0.00	6.31E-07	6.31E-07
NNW	1.09E-06	3.80E-07	0.00	3.48E-07	2.98E-07
N	1.24E-06	5.11E-07	0.00	5.24E-07	5.24E-07

* Zeroes indicate that this point was not calculated

** A milk goat was located here

TABLE A-3
D/Q VALUES FOR LONG-TERM GROUND LEVEL RELEASES AT SPECIAL LOCATIONS (m^{-2}) *

Carolina Power & Light Company - Robinson
Release Type: Annual
Release Mode: Ground Level
Variable: Relative Deposition Rate (Meter $^{-2}$)
Calculation Points: Special
Model: Straight Line (ANNX0Q9)
Application of Terrain Correction Factors: Yes
Number of Observations: 8703

Affected Sector	Site Boundary	Meat	Dairy	Resident	Garden
NNE	9.80E-09	5.63E-09	0.00	9.09E-09	7.74E-09
NE	5.59E-09	4.65E-09	3.70E-09	4.42E-09	3.70E-09
ENE	8.06E-09	6.96E-10	0.00	7.59E-09	1.05E-09
E	1.24E-08	4.13E-10	1.80E-10	6.43E-09	5.11E-10
ESE	1.71E-08	1.46E-09	0.00	1.20E-08	1.20E-08
SE	4.23E-08	0.00	0.00	4.14E-08	4.14E-08
SSE	8.08E-08	0.00	0.00	6.21E-08	6.21E-08
S	4.39E-08	4.77E-10	0.00	3.82E-08	2.33E-08
SSW	5.92E-08	1.38E-09	0.00	6.12E-08	2.33E-08
SW	2.80E-08	6.49E-10	5.17E-10**	2.15E-08	1.65E-08
WSW	1.91E-08	4.37E-10	0.00	1.54E-08	8.84E-09
W	8.84E-09	1.09E-10	0.00	5.75E-09	5.75E-09
WNW	8.10E-09	1.88E-10	0.00	5.08E-09	2.97E-09
NW	2.44E-09	1.45E-09	0.00	2.16E-09	2.16E-09
NNW	2.44E-09	7.45E-10	0.00	6.83E-10	5.73E-10
N	1.76E-09	6.44E-10	0.00	6.67E-10	6.67E-10

* Zeroes indicate that this point was not calculated

** A milk goat was located here

TABLE A-4

χ/Q VALUES FOR LONG-TERM GROUND LEVEL RELEASES
AT STANDARD DISTANCES (sec/m^3)

Carolina Power & Light Company - Robinson
Release Type: Annual
Release Mode: Ground Level
Variable: Relative Concentration (Sec./Cubic Meter)
Calculation Points: Standard
Model: Straight Line (ANNX0Q9)
Application of Terrain Correction Factors: Yes
Number of Observations: 8703

BASE DISTANCE IN MILES/KILOMETERS

Sector	Mi→	.25	.75	1.25	1.75	2.25	2.75	3.25	3.75	4.25	4.75
	Km→	.40	1.21	2.01	2.82	3.62	4.42	5.23	6.03	6.84	7.64
NNE		8.8E-05	1.5E-05	6.4E-06	3.5E-06	2.3E-06	1.7E-06	1.1E-06	8.0E-07	5.5E-07	3.7E-07
NE		3.9E-05	4.6E-06	2.0E-06	1.1E-06	6.9E-07	4.6E-07	3.5E-07	2.8E-07	2.2E-07	1.7E-07
ENE		3.2E-05	5.2E-06	1.8E-06	9.7E-07	5.3E-07	3.8E-07	2.6E-07	2.1E-07	1.7E-07	1.5E-07
E		2.9E-05	4.5E-06	1.6E-06	8.3E-07	6.2E-07	3.3E-07	2.7E-07	1.9E-07	1.3E-07	9.5E-08
ESE		3.6E-05	5.4E-06	2.3E-06	1.3E-06	9.2E-07	6.2E-07	5.1E-07	3.6E-07	2.7E-07	1.9E-07
SE		4.0E-05	5.4E-06	2.6E-06	1.3E-06	8.5E-07	4.8E-07	3.6E-07	2.1E-07	1.9E-07	1.6E-07
SSE		8.2E-05	1.2E-05	5.0E-06	2.6E-06	1.5E-06	9.2E-07	6.5E-07	5.5E-07	4.5E-07	4.0E-07
S		3.6E-05	4.4E-06	1.7E-06	9.1E-07	4.2E-07	3.3E-07	2.6E-07	2.1E-07	1.7E-07	1.4E-07
SSW		2.5E-05	4.6E-06	1.9E-06	7.9E-07	4.5E-07	3.0E-07	2.1E-07	1.6E-07	1.2E-07	9.8E-08
SW		1.5E-05	2.2E-06	8.3E-07	3.7E-07	2.3E-07	1.6E-07	1.2E-07	8.8E-08	7.1E-08	5.9E-08
WSW		6.5E-06	1.0E-06	3.7E-07	2.0E-07	1.6E-07	1.0E-07	6.9E-08	5.8E-08	4.8E-08	3.7E-08
W		6.5E-06	8.3E-07	3.2E-07	1.7E-07	1.3E-07	8.8E-08	6.7E-08	4.3E-08	3.0E-08	2.4E-08
WNW		6.1E-06	7.8E-07	3.0E-07	1.8E-07	1.3E-07	9.6E-08	7.1E-08	5.4E-08	4.0E-08	3.0E-08
NW		1.1E-05	1.6E-06	7.4E-07	4.2E-07	2.4E-07	1.3E-07	8.0E-08	6.7E-08	5.3E-08	4.4E-08
NNW		2.0E-05	3.6E-06	1.9E-06	1.4E-06	9.4E-07	5.2E-07	2.7E-07	1.8E-07	1.2E-07	9.2E-08
N		5.2E-05	8.0E-06	3.3E-06	1.6E-06	1.0E-06	7.1E-07	4.9E-07	3.7E-07	2.9E-07	2.4E-07

Number of Valid Observations	=	8703
Number of Invalid Observations	=	57
Number of Calms Lower Level	=	398
Number of Calms Upper Limit	=	0

TABLE A-5

DEPLETED χ/Q VALUES FOR LONG-TERM GROUND LEVEL RELEASES AT STANDARD DISTANCES (sec/m^3)

Carolina Power & Light Company - Robinson
Release Type: Annual
Release Mode: Ground Level
Variable: Relative Concentration (Sec./Cubic Meter)
Calculation Points: Standard
Model: Straight Line (ANNX0Q9)
Application of Terrain Correction Factors: Yes
Number of Observations: 8703

BASE DISTANCE IN MILES/KILOMETERS

Sector	Mi→	.25	.75	1.25	1.75	2.25	2.75	3.25	3.75	4.25	4.75
	Km→	.40	1.21	2.01	2.82	3.62	4.42	5.23	6.03	6.84	7.64
NNE		8.3E-05	1.3E-05	5.4E-06	3.0E-06	2.0E-06	1.3E-07	8.3E-06	6.2E-07	4.1E-07	2.7E-07
NE		3.6E-05	4.1E-06	1.7E-06	9.2E-07	5.6E-07	3.6E-07	2.7E-07	2.1E-07	1.6E-07	1.3E-07
ENE		3.1E-05	4.6E-06	1.5E-06	8.3E-07	4.3E-07	3.0E-07	2.0E-07	1.6E-07	1.3E-07	1.1E-07
E		2.7E-05	4.1E-06	1.3E-06	6.9E-07	5.0E-07	2.7E-07	2.1E-07	1.4E-07	9.4E-08	7.2E-08
ESE		3.4E-05	4.9E-06	2.0E-06	1.1E-06	7.4E-07	5.0E-07	4.0E-07	2.9E-07	2.1E-07	1.5E-07
SE		3.8E-05	4.9E-06	2.2E-06	1.1E-06	7.0E-07	3.8E-07	2.8E-07	1.7E-07	1.4E-07	1.2E-07
SSE		7.8E-05	1.1E-05	4.4E-06	2.2E-06	1.3E-06	7.6E-07	5.1E-07	4.3E-07	3.3E-07	2.9E-07
S		3.5E-05	3.9E-06	1.4E-06	7.6E-07	3.5E-07	2.6E-07	2.0E-07	1.6E-07	1.3E-07	1.1E-07
SSW		2.3E-05	4.1E-06	1.6E-06	6.6E-07	3.7E-07	2.4E-07	1.7E-07	1.2E-07	8.9E-08	6.9E-08
SW		1.4E-05	1.9E-06	7.1E-07	3.1E-07	1.9E-07	1.2E-07	9.8E-08	6.7E-08	5.0E-08	4.3E-08
WSW		6.2E-06	9.2E-07	3.2E-07	1.7E-07	1.3E-07	8.0E-08	5.4E-08	4.4E-08	3.6E-08	2.7E-08
W		6.1E-06	7.5E-07	2.8E-07	1.4E-07	1.1E-07	6.8E-08	5.2E-08	3.3E-08	2.3E-08	1.8E-08
WNW		5.8E-06	7.0E-07	2.6E-07	1.5E-07	1.1E-07	7.6E-08	5.5E-08	4.2E-08	3.0E-08	2.2E-08
NW		1.1E-05	1.4E-06	6.4E-07	1.4E-07	2.0E-07	1.0E-07	6.1E-08	5.0E-08	4.0E-08	3.3E-08
NNW		1.9E-05	3.1E-06	1.6E-06	1.1E-06	7.6E-07	4.2E-07	2.0E-07	1.3E-07	8.8E-08	7.1E-08
N		4.9E-05	7.2E-06	2.8E-06	1.4E-06	8.1E-07	5.6E-07	3.8E-07	2.9E-07	2.2E-07	1.8E-07

Number of Valid Observations	=	8703
Number of Invalid Observations	=	57
Number of Calms Lower Level	=	398
Number of Calms Upper Limit	=	0

TABLE A-6
D/Q VALUES FOR LONG-TERM GROUND LEVEL RELEASES AT STANDARD DISTANCES (m^{-2})

Carolina Power & Light Company - Robinson
Release Type: Annual
Release Mode: Ground Level
Variable: Relative Concentration (Meter $^{-2}$)
Calculation Points: Standard
Model: Straight Line (ANNX0Q9)
Application of Terrain Correction Factors: Yes
Number of Observations: 8703

BASE DISTANCE IN MILES/KILOMETERS

Sector	Mi→	.25	.75	1.25	1.75	2.25	2.75	3.25	3.75	4.25	4.75
	Km→	.40	1.21	2.01	2.82	3.62	4.42	5.23	6.03	6.84	7.64
NNE		1.3E-07	2.4E-08	9.3E-09	4.8E-09	3.0E-09	2.0E-09	1.2E-09	8.2E-10	5.4E-10	3.4E-10
NE		7.1E-08	8.9E-09	3.4E-09	1.8E-09	1.0E-09	6.5E-10	4.6E-10	3.4E-10	2.6E-10	2.0E-10
ENE		5.5E-08	9.6E-09	3.1E-09	1.5E-09	7.9E-10	5.1E-10	3.3E-10	2.6E-10	1.9E-10	1.6E-10
E		5.1E-08	8.7E-09	2.7E-09	1.4E-09	9.4E-10	4.7E-10	3.6E-10	2.4E-10	1.5E-10	1.1E-10
ESE		5.0E-08	8.2E-09	3.2E-09	1.6E-09	1.1E-09	6.9E-10	5.1E-10	3.6E-10	2.5E-10	1.8E-10
SE		4.8E-08	7.0E-09	3.1E-09	1.5E-09	8.6E-10	4.5E-10	3.1E-10	1.8E-10	1.5E-10	1.2E-10
SSE		8.2E-08	1.3E-08	5.2E-09	2.6E-09	1.4E-09	7.7E-10	4.9E-10	3.9E-10	3.0E-10	2.5E-10
S		4.8E-08	6.3E-09	2.2E-09	1.2E-09	4.8E-10	3.5E-10	2.6E-10	1.9E-10	1.6E-10	1.2E-10
SSW		7.2E-08	1.4E-08	5.1E-09	2.0E-09	1.1E-09	6.8E-10	4.5E-10	3.2E-10	2.3E-10	1.8E-10
SW		4.2E-08	6.5E-09	2.3E-09	1.0E-09	5.7E-10	3.7E-10	2.7E-10	1.8E-10	1.4E-10	1.1E-10
WSW		3.0E-08	4.9E-09	1.7E-09	8.5E-10	6.3E-10	3.8E-10	2.5E-10	1.9E-10	1.6E-10	1.2E-10
W		2.7E-08	3.4E-09	1.2E-09	6.1E-10	4.4E-10	2.7E-10	2.0E-10	1.3E-10	8.5E-11	6.7E-11
WNW		3.0E-08	3.9E-09	1.4E-09	7.4E-10	5.4E-10	3.7E-10	2.6E-10	2.0E-10	1.4E-10	1.0E-10
NW		3.4E-08	5.2E-09	2.2E-09	1.2E-09	6.3E-10	3.2E-10	1.8E-10	1.5E-10	1.1E-10	9.0E-11
NNW		4.1E-08	7.4E-09	3.6E-09	2.5E-09	1.6E-09	8.0E-10	3.9E-10	2.4E-10	1.5E-10	1.2E-10
N		6.7E-08	1.1E-08	4.1E-09	2.0E-09	1.1E-09	7.2E-10	4.7E-10	3.3E-10	2.5E-10	2.0E-10

Number of Valid Observations	=	8703
Number of Invalid Observations	=	57
Number of Calms Lower Level	=	398
Number of Calms Upper Limit	=	0

TABLE A-7
χ/Q VALUES FOR SHORT-TERM GROUND LEVEL RELEASES AT SPECIAL LOCATIONS (sec/m^3) *

Carolina Power & Light Company - Robinson
Release Type: Purge
Release Mode: Ground Level
Variable: Relative Concentration (Sec./Cubic Meter)
Calculation Points: Special
Model: Purge (ACNPURG2)
Application of Terrain Correction Factors: No
Number of Observations: 8703
Purge Time: 100 Hours

Affected Sector	**Site Boundary**	**Meat**	**Dairy**	**Resident**	**Garden**
NNE	7.20E-06	5.00E-06	0.00	6.80E-06	6.20E-06
NE	5.30E-06	4.60E-06	4.00E-06	4.40E-06	4.00E-06
ENE	6.90E-06	1.50E-06	0.00	6.70E-06	1.90E-06
E	1.00E-05	1.10E-06	6.40E-07	6.20E-06	1.20E-06
ESE	1.50E-05	2.60E-06	0.00	1.10E-05	1.10E-05
SE	3.40E-05	0.00	0.00	3.30E-05	3.30E-05
SSE	5.10E-05	0.00	0.00	4.10E-05	4.10E-05
S	3.00E-05	1.20E-06	0.00	2.60E-05	1.80E-05
SSW	2.10E-05	1.30E-06	0.00	2.00E-05	9.80E-06
SW	1.10E-05	7.80E-07	6.70E-07**	9.10E-06	7.20E-06
WSW	8.10E-06	5.50E-07	0.00	6.90E-06	4.20E-06
W	5.50E-06	3.00E-07	0.00	4.20E-06	4.20E-06
WNW	5.30E-06	3.90E-07	0.00	3.70E-06	2.50E-06
NW	2.30E-06	1.70E-06	0.00	2.20E-06	2.20E-06
NNW	2.40E-06	1.20E-06	0.00	1.20E-06	1.10E-06
N	2.70E-06	1.50E-06	0.00	1.50E-06	1.50E-06

* Zeroes indicate that this point was not calculated

** A milk goat was located here

TABLE A-8

DEPLETED χ/Q VALUES FOR SHORT-TERM GROUND LEVEL RELEASES AT SPECIAL LOCATIONS (sec/m^3) *

Carolina Power & Light Company - Robinson
Release Type: Purge
Release Mode: Ground Level
Variable: Relative Depleted Concentration (Sec./Cubic Meter)
Calculation Points: Special
Model: Purge (ACNPURG2)
Application of Terrain Correction Factors: No
Number of Observations: 8703
Purge Time: 100 Hours

Affected Sector	Site Boundary	Meat	Dairy	Resident	Garden
NNE	6.30E-06	4.09E-06	0.00	5.71E-06	5.31E-06
NE	4.71E-06	3.97E-06	3.37E-06	3.77E-06	3.37E-06
ENE	6.19E-06	1.21E-06	0.00	5.96E-06	1.53E-06
E	9.06E-06	8.80E-07	4.80E-07	5.51E-06	9.34E-07
ESE	1.36E-05	2.14E-06	0.00	9.90E-06	9.90E-06
SE	3.19E-05	0.00	0.00	3.08E-05	3.08E-05
SSE	4.71E-05	0.00	0.00	3.83E-05	3.83E-05
S	2.83E-05	9.74E-07	0.00	2.44E-05	1.67E-05
SSW	1.91E-05	1.05E-06	0.00	1.92E-05	8.93E-06
SW	1.02E-05	6.38E-07	7.64E-07**	8.49E-06	6.52E-06
WSW	7.50E-06	4.23E-07	0.00	6.30E-06	3.85E-06
W	5.16E-06	2.28E-07	0.00	3.85E-06	3.85E-06
WNW	4.82E-06	2.98E-07	0.00	3.33E-06	2.23E-06
NW	1.95E-06	1.41E-06	0.00	1.88E-06	1.88E-06
NNW	1.99E-06	9,53E-07	0.00	9.46E-07	8.59E-07
N	2.31E-06	1.19E-06	0.00	1.18E-06	1.18E-06

* Zeroes indicate that this point was not calculated

** A milk goat was located here

TABLE A-9
D/Q VALUES FOR SHORT-TERM GROUND LEVEL RELEASES AT SPECIAL LOCATIONS (m^{-2}) *

Carolina Power & Light Company - Robinson
Release Type: Purge
Release Mode: Ground Level
Variable: Relative Deposition Rate (Meter $^{-2}$)
Calculation Points: Special
Model: Purge (ACNPURG2)
Application of Terrain Correction Factors: No
Number of Observations: 8703
Purge Time: 100 Hours

Affected Sector	Site Boundary	Meat	Dairy	Resident	Garden
NNE	1.06E-08	6.80E-09	0.00	9.86E-09	8.62E-09
NE	9.80E-09	8.37E-09	6.96E-09	7.96E-09	6.96E-09
ENE	1.26E-08	2.12E-09	0.00	1.21E-08	2.72E-09
E	1.94E-08	1.51E-09	8.00E-10	1.13E-08	1.67E-09
ESE	2.29E-08	3.22E-09	0.00	1.68E-08	1.68E-08
SE	4.25E-08	0.00	0.00	4.19E-08	4.19E-08
SSE	5.10E-08	0.00	0.00	4.22E-08	4.22E-08
S	3.99E-08	1.36E-09	0.00	3.59E-08	2.54E-08
SSW	5.92E-08	3.18E-09	0.00	6.00E-08	2.83E-08
SW	3.46E-08	1.93E-09	1.61E-09**	2.83E-08	2.20E-08
WSW	3.90E-08	2.07E-09	0.00	3.30E-08	2.03E-08
W	2.30E-08	8.40E-10	0.00	1.75E-08	1.75E-08
WNW	2.65E-08	1.38E-09	0.00	1.82E-08	1.22E-08
NW	7.08E-09	4.86E-09	0.00	6.42E-09	6.42E-09
NNW	4.46E-09	1.87E-09	0.00	1.86E-09	1.65E-09
N	3.27E-09	1.50E-09	0.00	1.50E-09	1.50E-09

* Zeroes indicate that this point was not calculated

** A milk goat was located here

TABLE A-10
χ/Q VALUES FOR LONG-TERM MIXED MODE RELEASES AT SPECIAL LOCATIONS (sec/m^3) *

Carolina Power & Light Company - Robinson
Release Type: Annual
Release Mode: Mixed Mode
Variable: Relative Concentration (Sec./Cubic Meter)
Calculation Points: Special
Model: Straight Line (ANNX0Q9)
Application of Terrain Correction Factors: Yes
Number of Observations: 8703

Affected Sector	**Site Boundary**	**Meat**	**Dairy**	**Resident**	**Garden**
NNE	3.33E-07	2.82E-07	0.00	3.23E-07	3.18E-07
NE	1.34E-07	1.40E-07	1.23E-07	1.39E-07	1.23E-07
ENE	2.74E-07	1.23E-07	0.00	2.79E-07	8.51E-08
E	2.40E-07	1.11E-07	5.39E-08	2.53E-07	1.33E-07
ESE	2.75E-07	1.25E-07	0.00	2.17E-07	2.17E-07
SE	5.13E-07	0.00	0.00	5.23E-07	5.23E-07
SSE	9.94E-07	0.00	0.00	7.61E-07	7.61E-07
S	4.57E-07	3.61E-08	0.00	4.00E-07	2.50E-07
SSW	5.54E-07	1.27E-07	0.00	5.71E-07	2.69E-07
SW	2.31E-07	5.38E-08	4.72E-08**	1.84E-07	1.51E-07
WSW	2.06E-07	4.64E-08	0.00	1.68E-07	1.02E-07
W	9.36E-08	1.87E-08	0.00	7.13E-08	7.13E-08
WNW	1.02E-07	4.28E-08	0.00	9.55E-08	9.80E-08
NW	1.52E-07	1.30E-07	0.00	1.54E-07	1.54E-07
NNW	1.71E-07	8.86E-08	0.00	8.30E-08	7.28E-08
N	9.32E-08	5.66E-08	0.00	5.80E-08	5.80E-08

* Zeroes indicate that this point was not calculated

** A milk goat was located here

TABLE A-11

DEPLETED χ/Q VALUES FOR LONG-TERM MIXED MODE RELEASES AT SPECIAL LOCATIONS (sec/m^3) *

Carolina Power & Light Company - Robinson
Release Type: Annual
Release Mode: Mixed Mode
Variable: Relative Concentration (Sec./Cubic Meter)
Calculation Points: Special
Model: Straight Line (ANNX0Q9)
Application of Terrain Correction Factors: Yes
Number of Observations: 8703

Affected Sector	Site Boundary	Meat	Dairy	Resident	Garden
NNE	3.33E-07	2.82E-07	0.00	3.23E-07	2.98E-07
NE	1.23E-07	1.28E-07	1.23E-07	1.28E-07	1.23E-07
ENE	2.59E-07	1.23E-07	0.00	2.63E-07	8.12E-08
E	2.40E-07	1.11E-07	4.39E-08	2.53E-07	1.23E-07
ESE	2.54E-07	1.18E-07	0.00	1.96E-07	1.96E-07
SE	4.93E-07	0.00	0.00	5.02E-07	5.02E-07
SSE	9.32E-07	0.00	0.00	7.21E-07	7.21E-07
S	4.39E-07	3.42E-08	0.00	3.82E-07	2.33E-07
SSW	5.35E-07	1.27E-07	0.00	5.51E-07	2.51E-07
SW	2.31E-07	5.14E-08	5.31E-08**	1.84E-07	1.45E-07
WSW	2.06E-07	4.46E-08	0.00	1.68E-07	9.91E-08
W	9.10E-08	1.82E-08	0.00	6.90E-08	6.90E-08
WNW	9.88E-08	4.07E-08	0.00	9.26E-08	9.54E-08
NW	1.51E-07	1.27E-07	0.00	1.54E-07	1.54E-07
NNW	1.64E-07	8.44E-08	0.00	8.04E-08	6.92E-08
N	8.91E-08	5.42E-08	0.00	5.56E-08	5.56E-08

* Zeroes indicate that this point was not calculated

** A milk goat was located here

TABLE A-12
D/Q VALUES FOR LONG-TERM MIXED MODE RELEASES AT SPECIAL LOCATIONS (m^{-2}) *

Carolina Power & Light Company - Robinson
Release Type: Annual
Release Mode: Mixed Mode
Variable: Relative Deposition Rate (Meter $^{-2}$)
Calculation Points: Special
Model: Straight Line (ANNX0Q9)
Application of Terrain Correction Factors: Yes
Number of Observations: 8703

Affected Sector	Site Boundary	Meat	Dairy	Resident	Garden
NNE	2.29E-09	1.39E-09	0.00	2.22E-09	1.89E-09
NE	1.79E-09	1.51E-09	1.23E-09	1.39E-09	1.23E-09
ENE	3.19E-09	3.41E-10	0.00	3.10E-09	4.78E-10
E	4.99E-09	2.31E-10	1.15E-10	2.92E-09	2.76E-10
ESE	4.86E-09	5.90E-10	0.00	3.75E-09	3.75E-09
SE	6.98E-09	0.00	0.00	7.20E-09	7.20E-09
SSE	6.22E-09	0.00	0.00	5.21E-09	5.21E-09
S	7.31E-09	1.77E-10	0.00	6.60E-09	5.17E-09
SSW	1.01E-08	7.41E-10	0.00	1.06E-08	6.81E-09
SW	4.62E-09	3.32E-10	2.66E-10**	4.14E-09	3.87E-09
WSW	4.85E-09	2.59E-10	0.00	4.34E-09	3.35E-09
W	2.64E-09	6.74E-11	0.00	1.95E-09	1.95E-09
WNW	2.59E-09	1.25E-10	0.00	1.94E-09	1.29E-09
NW	1.20E-09	7.66E-10	0.00	1.12E-09	1.12E-09
NNW	7.77E-10	2.53E-10	0.00	2.41E-10	2.03E-10
N	3.62E-10	1.41E-10	0.00	1.51E-10	1.51E-10

* Zeroes indicate that this point was not calculated

** A milk goat was located here

TABLE A-13
χ/Q VALUES FOR LONG-TERM MIXED MODE RELEASES AT STANDARD DISTANCES (sec/m^3)

Carolina Power & Light Company - Robinson
Release Type: Annual
Release Mode: Mixed Mode
Variable: Relative Concentration (Sec./Cubic Meter)
Calculation Points: Standard
Model: Straight Line (ANNX0Q9)
Application of Terrain Correction Factors: Yes
Number of Observations: 8703

BASE DISTANCE IN MILES/KILOMETERS

Sector	Mi→	.25	.75	1.25	1.75	2.25	2.75	3.25	3.75	4.25	4.75
	Km→	.40	1.21	2.01	2.82	3.62	4.42	5.23	6.03	6.84	7.64
NNE		1.5E-06	3.9E-07	3.1E-07	2.7E-07	2.3E-07	2.0E-07	1.6E-07	1.4E-07	9.8E-08	6.5E-08
NE		1.0E-06	1.5E-07	1.1E-07	9.0E-08	6.7E-08	5.2E-08	7.8E-08	3.8E-08	5.4E-08	3.4E-08
ENE		8.6E-07	2.6E-07	1.9E-07	1.7E-07	1.2E-07	1.1E-07	7.4E-08	6.2E-08	4.8E-08	4.2E-08
E		7.2E-07	2.6E-07	2.2E-07	2.0E-07	2.1E-07	1.2E-07	9.4E-08	7.0E-08	4.7E-08	3.6E-08
ESE		7.8E-07	1.9E-07	1.7E-07	1.3E-07	1.0E-07	7.6E-08	6.6E-08	4.9E-08	3.8E-08	2.9E-08
SE		5.9E-07	1.0E-07	7.5E-08	5.1E-08	3.8E-08	2.4E-08	1.9E-08	1.2E-08	1.2E-08	1.1E-08
SSE		1.0E-06	1.8E-07	1.2E-07	8.0E-08	5.4E-08	3.6E-08	2.6E-08	2.3E-08	1.9E-08	1.8E-08
S		5.0E-07	9.4E-08	7.0E-08	5.9E-08	3.5E-08	3.2E-08	2.9E-08	2.5E-08	2.2E-08	1.9E-08
SSW		6.3E-07	2.7E-07	2.4E-07	1.5E-07	1.2E-07	8.4E-08	6.3E-08	4.7E-08	3.6E-08	3.1E-08
SW		3.5E-07	9.9E-08	8.8E-08	6.1E-08	4.6E-08	3.7E-08	3.2E-08	2.3E-08	2.0E-08	1.7E-08
WSW		3.0E-07	6.5E-08	6.2E-08	5.4E-08	5.4E-08	4.1E-08	3.0E-08	2.7E-08	2.4E-08	1.9E-08
W		2.4E-07	6.2E-08	6.0E-08	4.9E-08	4.9E-08	3.5E-08	3.0E-08	2.0E-08	1.5E-08	1.2E-08
WNW		2.8E-07	8.4E-08	8.6E-08	6.8E-08	6.3E-08	5.2E-08	4.2E-08	3.6E-08	3.6E-08	3.4E-08
NW		3.8E-07	1.2E-07	1.5E-07	1.2E-07	9.2E-08	6.5E-08	4.7E-08	4.1E-08	3.5E-08	2.9E-08
NNW		4.2E-07	1.8E-07	1.4E-07	1.6E-07	1.4E-07	9.2E-08	5.4E-08	3.7E-08	2.5E-08	2.1E-08
N		7.8E-07	1.7E-07	1.3E-07	9.3E-08	7.2E-08	5.9E-08	4.5E-08	3.8E-08	3.3E-08	2.9E-08

Number of Valid Observations = 8703

Number of Invalid Observations = 57

Number of Calms Lower Level = 60

Number of Calms Upper Limit = 5

TABLE A-14

DEPLETED χ/Q VALUES FOR LONG-TERM MIXED MODE RELEASES AT STANDARD DISTANCES (sec/m^3)

Carolina Power & Light Company - Robinson
Release Type: Annual
Release Mode: Mixed Mode
Variable: Relative Depleted Concentration (Sec./Cubic Meter)
Calculation Points: Standard
Model: Straight Line (ANNX0Q9)
Application of Terrain Correction Factors: Yes
Number of Observations: 8703

BASE DISTANCE IN MILES/KILOMETERS

Sector	Mi→	.25	.75	1.25	1.75	2.25	2.75	3.25	3.75	4.25	4.75
	Km→	.40	1.21	2.01	2.82	3.62	4.42	5.23	6.03	6.84	7.64
NNE		1.5E-06	3.7E-07	3.1E-07	2.5E-07	2.2E-07	1.8E-07	1.5E-07	1.3E-07	8.9E-08	6.1E-08
NE		9.8E-07	1.4E-07	1.1E-07	8.5E-08	6.4E-08	4.9E-08	7.8E-08	3.6E-08	5.2E-08	3.1E-08
ENE		8.3E-07	2.5E-07	1.8E-07	1.6E-07	1.2E-07	1.0E-07	6.9E-08	5.7E-08	4.5E-08	4.0E-08
E		7.0E-07	2.4E-07	2.0E-07	1.9E-07	2.1E-07	1.1E-07	9.4E-08	6.6E-08	4.5E-08	3.4E-08
ESE		7.3E-07	1.8E-07	1.6E-07	1.2E-07	9.6E-08	7.2E-08	6.1E-08	4.6E-08	3.6E-08	2.7E-08
SE		5.7E-07	9.6E-08	6.9E-08	4.7E-08	3.6E-08	2.3E-08	1.8E-08	1.2E-08	1.0E-08	9.9E-09
SSE		9.6E-07	1.7E-07	1.1E-07	7.4E-08	4.9E-08	3.3E-08	2.4E-08	2.1E-08	1.7E-08	1.6E-08
S		4.8E-07	8.9E-08	6.7E-08	5.8E-08	3.8E-08	3.1E-08	2.7E-08	2.4E-08	2.1E-08	1.8E-08
SSW		6.1E-07	2.5E-07	2.4E-07	1.5E-07	1.1E-07	8.0E-08	6.0E-08	4.5E-08	3.4E-08	2.9E-08
SW		3.4E-07	9.5E-08	8.5E-08	5.8E-08	4.4E-08	3.6E-08	3.1E-08	2.2E-08	1.9E-08	1.6E-08
WSW		2.9E-07	6.3E-08	6.1E-08	5.2E-08	5.2E-08	4.0E-08	2.9E-08	2.6E-08	2.2E-08	1.8E-08
W		2.4E-07	6.0E-08	5.9E-08	4.8E-08	4.7E-08	3.4E-08	2.9E-08	1.9E-08	1.4E-08	1.2E-08
WNW		2.6E-07	8.3E-08	8.4E-08	6.6E-08	6.2E-08	5.0E-08	4.0E-08	3.4E-08	3.4E-08	3.2E-08
NW		3.8E-07	1.1E-07	1.5E-07	1.1E-07	9.0E-08	6.3E-08	4.5E-08	3.9E-08	3.0E-08	2.4E-08
NNW		4.1E-07	1.2E-07	1.4E-07	1.6E-07	1.4E-07	8.8E-08	5.2E-08	3.5E-08	2.4E-08	2.0E-08
N		7.5E-07	1.5E-07	1.2E-07	8.8E-08	6.9E-08	5.7E-08	4.3E-08	3.6E-08	3.1E-08	2.7E-08

Number of Valid Observations	=	8703
Number of Invalid Observations	=	57
Number of Calms Lower Level	=	60
Number of Calms Upper Limit	=	5

TABLE A-15
D/Q VALUES FOR LONG-TERM MIXED MODE RELEASES AT STANDARD DISTANCES (m^{-2})

Carolina Power & Light Company - Robinson
Release Type: Annual
Release Mode: Mixed Mode
Variable: Relative Deposition Rate (Meter-2)
Calculation Points: Standard
Model: Straight Line (ANNX0Q9)
Application of Terrain Correction Factors: Yes
Number of Observations: 8703

BASE DISTANCE IN MILES/KILOMETERS

Sector	Mi→	.25	.75	1.25	1.75	2.25	2.75	3.25	3.75	4.25	4.75
	Km→	.40	1.21	2.01	2.82	3.62	4.42	5.23	6.03	6.84	7.64
NNE		1.6E-08	5.0E-09	2.1E-09	1.2E-09	7.5E-10	5.2E-10	3.4E-10	2.7E-10	2.0E-10	1.4E-10
NE		1.1E-08	2.6E-09	1.2E-09	6.2E-10	3.5E-10	2.3E-10	1.8E-10	1.2E-10	1.2E-10	1.0E-10
ENE		1.1E-08	3.8E-09	1.4E-09	7.6E-10	3.7E-10	2.7E-10	1.8E-10	1.4E-10	1.2E-10	1.1E-10
E		1.1E-08	3.7E-09	1.4E-09	7.2E-10	5.0E-10	2.6E-10	2.1E-10	1.4E-10	1.0E-10	7.8E-11
ESE		8.6E-09	2.7E-09	1.2E-09	6.7E-10	4.3E-10	2.8E-10	2.1E-10	1.5E-10	1.0E-10	7.3E-11
SE		7.0E-09	1.9E-09	9.5E-10	4.7E-10	2.8E-10	1.5E-10	1.1E-10	5.9E-11	5.0E-11	4.2E-11
SSE		6.2E-09	1.8E-09	8.6E-10	4.6E-10	2.6E-10	1.5E-10	9.5E-11	7.7E-11	5.9E-11	5.0E-11
S		7.1E-09	1.8E-09	7.6E-10	4.2E-10	1.8E-10	1.3E-10	9.9E-11	7.3E-11	6.1E-11	4.8E-11
SSW		1.0E-08	5.0E-09	2.6E-09	1.1E-09	6.1E-10	3.9E-10	2.6E-10	1.8E-10	1.3E-10	1.0E-10
SW		5.0E-09	2.0E-09	9.8E-10	4.7E-10	2.9E-10	1.9E-10	1.5E-10	9.8E-11	7.6E-11	6.4E-11
WSW		4.9E-09	1.9E-09	8.4E-10	4.8E-10	3.7E-10	2.3E-10	1.5E-10	1.2E-10	1.0E-10	7.1E-11
W		4.0E-09	1.4E-09	6.3E-10	3.4E-10	2.6E-10	1.6E-10	1.3E-10	7.9E-11	5.4E-11	4.1E-11
WNW		4.6E-09	1.5E-09	7.1E-10	4.2E-10	3.2E-10	2.2E-10	1.6E-10	1.2E-10	9.9E-11	7.4E-11
NW		5.6E-09	2.2E-09	1.1E-09	6.4E-10	3.6E-10	1.9E-10	1.2E-10	1.0E-10	1.1E-10	9.6E-11
NNW		4.5E-09	1.9E-09	1.1E-09	8.1E-10	5.2E-10	2.7E-10	1.4E-10	8.8E-11	5.7E-11	4.5E-11
N		5.9E-09	1.8E-09	8.2E-10	4.0E-10	2.4E-10	1.6E-10	1.0E-10	7.4E-11	5.8E-11	4.7E-11

Number of Valid Observations = 8703

Number of Invalid Observations = 57

Number of Calms Lower Level = 60

Number of Calms Upper Limit = 5

TABLE A-16
χ/Q VALUES FOR SHORT-TERM MIXED MODE RELEASES AT SPECIAL LOCATIONS (sec/m^3) *

Carolina Power & Light Company - Robinson
Release Type: Purge
Release Mode: Mixed Mode
Variable: Relative Concentration (Sec./Cubic Meter)
Calculation Points: Special
Model: Purge (ACNPURG2)
Application of Terrain Correction Factors: No
Number of Observations: 8703
Purge Time: 100 Hours

Affected Sector	Site Boundary	Meat	Dairy	Resident	Garden
NNE	8.40E-07	7.00E-07	0.00	8.30E-07	7.90E-07
NE	5.40E-07	5.30E-07	4.70E-07	5.20E-07	4.70E-07
ENE	8.90E-07	4.20E-07	0.00	8.80E-07	3.10E-07
E	1.00E-06	4.00E-07	2.50E-07	9.20E-07	4.50E-07
ESE	1.24E-06	4.70E-07	0.00	1.00E-06	1.00E-06
SE	2.20E-06	0.00	0.00	2.10E-06	2.10E-06
SSE	2.90E-06	0.00	0.00	2.40E-06	2.40E-06
S	1.90E-06	2.00E-07	0.00	1.70E-06	1.20E-06
SSW	2.00E-06	4.00E-07	0.00	2.00E-06	1.10E-06
SW	1.10E-06	2.40E-07	2.10E-07**	9.50E-07	7.70E-07
WSW	1.20E-06	2.20E-07	0.00	9.90E-07	6.30E-07
W	7.40E-07	1.30E-07	0.00	5.90E-07	5.90E-07
WNW	7.90E-07	2.20E-07	0.00	6.80E-07	6.20E-07
NW	6.30E-07	5.10E-07	0.00	6.20E-07	6.20E-07
NNW	5.10E-07	3.20E-07	0.00	3.10E-07	2.90E-07
N	3.50E-07	2.30E-07	0.00	2.40E-07	2.40E-07

* Zeroes indicate that this point was not calculated

** A milk goat was located here

TABLE A-17
DEPLETED χ/Q VALUES FOR SHORT-TERM MIXED MODE RELEASES AT SPECIAL LOCATIONS (sec/m^3) *

Carolina Power & Light Company - Robinson
Release Type: Purge
Release Mode: Mixed Mode
Variable: Relative Depleted Concentration (Sec./Cubic Meter)
Calculation Points: Special
Model: Purge (ACNPURG2)
Application of Terrain Correction Factors: No
Number of Observations: 8703
Purge Time: 100 Hours

Affected Sector	Site Boundary	Meat	Dairy	Resident	Garden
NNE	8.40E-07	7.00E-07	0.00	8.30E-07	7.41E-07
NE	4.95E-07	4.86E-07	4.70E-07	4.77E-07	4.70E-07
ENE	8.40E-07	4.20E-07	0.00	8.31E-07	2.96E-07
E	1.00E-06	4.00E-07	2.03E-07	9.20E-07	4.15E-07
ESE	1.11E-06	4.44E-07	0.00	9.00E-07	9.00E-07
SE	2.11E-06	0.00	0.00	2.01E-06	2.01E-06
SSE	2.72E-07	0.00	0.00	2.27E-06	2.27E-06
S	1.82E-06	1.90E-07	0.00	1.63E-06	1.12E-06
SSW	1.93E-06	4.00E-07	0.00	1.93E-06	1.03E-06
SW	1.10E-06	2.29E-07	2.35E-07**	9.50E-07	7.36E-07
WSW	1.20E-06	2.12E-07	0.00	9.90E-07	6.11E-07
W	7.19E-07	1.26E-07	0.00	5.71E-07	5.71E-07
WNW	7.65E-07	2.09E-07	0.00	6.59E-07	6.04E-07
NW	6.24E-07	4.99E-07	0.00	6.20E-07	6.20E-07
NNW	4.90E-07	3.05E-07	0.00	3.00E-07	2.76E-07
N	3.35E-07	2.20E-07	0.00	2.30E-07	2.30E-07

* Zeroes indicate that this point was not calculated

** A milk goat was located here

TABLE A-18

D/Q VALUES FOR SHORT-TERM MIXED MODE RELEASES AT SPECIAL LOCATIONS (m^{-2}) *

Carolina Power & Light Company - Robinson
Release Type: Purge
Release Mode: Mixed Mode
Variable: Relative Deposition Rate (Meter $^{-2}$)
Calculation Points: Special
Model: Purge (ACNPURG2)
Application of Terrain Correction Factors: No
Number of Observations: 8703
Purge Time: 100 Hours

Affected Sector	Site Boundary	Meat	Dairy	Resident	Garden
NNE	5.77E-09	3.45E-09	0.00	5.70E-09	4.68E-09
NE	7.18E-09	5.72E-09	4.70E-09	5.20E-09	4.70E-09
ENE	1.04E-08	1.16E-09	0.00	9.77E-09	1.74E-09
E	2.08E-08	8.36E-10	5.32E-10	1.06E-08	9.36E-10
ESE	2.12E-08	2.22E-09	0.00	1.73E-08	1.73E-08
SE	2.99E-08	0.00	0.00	2.88E-08	2.88E-08
SSE	1.81E-08	0.00	0.00	1.64E-08	1.64E-08
S	3.04E-08	9.84E-10	0.00	2.80E-08	2.48E-08
SSW	3.66E-08	2.33E-09	0.00	3.72E-08	2.78E-08
SW	2.20E-08	1.48E-09	1.18E-09**	2.14E-08	1.97E-08
WSW	2.83E-08	1.23E-09	0.00	2.55E-08	2.07E-08
W	2.09E-08	4.69E-10	0.00	1.62E-08	1.62E-08
WNW	2.01E-08	6.45E-10	0.00	1.38E-08	8.18E-09
NW	4.98E-09	3.00E-09	0.00	4.53E-09	4.53E-09
NNW	2.32E-09	9.15E-10	0.00	8.99E-10	8.09E-10
N	1.36E-09	5.75E-10	0.00	6.24E-10	6.24E-10

* Zeroes indicate that this point was not calculated

** A milk goat was located here

TABLE A-19
ROBINSON PLANT SITE INFORMATION TO BE USED FOR GROUND LEVEL CALCULATIONS WITH NRC "XOQDOQ" PROGRAM

CARD TYPE	COLUMNS	DESCRIPTION	VALUE TO BE USED IN XOQDOQ
1	1 38 39 41 55 56 58	Print input data Calculate annual X/Qs for points of interest Calculate annual X/Q averages for site radial segments Print out set distance X/Qs and D/Qs Calculate annual D/Q averages for the set radial segments Allow depleted X/Qs (if Decays (1), (2), or (3) are negative) Calculate annual D/Qs for points of interest	1 1 1 1 1 1 1
2	1-80	Title card	N/A
3	1-5 6-10 11-15 16-20 21-25 26-30 31-35	Number of wind velocity categories Number of stability categories Number of distances within terrain data for each sector Total number of hours in joint wind frequency distribution Increment in % for which plotted results are to be printed Number of titles of receptor types Number or release exit locations	7 7 5 (1) 5 5 3
4	1-5 6-20	Height of the measured wind (meters) Half-life (days) used in the X/Q calculations	11 101.00 226 -8.00
5	N/A	N/A	---
6	1-80	Joint wind frequency distribution	(1)

TABLE A-19 (continued)
ROBINSON PLANT SITE INFORMATION TO BE USED FOR
GROUND LEVEL CALCULATIONS WITH NRC "XOQDOQ" PROGRAM

CARD TYPE	**COLUMNS**	**DESCRIPTION**	**VALUE TO BE USED IN XOQDOQ**
7	1-5 6-75	Wind velocity units correction Maximum wind speed in each wind class (m/sec)	200.00 0.75 3.50 7.50 12.50 18.50 25.00 26.00
8	1-80	Distance in meters at which terrain heights are given	(2)
9	1-80	Terrain heights (in meters, above plant grade) correspond to distance in Card Type 8	(2)
10	1-25	Number of receptor locations for a particular receptor type	Site boundary = 16 Dairy = 1 Meat = 14 Residence = 16 Garden = 16
11	1-16	Title of receptor type for receptor locations	Site Boundary Dairy Meat Residence Garden
12	1-80	Receptor direction and distance	(See Table 1)
13	1-80	Title for release point whose characteristics are described on Card Type 14	(1)

TABLE A-19 (continued)
ROBINSON PLANT SITE INFORMATION TO BE USED FOR
GROUND LEVEL CALCULATIONS WITH NRC "XOQDOQ" PROGRAM

CARD TYPE	COLUMNS	DESCRIPTION	VALUE TO BE USED IN XOQDOQ
14	1-5	Vent average velocity (m/sec)	20.1
	6-10	Vent inside diameter (m)	1.0
	11-15	Height of vent release point (m)	0.000
	16-20	Height of the vent's building (m)	59.0
	21-25	Minimum cross-sectional area for the vent's building (m^2)	1370.0
	26-30	Wind height used for vent elevated release	11.0
	31-35	Vent heat emission rate (cal/sec)	0.0
15	1	Identification for release point	A
	2-5	Intermittent releases	1
	6-10	Number of intermittent releases per year for this release point	100
	11-15	Average number of hours per intermittent release	1

(1) Appropriate data to be supplied

(2) Obtained from cross-sectional topographic maps

TABLE A-20
ROBINSON PLANT SITE INFORMATION TO BE USED FOR MIXED MODE RELEASE CALCULATIONS WITH NRC "XOQDOQ" PROGRAM

CARD TYPE	COLUMNS	DESCRIPTION	VALUE TO BE USED IN XOQDOQ
1	1 38 39 41 55 56 58	Print input data Calculate annual X/Qs for points of interest Calculate annual X/Q averages for site radial segments Print out set distance X/Qs and D/Qs Calculate annual D/Q averages for the set radial segments Allow depleted X/Qs (if Decays (1), (2), or (3) are negative) Calculate annual D/Qs for points of interest	1 1 1 1 1 1 1
2	1-80	Title card	N/A
3	1-5 6-10 11-15 16-20 21-25 26-30 31-35	Number of wind velocity categories Number of stability categories Number of distances within terrain data for each sector Total number of hours in joint wind frequency distribution Increment in % for which plotted results are to be printed Number of titles of receptor types Number of release exit locations	7 7 5 (1) 5 5 3
4	1-5 6-20	Height of the measured wind (meters) Half-life (days) used in the X/Q calculations	11 101.00 226 -8.00
5	N/A	N/A	---
6	1-80	Joint wind frequency distribution	(1)

TABLE A-20 (continued)
ROBINSON PLANT SITE INFORMATION TO BE USED FOR MIXED MODE RELEASE CALCULATIONS WITH NRC "XOQDOQ" PROGRAM

CARD TYPE	COLUMNS	DESCRIPTION	VALUE TO BE USED IN XOQDOQ
7	1-5 6-75	Wind velocity units correction Maximum wind speed in each wind class (m/sec)	200.00 0.75 3.50 7.50 12.50 18.50 25.00 26.00
8	1-80	Distance in meters at which terrain heights are given	(2)
9	1-80	Terrain heights (in meters, above plant grade) corresponding to distances in Card Type 8	(2)
10	1-25	Number of receptor locations for a particular receptor type	Site boundary = 16 Dairy = 1 Meat = 14 Residence = 16 Garden = 16
11	1-16	Title of receptor type for receptor locations	Site Boundary Dairy Meat Residence Garden
12	1-80	Receptor direction and distance	(See Table 1)
13	1-80	Title for release point whose characteristics are described on Card Type 14	(1)

TABLE A-20 (continued)
ROBINSON PLANT SITE INFORMATION TO BE USED FOR
MIXED MODE RELEASE CALCULATIONS WITH NRC "XOQDOQ" PROGRAM

CARD TYPE	COLUMNS	DESCRIPTION	VALUE TO BE USED IN XOQDOQ
14	1-5	Vent average velocity (m/sec)	20.1
	6-10	Vent inside diameter (m)	1.0
	11-15	Height of vent release point (m)	60.7
	16-20	Height of the vent's building (m)	59.0
	21-25	Minimum cross-sectional area for the vent's building (m^2)	1370.0
	26-30	Wind height used for vent elevated release	11.
	31-35	Vent heat emission rate (cal/sec)	0.
15	1	Identification for release point	A
	2-5	Intermittent releases	1
	6-10	Number of intermittent releases per year for this release point	100
	11-15	Average number of hours per intermittent release	1

(1) Appropriate data to be supplied

(2) Obtained from cross-sectional topographic maps

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 10 CFR 20 and Appendix I of 10 CFR 50 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.

B.1 Calculation of P_i

The dose parameter, P_i, contained in the radioiodine and particulates portion of Section 3.3 includes pathway transport parameters of the 'i' radionuclide, the receptor's usage of the pathway media, and the dosimetry of the exposure. Pathway usage rates and the internal dosimetry are functions of the receptor's age. The following sections provide in detail the methodology which was used in calculating the P_i values for inclusion into this ODCM.

B.1.1 Inhalation Pathway

The dose factor from inhalation pathway is calculated by:

$$P_{iI} = K' * BR * DFA_i \tag{B.1-1}$$

where:

P_{iI} = Dose parameter for radionuclide 'i' for the inhalation pathway (mrem/yr per µCi/m^3).

K' = 10^6, a constant of unit conversion (pCi/µCi).

BR = The breathing rate of the child age group (m^3/yr).

DFA_i = The organ inhalation dose factor for the child age group for radionuclide 'i' (mrem/ρCi).

The age group considered is the child group. 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-10 of Regulatory Guide 1.109 in units of mrem/ρCi. The total body is considered as an organ in the selection of DFA_i.

The incorporation of breathing rate of a child and the unit conversion factor results in the following equation:

$$P_{iI} = 3.7x10^9 * DFA_i$$

(B.1-2)

B.1.2 Ground Plane Pathway

The dose factor from ground plane pathway is calculated by:

$$P_{iG} = K' * K'' * DFG_i * \frac{1 - e^{-\lambda_i * t}}{\lambda_i}$$

(B.1-3)

where:

P_{iG}	=	Dose parameter for radionuclide 'i' for the ground plane pathway (m^2-mrem/yr per μCi/sec).
K'	=	10^6, a constant of unit conversion (pCi/μCi).
K"	=	8760, a constant of unit conversion (hr/yr).
DFG_i	=	The ground plane dose conversion factor for radionuclide 'i' (mrem/hr per ρCi/m^2).
λ_i	=	The radiological decay constant for radionuclide 'i' (sec^{-1}).
t	=	$3.17x10^7$, the exposure period of 1 year (sec).

The deposition rate onto the ground plane results in a ground plane concentration that is assumed to persist over a year with radiological decay, the only operating removal mechanism for each radionuclide. The ground plane dose conversion factors for radionuclide 'i', DFG_i, are presented in Table E-6 of Regulatory Guide 1.109, Revision 1. Resolution of the units yields:

$$P_{iG} = 8.76x10^9 * DFG_i * \frac{1 - e^{-\lambda_i * t}}{\lambda_i}$$

(B.1-4)

B.1.3 Milk

The dose factor from the cow/goat-milk-man pathway is calculated by:

$$P_{iM} = \frac{K' * r * Q_F * U_{ap} * F_m}{Y_p * (\lambda_i + \lambda_w)} * DFL_i * e^{-\lambda_i * t_f}$$

(B.1-5)

where:

P_{iM} = Dose parameter for radionuclide 'i' for the cow milk or goat milk pathway (m^2-mrem/yr per µCi/sec).

K' = 10^6, a constant of unit conversion (ρCi/µCi).

r = Fraction of deposited activity retained on cow's or goat's feed grass (dimensionless).

Q_F = The cow's or goat's consumption rate of feed (kg/day, wet weight).

U_{ap} = The child's milk consumption rate (liters/yr).

F_m = The stable element transfer coefficient (ρCi/liter per ρCi/day).

Y_p = The agricultural productivity by unit area (kg/m^2).

λ_i = The radiological decay constant for radionuclide 'i' (sec^{-1}).

λ_w = 5.73×10^{-7} (corresponding to a 14 day half-life), the decay constant for removal of activity on leaf and plant surfaces by weathering (sec^{-1}).

DFL_i = The maximum organ ingestion dose factor for radionuclide 'i' (mrem/ρCi).

t_f = The transport time from pasture, to cow or goat, to milk, to child (sec).

A fraction of the airborne deposition is captured by the ground plane vegetation cover. The captured material is removed from the vegetation (grass) by both radiological decay and weathering processes.

Various parameters which were utilized to determine the P_i values for the cow and goat milk pathways are provided in Table B-1. Table E-1 of Regulatory Guide 1.109, Revision 1, provides the stable element transfer coefficients, F_m; and Table E-14 of the same regulatory guide provides the ingestion dose factors, DFL_i , for the child's organs. The organ with the maximum value of DFL_i was used in the determination of P_i for this pathway. The incorporation of the various constants of Table B-1 into Equation B.1-5 results in the following:

For radioiodines and particulates from cow's milk:

$$P_{iM} = 2.4x10^{10} * \frac{r * F_m}{\lambda_i + \lambda_w} * DFL_i * e^{-\lambda_i * t_f}$$

(B.1-6)

For radioiodines and particulates from goat's milk pathway:

$$P_{iM} = 2.8x10^{9} * \frac{r * F_m}{\lambda_i + \lambda_w} * DFL_i * e^{-\lambda_i * t_f}$$

(B.1-7)

The concentration of tritium in milk is based on its airborne concentration rather than the deposition rate and is calculated by:

$$P_{T_M} = K' * K''' * F_m * Q_F * U_{ap} * DFL_T * 0.75 * \frac{0.5}{H}$$

(B.1-8)

where:

P_{T_M} = Dose parameter for tritium for the cow milk and goat milk pathways (mrem/yr per μCi/m^3).

K''' = 10^3, a constant of unit conversion (gm/kg).

DFL_T = Maximum organ ingestion dose factor for tritium (mrem/ρCi).

H = Absolute humidity of the atmosphere (gm/m^3).

0.75 = The fraction of total feed that is water (dimensionless).

0.5 = The ratio of the specific activity of the feed grass water to the atmospheric water (dimensionless).

B.2 Calculation of R_i Followning Regulatory Guide 1.109 Methodology

The radioiodine and particulate ODCM Specification 3.5.2.1 is applicable to the location in the unrestricted area where the combination of existing pathways and receptor age groups indicates that the maximum potential exposure occurs. The inhalation and ground plane exposure pathways shall be considered to exist at all locations. The grass-goat-milk, the grass-cow-milk, grass-cow-meat, and vegetation pathways are considered based on their existence at the various locations. R_i values have been calculated for the adult, teen, and child age groups for the inhalation, ground plane, cow milk, goat milk, vegetable, and beef ingestion pathways. R_i values have been calculated for the infant age group for the inhalation, ground plane, cow milk, and goat milk pathways. The methodology which was utilized to calculate these values (see Tables 3.5-1 through 3.5-19) is presented below and follows the guidance given in Regulatory Guide 1.109.

B.2.1 Inhalation Pathway

The dose factor from the inhalation pathway is calculated by:

$$R_{iI} = K' * BR_a * (DFA_i)_a \tag{B.2-1}$$

where:

R_{iI} = Dose factor for each identified radionuclide 'i' of the organ of interest (mrem/yr per µCi/m^3).

K' = 10^6, a constant of unit conversion (ρCi/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/ρCi).

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:

$$R_{iG} = I_i * K' * K'' * S_F * DFG_i * \frac{1 - e^{-\lambda_i * t}}{\lambda_i} \quad \text{(B.2-2)}$$

where:

R_{iG} = Dose factor for the ground plane pathway for each identified radionuclide 'i' for the organ of interest (m^2-mrem/hr per µCi/sec).

I_i = 1.0, factor to account for fractional deposition of radionuclide 'i'. For radionuclides other than iodine, the factor I_i is equal to 1.0. For radioiodines, the value of I_i may vary. However, a value of 1.0 was used in calculating the R values in Table 3.5-1 (dimensionless).

K' = 10^6, a constant of unit conversion (ρCi/µCi).

K" = 8760, a constant of unit conversion (hr/yr).

S_F = 0.7, the shielding factor suggested in Table E-15 of Regulatory Guide 1.109, Revision 1 (dimensionless).

DFG_i = The ground plane dose conversion factor for radionuclide 'i'. A tabulation of DFG_i values is presented in Table E-6 of Regulatory Guide 1.109, Revision 1 (mrem/hr per ρCi/m^2).

λ_i = The radiological decay constant for radionuclide 'i' (sec^{-1}).

t = 4.73×10^8, exposure time in seconds over 15 years (sec).

B.2.3 Grass Cow or Goat Milk Pathway

The dose factor for the cow milk or goat milk pathway for each radionuclide for each organ is calculated by:

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

where:

R_{iM} = Dose factor for the cow milk or goat milk pathway for each identified radionuclide 'i' for the organ of interest (m^2-mrem/yr per μCi/sec).

I_i = 1.0, factor to account for fractional deposition of radionuclide 'i'. For radionuclides other than iodine, the factor I_i is equal to 1.0. For radioiodines, the value of I_i may vary. However, a value of 1.0 was used in calculating the R values in Tables 3.5-8 through 3.5-15 (dimensionless).

K' = 10^6, a constant of unit conversion (ρCi/μCi).

Q_F = The cow's or goat's consumption rate of feed (kg/day, wet weight).

U_{ap} = The receptor's milk consumption rate for age group 'a' (liters/yr).

F_m = The stable element transfer coefficient (ρCi/liter per ρCi/day).

$(DFL_i)_a$ = The organ ingestion dose for radionuclide 'i' for the receptor in age group 'a' (mrem/ρCi).

λ_i = The radiological decay constant for radionuclide 'i' (sec^{-1}).

t_f = The transport time from feed to cow or goat to milk to receptor (sec).

f_p = Fraction of the year that the cow or goat is on pasture (dimensionless).

f_s = Fraction of the cow or goat feed that is pasture grass while the animal is on pasture (dimensionless).

r = Fraction of deposited activity retained on cow's or goat's feed grass (dimensionless).

λ_{E_i} = $\lambda_i + \lambda_w$ (sec^{-1}).

λ_w = 5.73×10^{-7}, the decay constant for removal of activity on leaf and plant surfaces by weathering (corresponding to a 14 day half-life) (sec^{-1}).

t_e = Period of pasture grass and crop exposure during the growing season (sec).

Y_p = The agricultural productivity by unit area of pasture feed grass (kg/m^2).

B_{iV} = Concentration factor for uptake of radionuclide 'i' from the soil by the edible parts of crops (ρCi/kg wet weight per ρCi/kg dry soil).

t_b = Period of time that sediment is exposed to gaseous effluents (sec).

P = Effective surface density for soil (kg dry soil/m^2).

Y_s = The agricultural productivity by unit area of stored feed (kg/m^2).

t_h = The transport time for harvest, to cow or goat, to consumption (sec).

In lieu of site specific information regarding the fraction feed of milk cattle and goats, all feed will be considered to be from pasture grass. Therefore using the guidance from Regulatory Guide 1.109, Revision 1, the values of f_s and f_p are considered unity in lieu of site-specific information.

Table B-1 contains the appropriate parameter values and their source in Regulatory Guide 1.109, Revision 1.

The concentration of tritium in milk is based on the airborne concentration rather than the deposition. Therefore, the R_i is based on χ/Q:

$$R_{T_M} = K' * K''' * F_m * Q_F * U_{ap} * (DFL_i)_a * 0.75 * \frac{0.5}{H} \tag{B.2-4}$$

where:

R_{T_M} = Dose parameter for the cow or goat milk pathways for tritium for organ of interest (mrem/yr per μCi/m^3).

K''' = 10^3, a constant of unit conversion (gm/kg).

H = 8, used in lieu of site-specific information, absolute humidity of the atmosphere (gm/m^3).

0.75 = The fraction of total feed that is water (dimensionless).

0.5 = The ratio of the specific activity of the feed grass water to the atmospheric water (dimensionless).

All other terms remain the same as previously defined.

B.2.4 Grass-Cow-Meat Pathway

The integrated concentration in meat follows in a similar manner to the development for the milk pathway, therefore:

$$R_{iB} = I_i * K' * Q_F * U_{ap} * F_f * (DFL_i)_a * e^{-\lambda_i * t_s} * \left[\left[f_p * f_s * \left(\frac{r * \left(1 - e^{-\lambda_{E_i} * t_e}\right)}{Y_p * \lambda_{E_i}} + \frac{B_{iV} * \left(1 - e^{-\lambda_i * t_b}\right)}{P * \lambda_i}\right)\right] + \left[\left(1 - f_p * f_s\right) * \left(\frac{r * \left(1 - e^{-\lambda_{E_i} * t_e}\right)}{Y_s * \lambda_{E_i}} + \frac{B_{iV} * \left(1 - e^{-\lambda_i * t_b}\right)}{P * \lambda_i}\right) * \left(e^{-\lambda_i * t_h}\right)\right]\right] \tag{B.2-5}$$

where:

R_{iB} = Dose factor for the meat ingestion pathway for radionuclide 'i' for any organ of interest (m^2-mrem/yr per µCi/sec).

I_i = 1.0, factor to account for fractional deposition of radionuclide 'i'. For radionuclides other than iodine, the factor I_i is equal to 1.0. For radioiodines, the value of I_i may vary. However, a value of 1.0 was used in calculating the R values in Tables 3.5-8 through 3.5-15 (dimensionless).

U_{ap} = The receptor's meat consumption rate for age group 'a' (kg/yr).

F_f = The stable element transfer coefficients (ρCi/Kg per ρCi/day).

t_s = The transport time from slaughter to consumption (sec).

t_e = Period of pasture grass and crop exposure during the growing season (sec).

t_h = The transport time from harvest to animal consumption (sec).

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 χ/Q:

$$R_{T_B} = K' * K''' * F_f * Q_F * U_{ap} * (DFL_i)_a * 0.75 * \frac{0.5}{H} \tag{B.2-6}$$

where:

R_{T_B} = Dose parameter for the meat ingestion pathways for tritium for organ of interest (mrem/yr per µCi/m^3).

All other terms are defined in Equations B.2-4 and B.2-5.

B.2.5 Vegetation Pathway

The integrated concentration in vegetation consumed by man follows the expression developed in the derivation of the milk factor. Man is considered to consume two types of vegetation (fresh and stored) that differ only in the time period between harvest and consumption, therefore:

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

where:

R_{iV} = Dose factor for the vegetable pathway for radionuclide 'i' for any organ of interest (m^2-mrem/yr per µCi/sec).

I_i = 1.0, factor to account for fractional deposition of radionuclide 'i'. For radionuclides other than iodine, the factor I_i is equal to 1.0. For radioiodines, the value of I_i may vary. However, a value of 1.0 was used in calculating the R values in Tables 3.5-8 through 3.5-15 (dimensionless).

K' = 10^6, a constant of unit conversion (ρCi/µCi).

U_a^L = Consumption rate of fresh leafy vegetation by receptor in age group 'a' (kg/yr).

f_L = 1.0, used in lieu of site-specific data, fraction of the annual intake of fresh leafy vegetation grown locally. Value of 1.0, obtained from Table E-15 of Regulatory Guide 1.109, Revision 1, was used in the calculations of R_{iV} (dimensionless).

t_L = Average time between harvest of leafy vegetation and its consumption (sec).

t_e = Period of leafy vegetable exposure during growing season (sec).

Y_V = Vegetation areal density (kg/m^2).

U_a^S = Consumption rate of stored vegetation by receptor in age group 'a' (kg/yr).

f_g = 0.76, used in lieu of site-specific data, fraction of annual intake of stored vegetation grown locally. Value of 0.76, obtained from Table E-15 of Regulatory Guide 1.109, Revision 1, was used in the calculations of R_{iV} (dimensionless).

t_h = Average time between harvest of stored vegetation and its consumption (sec).

All other factors as defined before.

Table B-3 presents the appropriate parameter values and their source in 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 χ/Q:

$$R_{T_V} = K' * K''' * \left(U_a^L * f_L + U_a^S * f_g\right) * (DFL_i)_a * 0.75 * \frac{0.5}{H} \quad \text{(B.2-8)}$$

where:

R_{T_V} = Dose factor for the vegetable pathway for tritium for organ of interest (mrem/yr per μCi/m^3).

All other terms are defined in Equations B.2-4 and B.2-7.

B.3

The calculations that support the 2500 CFM maximum instantaneous flow rate for a C.V. pressure relief as calculated by CP&L Nuclear Fuels Section, Project 86-0015, as found in File 2486-0015 and were performed by Mr. Talmage Clements, 10 February 1986.

TABLE B-1
PARAMETERS FOR COW AND GOAT MILK PATHWAYS

Parameter	Value	Reg. Guide 1.109, Rev. 1 Reference
Q_F (kg/day)	50 (cow)	Table E-3
	6 (goat)	Table E-3
Y_p (kg/m^2)	0.7	Table E-15
t_f (seconds)	1.73 x 10^5 (2 days)	Table E-15
r (dimensionless)	1.0 (radioiodines)	Table E-15
	0.2 (particulates)	Table E-15
$(DFL_i)_a$ (mrem/ρCi)	Each radionuclide	Tables E-11 to E-14
F_m (ρCi/liter per ρCi/day)	Each stable element	Table E-1 (cow)
		Table E-2 (goat)
t_b (seconds)	4.73 x 10^8 (15 yr)	Table E-15
Y_s (kg/m^2)	2.0	Table E-15
Y_p (kg/m^2)	0.7	Table E-15
t_h (seconds)	7.78 x 10^6 (90 days)	Table E-15
U_{ap} (liters/yr)	330 infant	Table E-5
	330 child	Table E-5
	400 teen	Table E-5
	310 adult	Table E-5
t_e (seconds)	2.59 x 10^6 (pasture)	Table E-15
	5.18 x 10^6 (stored feed)	Table E-15
B_{iV} (ρCi/kg wet weight per ρCi/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	Reg. Guide 1.109, Rev. 1 Reference
r (dimensionless)	1.0 (radioiodines)	Table E-15
	0.2 (particulates)	Table E-15
F_f (pCi/kg per pCi/day)	Each stable element	Table E-1
U_{ap} (kg/yr)	0 infant	Table E-5
	41 child	Table E-5
	65 teen	Table E-5
	110 adult	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 (kg/m^2)	2.0	Table E-15
t_b (seconds)	4.73×10^8 (15 yr)	Table E-15
t_s (seconds)	1.73×10^6 (20 days)	Table E-15
t_h (seconds)	7.78×10^6 (90 days)	Table E-15
t_e (seconds)	2.59×10^6 (pasture)	Table E-15
	5.18×10^6 (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	Reg. Guide 1.109, Rev. 1 Reference
r (dimensionless)	1.0 (radioiodines)	Table E-1
	0.2 (particulates)	Table E-1
$(DFL_i)_a$ (mrem/Ci)	Each radionuclide	Tables E-11 to E-14
Q_F (kg/day)	50 (cow)	Table E-3
	6 (goat)	Table E-3
U_a^L (kg/yr)	0 Infant	Table E-5
	26 Child	Table E-5
	42 Teen	Table E-5
	64 Adult	Table E-5
U_a^S (kg/yr)	0 Infant	Table E-5
	520 Child	Table E-5
	630 Teen	Table E-5
	520 Adult	Table E-5
t_L (seconds)	8.6×10^4 (1 day)	Table E-15
t_h (seconds)	5.18×10^6 (60 days)	Table E-15
Y_V (kg/m^2)	2.0	Table E-15
t_e (seconds)	5.18×10^6 (60 days)	Table E-15
t_b (seconds)	4.73×10^8 (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

APPENDIX C:
LOWER LIMIT OF DETECTABILITY

C.1 Radiological Environmental Monitoring Program

The LLD[1,2] is defined as the smallest concentration of radioactive material in a sample that will yield a net count, above system background, that will be detected with 95% probability with only 5% probability of falsely concluding that a blank observation represents a "real" signal. For a particular measurement system, which may include radiochemical separation:

$$LLD = \frac{4.66 * S_b}{E * V * 2.22 * Y * e^{-\lambda * \Delta t}}$$

where:

LLD = "A priori" lower limit of detection as defined above, as picocuries per unit mass or volume.

S_b = Standard deviation of the background counting rate or of the counting rate of a blank sample, as appropriate, as counts per minute.

E = Counting efficiency, as counts per disintegration.

V = Sample size in units of mass or volume.

2.22 = Number of disintegrations per minute per picocurie.

Y = Fractional radiochemical yield, when applicable.

λ = Radioactive decay constant for the particular radionuclide.

Δt = The elapsed time between sample collection or end of the sample collection period and time of counting.

Typical values of efficiency (E), volume/mass (V), chemical yield (Y), and radionuclide decay correction time (Δt) are to 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 Technical Specification 5.6.2.

C.2 Radioactive Waste Sampling and Analysis Program

The LLD is defined as the smallest concentration of radioactive material in a sample that will yield a net count, above system background, that will be detected with 95% probability with only 5% probability of falsely concluding that a blank observation represents a "real" signal. For a particular measurement system, which may include radiochemical separation:

$$LLD = \frac{4.66 * S_b}{E * V * 2.22x10^6 * Y * e^{-\lambda * \Delta t}}$$

where:

LLD = "A priori" lower limit of detection as defined above, as microcuries per unit mass or volume.

S_b = Standard deviation of the background counting rate or of the counting rate of a blank sample, as appropriate, as counts per minute.

E = Counting efficiency, as counts per disintegration.

V = Sample size in units of mass or volume.

$2.22x10^6$ = Number of disintegrations per minute per microcurie.

Y = Fractional radiochemical yield, when applicable.

λ = Radioactive decay constant for the particular radionuclide.

Δt = The elapsed time between sample collection or end of the sample collection period and time of counting.

Typical values of efficiency (E), volume/mass (V), chemical yield (Y), and radionuclide decay correction time (Δt) are to 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.

C.3 Radioactive Gaseous Waste Monitoring System

The LLD is defined 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[3]:

$$LLD = \frac{4.66 * \sqrt{\frac{Bkg}{2 * \tau}}}{E}$$

where:

LLD = "A priori" lower limit of detection as defined above, as microcuries per cubic centimeter.

Bkg = the background counting rate as counts per minute.

E = counting efficiency, as counts per minute over microcurie per cubic centimeter.

τ = the time constant for the particular measurement system.

Typical values of E, and Bkg 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.

Appendix C References

1. HASL-300 (Suppl. 4), HASL Procedures Manual, (1972).

2. NBS SP456 "The Minimum Detectable Activity Concept," J. C. Lockamy (1976).

3. NUREG/CR-4007, Lower Limit of Detection: Definition and Elaboration of a Proposed Position for Radiological Effluent and Environmental Measurements, (September 1984).

APPENDIX D:
LIQUID AND GASEOUS PROCESS MONITORS AND RADWASTE SYSTEMS

D.1

This appendix contains tables and figures describing the liquid and gaseous process monitors and radwaste systems.

TABLE D-1
LIQUID PROCESS MONITORS

Name	R #	ID #	Drawing #
Containment Vessel Fan Cooling Water	16	R-16	C997261
Component Cooling Water	17	R-17	C997246
Liquid Waste Disposal	18	PI 871109	NRC Industries 4PI Liquid Sample Manual
Condensate Polisher Liquid Waste	37	R-37	Plant Mod.-723, H.B.R.-2-9065
	19A	R-19A	
Steam Generator Blowdown	19B	R-19B	Mod 898
	19C	R-19C	

Liquid Radwaste Flow Measurement Devices

Liquid Radwaste Flow Indicator	N/A	FIT 1064	A-190299 5379-00920 Sheet 4 (EC 60209)

TABLE D-2
GASEOUS PROCESS MONITORS

Name	R #	ID #	Drawing #	Sample Flow Rate Measurement Device	System Flow Rate Measurement Device
Containment Vessel Particulate	11	R-11	D997556	F&P Co. Flow Tube FP-3/4-27-G 10/80	UGC Microflow 3000 (if sampling stack)
Containment Vessel Gaseous	12	R-12	D997556	F&P Co. Flow Tube FP-3/4-27-G 10/80	UGC Microflow 3000 (if sampling stack)
Plant Vent Low Range	14C	R-14	EC 52464	1) Fluid Components Intl, AF89S Mass Flowmeter 2) F&P Flowmeter FP-1-35-G-10/55	F-14 Plant Vent Stack Flow Monitor (Kurz)
Fuel Handling Building Basement Exhaust	20	R-20	C998233	Fisher Porter Flowmeter Mod. 10A35755Z Serial 6908A0837A1	None (Use fan ratings)
Fuel Handling Building Upper Level Exhaust	21	R-21	C9988233	Fisher Porter Flowmeter Mod. 1043565 Serial 6908A0837A1	None (Use fan ratings)

FIGURE D-1

*H.B. ROBINSON LIQUID RADWASTE PROCESS / EFFLUENT SYSTEM

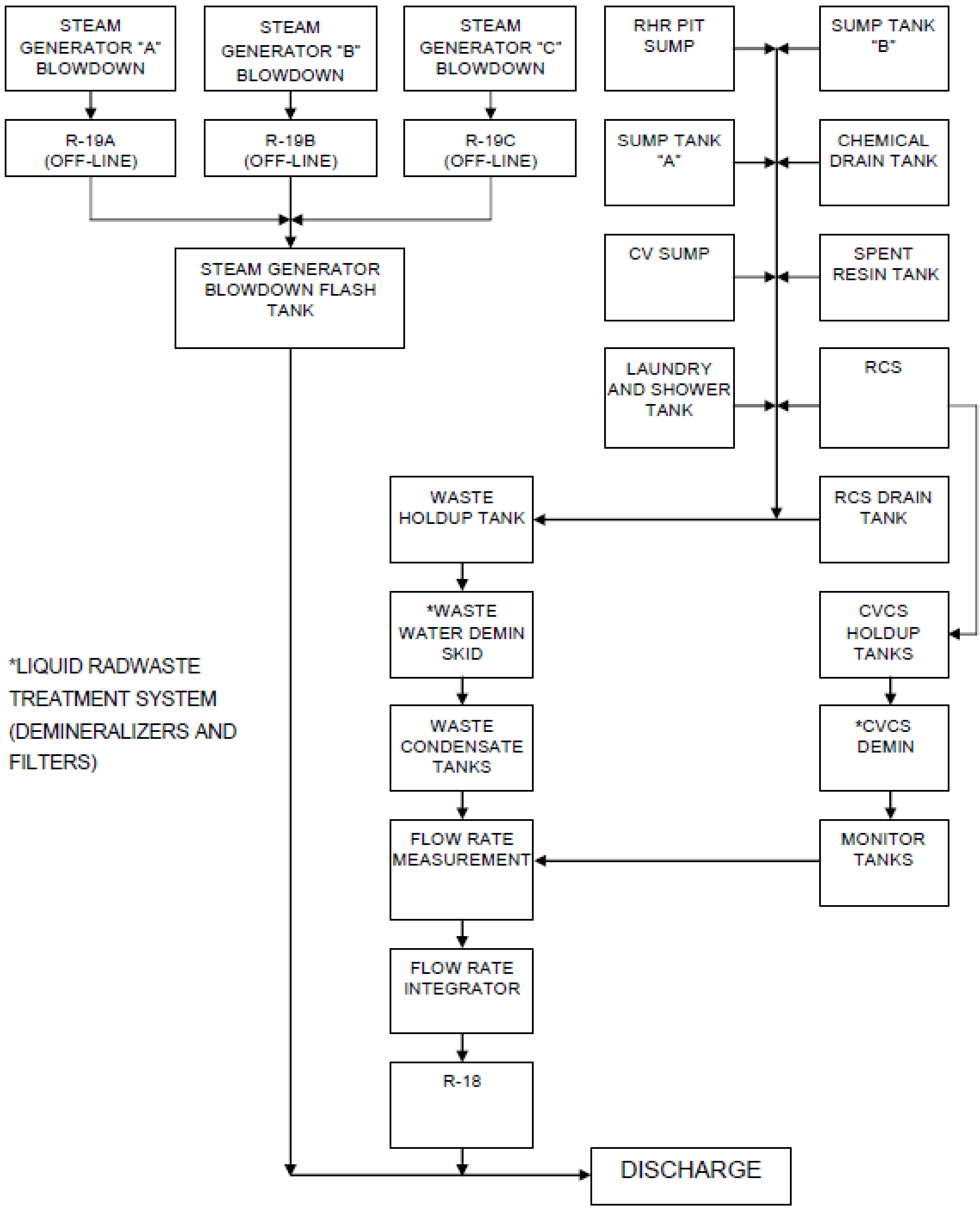
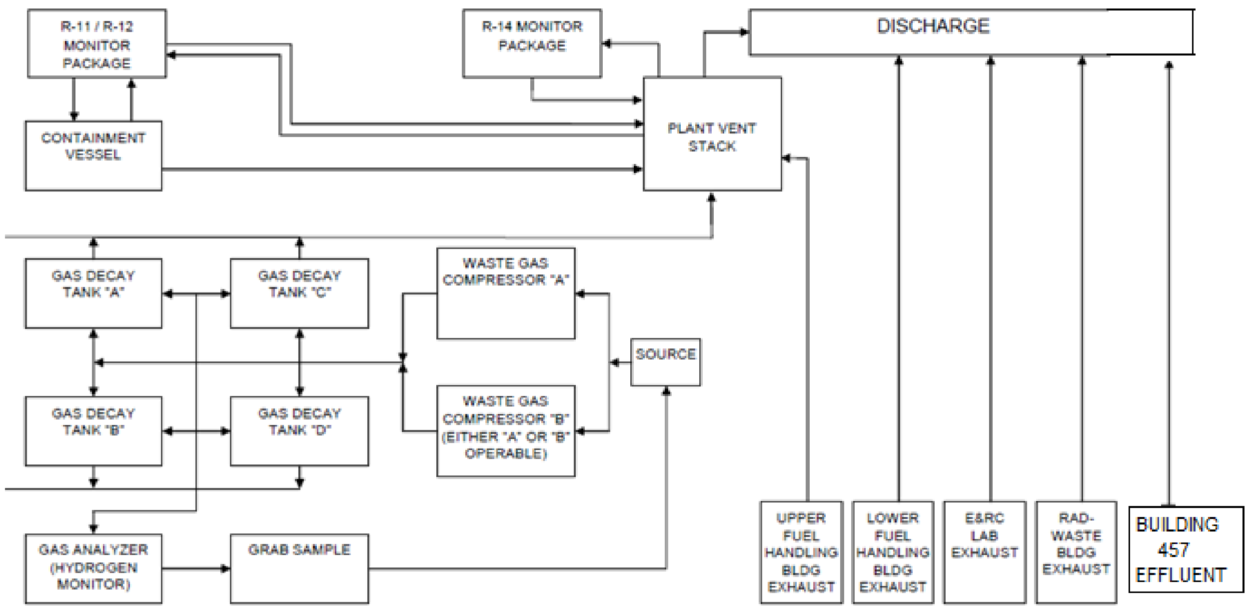


FIGURE D-2

*H.B. ROBINSON GASEOUS RADWASTE PROCESS / EFFLUENT SYSTEM



*SIMPLIFIED BLOCK FLOW DIAGRAM; THE GASEOUS RADWASTE SYSTEM MAY BE COMPRISED OF ONE WASTE GAS COMPRESSOR AND ONE WASTE GAS DECAY TANK.

APPENDIX E:
MAP OF LAKE ROBINSON

E.1

This appendix contains map sections of Lake Robinson.

FIGURE E-1
MAP OF THE FIVE SECTIONS OF LAKE ROBINSON

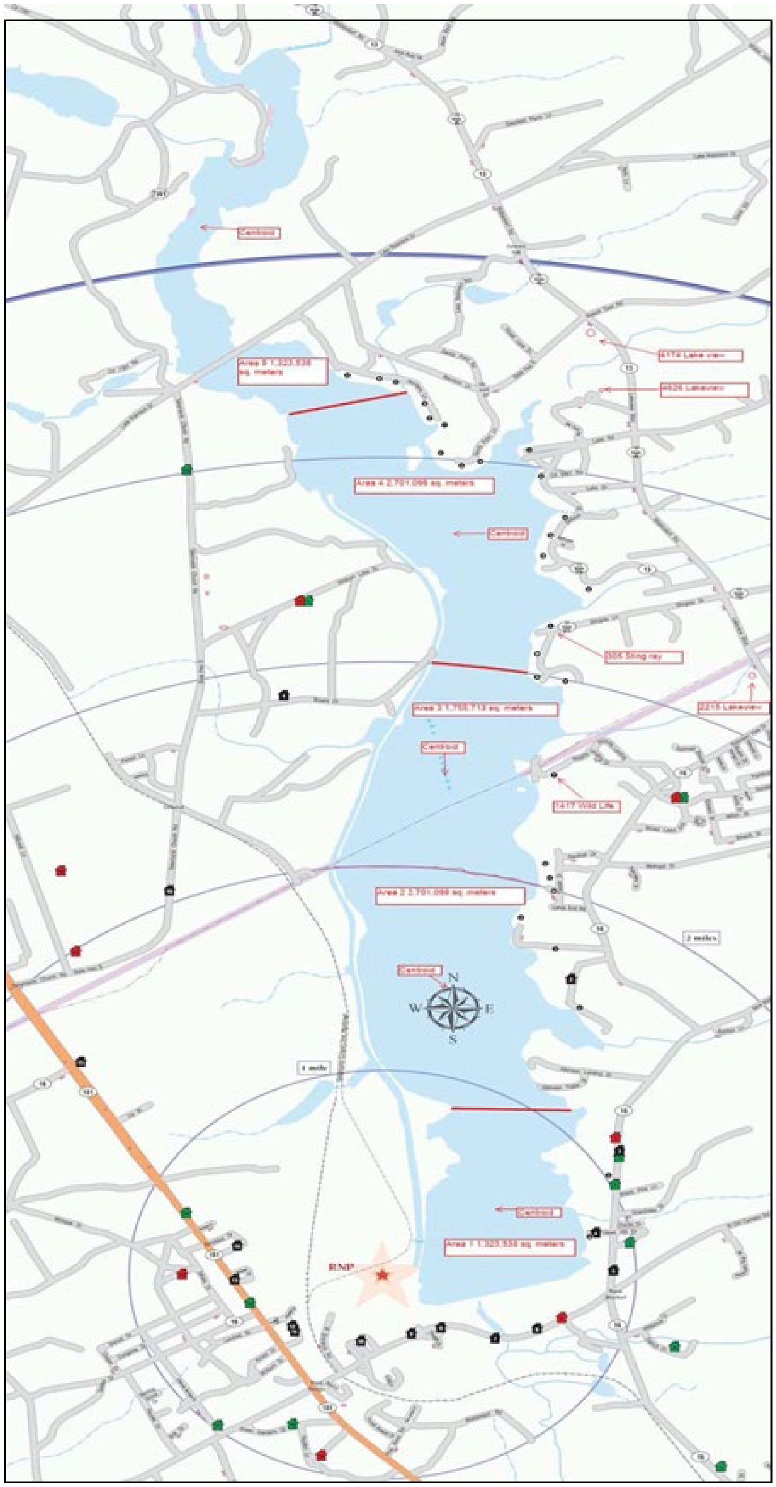


FIGURE E-1 (continued)

MAP OF THE FIVE SECTIONS OF LAKE ROBINSON

Lake Robinson is about 10 kilometers long and about 1 kilometer wide. Black Creek empties into the Lake at the North end of the Lake. The hot water released from the heat exchangers is discharged in the Lake about 6 kilometers north of the plant. Temperature in the Lake varies from north to south. In order to get a more accurate tritium evaporation analysis, the lake is divided into five sections. Section 5 is the northern most section, and Section 1 is the southernmost. The hot water discharge point (weir) is located in Section 4. The following table shows area of each section.

Section 1 Area 1323538 square meters
Section 2 Area 2701098 square meters
Section 3 Area 1755713 square meters
Section 4 Area 2161223 square meters
Section 5 Area 1285791 square meters

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

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2022 - 12/31/2022

The H.B. Robinson Steam Electric Plant Unit 2 Process Control Program procedure ERC-015, Revisions to the Offsite Dose Calculation Manual and Process Control Program was superseded by new fleet procedure AD-CP-ALL-0030, PROCESS CONTROL PROGRAM (PCP) REVIEW AND REVISION effective 5/23/2022 (See Attached).

Information Use

NUCLEAR OPERATING FLEET

ADMINISTRATIVE PROCEDURE

AD-CP-ALL-0030

PROCESS CONTROL PROGRAM (PCP) REVIEW AND REVISION

REVISION 0

Effective Dates:

05/23/2022	05/23/2022	05/23/2022	05/23/2022	05/23/2022
Brunswick	Catawba	Harris (HNP)	McGuire	Oconee
05/23/2022	05/23/2022			
Robinson	NGO			

REVISION SUMMARY

PRR 2392213

DESCRIPTION

This is a new fleet procedure which supersedes the following site-specific procedures:

- [BNP] 0E&RC-0515, Review of Process Control Program (PCP) (PRR 2417925)
  - ◊ There are no commitments in this procedure.
- [BNP] 0E&RC-4261, Revisions to the Process Control Program (PCP) (PRR 2417927)
  - ◊ There are no commitments in this procedure.
- [HNP] PLP-300, Process Control Program (PRR 2417928)
  - ◊ There are no commitments in this procedure.
- [RNP] ERC-015, Revisions to the Offsite Dose Calculation Manual and Process Control Program (PRR 2414935)
  - ◊ There are no commitments in this procedure.

TABLE OF CONTENTS

1.0 PURPOSE

1. This procedure provides guidance for the review and revision of the Process Control Program (PCP) for each site.

2.0 SCOPE

1. This procedure applies to the Duke Energy operating nuclear fleet.

3.0 DEFINITIONS

1. **Process Control Program (PCP):** A collection of program documents describing the administrative and operational controls used for the solidification of liquid or wet radioactive wastes and the dewatering of wet radioactive wastes to meet 10 CFR 61 waste form requirements.

    a. The PCP maintains the overall conformance of the solidified waste product to existing requirements of Federal, State, or other applicable regulations.

    b. The PCP contains the current formulas, sampling, analyses, tests, and determinations to be made to ensure that the 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 Part 20, 10 CFR Part 61, 10 CFR Part 71, and Federal and State regulations and other requirements governing disposal of the radioactive waste.

2. **PCP Revision:** Changes to the program accomplished within this procedure.

3. **PCP Subject Matter Expert (SME):** Individuals designated to administer and implement the PCP.

4.0 RESPONSIBILITIES

4.1 <u>On-Site Review Committee (ORC)</u>

1. Reviews and concurs with PCP Revisions.

4.2 <u>Plant Manager (Non-Delegated)</u>

1. Approves PCP Revisions.

4.3 Station Sciences Site Functional Area Manager (SFAM)

1. Ensures PCP annual review, revision, and approval meet the requirements of this procedure.
2. Ensures PCP Revisions are submitted with the Annual Radioactive Effluent Release Report (ARERR) per AD-CP-ALL-0023, Preparation of the Annual Radioactive Effluent Release Report.
3. Signs Attachment 1, Site PCP Cover Sheet (Example), as Reviewer when the PCP SME is the Preparer.

4.4 PCP SME

1. Administers and implements the PCP.
2. Determines when a revision is warranted.
3. Coordinates PCP Revisions.
4. Provides technical support for PCP implementation.
5. Reviews PCP Revisions for technical accuracy and compliance with regulatory and licensing requirements.
6. Evaluates impact of PCP changes to programs, processes, and procedures.
7. Supports compliance with ARERR requirements for PCP reporting.
8. Signs Attachment 1, Site PCP Cover Sheet (Example), as Reviewer when as the PCP SME is the Preparer.
9. Ensures applicable licensing reviews are complete per AD-LS-ALL-0007, Applicability Determination Process, AD-LS-ALL-0008,10 CFR 50.59 Review Process, and AD-LS-ALL-0009, 10 CFR 72.48 Review Process.
10. Ensures PCP Revisions are prepared and presented to the On-Site Review Committee (ORC) for concurrence.
11. Performs an annual review of the PCP, including vendor PCPs, for technical accuracy and compliance with regulatory and licensing requirements, which is considered completed when documentation is provided for the ARERR per AD-CP-ALL-0023, Preparation of the Annual Radioactive Effluent Release Report.

5.0 INSTRUCTIONS

5.1 Process Control Program (PCP) Annual Review

1. Perform the following reviews annually for technical accuracy and compliance with regulatory and licensing requirements and changes:

    a. Solidification vendor's PCP.

    b. Site PCP.

    c. Provide changes to the PCP to incorporate in the Annual Radioactive Effluent Release Report (ARERR).

    d. The annual review is considered complete with documentation provided for the ARERR.

5.2 PCP Change Proposal

1. Initiate Document Revision Request (DRR) for proposed changes to PCP document.

2. Provide adequate technical justification for change in applicable initiating process.

5.3 PCP Document Revision

1. Refer to NEI 07-10, Revision 3, Generic FSAR Template Guidance for Process Control Program (PCP), for additional guidance.

2. Ensure adequate technical justification and information was provided to support changes.

NOTE
All revisions are Major Revisions under LifeCycle Actions in EDMS.

3. Initiate PCP document revision in EDMS.

    a. Reference QRG-NA-0039, Controlled Document Lifecycle Step by Step, as needed.

4. Evaluate and make changes as directed by applicable DRRs.

5. If PCP revision impacts more than one site functional area, then consider a Change Management Plan in accordance with AD-PI-ALL-0003, Change Management.

5.4 PCP Revision Review

1. Complete reviews in EDMS along with Attachment 1, Site PCP Cover Sheet (Example), and Attachment 2, PCP Revision Worksheet.

2. Review all proposed changes for technical accuracy.

3. Ensure applicable licensing reviews are complete per AD-LS-ALL-0007, Applicability Determination Process, AD-LS-ALL-0008,10 CFR 50.59 Review Process, and AD-LS-ALL-0009, 10 CFR 72.48 Review Process.

4. Identify reviewers as necessary per revision scope impact to programs and processes as described below.

5. Identify impacts to and consistency with site programs and processes:

   - Site PCP documents
   - Vendor PCP Documents
   - Site and vendor PCP implementing procedures

6. Identify impacts to fleet programs, procedures and processes:

   - Other site PCP documents
   - Low Level Waste (LLW) shipping program and processes
   - 10 CFR 61 Program
   - Fleet procedures (e.g., AD-RP-ALL-5000, Preparation and Shipment of Radioactive Material and Radioactive Waste)

7. Initiate any changes required from identified impacts using PRRs or DRRs.

8. Document reviews using EDMS and on Attachment 1, Site PCP Cover Sheet (Example).

5.5 PCP Revision Approval

1. Complete applicable documentation necessary for PCP document revision package:
   - Attachment 1, Site PCP Cover Sheet (Example)
   - Attachment 2, PCP Revision Worksheet or equivalent
   - Revised PCP document
   - Applicability Determination, if required
   - 10 CFR 50.59, if required
   - 10 CFR 72.48, if required
   - Technical justification for changes
   - Change Management Plan, if required
   - Supporting evidence that the change will maintain the overall conformance of the solidified waste product to existing requirements of Federal, State, or other applicable regulations
   - Other supporting documents
2. Submit PCP revision package to On-Site Review Committee (ORC) for review and concurrence per AD-LS-ALL-0019, On-Site Review Committee.
   a. If ORC provide comments on PCP Revision, then resolve ORC comments and re-submit to ORC for review and concurrence.
3. Submit PCP document for approval to the Plant Manager (non-delegated).
4. Document approval in EDMS and on Attachment 1, Site PCP Cover Sheet (Example).
5. When approved, then implement PCP document revision.
   a. Ensure any applicable procedure revisions are implemented prior to PCP Revision implementation.
6. Retain all documentation used in PCP document revision package submitted to the ORC from Section 5.5 Step 2 as a completed record.
7. Ensure previous revisions are superseded (i.e., only one revision is 'issued').
8. Provide documentation of change for incorporation into the ARERR.

6.0 RECORDS

6.1 QA Records

1. Attachment 1, Site PCP Cover Sheet (Example)
2. Attachment 2, PCP Revision Worksheet
3. PCP document revision package

6.2 Business Records

None

7.0 REFERENCES

7.1 Commitments

None

7.2 Procedures

1. AD-CP-ALL-0023, Preparation of the Annual Radioactive Effluent Release Report
2. AD-LS-ALL-0007, Applicability Determination Process
3. AD-LS-ALL-0008, 10 CFR 50.59 Review Process
4. AD-LS-ALL-0009, 10 CFR 72.48 Review Process
5. AD-LS-ALL-0019, On-Site Review Committee
6. AD-PI-ALL-0003, Change Management
7. AD-RP-ALL-5000, Preparation and Shipment of Radioactive Material and Radioactive Waste

7.3 Miscellaneous Documents

1. DUKE-QAPD-001, Duke Energy Corporation Topical Report Quality Assurance Program Description Operating Fleet
    a. Brunswick Specific QAPD Attachment A, A17.3.1.7, Regulatory Commitments
2. NEI 07-10, Revision 3, Generic FSAR Template Guidance for Process Control Program (PCP)

7.3 Miscellaneous Documents (continued)

3. NUREG-0133, Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants: A Guidance Manual for Users of Standard Technical Specifications, issued October 1987

4. NUREG-0800, Standard Review Plan

   a. 1.5, Process and Effluent Radiological Monitoring Instrumentation and Sampling Systems

   b. 11.4, Waste Management System

   c. Branch Technical Position 11-3

5. NUREG-1301, Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Pressurized-Water Reactors

6. NUREG-1302, Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Boiling-Water Reactors

7. QRG-NA-0039, Controlled Document Lifecycle Step by Step

8. [ONS] SLC 16.11.5, Solid Radioactive Waste

9. [MNS] SLC 16.11.11, Solid Radioactive Waste

10. [CNS] SLC 16.11-11, Solid Radioactive Wastes

11. [HNP] Technical Specification 6.13, Process Control Program (PCP)

12. [RNP] TRMS 3.22, Solidification of Wet Radioactive Waste

13. [RNP] TRMS 5.5.17, Process Control Program (PCP)

14. [ONS] TS 5.6.3, Radioactive Effluent Release Report

15. [HNP] UFSAR 11.4.1.2, Process Control Program

16. [ONS] UFSAR 11.4.2, System Design and Evaluation

17. [RNP] UFSAR 11.4.2.2, Solid Waste Processing

18. [CNS] UFSAR 11.4.7, Process Control Program (PCP)

19. [BNP] UFSAR 12.5.3.8, Process Control Program (PCP)

ATTACHMENT 1
Page 1 of 1

<< Site PCP Cover Sheet (Example) >>

DUKE ENERGY

H.B. Robinson Steam Electric Plant

Unit 2

Process Control Program

Revision XX

Docket Number: 50-261

Effective Date: ______________

Prepared By (Print):		
Title/Organization	Signature	Date
Reviewed By (Print):		
Title/Organization	Signature	Date
Reviewed By (Print):		
RNP ORC Chairman	Signature	Date
Approved By (Print):		
RNP Plant Manager	Signature	Date

ATTACHMENT 2
Page 1 of 2

<< PCP Revision Worksheet >>

Section I: Preparer		
Print Name and Signature:_______________ Date:_______		
Section II: Process(es) Initiating Change		
DRR #:		
Section III: Subject (Provide a brief description of change below; attach sheets as necessary)		
______________________________		
Section IV: Technical and Supporting Information		
Revised PCP Document.	Yes ☐	NA ☐
Signed prepared by and reviewed in EDMS and on Attachment 1, Site PCP Cover Sheet (Example).	Yes ☐	NA ☐
Applicability Determination, if required.	Yes ☐	NA ☐
10 CFR 50.59, if required.	Yes ☐	NA ☐
10 CFR 72.48 Review, if required.	Yes ☐	NA ☐
Technical justification for changes.	Yes ☐	NA ☐
Change Management Plan, if required.	Yes ☐	NA ☐
Supporting evidence that change confirms with regulator requirements.	Yes ☐	NA ☐
Other supporting documents.	Yes ☐	NA ☐
Section V: Requested Implementation Schedule		
Requested Implementation Date:		
Bases for Date: ______________________________		
Section VI: Affected Documents (list below, attach additional pages as necessary)		
Affected Document:	Revise for Implementation:	
	Yes ☐	No ☐
	Yes ☐	No ☐
	Yes ☐	No ☐
	Yes ☐	No ☐

<< PCP Revision Worksheet >>

Section VII: Reviews		
Reviewing Organization:		
Comment	Resolution	
Print Name and Signature:		Date:
Reviewing Organization:		
Comment	Resolution	
Print Name and Signature:		Date:
Reviewing Organization:		
Comment	Resolution	
Print Name and Signature:		Date:

Section VIII: Final Review, Approval and Processing	
ORC Review	
Meeting #:	Date:
Comments:______________________	
Approved:______________________ ORC Chairperson [Plant Manager (non-delegated)] Print Name and Signature	Date:

Action	Print Name and Signature	Date:
Required procedure and document changes verified complete		
Electronic files updated (only one revision 'issued')		
Transmit final package to DCRM when complete.		

QA RECORD

ATTACHMENT 11

Summary of Major Modifications to the Radioactive Waste Treatment Systems

This attachment includes a description of major modifications to the radioactive waste treatment systems that are anticipated to affect effluent releases.

Attachment 11
Summary of Major Modifications to the Radioactive Waste Treatment Systems

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2022 - 12/31/2022

No major modifications to liquid, gaseous, solid, or mobile radioactive waste treatment systems occurred at H.B. Robinson Steam Electric Plant in 2022.

<u>ATTACHMENT 12</u>

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

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2022 - 12/31/2022

Description:

- Duke Energy was notified by Mirion (OpenEMS effluent permit vendor) that OpenEMS was not calculating liquid doses for the ARERR in accordance with the Offsite Dose Calculation Manual (ODCM). The ODCM liquid dose equation specifies that the dilution volume used in the near field average dilution factor should be the dilution water volume during the period of release. Previously, OpenEMS was using the dilution volume for a larger time frame when calculating liquid dose for the ARERR. The OpenEMS software ARERR liquid dose calculation was corrected to only include dilution during the liquid effluent release in the near field average dilution factor. Liquid doses on release permits were not impacted by this issue. This software issue was corrected by Mirion and the Errata for liquid dose values in prior ARERRs (2013-2019) due to this issue are attached below.

- Attachment 8 “Inoperable Equipment,” in the 2021 Robinson Annual Radioactive Effluent Release Report (ARERR) was submitted without explanation of why F-14 Plant Vent Flow Monitor was not returned to operable status within the 30 day requirement. This explanation was added and the Errata is attached below.

- The 2021 Robinson Annual Radioactive Effluent Release Report (ARERR) was found to contain the following two typographical errors in Attachment 1, Summary of Gaseous and Liquid Effluents:

  1. Gaseous Effluents – Summation of All Releases, the Carbon-14 Avg. Release Rate for the year incorrectly states 2.60E-01 uCi/sec versus the correct 2.74E-01 uCi/sec.

  2. Gaseous Effluents - Ground & Mixed-Mode Releases - Continuous Mode, the Tritium concentration for the year incorrectly states 7.17E+01 curies versus the correct 7.17E+00 curies.

  Errata for these two errors are attached below.

10. Results

The Radioactive Effluent Release Report is a detailed listing of the radioactivity released from the HBRSEP, Unit No. 2, during the period from January 1, 2013 through December 31, 2013. Some of the gaseous and liquid release parameters for this reporting period are summarized below:

GASEOUS EFFLUENTS

	Units	**1st Qtr**	**2nd Qtr**	**3rd Qtr**	**4th Qtr**
Fission & Act. Gas	Ci	4.18E-02	3.77E-02	2.71E+00	1.23E-01
1-131	Ci	ND[1]	ND[1]	1.45E-07	1.59E-06
Part.>8 Day Half-Lives	Ci	ND[1]	ND[1]	2.17E-07	2.25E-07
Tritium	Ci	1.86E+00	2.03E+00	3.67E+00	2.40E+00

LIQUID EFFLUENTS

	Units	**1st Qtr**	**2nd Qtr**	**3rd Qtr**	**4th Qtr**
Fission & Act. Products	Ci	1.21E-04	6.25E-04	4.24E-03	3.96E-03
Tritium	Ci	1.55E+01	2.21E+02	2.99E+02	6.22E+01
Dilution Volume	Liters	2.46E+11	2.42E+11	2.19E+11	1.83E+11
Waste Volume	Liters	9.07E+04	3.37E+05	9.17E+05	8.77E+05

During the period of January 1, 2013 through December 31, 2013, the estimated maximum individual offsite dose due to radioactivity released in effluents was:

Liquid Effluents:

- Total Body Dose 3.43E-03 ~~2.09E-04~~ millirem
- Critical Organ Dose 5.37E-03 ~~3.28E-04~~ millirem, Liver

Note - an additional 0.192 mrem to a child was estimated based on the evaporation of tritium from Lake Robinson. This is based on Lake Robinson 2013 environmental sample results, 2013 meteorology and represents the dose from the buildup in the lake. This conservatively bounds the dose due to 2013 tritium effluents.

[1] ND, No Detectable Activity

10. Results

The Radioactive Effluent Release Report is a detailed listing of the radioactivity released from the HBRSEP, Unit No. 2, during the period from January 1, 2013 through December 31, 2013. Some of the gaseous and liquid release parameters for this reporting period are summarized below:

GASEOUS EFFLUENTS

	Units	**1st Qtr**	**2nd Qtr**	**3rd Qtr**	**4th Qtr**
Fission & Act. Gas	Ci	4.18E-02	3.77E-02	2.71E+00	1.23E-01
1-131	Ci	ND[1]	ND[1]	1.45E-07	1.59E-06
Part.>8 Day Half-Lives	Ci	ND[1]	ND[1]	2.17E-07	2.25E-07
Tritium	Ci	1.86E+00	2.03E+00	3.67E+00	2.40E+00

LIQUID EFFLUENTS

	Units	**1st Qtr**	**2nd Qtr**	**3rd Qtr**	**4th Qtr**
Fission & Act. Products	Ci	1.21E-04	6.25E-04	4.24E-03	3.96E-03
Tritium	Ci	1.55E+01	2.21E+02	2.99E+02	6.22E+01
Dilution Volume	Liters	2.46E+11	2.42E+11	2.19E+11	1.83E+11
Waste Volume	Liters	9.07E+04	3.37E+05	9.17E+05	8.77E+05

During the period of January 1, 2013 through December 31, 2013, the estimated maximum individual offsite dose due to radioactivity released in effluents was:

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Note - an additional 0.192 mrem to a child was estimated based on the evaporation of tritium from Lake Robinson. This is based on Lake Robinson 2013 environmental sample results, 2013 meteorology and represents the dose from the buildup in the lake. This conservatively bounds the dose due to 2013 tritium effluents.

[1] ND, No Detectable Activity

Table 2A: Liquid Effluents - Summation of All Releases

	Units	**1st Qtr**	**2nd Qtr**	**3rd Qtr**	**4th Qtr**
Fission & Act. Products	Ci	1.98E-02	6.49E-03	1.92E-03	2.28E-03
Tritium	Ci	1.18E+02	2.74E+01	8.39E+00	2.55E+01
Pri. Waste Volume	Liters	5.17E+05	4.47E+05	1.86E+05	2.61E+05
Dilution Volume	Liters	2.32E+11	2.45E+11	2.54E+11	2.42E+11

During the period of January 1, 2014 through December 31, 2014, the estimated maximum individual offsite dose due to radioactivity released in effluents was:

Appendix I Dose Assessment:

Liquid Effluents:

- Total Body Dose 6.69E-04 ~~6.58E-04~~ millirem
- Critical Organ Dose 5.31E-03 ~~6.24E-03~~ millirem, GI-LU

Note - an additional 0.194 mrem to a child was estimated based on the evaporation of tritium from Lake Robinson. This is based on Lake Robinson 2014 environmental sample results, 2014 meteorology and represents the dose from the buildup in the lake. This conservatively bounds the dose due to 2014 tritium effluents.

[1] ND, No Detectable Activity

Table 2A: Liquid Effluents - Summation of All Releases

	Units	**1st Qtr**	**2nd Qtr**	**3rd Qtr**	**4th Qtr**
Fission & Act. Products	Ci	1.98E-02	6.49E-03	1.92E-03	2.28E-03
Tritium	Ci	1.18E+02	2.74E+01	8.39E+00	2.55E+01
Pri. Waste Volume	Liters	5.17E+05	4.47E+05	1.86E+05	2.61E+05
Dilution Volume	Liters	2.32E+11	2.45E+11	2.54E+11	2.42E+11

During the period of January 1, 2014 through December 31, 2014, the estimated maximum individual offsite dose due to radioactivity released in effluents was:

Appendix I Dose Assessment:

Liquid Effluents:

- Total Body Dose 6.69E-04 millirem
- Critical Organ Dose 5.31E-03 millirem, GI-LU

Note - an additional 0.194 mrem to a child was estimated based on the evaporation of tritium from Lake Robinson. This is based on Lake Robinson 2014 environmental sample results, 2014 meteorology and represents the dose from the buildup in the lake. This conservatively bounds the dose due to 2014 tritium effluents.

[1] ND, No Detectable Activity

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

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2015 - 12/31/2015

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Batch & Continuous Mode						
1. Maximum Organ Dose	mREM	7.42E-04 ~~1.70E-04~~	5.67E-03 ~~4.88E-04~~	2.54E-04 ~~4.29E-06~~	2.52E-04 ~~5.38E-05~~	6.92E-03 ~~7.16E-04~~
(a) Limit	mREM	5	5	5	5	10
(b) % of Limit		1.48E-02 ~~3.40E-03~~	1.13E-01 ~~9.76E-03~~	5.08E-03 ~~8.58E-05~~	5.04E-03 ~~1.08E-03~~	6.92E-02 ~~7.16E-03~~
2. Maximum Total Body Dose	mREM	7.58E-04 ~~1.66E-04~~	2.05E-03 ~~1.64E-04~~	2.94E-04 ~~4.32E-06~~	2.50E-04 ~~5.39E-05~~	3.35E-03 ~~3.89E-04~~
(a) Limit	mREM	1.5	1.5	1.5	1.5	3
(b) % of Limit		5.05E-02 ~~1.11E-02~~	1.37E-01 ~~1.09E-02~~	1.96E-02 ~~2.88E-04~~	1.67E-02 ~~3.59E-03~~	1.12E-01 ~~1.30E-02~~

Critical Age ***ADULT***
Critical Organ ***GI-LLI***

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

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2015 - 12/31/2015

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 H.B. Robinson Steam Electric Plant includes liquid and gaseous effluent dose contributions from H.B. Robinson Steam Electric Plant and direct and air-scatter dose from the onsite ISFSI. No other direct or air-scatter source or uranium fuel cycle facility contributes significantly to the maximum exposed individual. Included in the gaseous effluent dose below is the estimated dose contributed by Carbon-14 (Ref. Attachment 2, Supplemental Information, of this report for further information). Also included is dose from evaporation of H-3 in Lake Robinson and H-3 in fish from Lake Robinson. 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	
1. Location	0.42 km SSE
2. Critical Age	CHILD
3. Critical Organ	BONE
4. Organ Dose (mREM)	5.24E-01
5. Total Body Dose (mREM)	4.19E-01
B. Liquid Effluent Dose	
1. Location	6.76 km NE
2. Critical Age	ADULT
3. Critical Organ	GI-LLI
4. Organ Dose (mREM)	6.92E-03 ~~7.16E-04~~
5. Total Body Dose (mREM)	3.35E-03 ~~89E-04~~
C. Lake Robinson Evaporation H-3 Dose*	
1. Location	6.38 km N
2. Critical Age	CHILD
3. Critical Organ	N/A
4. Organ Dose (mREM)	2.45E-01
5. Total Body Dose (mREM)	2.45E-01
D. H-3 in Fish from Lake Robinson*	
1. Location	Lake
2. Critical Age	ADULT
3. Critical Organ	N/A
4. Organ Dose (mREM)	5.73E-03
5. Total Body Dose (mREM)	5.73E-03

* = Ref. Attachment 2, Supplemental Information, of this report.

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

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2015 - 12/31/2015

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Batch & Continuous Mode						
1. Maximum Organ Dose	mREM	7.42E-04	5.67E-03	2.54E-04	2.52E-04	6.92E-03
(a) Limit	mREM	5	5	5	5	10
(b) % of Limit		1.48E-02	1.13E-01	5.08E-03	5.04E-03	6.92E-02
2. Maximum Total Body Dose	mREM	7.58E-04	2.05E-03	2.94E-04	2.50E-04	3.35E-03
(a) Limit	mREM	1.5	1.5	1.5	1.5	3
(b) % of Limit		5.05E-02	1.37E-01	1.96E-02	1.67E-02	1.12E-01

Critical Age ***ADULT***
Critical Organ ***GI-LLI***

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

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2015 - 12/31/2015

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 H.B. Robinson Steam Electric Plant includes liquid and gaseous effluent dose contributions from H.B. Robinson Steam Electric Plant and direct and air-scatter dose from the onsite ISFSI. No other direct or air-scatter source or uranium fuel cycle facility contributes significantly to the maximum exposed individual. Included in the gaseous effluent dose below is the estimated dose contributed by Carbon-14 (Ref. Attachment 2, Supplemental Information, of this report for further information). Also included is dose from evaporation of H-3 in Lake Robinson and H-3 in fish from Lake Robinson. 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	
1. Location	0.42 km SSE
2. Critical Age	CHILD
3. Critical Organ	BONE
4. Organ Dose (mREM)	5.24E-01
5. Total Body Dose (mREM)	4.19E-01
B. Liquid Effluent Dose	
1. Location	6.76 km NE
2. Critical Age	ADULT
3. Critical Organ	GI-LLI
4. Organ Dose (mREM)	6.92E-03
5. Total Body Dose (mREM)	3.35E-03
C. Lake Robinson Evaporation H-3 Dose*	
1. Location	6.38 km N
2. Critical Age	CHILD
3. Critical Organ	N/A
4. Organ Dose (mREM)	2.45E-01
5. Total Body Dose (mREM)	2.45E-01
D. H-3 in Fish from Lake Robinson*	
1. Location	Lake
2. Critical Age	ADULT
3. Critical Organ	N/A
4. Organ Dose (mREM)	5.73E-03
5. Total Body Dose (mREM)	5.73E-03

* = Ref. Attachment 2, Supplemental Information, of this report.

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

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2016 - 12/31/2016

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Batch & Continuous Mode						
1. Maximum Organ Dose	mREM	7.07E-05 ~~3.66E-07~~	3.68E-04 ~~5.08E-06~~	1.24E-03 ~~7.53E-05~~	3.18E-04 ~~8.06E-06~~	2.00E-03 ~~8.88E-05~~
(a) Limit	mREM	5	5	5	5	10
(b) % of Limit		1.41E-03 ~~7.32E-06~~	7.36E-03 ~~1.02E-04~~	2.48E-02 ~~1.51E-03~~	6.36E-03 ~~1.61E-04~~	2.00E-02 ~~8.88E-04~~
2. Maximum Total Body Dose	mREM	5.41E-05 ~~2.82E-07~~	3.43E-04 ~~4.74E-06~~	1.20E-03 ~~7.21E-05~~	3.00E-04 ~~7.96E-06~~	1.90E-03 ~~8.51E-05~~
(a) Limit	mREM	1.5	1.5	1.5	1.5	3
(b) % of Limit		3.61E-03 ~~1.88E-05~~	2.29E-02 ~~3.16E-04~~	8.00E-02 ~~4.81E-03~~	2.00E-02 ~~5.31E-04~~	6.32E-02 ~~2.84E-03~~

Critical Age ***ADULT***
Critical Organ ***GI-LLI***

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

H.B. Robinson Steam Electric Plant Unit 2
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 H.B. Robinson Steam Electric Plant includes liquid and gaseous effluent dose contributions from H.B. Robinson Steam Electric Plant and direct and air-scatter dose from the onsite ISFSI. No other direct or air-scatter source or uranium fuel cycle facility contributes significantly to the maximum exposed individual. Included in the gaseous effluent dose below is the estimated dose contributed by Carbon-14 (Ref. Attachment 2, Supplemental Information, of this report for further information). Also included is dose from evaporation of H-3 in Lake Robinson and H-3 in fish from Lake Robinson. 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	
1. Location	0.42 km SSE
2. Critical Age	CHILD
3. Critical Organ	BONE
4. Organ Dose (mREM)	5.59E-01
5. Total Body Dose (mREM)	2.58E-01
B. Liquid Effluent Dose	
1. Location	6.76 km NE
2. Critical Age	ADULT
3. Critical Organ	GI-LLI
4. Organ Dose (mREM)	2.00E-03~~8.88E-05~~
5. Total Body Dose (mREM)	1.90E-03~~8.51E-05~~
C. Lake Robinson Evaporation H-3 Dose*	
1. Location	6.38 km N
2. Critical Age	CHILD
3. Critical Organ	N/A
4. Organ Dose (mREM)	1.71E-01
5. Total Body Dose (mREM)	1.71E-01
D. H-3 in Fish from Lake Robinson*	
1. Location	Lake
2. Critical Age	ADULT
3. Critical Organ	N/A
4. Organ Dose (mREM)	4.45E-03
5. Total Body Dose (mREM)	4.45E-03

* = Ref. Attachment 2, Supplemental Information, of this report.

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

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2016 - 12/31/2016

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Batch & Continuous Mode						
1. Maximum Organ Dose	mREM	7.07E-05	3.68E-04	1.24E-03	3.18E-04	2.00E-03
(a) Limit	mREM	5	5	5	5	10
(b) % of Limit		1.41E-03	7.36E-03	2.48E-02	6.36E-03	2.00E-02
2. Maximum Total Body Dose	mREM	5.41E-05	3.43E-04	1.20E-03	3.00E-04	1.90E-03
(a) Limit	mREM	1.5	1.5	1.5	1.5	3
(b) % of Limit		3.61E-03	2.29E-02	8.00E-02	2.00E-02	6.32E-02

Critical Age ***ADULT***
Critical Organ ***GI-LLI***

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

H.B. Robinson Steam Electric Plant Unit 2
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 H.B. Robinson Steam Electric Plant includes liquid and gaseous effluent dose contributions from H.B. Robinson Steam Electric Plant and direct and air-scatter dose from the onsite ISFSI. No other direct or air-scatter source or uranium fuel cycle facility contributes significantly to the maximum exposed individual. Included in the gaseous effluent dose below is the estimated dose contributed by Carbon-14 (Ref. Attachment 2, Supplemental Information, of this report for further information). Also included is dose from evaporation of H-3 in Lake Robinson and H-3 in fish from Lake Robinson. 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	
1. Location	0.42 km SSE
2. Critical Age	CHILD
3. Critical Organ	BONE
4. Organ Dose (mREM)	5.59E-01
5. Total Body Dose (mREM)	2.58E-01
B. Liquid Effluent Dose	
1. Location	6.76 km NE
2. Critical Age	ADULT
3. Critical Organ	GI-LLI
4. Organ Dose (mREM)	2.00E-03
5. Total Body Dose (mREM)	1.90E-03
C. Lake Robinson Evaporation H-3 Dose*	
1. Location	6.38 km N
2. Critical Age	CHILD
3. Critical Organ	N/A
4. Organ Dose (mREM)	1.71E-01
5. Total Body Dose (mREM)	1.71E-01
D. H-3 in Fish from Lake Robinson*	
1. Location	Lake
2. Critical Age	ADULT
3. Critical Organ	N/A
4. Organ Dose (mREM)	4.45E-03
5. Total Body Dose (mREM)	4.45E-03

* = Ref. Attachment 2, Supplemental Information, of this report.

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

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2017 - 12/31/2017

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Batch & Continuous Mode						
1. Maximum Organ Dose	mREM	1.37E-03 ~~5.48E-05~~	1.16E-03 ~~6.27E-06~~	3.45E-04 ~~3.27E-07~~	1.90E-04 ~~1.02E-07~~	3.07E-03 ~~6.15E-05~~
(a) Limit	mREM	5	5	5	5	10
(b) % of Limit		2.74E-02 ~~1.10E-03~~	2.32E-02 ~~1.25E-04~~	6.90E-03 ~~6.54E-06~~	3.80E-03 ~~2.04E-06~~	3.07E-02 ~~6.15E-04~~
2. Maximum Total Body Dose	mREM	8.35E-04 ~~3.36E-05~~	4.33E-04 ~~6.50E-06~~	1.04E-04 ~~7.13E-07~~	5.58E-05 ~~1.89E-07~~	1.43E-03 ~~4.10E-05~~
(a) Limit	mREM	1.5	1.5	1.5	1.5	3
(b) % of Limit		5.57E-02 ~~2.24E-03~~	2.89E-02 ~~4.33E-04~~	6.93E-03 ~~4.75E-05~~	3.72E-03 ~~1.26E-05~~	4.76E-02 ~~1.37E-03~~

Critical Age ***ADULT***
Critical Organ ***GI-LLI***

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

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2017 - 12/31/2017

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 H.B. Robinson Steam Electric Plant includes liquid and gaseous effluent dose contributions from H.B. Robinson Steam Electric Plant and direct and air-scatter dose from the onsite ISFSI. No other direct or air-scatter source or uranium fuel cycle facility contributes significantly to the maximum exposed individual. Included in the gaseous effluent dose below is the estimated dose contributed by Carbon-14 (Ref. Attachment 2, Supplemental Information, of this report for further information). Also included is dose from evaporation of H-3 in Lake Robinson and H-3 in fish from Lake Robinson. 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	
1. Location	0.42 km SSE
2. Critical Age	CHILD
3. Critical Organ	BONE
4. Organ Dose (mREM)	5.59E-01
5. Total Body Dose (mREM)	2.58E-01
B. Liquid Effluent Dose	
1. Location	6.76 km NE
2. Critical Age	ADULT
3. Critical Organ	GI-LLI
4. Organ Dose (mREM)	3.07E-03 ~~6.15E-05~~
5. Total Body Dose (mREM)	1.43E-03 ~~4.10E-05~~
C. Lake Robinson Evaporation H-3 Dose*	
1. Location	6.38 km N
2. Critical Age	CHILD
3. Critical Organ	N/A
4. Organ Dose (mREM)	1.71E-01
5. Total Body Dose (mREM)	1.71E-01
D. H-3 in Fish from Lake Robinson*	
1. Location	Lake
2. Critical Age	ADULT
3. Critical Organ	N/A
4. Organ Dose (mREM)	4.45E-03
5. Total Body Dose (mREM)	4.45E-03

* = Ref. Attachment 2, Supplemental Information, of this report.

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

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2017 - 12/31/2017

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Batch & Continuous Mode						
1. Maximum Organ Dose	mREM	1.37E-03	1.16E-03	3.45E-04	1.90E-04	3.07E-03
(a) Limit	mREM	5	5	5	5	10
(b) % of Limit		2.74E-02	2.32E-02	6.90E-03	3.80E-03	3.07E-02
2. Maximum Total Body Dose	mREM	8.35E-04	4.33E-04	1.04E-04	5.58E-05	1.43E-03
(a) Limit	mREM	1.5	1.5	1.5	1.5	3
(b) % of Limit		5.57E-02	2.89E-02	6.93E-03	3.72E-03	4.76E-02

Critical Age ***ADULT***
Critical Organ ***GI-LLI***

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2017 - 12/31/2017

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 H.B. Robinson Steam Electric Plant includes liquid and gaseous effluent dose contributions from H.B. Robinson Steam Electric Plant and direct and air-scatter dose from the onsite ISFSI. No other direct or air-scatter source or uranium fuel cycle facility contributes significantly to the maximum exposed individual. Included in the gaseous effluent dose below is the estimated dose contributed by Carbon-14 (Ref. Attachment 2, Supplemental Information, of this report for further information). Also included is dose from evaporation of H-3 in Lake Robinson and H-3 in fish from Lake Robinson. 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	
1. Location	0.42 km SSE
2. Critical Age	CHILD
3. Critical Organ	BONE
4. Organ Dose (mREM)	5.59E-01
5. Total Body Dose (mREM)	2.58E-01
B. Liquid Effluent Dose	
1. Location	6.76 km NE
2. Critical Age	ADULT
3. Critical Organ	GI-LLI
4. Organ Dose (mREM)	3.07E-03
5. Total Body Dose (mREM)	1.43E-03
C. Lake Robinson Evaporation H-3 Dose*	
1. Location	6.38 km N
2. Critical Age	CHILD
3. Critical Organ	N/A
4. Organ Dose (mREM)	1.71E-01
5. Total Body Dose (mREM)	1.71E-01
D. H-3 in Fish from Lake Robinson*	
1. Location	Lake
2. Critical Age	ADULT
3. Critical Organ	N/A
4. Organ Dose (mREM)	4.45E-03
5. Total Body Dose (mREM)	4.45E-03

* = Ref. Attachment 2, Supplemental Information, of this report.

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

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2018 - 12/31/2018

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Batch & Continuous Mode						
1. Maximum Organ Dose	mREM	2.05E-04 ~~5.56E-06~~	7.66E-04 ~~1.92E-05~~	9.14E-04 ~~3.61E-05~~	3.76E-03 ~~3.04E-04~~	5.65E-03 ~~3.64E-04~~
(a) Limit	mREM	5	5	5	5	10
(b) % of Limit		4.10E-03 ~~1.11E-04~~	1.53E-02 ~~3.84E-04~~	1.83E-02 ~~7.22E-04~~	7.52E-02 ~~6.08E-03~~	5.65E-02 ~~3.64E-03~~
2. Maximum Total Body Dose	mREM	2.05E-04 ~~5.55E-06~~	7.79E-04 ~~1.97E-05~~	7.12E-04 ~~2.81E-05~~	1.16E-03 ~~8.95E-05~~	2.86E-03 ~~1.43E-04~~
(a) Limit	mREM	1.5	1.5	1.5	1.5	3
(b) % of Limit		1.37E-02 ~~3.70E-04~~	5.19E-02 ~~1.31E-03~~	4.75E-02 ~~1.87E-03~~	7.73E-02 ~~5.97E-03~~	9.52E-02 ~~4.76E-03~~

Critical Age ***ADULT***
Critical Organ ***GI-LLI***

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

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2018 - 12/31/2018

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 H.B. Robinson Steam Electric Plant includes liquid and gaseous effluent dose contributions from H.B. Robinson Steam Electric Plant and direct and air-scatter dose from the onsite ISFSI. No other direct or air-scatter source or uranium fuel cycle facility contributes significantly to the maximum exposed individual. Included in the gaseous effluent dose below is the estimated dose contributed by Carbon-14 (Ref. Attachment 2, Supplemental Information, of this report for further information). Also included is dose from evaporation of H-3 in Lake Robinson and H-3 in fish from Lake Robinson. 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	
1. Location	0.42 km SSE
2. Critical Age	CHILD
3. Critical Organ	BONE
4. Organ Dose (mREM)	5.59E-01
5. Total Body Dose (mREM)	2.58E-01
B. Liquid Effluent Dose	
1. Location	6.76 km NE
2. Critical Age	ADULT
3. Critical Organ	GI-LLI
4. Organ Dose (mREM)	5.65E-03 ~~3.64E-04~~
5. Total Body Dose (mREM)	2.86E-03 ~~1.43E-04~~
C. Lake Robinson Evaporation H-3 Dose*	
1. Location	6.38 km N
2. Critical Age	CHILD
3. Critical Organ	N/A
4. Organ Dose (mREM)	1.71E-01
5. Total Body Dose (mREM)	1.71E-01
D. H-3 in Fish from Lake Robinson*	
1. Location	Lake
2. Critical Age	ADULT
3. Critical Organ	N/A
4. Organ Dose (mREM)	4.45E-03
5. Total Body Dose (mREM)	4.45E-03

* = Ref. Attachment 2, Supplemental Information, of this report.

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

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2018 - 12/31/2018

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Batch & Continuous Mode						
1. Maximum Organ Dose	mREM	2.05E-04	7.66E-04	9.14E-04	3.76E-03	5.65E-03
(a) Limit	mREM	5	5	5	5	10
(b) % of Limit		4.10E-03	1.53E-02	1.83E-02	7.52E-02	5.65E-02
2. Maximum Total Body Dose	mREM	2.05E-04	7.79E-04	7.12E-04	1.16E-03	2.86E-03
(a) Limit	mREM	1.5	1.5	1.5	1.5	3
(b) % of Limit		1.37E-02	5.19E-02	4.75E-02	7.73E-02	9.52E-02

Critical Age ***ADULT***
Critical Organ ***GI-LLI***

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

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2018 - 12/31/2018

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 H.B. Robinson Steam Electric Plant includes liquid and gaseous effluent dose contributions from H.B. Robinson Steam Electric Plant and direct and air-scatter dose from the onsite ISFSI. No other direct or air-scatter source or uranium fuel cycle facility contributes significantly to the maximum exposed individual. Included in the gaseous effluent dose below is the estimated dose contributed by Carbon-14 (Ref. Attachment 2, Supplemental Information, of this report for further information). Also included is dose from evaporation of H-3 in Lake Robinson and H-3 in fish from Lake Robinson. 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	
1. Location	0.42 km SSE
2. Critical Age	CHILD
3. Critical Organ	BONE
4. Organ Dose (mREM)	5.59E-01
5. Total Body Dose (mREM)	2.58E-01
B. Liquid Effluent Dose	
1. Location	6.76 km NE
2. Critical Age	ADULT
3. Critical Organ	GI-LLI
4. Organ Dose (mREM)	5.65E-03
5. Total Body Dose (mREM)	2.86E-03
C. Lake Robinson Evaporation H-3 Dose*	
1. Location	6.38 km N
2. Critical Age	CHILD
3. Critical Organ	N/A
4. Organ Dose (mREM)	1.71E-01
5. Total Body Dose (mREM)	1.71E-01
D. H-3 in Fish from Lake Robinson*	
1. Location	Lake
2. Critical Age	ADULT
3. Critical Organ	N/A
4. Organ Dose (mREM)	4.45E-03
5. Total Body Dose (mREM)	4.45E-03

* = Ref. Attachment 2, Supplemental Information, of this report.

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

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2019 - 12/31/2019

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Batch & Continuous Mode						
1. Maximum Organ Dose	mREM	4.75E-05~~6.89E-07~~	2.82E-05~~8.90E-08~~	4.94E-04~~1.19E-05~~	2.58E-04~~5.64E-04~~	8.28E-04~~1.83E-05~~
(a) Limit	mREM	5	5	5	5	10
(b) % of Limit		9.50E-04~~1.38E-05~~	5.64E-04~~1.78E-06~~	9.88E-03~~2.38E-04~~	5.16E-03~~1.13E-02~~	8.28E-03~~1.83E-04~~
2. Maximum Total Body Dose	mREM	2.16E-05~~3.13E-07~~	1.29E-05~~4.02E-08~~	4.78E-04~~1.16E-05~~	2.54E-04~~5.54E-06~~	7.67E-04~~1.75E-05~~
(a) Limit	mREM	1.5	1.5	1.5	1.5	3
(b) % of Limit		1.44E-03~~2.09E-05~~	8.60E-04~~2.68E-06~~	3.19E-02~~7.73E-04~~	1.69E-02~~3.69E-04~~	2.56E-02~~5.83E-04~~

Critical Age ***ADULT***
Critical Organ ***GI-LLI***

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2019 - 12/31/2019

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 H.B. Robinson Steam Electric Plant includes liquid and gaseous effluent dose contributions from H.B. Robinson Steam Electric Plant and direct and air-scatter dose from the onsite ISFSI. No other direct or air-scatter source or uranium fuel cycle facility contributes significantly to the maximum exposed individual. Included in the gaseous effluent dose below is the estimated dose contributed by Carbon-14 (Ref. Attachment 2, Supplemental Information, of this report for further information). Also included is dose from evaporation of H-3 in Lake Robinson and H-3 in fish from Lake Robinson. 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	
1. Location	0.42 km SSE
2. Critical Age	CHILD
3. Critical Organ	BONE
4. Organ Dose (mREM)	5.59E-01
5. Total Body Dose (mREM)	2.58E-01
B. Liquid Effluent Dose	
1. Location	6.76 km NE
2. Critical Age	ADULT
3. Critical Organ	GI-LLI
4. Organ Dose (mREM)	8.28E-04~~1.83E-05~~
5. Total Body Dose (mREM)	7.67E-04~~1.75E-05~~
C. Lake Robinson Evaporation H-3 Dose*	
1. Location	6.38 km N
2. Critical Age	CHILD
3. Critical Organ	N/A
4. Organ Dose (mREM)	1.71E-01
5. Total Body Dose (mREM)	1.71E-01
D. H-3 in Fish from Lake Robinson*	
1. Location	Lake
2. Critical Age	ADULT
3. Critical Organ	N/A
4. Organ Dose (mREM)	4.45E-03
5. Total Body Dose (mREM)	4.45E-03

* = Ref. Attachment 2, Supplemental Information, of this report.

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

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2019 - 12/31/2019

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Batch & Continuous Mode						
1. Maximum Organ Dose	mREM	4.75E-05	2.82E-05	4.94E-04	2.58E-04	8.28E-04
(a) Limit	mREM	5	5	5	5	10
(b) % of Limit		9.50E-04	5.64E-04	9.88E-03	5.16E-03	8.28E-03
2. Maximum Total Body Dose	mREM	2.16E-05	1.29E-05	4.78E-04	2.54E-04	7.67E-04
(a) Limit	mREM	1.5	1.5	1.5	1.5	3
(b) % of Limit		1.44E-03	8.60E-04	3.19E-02	1.69E-02	2.56E-02

Critical Age ***ADULT***
Critical Organ ***GI-LLI***

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

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2019 - 12/31/2019

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 H.B. Robinson Steam Electric Plant includes liquid and gaseous effluent dose contributions from H.B. Robinson Steam Electric Plant and direct and air-scatter dose from the onsite ISFSI. No other direct or air-scatter source or uranium fuel cycle facility contributes significantly to the maximum exposed individual. Included in the gaseous effluent dose below is the estimated dose contributed by Carbon-14 (Ref. Attachment 2, Supplemental Information, of this report for further information). Also included is dose from evaporation of H-3 in Lake Robinson and H-3 in fish from Lake Robinson. 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	
1. Location	0.42 km SSE
2. Critical Age	CHILD
3. Critical Organ	BONE
4. Organ Dose (mREM)	5.59E-01
5. Total Body Dose (mREM)	2.58E-01
B. Liquid Effluent Dose	
1. Location	6.76 km NE
2. Critical Age	ADULT
3. Critical Organ	GI-LLI
4. Organ Dose (mREM)	8.28E-04
5. Total Body Dose (mREM)	7.67E-04
C. Lake Robinson Evaporation H-3 Dose*	
1. Location	6.38 km N
2. Critical Age	CHILD
3. Critical Organ	N/A
4. Organ Dose (mREM)	1.71E-01
5. Total Body Dose (mREM)	1.71E-01
D. H-3 in Fish from Lake Robinson*	
1. Location	Lake
2. Critical Age	ADULT
3. Critical Organ	N/A
4. Organ Dose (mREM)	4.45E-03
5. Total Body Dose (mREM)	4.45E-03

* = Ref. Attachment 2, Supplemental Information, of this report.

Attachment 8
Inoperable Equipment

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2021 - 12/31/2021

H.B. Robinson Steam Electric Plant experienced one (1) instance of inoperable equipment relevant to effluent monitoring in excess of ODCM/TRMS limits during 2021. Details are described below.

H.B. Robinson Steam Electric Plant did not experience permanent or temporary outside liquid storage tanks not surrounded by liners, dikes, or walls, capable of holding the tank's contents and that does not have tank overflows and surrounding area drains connected to the Liquid Waste Disposal System exceeding 10 Curies total activity (excluding tritium and dissolved or entrained noble gases) during 2021.

ODCM # or TRMS #	Title	Completion Time	Description
ODCM 3.10, Condition "Table 3.10-1 Item 1.f."	Plant Vent Flow Rate	30 Days	NCR 02368858: At 1430 hrs. on 1/6/2021, F-14 Plant Vent Flow Monitor was declared out of service following an unsuccessful plant vent flow monitor calibration in accordance with RST-026. OMM-007 has been referenced and an Equipment Inoperable Record (EIR) is required. Component is unavailable, effluent releases via this pathway may continue provided that flow rate is estimated once per 4 hours by Chemistry personnel. F-14 Plant Vent Flow Monitor was not returned to operable status within the 30-day requirement due to long lead time for circuit board needed to repair the monitor.

Attachment 8
Inoperable Equipment

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2021 - 12/31/2021

H.B. Robinson Steam Electric Plant experienced one (1) instance of inoperable equipment relevant to effluent monitoring in excess of ODCM/TRMS limits during 2021. Details are described below.

H.B. Robinson Steam Electric Plant did not experience permanent or temporary outside liquid storage tanks not surrounded by liners, dikes, or walls, capable of holding the tank's contents and that does not have tank overflows and surrounding area drains connected to the Liquid Waste Disposal System exceeding 10 Curies total activity (excluding tritium and dissolved or entrained noble gases) during 2021.

ODCM # or TRMS #	Title	Completion Time	Description
ODCM 3.10, Condition "Table 3.10-1 Item 1.f."	Plant Vent Flow Rate	30 Days	NCR 02368858: At 1430 hrs. on 1/6/2021, F-14 Plant Vent Flow Monitor was declared out of service following an unsuccessful plant vent flow monitor calibration in accordance with RST-026. OMM-007 has been referenced and an Equipment Inoperable Record (EIR) is required. Component is unavailable, effluent releases via this pathway may continue provided that flow rate is estimated once per 4 hours by Chemistry personnel. F-14 Plant Vent Flow Monitor was not returned to operable status within the 30 day requirement due to long lead time for circuit board needed to repair the monitor.

Attachment 1
Summary of Gaseous and Liquid Effluents

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2021 - 12/31/2021

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	3.61E-02	3.58E-02	3.95E-02	8.72E-01	9.83E-01
2. Avg. Release Rate	μCi/sec	4.58E-03	4.54E-03	5.01E-03	1.11E-01	3.12E-02
B. Iodine-131						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Release Rate	μCi/sec	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C. Particulates Half-Life ≥ 8 days						
1. Total Release	Ci	0.00E+00	0.00E+00	7.03E-07	2.59E-06	3.29E-06
2. Avg. Release Rate	μCi/sec	0.00E+00	0.00E+00	8.84E-08	3.25E-07	1.03E-07
D. Tritium						
1. Total Release	Ci	1.22E+00	2.24E+00	3.06E+00	4.13E+00	1.07E+01
2. Avg. Release Rate	μCi/sec	1.56E-01	2.84E-01	3.85E-01	5.19E-01	3.36E-01
E. Carbon-14						
1. Total Release	Ci	2.13E+00	2.15E+00	2.18E+00	2.18E+00	8.64E+00
2. Avg. Release Rate	μCi/sec	2.70E-01	2.73E-01	2.77E-01	2.77E-01	2.74E-01
F. 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

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2021 - 12/31/2021

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	3.61E-02	3.58E-02	3.95E-02	8.72E-01	9.83E-01
2. Avg. Release Rate	μCi/sec	4.58E-03	4.54E-03	5.01E-03	1.11E-01	3.12E-02
B. Iodine-131						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Release Rate	μCi/sec	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C. Particulates Half-Life ≥ 8 days						
1. Total Release	Ci	0.00E+00	0.00E+00	7.03E-07	2.59E-06	3.29E-06
2. Avg. Release Rate	μCi/sec	0.00E+00	0.00E+00	8.84E-08	3.25E-07	1.03E-07
D. Tritium						
1. Total Release	Ci	1.22E+00	2.24E+00	3.06E+00	4.13E+00	1.07E+01
2. Avg. Release Rate	μCi/sec	1.56E-01	2.84E-01	3.85E-01	5.19E-01	3.36E-01
E. Carbon-14						
1. Total Release	Ci	2.13E+00	2.15E+00	2.18E+00	2.18E+00	8.64E+00
2. Avg. Release Rate	μCi/sec	2.70E-01	2.73E-01	2.77E-01	2.77E-01	2.74~~60~~E-01
F. 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

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2021 - 12/31/2021

Gaseous Effluents - Ground & Mixed-Mode Releases - Continuous Mode

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Gases						
Xe-133	Ci	0.00E+00	0.00E+00	0.00E+00	7.48E-01	7.48E-01
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	7.48E-01	7.48E-01
B. Iodines						
None	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C. Particulates Half-Life ≥ 8 days						
Co-56	Ci	0.00E+00	0.00E+00	2.50E-07	0.00E+00	2.50E-07
Co-58	Ci	0.00E+00	0.00E+00	3.32E-07	2.49E-06	2.82E-06
Te-123m	Ci	0.00E+00	0.00E+00	0.00E+00	4.12E-08	4.12E-08
Total for Period	Ci	0.00E+00	0.00E+00	5.82E-07	2.53E-06	3.11E-06
D. Tritium						
H-3	Ci	1.06E+00	1.60E+00	1.86E+00	2.65E+00	7.17E+00
E. Carbon-14						
C-14	Ci	1.31E+00	1.33E+00	1.34E+00	1.34E+00	5.32E+00
F. 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

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2021 - 12/31/2021

Gaseous Effluents - Ground & Mixed-Mode Releases - Continuous Mode

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Gases						
Xe-133	Ci	0.00E+00	0.00E+00	0.00E+00	7.48E-01	7.48E-01
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	7.48E-01	7.48E-01
B. Iodines						
None	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C. Particulates Half-Life ≥ 8 days						
Co-56	Ci	0.00E+00	0.00E+00	2.50E-07	0.00E+00	2.50E-07
Co-58	Ci	0.00E+00	0.00E+00	3.32E-07	2.49E-06	2.82E-06
Te-123m	Ci	0.00E+00	0.00E+00	0.00E+00	4.12E-08	4.12E-08
Total for Period	Ci	0.00E+00	0.00E+00	5.82E-07	2.53E-06	3.11E-06
D. Tritium						
H-3	Ci	1.06E+00	1.60E+00	1.86E+00	2.65E+00	7.17E+00 ~~1~~
E. Carbon-14						
C-14	Ci	1.31E+00	1.33E+00	1.34E+00	1.34E+00	5.32E+00
F. Gross Alpha						
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00