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10 CFR 50.36a

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 - 2023

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, 2023, through December 31, 2023. 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. ODCM Revision 40 was implemented in 2023 and is included with this submittal.

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. The ODCM was not revised during this report period.

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. The ODCM was not revised during this report period.

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 62 was implemented in 2023 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 38 was implemented in 2023 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,

Kevin Ellis
General Manager, 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
L. Haeg, USNRC NRR Project Manager for BNP/RNP
S. Williams, USNRC NRR Project Manager for CNS/ONS
M. Mahoney, USNRC NRR Project Manager for HNP
J. Klos, USNRC NRR Project Manager for MNS
G. Smith, USNRC Senior Resident Inspector for BNP
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C. Safouri, USNRC Senior Resident Inspector for MNS
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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, 2023 through December 31, 2023

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 1/1/2023 - 12/31/2023

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	4.33E+02	3.27E+02	3.29E+02	3.17E+02	1.41E+03
2. Avg. Release Rate	μCi/sec	5.57E+01	4.16E+01	4.14E+01	3.99E+01	4.47E+01
B. Iodine-131						
1. Total Release	Ci	2.90E-02	2.86E-02	2.40E-02	2.02E-02	1.02E-01
2. Avg. Release Rate	μCi/sec	3.73E-03	3.64E-03	3.01E-03	2.55E-03	3.23E-03
C. Particulates Half-Life ≥ 8 days						
1. Total Release	Ci	4.26E-03	5.17E-03	5.48E-03	5.09E-03	2.00E-02
2. Avg. Release Rate	μCi/sec	5.48E-04	6.57E-04	6.89E-04	6.40E-04	6.34E-04
D. Tritium						
1. Total Release	Ci	1.51E+01	1.31E+01	1.42E+01	1.69E+01	5.93E+01
2. Avg. Release Rate	μCi/sec	1.94E+00	1.67E+00	1.79E+00	2.13E+00	1.88E+00
E. Carbon-14						
1. Total Release	Ci	4.65E+00	5.73E+00	5.99E+00	5.93E+00	2.23E+01
2. Avg. Release Rate	μCi/sec	5.98E-01	7.28E-01	7.54E-01	7.46E-01	7.07E-01
F. Gross Alpha						
1. Total Release	Ci	9.60E-08	0.00E+00	3.20E-07	0.00E+00	4.16E-07

Attachment 1
Summary of Gaseous and Liquid Effluents

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2023 - 12/31/2023

Gaseous Effluents - Elevated Releases - Continuous Mode

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Gases						
Ar-41	Ci	4.30E-01	1.03E+00	9.15E-01	1.64E+00	4.02E+00
Kr-85m	Ci	3.51E+01	4.35E+01	4.03E+01	3.10E+01	1.50E+02
Kr-85	Ci	0.00E+00	0.00E+00	1.04E+01	1.16E+01	2.20E+01
Kr-87	Ci	1.03E+01	5.54E+00	4.85E+00	4.16E+00	2.49E+01
Kr-88	Ci	3.22E+01	3.89E+01	3.60E+01	2.63E+01	1.33E+02
Kr-89	Ci	0.00E+00	0.00E+00	0.00E+00	4.10E+00	4.10E+00
Xe-133	Ci	4.24E+01	5.16E+01	5.14E+01	3.67E+01	1.82E+02
Xe-135m	Ci	4.34E+01	3.64E+01	2.83E+01	2.08E+01	1.29E+02
Xe-135	Ci	2.29E+01	2.07E+01	1.73E+01	1.28E+01	7.37E+01
Xe-137	Ci	8.00E+01	2.93E+01	4.79E+01	9.35E+01	2.51E+02
Xe-138	Ci	1.01E+02	7.07E+01	6.29E+01	4.94E+01	2.84E+02
Total for Period	Ci	3.68E+02	2.98E+02	3.00E+02	2.92E+02	1.26E+03
B. Iodines						
I-131	Ci	1.12E-02	1.75E-02	1.49E-02	1.06E-02	5.42E-02
I-133	Ci	5.15E-02	9.14E-02	9.12E-02	6.68E-02	3.01E-01
I-135	Ci	6.47E-02	1.21E-01	1.10E-01	8.09E-02	3.77E-01
Total for Period	Ci	1.27E-01	2.30E-01	2.16E-01	1.58E-01	7.31E-01
C. Particulates Half-Life ≥ 8 days						
Cr-51	Ci	0.00E+00	1.98E-05	0.00E+00	0.00E+00	1.98E-05
Mn-54	Ci	4.23E-06	2.22E-06	0.00E+00	0.00E+00	6.45E-06
Co-58	Ci	6.91E-06	0.00E+00	0.00E+00	9.31E-06	1.62E-05
Co-60	Ci	6.65E-05	3.70E-05	1.39E-06	1.59E-06	1.06E-04
Sr-89	Ci	1.18E-04	3.40E-04	5.03E-04	3.56E-04	1.32E-03
Sr-90	Ci	1.16E-06	3.99E-08	3.55E-06	3.52E-06	8.27E-06
Cs-134	Ci	4.69E-06	0.00E+00	0.00E+00	0.00E+00	4.69E-06
Cs-137	Ci	3.41E-06	8.97E-07	3.08E-06	0.00E+00	7.39E-06
Ba-140	Ci	1.80E-04	9.89E-04	1.43E-03	1.03E-03	3.63E-03
La-140	CI	3.13E-04	1.71E-03	2.55E-03	1.84E-03	6.41E-03
Total	CI	6.98E-04	3.10E-03	4.49E-03	3.25E-03	1.15E-02
D. Tritium						
H-3	Ci	2.53E+00	2.61E+00	3.26E+00	2.52E+00	1.09E+01
E. Carbon-14						
C-14	Ci	1.86E+00	2.29E+00	2.40E+00	2.37E+00	8.92E+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 1/1/2023 - 12/31/2023

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	-	-	-	-	-

* 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 1/1/2023 - 12/31/2023

Gaseous Effluents - Ground Releases - Continuous Mode

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Gases						
Kr-87	Ci	7.93E-02	0.00E+00	5.57E-02	2.79E-02	1.63E-01
Xe-135m	Ci	6.09E+00	9.78E+00	1.38E+01	1.26E+01	4.23E+01
Xe-135	Ci	6.25E+00	1.49E+01	1.33E+01	9.81E+00	4.43E+01
Xe-137	Ci	6.86E-01	0.00E+00	0.00E+00	0.00E+00	6.86E-01
Xe-138	Ci	4.35E+00	8.15E-01	0.00E+00	1.15E+00	6.32E+00
Total for Period	Ci	1.75E+01	2.55E+01	2.71E+01	2.36E+01	9.37E+01
B. Iodines						
I-131	Ci	1.31E-02	9.92E-03	7.62E-03	8.08E-03	3.87E-02
I-133	Ci	1.01E-01	1.10E-01	7.92E-02	8.19E-02	3.72E-01
I-135	Ci	1.87E-01	2.22E-01	1.42E-01	1.42E-01	6.93E-01
Total for Period	Ci	3.01E-01	3.42E-01	2.29E-01	2.32E-01	1.10E+00
C. Particulates Half-Life ≥ 8 days						
Co-58	Ci	1.03E-05	0.00E+00	0.00E+00	0.00E+00	1.03E-05
Co-60	Ci	6.60E-05	3.15E-05	2.28E-05	5.04E-06	1.25E-04
Sr-89	Ci	3.38E-04	3.48E-04	9.75E-06	2.32E-04	9.28E-04
Sr-90	Ci	0.00E+00	0.00E+00	1.73E-06	4.81E-07	2.21E-06
Ag-110m	Ci	1.78E-05	1.08E-05	0.00E+00	0.00E+00	2.86E-05
Ba-140	Ci	8.13E-04	5.52E-04	2.78E-04	5.41E-04	2.18E-03
La-140	Ci	1.40E-03	8.53E-04	4.81E-04	9.87E-04	3.72E-03
Total for Period	Ci	2.65E-03	1.80E-03	7.93E-04	1.77E-03	7.01E-03
D. Tritium						
H-3	Ci	9.86E+00	8.08E+00	6.72E+00	1.13E+01	3.60E+01
E. Carbon-14						
C-14	Ci	9.30E-01	1.15E+00	1.20E+00	1.19E+00	4.47E+00
F. Gross Alpha						
G-A	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 1/1/2023 - 12/31/2023

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						
N/A	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 1/1/2023 - 12/31/2023

Gaseous Effluents - Mixed-Mode Releases - Continuous Mode

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Gases						
Xe-133	Ci	3.68E+01	0.00E+00	0.00E+00	0.00E+00	3.68E+01
Xe-135m	Ci	3.84E+00	1.64E+00	0.00E+00	0.00E+00	5.48E+00
Xe-135	Ci	6.48E+00	2.13E+00	1.81E+00	1.95E+00	1.24E+01
Xe-138	Ci	3.14E-01	0.00E+00	0.00E+00	0.00E+00	3.14E-01
Total for Period	Ci	4.74E+01	3.77E+00	1.81E+00	1.95E+00	5.49E+01
B. Iodines						
I-131	Ci	4.79E-03	1.21E-03	1.39E-03	1.52E-03	8.91E-03
I-133	Ci	3.66E-02	1.18E-02	1.35E-02	1.59E-02	7.78E-02
I-135	Ci	6.17E-02	2.08E-02	2.30E-02	2.75E-02	1.33E-01
Total for Period	Ci	1.03E-01	3.39E-02	3.79E-02	4.49E-02	2.20E-01
C. Particulates Half-Life ≥ 8 days						
Cr-51	Ci	1.17E-04	0.00E+00	0.00E+00	0.00E+00	1.17E-04
Mn-54	Ci	1.30E-05	1.50E-05	0.00E+00	0.00E+00	2.80E-05
Co-58	Ci	1.63E-05	7.05E-06	7.25E-07	0.00E+00	2.41E-05
Co-60	Ci	2.02E-04	1.00E-04	9.23E-05	2.19E-06	3.96E-04
Fe-59	Ci	5.82E-06	0.00E+00	0.00E+00	0.00E+00	5.82E-06
Sr-89	Ci	9.13E-07	0.00E+00	0.00E+00	0.00E+00	9.13E-07
Nb-95	Ci	1.04E-06	0.00E+00	0.00E+00	0.00E+00	1.04E-06
Ag-110m	Ci	8.54E-06	0.00E+00	0.00E+00	0.00E+00	8.54E-06
Cs-134	Ci	2.17E-06	9.80E-07	0.00E+00	0.00E+00	3.15E-06
Cs-137	Ci	7.37E-06	3.76E-06	0.00E+00	0.00E+00	1.11E-05
Ba-140	Ci	2.15E-04	3.45E-05	2.51E-05	1.54E-05	2.90E-04
La-140	Ci	3.28E-04	1.16E-04	7.81E-05	5.79E-05	5.80E-04
Ce-141	Ci	3.85E-06	0.00E+00	0.00E+00	0.00E+00	3.85E-06
Total for Period	Ci	9.21E-04	2.78E-04	1.96E-04	7.55E-05	1.47E-03
D. Tritium	Ci	2.67E+00	2.41E+00	4.23E+00	3.05E+00	1.24E+01
H-3						
E. Carbon-14	Ci	1.86E+00	2.29E+00	2.40E+00	2.37E+00	8.92E+00
C-14						
F. Gross Alpha						
G-A	Ci	9.60E-08	0.00E+00	3.20E-07	0.00E+00	4.16E-07

Attachment 1
Summary of Gaseous and Liquid Effluents

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2023 - 12/31/2023

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	-	-	-	-	-

* 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 1/1/2023 - 12/31/2023

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	3.40E-03	4.38E-03	6.60E-03	2.58E-03	1.70E-02
2. Avg. Diluted Conc.	μCi/ml	9.29E-12	8.91E-12	1.26E-11	5.51E-12	9.08E-12
B. Tritium						
1. Total Release	Ci	9.63E+00	1.23E+01	1.23E+01	1.07E+01	4.49E+01
2. Avg. Diluted Conc.	μCi/ml	2.63E-08	2.50E-08	2.34E-08	2.28E-08	2.44E-08
C. Dissolved & Entrained Gases						
1. Total Release	Ci	3.29E-02	5.40E-02	5.02E-02	3.82E-02	1.75E-01
2. Avg. Diluted Conc.	μCi/ml	8.99E-11	1.10E-10	9.57E-11	8.16E-11	9.43E-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	2.75E+06	4.74E+06	5.46E+06	3.72E+06	1.67E+07
2. Continuous Releases	Liters	1.14E+08	1.05E+08	1.50E+08	1.01E+08	4.70E+08
F. Volume of Dilution Water						
1. All Releases	Liters	3.66E+11	4.91E+11	5.24E+11	4.68E+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 1/1/2023 - 12/31/2023

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	0.00E+00	0.00E+00	4.15E-03	0.00E+00	4.15E-03
2. Avg. Diluted Conc.	µCi/ml	0.00E+00	0.00E+00	8.09E-08	0.00E+00	2.02E-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 1/1/2023 - 12/31/2023

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	1.56E-01	3.87E-01	5.43E-01
C. Dissolved & Entrained Gases						
None	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Gross Alpha						
G-A	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 1/1/2023 - 12/31/2023

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	0.00E+00	0.00E+00	4.15E-03	0.00E+00	4.15E-03
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						
G-A	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 1/1/2023 - 12/31/2023

Liquid Effluents - Batch Mode - Discharge Canal

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Products						
Mn-54	Ci	1.87E-05	3.71E-05	0.00E+00	8.38E-07	5.66E-05
Co-58	Ci	8.45E-06	7.09E-06	0.00E+00	0.00E+00	1.55E-05
Co-60	Ci	5.30E-05	2.41E-04	8.23E-05	3.94E-05	4.16E-04
Zn-65	Ci	9.06E-07	0.00E+00	0.00E+00	0.00E+00	9.06E-07
Tc-104	Ci	2.42E-06	0.00E+00	0.00E+00	0.00E+00	2.42E-06
Sb-125	Ci	0.00E+00	0.00E+00	0.00E+00	1.41E-05	1.41E-05
I-131	Ci	1.81E-03	1.44E-03	2.02E-03	1.27E-03	6.54E-03
I-132	Ci	0.00E+00	9.80E-06	2.82E-06	0.00E+00	1.26E-05
I-133	Ci	1.29E-03	2.14E-03	3.70E-03	1.11E-03	8.24E-03
I-135	Ci	1.50E-04	4.14E-04	7.75E-04	1.37E-04	1.48E-03
Cs-134	Ci	1.71E-05	3.48E-05	6.36E-06	4.97E-07	5.88E-05
Cs-137	Ci	4.98E-05	5.49E-05	1.77E-05	1.56E-06	1.24E-04
La-140	Ci	4.33E-07	0.00E+00	0.00E+00	0.00E+00	4.33E-07
Total for Period	Ci	3.40E-03	4.38E-03	6.60E-03	2.58E-03	1.70E-02
B. Tritium						
H-3	Ci	9.63E+00	1.23E+01	1.21E+01	1.03E+01	4.43E+01
C. Dissolved & Entrained Gases						
Xe-133m	Ci	5.75E-05	8.58E-05	1.76E-04	0.00E+00	3.19E-04
Xe-133	Ci	6.63E-03	1.00E-02	1.00E-02	7.76E-03	3.44E-02
Xe-135m	Ci	4.24E-05	9.74E-05	1.54E-04	2.24E-05	3.16E-04
Xe-135	Ci	2.61E-02	4.38E-02	3.99E-02	3.04E-02	1.40E-01
Total for Period	Ci	3.29E-02	5.40E-02	5.02E-02	3.82E-02	1.75E-01
D. Gross Alpha						
G-A	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 1/1/2023 - 12/31/2023

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						
G-A	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 1/1/2023 - 12/31/2023

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	=	114	130
2. Total Time (min) for Batch Releases	=	2.59E+05	4.16E+04
3. Maximum Time (min) for a Batch Release	=	4.29E+04	9.93E+03
4. Average Time (min) for Batch Releases	=	2.27E+03	3.20E+02
5. Minimum Time (min) for a Batch Release	=	1.30E+01	1.10E+01
6. Average Dilution Water Flow During Release (gpm)	=	7.32E+05	8.40E+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.

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 2023 ARERR contains estimates of C-14 radioactivity released in 2023 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 2.23E+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 2023 is well below the 10CFR50, Appendix I, ALARA design objective (i.e., 15 mrem/yr per unit).

Based on the 2023 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 2023 was 2.45E+00 mrem and the total body dose was 4.91E-01 mrem.

	Units	Year
1. C-14 Activity Released	Ci	2.23E+01
2. C-14 Total Body Dose	mREM	4.91E-01
3. C-14 Organ Dose	mREM	2.45E+00

Receptor Location ***1.5*** miles ***S***
Critical Age ***CHILD***
Critical Organ ***BONE***

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 19 occasions in 2023 due to heavy rains. Approximately 2.740E+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. The SDSF was turned into a continuous release in July of 2023. Approximately 1.14E+08 gallons containing 1.08E+00 curies of tritium were released from the SDSF. There was no detectable gamma radioactivity.

Discussion of water evaporation from the Drainage Holding Facility (DHF) and Retired Storm Drain Stabilization Pond (RSDSP)

It was calculated that up to 1.04E+06 cubic feet of water vapor were released via evaporation from the DHF in 2023. 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 north sector at approximately 0.3 miles. 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) was completed and placed in service in March 2023. This took the place of the Storm Drain Stabilization Pond (SDSP) which has sense been retired. The SDSP had an estimated evaporation of 7.08E+04 cubic feet of water vapor before it’s full retirement. This yields 0.00E+00 curies of tritium released to the atmosphere as a ground release.

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

It was calculated that 1.01E+06 cubic feet of water vapor were released via evaporation from the SDSF in 2023. This yields 1.17E-01 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 7.52E-05 mrem via the inhalation pathway in 2023. 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.

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2023 - 12/31/2023

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 2023 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 2023, it was calculated that 5.38E+07 gallons were released to Nancy's Creek containing 4.15E-03 curies of tritium. This yielded a Total Body dose of 5.04E-05 mrem to an adult from eating fish and invertebrate.

Discussion of liquid releases from the Retired Storm Drain Stabilization Pond (RSDSP) and the Drainage Holding Facility (DHF)

The Retired Storm Drain Stabilization Pond collected 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 releases in 2023. Approximately 0.00E+00 gallons were released in 2023 containing 0.00E+00 curies of tritium. There was no detectable gamma radioactivity. This system was completely retired in March of 2023.

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 was to cap the existing SDSP and construct a new holding facility for stormwater. The SDSP required 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 was degraded by vegetative overgrowth.

The new Drainage Holding Facility (DHF) was completed in March of 2023 within the SDSP footprint. The DHF controls aquatic vegetation by use of an aeration system and weighted high-density polyethylene (HDPE) balls. Also, the DHF is double lined to reduce the potential for any tritium leakage to groundwater. 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. The DHF can also serve as a back-up to the SDSF and can take inputs from the SDSF as well as all listed SDSF inputs. Typically, the DHF is maintained non-radioactive, and primarily takes rainwater runoff from the RSDSP. When in release the DHF is considered a continuous release per BNP ODCM. Approximately 7.72E+06 gallons were released in 2023 containing 0.00E+00 curies of tritium. There was no detectable gamma radioactivity.

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2023 - 12/31/2023

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 2023 Land Use Census was performed July 10-11, 2023. The results were certified and made available for use on August 31, 2023. The following are changes to residences, gardens, and milk animals from the previous year.

Residences

- No resident changes from 2022.

Gardens

- The closest garden in the N sector was replaced with a new garden at 1.10 miles.
- The closest garden in the S sector was replaced with a new garden at 1.56 miles.
- The closest garden in the SSW sector was replaced with a new garden at 1.59 miles.
- The closest garden in the W sector was replaced with a new garden at 1.28 miles.
- The closest garden in the NW sector was replaced with a new garden at 0.95 miles.
- The closest garden in the NNW sector was replaced with a new garden at 0.96 miles.

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

Broadleaf vegetation sample location 805 (0.8 miles ENE – East Intake Canal) was removed as a supplemental indicator location and sample location 806 (1.06 miles ENE – East Intake Canal) was added.

Direct Radiation (TLD) Locations 1 (1.1 miles E), 5 (1.1 miles S), 15 (0.9 miles ENE), 23 (4.6 miles WSW), 34 (5.4 miles E), and 38 (11.0 miles W) were removed, and Locations 86 (1.07 miles E), 87 (1.02 miles ENE), 88 (5.30 miles WSW), 89 (5.06 miles E), 90 (5.68 miles W), and 91 (0.95 miles S) were added.

Ground Water Locations 404 (Monitoring Well ESS-1B, 0.16 miles SW), 407 (Monitoring Well ESS-13B, 0.06 miles ENE), 418 (Monitoring Well ESS-21B, Near Storm Drain Stabilization Pond), 426 (Monitoring Well ESS-25B, Near Storm Drain Stabilization Pond), 429 (Monitoring Well ESS-27A, Near Storm Drain Stabilization Pond), and 612 (Monitoring Well ESS MWPA-118B, Near Intake Canal and Plant Stack) were removed, and Locations 412 (Monitoring Well, ESS-18B, west side of retired SDSP), 420 (Monitoring Well ESS-22B, south side of retired SDSP), and 1020 (Monitoring Well U1CSTREM-05B, east side of protected area near intake structure) were added.

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 1/1/2023 - 12/31/2023

	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)	23	23	A	Type A GDP	N/A	1.03E+2	2.72E+2
	b. Spent Resins, Filters, Sludges (dewatered	1	1	B	Type B	N/A	2.55	3.25E+1
	c. Solidified (cement) Acids, Oily Water	0	-	-	-	-	-	-
2.	**Dry Solid Waste**							
	a. Dry Active Waste (compacted & non-compacted)	40	64	A	Type A GDP	N/A	1.71E+3	6.83
	b. Irradiated Components	2	2	C	Type B	N/A	3.16	2.24E+4
	c. Other Waste (oil/sludge)	0	-	-		-	-	-
3.	**Total Solid Waste**	**64**		**-**	**-**	**-**	**1.82E+3**	**2.27E+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 1/1/2023 - 12/31/2023

Type of Waste Shipped	Radionuclide	% Abundance
1. Waste from Liquid Systems		
a. Spent Resins, Filters, Sludges (dewatered)	Fe-55	23.51
	Mn-54	4.69
	Co-60	51.03
	Ni-63	8.37
	Zn-65	4.67
	Cs-137	4.16
b. Solidified (cement) Acids, Oily Water	N/A	N/A
2. Dry Solid Waste		
a. Dry Active Waste (compacted & non-compacted)	Fe-55	37.56
	Mn-54	6.86
	Co-60	46.18
	Ni-63	1.9
	Cr-51	2.65
	Zn-65	1.42
	Co-58	1.63
b. Irradiated Components	Fe-55	66.61
	Co-60	22.24
	Ni-63	4.32
	Mn-54	2.96
	Ta-182	3.05
c. Other Waste	N/A	N/A

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) for each respective height (lower-level and upper level).

Attachment 4
Meteorological Data

Brunswick Nuclear Plant
Period 1/1/2023 - 12/31/2023

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	0	0
	3.51-7.50	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1
	7.51-12.50	1	0	2	0	0	0	0	0	0	7	8	0	0	1	1	2
	12.51-18.50	0	0	0	0	0	0	0	0	0	6	11	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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	3.51-7.50	3	4	2	0	0	4	6	0	0	0	0	0	3	1	5	1
	7.51-12.50	3	2	15	8	4	6	10	3	16	51	59	3	2	10	5	11
	12.51-18.50	0	1	5	5	1	0	0	0	3	17	16	2	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
C	0.75-3.50	1	1	0	0	0	0	0	0	0	0	0	0	0	0	2	3
	3.51-7.50	25	25	21	16	10	37	31	16	3	4	16	6	18	11	14	30
	7.51-12.50	11	11	67	42	25	20	6	23	43	75	89	14	5	5	7	14
	12.51-18.50	0	2	6	7	1	0	0	0	7	14	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
D	0.75-3.50	28	21	8	8	12	12	13	6	3	3	18	16	24	19	35	32
	3.51-7.50	123	233	114	79	49	68	73	59	82	130	251	112	75	64	95	84
	7.51-12.50	27	181	183	98	58	8	11	33	106	155	293	27	16	21	13	36
	12.51-18.50	4	21	31	17	3	2	1	8	17	22	29	0	0	0	6	14
	18.51-25.00	0	0	2	0	0	0	0	0	0	2	2	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 1/1/2023 - 12/31/2023

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	77	39	31	23	22	24	33	31	24	38	76	91	63	51	67	95
	3.51-7.50	101	63	62	45	29	30	16	44	45	69	241	61	35	47	33	55
	7.51-12.50	2	1	7	5	6	13	1	5	25	33	31	4	4	3	0	0
	12.51-18.50	0	0	0	1	3	0	3	0	5	5	0	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	80	19	11	3	3	8	2	6	8	8	32	45	57	59	52	120
	3.51-7.50	15	2	4	2	2	1	1	2	2	4	16	9	1	1	7	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	49	4	2	0	1	3	1	4	3	2	5	17	28	50	68	145
	3.51-7.50	5	0	0	0	1	0	0	0	0	0	4	3	1	3	0	2
	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 4
Meteorological Data

Brunswick Nuclear Plant
Period 1/1/2023 - 12/31/2023

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	0
	3.51-7.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	7.51-12.50	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
	12.51-18.50	1	0	1	0	0	0	0	0	0	2	9	1	0	0	1	2
	18.51-25.00	0	0	0	0	0	0	0	0	0	0	6	1	0	1	0	1
	25+	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0
B	0.75-3.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	3.51-7.50	0	1	0	0	0	2	2	0	0	0	0	0	0	0	0	1
	7.51-12.50	2	5	4	0	1	7	7	3	2	9	8	0	1	0	0	4
	12.51-18.50	5	1	8	10	2	0	0	0	9	30	39	3	3	7	3	11
	18.51-25.00	0	0	3	4	0	0	0	0	2	6	8	5	1	5	2	0
	25+	0	0	0	0	0	0	0	0	0	0	6	2	0	0	0	0
C	0.75-3.50	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1
	3.51-7.50	9	6	9	5	5	13	11	5	1	2	0	0	1	2	3	8
	7.51-12.50	21	19	23	20	23	31	22	19	23	36	38	10	7	11	9	11
	12.51-18.50	13	8	40	30	6	0	0	2	12	37	48	12	11	6	6	19
	18.51-25.00	1	2	5	12	0	0	1	0	1	9	14	3	0	3	4	6
	25+	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0
D	0.75-3.50	4	2	2	3	6	4	6	2	5	2	2	3	3	6	6	6
	3.51-7.50	20	23	22	25	29	29	28	17	25	15	15	26	24	19	20	22
	7.51-12.50	56	75	67	69	50	26	26	37	72	99	80	57	32	24	28	58
	12.51-18.50	75	168	122	79	28	11	5	13	47	128	204	78	56	29	45	40
	18.51-25.00	10	57	81	42	7	1	8	7	16	32	94	53	22	13	11	27
	25+	8	20	32	12	8	2	2	2	10	12	30	11	0	5	5	18

Attachment 4
Meteorological Data

Brunswick Nuclear Plant
Period 1/1/2023 - 12/31/2023

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	2	2	3	3	1	1	1	4	1	0	1	3	1	0	1	1
	3.51-7.50	7	1	10	9	16	11	10	14	13	9	12	5	4	11	10	5
	7.51-12.50	31	33	29	15	20	7	19	42	31	43	74	25	25	16	17	20
	12.51-18.50	76	104	74	58	18	20	14	25	29	59	141	89	56	29	32	31
	18.51-25.00	15	12	3	9	9	26	7	6	26	20	52	68	37	20	13	5
	25+	0	0	0	1	4	5	4	3	3	13	1	1	1	0	0	0
F	0.75-3.50	0	0	1	0	2	1	5	1	4	3	1	2	3	1	2	0
	3.51-7.50	4	5	3	3	4	4	5	6	18	4	5	6	8	3	6	4
	7.51-12.50	11	11	18	13	9	1	7	10	19	15	21	13	19	16	9	9
	12.51-18.50	26	37	52	20	4	5	1	1	5	12	27	34	20	13	11	19
	18.51-25.00	19	18	10	3	1	0	0	0	0	1	13	21	24	6	7	10
	25+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G	0.75-3.50	4	1	2	1	2	0	0	3	2	1	1	4	1	2	0	0
	3.51-7.50	1	6	10	5	12	8	8	2	11	2	8	8	6	9	11	5
	7.51-12.50	9	14	18	30	11	9	4	11	9	7	9	13	16	5	12	7
	12.51-18.50	21	27	51	26	1	6	1	1	1	11	18	13	21	9	5	3
	18.51-25.00	13	26	17	2	0	0	0	0	1	5	0	13	12	5	4	5
	25+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	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 1/1/2023 - 12/31/2023

Brunswick Steam Electric Plant did not experience any unplanned offsite gaseous or liquid effluent releases in 2023.

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 1/1/2023 - 12/31/2023

Gaseous Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Noble Gases						
1. Maximum Beta Air	mRAD	1.50E-02	1.06E-02	9.83E-03	9.53E-03	4.50E-02
(a) Limit	mRAD	2.00E+01	2.00E+01	2.00E+01	2.00E+01	4.00E+01
(b) % of Limit		7.50E-02	5.30E-02	4.91E-02	4.77E-02	1.12E-01
2. Maximum Gamma Air	mRAD	2.40E-02	2.01E-02	1.97E-02	1.87E-02	8.26E-02
(a) Limit	mRAD	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
(b) % of Limit		2.40E-01	2.01E-01	1.97E-01	1.87E-01	4.13E-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	3.81E-01	3.16E-01	2.61E-01	2.42E-01	1.20E+00
(a) Limit	mREM	1.50E+01	1.50E+01	1.50E+01	1.50E+01	3.00E+01
(b) % of Limit		2.54E+00	2.11E+00	1.74E+00	1.61E+00	4.00E+00

Receptor Location ***4.75*** miles NE
Critical Age ***Infant***
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 1/1/2023 - 12/31/2023

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Batch & Continuous Mode						
1. Maximum Organ Dose	mREM	1.27E-03	1.03E-03	1.52E-03	8.54E-04	4.68E-03
(a) Limit	mREM	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
(b) % of Limit		1.27E-02	1.03E-02	1.52E-02	8.54E-03	2.34E-02
2. Maximum Total Body Dose	mREM	4.10E-05	5.32E-05	8.98E-05	4.80E-05	2.32E-04
(a) Limit	mREM	3.00E+00	3.00E+00	3.00E+00	3.00E+00	6.00E+00
(b) % of Limit		1.37E-03	1.77E-03	2.99E-03	1.60E-03	3.87E-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 1/1/2023 - 12/31/2023

40 CFR Part 190 Uranium Fuel Cycle Dose Calculation Results

In accordance with the requirements of 40 CFR Part 190, the annual dose commitment to any member of the general public shall be calculated to assure that doses are limited to 25 millirems to the total body or any organ with the exception of the thyroid which is limited to 75 millirems. The fuel cycle dose assessment for 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 DHF, RSDSP, 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. RSDSP/DHF Evap. H-3 Dose	
1. Location	4.75 mi. NE	1. Location	0.30 mi. NW/N
2. Critical Age	INFANT	2. Critical Age	TEEN
3. Critical Organ	THYROID	3. Critical Organ	N/A
4. Organ Dose (mREM)	1.20E+00	4. Organ Dose (mREM)	0.00E+00
5. Total Body Dose (mREM)	3.35E-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)	4.68E-03	4. Organ Dose (mREM)	7.52E-05
5. Total Body Dose (mREM)	2.32E-04	5. Total Body Dose (mREM)	7.52E-05
C. Carbon-14 Dose		F. Nancy's Creek Marsh H-3 Dose	
1. Location	1.5 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)	2.45E+00	4. Organ Dose (mREM)	5.04E-05
5. Total Body Dose (mREM)	4.91E-01	5. Total Body Dose (mREM)	5.04E-05

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

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2023 - 12/31/2023

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 2.45E+00 mrem/yr based on 2.23E+01 Curies released in 2023 (Ref. Attachment 2, Supplemental Information, of this report).

Dose contributions from evaporation of the Drainage Holding Facility (DHF) and the Retired Storm Drain Stabilization Pond (RSDSP) have been determined from ODCM 3.3.2, I-131, I-133, Particulates, and Tritium, equation 3.3-19. The maximum dose rate to the nearest real individual from evaporation of tritium in the DHF/RSDSP is calculated to be 0.00E+00 mrem/yr based on 0.00E+00 Curies released in 2023 (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 3.3-19. The maximum dose rate to the nearest real individual from evaporation of tritium in the SDSF is conservatively calculated to be less than 7.52E-05 mrem/yr based on 1.17E-01 Curies released in 2023 (Ref. Attachment 2, Supplemental Information, of this report).

Dose contributions from marsh releases to Nancy's Creek from ODCM 2.1.7, 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 5.04E-05 mrem/yr based on 4.15E-03 Curies released in 2023 (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 19.0 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 1/1/2023 - 12/31/2023

The Brunswick Steam Electric Plant groundwater sampling and analysis program is a significant surveillance program. Wells are installed around the Retired Storm Drain Stabilization Pond (RSDSP), 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 RSDSP.

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. 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. Seven (7) of these wells are currently 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 2023.

No voluntary reports made in accordance with NEI Ground Water Protection Initiative in 2023.Results from sampling during 2023 are shown in the table below.

Key to below table

-	-	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.

Attachment 7
Information to Support the NEI Ground Water Protection Initiative

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2023 - 12/31/2023

Brunswick Shallow Wells for Plant Site						
Well Name	**Number of Samples in 2023**	**Number of Positive H-3 Samples in 2023**	**Average H-3 Activity (pCi/L)**	**Minimum H-3 Activity (pCi/L)**	**Maximum H-3 Activity (pCi/L)**	**Depth of Well (ft)**
ESS-2C	2	2	4.43E+02	3.98E+02	4.87E+02	27
ESS-3C	2	0	<LLD	<LLD	<LLD	14
ESS-12C	1	0	<LLD	<LLD	<LLD	15
ESS-13C	2	0	<LLD	<LLD	<LLD	25
ESS-16	1	1	4.93E+02	4.93E+02	4.93E+02	27
ESS-17C	2	2	5.70E+03	5.35E+03	6.04E+03	26
ESS-18C	2	2	2.88E+03	9.54E+02	4.80E+03	20
ESS-19C	2	2	5.10E+04	7.15E+04	3.06E+04	20
ESS-20C	4	4	1.26E+03	8.87E+02	1.69E+03	20
ESS-21C	1	0	<LLD	<LLD	<LLD	20
ESS-22C	1	1	1.74E+03	1.74E+03	1.74E+03	20
ESS-23C	3	3	3.35E+04	2.91E+04	4.03E+04	23
ESS-24C	4	4	2.95E+03	2.43E+03	3.65E+03	18
ESS-25C	1	0	<LLD	<LLD	<LLD	22
ESS-26C	2	2	2.72E+03	2.14E+03	3.30E+03	15
ESS-27C	2	2	5.31E+04	5.15E+04	5.46E+04	16
ESS-28C	1	0	<LLD	<LLD	<LLD	23
ESS-29C	0	-	-	-	-	28
ESS-30C	1	1	7.19E+02	7.19E+02	7.19E+02	15
ESS-31C	1	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	0	-	-	-	-	24
ESS-55C	0	-	-	-	-	38
ESS-56C	0	-	-	-	-	32
ESS-58C	0	-	-	-	-	18
ESS-59C	0	-	-	-	-	18
ESS-60C	0	-	-	-	-	19

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2023 - 12/31/2023

Brunswick Shallow Wells for Plant Site						
Well Name	**Number of Samples in 2023**	**Number of Positive H-3 Samples in 2023**	**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-68C	1	0	<LLD	<LLD	<LLD	19
ESS-69C	1	0	<LLD	<LLD	<LLD	30
ESS-70C	1	0	<LLD	<LLD	<LLD	18
ESS-71C	1	0	<LLD	<LLD	<LLD	19
ESS-72C	1	0	<LLD	<LLD	<LLD	18
ESS-73C	1	0	<LLD	<LLD	<LLD	15
ESS-74C	1	0	<LLD	<LLD	<LLD	25
ESS-201C	2	2	6.62E+02	5.88E+02	7.36E+02	19
ESS-202C	4	4	1.05E+04	4.76E+03	1.54E+04	19
ESS-203C	2	2	5.86E+02	5.34E+02	6.37E+02	19
ESS-STAB	12	12	5.12E+04	1.07E+03	6.35E+04	31
ESS-NC-4A	12	12	1.90E+04	1.53E+04	2.15E+04	17
MW-3	0	-	-	-	-	26
MWPA-100C	1	0	<LLD	<LLD	<LLD	30
MWPA-101C	2	0	<LLD	<LLD	<LLD	29
MWPA-102C	1	1	3.09E+02	3.09E+02	3.09E+02	30
MWPA-103C	1	0	<LLD	<LLD	<LLD	30
MWPA-104C	1	1	6.73E+02	6.73E+02	6.73E+02	29
MWPA-105C	1	0	<LLD	<LLD	<LLD	30
MWPA-106C	1	1	2.44E+02	2.44E+02	2.44E+02	29
MWPA-107C	4	4	2.81E+03	2.44E+03	3.14E+03	29
MWPA-108C	2	1	2.42E+02	2.42E+02	2.42E+02	29
MWPA-109C	4	4	8.58E+02	3.72E+02	1.20E+03	29
MWPA-110C	2	2	6.39E+02	4.94E+02	7.84E+02	29
MWPA-113C	4	4	1.63E+03	1.13E+03	1.96E+03	25
MWPA-114C	4	4	9.67E+02	8.08E+02	1.08E+03	30
MWPA-115C	2	2	2.07E+03	1.95E+03	2.19E+03	34
MWPA-117C	2	2	5.62E+02	5.18E+02	6.05E+02	30
MWPA-118C	1	1	3.85E+02	3.85E+02	3.85E+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	0	-	-	-	-	40

Attachment 7
Information to Support the NEI Ground Water Protection Initiative

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2023 - 12/31/2023

Brunswick Shallow Wells for Plant Site						
Well Name	**Number of Samples in 2023**	**Number of Positive H-3 Samples in 2023**	**Average H-3 Activity (pCi/L)**	**Minimum H-3 Activity (pCi/L)**	**Maximum H-3 Activity (pCi/L)**	**Depth of Well (ft)**
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-35C	1	0	<LLD	<LLD	<LLD	20
ESS-36C	1	0	<LLD	<LLD	<LLD	22
SME-01C	3	0	<LLD	<LLD	<LLD	36

Attachment 7
Information to Support the NEI Ground Water Protection Initiative

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2023 - 12/31/2023

Brunswick Intermediate Wells for Plant Site						
Well Name	Number of Samples in 2023	Number of Positive H-3 Samples in 2023	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	0	<LLD	<LLD	<LLD	52
ESS-18B	4	4	1.75E+03	1.71E+03	1.80E+03	63
ESS-19B	4	4	5.72E+03	4.92E+03	6.50E+03	42
ESS-20B	0	-	-	-	-	43
ESS-22B	4	4	4.26E+03	4.03E+03	4.40E+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	0	-	-	-	-	51
ESS-53B	0	-	-	-	-	76
MWPA-104B	1	1	1.52E+03	1.52E+03	1.52E+03	59
MWPA-107B	2	2	2.44E+03	2.35E+03	2.53E+03	60
ESS-401-BCH	1	0	<LLD	<LLD	<LLD	85
GWSP-2B	1	1	6.42E+02	6.42E+02	6.42E+02	65
GWSP-4B	1	0	<LLD	<LLD	<LLD	65
SME-01BCH	3	0	<LLD	<LLD	<LLD	100
SME-02B	3	0	<LLD	<LLD	<LLD	66
SME-02BCH	3	0	<LLD	<LLD	<LLD	107
SME-03B	3	0	<LLD	<LLD	<LLD	58
SME-04B	3	0	<LLD	<LLD	<LLD	50

Attachment 7
Information to Support the NEI Ground Water Protection Initiative

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2023 - 12/31/2023

Brunswick Deep Wells for Plant Site						
Well Name	**Number of Samples in 2023**	**Number of Positive H-3 Samples in 2023**	**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	3	0	<LLD	<LLD	<LLD	175
SME-02A	3	0	<LLD	<LLD	<LLD	157
SME-04A	3	0	<LLD	<LLD	<LLD	155
SME-05A	3	0	<LLD	<LLD	<LLD	166

Attachment 7
Information to Support the NEI Ground Water Protection Initiative

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2023 - 12/31/2023

Brunswick Unit 1 CST Groundwater Wells						
Well Name	**Number of Samples in 2023**	**Number of Positive H-3 Samples in 2023**	**Average H-3 Activity (pCi/L)**	**Minimum H-3 Activity (pCi/L)**	**Maximum H-3 Activity (pCi/L)**	**Depth of Well (ft)**
GWM-01	53	53	1.05E+03	3.77E+02	1.68E+03	61
GWM-02	0	-	-	-	-	45
GMW-06	0	-	-	-	-	45
GWM-08	0	-	-	-	-	45
GWM-09	0	-	-	-	-	46
GWM-10	0	-	-	-	-	45
GWM-11	0	-	-	-	-	45
GWM-12	0	-	-	-	-	33
GMW-13	53	53	8.33E+03	4.00E+03	1.35E+04	44
GWM-14	53	52	3.90E+03	<LLD	5.76E+03	44
GMW-15	52	37	6.13E+02	<LLD	4.37E+03	59
GWM-16	52	52	2.32E+04	6.55E+03	3.60E+04	40
GMW-17	53	53	8.91E+03	3.66E+03	1.31E+04	68
GWM-18	53	53	2.00e+04	4.69e+03	3.88e+04	29
GMW-19	53	53	5.77E+03	3.35E+03	9.17E+03	40
GMW-20	52	52	3.94E+03	1.00E+03	1.26E+04	45
GMW-21	0	-	-	-	-	45
GWM-22	0	-	-	-	-	29
MW-1	4	2	5.84E+02	<LLD	6.13E+02	24
MW-1B	4	1	4.01E+02	<LLD	4.01E+02	45
U1CSTREM-02B	12	1	3.47E+02	<LLD	3.47E+02	68
U1CSTREM-05B	4	0	<LLD	<LLD	<LLD	65
U1CSTREM-07BCH	12	9	4.88E+02	<LLD	7.69E+02	85
U1CSTREM-09B	12	8	9.73E+02	<LLD	1.31E+03	68
U1CSTREM-09BCH	12	3	4.20E+02	<LLD	4.64E+02	85
U1CSTREM-09C	12	12	3.47E+03	2.33E+03	4.11E+03	45
U1CSTREM-10C	4	1	4.50E+02	<LLD	4.50E+02	45
U1CSTREM-11C	4	2	3.82E+02	<LLD	3.87e+02	40
U1CSTREM-12C	12	9	1.68e+03	<LLD	4.59E+03	34
U1CSTREM-21B	12	6	4.26e+02	<LLD	5.41e+02	69
U1CSTREM-21C	12	12	4.42E+03	3.77E+03	5.17E+03	45
U1CSTREM-22B	4	2	3.92E+02	<LLD	4.13E+02	69
U1CSTREM-27B	4	1	3.36E+02	<LLD	3.36E+02	68
U1CSTREM-27C	12	11	7.93e+02	<LLD	1.07E+03	45
U1CSTREM-28C	12	5	4.16E+02	<LLD	4.89E+02	45
U1CSTREM-32C	4	2	4.73E+02	<LLD	5.51E+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 1/1/2023 - 12/31/2023

Brunswick Steam Electric Plant did not experience any instances of inoperable equipment relevant to effluent monitoring in excess of ODCM Specification 7.3.0 limits during 2023.

Brunswick Steam Electric Plant experienced no Liquid Hold-Up Tank exceeding the 10 Curie limit of ODCMS 7.3.6 during 2023.

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 1/1/2023 - 12/31/2023

ODCM Revision 40

The Brunswick Steam Electric Plant ODCM was revised in 2023. The ODCM was revised due to the retirement of the Storm Drain Stabilization Pond and the placing of the Drainage Holding Facility into service. The new Drainage Holding Facility and the existing Storm Drain Stabilization Facility are continuous releases when in release. The following is a list of changes:

- Updated list of effected pages, pages with changes to the ODCM can be found on pages marked rev. 40.
- Updated 2-1 index to reflect pages changed from revision.
- Updated 2-2 list of tables, Table 2.2-1, A_{it} Values For the Adult
- Updated 2.1.2 continuous release section to include the drainage holding facility and the storm drain stabilization facility as continuous releases.
- Updated list of release points on page 2-9 and 2-10 and removed storm drain stabilization pond and replaced it with the new drainage holding facility.
- Page 2-11 updated to reflect Drainage Holding Facility.
- Values in table 2.2-1 updated to include more radionuclide values.
- Flow values for Unit 2 Turbine and Stack updated on page 3-6 and 3-8.
- Table 3.2-2 updated to reflect newest distance values from the 2022 Land Use Census
- Page 3-39 updated to remove Storm Drain Stabilization Pond and include Drainage Holding Facility.
- Corrected equation numbering error on page 3-41 and changed references on page 3-42.
- Updated Radiological Environmental Program section 4.0 (page 4-3 to 4-16). This reflects current sampling program and maps from 2022 Land Use Census.
- Updated requirements in section 7.3.1 to reflect the removal of the V-notch weir that was in the retired Stabilization Storm Drain Facility with a partial flume that is at the new Drainage Holding Facility (pages 7.3.1-3, 7.3.1-4).
- Updated table 7.3.1-1 to reflect requirements of the new Drainage Holding Facility (page 7.3.1-7).
- Page 7.3.2-6, 7.3.2-11, 7.3.2-12 updated for better reading/clarification on requirement J.
- Table 7.3.3-1 updated to reflect sampling requirements of the Stabilization Storm Drain Facility and the Drainage Holding Facility for continuous release.
- Table 7.3.15-1 updated for clarification on sampling ingestion milk control sample.
- Table 7.3.15-2 and 7.3.15-3 edited for easier reading with no drinking water pathway.
- P. 7.3.16-3 Updated land use census compensatory action to allow sampling location removal to be optional.
- Values in table B-8 updated.
- Appendix E updated to reflect the new samplers at the Drainage Holding Facility and to remove the retired SDSP instrumentation.
- Figure F-1 updated to include Avantech rad waste system.

BRUNSWICK STEAM ELECTRIC PLANT

OFF-SITE DOSE CALCULATION MANUAL

(ODCM)

REVISION 40

DOCKET NOS. 50-324

50-325

Effective Date: 07/12/2023

Prepared By (Print): Matthew Barker		6-29-23
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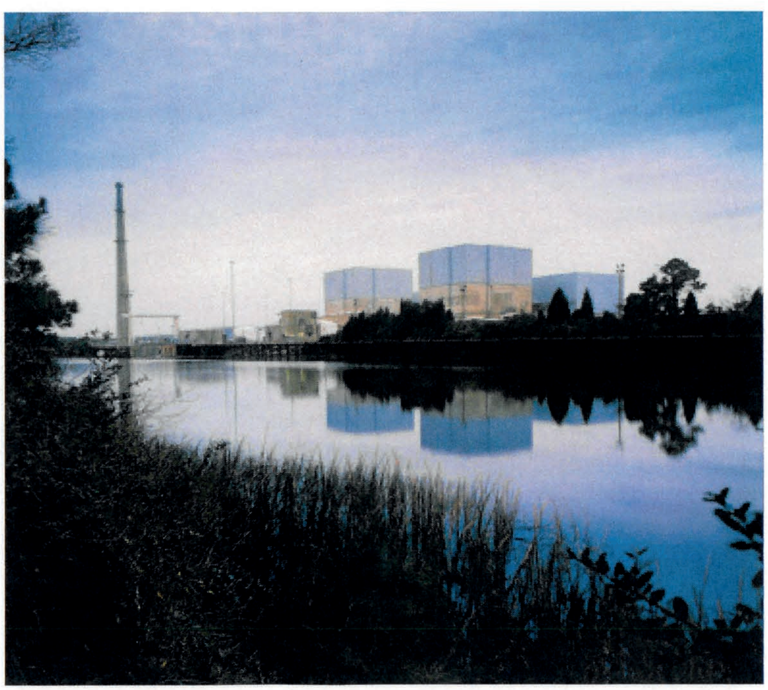
BNP Plant Manager	Signature	Date



LIST OF EFFECTIVE PAGES

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INTRODUCTION

The Off-Site Dose Calculation Manual (ODCM) provides the information and methodologies to be used by the Brunswick Steam Electric Plant (BSEP) to show compliance with 10CFR20, 10CFR50.36a, Appendix I of 10CFR50, 10CFR72, 40CFR190, and to assure compliance with ODCM Specifications (ODCMS).

The ODCM is based on "Radiological Effluent Technical Specifications for BWR's" (NUREG 0473, Draft), "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants" (NUREG 0133), and guidance from the United Stated Nuclear Regulatory Commission (NRC). Specific plant procedures for implementation of this manual are provided elsewhere. These procedures will be utilized to assure compliance with ODCMS and Test Requirements (TRs) provided in the Radioactive Effluents Control Program.

The ODCM has been prepared as generically as possible to minimize the need for future revisions. Any changes to the ODCM will be reviewed and approved as indicated in the Administrative Control section of the BSEP Technical Specifications.

The Radioactive Effluent Release Report prepared after January 1 of each year will include an assessment of the annual radiation doses to members of the public from radioactive liquid and gaseous effluents using the methodology in the ODCM for the report period. This report will be inclusive of the requirements outlined in the BSEP Technical Specifications and ODCM Specifications.

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2.0 LIQUID EFFLUENT

2.1 COMPLIANCE WITH 10CFR PART 20 (LIQUIDS)

2.1.1 Batch Releases

A batch release is the discharge of liquid waste of a discrete volume. Batch releases from the BSEP liquid radwaste system may occur from the waste sample tank, floor drain sample tank, detergent drain tank and the salt water tanks. The maximum release rate possible due to pump capacity is 200 GPM from all release tanks except the detergent drain tank, which has a maximum release rate of 50 GPM. All of the above liquid radwaste discharges go to the circulating water discharge canal. Circulating water leakage collected in the circulating water pits and low purity, low activity liquids are transferred to the salt water release tanks where they are recirculated, sampled, and released to the environment. For any batch release, if the radwaste monitor effluent is inoperable, then two independent samples are analyzed and must be within 15% of each other before the release is approved. The two samples may differ by more than 15% upon approval of the E&C Supervisor or equivalent. The maximum release rate is determined so that 10CFR Part 20 limits are not exceeded after dilution in the discharge canal.

The sampling and analysis frequency and the type of analysis required by the BSEP ODCM Specifications is given in Table 7.3.3-1. All applicable instrument numbers may be found in Appendix E.

1. Prerelease

The radioactive content of each batch release will be determined prior to release in accordance with Table 7.3.3-1 of the BSEP ODCM Specifications. Compliance with 10CFR Part 20 will be shown in the following manner:

a. Minimum acceptable dilution factor:

$$DF_O = \Sigma_i \left(\frac{C_i}{EC_i} \right) \qquad \text{(Eq. 2.1-1)}$$

Where:

DF_o = Minimum acceptable dilution factor determined from analysis of liquid effluent to be released.

C_i = Concentration of radionuclide i in the batch to be released, μCi/ml

EC_i = Effluent concentration limit of radionuclide i from Appendix B, Table 2, Column 2 of 10CFR20, μCi/ml

DF_B = (10) (DF_o) (Eq. 2.1-2)

Where:

DF_B = Conservative dilution factor used by BSEP to calculate maximum release rate prior to release in order to assure compliance with 10CFR Part 20

10 = A factor of 10 less than 10CFR Part 20 limits as specified in Appendix B, Table 2, Column 2. This factor represents one layer of conservatism for all releases at BSEP

DF_o = Minimum acceptable dilution factor per Equation 2.1-1

b. Maximum release rate:

$$MRR = \frac{(n-1)(RPF_{CW}) + (p-1)(RPF_{SW})}{2(DF_B)} \quad \text{(Eq. 2.1-3)}$$

Where:

MRR = Maximum release rate of the batch to be released, GPM

n = Number of operating circulating water pumps

p = Number of operating service water pumps

RPF_{CW} = Minimum rated pump flow of each circulating water pump

= 1.357 E5 GPM

RPF_{SW} = Rated pump flow of each service water pump

= 8 E3 GPM

2 = Engineering factor to prevent spurious alarms caused by deviations in the mixtures of radionuclides which affect the monitor response

DF_B = Conservative dilution factor used by BSEP to calculate maximum release rate prior to release in order to assure compliance with 10CFR Part 20

c. Monitor Alarm/Trip Setpoint:

Monitor alarm/trip setpoints are determined to ensure that the concentration of radionuclides in the liquid effluent released from the site to unrestricted areas does not exceed the limits specified in 10CFR Part 20, Appendix B, Table 2, Column 2, for radionuclides other than dissolved or entrained noble gases. An effluent concentration (EC) of 2 E-4 μCi/ml has been established for noble gases dissolved or entrained in liquid effluents, based on the assumption that Xenon-135 is the controlling radionuclide. (NUREG 0133)

$$SP = \frac{C_T(E_m)[(n-1)(RPF_{CW}) + (p-1)(RPF_{SW})]}{RR} + Bkg \qquad \text{(Eq. 2.1-4)}$$

Where:

SP = Monitor alarm/trip setpoint, cps

E_m = The monitor efficiency for the mixture of radionuclides in the liquid effluent prior to dilution, cps/μCi/ml

C_T = 3 E-7 μCi/ml; engineering factor to ensure that the final concentration for the mixture of radionuclides will be less than 10CFR Part 20 limits at unrestricted areas

n = Number of operating circulating water pumps

p = Number of operating service water pumps

RPF_{CW} = 1.357 E5 GPM

RPF_{SW} = 8 E3 GPM

RR = 200 GPM; maximum design release rate

Bkg = Background count rate due to internal contamination and the radiation levels in the area in which the monitor is installed when the detector sample chamber is filled with an uncontaminated fluid, cps

$$SP = \frac{3\,E-7(E_m)[(n-1)(1.357\,E5) + (p-1)(8.0\,E3)]}{200} + Bkg \qquad \text{(Eq. 2.1-5)}$$

d. Calculated concentration at unrestricted area:

$$Conc_i = \frac{(C_i)(MRR)}{(n-1)(RPF_{CW}) + (p-1)(RPF_{sw})} \quad \text{(Eq. 2.1-6)}$$

Where:

$Conc_i$ = Calculated concentration of radionuclide i at the unrestricted area, μCi/ml

C_i = Concentration of radionuclide i in the batch to be released, μCi/ml

MRR = Maximum release rate of the batch to be released (see Equation 2.1-3), GPM

n = Number of operating circulating water pumps

p = Number of operating service water pumps

RPF_{CW} = 1.357 E5 GPM

RPF_{SW} = 8 E3 GPM

e. 10CFR Part 20 Prerelease Compliance Check:

Before initiating the batch release, one final check for compliance with 10CFR Part 20 will be performed. If the calculated diluted Effluent Concentration Limit (ECL) fraction at the unrestricted area is less than or equal to 10, then 10CFR Part 20 limits have been met. The following equation must be true:

$$\Sigma_i(Conc_i/Ec_i) \leq 10 \quad \text{(Eq. 2.1-7)}$$

Where:

$Conc_i$ = Concentration of radionuclide i at the unrestricted area per Equation 2.1-6, μCi/ml

EC_i = Effluent concentration limit of radionuclide i from Appendix B, Table 2, Column 2 of 10CFR20, μCi/ml.

2. Postrelease

The actual concentration of each radionuclide following release from a batch tank will be calculated to show final compliance with 10CFR Part 20 as follows:

a. Actual concentration at unrestricted area:

$$Conc_{ik} = \frac{(C_i)(V_{eff})}{V_{dil}} \qquad \text{(Eq. 2.1-8)}$$

Where:

$Conc_{ik}$ = The actual concentration of radionuclide i at the unrestricted area during release k, µCi/ml

C_i = Concentration of radionuclide i in the batch released, µCi/ml

V_{eff} = Actual volume of liquid effluent released, gal

V_{dil} = Actual volume of dilution water during release k, gal

= $[n\,(RPF_{CW}) + p\,(RPF_{SW})]\,(t_k)$

Where:

n = Number of operating circulating water pumps

p = Number of operating service water pumps

RPF_{CW} = 1.357 E5 GPM

RPF_{SW} = 8 E3 GPM

t_k = Total release time, min

b. 10CFR Part 20 Postrelease Compliance Check:

To show final compliance with 10CFR Part 20, the following relationship must hold:

$$\Sigma i\ (Conc_{ik}/EC_i) \leq 10 \qquad \text{(Eq. 2.1-9)}$$

Where:

$Conc_{ik}$ = The actual concentration of radionuclide i during release k (from Equation 2.1-8), µCi/ml

EC_i = Annual average effluent concentration limit of radionuclide i from Appendix B, Table 2, Column 2 of 10CFR20, µCi/ml.

2.1.2 Continuous Releases

A continuous release is the discharge of liquid wastes of a nondiscrete volume; e.g., from a volume of a system that has an input flow during the continuous release. The Groundwater Extraction System, Drainage Holdup Facility, and Storm Drain Stabilization Facility are considered a continuous release when releasing effluent. The potential for a continuous release exists in the service water system. Weekly tests are performed on the service water system during system operation as specified in Table 7.3.3-1 of the BSEP ODCM Specifications. For continuous releases, the concentration of various radionuclides in the unrestricted area would be calculated using Equation 2.1-8 with C_i being the concentration of radionuclide i in the continuous release stream. To show compliance with 10CFR Part 20, the sum of the concentration of radionuclide i in the unrestricted area due to both continuous and batch releases divided by that isotope's EC must be less than 10.

1. Service Water Effluent Monitor Setpoint Determination

This procedure determines the monitor alarm setpoints that indicate the abnormal presence of radionuclides in the service water liquid effluents released from the site to unrestricted areas. This procedure is applicable to any service water effluent monitor.

a. Determine the monitor efficiency factor, EF, in $\frac{\mu\text{Ci/ml}}{\text{cps}}$, from the appropriate RST

b. Determine the monitor trigger level setpoint, TLS, in cps

$$TLS = TL/EF + Bkg \quad \text{(Eq. 2.1-10)}$$

Where:

TL = The alarm trigger level (μCi/ml) as per ODCM TR 7.3.3.2

= 5.0×10^{-6} μCi/ml

Bkg = Monitor background, (cps)

2.1.3 Drainage Holding Facility

The Storm Drain Stabilization Pond (SDSP) was retired in 2023 and was backfilled. The Drainage Holdup Facility (DHF) was created within the footprint of the SDSP. The primary function of the DHF is to collect surface water runoff from the retired SDSP. The secondary function of the DHF is to serve as a backup Storm Drain Stabilization Facility (SDSF). Due to its ability to take inputs that would normally go to the SDSF, releases from the DHF will be treated as potentially contaminated. Prior to the start of release, compliance checks similar to those in Section 2.1.1.1 will be performed. Once in release, it will be treated as a continuous release, as the release may continue uninterrupted for extended periods of time. Continuous release calculations will be based off grab sample data and composite sample data. The composite sample is collected in proportion to flow during the release period. Compliance checks will occur similar to 2.1.1.2 once release is established. Analyses will be performed in accordance with Table 7.3.3-1. Dilution flow will be estimated from the minimum number of circulating water and service water pumps possible.

2.1.4 Storm Drain Stabilization Facility Releases

The Storm Drain Stabilization Facility has water inputs from the Strom Drain Collector Basin, French Drain Pump Stations, Groundwater Extraction System, and ISFI are collection basin. Prior to the start of release, compliance checks similar to those in Section 2.1.1.1 will be performed. Once in release, it will be treated as a continuous release, as the release may continue uninterrupted for extended periods of time. This is due to the input flow from the above-mentioned systems. Continuous release calculations will be based off grab sample data and composite sample data. The composite sample is collected in proportion to flow during the release period. Compliance checks will occur similar to 2.1.1.2 once release is established. Analyses will be performed in accordance with Table 7.3.3-1. Dilution flow will be estimated from the minimum number of circulating water and service water pumps possible.

2.1.5 Storm Drain Collection Basin

Storm Drain Collection Basin (SDCB) collects rainwater from site drains. Typically, the SDCB is pumped to the Storm Drain Stabilization Facility or the Drainage Holding Facility. Releasing water directly to the discharge canal through the storm drain basin overflow valves is prohibited by the National Pollutant Discharge Elimination System (NPDES) permit except where unavoidable to prevent loss of life, personnel injury, or severe property damage. Prerelease and post-release compliance checks similar to those of Section 2.1.1 are to be performed for releases from the SDCB. Analyses will be performed on the composite sample after the release is complete in accordance with Table 7.3.3-1. Typical release times are on the order of days.

2.1.6 Groundwater Extraction System Releases

Groundwater Extraction System (GWES) collects groundwater from a sock drain and extraction wells that are strategically placed around the Retired Storm Drain Stabilization Pond. The GWES can output into the SDSF, DHF, or release directly to the intake canal. Typical configuration is output into the SDSF. Prior to the start of release compliance checks similar to those in Section 2.1.1.1 will be performed. Once in release, it will be treated as a continuous release, as the release may continue uninterrupted for extended periods of time. Continuous release calculations will be based off grab sample data and composite sample data. The composite sample is collected in proportion to flow during the release period. Compliance checks will occur similar to 2.1.1.2 once release is established. Analyses will be performed in accordance with Table 7.3.3-1. Dilution flow will be estimated from the minimum number of circulating water and service water pumps possible.

2.1.7 Marsh Releases

Marsh releases from the area around the outside area of the Drainage Holding Facility are an ongoing release. The release from the marsh areas to Nancy's Creek are sampled in accordance with Table 4.0-1. Curies released and associated doses will be determined and included in the Annual Radioactive Effluent Release Report. Doses will be calculated by the following methodology from Regulatory Guide 1.109:

$$R_{apj} = 1100\left(\frac{U_{ap}M_p}{F}\right)\sum_i Q_i B_{ip} D_{aipj}\ \exp^{(-\lambda_i t_p)}$$

Where:

R_{apj} = is total annual dose to organ *j* of individuals of age group a from all of the nuclides i in pathway *p*, in mrem/year;

1100 = is the factor to convert from (Ci/yr)/(ft^3/sec) to pCi/liter;

U_{ap} = is a usage factor that specifies the exposure time or intake rate for an individual of age group *a* associated with pathway *p*, in kg/yr;

M_p = is the mixing ratio (reciprocal of the dilution factor) at the point of exposure (or the point of withdrawal of harvest of aquatic foods), dimensionless;

F = is the flowrate of the liquid effluent in ft^3/sec;

Q_i = is the release rate of nuclide *i*, in Ci/yr;

B_{ip} = is the equilibrium bioaccumulation factor for nuclide *i* in pathway *p*, expressed as the ratio of the concentration in biota (in pCi/kg) to the radionuclide concentration in water (in pCi/liter), in liters/kg;

λ_i = is the radioactive decay constant of nuclide *i*, in hr^{-1};

t_p = is the average transit time required for nuclides to reach the point of exposure. For internal dose, t_p is the total time elapsed between release of the nuclide and ingestion, in hours.

D_{aipj} = is the dose factor, specific to a specific age group a, radionuclide *i*, pathway *p*, and organ *j*, which can be used to calculate the radiation dose from an intake of a radionuclide, in mrem/pCi.

Historically, only tritium has been identified in the marsh areas, therefore only tritium will be routinely used in dose calculations unless other nuclides are identified. Due to tidal fluctuations in the marsh area the annual dose will be determined on two releases per day for the year using average activity for the year.

TABLE 2.1-1

ECs FOR SELECTED RADIONUCLIDES

Radionuclide	**ECi (μCi/ml)**
H-3	1 E-3
Na-24	5 E-5
Cr-51	5 E-4
Mn-54	3 E-5
Co-58	2 E-5
Fe-59	1 E-5
Co-60	3 E-6
Cu-64	2 E-4
Zn-65	5 E-6
Zn-69m	6 E-5
Sr-89	8 E-6
Sr-90	5 E-7
Sr-91	2 E-5
Zr-95	2 E-5
Mo-99	2 E-5
I-131	1 E-6
I-132	1 E-4
I-133	7 E-6
Cs-134	9 E-7
I-134	4 E-4
I-135	3 E-5
Cs-137	1 E-6
La-141	5 E-5
Np-239	2 E-5
Am-241	2 E-8
Noble Gases	2 E-4

2.2 COMPLIANCE WITH 10CFR PART 50 (LIQUIDS)

2.2.1 Cumulation of Doses

ODCM TR 7.3.4.1 requires that the cumulative dose contributions from liquid effluents be determined at least once per 31 days, and a cumulative summation of these total body and any organ doses should be maintained for each calendar quarter. The cumulative dose contributions will consider the dose contributions from the maximum exposed individual's consumption of fish and invertebrates. At BSEP the adult is considered as the maximum exposed individual. The dose or dose commitment limits based on 10CFR Part 50, Appendix I, are defined in ODCM Specification 7.3.4 a and b. The dose contribution for all releases for the quarter will be calculated using the following equation:

$$D_\tau = \sum_k \left[\sum_i \left(A_{i\tau}\ t_k\ C_{ik}\ F_k \right) \right] \qquad \text{(Eq. 2.2-1)}$$

Where:

D_τ = The cumulative dose commitment to the total body or any organ τ, from the liquid effluents releases, mrem

t_k = The length of time of release k over which C_{ik} and F_k are averaged for each liquid release, hours

C_{ik} = The concentration of radionuclide i in the undiluted liquid effluent during release k from any liquid release, μCi/ml

F_k = The near-field average dilution factor for C_{ik} during any liquid effluent release. It is defined as the ratio of the volume of undiluted liquid waste released to the product of the dilution volume from the site discharge to unrestricted receiving water times 1. (1 is the site-specific applicable factor for the mixing effect of the BSEP discharge structure as defined in NUREG 0133.)

$= \dfrac{V_{eff}}{V_{dil}}$ (See Equation 2.1-8).

$A_{i\tau}$ = The ingestion dose commitment factor to the total body or any organ τ for each identified gamma and beta emitter i (as presented in Table 2.2-1). Values are for an adult, mrem-ml per hr-μCi

$= 1.14\ E5\ (5\ BI_i + 21\ BF_i)\ DCF_{i\tau}$

Where:

$$1.14\,E5 = \left(10^6\ \frac{pCi}{\mu Ci}\right)\left(10^3\ \frac{ml}{L}\right)\left(\frac{1yr}{8760\ hr}\right)$$

5 = Maximum adult invertebrate consumption rate from Table E-5 of Regulatory Guide 1.109, Rev. 1, kg/yr

BI_i = Bioaccumulation factor for radionuclide i in invertebrates from Table A-1 of Regulatory Guide 1.109, Rev. 1, pCi/kg per pCi/L

21 = Maximum adult fish consumption rate from Table E-5 of Regulatory Guide 1.109, Rev. 1, kg/yr

BF_i = Bioaccumulation factor for radionuclide i in fish from Table A-1 of Regulatory Guide 1.109, Rev. 1, pCi/kg per pCi/L

$DCF_{i\tau}$ = Dose conversion factor for radionuclide i for adults for a particular organ τ from Table E-11 of Regulatory Guide 1.109, Rev. 1, and BSEP File: B10-10530, Letter to J. W. Davis, "Dose Factors for Hf-181 and Sn-113," May 24, 1988, and NUREG CR4653 for Am-241, mrem/pCi.

2.2.2 Projection of Doses

Dose projections for this section are required at least once per 31 days in ODCM TR 7.3.5.2.

The projection of doses for liquid effluents can be accomplished by using Equation 2.2-2. Where possible, credit for expected operational evolutions (i.e., major planned liquid releases, etc.), can be taken 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.

$$D_{p\tau} = \left(\frac{D_\tau}{T_e}\,x\,31\right) + D_{a\tau} \qquad \text{(Eq. 2.2-2)}$$

Where:

$D_{p\tau}$ = 31 day projected dose by organ τ, in mrem;

D_τ = Current cumulative monthly dose of organ τ up to the end of the release under evaluation, in mrem;

T_e = Time elapsed in month up to the end of the release under evaluation, in days;

31= Number of days dose is projected; and

$D_{a\tau}$ = Additional anticipated dose by organ τ in mrem

TABLE 2.2-1
A_{it} VALUES FOR THE ADULT
(MREM/HR PER MICRO-CI/ML)

Note: Nuclides not listed in this table are assigned a value of zero.

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	2.82E-01	2.82E-01	2.82E-01	2.82E-01	2.82E-01	2.82E-01
C-14	1.45E+04	2.90E+03	2.90E+03	2.90E+03	2.90E+03	2.90E+03	2.90E+03
NA-24	4.57E-01	4.57E-01	4.57E-01	4.57E-01	4.57E-01	4.57E-01	4.57E-01
P-32	1.67E+07	1.04E+06	6.45E+05	0.00E+00	0.00E+00	0.00E+00	1.89E+06
CR-51	0.00E+00	0.00E+00	5.58E+00	3.34E+00	1.23E+00	7.40E+00	1.40E+03
MN-54	0.00E+00	7.06E+03	1.35E+03	0.00E+00	2.10E+03	0.00E+00	2.16E+04
MN-56	0.00E+00	1.78E+02	3.15E+01	0.00E+00	2.26E+02	0.00E+00	5.67E+03
FE-55	5.11E+04	3.53E+04	8.23E+03	0.00E+00	0.00E+00	1.97E+04	2.03E+04
FE-59	8.06E+04	1.90E+05	7.27E+04	0.00E+00	0.00E+00	5.30E+04	6.32E+05
CO-57	0.00E+00	1.42E+02	2.36E+02	0.00E+00	0.00E+00	0.00E+00	3.59E+03
CO-58	0.00E+00	6.03E+02	1.35E+03	0.00E+00	0.00E+00	0.00E+00	1.22E+04
CO-60	0.00E+00	1.73E+03	3.82E+03	0.00E+00	0.00E+00	0.00E+00	3.25E+04
NI-63	4.96E+04	3.44E+03	1.67E+03	0.00E+00	0.00E+00	0.00E+00	7.18E+02
NI-65	2.02E+02	2.62E+01	1.20E+01	0.00E+00	0.00E+00	0.00E+00	6.65E+02
CU-64	0.00E+00	2.14E+02	1.01E+02	0.00E+00	5.40E+02	0.00E+00	1.83E+04
ZN-65	1.61E+05	5.13E+05	2.32E+05	0.00E+00	3.43E+05	0.00E+00	3.23E+05
ZN-69	3.43E+02	6.56E+02	4.56E+01	0.00E+00	4.26E+02	0.00E+00	9.85E+01
BR-83	0.00E+00	0.00E+00	7.25E-02	0.00E+00	0.00E+00	0.00E+00	1.04E-01
BR-84	0.00E+00	0.00E+00	9.39E-02	0.00E+00	0.00E+00	0.00E+00	7.37E-07
BR-85	0.00E+00	0.00E+00	3.86E-03	0.00E+00	0.00E+00	0.00E+00	1.80E-18
RB-86	0.00E+00	6.24E+02	2.91E+02	0.00E+00	0.00E+00	0.00E+00	1.23E+02
RB-88	0.00E+00	1.79E+00	9.49E-01	0.00E+00	0.00E+00	0.00E+00	2.47E-11
RB-89	0.00E+00	1.19E+00	8.34E-01	0.00E+00	0.00E+00	0.00E+00	6.89E-14
SR-89	4.99E+03	0.00E+00	1.43E+02	0.00E+00	0.00E+00	0.00E+00	8.00E+02
SR-90	1.23E+05	0.00E+00	3.01E+04	0.00E+00	0.00E+00	0.00E+00	3.55E+03
SR-91	9.18E+01	0.00E+00	3.71E+00	0.00E+00	0.00E+00	0.00E+00	4.37E+02
SR-92	3.48E+01	0.00E+00	1.51E+00	0.00E+00	0.00E+00	0.00E+00	6.90E+02
Y-90	6.06E+00	0.00E+00	1.63E-01	0.00E+00	0.00E+00	0.00E+00	6.42E+04
Y-91M	5.73E-02	0.00E+00	2.22E-03	0.00E+00	0.00E+00	0.00E+00	1.68E-01
Y-91	8.88E+01	0.00E+00	2.37E+00	0.00E+00	0.00E+00	0.00E+00	4.89E+04
Y-92	5.32E-01	0.00E+00	1.56E-02	0.00E+00	0.00E+00	0.00E+00	9.32E+03
Y-93	1.69E+00	0.00E+00	4.66E-02	0.00E+00	0.00E+00	0.00E+00	5.35E+04

TABLE 2.2-1 (Cont'd)

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
ZR-95	1.59E+01	5.11E+00	3.46E+00	0.00E+00	8.02E+00	0.00E+00	1.62E+04
ZR-97	8.81E-01	1.78E-01	8.13E-02	0.00E+00	2.68E-01	0.00E+00	5.51E+04
NB-95	4.47E+02	2.49E+02	1.34E+02	0.00E+00	2.46E+02	0.00E+00	1.51E+06
MO-99	0.00E+00	1.28E+02	2.43E+01	0.00E+00	2.89E+02	0.00E+00	2.96E+02
TC-99M	1.30E-02	3.66E-02	4.66E-01	0.00E+00	5.56E-01	1.79E-02	2.17E+01
TC-101	1.33E-02	1.92E-02	1.88E-01	0.00E+00	3.46E-01	9.81E-03	5.77E-14
RU-103	1.07E+02	0.00E+00	4.60E+01	0.00E+00	4.07E+02	0.00E+00	1.25E+04
RU-105	8.89E+00	0.00E+00	3.51E+00	0.00E+00	1.15E+02	0.00E+00	5.44E+03
RU-106	1.59E+03	0.00E+00	2.01E+02	0.00E+00	3.06E+03	0.00E+00	1.03E+05
AG-110M	1.56E+03	1.45E+03	8.60E+02	0.00E+00	2.85E+03	0.00E+00	5.91E+05
SN-113	2.18E+03	8.43E+01	2.05E+03	2.96E+01	6.16E+01	0.00E+00	3.80E+04
TE-125M	2.17E+02	7.86E+01	2.91E+01	6.52E+01	8.82E+02	0.00E+00	8.66E+02
TE-127M	5.48E+02	1.96E+02	6.68E+01	1.40E+02	2.23E+03	0.00E+00	1.84E+03
TE-127	8.90E+00	3.20E+00	1.93E+00	6.60E+00	3.63E+01	0.00E+00	7.03E+02
TE-129M	9.31E+02	3.47E+02	1.47E+02	3.20E+02	3.89E+03	0.00E+00	4.69E+03
TE-129	2.54E+00	9.55E-01	6.19E-01	1.95E+00	1.07E+01	0.00E+00	1.92E+00
TE-131M	1.40E+02	6.85E+01	5.71E+01	1.08E+02	6.94E+02	0.00E+00	6.80E+03
TE-131	1.59E+00	6.66E-01	5.03E-01	1.31E+00	6.99E+00	0.00E+00	2.26E-01
TE-132	2.04E+02	1.32E+02	1.24E+02	1.46E+02	1.27E+03	0.00E+00	6.24E+03
I-130	3.96E+01	1.17E+02	4.61E+01	9.91E+03	1.82E+02	0.00E+00	1.01E+02
I-131	2.18E+02	3.12E+02	1.79E+02	1.02E+05	5.35E+02	0.00E+00	8.23E+01
I-132	1.06E+01	2.85E+01	9.96E+00	9.96E+02	4.54E+01	0.00E+00	5.35E+00
I-133	7.45E+01	1.30E+02	3.95E+01	1.90E+04	2.26E+02	0.00E+00	1.16E+02
I-134	5.56E+00	1.51E+01	5.40E+00	2.62E+02	2.40E+01	0.00E+00	1.32E-02
I-135	2.32E+01	6.08E+01	2.24E+01	4.01E+03	9.75E+01	0.00E+00	6.87E+01
CS-134	6.84E+03	1.63E+04	1.33E+04	0.00E+00	5.27E+03	1.75E+03	2.85E+02
CS-136	7.16E+02	2.83E+03	2.04E+03	0.00E+00	1.57E+03	2.16E+02	3.21E+02
CS-137	8.77E+03	1.20E+04	7.85E+03	0.00E+00	4.07E+03	1.35E+03	2.32E+02
CS-138	6.07E+00	1.20E+01	5.94E+00	0.00E+00	8.81E+00	8.70E-01	5.12E-05
BA-139	7.85E+00	5.59E-03	2.30E-01	0.00E+00	5.23E-03	3.17E-03	1.39E+01
BA-140	1.64E+03	2.06E+00	1.08E+02	0.00E+00	7.02E-01	1.18E+00	3.38E+03
BA-141	3.81E+00	2.88E-03	1.29E-01	0.00E+00	2.68E-03	1.63E-03	1.80E-09
BA-142	1.72E+00	1.77E-03	1.08E-01	0.00E+00	1.50E-03	1.00E-03	2.43E-18
LA-140	1.57E+00	7.94E-01	2.10E-01	0.00E+00	0.00E+00	0.00E+00	5.83E+04

TABLE 2.2-1 (Cont'd)

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
LA-142	8.06E-02	3.67E-02	9.13E-03	0.00E+00	0.00E+00	0.00E+00	2.68E+02
CE-141	3.43E+00	2.32E+00	2.63E-01	0.00E+00	1.08E+00	0.00E+00	8.86E+03
CE-143	6.04E-01	4.46E+02	4.94E-02	0.00E+00	1.97E-01	0.00E+00	1.67E+04
CE-144	1.79E+02	7.47E+01	9.59E+00	0.00E+00	4.43E+01	0.00E+00	6.04E+04
PR-143	5.79E+00	2.32E+00	2.87E-01	0.00E+00	1.34E+00	0.00E+00	2.54E+04
PR-144	1.90E-02	7.87E-03	9.64E-04	0.00E+00	4.44E-03	0.00E+00	2.73E-09
ND-147	3.96E+00	4.58E+00	2.74E-01	0.00E+00	2.68E+00	0.00E+00	2.20E+04
HF-181	1.72E+02	9.66E-01	1.94E+01	6.14E-01	8.08E-01	0.00E+00	1.27E+04
W-187	9.16E+00	7.66E+00	2.68E+00	0.00E+00	0.00E+00	0.00E+00	2.51E+03
NP-239	3.53E-02	3.47E-03	1.91E-03	0.00E+00	1.08E-02	0.00E+00	7.11E+02
AM-241	4.76E+05	4.44E+05	3.41E+04	0.00E+00	2.56E+05	0.00E+00	4.67E+04
F-18	6.66E+00	0.00E+00	7.38E-01	0.00E+00	0.00E+00	0.00E+00	1.97E-01
SE-75	1.27E+04	4.88E+03	9.76E+04	4.88E+03	9.76E+02	1.17E+04	1.37E+04
AG-108M	5.80E+03	2.23E+03	4.46E+04	2.23E+03	4.46E+02	5.36E+03	6.25E+03
EU-152	1.58E+02	3.59E+01	3.16E+01	0.00E+00	2.23E+02	0.00E+00	2.07E+04
SB-124	7.18E+03	1.36E+02	2.85E+03	1.74E+01	0.00E+00	5.59E+03	2.04E+05
SB-125	4.59E+03	5.13E+01	1.09E+03	4.67E+00	0.00E+00	3.54E+03	5.05E+04
SB-126	2.95E+03	6.00E+01	1.06E+03	1.81E+01	0.00E+00	1.81E+03	2.41E+05
SN-117M	8.76E+02	3.37E+02	6.74E+03	3.37E+02	6.74E+01	8.09E+02	9.43E+02
TE-123M	5.45E+03	2.10E+03	4.19E+04	2.10E+03	4.19E+02	5.03E+03	5.87E+03
BA-133	5.84E+01	2.25E+01	4.49E+02	2.25E+01	4.49E+00	5.39E+01	6.29E+01

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3.0 GASEOUS EFFLUENTS

3.1 MONITOR ALARM SETPOINT DETERMINATION

This procedure determines the monitor alarm setpoint that indicates if the dose rate in the unrestricted areas due to noble gas radionuclides 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. (NUREG-0133)

3.1.1 Setpoint Based on Conservative Radionuclide Mix (Ground and Mixed Mode Releases)

The following method applies to gaseous releases via the Units 1 and 2 Turbine Building Vents and via the Units 1 and 2 Reactor Building Vents when determining the high alarm setpoint for the Turbine Building Vent Gas Monitors and Reactor Building Vent Gas Monitors.

1. Determine the “mix” (noble gas radionuclide composition) of the gaseous effluent (the “mix” can be determined from actual data or by using GALE code results of Table 3.1-2):*

   a. Determine the gaseous source terms that are representative of the "mix" of the gaseous effluent. Gaseous source terms are the noble gas activities in the effluent.

      Gaseous source terms can be obtained from:

      - Table 3.1-2; Turbine Building Vent Release
      - Table 3.1-2; Reactor Building Vent Release
      - Actual release data

   b. Determine 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.

$$S_i = \frac{A_i}{\Sigma_i A_i} \qquad (3.1\text{-}1)$$

A_i = The radioactivity of noble gas radionuclide i in gaseous effluent from Table 3.1-2, Turbine Building Vent Release; Table 3.1-2, Reactor Building Vent Release; or from analysis of gaseous effluent.

*If actual plant data is used, the dose constants need to be confirmed.

2. Determine Q_t (the maximum acceptable total release rate of all noble gas radionuclides in the gaseous effluent, µCi/sec) based upon the whole body exposure limit.

$$Q_t = \frac{500}{\overline{(\chi/Q)}\,\Sigma_i\,(K_i\,S_i)} \tag{3.1-2}$$

$\overline{(\chi/Q)}_{tb}$ = The highest calculated annual average relative concentration of effluents released via the Turbine Building Vent for any area at or beyond the site boundary for all sectors (sec/m^3) from Table A-1, Appendix A

= 1.5 E-5 sec/m^3

$\overline{(\chi/Q)}_{rb}$ = The highest calculated annual average relative concentration of effluents released via the Reactor Building Vent for any area at or beyond the site boundary for all sectors (sec/m^3) from Table A-7, Appendix A

= 2.5 E-6 sec/m^3

NOTE: Use the χ/Q that applies to the monitor for which the alarm setpoint is being calculated.

K_i = The total whole body dose factor due to gamma emissions from noble gas radionuclide i (mrem/year/µCi/m^3) from Table 3.1-3.

3. Determine Q_t based upon the skin exposure limit.

$$Q_t = \frac{3000}{\overline{(\chi/Q)}\,\Sigma_i\,[(L_i + 1.1M_i)\,S_i]} \tag{3.1-3}$$

$L_i + 1.1M_i$ = The total skin dose factor due to emissions from noble gas radionuclide i (mrem/year/µCi/m^3) from Table 3.1-3.

NOTE: The Turbine Building radiation monitors are designed to input the monitor high alarm setpoint in µCi/sec or µCi/cc. The monitor setpoint in µCi/sec can be obtained by multiplying the lowest Q_t value (obtained from Sections 3.1.1.2 and 3.1.1.3) by the T_m value found in Section 3.1.1.5.b. The µCi/cc setpoint can be obtained by dividing the µCi/sec setpoint by the design flow rate in cc/sec. The equations for calculating the setpoint in cpm are included for completeness and may be used if desired.

4. Determine C_t (the maximum acceptable total radioactivity concentration of all noble gas radionuclides in the gaseous effluent, μCi/sec/cfm).

$$C_t = \frac{Q_t}{f} \quad (3.1\text{-}4)$$

NOTE:	Use the <u>lower</u> of the Q_t values obtained in Sections 3.1.1.2 and 3.1.1.3.

f = The maximum acceptable effluent flow rate at the point of release (cfm) based on design flow rates

= 15,000 cfm (Unit 2 Turbine Building Vent– Recirculation Mode)

= 15,500 cfm (Unit 1 Turbine Building Vent– Recirculation Mode)

= 95,000 cfm (Turbine Building Vent – Once Thru Mode)

= 172,800 cfm (Reactor Building Vent)

5. Determine the monitor high alarm setpoint above background:

a. Determine CR (the calculated monitor count rate above background attributed to the noble gas radionuclides, net cpm).

$$CR = \frac{C_t}{E_m} \quad (3.1\text{-}5)$$

E_m = The detection efficiency of the monitor for the "mix" of noble gas radionuclides in the gaseous effluent (μCi/sec/cfm•cpm) from E&RC files

b. Determine HSP (the monitor high alarm setpoint with background, cpm).

$$HSP = T_m CR + Bkg \quad (3.1\text{-}6)$$

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 during simultaneous releases from several pathways. Typical values for T_m are shown below.

= 0.10 for the Unit 1 Turbine Building Vent Gas Monitor

= 0.10 for the Unit 2 Turbine Building Vent Gas Monitor

= 0.20 for the Unit 1 Reactor Building Vent Gas Monitor

= 0.20 for the Unit 2 Reactor Building Vent Gas Monitor

NOTE:	T_m is defined such that $\sum Tm \leq 1$.

Bkg = The background count rate (cpm) due to internal contamination and the radiation levels in the area in which the monitor is installed when the detector sample chamber is filled with uncontaminated air

c. The monitor high alarm setpoint including background (cpm) shall be set at or below the HSP value determined above.

3.1.2 <u>Setpoint Based on Conservative Radionuclide Mix (Long-Term Elevated Release</u>

The following method applies to gaseous releases via the stack when determining the high-high alarm setpoint for the Stack Monitor during continuous release via the stack.

1. Determine the "mix" (noble gas radionuclide composition) of the gaseous effluent (the "mix" can be determined from actual data or by using GALE code results of Table 3.1-2):*

a. Determine the gaseous source terms that are representative of the "mix" of the gaseous effluent. Gaseous source terms are the noble gases radionuclide activity concentrations in the effluent.

Gaseous source teams can be obtained from:

- Table 3.1-2; Stack Release
- Actual Release Data

b. Determine S_i (the fraction of the total radioactivity in the gaseous effluent comprised by noble gas radionuclide i) for each individual noble gas radionuclide in the gaseous effluent.

$$S_i = \frac{A_i}{\Sigma_i A_i} \tag{3.1-7}$$

A_i = The radioactivity of noble gas radionuclide i in gaseous effluent from Table 3.1-2, Stack Release, or from analysis of gaseous effluent.

2. Determine Q_t (the maximum acceptable total release rate of all noble gas radionuclides in the gaseous effluent, μCi/sec) based upon the whole body exposure limit.

*If actual plant data is used, the dose constants need to be confirmed.

Q_t = $$\frac{500}{\Sigma_i[V_i S_i]}$$ (3.1-8)

V_i = The constant for noble gas radionuclide i accounting for the gamma radiation from the elevated finite plume (mrem/year/μCi/sec) from Table 3.1-3

3. Determine Q_t based upon the skin exposure limit.

Q_t = $$\frac{3000}{\Sigma_i[(L_i\,\overline{(\chi/Q)_s} + 1.1B_i)S_i]}$$ (3.1-9)

$L_i\overline{(\chi/Q)_s} + 1.1B_i$ = The total skin dose constant for long term releases (greater than 500 hours/year) due to emissions from noble gas radionuclide i (mrem/year/μCi/sec) from Table 3.1-3).

> **NOTE**: The stack radiation monitor is designed to input the monitor high-high alarm setpoint in μCi/sec or μCi/cc. The monitor setpoint in μCi/sec can be obtained by multiplying the lowest Q_t value (obtained from Sections 3.1.2.2 and 3.1.2.3 by the T_m value found in Section 3.1.2.5.b. The μCi/cc setpoint can be obtained by dividing the μCi/sec setpoint by the design flow rate in cc/sec. The equations for calculating the setpoint in cps are included for completeness and may be used if desired.

4. Determine C_t (the total maximum acceptable radioactivity concentration of noble gas radionuclides in the gaseous effluent, μCi/sec/cfm).

C_t = $$\frac{Q_t}{f}$$ (3.1-10)

> **NOTE**: Use the lowest of the Q_t values obtained in Sections 3.1.2.2 and 3.1.2.3.

f = The maximum acceptable effluent flow rate at the point of release (cfm) based on design flow rates

= 78,600 cfm (stack)

5. Determine the monitor high-high alarm setpoint above background:

a. Determine the CR (the calculated monitor count rate above background attributed to the noble gas radionuclides, net cpm).

$$CR = \frac{C_t}{E_m} \qquad (3.1\text{-}11)$$

E_m = The detection efficiency of the monitor for the "mix" of noble gas radionuclides in the gaseous effluent (μCi/sec/cfm•cpm) from E&RC files

b. Determine HHSP (the monitor high-high alarm setpoint with background, cpm).

$$HHSP = T_m CR + Bkg \qquad (3.1\text{-}12)$$

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 during simultaneous releases from several pathways

= 0.40 for the Stack Monitor

Bkg = The background count rate (cpm) due to internal contamination and the radiation levels in the area in which the monitor is installed when the detector sample chamber is filled with uncontaminated air

c. The monitor high-high alarm setpoint including background (cpm) shall be set at or below the HHSP value determined above.

3.1.3 Condenser Air Ejector Monitor Alarm Setpoint

This procedure determines the alarm setpoint for the Condenser Air Ejector Monitor that will provide reasonable assurance that the total body exposure to an individual at the exclusion area boundary will not exceed a small fraction of the limits of 10CFR100 in the event of an inadvertent release via the condenser air ejector.

1. The following method applies to gaseous releases via the Units 1 and 2 condenser air ejectors when determining the maximum allowable alarm setpoint for the Condenser Off-gas Radiation Monitors, Reference Table 3.1-1.

   a. Determine Q, the allowable release rate (μCi/sec) at the air ejector for the noble gas radionuclides.

      Technical Specification 3.7.5 limits the gross radioactivity rate of noble gases measured at the main condenser air ejector to less than or equal to 243,600 μCi/sec (after 30 minutes' decay). Assume that the noble gas concentrations at the air ejector (t = 0) are representative of the GALE code. Since the holdup time between the air ejector and the stack (down the 30-minute holdup line) can vary due to operational conditions, the mix of the noble gases at the stack should be determined based on the actual decay time not to exceed 30 minutes. This mix can then be applied to the 243,600 μCi/sec limit and then back-calculated to determine the allowable release rate at the air ejector, Q. As an example, assume that the holdup time is 30 minutes. The mix of the noble gases after 30 minutes' decay (t = 30 minutes) can be determined by the following table.

TABLE 3.1-1

GALE CODE 30 MINUTE AIR EJECTOR TECHNICAL SPECIFICATION

Decayed Release Fraction

Nuclide	GALE Code Rev. 0 Steam (μCi/gm) t = 0	Steam (μCi/gm) t = 0	μCi/sec* t = 0	$e^{-\lambda t}$ t = 30m	μCi/sec t = 30m	Fraction of Mix t = 30m
	(for 3400 MWt)	(for 2923 MWt)				
Kr-83m	1.1E-3	9.46E-4	1.52E+3	8.3E-1	1.26E+3	2.85E-2
Kr-85m	1.9E-3	1.63E-3	2.63E+3	9.2E-1	2.43E+3	5.50E-2
Kr-85	6.0E-6	5.16E-6	8.31E+0	1.0E+0	8.31E+0	1.88E-4
Kr-87	6.6E-3	5.67E-3	9.14E+3	7.6E-1	6.96E+3	1.57E-1
Kr-88	6.6E-3	5.67E-3	9.14E+3	8.8E-1	8.08E+3	1.82E-1
Kr-89	4.1E-2	3.52E-2	5.68E+4	1.4E-3	7.89E+1	1.78E-3
Kr-90	9.0E-2	7.74E-2	1.25E+5	1.7E-17	2.11E-12	4.76E-17
Xe-131m	4.7E-6	4.04E-6	6.51E+0	1.0E+0	6.50E+0	1.47E-4
Xe-133m	9.0E-5	7.74E-5	1.25E+2	9.9E-1	1.24E+2	2.80E-3
Xe-133	2.6E-3	2.24E-3	3.60E+3	1.0E+0	3.59E+3	8.11E-2
Xe-135m	8.4E-3	7.22E-3	1.16E+4	2.6E-1	2.99E+3	6.75E-2
Xe-135	7.2E-3	6.19E-3	9.97E+3	9.6E-1	9.60E+3	2.17E-1
Xe-137	4.7E-2	4.04E-2	6.54E+4	4.4E-3	2.90E+2	6.54E-3
Xe-138	2.8E-2	2.41E-2	3.88E+4	2.3E-1	8.87E+3	2.01E-1
				TOTAL	4.43E+4	1.00E+0

Applying this mix to 243,600 μCi/sec (after 30 minutes' delay) and back calculating to t = 0 will yield the allowable μCi/sec per noble gases at the air ejectors. The Gale Code numbers were obtained from NUREG-0016 April 1976 and were scaled in accordance with NUREG-0133 for 2923 MWt.

* Steam Flow = $(12.782\,\mathrm{E6\,lbs/hr})\left(\frac{0.1260\,\mathrm{gm/sec}}{\mathrm{lbs/hr}}\right) = 1.61\mathrm{E}+6\ \mathrm{gm/sec}$

TABLE 3.1-1 (Continued)

GALE CODE 30 MINUTE AIR EJECTOR TECHNICAL SPECIFICATION

Release Rate Limits

Nuclide	Fraction of Mix t = 30 min	Tech Spec (μCi/sec) t = 30 min	$e^{-\lambda t}$ t = 30 min	Tech Spec (μCi/sec) t = 0
Kr-83m	2.85E-2	6.95E+3	8.3E-1	8.38E+3
Kr-85m	5.50E-2	1.34E+4	9.2E-1	1.45E+4
Kr-85	1.88E-4	4.57E+1	1.0E+0	4.57E+1
Kr-87	1.57E-1	3.83E+4	7.6E-1	5.03E+4
Kr-88	1.82E-1	4.44E+4	8.8E-1	5.03E+4
Kr-89	1.78E-3	4.34E+2	1.4E-3	3.12E+5
Kr-90	4.76E-17	1.16E-11	1.7E-17	6.85E+5
Xe-131m	1.47E-4	3.58E+1	1.0E+0	3.58E+1
Xe-133m	2.80E-3	6.81E+2	9.9E-1	6.85E+2
Xe-133	8.11E-2	1.97E+4	1.0E+0	1.98E+4
Xe-135m	6.75E-2	1.64E+4	2.6E-1	6.40E+4
Xe-135	2.17E-1	5.28E+4	9.6E-1	5.48E+4
Xe-137	6.54E-3	1.59E+3	4.4E-3	3.58E+5
Xe-138	2.00E-1	4.88E+4	2.3E-1	2.13E+5
TOTALS	1.00E+0	2.44E+5		1.83E+6

Therefore:

Q = 1.83E+6 μCi/sec (for 30 minutes' holdup)

b. Determine C_m (the total radioactivity concentration of noble gases) in the condenser air ejector gas (μCi/sec/cfm).

$$C_m = Q/f \quad (3.1\text{-}13)$$

Q = The allowable release rate (μCi/sec) at the air ejector for noble gases

f = The main condenser air inleakage rate plus the radiolytic gas flow rate (cfm)

c. Determine the monitor high-high alarm setpoint above background.

(1) Determine MR (the calculated monitor response attributed to the noble gas radionuclides, mR/hr).

$$MR = \frac{C_m}{E_m} \qquad (3.1\text{-}14)$$

E_m = The detection efficiency of the monitor for the "mix" of noble gas radionuclides in the gaseous stream [(μCi/sec)/(mR/hr•cfm)] from E&RC files

(2) The monitor high-high alarm setpoint (mR/hr) should be set at or below the MR value determined above.

3.1.4 Condenser Off-Gas Treatment System (AOG) Monitor Alarm Setpoint Determination

This method determines the monitor alarm setpoint that includes sufficient noble gas activity to cause an alarm at the stack effluent noble gas monitor.

1. Determine Q_t (the maximum acceptable total release rate of all noble gas radionuclides in the gaseous effluent, μCi/sec) based upon the whole body exposure (see Equation 3.1-8) and skin exposure (see Equation 3.1-9).

NOTE:	Use the lowest of the Q_t values obtained.

2. Determine Q_s (the site adjusted maximum release rate, μCi/sec, for effluent releases via the stack).

$$Q_s = Q_t \times T_m \qquad (3.1\text{-}15)$$

T_m = Fraction of radioactivity from the site that may be released via the stack to ensure that the site boundary limit is not exceeded during simultaneous releases from several pathways. The typical value used for T_m is shown below

= 0.4 for the stack monitor

3. Determine HSP (high alarm setpoint in μCi/cc).

$$HSP = Q_s \div f \qquad (3.1\text{-}16)$$

f = Maximum design flow rate of the AOG System

= 70,800 cc/sec (150 cfm)

4. The monitor high alarm setpoint shall be set at or below the HSP value determined above.

TABLE 3.1-2

GASEOUS SOURCE TERMS **
(Ci/year/unit)

	Turbine Bldg Vent		Reactor Bldg Vent		Stack	
Radionuclide	A_i (Ci/yr)	S_i	A_i (Ci/yr)	S_i	A_i (Ci/yr)	S_i
Kr-83m	*	-	*	-	3.7E+4	2.84E-2
Kr-85m	6.8E+1	1.95E-2	6.0E0	1.72E-2	7.2E+4	5.46E-2
Kr-85	*	-	*	-	2.4E+2	1.86E-4
Kr-87	1.9E+2	5.45E-2	6.0E0	1.72E-2	2.05E+5	1.56E-1
Kr-88	2.3E+2	6.59E-2	6.0E0	1.72E-2	2.4E+5	1.82E-1
Kr-89	*	-	*	-	3.5E+3	2.64E-3
Xe-131m	*	-	*	-	1.9E+2	1.46E-4
Xe-133m	*	-	*	-	3.6E+3	2.78E-3
Xe-133	2.8E+2	8.03E-2	1.32E+2	3.78E-1	1.1E+5	8.24E-2
Xe-135m	6.5E+2	1.86E-1	9.2E+1	2.64E-1	8.8E+4	6.72E-2
Xe-135	6.3E+2	1.81E-1	6.8E+1	1.95E-1	2.8E+5	2.16E-1
Xe-137	*	-	*	-	1.1E+4	8.09E-3
Xe-138	1.44E+3	4.13E-1	1.4E+1	4.01E-2	2.6E+5	2.00E-1
Ar-41	*	-	2.5E+1	7.16E-2	*	-
TOTAL	3.49E+3		3.49E+2		1.31E+6	

* < 1.0E+1

**Source terms are based upon GALE code and not actual releases.

TABLE 3.1-3

DOSE FACTORS AND CONSTANTS

Radio Nuclide	Total Whole Body Dose Factor (K_i) (mrem/yr/μCi/m^3)	Total Skin Dose Factor (L_i + 1.1M_i) (mrem/yr/μCi/m^3)	Total Body Dose Constant For Long-Term Releases (V_i) (mrem/yr/μCi/sec)	Total Skin Dose Constant for Long-Term Releases ($L_i(\chi/Q)_s$ + 1.1B_i) (mrem/yr/μCi/sec)
Kr-83m	7.56E-2	2.12E+1	2.70E-09	8.21E-07
Kr-85m	1.17E+3	2.81E+3	1.14E-04	2.33E-04
Kr-85	1.61E+1	1.36E+3	1.69E-06	4.57E-05
Kr-87	5.92E+3	1.65E+4	5.12E-04	1.16E-03
Kr-88	1.47E+4	1.91E+4	1.35E-03	2.30E-03
Kr-89	1.66E+4	2.91E+4	7.59E-04	1.58E-03
Xe-131m	9.15E+1	6.48E+2	2.78E-05	6.41E-05
Xe-133m	2.51E+2	1.35E+3	2.12E-05	7.04E-05
Xe-133	2.94E+2	6.94E+2	2.22E-05	4.85E-05
Xe-135m	3.12E+3	4.41E+3	2.62E-04	4.59E-04
Xe-135	1.81E+3	3.97E+3	1.82E-04	3.61E-04
Xe-137	1.42E+3	1.39E+4	6.42E-05	4.97E-04
Xe-138	8.83E+3	1.43E+4	8.09E-04	1.46E-03
Ar-41	8.84E+3	1.29E+4	9.71E-04	1.69E-03

3.2 COMPLIANCE WITH ODCM SPECIFICATION 7.3.7 (GASEOUS)

3.2.1 Noble Gases

The gaseous effluent monitors' setpoints are utilized to show compliance with ODCM Specification (ODCMS) 7.3.7 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 ODCMS 7.3.7 limits may not be exceeded. 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 ODCMS 7.3.7.

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 are used to show compliance with ODCMS 7.3.7.

$$\Sigma_i \left[V_i \dot{Q}_{i_s} + K_i \overline{(\chi/Q)}_v \dot{Q}_{i_v} \right] \leq 500 \text{ mrem/yr} \qquad (3.2\text{-}1)$$

$$\Sigma_i \left\{ \left[L_i \overline{(\chi/Q)}_s + 1.1 B_i \right] \dot{Q}_{i_s} + (L_i + 1.1 M_i) \overline{(\chi/Q)}_v \dot{Q}_{i_v} \right\} \leq 3000 \text{ mrem/yr} \qquad (3.2\text{-}2)$$

where:

K_i = The total body dose factor due to gamma emissions for noble gas radionuclide i, mrem/year per $\mu Ci/m^3$

L_i = The skin dose factor due to beta emissions for noble gas radionuclide i, mrem/year per $\mu Ci/m^3$

M_i = The air dose factor due to gamma emissions for noble gas radionuclide i, mrad/year per $\mu Ci/m^3$

V_i = The constant for each identified noble gas radionuclide i accounting for the gamma radiation from the elevated finite plume mrem/year per μCi/sec

B_i = The constant for long-term releases (greater than 500 hours/year) for each identified noble gas radionuclide i accounting for the gamma radiation from the elevated finite plume in mrad/year per μCi/sec

1.1	=	The ratio of the tissue to air absorption coefficients over the energy range of the photon of interest, mrem/mrad
Q_{i_s}	=	The release rate of noble gas radionuclide i in gaseous effluents from free-standing stack, μCi/sec
Q_{i_v}	=	The release rate of noble gas radionuclide i in gaseous effluents from all vent releases, μCi/sec

At the Brunswick Steam Electric Plant (BSEP), gaseous releases may occur from:

1. The Turbine Building vent*
2. The Reactor Building vent
3. The Stack

Releases from the Turbine Building are ground level. The sources of these releases are steam leakage through valve stems, pump seals, and flanged connections. Releases from the Reactor Building are considered mixed mode in nature, and the source is also leakage through valve stems, pump seals, and flanged connections. Releases from the stack are considered elevated. Their sources are the main condenser's steam jet air ejectors, Radwaste Building and AOG Building ventilation system exhausts, mechanical vacuum pump exhausts during startup, and gland seal off-gases.

Noble gas releases may occur from all three points. To show compliance with ODCMS 7.3.7, Expressions 3.2-1 and 3.2-2 are now in terms of the actual release points for BSEP.

For the total body dose rate:

$$\Sigma_i V_i \dot{Q}_{i_s} + \Sigma_i K_i \left[\overline{(\chi/Q)}_{rb} \dot{Q}_{i_{rb}} + \overline{(\chi/Q)}_{tb} \dot{Q}_{i_{tb}} \right] \le 500 \text{ mrem/yr} \qquad (3.2\text{-}3)$$

For the skin dose rate:

$$\Sigma_i \left[L_i \overline{(\chi/Q)_s} + 1.1B_i\right]\dot{Q}_{i_s} + \Sigma_i \left[L_i + 1.1M_i\right]\left[\overline{(\chi/Q)_{rb}}\,\dot{Q}_{i_{rb}} + \overline{\chi/Q_{tb}}\,\dot{Q}_{i_{tb}}\right] \leq 3000 \text{ mrem/yr} \qquad (3.2\text{-}4)$$

Where:

$\dot{Q}_{i_s}$	=	Release rate of radionuclide i from the stack, μCi/sec
$\dot{Q}_{i_{rb}}$	=	Release rate of radionuclide i from the two Reactor Buildings, μCi/sec
$\dot{Q}_{i_{tb}}$	=	Release rate of radionuclide i from the two Turbine Buildings, μCi/sec
$\overline{(\chi/Q)_s}$	=	Annual average relative concentration for releases from the stack, sec/ m^3
$\overline{(\chi/Q)_{rb}}$	=	Annual average relative concentration for releases from the Reactor Buildings, sec/m^3
$\overline{(\chi/Q)_{tb}}$	=	Annual average relative concentration for releases from the Turbine Buildings, sec/ m^3

All other terms remain the same as those defined previously.

The determination of controlling location for implementation of ODCMS 7.3.7 for noble gases is a function of the radionuclide mix, the isotopic release rate, and the meteorology.

The incorporation of these variables into Expressions 3.2-3 and 3.2-4 result in the following expressions for the controlling locations for the BSEP. This location is 0.7 miles, the ENE site boundary.

For the total body:

$$\Sigma_i V_i \dot{Q}_{i_s} + \Sigma_i K_i (1.9 \times 10^{-6} \dot{Q}_{i_{rb}} + 6.0 \times 10^{-6} \dot{Q}_{i_{tb}}) \leq 500 \text{ mrem/yr} \quad (3.2\text{-}5)$$

For the skin:

$$\Sigma_i (3.2 \times 10^{-8} L_i + 1.1 B_i) \dot{Q}_{i_s} + \quad (3.2\text{-}6)$$

$$\Sigma_i \left[(L_i + 1.1 M_i)(1.9 \times 10^{-6} \dot{Q}_{i_{rb}} + 6.0 \times 10^{-6} \dot{Q}_{i_{tb}}) \right] \leq 3000 \text{ mrem/yr}$$

The radionuclide mix was based upon source terms calculated using the NRC GALE code. They are presented in Table 3.2-1 as a function of release point. It should be noted, however, that the releases in Table 3.2-1 do not reflect the actual BSEP release data to date. The releases to date have been substantially less. This table was used as a calculational tool to determine the controlling location.

The χ/Q values utilized in the equations for implementation of 10CFR20 are based upon the maximum long-term annual average $\overline{(X/Q)}$ in the unrestricted area. Table 3.2-2 presents the distances from the Reactor and Turbine Buildings to the nearest unrestricted area for each of the 16 sectors as well as to the nearest residence, vegetable garden, cow, goat, and beef animal. Table 3.2-3 presents the distances and directions from the stack to the same site boundaries of Table 3.2-2. Note that only distance has changed in relation to Table 3.2-2.

Long-term annual (χ/Q) values for the stack, Reactor Building, and Turbine Building release points from BSEP to the special locations in Table 3.2-2 are presented in Appendix A. A description of the derivation is also provided in this appendix. χ/Q values at the limiting site boundary for releases from the Turbine Building, Reactor Building, and stack were obtained from Tables A-1, A-7, and A-13, respectively, of the appendix.

To determine the controlling location for implementation of 10CFR20, the two or three highest site boundary χ/Q values for each release point were utilized in conjunction with the radionuclide mix and release rate for each release point. Since mixed mode and elevated releases occur from BSEP, their maximum χ/Q value may not decrease with distance; i.e., the site boundary may not have the highest χ/Q values.

Therefore, long-term annual average χ/Q values were calculated at the midpoint of the 10 standard distances as given in Table A-4 of Appendix A. The highest two or three χ/Q values for each release point at a distance greater than the site boundary were used in conjunction with the radionuclide mix to determine the controlling location. A particular combination of release point mix and meteorology dominates in the determination of the controlling location. For BSEP, it is the stack, and the dominant factor in determining a control location becomes the V_i values. The controlling location is at the ENE at the site boundary due to its higher V_i values.

Values for K_i, L_i, and M_i, which were used in the determination of the controlling locations and which are to be used by BSEP in Expressions 3.2-5 and 3.2-6 to show compliance with ODCMS 7.3.7, are presented in Table 3.2-4. 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 10^6 to convert picocuries^{-1} to microcuries^{-1} for use in Expressions 3.2-5 and 3.2-6.

Values for V_i and B_i for the finite plume model can be expressed as shown in Equations 3.2-7 and 3.2-8. They were calculated at the site boundary of each of the 16 sectors using the NRC code RABFIN. Values for V_i and B_i for each of the 16 sectors are presented in Appendix B.

$$B_i = \frac{K}{r_d} \Sigma_j \Sigma_k \Sigma_l \frac{f_{jk} A_{li} \mu_a E_l I}{\mu_j} \quad (3.2\text{-}7)$$

I = The results of numerical integration over the plume spatial distribution of the airborne activity as defined by the meteorological condition of wind speed (μ_j) and atmospheric stability class "K" for a particular wind direction

K = A numerical constant representing unit conversions

$$= \frac{260 \text{ mrad (radians)}(\text{m}^3)(\text{transformation})}{\sec(\text{Mev})(\text{Ci})} \times \frac{16 \text{ sectors}}{2\pi \text{ radians}} \times$$

$$\frac{10^{-6}\text{ Ci}}{\mu\text{Ci}} \times \frac{3.15 \times 10^{7} \sec}{\text{yr}}$$

$= 2.1 \times 10^4$ mrad (m^3) (transformation) / year (Mev) (μCi)

r_d	=	The distance from the release point to the receptor location, meters
μ_j	=	The mean wind speed assigned to the jth wind speed class, meters/sec
f_{jk}	=	The joint frequency of occurrence of the jth wind speed class and the kth stability class (dimensionless)
A_{li}	=	The number of photons of energy corresponding to the lth energy group emitted per transformation of the ith radionuclide, number/transformation
E_l	=	The energy assigned to the lth energy group, MeV
μ_a	=	The energy absorption coefficient in air for photon energy E_l, meters^{-1}

The V_i factor is computed with conversion from air dose to tissue depth dose, thus;

$$V_i = 1.1K/r_d \sum_j \sum_k \sum_l \frac{f_{jk} A_{li} \mu_a E_l I e^{-\mu} T^{T_d}}{\mu_j} \qquad (3.2\text{-}8)$$

Where:

μ_T	=	The tissue energy absorption coefficient for photons of energy E_l, cm^2/gm
T_d	=	The tissue density thickness taken to represent the total body dose (5 gm/cm^2)
1.1	=	The ratio of the tissue to air absorption coefficients over the energy range of photons of interest, mrem/mrad

3.2.2 I-131, I-133, Particulates, and Tritium*

The dose rate in unrestricted areas resulting from the release of radioiodines and particulates with half-lives greater than 8 days is limited to 1500 mrem/year to any organ. Based upon NUREG 0133, the following is used to show compliance with ODCMS 7.3.7.

$$\Sigma_i \; P_i \left[\left(\overline{\chi / Q}\right)_s \dot{Q}_{i_s} + \left(\overline{\chi / Q}\right)_{rb} \dot{Q}_{i_{rb}} + \left(\overline{\chi / Q}\right)_{tb} \left(\dot{Q}_{i_{tb}} + \dot{Q}_{i_{DC}} + \dot{Q}_{i_{RM}} + \dot{Q}_{i_{LLW}}\right)\right] \leq 1500 \;\; mrem/yr \qquad (3.2\text{-}9)$$

Where:

P_i = Dose parameter for radioiodines and particulates with half-lives greater than 8 days based upon the organ and the age group (child) at the site boundary, mrem/year per μCi/m^3

$\dot{Q}_{i_s}$ = The release rate of radionuclide *i* in gaseous effluents from free standing stack, μCi/sec

$\dot{Q}_{i_{rb}}$ = Release of radionuclide *i* from the two Reactor Buildings, μCi/sec

$\dot{Q}_{i_{tb}}$ = Release of radionuclide *i* from the two Turbine Buildings, μCi/sec

$\dot{Q}_{i_{DC}}$ = Release of radionuclide *i* from the Hot Shop (Decon) Facility, μCi/sec

$\dot{Q}_{i_{RM}}$ = Release of radionuclide *i* from the Radioactive Materials Container and Storage Building (RMCSB), μCi/sec

$\dot{Q}_{i_{LLW}}$ = Release of radionuclide *i* from the Low Level Warehouse (LLW), μCi/sec

$\overline{(\chi/Q)}_{rb}$ = Annual average relative concentrations for releases from the Reactor Buildings, sec/m^3

$\overline{(\chi/Q)}_{tb}$ = Annual average relative concentrations for releases from the Turbine Buildings, and other ground level releases such as Decon, RMCSB and LLW, sec/m^3

$\overline{(\chi/Q)}_{s}$ = Annual average relative concentrations for releases from the stack, sec/m^3

*For ODCM calculations performed to comply with ODCM TRs 7.3.7.2 and 7.3.9.1, the I-133 values used are determined by actual analysis.

Radioiodines, particulates, and tritium are primarily released from the Stack, Reactor Buildings, and Turbine Buildings at BSEP. Radioiodines and particulates may also be released from other sources such as the Hot Shop (Decon) Facility, the Radioactive Materials Container and Storage Building (RMCSB), and the Low Level Warehouse (LLW). Effluent doses from Decon, RMCSB, LLW, and any building exfiltration are quantified using ground level meteorology.

To show compliance with ODCMS 7.3.7, Expression 3.2-9 is evaluated at the limiting site boundary. The limiting site boundary location is 0.7 miles NE.

In the determination of the controlling site boundary location, the highest two or three site boundary χ/Q values for each release point were utilized in conjunction with the radionuclide mix and the release rate for each release point. At BSEP, the release rate which dominates comes from the stack. The higher value for χ/Q for the NE sector at the site boundary make it the dominant meteorological sector and the control location.

Values for P_i were calculated for a child for various radionuclides for the inhalation pathway using the methodology of NUREG 0133. The P_i values are presented in Table 3.2-5. Appendix C presents the methodology which was utilized in calculating P_i values.

Annual average χ/Q values at the standard distances for the Stack, Reactor Building, Turbine Building and other effluent release points can be obtained from Appendix A. A description of the derivation of the χ/Q values is provided in Appendix A.

TABLE 3.2-1

RELEASES FROM BRUNSWICK STEAM ELECTRIC PLANT *
(Ci/yr per unit)

Isotope	Turbine Building (Ground Level)	Reactor Building (Mixed Mode)	Stack (Elevated)
Kr-83m	0.0E+0	0.0E+0	3.7E+4
Kr-85m	6.8E+1	6.0E+0	7.2E+4
Kr-85	0.0E+0	0.0E+0	2.4E+2
Kr-87	1.9E+2	6.0E+0	2.05E+5
Kr-88	2.3E+2	6.0E+0	2.4E+5
Kr-89	0.0E+0	0.0E+0	3.5E+3
Xe-131m	0.0E+0	0.0E+0	1.9E+2
Xe-133m	0.0E+0	0.0E+0	3.6E+3
Xe-133	2.8E+2	1.3E+2	1.1E+5
Xe-135m	6.5E+2	9.2E+1	8.8E+4
Xe-135	6.3E+2	6.8E+1	2.8E+5
Xe-137	0.0E+0	0.0E+0	1.1E+4
Xe-138	1.4E+3	1.4E+1	2.6E+5
Ar-41	0.0E+0	2.5E+1	0.0E+0
I-131	1.9E-2	3.4E-1	5.1E+0
I-133	7.6E-2	1.4E+0	2.0E+1
Cr-51	1.3E-4	6.0E-4	9.0E-3
Mn-54	6.0E-6	6.0E-3	3.6E-2
Fe-59	5.0E-6	8.0E-4	1.5E-2
Co-58	6.0E-6	1.2E-3	4.5E-3
Co-60	2.0E-5	2.0E-2	9.0E-2
Zn-65	2.0E-6	4.0E-3	1.0E-3
Sr-89	6.0E-5	1.8E-4	5.0E-4
Sr-90	2.0E-7	1.0E-5	3.0E-4
Zr-95	1.0E-6	8.0E-4	5.0E-5
Sb-124	3.0E-6	4.0E-4	5.0E-5
Cs-134	3.0E-6	8.0E-3	4.5E-3
Cs-136	5.0E-7	6.0E-4	4.5E-4
Cs-137	6.0E-6	1.1E-2	9.0E-3
Ba-140	1.1E-4	8.0E-4	1.0E-4
Ce-141	6.0E-6	2.0E-4	2.6E-3
C-14	0.0E+0	0.0E+0	9.5E+0
H-3	0.0E+0	3.6E+1	0.0E+0

*Calculations based upon GALE code and not actual releases.

TABLE 3.2-2

DISTANCE TO CONTROLLING LOCATIONS AS MEASURED FROM THE BRUNSWICK PLANT CENTER (Mi)

Sector	Site Boundary	Milk Cow	Milk Goat	Meat Animal	Nearest Resident	Nearest Garden
NNE	0.7	-	-	-	0.91	0.99
NE	0.7	4.75*	-	-	-	-
ENE	0.7	-	-	-	-	-
E	0.7	-	-	-	-	-
ESE	0.7	-	-	-	1.37	1.48
SE	0.7	-	-	-	-	-
SSE	0.7	-	-	-	1.22	-
S	0.8	-	-	-	1.02	1.50
SSW	0.8	-	-	-	1.25	1.48
SW	0.7	-	-	-	0.97	0.97
WSW	0.7	-	-	-	1.27	1.27
W	0.7	-	-	-	0.84	0.85
WNW	0.6	-	-	-	0.90	-
NW	0.6	-	-	-	0.95	0.98
NNW	0.6	-	-	-	0.86	1.02
N	0.7	-	-	-	0.87	1.11

* A "hypothetical" cow milk pathway is located at this point in accordance with 5.3.1 of NUREG 0133.

TABLE 3.2-3

DISTANCE TO SITE BOUNDARIES BASED UPON BRUNSWICK PLANT CENTER AND DIRECTIONS FROM THE STACK

Based on Center of Brunswick Plant

Direction	Site Boundary Distance (Mi)
NNE	0.7
NE	0.7
ENE	0.7
E	0.7
ESE	0.7
SE	0.7
SSE	0.7
S	0.8
SSW	0.8
SW	0.7
WSW	0.7
W	0.7
WNW	0.6
NW	0.6
NNW	0.6
N	0.7

From Stack to Site Boundaries of Table 3.2-2

Direction	Distance (Mi)
NNE	0.7
NE	0.7
ENE	0.7
E	0.6
ESE	0.6
SE	0.6
SSE	0.6
S	0.6
SSW	0.7
SW	0.7
WSW	0.7
W	0.8
WNW	0.7
NW	0.7
NNW	0.7
N	0.8

TABLE 3.2-4

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.

** 7.56E-02 = 7.56×10^{-2}

TABLE 3.2-5

P_i VALUES FOR A CHILD FOR THE
BRUNSWICK STEAM ELECTRIC PLANT*

PATHWAY = Inhalation

AGE GROUP = Child

Nuclide	T. Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
H-3	1.12E+03	1.12E+03	0.00E+00	1.12E+03	1.12E+03	1.12E+03	1.12E+03	1.12E+03
P-32	9.86E+04	4.21E+04	2.60E+06	1.14E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CR-51	1.54E+02	1.08E+03	0.00E+00	0.00E+00	2.43E+01	8.53E+01	1.70E+04	0.00E+00
MN-54	9.50E+03	2.29E+04	0.00E+00	4.29E+04	1.00E+04	0.00E+00	1.57E+06	0.00E+00
FE-59	1.67E+04	7.06E+04	2.07E+04	3.34E+04	0.00E+00	0.00E+00	1.27E+06	0.00E+00
CO-58	3.16E+03	3.43E+04	0.00E+00	1.77E+03	0.00E+00	0.00E+00	1.10E+06	0.00E+00
CO-60	2.26E+04	9.61E+04	0.00E+00	1.31E+04	0.00E+00	0.00E+00	7.06E+06	0.00E+00
ZN-65	7.02E+04	1.63E+04	4.25E+04	1.13E+05	7.13E+04	0.00E+00	9.94E+05	0.00E+00
RB-86	1.14E+05	7.98E+03	0.00E+00	1.98E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-89	1.72E+04	1.67E+05	5.99E+05	0.00E+00	0.00E+00	0.00E+00	2.15E+06	0.00E+00
SR-90	6.43E+06	3.43E+05	1.01E+08	0.00E+00	0.00E+00	0.00E+00	1.47E+07	0.00E+00
Y-91	2.43E+04	1.84E+05	9.13E+05	0.00E+00	0.00E+00	0.00E+00	2.62E+06	0.00E+00
ZR-95	3.69E+04	6.10E+04	1.90E+05	4.17E+04	5.95E+04	0.00E+00	2.23E+06	0.00E+00
NB-95	6.54E+03	3.69E+04	2.35E+04	9.16E+03	8.61E+03	0.00E+00	6.13E+05	0.00E+00
RU-103	1.07E+03	4.47E+04	2.79E+03	0.00E+00	7.02E+03	0.00E+00	6.61E+05	0.00E+00
RU-106	1.69E+04	4.29E+05	1.36E+05	0.00E+00	1.84E+05	0.00E+00	1.43E+07	0.00E+00
AG-110M	9.13E+03	1.00E+05	1.68E+04	1.14E+04	2.12E+04	0.00E+00	5.47E+06	0.00E+00
SN-113	9.84E+03	7.45E+03	9.01E+03	2.91E+02	2.03E+02	1.19E+02	3.40E+05	0.00E+00
TE-127M	3.01E+03	7.13E+04	2.48E+04	8.53E+03	6.35E+04	6.06E+03	1.48E+06	0.00E+00
TE-129M	3.04E+03	1.81E+05	1.92E+04	6.84E+03	5.02E+04	6.32E+03	1.76E+06	0.00E+00
I-131	2.72E+04	2.84E+03	4.80E+04	4.80E+04	7.87E+04	1.62E+07	0.00E+00	0.00E+00
I-132	1.87E+03	3.20E+03	2.11E+03	4.06E+03	6.24E+03	1.93E+05	0.00E+00	0.00E+00
I-133	7.68E+03	5.47E+03	1.66E+04	2.03E+04	3.37E+04	3.84E+06	0.00E+00	0.00E+00
I-135	4.14E+03	4.43E+03	4.91E+03	8.72E+03	1.34E+04	7.91E+05	0.00E+00	0.00E+00
CS-134	2.24E+05	3.84E+03	6.50E+05	1.01E+06	3.30E+05	0.00E+00	1.21E+05	0.00E+00
CS-136	1.16E+05	4.17E+03	6.50E+04	1.71E+05	9.53E+04	0.00E+00	1.45E+04	0.00E+00
CS-137	1.28E+05	3.61E+03	9.05E+05	8.24E+05	2.82E+05	0.00E+00	1.04E+05	0.00E+00
BA-140	4.32E+03	1.02E+05	7.39E+04	6.47E+01	2.11E+01	0.00E+00	1.74E+06	0.00E+00
CE-141	2.89E+03	5.65E+04	3.92E+04	1.95E+04	8.53E+03	0.00E+00	5.43E+05	0.00E+00
CE-144	3.61E+05	3.88E+05	6.76E+06	2.11E+06	1.17E+06	0.00E+00	1.19E+07	0.00E+00
HF-181	8.50E+03	5.31E+04	8.44E+04	3.28E+02	2.64E+02	2.76E+02	7.95E+05	0.00E+00
AM-241	4.59E+08	1.75E+05	1.10E+10	6.81E+09	2.82E+09	0.00E+00	7.47E+08	0.00E+00

*Units are mrem/yr per $\mu Ci/m^3$ for the inhalation pathway.

3.3 COMPLIANCE WITH 10CFR50 (GASEOUS)

3.3.1 Noble Gases

1. Cumulation of Doses

Section II.B.1 of Appendix I of 10CFR50 limits the releases of gaseous effluents from each reactor such that the estimated annual gamma air dose is limited to 10 millirad and the beta air dose is limited to 20 millirad. 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 expressions:

During any calendar quarter, for gamma radiation:

$$3.17 \times 10^{-8} \Sigma_i \left\{ M_i \left[\overline{(\chi/Q)_v}\, Q_{i_v} + \overline{(\chi/q)_v}\, q_{i_v} \right] + B_i Q_{i_s} + b_i q_{i_s} \right\} \leq 5 \text{ mrad} \quad (3.3\text{-}1)$$

During any calendar quarter, for beta radiation:

$$3.17 \times 10^{-8} \Sigma_i N_i \left[\overline{(\chi/Q)_v}\, Q_{i_v} + \overline{(\chi/q)_v}\, q_{i_v} + \overline{(\chi/Q)_s}\, Q_{i_s} + \overline{(\chi/q)_s}\, q_{i_s} \right] \leq 10 \text{ mrad} \quad (3.3\text{-}2)$$

During any calendar year, for gamma radiation:

$$3.17 \times 10^{-8} \Sigma_i \left\{ M_i \left[\overline{(\chi/Q)_v}\, Q_{i_v} + \overline{(\chi/q)_v}\, q_{i_v} \right] + B_i Q_{i_s} + b_i q_{i_s} \right\} \leq 10 \text{ mrad} \quad (3.3\text{-}3)$$

During any calendar year, for beta radiation:

$$3.17 \times 10^{-8} \Sigma_i N_i \left[\overline{(\chi/Q)_v}\, Q_{i_v} + \overline{(\chi/q)_v}\, q_{i_v} + \overline{(\chi/Q)_s}\, Q_{i_s} + \overline{(\chi/q)_s}\, q_{i_s} \right] \leq 20 \text{ mrad} \quad (3.3\text{-}4)$$

Where:

M_i = The air dose factor due to gamma emissions for each identified noble gas radionuclide i, mrad/year per $\mu Ci/m^3$

N_i = The air dose factor due to beta emissions for each identified noble gas radionuclide i, mrad/year per $\mu Ci/m^3$

$\overline{(\chi/Q)_v}$ = The annual average relative concentration for areas at or beyond the unrestricted area boundary for long-term vent releases (greater than 500 hrs/year), sec/m^3

$\overline{(\chi/q)}_v$ = The relative concentration for areas at or beyond the unrestricted area boundary for short-term vent releases (equal to or less than 500 hours/year), sec/m^3

$\overline{(\chi/Q)}_s$ = The annual average relative concentration for areas at or beyond the unrestricted area boundary for long-term, free-standing stack releases (greater than 500 hours/year), sec/m^3

$\overline{(\chi/q)}_s$ = The relative concentration for areas at or beyond the unrestricted area boundary for short-term, free-standing stack releases (equal to or less than 500 hours year), sec/m^3

q_{i_s} = The average release of noble gas radionuclide i in gaseous effluents for short-term stack releases (equal to or less than 500 hours/year), μCi

q_{i_v} = The average release of noble gas radionuclide i in gaseous effluents for short-term vent releases (equal to or less than 500 hours/year), μCi

Q_{i_s} = The average release of noble gas radionuclide i in gaseous effluents for long-term, free-standing stack releases (greater than 500 hours/year), μCi

Q_{i_v} = The average release of noble gas radionuclide i in gaseous effluents for long-term vent releases (greater than 500 hours/year), μCi

B_i = The constant for long-term releases (greater than 500 hours/year) for each identified noble gas radionuclide i accounting for the gamma radiation from the elevated finite plume, mrad/year per μCi/sec

b_i = The constant for short-term releases (equal to or less than 500 hours/year) for each identified noble gas radionuclide i accounting for the gamma radiation from the elevated finite plume, mrad/year per μCi/sec

3.17×10^{-8} = The inverse of the number of seconds in a year

For BSEP all releases are considered long-term. The incorporation of the stack, Reactor Building, and Turbine Building release points into Expressions 3.3-1 through 3.3-4 results in the following expressions for two units to show compliance with 10CFR50.

During any calendar quarter or year:

Gamma radiation:

$$3.17 \times 10^{-8} \Sigma_i \left\{ M_i \left[\overline{(\chi/Q)}_{rb} (Q_{i_{rb1}} + Q_{i_{rb2}}) + \overline{(\chi/Q)}_{tb} (Q_{i_{tb1}} + Q_{i_{tb2}}) \right] + B_i Q_{i_s} \right\}$$
$$\leq 10 \text{ mrad per quarter or } 20 \text{ mrad per year}$$

(3.3-5)

Beta radiation:

$$3.17 \times 10^{-8} \Sigma_i N_i \left[\overline{(\chi/Q)}_{rb} (Q_{i_{rb1}} + Q_{i_{rb2}}) + \overline{(\chi/Q)}_{tb} (Q_{i_{tb1}} + Q_{i_{tb2}}) + \overline{(\chi/Q)}_{s} Q_{i_s} \right]$$

$$\leq 20 \text{ mrad per quarter or } 40 \text{ mrad per year}$$

(3.3-6)

Where:

$\overline{(\chi/Q)}_{rb}$	=	Annual average relative concentration for releases from the Reactor Building, sec/m^3
$\overline{(\chi/Q)}_{tb}$	=	Annual average relative concentration for releases from the Turbine Building, sec/m^3
$\overline{(\chi/Q)}_{s}$	=	Annual average relative concentration for releases from the stack, sec/m^3
$Q_{i_{rb1}}, Q_{i_{rb2}}$	=	Release of radionuclide i from Reactor Buildings 1 and 2, respectively, μCi
$Q_{i_{tb1}}, Q_{i_{tb2}}$	=	Release of radionuclide i from Turbine Buildings 1 and 2, respectively, μCi
Q_{i_s}	=	Release of radionuclide i from the stack, μCi

At BSEP, the limiting location for noble gases is 0.7 miles ENE. Substitution of the appropriate χ/Q values into Expressions 3.3-5 and 3.3-6 results in the following:

During any calendar quarter or year:

Gamma radiation:

$$3.17 \times 10^{-8}\ \Sigma_i \left\{ M_i \left[1.9 \times 10^{-6}\ (Q_{i_{rb1}} + Q_{i_{rb2}}) + 6.0 \times 10^{-6}\ (Q_{i_{tb1}} + Q_{i_{tb2}}) \right] + B_i Q_{i_s} \right\}$$
$$\leq 10 \text{ mrad per quarter or } 20 \text{ mrad per year}$$

(3.3-7)

Beta radiation:

$$3.17 \times 10^{-8}\ \Sigma_i N_i \left[1.9 \times 10^{-6}\ (Q_{i_{rb1}} + Q_{i_{rb2}}) + 6.0 \times 10^{-6}\ (Q_{i_{tb1}} + Q_{i_{tb2}}) + 3.2 \times 10^{-8}\ Q_{i_s} \right]$$
$$\leq 20 \text{ mrad per quarter or } 40 \text{ mrad per year}$$

(3.3-8)

The determination of the controlling locations for implementation of 10CFR50 is a function of parameters such as radionuclide mix, isotopic release, and meteorology.

The incorporation of these parameters into Expressions 3.3-1 through 3.3-4 resulted in the expressions for the controlling locations as presented in Expressions 3.3-7 and 3.3-8. The radionuclide mix was based upon source terms calculated using the NRC GALE Code and is presented in Table 3.2-1 as a function of release point.

The two or three highest site boundary $\overline{(\chi/Q)}$ values for each release point were utilized in conjunction with the radionuclide mix and release for each release point to determine the controlling site boundary location. Since mixed mode and elevated releases occur from BSEP and their maximum χ/Q values may not decrease with distance (i.e., the site boundary may not have the highest χ/Q values); χ/Q values were calculated at the midpoint of 10 standard distance intervals out to a distance of 5 miles. The two or three highest χ/Q values were considered in conjunction with the radionuclide mix and releases to determine the controlling location.

In the determination of the controlling location, annual average χ/Q values are utilized. These values are presented in tables in Appendix A. χ/Q values at the limiting site boundary location for releases from the Turbine Buildings, Reactor Buildings, and stack were obtained from Tables A-1, A-7, and A-13, respectively, of Appendix A. A description of the derivation of χ/Q values is also presented in Appendix A.

A particular combination of release point mix and meteorology dominates in the determination of the controlling location. For BSEP the controlling release point is the stack. The dominate factor in determining a control location becomes the B_i values. The ENE sector at the site boundary is the control location because of its higher B_i values.

Values for M_i and N_i, which were used in the determination of the controlling location and which are to be used by BSEP in Expressions 3.3-7 and 3.3-8 to show compliance with 10CFR50 were presented in Table 3.2-4. These values originate from NUREG 0472, Revision 0, and were taken from Table B-1 of NRC Regulatory Guide 1.109, Revision 1. The values have been multiplied by 10^6 to convert from picocuries to microcuries.

The following relationship should hold for BSEP to show compliance with ODCM Specification 7.3.8.

For the calendar quarter:

$$D\gamma \leq 10\text{mrad} \quad (3.3\text{-}9)$$

$$D\beta \leq 20\text{mrad} \quad (3.3\text{-}10)$$

For the calendar year:

$$D\gamma \leq 20\text{mrad} \quad (3.3\text{-}11)$$

$$D\beta \leq 40\text{mrad} \quad (3.3\text{-}12)$$

Where:

$D\gamma$ = The air dose from gamma radiation, mrad

$D\beta$ = The air dose from beta radiation, mrad

The quarterly limits given above represent one-half the annual design objective of Section II.B.1 of Appendix I of 10CFR50. If any of the limits of Expressions 3.3-9 through 3.3-12 are exceeded, a special report pursuant to Section IV.A of Appendix I of 10CFR50 must be filed with the NRC.

3.3.2 I-131, I-133, Particulates, and Tritium∗

1. Cumulation of Doses

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

During any calendar quarter or year:

$$3.17 \times 10^{-8} \, \Sigma_i R_i \, (W_s Q_{i_s} + w_s q_{i_s} + W_v Q_{v_s} + w_v q_{i_v}) \quad (3.3\text{-}13)$$

$$\leq 7.5 \text{ mrem per quarter or } 15 \text{ mrem per calendar year}$$

Where:

Q_{i_s} = Release of radionuclide i for long-term, free-standing stack releases (greater than 500 hours/year), μCi

Q_{i_v} = Release of radionuclide i for long-term vent releases (greater than 500 hours/year), μCi

q_{i_s} = Release of radionuclide i for short-term, free-standing stack releases (equal to or less than 500 hours/year), μCi

q_{i_v} = Release of radionuclide i for short-term vent releases (equal to or less than 500 hours/year), μCi

W_s = Dispersion parameter for estimating dose to an individual at the controlling location for long-term, free-standing stack releases (greater than 500 hours/year)

= sec/m^3 for the inhalation pathway and tritium

= meters^{-2} for the food and ground plane pathway

∗For ODCM calculations performed to comply with ODCM TRs 7.3.7.2 and 7.3.9.1, the I-133 values used are determined by actual analysis.

W_v = The dispersion parameter for estimating the dose to an individual at the controlling location for long-term vent releases (greater than 500 hours/year)

= sec/m^3 for the inhalation pathway and tritium

= meters^{-2} for the food and ground plane pathway

w_s = Dispersion parameter for estimating the dose to an individual at the controlling location for short-term stack releases (equal to or less than 500 hours/year)

= sec/m^3 for the inhalation pathway and tritium

= meters^{-2} for the food and ground plane pathway

w_v = The dispersion parameter for estimating the dose to an individual at the controlling location for short-term vent releases (equal to or less than 500 hours/year)

= sec/m^3 for the inhalation pathway and tritium

= meters^{-2} for the food and ground plane pathway

3.17×10^{-8} = The inverse of the number of seconds in a year

R_i = The dose factor for each identified radionuclide i of the organ of interest, mrem/yr per μCi/sec per m^{-2} or mrem/yr per μCi/m^3

Radioiodines, particulates, and tritium are primarily released from the Stack, Reactor Buildings, and Turbine Buildings at BSEP. Radioiodines and particulates, may also be released from other sources such as the Hot Shop (Decon) Facility, the Radioactive Materials Container and Storage Building (RMCSB), and the Low Level Warehouse (LLW). Effluent doses from Decon, RMCSB, LLW and any building exfiltration are quantified using ground level meteorology. At BSEP all releases are considered long-term in duration. Therefore, incorporating the various release points into Expression 3.3-13 results in the following expression to show compliance with 10CFR50 for a particular organ:

$$3.17 \times 10^{-8} \Sigma_i R_i \left[W_s Q_{i_s} + W_{rb} \left(Q_{i_{rb1}} + Q_{i_{rb2}} \right) + W_{tb} \left(Q_{i_{tb1}} + Q_{i_{tb2}} + Q_{i_{DC}} + Q_{i_{RM}} + Q_{i_{LLW}} \right) \right] \leq 15.0 \text{ mrem per quarter or } 30 \text{ mrem per year} \tag{3.3-14}$$

Where:

W_s = Dispersion parameter for releases from the stack

W_{rb} = Dispersion parameter for releases from the Reactor Building

W_{tb} = Dispersion parameter for releases from the Turbine Building

Q_{i_s} = Release of radionuclide i from the stack, μCi

$Q_{i_{rb1}}, Q_{i_{rb2}}$ = Release of radionuclide i from Reactor Buildings 1 and 2, respectively, μCi

$Q_{i_{tb1}}, Q_{i_{tb2}}$ = Release of radionuclide i from Turbine Buildings 1 and 2, respectively, μCi

$Q_{i_{DC}}$ = Release of radionuclide i from the Hot Shop (Decon) Facility, μCi

$Q_{i_{RM}}$ = Release of radionuclide i from the Radioactive Materials Container and Storage Building (RMCSB), μCi

$Q_{i_{LLW}}$ = Release of radionuclide i from the Low Level Warehouse (LLW), μCi

In determining the dose at a particular location, W (as in Section 3.2.2) is a function of the pathway. For the food and ground plane pathway, W is in terms of D/Q. If the inhalation pathway is considered, W is in terms of χ/Q. Incorporation of the various pathways into Expression 3.3-14 results in the following:

$$
\begin{aligned}
&3.17\,x\,10^{-8}\Sigma_i\\
&\{(R_{i_G}+R_{i_M}+R_{i_V}+R_{i_B})\,[\,\overline{(D/Q)}_s Q_{i_s}+\overline{(D/Q)}_{rb}(Q_{i_{rb1}}+Q_{i_{rb2}})+\overline{(D/Q)}_{tb}(Q_{i_{tb1}}+Q_{i_{tb2}}+Q_{iDC}+Q_{iRM}+Q_{iLLW})]+\\
&R_{i_I}\,[\,\overline{(\chi/Q)}_s Q_{i_s}+\overline{(\chi/Q)}_{rb}(Q_{i_{rb1}}+Q_{i_{rb2}})+\overline{(\chi/Q)}_{tb}(Q_{i_{tb1}}+Q_{i_{tb2}}+Q_{iDC}+Q_{RM}+Q_{iLLW})]\}\\
&\le 15\ mrem\,(per\ quarter)\ or\ 30\ mrem\,(per\ year)
\end{aligned}
\tag{3.3-15}
$$

Where:

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_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_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_{i_I} = Dose factor for an organ for radionuclide i for the inhalation pathway, mrem/yr per μCi/m^3

$\overline{(D/Q)}_{rb}$	=	Annual average deposition for releases from the Reactor Buildings,m^{-2}
$\overline{(D/Q)}_{tb}$	=	Annual average deposition for releases from the Turbine Buildings, and other ground level releases such as Decon, RMCSB, and LLW, m^{-2}
$\overline{(D/Q)}_{s}$	=	Annual average deposition for releases from the stack, m^{-2}

As discussed in Section 3.2.2, for tritium the parameter W for the food pathway is based upon χ/Q. The ground plane pathway is not appropriate for tritium. Therefore, the left-hand portion of Expression 3.3-15 may be modified for tritium as:

For tritium:

$$D_T = 3.17 \times 10^{-8} (R_{T_M} + R_{T_V} + R_{T_B} + R_{T_I}) \left[\overline{(\chi/Q)}_s Q_{T_s} + \overline{(\chi/Q)}_{rb} (Q_{T_{rb1}} + Q_{T_{rb2}}) + \overline{(\chi/Q)}_{tb} (Q_{T_{tb1}} + Q_{T_{tb2}}) \right] \quad (3.3\text{-}16)$$

Where:

D_T	=	Dose resulting from tritium, mrem
R_{T_M}	=	Dose factor for an organ for tritium for the milk pathway, mrem/yr per μCi/m^3
R_{T_V}	=	Dose factor for an organ for tritium for the vegetable pathway, mrem/yr per μCi/m^3
R_{T_B}	=	Dose factor for an organ for tritium for the beef pathway, mrem/yr per μCi/m^3
R_{T_I}	=	Dose factor for an organ for tritium for the inhalation pathway, mrem/yr per μCi/m^3
Q_{T_s}	=	Release of tritium from the stack, μCi
$Q_{T_{rb1}}, Q_{T_{rb2}}$	=	Release of tritium from Reactor Buildings 1 and 2, respectively, μCi
$Q_{T_{tb1}}, Q_{T_{tb2}}$	=	Release of tritium from Turbine Buildings 1 and 2, respectively, μCi

To show compliance with 10CFR50, Expression 3.3-15 is evaluated at the controlling pathway location. At BSEP the controlling location is a milk cow 4.75 miles in the NE sector. Expression 3.3-15 becomes:

$$3.17 \times 10^{-8} \Sigma_i \{(R_{i_G} + R_{i_M})[2.9 \times 10^{-10} Q_{i_S} + 7.0 \times 10^{-10}(Q_{i_{rb1}} + Q_{i_{rb2}}) + 7.2 \times 10^{-10}(Q_{i_{tb1}} + Q_{i_{tb2}} + Q_{i_{DC}} + Q_{i_{RM}} + Q_{i_{LLW}})] + Ri_I[2.4 \times 10^{-8} Q_{i_s} + 1.9 \times 10^{-7}(Q_{i_{rb1}} + Q_{i_{rb2}}) + 3.2 \times 10^{-7}(Q_{i_{tb1}} + Q_{i_{tb2}} + Q_{i_{DC}} + Q_{i_{RM}} + Q_{i_{LLW}})]\}$$

$\leq$ 15 mrem/quarter or 30 mrem/year (3.3-17)

For tritium, Equation 3.3-16 reduces to:

$$D_T = 3.17 \times 10^{-8} \left(R_{T_M} + R_{T_I}\right)\left[2.4 \times 10^{-8} Q_{T_s} + 1.9 \times 10^{-7} \left(Q_{T_{rb1}} + Q_{T_{rb2}}\right) + 3.2 \times 10^{-7} \left(Q_{T_{tb1}} + Q_{T_{tb2}}\right)\right]$$

(3.3-18)

Airborne Tritium Releases from the Drainage Holding Facility and Stabilization Facility

Airborne releases of tritium from the Drainage Holding Facility (DHF) and Storm Drain Stabilization Facility (SDSF) by evaporation are routinely calculated and dose rates determined based on the following equation:

$$D_T = \left(R_{TI} + R_{TV}\right)\left[\overline{(X/Q)} * Q_T\right] \quad (3.3\text{-}19)$$

Where:

D_T = Dose rate from the DHF or SDSF tritium airborne release, mrem/year

R_{TI} = Dose parameter for tritium for the inhalation pathway, mrem/year per μCi/m^3

R_{TV} = Dose parameter for tritium for the ingestion pathway, mrem/year per μCi/m^3

$\overline{X/Q}$ = Annual average relative concentrations for releases from the DHF or SDSF to the nearest resident.

Q_T = Release rate of tritium from the DHF or SDSF, μCi/sec.

Note: The nearest resident from the center of the DHF is typically to the N at approximately 0.3 miles. The nearest resident from the center of the SDSF is typically to the NNW at approximately 0.5 miles.

The determination of a controlling location for implementation of 10CFR50 for radioiodines and particulates is a function of:

a. Radionuclide mix and isotopic release

b. Meteorology

c. Exposure pathway

d. Receptor's age

The incorporation of these parameters into Expression 3.3-14 results in the respective equations at the controlling location.

In the determination of the controlling location, the radionuclide mix of radioiodines and particulates was based upon the source terms calculated using the GALE code. This mix was presented in Table 3.2-1 as a function of release point.

In the determination of the controlling location, all of the exposure pathways, as presented in Table 3.2-2, were evaluated. These include cow milk, goat milk, beef and vegetable ingestion, and inhalation 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 and inhalation pathways were considered present everywhere a residence was present.

For the determination of the controlling location, the highest D/Q values for each release point and release mode for the vegetable garden, cow milk, and goat milk pathways were selected. At BSEP, no cow milk or goat milk pathways are present. In accordance with NUREG 0133, dose to a "hypothetical" cow milk pathway located 4.75 miles NE was evaluated against existing vegetable garden pathways. The thyroid dose was calculated at each of these locations using the radionuclide mix and releases of Table 3.2-1. Based upon these calculations, it was determined that the controlling receptor pathway is the "hypothetical" cow milk-infant pathway in the NE sector, at 4.75 miles.

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, and 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 discussion of their calculation is presented in Appendix C.

In the determination of the controlling location annual average $\overline{D/Q}$ and $\overline{\chi/Q}$ values are utilized. D/Q values at the limiting real pathway locations for releases from the Turbine Buildings, Reactor Buildings, and the stack were obtained from Tables A-3, A-9, and A-15, respectively, of Appendix A. χ/Q values at the same location for these same release points were obtained from Tables A-1, A-7, and A-13 of Appendix A. A description of the derivation of the various χ/Q and D/Q values is presented in Appendix A.

Long-term $\overline{D/Q}$ values for the stack, Reactor Buildings, and Turbine Buildings are provided for the midpoints of the following distances:

0.0-0.5 mi.	0.5-1.0 mi.	1.0-1.5 mi.	1.5-2.0 mi.
2.0-2.5 mi.	2.5-3.0 mi.	3.0-3.5 mi.	3.5-4.0 mi.
4.0-4.5 mi.	4.5-5.0 mi.		

These values appear in tables in Appendix A. These tables may be utilized if an additional special location arises which is different from one presented in the special locations of Appendix A.

The following relationships should hold for BSEP to show compliance with BSEP ODCM Specification 7.3.9.

For the calendar quarter:

$$D_\tau \leq 15 \text{ mrem} \quad (3.3\text{-}20)$$

For the calendar year:

$$D_\tau \leq 30 \text{ mrem} \quad (3.3\text{-}21)$$

Where:

D_τ = The dose to any organ τ from radioiodines and particulates, mrem

The quarterly limits given above represent one-half the annual design objective of Section II.C of Appendix I of 10CFR50. If any of the limits of Expressions 3.3-20 or 3.3-21 are exceeded, a special report pursuant to Section IV.A of Appendix I of 10CFR50 must be filed with the NRC.

2. Projection of Doses

Dose projections for this section are required at least once per 31 days in ODCM TR 7.3.11.2.

The doses will be projected using the equation below. Where possible, credit for expected operational evolutions (i.e., outages, etc.) should be taken 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.

$$D_{pt} = \left(\frac{D_{\tau}}{T_e} \times 31 \right) + D_{a\tau}$$

Where:

$D_{p\tau}$	=	31 day projected dose by organ τ, in mrem;
D_{τ}	=	Current cumulative monthly dose of organ τ up to the end of the release under evaluation, in mrem
T_e	=	time elapsed in month up to the end of the release under evaluation, in days;
31	=	number of days dose is projected; and
$D_{a\tau}$	=	additional anticipated dose by organ τ in mrem.

TABLE 3.3-1 R VALUES FOR THE BRUNSWICK STEAM ELECTRIC PLANT*

PATHWAY = Ground

Nuclide	T. Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
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	1.34E+09	1.34E+09	1.34E+09	1.34E+09	1.34E+09	1.34E+09	1.34E+09	1.57E+09
FE-59	2.75E+08	2.75E+08	2.75E+08	2.75E+08	2.75E+08	2.75E+08	2.75E+08	3.23E+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+09
CO-60	2.15E+10	2.15E+10	2.15E+10	2.15E+10	2.15E+10	2.15E+10	2.15E+10	2.52E+10
ZN-65	7.49E+08	7.49E+08	7.49E+08	7.49E+08	7.49E+08	7.49E+08	7.49E+08	8.61E+08
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
SR-89	2.23E+04	2.23E+04	2.23E+04	2.23E+04	2.23E+04	2.23E+04	2.23E+04	2.58E+04
Y-91	1.08E+06	1.08E+06	1.08E+06	1.08E+06	1.08E+06	1.08E+06	1.08E+06	1.22E+06
ZR-95	2.49E+08	2.49E+08	2.49E+08	2.49E+08	2.49E+08	2.49E+08	2.49E+08	2.89E+08
NB-95	1.36E+08	1.36E+08	1.36E+08	1.36E+08	1.36E+08	1.36E+08	1.36E+08	1.60E+08
RU-103	1.09E+08	1.09E+08	1.09E+08	1.09E+08	1.09E+08	1.09E+08	1.09E+08	1.27E+08
RU-106	4.19E+08	4.19E+08	4.19E+08	4.19E+08	4.19E+08	4.19E+08	4.19E+08	5.03E+08
AG-110M	3.48E+09	3.48E+09	3.48E+09	3.48E+09	3.48E+09	3.48E+09	3.48E+09	4.06E+09
SN-113	1.44E+07	6.28E+06	1.22E+07	6.21E+06	1.00E+07	1.33E+07	8.14E+06	4.09E+07
TE-127M	9.15E+04	9.15E+04	9.15E+04	9.15E+04	9.15E+04	9.15E+04	9.15E+04	1.08E+05
TE-129M	2.00E+07	2.00E+07	2.00E+07	2.00E+07	2.00E+07	2.00E+07	2.00E+07	2.34E+07
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	1.24E+06	1.24E+06	1.24E+06	1.24E+06	1.24E+06	1.24E+06	1.24E+06	1.46E+06
I-133	2.47E+06	2.47E+06	2.47E+06	2.47E+06	2.47E+06	2.47E+06	2.47E+06	3.00E+06
I-135	2.56E+06	2.56E+06	2.56E+06	2.56E+06	2.56E+06	2.56E+06	2.56E+06	2.99E+06
CS-134	6.82E+09	6.82E+09	6.82E+09	6.82E+09	6.82E+09	6.82E+09	6.82E+09	7.96E+09
CS-136	1.49E+08	1.49E+08	1.49E+08	1.49E+08	1.49E+08	1.49E+08	1.49E+08	1.69E+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
BA-140	2.05E+07	2.05E+07	2.05E+07	2.05E+07	2.05E+07	2.05E+07	2.05E+07	2.34E+07
CE-141	1.36E+07	1.36E+07	1.36E+07	1.36E+07	1.36E+07	1.36E+07	1.36E+07	1.53E+07
CE-144	6.95E+07	6.95E+07	6.95E+07	6.95E+07	6.95E+07	6.95E+07	6.95E+07	8.03E+07
HF-181	1.97E+08	1.63E+08	2.30E+08	1.70E+08	1.76E+08	2.33E+08	1.82E+08	2.82E+08
AM-241	5.16E+08	5.16E+08	5.16E+08	5.16E+08	5.16E+08	5.16E+08	5.16E+08	7.45E+08

*R Values in units of mrem/yr per μCi/m^3 for inhalation and tritium, and in units of m^2-mrem/yr per μCi/sec for all others.

TABLE 3.3-2 R VALUES FOR THE BRUNSWICK STEAM ELECTRIC PLANT*

PATHWAY = Vegetable

AGE GROUP = Adult

Nuclide	T. Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
H-3	2.28E+03	2.28E+03	0.00E+00	2.28E+03	2.28E+03	2.28E+03	2.28E+03	2.28E+03
P-32	5.91E+07	1.72E+08	1.53E+09	9.51E+07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CR-51	4.60E+04	1.16E+07	0.00E+00	0.00E+00	1.01E+04	2.75E+04	6.10E+04	0.00E+00
MN-54	5.83E+07	9.36E+08	0.00E+00	3.05E+08	9.09E+07	0.00E+00	0.00E+00	0.00E+00
FE-59	1.12E+08	9.75E+08	1.24E+08	2.93E+08	0.00E+00	0.00E+00	8.17E+07	0.00E+00
CO-58	6.71E+07	6.07E+08	0.00E+00	2.99E+07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO-60	3.67E+08	3.12E+09	0.00E+00	1.66E+08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ZN-65	5.77E+08	8.04E+08	4.01E+08	1.28E+09	8.54E+08	0.00E+00	0.00E+00	0.00E+00
RB-86	1.03E+08	4.36E+07	0.00E+00	2.21E+08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-89	2.87E+08	1.60E+09	1.00E+10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-90	1.64E+11	1.93E+10	6.70E+11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-91	1.34E+05	2.76E+09	5.01E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ZR-95	2.51E+05	1.17E+09	1.16E+06	3.71E+05	5.82E+05	0.00E+00	0.00E+00	0.00E+00
NB-95	4.19E+04	4.73E+08	1.40E+05	7.79E+04	7.70E+04	0.00E+00	0.00E+00	0.00E+00
RU-103	2.04E+06	5.53E+08	4.74E+06	0.00E+00	1.81E+07	0.00E+00	0.00E+00	0.00E+00
RU-106	2.46E+07	1.26E+10	1.94E+08	0.00E+00	3.75E+08	0.00E+00	0.00E+00	0.00E+00
AG-110M	6.23E+06	4.28E+09	1.13E+07	1.05E+07	2.06E+07	0.00E+00	0.00E+00	0.00E+00
SN-113	1.36E+07	2.53E+08	1.44E+07	5.60E+05	4.09E+05	1.96E+05	0.00E+00	0.00E+00
TE-127M	6.12E+07	1.68E+09	5.02E+08	1.80E+08	2.04E+09	1.28E+08	0.00E+00	0.00E+00
TE-129M	4.71E+07	1.50E+09	2.98E+08	1.11E+08	1.24E+09	1.02E+08	0.00E+00	0.00E+00
I-131	6.61E+07	3.04E+07	8.07E+07	1.15E+08	1.98E+08	3.78E+10	0.00E+00	0.00E+00
I-132	5.21E+01	2.80E+01	5.57E+01	1.49E+02	2.37E+02	5.21E+03	0.00E+00	0.00E+00
I-133	1.12E+06	3.30E+06	2.11E+06	3.67E+06	6.40E+06	5.39E+08	0.00E+00	0.00E+00
I-135	3.91E+04	1.20E+05	4.05E+04	1.06E+05	1.70E+05	7.00E+06	0.00E+00	0.00E+00
CS-134	8.83E+09	1.89E+08	4.54E+09	1.08E+10	3.49E+09	0.00E+00	1.16E+09	0.00E+00
CS-136	1.19E+08	1.88E+07	4.19E+07	1.66E+08	9.21E+07	0.00E+00	1.26E+07	0.00E+00
CS-137	5.94E+09	1.76E+08	6.63E+09	9.07E+09	3.08E+09	0.00E+00	1.02E+09	0.00E+00
BA-140	8.40E+06	2.64E+08	1.28E+08	1.61E+05	5.47E+04	0.00E+00	9.22E+04	0.00E+00
CE-141	1.48E+04	4.99E+08	1.93E+05	1.31E+05	6.07E+04	0.00E+00	0.00E+00	0.00E+00
CE-144	1.69E+06	1.06E+10	3.15E+07	1.32E+07	7.80E+06	0.00E+00	0.00E+00	0.00E+00
HF-181	1.08E+06	7.06E+08	9.51E+06	5.36E+04	4.48E+04	3.41E+04	0.00E+00	0.00E+00
AM-241	4.12E+09	5.65E+09	5.75E+10	5.37E+10	3.10E+10	0.00E+00	0.00E+00	0.00E+00

*R Values in units of mrem/yr per μCi/m^3 for inhalation and tritium, and in units of m^2-mrem/yr per μCi/sec for all others.

TABLE 3.3-3 R VALUES FOR THE BRUNSWICK STEAM ELECTRIC PLANT*

PATHWAY = Vegetable

AGE GROUP = Teen

Nuclide	T. Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
H-3	2.61E+03	2.61E+03	0.00E+00	2.61E+03	2.61E+03	2.61E+03	2.61E+03	2.61E+03
P-32	6.80E+07	1.47E+08	1.75E+09	1.09E+08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CR-51	6.11E+04	1.03E+07	0.00E+00	0.00E+00	1.34E+04	3.39E+04	8.72E+04	0.00E+00
MN-54	8.79E+07	9.09E+08	0.00E+00	4.43E+08	1.32E+08	0.00E+00	0.00E+00	0.00E+00
FE-59	1.60E+08	9.78E+08	1.77E+08	4.14E+08	0.00E+00	0.00E+00	1.30E+08	0.00E+00
CO-58	9.79E+07	5.85E+08	0.00E+00	4.25E+07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO-60	5.57E+08	3.22E+09	0.00E+00	2.47E+08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ZN-65	8.68E+08	7.88E+08	5.36E+08	1.86E+09	1.19E+09	0.00E+00	0.00E+00	0.00E+00
RB-86	1.30E+08	4.09E+07	0.00E+00	2.76E+08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-89	4.36E+08	1.81E+09	1.52E+10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-90	2.05E+11	2.33E+10	8.32E+11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-91	2.06E+05	3.15E+09	7.68E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ZR-95	3.68E+05	1.23E+09	1.69E+06	5.35E+05	7.86E+05	0.00E+00	0.00E+00	0.00E+00
NB-95	5.77E+04	4.48E+08	1.89E+05	1.05E+05	1.02E+05	0.00E+00	0.00E+00	0.00E+00
RU-103	2.90E+06	5.66E+08	6.78E+06	0.00E+00	2.39E+07	0.00E+00	0.00E+00	0.00E+00
RU-106	3.93E+07	1.50E+10	3.12E+08	0.00E+00	6.02E+08	0.00E+00	0.00E+00	0.00E+00
AG-110M	9.39E+06	4.34E+09	1.63E+07	1.54E+07	2.95E+07	0.00E+00	0.00E+00	0.00E+00
SN-113	2.02E+07	2.29E+08	1.91E+07	8.03E+05	5.65E+05	2.63E+05	0.00E+00	0.00E+00
TE-127M	9.44E+07	1.98E+09	7.93E+08	2.81E+08	3.22E+09	1.89E+08	0.00E+00	0.00E+00
TE-129M	6.79E+07	1.61E+09	4.29E+08	1.59E+08	1.77E+09	1.38E+08	0.00E+00	0.00E+00
I-131	5.77E+07	2.13E+07	7.68E+07	1.07E+08	1.85E+08	3.14E+10	0.00E+00	0.00E+00
I-132	4.72E+01	5.72E+01	5.02E+01	1.31E+02	2.07E+02	4.43E+03	0.00E+00	0.00E+00
I-133	1.01E+06	2.51E+06	1.96E+06	3.32E+06	5.83E+06	4.64E+08	0.00E+00	0.00E+00
I-135	3.49E+04	1.04E+05	3.66E+04	9.42E+04	1.49E+05	6.06E+06	0.00E+00	0.00E+00
CS-134	7.54E+09	2.02E+08	6.90E+09	1.62E+10	5.16E+09	0.00E+00	1.97E+09	0.00E+00
CS-136	1.13E+08	1.35E+07	4.28E+07	1.68E+08	9.16E+07	0.00E+00	1.44E+07	0.00E+00
CS-137	4.90E+09	2.00E+08	1.06E+10	1.41E+10	4.78E+09	0.00E+00	1.86E+09	0.00E+00
BA-140	8.88E+06	2.12E+08	1.38E+08	1.69E+05	5.72E+04	0.00E+00	1.14E+05	0.00E+00
CE-141	2.12E+04	5.29E+08	2.77E+05	1.85E+05	8.70E+04	0.00E+00	0.00E+00	0.00E+00
CE-144	2.71E+06	1.27E+10	5.04E+07	2.09E+07	1.25E+07	0.00E+00	0.00E+00	0.00E+00
HF-181	1.54E+06	6.90E+08	1.38E+07	7.58E+04	6.32E+04	4.63E+04	0.00E+00	0.00E+00
AM-241	4.97E+09	6.80E+09	6.89E+10	6.50E+10	3.72E+10	0.00E+00	0.00E+00	0.00E+00

*R Values in units of mrem/yr per μCi/m^3 for inhalation and tritium, and in units of m^2-mrem/yr per μCi/sec for all others.

TABLE 3.3-4 R VALUES FOR THE BRUNSWICK STEAM ELECTRIC PLANT*

PATHWAY = Vegetable

AGE GROUP = Child

Nuclide	T. Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
H-3	4.04E+03	4.04E+03	0.00E+00	4.04E+03	4.04E+03	4.04E+03	4.04E+03	4.04E+03
P-32	1.42E+08	1.01E+08	3.67E+09	1.72E+08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CR-51	1.16E+05	6.15E+06	0.00E+00	0.00E+00	1.76E+04	6.44E+04	1.18E+05	0.00E+00
MN-54	1.73E+08	5.44E+08	0.00E+00	6.49E+08	1.82E+08	0.00E+00	0.00E+00	0.00E+00
FE-59	3.17E+08	6.62E+08	3.93E+08	6.36E+08	0.00E+00	0.00E+00	1.84E+08	0.00E+00
CO-58	1.92E+08	3.66E+08	0.00E+00	6.27E+07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO-60	1.11E+09	2.08E+09	0.00E+00	3.76E+08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ZN-65	1.70E+09	4.81E+08	1.03E+09	2.74E+09	1.73E+09	0.00E+00	0.00E+00	0.00E+00
RB-86	2.81E+08	2.94E+07	0.00E+00	4.56E+08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-89	1.03E+09	1.40E+09	3.62E+10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-90	3.49E+11	1.86E+10	1.38E+12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-91	4.89E+05	2.44E+09	1.83E+07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ZR-95	7.44E+05	8.71E+08	3.80E+06	8.35E+05	1.20E+06	0.00E+00	0.00E+00	0.00E+00
NB-95	1.12E+05	2.91E+08	4.04E+05	1.57E+05	1.48E+05	0.00E+00	0.00E+00	0.00E+00
RU-103	5.86E+06	3.94E+08	1.52E+07	0.00E+00	3.84E+07	0.00E+00	0.00E+00	0.00E+00
RU-106	9.38E+07	1.17E+10	7.52E+08	0.00E+00	1.02E+09	0.00E+00	0.00E+00	0.00E+00
AG-110M	1.87E+07	2.78E+09	3.46E+07	2.34E+07	4.35E+07	0.00E+00	0.00E+00	0.00E+00
SN-113	3.98E+07	1.46E+08	3.64E+07	1.18E+06	8.09E+05	4.82E+05	0.00E+00	0.00E+00
TE-127M	2.26E+08	1.54E+09	1.90E+09	5.12E+08	5.42E+09	4.55E+08	0.00E+00	0.00E+00
TE-129M	1.55E+08	1.22E+09	9.98E+08	2.79E+08	2.93E+09	3.22E+08	0.00E+00	0.00E+00
I-131	8.16E+07	1.23E+07	1.43E+08	1.44E+08	2.36E+08	4.75E+10	0.00E+00	0.00E+00
I-132	7.53E+01	1.93E+02	8.91E+01	1.64E+02	2.51E+02	7.60E+03	0.00E+00	0.00E+00
I-133	1.67E+06	1.78E+06	3.57E+06	4.42E+06	7.36E+06	8.21E+08	0.00E+00	0.00E+00
I-135	5.54E+04	8.92E+04	6.50E+04	1.17E+05	1.79E+05	1.04E+07	0.00E+00	0.00E+00
CS-134	5.40E+09	1.38E+08	1.56E+10	2.56E+10	7.93E+09	0.00E+00	2.84E+09	0.00E+00
CS-136	1.43E+08	7.77E+06	8.04E+07	2.21E+08	1.18E+08	0.00E+00	1.76E+07	0.00E+00
CS-137	3.52E+09	1.50E+08	2.49E+10	2.39E+10	7.78E+09	0.00E+00	2.80E+09	0.00E+00
BA-140	1.61E+07	1.40E+08	2.76E+08	2.42E+05	7.87E+04	0.00E+00	1.44E+05	0.00E+00
CE-141	4.75E+04	3.99E+08	6.42E+05	3.20E+05	1.40E+05	0.00E+00	0.00E+00	0.00E+00
CE-144	6.49E+06	9.94E+09	1.22E+08	3.81E+07	2.11E+07	0.00E+00	0.00E+00	0.00E+00
HF-181	3.15E+06	3.17E+08	3.13E+07	1.22E+05	9.78E+04	1.03E+05	0.00E+00	0.00E+00
AM-241	7.12E+09	5.34E+09	9.50E+10	8.17E+10	4.35E+10	0.00E+00	0.00E+00	0.00E+00

*R Values in units of mrem/yr per μCi/m^3 for inhalation and tritium, and in units of m^2-mrem/yr per μCi/sec for all others.

TABLE 3.3-5 R VALUES FOR THE BRUNSWICK STEAM ELECTRIC PLANT*

PATHWAY = Meat

AGE GROUP = Adult

Nuclide	T. Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
H-3	3.27E+02	3.27E+02	0.00E+00	3.27E+02	3.27E+02	3.27E+02	3.27E+02	3.27E+02
P-32	1.18E+08	3.43E+08	3.05E+09	1.89E+08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CR-51	4.27E+03	1.08E+06	0.00E+01	0.00E+00	9.42E+02	2.56E+03	5.67E+03	0.00E+00
MN-54	1.06E+06	1.71E+07	0.00E+00	5.57E+06	1.66E+06	0.00E+00	0.00E+00	0.00E+00
FE-59	1.43E+08	1.25E+09	1.59E+08	3.74E+08	0.00E+00	0.00E+00	1.04E+08	0.00E+00
CO-58	2.43E+07	2.20E+08	0.00E+00	1.08E+07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO-60	1.03E+08	8.76E+08	0.00E+00	4.66E+07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ZN-65	3.58E+08	4.98E+08	2.49E+08	7.91E+08	5.29E+08	0.00E+00	0.00E+00	0.00E+00
RB-86	1.42E+08	6.00E+07	0.00E+00	3.04E+08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-89	5.23E+06	2.92E+07	1.82E+08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-90	2.02E+09	2.38E+08	8.22E+09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-91	1.80E+04	3.71E+08	6.75E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ZR-95	2.43E+05	1.14E+09	1.12E+06	3.59E+05	5.64E+05	0.00E+00	0.00E+00	0.00E+00
NB-95	4.12E+05	4.65E+09	1.38E+06	7.66E+05	7.58E+05	0.00E+00	0.00E+00	0.00E+00
RU-103	2.72E+07	7.38E+09	6.32E+07	0.00E+00	2.41E+08	0.00E+00	0.00E+00	0.00E+00
RU-106	2.19E+08	1.12E+11	1.73E+09	0.00E+00	3.35E+09	0.00E+00	0.00E+00	0.00E+00
AG-110M	2.34E+06	1.61E+09	4.27E+06	3.95E+06	7.76E+06	0.00E+00	0.00E+00	0.00E+00
SN-113	2.80E+07	5.19E+08	2.97E+07	1.15E+06	8.40E+05	4.03E+05	0.00E+00	0.00E+00
TE-127M	1.00E+08	2.76E+09	8.22E+08	2.94E+08	3.34E+09	2.10E+08	0.00E+00	0.00E+00
TE-129M	1.17E+08	3.73E+09	7.40E+08	2.76E+08	3.09E+09	2.54E+08	0.00E+00	0.00E+00
I-131	5.77E+06	2.66E+06	7.04E+06	1.01E+07	1.73E+07	3.30E+09	0.00E+00	0.00E+00
I-133	1.51E-01	4.46E-01	2.85E-01	4.96E-01	8.66E-01	7.29E+01	0.00E+00	0.00E+00
I-135	6.07E-17	1.86E-16	6.28E-17	1.64E-16	2.64E-16	1.08E-14	0.00E+00	0.00E+00
CS-134	7.81E+08	1.67E+07	4.01E+08	9.55E+08	3.09E+08	0.00E+00	1.03E+08	0.00E+00
CS-136	2.14E+07	3.33E+06	7.53E+06	2.97E+07	1.65E+07	0.00E+00	2.27E+06	0.00E+00
CS-137	4.99E+08	1.47E+07	5.57E+08	7.61E+08	2.58E+08	0.00E+00	8.59E+07	0.00E+00
BA-140	1.20E+06	3.77E+07	1.83E+07	2.30E+04	7.82E+03	0.00E+00	1.32E+04	0.00E+00
CE-141	6.46E+02	2.18E+07	8.42E+03	5.69E+03	2.65E+03	0.00E+00	0.00E+00	0.00E+00
CE-144	4.70E+04	2.96E+08	8.75E+05	3.66E+05	2.17E+05	0.00E+00	0.00E+00	0.00E+00
HF-181	1.52E+06	9.97E+08	1.34E+07	7.57E+04	6.33E+04	4.81E+04	0.00E+00	0.00E+00
AM-241	1.80E+07	2.47E+07	2.52E+08	2.35E+08	1.36E+08	0.00E+00	0.00E+00	0.00E+00

*R Values in units of mrem/yr per µCi/m^3 for inhalation and tritium, and in units of m^2-mrem/yr per µCi/sec for all others.

TABLE 3.3-6 R VALUES FOR THE BRUNSWICK STEAM ELECTRIC PLANT*

PATHWAY = Meat

AGE GROUP = Teen

Nuclide	T. Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
H-3	1.95E+02	1.95E+02	0.00E+00	1.95E+02	1.95E+02	1.95E+02	1.95E+02	1.95E+02
P-32	9.98E+07	2.16E+08	2.58E+09	1.60E+08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CR-51	3.42E+03	5.75E+05	0.00E+00	0.00E+00	7.49E+02	1.90E+03	4.88E+03	0.00E+00
MN-54	8.43E+05	8.72E+06	0.00E+00	4.25E+06	1.27E+06	0.00E+00	0.00E+00	0.00E+00
FE-59	1.15E+08	7.02E+08	1.27E+08	2.97E+08	0.00E+00	0.00E+00	9.36E+07	0.00E+00
CO-58	1.93E+07	1.15E+08	0.00E+00	8.36E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO-60	8.15E+07	4.71E+08	0.00E+00	3.62E+07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ZN-65	2.83E+08	2.57E+08	1.75E+08	6.07E+08	3.89E+08	0.00E+00	0.00E+00	0.00E+00
RB-86	1.19E+08	3.76E+07	0.00E+00	2.54E+08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-89	4.40E+06	1.83E+07	1.54E+08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-90	1.31E+09	1.49E+08	5.32E+09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-91	1.52E+04	2.33E+08	5.68E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ZR-95	1.95E+05	6.53E+08	8.97E+05	2.83E+05	4.16E+05	0.00E+00	0.00E+00	0.00E+00
NB-95	3.29E+05	2.55E+09	1.08E+06	5.97E+05	5.79E+05	0.00E+00	0.00E+00	0.00E+00
RU-103	2.20E+07	4.30E+09	5.15E+07	0.00E+00	1.82E+08	0.00E+00	0.00E+00	0.00E+00
RU-106	1.84E+08	7.00E+10	1.46E+09	0.00E+00	2.81E+09	0.00E+00	0.00E+00	0.00E+00
AG-110M	1.86E+06	8.59E+08	3.23E+06	3.06E+06	5.83E+06	0.00E+00	0.00E+00	0.00E+00
SN-113	2.22E+07	2.51E+08	2.09E+07	8.80E+05	6.19E+05	2.89E+05	0.00E+00	0.00E+00
TE-127M	8.25E+07	1.73E+09	6.94E+08	2.46E+08	2.81E+09	1.65E+08	0.00E+00	0.00E+00
TE-129M	9.81E+07	2.33E+09	6.20E+08	2.30E+08	2.59E+09	2.00E+08	0.00E+00	0.00E+00
I-131	4.40E+06	1.62E+06	5.85E+06	8.20E+06	1.41E+07	2.39E+09	0.00E+00	0.00E+00
I-133	1.23E-01	3.06E-01	2.39E-01	4.05E-01	7.10E-01	5.65E+01	0.00E+00	0.00E+00
I-135	4.88E-17	1.46E-16	5.11E-17	1.32E-16	2.08E-16	8.46E-15	0.00E+00	0.00E+00
CS-134	3.48E+08	9.34E+06	3.19E+08	7.51E+08	2.39E+08	0.00E+00	9.11E+07	0.00E+00
CS-136	1.55E+07	1.86E+06	5.87E+06	2.31E+07	1.26E+07	0.00E+00	1.98E+06	0.00E+00
CS-137	2.14E+08	8.75E+06	4.62E+08	6.15E+08	2.09E+08	0.00E+00	8.13E+07	0.00E+00
BA-140	9.76E+05	2.34E+07	1.51E+07	1.86E+04	6.29E+03	0.00E+00	1.25E+04	0.00E+00
CE-141	5.42E+02	1.35E+07	7.07E+03	4.72E+03	2.22E+03	0.00E+00	0.00E+00	0.00E+00
CE-144	3.96E+04	1.85E+08	7.37E+05	3.05E+05	1.82E+05	0.00E+00	0.00E+00	0.00E+00
HF-181	1.23E+06	5.50E+08	1.10E+07	6.05E+04	5.04E+04	3.69E+04	0.00E+00	0.00E+00
AM-241	1.13E+07	1.55E+07	1.57E+08	1.48E+08	8.49E+07	0.00E+00	0.00E+00	0.00E+00

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

TABLE 3.3-7 R VALUES FOR THE BRUNSWICK STEAM ELECTRIC PLANT*

PATHWAY = Meat

AGE GROUP = Child

Nuclide	T. Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
H-3	2.36E+02	2.36E+02	0.00E+00	2.36E+02	2.36E+02	2.36E+02	2.36E+02	2.36E+02
P-32	1.87E+08	1.34E+08	4.86E+09	2.27E+08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CR-51	5.33E+03	2.83E+05	0.00E+00	0.00E+00	8.09E+02	2.96E+03	5.40E+03	0.00E+00
MN-54	1.30E+06	4.08E+06	0.00E+00	4.86E+06	1.36E+06	0.00E+00	0.00E+00	0.00E+00
FE-59	1.82E+08	3.80E+08	2.25E+08	3.65E+08	0.00E+00	0.00E+00	1.06E+08	0.00E+00
CO-58	2.99E+07	5.70E+07	0.00E+00	9.76E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO-60	1.27E+08	2.38E+08	0.00E+00	4.30E+07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ZN-65	4.35E+08	1.23E+08	2.62E+08	6.99E+08	4.40E+08	0.00E+00	0.00E+00	0.00E+00
RB-86	2.21E+08	2.32E+07	0.00E+00	3.60E+08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-89	8.31E+06	1.13E+07	2.91E+08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-90	1.74E+09	9.26E+07	6.87E+09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-91	2.87E+04	1.43E+08	1.07E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ZR-95	3.12E+05	3.65E+08	1.59E+06	3.50E+05	5.01E+05	0.00E+00	0.00E+00	0.00E+00
NB-95	5.17E+05	1.34E+09	1.86E+06	7.23E+05	6.80E+05	0.00E+00	0.00E+00	0.00E+00
RU-103	3.58E+07	2.41E+09	9.31E+07	0.00E+00	2.34E+08	0.00E+00	0.00E+00	0.00E+00
RU-106	3.43E+08	4.27E+10	2.75E+09	0.00E+00	3.71E+09	0.00E+00	0.00E+00	0.00E+00
AG-110M	2.89E+06	4.30E+08	5.36E+06	3.62E+06	6.74E+06	0.00E+00	0.00E+00	0.00E+00
SN-113	3.43E+07	1.25E+08	3.14E+07	1.01E+06	6.97E+05	4.15E+05	0.00E+00	0.00E+00
TE-127M	1.55E+08	1.06E+09	1.31E+09	3.52E+08	3.73E+09	3.13E+08	0.00E+00	0.00E+00
TE-129M	1.81E+08	1.42E+09	1.17E+09	3.26E+08	3.43E+09	3.77E+08	0.00E+00	0.00E+00
I-131	6.20E+06	9.72E+05	1.09E+07	1.09E+07	1.79E+07	3.61E+09	0.00E+00	0.00E+00
I-133	2.07E-01	2.21E-01	4.43E-01	5.48E-01	9.13E-01	1.02E+02	0.00E+00	0.00E+00
I-135	7.87E-17	1.27E-16	9.25E-17	1.66E-16	2.55E-16	1.47E-14	0.00E+00	0.00E+00
CS-134	1.95E+08	4.93E+06	5.63E+08	9.23E+08	2.86E+08	0.00E+00	1.03E+08	0.00E+00
CS-136	1.80E+07	9.78E+05	1.01E+07	2.78E+07	1.48E+07	0.00E+00	2.21E+06	0.00E+00
CS-137	1.20E+08	5.10E+06	8.51E+08	8.15E+08	2.65E+08	0.00E+00	9.55E+07	0.00E+00
BA-140	1.63E+06	1.42E+07	2.80E+07	2.45E+04	7.97E+03	0.00E+00	1.46E+04	0.00E+00
CE-141	9.86E+02	8.28E+06	1.33E+04	6.64E+03	2.91E+03	0.00E+00	0.00E+00	0.00E+00
CE-144	7.42E+04	1.14E+08	1.39E+06	4.36E+05	2.41E+05	0.00E+00	0.00E+00	0.00E+00
HF-181	2.02E+06	3.31E+08	2.01E+07	7.79E+04	6.26E+04	6.56E+04	0.00E+00	0.00E+00
AM-241	1.27E+07	9.49E+06	1.69E+08	1.45E+08	7.74E+07	0.00E+00	0.00E+00	0.00E+00

*R Values in units of mrem/yr per μCi/m^3 for inhalation and tritium, and in units of m^2-mrem/yr per μCi/sec for all others.

TABLE 3.3-8 R VALUES FOR THE BRUNSWICK STEAM ELECTRIC PLANT*

PATHWAY = Cow Milk

AGE GROUP = Adult

Nuclide	T. Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
H-3	7.69E+02	7.69E+02	0.00E+00	7.69E+02	7.69E+02	7.69E+02	7.69E+02	7.69E+02
P-32	4.32E+08	1.26E+09	1.12E+10	6.95E+08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CR-51	1.73E+04	4.36E+06	0.00E+00	0.00E+00	3.82E+03	1.04E+04	2.30E+04	0.00E+00
MN-54	9.76E+05	1.57E+07	0.00E+00	5.11E+06	1.52E+06	0.00E+00	0.00E+00	0.00E+00
FE-59	1.60E+07	1.39E+08	1.77E+07	4.17E+07	0.00E+00	0.00E+00	1.17E+07	0.00E+00
CO-58	6.28E+06	5.68E+07	0.00E+00	2.80E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO-60	2.24E+07	1.91E+08	0.00E+00	1.02E+07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ZN-65	1.38E+09	1.92E+09	9.59E+08	3.05E+09	2.04E+09	0.00E+00	0.00E+00	0.00E+00
RB-86	7.54E+08	3.19E+08	0.00E+00	1.62E+09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-89	2.50E+07	1.40E+08	8.70E+08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-90	7.59E+09	8.94E+08	3.09E+10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-91	1.37E+02	2.81E+06	5.11E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ZR-95	1.22E+02	5.71E+05	5.62E 02	1.80E 02	2.83E 02	0.00E+00	0.00E+00	0.00E+00
NB-95	1.48E+04	1.67E+08	4.95E+04	2.75E+04	2.72E+04	0.00E+00	0.00E+00	0.00E+00
RU-103	2.63E+02	7.14E+04	6.11E+02	0.00E+00	2.33E+03	0.00E+00	0.00E+00	0.00E+00
RU-106	1.60E+03	8.17E+05	1.26E+04	0.00E+00	2.44E+04	0.00E+00	0.00E+00	0.00E+00
AG-110M	2.04E+07	1.40E+10	3.71E+07	3.44E+07	6.76E+07	0.00E+00	0.00E+00	0.00E+00
SN-113	1.32E+06	2.44E+07	1.40E+06	5.41E+04	3.96E+04	1.90E+04	0.00E+00	0.00E+00
TE-127M	4.11E+06	1.13E+08	3.37E+07	1.21E+07	1.37E+08	8.62E+06	0.00E+00	0.00E+00
TE-129M	6.19E+06	1.97E+08	3.91E+07	1.46E+07	1.63E+08	1.34E+07	0.00E+00	0.00E+00
I-131	1.59E+08	7.32E+07	1.94E+08	2.77E+08	4.76E+08	9.09E+10	0.00E+00	0.00E+00
I-132	1.03E-01	5.51E-02	1.10E-01	2.93E-01	4.67E-01	1.03E+01	0.00E+00	0.00E+00
I-133	1.40E+06	4.13E+06	2.64E+06	4.59E+06	8.01E+06	6.75E+08	0.00E+00	0.00E+00
I-135	9.03E+03	2.76E+04	9.34E+03	2.45E+04	3.92E+04	1.61E+06	0.00E+00	0.00E+00
CS-134	6.71E+09	1.44E+08	3.45E+09	8.22E+09	2.66E+09	0.00E+00	8.82E+08	0.00E+00
CS-136	4.73E+08	7.46E+07	1.66E+08	6.57E+08	3.65E+08	0.00E+00	5.01E+07	0.00E+00
CS-137	4.22E+09	1.25E+08	4.71E+09	6.44E+09	2.19E+09	0.00E+00	7.27E+08	0.00E+00
BA-140	1.12E+06	3.53E+07	1.71E+07	2.15E+04	7.32E+03	0.00E+00	1.23E+04	0.00E+00
CE-141	2.23E+02	7.52E+06	2.91E+03	1.97E+03	9.14E+02	0.00E+00	0.00E+00	0.00E+00
CE-144	1.15E+04	7.26E+07	2.15E+05	8.97E+04	5.32E+04	0.00E+00	0.00E+00	0.00E+00
HF-181	6.68E+02	4.39E+05	5.91E+03	3.33E+01	2.79E+01	2.12E+01	0.00E+00	0.00E+00
AM-241	1.27E+06	1.74E+06	1.77E+07	1.66E+07	9.56E+06	0.00E+00	0.00E+00	0.00E+00

*R Values in units of mrem/yr per µCi/m^3 for inhalation and tritium, and in units of m^2-mrem/yr per µCi/sec for all others.

TABLE 3.3-9 R VALUES FOR THE BRUNSWICK STEAM ELECTRIC PLANT*

PATHWAY = Cow Milk

AGE GROUP = Teen

Nuclide	T. Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
H-3	1.00E+03	1.00E+03	0.00E+00	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03
P-32	8.00E+08	1.73E+09	2.06E+10	1.28E+09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CR-51	3.02E+04	5.08E+06	0.00E+00	0.00E+00	6.63E+03	1.68E+04	4.32E+04	0.00E+00
MN-54	1.69E+06	1.75E+07	0.00E+00	8.52E+06	2.54E+06	0.00E+00	0.00E+00	0.00E+00
FE-59	2.79E+07	1.71E+08	3.10E+07	7.23E+07	0.00E+00	0.00E+00	2.28E+07	0.00E+00
CO-58	1.09E+07	6.50E+07	0.00E+00	4.72E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO-60	3.88E+07	2.25E+08	0.00E+00	1.72E+07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ZN-65	2.38E+09	2.16E+09	1.47E+09	5.11E+09	3.27E+09	0.00E+00	0.00E+00	0.00E+00
RB-86	1.39E+09	4.37E+08	0.00E+00	2.95E+09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-89	4.59E+07	1.91E+08	1.60E+09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-90	1.08E+10	1.23E+09	4.37E+10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-91	2.52E+02	3.85E+06	9.40E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ZR-95	2.13E+02	7.14E+05	9.83E+02	3.10E+02	4.56E+02	0.00E+00	0.00E+00	0.00E+00
NB-95	2.58E+04	2.00E+08	8.45E+04	4.68E+04	4.54E+04	0.00E+00	0.00E+00	0.00E+00
RU-103	4.65E+02	9.08E+04	1.09E+03	0.00E+00	3.83E+03	0.00E+00	0.00E+00	0.00E+00
RU-106	2.93E+03	1.11E+06	2.32E+04	0.00E+00	4.48E+04	0.00E+00	0.00E+00	0.00E+00
AG-110M	3.53E+07	1.63E+10	6.14E+07	5.81E+07	1.11E+08	0.00E+00	0.00E+00	0.00E+00
SN-113	2.28E+06	2.58E+07	2.15E+06	9.06E+04	6.37E+04	2.97E+04	0.00E+04	0.00E+00
TE-127M	7.39E+06	1.55E+08	6.22E+07	2.21E+07	2.52E+08	1.48E+07	0.00E+00	0.00E+00
TE-129M	1.13E+07	2.69E+08	7.15E+07	2.65E+07	2.99E+08	2.31E+07	0.00E+00	0.00E+00
I-131	2.65E+08	9.75E+07	3.52E+08	4.93E+08	8.48E+08	1.44E+11	0.00E+00	0.00E+00
I-132	1.83E-01	2.22E-01	1.94E-01	5.09E-01	8.02E-01	1.71E+01	0.00E+00	0.00E+00
I-133	2.49E+06	6.19E+06	4.82E+06	8.18E+06	1.43E+07	1.14E+09	0.00E+00	0.00E+00
I-135	1.58E+04	4.74E+04	1.66E+04	4.27E+04	6.75E+04	2.75E+06	0.00E+00	0.00E+00
CS-134	6.54E+09	1.75E+08	5.99E+09	1.41E+10	4.48E+09	0.00E+00	1.71E+09	0.00E+00
CS-136	7.48E+08	8.97E+07	2.83E+08	1.11E+09	6.07E+08	0.00E+00	9.56E+07	0.00E+00
CS-137	3.96E+09	1.62E+08	8.54E+09	1.14E+10	3.87E+09	0.00E+00	1.50E+09	0.00E+00
BA-140	1.99E+06	4.77E+07	3.09E+07	3.79E+04	1.28E+04	0.00E+00	2.55E+04	0.00E+00
CE-141	4.09E+02	1.02E+07	5.35E+03	3.56E+03	1.68E+03	0.00E+00	0.00E+00	0.00E+00
CE-144	2.12E+04	9.93E+07	3.95E+05	1.63E+05	9.76E+04	0.00E+00	0.00E+00	0.00E+00
HF-181	1.18E+03	5.28E+05	1.06E+04	5.81E+01	4.84E+01	3.55E+01	0.00E+00	0.00E+00
AM-241	1.74E+06	2.38E+06	2.42E+07	2.28E+07	1.31E+07	0.00E+00	0.00E+00	0.00E+00

*R Values in units of mrem/yr per μCi/m^3 for inhalation and tritium, and in units of m^2-mrem/yr per μCi/sec for all others.

TABLE 3.3-10 R VALUES FOR THE BRUNSWICK STEAM ELECTRIC PLANT*

PATHWAY = Cow Milk

AGE GROUP = Child

Nuclide	T. Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
H-3	1.58E+03	1.58E+03	0.00E+00	1.58E+03	1.58E+03	1.58E+03	1.58E+03	1.58E+03
P-32	1.96E+09	1.41E+09	5.09E+10	2.38E+09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CR-51	6.17E+04	3.27E+06	0.00E+00	0.00E+00	9.36E+03	3.42E+04	6.25E+04	0.00E+00
MN-54	3.39E+06	1.07E+07	0.00E+00	1.27E+07	3.57E+06	0.00E+00	0.00E+00	0.00E+00
FE-59	5.79E+07	1.21E+08	7.18E+07	1.16E+08	0.00E+00	0.00E+00	3.37E+07	0.00E+00
CO-58	2.21E+07	4.20E+07	0.00E+00	7.21E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO-60	7.90E+07	1.48E+08	0.00E+00	2.68E+07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ZN-65	4.79E+09	1.35E+09	2.89E+09	7.70E+09	4.85E+09	0.00E+00	0.00E+00	0.00E+00
RB-86	3.36E+09	3.52E+08	0.00E+00	5.47E+09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-89	1.13E+08	1.54E+08	3.97E+09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-90	1.87E+10	9.95E+08	7.38E+10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-91	6.21E+02	3.09E+06	2.32E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ZR-95	4.47E+02	5.23E+05	2.28E+03	5.02E+02	7.18E+02	0.00E+00	0.00E+00	0.00E+00
NB-95	5.31E+04	1.37E+08	1.91E+05	7.42E+04	6.98E+04	0.00E+00	0.00E+00	0.00E+00
RU-103	9.88E+02	6.65E+04	2.57E+03	0.00E+00	6.47E+03	0.00E+00	0.00E+00	0.00E+00
RU-106	7.14E+03	8.90E+05	5.72E+04	0.00E+00	7.72E+04	0.00E+00	0.00E+00	0.00E+00
AG-110M	7.19E+07	1.07E+10	1.33E+08	9.00E+07	1.68E+08	0.00E+00	0.00E+00	0.00E+00
SN-113	4.61E+06	1.69E+07	4.22E+08	4.13E+07	4.37E+08	3.66E+07	0.00E+00	0.00E+00
TE-127M	1.82E+07	1.24E+08	1.53E+08	4.13E+07	4.37E+08	3.66E+07	0.00E+00	0.00E+00
TE-129M	2.74E+07	2.15E+08	1.76E+08	4.92E+07	5.18E+08	5.68E+07	0.00E+00	0.00E+00
I-131	4.88E+08	7.64E+07	8.54E+08	8.59E+08	1.41E+09	2.84E+11	0.00E+00	0.00E+00
I-132	3.89E-01	9.95E-01	4.60E-01	8.45E-01	1.29E+00	3.92E+01	0.00E+00	0.00E+00
I-133	5.48E+06	5.84E+06	1.17E+07	1.45E+07	2.41E+07	2.69E+09	0.00E+00	0.00E+00
I-135	3.35E+04	5.39E+04	3.93E+04	7.07E+04	1.08E+05	6.26E+06	0.00E+00	0.00E+00
CS-134	4.78E+09	1.22E+08	1.38E+10	2.27E+10	7.03E+09	0.00E+00	2.52E+09	0.00E+00
CS-136	1.14E+09	6.17E+07	6.39E+08	1.76E+09	9.36E+08	0.00E+00	1.40E+08	0.00E+00
CS-137	2.91E+09	1.23E+08	2.06E+10	1.97E+10	6.42E+09	0.00E+00	2.31E+09	0.00E+00
BA-140	4.36E+06	3.78E+07	7.47E+07	6.54E+04	2.13E+04	0.00E+00	3.90E+04	0.00E+00
CE-141	9.73E+02	8.17E+06	1.31E+04	6.55E+03	2.87E+03	0.00E+00	0.00E+00	0.00E+00
CE-144	5.20E+04	7.96E+07	9.74E+05	3.05E+05	1.69E+05	0.00E+00	0.00E+00	0.00E+00
HF-181	2.53E+03	4.16E+05	2.51E+04	9.79E+01	7.86E+01	8.24E+01	0.00E+00	0.00E+00
AM-241	2.55E+06	1.91E+06	3.40E+07	2.92E+07	1.56E+07	0.00E+00	0.00E+00	0.00E+00

*R Values in units of mrem/yr per μCi/m^3 for inhalation and tritium, and in units of m^2-mrem/yr per μCi/sec for all others.

TABLE 3.3-11 R VALUES FOR THE BRUNSWICK STEAM ELECTRIC PLANT*

PATHWAY = Cow Milk

AGE GROUP = Infant

Nuclide	T. Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
H-3	2.40E+03	2.40E+03	0.00E+00	2.40E+03	2.40E+03	2.40E+03	2.40E+03	2.40E+03
P-32	4.06E+09	1.42E+09	1.05E+11	6.17E+09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CR-51	9.77E+04	2.85E+06	0.00E+00	0.00E+00	1.39E+04	6.38E+04	1.24E+05	0.00E+00
MN-54	5.37E+06	8.71E+06	0.00E+00	2.37E+07	5.25E+06	0.00E+00	0.00E+00	0.00E+00
FE-59	9.23E+07	1.12E+08	1.34E+08	2.34E+08	0.00E+00	0.00E+00	6.92E+07	0.00E+00
CO-58	3.60E+07	3.59E+07	0.00E+00	1.44E+07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO-60	1.29E+08	1.30E+08	0.00E+00	5.47E+07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ZN-65	6.14E+09	1.12E+10	3.88E+09	1.33E+10	6.45E+09	0.00E+00	0.00E+00	0.00E+00
RB-86	6.86E+09	3.55E+08	0.00E+00	1.39E+10	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-89	2.17E+08	1.55E+08	7.55E+09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-90	2.05E+10	1.00E+09	8.04E+10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-91	1.16E+03	3.12E+06	4.36E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ZR-95	7.01E+02	4.92E+05	4.05E+03	9.88E+02	1.06E+03	0.00E+00	0.00E+00	0.00E+00
NB-95	8.48E+04	1.24E+08	3.56E+05	1.47E+05	1.05E+05	0.00E+00	0.00E+00	0.00E+00
RU-103	1.74E+03	6.33E+04	5.21E+03	0.00E+00	1.08E+04	0.00E+00	0.00E+00	0.00E+00
RU-106	1.47E+04	8.95E+05	1.18E+05	0.00E+00	1.39E+05	0.00E+00	0.00E+00	0.00E+00
AG-110M	1.19E+08	9.32E+09	2.46E+08	1.80E+08	2.57E+08	0.00E+00	0.00E+00	0.00E+00
SN-113	6.66E+06	1.37E+07	6.46E+06	2.45E+05	1.32E+05	9.34E+04	0.00E+00	0.00E+00
TE-127M	3.75E+07	1.25E+08	3.10E+08	1.03E+08	7.64E+08	8.96E+07	0.00E+00	0.00E+00
TE-129M	5.57E+07	2.16E+08	3.62E+08	1.24E+08	9.05E+08	1.39E+08	0.00E+00	0.00E+00
I-131	9.23E+08	7.49E+07	1.78E+09	2.10E+09	2.45E+09	6.90E+11	0.00E+00	0.00E+00
I-132	6.90E-01	1.57E+00	9.55E-01	1.94E+00	2.16E+00	9.09E+01	0.00E+00	0.00E+00
I-133	1.05E+07	6.09E+06	2.47E+07	3.60E+07	4.23E+07	6.55E+09	0.00E+00	0.00E+00
I-135	5.93E+04	5.83E+04	8.17E+04	1.63E+05	1.81E+05	1.46E+07	0.00E+00	0.00E+00
CS-134	4.19E+09	1.13E+08	2.23E+10	4.15E+10	1.07E+10	0.00E+00	4.38E+09	0.00E+00
CS-136	1.37E+09	5.58E+07	1.25E+09	3.67E+09	1.46E+09	0.00E+00	2.99E+08	0.00E+00
CS-137	2.72E+09	1.20E+08	3.28E+10	3.84E+10	1.03E+10	0.00E+00	4.18E+09	0.00E+00
BA-140	7.91E+06	3.77E+07	1.54E+08	1.54E+05	3.65E+04	0.00E+00	9.43E+04	0.00E+00
CE-141	1.87E+03	8.23E+06	2.60E+04	1.59E+04	4.90E+03	0.00E+00	0.00E+00	0.00E+00
CE-144	7.82E+04	8.01E+07	1.40E+06	5.71E+05	2.31E+05	0.00E+00	0.00E+00	0.00E+00
HF-181	4.23E+03	3.94E+05	4.78E+04	2.26E+02	1.32E+02	1.91E+02	0.00E+00	0.00E+00
AM-241	2.72E+06	1.92E+06	3.65E+07	3.17E+07	1.64E+07	0.00E+00	0.00E+00	0.00E+00

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

TABLE 3.3-12 R VALUES FOR THE BRUNSWICK STEAM ELECTRIC 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+00	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+00	0.00E+00	0.00E+00	0.00E+00
CR-51	2.08E+03	5.23E+05	0.00E+00	0.00E+00	4.58E+02	1.24E+03	2.76E+03	0.00E+00
MN-54	1.17E+05	1.88E+06	0.00E+00	6.14E+05	1.83E+05	0.00E+00	0.00E+00	0.00E+00
FE-59	2.08E+05	1.81E+06	2.31E+05	5.42E+05	0.00E+00	0.00E+00	1.51E+05	0.00E+00
CO-58	7.54E+05	6.82E+06	0.00E+00	3.36E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO-60	2.69E+06	2.29E+07	0.00E+00	1.22E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ZN-65	1.65E+08	2.31E+08	1.15E+08	3.66E+08	2.45E+08	0.00E+00	0.00E+00	0.00E+00
RB-86	9.05E+07	3.83E+07	0.00E+00	1.94E+08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-89	5.24E+07	2.93E+08	1.83E+09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-90	1.59E+10	1.88E+09	6.49E+10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-91	1.64E+01	3.37E+05	6.13E 02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ZR-95	1.46E+01	6.85E+04	6.74E+01	2.16E+01	3.39E+01	0.00E+00	0.00E+00	0.00E+00
NB-95	1.78E+03	2.01E+07	5.94E+03	3.31E+03	3.27E+03	0.00E+00	0.00E+00	0.00E+00
RU-103	3.16E+01	8.56E+03	7.33E+01	0.00E+00	2.80E+02	0.00E+00	0.00E+00	0.00E+00
RU-106	1.92E+02	9.81E+04	1.52E+03	0.00E+00	2.93E+03	0.00E+00	0.00E+00	0.00E+00
AG-110M	2.45E+06	1.68E+09	4.46E+06	4.12E+06	8.11E+06	0.00E+00	0.00E+00	0.00E+00
SN-113	1.32E+05	2.44E+06	1.40E+05	5.41E+03	3.96E+03	1.90E+03	0.00E+00	0.00E+00
TE-127M	4.93E+05	1.36E+07	4.05E+06	1.45E+06	1.64E+07	1.03E+06	0.00E+00	0.00E+00
TE-129M	7.43E+05	2.36E+07	4.69E+06	1.75E+06	1.96E+07	1.61E+06	0.00E+00	0.00E+00
I-131	1.91E+08	8.78E+07	2.33E+08	3.33E+08	5.71E+08	1.09E+11	0.00E+00	0.00E+00
I-132	1.23E-01	6.61E-02	1.32E-01	3.52E-01	5.61E-01	1.23E+01	0.00E+00	0.00E+00
I-133	1.68E+06	4.95E+06	3.17E+06	5.51E+06	9.61E+06	8.10E+08	0.00E+00	0.00E+00
I-135	1.08E+04	3.32E+04	1.12E+04	2.94E+04	4.71E+04	1.94E+06	0.00E+00	0.00E+00
CS-134	2.01E+10	4.31E+08	1.03E+10	2.46E+10	7.97E+09	0.00E+00	2.65E+09	0.00E+00
CS-136	1.42E+09	2.24E+08	4.99E+08	1.97E+09	1.10E+09	0.00E+00	1.50E+08	0.00E+00
CS-137	1.27E+10	3.74E+08	1.41E+10	1.93E+10	6.56E+09	0.00E+00	2.18E+09	0.00E+00
BA-140	1.35E+05	4.23E+06	2.06E+06	2.58E+03	8.78E+02	0.00E+00	1.48E+03	0.00E+00
CE-141	2.68E+01	9.03E+05	3.49E+02	2.36E+02	1.10E+02	0.00E+00	0.00E+00	0.00E+00
CE-144	1.38E+03	8.71E+06	2.58E+04	1.08E+04	6.39E+03	0.00E+00	0.00E+00	0.00E+00
HF-181	8.02E+01	5.26E+04	7.09E+02	3.99E+00	3.34E+00	2.54E+00	0.00E+00	0.00E+00
AM-241	1.52E+05	2.09E+05	2.12E+06	1.99E+06	1.15E+06	0.00E+00	0.00E+00	0.00E+00

*R Values in units of mrem/yr per μCi/m^3 for inhalation and tritium, and in units of m^2-mrem/yr per μCi/sec for all others.

TABLE 3.3-13 R VALUES FOR THE BRUNSWICK STEAM ELECTRIC 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+00	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+00	0.00E+00	0.00E+00	0.00E+00
CR-51	3.63E+03	6.10E+05	0.00E+00	0.00E+00	7.95E+02	2.02E+03	5.18E+03	0.00E+00
MN-54	2.03E+05	2.10E+06	0.00E+00	1.02E+06	3.05E+05	0.00E+00	0.00E+00	0.00E+00
FE-59	3.63E+05	2.22E+06	4.03E+05	9.40E+05	0.00E+00	0.00E+00	2.96E+05	0.00E+00
CO-58	1.30E+06	7.80E+06	0.00E+00	5.66E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO-60	4.66E+06	2.69E+07	0.00E+00	2.07E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ZN-65	2.86E+08	2.60E+08	1.77E+08	6.13E+08	3.93E+08	0.00E+00	0.00E+00	0.00E+00
RB-86	1.66E+08	5.24E+07	0.00E+00	3.54E+08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-89	9.65E+07	4.01E+08	3.37E+09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-90	2.27E+10	2.58E+09	9.18E+10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-91	3.02E+01	4.62E+05	1.13E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ZR-95	2.56E+01	8.59E+04	1.18E+02	3.72E+01	5.47E+01	0.00E+00	0.00E+00	0.00E+00
NB-95	3.09E+03	2.40E+07	1.01E+04	5.62E+03	5.45E+03	0.00E+00	0.00E+00	0.00E+00
RU-103	5.58E+01	1.09E+04	1.30E+02	0.00E+00	4.60E+02	0.00E+00	0.00E+00	0.00E+00
RU-106	3.51E+02	1.34E+05	2.79E+03	0.00E+00	5.38E+03	0.00E+00	0.00E+00	0.00E+00
AG-110M	4.24E+06	1.96E+09	7.37E+06	6.97E+06	1.33E+07	0.00E+00	0.00E+00	0.00E+00
SN-113	2.28E+05	2.58E+06	2.15E+05	9.06E+03	6.37E+03	2.97E+03	0.00E+00	0.00E+00
TE-127M	8.87E+05	1.86E+07	7.46E+06	2.65E+06	3.02E+07	1.77E+06	0.00E+00	0.00E+00
TE-129M	1.36E+06	3.22E+07	8.58E+06	3.19E+06	3.59E+07	2.77E+06	0.00E+00	0.00E+00
I-131	3.18E+08	1.17E+08	4.22E+08	5.91E+08	1.02E+09	1.73E+11	0.00E+00	0.00E+00
I-132	2.19E-01	2.66E-01	2.33E-01	6.11E-01	9.62E-01	2.06E+01	0.00E+00	0.00E+00
I-133	2.99E+06	7.43E+06	5.79E+06	9.81E+06	1.72E+07	1.37E+09	0.00E+00	0.00E+00
I-135	1.90E+04	5.63E+04	1.99E+04	5.13E+04	8.10E+04	3.30E+06	0.00E+00	0.00E+00
CS-134	1.96E+10	5.26E+08	1.80E+10	4.23E+10	1.34E+10	0.00E+00	5.13E+09	0.00E+00
CS-136	2.25E+09	2.71E+08	8.50E+08	3.34E+09	1.82E+09	0.00E+00	2.87E+08	0.00E+00
CS-137	1.19E+10	4.85E+08	2.56E+10	3.41E+10	1.16E+10	0.00E+00	4.51E+09	0.00E+00
BA-140	2.39E+05	5.72E+06	3.71E+06	4.55E+03	1.54E+03	0.00E+00	3.06E+03	0.00E+00
CE-141	4.91E+01	1.22E+06	6.40E+02	4.27E+02	2.01E+02	0.00E+00	0.00E+00	0.00E+00
CE-144	2.55E+03	1.19E+07	4.74E+04	1.96E+04	1.17E+04	0.00E+00	0.00E+00	0.00E+00
HF-181	1.41E+02	6.34E+04	1.27E+03	6.97E+00	5.81E+00	4.26E+00	0.00E+00	0.00E+00
AM-241	2.09E+05	2.86E+05	2.90E+06	2.74E+06	1.57E+06	0.00E+00	0.00E+00	0.00E+00

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

TABLE 3.3-14 R VALUES FOR THE BRUNSWICK STEAM ELECTRIC 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+00	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+00	0.00E+00	0.00E+00	0.00E+00
CR-51	7.40E+03	3.93E+05	0.00E+00	0.00E+00	1.12E+03	4.11E+03	7.50E+03	0.00E+00
MN-54	4.07E+05	1.28E+06	0.00E+00	1.53E+06	4.29E+05	0.00E+00	0.00E+00	0.00E+00
FE-59	7.52E+05	1.57E+06	9.34E+05	1.51E+06	0.00E+00	0.00E+00	4.38E+05	0.00E+00
CO-58	2.65E+06	5.05E+06	0.00E+00	8.65E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO-60	9.48E+06	1.78E+07	0.00E+00	3.21E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ZN-65	5.74E+08	1.62E+08	3.47E+08	9.24E+08	5.82E+08	0.00E+00	0.00E+00	0.00E+00
RB-86	4.04E+08	4.22E+07	0.00E+00	6.57E+08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-89	2.38E+08	3.23E+08	8.34E+09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-90	3.93E+10	2.09E+09	1.55E+11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-91	7.45E+01	3.71E+05	2.79E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ZR-95	5.36E+01	6.28E+04	2.74E+02	6.02E+01	8.62E+01	0.00E+00	0.00E+00	0.00E+00
NB-95	6.37E+03	1.65E+07	2.29E+04	8.91E+03	8.37E+03	0.00E+00	0.00E+00	0.00E+00
RU-103	1.19E+02	7.98E+03	3.09E+02	0.00E+00	7.77E+02	0.00E+00	0.00E+00	0.00E+00
RU-106	8.56E+02	1.07E+05	6.86E+03	0.00E+00	9.27E+03	0.00E+00	0.00E+00	0.00E+00
AG-110M	8.63E+06	1.28E+09	1.60E+07	1.08E+07	2.01E+07	0.00E+00	0.00E+00	0.00E+00
SN-113	4.61E+05	1.69E+06	4.22E+05	1.36E+04	9.38E+03	5.59E+03	0.00E+00	0.00E+00
TE-127M	2.18E+06	1.49E+07	1.84E+07	4.95E+06	5.24E+07	4.40E+06	0.00E+00	0.00E+00
TE-129M	3.28E+06	2.58E+07	2.12E+07	5.91E+06	6.21E+07	6.82E+06	0.00E+00	0.00E+00
I-131	5.85E+08	9.17E+07	1.02E+09	1.03E+09	1.69E+09	3.41E+11	0.00E+00	0.00E+00
I-132	4.67E-01	1.19E+00	5.52E-01	1.01E+00	1.55E+00	4.71E+01	0.00E+00	0.00E+00
I-133	6.58E+06	7.00E+06	1.41E+07	1.74E+07	2.90E+07	3.23E+09	0.00E+00	0.00E+00
I-135	4.01E+04	6.47E+04	4.72E+04	8.49E+04	1.30E+05	7.52E+06	0.00E+00	0.00E+00
CS-134	1.43E+10	3.67E+08	4.14E+10	6.80E+10	2.11E+10	0.00E+00	7.56E+09	0.00E+00
CS-136	3.41E+09	1.85E+08	1.92E+09	5.27E+09	2.81E+09	0.00E+00	4.19E+08	0.00E+00
CS-137	8.72E+09	3.70E+08	6.17E+10	5.91E+10	1.93E+10	0.00E+00	6.93E+09	0.00E+00
BA-140	5.23E+05	4.55E+06	8.96E+06	7.85E+03	2.56E+03	0.00E+00	4.68E+03	0.00E+00
CE-141	1.17E+02	9.81E+05	1.53E+03	7.36E+02	3.45E+02	0.00E+00	0.00E+00	0.00E+00
CE-144	6.24E+03	9.55E+06	1.17E+05	3.66E+04	2.03E+04	0.00E+00	0.00E+00	0.00E+00
HF-181	3.04E+02	4.99E+04	3.02E+03	1.17E+01	9.43E+00	9.89E+00	0.00E+00	0.00E+00
AM-241	3.06E+05	2.29E+05	4.08E+06	3.50E+06	1.87E+06	0.00E+00	0.00E+00	0.00E+00

*R Values in units of mrem/yr per μCi/m^3 for inhalation and tritium, and in units of m^2-mrem/yr per μCi/sec for all others.

TABLE 3.3-15 R VALUES FOR THE BRUNSWICK STEAM ELECTRIC 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+00	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+00	0.00E+00	0.00E+00	0.00E+00
CR-51	1.17E+04	3.42E+05	0.00E+00	0.00E+00	1.67E+03	7.65E+03	1.49E+04	0.00E+00
MN-54	6.45E+05	1.04E+06	0.00E+00	2.84E+06	6.30E+05	0.00E+00	0.00E+00	0.00E+00
FE-59	1.20E+06	1.45E+06	1.74E+06	3.04E+06	0.00E+00	0.00E+00	9.00E+05	0.00E+00
CO-58	4.31E+06	4.31E+06	0.00E+00	1.73E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO-60	1.55E+07	1.56E+07	0.00E+00	6.56E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ZN-65	7.36E+08	1.35E+09	4.66E+08	1.60E+09	7.74E+08	0.00E+00	0.00E+00	0.00E+00
RB-86	8.23E+08	4.26E+07	0.00E+00	1.67E+09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-89	4.55E+08	3.26E+08	1.59E+10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-90	4.30E+10	2.11E+09	1.69E+11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-91	1.39E+02	3.75E+05	5.23E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ZR-95	8.41E+01	5.90E+04	4.85E+02	1.19E+02	1.28E+02	0.00E+00	0.00E+00	0.00E+00
NB-95	1.02E+04	1.48E+07	4.27E+04	1.76E+04	1.26E+04	0.00E+00	0.00E+00	0.00E+00
RU-103	2.09E+02	7.60E+03	6.25E+02	0.00E+00	1.30E+03	0.00E+00	0.00E+00	0.00E+00
RU-106	1.77E+03	1.07E+05	1.41E+04	0.00E+00	1.67E+04	0.00E+00	0.00E+00	0.00E+00
AG-110M	1.43E+07	1.12E+09	2.95E+07	2.16E+07	3.08E+07	0.00E+00	0.00E+00	0.00E+00
SN-113	6.66E+05	1.37E+06	6.46E+05	2.45E+04	1.32E+04	9.34E+03	0.00E+00	0.00E+00
TE-127M	4.51E+06	1.50E+07	3.72E+07	1.23E+07	9.16E+07	1.08E+07	0.00E+00	0.00E+00
TE-129M	6.69E+06	2.59E+07	4.34E+07	1.49E+07	1.09E+08	1.67E+07	0.00E+00	0.00E+00
I-131	1.11E+09	8.99E+07	2.14E+09	2.52E+09	2.94E+09	8.28E+11	0.00E+00	0.00E+00
I-132	8.28E-01	1.88E+00	1.15E+00	2.33E+00	2.59E+00	1.09E+02	0.00E+00	0.00E+00
I-133	1.27E+07	7.31E+06	2.97E+07	4.32E+07	5.08E+07	7.86E+09	0.00E+00	0.00E+00
I-135	7.11E+04	7.06E+04	9.81E+04	1.95E+05	2.17E+05	1.75E+07	0.00E+00	0.00E+00
CS-134	1.26E+10	3.38E+08	6.68E+10	1.25E+11	3.21E+10	0.00E+00	1.31E+10	0.00E+00
CS-136	4.11E+09	1.67E+08	3.75E+09	1.10E+10	4.39E+09	0.00E+00	8.98E+08	0.00E+00
CS-137	8.17E+09	3.61E+08	9.85E+10	1.15E+11	3.10E+10	0.00E+00	1.25E+10	0.00E+00
BA-140	9.50E+05	4.53E+06	1.84E+07	1.84E+04	4.38E+03	0.00E+00	1.13E+04	0.00E+00
CE-141	2.24E+02	9.85E+05	3.13E+03	1.91E+03	5.88E+02	0.00E+00	0.00E+00	0.00E+00
CE-144	9.39E+03	9.61E+06	1.67E+05	6.86E+04	2.77E+04	0.00E+00	0.00E+00	0.00E+00
HF-181	5.08E+02	4.72E+04	5.74E+03	2.71E+01	1.58E+01	2.30E+01	0.00E+00	0.00E+00
AM-241	3.26E+05	2.30E+05	4.38E+06	3.80E+06	1.97E+06	0.00E+00	0.00E+00	0.00E+00

*R Values in units of mrem/yr per μCi/m^3 for inhalation and tritium, and in units of m^2-mrem/yr per μCi/sec for all others.

TABLE 3.3-16 R VALUES FOR THE BRUNSWICK STEAM ELECTRIC PLANT*

PATHWAY = Inhalation

AGE GROUP = Adult

Nuclide	T. Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
H-3	1.26E+03	1.26E+03	0.00E+00	1.26E+03	1.26E+03	1.26E+03	1.26E+03	1.26E+03
P-32	5.00E+04	8.63E+04	1.32E+06	7.70E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CR-51	9.99E+01	3.32E+03	0.00E+00	0.00E+00	2.28E+01	5.94E+01	1.44E+04	0.00E+00
MN-54	6.29E+03	7.72E+04	0.00E+00	3.95E+04	9.83E+03	0.00E+00	1.40E+06	0.00E+00
FE-59	1.05E+04	1.88E+05	1.17E+04	2.77E+04	0.00E+00	0.00E+00	1.01E+06	0.00E+00
CO-58	2.07E+03	1.06E+05	0.00E+00	1.58E+03	0.00E+00	0.00E+00	9.27E+05	0.00E+00
CO-60	1.48E+04	2.84E+05	0.00E+00	1.15E+04	0.00E+00	0.00E+00	5.96E+06	0.00E+00
ZN-65	4.65E+04	5.34E+04	3.24E+04	1.03E+05	6.89E+04	0.00E+00	8.63E+05	0.00E+00
RB-86	5.89E+04	1.66E+04	0.00E+00	1.35E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-89	8.71E+03	3.49E+05	3.04E+05	0.00E+00	0.00E+00	0.00E+00	1.40E+06	0.00E+00
SR-90	6.09E+06	7.21E+05	9.91E+07	0.00E+00	0.00E+00	0.00E+00	9.59E+06	0.00E+00
Y-91	1.24E+04	3.84E+05	4.62E+05	0.00E+00	0.00E+00	0.00E+00	1.70E+06	0.00E+00
ZR-95	2.32E+04	1.50E+05	1.07E+05	3.44E+04	5.41E+04	0.00E+00	1.77E+06	0.00E+00
NB-95	4.20E+03	1.04E+05	1.41E+04	7.80E+03	7.72E+03	0.00E+00	5.04E+05	0.00E+00
RU-103	6.57E+02	1.10E+05	1.53E+03	0.00E+00	5.82E+03	0.00E+00	5.04E+05	0.00E+00
RU-106	8.71E+03	9.11E+05	6.90E+04	0.00E+00	1.33E+05	0.00E+00	9.35E+06	0.00E+00
AG-110M	5.94E+03	3.02E+05	1.08E+04	9.99E+03	1.97E+04	0.00E+00	4.63E+06	0.00E+00
SN-113	6.48E+03	2.48E+04	6.87E+03	2.66E+02	1.97E+02	9.33E+01	2.99E+05	0.00E+00
TE-127M	1.57E+03	1.49E+05	1.26E+04	5.76E+03	4.57E+04	3.28E+03	9.59E+05	0.00E+00
TE-129M	1.58E+03	3.83E+05	9.75E+03	4.67E+03	3.65E+04	3.44E+03	1.16E+06	0.00E+00
I-131	2.05E+04	6.27E+03	2.52E+04	3.57E+04	6.12E+04	1.19E+07	0.00E+00	0.00E+00
I-132	1.16E+03	4.06E 02	1.16E+03	3.25E+03	5.18E+03	1.14E+05	0.00E+00	0.00E+00
I-133	4.51E+03	8.87E+03	8.63E+03	1.48E+04	2.58E+04	2.15E+06	0.00E+00	0.00E+00
I-135	2.56E+03	5.24E+03	2.68E+03	6.97E+03	1.11E+04	4.47E+05	0.00E+00	0.00E+00
CS-134	7.27E+05	1.04E+04	3.72E+05	8.47E+05	2.87E+05	0.00E+00	9.75E+04	0.00E+00
CS-136	1.10E+05	1.17E+04	3.90E+04	1.46E+05	8.55E+04	0.00E+00	1.20E+04	0.00E+00
CS-137	4.27E+05	8.39E+03	4.78E+05	6.20E+05	2.22E+05	0.00E+00	7.51E+04	0.00E+00
BA-140	2.56E+03	2.18E+05	3.90E+04	4.90E+01	1.67E+01	0.00E+00	1.27E+06	0.00E+00
CE-141	1.53E+03	1.20E+05	1.99E+04	1.35E+04	6.25E+03	0.00E+00	3.61E+05	0.00E+00
CE-144	1.84E+05	8.15E+05	3.43E+06	1.43E+06	8.47E+05	0.00E+00	7.76E+06	0.00E+00
HF-181	5.16E+03	1.29E+05	4.56E+04	2.57E+02	2.15E+02	1.63E+02	5.99E+05	0.00E+00
AM-241	5.37E+08	3.68E+05	1.34E+10	9.04E+09	4.03E+09	0.00E+00	4.85E+08	0.00E+00

*R Values in units of mrem/yr per μCi/m^3 for inhalation and tritium, and in units of m^2-mrem/yr per μCi/sec for all others.

TABLE 3.3-17 R VALUES FOR THE BRUNSWICK STEAM ELECTRIC PLANT*

PATHWAY = Inhalation

AGE GROUP = Teen

Nuclide	T. Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
H-3	1.27E+03	1.27E+03	0.00E+00	1.27E+03	1.27E+03	1.27E+03	1.27E+03	1.27E+03
P-32	7.15E+04	9.27E+04	1.89E+06	1.09E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CR-51	1.35E+02	3.00E+03	0.00E+00	0.00E+00	3.07E+01	7.49E+01	2.09E+04	0.00E+00
MN-54	8.39E+03	6.67E+04	0.00E+00	5.10E+04	1.27E+04	0.00E+00	1.98E+06	0.00E+00
FE-59	1.43E+04	1.78E+05	1.59E+04	3.69E+04	0.00E+00	0.00E+00	1.53E+06	0.00E+00
CO-58	2.77E+03	9.51E+04	0.00E+00	2.07E+03	0.00E+00	0.00E+00	1.34E+06	0.00E+00
CO-60	1.98E+04	2.59E+05	0.00E+00	1.51E+04	0.00E+00	0.00E+00	8.71E+06	0.00E+00
ZN-65	6.23E+04	4.66E+04	3.85E+04	1.33E+05	8.63E+04	0.00E+00	1.24E+06	0.00E+00
RB-86	8.39E+04	1.77E+04	0.00E+00	1.90E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-89	1.25E+04	3.71E+05	4.34E+05	0.00E+00	0.00E+00	0.00E+00	2.41E+06	0.00E+00
SR-90	6.67E+06	7.64E+05	1.08E+08	0.00E+00	0.00E+00	0.00E+00	1.65E+07	0.00E+00
Y-91	1.77E+04	4.08E+05	6.60E+05	0.00E+00	0.00E+00	0.00E+00	2.93E+06	0.00E+00
ZR-95	3.15E+04	1.49E+05	1.45E+05	4.58E+04	6.73E+04	0.00E+00	2.68E+06	0.00E+00
NB-95	5.66E+03	9.67E+04	1.85E+04	1.03E+04	9.99E+03	0.00E+00	7.50E+05	0.00E+00
RU-103	8.95E+02	1.09E+05	2.10E+03	0.00E+00	7.42E+03	0.00E+00	7.82E+05	0.00E+00
RU-106	1.24E+04	9.59E+05	9.83E+04	0.00E+00	1.90E+05	0.00E+00	1.61E+07	0.00E+00
AG-110M	7.98E+03	2.72E+05	1.38E+04	1.31E+04	2.50E+04	0.00E+00	6.74E+06	0.00E+00
SN-113	8.69E+03	2.03E+04	8.19E+03	3.45E+02	2.46E+02	1.13E+02	4.27E+05	0.00E+00
TE-127M	2.18E+03	1.59E+05	1.80E+04	8.15E+03	6.53E+04	4.38E+03	1.65E+06	0.00E+00
TE-129M	2.24E+03	4.04E+05	1.39E+04	6.57E+03	5.18E+04	4.57E+03	1.97E+06	0.00E+00
I-131	2.64E+04	6.48E+03	3.54E+04	4.90E+04	8.39E+04	1.46E+07	0.00E+00	0.00E+00
I-132	1.57E+03	1.27E+03	1.59E+03	4.37E+03	6.91E+03	1.51E+05	0.00E+00	0.00E+00
I-133	6.21E+03	1.03E+04	1.21E+04	2.05E+04	3.59E+04	2.92E+06	0.00E+00	0.00E+00
I-135	3.48E+03	6.94E+03	3.69E+03	9.43E+03	1.49E+04	6.20E+05	0.00E+00	0.00E+00
CS-134	5.48E+05	9.75E+03	5.02E+05	1.13E+06	3.75E+05	0.00E+00	1.46E+05	0.00E+00
CS-136	1.37E+05	1.09E+04	5.14E+04	1.93E+05	1.10E+05	0.00E+00	1.77E+04	0.00E+00
CS-137	3.11E+05	8.48E+03	6.69E+05	8.47E+05	3.04E+05	0.00E+00	1.21E+05	0.00E+00
BA-140	3.51E+03	2.28E+05	5.46E+04	6.69E+01	2.28E+01	0.00E+00	2.03E+06	0.00E+00
CE-141	2.16E+03	1.26E+05	2.84E+04	1.89E+04	8.87E+03	0.00E+00	6.13E+05	0.00E+00
CE-144	2.62E+05	8.63E+05	4.88E+06	2.02E+06	1.21E+06	0.00E+00	1.33E+07	0.00E+00
HF-181	7.05E+03	1.21E+05	6.32E+04	3.48E+02	2.90E+02	2.12E+02	9.39E+05	0.00E+00
AM-241	5.68E+08	3.90E+05	1.42E+10	9.60E+09	4.26E+09	0.00E+00	8.40E+08	0.00E+00

*R Values in units of mrem/yr per μCi/m^3 for inhalation and tritium, and in units of m^2-mrem/yr per μCi/sec for all others.

TABLE 3.3-18 R VALUES FOR THE BRUNSWICK STEAM ELECTRIC PLANT*

PATHWAY = Inhalation

AGE GROUP = Child

Nuclide	T. Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
H-3	1.12E+03	1.12E+03	0.00E+00	1.12E+03	1.12E+03	1.12E+03	1.12E+03	1.12E+03
P-32	9.86E+04	4.21E+04	2.60E+06	1.14E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CR-51	1.54E+02	1.08E+03	0.00E+00	0.00E+00	2.43E+01	8.53E+01	1.70E+04	0.00E+00
MN-54	9.50E+03	2.29E+04	0.00E+00	4.29E+04	1.00E+04	0.00E+00	1.57E+06	0.00E+00
FE-59	1.67E+04	7.06E+04	2.07E+04	3.34E+04	0.00E+00	0.00E+00	1.27E+06	0.00E+00
CO-58	3.16E+03	3.43E+04	0.00E+00	1.77E+03	0.00E+00	0.00E+00	1.10E+06	0.00E+00
CO-60	2.26E+04	9.61E+04	0.00E+00	1.31E+04	0.00E+00	0.00E+00	7.06E+06	0.00E+00
ZN-65	7.02E+04	1.63E+04	4.25E+04	1.13E+05	7.13E+04	0.00E+00	9.94E+05	0.00E+00
RB-86	1.14E+05	7.98E+03	0.00E+00	1.98E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-89	1.72E+04	1.67E+05	5.99E+05	0.00E+00	0.00E+00	0.00E+00	2.15E+06	0.00E+00
SR-90	6.43E+06	3.43E+05	1.01E+08	0.00E+00	0.00E+00	0.00E+00	1.47E+07	0.00E+00
Y-91	2.43E+04	1.84E+05	9.13E+05	0.00E+00	0.00E+00	0.00E+00	2.62E+06	0.00E+00
ZR-95	3.69E+04	6.10E+04	1.90E+05	4.17E+04	5.95E+04	0.00E+00	2.23E+06	0.00E+00
NB-95	6.54E+03	3.69E+04	2.35E+04	9.16E+03	8.61E+03	0.00E+00	6.13E+05	0.00E+00
RU-103	1.07E+03	4.47E+04	2.79E+03	0.00E+00	7.02E+03	0.00E+00	6.61E+05	0.00E+00
RU-106	1.69E+04	4.29E+05	1.36E+05	0.00E+00	1.84E+05	0.00E+00	1.43E+07	0.00E+00
AG-110M	9.13E+03	1.00E+05	1.68E+04	1.14E+04	2.12E+04	0.00E+00	5.47E+06	0.00E+00
SN-113	9.84E+03	7.45E+03	9.01E+03	2.91E+02	2.03E+02	1.19E+02	3.40E+05	0.00E+00
TE-127M	3.01E+03	7.13E+04	2.48E+04	8.53E+03	6.35E+04	6.06E+03	1.48E+06	0.00E+00
TE-129M	3.04E+03	1.81E+05	1.92E+04	6.84E+03	5.02E+04	6.32E+03	1.76E+06	0.00E+00
I-131	2.72E+04	2.84E+03	4.80E+04	4.80E+04	7.87E+04	1.62E+07	0.00E+00	0.00E+00
I-132	1.87E+03	3.20E+03	2.11E+03	4.06E+03	6.24E+03	1.93E+05	0.00E+00	0.00E+00
I-133	7.68E+03	5.47E+03	1.66E+04	2.03E+04	3.37E+04	3.84E+06	0.00E+00	0.00E+00
I-135	4.14E+03	4.43E+03	4.91E+03	8.72E+03	1.34E+04	7.91E+05	0.00E+00	0.00E+00
CS-134	2.24E+05	3.84E+03	6.50E+05	1.01E+06	3.30E+05	0.00E+00	1.21E+05	0.00E+00
CS-136	1.16E+05	4.17E+03	6.50E+04	1.71E+05	9.53E+04	0.00E+00	1.45E+04	0.00E+00
CS-137	1.28E+05	3.61E+03	9.05E+05	8.24E+05	2.82E+05	0.00E+00	1.04E+05	0.00E+00
BA-140	4.32E+03	1.02E+05	7.39E+04	6.47E+01	2.11E+01	0.00E+00	1.74E+06	0.00E+00
CE-141	2.89E+03	5.65E+04	3.92E+04	1.95E+04	8.53E+03	0.00E+00	5.43E+05	0.00E+00
CE-144	3.61E+05	3.88E+05	6.76E+06	2.11E+06	1.17E+06	0.00E+00	1.19E+07	0.00E+00
HF-181	8.50E+03	5.31E+04	8.44E+04	3.28E+02	2.64E+02	2.76E+02	7.95E+05	0.00E+00
AM-241	4.59E+08	1.75E+05	1.10E+10	6.81E+09	2.82E+09	0.00E+00	7.47E+08	0.00E+00

*R Values in units of mrem/yr per μCi/m^3 for inhalation and tritium, and in units of m^2-mrem/yr per μCi/sec for all others.

TABLE 3.3-19 R VALUES FOR THE BRUNSWICK STEAM ELECTRIC PLANT*

PATHWAY = Inhalation

AGE GROUP = Infant

Nuclide	T. Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
H-3	6.46E+02	6.46E+02	0.00E+00	6.46E+02	6.46E+02	6.46E+02	6.46E+02	6.46E+02
P-32	7.73E+04	1.61E+04	2.03E+06	1.12E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CR-51	8.93E+01	3.56E+02	0.00E+00	0.00E+00	1.32E+01	5.75E+01	1.28E+04	0.00E+00
MN-54	4.98E+03	7.05E+03	0.00E+00	2.53E+04	4.98E+03	0.00E+00	9.98E+05	0.00E+00
FE-59	9.46E+03	2.47E+04	1.35E+04	2.35E+04	0.00E+00	0.00E+00	1.01E+06	0.00E+00
CO-58	1.82E+03	1.11E+04	0.00E+00	1.22E+03	0.00E+00	0.00E+00	7.76E+05	0.00E+00
CO-60	1.18E+04	3.19E+04	0.00E+00	8.01E+03	0.00E+00	0.00E+00	4.50E+06	0.00E+00
ZN-65	3.10E+04	5.13E+04	1.93E+04	6.25E+04	3.24E+04	0.00E+00	6.46E+05	0.00E+00
RB-86	8.81E+04	3.03E+03	0.00E+00	1.90E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-89	1.14E+04	6.39E+04	3.97E+05	0.00E+00	0.00E+00	0.00E+00	2.03E+06	0.00E+00
SR-90	2.59E+06	1.31E+05	4.08E+07	0.00E+00	0.00E+00	0.00E+00	1.12E+07	0.00E+00
Y-91	1.57E+04	7.02E+04	5.87E+05	0.00E+00	0.00E+00	0.00E+00	2.45E+06	0.00E+00
ZR-95	2.03E+04	2.17E+04	1.15E+05	2.78E+04	3.10E+04	0.00E+00	1.75E+06	0.00E+00
NB-95	3.77E+03	1.27E+04	1.57E+04	6.42E+03	4.71E+03	0.00E+00	4.78E+05	0.00E+00
RU-103	6.78E+02	1.61E+04	2.01E+03	0.00E+00	4.24E+03	0.00E+00	5.51E+05	0.00E+00
RU-106	1.09E+04	1.64E+05	8.67E+04	0.00E+00	1.06E+05	0.00E+00	1.15E+07	0.00E+00
AG-110M	4.99E+03	3.30E+04	9.97E+03	7.21E+03	1.09E+04	0.00E+00	3.66E+06	0.00E+00
SN-113	4.89E+03	2.29E+03	4.68E+03	1.74E+02	9.94E+01	6.73E+01	2.30E+05	0.00E+00
TE-127M	2.07E+03	2.73E+04	1.66E+04	6.89E+03	3.75E+04	4.86E+03	1.31E+06	0.00E+00
TE-129M	2.22E+03	6.89E+04	1.41E+04	6.08E+03	3.17E+04	5.47E+03	1.68E+06	0.00E+00
I-131	1.96E+04	1.06E+03	3.79E+04	4.43E+04	5.17E+04	1.48E+07	0.00E+00	0.00E+00
I-132	1.26E+03	1.90E+03	1.69E+03	3.54E+03	3.94E+03	1.69E+05	0.00E+00	0.00E+00
I-133	5.59E+03	2.15E+03	1.32E+04	1.92E+04	2.24E+04	3.55E+06	0.00E+00	0.00E+00
I-135	2.77E+03	1.83E+03	3.86E+03	7.59E+03	8.46E+03	6.95E+05	0.00E+00	0.00E+00
CS-134	7.44E+04	1.33E+03	3.96E+05	7.02E+05	1.90E+05	0.00E+00	7.95E+04	0.00E+00
CS-136	5.28E+04	1.43E+03	4.82E+04	1.34E+05	5.63E+04	0.00E+00	1.17E+04	0.00E+00
CS-137	4.54E+04	1.33E+03	5.48E+05	6.11E+05	1.72E+05	0.00E+00	7.12E+04	0.00E+00
BA-140	2.89E+03	3.83E+04	5.59E+04	5.59E+01	1.34E+01	0.00E+00	1.59E+06	0.00E+00
CE-141	1.99E+03	2.15E+04	2.77E+04	1.66E+04	5.24E+03	0.00E+00	5.16E+05	0.00E+00
CE-144	1.76E+05	1.48E+05	3.19E+06	1.21E+06	5.37E+05	0.00E+00	9.83E+06	0.00E+00
HF-181	5.05E+03	1.90E+04	5.65E+04	2.66E+02	1.59E+02	2.26E+02	6.73E+05	0.00E+00
AM-241	1.83E+08	6.69E+04	4.41E+09	2.73E+09	1.11E+09	0.00E+00	5.68E+08	0.00E+00

*R Values in units of mrem/yr per μCi/m3 for inhalation and tritium, and in units of m2-mrem/yr per μCi/sec for all others.

3.3.3 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. The concentration of C-14 in the atmosphere was increased significantly in the 1950s and 1960s due to nuclear weapons testing. Commercial nuclear reactors also produce C-14, but in amounts much less than those produced naturally or as a result of weapons testing. Regulatory Guide 1.21 Revision 1 (1974), to which the Brunswick Steam Electric Plant (BSEP) is committed, did not address C-14. However, since that time analytical methods for determining C-14 have improved and Revision 2 (2009) states that Licensees should evaluate whether C-14 is a principal radionuclide for gaseous effluents. Improvements in fuel performance have resulted in a decrease in radioactive effluents from BSEP to the point that C-14 is now considered a principal radionuclide. In Boiling Water Reactors (BWRs), such as BSEP, the gaseous C-14 releases are primarily in the form of carbon dioxide. The dose contribution of C-14 in liquid radioactive waste is minimal, therefore, evaluation of C-14 in liquid discharges is not required.

The C-14 curies released may be determined by any of the following methodologies:

a. Use BSEP's Updated Final Safety Analysis Report (UFSAR) C-14 release rate of 9.5 Ci/yr per unit assuming 80% plant capacity factor (292 Effective Full Power Days (EFPD)) and scale it using actual EFPD for each unit. The curies per year will be allotted based on ODCM allocation fractions of 0.40 for the Stack, 0.20 for each Reactor Building, and 0.10 for each Turbine Building and attributed to each quarter for reporting in the Annual Radioactive Effluent Release Report.
b. Use of historical values (with power up-rate adjustment) as indicated in NUREG/CR-4245 (1985).
c. Use of actual sample data obtained during the reporting period.
d. Use of Electric Power Research Institute's, "Estimation of Carbon-14 in Nuclear Power Plant Gaseous Effluents" methodology.

The Annual Land Use Census will be used to determine the critical receptor. Typically, there are no meat or milk pathways within 5 miles of BSEP, therefore, unless other pathways are identified, the reported dose to the individual will be determined from inhalation and vegetable consumption. Regulatory Guide 1.109 Revision 1 methodology will be used to determine the dose. The dose rate and subsequent dose to an individual from C-14 intake depends on 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. Atmospheric Carbon Dioxide (CO_2) is incorporated in cellular material by the photosynthetic action of plants. Plants and grasses equilibrate with the C-14 CO_2 of the air. The portion of the curies released that is determined to be carbon dioxide is 90%. This value is based on conservative historical values from NUREG/CR-4245 (1985). The growing season may be utilized and can be derived from the North Carolina Cooperative Extension Service, current data available indicates that average growing season is 238 days. BSEP gaseous releases are continuous and no credit is taken for releases in non-daylight hours where photosynthetic action of plants is minimal or non-existent.

Carbon-14 releases are typically tabulated at the end of the yearly reporting period and included in the Annual Radioactive Effluent Release Report, however, special circumstances as determined by E&C Management may require that C-14 releases be assessed on a more frequent basis. Once the C-14 dose is determined it is included in the Annual Radioactive Effluent Release Report.

1. Annual Dose from Inhalation of Carbon-14 in Air

   a. The annual average airborne concentration of C-14 may be determined as follows:

$$X_c = (3.17 \times 10^4)\ (Q_c) \left(\frac{X}{Q}\right) \qquad (3.3\text{-}21)$$

   Where:

X_c	is the annual average concentration of C-14 in air, pCi/m^3 ;
3.17×10^4	is the number of pCi/Ci divided by the number of sec/year;
Q_c	is the release rate of C-14 to the atmosphere, in Ci/yr; and

For Reactor and Turbine Buildings using methodology a. listed under Section 3.3.3 to determine the C-14 curies released:

$$Q_c = \left(\frac{\mathrm{Ci}}{\mathrm{yr}} \text{ for applicable release point}\right)\left(\frac{\text{EFPD for applicable Unit}}{292\ \text{days}}\right)$$

For Stack using methodology a. listed under Section 3.3.3 to determine the C-14 curies released:

$$Q_c = \left(\frac{\mathrm{Ci}}{\mathrm{yr}}\right)\left(\frac{\text{EFPD of Unit 1 and Unit 2}}{292\ \text{days} + 292\ \text{days}}\right)$$

$\left(\frac{x}{Q}\right)$ is the annual average atmosphere dispersion factor, in sec/m^3.

   b. The annual dose associated with inhalation of C-14 may be determined as follows:

$$D^{c}_{ja} = \left[(BR)_a\right](X_c)(DFA_{cja}) \qquad (3.3\text{-}22)$$

   Where:

D^{c}_{ja}	is the C-14 annual dose to organ *j* of an individual in age group a, in mrem/yr;
$(BR)_a$	is the breathing rate of the receptor of age group *a*, in m^3/yr, reference ODCM Section C.2.1 for these values;
X_c	is the annual average concentration of C-14 in air, in pCi/m^3 .
DFA_{cja}	is the C-14 inhalation dose factor for organ *j*, and age group *a*, in mrem/pCi, reference Table 3.3-20 for values.

Table 3.3-20
Inhalation Dose Factors for Carbon-14 (DFA)
(mrem/pCi)

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

Note: These values are from Regulatory Guide 1.109 Revision 1 Tables E-7 through E-10.

2. Concentration of Airborne Carbon-14 in Vegetation

   a. The annual concentration of Carbon-14 in vegetation may be determined as follows:

$$C_{14}^{v} = (3.17 \times 10^{7})\,(p)\,(Q_c)\left(\frac{X}{Q}\right)\left(\frac{0.11}{0.16}\right) \qquad (3.3\text{-}23)$$

Where:

C_{14}^{v}	is the concentration of Carbon-14 in vegetation in pCi/kg;
Q_c	is the annual release rate of Carbon-14, in Ci/yr;
p	is the fractional equilibrium ratio, dimensionless (0.9 based off conservative historical values from NUREG/CR-4245 (1985));
$\left(\frac{X}{Q}\right)$	is the annual average atmosphere dispersion factor, in sec/m^3;
0.11	is the fraction of total plant mass that is natural carbon, dimensionless, from RG 1.109 Revision 1 Appendix C;
0.16	is equal to the concentration of natural carbon in the atmosphere in g/m^3 from RG 1.109 Revision 1 Appendix C; and
3.17×10^7	is equal to $(1.0 \times 10^{12}$ pCi/Ci$)(1.0 \times 10^{3}$ g/kg$)$ / $\left(3.15 \times 10^{7}\ \frac{\text{sec}}{\text{yr}}\right)$

3. Concentration of Airborne Carbon-14 in Milk

   a. The concentration of Carbon-14 in milk is dependent on the amount and contamination level of the feed consumed by the animal. The C-14 concentration in milk may be determined as follows:

$$C_{14}^{m} = (F_m)\left(C_{14}^{v}\right)(Q_F) \qquad (3.3\text{-}24)$$

   Where:

C_{14}^{m} is the C-14 concentration in milk, in pCi/liter;

F_m is the average fraction of the animal's daily intake of C-14, which appears in each liter of milk, in days/liter. Cow = 0.012 days/liter from Table E-1 of RG 1.109 Revision 1 and Goat = 0.10 days/liter from Table E-2 of RG 1.109 Revision 1;

C_{14}^{v} is the concentration of C-14 in the animal's feed, in pCi/kg;

Q_F is the amount of feed consumed by the animal per day, in kg/day, see ODCM Table C-1.

4. Concentration of Airborne Carbon-14 in Meat

   a. The concentration of Carbon-14 in meat is dependent on the amount and contamination level of the feed consumed by the animal. The C-14 concentration in meat may be determined as follows:

$$C_{14}^{F} = (F_f)(C_{14}^{v})(Q_F) \qquad (3.3\text{-}25)$$

Where:

C_{14}^{F} is the concentration of C-14 in animal flesh, in pCi/kg;

F_f is the fraction of the animal's daily intake of C-14, which appears in each kilogram of flesh, in days/kg. Value for C-14 is 0.031 days/kg from Table E-1 in RG 1.109 Revision 1;

C_{14}^{V} is the concentration of C-14 in the animal's feed, in pCi/kg;

Q_F is the amount of feed consumed by the animal per day, in kg/day, see ODCM Table C-1.

5. Annual Dose from Atmospherically Released Carbon-14 in Foods

   a. The annual dose associated with the ingestion of Carbon-14 in food may be determined as follows:

$$D_{ja}^{D} = DFI_{cja}\left[U_{a}^{s} f_g C_{14}^{v} + U_{a}^{m} C_{14}^{m} + U_{a}^{F} C_{14}^{F} + U_{a}^{L} f_1 C_{14}^{v}\right] \qquad (3.3\text{-}26)$$

Where:

D_{ja}^{D} is the annual dose to organ *j* of an individual in age group *a* from dietary intake of atmospherically released C-14, in mrem/yr;

DFI_{cja} is the dose conversion factor for the ingestion of C-14 for organ *j*, and age group *a*, in mrem/pCi, reference Table 3.3-21;

U_a^s the ingestion rate of produce (non-leafy vegetables, fruit, and grains) for individuals in age group *a,* in kg/yr, see ODCM Table C-3;

U_a^m the ingestion rate of milk for individuals in age group *a*, *in* liters/year, see ODCM Table C-1 (U_{ap});

U_a^F the ingestion rate of meat for individuals in age group *a,* in kg/yr, see ODCM Table C-2 (U_{ap});

U_a^L the ingestion rate of leafy vegetables for individuals in age group *a,* in kg/yr, see ODCM Table C-3;

f_g is the fraction of produce ingested grown in garden of interest, 0.76 from Table E-15 of RG 1.109;

f_l is the fraction of leafy vegetables grown in the garden of interest, 1.0 from Table E-15 of RG 1.109;

C_{14}^v is the concentration of C-14 in vegetation, in pCi/kg;

C_{14}^m is the concentration of C-14 in milk, in pCi/liter;

C_{14}^F is the concentration of C-14 in animal flesh, in pCi/kg.

Table 3.3-21

Ingestion Dose Factors for Carbon-14 (DFI)
(mrem/pCi)

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

Note: These values are from Regulatory Guide 1.109 Revision 1 Tables E-11 through E-14.

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LIST OF TABLES

4.0 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Table 4.0-1 contains the sample point description, sampling and collection frequency analysis, and analysis frequency for various exposure pathways in the vicinity of the BSEP for the radiological monitoring program. Figure 4.0-1, 4.0-2, 4.0-3 and 4.0-4 shows the location of various sample points. Figure F-2, Gaseous Radwaste Effluent System, denotes the various release pathways.

TABLE 4.0-1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM*

Exposure Pathway and/or Sample	Sample ID No.	Sample Point Description, Approximate Distance, and Direction	Sampling and Collection Frequency	Analysis Frequency	Analysis [a]
1. DIRECT RADIATION	86	1.07 miles E	Q	Q	Gamma Dose
	2	0.88 miles ESE	Q	Q	Gamma Dose
	3	0.82 miles SE	Q	Q	Gamma Dose
	4	1.01 miles SSE	Q	Q	Gamma Dose
	91	0.95 miles S	Q	Q	Gamma Dose
	6	1.45 miles SSW	Q	Q	Gamma Dose
	7	1.03 miles SW	Q	Q	Gamma Dose
	8	1.20 miles W	Q	Q	Gamma Dose
	9	1.08 miles WNW	Q	Q	Gamma Dose
	10	0.95 miles NW	Q	Q	Gamma Dose
	11	1.01 miles NNW	Q	Q	Gamma Dose
	12	1.16 miles N	Q	Q	Gamma Dose
	13	1.28 miles NNE	Q	Q	Gamma Dose
	14	0.61 miles NE	Q	Q	Gamma Dose
	87	1.02 miles ENE	Q	Q	Gamma Dose
	16	0.99 miles WSW	Q	Q	Gamma Dose
	17	1.41 miles ESE	Q	Q	Gamma Dose

Exposure Pathway and/or Sample	Sample ID No.	Sample Point Description, Approximate Distance, and Direction	Sampling and Collection Frequency	Analysis Frequency	Analysis [a]
1. DIRECT RADIATION (Cont'd)	18	1.60 miles SE	Q	Q	Gamma Dose
	77	5.34 miles S	Q	Q	Gamma Dose
	75	4.56 miles S	Q	Q	Gamma Dose
	76	4.70 miles SSW	Q	Q	Gamma Dose
	22	5.18 miles SW	Q	Q	Gamma Dose
	88	5.30 miles WSW	Q	Q	Gamma Dose
	24	3.00 miles W	Q	Q	Gamma Dose
	25	8.64 miles WNW	Q	Q	Gamma Dose
	26	5.95 miles NW	Q	Q	Gamma Dose
	27	5.17 miles NNW	Q	Q	Gamma Dose
	79	9.56 miles N	Q	Q	Gamma Dose
	78	10.0 miles NNE	Q	Q	Gamma Dose
	30	2.06 miles NE	Q	Q	Gamma Dose
	31	2.55 miles ENE	Q	Q	Gamma Dose
	32	5.85 miles ENE	Q	Q	Gamma Dose
	33	4.13 miles E	Q	Q	Gamma Dose
	89	5.06 miles E	Q	Q	Gamma Dose
	81	9.98 miles WNW [c]	Q	Q	Gamma Dose

TABLE 4.0-1 (Cont'd)

Exposure Pathway and/or Sample	Sample ID No.	Sample Point Description, Approximate Distance, and Direction	Sampling and Collection Frequency	Analysis Frequency	Analysis [a]
1. DIRECT RADIATION (Cont'd)	36	9.02 miles NE	Q	Q	Gamma Dose
	37	5.58 miles NNW	Q	Q	Gamma Dose
	90	5.68 miles W	Q	Q	Gamma Dose
	39	5.20 miles SW	Q	Q	Gamma Dose
	40	6.81 miles WSW	Q	Q	Gamma Dose
	20	2.01 miles S	Q	Q	Gamma Dose
	21	2.79 miles SSW	Q	Q	Gamma Dose
	28	4.31 miles NNW	Q	Q	Gamma Dose
	29	2.50 miles SSW	Q	Q	Gamma Dose
	35	7.09 miles SSE	Q	Q	Gamma Dose
	82	0.29 miles NNE	Q	Q	Gamma Dose
	83	0.40 miles NE	Q	Q	Gamma Dose
	84	0.39 miles NE	Q	Q	Gamma Dose
	85	0.21 miles NE	Q	Q	Gamma Dose

TABLE 4.0-1 (Cont'd)

Exposure Pathway and/or Sample	Sample ID No.	Sample Point Description, Approximate Distance, and Direction	Sampling and Collection Frequency	Analysis Frequency	Analysis [a]
2. AIRBORNE Radioiodine and Particulate	200	0.91 miles WSW - Brunswick Education & Energy Center	Continuous sampler operation with sample collected weekly or as required by dust loading, whichever is more frequent	W W	Radioiodine Canister I-131 analysis Particulate sampler
	201	0.61 miles NE – Bio. Lab Road – Projected Maximum Annual Concentration (PMAC)			Gross beta radioactivity analysis following filter change [b]
	202	0.86 miles S – Substation, Construction Rd.		Q	Gamma isotopic analysis of composite by location
	203	1.92 miles SSW - Southport Substation			
	204	22.6 miles N - Sutton Plant – (Historical Control)			
	205	0.55 miles SSE - Spoil Pond			
	206	11.3 miles NW – Brunswick County Complex – Control[c]			
	207	0.65 miles NNE – GWE Compressor Building			

TABLE 4.0-1 (Cont'd)

Exposure Pathway and/or Sample	Sample ID No.	Sample Point Description, Approximate Distance, and Direction	Sampling and Collection Frequency	Analysis Frequency	Analysis [(a)]
3. WATERBORNE	400	0.75 miles NE - Intake Canal - Control [(c)]	Composite sample[(d)] Collection-M	Monthly	Gamma Isotopic
a. Surface	401	4.82 miles SSW - Discharge Canal at OD Pumps		Q	Tritium
	495	Nancy's Creek – WP-52	Grab Sample, Monthly	Monthly	Tritium Gamma Isotopic [f,g]
	496	Nancy's Creek – WP-53			
	497	Nancy's Creek – WP-55			
	498	Nancy's Creek – WP-57			
	499	Control Station NE[(c)] – WP-61			
	494	Nancy's Creek Marsh Area – WP-106	Grab Sample, Monthly	Monthly	Tritium Gamma Isotopic [f,g]
	604	Nancy's Creek Marsh Area – WP-92			

TABLE 4.0-1 (Cont'd)

Exposure Pathway and/or Sample	Sample ID No.	Sample Point Description, Approximate Distance, and Direction	Sampling and Collection Frequency	Analysis Frequency	Analysis [a]
3. WATERBORNE (Cont'd) a. Surface (Continued)	607	Nancy's Creek Marsh Area – WP-76	Grab Sample, Monthly	Monthly	Tritium Gamma Isotopic [f,g]
	609	Nancy's Creek Marsh Area – WP-84	Grab Sample, Monthly	Monthly	Tritium Gamma Isotopic [f,g]

TABLE 4.0-1 (Cont'd)

Exposure Pathway and/or Sample	Sample ID No.	Sample Point Description, Approximate Distance, and Direction	Sampling and Collection Frequency	Analysis Frequency	Analysis [a]
3. WATERBORNE (Cont'd)	500	4.92 miles SSW – Discharge – Beach near OD Pumps	Semiannual	Semiannual	Gamma Isotopic [f]
b. Sediment	501	Nancy's Creek, Adjacent to WP-55, Near Retired SDSP	Annual	Annual	Gamma Isotopic [h]
c. Groundwater	409	Monitoring Well ESS-17A, northeast side of retired SDSP near Intake Canal	Grab Sample, Quarterly, Semiannual	Q Semiannual	Tritium Gamma Isotopic[f]
	410	Monitoring Well ESS-17B, northeast side of retired SDSP near Intake Canal			
	412	Monitoring Well, ESS-18B, west side of retired SDSP			
	420	Monitoring Well ESS-22B, south side of retired SDSP			
	423	Monitoring Well ESS-24A, southeast side of retired SDSP adjacent to SDSF near Intake Canal			
	424	Monitoring Well ESS-24B, southeast side of retired SDSP adjacent to SDSF near Intake Canal			
	1020	Monitoring Well U1CSTREM-05B, east side of protected area near intake structure			
4. INGESTION a. Milk	600	To be identified as available	With animals on pasture - semi-monthly At other times – monthly	Semi-monthly	Gamma isotopic and I-131 analyses (animals on pasture)
	601				

Exposure Pathway and/or Sample	Sample ID No.	Sample Point Description, Approximate Distance, and Direction	Sampling and Collection Frequency	Analysis Frequency	Analysis [a]
4. INGESTION (Cont'd) a. Milk		To be identified as available	With animals on pasture - semi-monthly At other times - monthly	Monthly	Gamma isotopic and I-131 analysis (other times)
	602				
	603				
b. Fish and Invertebrates	700-702	5.09 miles SSW - Atlantic Ocean [e] at Discharge	When in Season – Semiannual	Semiannual	Gamma isotopic on edible portions
	703-705	WSW - Atlantic Ocean [c][e]			
	706-708	Nancy’s Creek [e]	Annual	Annual	Gamma isotopic on edible portions
c. Broadleaf Vegetation	800	0.76 miles NE - Intake Canal	When available - Monthly	Monthly Monthly	Gamma Isotopic I-131
	801	0.71 miles SW - Discharge Canal			
	802	10.4 miles - Control - WNW [c]			
	803	0.48 miles SSE - Spoil Pond			
	804	0.67 miles S – Leonard Street plant exit adjacent to RR tracks			
	806	1.06 miles ENE – East Intake Canal			

TABLE 4.0-1 (Cont'd)

(a) The LLD for each analysis is specified in Table 7.3.15-3, except for the Nancy's Creek Marsh Area principal gamma isotopic and I-131. The LLD for the Nancy's Creek Marsh Area gamma isotopic is 5×10^{-7} µCi/ml for Principal Gamma Emitters and 1×10^{-6} µCi/ml for I-131.

(b) Particulate samples will be analyzed for gross beta radiation 24 hours or more following filter change. If gross beta activity in air particulate samples is greater than ten times the yearly mean of control samples, gamma isotopic shall be performed on the individual samples.

(c) Control Station - These stations are presumed to be outside the influence of plant effluents.

(d) Composite samples shall be collected by collecting an aliquot at intervals not exceeding 6 hours.

(e) A sample of one free swimmer, one bottom feeder, and one shellfish will be collected if available. A control sample of each species collected will be obtained if available.

(f) Gamma isotopic scan means the identification and quantification of gamma-emitting radionuclides that may be attributable to the effluents from the facility.

(g) The samples are to be analyzed for gamma isotopic analyses. If plant activity is detected from the gamma isotopic analysis, Sr-89, 90 and Fe-55 analysis are to be performed.

(h) If plant activity is detected, Sr-89, 90 and Fe-55 analysis are to be performed and frequency will be increased to Semi-Annual.

FIGURE 4.0-1

BSEP Sample Point Locations TLD, Air Sample (1 mile)

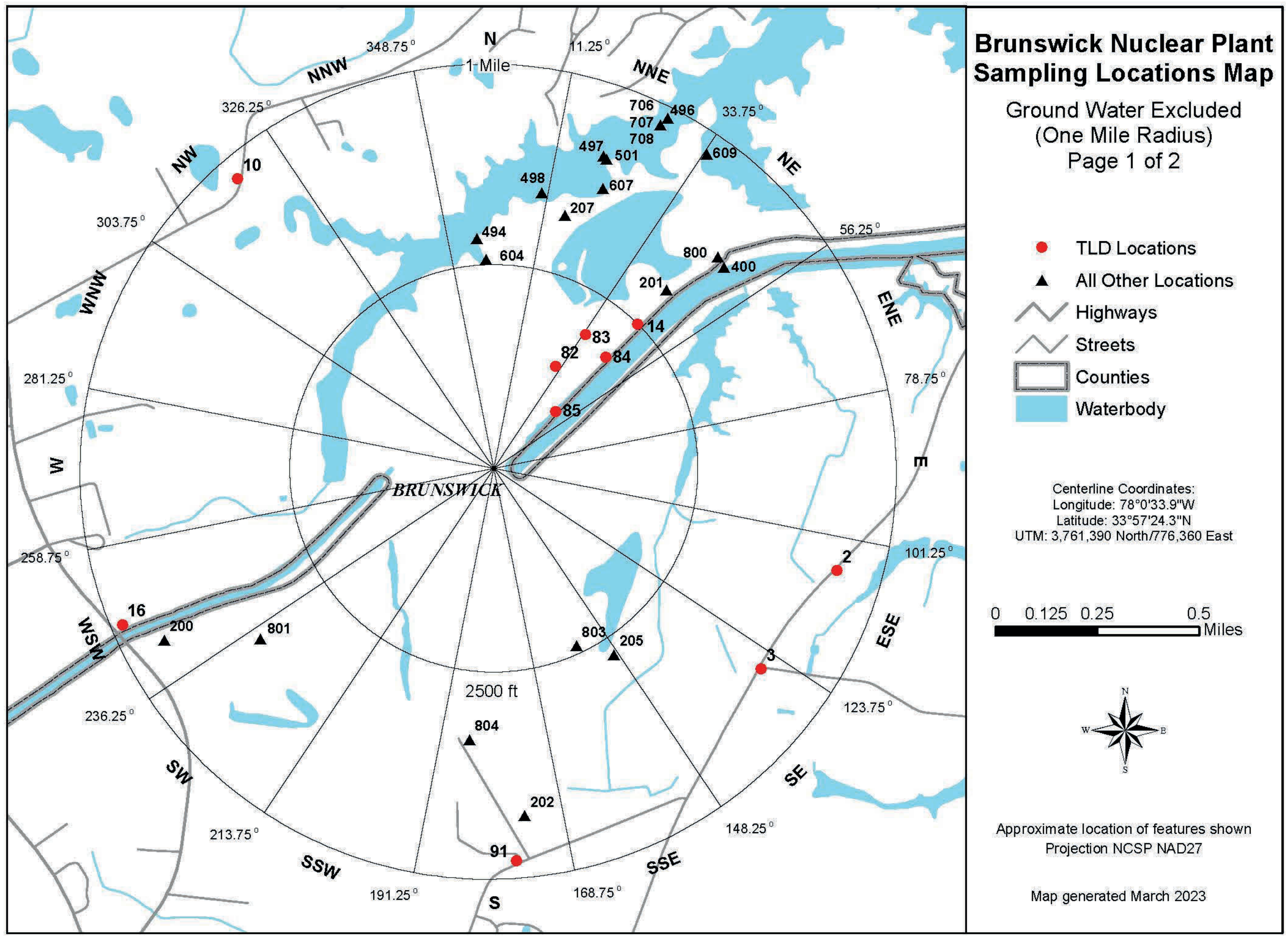


FIGURE 4.0-2

BSEP Sample Point Locations Groundwater (1 mile)

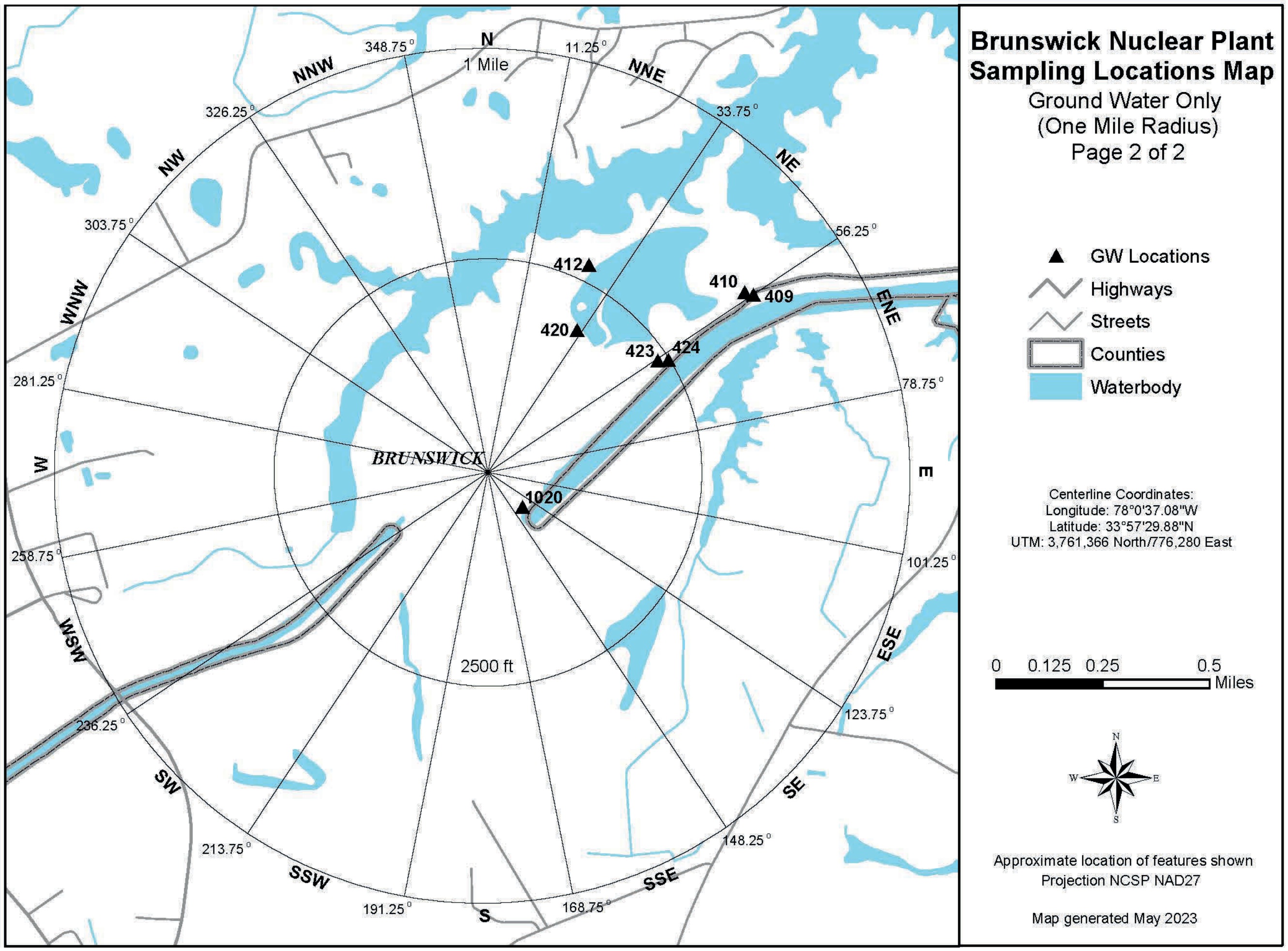


FIGURE 4.0-3

BSEP Sample Point Locations (10 miles)

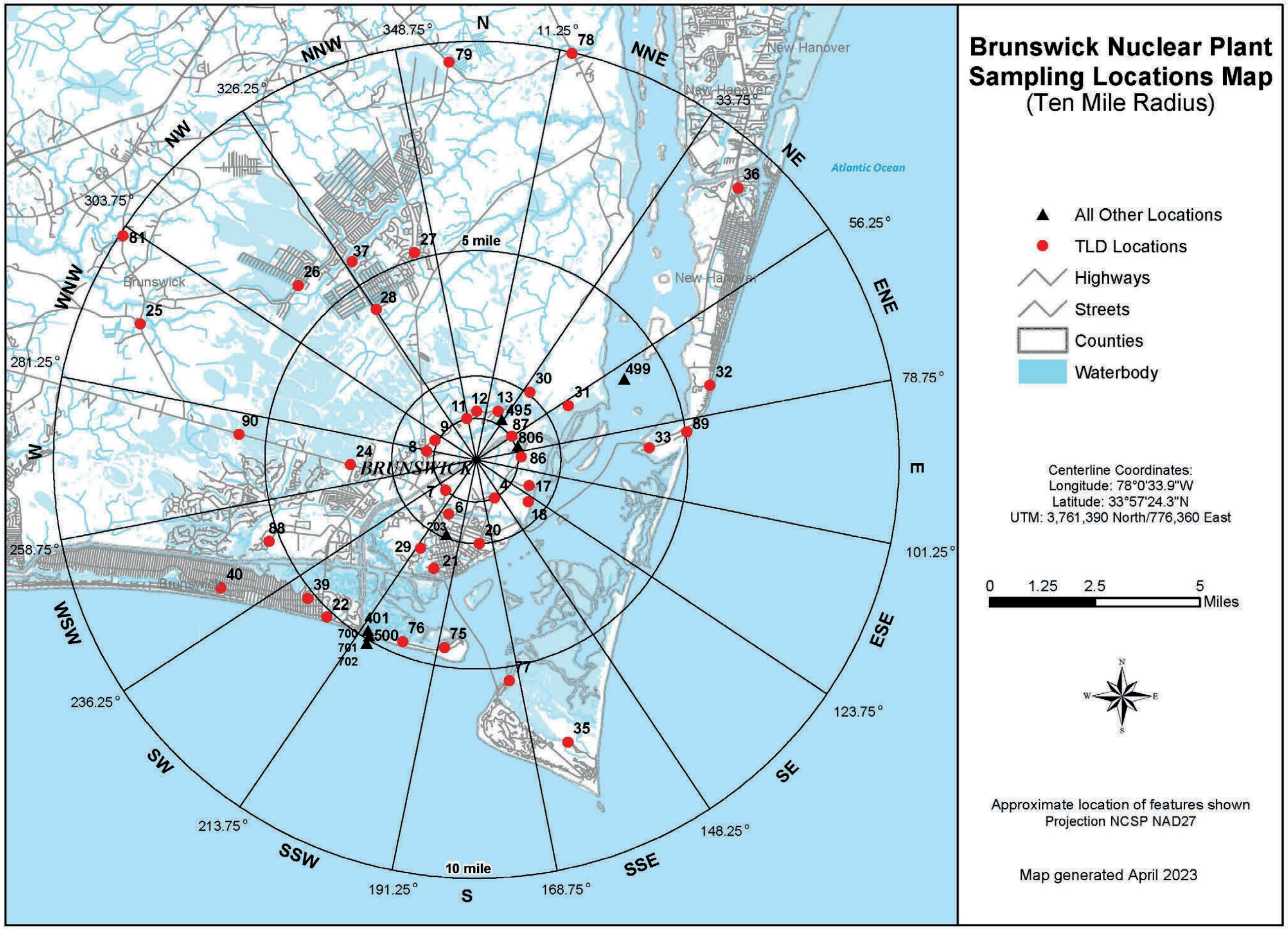
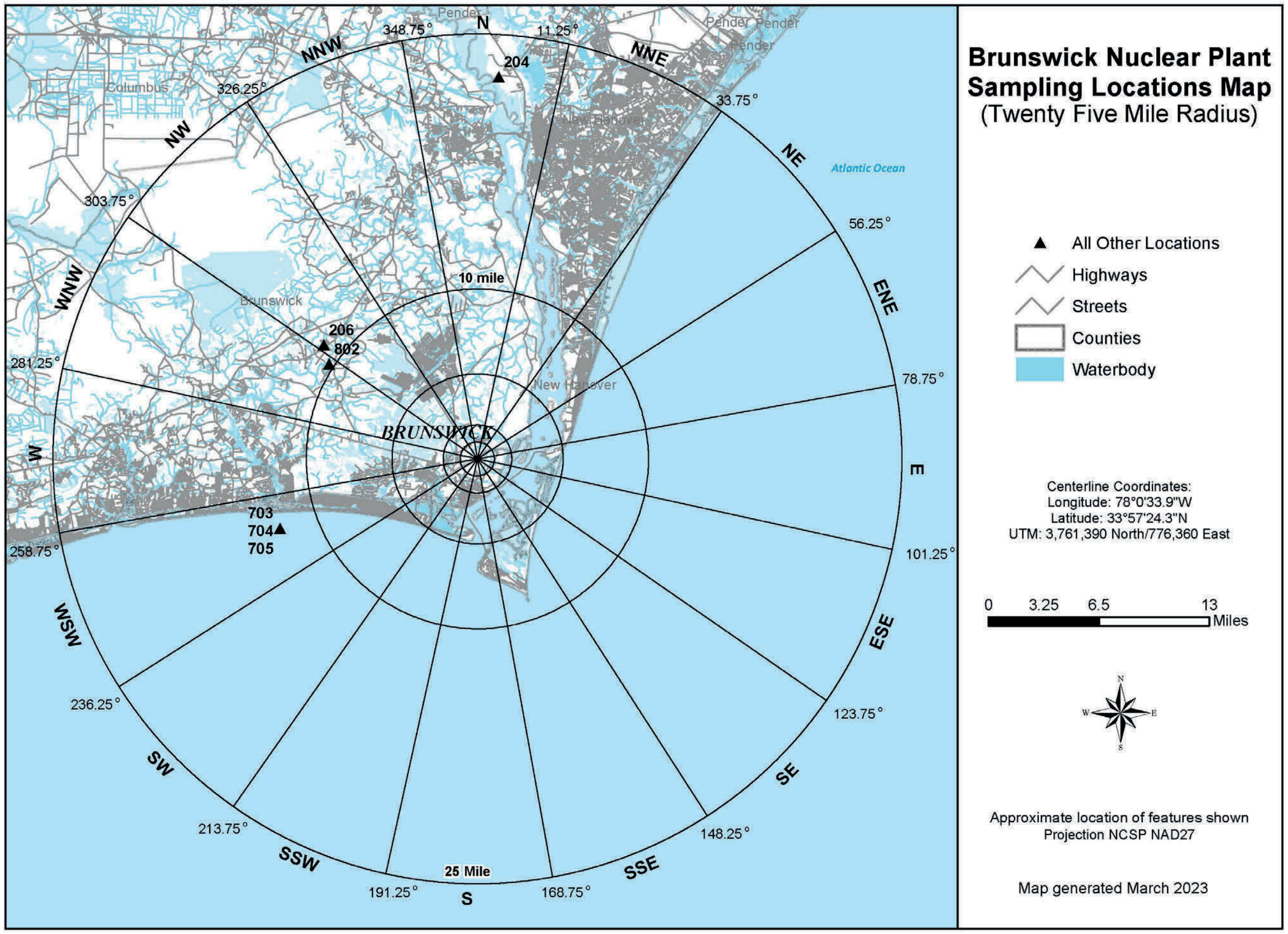


FIGURE 4.0-4

BSEP Sample Point Locations (25 miles)



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5.0 RADIOLOGICAL INTERLABORATORY COMPARISON STUDIES

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.

5.2 PROGRAM

5.2.1 <u>Environmental Sample Analyses Comparison Program</u>

Environmental samples from the BSEP environs will be analyzed by the Harris Energy & Environmental Center or by a qualified contracting laboratory. These laboratories will participate at least annually in a interlaboratory comparison study.

The results of the laboratories' performances in the study will be provided to BSEP E&RC and will be included in the Annual Radiological Environmental Operating Report. The results will be provided to the NRC upon request.

5.2.2 <u>Effluent Release Analyses Program</u>

BSEP 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 equivalent study. The results of these studies will be provided to the NRC upon request.

5.2.3 <u>Abnormal Results</u>

Progress Energy laboratory or vendor 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, or 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 - 1.18

If the Progress Energy laboratory or vendor laboratory results lie 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 BSEP and will be provided to the NRC upon request.

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6.0 TOTAL DOSE (40CFR190 COMPLIANCE)

6.1 INTRODUCTION

Compliance with 40CFR190 as prescribed by ODCM Specification 7.3.14 is to be demonstrated only when one or more of ODCM Specifications 7.3.4.a, 7.3.4.b, 7.3.8.a, 7.3.8.b, 7.3.9.a, 7.3.9.b is exceeded by a factor of 2. Once this occurs, the Company has 30 days to submit this report.

6.2 GENERAL

To perform the calculations to evaluate conformance with 40CFR190, 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 10CR50, Appendix I). To accomplish this, the following calculational rules are used:

6.2.1 Doses to a MEMBER OF THE PUBLIC via the liquid release pathway are considered to be <1 mrem/yr. (Ref: NUREG 0543).

6.2.2 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.

6.2.3 Environmental sampling data which demonstrates that no pathway exists may be used to delete a pathway to man from a calculation.

6.2.4 To sum numbers represented as "less than" (<), use the value of the largest number in the group.

(i.e., <5 + <1 + <1 + <3 = 5)

6.2.5 When doses via direct radiation are added to doses via inhalation pathway, they will be calculated for the same distance in the same sector.

6.2.6 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. Determining the direct radiation dose at the plant boundary in each sector, D_B, θ.
2. Extrapolating that dose to the calculational location as follows:

$$D_L, \theta = \frac{D_B, \theta\,(1.49\,E + 6)}{(X_L^2, \theta)}$$

D_L, θ = dose at calculational location in sector θ

1.49E + 6 = square of mean distance to the site boundary (1220 m).

X_L, θ = distance to calculational locations in sector θ in meters.

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 3.3 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 exists 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 to 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 3.3 of this manual.

6.4.1 Dose projections can incorporate planned plant operations such as power reduction or outages for the projected period.

SECTION 7.0

RADIOACTIVE EFFLUENTS CONTROLS PROGRAM

CONTAINING

OFFSITE DOSE CALCULATION MANUAL SPECIFICATIONS (ODCMS) AND BASES

FOR

BRUNSWICK STEAM ELECTRIC PLANT

UNITS 1 AND 2

BASES

(continued)

LIST OF TABLES

LIST OF FIGURES

7.1.0 USE AND APPLICATION

ODCMS 7.1.1 Definitions

NOTE
The defined terms of this section appear in capitalized type and are applicable throughout these Offsite Dose Calculation Manual Specifications and Bases.

Term	Definition
CHANNEL CALIBRATION	A CHANNEL CALIBRATION shall be the adjustment, as necessary, of the channel output such that it responds within the necessary range and accuracy to known values of the parameter that the channel monitors. The CHANNEL CALIBRATION shall encompass the entire channel, including the required sensor, alarm, display, and trip functions, and shall include the CHANNEL FUNCTIONAL TEST. The CHANNEL CALIBRATION may be performed by means of any series of sequential, overlapping, or total channel steps so that the entire channel is calibrated.
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.
CHANNEL FUNCTIONAL TEST	A CHANNEL FUNCTIONAL TEST shall be the injection of a simulated or actual signal into the channel as close to the sensor as practicable to verify OPERABILITY, including required alarm, interlock, display, and trip functions, and channel failure trips. The CHANNEL FUNCTIONAL TEST may be performed by means of any series of sequential, overlapping, or total channel steps so that the entire channel is tested.

(continued)

ODCMS 7.1.1 Definitions (continued)

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 offgases from the primary system and providing for delay or holdup for the purpose of reducing the total radioactivity prior to release to the environment.
LIQUID RADWASTE TREATMENT SYSTEM	A LIQUID RADWASTE TREATMENT SYSTEM is any system designed and installed to collect, treat and process radioactive liquid waste streams for reuse or for controlled discharge from the restricted area in compliance with established regulatory requirements.
MEMBER(S) OF THE PUBLIC	MEMBER(S) OF THE PUBLIC shall mean any individual(s) except when that individual is receiving occupational dose.
MODE	A MODE shall be as required by Technical Specifications.
OPERABLE—OPERABILITY	A system, subsystem, division, 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, division, component, or device to perform its specified safety function(s) are also capable of performing their related support function(s).
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 that replacement air or gas is required to purify the containment.

(continued)

ODCMS 7.1.1 Definitions (continued)

RATED THERMAL POWER (RTP)	RTP shall be a total reactor core heat transfer rate to the reactor coolant of 2923 MWt.
SITE BOUNDARY	The SITE BOUNDARY shall be that line beyond which the land is neither owned, nor leased nor otherwise controlled by the licensee, as defined by Figure 7.1.1-1. For the purpose of effluent release calculations, the boundary for atmospheric releases is the SITE BOUNDARY and the boundary for liquid releases is the SITE BOUNDARY prior to dilution in the Atlantic Ocean.
SOURCE CHECK	A SOURCE CHECK shall be the qualitative assessment of channel response when the channel sensor is exposed to radiation.
THERMAL POWER	THERMAL POWER shall be the total reactor core heat transfer rate to the reactor coolant.
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 purpose of protection of individuals from exposure to radiation and radioactive materials or any area within the SITE BOUNDARY used for residential quarters or industrial, commercial, institutional or recreational purposes.
VENTILATION EXHAUST TREATMENT SYSTEM	A VENTILATION EXHAUST TREATMENT SYSTEM is any system designed and installed to reduce gaseous radioiodine or radioactive material in particulate form in effluents by passing ventilation or vent exhaust gases through charcoal adsorbers and/or HEPA filters for the purpose of removing iodines or particulates from the gaseous exhaust stream prior to the release to the environment. Such a system is not considered to have any effect on noble gas effluents. Engineered Safety Feature (ESF) atmospheric cleanup systems are not considered to be VENTILATION EXHAUST TREATMENT SYSTEM components.

(continued)

ODCMS 7.1.1 Definitions (continued)

VENT-VENTING	VENT or 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. Vent, used in system names, does not imply a VENTING process.

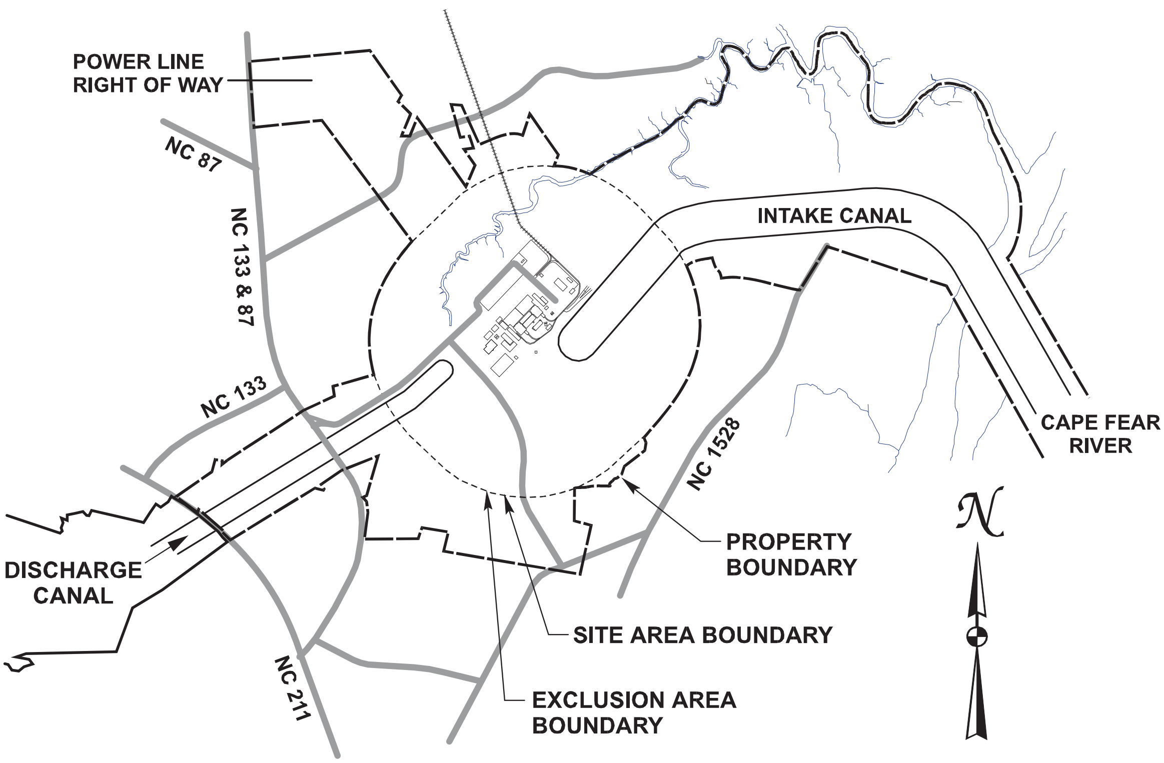

Figure 7.1.1-1 (page 1 of 1)
SITE BOUNDARY

7.1.0 USE AND APPLICATION

ODCMS 7.1.2 Logical Connectors

PURPOSE	The purpose of this section is to explain the meaning of logical connectors. Logical connectors are used in Offsite Dose Calculation Manual Specifications (ODCMS) to discriminate between, and yet connect, discrete Conditions, Required Compensatory Measures, Completion Times, Tests, and Frequencies. The only logical connectors that appear in ODCMS are AND and OR. The physical arrangement of these connectors constitutes logical conventions with specific meanings.
BACKGROUND	Several levels of logic may be used to state Required Compensatory Measures. These levels are identified by the placement (or nesting) of the logical connectors and by the number assigned to each Required Compensatory Measure. The first level of logic is identified by the first digit of the number assigned to a Required Compensatory Measure and the placement of the logical connector in the first level of nesting (i.e., left justified with the number of the Required Compensatory Measure). The successive levels of logic are identified by additional digits of the Required Compensatory Measure number and by successive indentions of the logical connectors. When logical connectors are used to state a Condition, Completion Time, Test, or Frequency, only the first level of logic is used, and the logical connector is left justified with the statement of the Condition, Completion Time, Test, or Frequency.
EXAMPLES	The following examples illustrate the use of logical connectors.

(continued)

ODCMS 7.1.2 Logical Connectors (continued)

EXAMPLES (continued)

EXAMPLE 7.1.2-1

COMPENSATORY MEASURES

CONDITION	REQUIRED COMPENSATORY MEASURE	COMPLETION TIME
A. ODCMS not met.	A.1 Verify . . . AND A.2 Restore . . .	

In this example the logical connector AND is used to indicate that when in Condition A, both Required Compensatory Measures A.1 and A.2 must be completed.

(continued)

ODCMS 7.1.2 Logical Connectors (continued)

EXAMPLES (continued)

EXAMPLE 7.1.2-2

COMPENSATORY MEASURES

CONDITION	REQUIRED COMPENSATORY MEASURE	COMPLETION TIME
A. ODCMS not met.	A.1 Trip . . . OR A.2.1 Verify . . . AND A.2.2.1 Reduce . . . OR A.2.2.2 Perform . . . OR A.3 Align . . .	

This example represents a more complicated use of logical connectors. Required Compensatory Measures A.1, A.2, and A.3 are alternative choices, only one of which must be performed as indicated by the use of the logical connector OR and the left justified placement. Any one of these three Compensatory Measures may be chosen. If A.2 is chosen, then both A.2.1 and A.2.2 must be performed as indicated by the logical connector AND. Required Compensatory Measure A.2.2 is met by performing A.2.2.1 or A.2.2.2. The indented position of the logical connector OR indicates that A.2.2.1 and A.2.2.2 are alternative choices, only one of which must be performed.

7.1.0 USE AND APPLICATION

ODCMS 7.1.3 Completion Times

PURPOSE	The purpose of this section is to establish the Completion Time convention and to provide guidance for its use.
BACKGROUND	Offsite Dose Calculation Manual Specifications (ODCMS) specify minimum requirements for unit systems or variables. The COMPENSATORY MEASURES associated with an ODCMS state Conditions that typically describe the ways in which the requirements of the ODCMS can fail to be met. Specified with each stated Condition are Required Compensatory Measure(s) and Completion Times(s).
DESCRIPTION	The Completion Time is the amount of time allowed for completing a Required Compensatory Measure. It is referenced to the time of discovery of a situation (e.g., inoperable equipment or variable not within limits) that requires entering a COMPENSATORY MEASURES Condition unless otherwise specified, providing the unit is in a MODE or specified condition stated in the Applicability of the ODCMS. Required Compensatory Measures must be completed prior to the expiration of the specified Completion Time. A COMPENSATORY MEASURES Condition remains in effect and the Required Compensatory Measures apply until the Condition no longer exists or the unit is not within the ODCMS Applicability. If situations are discovered that require entry into more than one Condition at a time within a single ODCMS (multiple Conditions), the Required Compensatory Measures for each Condition must be performed within the associated Completion Time. When in multiple Conditions, separate Completion Times are tracked for each Condition starting from the time of discovery of the situation that required entry into the Condition. Once a Condition has been entered, subsequent divisions, subsystems, components, or variables expressed in the Condition, discovered to be inoperable or not within limits, will not result in separate entry into the Condition unless specifically stated. The Required Compensatory Measures of the Condition continue to apply to each additional failure, with Completion Times based on initial entry into the Condition.

(continued)

ODCMS 7.1.3 Completion Times (continued)

DESCRIPTION (continued)

However, when a subsequent division, subsystem, component, or variable expressed in the Condition is discovered to be inoperable or not within limits, the Completion Time(s) may be extended. To apply this Completion Time extension, two criteria must first be met. The subsequent inoperability:

a. Must exist concurrent with the first inoperability; and

b. Must remain inoperable or not within limits after the first inoperability is resolved.

The total Completion Time allowed for completing a Required Compensatory Measure to address the subsequent inoperability shall be limited to the more restrictive of either:

a. The stated Completion Time, as measured from the initial entry into the Condition, plus an additional 24 hours; or

b. The stated Completion Time as measured from discovery of the subsequent inoperability.

The above Completion Time extension does not apply to those ODCMS that have exceptions that allow completely separate re-entry into the Condition (for each division, subsystem, component or variable expressed in the Condition) and separate tracking of Completion Times based on this re-entry. These exceptions are stated in individual ODCMS.

The above Completion Time extension does not apply to a Completion Time with a modified “time zero.” This modified “time zero” may be expressed as a repetitive time (i.e., “once per 8 hours,” where the Completion Time is referenced from a previous completion of the Required Compensatory Measures versus the time of Condition entry) or as a time modified by the phrase “from discovery . . .” Example 7.1.3-3 illustrates one use of this type of Completion Time. The 10 day Completion Time specified for Condition A and B in Example 7.1.3-3 may not be extended.

(continued)

ODCMS 7.1.3 Completion Times (continued)

EXAMPLES

The following examples illustrate the use of Completion Times with different types of Conditions and changing Conditions.

EXAMPLE 7.1.3-1

COMPENSATORY MEASURES

CONDITION	REQUIRED COMPENSATORY MEASURE	COMPLETION TIME
B. Required Compensatory Measure and associated Completion Time not met.	B.1 Be in MODE 3. <u>AND</u> B.2 Be in MODE 4.	12 hours 36 hours

Condition B has two Required Compensatory Measures. Each Required Compensatory Measure has its own separate Completion Time. Each Completion Time is referenced to the time that Condition B is entered.

The Required Compensatory Measures of Condition B are to be in MODE 3 within 12 hours <u>AND</u> in MODE 4 within 36 hours. A total of 12 hours is allowed for reaching MODE 3 and a total of 36 hours (**<u>not 48 hours</u>**) is allowed for reaching MODE 4 from the time that Condition B was entered. If MODE 3 is reached within 6 hours, the time allowed for reaching MODE 4 is the next 30 hours because the total time allowed for reaching MODE 4 is 36 hours.

If Condition B is entered while in MODE 3, the time allowed for reaching MODE 4 is the next 36 hours.

(continued)

ODCMS 7.1.3 Completion Times (continued)

EXAMPLES (continued)

EXAMPLE 7.1.3-2

COMPENSATORY MEASURES

CONDITION	REQUIRED COMPENSATORY MEASURE	COMPLETION TIME
A. One pump inoperable.	A.1 Restore pump to OPERABLE status.	7 days
B. Required Compensatory Measure and associated Completion Time not met.	B.1 Be in MODE 3. <u>AND</u> B.2 Be in MODE 4.	12 hours 36 hours

When a pump is declared inoperable, Condition A is entered. If the pump is not restored to OPERABLE status within 7 days, Condition B is also entered and the Completion Time clocks for Required Compensatory Measures B.1 and B.2 start. If the inoperable pump is restored to OPERABLE status after Condition B is entered, Condition A and B are exited, and therefore, the Required Compensatory Measures of Condition B may be terminated.

(continued)

ODCMS 7.1.3 Completion Times (continued)

EXAMPLES (continued)

EXAMPLE 7.1.3-3

COMPENSATORY MEASURES

CONDITION	REQUIRED COMPENSATORY MEASURE		COMPLETION TIME
A. One Function X subsystem inoperable.	A.1	Restore Function X subsystem to OPERABLE status.	7 days AND 10 days from discovery of failure to meet the ODCMS
B. One Function Y subsystem inoperable.	B.1	Restore Function Y subsystem to OPERABLE status.	72 hours AND 10 days from discovery of failure to meet the ODCMS
C. One Function X subsystem inoperable. AND One Function Y subsystem inoperable.	C.1	Restore Function X subsystem to OPERABLE status.	72 hours
	OR		
	C.2	Restore Function Y subsystem to OPERABLE status.	72 hours

(continued)

EXAMPLES (continued)

EXAMPLE 7.1.3-3 (continued)

When one Function X subsystem and one Function Y subsystem are inoperable, Condition A and Condition B are concurrently applicable. The Completion Times for Condition A and Condition B are tracked separately for each subsystem, starting from the time each subsystem was declared inoperable and the Condition was entered. A separate Completion Time is established for Condition C and tracked from the time the second subsystem was declared inoperable (i.e., the time the situation described in Condition C was discovered).

If Required Compensatory Measure C.2 is completed within the specified Completion Time, Conditions B and C are exited. If the Completion Time for Required Compensatory Measure A.1 has not expired, operation may continue in accordance with Condition A. The remaining Completion Time in Condition A is measured from the time the affected subsystem was declared inoperable (i.e., initial entry into Condition A).

The Completion Times of Conditions A and B are modified by a logical connector, with a separate 10 day Completion Time measured from the time it was discovered the ODCMS was not met. In this example, without the separate Completion Time, it would be possible to alternate between Conditions A, B, and C in such a manner that operation could continue indefinitely without ever restoring systems to meet the ODCMS. The separate Completion Time modified by the phrase “from discovery of failure to meet the ODCMS” is designed to prevent indefinite continued operation while not meeting the ODCMS. This Completion Time allows for an exception to the normal “time zero” for beginning the Completion Time “clock”. In this instance, the Completion Time “time zero” is specified as commencing at the time the ODCMS was initially not met, instead of at the time the associated Condition was entered.

(continued)

EXAMPLES (continued)

EXAMPLE 7.1.3-4

COMPENSATORY MEASURES

CONDITION	REQUIRED COMPENSATORY MEASURE	COMPLETION TIME
A. One or more valves inoperable.	A.1 Restore valve(s) to OPERABLE status.	4 hours
B. Required Compensatory Measure and associated Completion Time not met.	B.1 Be in MODE 3. AND B.2 Be in MODE 4.	12 hours 36 hours

A single Completion Time is used for any number of valves inoperable at the same time. The Completion Time associated with Condition A is based on the initial entry into Condition A and is not tracked on a per valve basis. Declaring subsequent valves inoperable, while Condition A is still in effect, does not trigger the tracking of separate Completion Times.

Once one of the valves has been restored to OPERABLE status, the Condition A Completion Time is not reset, but continues from the time the first valve was declared inoperable. The Completion Time may be extended if the valve restored to OPERABLE status was the first inoperable valve. The Condition A Completion Time may be extended for up to 4 hours provided this does not result in any subsequent valve being inoperable for > 4 hours.

If the Completion Time of 4 hours (plus the extension) expires while one or more valves are still inoperable, Condition B is entered.

(continued)

ODCMS 7.1.3 Completion Times (continued)

EXAMPLES (continued)

EXAMPLE 7.1.3-5

COMPENSATORY MEASURES

NOTE
Separate Condition entry is allowed for each inoperable valve.

CONDITION	REQUIRED COMPENSATORY MEASURE	COMPLETION TIME
A. One or more valves inoperable.	A.1 Restore valve to OPERABLE status.	4 hours
B. Required Compensatory Measure and associated Completion Time not met.	B.1 Be in MODE 3. AND B.2 Be in MODE 4.	12 hours 36 hours

The Note above the COMPENSATORY MEASURES Table is a method of modifying how the Completion Time is tracked. If this method of modifying how the Completion Time is tracked was applicable only to a specific Condition, the Note would appear in that Condition rather than at the top of the COMPENSATORY MEASURES Table.

The Note allows Condition A to be entered separately for each inoperable valve, and Completion Times tracked on a per valve basis. When a valve is declared inoperable, Condition A is entered and its Completion Time starts. If subsequent valves are declared inoperable, Condition A is entered for each valve and separate Completion Times start and are tracked for each valve.

(continued)

EXAMPLES (continued)

EXAMPLE 7.1.3-5 (continued)

If the Completion Time associated with a valve in Condition A expires, Condition B is entered for that valve. If the Completion Times associated with subsequent valves in Condition A expire, Condition B is entered separately for each valve and separate Completion Times start and are tracked for each valve. If a valve that caused entry into Condition B is restored to OPERABLE status, Condition B is exited for that valve.

Since the Note in this example allows multiple Condition entry and tracking of separate Completion Times, Completion Time extensions do not apply.

EXAMPLE 7.1.3-6

COMPENSATORY MEASURES

CONDITION	REQUIRED COMPENSATORY MEASURE	COMPLETION TIME
A. One channel inoperable.	A.1 Perform TR 7.3.x.x. OR A.2 Reduce THERMAL POWER to ≤ 50% RTP.	Once per 8 hours 8 hours
B. Required Compensatory Measure and associated Completion Time not met.	B.1 Be in MODE 3.	12 hours

(continued)

EXAMPLES (continued)

EXAMPLE 7.1.3-6 (continued)

Entry into Condition A offers a choice between Required Compensatory Measure A.1 or A.2. Required Compensatory Measure A.1 has a “once per” Completion Time, which qualifies for the 25% extension, per TR 7.3.0.2, to each performance after the initial performance. The initial 8 hour interval of Required Compensatory Measure A.1 begins when Condition A is entered and the initial performance of Required Compensatory Measure A.1 must be completed within the first 8 hour interval. If Required Compensatory Measure A.1 is followed and the Required Compensatory Measure is not met within the Completion Time (plus the extension allowed by TR 7.3.0.2), Condition B is entered. If Required Compensatory Measure A.2 is followed and the Completion Time of 8 hours is not met, Condition B is entered.

If after entry into Condition B, Required Compensatory Measure A.1 or A.2 is met, Condition B is exited and operation may then continue in Condition A.

(continued)

ODCMS 7.1.3 Completion Times (continued)

EXAMPLES (continued)

EXAMPLE 7.1.3-7

COMPENSATORY MEASURES

CONDITION	REQUIRED COMPENSATORY MEASURE	COMPLETION TIME
A. One subsystem inoperable.	A.1 Verify affected subsystem isolated. AND A.2 Restore subsystem to OPERABLE status.	1 hour AND Once per 8 hours thereafter 72 hours
B. Required Compensatory Measure and associated Completion Time not met.	B.1 Be in MODE 3. AND B.2 Be in MODE 4.	12 hours 36 hours

Required Compensatory Measure A.1 has two Completion Times. The 1 hour Completion Time begins at the time the Condition is entered and each "Once per 8 hours thereafter" interval begins upon performance of Required Compensatory Measure A.1.

If after Condition A is entered, Required Compensatory Measure A.1 is not met within either the initial 1 hour or any subsequent 8 hour interval from the previous performance (plus the extension allowed by TR 7.3.0.2), Condition B is entered. The Completion Time clock for Condition A does not stop after Condition B is entered, but continues

(continued)

ODCMS 7.1.3 Completion Times (continued)

EXAMPLES (continued)	EXAMPLE 7.1.3-7 (continued) from the time Condition A was initially entered. If Required Compensatory Measure A.1 is met after Condition B is entered, Condition B is exited and operation may continue in accordance with Condition A, provided the Completion Time for Required Compensatory Measure A.2 has not expired.
IMMEDIATE COMPLETION TIME	When “Immediately” is used as a Completion Time, the Required Compensatory Measure should be pursued without delay and in a controlled manner.

7.1.0 USE AND APPLICATION

ODCMS 7.1.4 Frequency

PURPOSE	The purpose of this section is to define the proper use and application of Frequency requirements.
DESCRIPTION	Each Test Requirement (TR) of the Offsite Dose Calculation Manual has a specified Frequency in which the Test must be met in order to meet the associated Offsite Dose Calculation Manual Specification (ODCMS). An understanding of the correct application of the specified Frequency is necessary for compliance with the TR. The “specified Frequency” is referred to throughout this section and each of the Specifications of Section 7.3.0, Test Requirement (TR) Applicability. The “specified Frequency” consists of the requirements of the Frequency column of each TR, as well as certain Notes in the Test column that modify performance requirements. Sometimes special situations dictate when the requirements of a Test are to be met. They are “otherwise stated” conditions allowed by TR 7.3.0.1. They may be stated as clarifying Notes in the Test, as part of the Test, or both. Example 7.1.4-4 discusses these special situations. Situations where a Test could be required (i.e., its Frequency could expire), but where it is not possible or not desired that it be performed until sometime after the associated ODCMS is within its Applicability, represent potential TR 7.3.0.4 conflicts. To avoid these conflicts, the TR (i.e., the Test or the Frequency) is stated such that it is only “required” when it can be and should be performed. With a TR satisfied, TR 7.3.0.4 imposes no restriction. The use of “met or “performed” in these instances conveys specific meanings. A Test is “met” only when the acceptance criteria are satisfied. Known failure of the requirements of a Test, even without a Test specifically being “performed,” constitutes a Test not “met.” “Performance” refers only to the requirement to specifically determine the

(continued)

DESCRIPTION (continued)

ability to meet the acceptance criteria. TR 7.3.0.4 restrictions would not apply if both the following conditions are satisfied:

a. The Test is not required to be performed; and

b. The Test is not required to be met or, even if required to be met, is not known to be failed.

EXAMPLES

The following examples illustrate the various ways that Frequencies are specified. In these examples, the Applicability of the ODCMS (ODCMS not shown) is MODES 1, 2, and 3.

EXAMPLE 7.1.4-1

TEST REQUIREMENTS

TEST	FREQUENCY
Perform CHANNEL CHECK.	12 hours

Example 7.1.4-1 contains the type of TR most often encountered in the ODCMS. The Frequency specifies an interval (12 hours) during which the associated Test must be performed at least one time. Performance of the Test initiates the subsequent interval. Although the Frequency is stated as 12 hours, an extension of the time interval to 1.25 times the interval specified in the Frequency is allowed by TR 7.3.0.2 for operational flexibility. The measurement of this interval continues at all times, even when the TR is not required to be met per TR 7.3.0.1 (such as when the equipment is inoperable, a variable is outside specified limits, or the unit is outside the Applicability of the ODCMS). If the interval specified by TR 7.3.0.2 is exceeded while the unit is in a MODE or other specified condition in the Applicability of the ODCMS, and the performance of the Test is not otherwise modified (refer to Examples 7.1.4-3 and 7.1.4-4), then TR 7.3.0.3 becomes applicable.

(continued)

EXAMPLES (continued)

EXAMPLE 7.1.4-1 (continued)

If the interval as specified by TR 7.3.0.2 is exceeded while the unit is not in a MODE or other specified condition in the Applicability of the ODCMS for which performance of the TR is required, the Test must be performed within the Frequency requirements of TR 7.3.0.2 prior to entry into the MODE or other specified condition. Failure to do so would result in a violation of TR 7.3.0.4.

EXAMPLE 7.1.4-2

TEST REQUIREMENTS

TEST	FREQUENCY
Verify flow is within limits.	Once within 12 hours after ≥ 25% RTP AND 24 hours thereafter

Example 7.1.4-2 has two Frequencies. The first is a one time performance Frequency, and the second is of the type shown in Example 7.1.4-1. The logical connector "AND" indicates that both Frequency requirements must be met. Each time reactor power is increased from a power level < 25% RTP to≥ 25% RTP, the Test must be performed within 12 hours.

The use of "once" indicates a single performance will satisfy the specified Frequency (assuming no other Frequencies are connected by "AND"). This type of Frequency does not qualify for the extension allowed by TR 7.3.0.2.

(continued)

EXAMPLES (continued)

EXAMPLE 7.1.4-2 (continued)

"Thereafter" indicates future performances must be established per TR 7.3.0.2, but only after a specified condition is first met (i.e., the "once" performance in this example). If reactor power decreases to < 25% RTP, the measurement of both intervals stops. New intervals start upon reactor power reaching 25% RTP.

EXAMPLE 7.1.4-3

TEST REQUIREMENTS

TEST	FREQUENCY
NOTE Not required to be performed until 12 hours after ≥ 25% RTP. Perform channel adjustment.	7 days

The interval continues whether or not the unit operation is < 25% RTP between performances.

As the Note modifies the required performance of the Test, it is construed to be part of the "specified Frequency." Should the 7 day interval be exceeded while operation is < 25% RTP, this Note allows 12 hours after power reaches ≥ 25% RTP to perform the Test. The Test is still considered to be within the "specified Frequency." Therefore, if the Test were not performed within the 7 day interval (plus the extension allowed by TR 7.3.0.2), but operation was < 25% RTP, it would not constitute a failure of the TR or failure to meet the ODCMS. Also, no violation of TR 7.3.0.4 occurs when changing MODES, even with the 7 day Frequency not met, provided operation does not exceed 12 hours with power ≥ 25% RTP.

(continued)

EXAMPLES (continued)

EXAMPLE 7.1.4-3 (continued)

Once the unit reaches 25% RTP, 12 hours would be allowed for completing the Test. If the Test were not performed within this 12 hour interval, there would then be a failure to perform a Test within the specified Frequency, and the provisions of TR 7.3.0.3 would apply.

EXAMPLE 7.1.4-4

TEST REQUIREMENTS

TEST	FREQUENCY
NOTE Only required to be met in MODE 1. Verify leakage rates are within limits.	24 hours

Example 7.1.4-4 specifies that the requirements of this Test do not have to be met until the unit is in MODE 1. The interval measurement for the Frequency of this Test continues at all times, as described in Example 7.1.4-1. However, the Note constitutes an “otherwise stated” exception to the Applicability of this Test. Therefore, if the Test were not performed within the 24 hour (plus the extension allowed by TR 7.3.0.2) interval, but the unit was not in MODE 1, there would be no failure of the TR nor failure to meet the ODCMS. Therefore, no violation of TR 7.3.0.4 occurs when changing MODES, even with the 24 hour Frequency exceeded, provided the MODE change was not made into MODE 1. Prior to entering MODE 1 (assuming again that the 24 hour Frequency were not met), TR 7.3.0.4 would require satisfying the TR.

7.2.0 Not used.

7.3.0 OFFSITE DOSE CALCULATION MANUAL SPECIFICATION (ODCMS) APPLICABILITY

ODCMS 7.3.0.1 ODCMSs shall be met during the MODES or other specified conditions in the Applicability, except as provided in ODCMS 7.3.0.2.

ODCMS 7.3.0.2 Upon discovery of a failure to meet an ODCMS, the required Compensatory Measures of the associated Conditions shall be met, except as provided in ODCMS 7.3.0.5.

If the ODCMS is met or is no longer applicable prior to expiration of the specified Completion Time(s), completion of the Required Compensatory measure(s) is not required, unless otherwise stated.

ODCMS 7.3.0.3 Not used.

ODCMS 7.3.0.4 When an ODCMS 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 ODCMS 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 ODCMS are stated in the individual ODCMSs. 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.

ODCMS 7.3.0.5 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 ODCMS 7.3.0.2 for the system returned to service under administrative control to perform the required testing.

(continued)

7.3.0 ODCMS APPLICABILITY (continued)

ODCMS 7.3.0.6 ODCMSs and associated COMPENSATORY MEASURES shall apply to both units except as follows:

a. Whenever the ODCMS refers to systems or components which are not shared by both units, the ODCMS and associated Applicability and COMPENSATORY MEASURES shall apply to each unit individually (e.g., in the event of an inoperability in a non-shared system, the appropriate COMPENSATORY MEASURES will apply only to the unit with the inoperable system);

b. Whenever the ODCMS only applies to one unit, this will be identified in the Applicability of the ODCMS; and

c. Whenever certain portions of the ODCMS, Applicability, or COMPENSATORY MEASURES contain operating parameters, setpoints, etc., which are different for each unit, this will be identified in parentheses, notes, or the body of the requirement.

7.3.0 TEST REQUIREMENT (TR) APPLICABILITY

TR 7.3.0.1	TRs shall be met during the MODES or other specified conditions in the Applicability for individual ODCMSs, unless otherwise stated in the TR. Failure to meet a Test whether such failure is experienced during the performance of the Test or between performances of the Test, shall be failure to meet the ODCMS. Failure to perform a Test within the specified Frequency shall be failure to meet the TRMS except as provided in TR 7.3.0.3. Tests do not have to be performed on inoperable equipment or variables outside specified limits.
TR 7.3.0.2	The specified Frequency for each TR is met if the Test 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 ODCMS are stated in the individual ODCMSs.
TR 7.3.0.3	If it is discovered that a Test was not performed within its specified Frequency, then compliance with the requirement to declare the ODCMS 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 Test. If the Test is not performed within the delay period, the ODCMS must immediately be declared not met, and the applicable Condition(s) must be entered. When the Test is performed within the delay period and the Test is not met, the ODCMS must immediately be declared not met, and the applicable Condition(s) must be entered.

(continued)

7.3.0 TR APPLICABILITY (continued)

TR 7.3.0.4 Entry into a MODE or other specified condition in the Applicability of an ODCMS shall not be made unless the ODCMS's Tests 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.

TR 7.3.0.5 TRs shall apply to both units (e.g., a single Test performed at the specified Frequency will satisfy the TR for both units) except as follows:

a. Whenever the ODCMS refers to systems or components which are not shared by both units, the associated TR shall apply to each unit individually (e.g., individual tests must be performed on each of the two units' non-shared systems or components; a single Test on a non-shared system of one unit performed at the specified Frequency will not satisfy the TR for the non-shared system of the other unit);

b. Whenever a TR only applies to one unit, this will be identified by a note to the TR; and

c. Whenever certain portions of the TRs, contain test parameters, acceptance criteria, or frequencies which are different for each unit, this will be identified in parentheses, notes, or the body of the requirement.

7.3.1 RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

ODCMS 7.3.1 The radioactive liquid effluent monitoring instrumentation channels in Table 7.3.1-1 shall be OPERABLE.

NOTE
The annunciator function may be removed from operation for performance of troubleshooting for up to 30 minutes provided the associated function maintains monitoring capability

APPLICABILITY: In accordance with Table 7.3.1-1.

COMPENSATORY MEASURES

NOTE
Separate Condition entry is allowed for each required channel.

CONDITION	REQUIRED COMPENSATORY MEASURE	COMPLETION TIME
A. One or more radioactive liquid effluent monitoring instrumentation channels inoperable.	A.1 Enter the Condition referenced in Table 7.3.1-1 for the channel.	Immediately
B. As required by Required Compensatory Measure A.1 and referenced in Table 7.3.1-1.	B.1 Perform TR 7.3.3.1 on two independent samples of the batch to be released.	Prior to release through the liquid radwaste effluent line
	<u>AND</u>	
	B.2 Verify the associated release rate calculations and the discharge valve lineup using two qualified members of the technical staff.	Prior to release through the liquid radwaste effluent line
	<u>AND</u>	
	B.3 Restore the channel to OPERABLE status.	30 days

(continued)

COMPENSATORY MEASURES (continued)

CONDITION	REQUIRED COMPENSATORY MEASURE		COMPLETION TIME
C. As required by Required Compensatory Measure A.1 and referenced in Table 7.3.1-1.	C.1	Estimate the flow rate through the associated pathway using pump performance curves or tank level indicators.	Once per 4 hours during releases through the associated line
	<u>AND</u>		
	C.2	Restore the channel to OPERABLE status.	30 days
D. As required by Required Compensatory Measure A.1 and referenced in Table 7.3.1-1.	D.1	Collect and analyze a grab sample for gross radioactivity (beta or gamma) of the associated effluent. The LLD shall be ≤ 1.0 E-7 μCi/gm.	Once per 12 hours
	<u>AND</u>		
	D.2	Restore the channel to OPERABLE status.	30 days
E. As required by Required Compensatory Measure A.1 and referenced in Table 7.3.1-1.	E.1	Collect and analyze a grab sample for principal gamma emitters per Table 7.3.3-1.	Once per 24 hours
	<u>AND</u>		
	E.2	Restore the channel to OPERABLE status.	30 days

(continued)

COMPENSATORY MEASURES (continued)

CONDITION	REQUIRED COMPENSATORY MEASURE		COMPLETION TIME
F. As required by Required Compensatory Measure A.1 and referenced in Table 7.3.1-1.	F.1	Estimate the tank liquid level.	Once per 8 hours during all liquid additions and deletions to and from the tank
	AND		
	F.2	Restore the channel to OPERABLE status.	30 days
G. Required Compensatory Measure B.1, B.2, C.1, D.1, E.1, or F.1 and associated Completion Time not met.	G.1	Suspend effluent releases via the associated pathway.	Immediately
	AND		
	G.2	NOTE Only applicable for Function 6. Suspend liquid additions to the Condensate Storage Tank.	Immediately

(continued)

COMPENSATORY MEASURES (continued)

CONDITION	REQUIRED COMPENSATORY MEASURE		COMPLETION TIME
H. Required Compensatory Measure B.3, C.2, D.2, E.2, F.2, G.2, or J.2 and associated Completion Time not met.	H.1	Prepare and submit, in the Radioactive Effluent Release Report, the reason the channel was not restored to OPERABLE status within 30 days.	Upon submittal of current calendar year Radioactive Effluent Release Report
I. As required by Required Compensatory Measure A.1 and referenced in Table 7.3.1-1.	I.1	Estimate the flow rate through the associated pathway using the Parshall flume or another acceptable method.	Once per 24 hours
	<u>AND</u>		
	I.2	Restore the channel to OPERABLE status.	30 days

TEST REQUIREMENTS

NOTE
Refer to Table 7.3.1-1 to determine which TRs apply for each Radioactive Liquid Effluent Monitoring Instrumentation Function.

TEST	FREQUENCY
TR 7.3.1.1 NOTE For Function 6, only required to be met during liquid additions to the tank. Perform CHANNEL CHECK.	24 hours
TR 7.3.1.2 NOTE Only required to be met during continuous, periodic, or batch releases. Verify indication of flow.	24 hours

(continued)

TEST REQUIREMENTS (continued)

TEST		FREQUENCY
TR 7.3.1.3	Perform SOURCE CHECK.	31 days
TR 7.3.1.4	Perform CHANNEL FUNCTIONAL TEST, including demonstration of automatic isolation of the pathway and control room annunciation in response to any of the following: a. Alarm/trip setpoint exceeded. b. Circuit failure. c. Downscale failure. d. Instrument controls not set in “operate” mode.	92 days
TR 7.3.1.5	Perform CHANNEL FUNCTIONAL TEST.	92 days
TR 7.3.1.6	Perform CHANNEL FUNCTIONAL TEST, including demonstration of control room annunciation in response to any of the following: a. Alarm/trip setpoint exceeded. b. Circuit failure. c. Downscale failure. d. Instrument controls not set in “operate” mode.	92 days

(continued)

TEST REQUIREMENTS (continued)

TEST		FREQUENCY
TR 7.3.1.7	NOTE For Functions 1 and 3, previously established calibration procedures or sources that have been related to the initial CHANNEL CALIBRATION shall be used. Perform CHANNEL CALIBRATION.	24 months

Table 7.3.1-1 (page 1 of 1)
Radioactive Liquid Effluent Monitoring Instrumentation

FUNCTION [a]	APPLICABLE MODES OR OTHER SPECIFIED CONDITIONS	REQUIRED CHANNELS PER FUNCTION	CONDITIONS REFERENCED FROM REQUIRED COMPENSATORY MEASURES A.1	TEST REQUIREMENTS	ALARM/ TRIP SETPOINT VALUE
1. Liquid Radwaste Radioactivity Effluent Monitor [b]	At all times	1	B	TR 7.3.1.1 TR 7.3.1.3 TR 7.3.1.4 TR 7.3.1.7	(c)
2. Liquid Radwaste Effluent Flow Measurement Device	At all times	1	C	TR 7.3.1.2 TR 7.3.1.5 TR 7.3.1.7	NA
3. Main Service Water System Effluent Radioactivity Monitor	At all times	1	D	TR 7.3.1.1 TR 7.3.1.3 TR 7.3.1.6 TR 7.3.1.7	(c)
4. Drainage Holding Facility Effluent Composite Sampler	(i)	1	E	TR 7.3.1.1 TR 7.3.1.5 TR 7.3.1.7	NA [e]
5. Drainage Holding Facility Effluent Flow Measurement Device	(i)	1	I	TR 7.3.1.1 TR 7.3.1.5 TR 7.3.1.7	NA
6. Condensate Storage Tank Level Indicating Device	At all times	1	F	TR 7.3.1.1 TR 7.3.1.5 TR 7.3.1.7	NA [f]
7. Groundwater Extraction Effluent Composite Sampler	(d)	1	E	TR 7.3.1.1 TR 7.3.1.5 TR 7.3.1.7	NA [g]
8. Groundwater Extraction Effluent Flow Measurement Device	(d)	1	I	TR 7.3.1.1 TR 7.3.1.5 TR 7.3.1.7	NA
9. Stabilization Facility Effluent Composite Sampler	(d)	1	E	TR 7.3.1.1 TR 7.3.1.5 TR 7.3.1.7	NA [h]
10. Stabilization Facility Effluent Flow Measurement Device	(d)	1	I	TR 7.3.1.1 TR 7.3.1.5 TR 7.3.1.7	NA

(a) Specific instrumentation identification numbers are provided in Appendix E.

(b) Provides alarm and automatic termination of release.

(c) Alarm/trip setpoints shall be determined in accordance with ODCM methodology and set to ensure the limits of ODCMS 7.3.3, “Concentration—Liquid Effluents,” are not exceeded.

(d) At all times other than when the line is valved out and locked.

(e) Flow Totalizer 0-DHF-FIT-1 provides a trip signal to the composite sampler that will initiate sampling.

(f) 1(2) CO-LIT-1160 provides local level indication and also provides a signal to 1(2) CO-LI-1160A and 1(2) CO-LI-1160B.

(g) Flow Measurement Device 0-GWE-FIT-1 directly triggers the composite sampler.

(h) Flow Measurement Device 0-SDSF-FIT-2 directly triggers the composite sampler.

(i) At all times when in release to the intake canal

7.3.2 RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

ODCMS 7.3.2 The radioactive gaseous effluent monitoring instrumentation channels in Table 7.3.2-1 shall be OPERABLE.

NOTE
The annunciator function may be removed from operation for performance of troubleshooting for up to 30 minutes provided the associated function maintains monitoring capability. If removing the annunciator for the 1/2-CAC-AT-1264 refer to ODCM Bases 7.3.2.

APPLICABILITY: In accordance with Table 7.3.2-1.

COMPENSATORY MEASURES

NOTE
Separate Condition entry is allowed for each required channel.

CONDITION	REQUIRED COMPENSATORY MEASURE	COMPLETION TIME
A. One or more radioactive gaseous effluent monitoring instrumentation channels inoperable.	A.1 Enter the Condition referenced in Table 7.3.2-1 for the channel.	Immediately
B. As required by Required Compensatory Measure A.1 and referenced in Table 7.3.2-1.	B.1 Take a grab sample at the associated sample location.	Once per 12 hours
	<u>AND</u>	
	B.2 Analyze the grab sample required by Required Compensatory Measure B.1 for gross noble gas activity.	24 hours after completion of Required Compensatory Measure B.1
	<u>AND</u>	
	B.3 Restore the channel to OPERABLE status.	30 days

(continued)

COMPENSATORY MEASURES (continued)

CONDITION	REQUIRED COMPENSATORY MEASURE	COMPLETION TIME
C. As required by Required Compensatory Measure A.1 and referenced in Table 7.3.2-1.	C.1.1 Initiate actions to establish auxiliary sampling equipment to continuously collect samples from the associated effluent release pathway as required by Table 7.3.7-1.	Immediately
	<u>OR</u>	
	C.1.2 NOTE: Only applicable for ODCM test requirements, sample analysis, or system purging. Reference ODCMS 7.3.0.5 for post maintenance test requirements. Initiate continuous sample collection from associated release pathway as required by Table 7.3.7-1 with auxiliary sampling equipment.	45 minutes
	<u>AND</u>	
	C.2 Restore the channel to OPERABLE status.	30 days

(continued)

COMPENSATORY MEASURES (continued)

CONDITION	REQUIRED COMPENSATORY MEASURE		COMPLETION TIME
D. As required by Required Compensatory Measure A.1 and referenced in Table 7.3.2-1.	D.1	Estimate the flow rate through the associated pathway.	Once per 8 hours
	AND		
	D.2	Restore the channel to OPERABLE status.	30 days
E. Required Compensatory Measure B.1, B.2, C.1.1, C.1.2, and D.1 and associated Completion Time not met.	E.1	Suspend effluent releases via the associated pathway.	Immediately

(continued)

COMPENSATORY MEASURES (continued)

CONDITION	REQUIRED COMPENSATORY MEASURE		COMPLETION TIME
F. As required by Required Compensatory Measure A.1 and referenced in Table 7.3.2-1.	NOTE Required Compensatory Measures F.1 and F.2 are only applicable if two channels are inoperable in the operating recombiner train.		
	F.1	Take a grab sample from the operating recombiner train.	Once per 24 hours
	<u>AND</u>		
	F.2	Analyze the grab sample required by Required Compensatory Measure F.1.	4 hours after completion of Required Compensatory Measure F.1
	<u>AND</u>		
	F.3	Verify proper functioning of the operating recombiner train by monitoring recombiner temperature.	In accordance with approved procedures
	<u>AND</u>		
	F.4	Restore the channel(s) to OPERABLE status.	30 days
G. Required Compensatory Measure F.1, F.2, or F.3 and associated Completion Time not met.	G.1	Suspend operation of the associated recombiner train.	Immediately

(continued)

COMPENSATORY MEASURES (continued)

CONDITION	REQUIRED COMPENSATORY MEASURE	COMPLETION TIME
H. Required Compensatory Measure B.3, C.2, D.2, or F.4 and associated Completion Time not met.	H.1 Prepare and submit in the Radioactive Effluent Release Report, the reason the channel was not restored to OPERABLE status within 30 days.	Upon submittal of current calendar year Radioactive Effluent Release Report
I. As required by Required Compensatory Measure A.1 and referenced in Table 7.3.2-1.	I.1 Verify GASEOUS RADWASTE TREATMENT SYSTEM is not bypassed.	Immediately
	<u>AND</u> I.2 Verify the main stack effluent noble gas monitor is OPERABLE.	Immediately
	<u>AND</u> I.3 --------NOTE--------------------- If the SJAE grab sample cannot be obtained at the normal sample point the sample can be obtained at the inlet to the Gaseous Radwaste Treatment System and the results decay corrected back to normal location to verify the activity level at the SJAE. ----------------------------------- Take a grab sample and analyze to verify that the noble gas gross gamma activity rate is ≤ 243,600 μCi/second	Once within 72 hours <u>AND</u> Every 4 hours thereafter
	<u>AND</u> I.4 Restore the channel to OPERABLE status.	30 days

(continued)

COMPENSATORY MEASURES (continued)

CONDITION	REQUIRED COMPENSATORY MEASURE		COMPLETION TIME
J. Required Compensatory Measure and associated Completion Time of Condition I.1, I.2, and I.3 not met.	J.1	Suspend effluent releases via the associated pathway.	Immediately
K. Required Compensatory Measure and associated completion Time of I.4 not met.	K.1	Prepare and submit in the Radioactive Effluent Release Report, the reason the channel was not restored to OPERABLE status within 30 days.	Upon submittal of current calendar year Radioactive Effluent Release Report
L. As required by Required Compensatory Measure A.1 and referenced in Table 7.3.2-1.	L.1	Suspend effluent releases via the associated pathway.	Immediately

TEST REQUIREMENTS

NOTE
Refer to Table 7.3.2-1 to determine which TRs apply for each Radioactive Gaseous Effluent Monitoring Instrumentation Function.

TEST		FREQUENCY
TR 7.3.2.1	Perform CHANNEL CHECK.	24 hours
TR 7.3.2.2	Perform CHANNEL CHECK.	7 days
TR 7.3.2.3	Perform SOURCE CHECK.	31 days
TR 7.3.2.4	Perform CHANNEL FUNCTIONAL TEST.	31 days

(continued)

TEST REQUIREMENTS (continued)

	TEST	FREQUENCY
TR 7.3.2.5	Perform CHANNEL FUNCTIONAL TEST, including demonstration of control room annunciation in response to any of the following: a. Alarm/trip setpoint exceeded. b. Downscale failure. c. Instrument controls not set in “operate” mode.	92 days
TR 7.3.2.6	Perform CHANNEL FUNCTIONAL TEST.	92 days
TR 7.3.2.7	Perform CHANNEL FUNCTIONAL TEST; including demonstration of control room annunciation in response to any of the following: a. Alarm/trip setpoint exceeded. b. Downscale failure.	92 days
TR 7.3.2.8	Perform CHANNEL FUNCTIONAL TEST including control room annunciation in response to any of the following: a. Alarm/trip setpoint exceeded. b. Circuit failure. c. Downscale failure. d. Instrument controls not set in “operate” mode.	92 days

(continued)

TEST REQUIREMENTS (continued)

TEST		FREQUENCY
TR 7.3.2.9	Perform CHANNEL CALIBRATION. The CHANNEL CALIBRATION shall include the use of standard gas samples containing a nominal: a. Two volume percent hydrogen, balance nitrogen; and b. Four volume percent hydrogen, balance nitrogen.	92 days
TR 7.3.2.10	NOTE For Functions 1.a, 2.a, 3.a, 4, and 6, previously established calibration procedures or sources that have been related to the initial CHANNEL CALIBRATION shall be used. Perform CHANNEL CALIBRATION.	24 months

Table 7.3.2-1 (page 1 of 4)
Radioactive Gaseous Effluent Monitoring Instrumentation

FUNCTION [(a)]	APPLICABLE MODES OR OTHER SPECIFIED CONDITIONS	REQUIRED CHANNELS PER FUNCTION	CONDITIONS REFERENCED FROM REQUIRED COMPENSATORY MEASURES A.1	TEST REQUIREMENTS	ALARM/ TRIP SETPOINT VALUE
1. Main Stack Monitoring System					
a. Noble Gas Activity Monitor	At all times	1	B	TR 7.3.2.1 TR 7.3.2.3 TR 7.3.2.5 TR 7.3.2.10	(b)
b. Iodine Sampler Cartridge	At all times	1	C	TR 7.3.2.2	NA
c. Particulate Sampler Filter	At all times	1	C	TR 7.3.2.2	NA
d. System Effluent Flow Rate Measurement Device	At all times	1	D	TR 7.3.2.1 TR 7.3.2.6 TR 7.3.2.10	NA
e. Low Range Sampler Flow Rate Measurement Device	At all times	1	D	TR 7.3.2.1 TR 7.3.2.6 TR 7.3.2.10	(c)
f. Mid/High Range Sampler Flow Rate Measurement Device	(m)	1	D	TR 7.3.2.6 TR 7.3.2.10	N/A
2. Reactor Building Ventilation Monitoring System					
a. Noble Gas Activity Monitor	At all times	1	B	TR 7.3.2.1 TR 7.3.2.3 TR 7.3.2.7 TR 7.3.2.10	(b)
b. Iodine Sampler Cartridge	At all times	1	C	TR 7.3.2.2	NA
c. Particulate Sampler Filter	At all times	1	C	TR 7.3.2.2	NA
d. System Effluent Flow Rate Measurement Device	At all times	1	D	TR 7.3.2.1 TR 7.3.2.6 TR 7.3.2.10	NA

(continued)

(a) Specific instrumentation identification numbers are provided in Appendix E.

(b) Alarm/trip setpoints shall be determined in accordance with ODCM methodology and set to ensure the limits of ODCMS 7.3.7, “Dose Rate—Gaseous Effluents,” are not exceeded.

(c) Alarm/trip setpoints shall be determined in accordance with associated design specification(s) and set to ensure the limits of ODCMS 7.3.7, “Dose Rate—Gaseous Effluents,” are not exceeded.

(m) During Mid/High Range System operation

Table 7.3.2-1 (page 2 of 4)
Radioactive Gaseous Effluent Monitoring Instrumentation

FUNCTION [(a)]	APPLICABLE MODES OR OTHER SPECIFIED CONDITIONS	REQUIRED CHANNELS PER FUNCTION	CONDITIONS REFERENCED FROM REQUIRED COMPENSATORY MEASURES A.1	TEST REQUIREMENTS	ALARM/ TRIP SETPOINT VALUE
2. Reactor Building Ventilation Monitoring System (continued)					
e. Sampler Flow Rate Measurement Device	At all times	1	D	TR 7.3.2.1 TR 7.3.2.6 TR 7.3.2.10	(c)
3. Turbine Building Ventilation Monitoring System					
a. Noble Gas Activity Monitor	At all times	1	B	TR 7.3.2.1 TR 7.3.2.3 TR 7.3.2.5 TR 7.3.2.10	(b)
b. Iodine Sampler Cartridge	At all times	1	C	TR 7.3.2.2	NA
c. Particulate Sampler Filter	At all times	1	C	TR 7.3.2.2	NA
d. System Effluent Flow Rate Measurement Device	At all times	1	D	TR 7.3.2.1 TR 7.3.2.6 TR 7.3.2.10	NA
e. Low Range Sampler Flow Rate Measurement Device	At all times	1	D	TR 7.3.2.1 TR 7.3.2.6 TR 7.3.2.10	(c)
f. Mid/High Range Sampler Flow Rate Measurement Device	(m)	1	D	TR 7.3.2.6 TR 7.3.2.10	NA
4. Main Condenser Off-Gas Treatment System Noble Gas Activity Monitor [(d)] (Downstream of AOG Treatment System)	(e)	1	B	TR 7.3.2.1 TR 7.3.2.3 TR 7.3.2.6 TR 7.3.2.10	(b)

(continued)

(a) Specific instrumentation identification numbers are provided in Appendix E.

(b) Alarm/trip setpoints shall be determined in accordance with ODCM methodology and set to ensure the limits of ODCMS 7.3.7, “Dose Rate—Gaseous Effluents,” are not exceeded.

(c) Alarm/trip setpoints shall be determined in accordance with associated design specification(s) and set to ensure the limits of ODCMS 7.3.7, “Dose Rate—Gaseous Effluents,” are not exceeded.

(d) Provides alarm.

(e) During Main Condenser Off-Gas Treatment System operation

(m) During Mid/High Range System operation

Table 7.3.2-1 (page 3 of 4)
Radioactive Gaseous Effluent Monitoring Instrumentation

FUNCTION [a]		APPLICABLE MODES OR OTHER SPECIFIED CONDITIONS	REQUIRED CHANNELS PER FUNCTION	CONDITIONS REFERENCED FROM REQUIRED COMPENSATORY MEASURES A.1	TEST REQUIREMENTS	ALARM/ TRIP SETPOINT VALUE
5.	Main Condenser Off-Gas Treatment System Explosive Gas Monitoring System					
	a. Recombiner Train A	(l)	2	F	TR 7.3.2.1 TR 7.3.2.4 TR 7.3.2.9	(c)
	b. Recombiner Train B	(l)	2	F	TR 7.3.2.1 TR 7.3.2.4 TR 7.3.2.9	(c)
6.	Main Condenser Air Ejector Noble Gas Radioactivity Monitor [k] (Prior to input to Treatment System)	(f)	1	I	TR 7.3.2.1 TR 7.3.2.3 TR 7.3.2.8 TR 7.3.2.10	(b)
7.	Hot Shop Ventilation Monitoring System					
	a. Iodine Sampler Cartridge	(j)	1	L	TR 7.3.2.2	NA
	b. Particulate Sampler Filter	(j)	1	L	TR 7.3.2.2	NA
	c. Sampler Flow Rate Measurement Device	(j)		L	TR 7.3.2.1 TR 7.3.2.2	NA

(continued)

(a) Specific instrumentation identification numbers are provided in Appendix E.

(b) Alarm/trip setpoints shall be determined in accordance with ODCM methodology and set to ensure the limits of ODCMS 7.3.7, “Dose Rate—Gaseous Effluents,” are not exceeded.

(c) Alarm/trip setpoints shall be determined in accordance with associated design specification(s) and set to ensure the limits of ODCMS 7.3.7, “Dose Rate—Gaseous Effluents,” are not exceeded.

(f) During operation of the main condenser air ejector

(j) During operation of the Hot Shop Ventilation System

(k) Provides Hi and Hi Hi alarm

(l) During associated recombiner train operation

Table 7.3.2-1 (page 4 of 4)
Radioactive Gaseous Effluent Monitoring Instrumentation

FUNCTION [(a)]	APPLICABLE MODES OR OTHER SPECIFIED CONDITIONS	REQUIRED CHANNELS PER FUNCTION	CONDITIONS REFERENCED FROM REQUIRED COMPENSATORY MEASURES A.1	TEST REQUIREMENTS	ALARM/ TRIP SETPOINT VALUE
8. Radioactive Materials Container and Storage Building Decontamination Facility					
a. Iodine Sampler Cartridge	(g)	1	L	TR 7.3.2.1	NA
b. Particulate Sampler Filter	(g)	1	L	TR 7.3.2.1	NA [(i)]
c. Sampler Flow Rate Measurement Device	(g)	1	L	TR 7.3.2.1	NA
9. Low Level Warehouse					
a. Particulate Sampler Filter	(h)	1	L	TR 7.3.2.2	NA [(i)]

(a) Specific instrumentation identification numbers are provided in Appendix E.

(g) During operation of the Radioactive Materials Container and Storage Building Decontamination Facility.

(h) During operation of the Low Level Warehouse ventilation system.

(i) Local alarm.

7.3.3 CONCENTRATION—LIQUID EFFLUENTS

ODCMS 7.3.3 The concentration of radioactive material released to UNRESTRICTED AREAS after dilution in the discharge canal shall be limited to:

a. 10 times the concentrations specified in Appendix B, Table 2, Column 2 to 10 CFR 20.1001-20.2401 for radionuclides other than dissolved or entrained noble gases; and

b. 2 x $10^{-4}\mu$Ci/ml total activity concentration for all dissolved or entrained noble gases.

APPLICABILITY: At all times.

COMPENSATORY MEASURES

CONDITION	REQUIRED COMPENSATORY MEASURE	COMPLETION TIME
A. Concentration of radioactive material released to UNRESTRICTED AREAS not within limits.	A.1 Initiate action to restore concentration to within limits.	Immediately

TEST REQUIREMENTS

TEST		FREQUENCY
TR 7.3.3.1	Verify the concentration of radioactive material released to UNRESTRICTED AREAS is within limits.	In accordance with Table 7.3.3-1

(continued)

TEST REQUIREMENTS (continued)

TEST	FREQUENCY
TR 7.3.3.2 NOTE Only required to be performed if service water samples analyzed in accordance with Table 7.3.3-1 indicate concentrations of any gamma-emitting radionuclides greater than the trigger level of $5 \times 10^{-6} \mu Ci/ml$. Verify concentration of radioactive material released to UNRESTRICTED AREAS is within limits.	In accordance with Table 7.3.3-2 for liquid wastes exceeding the trigger level

Table 7.3.3-1 (page 1 of 3)
Radioactive Liquid Waste Sampling and Analysis Program

LIQUID RELEASE TYPE	SAMPLE FREQUENCY	SAMPLE ANALYSIS FREQUENCY	SAMPLE ANALYSIS TYPE	SAMPLE LOWER LIMIT OF DETECTION (LLD) [a][e]
1. Sample Tanks, Detergent Drain Tank, and Salt Water Release Tanks (Batch Release), [h] AND Circulating Water Pit	Prior to release of each batch	Prior to release of each batch	Principal Gamma Emitters [g] I-131	5 x 10^{-7} [b] μCi/ml 1 x 10^{-6} μCi/ml
	Prior to release of one batch once per 31 days	31 days	Dissolved and entrained gases (Gamma Emitters)	1 x 10^{-5} μCi/ml
	Prior to release of each batch	31 days Composite[c]	Gross Alpha H-3	1 x 10^{-7} μCi/ml 1 x 10^{-5} μCi/ml
	Prior to release of each batch	92 days Composite[c]	Sr-89, Sr-90 Fe-55 Ni-63	5 x 10^{-8} μCi/ml 1 x 10^{-6} μCi/ml 3 x 10^{-8} μCi/ml
2. Drainage Holding Facility (Continuous Release) AND Stabilization Facility(Continuous Release) AND Groundwater Extraction System (Continuous Release)	Prior to each release start[j]	Prior to each release start[j]	Principal Gamma Emitters [g] H-3	5 x 10^{-7} [b] μCi/ml 1 x 10^{-5} μCi/ml
	AND During release	7 day Composite[c][f]	Principal Gamma Emitters [g] I-131	5 x 10^{-7} uCi/ml 1 x 10^{-6} μCi/ml
		31 days Grab	Dissolved and entrained gases (Gamma Emitters)	1 x 10^{-5} μCi/ml
		31 days Composite[c]	H-3 Gross Alpha	1 x 10^{-5} uCi/ml 1 x 10^{-7} uCi/ml
		92 days Composite[c]	Sr-89, Sr-90 Fe-55 Ni-63	5 x 10^{-8} μCi/ml 1 x 10^{-6} μCi/ml 3 x 10^{-8} uCi/ml
3. Service Water [d] (Potential Continuous Release)	7 days during system operation	7 days during system operation	Principal Gamma Emitters [g]	5 x 10^{-7} μCi/ml[b]

Table 7.3.3-1 (page 2 of 3)
Radioactive Liquid Waste Sampling and Analysis Program

LIQUID RELEASE TYPE	SAMPLE FREQUENCY	SAMPLE ANALYSIS FREQUENCY	SAMPLE ANALYSIS TYPE	SAMPLE LOWER LIMIT OF DETECTION (LLD) (a)(e)
4. Storm Drain Collection Basin	Prior to each release(k)	Prior to each release(k)	Principal Gamma Emitters (g) H-3	5×10^{-7} (b) µCi/ml 1×10^{-5} µCi/ml
	AND	AND		
	During each release	During each release	Principal Gamma Emitters (g) H-3	5×10^{-7} uCi/ml 1×10^{-5} uCi/ml
		31 days Composite(c)	Gross Alpha	1×10^{-7} uCi/ml
		92 days Composite(c)	Sr-89, Sr-90 Fe-55 Ni-63	5×10^{-8} µCi/ml 1×10^{-6} µCi/ml 3×10^{-8} uCi/ml

(a) The detectability limits for activity analyses are based on technical feasibility limits and on the potential significance in the environment of the quantities released. For some nuclides, lower detection limits may be readily achievable; and when nuclides are measured below the stated limits, they should also be reported.

(b) When operational limitations preclude specific gamma radionuclide analysis of each batch, gross radioactivity measurements shall be made to estimate the quantity and concentrations of radioactive material released in the batch; and a weekly sample composited from proportional aliquots from each batch released during the week shall be analyzed for principal gamma-emitting radionuclides.

(c) 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.

(d) The service water liquid release type represent potential release pathways and not an actual release pathway. Test of this pathway is intended to alert the plant to a potential problem; analysis for principal gamma emitters should be sufficient to meet this intent. If analysis for principal gamma emitters indicates a problem (i.e., exceeds the trigger level of 5×10^{-6} µCi/ml), then complete sampling and analyses shall be performed as per Table 7.3.3-2.

(e) The lower limit of detectability (LLD) is the smallest concentration of a radioactive material in an unknown sample that will be detected with a 95% probability with a 5% probability of falsely concluding that a blank observation represents a “real” signal. For a particular measurement system, which may include radiochemical separation:

$$LLD = \frac{4.66\, \sigma_b}{E \cdot V \cdot 2.22 \times 10^6 \cdot Y \cdot e^{-(\lambda_i t_e)}}$$

Where:

LLD is the “<u>a priori</u>” lower limit of detection as defined above (as microcuries per unit mass or volume)

σ_b = $(N/t_b)^{1/2}$
= standard deviation of background (cpm)

Table 7.3.3-1 (page 3 of 3)
Radioactive Liquid Waste Sampling and Analysis Program

N = background count rate (cpm)

t_b = time background counted for (min)

E = counting efficiency, as counts per disintegration

V = volume or mass of sample

2.22×10^6 = conversion factor (dpm/microcurie)

Y = fractional radiochemical yield

λ_i = radioactive decay constant of ith nuclide (sec^{-1})

t_e = elapsed time between sample collection and counting (sec)

Typical values of E, V, Y, and t_e 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.

(f) When composite sampling instrumentation is INOPERABLE, daily grab sampling of the effluent will be required during release and the composite sample will be analyzed. The daily grab sample will be composited as a weekly sample.

(g) The principal gamma emitters for which the LLD specifications apply 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 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.

(h) 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.

(i) Principal Gamma Emitters and H-3 are to be performed on the composite sample at the end of the release period.

(j) These requirements only apply if the Groundwater Extraction (GWE) System is being released directly to the intake canal. During periods when the GWE System is directed to the Drainage Holding Facility or Stabilization Facility sampling of the GWE System is not required.

(k) Releasing water directly to the discharge canal through the storm drain basin overflow valves is prohibited by the National Pollutant Discharge Elimination System (NPDES) permit except where unavoidable to prevent loss of life, personnel injury, or severe property damage. Sometimes due to unanticipated inclement weather a pre-release sample is not able to be obtained, however, there is a composite sampler that samples the basin continuously and can be used for the pre-release sample.

Table 7.3.3-2 (page 1 of 3)

Radioactive Liquid Waste Sampling and Analysis Program
for Potential Release Pathways Which Have Exceeded Trigger Levels

LIQUID RELEASE TYPE	SAMPLE FREQUENCY	SAMPLE ANALYSIS FREQUENCY	SAMPLE ANALYSIS TYPE	SAMPLE LOWER LIMIT OF DETECTION (LLD) [(a)(e)]
1. Service Water (Continuous Release) [(g)]	24 hours [(d)]	7 days Composite[(c)]	Principal Gamma Emitters [(f)]	5×10^{-7} [(b)] μCi/ml
			I-131	1×10^{-6} μCi/ml
	31 days Grab Sample	31 days	Dissolved and entrained gases (Gamma Emitters)	1×10^{-5} μCi/ml
	24 hours [(d)]	31 days Composite[(c)]	Gross Alpha	1×10^{-7} μCi/ml
			H-3	1×10^{-5} μCi/ml
	24 hours[(d)]	92 days Composite[(c)]	Sr-89, Sr-90	5×10^{-8} μCi/ml
			Fe-55	1×10^{-6} μCi/ml
			Ni-63	3×10^{-8} μCi/ml

Table 7.3.3-2 (page 2 of 3)
Radioactive Liquid Waste Sampling and Analysis Program
for Potential Release Pathways Which Have Exceeded Trigger Levels

(a) The detectability limits for activity analyses are based on technical feasibility limits and on the potential significance in the environment of the quantities released. For some nuclides, lower detection limits may be readily achievable; and when nuclides are measured below the stated limits, they should also be reported.

(b) When operational limitations preclude specific gamma radionuclide analysis of each batch, gross radioactivity measurements shall be made to estimate the quantity and concentrations of radioactive material released in the batch; and a weekly sample composited from proportional aliquots from each batch released during the week shall be analyzed for principal gamma-emitting radionuclides.

(c) 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.

(d) Until such time as continuous proportional composite samplers are installed on the service water discharge line, daily grab sampling of the service water effluent will be required for use in making up the composite.

(e) The lower limit of detectability (LLD) is the smallest concentration of a radioactive material in an unknown sample that will be detected with a 95% probability with a 5% probability of falsely concluding that a blank observation represents a "real" signal.

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

$$LLD = \frac{4.66\ \sigma_b}{E \cdot V \cdot 2.22 \times 10^6 \cdot Y \cdot e^{-(\lambda_i t_e)}}$$

Where:

LLD is the "a priori" lower limit of detection as defined above (as microcuries per unit mass or volume)

σ_b = $(N/t_b)^{1/2}$

= standard deviation of background (cpm)

N = background count rate (cpm)

Table 7.3.3-2 (page 3 of 3)
Radioactive Liquid Waste Sampling and Analysis Program
for Potential Release Pathways Which Have Exceeded Trigger Levels

t_b	=	time background counted for (min)
E	=	counting efficiency, as counts per disintegration
V	=	volume or mass of sample
2.22×10^6	=	conversion factor (dpm/microcurie)
Y	=	fractional radiochemical yield
λ_i	=	radioactive decay constant of ith nuclide (sec^{-1})
t_e	=	elapsed time between sample collection and counting (sec)

Typical values of E, V, Y, and t_e 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.

(f) The principal gamma emitters for which the LLD specifications apply 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 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.

(g) A continuous release is the discharge of liquid waste of a nondiscrete volume, e.g., from a volume or a system that has an input flow during the continuous release.

7.3.4 DOSE—LIQUID EFFLUENTS

ODCMS 7.3.4 The dose or dose commitment to a MEMBER OF THE PUBLIC from radioactive materials in liquid effluents released to UNRESTRICTED AREAS shall be limited to:

a. ≤ 3 mrem to the total body and ≤ 10 mrem to any organ during any calendar quarter; and

b. ≤ 6 mrem to the total body and ≤ 20 mrem to any organ during any calendar year.

APPLICABILITY: At all times.

COMPENSATORY MEASURES

NOTE
Enter applicable Conditions and Required Compensatory Measures of ODCMS 7.3.14, “Total Dose (40 CFR 190),” when liquid effluent dose results in exceeding an annual total dose limit.

CONDITION	REQUIRED COMPENSATORY MEASURE	COMPLETION TIME
A. NOTE Required Compensatory Measure A.1 shall be completed if this Condition is entered. Calculated dose from the release of radioactive materials in liquid effluents to UNRESTRICTED AREAS not within limits.	A.1 Submit a Special Report to the NRC that identifies causes for exceeding limits, corrective actions taken to reduce releases, and corrective actions to assure that subsequent releases will be in compliance with the required limits.	30 days

TEST REQUIREMENTS

TEST		FREQUENCY
TR 7.3.4.1	Verify the cumulative dose contributions from liquid effluents for the current calendar quarter and current calendar year are within limits in accordance with the methodology and parameters in the ODCM.	31 days

7.3.5 LIQUID RADWASTE TREATMENT SYSTEM

ODCMS 7.3.5 The Liquid Radwaste Treatment System shall be used to reduce radioactive materials in liquid wastes prior to their discharge.

APPLICABILITY: During release of liquid radioactive water when the projected doses due to the liquid effluent, from the site to UNRESTRICTED AREAS, would exceed 0.12 mrem to the total body or 0.4 mrem to any organ in a 31 day period.

COMPENSATORY MEASURES

CONDITION	REQUIRED COMPENSATORY MEASURE		COMPLETION TIME
A. NOTE Required Compensatory Measure A.1 shall be completed if this Condition is entered. Liquid waste being discharged without treatment.	A.1	Submit a Special Report to the NRC that includes explanation of why liquid radwaste was being discharged without treatment, identification of any required inoperable equipment or subsystem and the reasons for the inoperability, the corrective actions taken to restore the required inoperable equipment to OPERABLE status, and a summary description of the corrective actions taken to prevent recurrence.	30 days

TEST REQUIREMENTS

	TEST	FREQUENCY
TR 7.3.5.1	Verify required valve alignments to ensure Liquid Radwaste Treatment System is in use to reduce radioactive materials in liquid waste.	Prior to release of liquid effluents
	NOTE Only required to be performed when the Liquid Radwaste Treatment System is not in use when performing Liquid Radwaste Releases.	31 days
TR 7.3.5.2	Determine the projected doses due to liquid releases from the site to UNRESTRICTED AREAS in accordance with the methodology and parameters in the ODCM.	

7.3.6 LIQUID HOLDUP TANKS

ODCMS 7.3.6 The quantity of radioactive material, excluding tritium and dissolved or entrained gases, suspended in solution in the condensate storage tank, auxiliary surge tank and outdoor temporary tank shall be maintained within limits.

APPLICABILITY: At all times.

COMPENSATORY MEASURES

NOTE
Separate Condition entry is allowed for each tank.

CONDITION	REQUIRED COMPENSATORY MEASURE	COMPLETION TIME
A. Quantity of radioactive material in one or more of the specified liquid holdup tanks not within limit.	A.1 Suspend addition of radioactive materials to the associated tank.	Immediately
	AND	
	A.2 Restore quantity of radioactive material in the tank to within limit.	48 hours
	AND	
	A.3 Prepare and submit in the Radioactive Effluent Release Report, a description of the events leading to the non-compliance.	Upon submittal of the current calendar year Radioactive Effluent Release Report

TEST REQUIREMENTS

TEST		FREQUENCY
TR 7.3.6.1	NOTE Only required to be performed when radioactive materials are being added to the tank. Verify the quantity of radioactive material, excluding tritium and dissolved or entrained gases, in the condensate storage tank is ≤ 10 Ci by analyzing a representative sample of the tank's contents.	7 days
TR 7.3.6.2	NOTE Only required to be performed when radioactive materials are being added to the tank. Verify the quantity of radioactive material, excluding tritium and dissolved or entrained gases, in the auxiliary surge tank is ≤ 10 Ci by calculation using dose measurement(s) of the tank area.	7 days
TR 7.3.6.3	NOTE Only required to be performed when radioactive materials are being added to the tank. Verify the quantity of radioactive material, excluding tritium and dissolved or entrained gases, in the outdoor temporary tank is ≤ 10 Ci by analyzing a representative sample of the tank's contents.	7 days

7.3.7 DOSE RATE—GASEOUS EFFLUENTS

ODCMS 7.3.7 The dose rate at and beyond the SITE BOUNDARY due to radioactive materials released in gaseous effluents from the site shall be limited to the following:

a. For nobles gases, ≤ 500 mrem per year to the total body and ≤ 3000 mrem per year to the skin; and

b. For iodine-131, iodine-133, tritium, and all radionuclides in particulate form with half lives > 8 days, ≤ 1500 mrem per year to any organ.

APPLICABILITY: At all times.

COMPENSATORY MEASURES

CONDITION	REQUIRED COMPENSATORY MEASURE	COMPLETION TIME
A. Dose rate from the release of radioactive materials in gaseous effluents from the site at or beyond the SITE BOUNDARY not within limits.	A.1 Initiate action to restore dose rate to within limits.	Immediately

TEST REQUIREMENTS

TEST		FREQUENCY
TR 7.3.7.1	Verify the dose rate due to noble gases in gaseous effluents is within limits in accordance with methodology and parameters in the ODCM.	In accordance with the ODCM
TR 7.3.7.2	Verify 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.	In accordance with Table 7.3.7-1

Table 7.3.7-1 (page 1 of 3)
Radioactive Gaseous Waste Sampling and Analysis Program

GASEOUS RELEASE TYPE	SAMPLE FREQUENCY	SAMPLE ANALYSIS FREQUENCY	SAMPLE ANALYSIS TYPE	SAMPLE LOWER LIMIT OF DETECTION (LLD) (a)
1. Drywell Purge	Prior to each purge Grab Sample	Prior to each purge	Principal Gamma Emitters (b)	1 x 10^{-4} μCi/ml
2. Environmental Release Points a. Continuous Release: Main Stack Reactor Building Vents Turbine Building Vents Hot Shop (h) Building Vents	31 days Grab Sample	31 days	Principal Gamma Emitters(b) (c)	1 x 10^{-4} μCi/ml
			H-3 (d)	1 x 10^{-6} μCi/ml
	Continuous (e)	7 days (f) (g) Charcoal Sample	I-131	1 x 10^{-12} μCi/ml
	Continuous (e)	7 days (f) (g) Particulate Sample	Principal Gamma Emitters (b) (I-131, others)	1 x 10^{-11} μCi/ml
	Continuous (e)	31 days Composite Particulate Sample	Gross Alpha	1 x 10^{-11} μCi/ml
	Continuous (e)	92 days Composite Particulate Sample	Sr-89, Sr-90	1 x 10^{-11} μCi/ml
	Continuous (e)	Noble Gas Monitor	Noble Gases, Gross Beta or Gamma	1 x 10^{-6} μCi/ml
b. Radioactive Materials Container and Storage Building Decontamination Facility (RMCSB) Low Level Warehouse Facility (LLW)	During RMCSB (e) operation only	7 days (i) Charcoal Sample	I-131	1 x 10^{-12} μCi/ml
	During facility (e) operation	7 days (i) Particulate Sample	Principle Gamma Emitters(b) (I-131, others)	1 x 10^{-11} μCi/ml
	During facility (e) operation	31 days Composite Particulate Sample	Gross Alpha	1 x 10^{-11} μCi/ml
	During facility (e) operation	92 days Composite Particulate Sample	Sr-89, Sr-90	1 x 10^{-11} μCi/ml

Table 7.3.7-1 (page 2 of 3)
Radioactive Gaseous Waste Sampling and Analysis Program

(a) The lower limit of detectability (LLD) is the smallest concentration of a radioactive material in an unknown sample that will be detected with a 95% probability with a 5% probability of falsely concluding that a blank observation represents a "real" signal.

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

$$\mathrm{LLD} = \frac{4.66\ \sigma\ b}{\mathrm{E} \cdot \mathrm{V} \cdot 2.22 \times 10^{6} \cdot \mathrm{Y} \cdot e^{-(\lambda_i t_e)}}$$

Where:

LLD is the "a priori" lower limit of detection as defined above (as microcuries per unit mass or volume)

σ_b	=	$(N/t_b)^{1/2}$
	=	standard deviation of background (cpm)
N	=	background count rate (cpm)
t_b	=	time background counted for (min)
E	=	counting efficiency, as counts per disintegration
V	=	volume or mass of sample
2.22×10^6	=	conversion factor (dpm/microcurie)
Y	=	fractional radiochemical yield
λ_i	=	radioactive decay constant of ith nuclide (sec^{-1})
t_e	=	elapsed time between sample collection and counting (sec)

Typical values of E, V, Y, and t_e 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 7.3.7-1 (page 3 of 3)
Radioactive Gaseous Waste Sampling and Analysis Program

(b) The principal gamma emitters for which the LLD specification applies exclusively are the following radionuclides: Kr-87, Kr-88, Xe-133, Xe-133m, Xe-135, and Xe-138 for gaseous emissions and Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, Ce-141, and Ce-144 for particulate emissions. This list does not mean that only these nuclides are to be 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.

(c) With a THERMAL POWER change exceeding 15 percent of RATED THERMAL POWER within one hour, or following shutdown or start-up, sampling and analyses shall also be performed unless (1) analysis shows that the Dose Equivalent I-131 concentration in the primary coolant has not increased more than a factor of 3; and (2) the applicable noble gas activity monitor shows that effluent activity has not increased by more than a factor of 3.

(d) If during refueling, the tritium concentration in the spent fuel pool water exceeds 2×10^{-4} μCi/ml, 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. Spent fuel pool water will be sampled at least once per 7 days during refueling.

(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 ODCMS 7.3.7, 7.3.8, and 7.3.9.

(f) Sample cartridges/filters shall be changed at least once per 7 days and analyses shall be completed within 48 hours after changing (or after removal from sampler).

(g) Sampling shall be performed at least once per 24 hours for at least 7 days following each shutdown, start-up, or THERMAL POWER change exceeding 15 percent of RATED THERMAL POWER in 1 hour, 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 primary coolant has not increased more than a factor of 3; and (2) the applicable noble gas monitor shows that effluent activity has not increased more than a factor of 3. This footnote does not apply to the Hot Shop environmental release point.

(h) Monthly grab samples to be analyzed for principal gamma emitters and tritium are not applicable for the Hot Shop environmental release point. In addition, the Hot Shop release point does not have a noble gas monitor and, therefore, the noble gas activity analysis requirements of Table 7.3.7-1 are not applicable.

(i) Sample cartridges/filters shall be changed at least once per 7 days when the facility is in operation and analyses shall be completed within 48 hours after changing (or after removal from sampler).

7.3.8 DOSE—NOBLE GASES

ODCMS 7.3.8 The air dose at and beyond the SITE BOUNDARY due to noble gases in gaseous effluents from the site shall be limited to the following:

a. ≤ 10 mrads gamma radiation and ≤ 20 mrads beta radiation during any calendar quarter; and

b. ≤ 20 mrads gamma radiation and ≤ 40 mrads beta radiation during any calendar year.

APPLICABILITY: At all times.

COMPENSATORY MEASURES

NOTE
Enter applicable Conditions and Required Compensatory Measures of ODCMS 7.3.14, "Total Dose (40 CFR 190)," when gaseous effluent (noble gases) dose results in exceeding an annual total dose limit.

CONDITION	REQUIRED COMPENSATORY MEASURE		COMPLETION TIME
A. NOTE Required Compensatory Measure A.1 shall be completed if this Condition is entered. Calculated air dose from radioactive noble gases in gaseous effluents at or beyond the SITE BOUNDARY not within limits.	A.1	Submit a Special Report to the NRC that identifies causes for exceeding the limits, corrective actions taken to reduce releases, and corrective actions to assure that subsequent releases are within limits.	30 days

TEST REQUIREMENTS

TEST		FREQUENCY
TR 7.3.8.1	Verify the cumulative dose contributions from noble gases in gaseous effluents for the current calendar quarter and current calendar year are within limits in accordance with the methodology and parameters in the ODCM.	31 days

7.3.9 DOSE—I-131, I-133, TRITIUM, AND RADIONUCLIDES IN PARTICULATE FORM

ODCMS 7.3.9 The dose to a MEMBER OF THE PUBLIC at and beyond the SITE BOUNDARY from iodine-131, iodine-133, tritium, and all radionuclides in particulate form with half lives > 8 days, in gaseous effluents released from the site shall be limited to the following:

a. ≤ 15 mrems to any organ during any calendar quarter;

b. ≤ 30 mrems to any organ during any calendar year; and

APPLICABILITY: At all times.

COMPENSATORY MEASURES

NOTE
Enter applicable Conditions and Required Compensatory Measures of ODCMS 7.3.14, “Total Dose (40 CFR 190),” when gaseous effluent (I-131, I-133, tritium, radionuclides in particulate form) dose results in exceeding an annual total dose limit.

CONDITION	REQUIRED COMPENSATORY MEASURE	COMPLETION TIME
A. NOTE: Required Compensatory Measure A.1 shall be completed if this Condition is entered. Calculated dose from the release of iodine-131, iodine-133, tritium, and radionuclides in particulate form with half-lives > 8 days, in gaseous effluents at or beyond the SITE BOUNDARY not within limits.	A.1 Submit a Special Report to the NRC that identifies causes for exceeding the limits, corrective actions taken to reduce releases, and corrective actions to assure subsequent releases are within limits.	30 days

TEST REQUIREMENTS

TEST		FREQUENCY
TR 7.3.9.1	Verify the cumulative dose contributions from iodine-131, iodine-133, tritium, and radionuclides in particulate form with half lives > 8 days, in gaseous effluents for the current calendar quarter and current calendar year are within limits in accordance with the methodology and parameters in the ODCM.	31 days

7.3.10 GASEOUS RADWASTE TREATMENT SYSTEM

ODCMS 7.3.10 The GASEOUS RADWASTE TREATMENT SYSTEM shall be in operation.

APPLICABILITY: Whenever the Main Condenser Air Ejector (evacuation) System is in operation.

COMPENSATORY MEASURES

CONDITION	REQUIRED COMPENSATORY MEASURE	COMPLETION TIME
A. GASEOUS RADWASTE TREATMENT SYSTEM not in operation.	A.1 Place GASEOUS RADWASTE TREATMENT SYSTEM in operation.	7 days
B. NOTE: Required Compensatory Measure B.1 shall be completed if this Condition is entered. Required Compensatory measure and associated Completion Time not met.	B.1 Submit a Special Report to the NRC that identifies the required inoperable equipment and the reasons for the inoperability, corrective actions taken to restore the required inoperable equipment to OPERABLE status, and a summary description of the corrective actions taken to prevent recurrence.	30 days

TEST REQUIREMENTS

TEST		FREQUENCY
TR 7.3.10.1	Verify GASEOUS RADWASTE TREATMENT SYSTEM in operation by checking the readings of the relevant instruments.	12 hours

7.3.11 VENTILATION EXHAUST TREATMENT SYSTEM

ODCMS 7.3.11 The VENTILATION EXHAUST TREATMENT SYSTEM shall be used to reduce radioactive materials in gaseous waste prior to their discharge.

APPLICABILITY: During release of gaseous radioactive wastes when the projected doses due to gaseous effluent, from the site to areas at or beyond the SITE BOUNDARY, when averaged over 31 days, would exceed 0.6 mrem to any organ in a 31 day period.

COMPENSATORY MEASURES

CONDITION	REQUIRED COMPENSATORY MEASURE	COMPLETION TIME
A. NOTE Required Compensatory Measure A.1 shall be completed if this Condition is entered. Gaseous waste being discharged without treatment.	A.1 Submit a Special Report to the NRC that identifies the inoperable equipment or subsystems and the reason for inoperability, the corrective actions taken to restore the inoperable equipment to OPERABLE status, and a summary description of the corrective actions taken to prevent recurrence.	30 days

TEST REQUIREMENTS

TEST		FREQUENCY
TR 7.3.11.1	Verify required valve alignment to ensure VENTILATION EXHAUST TREATMENT SYSTEM is in use to reduce radioactive materials in gaseous waste.	Prior to release of gaseous effluents

(continued)

TEST REQUIREMENTS (continued)

	TEST	FREQUENCY
TR 7.3.11.2	NOTE Only required to be performed when the VENTILATION EXHAUST TREATMENT SYSTEM is not in use. Determine the projected doses due to gaseous releases from the site to areas at or beyond the SITE BOUNDARY in accordance with the methodology and parameters in the ODCM.	31 days

7.3.12 EXPLOSIVE GAS MIXTURE

ODCMS 7.3.12 The concentration of hydrogen in the Main Condenser Offgas Treatment System shall be ≤ 4% by volume.

APPLICABILITY: When the Main Condenser Air Ejector System is in operation.

COMPENSATORY MEASURES

NOTE
ODCMS 7.3.0.4 is not applicable.

CONDITION	REQUIRED COMPENSATORY MEASURE	COMPLETION TIME
A. Hydrogen concentration in the Main Condenser Offgas Treatment System > 4% by volume.	A.1 Restore hydrogen concentration to within limit.	48 hours

TEST REQUIREMENTS

TEST		FREQUENCY
TR 7.3.12.1	Verify the concentration of hydrogen in the Main Condenser Offgas Treatment System is ≤ 4% by volume by monitoring waste gases with the required hydrogen monitors of ODCMS 7.3.2, “Radioactive Gaseous Effluent Monitoring Instrumentation.”	Continuously

7.3.13 DRYWELL VENTING OR PURGING

ODCMS 7.3.13 The drywell shall be purged to the environment at a rate in conformance with ODCMS 7.3.7, “Dose Rate—Gaseous Effluents.”

APPLICABILITY: When the drywell is being vented or purged.

COMPENSATORY MEASURES

CONDITION	REQUIRED COMPENSATORY MEASURE	COMPLETION TIME
A. Requirements of ODCMS not met.	A.1 Suspend VENTING and PURGING of the drywell.	Immediately

TEST REQUIREMENTS

TEST	FREQUENCY
TR 7.3.13.1 Perform a sample analysis in accordance with Table 7.3.7-1.	Prior to each drywell PURGE

7.3.14 TOTAL DOSE (40 CFR PART 190)

ODCMS 7.3.14 The dose or dose commitment to any MEMBER OF THE PUBLIC over the calendar year due to releases of radioactivity and radiation from uranium fuel cycle sources shall be limited to:

a. ≤ 25 mrems to the total body or any organ (except the thyroid); and

b. ≤ 75 mrem to the thyroid.

APPLICABILITY: At all times.

COMPENSATORY MEASURES

CONDITION	REQUIRED COMPENSATORY MEASURE	COMPLETION TIME
A. NOTE Required Compensatory Measures A.1 and A.2 shall be completed if this Condition is entered. Calculated dose for uranium fuel cycle sources to any MEMBER OF THE PUBLIC not within limits.	A.1 NOTE Estimates of radiation exposure from uranium fuel cycle sources shall include the effects of all effluent pathways and direct radiation, including releases covered by this Special Report. Submit a Special Report to the NRC that includes corrective actions taken to prevent recurrence, the schedule for achieving conformance with required limits, an analysis that estimates the radiation exposure to a MEMBER OF THE PUBLIC from uranium fuel cycle sources for the calendar year, descriptions of the levels of radiation and concentrations of radioactive material involved, and the cause of the exposure levels or concentrations. <u>AND</u>	30 days

(continued)

COMPENSATORY MEASURES (continued)

CONDITION	REQUIRED COMPENSATORY MEASURE	COMPLETION TIME
A. (continued)	A.2 NOTES 1. Only applicable if the release condition resulting in violation of 40 CFR 190 has not been corrected. 2. Special Report submitted is considered a timely request and a variance is granted until NRC action on the request is complete. Submit a request for a variance in accordance with 40 CFR 190 in the Special Report to the NRC.	30 days

TEST REQUIREMENTS

TEST		FREQUENCY
TR 7.3.14.1	Determine cumulative dose contributions from liquid and gaseous effluents in accordance with TR 7.3.4.1, TR 7.3.8.1 and TR 7.3.9.1, and the methodology and parameters in the ODCM.	In accordance with ODCM

(continued)

TEST REQUIREMENTS (continued)

TEST		FREQUENCY
TR 7.3.14.2	NOTE Only required to be performed when calculated doses from the release of radioactive materials in liquid or gaseous effluents exceed twice the limits of ODCMSs 7.3.4.a, 7.3.4.b, 7.3.8.a, 7.3.8.b, 7.3.9.a., or 7.3.9.b. Determine cumulative dose contributions from direct radiation from the reactor units and from radwaste storage tanks in accordance with methodology and parameters in the ODCM.	In accordance with ODCM

7.3.15 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

ODCMS 7.3.15 The Radiological Monitoring Program shall be as follows:

a. Radiological environmental monitoring samples shall be collected at locations and analyzed as specified in Table 7.3.15-1.

b. Each sample location specified in Table 7.3.15-1 shall contain required milk or leafy vegetable samples

c. The level of radioactivity as the result of plant effluents for each radionuclide in each environmental sampling medium at a required location shall be less than the limits specified in Table 7.3.15-2, when averaged over the calendar quarter;

d. The total level of radioactivity as the result of plant effluents in each environmental sampling medium at a required location shall be less than the limit specified in Table 7.3.15-2, when averaged over the calendar quarter; and

e. The potential annual dose to a MEMBER OF THE PUBLIC from all radionuclides other than those in Table 7.3.15-2 in each environmental sampling medium at a required location shall be less than the calendar year limits of ODCMS 7.3.4, ODCMS 7.3.8, and ODCMS 7.3.9.

APPLICABILITY: At all times.

COMPENSATORY MEASURES

CONDITION	REQUIRED COMPENSATORY MEASURE		COMPLETION TIME
A. NOTE Required Compensatory Measure A.1 shall be completed if this Condition is entered. One or more samples not collected or analyzed as specified in Table 7.3.15-1.	A.1	Prepare and submit, in the Annual Radiological Environmental Operating Report, a description for not conducting the Radiological Environmental Monitoring sampling and analysis requirements as required and the corrective actions to prevent recurrence.	Upon submittal of current calendar year Annual Radiological Environmental Operating Report

(continued)

COMPENSATORY MEASURES (continued)

CONDITION	REQUIRED COMPENSATORY MEASURE		COMPLETION TIME
B. NOTES 1. Separate Condition entry is allowed for each sample location. 2. Required Compensatory Measure B.2 shall be completed if this Condition is entered. One or more sample locations required by Table 7.3.15-1 with required milk or fresh leafy vegetable samples unavailable.	B.1	Identify locations for obtaining replacement samples and replace, in the Radiological Environmental Monitoring Program, the location(s) from which samples are unavailable with the new location(s).	30 days
	<u>AND</u>		
	B.2	Prepare and submit, in the Radioactive Effluent Release Report, the cause of the unavailability of samples, the new locations for obtaining replacement samples, and the revised figure(s) and table for the ODCM reflecting the new locations.	Upon submittal of current calendar year Radioactive Effluent Release Report

(continued)

COMPENSATORY MEASURES (continued)

CONDITION	REQUIRED COMPENSATORY MEASURE		COMPLETION TIME
C. NOTES 1. Separate Condition entry is allowed for each sample location. 2. Required Compensatory Measure C.1 shall be completed if this Condition is entered. One or more sample locations with the level of radioactivity for one or more radionuclides as the result of plant effluents in an environmental sampling medium not within the limits of Table 7.3.15-2 when averaged over the calendar quarter. <u>OR</u> One or more sample locations with the total level of radioactivity as a result of plant effluents in an environmental sampling medium not within the limits of Table 7.3.15-2 when averaged over the calendar quarter.	C.1	Submit a Special Report to the NRC which includes the cause(s) for exceeding the limit(s) and the corrective actions to reduce radioactive effluents so that the potential annual dose to a MEMBER OF THE PUBLIC is less than the calendar year reporting limits of ODCMS 7.3.4, ODCMS 7.3.8, and ODCMS 7.3.9.	30 days

(continued)

COMPENSATORY MEASURES (continued)

CONDITION	REQUIRED COMPENSATORY MEASURE	COMPLETION TIME
D. NOTES 1. Separate Condition entry is allowed for each sample location. 2. Required Compensatory Measures D.1 and D.2 shall be completed if this Condition is entered. One or more sample locations with the potential annual dose to a MEMBER OF THE PUBLIC from all radionuclides other than those in Table 7.3.15-2 not within limits.	D.1 NOTE Only required if the radionuclides are the result of plant effluents. Submit a Special Report to the NRC which includes the methodology and parameters used for estimating the potential annual dose, the cause(s) for exceeding the limit(s) and the corrective actions to reduce radioactive effluents so that the potential annual dose to a MEMBER OF THE PUBLIC is less than the calendar year limits of ODCMS 7.3.4, ODCMS 7.3.8, and ODCMS 7.3.9.	30 days
	<u>AND</u>	
	D.2 NOTE Only required if the radionuclides are not the result of plant effluents. Describe the condition in the Annual Radiological Environmental Operating Report.	Upon submittal of the current calendar year Annual Radiological Environmental Operating Report

TEST REQUIREMENTS

	TEST	FREQUENCY
TR 7.3.15.1	Verify radiological environmental monitoring samples collected at the locations given in the table and figure(s) in the ODCM and analyzed as specified in Table 7.3.15-1 are within limits. Detection capabilities for the analyses are specified in Table 7.3.15-3.	In accordance with Table 7.3.15-1

Table 7.3.15-1 (page 1 of 5)
Radiological Environmental Monitoring Program

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF SAMPLES AND SAMPLE LOCATIONS[a]	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
1. Direct Radiation(b)	Forty-nine locations, either with two or more dosimeters or with one or more instruments for measuring and recording dose rate continuously to be placed as follows: An inner ring of stations, one in each meteorological sector in the general area of the SITE BOUNDARY as is reasonably accessible and practical. An outer ring of stations, one in each of the meteorological sectors at distances of 8 km or greater from the site as is reasonably accessible and practical. The balance of the stations to be placed in special interest areas such as population centers, nearby residences, schools, and one or two areas to serve as control stations.	92 days	Gamma dose: 92 days
2. Airborne-Radioiodine and Particulate	Samples from the following locations: Three samples from different sectors as close to the SITE BOUNDARY as is reasonably accessible, one of which being at the highest calculated annual average ground level D/Q. One sample from the vicinity of a nearby community. One sample from a control location, as for example greater than 15 km distant and in a less prevalent wind direction[c].	Continuous sampler operation Sample collection: 7 days or as required by dust loading, whichever is more frequent.	I-131 analysis of radioiodine canisters: 7 days <u>AND</u> Gross beta radioactivity analysis of particulate sampler: following filter change[d] <u>AND</u> Gamma isotopic analysis[e] of composite (by location): 92 days

(continued)

Table 7.3.15-1 (page 2 of 5)
Radiological Environmental Monitoring Program

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF SAMPLES AND SAMPLE LOCATIONS[a]	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
3. Waterborne a. Surface[f]	Two locations: One sample upstream. One sample downstream.	Composite[g] sample collection: 31 days	Gamma isotopic analysis[e]: 31 days AND Tritium analysis: 92 days
	Four locations from Nancy's Creek	Grab Samples 31 Days	Tritium 31 Days AND Gamma isotopic analysis[e]: 31 days If gamma activity detected from plant, Sr- 89, Sr-90, Fe-55 analysis required.
	Four locations from Nancy's Creek Marsh Areas	Grab Samples 31 Days	Tritium 31 Days AND Gamma isotopic analysis[e]: 31 days If gamma activity is detected from plant, Sr- 89, Sr-90, Fe-55 analysis required.
b. Sediment from Shoreline	One sample from downstream area with existing or potential recreational value.	184 days	Gamma isotopic analysis[e]: 184 days
	One sample from Nancy's Creek Area	365 days	Gamma isotopic [e], analysis 365 days
c. Groundwater	One sample from 10 Monitoring wells:	184 days 92 days	Gamma isotopic [e]: 184 days Tritium: 92 days
4. Ingestion a. Milk	Samples from the following four locations: One sample from milking animals in each of three locations within 8 km of the site having the highest dose potential (when available).[h] One sample from milking animals at a control location greater than 15 km distance from the site and in a less prevalent wind direction. [i]	With animals on pasture: 14 days At other times: 31 days	Gamma isotopic[e] and I-131 analyses: 14 days when animals are on pasture AND Gamma isotopic[e] and I-131 analyses: 31 days at other times

Table 7.3.15-1 (page 3 of 5)
Radiological Environmental Monitoring Program

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF SAMPLES AND SAMPLE LOCATIONS[a]	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
4. (continued)			
b. Fish and Invertebrates	Samples from the following locations: One sample of each of three recreationally important species in vicinity of plant discharge area (one free swimming species, one bottom feeding species, and one shellfish species). One sample of each similarly edible species from an area not influenced by plant discharge to serve as control samples .	When in season: 184 days	Gamma isotopic analysis[e] on edible portion: 184 days
	One sample of each of three recreationally important species in Nancy's Creek (one free swimming species, one bottom feeding species, and one shellfish species.)	365 days	Gamma isotopic analysis[e] on edible portion: 365 days
c. Broadleaf Vegetation	Samples from the following three locations: Samples of broadleaf vegetation grown in two sectors of historically high D/Q values at the SITE BOUNDARY if milk sampling is not performed. One sample of similar broadleaf vegetation grown at a distance of greater than 15 km from the site in a less prevalent wind direction if milk sampling is not performed.	When available: 31 days	Gamma isotopic[e] and I-131 analyses: 31 days when available

Table 7.3.15-1 (page 4 of 5)
Radiological Environmental Monitoring Program

(a) Specific parameters of distance and direction sector from the site, and additional description where pertinent, shall be provided for each and every sample location in Table 7.3.15-1 in a table and figure(s) in the ODCM. 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 practicable to continue to obtain samples of the media of choice at the most desired location or time. In these instances suitable alternative media and locations may be chosen for the particular pathway in question and appropriate substitutions made within 30 days in the radiological environmental monitoring program. Identify the cause of the unavailability of samples for that pathway and identify the new location(s) for obtaining replacement samples in the next Radioactive Effluent Release Report and also include in the report a revised figure(s) and table for the ODCM reflecting the new location(s).

(b) 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. Film badges shall not be used as dosimeters for measuring direct radiation. 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.

(c) 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.

(d) 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.

(e) Gamma isotopic analysis means the identification and quantification of gamma-emitting radionuclides that may be attributable to the effluents from the facility.

Table 7.3.15-1 (page 5 of 5)
Radiological Environmental Monitoring Program

(f) 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.

(g) 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. Composite samples shall be collected with equipment that is capable of collecting an aliquot at time intervals that are short (e.g., once per 6 hours) relative to compositing period (e.g., monthly) in order to assure obtaining a representative sample.

(h) When less than three (3) milking animal locations are available for testing within an 8-km distance, sampling of broadleaf vegetation shall be performed as indicated in Table 7.3.15-1, 4.c, in lieu of milk sampling.

(i) When less than three (3) milking animal locations are available for testing within an 8-km distance, sampling of broadleaf vegetation shall be performed for the control location indicated in Table 7.3.15-1, 4.c, in lieu of milk sampling.

Table 7.3.15-2 (page 1 of 1)
Limits for the Level of Radioactivity in Environmental Samples [(a)]

ANALYSIS	WATER (pCi/l)	AIRBORNE PARTICULATE AND GASES (pCi/m^3)	FISH (pCi/kg, wet)	MILK (pCi/l)	BROADLEAF VEGETATION (pCi/kg)
H-3	30,000 (b)				
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	20 (c)	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	

(a) The Limits are for samples that have only one radionuclide detected. When a sample contains more than one radionuclide, the total level of radioactivity limit is

$$\frac{\text{concentration(1)}}{\text{limit (1)}} + \frac{\text{concentration(2)}}{\text{limit (2)}} + \ldots < 1.0.$$

(b) If a drinking water pathway exists, 20,000 pCi/L shall be used.

(c) If a drinking water pathway exists then a value of 2 pCi/L shall be used.

Table 7.3.15-3 (page 1 of 3)
Detection Capabilities for Environmental Sample Analysis [(a)]

Lower Limit of detection (LLD) [(b)]

ANALYSIS	WATER (pCi/l)	AIRBORNE PARTICULATE OR GASES (pCi/m^3)	FISH (pCi/Kg, wet)	MILK (pCi/l)	BROADLEAF VEGETATION (pCi/kg, wet)	SEDIMENT (pCi/kg, dry)
Gross Beta	4	0.01				
H-3	3,000 (c)					
Mn-54	15		130			
Fe-59	30		260			
Co-58, 60	15		130			
Zn-65	30		260			
Zr-Nb-95	15					
I-131	15 (d)	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 7.3.15-3 (page 2 of 3)
Detection Capabilities for Environmental Sample Analysis

(a) 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 be analyzed and reported in the Annual Radiological Environmental Operating Report.

(b) The LLD is defined for purposes of the specifications, as the smallest concentration of radioactive material in an unknown sample that will be detected with 95% probability with a 5% probability of falsely concluding that a blank observation represents a "real" signal.

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

$$LLD = \frac{4.66\sigma_b}{E \cdot V \cdot 2.22 \cdot Y \cdot e^{-(\lambda_i t_e)}}$$

Where:

LLD is the "a priori" lower limit of detection as defined above, as picocuries per unit mass or volume.

σ_b	=	$(N/t_b)^{1/2}$
	=	standard deviation of background (cpm)
N	=	background count rate (cpm)
t_b	=	time background counted for (min)
E	=	counting efficiency, as counts per disintegration
V	=	volume or mass of sample
2.22	=	conversion factor (dpm/pCi)
Y	=	fractional radiochemical yield
λ_i	=	radioactive decay constant of ith nuclide (sec^{-1})
t_e	=	elapsed time between sampling collection and counting (sec)

Table 7.3.15-3 (page 3 of 3)
Detection Capabilities for Environmental Sample Analysis

Typical values of E, V, Y, and t_e 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 shall 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.

(c) LLD for non-drinking water samples. If a drinking water pathway exists, a value of 2,000 pCi/L shall be used.

(d) LLD for non-drinking water samples. If a drinking water pathway exists, a value of 1 pCi/L shall be used.

7.3.16 LAND USE CENSUS

ODCMS 7.3.16 A land use census shall be conducted and:

a. Shall identify the location of the nearest milk animal, residence, and garden of greater than $50m^2$ ($500\ ft^2$) producing broadleaf vegetation in each of the 16 meteorological sectors within a distance of 8 km (5 miles);

b. Shall identify (for elevated releases as defined in Regulatory Guide 1.111, Revision 1, July 1977) the location of all milk animals and all gardens of greater than $50m^2$ producing broadleaf vegetation in each of the 16 meteorological sectors within a distance of 5 km (3 miles);

c. The calculated dose and dose commitment at each identified location shall be less than the most recent values calculated by TR 7.3.9.1; and

d. The calculated dose and dose commitment at each identified location, via the same exposure pathways, shall be ≤ 120% of the actual dose and dose commitment from the current sample location identified in Table 7.3.15-1, excluding the central station location.

NOTE

In lieu of the garden census of ODCMS 7.3.16.a, broadleaf vegetable sampling of at least 3 different kinds of vegetation may be performed at the SITE BOUNDARY in each of 2 different direction sectors with the highest D/Qs. Specifications for broadleaf vegetation sampling of Table 7.3.15-1 (item 4.c) shall be followed, including analysis of control samples.

APPLICABILITY: At all times.

COMPENSATORY MEASURES

CONDITION	REQUIRED COMPENSATORY MEASURE		COMPLETION TIME
A. NOTE Required Compensatory Measure A.1 shall be completed if this Condition is entered. Land use census not conducted. <u>OR</u> All required locations not identified.	A.1	Prepare and submit, in the Annual Radiological Environmental Operating Report, a description for not conducting the land use census and the corrective actions to prevent recurrence.	Upon submittal of current calendar year Annual Radiological Environmental Operating Report
B. NOTE Required Compensatory Measure B.1 shall be completed if this Condition is entered. One or more identified locations with the calculated dose or dose commitment greater than the values calculated by TR 7.3.9.1.	B.1	Identify new location(s) in the Radioactive Effluent Release Report.	Upon submittal of the current calendar year Radioactive Effluent Release Report

(continued)

COMPENSATORY MEASURES (continued)

CONDITION	REQUIRED COMPENSATORY MEASURE		COMPLETION TIME
C. NOTE Required Compensatory Measure C.1 shall be completed if this Condition is entered. One or more identified locations with the calculated dose or dose commitment, via the same exposure pathway, > 120% of the actual dose or dose commitment from the current location identified in Table 7.3.15-1.	C.1	Add the new location to the Radiological Environmental Monitoring Program.	30 days
	<u>AND</u>		
	C.2	Sampling locations, excluding control locations, having the lowest calculated dose or dose commitment, via the same exposure pathway, may be removed from the Radiological Monitoring.	After October 31 of the year in which land use census was conducted
	<u>AND</u>		
	C.3	Identify the new location(s) in the Radioactive Effluent Release Report, and the revised figure(s) and table for the ODCM reflecting the new location.	Upon submittal of the current calendar year Radioactive Effluent Release Report

TEST REQUIREMENTS

TEST		FREQUENCY
TR 7.3.16.1	Conduct a land use census during the 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; identify all required locations, and verify the calculated dose and dose commitments at each identified location is within limits.	12 months

7.3.17 INTERLABORATORY COMPARISON PROGRAM

ODCMS 7.3.17 Analyses shall be performed on radioactive materials supplied as part of an Interlaboratory Comparison Program approved by the NRC.

APPLICABILITY: At all times.

COMPENSATORY MEASURES

CONDITION	REQUIRED COMPENSATORY MEASURE		COMPLETION TIME
A. NOTE: Required Compensatory Measure A.1 shall be completed if this Condition is entered. Requirements of ODCMS 7.3.17 not met.	A.1	Prepare and submit, in the Annual Radiological Environmental Operating Report, corrective actions to prevent recurrence.	Upon submittal of current calendar year Annual Radiological Environmental Operating Report

TEST REQUIREMENTS

TEST		FREQUENCY
TR 7.3.17.1	Perform the analyses required by the Interlaboratory Comparison Program.	In accordance with the ODCM

7.4.0 REPORTING REQUIREMENTS

ODCMS 7.4.1 Annual Radiological Environmental Operating Report

The Annual Radiological Environmental Operating Report shall be submitted in accordance with the requirements of Technical Specification 5.6.2. In addition to the requirements of Technical Specification 5.6.2, the Annual Radiological Environmental Operating Report shall include:

a. 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 impact of the plant operation on the environment;

b. Results of the land use census required by ODCMS 7.3.16;

c. A summary description of the radiological environmental monitoring program;

d. At least two legible maps of 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 and the second map shall include more distant stations);

e. Results of the Interlaboratory Comparison Program required by ODCMS 7.3.17;

f. Discussion of all deviations from the sampling schedule of Table 7.3.15-1; and

g. Discussion of all analyses in which the LLD required by Table 7.3.15-3 was not achievable.

ODCMS 7.4.2 Radioactive Effluent Release Report

The Radioactive Effluent Release Report shall be submitted in accordance with the requirements of Technical Specification 5.6.3. In addition to the requirements of Technical Specification 5.6.3, the Radioactive Effluent Release Report shall include:

(continued)

7.4.0 REPORTING REQUIREMENTS (continued)

ODCMS 7.4.2 Radioactive Effluent Release Report (continued)

a. A summary of the quantities of radioactive liquid and gaseous effluents and solid waste released for the facility as outlined in Regulatory Guide 1.21, “Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactivity Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants,” Revision 1, June 1974, with data summarized on a quarterly basis similar to the format of Appendix B thereof.

b. Information specified below for each class of solid waste (as defined by 10 CFR Part 61, when implemented) shipped offsite during the report period:

1. Container volume;
2. Total curie quantity (specify whether determined by measurement or estimate);
3. Principal radionuclides (specify whether determined by measurement or estimate);
4. Source of waste and processing employed (e.g., dewatered spent resin, compacted dry waste, evaporator bottoms);
5. Type of container (e.g., LSA, Type A, Type B, Large Quantity); and
6. Solidification agent or absorbent (e.g., cement, urea formaldehyde).

c. A list and description of unplanned releases from the site to the UNRESTRICTED AREAS of radioactive materials in gaseous and liquid effluents made during the reporting period.

d. Any changes made during the reporting period to the Process Control Program (PCP) or 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 ODCMS 7.3.16.

(continued)

7.4.0 REPORTING REQUIREMENTS (continued)

ODCMS 7.4.2 Radioactive Effluent Release Report (continued)

e. 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. In lieu of submission of this summary of required meteorological data with the Radioactive Effluent Release Report, the summary of required meteorological data may be retained in a file that shall be provided to the NRC upon request.

f. An assessment of radiation doses due to radioactive liquid and gaseous effluents released from the station during the previous calendar year.

g. The Radioactive Effluent Release Report shall include results from any groundwater samples obtained in accordance with the Radiological Environmental Monitoring Program during the reporting period that are not described in the ODCM.

h. The Radioactive Effluent Release Report shall include any assigned doses that were performed as a result of a spill or leak from the site that occurred during the reporting period.

i. The Radioactive Effluent Release Report shall include a summary of any on-site spills and leaks that occurred during the reporting period that were communicated to offsite agencies.

7.5.0 MAJOR CHANGES TO RADIOACTIVE WASTE TREATMENT SYSTEMS

ODCMS 7.5.1 Licensee initiated major changes to the liquid, gaseous, and solid Radioactive Waste Treatment Systems shall be reported to the NRC as part of the Radioactive Effluent Release Report or as part of 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 that shows the predicted release of radioactive materials in the liquid and gaseous effluents and quantity of solid waste differ from those previously predicted in the license application and amendments thereto;

e. An evaluation of the change that shows the expected maximum exposure 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 wastes, 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 PNSC.

ODCMS 7.5.2 The change shall become effective upon review and acceptance by the PNSC.

B 7.3.0 OFFSITE DOSE CALCULATION MANUAL SPECIFICATION (ODCMS) APPLICABILITY

BASES

ODCMSs	ODCMS 7.3.0.1 through ODCMS 7.3.0.6 establish the general requirements applicable to all Specifications and apply at all times, unless otherwise stated.
ODCMS 7.3.0.1	ODCMS 7.3.0.1 establishes the Applicability statement within each individual ODCMS as the requirement for when the ODCMS is required to be met (i.e., when the unit is in the MODES or other specified conditions of the Applicability statement of each ODCMS).
ODCMS 7.3.0.2	ODCMS 7.3.0.2 establishes that upon discovery of a failure to meet an ODCMS, the associated COMPENSATORY MEASURES shall be met. The Completion Time of each Required Compensatory Measure for a COMPENSATORY MEASURES Condition is applicable from the point in time that a COMPENSATORY MEASURES Condition is entered. The Required Compensatory Measures establish those remedial measures that must be taken within specified Completion Times when the requirements of an ODCMS are not met. This ODCMS establishes that: a. Completion of the Required Compensatory Measures within the specified Completion Times constitutes compliance with an ODCMS; and b. Completion of the Required Compensatory Measures is not required when an ODCMS is met within the specified Completion Time, unless otherwise specified. There are two basic types of Required Compensatory Measures. The first type of Required Compensatory Measure specifies a time limit in which the ODCMS must be met. This time limit is the Completion Time to restore an inoperable system or component to OPERABLE status or to restore variables to within specified limits. If this type of Required Compensatory Measure is not completed within the specified Completion Time, a shutdown may be required to place the unit in a MODE or condition in which the ODCMS is not applicable. (Whether stated as a Required Compensatory Measure or not, correction of the entered

(continued)

ODCMS 7.3.0.2 (continued)

Condition is a compensatory measure that may always be considered upon entering COMPENSATORY MEASURES.) The second type of Required Compensatory Measure specifies the remedial measures that permit continued operation of the unit that is not further restricted by the Completion Time. In this case, compliance with the Required Compensatory Measures provides an acceptable level of safety for continued operation.

Completing the Required Compensatory Measures is not required when an ODCMS is met or is no longer applicable, unless otherwise stated in the individual ODCMSs.

The nature of some Required Compensatory Measures of some Conditions necessitates that, once the Condition is entered, the Required Compensatory Measures must be completed even though the associated Condition no longer exists. The individual ODCMS's COMPENSATORY MEASURES specify the Required Compensatory Measures where this is the case.

The Completion Times of the Required Compensatory Measures are also applicable when a system or component is removed from service intentionally. The reasons for intentionally relying on the COMPENSATORY MEASURES include, but are not limited to, performance of Tests, preventive maintenance, corrective maintenance, or investigation of operational problems. Entering COMPENSATORY MEASURES for these reasons must be done in a manner that does not compromise safety. Intentional entry into COMPENSATORY MEASURES should not be made for operational convenience. Alternatives that would not result in redundant equipment being inoperable should be used instead. Doing so limits the time both subsystems/ divisions of a safety function are inoperable. Individual ODCMSs may specify a time limit for performing a TR when equipment is removed from service or bypassed for testing. In this case, the Completion Times of the Required Compensatory Measures are applicable when this time limit expires, if the equipment remains removed from service or bypassed.

When a change in MODE or other specified condition is required to comply with Required Compensatory Measures, the unit may enter a MODE or other specified condition in which another ODCMS becomes applicable. In this case, the Completion Times of the associated

(continued)

ODCMS 7.3.0.2 (continued)	Required Compensatory Measures would apply from the point in time that the new ODCMS becomes applicable and the COMPENSATORY MEASURES Condition(s) are entered.
ODCMS 7.3.0.3	Not used.
ODCMS 7.3.0.4	ODCMS 7.3.0.4 establishes limitations on changes in MODES or other specified conditions in the Applicability when an ODCMS is not met. It precludes placing the unit in a MODE or other specified condition stated in that Applicability (e.g., Applicability desired to be entered) when the following exist: a. Unit conditions are such that the requirements of the ODCMS would not be met in the Applicability desired to be entered; and b. Continued noncompliance with the ODCMS requirements, if the Applicability were entered, would result in the unit being required to exit the Applicability desired to be entered to comply with the Required Compensatory Measures. Compliance with Required Compensatory Measures that permit continued operation of the unit for an unlimited period of time in a MODE or other specified condition provides an acceptable level of safety for continued operation. This is without regard to the status of the unit before or after the MODE change. Therefore, in such cases, entry into a MODE or other specified condition in the Applicability may be made in accordance with the provisions of the Required Compensatory Measures. The provisions of this Specification should not be interpreted as endorsing the failure to exercise the good practice of restoring systems or components to OPERABLE status before unit startup. The provisions of ODCMS 7.3.0.4 shall not prevent changes in MODES or other specified conditions in the Applicability that are required to comply with COMPENSATORY MEASURES. In addition, the provisions of ODCMS 7.3.0.4 shall not prevent changes in MODES or other specified conditions in the Applicability that result from any unit shutdown.

(continued)

ODCMS 7.3.0.4 (continued)

Exceptions to ODCMS 7.3.0.4 are stated in the individual Tests. Exceptions may apply to all the COMPENSATORY MEASURES or to a specific Required Compensatory Measure of an ODCMS.

Tests do not have to be performed on the associated inoperable equipment (or on variables outside the specified limits), as permitted by TR 7.3.0.1. Therefore, changing MODES or other specified conditions while in a COMPENSATORY MEASURES Condition, either in compliance with ODCMS 7.3.0.4 or where an exception to ODCMS 7.3.0.4 is stated, is not a violation of TR 7.3.0.1 or TR 7.3.0.4 for those Tests that do not have to be performed due to the associated inoperable equipment. However, TRs must be met to ensure OPERABILITY prior to declaring the associated equipment OPERABLE (or variable within limits) and restoring compliance with the affected ODCMS.

ODCMS 7.3.0.5

ODCMS 7.3.0.5 establishes the allowance for restoring equipment to service under administrative controls when it has been removed from service or declared inoperable to comply with COMPENSATORY MEASURES. The sole purpose of this ODCMS is to provide an exception to ODCMS 7.3.0.2 (e.g., to not comply with the applicable Required Compensatory Measure(s)) to allow the performance of TRs to demonstrate:

a. The OPERABILITY of the equipment being returned to service; or

b. The OPERABILITY of other equipment.

The administrative controls ensure the time the equipment is returned to service in conflict with the requirements of the COMPENSATORY MEASURES is limited to the time absolutely necessary to perform the allowed TRs. This ODCMS does not provide time to perform any other preventive or corrective maintenance.

An example of demonstrating the OPERABILITY of the equipment being returned to service is taking an inoperable channel or trip system out of the tripped condition after it has been tripped to comply with Required Compensatory Measures since it must be untripped to perform the TRs.

(continued)

ODCMS 7.3.0.5 (continued)	An example of demonstrating the OPERABILITY of other equipment is taking an inoperable channel or trip system out of the tripped condition to prevent the trip function from occurring during the performance of a TR on another channel in the other trip system. A similar example of demonstrating the OPERABILITY of other equipment is taking an inoperable channel or trip system out of the tripped condition to permit the logic to function and indicate the appropriate response during the performance of a TR on another channel in the same trip system.
ODCMS 7.3.0.6	ODCM 7.3.0.6 delineates the applicability of each ODCMS and associated COMPENSATORY MEASURE to Brunswick Unit 1 and Brunswick Unit 2 operations.

B 7.3.0 TEST REQUIREMENT (TR) APPLICABILITY

BASES

TRs	TR 7.3.0.1 through TR 7.3.0.5 establish the general requirements applicable to all ODCMSs and apply at all times, unless otherwise stated.

TR 7.3.0.1

TR 7.3.0.1 establishes the requirement that TRs must be met during the MODES or other specified conditions in the Applicability for which the requirements of the ODCMS apply, unless otherwise specified in the individual TRs. This ODCMS is to ensure that Tests are performed to verify the OPERABILITY of systems and components, and that variables are within specified limits. Failure to meet a Test within the specified Frequency, in accordance with TR 7.3.0.2, constitutes a failure to meet an ODCMS.

Systems and components are assumed to be OPERABLE when the associated TRs have been met. Nothing in this ODCMS, however, is to be construed as implying that systems or components are OPERABLE when:

a. The systems or components are known to be inoperable, although still meeting the TRs; or

b. The requirements of the Test(s) are known to be not met between required Test performances.

Tests do not have to be performed when the unit is in a MODE or other specified condition for which the requirements of the associated ODCMS are not applicable, unless otherwise specified.

Tests, including Tests invoked by Required Compensatory Measures, do not have to be performed on inoperable equipment because the COMPENSATORY MEASURES define the remedial measures that apply. Tests have to be met and performed in accordance with TR 7.3.0.2, prior to returning equipment to OPERABLE status.

Upon completion of maintenance, appropriate post maintenance testing is required to declare equipment OPERABLE. This includes ensuring applicable Tests are not failed and their most recent performance is in accordance with TR 7.3.0.2. Post maintenance testing may not be possible in the current MODE or other specified conditions in the

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TR 7.3.0.1 (continued)	Applicability due to the necessary unit parameters not having been established. In these situations, the equipment may be considered OPERABLE provided testing has been satisfactorily completed to the extent possible and the equipment is not otherwise believed to be incapable of performing its function. This will allow operation to proceed to a MODE or other specified condition where other necessary post maintenance tests can be completed.
TR 7.3.0.2	TR 7.3.0.2 establishes the requirements for meeting the specified Frequency for Tests and any Required Compensatory Measure with a Completion Time that requires the periodic performance of the Required Compensatory Measure on a “once per...” interval. TR 7.3.0.2 permits a 25% extension of the interval specified in the Frequency. This extension facilitates Test 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 Test 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 TRs. As stated in TR 7.3.0.2, 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, whether it is a particular Test or some other remedial action, is considered a single compensatory measure with a single Completion Time. One reason for not allowing the 25% extension to this Completion Time is that such a compensatory measure may verify that no loss of function has occurred by checking the status of redundant or diverse components or accomplishes the function of the inoperable equipment in an alternative manner.

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BASES

TR 7.3.0.2 (continued)	The provisions of TR 7.3.0.2 are not intended to be used repeatedly merely as an operational convenience to extend Test intervals (other than those consistent with refueling intervals) or periodic Completion Time intervals beyond those specified.
TR 7.3.0.3	TR 7.3.0.3 establishes the flexibility to defer declaring affected equipment inoperable or an affected variable outside the specified limits when a Test has not been completed within the specified Frequency. A delay period of up to 24 hours or up to the limit of the specified Frequency, whichever is less, applies from the point in time that it is discovered that the Test has not been performed in accordance with TR 7.3.0.2, and not at the time that the specified Frequency was not met. This delay period provides adequate time to complete Tests that have been missed. This delay period permits the completion of a Test before complying with Required Compensatory Measures or other remedial measures that might preclude completion of the Test. The basis for this delay period includes consideration of unit conditions, adequate planning, availability of personnel, the time required to perform the Test, the safety significance of the delay in completing the required Test, and the recognition that the most probable result of any particular Test being performed is the verification of conformance with the requirements. When a Test with a Frequency based not on time intervals, but upon specified unit conditions or operational situations, is discovered not to have been performed when specified, TR 7.3.0.3 allows the full delay period of 24 hours to perform the Test. TR 7.3.0.3 also provides a time limit for completion of Tests that become applicable as a consequence of MODE changes imposed by Required Compensatory Measures.

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TR 7.3.0.3 (continued)	Failure to comply with specified Frequencies for TRs is expected to be an infrequent occurrence. Use of the delay period established by TR 7.3.0.3 is a flexibility which is not intended to be used as an operational convenience to extend Test intervals. If a Test is not completed within the allowed delay period, then the equipment is considered inoperable or the variable is considered outside the specified limits and the Completion Times of the Required Compensatory Measures for the applicable ODCMS Conditions begin immediately upon expiration of the delay period. If a Test is failed within the delay period, then the equipment is inoperable, or the variable is outside the specified limits and the Completion Times of the Required Compensatory Measures for the applicable ODCMS Conditions begin immediately upon the failure of the Test. Completion of the Test within the delay period allowed by this ODCMS, or within the Completion Time of the COMPENSATORY MEASURES, restores compliance with TR 7.3.0.1.
TR 7.3.0.4	TR 7.3.0.4 establishes the requirement that all applicable TRs must be met before entry into a MODE or other specified condition in the Applicability. This ODCMS ensures that system and component OPERABILITY requirements and variable limits are met before entry into MODES or other specified conditions in the Applicability for which these systems and components ensure safe operation of the unit. However, in certain circumstances failing to meet a TR will not result in TR 7.3.0.4 restricting a MODE change or other specified condition change. When a system, subsystem, division, component, device, or variable is inoperable or outside its specified limits, the associated TR(s) are not required to be performed, per TR 7.3.0.1, which states that Tests do not have to be performed on inoperable equipment. When equipment is inoperable, TR 7.3.0.4 does not apply to the associated TR(s) since the requirement for the TR(s) to be performed is removed. Therefore, failing to perform the Test(s) within the specified Frequency does not result in a

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TR 7.3.0.4 (continued)	TR 7.3.0.4 restriction to changing MODES or other specified conditions of the Applicability. However, since the ODCMS is not met in this instance, ODCMS 7.3.0.4 will govern any restrictions that may (or may not) apply to MODE or other specified condition changes. The provisions of TR 7.3.0.4 shall not prevent changes in MODES or other specified conditions in the Applicability that are required to comply with COMPENSATORY MEASURES. In addition, the provisions of TR 7.3.0.4 shall not prevent changes in MODES or other specified conditions in the Applicability that result from any unit shutdown. The precise requirements for performance of TRs are specified such that exceptions to TR 7.3.0.4 are not necessary. The specific time frames and conditions necessary for meeting the TRs are specified in the Frequency, in the Test, or both. This allows performance of Tests when the prerequisite condition(s) specified in a Test procedure require entry into the MODE or other specified condition in the Applicability of the associated ODCMS prior to the performance or completion of a Test. A Test that could not be performed until after entering the ODCMS Applicability would have its Frequency specified such that it is not “due” until the specific conditions needed are met. Alternately, the Test may be stated in the form of a Note as not required (to be met or performed) until a particular event, condition, or time has been reached. Further discussion of the specific formats of TRs’ annotation is found in ODCMS Section 7.1.4, Frequency.
TR 7.3.0.5	TR 7.3.0.5 delineates the applicability of the test activities to Brunswick Unit 1 and Brunswick Unit 2 operations.

B 7.3.1 RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

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 in accordance with 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 purpose of tank level indicating devices is to assure the detection and control of leaks that, if not controlled, could potentially result in the transport of radioactive materials to UNRESTRICTED AREAS.

The initial CHANNEL CALIBRATION for the Table 7.3.1-1, Functions 1 and 3, instruments was performed using National Bureau of Standards traceable sources which verified that each detector would operate properly over its intended energy range and measurement range. For instruments which were operational prior to this specification being implemented, previously established calibration procedures may be substituted for the initial requirement. Subsequent to CHANNEL CALIBRATIONS will be performed using sources that have been related to the initial calibration in order to ensure that each detector is still operational, but the sources need not span the full ranges used in the initial CHANNEL CALIBRATION.

The ODCMS are modified by a Note to indicate that the annunciator function may be removed from operation for performance of troubleshooting for up to 30 minutes provided the associated function maintains monitoring capability. Upon completion of troubleshooting, or expiration of the 30 minute allowance, the annunciator must be returned to operation or the applicable condition entered and required Compensatory Measures taken. Appropriate compensatory actions should be determined an implemented during the loss of annunciator function. This note is based on the availability of the associated monitor and appropriate compensatory actions to identify changes in the liquid effluent for the monitored location. The monitor availability and compensatory actions ensure that the 30 minute trouble shooting allowance does not significantly reduce the probability of identifying the changing radiological conditions to allow appropriate response.

B 7.3.2 RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

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 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 and 64 of Appendix A to 10 CFR Part 50.

The main condenser air ejector monitoring instrumentation, the main condenser offgas treatment system monitor, and the explosive gas monitoring instrumentation shown in Table 7.3.2-1 are not considered effluent monitoring instrumentation in the same sense as the other instrumentation listed in the table. Therefore, their alarm/trip setpoints are not necessarily set to ensure that the limits of ODCMS 7.3.7 are not exceeded.

The main condenser air ejector monitoring instrumentation channels 1(2)-D12-RM-K601A and 1(2)-D12-RM-K601B are provided to monitor and control gross radioactivity removed from the main condenser. The alarm/trip setpoints for the main condenser air ejector monitors are set to ensure that the limits of Technical Specification 3.7.5 are not exceeded. The alarms alert the operator that an abnormal condition exists. Operability of the Hi and Hi Hi alarms are required for satisfying the main condenser air ejector monitoring instrumentation channel function. The trip function associated with the monitors, initiates when any combination of HI-HI, downscale, or INOP is received on both monitors. The trip function associated with the monitors initiates the off-gas timer which, after 15 minutes, initiates closure of 1(2)-AOG-HCV-102 and the Loop Seal Reservoir Drain Valve. Operability of the 1(2)-AOG-HCV-102 and Loop Seal Reservoir Drain Valve are not required for operability of the main condenser air ejector monitoring instrumentation.

The alarm/trip setpoint for this monitor shall be calculated in accordance with NRC approved methods to provide reasonable assurance that the potential total body accident dose will not exceed a fraction of the limits specified in 10 CFR Part 100.

This specification also includes provisions for monitoring the concentrations of potentially explosive gas mixtures in the offgas treatment system (hydrogen monitors).

The initial CHANNEL CALIBRATION for the Table 7.3.2-1, Functions 1.a, 2.a, 3.a, 4 and 6, instruments was performed using National Bureau of Standards traceable sources which verified that each detector would operate properly over its intended energy range and measurement range. For instruments which were operational prior to this specification being implemented, previously established calibration procedures may be substituted for the initial requirement. Subsequent CHANNEL CALIBRATIONS will be performed using sources that have been related to the initial calibration in order to ensure that each detector is still operational, but the sources need not span the full ranges used in the initial CHANNEL CALIBRATION.

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Regulatory Guide 1.21 requires continuous sampling of iodine and particulate in gaseous effluents and subsequent analysis at least weekly. However, a short downtime period of the sample devices is necessary to accomplish applicable ODCM test requirements, sample analysis, or system purging. This time will be accounted for in sample volume calculations. As such, 45 minutes is provided to initiate the auxiliary sampling system or restore the normal sampling devices to OPERABLE status.

Reference ODCMS 7.3.0.5 and B 7.3.0.5 for the performance of post maintenance testing.

Upon identification of a loss of radioactive gaseous effluent monitoring instrumentation, steps shall be taken immediately to install auxiliary sampling. If this cannot be accomplished, releases via the associated effluent pathway shall be secured. Any monitor downtime will be accounted for in sample volume calculations.

The ODCMS are modified by a note to indicate that the annunciator function may be removed from operation for performance of trouble shooting for up to 30 minutes provided the associated function maintains monitoring capability. Upon completion of the troubleshooting, or expiration of the 30 minute allowance, the annunciator must be returned to operation or the applicable condition entered and Required Compensatory Measures taken. Appropriate compensatory actions should be determined and implemented during the loss of annunciator function. Since the 1/2-CAC-AT-1264 alarm is used as an EAL entry condition, removal of the 1/2-CAC-AT-1264 annunciator for 30 minutes for troubleshooting is prohibited when there are any fuel handling activities on the refuel floor or activities where there is the potential to cause a decrease in spent fuel pool water level. This Note is based on the availability of the associated monitor and appropriate compensatory actions to identify changes in the gaseous effluent for the monitored location. The monitor availability and compensatory actions ensure that the 30 minute troubleshooting allowance does not significantly reduce the probability of identifying the hanging radiological conditions to allow appropriate response.

B 7.3.3 CONCENTRATION—LIQUID EFFLUENTS

BASES

This specification is provided to ensure that the concentration of radioactive materials released in liquid waste effluents to UNRESTRICTED AREAS after dilution in the discharge canal will be less than or equal to 10 times the concentration levels specified in 10 CFR Part 20, Appendix B, Table 2, Column 2 to 10 CFR 20.1001-20.2401 for radionuclides other than dissolved and entrained noble gases. This limitation provides additional assurance that the levels of radioactive materials in bodies of water in UNRESTRICTED AREAS will not 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 20.1302(b)(2)(i) 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 Manuals, 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).

Note that for batch releases, recirculation of at least two tank volumes shall be considered adequate for thorough mixing.

The service water liquid release represents a potential release pathway and not an actual release pathway. Test of this pathway is intended to alert the plant to a potential problem; analysis for principal gamma emitters is sufficient to meet this intent. If analysis for principal gamma emitters indicates a problem (i.e., exceeds the trigger level of 5×10^{-6} μCi/ml), then complete sampling and analyses shall be performed as per Table 7.3.3-2. The trigger level of 5×10^{-6} μCi/ml was chosen as being sufficient to provide reasonable assurance of accountability of all nuclides released based upon lower limits of detection and expected concentrations.

B 7.3.4 DOSE—LIQUID EFFLUENTS

BASES

This specification is provided to implement the requirements of Sections II.A, III.A, and IV.A of Appendix I, 10 CFR Part 50. ODCMS 7.3.4 implements the guides set forth in Section II.A of Appendix I. The COMPENSATORY MEASURES provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I of 10 CFR Part 50 to assure that releases of radioactive material in liquid effluents to UNRESTRICTED AREAS 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 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 will be 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.

The dose or dose commitment to a MEMBER OF THE PUBLIC is based on the 10 CFR Part 50, Appendix I, guideline of:

a. 1.5 mrem to the total body and 5.0 mrem to any organ during any calendar quarter, and

b. 3 mrem to the total body and 10 mrem to any organ during any calendar year,

from radioactive material in liquid effluents from each reactor unit to UNRESTRICTED AREAS. This specification is written for a two unit site.

B 7.3.5 LIQUID RADWASTE TREATMENT SYSTEM

BASES

The requirement that 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 reasonably achievable.” This specification implements the requirements of 10 CFR Part 50.36a, General Design Criteria 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 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.

Mechanical filtration as per system design is considered to be an appropriate component of the Liquid Radwaste Treatment System.

The requirements of 0.12 mrem total body or 0.4 mrem to any organ in a 31-day period is based on two reactor units having a shared Liquid Radwaste Treatment System.

B 7.3.6 LIQUID HOLDUP TANKS

BASES

The tanks listed in this specification include all those outdoor tanks that are not surrounded by liners, dikes, or walls capable of holding the tank contents and do not have tank overflows and surrounding area drains connected to the Liquid Radwaste Treatment System.

Since the condensate storage tanks have continuous influent and effluent, stratification should not occur. Samples taken from the operating condensate transfer pump(s) vent or drain shall be deemed representative of this system.

Appropriate alternatives to the COMPENSATORY MEASURES and TEST REQUIREMENTS are acceptable if they provide reasonable assurance that in the event of an uncontrolled release of the tank's content, the resulting concentrations would be less than 10 times the concentration values in Appendix B, Table 2, Column 2 to 10 CFR 20.1001-20.2401 at the nearest potable water supply and the nearest surface water supply in an UNRESTRICTED AREA.

B 7.3.7 DOSE RATE—GASEOUS EFFLUENTS

BASES

This specification provides reasonable assurance that radioactive material discharged in gaseous effluents will not result in the exposure of a Member of the Public in an Unrestricted Area, either at or beyond the Site Boundary in excess of the design objectives of Appendix I to 10 CFR part 50. This specification is provided to ensure that gaseous effluents from all units on the site will be appropriately controlled. It provides operational flexibility for releasing gaseous effluents to satisfy the Section II.A and II.C design objectives of Appendix I to 10 CFR part 50.

For MEMBERS OF THE PUBLIC who may at times be within the SITE BOUNDARY, the occupancy of that MEMBER OF THE PUBLIC will be sufficiently low to compensate for any increase in the atmospheric diffusion factor above that for the SITE BOUNDARY. 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 total 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. This specification does not affect the requirements to comply with the annual limitations of 10 CFR 20.1301.

This specification applies to the release of gaseous effluents from all reactors at the site.

With regard to footnotes (c) and (g) of Table 7.3.7-1:

1. The sampling is only required following transients when the primary coolant DEI **and** the applicable noble gas monitor increase by a factor of 3.
2. To determine whether the Dose Equivalent I-131 concentration in the primary coolant has increased by more than a factor of 3, the iodine-131 analysis performed after the transient will be compared to the most recent routine analysis for Dose Equivalent I-131 concentration performed before the transient.
3. To determine whether the effluent noble gas monitor has increased by more than a factor of 3, the activity indicated on the monitor's chart recorder after the transient will be compared to the activity indicated on the recorder just before the transient occurred.
4. The intent of footnote (c) is to determine the impact of the transient on the isotopic mix release for the applicable effluent pathway.
5. Sampling described in footnote (g) shall be performed on the applicable effluent pathways. For example, a Unit 1 transient could potentially result in sampling the Stack, Unit 1 Reactor Vent, and the Unit 1 Turbine Building Vent. Each of these pathways should be included in the evaluation. Actual sampling will only be performed on the path or pathways that meet the factor of 3 increase criteria.
6. The intent of the sampling is to evaluate the impact on particulate and iodine releases during the transient. The sampling can be exited when both entry conditions (DEI and noble gas monitor) have returned to steady-state levels below a factor of 3 change or after 7 days, whichever condition comes first.

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).

B 7.3.8 DOSE —NOBLE GASES

BASES

This specification is provided to implement the requirements of Sections II.B, III.A, and IV.A of Appendix I, 10 CFR Part 50. ODCMS 7.3.8 implements the guides set forth in Section II.B of Appendix I. The COMPENSATORY MEASURES 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 TEST REQUIREMENTS implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I is to be shown by calculational procedures based on models and data such that the actual exposure of a MEMBER OF THE PUBLIC through the appropriate pathways is unlikely to be substantially underestimated. The dose calculations established in the ODCM for calculating the doses due to the actual release rates of radioactive noble gases in gaseous effluents will be 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 will be based upon the historical annual average atmospheric conditions. NUREG-0133 provides methods for dose calculations consistent with Regulatory Guides 1.109 and 1.111. The limits of this specification are twice the 10 CFR 50 Appendix I per reactor guidelines because they are written for a two unit site.

B 7.3.9 DOSE - IODINE-131, IODINE-133, TRITIUM, AND RADIONUCLIDES IN PARTICULATE FORM

BASES

This specification is provided to implement the requirements of Section II.C, III.A, and IV.A of Appendix I, 10 CFR Part 50. ODCMS 7.3.9 implements the guides set forth in Section II.C of Appendix I. The COMPENSATORY MEASURES provide 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 in gaseous effluents to UNRESTRICTED AREAS will be kept “as low as is reasonably achievable.” The ODCM calculational methods specified in the TEST REQUIREMENTS implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data such that the actual exposure of a MEMBER OF THE PUBLIC through appropriate pathways is unlikely to be substantially underestimated. The ODCM calculational methods for calculating the doses due to the actual release rates of the subject materials are required to 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,” Revision 1, July 1977. These equations also provide for determining the actual doses based upon the historical average atmospheric conditions. The release rate specification for iodine-131, iodine-133, tritium, and radioactive material in particulate form with half-lives greater than 8 days are dependent on the existing radionuclide pathways to man in the areas at and beyond the SITE BOUNDARY. The pathways which are examined in the development of these calculations are: (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. The limits of this specification are twice the 10 CFR 50 Appendix I per reactor guidelines because they are written for a two unit site.

B 7.3.10 GASEOUS RADWASTE TREATMENT SYSTEM

BASES

This requirement 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 GASEOUS RADWASTE TREATMENT SYSTEM refers to the 30-minute offgas holdup line, stack filter house filtration, and the Augmented Off-Gas-Treatment System.

B 7.3.11 VENTILATION EXHAUST TREATMENT SYSTEM

BASES

This requirement 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 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. At the Brunswick Steam Electric Plant, the only VENTILATION EXHAUST TREATMENT SYSTEMS shall be those installed for the Turbine Buildings’ ventilation.

B 7.3.12 EXPLOSIVE GAS MIXTURE

BASES

This specification is provided to ensure that the concentration of potentially explosive gas mixtures contained in the waste gas treatment system is maintained below the flammability limits of hydrogen. Maintaining the concentration of hydrogen below the 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.

B 7.3.13 DRYWELL VENTING or PURGING

BASES

This specification provides reasonable assurance that releases from drywell VENTING or PURGING operations will not exceed the annual dose limits of 10 CFR Part 20 for UNRESTRICTED AREAS.

B 7.3.14 TOTAL DOSE (40 CFR PART 190)

BASES

This specification is provided to meet the dose limitations of 40 CFR Part 190 that have now 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. For sites containing up to 4 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 the reporting requirement level. 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 ODCMSs 7.3.3 through 7.3.14. 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.

B 7.3.15 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

BASES

The radiological environmental monitoring program required by this specification provides 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 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 are not higher than expected on the basis of effluent measurements and the modeling of the environmental exposure pathways.

The required detection capabilities for environmental sample analyses are tabulated in terms of the Lower Limits of Detection (LLDs). The LLDs required by Table 7.3.15-3 are considered optimum for routine environmental measurements in industrial laboratories. 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 a posteriori (after the fact) limit for a particular measurement.

Detailed discussion of the LLD and other detection limits can be found in HASL Procedure 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, L. K., “Detection Limits for Radioanalytical Counting Techniques,” Atlantic Richfield Hanford Company Report ARH-SA-215 (June 1975).

Groundwater is not monitored by this specification because plant liquid effluents are not tapped as a source for drinking or irrigation purposes.

In the absence of the availability of leafy vegetables intended for human consumption, sampling of indigenous broadleaf vegetation may be performed since the objective of sampling broadleaf vegetation (i.e., to approximate fallout from plant operation) is satisfied in either case.

B 7.3.16 LAND USE CENSUS

BASES

This specification is provided to ensure that changes in the use of the area at and beyond the SITE BOUNDARY are identified and that modifications to the radiological environmental monitoring program are made, if required, as a result of the census. The best information from door-to-door surveys, aerial surveys, or 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/yr) of leafy vegetables assumed in Regulatory Guide 1.109 for consumption by a child. To determine the minimum garden size, the following assumptions were made: (1) 20% of the garden was used for growing broadleaf vegetation (i.e., similar to lettuce and cabbage; and (2) a vegetation yield of 2 kg/m^2.

B 7.3.17 INTERLABORATORY COMPARISON PROGRAM

BASES

The requirement for participation in the 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 reasonably valid for the purposes of Section IV.B.2 of Appendix I to 10 CFR Part 50.

LIST OF TABLES

APPENDIX A

METEOROLOGICAL DISPERSION FACTOR COMPUTATIONS

Carolina Power & Light Company (CP&L) engaged the services of Dames and 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 depositions 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 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.

In 2005, Murray and Trettel utilized a five-year record of meteorological data from the on-site meteorological program at the Brunswick Steam Electric Plant. This data consisted of all collected parameters at both the 10-meter and 103-meter tower levels for the years 2000 through 2004.

Tables A-1 through A-3	Relative undepleted concentration, relative depleted concentration, and relative deposition flux estimates for ground-level release for standard distances.
Tables A-4 through A-6	Relative undepleted concentration, relative depleted concentration, and relative deposition flux estimates for mixed-mode release for standard distances.

Tables A-7 through A-9	Relative undepleted concentration, relative depleted concentration, and relative deposition flux estimates for elevated release for standard distances.

Operation Computations

The NRC "XOQDOQ" Program (Revision 1) was obtained and installed on the CP&L computer system. 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 input to "XOQDOQ" for ground-level releases are presented in Table A-10 and for elevated releases in Table A-11. The resulting computations will have applied the TCFs to produce a final atmospheric diffusion estimate for the site.

In general, it is 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.

Reference

Chandler, Martin W. and George Hoopes, Revised Radiological Effluent Technical Specifications: Gaseous Effluent Dilution Factors, Prepared for Carolina Power & Light Company, Brunswick Facility, Dames and Moore, January 18, 1979.

TABLE A-1

χ/Q Values at the Standard Distances for Releases from the Turbine Buildings

Progress Energy – Brunswick
Release Type: Annual
Release Mode: Ground Level
Variable: Relative Concentration (Sec./Cubic Meter)
Calculation Points: Standard
Model: Straight Line Gaussian Diffusion
Period: 2000-2004
Number of Observations: 43598

Base Distance in Miles

Aftd Sect	Design Dist Mi	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.50	3.00	3.50	4.00	4.50	4.75
NNE	0.	1.0E-05	3.2E-06	1.7E-06	1.1E-06	7.9E-07	6.0E-07	4.9E-07	4.1E-07	3.0E-07	2.3E-07	1.9E-07	1.6E-07	1.3E-07	1.2E-07
NE	0.	2.6E-05	8.2E-06	4.3E-06	2.8E-06	2.0E-06	1.5E-06	1.2E-06	1.0E-06	7.6E-07	6.0E-07	4.8E-07	4.0E-07	3.4E-07	3.2E-07
ENE	0.	4.0E-05	1.2E-05	6.0E-06	3.9E-06	2.8E-06	2.2E-06	1.8E-06	1.5E-06	1.1E-06	9.0E-07	7.4E-07	6.2E-07	5.3E-07	5.0E-07
E	0.	4.1E-05	1.2E-05	6.0E-06	3.9E-06	2.8E-06	2.1E-06	1.8E-06	1.5E-06	1.1E-06	9.0E-07	7.4E-07	6.2E-07	5.4E-07	5.0E-07
ESE	0.	4.3E-05	1.3E-05	6.3E-06	4.0E-06	2.9E-06	2.2E-06	1.8E-06	1.6E-06	1.2E-06	9.4E-07	7.7E-07	6.5E-07	5.7E-07	5.3E-07
SE	0.	6.1E-05	1.8E-05	8.9E-06	5.7E-06	4.1E-06	3.1E-06	2.6E-06	2.2E-06	1.7E-06	1.3E-06	1.1E-06	9.2E-07	8.0E-07	7.5E-07
SSE	0.	1.2E-04	3.1E-05	1.5E-05	9.6E-06	6.9E-06	5.2E-06	4.3E-06	3.7E-06	2.8E-06	2.2E-06	1.9E-06	1.6E-06	1.4E-06	1.3E-07
S	0.	6.3E-05	1.9E-05	9.4E-06	6.1E-06	4.4E-06	3.4E-06	2.8E-06	2.4E-06	1.8E-06	1.4E-06	1.2E-06	9.7E-07	8.4E-07	7.8E-07
SSW	0.	2.8E-05	8.6E-06	4.4E-06	2.9E-06	2.1E-06	1.6E-06	1.3E-06	1.1E-06	8.1E-07	6.4E-07	5.2E-07	4.4E-07	3.8E-07	3.5E-07
SW	0.	1.7E-05	5.4E-06	2.8E-06	1.8E-06	1.3E-06	1.0E-06	8.2E-07	6.8E-07	5.1E-07	4.0E-07	3.2E-07	2.7E-07	2.3E-07	2.2E-07
WSW	0.	1.1E-05	3.5E-06	1.9E-06	1.2E-06	8.9E-07	6.9E-07	5.5E-07	4.6E-07	3.4E-07	2.6E-07	2.1E-07	1.8E-07	1.5E-07	1.4E-07
W	0.	7.9E-06	2.5E-06	1.3E-06	8.8E-07	6.4E-07	4.9E-07	3.9E-07	3.3E-07	2.4E-07	1.9E-07	1.5E-07	1.2E-07	1.1E-07	9.8E-08
WNW	0.	7.4E-06	2.3E-06	1.2E-06	8.0E-07	5.8E-07	4.5E-07	3.6E-07	3.0E-07	2.2E-07	1.7E-07	1.4E-07	1.2E-07	9.9E-08	9.2E-08
NW	0.	7.6E-06	2.4E-06	1.3E-06	8.3E-07	6.0E-07	4.6E-07	3.7E-07	3.1E-07	2.3E-07	1.8E-07	1.4E-07	1.2E-07	1.0E-07	9.4E-08
NNW	0.	1.0E-05	3.2E-06	1.7E-06	1.1E-06	8.1E-07	6.2E-07	5.0E-07	4.2E-07	3.1E-07	2.4E-07	2.0E-07	1.6E-07	1.4E-07	1.3E-07
N	0.	8.6E-06	2.7E-06	1.5E-06	9.7E-07	7.1E-07	5.4E-07	4.4E-07	3.7E-07	2.7E-07	2.1E-07	1.7E-07	1.4E-07	1.2E-07	1.1E-07

TABLE A-2

Depleted χ/Q Values at the Standard Distances for Releases from the Turbine Buildings

Progress Energy – Brunswick
Release Type: Annual
Release Mode: Ground Level
Variable: Relative Concentration (Sec./Cubic Meter)
Calculation Points: Standard
Model: Straight Line Gaussian Diffusion
Period: 2000 - 2004 Number of Observations: 43598

Base Distance in Miles

Aftd Sect	Design Dist Mi	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.50	3.00	3.50	4.00	4.50	4.75
NNE	0.	9.6E-06	2.9E-06	1.5E-06	9.5E-07	6.7E-07	5.1E-07	4.0E-07	3.3E-07	2.4E-07	1.8E-07	1.4E-07	1.2E-07	9.9E-08	9.1E-08
NE	0.	2.4E-05	7.5E-06	3.8E-06	2.4E-06	1.7E-06	1.3E-06	1.0E-06	8.5E-07	6.1E-07	4.7E-07	3.7E-07	3.0E-07	2.5E-07	2.3E-07
ENE	0.	3.8E-05	1.1E-05	5.3E-06	3.4E-06	2.4E-06	1.8E-06	1.5E-06	1.2E-06	9.0E-07	7.0E-07	5.6E-07	4.6E-07	3.9E-07	3.6E-07
E	0.	3.9E-05	1.1E-05	5.3E-06	3.4E-06	2.4E-06	1.8E-06	1.4E-06	1.2E-06	8.9E-07	6.9E-07	5.6E-07	4.6E-07	3.9E-07	3.6E-07
ESE	0.	4.1E-05	1.2E-05	5.6E-06	3.5E-06	2.5E-06	1.9E-06	1.5E-06	1.3E-06	9.3E-07	7.3E-07	5.9E-07	4.9E-07	4.1E-07	3.8E-07
SE	0.	5.8E-05	1.6E-05	7.9E-06	4.9E-06	3.5E-06	2.6E-06	2.1E-06	1.8E-06	1.3E-06	1.0E-06	8.2E-07	6.9E-07	5.8E-07	5.4E-07
SSE	0.	1.0E-04	2.8E-05	1.3E-05	8.3E-06	5.8E-06	4.4E-06	3.6E-06	3.0E-06	2.2E-06	1.7E-06	1.4E-06	1.2E-06	9.9E-07	9.2E-07
S	0.	6.0E-05	1.7E-05	8.3E-06	5.3E-06	3.8E-06	2.9E-06	2.3E-06	1.9E-06	1.4E-06	1.1E-06	8.8E-07	7.3E-07	6.1E-07	5.7E-07
SSW	0.	2.7E-05	7.9E-06	3.9E-06	2.5E-06	1.8E-06	1.3E-06	1.1E-06	8.9E-07	6.5E-07	5.0E-07	4.0E-07	3.3E-07	2.8E-07	2.5E-07
SW	0.	1.6E-05	4.9E-06	2.5E-06	1.6E-06	1.1E-06	8.5E-07	6.8E-07	5.6E-07	4.0E-07	3.0E-07	2.5E-07	2.0E-07	1.7E-07	1.6E-07
WSW	0.	1.1E-05	3.2E-06	1.7E-06	1.1E-06	7.6E-07	5.8E-07	4.6E-07	3.8E-07	2.7E-07	2.1E-07	1.6E-07	1.3E-07	1.1E-07	1.0E-07
W	0.	7.4E-06	2.3E-06	1.2E-06	7.6E-07	5.4E-07	4.1E-07	3.3E-07	2.7E-07	1.9E-07	1.4E-07	1.1E-07	9.4E-08	7.8E-08	7.2E-08
WNW	0.	7.0E-06	2.1E-06	1.1E-06	7.0E-07	5.0E-07	3.8E-07	3.0E-07	2.5E-07	1.8E-07	1.3E-07	1.1E-07	8.7E-08	7.3E-08	6.7E-08
NW	0.	7.1E-06	2.2E-06	1.1E-06	7.2E-07	5.2E-07	3.9E-07	3.1E-07	2.5E-07	1.8E-07	1.4E-07	1.1E-07	8.9E-08	7.5E-08	6.9E-08
NNW	0.	9.6E-06	2.9E-06	1.5E-06	9.7E-07	6.9E-07	5.2E-07	4.2E-07	3.4E-07	2.5E-07	1.9E-07	1.5E-07	1.2E-07	1.0E-07	9.5E-08
N	0.	8.1E-06	2.5E-06	1.3E-06	8.4E-07	6.0E-07	4.6E-07	3.6E-07	3.0E-07	2.1E-07	1.6E-07	1.3E-07	1.1E-07	8.8E-08	8.1E-08

TABLE A-3
D/Q Values at the Standard Distances for Releases from the Turbine Buildings

Progress Energy – Brunswick
Release Type: Annual
Release Mode: Ground Level
Variable: Relative Deposition (Meter**-2)
Calculation Points: Standard
Model: Straight Line Gaussian Diffusion
Period: 2000-2004
Number of Observations: 43598

Base Distance in Miles

Aftd Sect	Design Dist Mi	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.50	3.00	3.50	4.00	4.50	4.75
NNE	0.	4.1E-08	1.4E-08	7.2E-09	4.4E-09	3.0E-09	2.2E-09	1.7E-09	1.3E-09	9.0E-10	6.5E-10	5.0E-10	3.9E-10	3.2E-10	2.9E-10
NE	0.	1.0E-07	3.5E-08	1.8E-08	1.1E-08	7.5E-09	5.5E-09	4.2E-09	3.3E-09	2.3E-09	1.6E-09	1.2E-09	9.8E-10	7.9E-10	7.2E-10
ENE	0.	4.4E-08	1.5E-08	7.6E-09	4.7E-09	3.2E-09	2.3E-09	1.8E-09	1.4E-09	9.6E-10	6.9E-10	5.3E-10	4.1E-10	3.4E-10	3.0E-10
E	0.	2.5E-08	8.3E-09	4.3E-09	2.6E-09	1.8E-09	1.3E-09	1.0E-09	7.9E-10	5.4E-10	3.9E-10	3.0E-10	2.3E-10	1.9E-10	1.7E-10
ESE	0.	2.6E-08	8.7E-09	4.5E-09	2.8E-09	1.9E-09	1.4E-09	1.0E-09	8.3E-10	5.6E-10	4.1E-10	3.1E-10	2.4.E-10	2.0E-10	1.8E-10
SE	0.	3.6E-08	1.2E-08	6.3E-09	3.9E-09	2.6E-09	1.9E-09	1.5E-09	1.2E-09	7.9E-10	5.7E-10	4.3E-10	3.4E-10	2.8E-10	2.5E-10
SSE	0.	5.0E-08	1.7E-08	8.6E-09	5.3E-09	3.6E-09	2.6E-09	2.0E-09	1.6E-09	1.1E-09	7.8E-10	5.9E-10	4.7E-10	3.8E-10	3.4E-10
S	0.	5.3E-08	1.8E-08	9.2E-09	5.6E-09	3.8E-09	2.8E-09	2.1E-09	1.7E-09	1.1E-09	8.3E-10	6.3E-10	5.0E-10	4.0E-10	3.7E-10
SSW	0.	4.3E-08	1.5E-08	7.5E-09	4.6E-09	3.1E-09	2.3E-09	1.8E-09	1.4E-09	9.4E-10	6.8E-10	5.2E-10	4.1E-10	3.3E-10	3.0E-10
SW	0.	4.1E-08	1.4E-08	7.1E-09	4.4E-09	3.0E-09	2.2E-09	1.7E-09	1.3E-09	8.9E-10	6.5E-10	4.9E-10	3.9E-10	3.1E-10	2.8E-10
WSW	0.	2.9E-08	9.8E-09	5.1E-09	3.1E-09	2.1E-09	1.5E-09	1.2E-09	9.4E-10	6.3E-10	4.6E-10	3.5E-10	2.8E-10	2.2E-10	2.0E-10
W	0.	1.8E-08	6.2E-09	3.2E-09	2.0E-09	1.3E-09	9.7E-10	7.4E-10	5.9E-10	4.0E-10	2.9E-10	2.2E-10	1.7E-10	1.4E-10	1.3E-10
WNW	0.	1.5E-08	4.9E-09	2.5E-09	1.6E-09	1.1E-09	7.7E-10	5.9E-10	4.7E-10	3.2E-10	2.3E-10	1.7E-10	1.4E-10	1.1E-10	1.0E-10
NW	0.	1.6E-08	5.2E-09	2.7E-09	1.7E-09	1.1E-09	8.2E-10	6.3E-10	5.0E-10	3.4E-10	2.4E-10	1.9E-10	1.5E-10	1.2E-10	1.1E-10
NNW	0.	1.7E-08	5.9E-09	3.0E-09	1.9E-09	1.3E-09	9.2E-10	7.0E-10	5.6E-10	3.8E-10	2.7E-10	2.1E-10	1.6E-10	1.3E-10	1.2E-10
N	0.	2.3E-08	7.7E-09	3.9E-09	2.4E-09	1.7E-09	1.2E-09	9.2E-10	7.3E-10	4.9E-10	3.6E-10	2.7E-10	2.1E-10	1.7E-10	1.6E-10

TABLE A-4

χ/Q Values at the Standard Distances for Releases from the Reactor Buildings

Progress Energy – Brunswick
Release Type: Annual
Release Mode: Mixed Mode
Variable: Relative Concentration (Sec./Cubic Meter)
Calculation Points: Standard
Model: Straight Line Gaussian Diffusion
Period: 2000-2004
Number of Observations: 43598

Base Distance in Miles

Aftd Sect	Design Dist Mi	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.50	3.00	3.50	4.00	4.50	4.75
NNE	0.	4.9E-06	1.7E-06	9.0E-07	6.0E-07	4.4E-07	3.4E-07	2.8E-07	2.3E-07	1.7E-07	1.4E-07	1.1E-07	9.3E-08	8.0E-08	7.5E-08
NE	0.	1.3E-05	4.3E-06	2.3E-06	1.6E-06	1.1E-06	8.8E-07	7.1E-07	6.0E-07	4.5E-07	3.5E-07	2.9E-07	2.4E-07	2.1E-07	1.9E-07
ENE	0.	1.1E-05	3.5E-06	1.9E-06	1.3E-06	9.6E-07	7.6E-07	6.4E-07	5.5E-07	4.3E-07	3.5E-07	3.0E-07	2.6E-07	2.3E-07	2.2E-07
E	0.	7.8E-06	2.5E-06	1.3E-06	9.0E-07	6.8E-07	5.5E-07	4.5E-07	4.0E-07	3.2E-07	2.7E-07	2.3E-07	2.0E-07	1.8E-07	1.7E-07
ESE	0.	7.8E-06	2.5E-06	1.3E-06	8.8E-07	6.6E-07	5.3E-07	4.4E-07	3.9E-07	3.1E-07	2.6E-07	2.2E-07	1.9E-07	1.7E-07	1.7E-07
SE	0.	1.1E-05	3.4E-06	1.8E-06	1.2E-06	8.9E-07	7.1E-07	6.0E-07	5.2E-07	4.2E-07	3.5E-07	3.0E-07	2.7E-07	2.4E-07	2.3E-07
SSE	0.	1.6E-05	4.8E-06	2.5E-06	1.6E-06	1.2E-06	9.8E-07	8.3E-07	7.2E-07	5.9E-07	5.0E-07	4.3E-07	3.9E-07	3.5E-07	3.4E-07
S	0.	1.4E-05	4.6E-06	2.5E-06	1.7E-06	1.3E-06	1.0E-06	8.6E-07	7.4E-07	5.9E-07	4.9E-07	4.2E-07	3.6E-07	3.2E-07	3.1E-07
SSW	0.	8.9E-06	3.0E-06	1.6E-06	1.1E-06	8.2E-07	6.5E-07	5.3E-07	4.5E-07	3.5E-07	2.8E-07	2.4E-07	2.0E-07	1.8E-07	1.7E-07
SW	0.	6.7E-06	2.3E-06	1.2E-06	8.3E-07	6.1E-07	4.8E-07	3.9E-07	3.3E-07	2.5E-07	2.0E-07	1.7E-07	1.4E-07	1.2E-07	1.2E-07
WSW	0.	5.2E-06	1.7E-06	9.8E-07	6.5E-07	4.8E-07	3.8E-07	3.1E-07	2.7E-07	2.0E-07	1.6E-07	1.3E-07	1.1E-07	9.7E-08	9.1E-08
W	0.	3.6E-06	1.2E-06	6.7E-07	4.6E-07	3.5E-07	2.7E-07	2.3E-07	1.9E-07	1.5E-07	1.2E-07	9.6E-08	8.1E-08	7.0E-08	6.6E-08
WNW	0.	3.1E-06	1.0E-06	5.8E-07	3.9E-07	2.9E-07	2.3E-07	1.9E-07	1.6E-07	1.2E-07	1.0E-07	8.2E-08	7.0E-08	6.1E-08	5.7E-08
NW	0.	3.4E-06	1.1E-06	6.3E-07	4.3E-07	3.2E-07	2.5E-07	2.1E-07	1.8E-07	1.3E-07	1.1E-07	8.8E-08	7.5E-08	6.4E-08	6.0E-08
NNW	0.	4.1E-06	1.4E-06	7.8E-07	5.3E-07	4.0E-07	3.2E-07	2.6E-07	2.3E-07	1.7E-07	1.4E-07	1.2E-07	9.8E-08	8.5E-08	8.0E-08
N	0.	4.2E-06	1.4E-06	7.9E-07	5.4E-07	4.0E-07	3.2E-07	2.6E-07	2.2E-07	1.7E-07	1.4E-07	1.1E-07	9.5E-08	8.2E-08	7.7E-08

TABLE A-5

Depleted x/Q Values at the Standard Distances for Releases from the Reactor Buildings

Progress Energy – Brunswick
Release Type: Annual
Release Mode: Mixed Mode
Variable: Relative Depleted Concentration (Sec./Cubic Meter)
Calculation Points: Standard
Model: Straight Line Gaussian Diffusion
Period: 2000-2004
Number of Observations: 43598

Base Distance in Miles

Aftd Sect	Design Dist Mi	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.50	3.00	3.50	4.00	4.50	4.75
NNE	0.	4.6E-06	1.5E-06	8.1E-07	5.3E-07	3.8E-07	2.9E-07	2.3E-07	1.9E-07	1.4E-07	1.1E-07	9.0E-08	7.5E-08	6.4E-08	6.0E-08
NE	0.	1.2E-05	3.9E-06	2.1E-06	1.4E-06	9.8E-07	7.6E-07	6.1E-07	5.0E-07	3.7E-07	2.9E-07	2.3E-07	1.9E-07	1.7E-07	1.5E-07
ENE	0.	1.0E-05	3.2E-06	1.7E-06	1.1E-06	8.3E-07	6.6E-07	5.5E-07	4.7E-07	3.6E-07	3.0E-07	2.5E-07	2.2E-07	1.9E-07	1.8E-07
E	0.	7.4E-06	2.2E-06	1.2E-06	7.9E-07	5.9E-07	4.7E-07	4.0E-07	3.5E-07	2.7E-07	2.3E-07	1.9E-07	1.7E-07	1.5E-07	1.4E-07
ESE	0.	7.4E-06	2.2E-06	1.2E-06	7.7E-07	5.8E-07	4.6E-07	3.8E-07	3.3E-07	2.6E-07	2.2E-07	1.8E-07	1.6E-07	1.4E-07	1.4E-07
SE	0.	1.0E-05	3.1E-06	1.6E-06	1.0E-06	7.7E-07	6.1E-07	5.1E-07	4.4E-07	3.5E-07	2.9E-07	2.5E-07	2.2E-07	2.0E-07	1.9E-07
SSE	0.	1.5E-05	4.4E-06	2.2E-06	1.4E-06	1.1E-06	8.4E-07	7.1E-07	6.2E-07	5.0E-07	4.2E-07	3.7E-07	3.3E-07	3.0E-07	2.8E-07
S	0.	1.4E-05	4.2E-06	2.2E-06	1.5E-06	1.1E-06	8.8E-07	7.4E-07	6.3E-07	5.0E-07	4.1E-07	3.5E-07	3.0E-07	2.7E-07	2.6E-07
SSW	0.	8.4E-06	2.7E-06	1.5E-06	9.6E-07	7.1E-07	5.6E-07	4.6E-07	3.9E-07	2.9E-07	2.3E-07	1.9E-07	1.7E-07	1.4E-07	1.4E-07
SW	0.	6.4E-06	2.1E-06	1.1E-06	7.3E-07	5.3E-07	4.1E-07	3.4E-07	2.8E-07	2.1E-07	1.7E-07	1.4E-07	1.2E-07	1.0E-07	9.3E-08
WSW	0.	4.9E-06	1.6E-06	8.5E-07	5.7E-07	4.2E-07	3.3E-07	2.7E-07	2.3E-07	1.7E-07	1.3E-07	1.1E-07	9.2E-08	7.9E-08	7.4E-08
W	0.	3.4E-06	1.1E-06	6.0E-07	4.1E-07	3.0E-07	2.4E-07	1.9E-07	1.6E-07	1.2E-07	9.8E-08	8.0E-08	6.7E-08	5.8E-08	5.4E-08
WNW	0.	2.9E-06	9.5E-06	5.2E-07	3.5E-07	2.6E-07	2.0E-07	1.7E-07	1.4E-07	1.1E-07	8.3E-08	6.9E-08	5.8E-08	5.0E-08	4.6E-08
NW	0.	3.2E-06	1.0E-06	5.6E-07	3.8E-07	2.8E-07	2.2E-07	1.8E-07	1.5E-07	1.1E-07	8.9E-08	7.3E-08	6.1E-08	5.3E-08	4.9E-08
NNW	0.	3.9E-06	1.2E-06	6.9E-07	4.7E-07	3.5E-07	2.8E-07	2.3E-07	1.9E-07	1.5E-07	1.2E-07	9.6E-08	8.1E-08	7.0E-08	6.5E-08
N	0.	4.0E-06	1.3E-06	7.1E-07	4.7E-07	3.5E-07	2.8E-07	2.3E-07	1.9E-07	1.4E-07	1.1E-07	9.2E-08	7.8E-08	6.7E-08	6.2E-08

TABLE A-6

D/Q Values at the Standard Distances for Releases from the Reactor Buildings

Progress Energy– Brunswick
Release Type: Annual
Release Mode: Mixed Mode
Variable: Relative Deposition (Meter**-2)
Calculation Points: Standard
Model: Straight Line Gaussian Diffusion
Period: 2000-2004
Number of Observations: 43598

Base Distance in Miles

Aftd Sect	Design Dist Mi	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.50	3.00	3.50	4.00	4.50	4.75
NNE	0.	4.0E-08	1.4E-08	7.0E-09	4.3E-09	2.9E-09	2.1E-09	1.6E-09	1.3E-09	8.8E-10	6.4E-10	4.8E-10	3.8E-10	3.1E-10	2.8E-10
NE	0.	1.0E-07	3.4E-08	1.7E-08	1.1E-08	7.3E-09	5.3E-09	4.1E-09	3.2E-09	2.2E-09	1.6E-09	1.2E-09	9.5E-10	7.7E-10	7.0E-10
ENE	0.	3.8E-08	1.3E-08	6.5E-09	4.0E-09	2.8E-09	2.0E-09	1.5E-09	1.2E-09	8.2E-10	6.0E-10	4.5E-10	3.6E-10	2.9E-10	2.6E-10
E	0.	1.8E-08	6.1E-09	3.1E-09	1.9E-09	1.3E-09	9.6E-09	7.4E-10	5.9E-10	4.0E-10	2.9E-10	2.2E-10	1.7E-10	1.4E-10	1.3E-10
ESE	0.	1.9E-08	6.5E-09	3.3E-09	2.0E-09	1.4E-09	1.0E-09	7.8E-10	6.2E-10	4.2E-10	3.0E-10	2.3E-10	1.8E-10	1.5E-10	1.3E-10
SE	0.	2.7E-08	9.0E-09	4.7E-09	2.9E-09	2.0E-09	1.4E-09	1.1E-09	8.7E-10	5.9E-10	4.2E-10	3.2E-10	2.5E-10	2.1E-10	1.9E-10
SSE	0.	3.3E-08	1.1E-08	5.8E-09	3.6E-09	2.5E-09	1.8E-09	1.4E-09	1.1E-09	7.3E-10	5.3E-10	4.0E-10	3.2E-10	2.6E-10	2.3E-10
S	0.	4.3E-08	1.4E-08	7.4E-09	4.6E-09	3.1E-09	2.3E-09	1.7E-09	1.4E-09	9.3E-10	6.8E-10	5.1E-10	4.0E-10	3.3E-10	3.0E-10
SSW	0.	3.9E-08	1.3E-08	6.8E-09	4.2E-09	2.8E-09	2.1E-09	1.6E-09	1.3E-09	8.5E-10	6.2E-10	4.7E-10	3.7E-10	3.0E-10	2.7E-10
SW	0.	3.8E-08	1.3E-08	6.7E-09	4.1E-09	2.8E-09	2.1E-09	1.6E-09	1.2E-09	8.4E-10	6.1E-10	4.6E-10	3.7E-10	3.0E-10	2.7E-10
WSW	0.	2.7E-08	9.3E-09	4.8E-09	2.9E-09	2.0E-09	1.5E-09	1.1E-09	8.9E-10	6.0E-10	4.3E-10	3.3E-10	2.6E-10	2.1E-10	1.9E-10
W	0.	1.7E-08	5.7E-09	3.0E-09	1.8E-09	1.2E-09	9.1E-10	6.9E-10	5.5E-10	3.7E-10	2.7E-10	2.0E-10	1.6E-10	1.3E-10	1.2E-10
WNW	0.	1.3E-08	4.5E-09	2.3E-09	1.4E-09	9.7E-10	7.1E-10	5.4E-10	4.3E-10	2.9E-10	2.1E-10	1.6E-10	1.3E-10	1.0E-10	9.3E-11
NW	0.	1.4E-08	4.8E-09	2.5E-09	1.5E-09	1.0E-09	7.6E-10	5.8E-10	4.6E-10	3.1E-10	2.3E-10	1.7E-10	1.4E-10	1.1E-10	1.0E-10
NNW	0.	1.6E-08	5.3E-09	2.7E-09	1.7E-09	1.1E-09	8.3E-10	6.4E-10	5.1E-10	3.4E-10	2.5E-10	1.9E-10	1.5E-10	1.2E-10	1.1E-10
N	0.	2.1E-08	7.2E-09	3.7E-09	2.3E-09	1.6E-09	1.1E-09	8.7E-10	6.9E-10	4.7E-10	3.4E-10	2.6E-10	2.0E-10	1.6E-10	1.5E-10

TABLE A-7

χ/Q Values at the Standard Distances for Releases from the Stack

Progress Energy – Brunswick
Release Type: Annual
Release Mode: Elevated
Variable: Relative Concentration (Sec./Cubic Meter)
Calculation Points: Standard
Model: Straight Line Gaussian Diffusion
Period: 2000-2004
Number of Observations: 42768

Base Distance in Miles

Aftd Sect	Design Dist Mi	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.50	3.00	3.50	4.00	4.50	4.75
NNE	0.	1.1E-08	1.7E-08	1.9E-08	2.1E-08	2.3E-08	2.3E-08	2.3E-08	2.3E-08	2.1E-08	1.9E-08	1.7E-08	1.6E-08	1.4E-08	1.4E-08
NE	0.	4.1E-08	4.7E-08	4.6E-08	4.7E-08	4.8E-08	4.7E-08	4.6E-08	4.4E-08	3.9E-08	3.5E-08	3.1E-08	2.8E-08	2.5E-08	2.4E-08
ENE	0.	2.3E-08	2.9E-08	3.2E-08	3.7E-08	4.0E-08	4.2E-08	4.3E-08	4.2E-08	4.0E-08	3.6E-08	3.3E-08	3.0E-08	2.7E-08	2.6E-08
E	0.	3.0E-09	5.7E-09	8.4E-09	1.1E-08	1.3E-08	1.4E-08	1.5E-08	1.5E-08	1.5E-08	1.5E-08	1.4E-08	1.3E-08	1.2E-08	1.2E-08
ESE	0.	5.4E-09	8.0E-09	9.3E-09	1.0E-08	1.1E-08	1.1E-08	1.1E-08	1.1E-08	1.0E-08	9.7E-09	9.0E-09	8.3E-09	7.7E-09	7.4E-09
SE	0.	8.9E-09	9.8E-09	1.0E-08	1.1E-08	1.1E-08	1.2E-08	1.2E-08	1.2E-08	1.1E-08	1.0E-08	9.3E-09	8.6E-09	7.9E-09	7.6E-09
SSE	0.	1.7E-08	1.6E-08	1.5E-08	1.6E-08	1.6E-08	1.6E-08	1.6E-08	1.5E-08	1.4E-08	1.2E-08	1.1E-08	1.0E-08	9.2E-09	8.8E-09
S	0.	1.4E-08	1.4E-08	1.6E-08	1.8E-08	2.0E-08	2.1E-08	2.1E-08	2.0E-08	1.9E-08	1.7E-08	1.5E-08	1.4E-08	1.2E-08	1.2E-08
SSW	0.	8.2E-09	1.1E-08	1.5E-08	2.0E-08	2.4E-08	2.5E-08	2.6E-08	2.6E-08	2.4E-08	2.2E-08	2.0E-08	1.8E-08	1.6E-08	1.5E-08
SW	0.	6.5E-09	1.2E-08	1.6E-08	2.0E-08	2.3E-08	2.4E-08	2.5E-08	2.4E-08	2.3E-08	2.0E-08	1.8E-08	1.7E-08	1.5E-08	1.4E-08
WSW	0.	2.2E-08	2.4E-08	2.4E-08	2.5E-08	2.5E-08	2.5E-08	2.5E-08	2.4E-08	2.2E-08	2.0E-08	1.8E-08	1.6E-08	1.4E-08	1.4E-08
W	0.	2.2E-08	2.2E-08	1.9E-08	1.7E-08	1.7E-08	1.7E-08	1.6E-08	1.5E-08	1.4E-08	1.3E-08	1.2E-08	1.1E-08	9.8E-09	9.4E-09
WNW	0.	1.4E-08	1.6E-08	1.4E-08	1.3E-08	1.2E-08	1.2E-08	1.1E-08	1.1E-08	1.0E-08	9.2E-09	8.4E-09	7.7E-09	7.1E-09	6.8E-09
NW	0.	1.4E-08	1.5E-08	1.4E-08	1.3E-08	1.2E-08	1.2E-08	1.1E-08	1.1E-08	1.0E-08	9.1E-09	8.3E-09	7.5E-09	6.9E-09	6.6E-09
NNW	0.	1.2E-08	1.1E-08	1.0E-08	1.0E-08	1.0E-08	1.1E-08	1.1E-08	1.0E-08	9.9E-09	9.2E-09	8.5E-09	7.8E-09	7.2E-09	6.9E-09
N	0.	7.7E-09	8.9E-09	9.8E-09	1.1E-08	1.2E-08	1.2E-08	1.2E-08	1.2E-08	1.2E-08	1.1E-08	1.0E-08	9.6E-09	8.9E-09	8.6E-09

TABLE A-8

Depleted χ/Q Values at the Standard Distances for Releases from the Stack

Progress Energy – Brunswick
Release Type: Annual
Release Mode: Elevated
Variable: Relative Depleted Concentration (Sec./Cubic Meter)
Calculation Points: Standard
Model: Straight Line Gaussian Diffusion
Period: 2000-2004
Number of Observations: 42768

Base Distance in Miles

Aftd Sect	Design Dist Mi	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.50	3.00	3.50	4.00	4.50	4.75
NNE	0.	1.1E-08	1.7E-08	1.9E-08	2.1E-08	2.2E-08	2.3E-08	2.3E-08	2.2E-08	2.0E-08	1.8E-08	1.7E-08	1.5E-08	1.4E-08	1.3E-08
NE	0.	4.1E-08	4.7E-08	4.5E-08	4.6E-08	4.6E-08	4.6E-08	4.4E-08	4.2E-08	3.8E-08	3.3E-08	2.9E-08	2.6E-08	2.3E-08	2.2E-08
ENE	0.	2.3E-08	2.8E-08	3.1E-08	3.6E-08	4.0E-08	4.2E-08	4.2E-08	4.1E-08	3.8E-08	3.5E-08	3.2E-08	2.9E-08	2.6E-08	2.5E-08
E	0.	3.0E-09	5.6E-09	8.3E-09	1.1E-08	1.2E-08	1.4E-08	1.4E-08	1.5E-08	1.5E-08	1.4E-08	1.3E-08	1.2E-08	1.1E-08	1.1E-08
ESE	0.	5.8E-09	7.9E-09	9.1E-09	9.8E-09	1.0E-08	1.1E-08	1.1E-08	1.1E-08	1.0E-08	9.4E-09	8.7E-09	8.0E-09	7.5E-09	7.1E-09
SE	0.	8.9E-09	9.7E-09	9.8E-09	1.0E-08	1.1E-08	1.1E-08	1.1E-08	1.1E-08	1.1E-08	9.8E-09	9.0E-09	8.2E-09	7.5E-09	7.2E-09
SSE	0.	1.7E-08	1.6E-08	1.5E-08	1.5E-08	1.6E-08	1.6E-08	1.5E-08	1.5E-08	1.3E-08	1.2E-08	1.1E-08	9.6E-09	8.7E-09	8.3E-09
S	0.	1.4E-08	1.4E-08	1.6E-08	1.8E-08	2.0E-08	2.0E-08	2.0E-08	2.0E-08	1.8E-08	1.6E-08	1.5E-08	1.3E-08	1.2E-08	1.1E-08
SSW	0.	8.2E-09	1.1E-08	1.5E-08	2.0E-08	2.3E-08	2.5E-08	2.5E-08	2.5E-08	2.3E-08	2.1E-08	1.9E-08	1.7E-08	1.5E-08	1.4E-08
SW	0.	6.5E-09	1.2E-08	1.6E-08	2.0E-08	2.3E-08	2.4E-08	2.4E-08	2.4E-08	2.2E-08	2.0E-08	1.8E-08	1.6E-08	1.4E-08	1.4E-08
WSW	0.	2.2E-08	2.4E-08	2.3E-08	2.4E-08	2.5E-08	2.5E-08	2.4E-08	2.3E-08	2.1E-08	1.9E-08	1.7E-08	1.5E-08	1.4E-08	1.3E-08
W	0.	2.2E-08	2.2E-08	1.9E-08	1.7E-08	1.6E-08	1.6E-08	1.5E-08	1.5E-08	1.4E-08	1.2E-08	1.1E-08	1.0E-08	9.3E-09	8.9E-09
WNW	0.	1.4E-08	1.5E-08	1.4E-08	1.3E-08	1.2E-08	1.2E-08	1.1E-08	1.1E-08	9.7E-09	8.8E-09	8.0E-09	7.3E-09	6.7E-09	6.4E-09
NW	0.	1.4E-08	1.5E-08	1.3E-08	1.2E-08	1.2E-08	1.1E-08	1.1E-08	1.0E-08	9.6E-09	8.7E-09	7.9E-09	7.1E-09	6.5E-09	6.2E-09
NNW	0.	1.2E-08	1.1E-08	1.0E-08	1.0E-08	1.0E-08	1.0E-08	1.0E-08	1.0E-08	9.5E-09	8.8E-09	8.1E-09	7.4E-09	6.8E-09	6.6E-09
N	0.	7.5E-09	8.8E-09	9.6E-09	1.1E-08	1.1E-08	1.2E-08	1.2E-08	1.2E-08	1.2E-08	1.1E-08	1.0E-08	9.2E-09	8.5E-09	8.2E-09

TABLE A-9

D/Q Values at the Standard Distances for Releases from the Stack

Progress Energy – Brunswick
Release Type: Annual
Release Mode: Elevated
Variable: Relative Deposition (Meter**-2)
Calculation Points: Standard
Model: Straight Line Gaussian Diffusion
Period: 2000-2004
Number of Observations: 42768

Base Distance in Miles

Aftd Sect	Design Dist Mi	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.50	3.00	3.50	4.00	4.50	4.75
NNE	0.	1.6E-09	1.3E-09	1.0E-09	8.4E-10	6.7E-10	5.5E-10	4.5E-10	4.0E-10	3.1E-10	2.4E-10	2.0E-10	1.6E-10	1.3E-10	1.2E-10
NE	0.	4.5E-09	3.5E-09	2.7E-09	2.2E-09	1.7E-10	1.3E-09	1.1E-09	9.6E-10	7.3E-10	5.7E-10	4.6E-10	3.8E-10	3.1E-10	2.9E-10
ENE	0.	2.7E-09	2.1E-09	1.8E-09	1.5E-09	1.2E-10	1.0E-09	8.4E-10	7.4E-10	5.7E-10	4.5E-10	3.7E-10	3.0E-10	2.5E-10	2.3E-10
E	0.	5.1E-10	4.2E-10	3.7E-10	3.4E-10	2.8E-10	2.3E-10	2.0E-10	1.8E-10	1.4E-10	1.1E-10	8.9E-11	7.3E-11	6.1E-11	5.6E-11
ESE	0.	7.2E-10	5.6E-10	4.4E-10	3.6E-10	2.8E-10	2.3E-10	1.9E-10	1.7E-10	1.3E-10	1.0E-10	8.1E-11	6.6E-11	5.5E-11	5.1E-11
SE	0.	9.2E-10	7.1E-10	5.5E-10	4.6E-10	3.5E-10	2.8E-10	2.3E-10	2.0E-10	1.5E-10	1.2E-10	9.7E-11	7.9E-11	6.6E-11	6.1E-11
SSE	0.	1.4E-09	1.1E-09	8.0E-10	6.4E-10	4.9E-10	3.9E-10	3.2E-10	2.8E-10	2.1E-10	1.7E-10	1.3E-10	1.1E-10	9.1E-11	8.3E-11
S	0.	1.3E-09	1.0E-09	8.5E-10	7.3E-10	5.9E-10	4.9E-10	4.1E-10	3.6E-10	2.8E-10	2.2E-10	1.8E-10	1.5E-10	1.2E-10	1.1E-10
SSW	0.	9.3E-10	8.2E-10	7.9E-10	7.7E-10	6.6E-10	5.6E-10	4.9E-10	4.4E-10	3.4E-10	2.8E-10	2.2E-10	1.8E-10	1.5E-10	1.4E-10
SW	0.	1.1E-09	9.5E-10	8.5E-10	7.9E-10	6.6E-10	5.6E-10	4.8E-10	4.2E-10	3.3E-10	2.7E-10	2.2E-10	1.8E-10	1.5E-10	1.3E-10
WSW	0.	2.1E-09	1.6E-09	1.3E-09	1.0E-09	8.0E-10	6.4E-10	5.3E-10	4.7E-10	3.5E-10	2.8E-10	2.2E-10	1.8E-10	1.5E-10	1.4E-10
W	0.	1.6E-09	1.2E-09	8.9E-10	6.8E-10	5.1E-10	4.0E-10	3.2E-10	2.8E-10	2.1E-10	1.6E-10	1.3E-10	1.1E-10	8.9E-11	8.1E-11
WNW	0.	1.1E-09	8.2E-10	5.9E-10	4.4E-10	3.3E-10	2.5E-10	2.0E-10	1.7E-10	1.3E-10	1.0E-10	8.0E-11	6.6E-11	5.5E-11	5.0E-11
NW	0.	1.0E-09	7.8E-10	5.6E-10	4.3E-10	2.2E-10	2.5E-10	2.0E-10	1.7E-10	1.3E-10	1.0E-10	8.0E-11	6.5E-11	5.4E-11	5.0E-11
NNW	0.	8.2E-10	6.2E-10	4.6E-10	3.6E-10	2.8E-10	2.2E-10	1.7E-10	1.5E-10	1.2E-10	9.0E-11	7.3E-11	6.0E-11	5.0E-11	4.5E-11
N	0.	7.7E-10	6.0E-10	4.7E-10	3.9E-10	3.1E-10	2.4E-10	2.0E-10	1.8E-10	1.4E-10	1.1E-10	8.8E-11	7.2E-11	6.0E-11	5.5E-11

TABLE A-10

Brunswick 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	Print input data	1
	38	Calculate annual χ/Qs for points of interest	1
	39	Calculate annual χ/Q averages for site radial segments	1
	41	Print out set distance χ/Qs and D/Qs	1
	55	Calculate annual D/Q averages for the set radial segments	1
	56	Allow depleted χ/Qs (if Decays (1), (2), or (3) are negative)	1
	58	Calculate annual D/Qs for points of interest	1
2	1-80	Title card	N/A
3	1-5	Number of wind velocity categories	7
	6-10	Number of stability categories	7
	11-15	Number of distances within terrain data for each sector	1
	16-20	Total number of hours in joint wind frequency distribution	*
	21-25	Increment in % for which plotted results are to be printed	5
	26-30	Number of titles of receptor types	
	31-35	Number of release exit locations	1
4	1-5	Height of the measured wind	11
	6-20	Half-life (days) used in the χ/Q calculations	101.00 2.26 8.00

*Appropriate data to be supplied.

TABLE A-10 (Cont'd)

Card Type	Columns	Description	Value to be Used in XOQDOQ
5	N/A	N/A	
6	1-80	Joint wind frequency distribution	*
7	1-5	Wind velocity units correction	200.00
	6-75	Maximum wind speed in each wind class (m/sec)	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	All are 100
9	1-80	Terrain heights (in meters, above plant grade) correspond to distances in Card Type 8	All are 0
10	1-25	Number of receptor locations for a particular receptor type	
		Site Boundary	16
		Dairy	1
		Meat	8
		Residence	14
		Garden	12
11	1-16	Title of receptor type for receptor locations	Site Boundary
			Dairy
			Meat
			Residence

*Appropriate data to be supplied.

TABLE A-10 (Cont'd)

Card Type	Columns	Description	Value to be Used in XOQDOQ
	1-16 Cont'd	Title of receptor type for receptor locations (Cont'd)	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	*
14	1-5	Vent average velocity (m/sec)	1.0
	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)	56.9
	21-25	Minimum cross-sectional area for the vent's building (m^2)	2120.0
	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	0
	6-10	Number of intermittent releases per year for this release point	0
	11-15	Average number of hours per intermittent release	0

*Appropriate data to be supplied.

TABLE A-11

Brunswick Plant Site Information To Be Used
for Elevated Release Calculations with NRC "XOQDOQ" Program

Card Type	Columns	Description	Value to Be Used in XOQDOQ
1	1	Print input data	1
	4	Release to be elevated 100% of the time	1
	38	Calculate annual χ/Qs for points of interest	1
	39	Calculate annual χ/Q averages for site radial segments	1
	41	Print out set distance χ/Qs and D/Qs	1
	55	Calculate annual D/Q averages for the set radial segments	1
	56	Allow depleted χ/Qs (if Decays (1), (2), or (3) are negative)	1
	58	Calculate annual D/Qs for points of interest	1
2	1-80	Title card	N/A
3	1-5	Number of wind velocity categories	7
	6-10	Number of stability categories	7
	11-15	Number of distances within terrain data for each sector	1
	16-20	Total number of hours in joint wind frequency distribution	*
	21-25	Increment in % for which plotted results are to be printed	5
	26-30	Number of titles of receptor types	5
	31-35	Number of release exit locations	1
4	1-5	Height of the measured wind	104
	6-20	Half-life (days) used in the χ/Q calculations	101.00 2.26

*Appropriate data to be supplied.

TABLE A-11 (Cont'd)

Card Type	Columns	Description	Value to Be Used in XOQDOQ
	6-20 (Cont'd)	Half-life (days) used in the χ/Q calculations (Cont'd)	8.00
5	N/A	N/A	
6	1-80	Joint wind frequency distribution	*
7	1-5	Wind velocity units correction	200.00
	6-75	Maximum wind speed in each wind class (m/sec)	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	All are 100
9	1-80	Terrain heights (in meters, above plant grade) correspond to distances in Card Type 8	All are 0
10	1-25	Number of receptor locations for a particular receptor type	
		Site Boundary	16
		Dairy	1
		Meat	8
		Residence	14
		Garden	12

*Appropriate data to be supplied.

TABLE A-11 (Cont'd)

Card Type	Columns	Description	Value to Be Used in XOQDOQ
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	*
14	1-5	Vent average velocity (m/sec)	4.66
	6-10	Vent inside diameter (m)	3.58
	11-15	Height of vent release point (m)	100.9
	16-20	Height of the vent's building (m)	0.0
	21-25	Minimum cross-sectional area for the vent's building (m^2)	0.00
	26-30	Wind height used for vent elevated release	104.0
	31-35	Vent heat emission rate (cal/sec)	0.0
15	1	Identification for release point	A
	2-5	Intermittent releases	0
	6-10	Number of intermittent releases per year for this release point	0
	11-15	Average number of hours per intermittent release	0

*Appropriate data to be supplied.

LIST OF TABLES

LIST OF TABLES (Cont'd)

LIST OF TABLES (Cont'd)

APPENDIX B

Calculation of V_i and B_i Values for the Elevated Plume

Values of V_i and B_i were calculated for the elevated plume release from the Brunswick stack using the NRC computer program RABFIN. This program was used to determine the controlling location based upon the releases of Table 3.2-1. In addition it was used to develop the V_i and B_i values for the various noble gas radionuclides at the site boundary at each of the 16 sectors. Table B-1 presents the V_i and B_i values for the ENE sector which is the controlling location for noble gases for showing compliance with 10CFR20 and 10CFR50. Table B-2 presents the joint frequency distribution for the ENE sector. Tables B-3 through B-32 present the V_i and B_i values and the joint frequency distribution for the remaining sectors. The inputs which were utilized in the RABFIN code are presented below.

1. Height of Stack - 100.9 (m)
2. Stack Diameter - 3.6 (m)
3. Exit Velocity - 5.0 m/sec
4. Wind Height - 104.6 (m)

TABLE B-1

DOSE PARAMETERS FOR FINITE ELEVATED PLUMES
ENE SITE BOUNDARY*

Noble Gas Radionuclides	V_i Total Body $\left(\frac{\text{mrem/yr}}{\mu\text{Ci/ sec}}\right)$	B_i Gamma Air $\left(\frac{\text{mrad/yr}}{\mu\text{Ci/ sec}}\right)$
Kr-83m	2.70E-09	7.46E-07
Kr-85m	1.14E-04	1.69E-04
Kr-85	1.69E-06	2.56E-06
Kr-87	5.12E-04	7.71E-04
Kr-88	1.35E-03	2.02E-03
Kr-89	7.59E-04	1.14E-03
Xe-131m	2.78E-05	4.44E-05
Xe-133m	2.12E-05	3.51E-05
Xe-133	2.22E-05	3.52E-05
Xe-135m	2.62E-04	3.97E-04
Xe-135	1.82E-04	2.74E-04
Xe-137	6.42E-05	9.70E-05
Xe-138	8.09E-04	1.21E-03
Xe-139	1.89E-05	2.83E-05
Ar-41	9.71E-04	1.46E-03

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

TABLE B-2

JOINT FREQUENCY DISTRIBUTION FOR ENE SECTOR (%)
PERIOD 1-1-00 THROUGH 12-31-04
BRUNSWICK STEAM ELECTRIC PLANT

		MAXIMUM WIND SPEED (m/sec)						
Stability	Total	0.36	1.56	3.35	5.59	8.27	10.95	15.65
1	0.39	0.00	0.00	0.01	0.10	0.21	0.06	0.01
2	0.55	0.00	0.00	0.02	0.13	0.32	0.08	0.00
3	0.95	0.00	0.00	0.05	0.33	0.44	0.12	0.01
4	5.71	0.00	0.06	0.45	1.58	2.33	1.06	0.22
5	3.69	0.00	0.02	0.24	1.17`	1.58	0.58	0.09
6	0.96	0.00	0.03	0.19	0.39	0.28	0.06	0.00
7	0.77	0.01	0.06	0.22	0.32	0.16	0.00	0.00
Total	13.02	0.02	0.16	1.18	4.01	5.32	1.98	0.34
Entrapment		0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ground Velocity		0.06	0.30	0.76	1.39	2.15	2.98	4.12
Elevated Velocity		0.18	0.95	2.42	4.40	6.83	9.47	13.10

AVERAGE WIND SPEED (m/sec)			
Mean	Ground	Elevated	Combined
Arithmetic	0.00	6.16	6.16
Harmonic	0.00	4.85	4.85

TABLE B-3

DOSE PARAMETERS FOR FINITE ELEVATED PLUMES
N SITE BOUNDARY*

Noble Gas Radionuclides	V_i Total Body $\left(\frac{mrem/yr}{\mu Ci/sec}\right)$	B_i Gamma Air $\left(\frac{mrad/yr}{\mu Ci/sec}\right)$
Kr-83m	9.02E-10	2.46E-07
Kr-85m	4.25E-05	6.29E-05
Kr-85	6.50E-07	9.85E-07
Kr-87	1.91E-04	2.88E-04
Kr-88	5.24E-04	7.86E-04
Kr-89	2.49E-04	3.74E-04
Xe-131m	1.03E-05	1.64E-05
Xe-133m	7.88E-06	1.30E-05
Xe-133	8.13E-06	1.28E-05
Xe-135m	9.13E-05	1.39E-04
Xe-135	6.88E-05	1.03E-04
Xe-137	2.01E-05	3.03E-05
Xe-138	2.98E-04	4.47E-04
Xe-139	5.74E-06	8.62E-06
Ar-41	3.67E-04	5.50E-04

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

TABLE B-4

JOINT FREQUENCY DISTRIBUTION FOR N SECTOR (%)
PERIOD 1-1-00 THROUGH 12-31-04
BRUNSWICK STEAM ELECTRIC PLANT

MAXIMUM WIND SPEED (m/sec)								
Stability	Total	0.36	1.56	3.35	5.59	8.27	10.95	15.65
1	0.11	0.00	0.00	0.01	0.06	0.04	0.00	0.00
2	0.12	0.00	0.00	0.01	0.08	0.02	0.00	0.00
3	0.31	0.00	0.00	0.05	0.17	0.06	0.02	0.00
4	1.27	0.00	0.04	0.23	0.44	0.31	0.16	0.08
5	1.52	0.00	0.02	0.11	0.42	0.49	0.33	0.14
6	0.48	0.00	0.03	0.09	0.17	0.12	0.04	0.02
7	0.43	0.00	0.04	0.16	0.16	0.06	0.01	0.00
Total	4.23	0.02	0.14	0.66	1.50	1.09	0.57	0.25
Entrapment		0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ground Velocity		0.06	0.30	0.76	1.39	2.15	2.98	4.12
Elevated Velocity		0.18	0.95	2.42	4.40	6.83	9.47	13.10

AVERAGE WIND SPEED (m/sec)			
Mean	Ground	Elevated	Combined
Arithmetic	0.00	5.78	5.78
Harmonic	0.00	3.87	3.87

TABLE B-5

DOSE PARAMETERS FOR FINITE ELEVATED PLUMES
NNE SITE BOUNDARY*

Noble Gas Radionuclides	V_i Total Body $\left(\frac{\text{mrem/yr}}{\mu\text{Ci/ sec}}\right)$	B_i Gamma Air $\left(\frac{\text{mrad/yr}}{\mu\text{Ci/ sec}}\right)$
Kr-83m	1.55E-09	4.62E-07
Kr-85m	6.42E-05	9.54E-05
Kr-85	9.59E-07	1.45E-06
Kr-87	2.88E-04	4.34E-04
Kr-88	7.66E-04	1.15E-03
Kr-89	4.14E-04	6.22E-04
Xe-131m	1.58E-05	2.52E-05
Xe-133m	1.20E-05	2.00E-05
Xe-133	1.26E-05	2.00E-05
Xe-135m	1.45E-04	2.20E-04
Xe-135	1.03E-04	1.55E-04
Xe-137	3.47E-05	5.25E-05
Xe-138	4.54E-04	6.81E-04
Xe-139	1.05E-05	1.58E-05
Ar-41	5.48E-04	8.22E-04

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

TABLE B-6

JOINT FREQUENCY DISTRIBUTION FOR NNE SECTOR (%)
PERIOD 1-1-00 THROUGH 12-31-04
BRUNSWICK STEAM ELECTRIC PLANT

MAXIMUM WIND SPEED (m/sec)									
Stability	Total	0.36	1.56	3.35	5.59	8.27	10.95	15.65	
1	0.17	0.00	0.00	0.00	0.06	0.09	0.01	0.00	
2	0.33	0.00	0.00	0.00	0.13	0.16	0.03	0.00	
3	0.62	0.00	0.00	0.02	0.27	0.23	0.08	0.01	
4	2.93	0.00	0.04	0.25	0.86	1.04	0.58	0.15	
5	1.86	0.00	0.02	0.18	0.48	0.52	0.41	0.24	
6	0.62	0.00	0.02	0.11	0.22	0.20	0.06	0.00	
7	0.57	0.00	0.04	0.16	0.22	0.13	0.02	0.00	
Total	7.11	0.01	0.13	0.74	2.24	2.38	1.19	0.41	
Entrapment			0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ground Velocity			0.06	0.30	0.76	1.39	2.15	2.98	4.12
Elevated Velocity			0.18	0.95	2.42	4.40	6.83	9.47	13.10

AVERAGE WIND SPEED (m/sec)			
Mean	Ground	Elevated	Combined
Arithmetic	0.00	6.29	6.29
Harmonic	0.00	4.62	4.62

TABLE B-7

DOSE PARAMETERS FOR FINITE ELEVATED PLUMES
NE SITE BOUNDARY*

Noble Gas Radionuclides	V_i Total Body $\left(\frac{\text{mrem/yr}}{\mu\text{Ci/ sec}}\right)$	B_i Gamma Air $\left(\frac{\text{mrad/yr}}{\mu\text{Ci/ sec}}\right)$
Kr-83m	3.11E-09	1.10E-06
Kr-85m	1.07E-04	1.59E-04
Kr-85	1.55E-06	2.35E-06
Kr-87	4.73E-04	7.11E-04
Kr-88	1.23E-03	1.84E-03
Kr-89	7.51E-04	1.13E-03
Xe-131m	2.69E-05	4.35E-05
Xe-133m	2.05E-05	3.46E-05
Xe-133	2.19E-05	3.51E-05
Xe-135m	2.48E-04	3.77E-04
Xe-135	1.70E-04	2.55E-04
Xe-137	6.53E-05	9.87E-05
Xe-138	7.49E-04	1.12E-03
Xe-139	2.22E-05	3.33E-05
Ar-41	8.91E-04	1.34E-03

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

TABLE B-8

JOINT FREQUENCY DISTRIBUTION FOR NE
SECTOR (%) PERIOD 1-1-00 THROUGH 12-31-04
BRUNSWICK STEAM ELECTRIC PLANT

MAXIMUM WIND SPEED (m/sec)								
Stability	Total	0.36	1.56	3.35	5.59	8.27	10.95	15.65
1	0.74	0.00	0.00	0.00	0.10	0.36	0.24	0.03
2	1.09	0.00	0.00	0.01	0.22	0.59	0.23	0.00
3	1.38	0.00	0.00	0.03	0.39	0.64	0.26	0.05
4	6.24	0.00	0.05	0.31	1.04	2.66	1.75	0.43
5	2.67	0.00	0.03	0.14	0.52	0.92	0.74	0.32
6	0.79	0.00	0.03	0.12	0.30	0.26	0.07	0.01
7	0.61	0.00	0.02	0.12	0.28	0.17	0.02	0.00
Total	13.52	0.02	0.13	0.73	2.85	5.60	3.31	0.88
Entrapment		0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ground Velocity		0.06	0.30	0.76	1.39	2.15	2.98	4.12
Elevated Velocity		0.18	0.95	2.42	4.40	6.83	9.47	13.10

AVERAGE WIND SPEED (m/sec)			
Mean	Ground	Elevated	Combined
Arithmetic	0.00	7.07	7.07
Harmonic	0.00	5.62	5.62

TABLE B-9

DOSE PARAMETERS FOR FINITE ELEVATED PLUMES
E SITE BOUNDARY*

Noble Gas Radionuclides	V_i Total Body $\left(\frac{mrem/yr}{\mu Ci/sec}\right)$	B_i Gamma Air $\left(\frac{mrad/yr}{\mu Ci/sec}\right)$
Kr-83m	1.05E-09	2.15E-07
Kr-85m	5.81E-05	8.63E-05
Kr-85	9.08E-07	1.38E-06
Kr-87	2.66E-04	4.00E-04
Kr-88	7.39E-04	1.11E-03
Kr-89	3.12E-04	4.69E-04
Xe-131m	1.39E-05	2.19E-05
Xe-133m	1.06E-05	1.73E-05
Xe-133	1.08E-05	1.69E-05
Xe-135m	1.23E-04	1.86E-04
Xe-135	9.52E-05	1.43E-04
Xe-137	2.40E-05	3.62E-05
Xe-138	4.13E-04	6.19E-04
Xe-139	5.31E-06	7.98E-06
Ar-41	5.12E-04	7.69E-04

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

TABLE B-10

JOINT FREQUENCY DISTRIBUTION FOR E SECTOR (%)
PERIOD 1-1-00 THROUGH 12-31-04
BRUNSWICK STEAM ELECTRIC PLANT

		MAXIMUM WIND SPEED (m/sec)						
Stability	Total	0.36	1.56	3.35	5.59	8.27	10.95	15.65
1	0.04	0.00	0.00	0.01	0.02	0.01	0.00	0.00
2	0.06	0.00	0.00	0.02	0.03	0.01	0.00	0.00
3	0.26	0.00	0.01	0.12	0.10	0.03	0.00	0.00
4	1.50	0.00	0.06	0.39	0.68	0.31	0.04	0.01
5	1.67	0.00	0.04	0.28	0.96	0.39	0.00	0.00
6	0.72	0.00	0.03	0.16	0.35	0.16	0.00	0.00
7	0.67	0.01	0.07	0.25	0.24	0.10	0.00	0.00
Total	4.91	0.02	0.21	1.23	2.38	1.01	0.05	0.01
Entrapment		0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ground Velocity		0.06	0.30	0.76	1.39	2.15	2.98	4.12
Elevated Velocity		0.18	0.95	2.42	4.40	6.83	9.47	13.10

MAXIMUM WIND SPEED (m/sec)			
Mean	Ground	Elevated	Combined
Arithmetic	0.00	4.31	4.31
Harmonic	0.00	3.15	3.15

TABLE B-11

DOSE PARAMETERS FOR FINITE ELEVATED PLUMES
ESE SITE BOUNDARY*

Noble Gas Radionuclides	V_i Total Body $\left(\frac{\text{mrem/yr}}{\mu\text{Ci/ sec}}\right)$	Bi Gamma Air $\left(\frac{\text{mrad/yr}}{\mu\text{Ci/ sec}}\right)$
Kr-83m	8.29E-10	2.29E-07
Kr-85m	3.88E-05	5.76E-05
Kr-85	5.93E-07	8.99E-07
Kr-87	1.76E-04	2.65E-04
Kr-88	4.77E-04	7.17E-04
Kr-89	2.42E-04	3.64E-04
Xe-131m	9.43E-06	1.50E-05
Xe-133m	7.20E-06	1.19E-05
Xe-133	7.43E-06	1.17E-05
Xe-135m	8.55E-05	1.30E-04
Xe-135	6.29E-05	9.46E-05
Xe-137	2.00E-05	3.02E-05
Xe-138	2.75E-04	4.12E-04
Xe-139	6.19E-06	9.30E-06
Ar-41	3.37E-04	5.05E-04

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

TABLE B-12

JOINT FREQUENCY DISTRIBUTION FOR ESE SECTOR (%)
PERIOD 1-1-00 THROUGH 12-31-04
BRUNSWICK STEAM ELECTRIC PLANT

		MAXIMUM WIND SPEED (m/sec)						
Stability	Total	0.36	1.56	3.35	5.59	8.27	10.95	15.65
1	0.09	0.00	0.00	0.01	0.03	0.03	0.02	0.00
2	0.14	0.00	0.00	0.01	0.05	0.05	0.02	0.00
3	0.29	0.00	0.01	0.06	0.12	0.08	0.02	0.00
4	1.15	0.00	0.06	0.13	0.30	0.41	0.19	0.05
5	1.23	0.00	0.01	0.13	0.24	0.50	0.34	0.01
6	0.70	0.00	0.02	0.05	0.16	0.24	0.21	0.02
7	0.69	0.00	0.04	0.09	0.16	0.23	0.14	0.03
Total	4.28	0.01	0.14	0.48	1.05	1.54	0.95	0.11
Entrapment		0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ground Velocity		0.06	0.30	0.76	1.39	2.15	2.98	4.12
Elevated Velocity		0.18	0.95	2.42	4.40	6.83	9.47	13.10

AVERAGE WIND SPEED (m/sec)			
Mean	Ground	Elevated	Combined
Arithmetic	0.00	6.27	6.27
Harmonic	0.00	4.29	4.29

TABLE B-13

DOSE PARAMETERS FOR FINITE ELEVATED PLUMES
SE SITE BOUNDARY*

Noble Gas Radionuclides	V_i Total Body $\left(\frac{\text{mrem/yr}}{\mu\text{Ci/ sec}}\right)$	B_i Gamma Air $\left(\frac{\text{mrad/yr}}{\mu\text{Ci/ sec}}\right)$
Kr-83m	8.52E-10	2.44E-07
Kr-85m	3.84E-05	5.70E-05
Kr-85	5.86E-07	8.88E-07
Kr-87	1.73E-04	2.61E-04
Kr-88	4.71E-04	7.07E-04
Kr-89	2.41E-04	3.62E-04
Xe-131m	9.38E-06	1.49E-05
Xe-133m	7.17E-06	1.18E-05
Xe-133	7.42E-06	1.17E-05
Xe-135m	8.42E-05	1.28E-04
Xe-135	6.23E-05	9.36E-05
Xe-137	2.00E-05	3.02E-05
Xe-138	2.70E-04	4.06E-04
Xe-139	6.45E-06	9.68E-06
Ar-41	3.32E-04	4.98E-04

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

TABLE B-14

JOINT FREQUENCY DISTRIBUTION FOR SE SECTOR (%)
PERIOD 1-1-00 THROUGH 12-31-04
BRUNSWICK STEAM ELECTRIC PLANT

		MAXIMUM WIND SPEED (m/sec)						
Stability	Total	0.36	1.56	3.35	5.59	8.27	10.95	15.65
1	0.17	0.00	0.00	0.01	0.03	0.06	0.04	0.02
2	0.20	0.00	0.00	0.02	0.04	0.06	0.06	0.01
3	0.29	0.00	0.00	0.04	0.08	0.09	0.06	0.01
4	1.34	0.00	0.06	0.17	0.34	0.44	0.25	0.07
5	1.13	0.00	0.02	0.04	0.20	0.44	0.41	0.01
6	0.62	0.00	0.04	0.06	0.15	0.19	0.15	0.02
7	0.60	0.00	0.02	0.06	0.17	0.24	0.09	0.02
Total	4.33	0.02	0.15	0.42	1.02	1.51	1.07	0.16
Entrapment		0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ground Velocity		0.06	0.30	0.76	1.39	2.15	2.98	4.12
Elevated Velocity		0.18	0.95	2.42	4.40	6.83	9.47	13.10

AVERAGE WIND SPEED (m/sec)			
Mean	Ground	Elevated	Combined
Arithmetic	0.00	6.49	6.49
Harmonic	0.00	4.38	4.38

TABLE B-15

DOSE PARAMETERS FOR FINITE ELEVATED PLUMES
SSE SITE BOUNDARY*

Noble Gas Radionuclides	V_i Total Body $\left(\frac{\text{mrem/yr}}{\mu\text{Ci/sec}}\right)$	B_i Gamma Air $\left(\frac{\text{mrad/yr}}{\mu\text{Ci/sec}}\right)$
Kr-83m	1.15E-09	3.88E-07
Kr-85m	4.49E-05	6.67E-05
Kr-85	6.69E-07	1.01E-06
Kr-87	2.01E-04	3.02E-04
Kr-88	5.35E-04	8.04E-04
Kr-89	2.86E-04	4.30E-04
Xe-131m	1.11E-05	1.79E-05
Xe-133m	8.49E-06	1.42E-05
Xe-133	8.92E-06	1.42E-05
Xe-135m	1.00E-04	1.52E-04
Xe-135	7.20E-05	1.08E-04
Xe-137	2.39E-05	3.61E-05
Xe-138	3.16E-04	4.75E-04
Xe-139	7.36E-06	1.10E-05
Ar-41	3.82E-04	5.74E-04

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

TABLE B-16

JOINT FREQUENCY DISTRIBUTION FOR SSE SECTOR (%)
PERIOD 1-1-00 THROUGH 12-31-04
BRUNSWICK STEAM ELECTRIC PLANT

		MAXIMUM WIND SPEED (m/sec)						
Stability	Total	0.36	1.56	3.35	5.59	8.27	10.95	15.65
1	0.28	0.00	0.00	0.02	0.09	0.13	0.04	0.00
2	0.27	0.00	0.00	0.02	0.10	0.09	0.04	0.01
3	0.43	0.00	0.00	0.11	0.17	0.10	0.05	0.00
4	1.74	0.00	0.05	0.22	0.53	0.57	0.29	0.08
5	0.98	0.00	0.01	0.05	0.20	0.36	0.34	0.02
6	0.70	0.00	0.02	0.08	0.08	0.26	0.27	0.00
7	0.66	0.00	0.03	0.10	0.15	0.22	0.14	0.02
Total	5.06	0.01	0.11	0.59	1.32	1.72	1.18	0.13
Entrapment		0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ground Velocity		0.06	0.30	0.76	1.39	2.15	2.98	4.12
Elevated Velocity		0.18	0.95	2.42	4.40	6.83	9.47	13.10

AVERAGE WIND SPEED (m/sec)			
Mean	Ground	Elevated	Combined
Arithmetic	0.00	6.31	6.31
Harmonic	0.00	4.58	4.58

TABLE B-17

DOSE PARAMETERS FOR FINITE ELEVATED PLUMES
S SITE BOUNDARY*

Noble Gas Radionuclides	V_i Total Body $\left(\frac{\text{mrem/yr}}{\mu\text{Ci/ sec}}\right)$	B_i Gamma Air $\left(\frac{\text{mrad/yr}}{\mu\text{Ci/ sec}}\right)$
Kr-83m	1.31E-09	3.79E-07
Kr-85m	5.42E-05	8.06E-05
Kr-85	8.09E-07	1.22E-06
Kr-87	2.44E-04	3.68E-04
Kr-88	6.46E-04	9.70E-04
Kr-89	3.57E-04	5.37E-04
Xe-131m	1.33E-05	2.13E-05
Xe-133m	1.01E-05	1.69E-05
Xe-133	1.06E-05	1.69E-05
Xe-135m	1.23E-04	1.87E-04
Xe-135	8.71E-05	1.31E-04
Xe-137	3.01E-05	4.55E-05
Xe-138	3.85E-04	5.79E-04
Xe-139	9.15E-06	1.37E-05
Ar-41	4.64E-04	6.96E-04

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

TABLE B-18

JOINT FREQUENCY DISTRIBUTION FOR S SECTOR (%)
PERIOD 1-1-00 THROUGH 12-31-04
BRUNSWICK STEAM ELECTRIC PLANT

		MAXIMUM WIND SPEED (m/sec)						
Stability	Total	0.36	1.56	3.35	5.59	8.27	10.95	15.65
1	0.24	0.00	0.00	0.03	0.08	0.08	0.05	0.01
2	0.24	0.00	0.00	0.02	0.09	0.10	0.03	0.01
3	0.42	0.00	0.01	0.09	0.14	0.14	0.05	0.00
4	2.81	0.00	0.06	0.25	0.69	1.07	0.69	0.06
5	1.21	0.00	0.01	0.07	0.30	0.56	0.26	0.00
6	0.62	0.00	0.01	0.05	0.12	0.29	0.14	0.00
7	0.72	0.00	0.03	0.11	0.23	0.26	0.08	0.01
Total	6.27	0.01	0.12	0.61	1.64	2.50	1.30	0.09
Entrapment		0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ground Velocity		0.06	0.30	0.76	1.39	2.15	2.98	4.12
Elevated Velocity		0.18	0.95	2.42	4.40	6.83	9.47	13.10

AVERAGE WIND SPEED (m/sec)			
Mean	Ground	Elevated	Combined
Arithmetic	0.00	6.28	6.28
Harmonic	0.00	4.75	4.75

TABLE B-19

DOSE PARAMETERS FOR FINITE ELEVATED PLUMES
SSW SITE BOUNDARY*

Noble Gas Radionuclides	V_i Total Body $\left(\frac{mrem/yr}{\mu Ci/sec}\right)$	B_i Gamma Air $\left(\frac{mrad/yr}{\mu Ci/sec}\right)$
Kr-83m	1.45E-09	3.36E-07
Kr-85m	6.52E-05	9.96E-05
Kr-85	9.75E-07	1.48E-06
Kr-87	2.95E-04	4.45E-04
Kr-88	7.77E-04	1.17E-03
Kr-89	4.48E-04	6.73E-04
Xe-131m	1.58E-05	2.52E-05
Xe-133m	1.20E-05	1.99E-05
Xe-133	1.26E-05	1.99E-05
Xe-135m	1.51E-04	2.30E-04
Xe-135	1.05E-04	1.58E-04
Xe-137	3.81E-05	5.76E-05
Xe-138	4.66E-04	7.00E-04
Xe-139	1.16E-05	1.74E-05
Ar-41	5.61E-04	8.41E-04

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

TABLE B-20

JOINT FREQUENCY DISTRIBUTION FOR SSW SECTOR (%)
PERIOD 1-1-00 THROUGH 12-31-04
BRUNSWICK STEAM ELECTRIC PLANT

		MAXIMUM WIND SPEED (m/sec)						
Stability	Total	0.36	1.56	3.35	5.59	8.27	10.95	15.65
1	0.12	0.00	0.00	0.02	0.04	0.06	0.00	0.00
2	0.19	0.00	0.00	0.02	0.08	0.07	0.02	0.00
3	0.33	0.00	0.00	0.05	0.14	0.10	0.04	0.00
4	4.02	0.00	0.05	0.24	0.88	2.03	0.78	0.03
5	1.53	0.00	0.02	0.06	0.29	0.90	0.26	0.00
6	0.81	0.00	0.01	0.06	0.17	0.34	0.23	0.00
7	0.82	0.00	0.03	0.12	0.24	0.31	0.13	0.00
Total	7.84	0.01	0.12	0.56	1.83	3.81	1.46	0.04
Entrapment		0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ground Velocity		0.06	0.30	0.76	1.39	2.15	2.98	4.12
Elevated Velocity		0.18	0.95	2.42	4.40	6.83	9.47	13.10

AVERAGE WIND SPEED (m/sec)			
Mean	Ground	Elevated	Combined
Arithmetic	0.00	6.37	6.37
Harmonic	0.00	5.01	5.01

TABLE B-21

DOSE PARAMETERS FOR FINITE ELEVATED PLUMES
SW SITE BOUNDARY*

Noble Gas Radionuclides	V_i Total Body $\left(\frac{mrem/yr}{\mu Ci/sec}\right)$	B_i Gamma Air $\left(\frac{mrad/yr}{\mu Ci/sec}\right)$
Kr-83m	1.45E-09	3.61E-07
Kr-85m	6.40E-05	9.51E-05
Kr-85	9.58E-07	1.45E-06
Kr-87	2.89E-04	4.36E-04
Kr-88	7.63E-04	1.15E-03
Kr-89	4.38E-04	6.57E-04
Xe-131m	1.56E-05	2.48E-05
Xe-133m	1.19E-05	1.96E-05
Xe-133	1.24E-05	1.96E-05
Xe-135m	1.48E-04	2.24E-04
Xe-135	1.03E-04	1.55E-04
Xe-137	3.73E-05	5.63E-05
Xe-138	4.56E-04	6.85E-04
Xe-139	1.13E-05	1.69E-05
Ar-41	5.49E-04	8.24E-04

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

TABLE B-22

JOINT FREQUENCY DISTRIBUTION FOR SW SECTOR (%)
PERIOD 1-1-00 THROUGH 12-31-04
BRUNSWICK STEAM ELECTRIC PLANT

		MAXIMUM WIND SPEED (m/sec)						
Stability	Total	0.36	1.56	3.35	5.59	8.27	10.95	15.65
1	0.10	0.00	0.00	0.00	0.02	0.04	0.03	0.00
2	0.21	0.00	0.00	0.01	0.06	0.11	0.02	0.00
3	0.48	0.00	0.00	0.04	0.14	0.22	0.08	0.00
4	3.69	0.00	0.05	0.23	0.77	1.83	0.69	0.10
5	1.55	0.00	0.01	0.08	0.36	0.94	0.16	0.00
6	0.68	0.00	0.02	0.04	0.15	0.36	0.10	0.00
7	0.90	0.01	0.05	0.08	0.30	0.38	0.07	0.00
Total	7.60	0.01	0.13	0.50	1.80	3.89	1.17	0.10
Entrapment		0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ground Velocity		0.06	0.30	0.76	1.39	2.15	2.98	4.12
Elevated Velocity		0.18	0.95	2.42	4.40	6.83	9.47	13.10

AVERAGE WIND SPEED (m/sec)			
Mean	Ground	Elevated	Combined
Arithmetic	0.00	6.34	6.34
Harmonic	0.00	4.96	4.96

TABLE B-23

DOSE PARAMETERS FOR FINITE ELEVATED PLUMES
WSW SITE BOUNDARY*

Noble Gas Radionuclides	V_i Total Body $\left(\frac{\text{mrem/yr}}{\mu\text{Ci/ sec}}\right)$	B_i Gamma Air $\left(\frac{\text{mrad/yr}}{\mu\text{Ci/ sec}}\right)$
Kr-83m	1.75E-09	5.79E-07
Kr-85m	6.69E-05	9.93E-05
Kr-85	9.93E-07	1.50E-06
Kr-87	2.98E-04	4.49E-04
Kr-88	7.92E-04	1.19E-03
Kr-89	4.32E-04	6.50E-04
Xe-131m	1.66E-05	2.67E-05
Xe-133m	1.27E-05	2.12E-05
Xe-133	1.33E-05	2.13E-05
Xe-135m	1.51E-04	2.29E-04
Xe-135	1.07E-04	1.61E-04
Xe-137	3.64E-05	5.51E-05
Xe-138	4.70E-04	7.06E-04
Xe-139	1.05E-05	1.58E-05
Ar-41	5.67E-04	8.51E-04

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

TABLE B-24

JOINT FREQUENCY DISTRIBUTION FOR WSW SECTOR (%)
PERIOD 1-1-00 THROUGH 12-31-04
BRUNSWICK STEAM ELECTRIC PLANT

		MAXIMUM WIND SPEED (m/sec)						
Stability	Total	0.36	1.56	3.35	5.59	8.27	10.95	15.65
1	0.37	0.00	0.00	0.01	0.12	0.20	0.04	0.00
2	0.45	0.00	0.00	0.02	0.15	0.24	0.05	0.00
3	0.68	0.00	0.01	0.08	0.25	0.28	0.07	0.00
4	3.10	0.00	0.06	0.26	0.69	1.32	0.68	0.10
5	1.51	0.00	0.01	0.10	0.44	0.84	0.11	0.00
6	0.56	0.00	0.03	0.09	0.23	0.20	0.01	0.00
7	0.74	0.00	0.04	0.13	0.34	0.21	0.01	0.00
Total	7.41	0.01	0.14	0.67	2.21	3.29	0.98	0.11
Entrapment		0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ground Velocity		0.06	0.30	0.76	1.39	2.15	2.98	4.12
Elevated Velocity		0.18	0.95	2.42	4.40	6.83	9.47	13.10

AVERAGE WIND SPEED (m/sec)			
Mean	Ground	Elevated	Combined
Arithmetic	0.00	6.02	6.02
Harmonic	0.00	4.61	4.61

TABLE B-25

DOSE PARAMETERS FOR FINITE ELEVATED PLUMES
W SITE BOUNDARY*

Noble Gas Radionuclides	V_i Total Body $\left(\frac{\text{mrem/yr}}{\mu\text{Ci/sec}}\right)$	B_i Gamma Air $\left(\frac{\text{mrad/yr}}{\mu\text{Ci/sec}}\right)$
Kr-83m	1.34E-09	4.89E-07
Kr-85m	5.04E-05	7.49E-05
Kr-85	7.56E-07	1.15E-06
Kr-87	2.24E-04	3.37E-04
Kr-88	6.07E-04	9.11E-04
Kr-89	2.93E-04	4.41E-04
Xe-131m	1.26E-05	2.03E-05
Xe-133m	9.63E-06	1.61E-05
Xe-133	1.01E-05	1.61E-05
Xe-135m	1.09E-04	1.65E-04
Xe-135	8.11E-05	1.22E-04
Xe-137	2.38E-05	3.60E-05
Xe-138	3.52E-04	5.28E-04
Xe-139	5.78E-06	8.68E-06
Ar-41	4.28E-04	6.42E-04

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

TABLE B-26

JOINT FREQUENCY DISTRIBUTION FOR W SECTOR (%)
PERIOD 1-1-00 THROUGH 12-31-04
BRUNSWICK STEAM ELECTRIC PLANT

		MAXIMUM WIND SPEED (m/sec)						
Stability	Total	0.36	1.56	3.35	5.59	8.27	10.95	15.65
1	0.31	0.00	0.00	0.04	0.19	0.08	0.01	0.00
2	0.40	0.00	0.00	0.02	0.26	0.11	0.00	0.00
3	0.44	0.00	0.00	0.06	0.25	0.13	0.00	0.00
4	1.50	0.00	0.04	0.26	0.54	0.49	0.16	0.01
5	1.14	0.00	0.03	0.11	0.44	0.47	0.08	0.01
6	0.47	0.00	0.03	0.11	0.25	0.06	0.00	0.00
7	0.53	0.00	0.02	0.11	0.30	0.09	0.00	0.00
Total	4.79	0.01	0.14	0.71	2.22	1.43	0.25	0.02
Entrapment		0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ground Velocity		0.06	0.30	0.76	1.39	2.15	2.98	4.12
Elevated Velocity		0.18	0.95	2.42	4.40	6.83	9.47	13.10

AVERAGE WIND SPEED (m/sec)			
Mean	Ground	Elevated	Combined
Arithmetic	0.00	5.02	5.02
Harmonic	0.00	3.80	3.80

TABLE B-27

DOSE PARAMETERS FOR FINITE ELEVATED PLUMES
WNW SITE BOUNDARY*

Noble Gas Radionuclides	V_i Total Body $\left(\frac{\text{mrem/yr}}{\mu\text{Ci/ sec}}\right)$	B_i Gamma Air $\left(\frac{\text{mrad/yr}}{\mu\text{Ci/ sec}}\right)$
Kr-83m	1.01E-09	3.71E-07
Kr-85m	3.96E-05	5.89E-05
Kr-85	6.01E-07	9.11E-07
Kr-87	1.76E-04	2.65E-04
Kr-88	4.86E-04	7.29E-04
Kr-89	2.10E-04	3.15E-04
Xe-131m	9.88E-06	1.59E-05
Xe-133m	7.57E-06	1.26E-05
Xe-133	7.89E-06	1.26E-05
Xe-135m	8.24E-05	1.25E-04
Xe-135	6.41E-05	9.63E-05
Xe-137	1.63E-05	2.47E-05
Xe-138	2.75E-04	4.12E-04
Xe-139	3.71E-06	5.57E-06
Ar-41	3.38E-04	5.07E-04

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

TABLE B-28

JOINT FREQUENCY DISTRIBUTION FOR WNW SECTOR (%)
PERIOD 1-1-00 THROUGH 12-31-04
BRUNSWICK STEAM ELECTRIC PLANT

		MAXIMUM WIND SPEED (m/sec)						
Stability	Total	0.36	1.56	3.35	5.59	8.27	10.95	15.65
1	0.21	0.00	0.00	0.02	0.13	0.05	0.00	0.00
2	0.25	0.00	0.00	0.04	0.18	0.02	0.00	0.00
3	0.32	0.00	0.01	0.11	0.18	0.02	0.00	0.00
4	0.85	0.00	0.03	0.25	0.34	0.20	0.04	0.00
5	0.88	0.00	0.02	0.14	0.32	0.33	0.06	0.01
6	0.39	0.00	0.03	0.10	0.19	0.06	0.00	0.00
7	0.43	0.00	0.04	0.14	0.21	0.03	0.00	0.00
Total	3.33	0.01	0.13	0.81	1.55	0.71	0.11	0.01
Entrapment		0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ground Velocity		0.06	0.30	0.76	1.39	2.15	2.98	4.12
Elevated Velocity		0.18	0.95	2.42	4.40	6.83	9.47	13.10

AVERAGE WIND SPEED (m/sec)			
Mean	Ground	Elevated	Combined
Arithmetic	0.00	4.49	4.49
Harmonic	0.00	3.29	3.29

TABLE B-29

DOSE PARAMETERS FOR FINITE ELEVATED PLUMES
NW SITE BOUNDARY*

Noble Gas Radionuclides	V_i Total Body $\left(\frac{\text{mrem/yr}}{\mu\text{Ci/ sec}}\right)$	B_i Gamma Air $\left(\frac{\text{mrad/yr}}{\mu\text{Ci/ sec}}\right)$
Kr-83m	9.83E-10`	3.64E-07
Kr-85m	3.83E-05	5.69E-05
Kr-85	5.83E-07	8.83E-07
Kr-87	1.70E-04	2.55E-04
Kr-88	4.72E-04	7.08E-04
Kr-89	1.95E-04	2.93E-04
Xe-131m	9.58E-06	1.54E-05
Xe-133m	7.34E-06	1.23E-05
Xe-133	7.64E-06	1.22E-05
Xe-135m	7.85E-05	1.19E-04
Xe-135	6.21E-05	9.33E-05
Xe-137	1.50E-05	2.27E-05
Xe-138	2.64E-04	3.97E-04
Xe-139	3.48E-06	5.23E-06
Ar-41	3.26E-04	4.90E-04

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

TABLE B-30

JOINT FREQUENCY DISTRIBUTION FOR NW SECTOR (%)
PERIOD 1-1-00 THROUGH 12-31-04
BRUNSWICK STEAM ELECTRIC PLANT

		MAXIMUM WIND SPEED (m/sec)						
Stability	Total	0.36	1.56	3.35	5.59	8.27	10.95	15.65
1	0.19	0.00	0.00	0.04	0.14	0.01	0.00	0.00
2	0.25	0.00	0.00	0.05	0.18	0.02	0.00	0.00
3	0.30	0.00	0.00	0.13	0.13	0.04	0.00	0.00
4	0.88	0.00	0.02	0.36	0.29	0.14	0.05	0.02
5	0.72	0.00	0.02	0.12	0.29	0.18	0.08	0.03
6	0.31	0.00	0.03	0.09	0.09	0.09	0.01	0.00
7	0.43	0.01	0.05	0.15	0.18	0.05	0.00	0.00
Total	3.09	0.01	0.12	0.94	1.30	0.52	0.14	0.05
Entrapment		0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ground Velocity		0.06	0.30	0.76	1.39	2.15	2.98	4.12
Elevated Velocity		0.18	0.95	2.42	4.40	6.83	9.47	13.10

AVERAGE WIND SPEED (m/sec)			
Mean	Ground	Elevated	Combined
Arithmetic	0.00	4.42	4.42
Harmonic	0.00	3.13	3.13

TABLE B-31

DOSE PARAMETERS FOR FINITE ELEVATED PLUMES
NNW SITE BOUNDARY*

Noble Gas Radionuclides	V_i Total Body $\left(\frac{\text{mrem/yr}}{\mu\text{Ci/ sec}}\right)$	B_i Gamma Air $\left(\frac{\text{mrad/yr}}{\mu\text{Ci/ sec}}\right)$
Kr-83m	8.53E-10	2.74E-07
Kr-85m	3.71E-05	5.52E-05
Kr-85	5.69E-07	8.62E-07
Kr-87	1.67E-04	2.51E-04
Kr-88	4.61E-04	6.92E-04
Kr-89	1.97E-04	2.96E-04
Xe-131m	9.13E-06	1.46E-05
Xe-133m	6.99E-06	1.16E-05
Xe-133	7.23E-06	1.14E-05
Xe-135m	7.75E-05	1.18E-04
Xe-135	6.03E-05	9.06E-05
Xe-137	1.53E-05	2.31E-05
Xe-138	2.59E-04	3.89E-04
Xe-139	3.77E-06	5.66E-06
Ar-41	3.20E-04	4.80E-04

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

TABLE B-32

JOINT FREQUENCY DISTRIBUTION FOR NNW SECTOR (%)
PERIOD 1-1-00 THROUGH 12-31-04
BRUNSWICK STEAM ELECTRIC PLANT

		MAXIMUM WIND SPEED (m/sec)						
Stability	Total	0.36	1.56	3.35	5.59	8.27	10.95	15.65
1	0.17	0.00	0.00	0.04	0.12	0.01	0.00	0.00
2	0.16	0.00	0.00	0.03	0.11	0.02	0.00	0.00
3	0.25	0.00	0.00	0.10	0.12	0.02	0.00	0.00
4	0.91	0.00	0.03	0.29	0.36	0.16	0.05	0.01
5	0.94	0.00	0.02	0.12	0.34	0.22	0.14	0.09
6	0.42	0.00	0.03	0.12	0.16	0.05	0.04	0.02
7	0.36	0.00	0.03	0.16	0.13	0.03	0.00	0.00
Total	3.21	0.01	0.12	0.86	1.34	0.52	0.23	0.12
Entrapment		0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ground Velocity		0.06	0.30	0.76	1.39	2.15	2.98	4.12
Elevated Velocity		0.18	0.95	2.42	4.40	6.83	9.47	13.10

AVERAGE WIND SPEED (m/sec)			
Mean	Ground	Elevated	Combined
Arithmetic	0.00	4.80	4.80
Harmonic	0.00	3.28	3.28

LIST OF TABLES

APPENDIX C

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 10CFR 20 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, Regulatory Guide 1.109 Revision 1, and letter to J. W. Davis, "Dose Factors for Hf-181 and SN-113", BSEP File: B10-10530, May 24, 1988 and NUREG CR4653 for Am-241. The following sections provide the specific methodology which was utilized in calculating the P_i and R_i values for the inhalation pathway.

C.1 CALCULATION OF P_i

The parameter P_i contained in the radioiodine and particulate portion of Section 3.2, includes pathway transport parameters of the ith 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 section provides the methodology which was used in calculating the P_i values for inclusion into this ODCM.

C.1.1 Inhalation Pathway

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

where:

P_{i_I} = dose parameter for radionuclide i for the inhalation pathway, mrem/yr per $\mu Ci/m^3$

K' = a constant of unit conversion

= 10^6 pCi/μCi

BR = the breathing rate of the receptor age group, m^3/yr

DFA_i = the organ inhalation dose factor for the receptor age group for radionuclide i, mrem/pCi. The total body is considered as an organ in the selection of DFA_i.

C.2 CALCULATION OF R_i

The Radioiodine and Particulate ODCM Specification 7.3.9 is applicable to the location in the unrestricted area where the combination of existing pathways and receptor age groups indicates 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, child, and infant age groups for the ground plane, cow milk, goat milk, vegetable and beef ingestion pathways. The methodology which was utilized to calculate these values is presented below.

C.2.1 Inhalation Pathway

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

where:

R_{i_I} = Dose factor for each identified radionuclide i of the organ of interest, mrem/yr per $\mu Ci/m^3$

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 the 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, BSEP File: B10-10530, Letter to J. W. Davis "Dose Factors for Hf-181 and Sn-113," May 24, 1988, and NUREG CR4653 for AM-241.

C.2.2 Ground Plane Pathway

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

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

λ_i = The radiological decay constant for radionuclide i, sec^{-1}

t = The exposure time, sec

= 4.73×10^8 sec (15 years)

DFG_i = The ground plane dose conversion factor for radionuclide i; mrem/hr per pCi/m^2

SF	=	The shielding factor (dimensionless)
I_i	=	Factor to account for fractional deposition of radionuclide i

For radionuclides other than iodine, the factor I_i is equal to one. For radioiodines, the value of I_i may vary. However, a value of 1.0 was used in calculating the R values in Table 3.3-2.

A shielding factor of 0.7 is suggested in Table E-15 of Regulatory Guide 1.109 Revision 1. A tabulation of DFG_i values is presented in Table E-6 of Regulatory Guide 1.109, Revision 1.

C.2.3 <u>Grass-Cow or Goat Milk Pathway</u>

$$R_{i_M} = I_i K' Q_F U_{ap} F_m (DFL_i)_a e^{-\lambda_i t_f}$$

$$\left\{ f_p f_s \left[\frac{r(1-e^{-\lambda_{E_i} t_e})}{Y_p \lambda_{E_i}} + \frac{B_{iv}(1-e^{-\lambda_i t_b})}{P\lambda_i} \right] + (1-f_p f_s) \left[\frac{r(1-e^{-\lambda_{E_i} t_e})}{Y_s \lambda_{E_i}} + \frac{B_{iv}(1-e^{-\lambda_i t_b})}{P\lambda_i} \right] e^{-\lambda_i t_h} \right\} \quad (C.2\text{-}3)$$

where:

R_{i_M}	=	Dose factor for the cow milk or goat milk pathway, for each identified radionuclide i for the organ of interest, mrem/yr per μCi/sec per m^{-2}
K′	=	A constant of unit conversion
	=	10^6 pCi/μCi
Q_F	=	The cow's or goat's feed consumption rate. kg/day (wet weight)
U_{ap}	=	The receptor's milk consumption rate for age group a, liters/yr
Y_p	=	The agricultural productivity by unit area of pasture feed grass, kg/m^2
Y_s	=	The agricultural productivity by unit area of stored feed, kg/m^2
F_m	=	The stable element transfer coefficients, pCi/liter per pCi/day

r	=	Fraction of deposited activity retained on cow's feed grass
$(DFL_i)_a$	=	The organ ingestion dose factor for radionuclide i for the receptor in age group a, mrem/pCi
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}
	=	5.73×10^{-7} sec^{-1} (corresponding to a 14 day half-life)
t_f	=	The transport time from feed to cow or goat to milk, to receptor, sec
t_h	=	The transport time from harvest to cow or goat consumption, sec
t_b	=	Period of time that soil 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
f_s	=	Fraction of the cow feed that is pasture grass while the cow is on pasture
t_e	=	Period of pasture grass and crop exposure during the growing season, sec
I_i	=	Factor to account for fractional deposition of radionuclide i

For radionuclides other than iodine, the factor I_i is equal to one. For radioiodines, the value of I_i may vary. However, a value of 1.0 was used in calculating the R values Tables 3.3-9 through 3.3-16.

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 C-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 X/Q:

$$R_{T_M} = K'K'''F_m Q_F U_{ap} (DFL_i)_a \left[0.75\left(\frac{0.5}{H}\right)\right] \qquad \text{(C.2-4)}$$

where:

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

K′ = A constant unit of conversion, 10^6 pCi/μCi

K‴ = A constant unit of conversion

= 10^3gm/kg

H = Absolute humidity of the atmosphere, gm/m^3

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

Other parameters and values as defined previously. A value for H of 8 grams/meter^3, was used in lieu of site-specific information.

C.2.4 <u>Grass-Cow-Meat Pathway</u>

The integrated concentration in meat follows in a similar manner to the development for the milk pathway, therefore:

$$R_{i_B} = I_i K' Q_F U_{ap} F_f (DFL_i)_a e^{-\lambda_i t_s}$$

$$\left\{ f_p f_s \left[\frac{r(1-e^{-\lambda_{E_i} t_e})}{Y_p \lambda_{E_i}} + \frac{B_{iv}(1-e^{-\lambda_i t_b})}{P\lambda_i} \right] + (1-f_p f_s) \left[\frac{r(1-e^{-\lambda_{E_i} t_e})}{Y_s \lambda_{E_i}} + \frac{B_{iv}(1-e^{-\lambda_i t_b})}{P\lambda_i} \right] e^{-\lambda_i t_h} \right\}$$

(C.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 = The transport time from slaughter to consumption, sec

t_h = The 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, the factor I_i is equal to one. For radioiodines, the value of I_i may vary. However, a value of 1.0 was used in calculating the R values in Tables 3.3-6 through 3.3-8.

All other terms remain the same as defined in Equation C.2-3. Table C-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, R_i is based on X/Q.

$$R_{T_B} = K'K'''F_f Q_F U_{ab} (DFL_i)_a \left[0.75\left(\frac{0.5}{H}\right)\right] \qquad \text{(C.2-6)}$$

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 as defined in Equation C.2-4 and C.2-5, above.

C.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:

$$R_{i_V} = I_i K'(DFL_i)_a$$

$$\left\{U_a^L f_L e^{-\lambda_i t_L}\left[\frac{r(1-e^{-\lambda_{E_i} t_e})}{Y_V \lambda_{E_i}} + \frac{B_{iv}(1-e^{-\lambda_i t_b})}{P\lambda_i}\right] + U_a^S f_g e^{-\lambda_i t_h}\left[\frac{r(1-e^{-\lambda_{E_i} t_e})}{Y_V \lambda_{E_i}} + \frac{B_{iv}(1-e^{-\lambda_i t_b})}{P\lambda_i}\right]\right\}$$

(C.2-7)

where:

R_{i_V}	=	Dose factor for vegetable pathway for radio nuclide i for the organ of interest mrem/yr per μCi/sec per m $^{-2}$
K'	=	a constant of unit conversion
	=	10^6 pCi/μCi
U_a^L	=	The consumption rate of fresh leafy vegetation by the receptor age group a, kg/yr
U_a^S	=	The consumption rate of stored vegetation by the receptor in age group a, kg/yr
f_g	=	The fraction of the annual intake of stored vegetation grown locally
f_L	=	The fraction of annual intake of fresh, leafy vegetables grown locally
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 area 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

For radionuclides other than iodine, the factor I_i is equal to one. For radioiodines, the value of I_i may vary. However, a value of 1.0 was used in Tables 3.3-3 through 3.3-5.

All other factors were defined above.

Table C-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 calculation of 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 bases on χ/Q:

$$R_{T_V} = K'K''' \left[U_a^L f_L + U_a^S f_g\right](DFL_i)_a \left[0.075\left(\frac{0.5}{H}\right)\right] \quad (C.2\text{-}8)$$

where:

R_{T_V} = Dose factor for the cow or goat milk pathway for tritium for the organ of interest, mrem/yr per μCi/m^3

All other terms remain the same as those in Equations C.2-4 and C.2-7.

TABLE C-1

PARAMETERS FOR COW AND GOAT MILK PATHWAYS

Parameter	Value	Reference (Reg. Guide 1.109, Rev. 1)
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	1.0 (radioiodines) 0.2 (particulates)	Table E-15 Table E-15
$(DFL_i)_a$ (mrem/pCi)	Each radionuclide	Tables E-11 to E-14*
F_m (pCi/1 per pCi/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 330 child 400 teen 310 adult	Table E-5 Table E-5 Table E-5 Table E-5
t_e (seconds)	2.59 x 10^6 (pasture) 5.18 x 10^6 (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

*Reference 1, BSEP File: B10-10530, Letter to J. W. Davis "Dose Factors for Hf-181 and Sn-113," May 24, 1988, and NUREG CR4653 for AM-241.

**Where goat data was not available, cow value F_m was assumed.

TABLE C-2

PARAMETERS FOR THE MEAT PATHWAY

Parameter	Value	Reference (Reg. Guide 1.109, Rev. 1)
r	1.0 (radioiodines) 0.2 (particulates)	Table E-15 Table E-15
F_f (pCi/Kg 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 (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) 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

*Reference 1, BSEP File: B10-10530, Letter to J. W. Davis "Dose Factors for Hf-181 and Sn-113," May 24, 1988, and NUREG CR4653 for AM-241.

TABLE C-3

PARAMETERS FOR THE VEGETABLE PATHWAY

Parameter		Value	Reference (Reg. Guide 1.109, Rev. 1)
r (dimensionless)		1.0 (radioiodines) 0.2 (particulates)	Table E-1 Table E-1
$(DFL_i)_a$ (mrem/Ci)		Each radionuclide	Tables E-11 to E-14*
U_a^L (kg/yr)	-Infant -Child -Teen -Adult	0 26 42 64	Table E-5 Table E-5 Table E-5 Table E-5
U_a^S (kg/yr)	-Infant -Child -Teen -Adult	0 520 630 520	Table E-5 Table E-5 Table E-5 Table E-5
t_L (seconds)		8.6×10^4 (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*

*Reference 1, BSEP File: B10-10530, Letter to J. W. Davis "Dose Factors for Hf-181 and Sn-113," May 24, 1988, and NUREG CR4653 for AM-241.

APPENDIX D

LOWER LIMIT OF DETECTION (LLD)

The following discussion of LLD is taken from NUREG-0473, Rev. 2, February 1, 1980. It represents the bases for LLD footnotes (e) in Table 7.3.3-1, (e) in Table 7.3.3-2, (a) in Table 7.3.7-1, and (b) in Table 7.3.15-3 of the BSEP ODCM Specifications. The LLD is the smallest concentration of radioactive material in a sample that will be detected with 95 percent probability with 5 percent probability of falsely concluding that a blank observation represents a "real" signal.

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

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

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 transformation),

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

2.22×10^6 is the number of transformations per minute per microcurie,

Y is the fractional radiochemical yield (when applicable),

λ is the radioactive decay constant for the particular radionuclide, and Δt is the elapsed time between midpoint of sample collection and time of counting (for plants effluents, not environmental samples).

The value of s_b used in the calculation of the LLD for a detection system shall be based on the actual observed variance of the background counting rate or of the counting rate of the blank samples (as appropriate) rather than on an unverified theoretically predicted variance. Typical values of E, V, Y, and Δt shall be used in the calculation.

APPENDIX E

RADIOACTIVE LIQUID AND GASEOUS EFFLUENT MONITORING INSTRUMENTATION NUMBERS

I. Liquid Effluent Monitoring Instruments

A.	Liquid Radwaste Radioactivity Monitor	2-D12-RM-K604
B.	Liquid Radwaste Effluent Flow Measurement Device	2-G16-FIT-N057
C.	Main Service Water Effluent Radioactivity Monitor	1(2)-D12-RM-K605
D.	Drainage Holding Facility Effluent Composite Sampler	0-DHF-COMP-SAMPLER1
E.	Drainage Holding Facility Effluent Flow Measurement Device	0-DHF-FIT-1
F.	Condensate Storage Tank Level Indicating Device	1(2)-CO-LIT-1160
G.	Groundwater Extraction Effluent Composite Sampler	0-GWE-COMP-SAMPLER-1
H.	Groundwater Extraction Effluent Flow Measurement Device	0-GWE-FIT-1
I.	Stabilization Facility Effluent Composite Sampler	0-SDSF-COMP-SAMPLER-2
J.	Stabilization Facility Effluent Flow Measurement Device	0-SDSF-FIT-2

I. Gaseous Effluent Monitoring Instruments

1. Main Stack Monitoring System

a.	Noble Gas Activity Monitor	2-D12-RM-23S (2-D12-RE-4982)
b.	Iodine Sampler Cartridge	IRSH35 Prefilters A or B
c.	Particulate Sampler Filter	IRSH35 Prefilters A or B
d.	System Effluent Flow Rate Measurement Device	2-VA-FIQ-5902-1 OR -2
e.	Low Range Sampler Flow Rate Measurement Device	2-D12-FE-4597
f.	Mid/High Range Sampler Flow Rate Measurement Device	2-D12-FE-4596

RADIOACTIVE LIQUID AND GASEOUS EFFLUENT MONITORING
INSTRUMENTATION NUMBERS (Cont'd)

2. Reactor Building Ventilation Monitoring System

a.	Noble Gas Activity Monitor	1(2)-CAC-AQH-1264-3
b.	Iodine Sampler Cartridge	1(2)-CAC-AQH-1264-2 (collection cartridge only)
c.	Particulate Sampler Filter	1(2)-CAC-AQH-1264-1 (collection filter only)
d.	System Effluent Flow Rate Measurement Device	1(2)-VA-FIQ-3356
e.	Sampler Flow Rate Measurement Device	1(2)-CAC-FI-1264

3. Turbine Building Ventilation Monitoring System

a.	Noble Gas Activity Monitor	1(2)-D12-RM-23 (1(2)-D12-RE-4563)
b.	Iodine Sampler Cartridge (Recirculation Mode)	1(2)-IRTB32 Prefilters A or B
	Iodine Sampler Cartridge for Once Through Ventilation (Unit 2 only)	2-D12-OTV-FLT-03(04)
c.	Particulate Sampler Filter (Recirculation Mode)	1(2)-IRTB32 Prefilters A or B
	Particulate Sampler Filter Once Through Ventilation (Unit 2 only)	2-D12-OTV-FLT-03(04)
d.	System Effluent Flow Rate Measurement Device (Recirculation Mode)	1(2)-VA-FIQ-3358
	System Effluent Flow Rate Measurement Device for Once Through Ventilation (Unit 2 only)	2-VA-FIQ-7554
e.	Low Range Sampler Flow Rate Measurement Device	1(2)-D12-FE-4542
	Sampler Flow Rate Measurement Device for Once Through Ventilation (Unit 2 only)	2-D12-FE-7559
f.	Mid/High Range Sampler Flow Rate Measurement Device	1(2)-D12-FE-4543

RADIOACTIVE LIQUID AND GASEOUS EFFLUENT MONITORING
INSTRUMENTATION NUMBERS (Cont'd)

4. Main Condenser Off-Gas Treatment System (AOG) Monitor

   a. Noble Gas Activity Monitor — 1(2)-AOG-RM-103

5. Main Condenser Off-Gas Treatment System Explosive Gas Monitoring System

   a. Recombiner Train A

      1. First Hydrogen Monitor — 1(2)-OG-AIT-4284 - Stream 1

      2. Second Hydrogen Monitor — 1(2)-OG-AIT-4324 - Stream 2

   b. Recombiner Train B

      1. First Hydrogen Monitor — 1(2)-OG-AIT-4324 - Stream 1

      2. Second Hydrogen Monitor — 1(2)-OG-AIT-4284 - Stream 2

6. Main Condenser Air Ejector Radioactivity Monitor

   a. Noble Gas Activity Monitor — 1(2)-D12-RM-K601A
      1(2)-D12-RM-K601B

7. Hot Shop Ventilation Monitoring System

   a. Iodine Sampler Cartridge

   b. Particulate Sampler Filter

   c. Sampler Flow Rate Measurement Device — 2-D12-FI-6094

8. Radioactive Materials Container and Storage Building Decontamination Facility

   a. Iodine Sampler Cartridge

   b. Particulate Sampler Filter

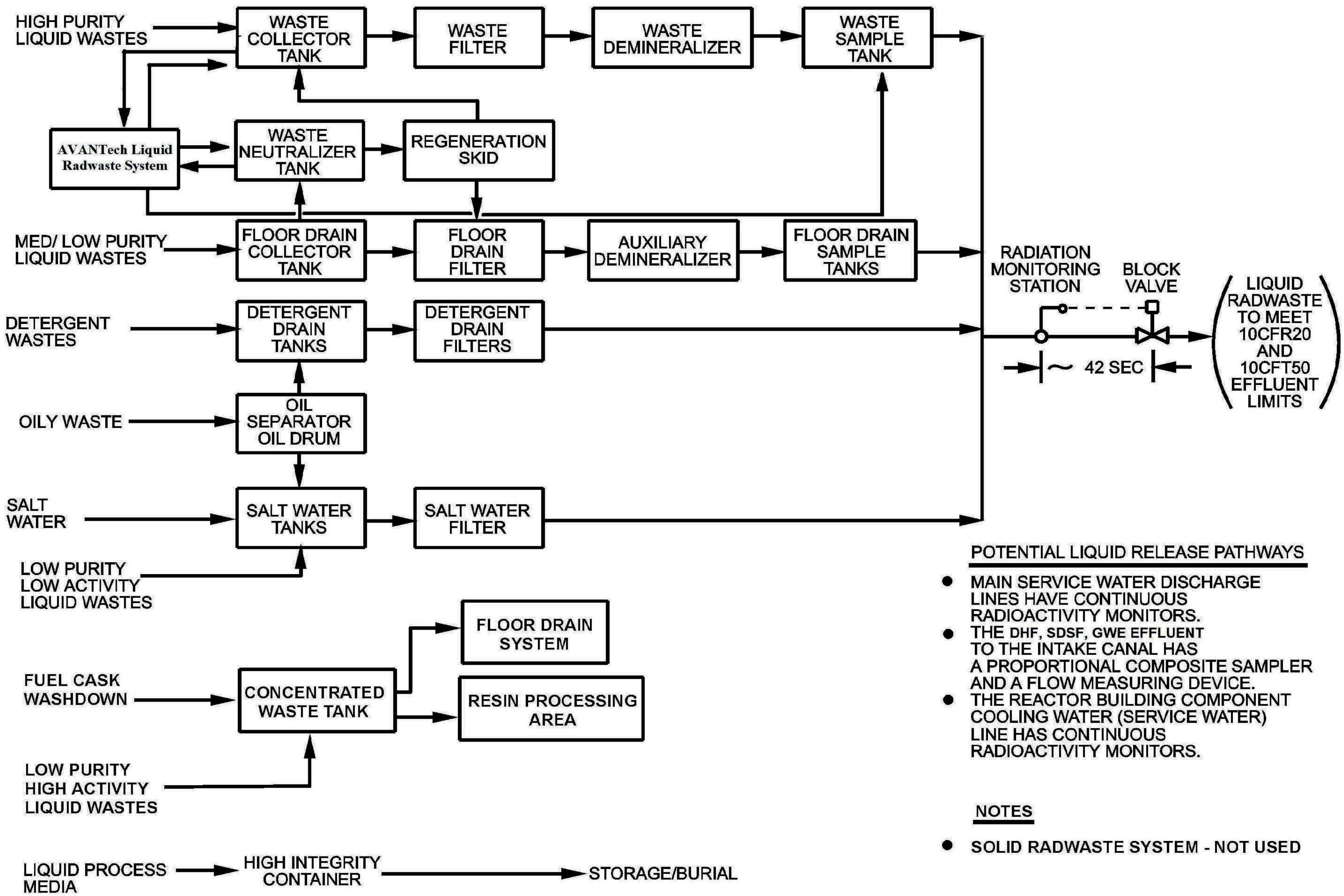
   c. Sampler Flow Rate Measurement Device

APPENDIX F

LIQUID AND GASEOUS EFFLUENT SYSTEM DIAGRAMS

FIGURE F-1

Liquid Radwaste Effluent System



POTENTIAL LIQUID RELEASE PATHWAYS

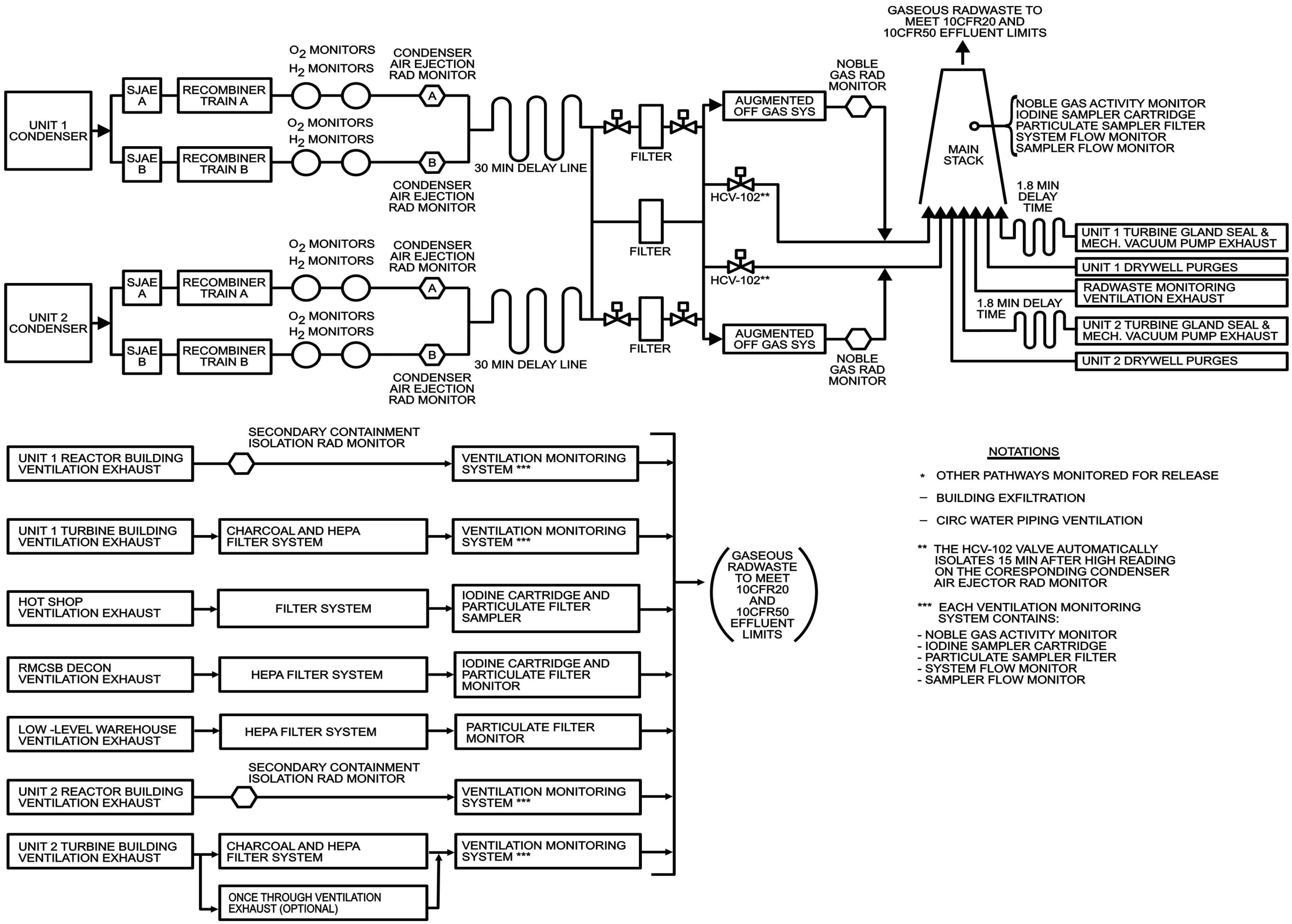
- MAIN SERVICE WATER DISCHARGE LINES HAVE CONTINUOUS RADIOACTIVITY MONITORS.
- THE DHF, SDSF, GWE EFFLUENT TO THE INTAKE CANAL HAS A PROPORTIONAL COMPOSITE SAMPLER AND A FLOW MEASURING DEVICE.
- THE REACTOR BUILDING COMPONENT COOLING WATER (SERVICE WATER) LINE HAS CONTINUOUS RADIOACTIVITY MONITORS.

NOTES

- SOLID RADWASTE SYSTEM - NOT USED

FIGURE F-2

Gaseous Radwaste Effluent System



NOTATIONS

* OTHER PATHWAYS MONITORED FOR RELEASE

– BUILDING EXFILTRATION

– CIRC WATER PIPING VENTILATION

** THE HCV-102 VALVE AUTOMATICALLY ISOLATES 15 MIN AFTER HIGH READING ON THE CORESPONDING CONDENSER AIR EJECTOR RAD MONITOR

*** EACH VENTILATION MONITORING SYSTEM CONTAINS:

- NOBLE GAS ACTIVITY MONITOR
- IODINE SAMPLER CARTRIDGE
- PARTICULATE SAMPLER FILTER
- SYSTEM FLOW MONITOR
- SAMPLER FLOW MONITOR

APPENDIX G

ODCM SOFTWARE PACKAGE

In order to minimize calculational errors and to facilitate the use of the ODCM, BSEP utilizes a Canberra developed software package called OpenEMS. All applicable calculations listed in the ODCM have been included in this software.

During periods when the OpenEMS software is not available, the following alternate method may be used to assess dose or dose rates to the public from liquid or gaseous effluents:

Dt = (Dh x Ct)/Ch

where: Dt = the unknown dose/dose rate for the time period

Dh = the known dose/dose rate from historical data

Ct = the total curies released for the time period

Ch = the total curies used to calculate the known dose/dose rate

When the OpenEMS software becomes available again, all doses to the public will be reassessed using the software package.

LIST OF TABLES

TABLE H-1

χ/Q Values at the Standard Distances for Releases from the Stabilization Facility

Progress Energy - Brunswick
Release Type: Annual
Release Mode: Ground Level
Variable: Relative Concentration Sec./Cubic Meter)
Calculated Points: Standard
Model: Straight Line Gaussian Diffusion
Period: 2006-2010
Number of Observations: 43738

Base Distance in Miles

Sector	0.25	0.50	0.75	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50
NNE	5.78E-05	1.69E-05	8.21E-06	3.92E-06	1.48E-06	7.79E-07	4.86E-07	3.36E-07	2.48E-07	1.93E-07	1.55E-07
NE	1.10E-04	3.20E-05	1.56E-05	7.46E-06	2.80E-06	1.47E-06	9.12E-07	6.28E-07	4.64E-07	3.59E-07	2.88E-07
ENE	2.04E-04	5.97E-05	2.91E-05	1.39E-05	5.26E-06	2.77E-06	1.73E-06	1.20E-06	8.86E-07	6.88E-07	5.54E-07
E	2.36E-04	6.88E-05	3.33E-05	1.60E-05	6.08E-06	3.23E-06	2.03E-06	1.41E-06	1.05E-06	8.20E-07	6.63E-07
ESE	2.77E-04	8.04E-05	3.87E-05	1.86E-05	7.10E-06	3.78E-06	2.38E-06	1.66E-06	1.24E-06	9.70E-07	7.85E-07
SE	3.47E-04	1.01E-04	4.85E-05	2.32E-05	8.88E-06	4.73E-06	2.98E-06	2.08E-06	1.55E-06	1.21E-06	9.84E-07
SSE	6.69E-04	1.94E-04	9.29E-05	4.46E-05	1.71E-05	9.13E-06	5.77E-06	4.03E-06	3.01E-06	2.36E-06	1.91E-06
S	6.39E-04	1.85E-04	8.91E-05	4.27E-05	1.64E-05	8.73E-06	5.51E-06	3.85E-06	2.87E-06	2.25E-06	1.82E-06
SSW	2.38E-04	6.95E-05	3.38E-05	1.62E-05	6.14E-06	3.25E-06	2.04E-06	1.41E-06	1.05E-06	8.18E-07	6.60E-07
SW	8.73E-05	2.55E-05	1.24E-05	5.94E-06	2.24E-06	1.18E-06	7.34E-07	5.06E-07	3.74E-07	2.90E-07	2.33E-07
WSW	5.67E-05	1.65E-05	8.08E-06	3.85E-06	1.44E-06	7.54E-07	4.67E-07	3.21E-07	2.36E-07	1.82E-07	1.46E-07
W	5.40E-05	1.58E-05	7.70E-06	3.67E-06	1.38E-06	7.22E-07	4.49E-07	3.09E-07	2.28E-07	1.77E-07	1.42E-07
WNW	4.83E-05	1.41E-05	6.88E-06	3.28E-06	1.23E-06	6.47E-07	4.03E-07	2.78E-07	2.05E-07	1.59E-07	1.28E-07
NW	4.80E-05	1.40E-05	6.85E-06	3.27E-06	1.23E-06	6.45E-07	4.01E-07	2.76E-07	2.04E-07	1.58E-07	1.27E-07
NNW	5.48E-05	1.60E-05	7.82E-06	3.73E-06	1.41E-06	7.40E-07	4.61E-07	3.19E-07	2.36E-07	1.83E-07	1.47E-07
N	6.23E-05	1.82E-05	8.91E-06	4.26E-06	1.61E-06	8.47E-07	5.29E-07	3.65E-07	2.70E-07	2.10E-07	1.69E-07

<u>ATTACHMENT 10</u>

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 1/1/2023 - 12/31/2023

No changes were made to the BSEP Process Control Program (PCP) in 2023

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 1/1/2023 - 12/31/2023

Summary:

No major modifications to Brunswick Steam Electric Plant liquid, gaseous, solid, or mobile radioactive waste treatment systems occurred in 2023.

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

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2023 - 12/31/2023

There was an error found in the 2021 and 2022 ARERR for attachment 7 Information to Support the NEI Ground Water Protection Initiative. This error reported some information the same for years 2021 and 2022. Below are the corrected pages of attachment 7 for the years 2021 and 2022.

Attachment 12
Errata to a Previous Year's ARERR

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2023 - 12/31/2023

Attachment 7
Information to Support the NEI Ground Water Protection Initiative

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2021 - 12/31/2021

Brunswick Unit 1 CST Groundwater Wells						
Well Name	Number of Samples in 2021	Number of Positive H-3 Samples in 2021	Average H-3 Activity (pCi/L)	Minimum H-3 Activity (pCi/L)	Maximum H-3 Activity (pCi/L)	Depth of Well (ft)
GWM-01	27	27	1.59E+03	628	2389	61
GWM-02	9	9	8.28E+03	1929	11795	45
GMW-06	0	-	-	-	-	45
GWM-08	0	-	-	-	-	45
GWM-09	0	-	-	-	-	46
GWM-10	0	-	-	-	-	45
GWM-11	0	-	-	-	-	45
GWM-12	0	-	-	-	-	33
GMW-13	27	27	1.01E+04	4233	18336	44
GWM-14	27	26	2.14E+04	4407	32811	44
GMW-15	27	27	6.27E+03	1744	24476	59
GWM-16	27	26	7.41E+04	42976	120232	40
GMW-17	13	13	1.12E+04	3674	18374	68
GWM-18	27	27	1.02E+05	20686	236881	29
GMW-19	22	22	6.16E+03	2054	13512	40
GMW-20	15	14	4.30E+03	1836	7425	45
GMW-21	13	13	1.89E+04	9702	28295	45
GWM-22	25	25	8.08E+03	2776	12313	29
MW-1	11	4	4.13E+02	300	643	24
MW-1B	11	0	0.00E+00	0	0	45
U1CSTREM-02B	13	10	1.08E+03	282	4531	68
U1CSTREM-05B	10	1	3.39E+02	339	339	65
U1CSTREM-07BCH	11	6	4.61E+02	401	505	85
U1CSTREM-09B	11	5	5.45E+02	335	690	68
U1CSTREM-09BCH	11	11	2.31E+03	523	17353	85
U1CSTREM-09C	13	13	6.72E+03	2630	10181	45
U1CSTREM-10C	11	1	3.03E+02	303	303	45
U1CSTREM-11C	11	2	3.38E+02	335	341	40
U1CSTREM-12C	14	14	2.91E+04	7250	61015	34
U1CSTREM-21B	11	6	5.99E+02	433	782	69
U1CSTREM-21C	11	11	4.56E+03	4112	4999	45
U1CSTREM-22B	11	3	3.99E+02	294	505	69
U1CSTREM-27B	11	0	0.00E+00	0	0	68
U1CSTREM-27C	11	11	7.23E+02	551	936	45
U1CSTREM-28C	11	7	3.76E+02	305	461	45
U1CSTREM-32C	11	7	4.55E+02	325	830	45

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	45	44	1.11E+03	531	1750	61
GWM-02	0	-	-	-	-	45
GMW-06	0	-	-	-	-	45
GWM-08	0	-	-	-	-	45
GWM-09	0	-	-	-	-	46
GWM-10	0	-	-	-	-	45
GWM-11	0	-	-	-	-	45
GWM-12	0	-	-	-	-	33
GMW-13	46	45	7.43E+03	1902	11343	44
GWM-14	50	47	7.13E+03	1407	14421	44
GMW-15	49	46	8.44E+02	325	2688	59
GWM-16	50	49	3.48E+04	2981	71584	40
GMW-17	50	50	9.45E+03	4276	13342	68
GWM-18	50	50	5.34E+04	6296	227418	29
GMW-19	50	48	5.57E+03	3329	9343	40
GMW-20	49	49	7.68E+03	1644	32426	45
GMW-21	0	-	-	-	-	45
GWM-22	0	-	-	-	-	29
MW-1	8	3	5.36E+02	366	782	24
MW-1B	8	1	3.60E+02	360	360	45
U1CSTREM-02B	12	4	9.69E+02	666	1225	68
U1CSTREM-05B	8	1	2.91E+02	291	291	65
U1CSTREM-07BCH	12	8	4.66E+02	268	705	85
U1CSTREM-09B	12	12	6.78E+02	425	1045	68
U1CSTREM-09BCH	12	6	5.69E+02	422	823	85
U1CSTREM-09C	12	12	3.32E+03	2114	4631	45
U1CSTREM-10C	8	1	4.19E+02	419	419	45
U1CSTREM-11C	8	2	2.73E+02	267	279	40
U1CSTREM-12C	12	11	4.62E+03	261	16896	34
U1CSTREM-21B	12	9	7.09E+02	247	1326	69
U1CSTREM-21C	12	12	5.14E+03	3201	5906	45
U1CSTREM-22B	8	4	3.50E+02	299	435	69
U1CSTREM-27B	8	1	6.67E+02	667	667	68
U1CSTREM-27C	12	12	6.72E+02	435	1096	45
U1CSTREM-28C	12	1	4.78E+02	478	478	45
U1CSTREM-32C	8	1	5.96E+02	596	596	45

ENCLOSURE 2: CNS Annual Radioactive Effluent Release Report

Catawba Nuclear Station
Units 1 and 2

Annual Radioactive Effluent Release Report

January 1, 2023 through December 31, 2023

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 1/1/2023 - 12/31/2023

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	5.06E-01	6.78E-01	7.99E-01	2.62E+00
2. Avg. Release Rate	μCi/sec	8.17E-02	6.44E-02	8.53E-02	1.01E-01	8.31E-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	1.23E-05	1.03E-05	0.00E+00	0.00E+00	2.25E-05
2. Avg. Release Rate	μCi/sec	1.58E-06	1.31E-06	0.00E+00	0.00E+00	7.15E-07
D. Tritium						
1. Total Release	Ci	3.90E+01	4.63E+01	5.02E+01	5.36E+01	1.89E+02
2. Avg. Release Rate	μCi/sec	5.01E+00	5.89E+00	6.32E+00	6.75E+00	6.00E+00
E. Carbon-14						
1. Total Release	Ci	5.43E+00	4.15E+00	5.43E+00	5.56E+00	2.06E+01
2. Avg. Release Rate	μCi/sec	6.98E-01	5.27E-01	6.83E-01	6.99E-01	6.52E-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 1/1/2023 - 12/31/2023

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 1/1/2023 - 12/31/2023

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 1/1/2023 - 12/31/2023

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	3.88E+01	4.61E+01	4.97E+01	5.29E+01	1.88E+02
E. Carbon-14 *						
C-14	Ci	1.63E+00	1.24E+00	1.63E+00	1.67E+00	6.17E+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 1/1/2023 - 12/31/2023

Gaseous Effluents - Ground Releases - Batch Mode

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Gases						
Ar-41	Ci	5.10E-01	4.06E-01	5.86E-01	6.74E-01	2.18E+00
Kr-85	Ci	3.18E-04	0.00E+00	2.28E-04	0.00E+00	5.47E-04
Xe-133	Ci	1.17E-01	9.46E-02	8.77E-02	1.18E-01	4.17E-01
Xe-135	Ci	8.54E-03	5.98E-03	4.35E-03	6.93E-03	2.58E-02
Total for Period	Ci	6.35E-01	5.06E-01	6.78E-01	7.99E-01	2.62E+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						
Bi-214	Ci	5.94E-06	5.24E-06	0.00E+00	0.00E+00	1.12E-05
Pb-214	Ci	6.33E-06	5.03E-06	0.00E+00	0.00E+00	1.14E-05
Total for Period	Ci	1.23E-05	1.03E-05	0.00E+00	0.00E+00	2.25E-05
D. Tritium						
H-3	Ci	1.40E-01	1.87E-01	4.86E-01	7.36E-01	1.55E+00
E. Carbon-14 *						
C-14	Ci	3.80E+00	2.90E+00	3.80E+00	3.89E+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

Catawba Nuclear Station Units 1 & 2
Period 1/1/2023 - 12/31/2023

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 1/1/2023 - 12/31/2023

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 1/1/2023 - 12/31/2023

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	5.61E-03	1.23E-02	9.87E-03	4.52E-02	7.30E-02
2. Avg. Diluted Conc.	µCi/ml	2.23E-10	3.91E-10	2.29E-10	1.59E-09	5.70E-10
3. Batch Releases	µCi/ml	2.23E-10	3.91E-10	2.29E-10	1.59E-09	5.70E-10
B. Tritium						
1. Total Release	Ci	3.86E+02	3.17E+02	2.83E+02	1.31E+02	1.12E+03
2. Avg. Diluted Conc.	µCi/ml	1.54E-05	1.00E-05	6.57E-06	4.62E-06	8.72E-06
3. Batch Releases	µCi/ml	1.54E-05	1.00E-05	6.57E-06	4.62E-06	8.72E-06
C. Dissolved & Entrained Gases						
1. Total Release	Ci	1.22E-05	0.00E+00	0.00E+00	0.00E+00	1.22E-05
2. Avg. Diluted Conc.	µCi/ml	4.84E-13	0.00E+00	0.00E+00	0.00E+00	9.50E-14
3. Batch Releases	µCi/ml	4.84E-13	0.00E+00	0.00E+00	0.00E+00	9.50E-14
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	5.13E+07	0.00E+00	0.00E+00	0.00E+00	5.13E+07
2. Batch Releases	liters	1.38E+06	2.08E+06	1.44E+06	1.16E+06	6.06E+06
F. Volume of Dilution Water						
1. Continuous Releases	liters	2.51E+09	3.16E+09	4.31E+09	2.84E+09	1.28E+10
2. Batch Releases	liters	2.51E+10	3.16E+10	4.31E+10	2.84E+10	1.28E+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 1/1/2023 - 12/31/2023

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	7.73E-02	0.00E+00	0.00E+00	0.00E+00	7.73E-02
C. Dissolved & Entrained Gases						
None	Ci	-	-	-	-	-
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Gross Alpha						
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Attachment 1
Summary of Gaseous and Liquid Effluents

Catawba Nuclear Station Units 1 & 2
Period 1/1/2023 - 12/31/2023

Liquid Effluents - Batch Mode

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Products						
Ag-110m	Ci	0.00E+00	2.38E-05	4.25E-06	0.00E+00	2.80E-05
Ba-140	Ci	0.00E+00	4.89E-06	0.00E+00	0.00E+00	4.89E-06
Be-7	Ci	0.00E+00	0.00E+00	0.00E+00	4.42E-05	4.42E-05
Bi-214	Ci	3.80E-05	6.54E-06	1.58E-05	1.33E-06	6.17E-05
Br-84	Ci	0.00E+00	0.00E+00	0.00E+00	5.03E-05	5.03E-05
Co-57	Ci	0.00E+00	0.00E+00	5.95E-06	1.24E-04	1.30E-04
Co-58	Ci	4.90E-04	1.04E-03	1.35E-03	7.69E-03	1.06E-02
Co-60	Ci	2.07E-03	3.13E-03	3.31E-03	1.46E-02	2.31E-02
Cr-51	Ci	0.00E+00	2.60E-03	0.00E+00	0.00E+00	2.60E-03
Cs-137	Ci	0.00E+00	2.10E-05	4.81E-06	1.51E-05	4.09E-05
Fe-55	Ci	1.42E-03	1.80E-03	1.17E-03	5.62E-03	1.00E-02
Mn-54	Ci	4.48E-05	1.02E-04	1.07E-04	4.77E-03	5.02E-03
Nb-95	Ci	0.00E+00	1.03E-04	0.00E+00	1.49E-05	1.18E-04
Nb-97	Ci	0.00E+00	4.07E-06	5.28E-06	0.00E+00	9.34E-06
Ni-63	Ci	1.44E-03	3.31E-03	3.74E-03	1.17E-02	2.02E-02
Pb-214	Ci	6.82E-05	5.33E-05	4.62E-05	4.75E-05	2.15E-04
Sb-124	Ci	0.00E+00	0.00E+00	0.00E+00	4.97E-06	4.97E-06
Sb-125	Ci	3.53E-05	1.06E-04	1.03E-04	3.40E-04	5.84E-04
Se-75	Ci	0.00E+00	0.00E+00	3.51E-06	0.00E+00	3.51E-06
Sr-92	Ci	0.00E+00	3.70E-06	0.00E+00	0.00E+00	3.70E-06
Zn-65	Ci	0.00E+00	0.00E+00	0.00E+00	1.94E-04	1.94E-04
Zr-95	Ci	0.00E+00	4.03E-05	0.00E+00	0.00E+00	4.03E-05
Total for Period	Ci	5.61E-03	1.23E-02	9.87E-03	4.52E-02	7.30E-02
B. Tritium						
H-3	Ci	3.86E+02	3.17E+02	2.83E+02	1.31E+02	1.12E+03
C. Dissolved & Entrained Gases						
Xe-133m	Ci	1.22E-05	0.00E+00	0.00E+00	0.00E+00	1.22E-05
Total for Period	Ci	1.22E-05	0.00E+00	0.00E+00	0.00E+00	1.22E-05
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 1/1/2023 - 12/31/2023

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	=	108
2. Total Time (min) for Batch Releases	=	7.00E+03
3. Maximum Time (min) for a Batch Release	=	1.11E+02
4. Average Time (min) for Batch Releases	=	6.48E+01
5. Minimum Time (min) for a Batch Release	=	3.00E+01
6. Average Dilution Water Flow During Release (gpm)	=	6.44E+04

B. Gaseous Effluents

1. Total Number of Batch Releases	=	50
2. Total Time (min) for Batch Releases	=	1.02E+06
3. Maximum Time (min) for a Batch Release	=	4.58E+04
4. Average Time (min) for Batch Releases	=	2.04E+04
5. Minimum Time (min) for a Batch Release	=	9.10E+01

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 2023 ARERR contains estimates of C-14 radioactivity released in 2023 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 2023 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 2023 results in a site total C-14 gaseous release estimate to the environment of 2.06E+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 2023 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 2023 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 1/1/2023 - 12/31/2023

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%

Summary of Changes in Land Use Census Affecting Effluent Dose Calculations

The 2023 Land Use Census was performed June 19 to 21, 2023, and the results were certified and made available for use on July 27th, 2023. The following are changes to residences, gardens, and milk animals from the previous year.

Residences

The Residence in the SSE Sector (0.80 miles) was replaced with a residence at 0.73 miles.

Gardens

The garden in the NE sector (0.67 miles) was replaced with a garden at 2.61 miles.
The garden in the E sector (2.21 miles) was replaced with a garden at 2.14 miles.
The garden in the ESE sector (3.72 miles) was replaced with a garden at 1.12 miles.
The garden in the SW sector (1.99 miles) was replaced with a garden at 1.34 miles.
The garden in the WSW sector (2.07 miles) was replaced with a garden at 2.21 miles.
The garden in the NW sector (2.41 miles) was replaced with a garden at 1.72 miles.

Milk Animals

There were no new milk animals identified during the 2023 census.

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 1/1/2023 - 12/31/2023

	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	2	12	A	B-25	N/A	46.68	1.28E-02
b.	Dewatered Primary Resins	4	4	A / B	HIC	N/A	16.06	252
c.	Evaporator Concentrates	0	-	-	-	-	-	-
d.	Dewatered Mechanical Filters	1	1	C	HIC	N/A	3.41	73.1
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)	2	2	A	GDP	N/A	11.37	5.29
c.	Dry Active Waste (brokered)	12	23	A	GDP	N/A	101.1	2.61
d.	Irradiated Components	0	-	-	-	-	-	-
e.	***Other (add as necessary)***	0	-	-	-	-	-	-
3.	**Total Solid Waste**	**21**	**42**				**178.6**	**333**

Attachment 3
Solid Radioactive Waste Disposal

Catawba Nuclear Station Units 1 & 2
Period 1/1/2023 - 12/31/2023

Type of Waste Shipped	Radionuclide	% Abundance
1. Waste from Liquid Systems		
a. Dewatered Secondary Resins	Mn-54	0.31%
	Co-60	18.28%
	Cs-137	33.50%
	Ce-144	47.91%
b. Dewatered Primary Resins	H-3	0.03%
	Be-7	0.07%
	Mn-54	1.30%
	Co-57	0.11%
	Co-58	1.28%
	Co-60	10.59%
	Zn-65	0.37%
	Sb-125	0.42%
	Cs-134	0.04%
	Cs-137	0.35%
	Ce-144	0.14%
	C-14	0.05%
	Fe-55	37.39%
	Ni-59	0.25%
	Ni-63	47.20%
	Tc-99	0.41%
c. Evaporator Concentrates	N/A	N/A
d. Dewatered Mechanical Filters	H-3	0.03%
	Be-7	0.35%
	Cr-51	4.40%
	Mn-54	3.94%
	Co-57	0.14%
	Co-58	13.28%
	Fe-59	0.24%
	Co-60	20.52%
	Zn-65	1.57%
	Nb-95	3.43%
	Zr-95	1.83%
	Sn-113	0.21%
	Sb-124	0.06%
	Sb-125	1.33%
	Cs-137	0.84%
	Hf-181	0.02%
	Ce-144	2.28%
	C-14	0.78%
	Fe-55	35.01%
	Ni-59	0.00%
	Ni-63	9.67%
	Sr-89	0.01%
	Sr-90	0.00%
	Tc-99	0.03%
	Sn-117m	0.01%
	Cm-242	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 1/1/2023 - 12/31/2023

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

a.	Dry Active Waste (compacted)	N/A	N/A
b.	Dry Active Waste (non-compacted)	H-3	0.01%
		Mn-54	0.16%
		Co-57	0.01%
		Co-58	0.08%
		Co-60	39.59%
		Nb-94	0.03%
		Sb-125	0.21%
		Cs-137	0.01%
		Ce-144	0.05%
		C-14	0.22%
		Fe-55	27.09%
		Ni-59	0.18%
		Ni-63	32.34%
		Tc-99	0.00%
		Am-241	0.00%
		Pu-241	0.01%
		Cm-243	0.00%
c.	Dry Active Waste (brokered)	H-3	0.18%
		Cr-51	8.62%
		Mn-54	3.04%
		Co-57	0.17%
		Co-58	30.32%
		Fe-59	0.58%
		Co-60	16.79%
		Zn-65	0.62%
		Nb-95	3.91%
		Zr-95	2.33%
		Sn-113	0.37%
		Sb-124	0.05%
		Sb-125	0.47%
		Cs-137	0.06%
		Ce-144	0.22%
		C-14	0.16%
		Fe-55	19.73%
		Ni-59	0.36%
		Ni-63	11.27%
		Sr-89	0.39%
		Sr-90	0.35%
		Tc-99	0.00%
		I-129	0.00%
d.	Irradiated Components	N/A	N/A
e.	***Other (add as necessary)***	N/A	N/A

ATTACHMENT 4

Meteorological Data

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

Attachment 4
Meteorological Data

Catawba Nuclear Station Units 1 & 2
Period 1/1/2023 - 12/31/2023

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	1	0	0	0	0
	1.01-1.25	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
	1.26-1.50	0	0	1	0	0	0	1	0	2	5	4	5	2	1	0	0
	1.51-2.00	4	0	5	1	0	0	2	5	9	15	33	18	17	4	3	1
	2.01-3.00	11	6	3	0	0	0	4	27	24	85	99	42	48	25	15	11
	3.01-4.00	42	29	12	1	2	2	0	1	5	23	43	28	16	9	10	4
	4.01-5.00	30	34	28	3	0	0	0	0	0	4	6	3	0	1	2	3
	5.01-6.00	7	33	6	1	0	0	0	0	0	2	0	0	0	1	0	5
	6.01-8.00	4	8	1	0	0	0	0	0	0	0	0	0	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
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	2	0	0	0	1	1	0	0
	1.01-1.25	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0
	1.26-1.50	0	0	0	0	0	0	2	3	4	7	8	4	2	2	1	0
	1.51-2.00	4	1	0	1	0	2	9	14	22	16	14	12	9	10	3	3
	2.01-3.00	21	11	1	0	2	1	0	15	11	29	21	9	12	11	12	11
	3.01-4.00	40	19	4	2	0	0	0	0	1	14	6	4	1	4	0	5
	4.01-5.00	7	13	10	0	1	1	0	0	0	1	3	1	0	0	1	5
	5.01-6.00	7	8	1	2	0	0	0	0	0	0	0	0	0	0	2	3
	6.01-8.00	2	6	0	0	0	0	0	0	0	0	0	0	0	0	0	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 1/1/2023 - 12/31/2023

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	1	1	0	0	0	0
	0.76-1.00	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0
	1.01-1.25	0	1	0	0	0	0	1	1	0	0	3	2	1	0	0	1
	1.26-1.50	1	0	0	0	0	2	4	2	8	7	6	6	9	2	3	1
	1.51-2.00	8	2	2	1	2	5	8	15	16	20	17	8	7	5	3	11
	2.01-3.00	31	17	3	4	1	1	5	12	17	31	19	7	7	12	8	6
	3.01-4.00	31	26	13	3	2	0	2	1	1	6	5	1	5	6	4	9
	4.01-5.00	10	31	19	3	0	0	0	0	1	1	1	1	0	1	1	11
	5.01-6.00	5	15	0	1	0	0	0	0	0	1	0	0	0	0	1	5
	6.01-8.00	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	8.01-10.00	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10.01-max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D	0.46-0.75	1	1	0	0	0	0	1	2	3	2	2	2	1	0	0	0
	0.76-1.00	3	1	0	1	0	1	0	2	18	15	22	15	11	7	7	0
	1.01-1.25	6	1	3	2	1	1	2	12	23	37	37	27	13	14	11	6
	1.26-1.50	13	4	2	1	4	4	3	16	60	60	44	26	24	25	17	16
	1.51-2.00	38	17	4	6	9	4	18	33	93	89	67	32	27	27	38	37
	2.01-3.00	106	46	13	10	7	5	18	51	80	94	47	24	25	29	28	69
	3.01-4.00	100	128	74	8	5	9	13	12	30	23	8	2	3	14	12	46
	4.01-5.00	45	85	41	9	5	1	7	1	8	5	4	0	0	1	5	27
	5.01-6.00	29	22	12	9	0	0	1	0	0	0	1	0	0	2	1	13
	6.01-8.00	13	14	1	1	0	0	0	0	0	0	0	0	0	1	2	6
	8.01-10.00	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10.01-max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment 4
Meteorological Data

Catawba Nuclear Station Units 1 & 2
Period 1/1/2023 - 12/31/2023

Stability Class	Wind Speed (m/s)	Hours of Occurrence															
		Sector															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
E	0.46-0.75	0	0	0	0	0	0	0	1	5	11	7	7	5	2	3	0
	0.76-1.00	6	0	1	1	0	0	2	6	25	62	35	37	25	10	15	3
	1.01-1.25	1	0	1	1	2	0	2	11	58	101	44	26	30	10	20	7
	1.26-1.50	3	0	0	1	1	1	0	14	67	89	37	23	27	26	26	21
	1.51-2.00	16	4	2	2	1	3	5	13	86	70	39	35	21	26	44	51
	2.01-3.00	89	10	0	0	4	5	13	16	66	39	20	10	11	24	51	107
	3.01-4.00	40	11	1	1	2	3	9	7	18	15	3	2	0	1	7	25
	4.01-5.00	1	6	12	2	0	0	7	7	2	3	3	0	0	0	1	8
	5.01-6.00	2	1	7	1	0	0	2	0	3	0	0	0	0	0	0	0
	6.01-8.00	2	1	3	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	0	0	0	0	0	1	1	0	11	14	12	6	3	2	2	0
	0.76-1.00	1	1	0	0	0	0	0	1	28	42	33	14	14	9	5	0
	1.01-1.25	1	0	0	0	0	0	0	0	55	39	31	18	9	15	13	6
	1.26-1.50	2	0	0	0	0	0	0	2	45	23	7	16	19	19	24	21
	1.51-2.00	8	1	0	0	0	1	1	8	10	3	11	7	27	19	18	47
	2.01-3.00	33	0	0	0	0	2	5	6	0	0	0	0	5	13	12	24
	3.01-4.00	1	1	0	0	0	0	1	5	0	0	0	0	0	0	0	0
	4.01-5.00	0	0	0	0	0	0	4	1	0	0	0	0	0	0	0	0
	5.01-6.00	0	0	0	0	0	0	1	1	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 1/1/2023 - 12/31/2023

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	2	1	0	0	0	0	0	3	12	11	12	12	16	15	8	0
	0.76-1.00	0	3	0	0	0	0	0	2	28	40	37	28	27	16	21	7
	1.01-1.25	0	0	0	0	0	0	0	0	29	32	29	20	16	9	32	15
	1.26-1.50	1	0	0	0	0	0	0	2	24	16	19	20	12	9	14	29
	1.51-2.00	11	0	0	0	0	0	0	1	2	4	11	4	9	2	9	33
	2.01-3.00	17	0	0	0	0	0	0	0	0	0	2	3	7	0	4	8
	3.01-4.00	2	0	0	0	0	0	2	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

Catawba Nuclear Station Units 1 & 2
Period 1/1/2023 - 12/31/2023

Catawba Nuclear Station had no unplanned liquid releases in 2023.

Catawba Nuclear Station had no unplanned gaseous releases in 2023.

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 1/1/2023 - 12/31/2023

Gaseous Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Noble Gases						
1. Maximum Gamma Air	mRAD	5.34E-03	4.25E-03	6.11E-03	7.04E-03	2.27E-02
(a) Limit	mRAD	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
(b) % of Limit		5.34E-02	4.25E-02	6.11E-02	7.04E-02	1.14E-01
Receptor Location	***0.5*** miles	***NNE***	***NNE***	***NNE***	***NNE***	***NNE***
2. Maximum Beta Air	mRAD	2.02E-03	1.61E-03	2.25E-03	2.62E-03	8.50E-03
(a) Limit	mRAD	2.00E+01	2.00E+01	2.00E+01	2.00E+01	4.00E+01
(b) % of Limit		1.01E-02	8.04E-03	1.13E-02	1.31E-02	2.13E-02
Receptor Location	***0.5*** miles	***NNE***	***NNE***	***NNE***	***NNE***	***NNE***
B. Iodine, H-3, & Particulates						
1. Maximum Organ Dose	mREM	3.43E-01	2.62E-01	3.43E-01	3.51E-01	1.30E+00
(a) Limit	mREM	1.50E+01	1.50E+01	1.50E+01	1.50E+01	3.00E+01
(b) % of Limit		2.29E+00	1.75E+00	2.29E+00	2.34E+00	4.33E+00
Receptor Location	***1.0*** miles	***N***	***N***	***N***	***N***	***N***
Critical Age		***CHILD***	***CHILD***	***CHILD***	***CHILD***	***CHILD***
Critical Organ		***BONE***	***BONE***	***BONE***	***BONE***	***BONE***
Critical Pathway		***VEGETATION***	***VEGETATION***	***VEGETATION***	***VEGETATION***	***VEGETATION***

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

Catawba Nuclear Station Units 1 & 2
Period 1/1/2023 - 12/31/2023

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Batch Mode						
1. Maximum Organ Dose	mREM	4.46E-02	3.65E-02	2.01E-02	4.44E-02	1.14E-01
(a) Limit	mREM	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
(b) % of Limit		4.46E-01	3.65E-01	2.01E-01	4.44E-01	5.68E-01
Critical Age		***Child***	***Adult***	***Child***	***Child***	***Adult***
Critical Organ		***Liver***	***GI-LLi***	***Liver***	***Bone***	***GI-LLi***
Critical Pathway		***Potable Water (PWtr)***	***Potable Water (PWtr)***	***Potable Water (PWtr)***	***Fresh Water Fish Sport (FFSP)***	***Potable Water (PWtr)***
2. Maximum Total Body Dose	mREM	4.45E-02	3.00E-02	1.99E-02	1.86E-02	1.08E-01
(a) Limit	mREM	3.00E+00	3.00E+00	3.00E+00	3.00E+00	6.00E+00
(b) % of Limit		1.48E+00	9.99E-01	6.64E-01	6.19E-01	1.80E+00
Critical Age		***CHILD***	***CHILD***	***CHILD***	***TEENAGER***	***CHILD***
Critical Pathway		***POTABLE WATER (PWTR)***	***POTABLE WATER (PWTR)***	***POTABLE WATER (PWTR)***	***SHORELINE SEDIMENT (SHDP)***	***POTABLE WATER (PWTR)***
B. Continuous Mode						
1. Maximum Organ Dose	mREM	8.62E-05	0.00E+00	0.00E+00	0.00E+00	6.97E-05
(a) Limit	mREM	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
(b) % of Limit		8.62E-04	0.00E+00	0.00E+00	0.00E+00	3.48E-04
Critical Age		***CHILD***	***N/A***	***N/A***	***N/A***	***CHILD***
Critical Organ		***LIVER***	***N/A***	***N/A***	***N/A***	***LIVER***
Critical Pathway		***POTABLE WATER (PWTR)***	***N/A***	***N/A***	***N/A***	***POTABLE WATER (PWTR)***
2. Maximum Total Body Dose	mREM	8.62E-05	0.00E+00	0.00E+00	0.00E+00	6.97E-05
(a) Limit	mREM	3.00E+00	3.00E+00	3.00E+00	3.00E+00	6.00E+00
(b) % of Limit		2.87E-03	0.00E+00	0.00E+00	0.00E+00	1.16E-03
Critical Age		***CHILD***	***N/A***	***N/A***	***N/A***	***CHILD***
Critical Pathway		***POTABLE WATER (PWTR)***	***N/A***	***N/A***	***N/A***	***POTABLE WATER (PWTR)***

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)	1.367E+00 mrem
1. Location	1.0 miles N
2. Critical Age	Child
3. Critical Organ	Bone
4. Gas Contribution %	95.074%
5. Liquid Contribution %	4.926%
B. Maximum Total Body Dose	6.126E-01 mrem
1. Location	1.0 miles N
2. Critical Age	Child
3. Gas non-NG Contribution %	81.607%
4. Gas NG Contribution %	0.791%
5. Liquid Contribution %	17.601%

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 5 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 2023 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 535 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 4.963 mrem and maximum total body dose is 4.2086 mrem, which are below the dose limits of 40 CFR 190.

Attachment 7
Information to Support the NEI Ground Water Protection Initiative

Catawba Nuclear Station Units 1 & 2
Period 1/1/2023 - 12/31/2023

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 1/1/2023 - 12/31/2023

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 48 wells and 1 outfall from the Conventional Wastewater Treatment Ponds in 2023.

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 2023 confirmed existing knowledge of tritium concentrations in site ground water.

In June of 2022, Groundwater Well C-105R was damaged and can no longer be used as a GWPI monitoring well and was declared abandoned as a result. The groundwater well C-105R was not required to meet groundwater monitoring requirements described in AD-CP-ALL-0017 and abandonment of this well does not impact ability to collect regulatory required samples.

Tritium results from sampling during 2023 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 2023.

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 1/1/2023 - 12/31/2023

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	2.04E+02	<MDA	<MDA	<MDA	4
C-101DR	CNS GWPI / C-101DR / U-1 SFP	<MDA	3.08E+02	1.94E+02	<MDA	4
C-101R	CNS GWPI / C-101R / U-1 SFP	5.54E+02	4.90E+02	4.51E+02	5.25E+02	4
C-102	CNS GWPI / C-102 / E of U1 SFP O/S protected area	2.39E+02	NS	<MDA	NS	4
C-103	CNS GWPI / C-103 / E of U1 SFP @ Cooling Towers	3.04E+02	NS	<MDA	NS	2
C-104	CNS GWPI / C-104 / U-1 RMWST	4.65E+02	4.33E+02	4.88E+02	5.04E+02	4
C-105	CNS GWPI / C-105 / Engr. Bldg.	3.17E+02	2.90E+02	3.64E+02	2.22E+02	4
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	8.98E+02	9.36E+02	7.10E+02	6.83E+02	4
C-108	CNS GWPI / C-108 /	1.33E+03	NS	4.04E+02	NS	2
C-109	CNS GWPI / C-109 /	5.66E+02	NS	4.53E+02	NS	2
C-110	CNS GWPI / C-110 /	1.29E+03	1.42E+03	1.35E+03	1.25E+03	4
C-200DR	CNS GWPI / C-200DR / U-2 SFP	3.36E+02	4.10E+02	4.83E+02	3.83E+02	4
C-200R	CNS GWPI / C-200R / U-2 SFP	6.01E+02	5.03E+02	5.61E+02	5.62E+02	4
C-201DR	CNS GWPI / C-201DR / U-2 SFP	3.73E+02	4.10E+02	3.63E+02	4.45E+02	4
C-201R	CNS GWPI / C-201R / U-2 SFP	1.79E+03	1.66E+03	2.15E+03	1.82E+03	4
C-202	CNS GWPI / C-202 / S of RMC Tent	5.61E+02	NS	6.27E+02	NS	2
C-203	CNS GWPI / C-203 / E of RMC Tent @ Cooling Towers	4.01E+02	NS	3.98E+02	NS	2
C-204	CNS GWPI / C-204 / S of RMC Tent	3.65E+02	NS	4.49E+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	<MDA	2.67E+02	2.00E+02	2.24E+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	<MDA	NS	2
C-209	CNS GWPI / C-209 / MTUville S of light pole 23A	<MDA	2.44E+02	2.23E+02	2.43E+02	4
C-210	CNS GWPI / C-210 / N of U2 Mech Equip Bldg	<MDA	NS	3.28E+02	NS	2
C-211	CNS GWPI / C-211 / W of RL Intake O/S Protected Area	4.82E+02	NS	5.21E+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	1.97E+03	2.48E+03	2.25E+03	2.21E+03	4
C-213R	CNS GWPI / C-213R / Mon. Tank B	<MDA	<MDA	<MDA	<MDA	4
C-214	CNS GWPI / C-214 / N of U2 TB	5.02E+02	8.40E+02	6.57E+02	7.10E+02	4
C-215	CNS GWPI / C-215 / N of U2 TB	4.94E+02	5.67E+02	3.08E+02	3.68E+02	4
C-217	CNS GWPI / C-217 / N of U2 TB	5.13E+02	NS	5.13E+02	NS	2

Attachment 7
Information to Support the NEI Ground Water Protection Initiative

Catawba Nuclear Station Units 1 & 2
Period 1/1/2023 - 12/31/2023

C-218	CNS GWPI / C-218 / N of U2 TB	<MDA	3.61E+02	<MDA	2.88E+02	4
C-220	CNS GWPI / C-220 / N of U2 TB	7.51E+02	6.63E+02	6.50E+02	5.25E+02	4
C-221	CNS GWPI / C-221 / N of U2 TB	3.24E+02	4.75E+02	3.71E+02	4.69E+02	4
LMW-1B	CNS Landfill / LMW-1B / Landfill	NS	<MDA	NS	<MDA	2
LMW-2A	CNS Landfill / LMW-2A / Landfill	NS	<MDA	NS	<MDA	2
LMW-3A	CNS Landfill / LMW-3A / Landfill	NS	<MDA	NS	<MDA	2
LMW-4	CNS Landfill / LMW-4 / Landfill	NS	2.32E+02	NS	<MDA	2
LMW-5D	CNS Landfill / LMW-5D / Landfill	NS	<MDA	NS	<MDA	2
LMW-5S	CNS Landfill / LMW-5S / Landfill	NS	1.68E+02	NS	<MDA	2
OUTFALL017	CNS WC Ponds / OUTFALL-017 / WC Ponds	1.26E+03	1.57E+03	1.75E+03	1.54E+03	4
WCMW-2	CNS WC Ponds / WCMW-2 / WC Ponds	2.93E+03	2.07E+03	2.12E+03	2.32E+03	4
WCMW-3	CNS WC Ponds / WCMW-3 / WC Ponds	1.41E+03	1.13E+03	7.99E+02	1.27E+03	4
WCMW-4	CNS WC Ponds / WCMW-4 / WC Ponds	2.48E+02	4.13E+02	2.90E+02	4.05E+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 1/1/2023 - 12/31/2023

Catawba Nuclear Station had no instances of any inoperable equipment relevant to effluent monitoring in excess of SLC 16.11 limits during 2023.

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 2023.

ATTACHMENT 9

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

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 1/1/2023 - 12/31/2023

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 2023.

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 no revisions to the Catawba Nuclear Station Updated Final Safety Analysis Report, Section 16.11, Radiological Controls, in 2023.

As per TS 5.5.5.b, "Licensee initiated changes to the Radiological Effluent Controls of the UFSAR," Catawba is attaching the List of Effective Sections (LOES) which demonstrate no revisions were made in 2023. Revisions 117 - 118 of the LOES are included as they indicate no changes to Section 16.11 were approved in 2023.

LIST OF EFFECTIVE SECTIONS

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	6	06/15/23
16.7-4	Deleted	
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	3	02/23/23
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	4	1/31/24
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

SECTION	REVISION NUMBER	REVISION DATE
16.9-7	4	08/21/09
16.9-8	6	06/15/23
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

LIST OF EFFECTIVE SECTIONS

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

LIST OF EFFECTIVE SECTIONS

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	6	06/15/23
16.7-4	Deleted	
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	3	02/23/23
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	4	1/31/24
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

LIST OF EFFECTIVE SECTIONS

SECTION	REVISION NUMBER	REVISION DATE
16.9-7	4	08/21/09
16.9-8	6	06/15/23
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

LIST OF EFFECTIVE SECTIONS

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	15	03/12/24
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

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 1/1/2023 - 12/31/2023

No revision of the Catawba Nuclear Station PCP was published in 2023.

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 1/1/2023 - 12/31/2023

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 2023.

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 1/1/2023 - 12/31/2023

There is one (1) amendment to a previous year's ARERR.

The following contains amended pages to the Catawba Nuclear Station 2022 ARERR. The Amended pages are identified with “Amendment #” on page. Specific changes are identified with change bars in the right margin.

Catawba Nuclear Station 2022 ARERR Amendment #1 requires the following changes to the Cover Letter Introduction and Attachment 6 (reference NCR 02512440). Specifically, the Cover Letter Introduction states that the ODCM is included pursuant to TS 5.5.1; however, the ODCM was not included with the 2022 ARERR. The ODCM was not revised in the period of the report (1/1/2021 – 12/31/2021) and was not required to be submitted per TS 5.5.1. This change removes the statement that the ODCM was included in the report.

The amendment to Attachment 6, Page 6-6 corrects the distance from the 2x6 array of MAGNASTOR casks from 550 m to 535 m in the final paragraph. This change aligns with the distance that is specified in the 10 CFR 72.212 Evaluation Report, MAGNASTOR®, Revision 4. The correct distance was used in the dose calculations for the 2022 report, and thus there is no change to any reported doses.

Catawba Nuclear Station 2022 ARERR Cover Letter Introduction, page 2 as submitted:

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. In addition, the ODCM is included pursuant to Catawba 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	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

Catawba Nuclear Station 2022 ARERR Cover Letter Introduction page 2 as amended (Amendment #1):

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
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Attachment 7	Information to Support the NEI Ground Water Protection Initiative
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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

Catawba Nuclear Station 2022 ARERR Attachment 6, Page 6-6 as submitted:

> 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 12
Errata to a Previous Year's ARERR

Catawba Nuclear Station Units 1 & 2
Period 1/1/2023 - 12/31/2023

Catawba Nuclear Station 2022 ARERR Attachment 6, Page 6-6 as amended (Amendment #1):

> 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 535 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.

ENCLOSURE 3: HNP Annual Radioactive Effluent Release Report

Shearon Harris Nuclear Power Plant
Unit 1

Annual Radioactive Effluent Release Report

January 1, 2023, through December 31, 2023

Docket 50-400

Introduction

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

Attachment 1	Summary of Gaseous and Liquid Effluents
Attachment 2	Supplemental Information
Attachment 3	Solid Radioactive Waste Disposal
Attachment 4	Meteorological Data
Attachment 5	Unplanned Offsite Releases
Attachment 6	Assessment of Radiation Dose from Radioactive Effluents to Members of the Public
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ATTACHMENT 1

Summary of Gaseous and Liquid Effluents

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

Attachment 1
Summary of Gaseous and Liquid Effluents

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2023 - 12/31/2023

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	0.00E+00	0.00E+00	1.09E-03	0.00E+00	1.09E-03
2. Avg. Release Rate	μCi/sec	0.00E+00	0.00E+00	1.37E-04	0.00E+00	3.43E-05
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	5.92E+01	5.06E+01	4.77E+01	4.89E+01	2.06E+02
2. Avg. Release Rate	μCi/sec	7.62E+00	6.44E+00	6.00E+00	6.15E+00	6.55E+00
E. Gross Alpha						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Attachment 1
Summary of Gaseous and Liquid Effluents

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2023 - 12/31/2023

Gaseous Effluents - Elevated Releases - Continuous Mode *

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

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

Attachment 1
Summary of Gaseous and Liquid Effluents

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2023 - 12/31/2023

Gaseous Effluents - Elevated Releases - Batch Mode *

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

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

Attachment 1
Summary of Gaseous and Liquid Effluents

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2023 - 12/31/2023

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	5.92E+01	5.06E+01	4.77E+01	4.89E+01	2.06E+02
E. Gross Alpha						
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Attachment 1
Summary of Gaseous and Liquid Effluents

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2023 - 12/31/2023

Gaseous Effluents - Ground Releases - Batch 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	9.00E-04	0.00E+00	9.00E-04
Xe-135	Ci	0.00E+00	0.00E+00	1.91E-04	0.00E+00	1.91E-04
Total for Period	Ci	0.00E+00	0.00E+00	1.09E-03	0.00E+00	1.09E-03
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	0.00E+00	0.00E+00	2.02E+04	0.00E+00	2.02E+04
E. Gross Alpha						
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Attachment 1
Summary of Gaseous and Liquid Effluents

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2023 - 12/31/2023

Gaseous Effluents - Mixed-Mode Releases - Continuous Mode *

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

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

Attachment 1
Summary of Gaseous and Liquid Effluents

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2023 - 12/31/2023

Gaseous Effluents - Mixed-Mode Releases - Batch Mode *

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

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

Attachment 1
Summary of Gaseous and Liquid Effluents

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2023 - 12/31/2023

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	6.89E-04	3.68E-04	8.50E-04	2.25E-04	2.13E-03
2. Avg. Diluted Conc.	μCi/ml	1.46E-10	7.24E-11	1.60E-10	4.55E-11	1.06E-10
B. Tritium						
1. Total Release	Ci	1.07E+01	1.10E+02	1.11E+02	4.96E+01	2.81E+02
2. Avg. Diluted Conc.	μCi/ml	2.28E-06	2.16E-05	2.10E-05	1.00E-05	1.37E-05
C. Dissolved & Entrained Gases						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Diluted Conc.	μCi/ml	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Gross Alpha						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Diluted Conc.	μCi/ml	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
E. Volume of Liquid Waste						
1. Batch Releases	liters	4.88E+05	7.15E+05	9.70E+05	4.03E+05	2.58E+06
2. Continuous Releases	liters	1.08E+07	1.22E+07	1.43E+07	1.37E+07	5.10E+07
F. Volume of Dilution Water						
1. Batch Releases	liters	4.71E+09	5.08E+09	5.31E+09	4.95E+09	2.01E+10
2. Continuous Releases	liters	4.71E+09	5.08E+09	5.31E+09	4.95E+09	2.01E+10

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

Attachment 1
Summary of Gaseous and Liquid Effluents

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2023 - 12/31/2023

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	-	-	-	-	-
B. Tritium						
H-3	Ci	2.79E-02	1.14E-01	2.54E-1	1.13E-01	5.09E-01
C. Dissolved & Entrained Gases						
None	Ci	-	-	-	-	-
Total for Period	Ci	-	-	-	-	-
D. Gross Alpha						
Total for Period	Ci	-	-	-	-	-

Attachment 1
Summary of Gaseous and Liquid Effluents

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2023 - 12/31/2023

Liquid Effluents - Batch Mode

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Products						
Mr-54	Ci	7.95E-06	1.34E-05	9.96E-06	0.00E+00	3.13E-05
Fe-55	Ci	2.40E-04	4.61E-05	2.40E-04	6.25E-05	5.89E-04
Co-58	Ci	1.07E-04	6.89E-05	4.47E-05	0.00E+00	2.21E-04
Co-60	Ci	7.90E-05	1.06E-04	2.50E-04	4.96E-05	4.85E-04
Ni-63	Ci	8.75E-05	1.28E-04	1.38E-04	3.23E-05	3.86E-04
Sb-124	Ci	1.23E-05	0.00E+00	0.00E+00	0.00E+00	1.23E-05
Sb-125	Ci	8.90E-05	6.08E-06	1.67E-04	7.27E-05	3.35E-04
Cs-137	Ci	6.73E-05	0.00E+00	0.00E+00	8.04E-06	7.53E-05
Total for Period	Ci	6.90E-04	3.68E-04	8.50E-04	2.25E-04	2.13E-03
B. Tritium						
H-3	Ci	1.07E+01	1.10E+02	1.11E+02	4.96E+01	2.81E-02
C. Dissolved & Entrained Gases						
None	Ci	-	-	-	-	-
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Gross Alpha						
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

ATTACHMENT 2

Supplemental Information

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

Attachment 2
Supplemental Information

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2023 - 12/31/2023

I. Regulatory Limits - Per Unit

A. Noble Gases - Air Dose

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

B. Liquid Effluents - Dose

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

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

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

II. Maximum Permissible Effluent Concentrations

A. Gaseous Effluents

1. Information found in Offsite Dose Calculation Manual

B. Liquid Effluents

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

III. Average Energy

(Not applicable)

IV. Measurements and Approximations of Total Radioactivity

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

V. Batch Releases

A. Liquid Effluents		Jan - Jun	Jul - Dec
1. Number of Batch Releases	=	15	17
2. Total Time Period for Batch Releases	=	1.26E+04 min	1.35E+04 min
3. Maximum Time Period for a Batch Release	=	9.49E+02 min	9.09E+02 min
4. Average Time Period for a Batch Release	=	8.38E+02 min	7.92E+02 min
5. Minimum Time Period for a Batch Release	=	7.21E+02 min	7.20E+02 min
6. Average Stream Flow During Release Periods	=	9.67E+03 gpm	1.04E+04 gpm

B. Gaseous Effluents		Jan - Jun	Jul - Dec
1. Number of Batch Releases	=	0	4
2. Total Time Period for Batch Releases	=	0.00E+00 min	1.23E+03 min
3. Maximum Time Period for a Batch Release	=	0.00E+00 min	3.43E+02 min
4. Average Time Period for a Batch Release	=	0.00E+00 min	3.06E+02 min
5. Minimum Time Period for a Batch Release	=	0.00E+00 min	2.60E+02 min

VI. Abnormal Releases

See Attachment 5, Unplanned Offsite Releases.

Attachment 2
Supplemental Information

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2023 - 12/31/2023

Carbon-14

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

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

The Shearon Harris Nuclear Power Plant 2023 ARERR contains estimates of C-14 radioactivity released in 2023 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). Many documents provide information related to the magnitude of C-14 in typical effluents from commercial nuclear power plants. Those documents suggest that nominal annual releases of C-14 in gaseous effluents are approximately 5 to 7.3 curies from PWRs (Ref. Reg. Guide 1.21, Rev. 2). For Shearon Harris Nuclear Power Plant 2023 ARERR, a source term scaling factor was calculated using an annual release rate of 7.3 curies/ year and the actual 2023 EFPD of 364.850 days. Using the source term scaling factor from Shearon Harris Nuclear Power Plant in 2023 results in a site total C-14 gaseous release estimate to the environment of 9.12 Curies.

The resultant offsite doses were based upon this source term and the dose calculations described in NRC Regulatory Guide 1.109, Revision 1, and the Shearon Harris Nuclear Power Plant ODCM. The estimated C-14 dose impact on the maximum organ dose from airborne effluents released from Shearon Harris Nuclear Power Plant in 2023 was well below the 10CFR 50, Appendix I, ALARA design objective (i.e., 15 mrem/yr. per unit). Based on the calculations performed, bone dose to a child 2.76 miles from the plant in the SW sector had the highest estimated dose of 5.34E-01 mREM/year.

	Units	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Year
1. EFPD	Days	89.87	90.93	92.02	92.03	364.85
2. C-14 Activity Released	Ci	2.25E+00	2.27E+00	2.30E+00	2.30E+00	9.12E+00
3. C-14 Total Body Dose	mREM	2.59E-02	2.62E-02	2.75E-02	2.65E-02	1.06E-01
4. C-14 Organ Dose	mREM	1.30E-01	1.32E-01	1.38E-01	1.33E-01	5.34E-01

Receptor Location: 2.76 mi SW
Critical Age: CHILD
Critical Organ: BONE

Attachment 2
Supplemental Information

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2023 - 12/31/2023

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

Cooling Tower Plume

Tritium in Cooling Tower plume creates an exposure pathway to a member of the public. Murray and Trettle, Inc. was contracted to perform an evaluation of the dose to a member of the public from exposure to tritium in the Cooling Tower plume. Results of the plume exposure are contained in report "*Impact of Tritium Release from the Cooling Tower at the Harris Nuclear Plant for 2023*". 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 2023.

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
1. H-3 Activity Released	Ci	1.99E+01	2.21E+01	3.11E+01	3.96E+01	1.13E+02
2. H-3 Dose	mREM	7.34E-04	8.15E-04	1.15E-03	1.46E-03	4.16E-03

Receptor Location 1.81 mi NNE
Critical Age CHILD
Critical Organ N/A *

Harris Lake Evaporation

Evaporation of water containing tritium in Harris Lake creates an exposure pathway to a member of the public. Murray and Trettle, Inc. was contracted to perform an evaluation of the dose to a member of the public from evaporation of tritium in Harris Lake. Results of the evaluation are contained in report "*Impact of Tritium Release from the Water Reservoir (Lake Harris) at the Harris Nuclear Plant for 2023*". Using the methodology described in ODCM 2.3.3, the following is a summary of tritium activity released through evaporation and resulting dose for 2023.

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
1. H-3 Activity Released	Ci	1.35E+01	2.26E+01	2.25E+01	1.33E+01	7.18E+01
2. H-3 Dose	mREM	1.24E-02	2.09E-02	2.06E-02	1.22E-02	6.61E-02

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

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

Concentrations of radionuclides used in this specific drinking water pathway are determined by averaging the monthly concentrations detected in environmental location (REMP) DW-51. In 2023, 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 2023.

	Units	Year
1. Avg. H-3 Concentration	ρCi/L	2.86E+03
2. H-3 Dose	mREM	7.83E-02

Critical Age ADULT
Critical Organ N/A *

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

Tritium in Fish from Harris Lake NOTE

Concentrations of radionuclides used in this specific fish consumption pathway are determined by averaging the monthly concentrations detected in environmental location (REMP) SW-26. In 2023, 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 2023.

	Units	Year
1. Avg. H-3 Concentration	ρCi/L	3.97E+03
2. H-3 Dose	mREM	7.87E-03

Critical Age ADULT
Critical Organ N/A *

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

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

Overall Estimate of Error for Effluent Radioactivity Release Reported

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

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

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

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

Overall Estimate of Error for Solid Waste Radioactivity Reported

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

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

Independent Spent Fuel Storage Installation (ISFSI) Monitoring Program

Not applicable to HNPP.

Summary of Changes in Land Use Census Affecting Effluent Dose Calculations

The 2023 Land Use Census was performed May 15-16, 2023. The following are changes to residences, gardens, and milk animals from the previous year.

RESIDENCES

- No changes were noted in the nearest residences during the 2023 land use census.

GARDENS

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

- The garden in the ESE sector at 4.83 miles was replaces with a garden at 4.63 miles
- The garden in the NNW sector at 1.82 miles was replaced with a garden at 1.55 miles.

MEAT ANIMALS

NOTE: Meat animals were only identified at the nearest garden or closer in each sector, and poultry and egg laying animals were not classified as meat animals for the 2023 census.

- The meat animals in the NNW sector at 1.82 miles were no longer applicable due to the garden moving to 1.55 miles in this sector. There were not any other meat animals present at or closer than 1.55 miles in the NNW sector during the 2023 land use census.

MILK ANIMALS

- No changes were noted with the milk animals during the 2023 land use census.
- Although not identified during the 2023 land use census. Manco Dairy (control milk location 5, located 19.31 km from the site) ceased operation on February 13, 2023 (NCR # 02460334) and a replacement control location could not be located.

No other changes to environmental monitoring locations in each sector.

ATTACHMENT 3

Solid Radioactive Waste Disposal

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

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

Attachment 3
Solid Radioactive Waste Disposal

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2023 - 12/31/2023

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

NOTE: Values reported in Attachment 3 section 1.A.a, b, c & 1.B.a, b, c refers to radioactive solid waste materials shipped in 2023 to a vendor for processing and subsequent burial.

A. Type of Waste

a. Spent resins

Note: Waste shipped in 2023 for processing and subsequent burial

Number of Shipments	4
Activity Shipped	1.05 E+01 Curies
Estimated Total Error	96%
Quantity Shipped	16.82 m^3
Solidification Agent	N/A
Container Type	14-215 Cask as General Design
Shipment Form	Gross Dewatered

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

Note: Waste shipped in 2023 for processing and subsequent burial.

Number of Shipments	1
Activity Shipped	2.36E-02 Curies
Estimated Total Error	96%
Quantity Shipped	58.67 m^3
Solidification Agent	N/A
Container Type	General Design
Shipment Form	Compacted, Non-Compacted

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

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

d. Other: GAC Vessels

Note: Waste shipped in 2023 for processing and subsequent burial.

Number of Shipments	1
Activity Shipped	8.07 E-02 Curies
Estimated Total Error	96%
Quantity Shipped	1.27 m^3
Solidification Agent	N/A
Container Type	General Design
Shipment Form	Dewatered, Non- Compacted

Attachment 3
Solid Radioactive Waste Disposal

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2023 - 12/31/2023

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

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

      a. Spent Radwaste Bead Resin.

      Note: Waste shipped in 2023 for processing and subsequent burial.

Class A Spent Resin Totals

Resin			
Isotope	**Activity(mCi)**	**Activity (Ci)**	**Abundance**
H-3	3.28E+02	3.28E-01	3.12%
C-14	6.32E+01	6.32E-02	0.60%
Mn-54	6.73E+02	6.73E-01	6.41%
Fe-55	2.26E+03	2.26E+00	21.53%
Co-58	4.90E+00	4.90E-03	0.05%
Co-60	2.75E+03	2.75E+00	26.19%
Ni-59	1.33E+01	1.33E-02	0.13%
Ni-63	3.21E+03	3.21E+00	30.57%
Sr-90	3.93E+00	3.93E-03	0.04%
Tc-99	1.75E+00	1.75E-03	0.02%
Sb-125	4.17E+02	4.17E-01	3.97%
Cs-137	7.63E+02	7.63E-01	7.27%
Ce-144	1.08E+01	1.08E-02	0.10%
I-129	1.95E-01	1.95E-04	0.00%
Grand Total	**1.05E+04**	**1.05E+01**	**100.00%**

Attachment 3
Solid Radioactive Waste Disposal

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2023 - 12/31/2023

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

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

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

      Note: Waste shipped in 2023 for processing and subsequent burial.

Class A DAW Totals

DAW			
Isotope	**Activity(mCi)**	**Activity (Ci)**	**Abundance**
C-14	4.27E-02	4.27E-05	0.18%
Cr-51	2.26E+00	2.26E-03	9.59%
Mn-54	2.83E-01	2.83E-04	1.20%
Co-58	5.35E-01	5.35E-04	2.27%
Co-60	3.02E+00	3.02E-03	12.82%
Ni-63	3.27E+00	3.27E-03	13.88%
Zr-95	5.68E+00	5.68E-03	24.11%
Nb-95	7.41E+00	7.41E-03	31.45%
Cs-137	8.73E+00	2.62E-04	1.11%
Ce-144	1.29E-01	1.29E-04	0.55%
H-3	5.55E-01	5.55E-04	2.36%
I-129	1.28E-02	1.28E-05	0.05%
Tc-99	9.90E-02	9.90E-05	0.42%
Grand Total	**3.20E+01**	**2.36E-02**	**100.00%**

      c. Irradiated components, control rods, etc.

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

Attachment 3
Solid Radioactive Waste Disposal

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2023 - 12/31/2023

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

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

d. Other (GAC Vessels)

Note: Waste shipped in 2023 for processing and subsequent burial

Class A Other (GAC Vessels) Totals

GAC Vessels			
Isotope	**Activity(mCi)**	**Activity (Ci)**	**Abundance**
H-3	2.10E+01	2.10E-02	26.02%
C-14	8.42E-01	8.42E-04	1.04%
Mn-54	2.54E-01	2.54E-04	0.31%
Fe-55	1.42E+01	1.42E-02	17.59%
Co-57	4.40E-03	4.40E-06	0.01%
Co-58	6.12E-05	6.12E-08	0.00%
Co-60	2.40E+01	2.40E-02	29.73%
Ni-63	1.93E+01	1.93E-02	23.91%
Sb-125	7.52E-01	7.52E-04	0.93%
Cs-137	1.56E-01	1.56E-04	0.19%
Ce-144	1.47E-02	1.47E-05	0.02%
I-129	2.28E-02	2.28E-05	0.03%
Tc-99	1.74E-01	1.74E-04	0.22%
Grand Total	**8.07E+01**	**8.07E-02**	**100.00%**

C. Solid Waste Disposal

Number of Shipments 6
Mode of Transportation Truck
Destination Energy Solutions

Note: Waste shipped in 2023 for processing and subsequent burial

2. Solid Waste Shipped for Burial or Disposal (WASTE CLASS B)

   A. Type of Waste

      a. Spent resins

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

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

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

      c. Irradiated components, control cods, etc.

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

      d. Other (Describe)

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

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

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

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

   C. Solid Waste Disposal

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

Attachment 3
Solid Radioactive Waste Disposal

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2023 - 12/31/2023

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

A. Type of Waste

a. Spent resins, filter sludge’s, evaporator bottoms, etc.

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

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

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

c. Irradiated Components, Control Rods, etc.

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

d. Other (Describe)

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

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

N/A

C. Solid Waste Disposal

N/A

Estimated Total Error for Solid Waste Disposal

a)	Counting Standard (20000 counts/energy % error)	(< 0.1%)
b)	Calibration Standard	(5.0%)
c)	Acceptable Counting Statistic for nuclide ID (R. E.)	(95%)
d)	Sample Volume Variability	(0.001%)
e)	Instrument Errors	(5.0%)
f)	Dose Rate Measurement	(10.0%)
g)	Geometry	(5.0%)
h)	Volume Determinations	(5.0%)
i)	RADMAN Database (sample analysis variance)	(0.96)

$$\%E = \sqrt{(0.1)^2+(5)^2+(95)^2+(5)^2+(10)^2+(5)^2+(.001)^2+(5)^2+(0.96)^2} = 96\%$$

ATTACHMENT 4

Meteorological Data

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

Attachment 4
Meteorological Data

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2023 - 12/31/2023

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	0	0	0	0	0	0	0	0	0	0
	2.01-3.00	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0
	3.01-4.00	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0
	4.01-5.00	0	1	1	0	0	0	0	0	1	0	0	1	0	1	0	1
	5.01-6.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	6.01-8.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10.01-Max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B	0.46-0.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.76-1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1.01-1.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	1.26-1.50	0	1	0	0	0	0	1	0	0	0	0	0	0	1	0	0
	1.51-2.00	2	1	1	4	1	0	0	0	0	0	0	0	0	3	1	1
	2.01-3.00	1	13	10	8	3	0	1	1	8	0	1	9	6	8	10	4
	3.01-4.00	4	10	3	7	1	0	1	1	21	5	4	3	3	4	7	5
	4.01-5.00	3	1	0	0	0	0	0	0	3	2	2	6	3	2	5	1
	5.01-6.00	1	0	0	0	0	0	0	0	0	0	1	6	1	4	2	1
	6.01-8.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10.01-Max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment 4
Meteorological Data

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2023 - 12/31/2023

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	1	0	0
	1.01-1.25	0	1	1	0	2	0	0	0	2	0	0	0	1	1	2	1
	1.26-1.50	2	2	1	2	2	1	2	0	0	1	2	6	5	7	3	4
	1.51-2.00	8	8	16	9	2	1	2	1	4	6	5	10	8	7	17	17
	2.01-3.00	16	33	23	22	8	2	4	13	24	14	17	31	27	25	39	27
	3.01-4.00	15	21	7	2	2	0	1	5	27	4	12	19	9	17	14	13
	4.01-5.00	5	2	6	1	0	0	0	0	1	7	7	8	5	6	9	9
	5.01-6.00	0	0	0	0	0	0	0	0	0	2	1	8	1	1	3	3
	6.01-8.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10.01-Max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D	0.46-0.75	1	3	3	3	2	6	2	6	4	3	1	4	4	4	7	4
	0.76-1.00	6	4	8	10	11	2	10	9	9	14	9	10	10	4	10	12
	1.01-1.25	16	12	8	7	4	7	5	8	17	20	20	18	16	15	7	11
	1.26-1.50	27	19	8	15	14	12	14	22	25	25	30	35	14	9	14	13
	1.51-2.00	43	53	34	40	13	16	29	43	40	67	61	50	36	31	38	32
	2.01-3.00	89	116	92	54	37	16	35	40	109	106	94	87	49	31	58	72
	3.01-4.00	26	65	45	8	4	1	1	3	45	44	47	32	17	31	45	44
	4.01-5.00	18	29	7	0	1	0	1	0	17	18	18	11	5	14	9	28
	5.01-6.00	11	2	0	0	0	0	0	0	1	16	4	2	0	1	2	4
	6.01-8.00	2	0	0	0	0	0	0	0	2	10	4	0	0	0	0	0
	8.01-10.00	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	10.01-Max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment 4
Meteorological Data

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2023 - 12/31/2023

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	14	23	7	5	2	9	7	12	12	10	11	8	14	9	6
	0.76-1.00	17	16	19	16	10	20	17	13	18	26	12	21	13	14	8	21
	1.01-1.25	24	15	7	6	7	3	18	13	10	12	16	15	16	3	17	16
	1.26-1.50	27	22	19	7	3	5	13	13	23	24	17	27	17	12	10	10
	1.51-2.00	35	18	15	24	11	1	11	22	29	41	28	28	16	12	11	17
	2.01-3.00	21	20	15	10	11	2	3	10	54	61	37	27	8	13	15	15
	3.01-4.00	4	3	1	0	2	0	0	6	20	27	13	5	4	1	4	9
	4.01-5.00	0	1	0	0	0	0	0	1	1	5	5	5	0	2	1	0
	5.01-6.00	0	0	0	0	0	0	0	0	0	1	2	1	0	0	0	0
	6.01-8.00	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10.01-Max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F	0.46-0.75	12	13	22	12	8	6	9	10	7	8	10	8	16	8	10	8
	0.76-1.00	13	13	9	11	5	10	8	7	7	11	12	8	10	7	9	13
	1.01-1.25	9	11	5	4	1	4	7	3	7	8	4	8	4	5	7	12
	1.26-1.50	10	11	1	0	0	2	2	1	4	5	5	12	5	2	3	1
	1.51-2.00	5	0	0	3	1	1	0	0	5	8	6	6	2	0	1	3
	2.01-3.00	1	0	0	0	0	0	0	1	0	2	1	2	0	0	0	1
	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

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2023 - 12/31/2023

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	50	47	36	21	7	9	6	8	3	4	12	11	7	11	27	51
	0.76-1.00	15	10	10	6	5	2	2	4	4	8	4	4	5	7	3	27
	1.01-1.25	4	7	1	3	0	3	1	0	2	0	4	2	2	2	1	7
	1.26-1.50	3	3	1	0	0	0	0	0	3	0	1	1	0	0	0	4
	1.51-2.00	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
	2.01-3.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	3.01-4.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	4.01-5.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	5.01-6.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	6.01-8.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10.01-Max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

ATTACHMENT 5

Unplanned Offsite Releases

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

Attachment 5
Unplanned Offsite Releases

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2023 - 12/31/2023

Shearon Harris Nuclear Power Plant had zero (0) unplanned liquid releases in 2023.

Shearon Harris Nuclear Power Plant had zero (0) unplanned gaseous releases in 2023.

ATTACHMENT 6

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

(Includes fuel cycle dose calculation results)

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

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

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

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

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2023 - 12/31/2023

Gaseous Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Noble Gases						
1. Maximum Beta Air	mRAD	0.00E+00	0.00E+00	8.07E-07	0.00E+00	8.07E-07
(a) Limit	mRAD	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
(b) % of Limit		0.00E+00	0.00E+00	8.07E-06	0.00E+00	4.04E-06
2. Maximum Gamma Air	mRAD	0.00E+00	0.00E+00	3.90E-07	0.00E+00	3.90E-07
(a) Limit	mRAD	5.00E+00	5.00E+00	5.00E+00	5.00E+00	1.00E+01
(b) % of Limit		0.00E+00	0.00E+00	7.80E-06	0.00E+00	3.90E-06

Receptor Location 2.14 km SW
Critical Age CHILD

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
B. Iodine, H-3, & Particulates						
1. Maximum Organ Dose	mREM	2.36E-01	2.02E-01	1.90E-01	1.95E-01	8.22E-01
(a) Limit	mREM	7.50E+00	7.50E+00	7.50E+00	7.50E+00	1.50E+01
(b) % of Limit		3.14E+00	2.69E+00	2.53E+00	2.60E+00	5.48E+00

Receptor Location 2.14 km SW
Critical Age CHILD
Critical Organ LIVER

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

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2023 - 12/31/2023

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Batch Mode						
1. Maximum Organ Dose	mREM	2.07E-02	4.12E-02	3.87E-02	2.10E-02	1.22E-01
(a) Limit	mREM	5.00E+00	5.00E+00	5.00E+00	5.00E+00	1.00E+01
(b) % of Limit		4.15E-01	8.23E-01	7.73E-01	4.21E-01	1.22E+00
2. Maximum Total Body Dose	mREM	1.51E-02	4.11E-02	3.86E-02	2.04E-02	1.15E-01
(a) Limit	mREM	1.50E+00	1.50E+00	1.50E+00	1.50E+00	3.00E+00
(b) % of Limit		1.01E+00	2.74E+00	2.57E+00	1.36E+00	3.84E+00

Receptor Location 2.19 km S
Critical Age ADULT
Critical Organ LIVER

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

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2023 - 12/31/2023

40 CFR Part 190 Uranium Fuel Cycle Dose Calculation Results

In accordance with the requirements of 40 CFR Part 190, the annual dose commitment to any member of the general public shall be calculated to assure that doses are limited to 25 millirems to the total body or any organ with the exception of the thyroid which is limited to 75 millirems. The fuel cycle dose assessment for Shearon Harris Nuclear Power Plant includes liquid and gaseous effluent dose contributions from the plant. Direct and air-scatter dose from the reactor building and other onsite structures does not contribute measurable dose to the maximum exposed individual based on review of the 2023 environmental TLD data. No other uranium fuel cycle facility contributes significantly to the maximum exposed individual. Included below is an estimate of the dose contributed by Carbon-14 (Ref. Attachment 2, Supplemental Information, of this report for further information). Also included is dose from H-3 in the Shearon Harris Nuclear Power Plant Cooling Tower plume, evaporation of H-3 in Harris Lake, H-3 in on-site drinking water, and H-3 in fish from Harris Lake. The combined dose to a maximum exposed individual from effluent releases, combined with the additional dose pathways, is below 40 CFR Part 190 limits as shown by the following summary.

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

40 CFR Part 190 Effluent Dose Summary

A. Gaseous Effluent Dose		E. Harris Lake Evaporation H-3 Dose	
1. Location	2.14 km SW	1. Location	4.16 mi SSW
2. Critical Age	CHILD	2. Critical Age	CHILD
3. Critical Organ	LIVER	3. Critical Organ	N/A
4. Organ Dose (mREM)	8.22E-01	4. Organ Dose (mREM)	6.61E-02
5. Total Body Dose (mREM)	8.22E-01	5. Total Body Dose (mREM)	6.61E-02
B. Liquid Effluent Dose		F. Drinking Water H-3 Dose	
1. Location	2.19 km S	1. Location	On Site
2. Critical Age	ADULT	2. Critical Age	ADULT
3. Critical Organ	LIVER	3. Critical Organ	N/A
4. Organ Dose (mREM)	1.22E-01	4. Organ Dose (mREM)	2.86E+03
5. Total Body Dose (mREM)	1.15E-01	5. Total Body Dose (mREM)	2.86E+03
C. Carbon-14 Dose		G. H-3 in Fish from Harris Lake	
1. Location	2.76 mi SW	1. Location	Harris Lake
2. Critical Age	CHILD	2. Critical Age	ADULT
3. Critical Organ	BONE	3. Critical Organ	N/A
4. Organ Dose (mREM)	5.34E-01	4. Organ Dose (mREM)	7.87E-03
5. Total Body Dose (mREM)	1.06E-01	5. Total Body Dose (mREM)	7.87E-03
D. Cooling Tower Plume H-3 Dose			
1. Location	1.81 mi NNE		
2. Critical Age	CHILD		
3. Critical Organ	N/A		
4. Organ Dose (mREM)	4.16E-03		
5. Total Body Dose (mREM)	4.16E-03		

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

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2023 - 12/31/2023

Dose contributions from Carbon-14 in gaseous effluents have been determined from ODCM 3.3.2, Carbon-14. The maximum dose rate to the nearest real individual from the release of Carbon-14 in batch and continuous gaseous effluents is conservatively calculated to be 5.34E-01 mrem/yr based on 9.12E+00 Curies released in 2023 (Ref. Attachment 2, Supplemental Information, of this report).

Dose contributions from Tritium in the Shearon Harris Nuclear Power Plant Cooling Tower plume have been determined from ODCM 2.3, Doses from Return/Re-use of Previously Discharged Radioactive Effluents. The maximum dose rate to the nearest real individual from the release of Tritium the plume is conservatively calculated to be 4.16E-03 mrem/yr based on 1.13E+02 Curies released in 2023 (Ref. Attachment 2, Supplemental Information, of this report).

Dose contributions from evaporation of Tritium Harris Lake have been determined from ODCM 2.3, Doses from Return/Re-use of Previously Discharged Radioactive Effluents. The maximum dose rate to the nearest real individual from evaporation of Tritium in Harris Lake is conservatively calculated to be 6.61E-02 mrem/yr based on 7.18E+01 Curies released in 2023 (Ref. Attachment 2, Supplemental Information, of this report).

Dose contributions from Tritium in drinking water at the HE&EC Training Centers and Harris Nuclear Plant have been determined from 2.3, Doses from Return/Re-use of Previously Discharged Radioactive Effluents. The maximum dose rate to the nearest real individual from consuming the drinking water is conservatively calculated to be less than 1.18E-01 mrem/yr based on an average concentration of 4.32E+03 ρCi/L consumed in 2023 (Ref. Attachment 2, Supplemental Information, of this report).

Dose contributions from Tritium in fish in Harris Lake have been determined using NRC Regulatory Guide 1.109, Rev.1, October 1977, Equation A-1, and data from REMP location SW-26. This information was previously included in the Shearon Harris Nuclear Power Plant AREOR. DRR 2008147 was written to include the fish dose calculation methodology in ODCM revision 26, and report in the ARERR. The maximum dose rate to the nearest real individual from consuming the fish in Harris Lake is conservatively calculated to be 7.87E-03 mrem/yr based on an average concentration of 3.97E+03 ρCi/L consumed in 2023 (Ref. Attachment 2, Supplemental Information, of this report).

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

ATTACHMENT 7

Information to Support the NEI Ground Water Protection Initiative

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

Attachment 7
Information to Support the NEI Ground Water Protection Initiative

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2023 - 12/31/2023

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

Results from sampling during 2023 are shown in the table below:

Well name	Number of Samples in 2023	Number of Positive H-3 Samples in 2023	Average H-3 Activity (pCiL)**	Minimum H-3 Activity (pCi/L)	Maximum H-3 Activity (pCi/L)	Depth of Well (ft)
76	2	2	3.61E+02	2.20E+02	5.01E+02	11
HMW1S	2	1	3.00E+02	<LLD*	3.00E+02	26.5
HMW2S	2	0	<LLD*	<LLD*	<LLD*	22.5
HMW3S	1	0	<LLD*	<LLD*	<LLD*	26
HMW4D	2	0	<LLD*	<LLD*	<LLD*	57.5
HMW4S	2	0	<LLD*	<LLD*	<LLD*	30
HMW5S	1	1	3.90E+02	<LLD*	3.90E+02	32
HMW6S	2	1	4.19E+02	<LLD*	4.19E+02	31.5
HMW7S	1	0	<LLD*	<LLD*	<LLD*	24
HMW8S	1	0	<LLD*	<LLD*	<LLD*	26
HMW9S	1	0	<LLD*	<LLD*	<LLD*	31
HMW10S	1	0	<LLD*	<LLD*	<LLD*	31.5
HMW11S	1	0	<LLD*	<LLD*	<LLD*	26.5

* <LLD = less than the lower limit of detection, typically 250 pCi/L
** Average taken of only positive H-3 Samples.

Zero (0) events meeting the criteria for voluntary notification per NEI 07-07, Industry Ground Water Protection Initiative, occurred at Shearon Harris Nuclear Power Plant in 2023.

ATTACHMENT 8

Inoperable Equipment

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

Attachment 8
Inoperable Equipment

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2017 - 12/31/2017

Harris Nuclear Power Plant had one (1) instance of inoperable equipment related to effluent monitoring in excess of ODCM limits during 2023. Details of the incident are described below.

NCR 02496490

The Secondary Waste Effluent radiation monitor (RM-3542) was declared inoperable on 11/2/23 due to sample flow issues. Troubleshooting identified a degraded sample pump. With no replacement pump in stock, one had to be custom built for the site's application. Supply chain issues delayed the factory from being able to provide a replacement pump prior to the 30-day period. Prompting the site to pursue other options to correct the issue. The site was able to utilize a pump from another radiation monitor, which resolved the sample flow issue. However, during post maintenance testing, an unrelated issue with a check source function prevented monitor restoration within the 30-day limit.

During the post maintenance test, the check source failed. While troubleshooting the cause for the failure, two additional issues were discovered; the High Volts Power Supply (HVPS) was reading low, and the sample chamber was leaking water into the detector. The HVPS and sample chamber were replaced along with the detector that was also found to be failed. Upon restoration the detector was reading high, prompting further troubleshooting. As a result of the troubleshooting the HVPS was replaced a second time. Since components were replaced, a new calibration of the radiation monitor was required. While attempting to perform the recalibration of the monitor another issue discovered. Limitations within HNP procedure CM-I0122, General Atomic Gas and Liquid Detector Alignment, prevented the calibration from being able to be performed. When replacing a detector, pre-amp card, or HVSP the procedure was not able to be utilized due to recent equipment updates not being incorporated into the procedure. This procedure was revised to incorporate the changes in equipment and was used to restore RM-3542 to service on 2/12/2024.

Other Deviations

NCR 02488192- Turbine Building Drains Composite Sample Deviation

On 09/26/23, during weekly sampling, the Turbine Building Drain (TBDR) composite sampler was found to have approximately 300 ml of sample vice they expect volume of about 20 L. It was also noted that the light for auto sampler was not indicating on as expected. NCR 02488192 was generated to document the deviation in sampling and as a result WO 20629106 was created to fix the composite sampler. When the issue was discovered, chemistry initiated compensatory sampling to collect a grab sample once every 12 hours. The samples collected were used for the weekly composite sample. WO 20629106 was completed on 11/09/2023.

ATTACHMENT 9

Summary of Changes to the Offsite Dose Calculation Manual

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

Attachment 9
Summary of Changes to the Offsite Dose Calculation Manual

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2023 - 12/31/2023

ODCM Revision 29

The HNP ODCM was not revised in 2023. The most recent revision as of 12/31/2023 was revision 29. Revision 30 was implemented January 18, 2024.

ATTACHMENT 10

Summary of Changes to the Process Control Program

This attachment includes a summary of changes to the PCP.

Attachment 10
Summary of Changes to the Process Control Program

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2023 - 12/31/2023

In 2022, the HNPP Process control Program Document, PLP-300 was superseded and implemented into AD-CP-ALL-0030, Process Control Program (PCP Review and Revision. No revisions to AD-CP-ALL-0030 were made in 2023. The most recent revision is Revision 0.

ATTACHMENT 11

Summary of Major Modifications to the Radioactive Waste Treatment Systems

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

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

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2023 - 12/31/2023

No major modifications to Shearon Harris Nuclear Power Plant liquid or solid waste treatment systems in 2023.

ATTACHMENT 12

Errata to a Previous Year's ARERR

This attachment includes any amended pages from a previous year's ARERR.

Attachment 12
Errata to a Previous Year's ARERR

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2023 - 12/31/2023

There were no changes to the previous year's ARERR.

ENCLOSURE 4: **MNS Annual Radioactive Effluent Release Report**

McGuire Nuclear Station
Units 1 and 2

Annual Radioactive Effluent Release Report

January 1, 2023 through December 31, 2023

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 1/1/2023- 12/31/2023

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 1/1/2023- 12/31/2023

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	6.32E-01	9.01E-01	8.02E-01	5.46E-01	2.88E+00
2. Avg. Release Rate	μCi/sec	8.12E-02	1.15E-01	1.01E-01	6.87E-02	9.13E-02
B. Iodine-131						
1. Total Release	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2. Avg. Release Rate	μCi/sec	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C. Particulates Half-Life ≥ 8 days						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	5.87E-06	5.87E-06
2. Avg. Release Rate	μCi/sec	0.00E+00	0.00E+00	0.00E+00	7.38E-07	1.86E-07
D. Tritium						
1. Total Release	Ci	3.19E+01	1.73E+01	2.22E+01	2.37E+01	9.50E+01
2. Avg. Release Rate	μCi/sec	4.10E+00	2.20E+00	2.80E+00	2.98E+00	3.01E+00
E. Carbon-14						
1. Total Release	Ci	4.23E+00	5.30E+00	5.04E+00	4.83E+00	1.94E+01
2. Avg. Release Rate	μCi/sec	5.43E-01	6.74E-01	6.35E-01	6.07E-01	6.15E-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 1/1/2023- 12/31/2023

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 1/1/2023- 12/31/2023

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 1/1/2023- 12/31/2023

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	0.00E+00	0.00E+00	5.87E-06	5.87E-06
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	5.87E-06	5.87E-06
D. Tritium						
H-3	Ci	2.77E+01	1.72E+01	2.18E+01	2.13E+01	8.79E+01
E. Carbon-14 *						
C-14	Ci	1.27E+00	1.59E+00	1.51E+00	1.45E+00	5.82E+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 1/1/2023- 12/31/2023

Gaseous Effluents - Ground Releases - Batch Mode

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Gases						
AR-41	Ci	5.89E-01	8.57E-01	7.52E-01	5.14E-01	2.71E+00
XE-133	Ci	4.14E-02	3.79E-02	5.00E-02	3.21E-02	1.61E-01
XE-135	Ci	1.22E-03	5.66E-03	0.00E+00	0.00E+00	6.87E-03
Total for Period	Ci	6.32E-01	9.01E-01	8.02E-01	5.46E-01	2.88E+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	4.17E+00	8.57E-02	4.70E-01	2.41E+00	7.13E+00
E. Carbon-14*						
C-14	Ci	2.96E+00	3.71E+00	3.53E+00	3.38E+00	1.36E+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 1/1/2023- 12/31/2023

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 1/1/2023- 12/31/2023

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 1/1/2023- 12/31/2023

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	2.91E-02	2.22E-02	5.31E-03	5.93E-03	6.26E-02
2. Avg. Diluted Conc.	μCi/ml	3.89E-11	2.28E-11	5.65E-12	6.47E-12	1.75E-11
3. Batch Releases	μCi/ml	3.89E-11	2.28E-11	5.65E-12	6.47E-12	1.75E-11
B. Tritium						
1. Total Release	Ci	3.91E+02	2.90E+02	4.26E+02	3.34E+02	1.44E+03
2. Avg. Diluted Conc.	μCi/ml	5.29E-07	2.99E-07	4.56E-07	3.67E-07	4.06E-07
3. Batch Releases	μCi/ml	5.22E-07	2.98E-07	4.53E-07	3.64E-07	4.03E-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	9.74E+07	6.47E+07	7.17E+07	6.83E+07	3.02E+08
2. Batch Releases	liters	1.26E+06	8.87E+05	1.39E+06	1.13E+06	4.67E+06
F. Volume of Dilution Water						
1. Continuous Releases	liters	7.49E+10	9.73E+10	9.40E+10	9.17E+10	3.58E+11
2. Batch Releases	liters	7.49E+11	9.73E+11	9.40E+11	9.17E+11	3.58E+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 1/1/2023- 12/31/2023

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	5.17E-01	8.79E-02	2.13E-01	3.12E-01	1.13E+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 1/1/2023- 12/31/2023

Liquid Effluents - Batch Mode

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Products						
Ag-110m	Ci	1.67E-05	0.00E+00	0.00E+00	0.00E+00	1.67E-05
Co-57	Ci	0.00E+00	0.00E+00	1.51E-06	0.00E+00	1.51E-06
Co-58	Ci	6.03E-03	5.61E-03	7.96E-04	6.87E-04	1.31E-02
Co-60	Ci	9.85E-03	5.83E-03	2.94E-03	1.98E-03	2.06E-02
Cr-51	Ci	3.68E-03	3.18E-04	0.00E+00	0.00E+00	4.00E-03
Cs-137	Ci	1.42E-04	4.59E-05	2.58E-05	1.97E-04	4.11E-04
Fe-55	Ci	1.14E-03	6.53E-04	3.16E-04	1.41E-04	2.25E-03
Fe-59	Ci	0.00E+00	3.88E-06	0.00E+00	0.00E+00	3.88E-06
Mn-54	Ci	6.38E-04	3.28E-04	1.14E-04	5.22E-05	1.13E-03
Nb-95	Ci	1.17E-04	1.77E-04	2.73E-05	1.36E-05	3.35E-04
Nb-97	Ci	1.54E-05	0.00E+00	0.00E+00	0.00E+00	1.54E-05
Ni-63	Ci	3.16E-03	2.20E-03	5.74E-04	7.16E-04	6.64E-03
Sb-124	Ci	2.87E-05	1.29E-04	0.00E+00	4.65E-05	2.05E-04
Sb-125	Ci	4.27E-03	6.89E-03	5.17E-04	2.10E-03	1.38E-02
Sb-126	Ci	2.95E-06	0.00E+00	0.00E+00	0.00E+00	2.95E-06
Sr-89	Ci	0.00E+00	0.00E+00	3.43E-07	0.00E+00	3.43E-07
Zn-65	Ci	9.03E-06	0.00E+00	0.00E+00	0.00E+00	9.03E-06
Zr-95	Ci	1.46E-05	3.49E-05	0.00E+00	0.00E+00	4.96E-05
Total for Period	Ci	2.91E-02	2.22E-02	5.31E-03	5.93E-03	6.26E-02
B. Tritium						
H-3	Ci	3.91E+02	2.90E+02	4.26E+02	3.34E+02	1.44E+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

<u>ATTACHMENT 2</u>

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 1/1/2023 - 12/31/2023

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	=	256
2.	Total Time (min) for Batch Releases	=	1.76E+04
3.	Maximum Time (min) for a Batch Release	=	1.51E+03
4.	Average Time (min) for Batch Releases	=	6.88E+01
5.	Minimum Time (min) for a Batch Release	=	2.10E+01
6.	Average Dilution Water Flow During Release (lpm)	=	1.80E+06

B. Gaseous Effluents

1.	Total Number of Batch Releases	=	36
2.	Total Time (min) for Batch Releases	=	1.03E+06
3.	Maximum Time (min) for a Batch Release	=	4.46E+04
4.	Average Time (min) for Batch Releases	=	2.87E+04
5.	Minimum Time (min) for a Batch Release	=	1.45E+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 2023 ARERR contains estimates of C-14 radioactivity released in 2023, 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 2023 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 2023 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 2023 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 2023 is well below the 10CFR50, Appendix I, ALARA design objective (i.e., 15 mrem/yr per unit).

McGuire Nuclear Station Units 1 & 2
Period 1/1/2023 - 12/31/2023

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%

McGuire Nuclear Station Units 1 & 2
Period 1/1/2023 - 12/31/2023

Summary of Changes in Land Use Census Affecting Effluent Dose Calculations

The 2023 Land Use Census was performed June 19-20, 2023, and the results were certified and made available for use on July 3, 2023. The following are changes to residences, gardens, and milk animals from the previous year.

Residences

No changes were identified during the 2023 census.

Gardens

The garden in the N sector (3.03 miles) was replaced with a closer garden at 2.64 miles.
The garden in the NNE sector (4.23 miles) was replaced with a closer garden at 1.40 miles.
The garden in the ESE sector (1.23 miles) was replaced with a closer garden at 1.14 miles.
The garden in the SSE sector (1.22 miles) was replaced with a closer garden at 1.06 miles.
The garden in the SSW sector (3.30 miles) was replaced with a closer garden at 2.79 miles.

Milk Animals

No changes to nearest milk animal in each sector.

Environmental Monitoring Locations

No changes to environmental monitoring locations in each sector.

ATTACHMENT 3

Solid Radioactive Waste Disposal

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

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

Attachment 3
Solid Radioactive Waste Disposal

McGuire Nuclear Station Units 1 & 2
Period 1/1/2023 - 12/31/2023

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)	20	69	A	DBP	991	2.90
e. Sealed Sources / Smoke Detectors	None					
f. Sealed Sources	None					
g. Irradiated Components	None					
3. Total Waste	**20**	**69**			**991**	**2.90**

Attachment 3
Solid Radioactive Waste Disposal

McGuire Nuclear Station Units 1 & 2
Period 1/1/2023 - 12/31/2023

Type of Waste Shipped	Radionuclide	% Abundance
1. Waste from Liquid Systems		
a. Dewatered Powdex Resin (brokered)	No shipments in 2023	
b. Dewatered Powdex Resin	No shipments in 2023	
c. Dewatered Bead Resin (brokered)	No shipments in 2023	
d. Dewatered Bead Resin	No shipments in 2023	
e. Dewatered Radwaste System Resin (brokered)	No shipments in 2023	
f. Dewatered Primary Bead Resins (brokered)	No shipments in 2023	
g. Dewatered Mechanical Filter Media	No shipments in 2023	
h. Dewatered Mechanical Filter Media (brokered)	No shipments in 2023	
i. Solidified Waste	No shipments in 2023	
2. Dry Solid Waste		
a. Dry Active Waste (compacted)	Compaction no longer	performed on site
b. Dry Active Waste (non-compacted)	No shipments in 2023	
c. Dry Active Waste (brokered / compacted)		
a. RSRMNS#23-0001	Radionuclide	% Abundance
	Cr-51	22.53%
	Mn-54	3.02%
	Fe-55	21.65%
	Fe-59	0.61%
	Co-57	0.07%
	Co-58	15.26%
	Co-60	14.42%
	Ni-63	2.48%
	Zn-65	0.87%
	Zr-95	5.92%
	Nb-95	12.09%
	Sn-113	0.13%
	Sb-124	0.29%
	Sb-125	0.58%
	Cs-137	0.08%

Attachment 3
Solid Radioactive Waste Disposal

McGuire Nuclear Station Units 1 & 2
Period 1/1/2023 - 12/31/2023

b. RSR#MNS23-0003

Radionuclide	% Abundance
Cr-51	38.39%
Mn-54	2.09%
Fe-55	13.97%
Fe-59	0.74%
Co-57	0.05%
Co-58	14.79%
Co-60	9.15%
Ni-63	1.55%
Zn-65	0.62%
Zr-95	5.99%
Nb-95	11.82%
Sn-113	0.1%
Sb-124	0.31%
Sb-125	0.37%
Cs-137	0.05%

c. RSR#MNS23-0004

Radionuclide	% Abundance
Cr-51	32.03%
Mn-54	2.43%
Fe-55	16.62%
Fe-59	0.71%
Co-57	0.06%
Co-58	15.34%
Co-60	10.95%
Ni-63	1.87%
Zn-65	0.72%
Zr-95	6.11%
Nb-95	12.25%
Sn-113	0.11%
Sb-124	0.31%
Sb-125	0.44%
Cs-137	0.06%

d. RSR#MNS23-0009

Radionuclide	% Abundance
Cr-51	37%
Mn-54	2.16%
Fe-55	14.52%
Fe-59	0.74%
Co-57	0.05%
Co-58	14.94%
Co-60	9.52%
Ni-63	1.62%
Zn-65	0.64%
Zr-95	6.03%
Nb-95	11.94%
Sn-113	0.11%
Sb-124	0.31%
Sb-125	0.39%
Cs-137	0.05%

e. RSR#MNS23-0010

Radionuclide	% Abundance
Cr-51	35.53%
Mn-54	2.24%
Fe-55	15.13%
Fe-59	0.73%
Co-57	0.05%
Co-58	15.06%
Co-60	9.94%
Ni-63	1.69%
Zn-65	0.66%
Zr-95	6.05%
Nb-95	12.03%
Sn-113	0.11%
Sb-124	0.31%
Sb-125	0.4%
Cs-137	0.05%

f. RSR#MNS23-0014

Radionuclide	% Abundance
Cr-51	39.01%
Mn-54	2.06%
Fe-55	13.76%
Fe-59	0.75%
Co-57	0.05%
Co-58	14.7%
Co-60	9.01%
Ni-63	1.53%
Zn-65	0.61%
Zr-95	5.96%
Nb-95	11.74%
Sn-113	0.1%
Sb-124	0.3%
Sb-125	0.37%
Cs-137	0.05%

g. RSR#MNS23-0016

Radionuclide	% Abundance
Cr-51	35.69%
Mn-54	2.23%
Fe-55	15.04%
Fe-59	0.73%
Co-57	0.05%
Co-58	15.07%
Co-60	9.87%
Ni-63	1.68%
Zn-65	0.66%
Zr-95	6.06%
Nb-95	12.04%
Sn-113	0.11%
Sb-124	0.31%
Sb-125	0.4%
Cs-137	0.05%

h. RSR#MNS23-0021

Radionuclide	% Abundance
Cr-51	9.85%
Mn-54	3.88%
Fe-55	29.7%
Fe-59	0.43%
Co-57	0.09%
Co-58	14.02%
Co-60	20.06%
Ni-63	3.51%
Zn-65	1.09%
Zr-95	5.18%
Nb-95	10.89%
Sn-113	0.14%
Sb-124	0.25%
Sb-125	0.79%
Cs-137	0.11%

i. RSR#MNS23-0022

Radionuclide	% Abundance
Cr-51	40.93%
Mn-54	1.96%
Fe-55	13.01%
Fe-59	0.75%
Co-57	0.05%
Co-58	14.49%
Co-60	8.51%
Ni-63	1.44%
Zn-65	0.59%
Zr-95	5.9%
Nb-95	11.58%
Sn-113	0.1%
Sb-124	0.3%
Sb-125	0.35%
Cs-137	0.04%

j. RSR#MNS23-0023

Radionuclide	% Abundance
Cr-51	40.49%
Mn-54	1.99%
Fe-55	13.18%
Fe-59	0.75%
Co-57	0.05%
Co-58	14.54%
Co-60	8.62%
Ni-63	1.46%
Zn-65	0.59%
Zr-95	5.91%
Nb-95	11.62%
Sn-113	0.1%
Sb-124	0.3%
Sb-125	0.35%
Cs-137	0.04%

Attachment 3
Solid Radioactive Waste Disposal

McGuire Nuclear Station Units 1 & 2
Period 1/1/2023 - 12/31/2023

k. RSR#MNS23-0024

Radionuclide	% Abundance
Cr-51	2.93%
Mn-54	4.48%
Fe-55	37.35%
Fe-59	0.23%
Co-57	0.1%
Co-58	10.47%
Co-60	25.73%
Ni-63	4.58%
Zn-65	1.22%
Zr-95	3.64%
Nb-95	7.82%
Sn-113	0.13%
Sb-124	0.17%
Sb-125	1%
Cs-137	0.14%

l. RSR#MNS23-0025

Radionuclide	% Abundance
Cr-51	35.94%
Mn-54	2.22%
Fe-55	14.95%
Fe-59	0.73%
Co-57	0.05%
Co-58	15.03%
Co-60	9.82%
Ni-63	1.67%
Zn-65	0.66%
Zr-95	6.05%
Nb-95	12.01%
Sn-113	0.11%
Sb-124	0.31%
Sb-125	0.4%
Cs-137	0.05%

m. RSR#MNS23-0026

Radionuclide	% Abundance
Cr-51	40.93%
Mn-54	1.96%
Fe-55	13.01%
Fe-59	0.75%
Co-57	0.05%
Co-58	14.49%
Co-60	8.51%
Ni-63	1.44%
Zn-65	0.59%
Zr-95	5.9%
Nb-95	11.58%
Sn-113	0.1%
Sb-124	0.3%
Sb-125	0.35%
Cs-137	0.04%

Attachment 3
Solid Radioactive Waste Disposal

McGuire Nuclear Station Units 1 & 2
Period 1/1/2023 - 12/31/2023

n. RSR#MNS23-0027

Radionuclide	% Abundance
Cr-51	17.54%
Mn-54	3.31%
Fe-55	23.99%
Fe-59	0.57%
Co-57	0.08%
Co-58	15.48%
Co-60	16.01%
Ni-63	2.76%
Zn-65	0.95%
Zr-95	5.92%
Nb-95	12.23%
Sn-113	0.13%
Sb-124	0.29%
Sb-125	0.64%
Cs-137	0.08%

o. RSR#MNS23-0028

Radionuclide	% Abundance
Cr-51	17.54%
Mn-54	3.31%
Fe-55	23.99%
Fe-59	0.57%
Co-57	0.08%
Co-58	15.48%
Co-60	16.01%
Ni-63	2.76%
Zn-65	0.95%
Zr-95	5.92%
Nb-95	12.23%
Sn-113	0.13%
Sb-124	0.29%
Sb-125	0.64%
Cs-137	0.08%

p. RSR#MNS23-0029

Radionuclide	% Abundance
Cr-51	36.36%
Mn-54	2.2%
Fe-55	14.83%
Fe-59	0.73%
Co-57	0.05%
Co-58	14.96%
Co-60	9.73%
Ni-63	1.65%
Zn-65	0.65%
Zr-95	6.02%
Nb-95	11.95%
Sn-113	0.11%
Sb-124	0.31%
Sb-125	0.4%
Cs-137	0.05%

q. RSR#MNS23-0030

Radionuclide	% Abundance
Cr-51	37.44%
Mn-54	2.14%
Fe-55	14.34%
Fe-59	0.74%
Co-57	0.05%
Co-58	14.89%
Co-60	9.4%
Ni-63	1.6%
Zn-65	0.64%
Zr-95	6.01%
Nb-95	11.9%
Sn-113	0.11%
Sb-124	0.31%
Sb-125	0.38%
Cs-137	0.05%

r. RSR#MNS23-0032

Radionuclide	% Abundance
Cr-51	37.88%
Mn-54	2.12%
Fe-55	14.17%
Fe-59	0.74%
Co-57	0.05%
Co-58	14.85%
Co-60	9.29%
Ni-63	1.57%
Zn-65	0.63%
Zr-95	6%
Nb-95	11.87%
Sn-113	0.1%
Sb-124	0.31%
Sb-125	0.38%
Cs-137	0.05%

s. RSR#MNS23-0034

Radionuclide	% Abundance
Cr-51	38.15%
Mn-54	2.11%
Fe-55	14.08%
Fe-59	0.74%
Co-57	0.05%
Co-58	14.81%
Co-60	9.22%
Ni-63	1.56%
Zn-65	0.63%
Zr-95	5.99%
Nb-95	11.83%
Sn-113	0.1%
Sb-124	0.31%
Sb-125	0.38%
Cs-137	0.05%

Attachment 3
Solid Radioactive Waste Disposal

McGuire Nuclear Station Units 1 & 2
Period 1/1/2023 - 12/31/2023

t. RSR#MNS23-0043

Radionuclide	% Abundance
Cr-51	36.65%
Mn-54	2.18%
Fe-55	14.66%
Fe-59	0.74%
Co-57	0.05%
Co-58	14.97%
Co-60	9.61%
Ni-63	1.63%
Zn-65	0.65%
Zr-95	6.03%
Nb-95	11.96%
Sn-113	0.11%
Sb-124	0.31%
Sb-125	0.39%
Cs-137	0.05%

d. Sealed Sources / Smoke Detectors — No shipments in 2023

e. Sealed Sources — No shipments in 2023

f. Irradiated Components — No shipments in 2023

ATTACHMENT 4

Meteorological Data

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

Attachment 4
Meteorological Data

McGuire Nuclear Station Units 1 & 2
Period 1/1/2023 - 12/31/2023

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	0	0	0	0	0	0	0	0	0	0	0	0	0
	1.01-1.25	6	3	0	0	0	0	0	0	0	0	1	0	0	0	1	2
	1.26-1.50	41	10	4	1	2	0	0	0	0	0	0	0	0	1	3	9
	1.51-2.00	83	46	13	3	1	0	0	0	0	0	0	7	3	3	2	29
	2.01-3.00	17	49	14	9	1	1	6	0	1	0	1	5	6	6	3	3
	3.01-4.00	5	5	3	4	1	2	0	2	0	3	2	1	1	2	2	3
	4.01-5.00	7	1	0	1	1	0	0	0	0	0	0	2	2	0	3	0
	5.01-6.00	7	1	0	0	0	0	1	0	0	0	0	0	1	0	1	0
	6.01-8.00	3	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0
	8.01-10.00	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10.01-max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B	0.46-0.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.76-1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1.01-1.25	2	5	0	0	0	0	0	0	0	0	0	0	0	0	0	3
	1.26-1.50	12	7	5	2	0	0	0	0	0	0	0	0	0	6	3	9
	1.51-2.00	11	11	11	6	3	1	0	0	3	0	0	4	5	5	5	6
	2.01-3.00	9	14	16	8	11	7	1	3	3	5	6	11	8	1	1	3
	3.01-4.00	7	4	10	14	3	1	0	0	1	3	7	10	1	3	6	5
	4.01-5.00	9	1	7	1	0	0	0	0	0	1	6	3	4	2	2	1
	5.01-6.00	3	1	1	1	0	0	0	0	0	1	2	3	3	0	0	1
	6.01-8.00	2	1	0	0	0	0	0	0	0	0	1	1	0	0	2	5
	8.01-10.00	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	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 1/1/2023 - 12/31/2023

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	1	0	0	0	1	0
	1.01-1.25	11	1	2	0	1	0	0	0	0	0	1	0	0	2	3	2
	1.26-1.50	9	11	2	0	0	0	0	0	1	1	3	0	3	8	6	5
	1.51-2.00	8	11	13	4	2	1	1	0	0	8	5	4	9	7	4	3
	2.01-3.00	8	13	18	12	14	3	6	4	6	10	12	25	12	6	5	6
	3.01-4.00	7	7	8	9	4	2	2	1	0	13	22	13	7	6	3	3
	4.01-5.00	6	5	13	5	0	0	0	0	0	7	15	12	10	5	2	9
	5.01-6.00	3	1	1	0	0	0	0	0	0	1	11	8	1	2	9	10
	6.01-8.00	5	2	6	0	0	0	0	0	0	0	3	1	1	2	3	21
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
	10.01-max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D	0.46-0.75	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
	0.76-1.00	10	3	2	1	2	1	2	0	0	2	3	0	3	4	7	3
	1.01-1.25	20	9	6	3	2	6	7	4	6	3	5	4	9	7	12	14
	1.26-1.50	26	12	12	13	5	4	6	12	11	13	12	15	12	9	10	11
	1.51-2.00	37	46	62	38	18	13	26	19	27	16	33	38	36	18	16	16
	2.01-3.00	29	71	192	134	87	34	47	17	49	97	155	116	43	18	45	39
	3.01-4.00	18	39	177	108	75	38	7	7	8	82	215	56	34	25	40	31
	4.01-5.00	10	21	94	25	8	10	8	0	0	37	126	19	6	14	28	18
	5.01-6.00	7	11	50	1	1	0	0	0	0	11	52	10	5	5	15	14
	6.01-8.00	5	8	3	0	0	0	0	0	0	2	32	2	1	7	8	10
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	2	1	0	0	5	2
	10.01-max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0

Attachment 4
Meteorological Data

McGuire Nuclear Station Units 1 & 2
Period 1/1/2023 - 12/31/2023

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	1	0	1	1	0	2	1	2	2	4	5	0	0	0	0
E	0.76-1.00	4	0	0	4	5	5	7	9	12	11	8	11	4	4	6	3
E	1.01-1.25	9	4	11	2	5	7	9	10	8	20	14	13	20	13	9	9
E	1.26-1.50	9	8	4	3	9	11	14	28	27	20	14	18	22	24	17	6
E	1.51-2.00	19	7	19	21	15	15	36	28	46	73	47	57	25	19	25	15
E	2.01-3.00	10	4	20	19	29	9	44	7	27	159	156	80	22	21	17	12
E	3.01-4.00	0	0	2	2	16	1	3	1	3	17	83	14	10	15	13	3
E	4.01-5.00	1	0	0	0	0	0	2	0	0	1	13	3	0	2	4	0
E	5.01-6.00	0	0	0	0	0	0	0	0	0	0	1	1	1	0	2	0
E	6.01-8.00	0	0	0	0	0	0	0	0	0	0	0	3	0	0	3	0
E	8.01-10.00	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
E	10.01-max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F	0.46-0.75	1	1	0	0	0	0	0	1	4	7	5	3	4	3	0	0
F	0.76-1.00	1	1	2	2	3	4	3	5	17	24	24	17	8	2	3	1
F	1.01-1.25	3	2	0	1	1	1	2	8	10	22	23	20	10	5	1	2
F	1.26-1.50	0	2	0	0	0	0	2	11	25	38	17	14	9	2	2	0
F	1.51-2.00	0	0	1	0	0	0	2	9	35	49	31	21	7	2	1	2
F	2.01-3.00	0	0	0	0	0	1	0	2	9	21	29	12	15	7	2	0
F	3.01-4.00	1	0	0	0	0	0	1	0	0	1	1	0	0	1	0	0
F	4.01-5.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F	5.01-6.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F	6.01-8.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F	8.01-10.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F	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 1/1/2023 - 12/31/2023

Stability Class	Wind Speed (m/s)	Hours of Occurrence															
		Sector															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
G	0.46-0.75	1	0	0	0	1	0	0	1	5	14	24	5	5	0	0	1
	0.76-1.00	0	2	2	0	0	1	0	0	6	44	55	21	5	4	2	0
	1.01-1.25	0	0	0	0	0	0	0	1	5	24	24	13	2	0	0	0
	1.26-1.50	0	0	0	0	0	0	0	1	6	13	6	9	1	0	1	0
	1.51-2.00	0	0	0	0	0	0	0	0	10	7	7	3	1	0	0	0
	2.01-3.00	0	0	0	0	0	0	0	0	0	0	2	3	1	0	0	0
	3.01-4.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	4.01-5.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	5.01-6.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	6.01-8.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10.01-max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

ATTACHMENT 5

Unplanned Offsite Releases

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 1/1/2023 - 12/31/2023

McGuire Nuclear Station experienced no unplanned offsite releases in 2023.

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

McGuire Nuclear Station Units 1 & 2
Period 1/1/2023 - 12/31/2023

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 1/1/2023 - 12/31/2023

Gaseous Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Noble Gases						
1. Maximum Gamma Air	mRAD	5.14E-03	7.48E-03	6.56E-03	4.48E-03	2.37E-02
(a) Limit	mRAD	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
(b) % of Limit		5.14E-02	7.48E-02	6.56E-02	4.48E-02	1.18E-01
2. Maximum Beta Air	mRAD	1.85E-03	2.68E-03	2.36E-03	1.61E-03	8.50E-03
(a) Limit	mRAD	2.00E+01	2.00E+01	2.00E+01	2.00E+01	4.00E+01
(b) % of Limit		9.25E-03	1.34E-02	1.18E-02	8.04E-03	2.12E-02

Receptor Location ***0.5*** miles ***ENE***

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
B. Iodine, H-3, & Particulates						
1. Maximum Organ Dose	mREM	6.47E-01	8.12E-01	7.73E-01	7.39E-01	2.97E+00
(a) Limit	mREM	1.50E+01	1.50E+01	1.50E+01	1.50E+01	3.00E+01
(b) % of Limit		4.31E+00	5.41E+00	5.15E+00	4.93E+00	9.90E+00

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

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

McGuire Nuclear Station Units 1 & 2
Period 1/1/2023 - 12/31/2023

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Batch Mode						
1. Maximum Organ Dose	mREM	5.51E-02	3.22E-02	4.81E-02	3.94E-02	1.71E-01
(a) Limit	mREM	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
(b) % of Limit		5.51E-01	3.22E-01	4.81E-01	3.94E-01	8.57E-01
(c) Critical Age		Child	Child	Child	Child	Child
(d) Critical Organ		Liver	GI-Lli	Gi-Lli	Liver	Liver
2. Maximum Total Body Dose	mREM	5.44E-02	3.14E-02	4.80E-02	3.86E-02	1.70E-01
(a) Limit	mREM	3.00E+00	3.00E+00	3.00E+00	3.00E+00	6.00E+00
(b) % of Limit		1.81E+00	1.05E+00	1.60E+00	1.29E+00	2.83E+00
(c) Critical Age		Child	Child	Child	Child	Child
B. Continuous Mode						
1. Maximum Organ Dose	mREM	7.11E-04	9.42E-05	2.39E-04	3.59E-04	1.32E-03
(a) Limit	mREM	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
(b) % of Limit		7.11E-03	9.42E-04	2.39E-03	3.59E-03	6.60E-03
(c) Critical Age		Child	Child	Child	Child	Child
(d) Critical Organ		Liver	Liver	Liver	Liver	Liver
2. Maximum Total Body Dose	mREM	7.11E-04	9.42E-05	2.39E-04	3.59E-04	1.32E-03
(a) Limit	mREM	3.00E+00	3.00E+00	3.00E+00	3.00E+00	6.00E+00
(b) % of Limit		2.37E-02	3.14E-03	7.95E-03	1.20E-02	2.20E-02
(c) Critical Age		Child	Child	Child	Child	Child

McGuire Nuclear Station Units 1 & 2
Period 1/1/2023 - 12/31/2023

40 CFR Part 190 Uranium Fuel Cycle Dose Calculation Results

In accordance with the requirements of 40 CFR Part 190, the annual dose commitment to any member of the general public shall be calculated to assure that doses are limited to 25 millirems to the total body or any organ with the exception of the thyroid which is limited to 75 millirems. The fuel cycle dose assessment for 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)	2.978E+00
1. Location	1.0 miles NNE
2. Critical Age	Child
3. Critical Organ	Bone
4. Gas Contribution %	9.975E+01
5. Liquid Contribution %	2.490E-01
B. Maximum Total Body Dose	1.068 E+00
1. Location	1.0 miles NNE
2. Critical Age	Child
3. Gas non-NG Contribution %	8.275E+01
4. Gas Contribution %	1.363E+00
5. Liquid Contribution %	1.588E+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 13

The attached excerpt from the 10 CFR 72.212 Evaluation Report, MAGNASTOR®, Revision 13 is provided to document the method used to calculate the dose from ISFSI as less than 7 mrem/yr to the nearest real individual.

Total dose from liquid and gaseous effluents from McGuire Nuclear Station and direct and air-scatter dose from the onsite ISFSI is conservatively estimated to be less than 11 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 13

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

McGuire Nuclear Station ISFSI Page 55
10 CFR 72.212 Evaluation Report, MAGNASTOR®, Rev. 13
calculated (700 meters) is conservative compared to the distance to the closest real individual.

NAC International determined the annual total dose (gamma plus neutron) at a distance of 700 meters from a 2x6 array of MAGNASTOR® casks to be approximately 1.01 mrem (3.03 mrem for three arrays). The evaluation was conservatively based on full cask loads of 37 fuel assemblies at the maximum allowable heat load of 35.5 kW. The distance at which this dose is calculated (700 meters) is conservative compared to the distance to the closest real individual.

NAC International determined the annual total dose (gamma plus neutron) at a distance of 700 meters from a 1x6 array of MAGNASTOR® casks to be approximately 0.91 mrem. The evaluation was conservatively based on full cask loads of 37 fuel assemblies at the maximum allowable heat load of 35.5 kW. The distance at which this dose is calculated (700 meters) is conservative compared to the distance to the closest real individual.

NAC International determined the annual total dose (gamma plus neutron) at a distance of 700 meters from a 3x7 array of MAGNASTOR® casks to be approximately 1.35 mrem. The evaluation was conservatively based on full cask loads of 37 fuel assemblies at the maximum allowable heat load of 35.5 kW. The distance at which this dose is calculated (700 meters) is conservative compared to the distance to the closest real individual.

The total calculated annual public dose from liquid and gaseous effluent pathways averaged over a ten-year period is less than 4 mrem. No other uranium fuel cycle facility contributes significantly to the dose received by the closest real individual.

Based on the above, the calculated annual dose to the closest real individual due to the ISFSI, which is comprised of the currently existing ten TN-32A casks and 28 NAC-UMS® casks, and up to three 2x6 arrays, one 1x6 array, and one 3x7 array of MAGNASTOR® casks (*see Note below*), is determined to be less than 7 mrem, and the estimated annual dose due to McGuire power generation is less than 4 mrem. Hence, the total annual dose to the closest real individual (less than 11 mrem) is within the 10 CFR 72.104(a) limit.

Note: As stated above, up to three 2x6 arrays, one 1x6 array, and one 3x7 array of MAGNASTOR® casks *are assumed in this evaluation. The first eight MAGNASTOR® casks are placed on a concrete pad currently containing four NAC-UMS® casks. This will conservatively count as one 2x6 array. Additional MAGNASTOR® casks will be placed on their own concrete pads in two additional*

2x6 arrays, one 1x6 array, and one 3x7 array. Hence, this
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10 CFR 72.212 Evaluation Report, MAGNASTOR®, Rev. 13
§72.104(a) evaluation bounds up to 59 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 1/1/2023 - 12/31/2023

Duke Energy implemented a Ground Water Protection program in 2007. This initiative was developed to ensure timely and effective management of situations involving inadvertent releases of licensed material to ground water. As part of this program, McGuire Nuclear Station monitored 99 wells, 4 surface water points and 1 Leachate Pond.

Wells are typically sampled quarterly or semi-annually. Ground water samples are regularly analyzed for tritium and gamma emitters, with select wells being analyzed for difficult-to-detect radionuclides. No gamma or difficult-to-detect radionuclides, other than naturally occurring radionuclides, were identified in well samples during 2023. Results from sampling during 2023 confirmed existing knowledge of tritium concentrations in site ground water.

Results from sampling during 2023 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 2023.

Key to below table.

McGuire Nuclear Station Units 1 & 2
Period 1/1/2023 - 12/31/2023

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 1/1/2023 - 12/31/2023

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	5.47E+02	3.89E+02	3.89E+02	5.24E+02	4
M-103	MNS GWPI / M-103 / S of WC	5.10E+02	2.93E+02	4.21E+02	3.96E+02	4
M-103R	MNS GWPI / M-103R / S of WC	NS	3.96E+02	NS	5.29E+02	2
M-104DR	MNS GWPI / M-104DR / W of WC	NS	3.56E+02	NS	3.72E+02	2
M-104R	MNS GWPI / M-104R / W of WC	6.06E+02	4.35E+02	4.77E+02	5.11E+02	4
M-105	MNS GWPI / M-105 / Landfarm	NS	<MDA	NS	2.21E+02	2
M-20	MNS GWPI / M-20 / S of Hwy. 73	NS	2.57E+02	NS	3.53E+02	2
M-20R	MNS GWPI / M-20R / S of Hwy. 73	NS	NS	NS	3.97E+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.	2.18E+03	6.99E+03	7.11E+03	4.40E+03	6
M-48DR	MNS GWPI / M-48DR / U-2 SFP	NS	<MDA	NS	<MDA	2
M-48R	MNS GWPI / M-48R / U-2 SFP	NS	3.84E+02	NS	3.58E+02	2
M-53	MNS GWPI / M-53 / N of plant	NS	5.47E+02	NS	5.42E+02	2
M-55	MNS GWPI / M-55 / NAB	NS	<MDA	NS	<MDA	2
M-59	MNS GWPI / M-59 / U-2 Doghouse	1.07E+03	8.11E+02	7.99E+02	8.04E+02	4
M-60	MNS GWPI / M-60 / MOC Parking	NS	NS	NS	<MDA	1
M-62	MNS GWPI / M-62 / S of RWF	3.33E+02	<MDA	<MDA	<MDA	4
M-64	MNS GWPI / M-64 / Rdwst. Bldg.	NS	3.38E+02	NS	2.70E+02	2
M-66	MNS GWPI / M-66 / S of SSF	4.96E+02	6.26E+02	5.96E+02	5.40E+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	3.56E+02	4.25E+02	3.19E+02	2.55E+02	4
M-70	MNS GWPI / M-70 / U-1 SFP	5.03E+02	<MDA	2.44E+02	2.87E+02	4
M-70DR	MNS GWPI / M-70DR / U-1 SFP	NS	<MDA	NS	<MDA	2
M-70R	MNS GWPI / M-70R / U-1 SFP	NS	4.08E+02	NS	5.45E+02	2
M-72	MNS GWPI / M-72 / Rdwst. Trench	5.66E+02	4.88E+02	3.90E+02	4.40E+02	4
M-76	MNS GWPI / M-76 / W of U-1 SFP	4.28E+02	3.95E+02	2.89E+02	2.52E+02	4
M-82	MNS GWPI / M-82 / River	NS	NS	NS	3.56E+02	1
M-84	MNS GWPI / M-84 / River	NS	NS	NS	7.29E+02	1
M-84R	MNS GWPI / M-84R / River	NS	NS	NS	7.33E+02	1
M-85	MNS GWPI / M-85 / River	NS	NS	NS	3.13E+02	1
M-87	MNS GWPI / M-87 / Landfarm	NS	NS	NS	<MDA	1
M-89	MNS GWPI / M-89 / Landfarm	NS	NS	NS	2.58E+02	1

Attachment 7
Information to Support the NEI Ground Water Protection Initiative

McGuire Nuclear Station Units 1 & 2
Period 1/1/2023 - 12/31/2023

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	3.34E+02	1
M-91	MNS GWPI / M-91 / E of WC	NS	3.62E+02	NS	2.56E+02	2
M-91R	MNS GWPI / M-91R / E of WC	NS	NS	NS	1.83E+02	1
M-92	MNS GWPI / M-92 / N of WC Ponds	NS	2.20E+02	NS	2.40E+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	3.81E+02	NS	2.68E+02	2
M-93R	MNS GWPI / M-93R / N of IHUP	NS	NS	NS	2.12E+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	2.38E+02	NS	5.73E+02	2
MNS_MW-10A	MNS Landfill 2 / MW-10A	NS	<MDA	NS	<MDA	2
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
MNS-MW-1	MNS Landfarm 2 / MW-1	NS	NS	NS	<MDA	1
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
MS-1	MNS GWPI / MS-1 / Surface Water	NS	<MDA	NS	<MDA	2
MS-2	MNS GWPI / MS-2 / Surface Water	NS	2.49E+02	NS	2.95E+02	2
MS-3	MNS GWPI / MS-3 / Surface Water	NS	3.21E+02	NS	3.98E+02	2

Attachment 7
Information to Support the NEI Ground Water Protection Initiative

McGuire Nuclear Station Units 1 & 2
Period 1/1/2023 - 12/31/2023

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	2.29E+02	NS	2.61E+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 1/1/2023 - 12/31/2023

McGuire Nuclear Station experienced one instance of inoperable equipment relevant to effluent monitoring in excess of SLC limits during 2023. 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 2023.

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 2023 is 365 days (1/1/2023 to 1/1/2024*) LCOTR A-2-22-01213

For 2023, 2WPFT5120 was non-functional from 1/1/2023 to 1/1/2024*. During alignment for 2WPLP5120 calibration, 2WPFT5120 failed the acceptance criteria.

*2WPFT5120 remained non-functional through the end of the year 2023. Additional non-functional time will be accounted for in the 2024 ARERR.

- WO 20498458-01
- WO 20498458-02

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 1/1/2023 - 12/31/2023

The McGuire ODCM was not revised in 2023. The most recent revision is 61 and was provided with the 2022 ARERR.

Radiological Effluent Controls (SLC 16.11)

The McGuire Nuclear Station Radiological Effluent Controls are contained in SLC 16.11 and are included in this section. SLC 16.11 was not revised in 2023.

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.1 Liquid Effluents – Concentration

COMMITMENT The concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS (see Figure 16.11.1-1) shall be limited:

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

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

APPLICABILITY At all times.

REMEDIAL ACTIONS

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

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11.1.1 ---------------------------------NOTE-------------------------------- The results of the radioactivity analyses shall be used in accordance with the methodology and parameters in the ODCM to assure that the concentrations at the point of release are maintained within the limits. -- Sample and analyze radioactive liquid wastes according to Table 16.11.1-1.	According to Table 16.11.1-1

TABLE 16.11.1-1
(Page 1 of 3)

RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

LIQUID RELEASE TYPE	SAMPLING FREQUENCY	MINIMUM ANALYSIS FREQUENCY	TYPE OF ACTIVITY ANALYSIS	LOWER LIMIT OF DETECTION (LLD) microCi/ml (1)
1. Batch Waste Release Tanks (WMT and RMT)(4)	P Each Batch	P Each Batch	Principal Gamma Emitters(6)	$5x10^{-7}$
			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.

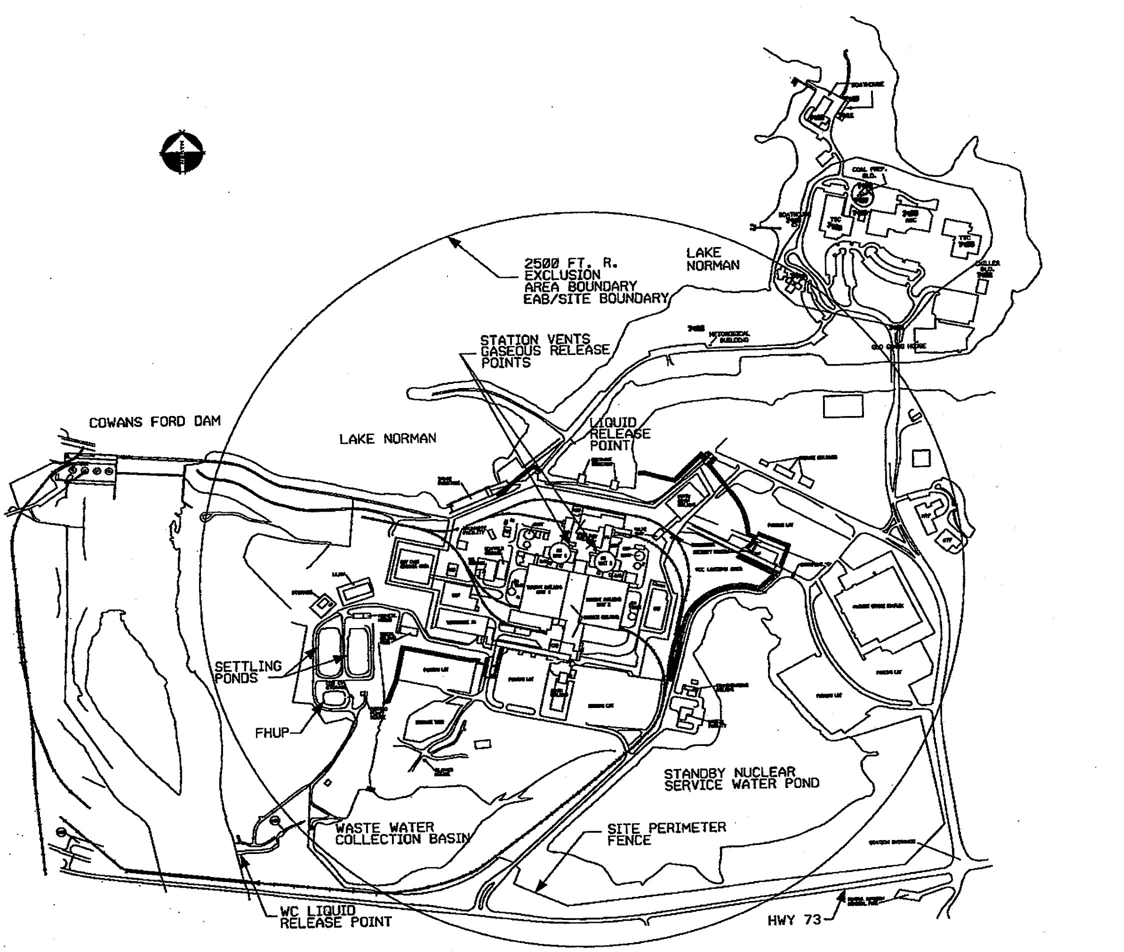

FIGURE 16.11.1-1 SITE BOUNDARY / EXCLUSION AREA BOUNDARY

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.
	<u>AND</u>	
	D.2 Perform an analysis of grab samples for radioactivity.	To meet LLD requirements per Table 16.11.1-1.
	<u>AND</u>	
	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
	<u>AND</u>	
	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
	<u>AND</u>	
	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 ≤ 1.5 mrem to the total body and to ≤ 5 mrem to any organ, and

b. During any calendar year, to ≤ 3 mrem to the total body and to ≤ 10 mrem to any organ.

APPLICABILITY At all times.

REMEDIAL ACTIONS

--NOTES--
Enter applicable Conditions and Required Actions of SLC 16.11.12, "Total Dose," when the limits of this SLC are exceeded by twice the specified limit.

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

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11.3.1 Determine cumulative dose contributions from liquid effluents for current calendar quarter and current calendar year in accordance with the methodology and parameters in the ODCM.	31 days

BASES

This commitment is provided to implement the requirements of Sections II.A, III.A and IV.A of Appendix I, 10 CFR Part 50. The commitment implements the guides set forth in Section II.A of Appendix I. The REMEDIAL ACTION statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in liquid effluents to UNRESTRICTED AREAS will be kept "as low as is reasonably achievable." Also, for fresh water sites with drinking water supplies that can be potentially affected by plant operations, there is reasonable assurance that the operation of the facility will not result in radionuclide concentrations in the finished drinking water that are in excess of the requirements of 40 CFR Part 141. These requirements are applicable only if the drinking water supply is taken from the river 3 miles downstream of the plant discharge.

The dose calculation methodology and parameters in the ODCM implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data, such that the actual exposure of a MEMBER OF THE PUBLIC through appropriate pathways is unlikely to be substantially underestimated. The equations specified in the ODCM for calculating the doses due to the actual release rates of radioactive materials in liquid effluents are consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1, October 1977 and Regulatory Guide 1.113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I," April 1977.

This commitment applies to the release of liquid effluents from each unit at the site. For units with shared Radwaste Treatment Systems, the liquid effluents from the shared system are to be proportioned among the units sharing that system in accordance with the guidance given in NUREG-0133, Chapter 3.1.

REFERENCES

1. McGuire Nuclear Station, Off site Dose Calculation Manual

2. 40 CFR Part 141, Safe Drinking Water Act

3. 10 CFR Part 50, Appendix I

4. Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1, October 1977.

5. Regulatory Guide 1.113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I," April 1977.

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.4 Liquid Radwaste Treatment System

COMMITMENT The Liquid Radwaste Treatment System shall be FUNCTIONAL and appropriate portions of the system shall be used to reduce releases of radioactivity when the projected doses due to the liquid effluent from each unit to UNRESTRICTED AREAS (see 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. <u>AND</u> Any portion of Liquid Radwaste Treatment System not in operation.	A.1 Prepare and submit a Special Report to the NRC which identifies the reasons liquid radwaste was discharged without treatment, identification of non-functional equipment and reasons for non-functionality, corrective actions taken to restore the equipment to FUNCTIONAL status, and actions taken to prevent recurrence.	30 days

TESTING REQUIREMENTS

---NOTE---

The Liquid Radwaste Treatment System shall be demonstrated FUNCTIONAL by meeting SLC 16.11.1 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
	AND	
	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] ($\mu Ci/ml$)
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
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NOTES:

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

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

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

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
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NOTES:

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

3. Not used.

4. Not used.

5. The ratio of the sample flow volume to the sampled stream flow volume shall be known for the time period covered by each dose or dose rate calculation made in accordance with SLCs 16.11.6, 16.11.8 and 16.11.9.

6. The principal gamma emitters for which the LLD specification applies include the following radionuclides: Kr-87, Kr-88, Xe-133, Xe-133m, 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
	<u>AND</u>	
	C.1.2 Perform independent verification of the discharge valve lineup.	Prior to initiating a release
	<u>AND</u>	
	C.1.3.1 Perform independent verification of manual portion of the computer input for the release rate calculations performed by computer.	Prior to initiating a release
	<u>OR</u>	
	C.1.3.2 Perform independent verification of entire release rate calculations for calculations performed manually.	Prior to initiating a release
	<u>AND</u>	
	C.1.4 Restore channel to FUNCTIONAL status.	14 days
	<u>OR</u>	
	C.2 Suspend the release of radioactive effluents via this pathway.	Immediately

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
D. One or more flow rate measurement channels non-functional.	D.1 Estimate the flow rate of the release.	Once per 4 hours during releases
	<u>AND</u>	
	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
	<u>AND</u>	
	E.2 Perform an analysis of grab samples for radioactivity.	To meet LLD requirements per Table 16.11.6-1
	<u>AND</u>	
	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
	<u>AND</u>	
	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
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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.	Immediately
	AND	
	A.2 Initiate action to correct the PROCESS CONTROL PROGRAM, procedures, or solid waste equipment as necessary to prevent recurrence.	Prior to next shipment for disposal of solidified or dewatered wastes.
B. A solidification test as described in the PCP fails to verify Solidification.	B.1 Suspend solidification of the batch under test and follow PCP guidance for test failures.	Immediately
	AND	
	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 ≤ 25 mrem to the whole body or any organ, except the thyroid, which shall be limited to ≤ 75 mrem.

APPLICABILITY At all times.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Calculated doses from releases exceeding twice the specified limits of SLC 16.11.3, 16.11.8 or 16.11.9.	A.1 Verify, by calculation, the cumulative dose from direct radiation contributions, the ISFSI, outside storage tanks, and radioactivity releases are within the total dose limit.	Immediately
	<u>AND</u>	
	A.2 --------------NOTE------------ Only required to be performed if the total dose limit is exceeded. ---------------------------------- Prepare and submit a Special Report to the NRC which identifies corrective actions to be taken to reduce subsequent releases to prevent recurrence and schedule for achieving conformance with specified limits.	30 days

TESTING REQUIREMENTS

--NOTE--

Cumulative dose contributions from liquid and gaseous effluents shall be determined in accordance with SLC 16.11.3, 16.11.8 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

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RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

NOTES (continued):

5. Gamma isotopic analysis means the identification and quantification of gamma-emitting radionuclides that may be attributable to the effluents from the facility.

6. The "upstream sample" shall be taken at a distance beyond significant influence of the discharge. The "downstream" sample shall be taken in an area beyond but near the mixing zone. "Upstream" samples in an estuary must be taken far enough upstream to be beyond the plant influence. Salt water shall be sampled only when the receiving water is utilized for recreational activities.

7. A composite sample is one in which the quantity (aliquot) of liquid sampled is proportional to the quantity of flowing liquid and in which the method of sampling employed results in a specimen that is representative of the liquid flow. In this program composite sample aliquots shall be collected at time intervals that are very short (e.g., hourly) relative to the compositing period (e.g., monthly) in order to assure obtaining a representative sample.

8. Groundwater samples shall be taken when this source is tapped for drinking or irrigation purposes in areas where the hydraulic gradient or recharge properties are suitable for contamination.

9. The dose shall be calculated for the maximum organ and age group, using the methodology and parameters in the ODCM.

10. If harvest occurs more than once a year, sampling shall be performed during each discrete harvest. If harvest occurs continuously, sampling shall be monthly. Attention shall be paid to including samples of tuborous and root food products.

TABLE 16.11.13-2
(Page 1 of 1)

REPORTING LEVELS FOR RADIOACTIVITY CONCENTRATIONS IN ENVIRONMENTAL SAMPLES

	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:

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

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.	30 days
	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.	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
	<u>AND</u>	
	A.2 Reduce the tank contents to within limit.	48 hours
	<u>AND</u>	
	A.3 Describe the events leading to this condition in the next Annual Radioactive Effluent Release Report.	Within the next scheduled Annual Radioactive Effluent Release Report

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11.18.1 Verify the quantity of radioactive material contained in unprotected outdoor radwaste tanks is within limits by analyzing a representative sample of the tank's contents when radioactive materials are being added to the tank.	7 days

BASES

The tanks applicable to this SLC include all those outdoor radwaste tanks that are not surrounded by liners, dikes, or walls capable of holding the tank contents and that do not have tank overflows and surrounding area drains connected to the Liquid Radwaste Treatment System.

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

REFERENCES

None

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.19 Explosive Gas Mixture

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

APPLICABILITY At all times.

REMEDIAL ACTIONS

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

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11.19.1 Verify the concentrations of hydrogen and oxygen in the WASTE GAS HOLDUP SYSTEM is within limits by monitoring waste gases in the WASTE GAS HOLDUP SYSTEM with the hydrogen and oxygen monitors required by SLC 16.7.8.	During WASTE GAS HOLDUP SYSTEM operation

BASES

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

REFERENCES

None

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.20 Gas Storage Tanks

COMMITMENT The quantity of radioactivity contained in each gas storage tank shall be limited $\leq$ 49,000 Curies noble gases (considered as Xe-133).

APPLICABILITY At all times.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Quantity of radioactive material in tank not within limit.	A.1 Suspend all additions of radioactive material to the tank.	Immediately
	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 1/1/2023 - 12/31/2023

The McGuire Nuclear Station PCP was not revised in 2023. The most recent revision was provided with the McGuire Nuclear Station 2022 ARERR.

ATTACHMENT 11

Summary of Major Modifications to the Radioactive Waste Treatment Systems

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 1/1/2023 - 12/31/2023

No major modifications to McGuire Nuclear Station liquid, gaseous, solid, or mobile radioactive waste treatment systems occurred in 2023.

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 1/1/2023 - 12/31/2023

The following contains amended pages to the MNS 2022 ARERR. Amended pages are identified with Amendment # on page. Specific changes are identified with change bars in right margin.

Amendment #1

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 12
Errata to a Previous Year's ARERR

McGuire Nuclear Station Units 1 & 2
Period 1/1/2023 - 12/31/2023

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	0.328
e. Sealed Sources / Smoke Detectors	None					
f. Sealed Sources	None					
g. Irradiated Components	None					
3. Total Waste	**10**	**48**			**499**	**0.328**

Attachment 12
Errata to a Previous Year's ARERR

McGuire Nuclear Station Units 1 & 2
Period 1/1/2023 - 12/31/2023

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%

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%

e. RSR#MNS22-0013

Radionuclide	% Abundance
Cr-51	38.19%
Mn-54	2.1%
Fe-55	14.05%
Fe-59	0.74%
Co-57	0.05%
Co-58	14.81%
Co-60	9.2%
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	0.38%
Cs-137	0.05%

f. RSR#MNS22-0014

Radionuclide	% Abundance
Cr-51	38.19%
Mn-54	2.1%
Fe-55	14.05%
Fe-59	0.74%
Co-57	0.05%
Co-58	14.81%
Co-60	9.2%
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	0.38%
Cs-137	0.05%

g. RSR#MNS22-0015

Radionuclide	% Abundance
Cr-51	4.42%
Mn-54	4.34%
Fe-55	35.14%
Fe-59	0.29%
Co-57	0.1%
Co-58	11.75%
Co-60	24.04%
Ni-63	4.26%
Zn-65	1.19%
Zr-95	4.17%
Nb-95	8.9%
Sn-113	0.13%
Sb-124	0.19%
Sb-125	0.94%
Cs-137	0.13%

h. RSR#MNS22-0016

Radionuclide	% Abundance
Cr-51	2.87%
Mn-54	4.49%
Fe-55	37.46%
Fe-59	0.22%
Co-57	0.1%
Co-58	10.4%
Co-60	25.81%
Ni-63	4.6%
Zn-65	1.22%
Zr-95	3.61%
Nb-95	7.76%
Sn-113	0.13%
Sb-124	0.17%
Sb-125	1%
Cs-137	0.14%

i. RSR#MNS22-0017

Radionuclide	% Abundance
Cr-51	29.54%
Mn-54	2.57%
Fe-55	17.67%
Fe-59	0.7%
Co-57	0.06%
Co-58	15.54%
Co-60	11.66%
Ni-63	1.99%
Zn-65	0.75%
Zr-95	6.16%
Nb-95	12.4%
Sn-113	0.12%
Sb-124	0.31%
Sb-125	0.47%
Cs-137	0.06%

j. RSR#MNS22-0020

Radionuclide	% Abundance
Cr-51	9.52%
Mn-54	3.9%
Fe-55	29.79%
Fe-59	0.43%
Co-57	0.09%
Co-58	14.09%
Co-60	20.12%
Ni-63	3.51%
Zn-65	1.1%
Zr-95	5.2%
Nb-95	10.95%
Sn-113	0.14%
Sb-124	0.25%
Sb-125	0.8%
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

ENCLOSURE 5: **ONS Annual Radioactive Effluent Release Report**

Oconee Nuclear Station
Units 1, 2, and 3

Annual Radioactive Effluent Release Report

January 1, 2023 through December 31, 2023

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 1/1/2023 - 12/31/2023

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	1.45E+01	4.79E+01	1.06E+00	3.64E+01	9.99E+01
2. Avg. Release Rate	μCi/sec	1.86E+00	6.10E+00	1.33E-01	4.58E+00	3.17E+00
B. Iodines and Halogens						
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	7.61E+00	1.41E+01	1.27E+01	4.54E+01	7.98E+01
2. Avg. Release Rate	μCi/sec	9.78E-01	1.79E+00	1.59E+00	5.71E+00	2.53E+00
E. Carbon-14						
1. Total Release	Ci	6.11E+00	6.08E+00	6.09E+00	5.59E+00	2.39E+01
2. Avg. Release Rate	μCi/sec	7.86E-01	7.74E-01	7.67E-01	7.03E-01	7.57E-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 1/1/2023 - 12/31/2023

Gaseous Effluents - Mixed Releases - Continuous Mode *

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Gases						
Xe-133	Ci	1.45E+01	4.79E+01	1.05E+00	3.53E+01	9.87E+01
Total for Period	Ci	1.45E+01	4.79E+01	1.05E+00	3.53E+01	9.87E+01
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	6.69E+00	1.16E+01	1.01E+01	1.97E+01	4.81E+01
E. Carbon-14						
C-14	Ci	1.83E+00	1.82E+00	1.83E+00	1.68E+00	7.16E+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

Attachment 1
Summary of Gaseous and Liquid Effluents

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2023 - 12/31/2023

Gaseous Effluents - Mixed Releases - Batch Mode *

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Gases						
Xe-131m	Ci	0.00E+00	0.00E+00	6.13E-05	5.84E-05	1.20E-04
Xe-133	Ci	5.68E-03	3.27E-03	4.43E-03	2.17E-01	2.30E-01
Xe-133m	Ci	2.71E-05	0.00E+00	4.36E-05	2.56E-05	9.62E-05
Xe-135	Ci	1.88E-04	2.25E-04	0.00E+00	1.83E-02	1.88E-02
Ar-41	Ci	1.84E-02	1.91E-02	0.00E+00	9.04E-01	9.41E-01
Total for Period	Ci	2.43E-02	2.26E-02	4.54E-03	1.14E+00	1.19E+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	2.29E-03	3.15E-03	3.64E-05	8.79E-01	8.84E-01
E. Carbon-14						
C-14	Ci	4.28E+00	4.26E+00	4.26E+00	3.91E+00	1.67E+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

Attachment 1
Summary of Gaseous and Liquid Effluents

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2023 - 12/31/2023

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	9.13E-01	2.47E+00	2.59E+00	2.48E+01	3.08E+01
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 1/1/2023 - 12/31/2023

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	3.20E-03	2.94E-03	2.18E-02	4.11E-02	6.90E-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 1/1/2023 - 12/31/2023

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	2.99E-03	2.40E-04	7.16E-04	2.61E-04	4.21E-03
2. Avg. Diluted Conc	μCi/ml	3.57E-10	2.83E-11	8.35E-11	3.04E-11	1.24E-10
3. Batch Releases	μCi/ml	3.57E-10	2.83E-11	8.35E-11	3.04E-11	1.24E-10
B. Tritium						
1. Total Release	Ci	3.35E+01	1.95E+02	3.72E+02	7.52E+02	1.35E+03
2. Avg. Diluted Conc	μCi/ml	3.99E-06	2.30E-05	4.34E-05	8.77E-05	3.98E-05
3. Batch Releases	μCi/ml	3.96E-06	2.30E-05	4.34E-05	8.76E-05	3.97E-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	6.45E+05	9.82E+05	1.02E+06	2.66E+06	5.31E+06
2. Continuous Volume	liters	5.89E+08	5.69E+08	4.45E+08	4.56E+08	2.06E+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 gases, and gross alpha

Attachment 1
Summary of Gaseous and Liquid Effluents

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2023 - 12/31/2023

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	2.78E-01	2.88E-01	2.97E-01	1.63E-01	1.03E+00
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 1/1/2023 - 12/31/2023

Liquid Effluents - Batch Mode

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Products						
Mn-54	Ci	1.06E-04	1.04E-05	0.00E+00	0.00E+00	1.16E-04
Co-58	Ci	6.22E-04	5.20E-05	0.00E+00	1.76E-04	8.50E-04
Co-60	Ci	6.45E-04	5.48E-05	0.00E+00	0.00E+00	7.00E-04
Zn-65	Ci	3.31E-05	0.00E+00	0.00E+00	0.00E+00	3.31E-05
Nb-95	Ci	9.12E-04	7.06E-05	0.00E+00	0.00E+00	9.82E-04
Nb-97	Ci	1.65E-05	0.00E+00	0.00E+00	4.74E-05	6.39E-05
Zr-95	Ci	4.78E-04	4.27E-05	0.00E+00	0.00E+00	5.20E-04
Zr-97	Ci	1.01E-05	0.00E+00	0.00E+00	0.00E+00	1.01E-05
Ag-108m	Ci	6.74E-06	0.00E+00	0.00E+00	0.00E+00	6.74E-06
Ag-110m	Ci	1.63E-04	9.89E-06	0.00E+00	3.74E-05	2.10E-04
Te-125m	Ci	0.00E+00	0.00E+00	7.16E-04	0.00E+00	7.16E-04
Total for Period	Ci	2.99E-03	2.40E-04	7.16E-04	2.61E-04	4.21E-03
B. Tritium						
H-3	Ci	3.32E+01	1.95E+02	3.72E+02	7.52E+02	1.35E+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 1/1/2023 - 12/31/2023

I. <u>Regulatory Limits - Per Unit</u>

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. <u>Maximum Permissible Effluent Concentrations</u>

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. <u>Average Energy</u>

(not applicable)

IV. <u>Measurements and Approximations of Total Radioactivity</u>

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. <u>Batch Releases</u>

A. Liquid Effluents

1.	Total Number of Batch Releases	=	60
2.	Total Time (min) for Batch Releases	=	1.08E+04
3.	Maximum Time (min) for a Batch Release	=	2.02E+02
4.	Average Time (min) for Batch Releases	=	1.80E+02
5.	Minimum Time (min) for a Batch Release	=	3.00E+00
6.	Average Dilution Water Flow During Release (lpm)	=	6.47E+04

B. Gaseous Effluents

1.	Total Number of Batch Releases	=	33
2.	Total Time (min) for Batch Releases	=	4.73E+04
3.	Maximum Time (min) for a Batch Release	=	1.36E+04
4.	Average Time (min) for Batch Releases	=	1.43E+03
5.	Minimum Time (min) for a Batch Release	=	2.00E+00

VI. <u>Abnormal Releases</u>

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 3, “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. 3. Oconee Nuclear Station 2023 ARERR contains estimates of C-14 radioactivity released in 2023, 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. 3). 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. 3). 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. 3). 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 2023 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 2023 results in a site total C-14 gaseous release estimate to the environment of 2.39E+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 2023 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 2023 is well below the 10CFR50, Appendix I, ALARA design objective (i.e., 15 mrem/yr per unit).

Attachment 2
Supplemental Information

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2023 - 12/31/2023

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 2023 Land Use Census was performed May 23, 2023, and the results were certified and made available for use on June 14, 2023. The following are changes to residences, gardens, and milk animals from the previous year.

Residences

No change from prior year.

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

No change from prior year.

Environmental Monitoring Locations

No changes to environmental monitoring locations in each sector.

ATTACHMENT 3

Solid Radioactive Waste Disposal

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

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

Attachment 3
Solid Radioactive Waste Disposal

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2023 - 12/31/2023

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.)	9	Type A	None	32.03	1.06E+02
2. Dry radioactive waste (e.g., trash, paper, discarded protective clothing, etc.)	24	GDP	None	830	2.20E-01
3. Activated or contaminated metal or equipment, etc.	None	NA	NA	0	0.00E+00
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 1/1/2023 - 12/31/2023

Type of Waste Shipped	Radionuclide	% Abundance
1. Wet Radioactive Waste	H-3	1.87
	C-14	1.47
	Mn-54	4.61
	Fe-55	34.20
	Co-58	5.33
	Co-60	25.73
	Ni-63	20.74
	Zn-65	1.54
	Cs-137	2.59
2. Dry Radioactive Waste	Mn-54	5.03
	Co-58	10.45
	Co-60	8.36
	Zr-95	9.09
	Nb-95	10.47
	Cs-137	38.26
	Ce-144	18.35
3. Activated or Contaminated Metal or Equipment	NA	NA
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) for each respective height (lower-level and upper-level).

Attachment 4
Meteorological Data

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2023 - 12/31/2023

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	0	0	0	0	0	0	0	0	0	0	0	0	0
	1.01-1.25	2	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0
	1.26-1.50	2	3	2	1	0	0	1	1	0	9	6	4	3	1	3	3
	1.51-2.00	7	12	14	11	5	1	4	2	15	46	72	23	11	4	6	2
	2.01-3.00	0	1	20	36	11	5	2	1	8	120	128	27	9	10	5	2
	3.01-4.00	0	0	4	10	1	0	0	0	1	23	16	6	6	4	8	2
	4.01-5.00	0	0	1	1	0	0	0	0	0	2	2	2	3	3	2	0
	5.01-6.00	0	0	0	0	0	0	0	0	0	0	0	2	5	2	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
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	1	0	1	1	0
	1.01-1.25	0	1	0	0	1	0	0	0	0	1	1	1	0	1	1	0
	1.26-1.50	2	5	2	1	2	2	1	1	5	4	9	7	6	8	1	2
	1.51-2.00	3	7	12	13	3	5	2	6	13	21	25	16	10	5	7	2
	2.01-3.00	1	2	10	29	9	9	2	5	8	52	35	12	6	4	1	2
	3.01-4.00	0	2	2	8	0	0	0	0	0	14	10	4	2	3	5	2
	4.01-5.00	0	0	0	0	0	0	0	0	0	1	5	3	2	1	2	0
	5.01-6.00	0	0	0	0	0	0	0	0	0	0	0	6	3	2	6	0
	6.01-8.00	0	0	0	0	0	0	0	0	0	0	0	5	1	1	3	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 1/1/2023 - 12/31/2023

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	1	0	1	0	0	0	0	0	2	0	0	1	1	0	0
	1.01-1.25	4	1	3	0	0	0	1	1	0	5	6	5	3	3	1	2
	1.26-1.50	7	12	2	4	3	3	2	8	2	2	15	9	4	5	10	5
	1.51-2.00	2	8	8	8	3	4	3	8	9	12	18	10	8	5	2	0
	2.01-3.00	2	2	19	21	8	0	6	2	7	31	22	4	2	1	2	0
	3.01-4.00	1	0	8	8	1	0	0	0	0	9	8	4	3	1	3	1
	4.01-5.00	0	0	0	0	0	0	0	0	0	0	3	5	1	2	3	1
	5.01-6.00	0	0	0	0	0	0	0	0	0	0	2	8	0	1	2	0
	6.01-8.00	0	0	0	0	0	0	0	0	0	0	1	3	1	1	1	0
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10.01-max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D	0.46-0.75	5	4	1	0	3	1	3	6	6	3	7	5	2	3	6	8
	0.76-1.00	20	11	14	6	9	11	15	8	10	13	23	30	29	18	24	33
	1.01-1.25	31	19	13	17	16	12	11	20	19	13	34	27	28	26	16	30
	1.26-1.50	20	19	32	35	19	15	27	19	27	27	30	25	28	19	4	39
	1.51-2.00	16	19	81	108	46	13	24	34	47	49	72	57	21	18	16	18
	2.01-3.00	12	18	123	173	29	7	11	13	26	94	105	74	33	43	25	19
	3.01-4.00	3	16	12	27	4	2	1	1	3	35	79	47	29	23	22	11
	4.01-5.00	1	1	2	3	0	0	0	0	0	8	34	47	16	13	15	1
	5.01-6.00	0	0	3	0	0	0	0	0	0	1	6	18	10	3	6	0
	6.01-8.00	0	0	1	0	0	0	0	0	0	0	1	9	6	4	1	0
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
	10.01-max	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0

Attachment 4
Meteorological Data

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2023 - 12/31/2023

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	29	15	13	11	7	4	10	6	6	10	7	13	18	22	37	26
	0.76-1.00	111	59	51	52	38	22	35	32	30	31	31	52	75	103	115	97
	1.01-1.25	48	31	47	34	35	26	33	38	14	29	36	35	42	57	74	79
	1.26-1.50	13	13	26	55	46	36	31	41	32	31	42	16	21	25	41	29
	1.51-2.00	12	5	34	67	34	30	31	44	43	41	42	30	20	13	4	9
	2.01-3.00	6	2	11	23	8	4	7	12	17	47	49	43	21	10	5	4
	3.01-4.00	0	0	1	5	3	0	0	0	0	5	23	25	11	4	3	1
	4.01-5.00	0	0	0	0	0	0	0	1	0	0	3	19	6	2	0	1
	5.01-6.00	0	0	0	0	0	0	0	0	0	0	4	7	1	0	1	0
	6.01-8.00	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	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
F	0.46-0.75	1	1	0	0	3	0	1	1	0	2	2	0	4	3	5	1
	0.76-1.00	3	2	3	3	2	2	1	3	2	3	7	10	11	28	25	3
	1.01-1.25	0	3	0	3	3	3	6	0	0	2	3	3	10	32	29	5
	1.26-1.50	1	0	0	0	6	6	7	1	0	4	2	2	0	11	16	2
	1.51-2.00	0	0	0	0	5	6	4	0	0	0	5	1	2	1	2	0
	2.01-3.00	0	0	0	0	0	0	1	0	0	0	3	2	0	0	1	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 1/1/2023 - 12/31/2023

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	0	0	0	0	0	0	1	1	0	0	1	2	2	0	1
	0.76-1.00	0	0	0	0	0	0	0	0	0	0	0	0	5	8	2	0
	1.01-1.25	0	0	0	0	0	0	0	1	0	0	0	1	4	6	3	0
	1.26-1.50	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0
	1.51-2.00	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
	2.01-3.00	0	0	0	0	0	0	0	0	0	0	0	2	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 1/1/2023 - 12/31/2023

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	1	0	0	0	0	0	0	1	0	0	0	0	0	0
	1.26-1.50	0	0	0	0	0	0	0	1	0	4	3	2	1	0	1	1
	1.51-2.00	3	5	2	2	1	1	2	2	0	13	13	11	3	2	2	2
	2.01-3.00	3	10	16	7	8	3	4	3	20	60	92	26	1	4	2	1
	3.01-4.00	0	2	12	19	9	2	1	0	12	70	40	4	1	5	3	0
	4.01-5.00	0	0	6	14	2	1	0	0	6	37	28	0	4	1	1	1
	5.01-6.00	0	0	6	6	4	0	0	0	2	24	21	4	7	1	5	3
	6.01-8.00	0	0	4	2	2	0	0	1	0	12	10	2	4	8	3	1
	8.01-10.00	0	0	1	1	0	0	0	0	0	1	2	3	6	2	2	0
	10.01-max	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	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	1	0	0	0	3	0	1
	1.26-1.50	1	0	3	0	0	0	0	0	0	2	3	4	3	3	1	1
	1.51-2.00	2	3	3	2	2	1	2	2	5	8	11	15	7	3	5	3
	2.01-3.00	4	5	8	12	13	8	5	8	11	29	20	13	4	1	2	2
	3.01-4.00	1	0	5	10	5	5	3	1	10	24	7	3	1	0	0	0
	4.01-5.00	0	2	3	13	2	1	0	0	4	23	12	0	2	2	0	2
	5.01-6.00	1	0	3	6	4	1	0	0	1	11	11	1	1	1	4	1
	6.01-8.00	0	2	0	4	0	0	0	0	0	7	6	4	3	2	0	1
	8.01-10.00	0	0	0	0	0	0	0	0	0	1	3	10	4	4	10	0
	10.01-max	0	0	0	0	0	0	0	0	0	0	2	0	2	0	1	0

Attachment 4
Meteorological Data

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2023 - 12/31/2023

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	1	0	0	1	0	0	0	0	0
	1.01-1.25	2	1	0	0	0	0	1	0	1	3	2	3	5	2	0	1
	1.26-1.50	4	0	2	1	1	0	0	1	2	3	6	3	4	1	5	2
	1.51-2.00	6	8	6	1	4	4	4	4	5	5	14	7	7	1	3	4
	2.01-3.00	4	9	6	7	4	6	5	10	8	12	17	2	1	2	4	0
	3.01-4.00	1	1	13	10	6	2	2	1	7	11	7	1	1	1	0	0
	4.01-5.00	1	1	6	9	2	0	0	0	3	14	9	5	1	0	0	0
	5.01-6.00	1	3	5	5	1	0	0	0	0	5	7	3	1	0	3	2
	6.01-8.00	1	0	5	4	1	0	0	0	0	7	8	5	3	2	5	1
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	5	7	0	3	2	0
	10.01-max	0	0	0	0	0	0	0	0	0	0	1	1	2	0	1	0
D	0.46-0.75	1	1	1	0	1	2	0	0	0	0	1	2	0	0	0	0
	0.76-1.00	5	2	3	4	3	1	3	1	4	3	10	8	6	4	9	10
	1.01-1.25	7	7	5	2	4	5	4	8	10	4	11	10	12	16	10	8
	1.26-1.50	18	11	7	4	2	3	9	4	7	10	10	13	21	24	21	12
	1.51-2.00	28	21	8	11	14	6	13	16	20	16	28	25	25	29	19	45
	2.01-3.00	46	46	60	44	28	20	28	27	51	52	77	56	28	27	31	38
	3.01-4.00	17	28	121	74	31	11	12	13	24	55	54	38	13	24	24	12
	4.01-5.00	12	19	86	70	18	6	1	4	14	50	52	25	15	37	19	5
	5.01-6.00	7	15	30	32	15	3	1	1	0	29	62	40	16	14	19	7
	6.01-8.00	2	9	9	17	4	0	0	1	3	26	64	58	34	27	29	4
	8.01-10.00	0	0	3	0	1	0	0	0	0	8	21	20	16	3	6	0
	10.01-max	0	0	1	0	0	0	0	0	0	0	5	8	4	6	0	0

Attachment 4
Meteorological Data

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2023 - 12/31/2023

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	2	0	2	0	0	0	2	1	0	3	0	0	3	1	2	1
	0.76-1.00	15	6	4	5	3	3	4	3	1	8	7	6	6	9	13	14
	1.01-1.25	28	11	11	4	5	4	2	4	8	6	8	9	16	21	29	36
	1.26-1.50	50	36	10	8	4	4	7	6	5	7	14	28	30	37	45	57
	1.51-2.00	139	58	35	14	6	14	8	11	10	25	21	30	50	57	78	131
	2.01-3.00	185	127	75	44	35	27	22	30	32	42	72	43	25	24	37	133
	3.01-4.00	22	40	52	33	16	12	14	22	25	48	57	24	13	9	14	10
	4.01-5.00	2	5	19	25	6	1	2	13	25	37	37	17	11	9	8	4
	5.01-6.00	2	0	3	7	1	0	1	0	5	15	23	24	16	6	4	0
	6.01-8.00	0	0	2	5	2	0	0	0	0	6	29	21	28	10	2	2
	8.01-10.00	0	0	0	1	0	0	0	0	0	0	7	6	6	0	1	0
	10.01-max	0	0	0	0	0	0	0	0	0	0	3	0	3	0	0	0
F	0.46-0.75	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	0
	0.76-1.00	1	1	1	0	2	1	0	1	1	0	0	1	2	0	3	0
	1.01-1.25	4	4	7	1	0	0	1	0	0	1	1	3	0	0	1	2
	1.26-1.50	6	4	4	3	2	1	1	2	1	2	2	4	0	2	3	4
	1.51-2.00	19	11	4	1	1	1	2	2	3	2	5	2	4	3	7	7
	2.01-3.00	35	39	3	2	4	4	1	3	1	3	3	7	1	0	1	4
	3.01-4.00	2	1	1	1	2	4	3	4	6	3	8	4	1	0	2	0
	4.01-5.00	0	0	0	0	1	0	0	0	0	0	3	0	3	1	0	0
	5.01-6.00	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0
	6.01-8.00	0	0	0	0	0	0	0	0	0	0	1	1	1	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 1/1/2023 - 12/31/2023

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	1	0	0	0	0	0	0	0	0	0	0
	1.01-1.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1.26-1.50	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	1
	1.51-2.00	0	2	0	0	1	0	1	1	1	2	0	0	0	1	1	1
	2.01-3.00	3	1	0	0	0	0	0	0	0	2	2	2	1	2	0	0
	3.01-4.00	0	0	0	0	0	0	0	0	1	2	2	0	2	2	1	0
	4.01-5.00	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0
	5.01-6.00	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
	6.01-8.00	0	0	0	0	0	0	0	0	0	0	0	0	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

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 1/1/2023 - 12/31/2023

Oconee Nuclear Station had zero (0) unplanned liquid offsite release radioactive effluents in 2023.

Oconee Nuclear Station had zero (0) unplanned gaseous offsite release of radioactive effluents in 2023.

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 1/1/2023 - 12/31/2023

Gaseous Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Noble Gases						
1. Maximum Gamma Air	mRAD	2.80E-04	9.06E-04	1.98E-05	1.11E-03	2.32E-03
(a) Limit	mRAD	1.50E+01	1.50E+01	1.50E+01	1.50E+01	3.00E+01
(b) % of Limit		1.87E-03	6.04E-03	1.32E-04	7.41E-03	7.73E-03
2. Maximum Beta Air	mRAD	8.09E-04	2.67E-03	5.88E-05	2.14E-03	5.67E-03
(a) Limit	mRAD	3.00E+01	3.00E+01	3.00E+01	3.00E+01	6.00E+01
(b) % of Limit		2.70E-03	8.90E-03	1.96E-04	7.12E-03	9.46E-03

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	9.10E-02	9.06E-02	9.07E-02	8.32E-02	3.56E-01
(a) Limit	mREM	2.25E+01	2.25E+01	2.25E+01	2.25E+01	4.50E+01
(b) % of Limit		4.04E-01	4.03E-01	4.03E-01	3.70E-01	7.90E-01

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

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2023 - 12/31/2023

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Batch & Continuous Mode						
1. Maximum Organ Dose	mREM	3.54E-01	5.31E-02	5.21E-02	1.04E-01	5.59E-01
(a) Limit	mREM	1.50E+01	1.50E+01	1.50E+01	1.50E+01	3.00E+01
(b) % of Limit		2.36E+00	3.54E-01	3.48E-01	6.94E-01	1.86E+00
(c) Critical Age		Adult	Adult	Child	Child	Adult
(d) Critical Organ		GI-Lli	GI-Lli	GI-Lli	GI-Lli	GI-Lli
2. Maximum Total Body Dose	mREM	5.31E-03	2.70E-02	5.16E-02	1.04E-01	1.88E-01
(a) Limit	mREM	4.50E+00	4.50E+00	4.50E+00	4.50E+00	9.00E+00
(b) % of Limit		1.18E-01	6.01E-01	1.15E+00	2.31E+00	2.09E+00
(c) Critical Age		Child	Child	Child	Child	Child

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

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2023 - 12/31/2023

40 CFR Part 190 Uranium Fuel Cycle Dose Calculation Results

In accordance with the requirements of 40 CFR Part 190, the annual dose commitment to any member of the general public shall be calculated to assure that doses are limited to 25 millirems to the total body or any organ with the exception of the thyroid which is limited to 75 millirems. The fuel cycle dose assessment for 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)	6.02E-01 mrem
1. Location	1.0 miles SW
2. Critical Age	Adult
3. Critical Organ	GI-Lli
4. Gas Contribution %	7.23%
5. Liquid Contribution %	92.77%
B. Maximum Total Body Dose	2.95E-01 mrem
1. Location	1.0 miles SW
2. Critical Age	Child
3. Gas non-NG Contribution %	35.51%
4. Gas Contribution %	0.67%
5. Liquid Contribution %	63.82%

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.

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

1. United States Nuclear Regulatory Commission, Spent Fuel Project Office, Interim Staff Guidance - 13, "Real Individual."

2. "Design Basis" fuel (considering fuel burnup and initial enrichment) is assumed to reside in Phase IX of the Oconee ISFSI, as defined in Appendix C of OSC-11917.
3. Calculation OSC-8675, "Oconee ISFSI Spent Fuel Radiation Source Terms," Revision 4.
4. O. W. Hermann, C. V. Parks, "SAS2H: A Coupled One-Dimensional Depletion and Shielding Analysis Module," NUREG/CR-0200, Revision 6, Volume 1, Section S2, ORNLINUREG/CSD-2N21R6.
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 1/1/2023 - 12/31/2023

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 2023. 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 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 2023. Results from sampling during 2023 confirmed existing knowledge of tritium concentrations in site ground water.

Results from sampling during 2023 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 2023.

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 1/1/2023 - 12/31/2023

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	<MDA	NS	<MDA	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	2.83E+02	NS	NS	1
GM-16DR	ONS GWPI / GM-16DR	3.66E+03	3.54E+03	3.37E+03	3.29E+03	4
GM-16R	ONS GWPI / GM-16R	1.23E+03	1.63E+03	1.32E+03	1.26E+03	4
GM-17DR	ONS GWPI / GM-17DR	NS	3.42E+02	5.12E+02	4.79E+02	3
GM-17R	ONS GWPI / GM-17R	2.78E+03	4.54E+03	1.24E+03	1.62E+03	4
GM-18R	ONS GWPI / GM-18R	2.13E+03	2.16E+03	1.88E+03	1.99E+03	4
GM-19	ONS GWPI / GM-19	3.55E+02	4.78E+02	4.47E+02	4.28E+02	4
GM-19R	ONS GWPI / GM-19R	1.02E+03	1.18E+03	9.12E+02	9.97E+02	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	2.18E+02	3.02E+02	2.45E+02	3.17E+02	4
GM-24R	ONS GWPI / GM-24R	1.30E+03	1.42E+03	1.19E+03	1.23E+03	4
GM-25R	ONS GWPI / GM-25R	3.20E+02	2.93E+02	2.32E+02	2.58E+02	4
GM-2DR	ONS GWPI / GM-2DR / U-1/2 SFP	4.08E+02	8.16E+02	3.72E+02	2.22E+02	4
GM-2R	ONS GWPI / GM-2R / U-1/2 SFP	8.89E+03	1.26E+03	9.51E+02	5.73E+02	5
GM-3DR	ONS GWPI / GM-3DR / U-3 SFP	NS	2.91E+02	NS	5.51E+02	2
GM-3R	ONS GWPI / GM-3R / U-3 SFP	2.35E+02	2.95E+02	3.38E+02	3.54E+02	4
GM-4	ONS GWPI / GM-4 / Rad. Mat. WH	4.24E+02	5.61E+02	4.91E+02	5.84E+02	4
GM-5	ONS GWPI / GM-5 / Rdwst. Bldg.	<MDA	<MDA	<MDA	<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 1/1/2023 - 12/31/2023

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	<MDA	NS	2.42E+02	2
GM-7DR	ONS GWPI / GM-7DR	NS	<MDA	NS	NS	1
GM-7R	ONS GWPI / GM-7R / 525 kv Sw Yard	1.10E+03	9.39E+02	1.01E+03	9.46E+02	4
GM-8	ONS GWPI / GM-8 / E of U-3 TB	<MDA	<MDA	2.13E+02	3.16E+02	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	2.21E+02	<MDA	3.09E+02	2.90E+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	3.25E+02	<MDA	2.30E+02	2.90E+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 1/1/2023 - 12/31/2023

Oconee Nuclear Station had three instances of inoperable effluent monitoring instrumentation in excess of SLC limits during 2023.

The Radwaste 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. Engineering change (EC# 421844) replaced the noble gas monitoring skid. Following replacement, the radwaste noble gas monitor was operable on 10/10/23. The radwaste particulate and iodine sampling was operable on 10/11/23.

The Hot Machine Shop ventilation effluent flow rate monitor, iodine sampler, and particulate sampler was declared inoperable on 6/15/23. During repair it was determined that the exhaust fans were no longer providing flow to the flow rate monitor and samplers due to the wiring between the exhaust fans and associated air handler unit (NCR 02477133). This condition was corrected by work order 01922322 task 34. The Hot Machine Shop ventilation effluent flow rate monitor, iodine sampler, and particulate sampler was returned to operable on 12/14/23.

The Radwaste Facility (RWF) ventilation exhaust noble gas monitor was declared inoperable on 12/7/2023. The noble gas monitor skid pump was unable to maintain a sample flowrate within the monitor flow setpoint range. The monitor flow setpoints were revised in the equipment manual after investigating the cause in work request 20260331. The Radwaste Facility (RWF) ventilation exhaust noble gas monitor was returned to operable on 1/10/2024.

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 2023.

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 1/1/2023 - 12/31/2023

ODCM Revision 62

Oconee ODCM revision 62 was approved on 9/20/2023. Radiation monitor 4 RIA 45 setpoints in section 3 were revised for engineering change 421844, which replaced the radiation monitor equipment. The new monitor output is in counts per minute (cpm) instead of μCi/ml used by the prior monitor. The new monitor's correlation factor of 3.48E-08 μCi/ml/cpm for Xe-133 was inputted into the existing setpoint calculation to convert the setpoint units to cpm. The new 4 RIA 45 high setpoint is 5460 cpm and the alert setpoint is 1820 cpm.

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 2023.

Oconee Nuclear Station
Units 1, 2 and 3

ODCM

Offsite Dose
Calculation Manual

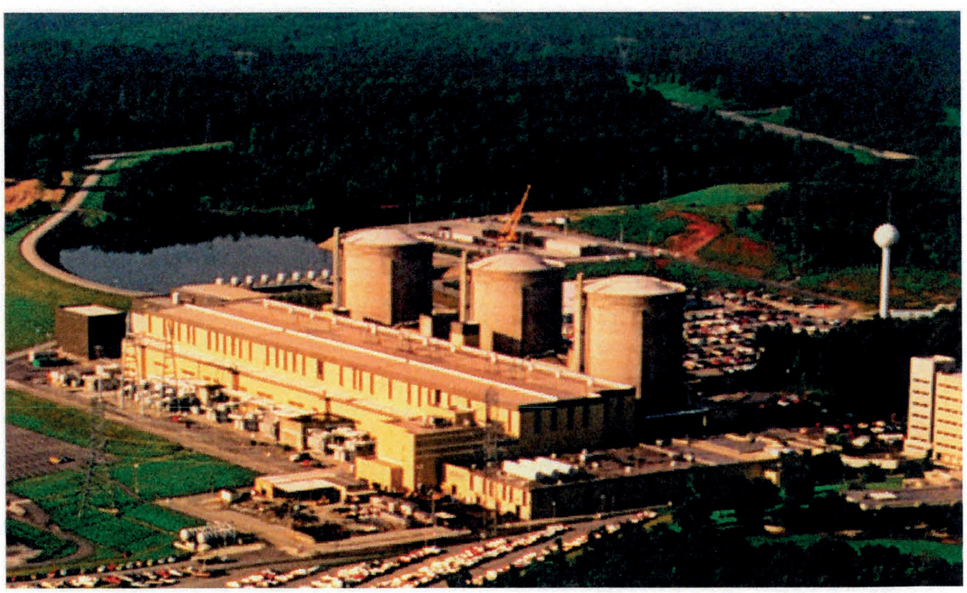
DUKE ENERGY

Oconee Nuclear Station
Units 1, 2 and 3

OFFSITE DOSE CALCULATION MANUAL (ODCM)

Prepared By: Austin K. Wallach ONS Radiation Protection	Austin Wallach **Signature**	9/18/23 **Date**
Reviewed By: Robert W. Elliott ONS Radiation Protection	Robert W. Elliott **Signature**	09/20/23 **Date**
Approved By: Timothy A. Mc Call ONS Radiation Protection Manager	Timothy A McCall **Signature**	9/20/23 **Date**

Revision 62



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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:

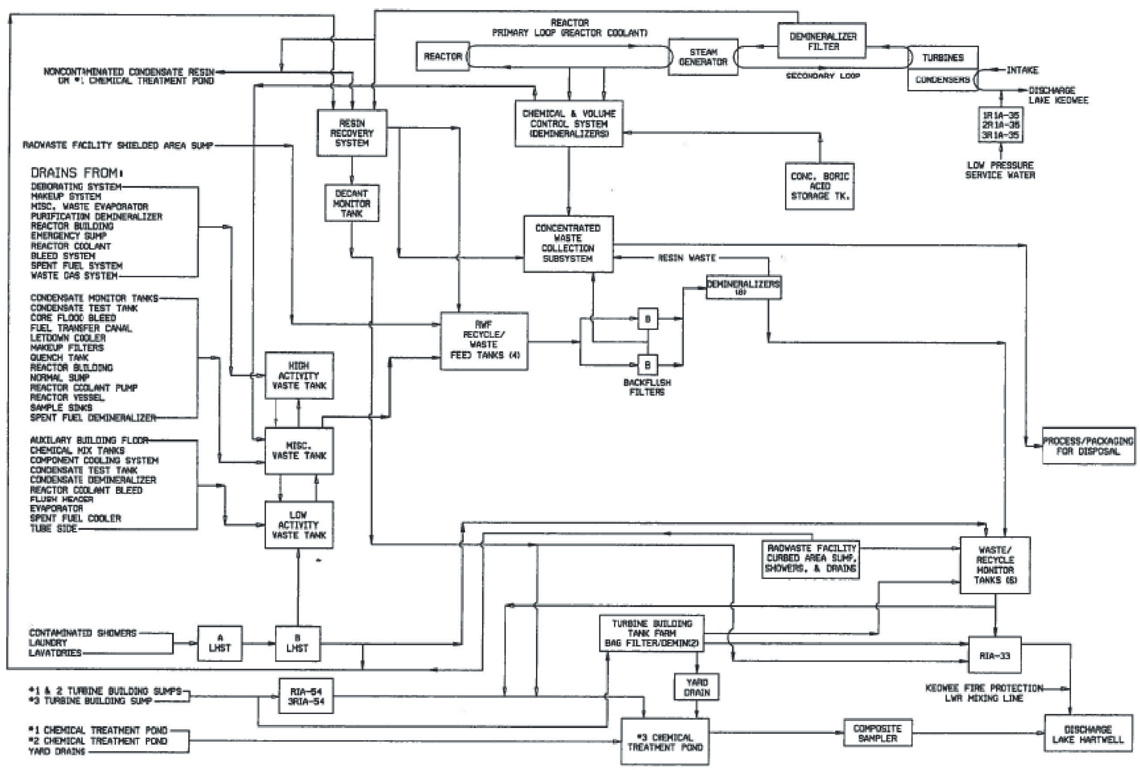
(A) Filtration - Waste sources are filtered prior to processing as necessary.

(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
Page 1 of 4

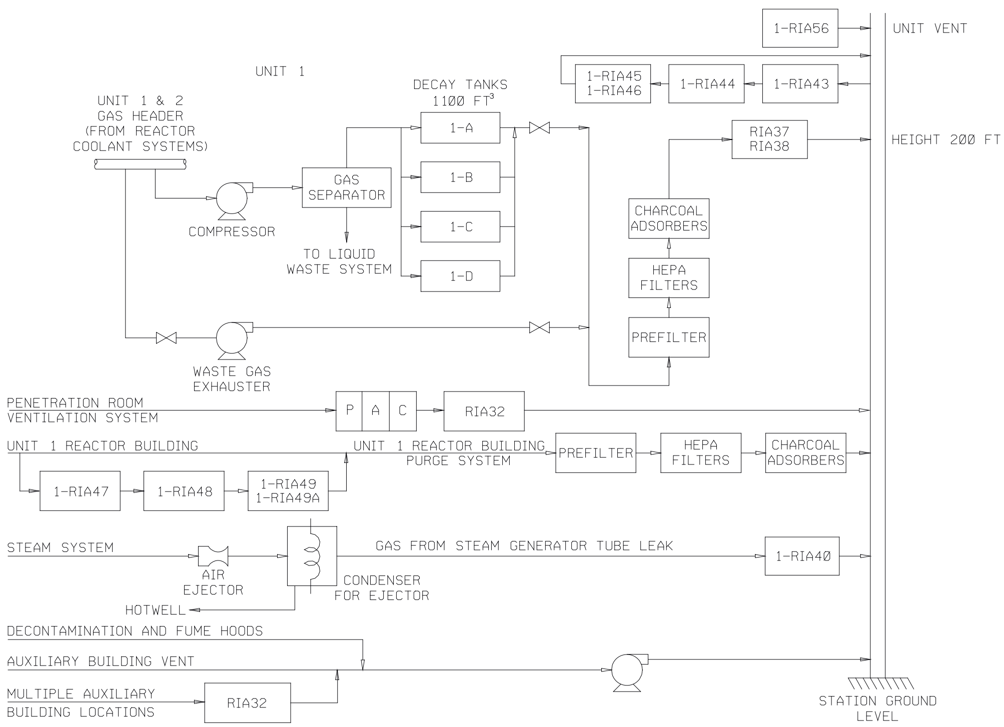


Figure 1.0-2 Oconee Nuclear Station Gaseous Radwaste System Page 2 of 4

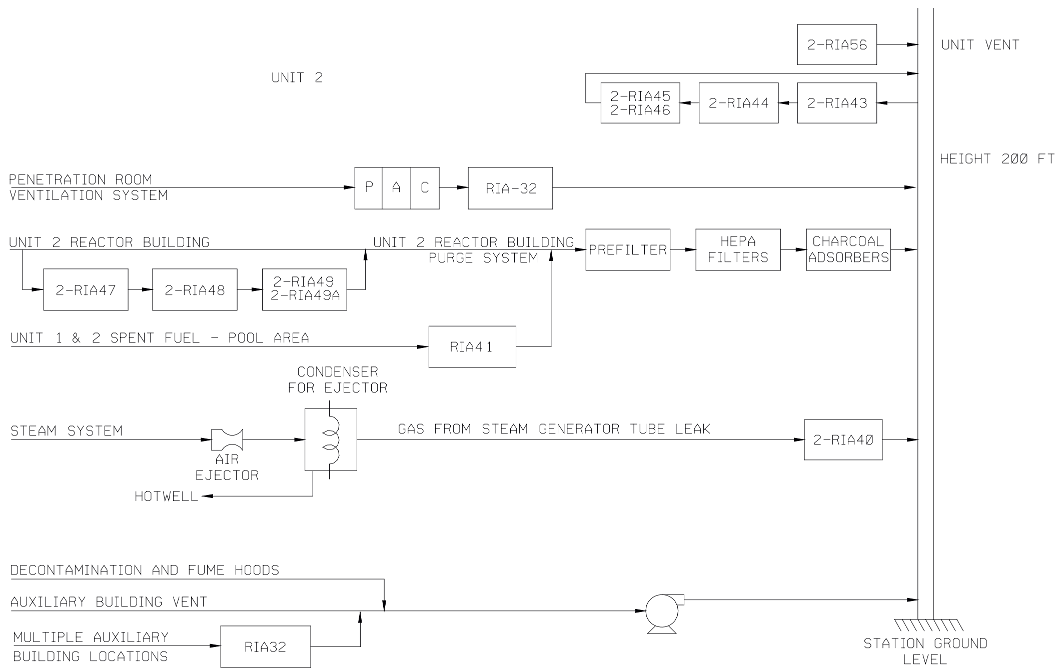


Figure 1.0-2 Oconee Nuclear Station Gaseous Radwaste System Page 3 of 4

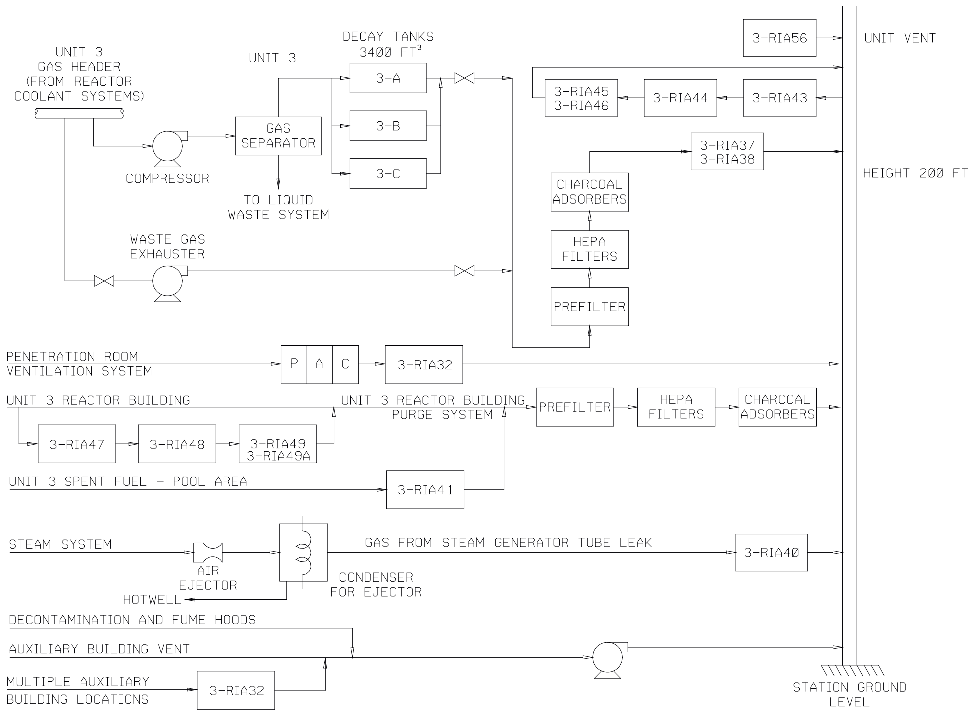
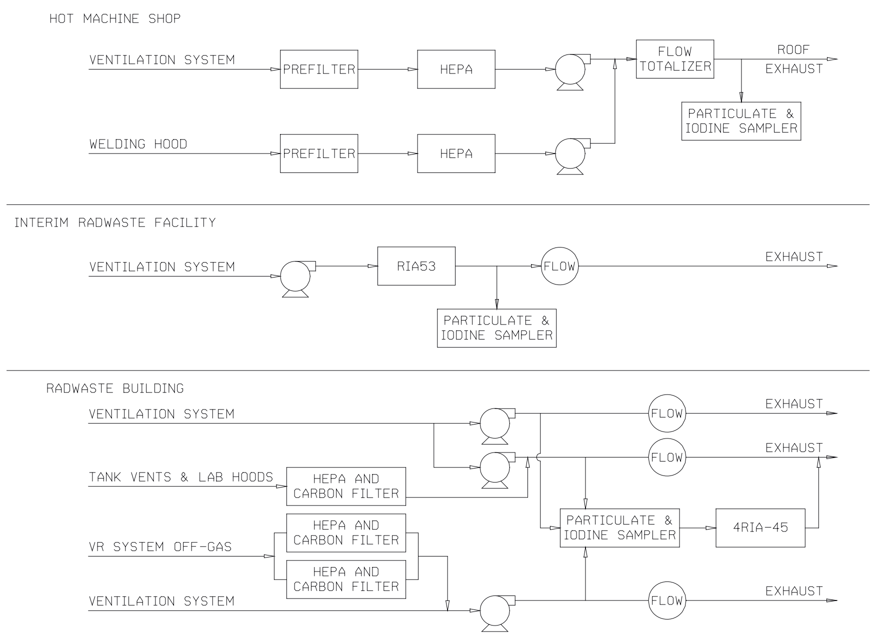


Figure 1.0-2 Oconee Nuclear Station Gaseous Radwaste System
Page 4 of 4



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:

$f \leq (F \div (DF - 1))$ 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.

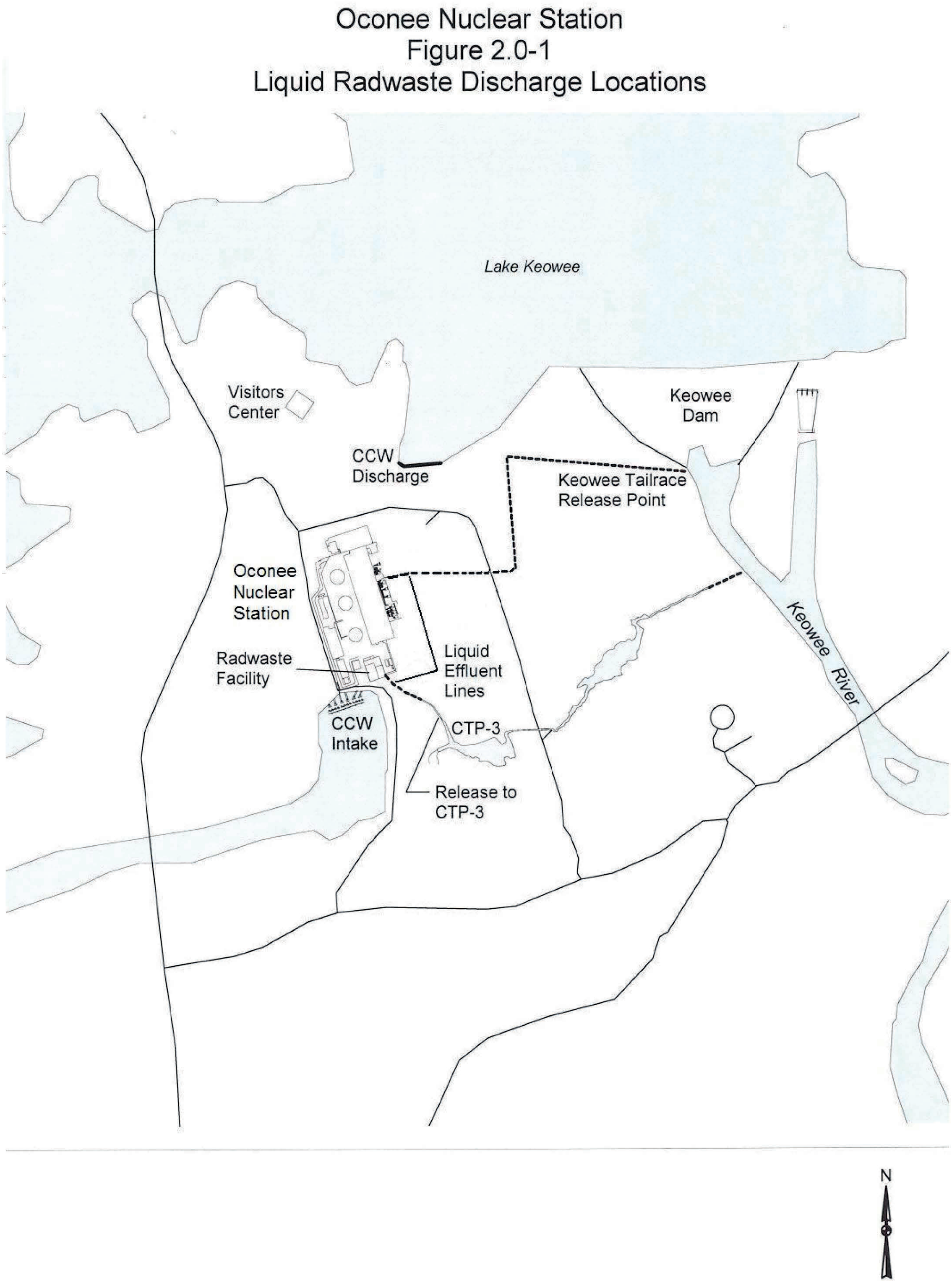
Once the maximum release rate, *f*, is calculated the value is multiplied by 0.8 for additional conservatism.

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 $\mu Ci/m^3$ (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 ($m^2 \times$ (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:

$$f_{sk} < \frac{3000}{472 \times \chi/Q \times \sum_{i}\left[\left(L_i + 1.1M_i\right) \times C_i\right]}$$

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:

$$C_i \leq \frac{(F + f) \times (10 \times EC_i)}{\sigma \times f}$$ 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, 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:

$$C\ CONC = \sum_i (C_i \times EQ_i)$$

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:

$$K_{Xe-133} \times \chi/Q \times Q_{Xe-133} < \text{ 500 mrem/yr}$$

Solve for Q_{Xe-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-133}:

$$C_{Xe-133} < \frac{500}{472 \times f \times K_{Xe-133} \times \chi/Q}$$

$$SP = \frac{C_{Xe-133}}{\text{CF}} + \text{ bkg} \qquad \text{Equation 3.6}$$

where:

K_{Xe-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-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-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:

$$SP = \frac{C_{Xe-133}}{\mathrm{CF}} + \mathrm{bkg}$$

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.

$$RIA-46_{unit\ \mathrm{vent,\,high}} = \frac{150}{472 \times 6.5E{+}04 \times 294 \times 1.672E{-}06 \times 3.17E{-}04}$$

$$RIA-46_{unit\ \mathrm{vent,\,high}} \cong 31\ \mathrm{cpm} + \mathrm{bkg}$$

where:

3.17E-04 = RIA-46 Correlation Factor, µCi/ml/cpm.

All other factors were previously defined.

Alert setpoints are determined as follows:

$$RIA-45_{unit\ vent,\ alert} = RIA-45_{unit\ \mathrm{vent,\,high}} \times \frac{1}{3}$$

$$RIA-45_{unit\ \mathrm{vent,\,alert}} \cong 4.66\mathrm{E}{+}04\ \mathrm{cpm} + \mathrm{bkg}$$

$$RIA-46_{unit\ \mathrm{vent,\,alert}} = RIA-46_{unit\ \mathrm{vent,\,high}} \times \frac{1}{3}$$

$$RIA-46_{unit\ \mathrm{vent,\,alert}} \cong 10\ \mathrm{cpm} + \mathrm{bkg}$$

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)

$$4RIA-45_{\mathrm{high}} = \frac{25}{472 \times 1.297\mathrm{E}{+}05 \times 294 \times 7.308\mathrm{E}{-}06 \times 3.48\mathrm{E}{-}08}$$

$$4RIA-45_{\mathrm{high}} \cong 5460 \text{ cpm}$$

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.

3.48E-08 = 4 RIA 45 Xe-133 correlation factor, µCi/ml/cpm.

All other factors were previously defined.

4RIA-45 reads in units counts per minute, cpm.

Alert setpoint is determined as follows:

$$4RIA-45_{\mathrm{alert}} = 4RIA-45_{\mathrm{high}} \times \frac{1}{3}$$

$$4RIA-45_{\mathrm{alert}} \cong 1820 \text{ cpm} + \text{bkg}$$

All other factors were previously defined.

3.0.2.3 INTERIM RADWASTE BUILDING SETPOINTS (RIA-53)

$$RIA-53_{\text{high}} = \frac{25}{472 \times 1.5E{+}04 \times 294 \times 7.308E{-}06 \times 3.4E{-}08}$$

$$RIA-53_{\text{high}} \cong 4.8E+04 \text{ cpm} + \text{bkg}$$

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:

$$RIA-53_{\text{alert}} = RIA-53_{\text{high}} \times \frac{1}{3}$$

$$RIA-53_{\text{alert}} \cong 1.6E+04 \text{ cpm} + \text{bkg}$$

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:

$$C_{Xe-133} = \sum_i (C_i \times Eq_i)$$

$$Expected\ Cpm = \frac{C_{Xe-133}}{CF_{Xe-133}} + bkg$$

$$RIA-37\ and\ RIA-38\ Setpoint = \frac{C_{Xe-133}}{CF_{Xe-133}} \times 1.5 + bkg \qquad \text{Equation 3.7}$$

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

$$Dose_{\gamma} = 3.17 \times 10^{-8} \times \chi / Q \times \sum_{i} \left(M_i \times Q_i \right)$$

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 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

$$Dose_{\beta} = 3.17 \times 10^{-8} \times \chi / Q \times \sum_{i} \left(N_i \times Q_i \right)$$

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 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

$$Dose_{oa} = 3.17 \times 10^{-8} \times W \times \sum_{p} \sum_{i} \left(R_{oapi} \times Q_i \right)$$

Formula: adapted from NUREG-0133, pages 29 & 30.		
Where:		
$Dose_{oa}$	The cumulative dose commitment to the total body or any organ o, for an individual of age group a (mrem).	
3.17×10^{-8}	Inverse number of seconds in year (year/seconds).	
R_{oapi}	Dose commitment factor for organ o, age group a, pathway p, and nuclide i. The units are based on whether a dispersion or deposition factor is used. When a χ/Q is used the units are mrem/yr per μCi/m^3. When a D/Q is used the units are (m^2 · mrem/yr) per μCi/sec. (See Appendices G through J for age group and pathway specific dose commitment factors).	
W*	Dispersion (χ/Q) or deposition factor (D/Q). The factor used is based upon the pathway. Note: χ/Q is always used for tritium and C-14.	
	Pathway	Factor Used
	Ground Plane Deposition	D/Q (m^{-2})
	Inhalation	χ/Q (sec/m^3)
	Vegetation	D/Q (m^{-2})
	Grass/Cow/Milk	D/Q (m^{-2})
	Grass/Goat/Milk	D/Q (m^{-2})
	Grass/Cow/Meat	D/Q (m^{-2})
	Grass/Goat/Meat	D/Q (m^{-2})
Q_i**	Activity for nuclide i, released during the time period of interest (μCi).	

* 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·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 ($m^2 \cdot$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 0.35, 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

$$R_{oapi} = K'K''' F_{fi} Q_F U_{ap} (DFL_{oi})_a [0.11/0.16](p)(f_I)$$

Formula: from NUREG-0133, page 35 and Regulatory Guide 1.109, page 26.	
Where:	
R_{oapi}	Dose commitment factor for organ o, age group a, nuclide i, for grass/cow/meat pathway (mrem/yr per 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)

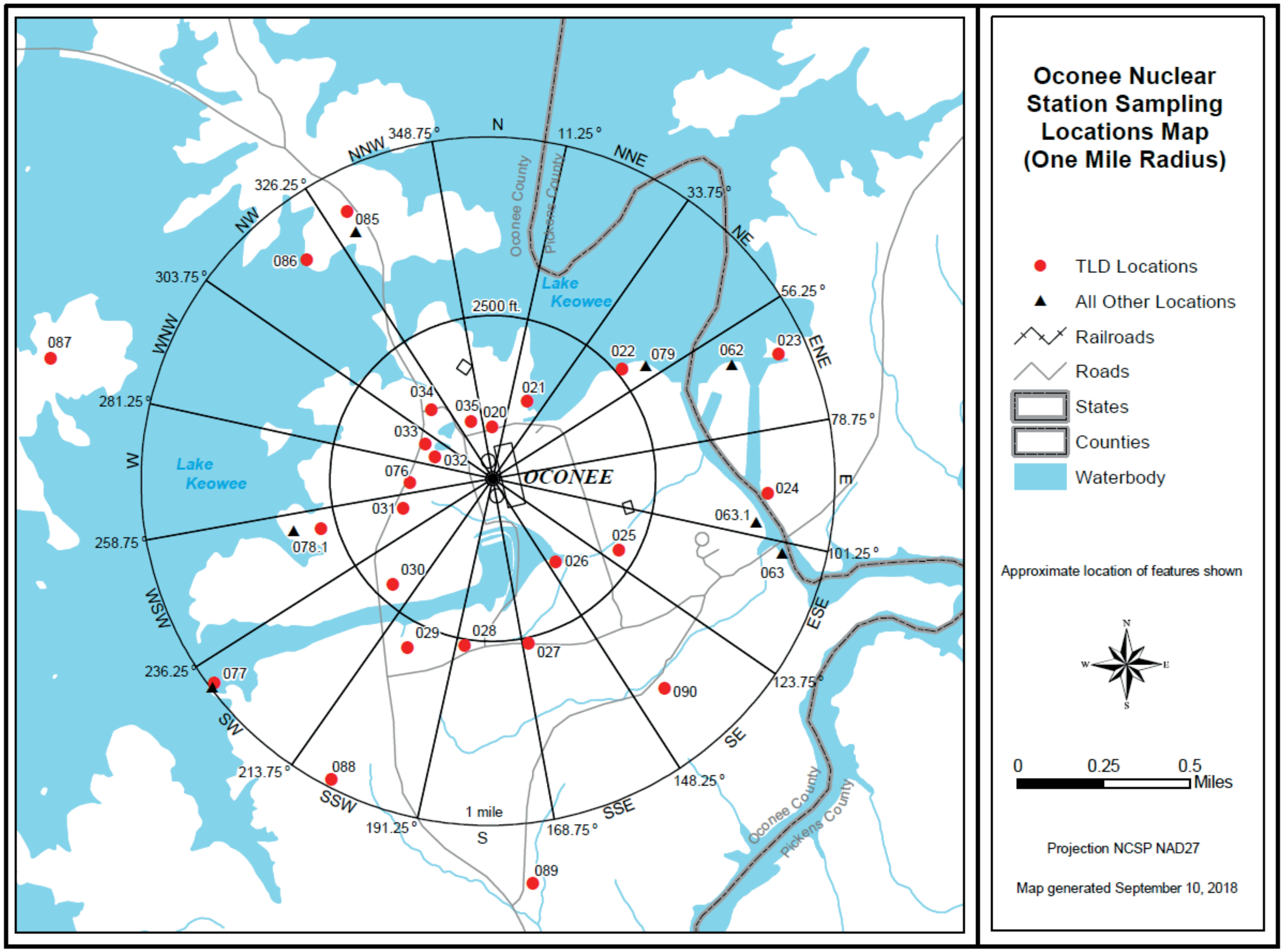


Figure 6.0-2 Sampling Locations Map (Ten Mile Radius)

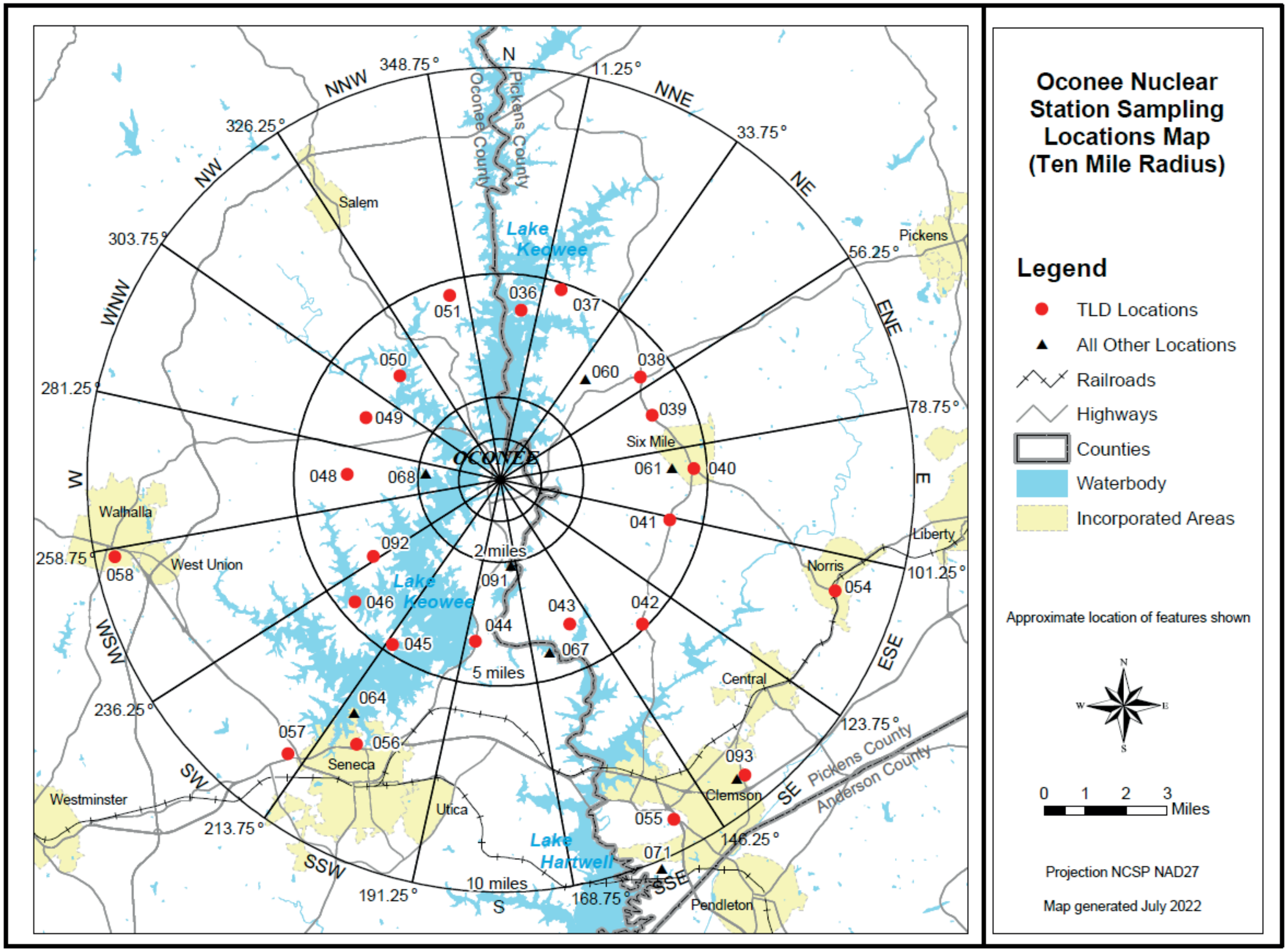
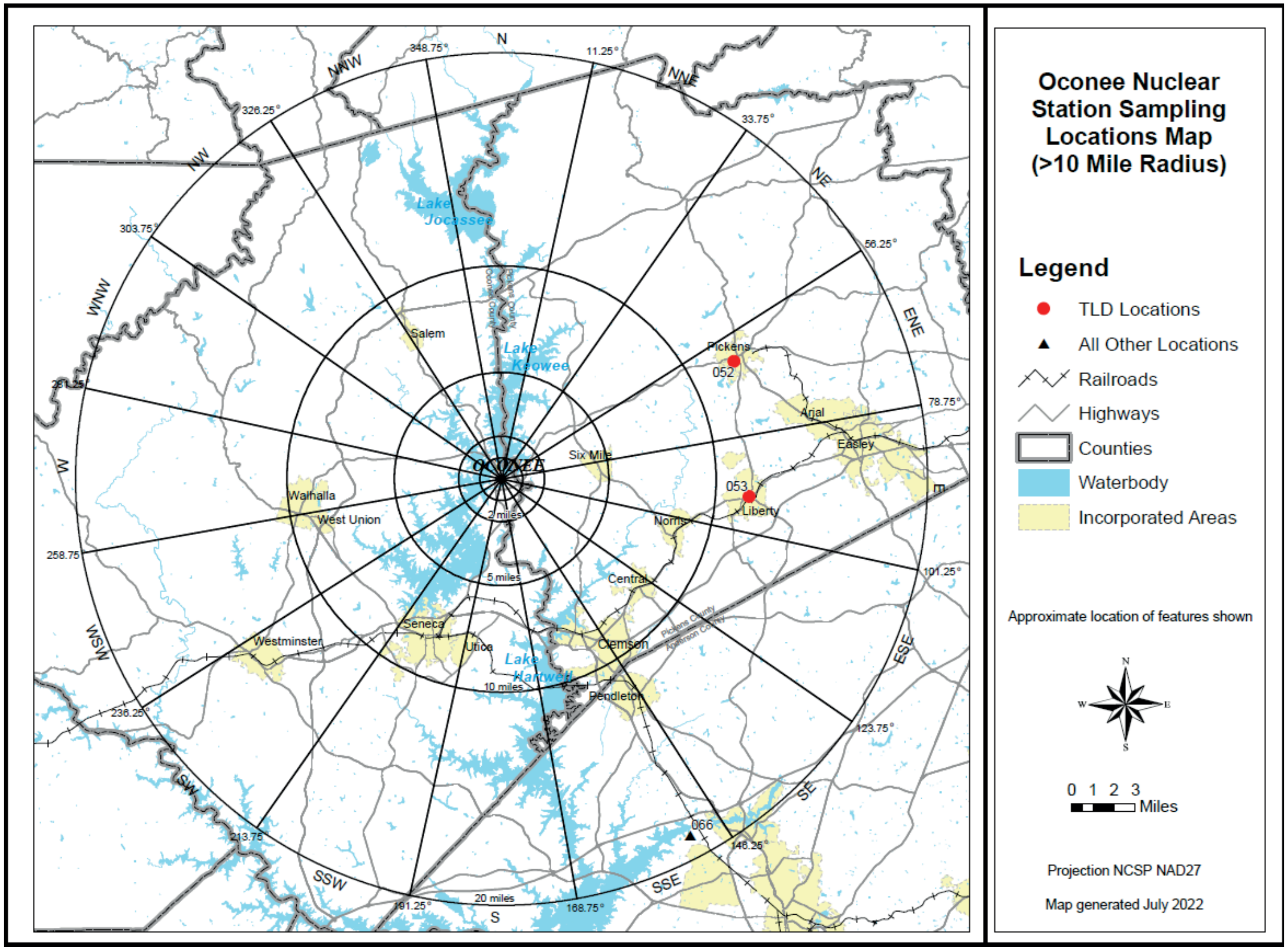


Figure 6.0-3 Sampling Locations Map (>Ten Mile Radius)



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/m³)

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/m³ 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 62

ODCM Revision 62 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.

Section 3 - Page 9

Revised the 4 RIA 45 setpoints for EC 421844, which replaces the radiation monitor. The new monitor output is in counts per minute (cpm) instead of µCi/ml used by the prior monitor. The new monitor's correlation factor of 3.48E-08 µCi/ml/cpm for Xe-133 was inputted into the existing setpoint calculation to convert the setpoint units to cpm. The correlation factor is from document OM 3333.A-0030.001, General Atomics Vendor Manual 4RIA-45. Since the unit conversion uses the new detector's correlation factor, the new setpoints in cpm are equivalent to the prior setpoints that were in units of uCi/ml of Xe-133. The new 4 RIA 45 high setpoint is 5460 cpm and the alert setpoint is 1820 cpm. (DRR #02481555)

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 / $\mu Ci/m^3$	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	1.120E+03	1.120E+03	1.120E+03	1.120E+03	1.120E+03	0.000E+00	1.120E+03
C-14	3.590E+04	6.730E+03	6.730E+03	6.730E+03	6.730E+03	6.730E+03	0.000E+00	6.730E+03
NA-24	1.610E+04	1.610E+04	1.610E+04	1.610E+04	1.610E+04	1.610E+04	0.000E+00	1.610E+04
P-32	2.600E+06	1.140E+05	0.000E+00	0.000E+00	0.000E+00	4.220E+04	0.000E+00	9.880E+04
CR-51	0.000E+00	0.000E+00	8.550E+01	2.430E+01	1.700E+04	1.080E+03	0.000E+00	1.540E+02
MN-54	0.000E+00	4.290E+04	0.000E+00	1.000E+04	1.580E+06	2.290E+04	0.000E+00	9.510E+03
MN-56	0.000E+00	1.660E+00	0.000E+00	1.670E+00	1.310E+04	1.230E+05	0.000E+00	3.120E-01
FE-55	4.740E+04	2.520E+04	0.000E+00	0.000E+00	1.110E+05	2.870E+03	0.000E+00	7.770E+03
FE-59	2.070E+04	3.340E+04	0.000E+00	0.000E+00	1.270E+06	7.070E+04	0.000E+00	1.670E+04
CO-58	0.000E+00	1.770E+03	0.000E+00	0.000E+00	1.110E+06	3.440E+04	0.000E+00	3.160E+03
CO-60	0.000E+00	1.310E+04	0.000E+00	0.000E+00	7.070E+06	9.620E+04	0.000E+00	2.260E+04
NI-63	8.210E+05	4.620E+04	0.000E+00	0.000E+00	2.750E+05	6.330E+03	0.000E+00	2.800E+04
NI-65	2.990E+00	2.960E-01	0.000E+00	0.000E+00	8.180E+03	8.400E+04	0.000E+00	1.640E-01
CU-64	0.000E+00	1.990E+00	0.000E+00	6.030E+00	9.580E+03	3.670E+04	0.000E+00	1.070E+00
ZN-65	4.260E+04	1.130E+05	0.000E+00	7.140E+04	9.950E+05	1.630E+04	0.000E+00	7.030E+04
ZN-69	6.700E-02	9.660E-02	0.000E+00	5.850E-02	1.420E+03	1.020E+04	0.000E+00	8.920E-03
BR-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.740E+02
BR-84	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.480E+02
BR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.530E+01
RB-86	0.000E+00	1.980E+05	0.000E+00	0.000E+00	0.000E+00	7.990E+03	0.000E+00	1.140E+05
RB-88	0.000E+00	5.620E+02	0.000E+00	0.000E+00	0.000E+00	1.720E+01	0.000E+00	3.660E+02
RB-89	0.000E+00	3.450E+02	0.000E+00	0.000E+00	0.000E+00	1.890E+00	0.000E+00	2.900E+02
SR-89	5.990E+05	0.000E+00	0.000E+00	0.000E+00	2.160E+06	1.670E+05	0.000E+00	1.720E+04
SR-90	1.010E+08	0.000E+00	0.000E+00	0.000E+00	1.480E+07	3.430E+05	0.000E+00	6.440E+06
SR-91	1.210E+02	0.000E+00	0.000E+00	0.000E+00	5.330E+04	1.740E+05	0.000E+00	4.590E+00

APPENDIX B

P_i Dose Factors for use in the Gaseous Release Rate Limit Calculations

Agegroup:	CHILD	Pathway:	Inhalation (INHL)			Units:	mrem/yr / $\mu Ci/m^3$	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
SR-92	1.310E+01	0.000E+00	0.000E+00	0.000E+00	2.400E+04	2.420E+05	0.000E+00	5.250E-01
Y-90	4.110E+03	0.000E+00	0.000E+00	0.000E+00	2.620E+05	2.680E+05	0.000E+00	1.110E+02
Y-91	9.140E+05	0.000E+00	0.000E+00	0.000E+00	2.630E+06	1.840E+05	0.000E+00	2.440E+04
Y-91M	5.070E-01	0.000E+00	0.000E+00	0.000E+00	2.810E+03	1.720E+03	0.000E+00	1.840E-02
Y-92	2.030E+01	0.000E+00	0.000E+00	0.000E+00	2.390E+04	2.390E+05	0.000E+00	5.810E-01
Y-93	1.860E+02	0.000E+00	0.000E+00	0.000E+00	7.440E+04	3.880E+05	0.000E+00	5.110E+00
ZR-95	1.900E+05	4.180E+04	0.000E+00	5.960E+04	2.230E+06	6.110E+04	0.000E+00	3.700E+04
ZR-97	1.880E+02	2.720E+01	0.000E+00	3.880E+01	1.130E+05	3.510E+05	0.000E+00	1.600E+01
NB-95	2.350E+04	9.180E+03	0.000E+00	8.620E+03	6.140E+05	3.700E+04	0.000E+00	6.550E+03
MO-99	0.000E+00	1.720E+02	0.000E+00	3.920E+02	1.350E+05	1.270E+05	0.000E+00	4.260E+01
TC-99M	1.780E-03	3.480E-03	0.000E+00	5.070E-02	9.510E+02	4.810E+03	0.000E+00	5.770E-02
TC-101	8.100E-05	8.510E-05	0.000E+00	1.450E-03	5.850E+02	1.630E+01	0.000E+00	1.080E-03
RU-103	2.790E+03	0.000E+00	0.000E+00	7.030E+03	6.620E+05	4.480E+04	0.000E+00	1.070E+03
RU-105	1.530E+00	0.000E+00	0.000E+00	1.340E+00	1.590E+04	9.950E+04	0.000E+00	5.550E-01
RU-106	1.360E+05	0.000E+00	0.000E+00	1.840E+05	1.430E+07	4.290E+05	0.000E+00	1.690E+04
AG-110M	1.690E+04	1.140E+04	0.000E+00	2.120E+04	5.480E+06	1.000E+05	0.000E+00	9.140E+03
TE-125M	6.730E+03	2.330E+03	1.920E+03	0.000E+00	4.770E+05	3.380E+04	0.000E+00	9.140E+02
TE-127	2.770E+00	9.510E-01	1.960E+00	7.070E+00	1.000E+04	5.620E+04	0.000E+00	6.100E-01
TE-127M	2.490E+04	8.550E+03	6.070E+03	6.360E+04	1.480E+06	7.140E+04	0.000E+00	3.020E+03
TE-129	9.770E-02	3.500E-02	7.140E-02	2.570E-01	2.930E+03	2.550E+04	0.000E+00	2.380E-02
TE-129M	1.920E+04	6.840E+03	6.330E+03	5.030E+04	1.760E+06	1.820E+05	0.000E+00	3.040E+03
TE-131	2.170E-02	8.440E-03	1.700E-02	5.880E-02	2.050E+03	1.330E+03	0.000E+00	6.590E-03
TE-131M	1.340E+02	5.920E+01	9.770E+01	4.000E+02	2.060E+05	3.080E+05	0.000E+00	5.070E+01
TE-132	4.810E+02	2.720E+02	3.170E+02	1.770E+03	3.770E+05	1.380E+05	0.000E+00	2.630E+02
I-130	8.180E+03	1.640E+04	1.850E+06	2.450E+04	0.000E+00	5.110E+03	0.000E+00	8.440E+03

APPENDIX B

P_i Dose Factors for use in the Gaseous Release Rate Limit Calculations

Agegroup:	CHILD	Pathway:	Inhalation (INHL)			Units:	mrem/yr / $\mu Ci/m^3$	
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:	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	2.960E+08	4.230E+08	1.390E+11	7.260E+08	0.000E+00	1.120E+08	0.000E+00	2.430E+08
I-132	1.640E-01	4.390E-01	1.540E+01	7.000E-01	0.000E+00	8.250E-02	0.000E+00	1.540E-01
I-133	3.870E+06	6.730E+06	9.890E+08	1.170E+07	0.000E+00	6.050E+06	0.000E+00	2.050E+06
I-134	2.020E-12	5.480E-12	9.490E-11	8.710E-12	0.000E+00	4.770E-15	0.000E+00	1.960E-12
I-135	1.280E+04	3.360E+04	2.220E+06	5.390E+04	0.000E+00	3.800E+04	0.000E+00	1.240E+04
CS-134	5.650E+09	1.350E+10	0.000E+00	4.350E+09	1.450E+09	2.350E+08	0.000E+00	1.100E+10
CS-136	2.630E+08	1.040E+09	0.000E+00	5.780E+08	7.930E+07	1.180E+08	0.000E+00	7.480E+08
CS-137	7.380E+09	1.010E+10	0.000E+00	3.430E+09	1.140E+09	1.950E+08	0.000E+00	6.610E+09
CS-138	9.050E-24	1.790E-23	0.000E+00	1.310E-23	1.300E-24	7.620E-29	0.000E+00	8.850E-24
BA-139	4.420E-08	3.150E-11	0.000E+00	2.940E-11	1.790E-11	7.830E-08	0.000E+00	1.290E-09
BA-140	2.690E+07	3.380E+04	0.000E+00	1.150E+04	1.930E+04	5.530E+07	0.000E+00	1.760E+06
BA-141	4.090E-46	3.090E-49	0.000E+00	2.880E-49	1.760E-49	1.930E-55	0.000E+00	1.380E-47
BA-142	2.640E-80	2.720E-83	0.000E+00	2.300E-83	1.540E-83	3.720E-98	0.000E+00	1.660E-81
LA-140	4.510E+00	2.270E+00	0.000E+00	0.000E+00	0.000E+00	1.670E+05	0.000E+00	6.010E-01
LA-142	1.860E-11	8.460E-12	0.000E+00	0.000E+00	0.000E+00	6.170E-08	0.000E+00	2.110E-12
CE-141	4.840E+03	3.280E+03	0.000E+00	1.520E+03	0.000E+00	1.250E+07	0.000E+00	3.720E+02
CE-143	4.160E+01	3.070E+04	0.000E+00	1.350E+01	0.000E+00	1.150E+06	0.000E+00	3.400E+00
CE-144	3.580E+05	1.500E+05	0.000E+00	8.870E+04	0.000E+00	1.210E+08	0.000E+00	1.920E+04
PR-143	1.580E+02	6.330E+01	0.000E+00	3.660E+01	0.000E+00	6.920E+05	0.000E+00	7.830E+00
PR-144	5.870E-54	2.440E-54	0.000E+00	1.380E-54	0.000E+00	8.450E-61	0.000E+00	2.990E-55
ND-147	9.420E+01	1.090E+02	0.000E+00	6.360E+01	0.000E+00	5.220E+05	0.000E+00	6.510E+00
W-187	6.510E+03	5.450E+03	0.000E+00	0.000E+00	0.000E+00	1.780E+06	0.000E+00	1.900E+03
NP-239	3.670E+00	3.610E-01	0.000E+00	1.130E+00	0.000E+00	7.410E+04	0.000E+00	1.990E-01

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	ADULT	Pathway:	Grs/Goat/Milk (GMILK)			Units:	$m^2 \cdot$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	1.560E+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:	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

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:	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	1.180E-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:	m^2·mrem/yr / µCi/sec; mrem/yr / µCi/m^3 (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	1.416E-50	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.808E-49	0.000E+00	6.120E-52
Y-90	1.296E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.368E+05	0.000E+00	3.468E-01
Y-91	1.356E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.476E+07	0.000E+00	3.636E+03
Y-91M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y-92	1.824E-40	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.192E-36	0.000E+00	5.316E-42
Y-93	5.628E-13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.788E-08	0.000E+00	1.560E-14
ZR-95	2.244E+05	7.212E+04	0.000E+00	1.130E+05	0.000E+00	2.280E+08	0.000E+00	4.884E+04
ZR-97	2.484E-06	5.004E-07	0.000E+00	7.560E-07	0.000E+00	1.548E-01	0.000E+00	2.292E-07
NB-95	2.760E+05	1.536E+05	0.000E+00	1.512E+05	0.000E+00	9.312E+08	0.000E+00	8.244E+04
MO-99	0.000E+00	1.200E+04	0.000E+00	2.712E+04	0.000E+00	2.784E+04	0.000E+00	2.280E+03
TC-99M	5.340E-22	1.512E-21	0.000E+00	2.292E-20	7.380E-22	8.916E-19	0.000E+00	1.920E-20
TC-101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-103	1.260E+07	0.000E+00	0.000E+00	4.812E+07	0.000E+00	1.476E+09	0.000E+00	5.436E+06
RU-105	6.936E-29	0.000E+00	0.000E+00	8.952E-28	0.000E+00	4.236E-26	0.000E+00	2.736E-29
RU-106	3.360E+08	0.000E+00	0.000E+00	6.480E+08	0.000E+00	2.172E+10	0.000E+00	4.248E+07
AG-110M	8.016E+05	7.416E+05	0.000E+00	1.464E+06	0.000E+00	3.024E+08	0.000E+00	4.404E+05
TE-125M	4.308E+07	1.560E+07	1.296E+07	1.752E+08	0.000E+00	1.716E+08	0.000E+00	5.772E+06
TE-127	2.544E-11	9.132E-12	1.884E-11	1.037E-10	0.000E+00	2.004E-09	0.000E+00	5.508E-12
TE-127M	1.344E+08	4.788E+07	3.420E+07	5.436E+08	0.000E+00	4.488E+08	0.000E+00	1.632E+07
TE-129	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-129M	1.356E+08	5.076E+07	4.680E+07	5.676E+08	0.000E+00	6.852E+08	0.000E+00	2.148E+07
TE-131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-131M	5.412E+01	2.652E+01	4.188E+01	2.676E+02	0.000E+00	2.628E+03	0.000E+00	2.208E+01
TE-132	1.704E+05	1.102E+05	1.212E+05	1.061E+06	0.000E+00	5.208E+06	0.000E+00	1.034E+05
I-130	2.532E-07	7.464E-07	6.324E-05	1.164E-06	0.000E+00	6.420E-07	0.000E+00	2.940E-07

APPENDIX G

R_i Adult Dose Factors for use in the Gaseous Dose Calculations

Age group:	ADULT	Pathway:	Grs/Goat/Meat (GMEAT)			Units:	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:	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	2.260E+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·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/m³	
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:	$m^2 \cdot mrem/yr$ / $\mu Ci/sec$	
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 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:	$m^2 \cdot mrem/yr$ / 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	4.690E+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:	m^2·mrem/yr / µCi/sec; mrem/yr / µCi/m^3 (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
H-3	0.000E+00	2.030E+03	2.030E+03	2.030E+03	2.030E+03	2.030E+03	0.000E+00	2.030E+03
C-14	4.690E+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:	m^2·mrem/yr / μCi/sec; mrem/yr / μCi/m^3 (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	8.920E+06	1.250E+07	3.650E+09	2.150E+07	0.000E+00	2.470E+06	0.000E+00	6.710E+06
I-132	5.660E-59	1.480E-58	4.990E-57	2.330E-58	0.000E+00	6.450E-59	0.000E+00	5.320E-59
I-133	3.050E-01	5.180E-01	7.230E+01	9.090E-01	0.000E+00	3.920E-01	0.000E+00	1.580E-01
I-134	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-135	3.600E-17	9.260E-17	5.960E-15	1.460E-16	0.000E+00	1.030E-16	0.000E+00	3.430E-17
CS-134	5.230E+08	1.230E+09	0.000E+00	3.910E+08	1.490E+08	1.530E+07	0.000E+00	5.710E+08
CS-136	9.400E+06	3.700E+07	0.000E+00	2.010E+07	3.170E+06	2.980E+06	0.000E+00	2.480E+07
CS-137	7.240E+08	9.630E+08	0.000E+00	3.280E+08	1.270E+08	1.370E+07	0.000E+00	3.360E+08
CS-138	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-139	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-140	2.380E+07	2.910E+04	0.000E+00	9.870E+03	1.960E+04	3.660E+07	0.000E+00	1.530E+06
BA-141	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA-140	3.050E-02	1.500E-02	0.000E+00	0.000E+00	0.000E+00	8.610E+02	0.000E+00	3.990E-03
LA-142	2.870E-92	1.280E-92	0.000E+00	0.000E+00	0.000E+00	3.880E-88	0.000E+00	3.180E-93
CE-141	1.180E+04	7.870E+03	0.000E+00	3.710E+03	0.000E+00	2.250E+07	0.000E+00	9.040E+02
CE-143	1.690E-02	1.230E+01	0.000E+00	5.510E-03	0.000E+00	3.690E+02	0.000E+00	1.370E-03
CE-144	1.230E+06	5.080E+05	0.000E+00	3.040E+05	0.000E+00	3.090E+08	0.000E+00	6.600E+04
PR-143	1.760E+04	7.040E+03	0.000E+00	4.090E+03	0.000E+00	5.800E+07	0.000E+00	8.780E+02
PR-144	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND-147	6.230E+03	6.770E+03	0.000E+00	3.980E+03	0.000E+00	2.440E+07	0.000E+00	4.060E+02
W-187	1.730E-02	1.410E-02	0.000E+00	0.000E+00	0.000E+00	3.820E+00	0.000E+00	4.940E-03
NP-239	2.260E-01	2.140E-02	0.000E+00	6.700E-02	0.000E+00	3.440E+03	0.000E+00	1.190E-02

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Age group:	TEEN	Pathway:	Grs/Goat/Meat (GMEAT)			Units:	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·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	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:	m^2·mrem/yr / µCi/sec	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
SR-92	7.770E+05	7.770E+05	7.770E+05	7.770E+05	7.770E+05	7.770E+05	8.630E+05	7.770E+05
Y-90	4.490E+03	4.490E+03	4.490E+03	4.490E+03	4.490E+03	4.490E+03	5.310E+03	4.490E+03
Y-91	1.070E+06	1.070E+06	1.070E+06	1.070E+06	1.070E+06	1.070E+06	1.210E+06	1.070E+06
Y-91M	1.000E+05	1.000E+05	1.000E+05	1.000E+05	1.000E+05	1.000E+05	1.160E+05	1.000E+05
Y-92	1.800E+05	1.800E+05	1.800E+05	1.800E+05	1.800E+05	1.800E+05	2.140E+05	1.800E+05
Y-93	1.830E+05	1.830E+05	1.830E+05	1.830E+05	1.830E+05	1.830E+05	2.510E+05	1.830E+05
ZR-95	2.450E+08	2.450E+08	2.450E+08	2.450E+08	2.450E+08	2.450E+08	2.840E+08	2.450E+08
ZR-97	2.960E+06	2.960E+06	2.960E+06	2.960E+06	2.960E+06	2.960E+06	3.440E+06	2.960E+06
NB-95	1.370E+08	1.370E+08	1.370E+08	1.370E+08	1.370E+08	1.370E+08	1.610E+08	1.370E+08
MO-99	3.990E+06	3.990E+06	3.990E+06	3.990E+06	3.990E+06	3.990E+06	4.630E+06	3.990E+06
TC-99M	1.840E+05	1.840E+05	1.840E+05	1.840E+05	1.840E+05	1.840E+05	2.110E+05	1.840E+05
TC-101	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.040E+04	2.260E+04	2.040E+04
RU-103	1.080E+08	1.080E+08	1.080E+08	1.080E+08	1.080E+08	1.080E+08	1.260E+08	1.080E+08
RU-105	6.360E+05	6.360E+05	6.360E+05	6.360E+05	6.360E+05	6.360E+05	7.210E+05	6.360E+05
RU-106	4.220E+08	4.220E+08	4.220E+08	4.220E+08	4.220E+08	4.220E+08	5.070E+08	4.220E+08
AG-110M	3.440E+09	3.440E+09	3.440E+09	3.440E+09	3.440E+09	3.440E+09	4.010E+09	3.440E+09
TE-125M	1.550E+06	1.550E+06	1.550E+06	1.550E+06	1.550E+06	1.550E+06	2.130E+06	1.550E+06
TE-127	2.980E+03	2.980E+03	2.980E+03	2.980E+03	2.980E+03	2.980E+03	3.280E+03	2.980E+03
TE-127M	9.160E+04	9.160E+04	9.160E+04	9.160E+04	9.160E+04	9.160E+04	1.080E+05	9.160E+04
TE-129	2.620E+04	2.620E+04	2.620E+04	2.620E+04	2.620E+04	2.620E+04	3.100E+04	2.620E+04
TE-129M	1.980E+07	1.980E+07	1.980E+07	1.980E+07	1.980E+07	1.980E+07	2.310E+07	1.980E+07
TE-131	2.920E+04	2.920E+04	2.920E+04	2.920E+04	2.920E+04	2.920E+04	3.450E+07	2.920E+04
TE-131M	8.030E+06	8.030E+06	8.030E+06	8.030E+06	8.030E+06	8.030E+06	9.460E+06	8.030E+06
TE-132	4.230E+06	4.230E+06	4.230E+06	4.230E+06	4.230E+06	4.230E+06	4.980E+06	4.230E+06
I-130	5.510E+06	5.510E+06	5.510E+06	5.510E+06	5.510E+06	5.510E+06	6.690E+06	5.510E+06

APPENDIX H

R_i Teen Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	TEEN	Pathway:	Ground Plane Deposition (GPD)			Units:	m^2·mrem/yr / µCi/sec	
Nuclide	Bone	Liver	Thyroid	Kidney	Lung	Gilli	Skin	Total Body
I-131	1.720E+07	1.720E+07	1.720E+07	1.720E+07	1.720E+07	1.720E+07	2.090E+07	1.720E+07
I-132	1.250E+06	1.250E+06	1.250E+06	1.250E+06	1.250E+06	1.250E+06	1.470E+06	1.250E+06
I-133	2.450E+06	2.450E+06	2.450E+06	2.450E+06	2.450E+06	2.450E+06	2.980E+06	2.450E+06
I-134	4.470E+05	4.470E+05	4.470E+05	4.470E+05	4.470E+05	4.470E+05	5.300E+05	4.470E+05
I-135	2.530E+06	2.530E+06	2.530E+06	2.530E+06	2.530E+06	2.530E+06	2.950E+06	2.530E+06
CS-134	6.860E+09	6.860E+09	6.860E+09	6.860E+09	6.860E+09	6.860E+09	8.000E+09	6.860E+09
CS-136	1.510E+08	1.510E+08	1.510E+08	1.510E+08	1.510E+08	1.510E+08	1.710E+08	1.510E+08
CS-137	1.030E+10	1.030E+10	1.030E+10	1.030E+10	1.030E+10	1.030E+10	1.200E+10	1.030E+10
CS-138	3.590E+05	3.590E+05	3.590E+05	3.590E+05	3.590E+05	3.590E+05	4.100E+05	3.590E+05
BA-139	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.060E+05	1.190E+05	1.060E+05
BA-140	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.050E+07	2.350E+07	2.050E+07
BA-141	4.170E+04	4.170E+04	4.170E+04	4.170E+04	4.170E+04	4.170E+04	4.750E+04	4.170E+04
BA-142	4.490E+04	4.490E+04	4.490E+04	4.490E+04	4.490E+04	4.490E+04	5.110E+04	4.490E+04
LA-140	1.920E+07	1.920E+07	1.920E+07	1.920E+07	1.920E+07	1.920E+07	2.180E+07	1.920E+07
LA-142	7.600E+05	7.600E+05	7.600E+05	7.600E+05	7.600E+05	7.600E+05	9.120E+05	7.600E+05
CE-141	1.370E+07	1.370E+07	1.370E+07	1.370E+07	1.370E+07	1.370E+07	1.540E+07	1.370E+07
CE-143	2.310E+06	2.310E+06	2.310E+06	2.310E+06	2.310E+06	2.310E+06	2.630E+06	2.310E+06
CE-144	6.950E+07	6.950E+07	6.950E+07	6.950E+07	6.950E+07	6.950E+07	8.040E+07	6.950E+07
PR-143	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR-144	1.830E+03	1.830E+03	1.830E+03	1.830E+03	1.830E+03	1.830E+03	2.110E+03	1.830E+03
ND-147	8.390E+06	8.390E+06	8.390E+06	8.390E+06	8.390E+06	8.390E+06	1.010E+07	8.390E+06
W-187	2.350E+06	2.350E+06	2.350E+06	2.350E+06	2.350E+06	2.350E+06	2.730E+06	2.350E+06
NP-239	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.710E+06	1.980E+06	1.710E+06

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Grs/Cow/Milk (CMILK)			Units:	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

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:	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	3.200E+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:	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:	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:	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

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**
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

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**
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:	$m^2 \cdot mrem/yr / \mu Ci/sec$; mrem/yr / $\mu Ci/m^3$ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	1.980E+06	1.992E+06	6.600E+08	3.276E+06	0.000E+00	1.776E+05	0.000E+00	1.135E+06
I-132	1.224E-59	2.256E-59	1.048E-57	3.456E-59	0.000E+00	2.652E-59	0.000E+00	1.038E-59
I-133	6.804E-02	8.424E-02	1.560E+01	1.404E-01	0.000E+00	3.396E-02	0.000E+00	3.192E-02
I-134	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-135	7.812E-18	1.404E-17	1.248E-15	2.160E-17	0.000E+00	1.072E-17	0.000E+00	6.660E-18
CS-134	1.106E+08	1.812E+08	0.000E+00	5.628E+07	2.016E+07	9.792E+05	0.000E+00	3.828E+07
CS-136	1.944E+06	5.352E+06	0.000E+00	2.844E+06	4.248E+05	1.884E+05	0.000E+00	3.456E+06
CS-137	1.596E+08	1.536E+08	0.000E+00	4.992E+07	1.800E+07	9.588E+05	0.000E+00	2.256E+07
CS-138	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-139	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-140	5.256E+06	4.608E+03	0.000E+00	1.500E+03	2.748E+03	2.664E+06	0.000E+00	3.072E+05
BA-141	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA-140	6.708E-03	2.340E-03	0.000E+00	0.000E+00	0.000E+00	6.528E+01	0.000E+00	7.896E-04
LA-142	6.360E-93	2.028E-93	0.000E+00	0.000E+00	0.000E+00	4.020E-88	0.000E+00	6.348E-94
CE-141	2.664E+03	1.332E+03	0.000E+00	5.820E+02	0.000E+00	1.656E+06	0.000E+00	1.968E+02
CE-143	3.804E-03	2.064E+00	0.000E+00	8.652E-04	0.000E+00	3.024E+01	0.000E+00	2.988E-04
CE-144	2.784E+05	8.712E+04	0.000E+00	4.824E+04	0.000E+00	2.268E+07	0.000E+00	1.488E+04
PR-143	4.008E+03	1.200E+03	0.000E+00	6.516E+02	0.000E+00	4.320E+06	0.000E+00	1.992E+02
PR-144	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND-147	1.404E+03	1.136E+03	0.000E+00	6.228E+02	0.000E+00	1.800E+06	0.000E+00	8.796E+01
W-187	3.852E-03	2.280E-03	0.000E+00	0.000E+00	0.000E+00	3.204E-01	0.000E+00	1.024E-03
NP-239	5.112E-02	3.672E-03	0.000E+00	1.062E-02	0.000E+00	2.712E+02	0.000E+00	2.580E-03

APPENDIX I

R_i Child Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	CHILD	Pathway:	Vegetation (VEG)			Units:	$m^2 \cdot$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	4.010E+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

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 / $\mu Ci/m^3$	
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:	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 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**
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:	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	4.860E+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:	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	9.750E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.050E+02	0.000E+00	3.620E-01
Y-90	8.170E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.130E+05	0.000E+00	2.190E+00
Y-91	8.790E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.300E+05	0.000E+00	2.340E+02
Y-91M	6.810E-20	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.270E-16	0.000E+00	2.320E-21
Y-92	6.450E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.230E+00	0.000E+00	1.810E-06
Y-93	2.590E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.040E+03	0.000E+00	7.050E-03
ZR-95	8.170E+02	1.990E+02	0.000E+00	2.140E+02	0.000E+00	9.910E+04	0.000E+00	1.410E+02
ZR-97	4.870E-01	8.360E-02	0.000E+00	8.430E-02	0.000E+00	5.340E+03	0.000E+00	3.820E-02
NB-95	7.120E+04	2.930E+04	0.000E+00	2.100E+04	0.000E+00	2.480E+07	0.000E+00	1.700E+04
MO-99	0.000E+00	2.500E+07	0.000E+00	3.730E+07	0.000E+00	8.220E+06	0.000E+00	4.870E+06
TC-99M	3.300E+00	6.800E+00	0.000E+00	7.320E+01	3.550E+00	1.970E+03	0.000E+00	8.760E+01
TC-101	2.960E-60	3.730E-60	0.000E+00	4.440E-59	2.030E-60	6.340E-58	0.000E+00	3.690E-59
RU-103	1.040E+03	0.000E+00	0.000E+00	2.170E+03	0.000E+00	1.270E+04	0.000E+00	3.480E+02
RU-105	9.660E-04	0.000E+00	0.000E+00	7.110E-03	0.000E+00	3.840E-01	0.000E+00	3.250E-04
RU-106	2.280E+04	0.000E+00	0.000E+00	2.700E+04	0.000E+00	1.730E+05	0.000E+00	2.850E+03
AG-110M	4.630E+07	3.380E+07	0.000E+00	4.830E+07	0.000E+00	1.750E+09	0.000E+00	2.240E+07
TE-125M	1.810E+07	6.050E+06	6.090E+06	0.000E+00	0.000E+00	8.620E+06	0.000E+00	2.450E+06
TE-127	7.580E+02	2.540E+02	6.170E+02	1.850E+03	0.000E+00	1.590E+04	0.000E+00	1.630E+02
TE-127M	5.050E+07	1.680E+07	1.460E+07	1.240E+08	0.000E+00	2.040E+07	0.000E+00	6.120E+06
TE-129	3.260E-10	1.130E-10	2.740E-10	8.130E-10	0.000E+00	2.610E-08	0.000E+00	7.620E-11
TE-129M	6.690E+07	2.290E+07	2.570E+07	1.670E+08	0.000E+00	3.990E+07	0.000E+00	1.030E+07
TE-131	4.110E-33	1.520E-33	3.670E-33	1.050E-32	0.000E+00	1.660E-31	0.000E+00	1.150E-33
TE-131M	4.050E+05	1.630E+05	3.310E+05	1.120E+06	0.000E+00	2.750E+06	0.000E+00	1.350E+05
TE-132	2.530E+06	1.250E+06	1.850E+06	7.840E+06	0.000E+00	4.640E+06	0.000E+00	1.170E+06
I-130	4.260E+06	9.370E+06	1.050E+09	1.030E+07	0.000E+00	2.010E+06	0.000E+00	3.760E+06

APPENDIX J

R_i Infant Dose Factors for use in the Gaseous Dose Calculations

Agegroup:	INFANT	Pathway:	Grs/Goat/Milk (GMILK)			Units:	$m^2 \cdot mrem/yr / \mu Ci/sec$; mrem/yr / $\mu Ci/m^3$ (H-3, C-14)	
Nuclide	**Bone**	**Liver**	**Thyroid**	**Kidney**	**Lung**	**Gilli**	**Skin**	**Total Body**
I-131	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/m³	
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:	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 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

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16.5.1	000		11/26/12
16.5.2	000		11/15/12
16.5.3	000		02/21/07
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16.5.8	000		01/31/07
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16.7.1	000		11/15/12

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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 2×10^{-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:

   ≤ 4.5 mrem to the total body

   ≤ 15 mrem to any organ; and

2. during any calendar year:

   ≤ 9 mrem to the total body

   ≤ 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: 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.	30 days from the end of the quarter during which the release occurred

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:

≤ 22.5 mrem to any organ

ii. During any calendar year:

≤ 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 ≤ 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. AND 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

BASES

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. OR 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
	AND		
	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
	AND		
	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
	<u>AND</u>		
	E.1.2	Conduct two independent data entry checks for release rate calculations	Prior to initiating subsequent release
	<u>AND</u>		
	E.1.3	Conduct two independent valve lineups of the effluent pathway.	Prior to initiating subsequent release
	<u>OR</u>		
	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
	<u>OR</u>		
	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
	AND	
	I.1.2 Conduct two independent data entry checks for release rate calculations	Prior to initiating subsequent release
	AND	
	I.1.3 Conduct two independent valve lineups of the effluent pathway.	Prior to initiating subsequent release
	OR	
	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
	<u>OR</u>	
	K.2.1 Collect grab sample.	Immediately <u>AND</u> Once per 8 hours
	<u>AND</u>	
	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
	OR	
	M.2 Suspend release of radioactive effluents by this pathway.	Immediately
	OR	
	M.3.1 Collect grab sample.	Immediately AND Once per 8 hours
	AND	
	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.	Prior to shipment for disposal of the inadequately processed waste that requires solidification or dewatering
	OR		
	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.	
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
	<u>AND</u>		
	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

Δ t 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 Δ t 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.

<u>REFERENCES</u>:

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.	Immediately
	<u>AND</u>	
	A.2 Reduce tank contents to within limit.	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

<u>BASES</u>

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 $\leq$ 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 $\leq$ 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. AND B.2 Reduce Concentration of Hydrogen to within limit.	Immediately 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 <u>AND</u> 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 1/1/2023 - 12/31/2023

The (ONS) PCP was not revised in (2023). The most recent revision is (0), 05/23/2022 and is provided in the 2022 ARERR.

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 1/1/2023 - 12/31/2023

No major modifications to Oconee Nuclear Station liquid, gaseous, solid, or mobile radioactive waste treatment systems occurred in 2023.

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

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2023 - 12/31/2023

There is one (1) change to a previous year's ARERR.

The following contains amended pages to the Oconee Nuclear Station 2022 ARERR. Amended pages are identified with "Amendment #" on page. Specific changes are identified with change bars in right margin.

The Oconee Nuclear Station 2022 ARERR Amendment #1 requires the following changes to Attachment 1 and Attachment 6 (Reference NCR 02506651).

Oconee Nuclear Station 2022 ARERR Attachment 1 Page 1-7 as submitted:

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

Oconee Nuclear Station 2022 ARERR Attachment 1 Page 1-7 Amendment #1 as revised:

B. Tritium						
1. Total Release	Ci	6.45E+02	2.82E+02	2.43E+02	2.20E+02	1.39E+03
2. Avg. Diluted Conc	µCi/ml	7.69E-05	3.32E-05	2.84E-05	2.56E-05	4.09E-05
3. Batch Releases	µCi/ml	7.69E-05	3.32E-05	2.83E-05	2.56E-05	4.08E-05

Oconee Nuclear Station 2022 ARERR Attachment 1 Page 1-9 as submitted:

B. Tritium						
H-3	Ci	6.55E+02	3.53E+02	2.43E+02	2.53E+02	1.50E+03

Oconee Nuclear Station 2022 ARERR Attachment 1 Page 1-9 Amendment #1 as revised:

B. Tritium						
H-3	Ci	6.45E+02	2.82E+02	2.43E+02	2.20E+02	1.39E+03

Oconee Nuclear Station 2022 ARERR Attachment 6 Page 6-3 as submitted:

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

Attachment 12
Errata to a Previous Year's ARERR

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2023 - 12/31/2023

Oconee Nuclear Station 2022 ARERR Attachment 6 Page 6-3 Amendment #1 as revised:

A. Batch & Continuous Mode

1.	Maximum Organ Dose	mREM	8.93E-02	3.90E-02	3.37E-02	3.04E-02	1.92E-01
(e)	Limit	mREM	1.50E+01	1.50E+01	1.50E+01	1.50E+01	3.00E+01
(f)	% of Limit		5.95E-01	2.60E-01	2.24E-01	2.03E-01	6.41E-01
(g)	Critical Age		Child	Child	Child	Child	Child
(h)	Critical Organ		GI-Lli	GI-Lli	Liver	GI-Lli	GI-Lli
2.	Maximum Total Body Dose	mREM	8.93E-02	3.90E-02	3.37E-02	3.04E-02	1.92E-01
(d)	Limit	mREM	4.50E+00	4.50E+00	4.50E+00	4.50E+00	9.00E+00
(e)	% of Limit		1.98E+00	8.66E-01	7.48E-01	6.76E-01	2.14E+00
(f)	Critical Age		Child	Child	Child	Child	Child

Oconee Nuclear Station 2022 ARERR Attachment 6 Page 6-4 as submitted:

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%

Oconee Nuclear Station 2022 ARERR Attachment 6 Page 6-4 Amendment #1 as revised:

B. Maximum Total Body Dose	2.868E-01 mrem
1. Location	1.0 miles SW
2. Critical Age	Child
3. Gas non-NG Contribution %	32.828%
4. Gas Contribution %	0.121%
5. Liquid Contribution %	67.051%

Attachment 12
Errata to a Previous Year's ARERR

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2023 - 12/31/2023

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	6.45E+02	2.82E+02	2.43E+02	2.20E+02	1.39E+03
2. Avg. Diluted Conc	µCi/ml	7.69E-05	3.32E-05	2.84E-05	2.56E-05	4.09E-05
3. Batch Releases	µCi/ml	7.69E-05	3.32E-05	2.83E-05	2.56E-05	4.08E-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 12
Errata to a Previous Year's ARERR

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2023 - 12/31/2023

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	6.45E+02	2.82E+02	2.43E+02	2.20E+02	1.39E+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 12
Errata to a Previous Year's ARERR

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2023 - 12/31/2023

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	8.93E-02	3.90E-02	3.37E-02	3.04E-02	1.92E-01
(i) Limit	mREM	1.50E+01	1.50E+01	1.50E+01	1.50E+01	3.00E+01
(j) % of Limit		5.95E-01	2.60E-01	2.24E-01	2.03E-01	6.41E-01
(k) Critical Age		Child	Child	Child	Child	Child
(l) Critical Organ		GI-Lli	GI-Lli	Liver	GI-Lli	GI-Lli
2. Maximum Total Body Dose	mREM	8.93E-02	3.90E-02	3.37E-02	3.04E-02	1.92E-01
(g) Limit	mREM	4.50E+00	4.50E+00	4.50E+00	4.50E+00	9.00E+00
(h) % of Limit		1.98E+00	8.66E-01	7.48E-01	6.76E-01	2.14E+00
(i) Critical Age		Child	Child	Child	Child	Child

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

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	2.868E-01 mrem
1. Location	1.0 miles SW
2. Critical Age	Child
3. Gas non-NG Contribution %	32.828%
4. Gas Contribution %	0.121%
5. Liquid Contribution %	67.051%

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.

ENCLOSURE 6: RNP Annual Radioactive Effluent Release Report

H.B. Robinson Steam Electric Plant
Unit 2

Annual Radioactive Effluent Release Report

January 1, 2023 through December 31, 2023

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 1/1/2023 - 12/31/2023

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	4.86E-02	4.64E-02	4.25E-02	5.30E-02	1.91E-01
2. Avg. Release Rate	μCi/sec	6.25E-03	5.90E-03	5.35E-03	6.67E-03	6.04E-03
B. Iodine-131						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Release Rate	μCi/sec	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C. Particulates Half-Life ≥ 8 days						
1. Total Release	Ci	1.10E-07	5.94E-08	0.00E+00	0.00E+00	1.69E-07
2. Avg. Release Rate	μCi/sec	1.41E-08	7.56E-09	0.00E+00	0.00E+00	5.42E-09
D. Tritium						
1. Total Release	Ci	3.10E-01	7.98E-01	1.08E+00	9.03E-01	3.09E+00
2. Avg. Release Rate	μCi/sec	3.99E-02	1.01E-01	1.36E-01	1.14E-01	9.77E-02
E. Carbon-14						
1. Total Release	Ci	2.21E+00	2.24E+00	2.26E+00	2.26E+00	8.97E+00
2. Avg. Release Rate	μCi/sec	2.80E-07	2.84E-07	2.87E-07	2.87E-07	2.84E-07
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 1/1/2023 - 12/31/2023

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 1/1/2023 - 12/31/2023

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 1/1/2023 - 12/31/2023

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	0.00E+00	0.00E+00
Xe-133	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
B. Iodines						
None	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C. Particulates Half-Life ≥ 8 days						
Co-56	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
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
D. Tritium						
H-3	Ci	2.60E-01	6.13E-01	8.26E-01	6.93E-01	2.39E+00
E. Carbon-14						
C-14	Ci	1.36E+00	1.38E+00	1.39E+00	1.39E+00	5.53E+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 1/1/2023 - 12/31/2023

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	4.82E-02	4.63E-02	4.20E-02	5.19E-02	1.88E-01
Xe-131m	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xe-133m	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xe-133	Ci	4.29E-04	1.38E-04	5.69E-04	1.10E-03	2.24E-03
Xe-135	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total for Period	Ci	4.86E-02	4.64E-02	4.26E-02	5.30E-02	1.91E-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	0.00E+00	0.00E+00
Co-58	Ci	1.10E-07	5.94E-08	0.00E+00	0.00E+00	1.69E-07
Co-60	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zr-95	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-95	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total for Period	Ci	1.10E-07	5.94E-08	0.00E+00	0.00E+00	1.69E-07
D. Tritium						
H-3	Ci	5.03E-02	1.85E-01	2.54E-01	2.11E-01	7.00E-01
E. Carbon-14						
C-14	Ci	8.47E-01	8.57E-01	8.67E-01	8.67E-01	3.42E+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 1/1/2023 - 12/31/2023

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	2.33E-03	4.33E-04	5.81E-04	5.38E-03	8.72E-03
2. Avg. Diluted Conc.	μCi/ml	1.08E-11	1.82E-12	2.15E-12	2.20E-11	9.19E-12
B. Tritium						
1. Total Release	Ci	5.02E+00	6.92E+01	4.59E+01	7.35E+00	1.27E+02
2. Avg. Diluted Conc.	μCi/ml	2.33E-08	2.91E-07	1.69E-07	3.00E-08	1.28E-07
C. Dissolved & Entrained Gases						
1. Total Release	Ci	4.63E-06	2.88E-06	1.39E-05	0.00E+00	2.14E-05
2. Avg. Diluted Conc.	μCi/ml	2.15E-14	1.21E-14	5.12E-14	0.00E+00	2.12E-14
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	7.49E+05	2.55E+05	1.48E+05	7.74E+04	1.23E+06
F. Volume of Dilution Water						
1. Total	liters	2.15E+11	2.38E+11	2.71E+11	2.45E+11	9.69E+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 1/1/2023 - 12/31/2023

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	6.06E-03	0.00E+00	0.00E+00	0.00E+00	6.06E-03
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 1/1/2023 - 12/31/2023

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	0.00E+00	0.00E+00
Mn-54	Ci	5.32E-06	0.00E+00	0.00E+00	1.55E-05	2.08E-05
Fe-55	Ci	8.49E-04	1.40E-04	1.79E-04	4.45E-03	5.62E-03
Fe-59	Ci	1.25E-05	0.00E+00	0.00E+00	0.00E+00	1.25E-05
Co-57	Ci	1.58E-06	1.02E-06	6.08E-07	7.82E-06	1.10E-05
Co-58	Ci	9.29E-04	1.70E-04	7.80E-05	2.58E-04	1.44E-03
Co-60	Ci	1.47E-04	5.50E-05	3.84E-05	1.92E-04	4.32E-04
Ni-63	Ci	2.97E-04	6.22E-05	1.08E-04	4.43E-04	9.10E-04
Ni-65	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zn-65	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-90	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zr-95	Ci	2.53E-05	0.00E+00	0.00E+00	0.00E+00	2.53E-05
Nb-95	Ci	4.95E-05	0.00E+00	0.00E+00	0.00E+00	4.95E-05
Ru-105	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ag-110m	Ci	6.56E-06	4.87E-07	0.00E+00	0.00E+00	7.05E-06
Sn-117m	Ci	8.88E-07	0.00E+00	0.00E+00	0.00E+00	8.88E-07
Sb-124	Ci	0.00E+00	0.00E+00	9.61E-06	0.00E+00	9.61E-06
Sb-125	Ci	5.18E-06	2.93E-06	1.67E-04	1.35E-05	1.89E-04
Te-123m	Ci	9.11E-07	0.00E+00	0.00E+00	0.00E+00	9.11E-07
Ba-142	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cs-137	Ci	0.00E+00	0.00E+00	0.00E+00	5.16E-06	5.16E-06
Ce-144	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.76E-06
Ba-133	Ci	1.71E-06	1.10E-06	0.00E+00	0.00E+00	2.81E-06
W-187	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total for Period	Ci	2.33E-03	4.33E-04	5.81E-04	5.38E-03	8.73E-03
B. Tritium						
H-3	Ci	5.01E+00	6.92E+00	4.59E+01	7.35E+00	6.52E+01
C. Dissolved & Entrained Gases						
Xe-133m	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xe-133	Ci	4.63E-06	2.88E-06	1.39E-05	0.00E+00	1.18E-02
Xe-135	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total for Period	Ci	4.63E-06	2.88E-06	1.39E-05	0.00E+00	1.18E-02
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 1/1/2023 - 12/31/2023

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	=	20	8
2. Total Time (min) for Batch Releases	=	3.92E+03	1.54E+03
3. Maximum Time (min) for a Batch Release	=	2.91E+02	2.33E+02
4. Average Time (min) for Batch Releases	=	1.96E+02	1.93E+02
5. Minimum Time (min) for a Batch Release	=	7.10E+01	1.40Ee+02
6. Average Dilution Water Flow During Release (gpm)	=	3.40E+05	3.62E+05

B. Gaseous Effluents		**Jan - Jun**	**Jul - Dec**
1. Total Number of Batch Releases	=	54	52
2. Total Time (min) for Batch Releases	=	5.06E+04	1.89E+04
3. Maximum Time (min) for a Batch Release	=	1.01E+04	6.46E+02
4. Average Time (min) for Batch Releases	=	9.37E+02	3.64E+02
5. Minimum Time (min) for a Batch Release	=	2.38E+02	3.40E+01

VI. Abnormal Releases

See Attachment 5, Unplanned Offsite Releases.

Attachment 2
Supplemental Information

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2023 - 12/31/2023

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 2023 ARERR contains estimates of C-14 radioactivity released in 2023 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 2023 ARERR, a source term scaling factor using actual EFPD of 358.96 days is assumed. Using the source term scaling factor from H.B. Robinson Steam Electric Plant in 2023 results in a site total C-14 gaseous release estimate to the environment of 8.974 Curies, 3.442 Curies in batch mode and 5.532 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 2023 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 2023 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 2023*". Using the methodology described in ODCM 2.5.3, the following is a summary of tritium activity released through evaporation and resulting dose for 2023.

	Units	Year
1. H-3 Activity Released	Ci	2.41E+01
2. H-3 Dose	mREM	1.30E-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 2023, 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 2023.

	Units	Year
1. Avg. H-3 Concentration	ρCi/L	1.43E+03
2. H-3 Dose	mREM	3.16E-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).*

Attachment 2
Supplemental Information

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2023 - 12/31/2023

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 1/1/2023 - 12/31/2023

Summary of Changes in Land Use Census Affecting Effluent Dose Calculations

The 2023 Land Use Census was performed June 26, 2023-June 27, 2023, and the results were certified and made available for use on July 31, 2023. 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 2023 LUC.

Gardens

- The garden in the N sector (4.48 miles) was replaced with a new garden at 3.82 miles.
- The garden in the E sector (2.94 miles) was replaced with a new garden at 2.09 miles.

Meat Animals

NOTE: Meat animals were only identified at the nearest garden or closer in each sector.

- The meat animal in the SE sector (1.96 miles) was not present during the 2023 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 2023 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 1/1/2023 - 12/31/2023

	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	1	1	A	10-160 Poly HIC	N/A	2.83	3.8
	c. Evaporator Concentrates	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	d. Dewatered Mechanical Filters	2	2	C	10-160 Poly HIC	N/A	1.31	23.1
	e. Dewatered Demineralizers	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	f. Solidified (cement) Acids, Oils, Sludge	1	2	A	55 Gallon Drum	N/A	0.34	0.000407
	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)	3	5	A	20’ Sealand, Metal Box	N/A	120	0.0836
	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**	6	8	N/A	N/A	N/A	124.48	26.98

Attachment 3
Solid Radioactive Waste Disposal

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2023 - 12/31/2023

	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	0.67
		C-14	1.32
		Mn-54	0.51
		Fe-55	17.18
		Fe-59	0.02
		Co-57	0.32
		Co-58	36.7
		Co-60	8.75
		Ni-59	0.15
		Ni-63	33.75
		Zn-65	0.07
		Zr-95	0.02
		Nb-95	0.05
		Tc-99	0.01
		Ag-110m	0.07
		Sb-124	0.07
		Sb-125	0.28
		Cs-137	0.02
		Ce-144	0.05
	c. Evaporator Concentrates	N/A	N/A
	d. Dewatered Mechanical Filters*	H-3	0.34
		C-14	5.8
		Cr-51	0.46
		Mn-54	0.76
		Fe-55	16.36
		Fe-59	0.17
		Co-57	0.34
		Co-58	28.36
		Co-60	21.66
		Ni-59	0.01
		Ni-63	18.84
		Zn-65	0.08
		Zr-95	1.61
		Nb-95	4.21
		Tc-99	0.04
		Ag-110m	0.34
		Sb-124	0.07
		Sb-125	0.29
		Cs-137	0.11
		Ce-144	0.15
	e. Dewatered Demineralizers	N/A	N/A
	f. Solidified (cement) Acids, Oils, Sludge*	H-3	99.0
		Mn-54	0.01
		Co-60	0.93
		Ag-108m	0.04
		Cs-137	0.03

Attachment 3
Solid Radioactive Waste Disposal

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2023 - 12/31/2023

2.

a.	Dry Active Waste (compacted)*	C-14	1.22
		Cr-51	5.41
		Mn-54	0.41
		Fe-55	0.19
		Fe-59	0.03
		Co-58	44.95
		Co-60	2.77
		Ni-63	0.08
		Zr-95	17.43
		Nb-95	26.77
		Ag-110m	0.01
		Cs-137	0.15
		Ce-144	0.58
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) at the lower level.

Attachment 4
Meteorological Data

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2023 - 12/31/2023

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	1	0	0	0	0	0	0	0	0	0	0
	3.51-7.50	0	1	2	3	7	2	6	17	13	24	23	21	17	2	1	0
	7.51-12.50	0	0	0	0	0	0	0	2	7	4	20	11	1	4	1	3
	12.51-18.50	0	0	0	0	0	0	0	0	0	0	0	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
B	0.75-3.50	0	0	0	0	3	3	6	3	3	3	1	2	3	0	0	1
	3.51-7.50	7	8	20	12	3	2	6	28	21	29	40	44	32	8	3	2
	7.51-12.50	8	6	1	0	0	0	0	1	2	9	32	7	0	4	8	6
	12.51-18.50	0	0	0	0	0	0	0	0	0	0	0	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	0	1	1	17	14	17	27	11	6	6	11	10	17	7	0	1
	3.51-7.50	30	30	29	16	10	2	7	19	20	29	48	28	27	27	12	9
	7.51-12.50	16	8	2	0	0	0	0	0	3	8	13	2	3	3	2	18
	12.51-18.50	1	0	0	0	0	0	0	0	0	1	2	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
D	0.75-3.50	37	71	127	106	89	69	92	72	50	54	46	56	61	36	32	34
	3.51-7.50	215	405	159	79	35	5	9	104	150	86	99	64	66	47	58	89
	7.51-12.50	64	142	3	0	0	0	0	2	11	33	42	5	2	5	11	45
	12.51-18.50	6	5	0	0	0	0	0	0	1	3	4	0	0	0	0	11
	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

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2023 - 12/31/2023

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	75	52	60	49	42	14	20	77	204	157	132	136	80	55	56	63
	3.51-7.50	83	20	15	8	10	1	2	52	145	107	68	52	24	11	44	135
	7.51-12.50	1	1	0	0	0	0	0	1	15	21	25	2	1	2	4	32
	12.51-18.50	0	0	0	0	0	0	0	0	1	0	0	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
F	0.75-3.50	25	16	3	3	1	4	6	47	98	83	92	79	39	40	65	79
	3.51-7.50	4	0	0	1	0	0	0	1	5	1	2	0	1	0	22	50
	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	35	6	6	2	2	1	9	27	63	56	42	48	44	60	165	144
	3.51-7.50	3	0	1	0	0	0	0	0	0	0	0	0	0	0	1	14
	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 1/1/2023 - 12/31/2023

H.B. Robinson Steam Electric Plant had zero (0) unplanned liquid release in 2023.

H.B. Robinson Steam Electric Plant had zero (0) unplanned gaseous release in 2023.

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 1/1/2023 - 12/31/2023

Gaseous Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Noble Gases						
1. Maximum Gamma Air	mRAD	1.15E-03	1.10E-03	1.00E-03	1.24E-03	4.49E-03
(a) Limit	mRAD	5.00	5.00	5.00	5.00	10.00
(b) % of Limit		2.30E-02	2.20E-02	2.00E-02	2.48E-02	4.49E-02
2. Maximum Beta Air	mRAD	4.06E-04	3.89E-04	3.54E-04	4.39E-04	1.59E-03
(a) Limit	mRAD	10	10	10	10	20
(b) % of Limit		4.06E-03	3.89E-03	3.54E-03	4.39E-03	7.94E-03

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	1.51E-01	1.52E-01	1.54E-01	1.54E-01	6.11E-01
(a) Limit	mREM	7.5	7.5	7.5	7.5	15
(b) % of Limit		2.01E+00	2.03E+00	2.05E+00	2.05E+00	4.07E+00

Receptor Location ***0.42*** km ***SSE***
Critical Age ***CHILD***
Critical Organ ***BONE***

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2023 - 12/31/2023

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Batch & Continuous Mode						
1. Maximum Organ Dose	mREM	8.96E-04	1.83E-04	1.20E-04	7.09E-05	1.27E-03
(a) Limit	mREM	5	5	5	5	10
(b) % of Limit		1.79E-02	3.66E-03	2.40E-03	1.42E-03	1.27E-02
2. Maximum Total Body Dose	mREM	2.91E-05	1.77E-04	1.17E-04	6.59E-05	3.89E-04
(a) Limit	mREM	1.5	1.5	1.5	1.5	3
(b) % of Limit		1.94E-03	1.18E-02	7.80E-03	4.39E-03	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 1/1/2023 - 12/31/2023

40 CFR Part 190 Uranium Fuel Cycle Dose Calculation Results

In accordance with the requirements of 40 CFR Part 190, the annual dose commitment to any member of the general public shall be calculated to assure that doses are limited to 25 millirems to the total body or any organ with the exception of the thyroid which is limited to 75 millirems. The fuel cycle dose assessment for 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)	6.11E-01
5. Total Body Dose (mREM)	1.65E-01
B. Liquid Effluent Dose	
1. Location	6.76 km NE
2. Critical Age	ADULT
3. Critical Organ	GI-LLI
4. Organ Dose (mREM)	1.27E-03
5. Total Body Dose (mREM)	3.89E-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)	1.30E-01
5. Total Body Dose (mREM)	1.30E-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)	3.16E-03
5. Total Body Dose (mREM)	3.16E-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 1/1/2023 - 12/31/2023

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 6.11E-01 mrem/yr based on 8.974 Curies released in 2023 (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 2023, 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 1/1/2023 - 12/31/2023

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 2023. 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 2023. There were no anomalous results identified in 2023.

Results from sampling during 2023 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 2023. 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 1/1/2023 - 12/31/2023

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	3.00E+02	NS	2.78E+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 - 20 ft from FP/FH 7 fire hydrant & U/1 North Deep Well Pump	NS	<MDA	NS	<MDA	2
R73	MW-13 - 0.11 miles ENE - Between Discharge Canal & U/1 Stand Alone Fuel Oil Tanks	7.34E+02	4.31E+02	6.13E+02	4.60E+02	4
R75	PSW-02 - 0.05 miles NE - By U/1 boundary fence to U/2 across paved Rd	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	<MDA	<MDA	4
R78	TS-02C - 0.17 miles SSE - Northeast corner by East Settling Pond influent by fence	NS	<MDA	NS	<MDA	2
R79	TS-07C - 1.0 miles N - South corner by cove & Discharge Canal	<MDA	<MDA	<MDA	<MDA	4
R81	TS-17B - 0.19 miles SSE - West of West Settling Pond across paved road	<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	1.99E+02	<MDA	<MDA	<MDA	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	3.33E+02	3.90E+02	4.07E+02	3.51E+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	1.91E+02	<MDA	<MDA	<MDA	4
RMW-103S	MW-103S - Robinson Monitoring Well	<MDA	<MDA	<MDA	<MDA	4
RMW-104	MW-104 - Robinson Monitoring Well	<MDA	<MDA	<MDA	<MDA	4
RMW-105	MW-105 - Robinson Monitoring Well	<MDA	<MDA	<MDA	<MDA	4
RMW-106	MW-106 - Robinson Monitoring Well	3.05E+03	6.15E+03	1.28E+03	1.32E+03	4
RMW-107	MW-107 - Robinson Monitoring Well	<MDA	<MDA	<MDA	<MDA	4
RMW-108	MW-108 - Robinson Monitoring Well	1.20E+03	1.57E+03	1.22E+03	8.54E+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	<MDA	<MDA	<MDA	<MDA	4
RMW4RASH	MW-4R (NPDES) ASH - Robinson	NS	<MDA	NS	<MDA	2
RMW5ASH	MW-5 (NPDES) ASH- Robinson	<MDA	<MDA	<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	3.08E+02	<MDA	6.96E+02	6.52E+02	4
RP2	P2 (South of discharge canal) - Robinson Monitoring Well	<MDA	<MDA	<MDA	<MDA	4

H.B. Robinson Steam Electric Plant Unit 2
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RPSW04	PSW-04	<MDA	<MDA	<MDA	<MDA	4
RPSW05	SW of Plant, grassed area on Entrance Road at road for Unit 1 access (Background Well)	NS	<MDA	NS	<MDA	2
RTS04B	RTS04B	NS	<MDA	NS	<MDA	2
U1SDEEP	Unit 1 South Deep Well	2.84E+02	NS	2.55E+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 1/1/2023 - 12/31/2023

H.B. Robinson Steam Electric Plant experienced one (1) instance of inoperable equipment relevant to effluent monitoring in excess of ODCM/TRMS limits during 2023. 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 2023.

ODCM # or TRMS #	Title	Completion Time	Description
ODCM Table 3.10-1 Item 5.a."	R-22 E&RC Building Exhaust Radiation Monitor	30 Days	NCR 02489379 : R-22, E&RC Building Exhaust Monitor, was not restored to a functional status within 30 days as required by ODCM Table 3.10-1 Item 5.a. This 30-day time limit was exceeded on 10/4/2023. The monitor was removed from service on 9/5/2023 due to R-22 power supply failure. The monitor was unable to be returned to service within the 30-day requirement due to extensive lead times for replacement parts needed to repair monitor. 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. R-22 was returned to service 10/25/2023 following repairs and successful channel functional test and source check.
ODCM Table 3.10-1 Item 1. f."	F-14, Plant Vent Sampler Flow Rate Monitor	30 Days	NCR 02496584: F-14, Plant Vent Flow Monitor, was not restored to a functional status within 30 days as required by ODCM Table 3.10-1 Item 1.f. This 30-day time limit was exceeded on 12/02/2023. The monitor was removed from service on 11/02/2023 due to F-14 flow sensor failures. The monitor was unable to be returned to service within the 30-day requirement due to extensive lead times for replacement parts needed to repair monitor. Effluent releases via this pathway may continue provided that flow estimates are performed once per 4 hours

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 1/1/2023 - 12/31/2023

SUMMARY OF CHANGES

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 (see 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 38

Docket Number: 50-261

Effective Date: 3/30/2023

Prepared By: Chase Gainey RNP Chemistry	DRR 02448739-06	3/1/2023
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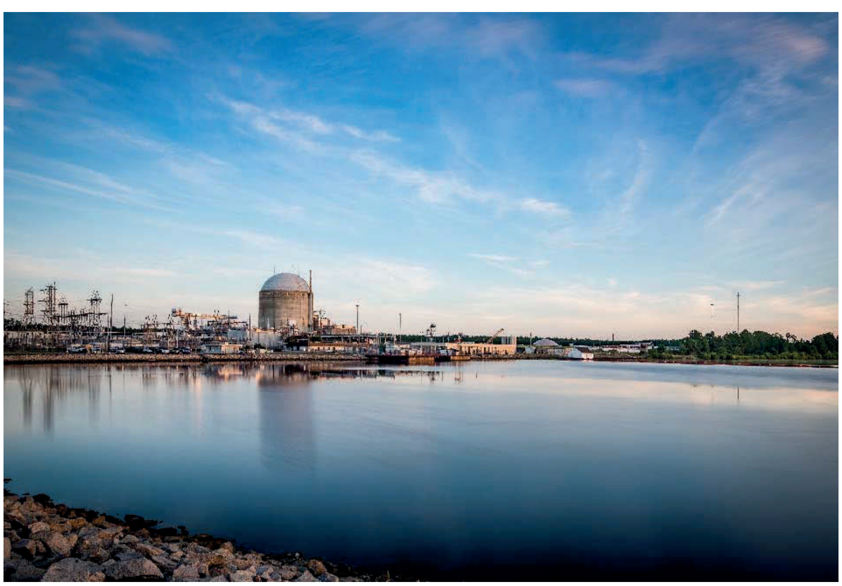
Reviewed By: Catherine Kemmerlin RNP Chemistry	DRR 02448739-03	3/29/2023
	Signature	**Date**
Reviewed By (Print): Michael Classe	DRR 02448739-04	3/30/2023
RNP ORC Chairman/Designee	**Signature**	**Date**
Approved By: Rory Frederick RNP Plant Manager/Designee	DRR 02448739-04	3/30/2023
	Signature	**Date**



LIST OF EFFECTIVE PAGES

Effective Pages	**Revision**
All	38

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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 (dimensionless).
	=	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 <u>Setpoint Based on an Analysis of Liquid Prior to Discharge.</u>

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:

$$Conc_i = \frac{C_{ic} * V_c}{V_{dc}} \qquad (2.3\text{-}1)$$

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:

$$Conc_i = \frac{C_{ib} * R_b}{D_{fr} * T_m} \quad (2.3\text{-}2)$$

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:

$$\sum_i \frac{Conc_i}{10 * EC_i} \leq 1$$

(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:

$$Conc_i = \frac{(C_{ib} * R_b) + (C_{ic} * R_c)}{D_{fr} * \sum T_m}$$

(2.3-4)

where:

R_c = Maximum continuous liquid effluent release rate (gpm).

ΣT_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 shoreline 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:

$$A_{i\tau} = (1.14x10^5 * 21 * BF_i * DF_{i\tau}) + \left[1.14x10^5 * 100 * 12 * 0.3 * T_i * e^{-\lambda_i * t_p} * \left(1 - e^{-\lambda_i * t_b}\right) * DFG_i\right] \quad (2.5\text{-}2)$$

Note: Some Ait values for radionuclides not in Regulatory Guide 1.109 were developed using Equation 2.5-2, but with parameters as described in CSD-RP-ALL-0028.

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:

$$PD = \frac{92 * (DA + DB)}{TE} + M \tag{2.5-8}$$

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

$$D_\tau = 3.17x10^{-8} * \left(R_{T_B} + R_{T_I} + R_{T_V}\right) * \sum_{i=1}^{5}\left[\left(\overline{\chi/Q}\right)_i * Q_i\right] \tag{2.5-9}$$

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	7.02E+02	4.48E+01	2.98E+02	3.37E+01	3.21E+01	5.54E+02	1.91E+04	3.70E+01
SB-125	5.54E+02	1.30+02	2.27E+02	1.26E+02	1.25E+02	4.56E+02	4.84E+03	1.41E+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

Note: Some Ait values for radionuclides not in Regulatory Guide 1.109 were developed using Equation 2.5-2, but with parameters as described in CSD-RP-ALL-0028.

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 functional 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 functional, 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 functionality 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	MCF*	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 functional less than the MCF requirements: a. Exert best efforts to return the instruments to functional status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the non-functionality 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 functional less than the MCF requirement: a. Exert best efforts to return the instruments to functional status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the non-functionality 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.

*MCF - Minimum Channels Functional

TABLE 2.6-1 (continued)
RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

Release Pathway / Instrumentation	MCF*	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 functional less than the MCF requirement: a. Exert best efforts to return the instruments to functional status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the non-functionality 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 functional less than the MCF requirement due to non-functional equipment: a. Exert best efforts to return the instruments to functional status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the non-functionality was not corrected in a timely manner in accordance with Technical Specification 5.6.3 **AND**, With the number of channels functional less than the MCF requirement due to non-functional 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.

*MCF - Minimum Channels Functional

TABLE 2.6-1 (continued)
RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

Release Pathway/Instrumentation	MCF*	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 functional less than the MCF requirement due to non-functional equipment: a. Exert best efforts to return the instruments to functional status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the non-functionality 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 functional less than the MCF requirement suspend effluent release via this pathway.
4. Tank Level Indicating Devices		With the number of channels functional less than the MCF requirement: a. Exert best efforts to return the instruments to functional status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the non-functionality 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).
a. Refueling Water Storage Tank	1	
b. Monitor Tanks		
Tank A	1	
Tank B	1	
c. Waste Condensate Tanks		
Tank C	1	
Tank D	1	
Tank E	1	
d. Deleted		

*MCF - Minimum Channels Functional

TABLE 2.6-1 (continued)

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

Release Pathway/Instrumentation	MCF*	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 functional less than the MCF requirement: a. Exert best efforts to return the instruments to functional status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the non-functionality 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 functional less than the MCF requirement: a. Exert best efforts to return the instruments to functional status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the non-functionality 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.

*MCF - Minimum Channels Functional

TABLE 2.6-1 (continued)
RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

Release Pathway/Instrumentation	MCF*	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 functional less than the MCF requirement: a. Exert best efforts to return the instruments to functional status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the non-functionality 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.

*MCF - Minimum Channels Functional

NOTES TO TABLE 2.6-1

Note 1 Pump curves for Unit 2 operating circulating water pumps may be used to satisfy this MCF. 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 MCF.

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 functional by performance of the channel check, source check, channel calibration, and Channel Functional Test 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 Functional 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 Functional Test shall also demonstrate that automatic isolation of this pathway and Control Room alarm annunciation occur if any of the following conditions exists:

1. Instrument indicates measured levels above the alarm/trip setpoint.
2. Power failure.
3. Instrument controls not set in operate mode.

Note 5 The Channel Functional 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 non-functional, 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:

$$Q_m = \frac{500}{\left(\overline{\chi/Q}\right) * \sum_i (K_i * S_i)} \tag{3.1-2}$$

where:

$\left(\overline{\chi/Q}\right)$ = 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 $\mu Ci/m^3$).

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:

$$Q_m = \frac{3000}{\left(\overline{\chi/Q}\right) * \sum_i [(L_i + 1.11 M_i) * S_i]} \tag{3.1-3}$$

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 $\mu Ci/m^3$).

3.1.1.4 Determine the C_m, the maximum acceptable total radioactivity concentration ($\mu Ci/cm^3$) of all noble gas radionuclides in the gaseous effluent.

$$C_m = \frac{2.12x10^{-3} * Q_m}{F} * T_m * S \tag{3.1-4}$$

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.
2.12×10^{-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 Setpoint Based on Sample Analysis Prior to Release

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.

$$S_F * \sum_i \left[K_i * \left(\left(\overline{\chi/Q}\right)_v * \dot{Q}_{iv} + \left(\overline{\chi/Q}\right)_e * \dot{Q}_{ie}\right)\right] \leq 500\, mrem/yr \tag{3.3-1}$$

$$S_F * \sum_i \left[(L_i + 1.11M_i) * \left(\left(\overline{\chi/Q}\right)_v * \dot{Q}_{iv} + \left(\overline{\chi/Q}\right)_e * \dot{Q}_{ie}\right)\right] \leq 3000\, mrem/yr \tag{3.3-2}$$

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 $\mu Ci/m^3$).
$\left(\overline{\chi/Q}\right)_v$	=	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 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 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:

$$D_{\gamma} = 3.17x10^{-8} * \sum_{i} \left[M_i * \left[\left(\left(\overline{\chi/Q}\right)_v * \bar{Q}_{iv} \right) + \left(\left(\overline{\chi/q}\right)_v * \bar{q}_{iv} \right) + \left(\left(\overline{\chi/Q}\right)_e * \bar{Q}_{ie} \right) \right] \right] \tag{3.5-1}$$

$$D_{\beta} = 3.17x10^{-8} * \sum_{i} \left[N_i * \left[\left(\left(\overline{\chi/Q}\right)_v * \bar{Q}_{iv} \right) + \left(\left(\overline{\chi/q}\right)_v * \bar{q}_{iv} \right) + \left(\left(\overline{\chi/Q}\right)_e * \bar{Q}_{ie} \right) \right] \right] \tag{3.5-2}$$

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).

3.17×10^{-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 $(\overline{\chi/Q})$ 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 $(\overline{\chi/Q})$ 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.

$\left(\overline{D/q}\right)_v$ = 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.

$\left(\overline{D/Q}\right)_e$ = 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:

$$D_\tau \leq 7.5 \text{ mrem} \tag{3.5-9}$$

For the calendar year:

$$D_\tau \leq 15 \text{ mrem} \tag{3.5-10}$$

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

TABLE 3.5-11 (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 $\mu Ci/m^3$ 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 µCi/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 µCi/m^3 for inhalation and tritium, and units of m^2-mrem/yr per µCi/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 µCi/m^3 for inhalation and tritium, and units of m^2-mrem/yr per µCi/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 $\mu Ci/m^3$ 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'.

$$PDRR_j = \frac{DR_j}{1500} \qquad (3.6\text{-}2)$$

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'.

$$Maximum\ Monitor\ Setpoint\ for\ Organ\ 'j' = \frac{\sum_i C_i}{PDRR_j} * S * T_m * TL \qquad (3.6\text{-}3)$$

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'.

$$Setpoint = \left(Maximum\ Monitor\ Setpoint\ for\ Organ\ 'j'\ in\ \frac{\mu Ci}{cm^3}\right) * (Monitor\ Eff) + Bkg \qquad (3.6\text{-}4)$$

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 Deleted

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 functional 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 functional.

3.10.3 With less than the minimum number of radioactive gaseous effluent monitoring instrumentation channels functional 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 functionality 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	MCF*	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 functional less than the MCF requirements: a. Exert best efforts to return the instruments to functional status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the non-functionality 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 functional less than the MCF requirement: a. Exert best efforts to return the instruments to functional status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the non-functionality 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.

* MCF - Minimum Channels Functional

TABLE 3.10-1 (continued)
RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

Release Pathway/Instrumentation	MCF*	Compensatory Measures
1. Plant Vent (Continued)		
c. Radioiodine Sampler	1	With the number of channels functional less than the MCF requirements: a. Exert best efforts to return the instruments to functional status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the non-functionality 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 functional less than the MCF requirement: a. Exert best efforts to return the instruments to functional status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the non-functionality 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 functional less than the MCF requirement: a. Exert best efforts to return the instruments to functional status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the non-functionality 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.

* MCF - Minimum Channels Functional

TABLE 3.10-1 (continued)
RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

Release Pathway/Instrumentation	MCF*	Compensatory Measures
1. Plant Vent (Continued)		
f. Plant Vent flow rate	1	With the number of channels functional less than the MCF requirement: a. Exert best efforts to return the instruments to functional status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the non-functionality 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 functional less than the MCF requirement: a. Exert best efforts to return the instruments to functional status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the non-functionality 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 functional; 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 functional less than the MCF requirement: a. Exert best efforts to return the instruments to functional status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the non-functionality 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 functional; otherwise, suspend all releases via this pathway. (note 2)

* MCF - Minimum Channels Functional

TABLE 3.10-1 (continued)
RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

Release Pathway/Instrumentation	MCF*	Compensatory Measures
2. Containment Vessel via Plant Vent (Continued)		
c. Sampler flow rate monitor (R-11)	1	With the number of channels functional less than the MCF requirement: a. Exert best efforts to return the instruments to functional status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the non-functionality 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 functional 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 functional less than the MCF requirement: a. Exert best efforts to return the instruments to functional status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the non-functionality 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 functional less than the MCF requirement: a. Exert best efforts to return the instruments to functional status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the non-functionality 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.

* MCF - Minimum Channels Functional

TABLE 3.10-1 (continued)

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

Release Pathway/Instrumentation	MCF*	Compensatory Measures
3. Fuel Handling Building Lower Level Exhaust Vent (continued)		
c. Radioiodine sampler	1	With the number of channels functional less than the MCF requirements: a. Exert best efforts to return the instruments to functional status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the non-functionality 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 functional less than the MCF requirement: a. Exert best efforts to return the instruments to functional status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the non-functionality 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)

* MCF - Minimum Channels Functional

TABLE 3.10-1 (continued)

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

Release Pathway/Instrumentation	MCF*	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 functional less than the MCF requirement: a. Exert best efforts to return the instruments to functional status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the non-functionality 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 functional, 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 functional less than the MCF requirement: a. Exert best efforts to return the instruments to functional status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the non-functionality 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.

* MCF - Minimum Channels Functional

TABLE 3.10-1 (continued)
RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

Release Pathway/Instrumentation	MCF*	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 functional less than the MCF requirement: a. Exert best efforts to return the instruments to functional status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the non-functionality 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 functional less than the MCF requirements: a. Exert best efforts to return the instruments to functional status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the non-functionality 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 functional less than the MCF requirements: a. Exert best efforts to return the instruments to functional status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the non-functionality 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)

* MCF - Minimum Channels Functional

TABLE 3.10-1 (continued)

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

Release Pathway/Instrumentation	MCF*	Compensatory Measures
5. E&RC Building Exhaust (Continued)		
d. Sampler flow rate gauge	1	With the number of channels functional less than the MCF requirement: a. Exert best efforts to return the instruments to functional status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the non-functionality 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 functional less than the MCF requirements: a. Exert best efforts to return the instruments to functional status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the non-functionality 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 functional less than the MCF requirements: a. Exert best efforts to return the instruments to functional status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the non-functionality 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)

* MCF - Minimum Channels Functional

TABLE 3.10-1 (continued)
RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

Release Pathway/Instrumentation	MCF*	Compensatory Measures
6. Radwaste Building Exhaust (Continued) c. Sampler flow rate gauge	1	With the number of channels functional less than the MCF requirement: a. Exert best efforts to return the instruments to functional status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the non-functionality 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

* MCF - Minimum Channels Functional

NOTES TO TABLE 3.10-1

Note 1 - No auxiliary sampling is required for periods when normal sampling is off ≤ 45 minutes.

Note 2 - This MCF 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 functional by performance of the channel check, source check, channel calibration, and Channel Functional 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 Functional 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 Functional Test shall also demonstrate that automatic isolation of this pathway and control room alarm annunciation occur if any of the following conditions exists:

1. Instrument indicates measured levels above the alarm/trip setpoint.
2. Power failure.
3. Channel Fail Alarm.

Note 6 The Channel Functional 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 $\leq$ 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 functional 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.

$$X_S = 3.17x10^4 * Q_{SY} * \left(\overline{\chi/q}\right)_v \quad (3.16\text{-}1)$$

where:

Xs Building	=	The annual average ground-level concentration of C-14 in air from short term mixed mode WGDT and Containment releases (pCi/m^3).
$\left(\overline{\chi/q}\right)_v$ mixed	=	Annual average relative concentration for the short term 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.

$$X_L = 3.17x10^4 * Q_{LY} * \left(\overline{\chi/Q}\right)_v \qquad (3.16\text{-}2)$$

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.

= $Q_L * \frac{\text{EFPD}}{292}$

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.	<u>Radioiodine Canister:</u> I-131 analysis weekly. <u>Particulate Sampler:</u> 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
	5.	East Shore of lake near Johnson's Landing 0.9 miles ENE		Weekly	Gross Beta[3]
	6.	Information Center 0.2 miles SSW		Quarterly	Gamma Scan[4] of composite (by location)
	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.	Duke Energy 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
	52.	10 miles W, near Bethune (Control Station for Broad-leaf Vegetation).			
	86.	NNE Close to Site Boundary[9]			
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 86 and 50 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

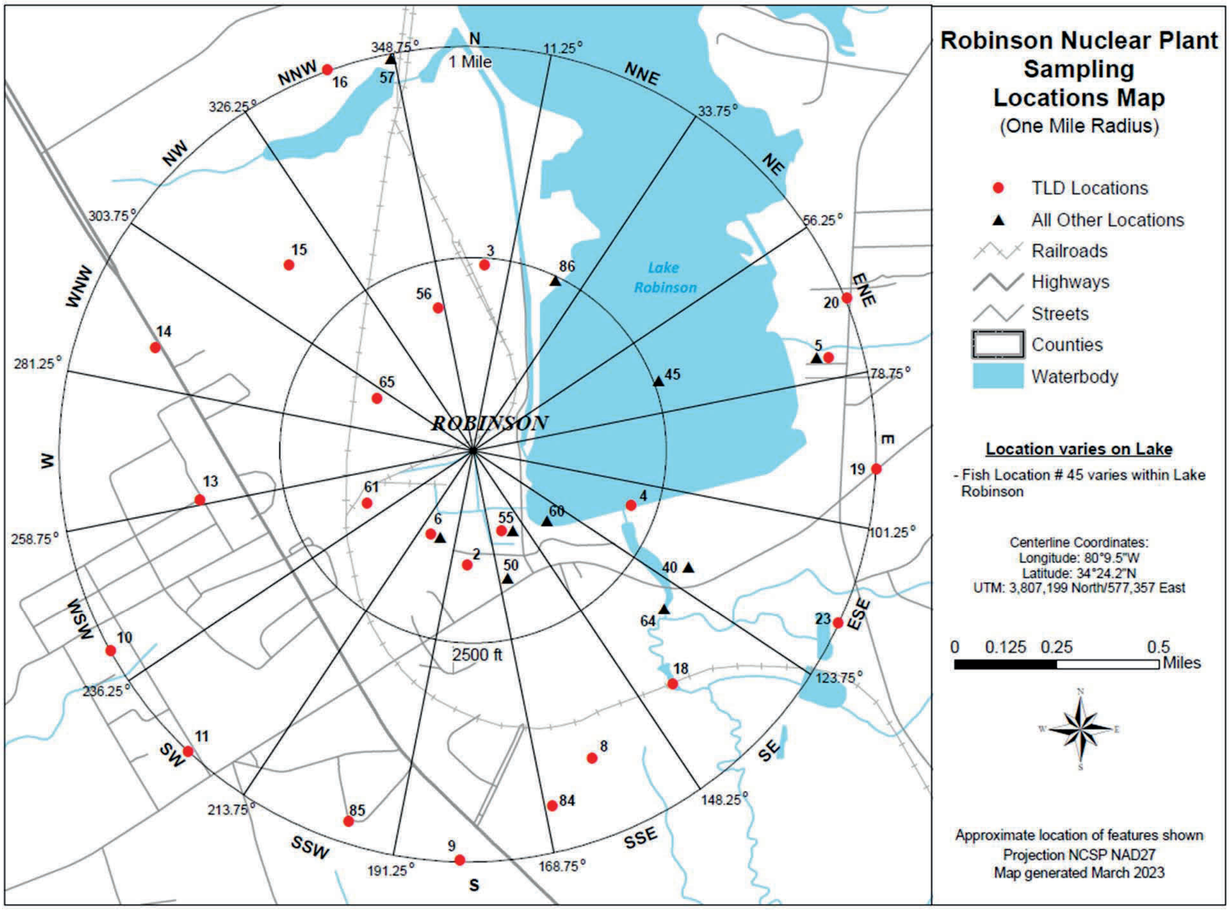


FIGURE 4-2

RADIOLOGICAL SAMPLE LOCATIONS WITHIN 10 MILES

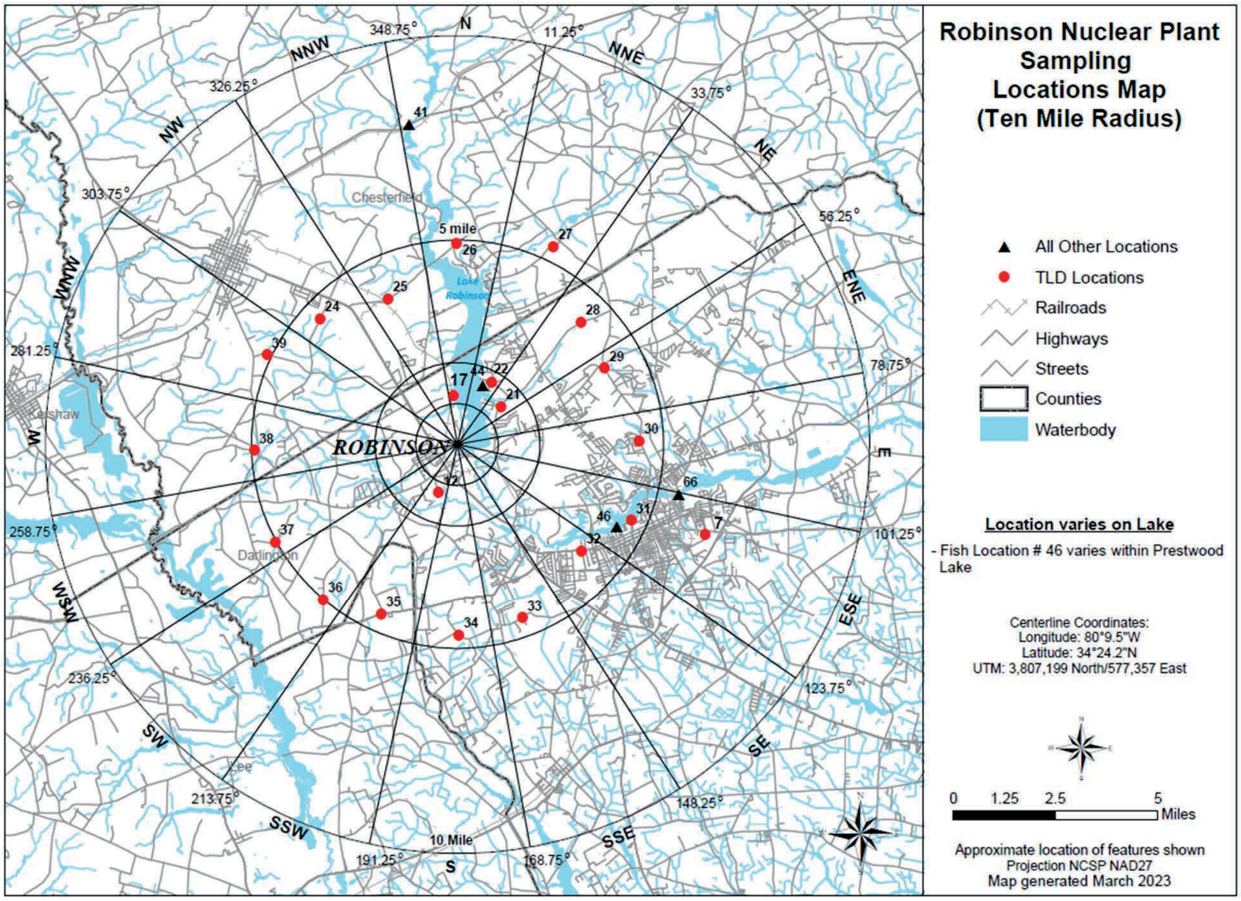
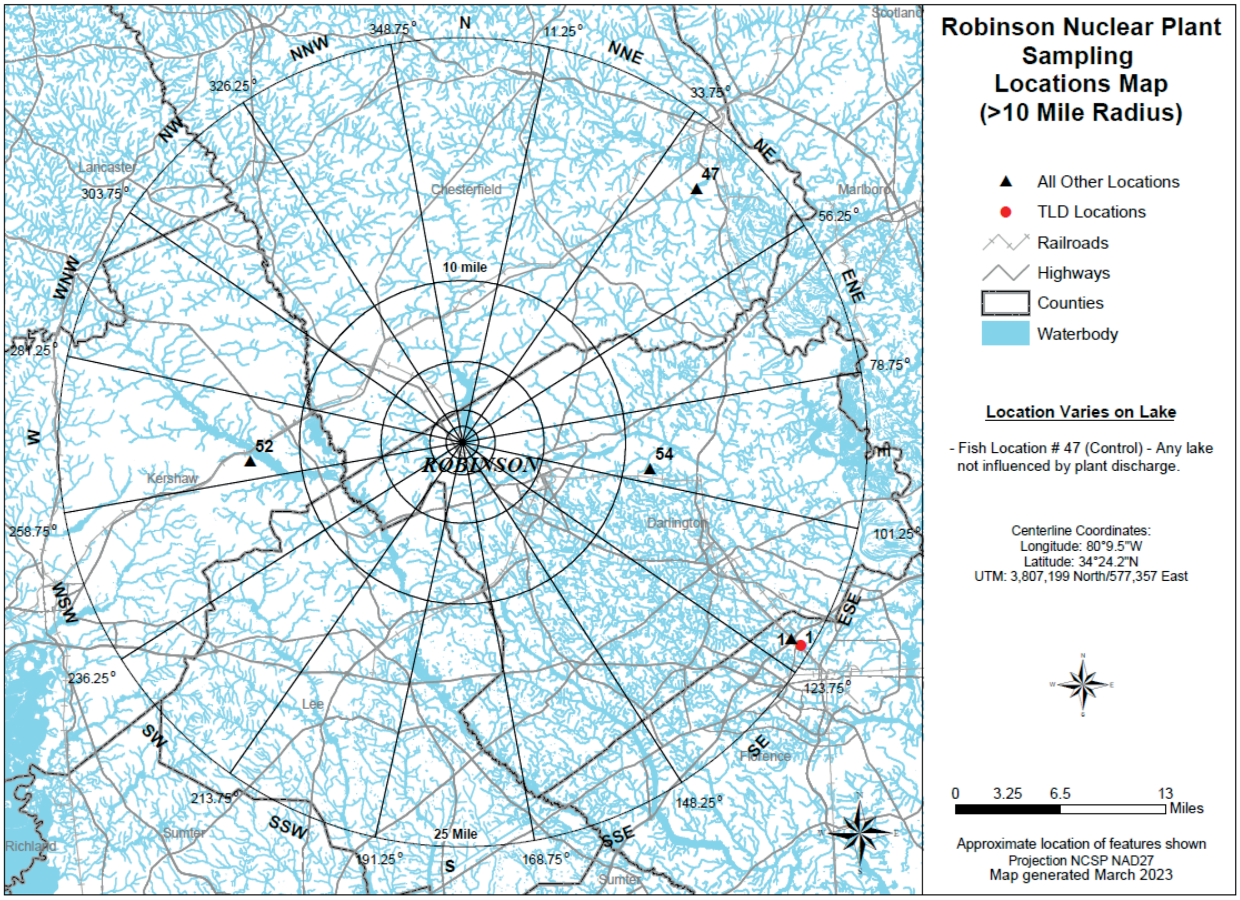


FIGURE 4-3

RADIOLOGICAL SAMPLE LOCATIONS > 10 MILES



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.

   (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 Functional - Functionality

An attribute of Structures, Systems, and Components (SSCs) FUNCTIONALITY that is not controlled by Technical Specifications. An SSC not controlled by Technical Specifications is FUNCTIONAL or has FUNCTIONALITY when it is capable of performing its functions as set forth in the current licensing basis (CLB). These CLB functions may include the capability to perform a necessary and related support function for an SSC controlled by Technical Specifications.

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 Functional Test (CFT)

A CFT shall be the injection of a simulated or actual signal into the channel as close to the sensor as practicable to verify the FUNCTIONALITY of required alarm, interlock, display, and trip functions. The CFT 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

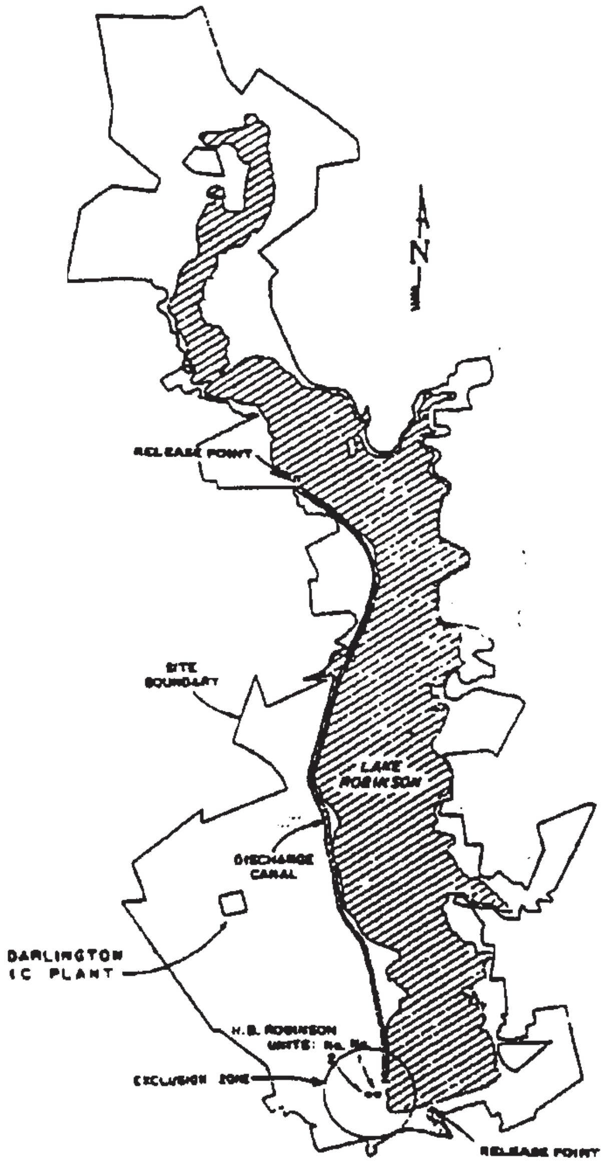
Member(s) of the public shall include all individuals who by virtue of their occupational status have no formal association with the plant. This category shall include non-employees of the licensee who are permitted to use portions of the site for recreational, occupational or other purposes not associated 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 a 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 a 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 non-functional to comply with COMPENSATORY MEASURES may be returned to service under administrative control solely to perform testing required to demonstrate its FUNCTIONALITY or the FUNCTIONALITY 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 FUNCTIONALITY.

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 non-functional 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 a 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.
C	At least once per 24 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 an "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 an "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 functional.

   2. The corrective action(s) taken to restore the affected radwaste treatment system to an functional 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 38 changes do not adversely impact the accuracy or reliability of effluent, dose, or setpoint calculations.

ODCM Revision 38 – Implementation Date: refer to Cover Page

Front Cover

Front cover RNP photo was updated removing the decommissioned Unit 1 plant.

ODCM Cover Page

ODCM Cover Page RNP photo was updated removing the decommissioned Unit 1 plant. Added "Designee" to Plant Manager and ORC Chairman signature line to align with AD-CP-ALL-0022, ODCM Revision Process.

Section 2 – Throughout

Replace the word "Operable" with "Functional" throughout. An attribute of an SSC that is not controlled by Technical Specifications. Change made per DRR 02162363 to allow changing in wording from Operational to Functional. Setpoint, compliance with 10CFR20 Appendix B, and compliance with 10CFR50 Appendix I methodologies are unchanged.

Table of Contents

Added "Figure 4-3 Radiological Sample Locations > 10 Miles" to LIST OF FIGURES. Changes made per DRR 02428425.

Section 3 – Throughout

Replace the word "Operable" with "Functional" throughout. An attribute of an SSC that is not controlled by Technical Specifications. Change made per DRR 02162363 to allow changing in wording from Operational to Functional. Setpoint, compliance with 10CFR20 Appendix B, and compliance with 10CFR50 Appendix I methodologies are unchanged.

Section 7.3 – Page 7-1

Replace the term "Operable" with "Functional" and definition. An attribute of an SSC that is not controlled by Technical Specifications. Change made per DRR 02162363 to allow changing in wording from Operational to Functional. Setpoint, compliance with 10CFR20 Appendix B, and compliance with 10CFR50 Appendix I methodologies are unchanged.

Section 2 – Page 2-17
Equation 2.5-2

Note added to equation 2.5-2 to state "Some Ait values for radionuclides not in Regulatory Guide 1.109 were developed using Equation 2.5-2, but with parameters as described in CSD-RP-ALL-0028." Change made per DRR 02221016. Setpoint, compliance with 10CFR20 Appendix B, and compliance with 10CFR50 Appendix I methodologies are unchanged.

Section 2 – Page 2-24
Table 2.5-1

Sb-124 and Sb-125 dose factors were updated per CSD-RP-ALL-0028 and a note was added below Table 2.5-1 to state "Some Ait values for radionuclides not in Regulatory Guide 1.109 were developed using Equation 2.5-2, but with parameters as described in CSD-RP-ALL-0028." Change made per DRR 02221016. Setpoint, compliance with 10CFR20 Appendix B, and compliance with 10CFR50 Appendix I methodologies are unchanged.

Section 3.9 – Page 3-70

Deleted section for determining methodology for R-22 setpoint determination for Iodine and Particulate Monitors. EC 415185 replaces R-22 Radiation Monitor. EC removes the Particulate and Iodine monitoring functions. Changes made per DRR 02295653, setpoint, compliance with 10CFR20 Appendix B, and compliance with 10CFR50 Appendix I methodologies are unchanged.

Section 4 – Page 4-25
Figure 4-2

Renamed Figure 4-2 to "RADIOLOGICAL SAMPLE LOCATIONS WITHIN 10 MILES" due to adding an additional map to include sample locations outside of 10 miles. Changes made per DRR 02428425, setpoint, compliance with 10CFR20 Appendix B, and compliance with 10CFR50 Appendix I methodologies are unchanged. Map (Ten Mile Radius) updated to show deletion of Sample Locations 7 and 83. Sample Type and Sample Locations columns below map were deleted since this is repetitive information and can be found in Table 4.5-1. Change made per DRR 02448739 and 02456632.

Section 4 – Page 4-26
Figure 4-3

Added Figure 4-3 to include locations outside of the 10-mile radius. Changes made per DRR 02428425, setpoint, compliance with 10CFR20 Appendix B, and compliance with 10CFR50 Appendix I methodologies are unchanged.

Section 4.5 – Page 4-16
Table 4.5-1

Deleted Airborne Particulates and Radioiodines Sample Points 2, 4, and 7 per DRR 02448739. The locations to be deleted are supplemental locations and does not negatively affect the efficacy of the radiological environmental monitoring program.

Section 4.5 – Page 4-17
Table 4.5-1

Direct Radiation Sample Point 2, Editorial change, replaced "CP&L" with "Duke Energy" to reflect accurate company name.

Section 4.5 – Page 4-22
Table 4.5-1

Deleted Broadleaf Sample Locations 51 (SSW), 62 (SE), 67 (S), and 83 (1.7 miles NNE). Added Sample Location 86 (NNE Close to Site Boundary) per DRR 02448739.

Section 4.5 – Page 4-23
Table 4.5-1 NOTATION

Updated Notation #9 to reflect sample points 86 and 50 are the highest and second highest D/Q values, respectively. Change made per DRR 02456632.

Section 4 – Page 4-24
Figure 4-1

Map of Near Site Locations (One Mile Radius) updated to show deletion of Sample Locations 2, 4 , 51, 62, 67 and the addition of Sample Location 86. Sample Type and Sample Locations columns below map were deleted since this is repetitive information and can be found in Table 4.5-1. Change made per DRR 02448739 and 02456632.

Section 8 – Page 8-4
Table 8.2-1

Added 24-month frequency to support certain surveillance requirements being extended to 24-month time intervals. Change made per DRR 02461520.

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:

$$P_{iI} = 3.7x10^9 * DFA_i \tag{B.1-2}$$

B.1.2 Ground Plane Pathway

The dose factor from ground plane pathway is calculated by:

$$P_{iG} = K' * K'' * DFG_i * \frac{1 - e^{-\lambda_i * t}}{\lambda_i} \tag{B.1-3}$$

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:

$$P_{iG} = 8.76x10^9 * DFG_i * \frac{1 - e^{-\lambda_i * t}}{\lambda_i} \tag{B.1-4}$$

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 Follownig 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:

$$R_{iG} = I_i * K' * K'' * S_F * DFG_i * \frac{1 - e^{-\lambda_i * t}}{\lambda_i} \qquad \text{(B.2-2)}$$

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:

$$R_{iM} = I_i * K' * Q_F * U_{ap} * F_m * (DFL_i)_a * e^{-\lambda_i * t_f} * \left[\left[f_p * f_s * \left(\frac{r * \left(1 - e^{-\lambda_{E_i} * t_e}\right)}{Y_p * \lambda_{E_i}} + \frac{B_{iV} * \left(1 - e^{-\lambda_i * t_b}\right)}{P * \lambda_i} \right) \right] + \left[\left(1 - f_p * f_s\right) * \left(\frac{r * \left(1 - e^{-\lambda_{E_i} * t_e}\right)}{Y_s * \lambda_{E_i}} + \frac{B_{iV} * \left(1 - e^{-\lambda_i * t_b}\right)}{P * \lambda_i} \right) * \left(e^{-\lambda_i * t_h}\right) \right] \right] \tag{B.2-3}$$

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 = $5.73x10^{-7}$, 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:

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

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:

$$R_{iB} = I_i * K' * Q_F * U_{ap} * F_f * (DFL_i)_a * e^{-\lambda_i * t_s} * \left[\left[f_p * f_s * \left(\frac{r * \left(1 - e^{-\lambda_{E_i} * t_e}\right)}{Y_p * \lambda_{E_i}} + \frac{B_{iV} * \left(1 - e^{-\lambda_i * t_b}\right)}{P * \lambda_i} \right) \right] + \left[\left(1 - f_p * f_s\right) * \left(\frac{r * \left(1 - e^{-\lambda_{E_i} * t_e}\right)}{Y_s * \lambda_{E_i}} + \frac{B_{iV} * \left(1 - e^{-\lambda_i * t_b}\right)}{P * \lambda_i} \right) * \left(e^{-\lambda_i * t_h}\right) \right] \right] \quad \text{(B.2-5)}$$

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:

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

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:

$$R_{T_V} = K' * K''' * \left(U_a^L * f_L + U_a^S * f_g\right) * (DFL_i)_a * 0.75 * \frac{0.5}{H} \tag{B.2-8}$$

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 x 10^8 (15 yr)	Table E-15
t_s (seconds)	1.73 x 10^6 (20 days)	Table E-15
t_h (seconds)	7.78 x 10^6 (90 days)	Table E-15
t_e (seconds)	2.59 x 10^6 (pasture)	Table E-15
	5.18 x 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

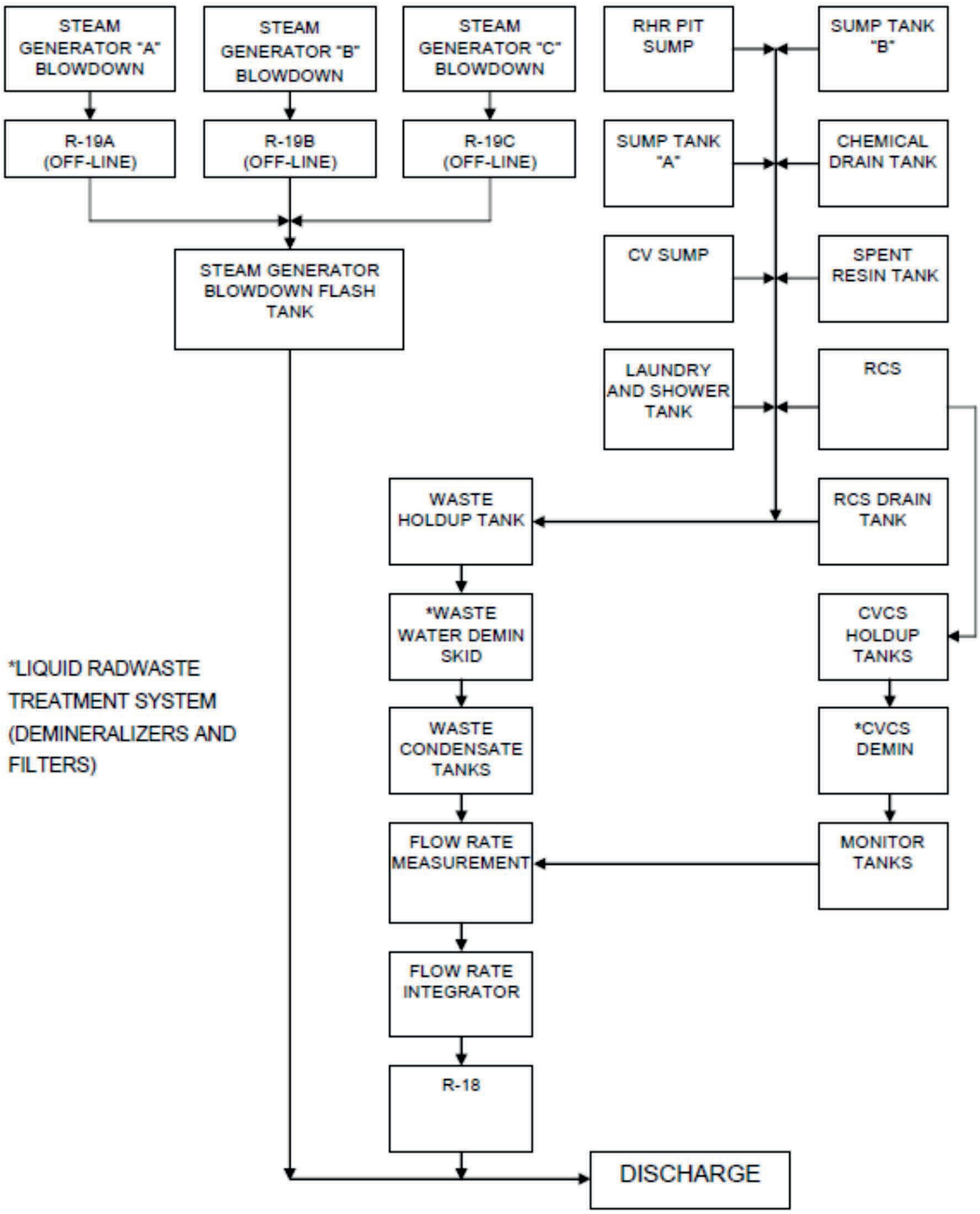
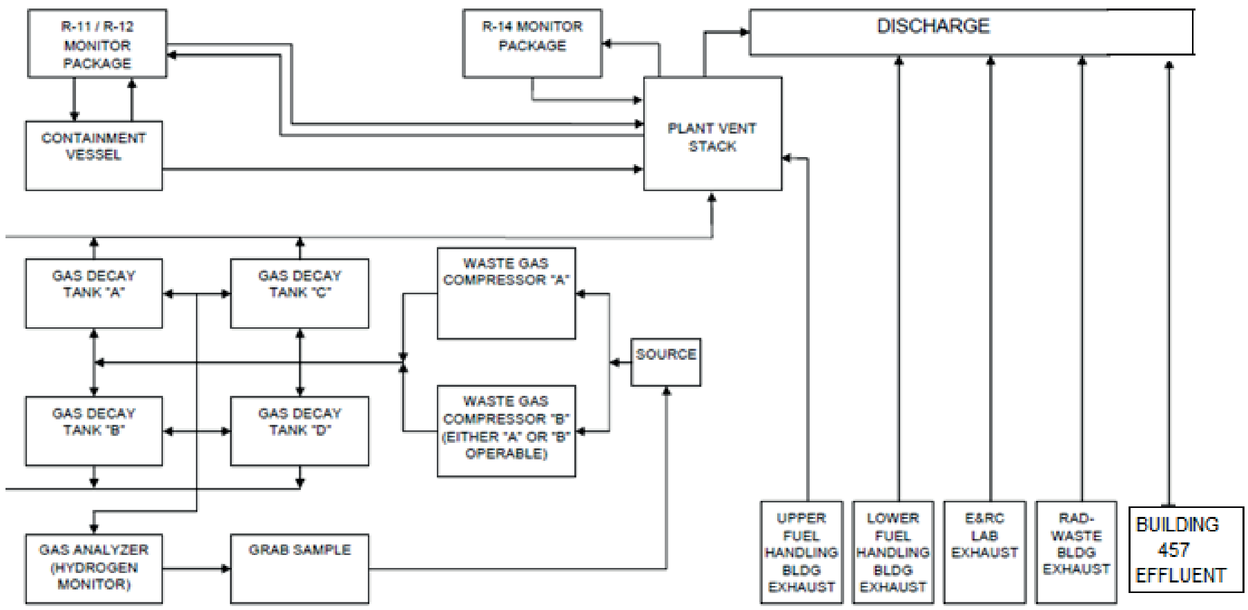


FIGURE D-2
*H.B. ROBINSON GASEOUS RADWASTE PROCESS / EFFLUENT SYSTEM



*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

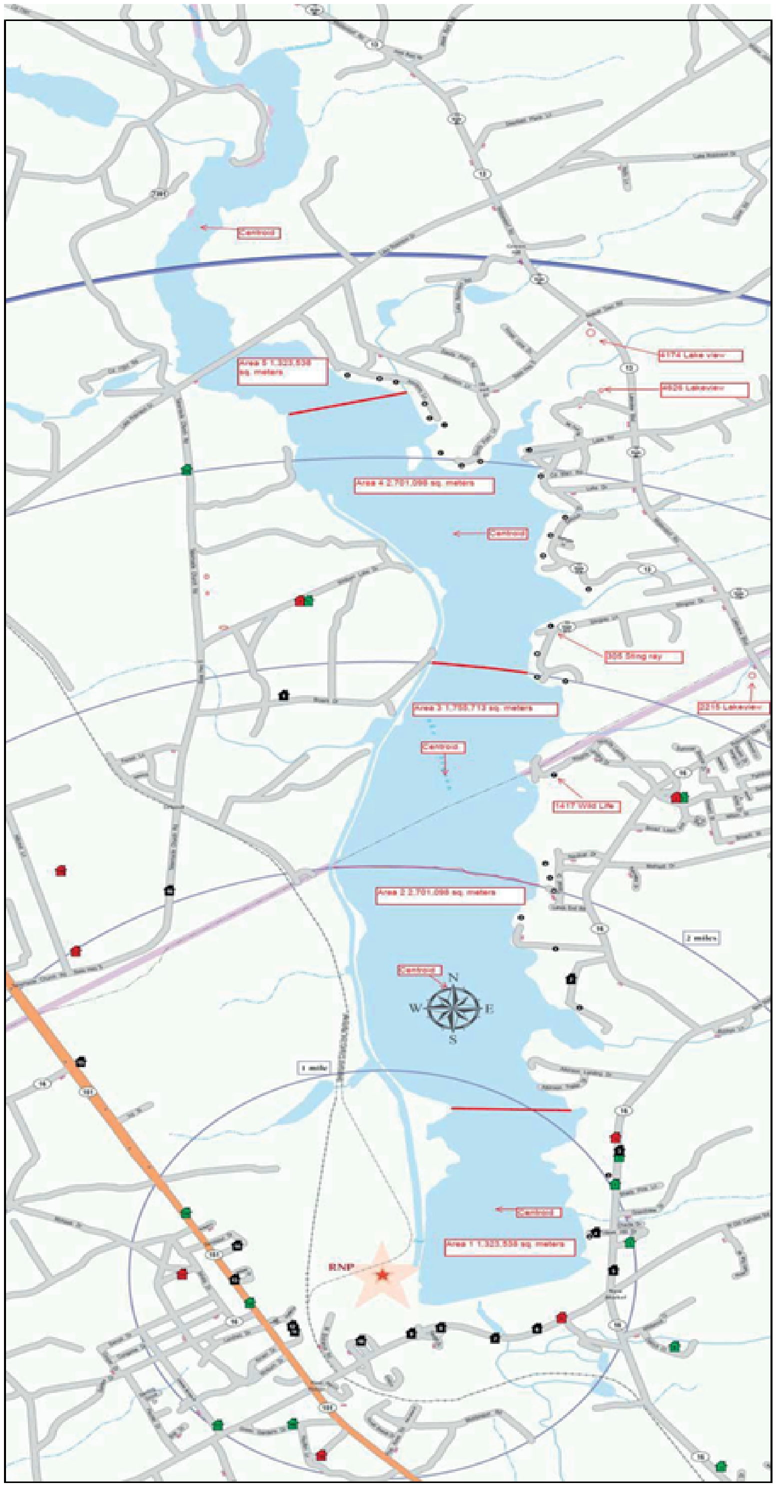


FIGURE E-1 (continued)
MAP OF THE FIVE SECTIONS OF LAKE ROBINSON

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 1/1/2023 - 12/31/2023

The H.B. Robinson Steam Electric Plant Unit 2 Process Control Program procedure ERC-015, was not revised during the year 2023.

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 1/1/2023 - 12/31/2023

No major modifications to liquid, gaseous, solid, or mobile radioactive waste treatment systems occurred at H.B. Robinson Steam Electric Plant in 2023.

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

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2023 - 12/31/2023

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